1949

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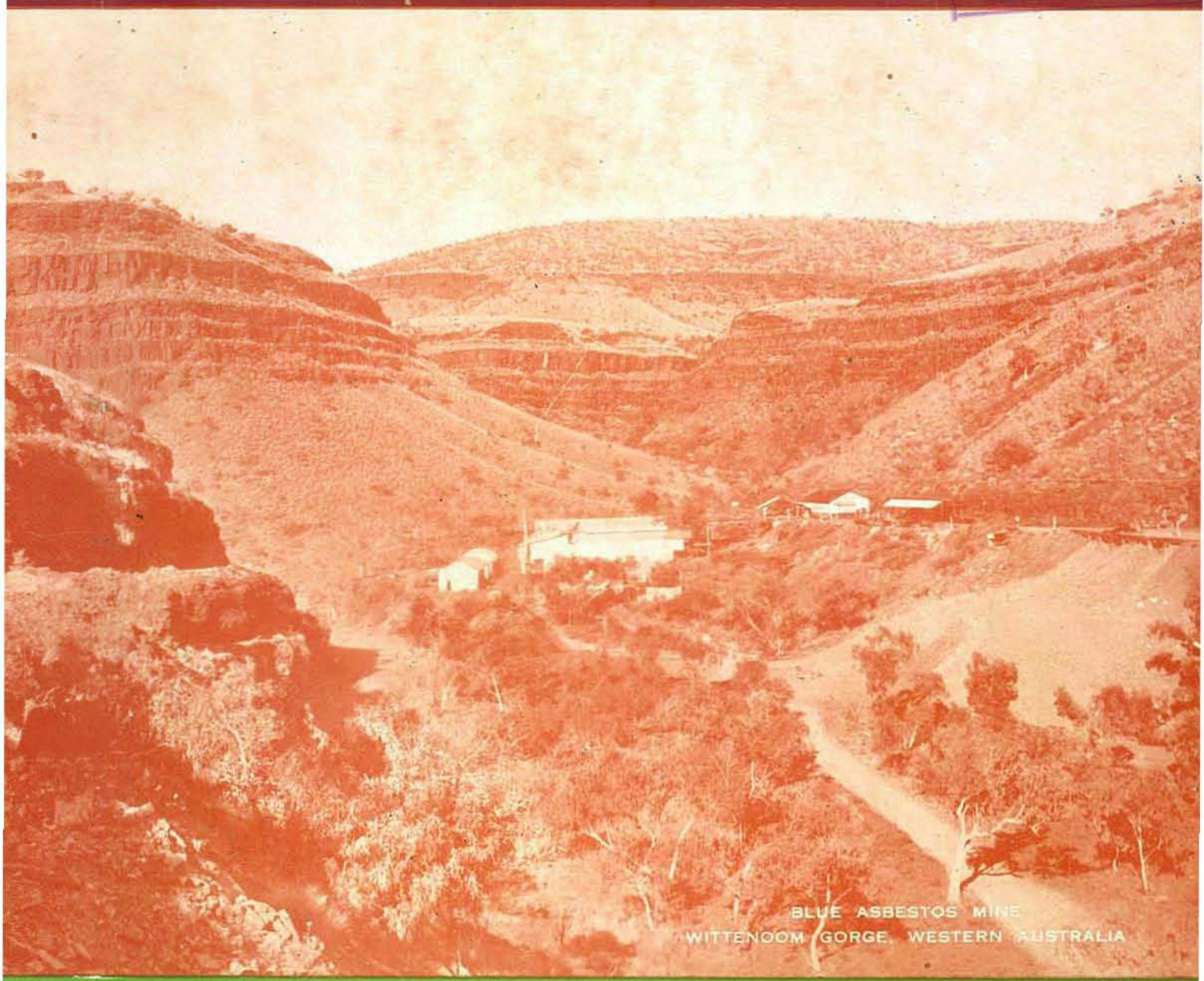
WESTERN AUSTRALIA



BLUE ASBESTOS MINE
WITTENOOM GORGE, WESTERN AUSTRALIA

Report of the

DEPARTMENT OF MINES

WESTERN AUSTRALIA

PRESENTED TO BOTH HOUSES OF PARLIAMENT BY HIS EXCELLENCY'S COMMAND

1951

—

WESTERN AUSTRALIA.

REPORT

of the

Department of Mines

FOR THE YEAR

1949

PERTH :

By Authority: WILLIAM H. WYATT, Government Printer, Perth

—

1951.

43927/4/51.

ANNUAL REPORT OF THE DEPARTMENT OF MINES, WESTERN AUSTRALIA, 1949.

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STATE OF WESTERN AUSTRALIA.

Report of the Department of Mines of the State of Western Australia for the Year 1949.

To the Hon. Minister for Mines.

Sir,—I have the honour to submit the Annual Report of the Department for the year 1949, together with reports from the officers controlling Sub-Departments, and comparative tables furnishing statistics relative to the Mining Industry.

Department of Mines,
Perth, 31st March, 1950.

I have, etc.,
A. H. TELFER,
Under Secretary for Mines.

Division I.

The Honourable Minister for Mines:

I have the honour to submit for your information, a report on the Mining Industry for the year 1949.

The estimated value of the mineral output of the State for the year was £4,420,827 (calculating gold at £4 4s. 11.45d. per fine ounce); an increase in value of £168,215 compared with the preceding 12 months, despite the new year institution of lower points of value for various minerals, i.e., free on rail in lieu of landed at factory etc., which was the first step taken towards the Australian-wide movement for standardisation of mineral statistics. The estimated value of the premium paid to gold producers amounted to £A5,208,473, bringing the gross value of all minerals up to £A9,269,300, an increase of £A1,044,457 compared with the 1948 production.

There were increases in quantities and values of abrasives silica stone, asbestos, clays, copper ore, cupreous ore (fertiliser), coal, diatomaceous earth, felspar, glass sand, ilmenite sand, iron ore, lead ores and concentrates magnesite, manganese, mica, petalite, silver, talc, and vermiculite, and decreases in quantities and values of alunite, antimony, arsenic, bentonite, beryl, dolomite, glauconite, kaolin, kyanite, pyrites, sillimanite, tantalite and tungsten. Cupreous ore (fertiliser), and tin, were produced in smaller quantities and realised greater values, but gypsum production, although higher, receded considerably in value owing to an adjustment in point of value which eliminated cost of railage to the factory.

The estimated value of gold received at the Perth Branch of the Royal Mint and exported in gold-bearing material was £A7,962,808 (and equalled 82.69 per cent. of all minerals). (See footnote to Table 1 (a), Part II.)

Other minerals realised: Coal, £972,245; lead ores and concentrates, £154,777; pyrites, £125,857; asbestos, £125,332; iron ore, £66,296; manganese, £56,289; silver, £49,246; alunite, £43,417; gypsum, £18,610; tin, £13,079; clays, £11,813; glauconite, £5,286; magnesite, £4,714; felspar, £3,934; cupreous ore (fertiliser), £2,821; talc, £2,375; beryl ore, £1,497; mica, £1,343; vermiculite, £987; arsenic, £982; antimony, £954; diatamaceous earth, £950; copper ore, £630; bentonite, £450; ochres, £366; tantalite, £286; ilmenite sand, £255; dolomite, £247; tungsten, £219; kaolin, £160; petalite, £52; and abrasive silica stone, £9.

Dividends paid by mining companies amounted to £843,782, an increase of £6,843 when compared with the previous year (see Table 6, Part II).

To the end of 1949, the total amount distributed by gold mining companies was £45,031,875.

To the same date the value of the mineral production amounted to £250,447,361, of which gold accounted for £224,501,434 based on normal values; but premiums on sale of gold during years 1920-1924, plus payments under the Gold Bounty Act, 1930, and further premiums by virtue of enhanced value, increase the total value of gold and mineral production by £81,292,049.

GOLD.

The quantity of gold reported as being received at the Perth Branch of the Royal Mint (644,252.48 fine oz.), together with that contained in bullion, concentrates and other gold-bearing materials exported for treatment (4,173.14 fine oz.), totalled 648,425.62 fine oz. and failed to equal that of 1948 by 16,560.17 fine oz. (*vide* Table 1 (a) of Part II).

Similarly, the total gold yield for the year reported directly to the department by the producers was 649,572.07 fine oz., which constituted a decrease of 13,168.75 fine oz. in comparison with the previous year's figures (*vide* Table 3 of Part II).

The non-collation of the two totals mentioned above is principally due to the fact that the gold reported as being received at the Mint and exported for treatment, is not all necessarily produced during the calendar year under review, a certain quantity being in the transitory or near transitory stage from the producer at the end of the year. For this reason, the former total is accepted as the official production of the State, whilst the latter is utilised mainly in tracing the gold back to its source, i.e., individual mine production to which a respective ore tonnage can be applied.

The calculated average value per ton of ore treated in the State as a whole showed a slight decrease from 23.004 shillings per ton in 1948 to 22.357 shillings per ton in 1949, calculating gold at the par rate of £4 4s. 11.45d. per fine oz., but the premium (which jumped from 153.37 to 264.70 per cent. on 19th September, 1949), would more than double this estimate in current Australian currency. For East Coolgardie Goldfield (which produced approximately 67.33 per cent. of the State's yield of gold), the calculated average value of the ore decreased very slightly from 22.793s. to 22.601s. per ton. The estimates for Murchison (Big Bell Mines Ltd. and Hill 50 Gold Mines N.L.), Mt. Margaret (Sons of Gwalia), and Dundas (Central Norseman Gold Corporation), were 14.216s. (15.739s.), 31.655s. (33.633s.), and 30.289s. (28.711s.) respectively. Figures for 1948 are shown in parenthesis.

The tonnage of ore reported to have been treated in 1949, viz., 2,468,297.20 tons, was 20,752 tons more than the previous year and formed 57.5 per cent. of the State record tonnage established in 1940.

The following tonnage increases were reported from the respective Goldfields:—West Pilbara (previously included in State generally), 297; Ashburton, 179; Yalgoo, 149; Mt. Margaret, 22,706; Broad Arrow, 882; North-East Coolgardie, 530; East Coolgardie, 21,865; Coolgardie, 16,732; Yilgarn, 4,611; Dundas, 15,462; and Phillips River, 226, whilst those fields in recession were Pilbara by 5,675, Peak Hill, 1,878, East Murchison, 8,564, Murchison, 45,704, and North Coolgardie, 1,066 tons.

The 20,000-ton increase by the North Kalgurli (1912) Ltd. was the principal factor in the higher tonnage reported from the East Coolgardie Goldfield, the smaller additional improvements shown by three other companies being offset by a slight decline in the output of the remaining five of the larger producing companies on the Golden Mile; reduction in the Murchison Goldfields figures was attributable to the loss of the Triton Gold Mine in the previous twelve months, as Big Bell Mines Ltd. maintained even production with slightly better results. Increased production by the Sons of Gwalia Ltd. and Central Norseman Gold Corporation was featured in the improvements of the Mt. Margaret and Dundas Goldfields respectively, whilst the New Coolgardie Gold Mines N.L. at Hampton Plains was entirely responsible for the favourable recovery of the Coolgardie Goldfield, despite the closure of the Phoenix Gold Mine during the previous year.

Apart from the figures for the West Pilbara Goldfield, which was proclaimed during the year, the usual drift of prospecting activities was reflected in slight variations from other Goldfields.

The year 1949 was notable for the devaluation of sterling in relation to the dollar, and such devaluation had the effect of raising the price of gold in Australian currency from £10 15s. 3d. to £15 9s. 10d. per fine oz. as from 19th September, 1949. This, of course, had an immediate tonic effect on the gold mining industry, particularly on many of the lower grade mines where the rising costs of production had equalled or almost equalled returns. The position was so acute with some of these latter mines, that they were receiving financial assistance from the Commonwealth Government to permit of the continuance of operations.

The new price of gold altered the position completely and not only restored the balance in regard to marginal producers but gave a fillip to the opening up of new properties. There were a number of the latter partly developed on which operations had been stopped or slowed down because of high costs. Work at full capacity on these has now been resumed, and providing sufficient labour and machinery is available, several should be in production this year.

Labour is very scarce on the goldfields today and this is one of the factors retarding the expansion of production. Every effort to overcome the position by bringing labour from England and Europe is being made, but it will be some time before the shortage is overtaken. Associated with the labour question is the matter of provision of housing for newcomers to the goldfields. While every assistance is given by the Housing Commission the erection of houses is a slow process because of the scarcity of materials and builders.

Plant and machinery are still difficult to obtain, and delivery dates are uncertain. Supplies of mining stores have, however, been more readily available.

Production costs have steadily risen, as is the case in every industry, but as earlier mentioned, the position in regard to gold mining has been tempered by the rise in price of gold.

Aluminium Therapy Treatment.

At the request of the State Government, Dr. Robson, Chief Medical Director of McIntyre Research Ltd. of Canada, visited Western Australia early in 1949 and examined the gold mining industry with a view to reporting to his institute in regard to the Government's request for permission to establish this treatment in Western Australia.

As a result of the visit, authority was given to use the patent, and it is anticipated that early 1950 will see it in operation.

MINERALS.

The post-war period has undoubtedly been notable for the record rate of consumption of major minerals and metals throughout the world, and in this State the active search for minerals to supply the markets offering continues to be maintained.

To a great extent the demand for minerals has arisen from the need to repair the ravages of a most destructive war, but there is also the factor that the present is a metal age. Mechanisation is taking place in all industries, and a higher standard of living has increased metal requirements. Simple illustrations occur in present-day homes where the refrigerator has replaced the wooden ice chest, or hessian water cooler, the electric cleaner and polisher has ousted the broom and brush, while the motor car is almost common to every household. In the non-metallic section, the housing programmes everywhere call for greater quantities of asbestos, bricks, cement, plaster and lime.

The present world shortage and the markets offering have of course encouraged the development of mineral deposits in all countries and as these come into production the present clamour for supplies must reduce, and prices recede somewhat. There should still remain, however, for a long time, a reasonably profitable market for minerals.

Steady progress during the year was made in the following mineral undertakings:—

(a) The blue asbestos project worked by Australian Blue Asbestos Ltd. in the Hamersley Ranges. The township named Wittenoom adjoining the ranges was established during the year, and the provision of housing is expected to ensure more permanent labour than in the past.

(b) The Cockatoo Island iron deposit worked by Australian Iron and Steel Ltd. The main requirement now is, it is understood, the necessary shipping to transport the ore to the smelters in the Eastern States. The company has experienced considerable delay in its shipbuilding programme.

(c) The lead mines in the Northampton and Ashburton mineral fields. Lead ores to the value of £154,777 were produced during the year and a number of mines are now established producers. The department has granted a considerable amount of financial assistance to many of the operators in order that they might take early advantage of the market offering.

(d) The Iron King Pyrite mine at Norseman operated by the Norseman Gold Mines N.L. The higher price received for pyrite and the steady demand has proved very beneficial to this project.

(e) The Horseshoe Manganese deposits. Production valued at £56,289 took place during 1949, and as the manganese demand in Australia and abroad is still considerable, this undertaking should experience another successful year in 1950.

COAL.

The year 1949 resulted in a record coal output of 750,594 tons value at £A972,245.

During the year a new Company, Western Collieries Ltd., was formed, and it expects to develop a deep coal mine and also an open-cut at Collie. The latter should be in production in 1951, but the former will of course take much longer.

The Department's deep drilling unit was received from Canada towards the end of the year, and all arrangements were in hand for it to be put into operation at the beginning of 1950 with a Canadian drilling crew. The drill will be used to ascertain actual bedrock of the Collie field.

MINING DEVELOPMENT ACT, 1902-1924.

The expenditure incurred in rendering assistance to mine owners and the industry generally under the provision of this Act totalled £38,454 7s. 1d.

PART II.—MINERALS.

TABLE 1.—*Quantity and Value of Minerals, other than Gold and Silver, produced and/or exported during Years* 1948 *and* 1949.

Description of Minerals.	1948.		1949.		Increase or Decrease for Year compared with 1948.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Tons.	£A.	Tons.	£A.	Tons.	£A.
Abrasive Silica Stone	Nil	Nil	1·50	9	+ 1·50	+ 9
Alunite (Crude Potash)	1,778·30	49,430	1,447·80	43,417	— 330·50	— 6,013
Antimony (Ore and Concentrates)	116·16	3,582	21·68	954	— 94·48	— 2,628
Arsenic	214·00	4,494	32·75	982	— 181·25	— 3,512
Asbestos (Anthophyllite)	284·24	4,173	Nil	Nil	— 284·24	— 4,173
Asbestos (Chrysotile)	71·31	5,591	141·27	8,504	+ 69·96	+ 2,913
Asbestos (Crocidolite)	607·30	27,997	1,155·87	116,828	+ 548·57	+ 88,831
Bentonite	268·75	806	150·00	450	— 118·75	— 356
Beryl Ore	34·85	2,034	20·45	1,497	— 14·40	— 537
Clays	4,858·50	4,113	10,047·00	11,813	+ 5,188·50	+ 7,700
Coal	732,938·42	880,236	750,594·06	972,245	+ 17,655·64	+ 92,009
Copper Ore	Nil	Nil	49·49	630	+ 49·49	+ 630
Cupreous Ore (Fertiliser)	258·65	2,204	253·98	2,821	— 4·67	+ 617
Diatomaceous Earth	Nil	Nil	540·00	950	+ 540·00	+ 950
Dolomite	107·25	536	49·50	247	— 57·75	— 289
Felspar	1,011·00	3,538	1,049·00	3,934	+ 38·00	+ 396
Glass Sand	516 90	644	986·15	1,014	+ 469·25	+ 370
Glauconite (recovered)	319·00	7,975	203·50	5,286	— 115·50	— 2,689
Gypsum	25,521·50	35,173	25,907·30	18,610	+ 385·80	— 16,563
Ilmenite Sand	Nil	Nil	71·95	255	+ 71·95	+ 255
Iron Ore	7,222·20	26,165	12,524·13	66,296	+ 5,301·93	+ 40,131
Kaolin	146·00	292	80·00	160	— 66·00	— 132
Kyanite	1,125·00	6,516	Nil	Nil	— 1,125·00	— 6,516
Lead Ores and Concentrates	2,191·55	114,269	2,922·13	154,777	+ 730·58	+ 40,508
Magnesite	961·82	3,176	2,033·76	4,714	+ 1,071·94	+ 1,538
Manganese Ore	1,644·85	10,442	9,420·31	56,289	+ 7,775·46	+ 45,847
	lb.		lb.		lb.	
Mica	Nil	Nil	1,253·75	1,343	+ 1,253·75	+ 1,343
	Tons.		Tons.		Tons.	
Ochres	566·37	6,791	44·15	366	— 522·22	— 6,425
Petalite	Nil	Nil	5·19	52	+ 5·19	+ 52
Pyrites Ore and Concentrates	37,499·00	164,203	31,299·00	125,857	— 6,200·00	— 38,346
Sillimanite	2·00	13	Nil	Nil	— 2·00	— 13
Talc	72·00	732	181·00	2,375	+ 109·00	+ 1,643
Tantalite (Tant./Col. Concentrates)	4·31	1,139	1·16	286	— 3·15	— 853
Tin Concentrates	36·99	12,985	34·66	13,079	— 2·33	+ 94
	lb.		lb.		lb.	
Tungsten (Scheelite Concentrates)	16,274·99	3,913	1,294·00	219	— 14,980·99	— 3,694
	Tons.		Tons.		Tons.	
Vermiculite	*96·00	*574	161·97	987	+ 65·97	+ 413
Total	....	*1,383,736	....	1,617,246	....	+ 333,510

TABLE 1 (a).—*Quantity and Value of Gold and Silver exported and minted during Years* 1948 *and* 1949.

	Fine ozs.	£A.	Fine ozs.	£A.	Fine ozs.	£A.
Gold (exported and minted)	664,985·79	‡7,156,909	648,425·62	‡7,962,808	+ 16,560·17	+ 805,899
Silver (exported and minted)	193,805·25	44,198	204,712·55	49,246	— 10,907·30	+ 5,048
Total	....	7,201,107	....	8,012,054	....	+ 810,947

* Adjusted figures. ‡ Included in the value of Gold shown are the following estimated premiums :— 1948, £A4,332,231 ; 1949, £A5,208,473.

TABLE 2.—*Value and Percentage of Mineral Exports in relation to the Value of Total Exports from Western Australia.*

Year.	Total Exports. †	Mineral Exports (exclusive of Coal).	Percentage.
	£	£	
1902	9,051,358	7,530,319	83·20
1903	10,324,732	8,727,060	84·53
1904	10,271,489	8,625,676	83·98
1905	9,871,019	7,731,954	78·33
1906	9,832,679	7,570,305	76·99
1907	9,904,860	7,544,992	76·17
1908	9,518,020	7,151,317	75·13
1909	8,860,494	5,906,673	66·66
1910	8,299,781	4,795,654	57·78
1911	10,606,863	7,171,638	67·61
1912	8,941,008	5,462,499	61·09
1913	9,128,607	4,608,188	50·48
1914	8,406,182	3,970,182	47·23
1915	6,291,934	2,969,502	47·19
1916	10,878,153	6,842,621	62·92
1917	9,323,229	5,022,694	53·87
1918	6,931,834	2,102,923	30·34
1919	14,279,240	6,236,585	43·67
1920	15,149,323	3,096,849	20·44
1921	10,331,405	1,373,810	13·30
1922	11,848,025	2,875,402	24·27
1923	11,999,500	3,259,476	27·16
1924	13,808,910	1,424,319	13·24
1925	13,642,852	173,126	1·27
1926	14,668,184	1,597,698	10·89
1927	15,805,120	472,041	2·99
1928	16,911,932	996,099	5·88
1929	16,660,742	1,802,709	10·82
1930	19,016,639	6,370,396	33·49
1931	14,266,650	4,333,421	30·37
1932	16,771,465	5,657,870	33·74
1933	18,098,214	5,328,869	29·44
1934	16,784,705	5,759,324	34·31
1935	17,611,547	5,698,721	32·36
1936	19,564,716	7,130,381	36·45
1937	21,594,942	9,026,313	41·80
1938	24,220,864	10,417,458	43·01
1939	23,244,509	11,969,562	51·49
1940	25,800,562	12,480,721	48·37
1941	24,536,777	12,411,316	50·58
1942	20,681,284	8,476,622	40·99
1943	18,014,340	6,539,295	36·30
1944	19,453,001	(a) 1,282,867	6·59
1945	20,170,624	(b) 205,587	1·02
1946	26,342,125	(b) 211,890	0·80
1947	42,147,241	(c) 4,163,991	9.98
1948	*57,779,996	(b) 342,646	0·59
1949	58,197,775	(b) 465,124	0·80
Total since 1902	815,845,451	245,314,685	30·07

Exclusive of Arsenic prior to 1935. * Amended figure. † Including Ship's Stores. (a) Approximately 25 per cent. of gold production for year exported. (b) No gold bullion exported. (c) Approximately 51 per cent. of gold production for year exported.

Comparative Statistical Diagrams

showing:

OUTPUT AND VALUE OF GOLD AND OTHER MINERALS, LANDS LEASED FOR GOLD MINING IN WESTERN AUSTRALIA

and the

GOLD PRODUCTION OF AUSTRALASIA FOR THE YEAR 1949

Fig. 1 Output of Gold from various Goldfields as reported to Mines Dept.

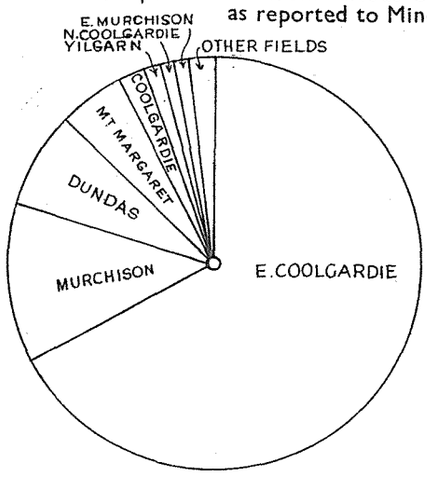


Fig. 2 Gold produced from various Goldfields as given by the Export and Mint Returns

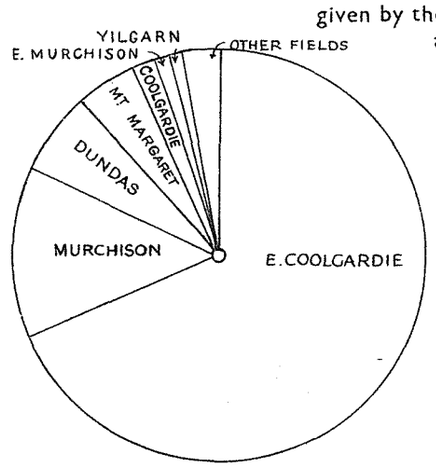


Fig. 3 Value of Gold and other Minerals

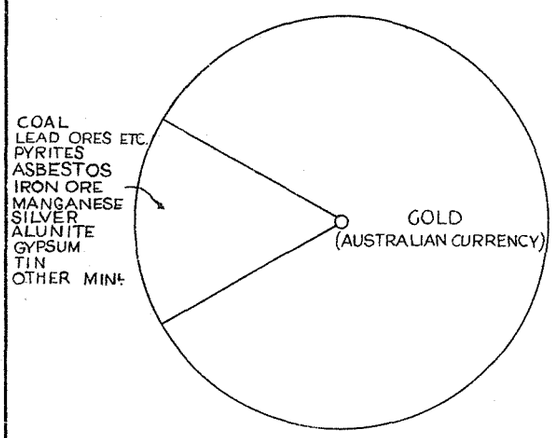


Fig. 4 Value of Minerals other than Gold

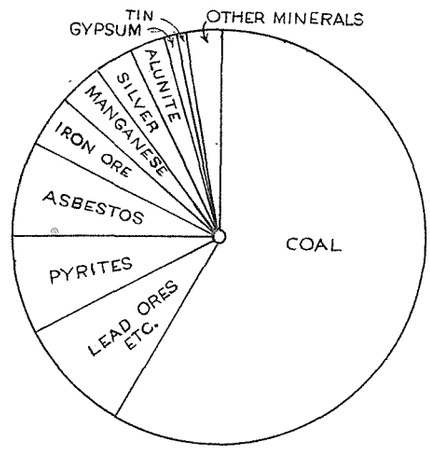


Fig. 5 Areas of land leased for Goldmining on various Goldfields

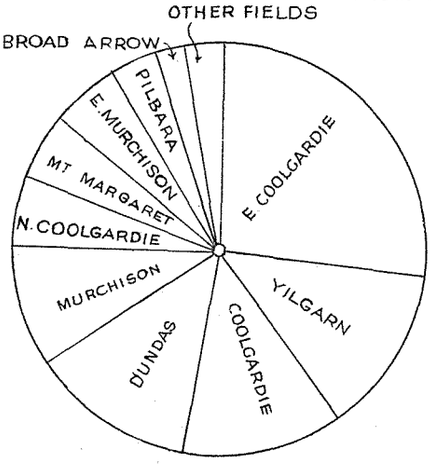


Fig. 6 Output of Gold in the States of Australia and the Dominion of New Zealand

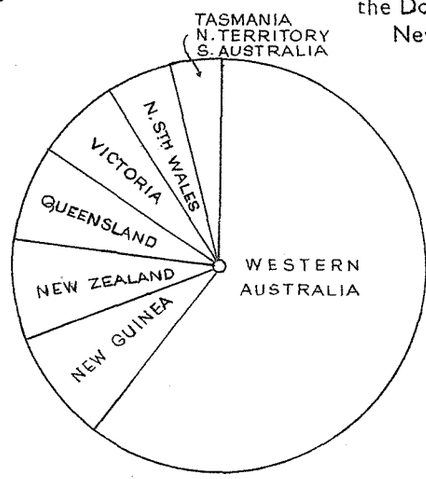


DIAGRAM OF GOLD OUTPUT

Showing Tonnage Treated (as reported to Mines Dept.); the Total Output of Gold Bullion, Concentrates etc., entered for export and received at the Perth Mint, and the Estimated Value thereof, in Australian Currency.

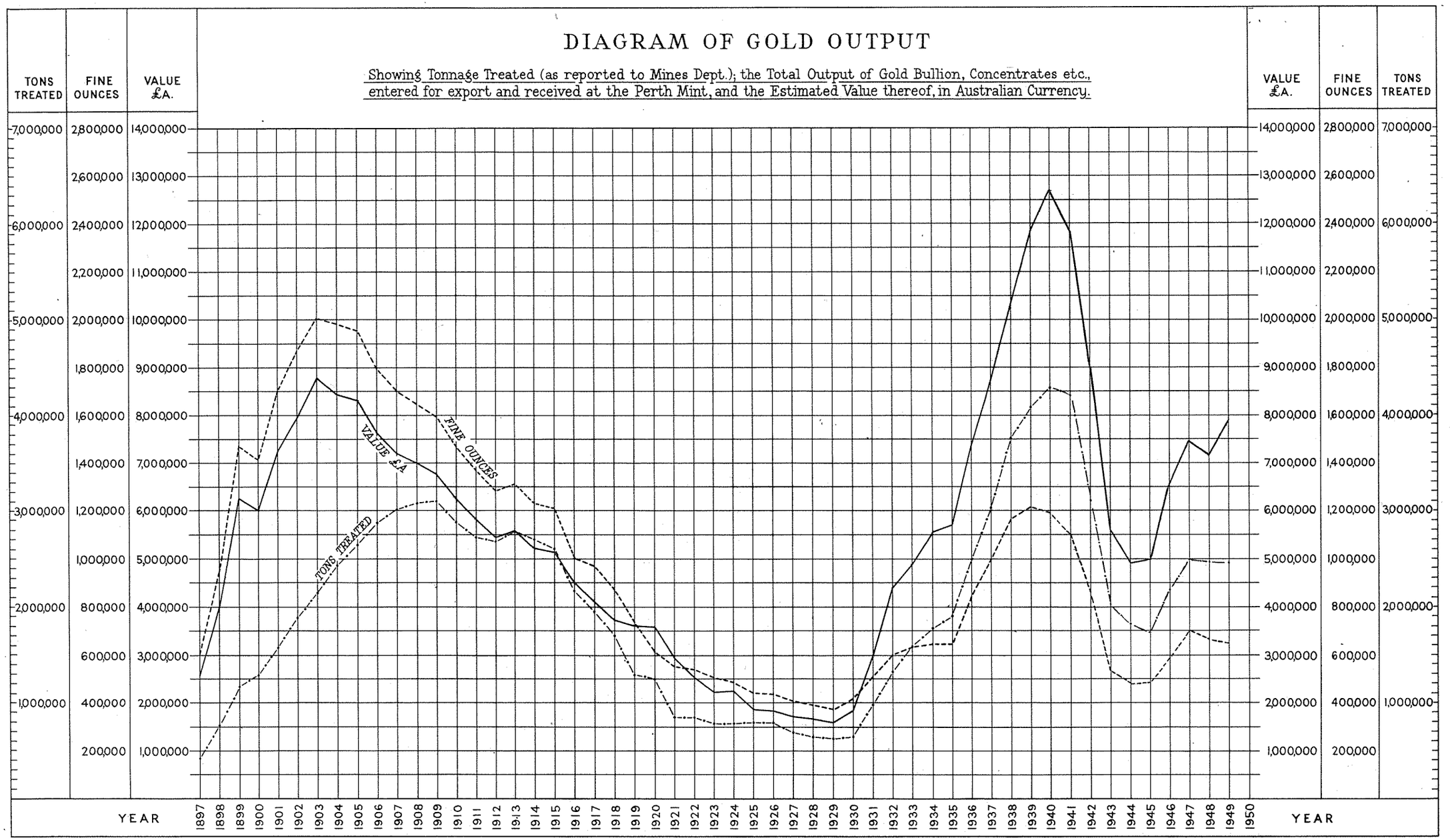


TABLE 3.

Showing for every Goldfield the amount of Gold reported to the Mines Department as required by the Regulations; also the percentage for the several Goldfields of the total reported, and the average value of the yield of Gold per ton of ore treated.

Goldfield.	Reported Yield.		Percentage for each Goldfield.		Average Value per ton of Ore Treated. (Gold at £4 4s. 11·45d. per fine oz.).	
	1948.	1949.	1948.	1949.	1948.	1949.
	Fine ozs.	Fine ozs.	%	%	Shillings.	Shillings.
1. Kimberley	496*	269*	·075	·041	....	....
2. West Kimberley	....	....	....	....	....	....
3. Pilbara	8,529	5,712	1·287	·879	64·851	88·261
4. West Pilbara‡	84	94	·013	·014	26·827	14·185
5. Ashburton	42	70	·006	·011	19·668	16·519
6. Gascoyne	....	....	....	....	....	....
7. Peak Hill	960	585	·145	·090	26·794	42·623
8. East Murchison	17,910†	6,546†	2·703	1·008	....	....
9. Murchison	99,081	81,844	14·950	12·600	15·739	14·216
10. Yalgoo	1,564	793	·236	·122	81·911	38·040
11. Mt. Margaret	26,940	33,816	4·065	5·206	33·633	31·655
12. North Coolgardie	6,116	7,049	·923	1·085	81·007	111·996
13. Broad Arrow	3,687	4,287	·556	·660	67·420	72·334
14. North East Coolgardie	908	510	·137	·078	97·522	32·799
15. East Coolgardie	435,257	437,405	65·675	67·337	22·793	22·601
16. Coolgardie	8,973	13,664	1·354	2·104	31·077	28·134
17. Yilgarn	12,077	8,287	1·822	1·276	27·333	16·703
18. Dundas	40,074	48,600	6·047	7·482	28·171	30·289
19. Phillips River	14	30	·002	·005	14·634	8·276
20. Outside Proclaimed Goldfields	29*	11*	·004	·002	....	....
Totals and Averages	662,741	649,572	100·000	100·000	23·004	22·357

* Alluvial and/or dollied. † Over 50 per cent. from sands retreatment. ‡ Previously included in Outside Proclaimed Goldfields.

The total yield of the State is as shown in Table 1 (a), being the amount of the gold received at the Royal Mint, gold exported in bullion and concentrates, and alluvial and other gold not reported to the Mines Department.

When comparisons are made as to the yield from any particular Field with the preceding year, the figures reported to the Department are used.

TABLE 4.

Average Quantities of Gold Ore raised and treated, and Gold produced therefrom, per man employed on the several Goldfields of the State, during 1948 *and* 1949.

Goldfield.	1948.				1949.			
	Tons of Gold Ore raised and treated.		Fine ounces of Gold produced therefrom.		Tons of Gold Ore raised and treated.		Fine ounces of Gold produced therefrom.	
	Per man employed under ground.	Per man employed above and under ground.	Per man employed under ground.	Per man employed above and under ground.	Per man employed under ground.	Per man employed above and under ground.	Per man employed under ground.	Per man employed above and under ground.
	Tons.	Tons.	Fine ozs.	Fine ozs.	Tons.	Tons.	Fine ozs.	Fine ozs.
1. Kimberley	....	....	124·00	35·43	....	....	89·67	26·90
2. West Kimberley	....	....	....	....	....	....	....	....
3. Pilbara	161·93	83·38	123·61	63·65	98·15	53·90	102·00	56·00
4. West Pilbara	44·33	26·60	16·08	8·45	140·70	56·30	23·50	9·40
5. Ashburton	90·50	45·25	21·00	10·50	180·00	90·00	35·00	17·50
6. Gascoyne	....	....	....	....	....	....	....	....
7. Peak Hill	138·36	63·42	43·64	20·00	72·87	30·68	36·56	15·39
8. East Murchison	206·67	64·37	314·21	97·87	76·57	24·00	155·86	48·85
9. Murchison	1,065·37	553·07	197·37	102·46	1,257·36	627·07	210·40	104·93
10. Yalgoo	85·37	45·06	82·32	43·44	147·58	70·84	66·08	31·72
11. Mt. Margaret	324·04	146·66	128·29	58·06	381·32	189·47	142·08	70·60
12. North Coolgardie	48·59	21·97	46·33	19·73	46·50	19·80	61·30	25·09
13. Broad Arrow	52·57	23·87	46·67	20·37	62·94	28·77	53·59	23·68
14. North East Coolgardie	32·96	16·14	37·83	15·65	62·90	30·02	24·29	10·41
15. East Coolgardie	805·49	443·00	216·12	118·34	824·95	448·36	219·47	118·76
16. Coolgardie	181·70	86·67	66·47	31·71	251·59	122·44	83·32	40·55
17. Yilgarn	226·13	113·75	72·75	36·60	366·51	189·86	72·06	37·33
18. Dundas	382·43	259·33	126·82	86·00	474·95	298·93	169·34	106·58
19. Phillips River	16·40	6·83	2·80	1·17	102·67	34·22	10·00	3·33
20. Outside Proclaimed Goldfields	....	....	....	....	....	....	....	....
Total Averages	650·60	343·37	176·17	92·33	697·26	365·02	183·49	95·53

TABLE 5.

Output of Gold from the several States of Australia, the Northern Territory, Papua, the Mandated Territory of New Guinea, and the Dominion of New Zealand, during 1949.

State.	Output of Gold.	*Value.	Percentage of Total.	
			Output of Commonwealth.	Output of Australasia.
	Fine ozs.	£		
1. Western Australia	648,426	2,754,335	65.710	60.507
2. Victoria	68,426	290,655	6.934	6.385
3. New South Wales	56,075	238,192	5.683	5.233
4. Queensland	76,282	324,025	7.730	7.118
5. Tasmania	12,152	51,618	1.231	1.134
6. South Australia	2,198	9,337	.223	.205
7. Papua	414	1,759	.042	.039
8. Northern Territory	29,781	126,502	3.018	2.779
9. Mandated Territory of New Guinea	93,045	395,230	9.429	8.682
10. New Zealand	84,856	360,445	....	7.918
	1,071,655	4,552,098	100.000	100.000

* Exclusive of Premium.

TABLE 6.

Dividends, etc., paid by Western Australian Mining Companies during 1949, *and the Total to date.*

Mainly compiled from information supplied to the Government Statistician's Office by the Chamber of Mines of Western Australia.

Goldfield.	Name of Company.	Dividends Paid.	
		1949.	Grand Total to end of 1949.
		£	£
Pilbara	Various Companies	....	26,513
Peak Hill	do. do.	....	199,305
East Murchison	do. do.	....	1,914,053
Murchison	Mountain View Gold, No Liability	50,000	50,000
	Hill 50 Gold Mine, No Liability	9,375	240,626
	Various Companies	....	2,714,945
Mt. Margaret	do. do.	....	2,972,399
North Coolgardie	do. do.	....	712,551
Broad Arrow	do. do.	....	92,500
North-East Coolgardie	do. do.	....	129,493
East Coolgardie	Boulder Perseverance, Ltd.	28,103	2,551,270
	Golden Horseshoe (New), Ltd.	11,459	4,055,836
	Gold Mines of Kalgoorlie, Ltd.	76,844	548,469
	Great Boulder Proprietary G.M's., Ltd.	39,063	7,121,900
	Kalgoorlie Enterprise Mines, Ltd.	5,500	281,875
	Lake View & Star, Ltd.	350,000	4,774,500
	North Kalgurli (1912), Ltd.	103,025	1,264,999
	South Kalgurli Consolidated, Ltd.	7,813	1,152,064
	Various Companies	....	11,068,089
Coolgardie	do. do.	....	388,770
Yilgarn	do. do.	....	1,205,556
Dundas	Central Norseman Gold Corporation, No Liability	162,500	780,000
	Various Companies	....	786,162
	Totals	843,782	45,031,875

TABLE 7.

Quantity and Value of Minerals, other than Gold and Silver, reported to the Mines Department during 1949.

Goldfield, District or Mineral Field.	1949.		Increase or Decrease as compared with 1948.	
	Quantity.	Value.	Quantity.	Value.
	Tons.	£A.	Tons.	£A.
ABRASIVE SILICA STONE—				
Murchison (Mount Magnet)	1.50	9	+ 1.50	+ 9
ALUNITE (Crude Potash)—				
Yilgarn	1,447.80	43,417	— 330.50	— 6,013
ANTIMONY ORE AND CONCENTRATES—				
Pilbara (Nullagine)	21.68	954	— 94.48	— 2,628
ARSENIC—				
East Murchison (Wiluna)	32.75	982	— 181.25	— 3,512
ASBESTOS (Anthophyllite)—				
Outside Proclaimed Goldfield	....	....	— 284.24	— 4,173
ASBESTOS (Chrysotile)—				
West Pilbara	141.27	8,504	+ 69.96	+ 2913
ASBESTOS (Crocidolite)—				
West Pilbara	1,155.87	116,828	+ 548.57	+ 88,831
BENTONITE—				
Outside Proclaimed Goldfield	150.00	450	— 118.75	— 356
BERYL ORE—				
West Kimberley	3.50	297	+ 3.50	+ 297
Pilbara	....	....	— 30.17	— 1,767
Coolgardie	....	....	— 4.68	— 267
Outside Proclaimed Goldfield	16.95	1,200	+ 16.95	+ 1,200
CLAYS—				
Outside Proclaimed Goldfield	10,047.00	11,813	+ 5,188.50	+ 7,700
COAL—				
Collie	750,594.06	972,245	+ 17,655.74	+ 92,009
COPPER ORE—				
Ashburton	1.30	13	+ 1.30	+ 13
Peak Hill	8.19	498	+ 8.19	+ 498
Phillips River	40.00	119	+ 40.00	+ 119
CUPREOUS ORE (Fertiliser)—				
West Pilbara	133.98	1,844	+ 133.98	+ 1,844
Peak Hill	113.00	929	— 145.65	— 1,275
Yalgoo	7.00	48	+ 7.00	+ 48
DIATOMACEOUS EARTH—				
Outside Proclaimed Goldfield	540.00	950	+ 540.00	+ 950
DOLOMITE—				
Murchison (Mt. Magnet)	49.50	247	— 57.75	— 289
FELSPAR—				
Coolgardie	1,049.00	3,934	+ 38.00	+ 369
GLASS SAND—				
Outside Proclaimed Goldfield	986.15	1,014	+ 469.25	+ 370
GLAUCONITE (recovered)				
Outside Proclaimed Goldfield	203.50	5,286	— 115.50	— 2689
GYPSUM—				
Yilgarn	15,962.00	11,181	+ 92.00	— 13,346
Dundas	10.00	6	+ 10.00	+ 6
Outside Proclaimed Goldfield	9,935.30	7,423	+ 283.80	— 3,223
ILMENITE SAND—				
Outside Proclaimed Goldfield	71.95	255	+ 71.95	+ 255
IRON ORE—				
Outside Proclaimed Goldfield	12,524.13	66,296	+ 5,301.93	+ 40,131
KAOLIN—				
Outside Proclaimed Goldfield	80.00	160	— 66.00	— 132
KYANITE—				
Outside Proclaimed Goldfield	....	....	— 1,125.00	— 6,516

TABLE 7—*continued.*

Quantity and Value of Minerals, other than Gold and Silver, reported to the Mines Department during 1949—*continued.*

Goldfield, District or Mineral Field.	1949.		Increase or Decrease as compared with 1948.	
	Quantity.	Value.	Quantity.	Value.
	Tons.	£A.	Tons.	£A.
LEAD ORES AND CONCENTRATES—				
Northampton	1,910.40	103,609	+ 565.21	+ 11,117
Ashburton	719.92	37,349	+ 593.16	+ 30,190
Pilbara	235.15	11,424	+ 235.15	+ 11,424
Kimberley	2.46	161	— 1.61	— 36
West Pilbara	15.32	457	+ 13.25	+ 394
Peak Hill	5.50	295	+ 5.50	+ 295
West Kimberley	33.38	1,482	— 680.08	— 12,876
MAGNESITE—				
East Coolgardie (Bulong)	26.71	74	+ 26.71	+ 74
Coolgardie	21.00	57	— 445.75	— 1,634
Outside Proclaimed Goldfield	1,986.05	4,583	+ 1,490.98	+ 3,098
MANGANESE ORE—				
Peak Hill	9,420.31	56,289	+ 7,820.31	+ 46,139
Mt. Margaret	....	....	— 20.00	— 180
Outside Proclaimed Goldfield	....	....	— 24.85	— 112
	lb.		lb.	
MICA—				
West Kimberley	31.25	4	+ 31.25	+ 4
Outside Proclaimed Goldfield	1,222.50	1,339	+ 1,222.50	+ 1,339
	Tons.		Tons.	
OCHRES—				
West Pilbara	15.60	225	— 373.82	— 4,071
Murchison (Cue)	7.55	38	— 169.40	— 2,457
Yalgoo	11.00	66	+ 11.00	+ 66
East Coolgardie	10.00	37	+ 10.00	+ 37
PETALITE—				
Coolgardie	5.19	52	+ 5.19	+ 52
PYRITES ORE AND CONCENTRATES—				
Dundas	31,299.00	125,857	— 6,200.00	— 38,346
SILLIMANITE—				
Outside Proclaimed Goldfield	....	....	— 2.00	— 13
TALC—				
East Coolgardie	....	....	— 72.00	— 732
Outside Proclaimed Goldfield	181.00	2,375	+ 181.00	+ 2375
TANTALITE—				
Pilbara	....	....	— .53	— 166
Greenbushes	1.16	286	— 2.62	— 687
TIN CONCENTRATES—				
Pilbara	31.52	11,980	— 3.47	— 409
Greenbushes	3.14	1,099	+ 1.14	+ 503
	lb.		lb.	
TUNGSTEN (Scheelite Concentrates)—				
Coolgardie	1,294.00	219	+ 371.00	+ 23
Yilgarn	....	....	— 15,351.99	— 3,717
	Tons.		Tons.	
VERMICULITE—				
East Coolgardie (Bulong)	23.22	155	+ 18.22	+ 127
Outside Proclaimed Goldfield	138.75	832	+ 47.75	+ 286

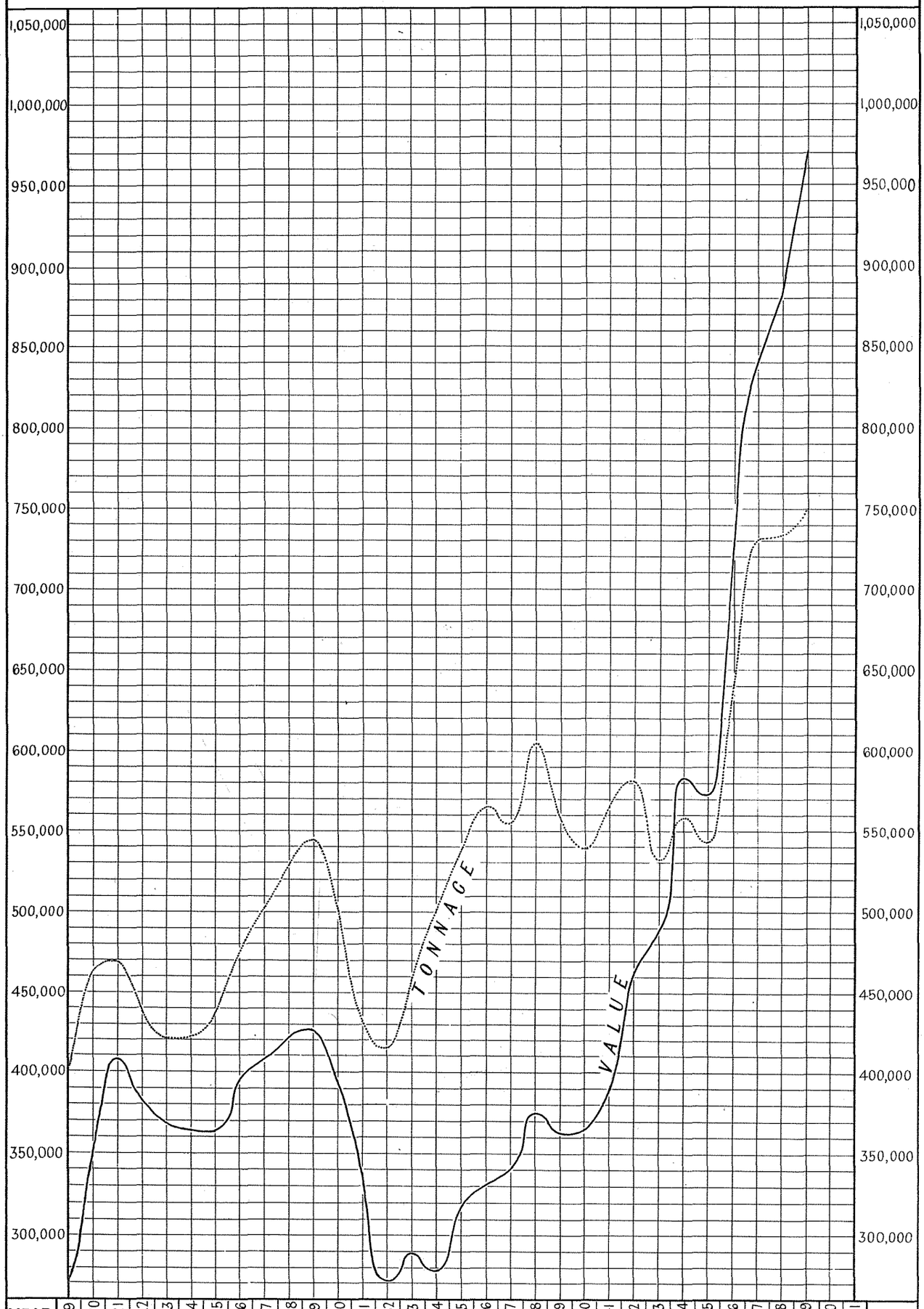
TABLE 8.

Total Coal output from Collie Coalfield during 1948 *and* 1949, *estimated Value thereof, Number of Men employed, and Output per Man.*

Year.	Total. Output.	Estimated Value.	Men Employed.			Output per Man Employed.		
			Above ground.	Under ground.	Above and under ground.	Above ground.	Under ground.	Above and under ground.
Deep Mining—	Tons.	£				Tons.	Tons.	Tons.
1948	586,990	706,940	216	768	984	2,718	764	597
1949	543,944	711,342	216	716	932	2,518	760	584
Open-Cut Mining—								
1948	145,948	173,295	80	....	80	1,824	....	1,824
1949	206,650	260,903	112	....	112	1,845	....	1,845
Totals—								
1948	732,938	880,235	296	768	1,064	2,476	954	689
1949	750,594	972,245	328	716	1,044	2,288	1,048	719

GRAPH OF COAL OUTPUT

Showing Quantities and Values as reported to Mines Dept.



YEAR	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	YEAR
£A VALUE	270355	350346	407117	381555	368949	363255	363203	394400	407967	420145	426706	394758	336178	270630	289806	278704	318013	331565	340444	375083	362811	364500	389278	461495	489721	583075	572896	730104	840249	880236	972245			£A VALUE
TONS	401713	462021	468817	438443	420714	421864	437461	474819	501505	528420	544719	501425	432400	415719	458399	500343	537188	565075	553510	604793	557535	539427	556574	581176	531546	558322	543363	642787	730506	732938	750594			TONS

PART III.—LEASES AND OTHER HOLDINGS UNDER THE VARIOUS ACTS RELATING TO MINING.

TABLE 9.

Total Number and Acreage of Lease, Mineral Claims and Prospecting Areas held for Mining on the 31st December, 1948 and 1949.

Leases and Other Holdings.	1948.		1949.	
	No.	Acreage.	No.	Acreage.
Gold Mining Leases on Crown Lands	1,379	23,857	**1,380**	**24,745**
Gold Mining Leases on Private Property	15	360	**10**	**240**
Mineral Leases on Crown Lands	179	33,122	**210**	**36,258**
Mineral Claims	207	12,673	**263**	**16,448**
Prospecting Areas	†687	17,724	**‡1,079**	**18,690**
Totals	2,467	87,736	**2,942**	**96,381**

† Includes 92 Prospecting Areas for Minerals of a total of 2,169 Acres.
‡ Includes 73 Prospecting Areas for Minerals of a total of 5,630 Acres.

PART IV.—MEN EMPLOYED.

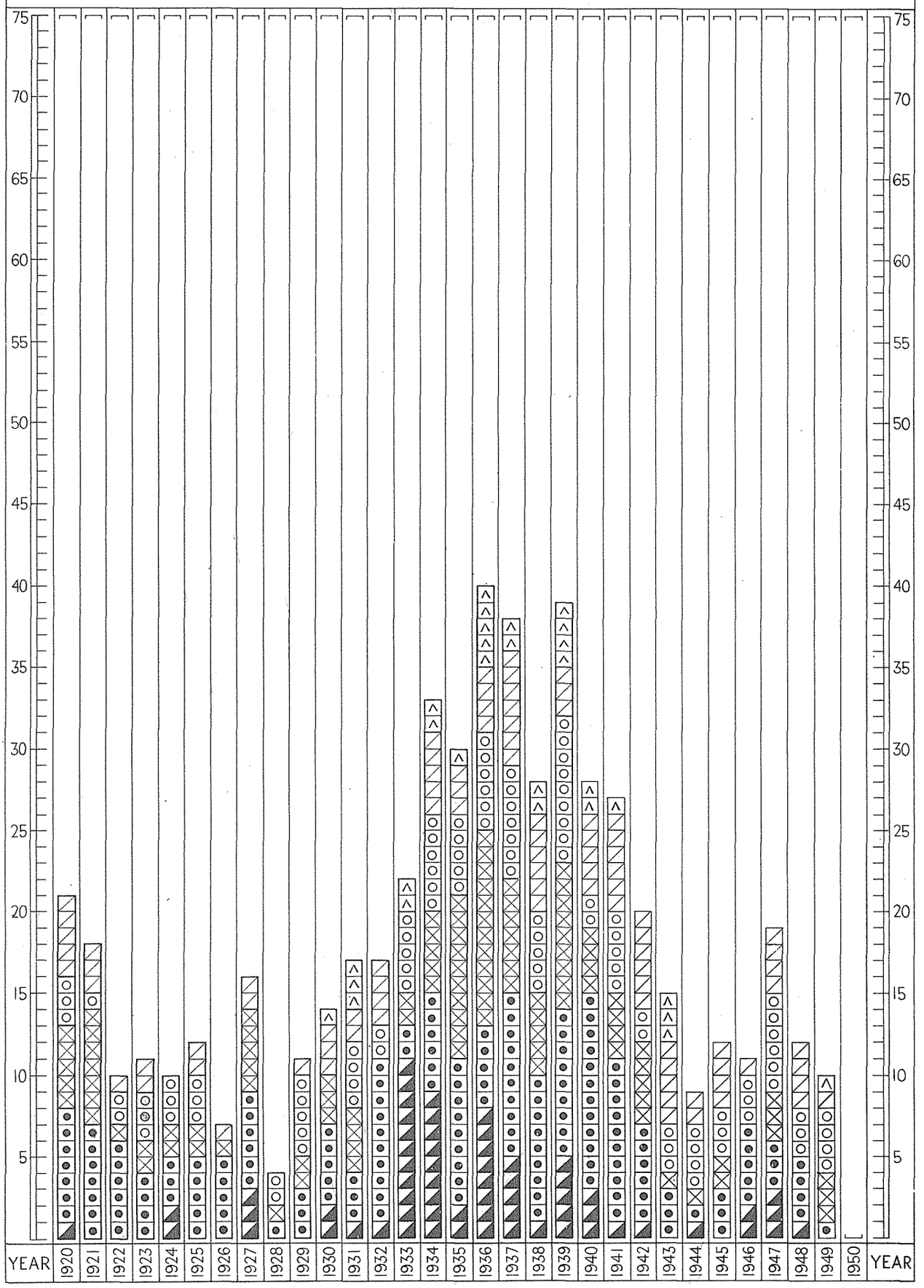
TABLE 10.

Average number of Men reported as engaged in Mining during 1948 *and* 1949.

Goldfield.	District.	Reef or Lode.		Alluvial.		Total.	
		1948.	1949.	1948.	1949.	1948.	1949.
Kimberley	....	14	10	....	....	14	10
West Kimberley	....	....	....	....	....	....	....
Pilbara	Marble Bar	62	52	....	....	62	52
	Nullagine	72	50	....	....	72	50
West Pilbara	....	10	10	....	....	10	10
Ashburton	....	4	4	....	....	4	4
Gascoyne	....	....	....	....	....	....	....
Peak Hill	....	48	38	....	....	48	38
East Murchison	Lawlers	40	25	....	....	40	25
	Wiluna	109	84	....	....	109	84
	Black Range	34	25	....	....	34	25
Murchison	Cue	645	498	....	....	645	498
	Meekatharra	116	69	....	....	116	69
	Day Dawn	42	44	....	....	42	44
	Mt. Magnet	164	169	....	....	164	169
Yalgoo	....	36	25	....	....	36	25
Mt. Margaret	Mt. Morgans	106	88	....	....	106	88
	Mt. Malcolm	267	302	....	....	267	302
	Mt. Margaret	91	89	....	....	91	89
North Coolgardie	Menzies	114	117	7	5	121	122
	Ularring	70	56	5	4	75	60
	Niagara	32	26	....	....	32	26
	Yerilla	76	71	6	2	82	73
Broad Arrow	....	174	175	7	6	181	181
North-East Coolgardie	Kanowna	38	33	4	3	42	36
	Kurnalpi	11	11	5	2	16	13
East Coolgardie	East Coolgardie	3,632	3,640	10	14	3,642	3,654
	Bulong	30	27	6	2	36	29
Coolgardie	Coolgardie	255	296	....	....	255	296
	Kunanalling	28	41	....	....	28	41
Yilgarn	....	330	222	....	....	330	222
Dundas	....	466	456	....	....	466	456
Phillips River	....	12	9	....	....	12	9
State Generally	....	....	....	....	....	....	....
Total—Gold Mining	....	7,128	6,762	50	38	7,178	6,800
MINERALS OTHER THAN GOLD.							
Alunite	....	117	114	....	....	117	114
Arsenic	....	4	....	....	....	4	....
Asbestos	....	106	123	....	....	106	123
Bentonite	....	1	1	....	....	1	1
Beryl	....	2	3	....	....	2	3
Clays	....	5	8	....	....	5	8
Coal	....	1,064	1,044	....	....	1,064	1,044
Copper Ore	....	1	3	....	....	1	3
Diatomaceous Earth	....	....	1	....	....	....	1
Dolomite	....	1	1	....	....	1	1
Felspar	....	3	3	....	....	3	3
Glass Sand	....	1	2	....	....	1	2
Glauconite	....	8	8	....	....	8	8
Gypsum	....	32	34	....	....	32	34
Iron Ore	....	24	30	....	....	24	30
Kaolin	....	1	1	....	....	1	1
Kyanite	....	8	....	....	....	8	....
Lead	....	114	135	....	....	114	135
Magnesite	....	3	4	....	....	3	4
Managanese Ore	....	3	13	....	....	3	13
Mica	....	....	2	....	....	....	2
Ochre—Red and Yellow	....	4	2	....	....	4	2
Pyrites	....	123	96	....	....	123	96
Talc	....	2	2	....	....	2	2
Tantalite	....	....	2	....	....	....	2
Tin	....	11	24	....	....	11	24
Tungsten Ore (Scheelite)	....	2	1	....	....	2	1
Vermiculite	....	2	2	....	....	2	2
Total—Other Minerals	....	1,642	1,659	....	....	1,642	1,659
GRAND TOTAL	....	8,770	8,421	50	38	8,820	8,459

DIAGRAM OF ACCIDENTS

Showing the number of Deaths, arranged in Six Classes, in the Mines of Western Australia, from 1920 onwards



PART V.—ACCIDENTS.

TABLE 11.

MEN EMPLOYED IN MINES KILLED AND INJURED IN MINING ACCIDENTS DURING 1948 AND 1949.

A.—*According to Locality of Accident.*

Goldfield.	Killed.		Injured.		Total Killed and Injured.	
	1948.	1949.	1948.	1949.	1948.	1949.
1. Kimberley	....	....	11	29	11	29
2. West Kimberley	....	....	....		....	
3. Pilbara	....	....	10	13	10	13
4. West Pilbara	....	....	....		....	
5. Ashburton	....	....	....	....	....	....
6. Gascoyne	....	....	....	....	....	....
7. Peak Hill	....	....	....	1	....	1
8. East Murchison	....	....	4	3	4	3
9. Murchison	1	2	68	46	69	48
10. Yalgoo	....	....	....	....	....	....
11. Mount Margaret	....	1	32	38	32	39
12. North Coolgardie	....	....	2	4	2	4
13. North-East Coolgardie	....	....	....	....	....	....
14. Broad Arrow	....	....	1	....	1	....
15. East Coolgardie	8	4	459	475	467	479
16. Coolgardie	....	1	8	29	8	30
17. Yilgarn	....	....	15	9	15	9
18. Dundas	1	1	57	44	58	45
19. Phillips River	....	....	....	....	....	....
Mining Districts—						
Northampton	....	....	....	....	....	....
Greenbushes	....	....	....	....	....	....
Collie	....	1	223	175	223	176
South-West	2	....	5	6	7	6
Totals	12	10	895	872	907	882

From the above Table it will be seen that the number of fatal accidents for the year 1949 was 10 as against 12 in 1948. The number injured showed a decrease of 23. In the report of the State Mining Engineer, published as Division II. of this Report, these accidents are classified according to their causes.

B.—*According to Causes of Accidents.*

Cause.	1948.		1949.		Comparison with 1948.	
	Fatal.	Serious.	Fatal.	Serious.	Fatal.	Serious.
1. Explosives	1	4	....	7	— 1	+ 3
2. Falls of Ground	4	79	1	57	— 3	— 22
3. In Shafts	....	16	3	15	+ 3	— 1
4. Miscellaneous Underground	3	582	4	582	+ 1	....
5. Surface	4*	213†	1	210‡	— 3	— 3
6. Fumes	....	1	1	1	+ 1	....
Totals	12	895	10	872	— 2	— 23

* Includes 2 fatal accidents in quarries. † Includes 5 serious accidents in quarries.
‡ Includes 6 serious accidents in quarries.

PART VI.—STATE AID TO MINING.

(a) State Batteries.

The number of State Batteries existing at the end of the year was 20 with three leased. From inception to the end of 1949 gold and tin to the value of £13,958,331.643 including gold premiums, estimated at £4,016,923.437 have been received from the State Batteries, 2,827,221.19 tons of auriferous ore have been treated and have produced £9,846,953.046 plus estimated premium of £4,016,923,437 and 81,810.5 tons of tin ore produced, tin to the value of £93,883.16 and residues to the value of £572.

During the year 41,171 tons of ore were crushed for 26,628.95 ounces of bullion estimated to contain 2,254.7 fine ounces of gold equal to 10 dwts. 22.9 grains per ton. The average value of tailings produced was 4 dwts. 13.7 grains making the average head value of 15 dwts. 12.6 grains. The estimated value of gold produced was 22,554.7 ounces by amalgamation and 5,827.04 from tailings treatment, a total of 28,374.74 ounces valued at £356,531.648.

The working expenditure for all plants for the year was £74,329 8s. 8d. and the revenue was £55,440 15s. 11d., which shows a loss of £18,888 12s. 9d. on the year's operations.

The capital expenditure since inception of the scheme has been £557,069 2s. 1d.; £413,924 9s. 5d. from the General Loan Fund, £100,700 4s. 5d. from the Consolidated Revenue, £28,658 0s. 3d. from Assistance to Gold Mining Industry and £13,786 8s. from Commonwealth Assistance to Metalliferous Mining.

Head Office expenditure including insurance under the Workers' Compensation Act and Pay Roll Tax was £7,063 16s. 4d. as against £6,076 4s. 6d. for 1948. The working expenditure from inception to the end of the year exceeds revenue by £196,756 11s. 1d.

(b) Geological Survey of Western Australia.

The principal work of the Geological Survey for the year 1949 is covered by the following reports published in Division IV of this Report.

- Kyanite at West Beach, 10 miles west of Hopetoun and East Mt. Barren, 5 miles west of Hopetoun, S.W. Division.
- Report on an Alleged Uranium Deposit on M.C. 140, Wodgina, Pilbara Goldfield.
- Reconnaissance Examination of the Kooline Lead Field, Ashburton Goldfield.
- Talc Deposit on M.C. 14E. Mt. Monger East Coolgardie Goldfield.
- Beach Sands of the Busselton Area, S.W. Division.
- Notes on Beach Sands of Torbay, S.W. Division.
- The Doubtful Island Bay and Gairdner River Beach Sands, S.W. Division.
- Tower Hill Leases, Gwalia, Mt. Margaret Goldfield.
- G.M.L. 1829C, "Jessie Alma" and Adjacent Leases or P.A's. Gwalia, Mt. Margaret Goldfield.
- Horseshoe Range Manganese Ores, Peak Hill Goldfield.
- Petroleum Possibilities on Location 2805, Plantagenet District, S.W. Division.
- Water Prospects at Bindoon Boys' Town, Bindoon, S.W. Division.
- Drilling for Open Cut Coal on Temporary Reserve 1235H, Collie-Burn, Collie Mineral Field.
- Asbestos on P.A. 377PP, six miles South of Donnybrook, S.W. Division.
- Examination of the Iron Deposit at Mt. Dick, near Northam, S.W. Division.
- Examination of Location 21, 14 miles South of Baker's Hill for Radio-Active Minerals.
- Report on Edwards' Find, Yilgarn Goldfield.
- Report on P.A. 54, Collie Coalfield.
- Vermiculite Deposits on M.C. 187H, Young River, Eucla Division.
- Bandalup Creek Magnesite Deposit, S.W. Division.
- Interim Report on the Geology of parts of the Irwin Lockier and Greenough River Drainage Basins, S.W. Division.
- Location of Water Bore Sites, Tootra Station, Bindi Bindi, S.W. Division.
- Pyrite, Mt. McMahon, Phillips River Goldfield.
- Manganese Deposit near Mt. Walton, Coolgardie Goldfield.
- Manganese Deposits of the Phillips River Goldfield.
- Gravel Deposits, Learmonth, N.W. Division.
- Notes on Water Supply, Exmouth Gulf Area, N.W. Division.
- Possible Bentonite Deposits, East Cardabia Area, N.W. Division.
- Shale and Clay on Location 310, Byford, S.W. Division.
- Standard Symbols and Conventional Signs.

During the year the following publications were issued:—

- Annual Progress Report of the Geological Survey of Western Australia for 1946.

The following publications are still in the press:—

- Annual Progress Report of the Geological Survey of Western Australia for 1947 and 1948.
- Bulletin No. 102: The Greenbushes Mineral Field, by R. A. Hobson, B.Sc. (Hons.) and R. S. Matheson, B.Sc.
- Bulletin No. 103: Geology of Portion of the Mt. Margaret Goldfield, by R. A. Hobson, B.Sc. (Hons.) and K. R. Miles, D.Sc., with two atlases of maps.
- Mineral Resources of Western Australia Bulletin No. 5: Moulding Sands of Western Australia, by K. R. Miles, D.Sc. and H. A. Stephens, B.Sc.
- Bulletin No. 104: Some Economic Aspects of the Principal Tantalum Bearing Deposits of the Pilbara Goldfield, by H. A. Ellis, B.Sc., A.O.S.M.
- Bulletin No. 106: A Geological Reconnaissance of Portion of the Yalgoo Murchison, Peak Hill and Gascoyne Goldfields, by W. Johnson, B.Sc. (Hons.).
- Bulletin No. 95: (1st Reprint): The Physiography of Western Australia, by J. T. Jutson, B.Sc. LL.B.
- Atlas of Maps to accompany Bulletin No. 101 (issued 1947).
- Geological Sketch Map of Western Australia, Scale 40 miles=1 inch.

The following reports have been compiled and await publication:—

- Bulletin No. 107: A Re-Survey of the Coolgardie District, W.A., by J. C. McMath, B.Sc. (Hons. Lond.), F.G.S., M. Aust. I.M.M. and N. M. Gray, B.Sc.
- Mineral Resources Bulletin No. 6: Silver, Lead and Zinc, by W. Johnson, B.Sc. (Hons.).
- Mineral Resources Bulletin No. 7: Vermiculite, Talc and Soapstone, Fuller's Earth, Bentonite and Diatomite, by W. Johnson, B.Sc. (Hons.).

In course of preparation:

- Bulletin No. 105: The Geology and Mines of the Collie Coalfield, by J. H. Lord, B.Sc.
- Bulletin No. 108: The Geology of the Irwin River and Eradu Coal Basins, by W. Johnson, B.Sc. (Hons.), J. S. Gleeson, B.Sc., and L. E. de la Hunty, B.Sc.

Officers of the Survey have rendered varied types of practical assistance to individuals, syndicates and companies as well as other Government Departments who have been concerned with the exploration of mineral and water resources in all parts of the State.

(c) Assistance under the Mining Development Act, 1902-1924.

The following statement shows the sum advanced during the year 1949 under this Act:—

	£	s.	d.
(1) Advanced in aid of mining work and equipment of mines with machinery	35,509	4	1
(2) Subsidies on stone crushed for public being amounts paid to owners of plants crushing at fixed rates	625	5	0
(3) Providing means of transport, equipment and sustenance for prospectors	1,861	12	1
(4) Other assistance	458	5	11
	£38,454	7	1

The receipts under this Act, exclusive of interest payments amounted to—

(1) Refunds of advances	1,364	18	10
(2) Prospecting refunds	773	0	3
	£2,137	19	1

PART VII—INSPECTION OF MACHINERY.

The Chief Inspector of Machinery reports that the number of useful boilers registered at the end of the year totalled 6,107 against 5,892 total for the preceding year, showing an increase after all adjustments of 215 boilers.

Of the total 6,107 useful boilers, 3,415 were out of use at the end of the year, 2,716 thorough and 315 working inspections were made and 2,692 certificates were issued.

Permanent condemnations totalled 19 and temporary condemnations 22. Six boilers were transferred beyond the jurisdiction of the Act.

The total number of machinery groups registered was 24,041 against 22,537 for the previous year, showing an increase of 1,504.

Inspections made total 14,285 and 2,379 certificates were granted.

The total miles travelled for the year were 70,760 against 65,914 miles for the previous year, showing increase of 4,846 miles. The average miles travelled per inspection were 4.07 as against 3.96 miles per inspection for the previous year.

Three hundred and twenty-five applications for engine drivers' and boiler attendants' certificates were received and dealt with, and 332 certificates, all classes, were granted as follows:—

Winding Competency (including certificates issued under Regulation 40 and Section 60)	11
First Class Competency (including certificates issued under Regulations 40 and 45, and Sections 60 and 63)	14
Second Class Competency (including certificates issued under Regulation 40 and Section 60)	32
Third Class Competency (including certificates issued under Regulations 40 and 45 and sections 60 and 63 of the Act)	38
Locomotive Competency (including certificates issued under Regulation 40 and Section 60)	18
Traction Competency (including Certificates issued under Regulation 40 and Section 60)	3
Internal Combustion Competency (including certificates issued under Regulation 40 and Section 60)	79
Crane and Hoist Competency (including certificates issued under Regulation 40 and Section 60)	39
Boiler Attendants' Competency (including certificates issued under Regulation 40 and Section 60)	101
Interim	1
Copies	6
Transfers	—
Total	332

The total revenue from all sources during the year was £11,954 7s. 3d., as against £9,774 17s. 3d. for the previous year, showing an increase of £2,179 10s.

The total expenditure for the year was £16,016 8s. 11d. as against £13,276 6s. 7d. for the previous year, showing an increase of £2,740 2s. 4d.

PART VIII—CHEMICAL AND MINERALOGICAL LABORATORIES.

The activities of these laboratories continue to expand and a highly satisfactory year was completed on 31st December, 1949. The number of samples received for analysis and examination was slightly lower than the previous year, due largely to reduction of the number of samples received from the Government Geologist in connection with the Beach and River Sands Survey. However, the volume of work of an advisory nature for all Government departments and the general public has increased.

The main activities of the Food and Drug Division were as follows:—Food samples were examined for compliance with the Food and Drug Regulations, and Tender Board purchases for Government institutions, etc. Specimens and exhibits were examined in connection with human poisoning cases and for the Criminal Investigation Department. The work on the chemical sewage control and trade wastes was continued. The chief extension of the work of the Division was in connection with the Swan River Pollution Survey. The number of sampling points was extended to take in a further stretch of the river from Maylands to Woodbridge Creek and a few extra points in the original section to embrace points where industrial trade wastes are discharged. This necessitated the appointment of another chemist.

The number of water samples examined in the year by the Agricultural Division was slightly less than last year although there has been an increase in the number received from farmers, graziers, market gardeners and orchardists. Advice is given in this connection as to the suitability of the waters for stock, irrigation and domestic purposes, and is an important feature of the work of the Division. The routine examination of existing water supplies to towns and cities has been continued.

A large volume of work was undertaken by this Division for the Department of Agriculture in connection with their field experiments in the agricultural areas. The two main functions of this work are to determine the improvement of growth in plants and the correction of deficiencies in growths to produce better pasture plants for stock husbandry. Similar work is now being undertaken to embrace the pastoral areas of the North-West and Kimberley Divisions. The latter is important in regard to the proposed dam and irrigation of the Ord River.

As in previous years the major portion of the work of the Mineral Division dealt with the mineral determination and evaluation of ores and minerals of economic value or scientific interest. As a result several new localities can be added to the mineral census. This work is an important feature in the development of the mineral industry of the State.

The beach and river sand survey conducted by the Government Geologist has now ceased. This is largely responsible for the reduction in the number of samples received for the year. There are, however, a considerable number in hand still to be examined. It is hoped to accelerate this work when the new Isodynamic magnetic separator is received.

An important feature of the work of this division is the study of corrosion problems on metals and alloys. Many of these have been submitted from State Departments and accelerated corrosion tests carried out. These have enabled advice to be given on methods of prevention and suggestions made on the use of substitute materials. In this connection a corrosion committee has been formed consisting of two representatives of these laboratories and representatives of engineers of the Public Works Department to study these problems.

Valuable work has been performed by the Fuel Technology Division on research into the many problems associated with Collie coal and its uses. It has been found possible to use coal from one of the Collie seams successfully in a carburetted water gas plant. Such a plant has been running continuously on this coal for several months at Fremantle.

Work of a fundamental nature on Collie coal is continuing. A comprehensive survey of the whole field was initiated towards the end of the year. The analyses of the samples taken will give a reasonably complete picture of the coal resources at Collie. This is a long term programme. A research programme is being carried out on the briquetting of Collie coal. This includes a preliminary investigation on the direct reduction of high grade iron ore.

The Industrial Chemistry Division has not been able to function properly again this year owing to the lack of proper accommodation. However, much valuable work has been done of a consultative character for State industries and private industry. A certain amount of laboratory work has been carried out on bentonite and its benefication with a view to use in foundry sands. Other investigations undertaken were, preparation of marketable salt from natural salt lake deposits, possibility of blackboy gum production, building boards, plaster of Paris, insecticides and polishes.

PART IX—SCHOOL OF MINES.

(a) Kalgoorlie.

The total number of students enrolled for 1949 was 360.

This figure included 52 part-time and 53 full-time students under the Commonwealth Rehabilitation Training Scheme.

During the year considerable addition was made to the mechanical plant in the workshop and in the electrical engineering laboratory. The Wiluna school building was also transferred to Kalgoorlie and re-erected and altered. It now comprises additional laboratories for the Metallurgy and Chemical Department and will enable practical work in metallography and mineral dressing to be available to students.

The metallurgical research laboratory received 37 samples of ore during the year for investigation in regard to suitable methods of treatment. Twenty-eight of these had reference to gold and nine to other minerals.

In addition, 288 samples were assayed for prospectors.

(b) Norseman.

The total number of students enrolled was 78.

The Instructor-in-charge (Mr. R. C. Dowson) died suddenly in November last. He had rendered very fine service to the Department and the district during his three years' operations at the school and his passing was very generally regretted.

The full-time staff at Norseman was increased during the year and comprised a lecturer, an assistant lecturer and a cadet.

PART X—EXPLOSIVES.

For the year 1949 a very much greater quantity of explosives of all types was imported than for a long time. Such explosives were made up mainly as follows:—

Gelignite, 3,098,900 lb.
Gelatin Dynamite, 437,500 lb.
Permitted Explosives, 932,500 lb.
Powder, 55,000 lb.
Detonators in number, 3,750,000.
Fuse, in yards, 4,845,600.

The quantity of explosives used in the different classes of industry during 1949 totalled 3,966,450 lb. as against 3,924,100 lb. used during 1948.

PART XI—MINER'S PHTHISIS ACT AND MINE WORKERS' RELIEF ACT.

In 1949 all Goldfields were visited with the exception of Ashburton, Gascoyne, Kimberley and Phillips River.

The number of examinations conducted was 5,489, compared with 5,134 for the previous year.

STAFF.

During the year two of the senior technical officers of the Department in the persons of Mr. Desmond Browne, M.Aust.M.M., M.Inst.M.M., and Mr. George Moore, retired, having reached the age of 65 years.

Mr. Browne held the position of Superintendent of State Batteries, while Mr. Moore was the Deputy Chief Inspector of Machinery, both exceedingly onerous positions. Both officers had been with the Department for many years and had rendered it and the State signal service. Their respective duties had taken them all over the State and they were held in high regard not only by their fellow officers but by the mining community generally. They have both earned long and happy retirements.

Throughout a heavy year all members of the staff, head office and outstations, carried out their duties loyally and efficiently and I am glad to be able to publicly acknowledge their efforts.

In dealing with the various activities I have commented only on the principal items. Divisions II to X of this publication contain the detailed reports of the responsible officers.

(Sgd.) A. H. TELFER,
Under Secretary for Mines.

Department of Mines,
Perth, 20th April, 1950.

Division II.

Report of the State Mining Engineer for the Year 1949.

The Under Secretary for Mines,

Sir,

I have the honour to submit, for the information of the Hon. the Minister for Mines, my Annual Report on this branch of the Mines Department for the year 1949.

A detailed report on the mining activities in this State for the year under review, compiled by the Assistant State Mining Engineer and based on reports from the Inspectors of Mines and his own observations in the field and also on tabulated information supplied by the Statistical Clerk, is submitted in its entirety as portion of my report.

ACCIDENTS.

The accident rate is still low in comparison with previous years.

The average death rate in all mines was 1.32 per 1,000 men employed as against 1.39 in the previous year and 2.01 per 1,000 average since 1929.

There was a slight increase in the serious accident rate on gold mines, but the serious accidents on coal mines showed a decrease of approximately 20 per cent.

ADMINISTRATION.

The new Mines Regulation Act, 1946, and Regulations came into force on the 1st May, 1949.

In compiling this Act an attempt was made to consolidate and simplify the old Act and bring it into conformity with modern mining practice. Acknowledgment is made of assistance extended in such compilation by the Chamber of Mines, all Inspectors of Mines and the Australian Workers' Union, Mining Division. I would like particularly to acknowledge the help given in this direction by Mr. I. W. Morley, now State Mining Engineer for Queensland, who, while an Inspector of Mines in this State some years ago, laid out the pattern finally adopted in this Act.

The principal innovations in this Act were provision for the certification of Mine Managers, for the introduction of diesel locomotives underground, and for the introduction of Aluminium Therapy.

Unfortunately, the regulations governing the use of diesel locomotives were disallowed by Parliament and the introduction of this modern, economical and valuable aid to mining has thus been deferred indefinitely.

VENTILATION.

A visit to the State during the year by Dr. W. D. Robson, of McIntyre Research Ltd. cleared up a number of matters in doubt concerning the use of Aluminium Therapy as a control for silicosis, and as a direct result of this visit arrangements were made for its early introduction into this State. Old change rooms are being remodelled and new ones built to the necessary specifications, and the required apparatus and materials have been ordered from Canada. It is anticipated that most of the larger mines will be ready to commence the treatment towards the end of 1950.

The ventilation of mines generally continues to receive constant attention by the Departmental ventilation officers and gratifying co-operation is now being received from the majority of the large companies.

GOLD MINING.

Gold production for the year was again disappointing, falling some 13,000 ounces behind the total for 1948. The man-power and supply position was still very unsatisfactory, although a reduced number of men produced a slightly higher tonnage than the previous year. The lag in production was partially due to a decreased production of over 11,000 ounces by the large retreatment plants, while gold from prospecting, small mines and small retreatment plants showed a falling off of 30,000 ounces.

All of the larger mines, with the exception of Paringa, either showed appreciable increases or maintained outputs comparable with those of the previous year.

The rise in the price of gold from £10 15s. 3d. to £15 9s. 10d. per fine ounce, which came into force on the 19th September, due to the devaluation of sterling, and consequently of the Australian pound, in relation to dollar currency, was expected to give a considerable impetus to production, but the increase to the end of the year was negligible, due chiefly to conditions of labour and material shortages, which militate against any rapid expansion of operations.

The Western Mining Corporation subsidiary, New Coolgardie Gold Mines, N.L., commenced production during April, and recovered 9,299 fine ounces from the treatment of 24,062 tons of ore.

The Blue Spec Gold Mine at Nullagine was preparing to recommence operations at the end of the year, under the management of Bewick, Moreing and Co. The advent of this rich small mine into the ranks of the producers again should swell the production figures from the Pilbara Goldfield, which has been rather in the doldrums during recent years.

Intensive investigation in the Yilgarn Goldfield by Western Mining Corporation has proved the existence of very considerable reserves of payable ore from Southern Cross to Bullfinch, which is to be floated early in 1950 into a company to be known as Great Western Consolidated, which proposes to go into large scale operation. This should have the effect of a big revival of mining in the Southern Cross area.

It is rather difficult to forecast the immediate future of the goldmining industry in the State. Devaluation certainly assisted by raising the value nearly £5 per ounce, but also sent wages and other costs climbing rapidly after the price, so that the enhanced value is more apparent than real.

COAL.

Coal production for the year at 750,594 tons, eclipsed the record figure for 1948 by 17,635 tons, in spite of a stoppage of production for three weeks owing to a strike.

The output from underground mines decreased by approximately 43,000 tons on that of the previous year, while the yield from open cuts increased by 60,700 tons.

The strike mentioned above was largely responsible for the lag in underground production. The only mine to record an increased production was the Cardiff.

The fact that the increased output consists of Cardiff and open cut coal is somewhat unfortunate, as Cardiff coal is unpopular owing to its low calorific value and open cut coal is liable to be dirty and is not highly regarded.

Extensive plans for underground mechanisation suggest that these drawbacks will be minimised in future by higher underground production. Mechanical coal-winning units consisting of arc-wall cutters, Joy loaders and shuttle cars have been purchased for installation on two mines but had not been placed in operation at the end of the year.

Preparations are also in full swing by Western Collieries Ltd. for the opening up of a new totally mechanised mine in the vicinity of the old Premier colliery at Shotts. An extensive basin of coal, apparently free from any major faulting, has been proved in this area, in which three adjacent seams can be worked simultaneously. The opening of this colliery should place production at Collie on a very sound footing in the near future.

OTHER MINERALS.

The value of minerals other than gold and coal showed a further appreciable advance during the year from £553,000 in 1948 to £674,000 in 1949. This amount does not include a considerable quantity of lead concentrate in transit to overseas markets at the end of the year, the value of which is not reported until final payments are received.

Considerable increases in the value of production were reported for the following minerals.

The value of asbestos production rose from £40,761 in 1948 to £125,332 in 1949. Of this amount £116,828 was the reported value of 1,156 tons of blue fibre from the Australian Blue Asbestos mines at Wittenoom, while 141 tons of chrysotile produced at Nunyerri was valued at £8,503. There was no production of anthophyllite as the previous producers, Midland Mining Company, have gone out of business.

The unit values of the various grades of blue asbestos took a considerable jump during the year, which is reflected in the greatly increased total value. A further increased output of blue fibre is anticipated during 1950.

The output of clays (fire-clay, pottery clay, and cement clay) more than doubled, both in tonnage and value, the 1948 production, the total value being £11,813 compared with £4,113 for 1948.

Lead producers had a somewhat worrying year owing to rather violent fluctuations in the lead market, for which they were unprepared. Nevertheless, the value of production rose from £114,268 in 1948 to £154,777 in 1949. The great majority of the producers were caught by a sudden fall from 21.5 cents to 15 cents per lb. and approached the Department for assistance, which was freely given in practically every case. A few walked off their properties but generally the lead mining industry may be said to be approaching a stable condition.

The production of manganese ore, practically all from the Peak Hill Goldfield, increased from 1,645 tons in 1948 valued at £10,442 to 9,420 tons in 1949 valued at £56,289.

Production of pig iron at the Wundowie Charcoal Iron furnace advanced from 3,333 tons valued at £26,165 in 1948 to 6,609 tons worth £66,296 in the year under review. This plant is now working well and has passed its teething troubles.

By-products in the form of acetic acid and methanol from the wood distillation plant find a ready sale, while any timber in the area being cut for fuel, which is suitable for building, is milled and sold as such.

The first mica production since 1944 was reported this year, 1,254 lb. valued at £1,343 having been produced mostly from the Yinnietharra field. The present favourable prices ruling for this comodity should have the effect of rousing interest in its production.

Decreased value of production was recorded as follows:—

Gypsum was produced to the value of £18,610, compared with £35,173 in 1948. This, however, is perhaps a healthy sign indicating stabilisation in the industry, as the tonnage produced was somewhat higher in the previous year, but the price has dropped to normal in place of rather inflated values ruling during the post-war years.

Kyanite production ceased altogether when the operations at Yanmah ceased owing to the failure of the Midland Mining Company. There are possibilities of substantial deposits in this area, but the defunct company was not equipped financially or technically to undertake the costly exploration necessary to locate them in the heavy karri forest country of that district.

Pyrites produced by Norseman Gold Mines, N.L., decreased in quantity by 6,000 tons on the previous year's total, while the value fell from £164,203 to £125,857. The decline in value was partially due to a fall in the unit price.

Tungsten production, with the exception of two minor parcels from the Coolgardie Goldfield, practically ceased with the closing of Edna May Amalgamated Gold Mines in 1948.

Generally, it may be stated that the mineral industry as a whole is in a fairly healthy condition. The normal expansion of lead and asbestos production, the anticipated early start of production of iron ore from Cockatoo Island and an appreciable production of antimony from the Blue Spec Mine are items which it is expected will substantially swell the total output in the near future.

GENERAL.

In conclusion I wish again to express my appreciation of the loyal and efficient co-operation of all members of my staff, who have been very fully occupied during the year.

I took three months' long service leave commencing 8th November, and my duties during that period were capably handled by the Assistant State Mining Engineer.

I would also like to congratulate Mr. C. F. Adams on his promotion to the position of Superintendent of State Batteries and to place on record my appreciation of his valuable services during his 10 years' term as District Inspector of Mines for the Cue Inspectorial District, which embraces nearly half of the State, including the whole of the North-West and Kimberley Divisions.

JOHN S. FOXALL,
State Mining Engineer.

ANNUAL REPORT FOR 1949.

State Mining Engineer.

Mining activities in the State during the year 1949 are detailed in this report, which is based on information supplied by the Statistician and by Inspectors of Mines.

STAFF.

The creation of a separate branch to control coal-mining was effected during the year and Mr. G. Morgan was appointed Chief Coal Mining Engineer on 12th December, 1949.

Mr. C. F. Adams, District Inspector of Mines, at Cue was appointed to the position of Superintendent of State Batteries and relinquished his position with this Branch on the last day of the year.

Mr. G. F. Mead, Assistant Ventilation Inspector at Kalgoorlie, resigned on the 14th March, 1949 to take up a position with the Commonwealth Bureau of Mineral Resources. The consequent vacancy was filled by the appointment of Mr. A. W. Ibbotsen on 3rd October, 1949.

Mr. D. R. Culley resigned from the position of Workmen's Inspector at Leonora and Mr. D. V. Chisholm was elected and was appointed to this position on 7th June, 1949.

ACCIDENTS.

Fatal and serious accidents in mines and quarries reported to the Department are shown below. Corresponding figures for 1948 are shown in brackets.

There were 10 (12) fatal and 872 (895) serious accidents including 1 (1) fatal and 181 (228) serious in coal mines and quarries.

Of the fatal accidents 9 (10) occurred in gold mines. There was no fatality in quarries as against (1) in 1948.

The total number of serious accidents reported from the gold mines was 662 (656). The average number of men employed was 6,800 (7,178) and the average accident rate per 1,000 men employed was thus 1.32 (1.39) for fatal and 97.35 (91.89) for serious accidents.

Name and Occupation.	Date.	Mine.	Details and Remarks.
Wilson, Alasdair (Sampler)	2–3–49	Brownhill	While examining an old mine this man fell down a shaft. The centre compartment was decked over and he attempted to cross the shaft but how he came to get into it is not known.
Shetter, Warren George (Toolie)	16–3–49	Phoenix	This man fell into a chute while removing a rock drill from a stope. There was no witness to the accident but it seems clear that he slipped while bringing the machine down the footwall of the stope.
Paulsen, Frederick Carl (Mill Hand)	11–5–49	Gold Mines of Kalgoorlie	There was no witness to this accident. Paulsen was found dead with the left side of his face in a drain conveying cyanide solution. It is surmised that he slipped and fell.
Passamini, Beniamino	30–8–49	North Democrat	Two drive faces were fired out on the 500 level at the end of the afternoon shift on the previous day. The compressor was left running for half an hour. Passamini descended the shaft from the 400 level on the following morning. His mate followed some ten minutes later and found that he had been overcome by fumes.
McCann, Charles James (Miner)	2–9–49	Lake View & Star	A fall of stone from the back of a leading stope struck this man who was operating a rock drill in the face.
Moloney, Francis William (Prospector)	12–10–49	Prospecting Area	This man was found dead at the bottom of a prospecting shaft which was 58 feet deep. His lamp was still at the surface and it is thought that he slipped as he was getting into the shaft.
Hepworth, Frederick Joshua (Miner)	18–10–49	Barbara	Injuries received when he fell from a bucket in which he was being hauled to the surface caused this man's death. He was not wearing a safety belt.
Cronin, Michael Dennis (Miner)	25–10–49	Big Bell	This man went up a rill above a grizzley to fire down some stone. The rock moved and injured a leg which was subsequently amputated. He subsequently died in hospital.
Rosel, John William Frederick (Shiftman)	10–12–49	Proprietary	Two loaded skips of coal escaped from the set and ran back over the section of line where this man was working and struck him.
Leggerini, Leo Gramby (Scraper Driver)	20–12–49	Kalgoorlie Enterprise	This man was working on top of a pass to clear dirt fired down on to it. The dirt ran and carried him into the pass.

TABLE A.

SERIOUS ACCIDENTS FOR 1949.

Class of Accident.	Kimberley and West Kimberley.	East Coolgardie.	Peak Hill.	Yilgarn.	Coolgardie.	Dundas.	Broad Arrow.	Mt. Margaret.	North Coolgardie.	East Murchison.	Murchison.	Pilbara and West Pilbara.	South-West.	Collie.	TOTAL.
Major Injuries—Exclusive of Fatal—															
Fractures :															
Head	....	1	....	....	....	1	....	....	....	....	2	....	....	....	4
Shoulder	....	1	....	1	1	....	....	....	....	....	....	....	....	1	4
Arm	....	3	....	1	1	2	....	1	....	....	2	....	....	....	10
Hand	....	2	....	....	1	....	....	1	....	....	....	1	....	2	7
Spine	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Rib	1	7	....	1	1	....	....	3	....	....	1	....	....	3	17
Pelvis	....	2	....	....	....	....	....	....	....	....	....	....	....	....	2
Thigh	....	1	....	....	....	....	....	....	....	....	....	....	....	....	1
Leg	....	6	....	....	....	....	....	1	....	....	2	....	1	2	12
Ankle	....	4	....	....	....	....	....	....	1	....	1	....	....	1	7
Foot	....	4	....	....	....	3	....	....	1	....	3	....	....	....	11
Amputations :															
Arm	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Hand	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Finger	....	3	....	....	1	....	....	1	....	1	....	....	....	1	7
Leg	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Foot	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1
Toe	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1
Loss of Eye	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Serious Internal	1	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Hernia	1	5	....	....	....	1	....	....	....	....	2	1	....	4	14
Dislocations	1	....	....	....	....	....	....	....	....	....	1	....	....	....	2
Other Major	1	8	....	....	1	....	....	....	....	....	....	....	....	5	15
Total Major	5	47	....	3	6	7	....	7	2	1	14	2	1	21	116
Minor Injuries—															
Fractures :															
Finger	1	10	1	1	....	....	....	3	....	....	5	....	....	13	34
Toe	....	8	....	....	....	....	....	1	....	....	1	....	....	3	13
Head	2	12	....	....	1	....	....	2	1	....	1	....	....	2	21
Eyes	3	17	....	....	3	1	....	2	....	....	1	1	....	2	30
Shoulder	....	10	....	....	....	1	....	....	....	....	....	....	....	9	20
Arm	2	16	....	....	1	1	....	2	....	....	....	1	1	11	35
Hand	3	138	....	3	7	16	....	9	1	....	11	3	1	33	225
Back	3	73	....	....	4	6	....	3	....	....	3	1	1	22	116
Rib	....	7	....	....	....	....	....	....	....	....	....	....	....	1	8
Leg	4	62	....	....	6	7	....	3	....	1	5	1	1	27	117
Foot	5	47	....	1	....	4	....	3	....	....	2	2	....	17	81
Other Minor	1	28	....	1	1	1	....	3	....	1	3	2	1	14	56
Total Minor	24	428	1	6	23	37	....	31	2	2	32	11	5	154	750
GRAND TOTAL	29	475	1	9	29	44	....	38	4	3	46	13	6	175	872

TABLE B.

FATAL ACCIDENT RATE.

Year	Gold.						Coal.						Other Minerals.					
	Men Employed.		Fatal Accidents.		Death Rate per 1,000.		Men Employed.		Fatal Accidents.		Death Rate per 1,000.		*Men Employed.		Fatal Accidents.		Death Rate per 1,000.	
	Current.	Progress.	Current.	Progress.	Current.	Progress.	Current.	Progress.	Current.	Progress.	Current.	Progress.	Current.	Progress.	Current.	Progress.	Current.	Progress.
1929	4,108	4,108	7	7	1·70	1·70	858	858	4	4	4·66	4·66	193	193	....	....	....	....
1930	4,452	8,560	14	21	3·14	2·45	896	1,754	....	4	....	2·28	94	287	....	....	....	....
1931	6,344	14,904	16	37	2·52	2·49	752	2,506	1	5	1·33	2·00	51	338	....	....	....	....
1932	7,983	22,887	16	53	2·00	2·31	604	3,110	....	5	....	1·61	108	446	1	1	9·26	2·24
1933	9,900	32,787	21	74	2·12	2·26	626	3,736	1	6	1·59	1·61	164	610	....	1	....	1·64
1934	12,523	45,310	30	104	2·39	2·29	624	4,360	....	6	....	1·38	158	768	3	4	19·00	5·21
1935	14,708	60,018	28	132	1·90	2·20	689	5,049	2	8	2·90	1·58	160	928	....	4	....	4·31
1936	15,696	75,714	38	170	2·42	2·24	768	5,817	....	8	....	1·37	188	1,116	2	6	10·64	5·38
1937	16,174	91,888	36	206	2·22	2·24	723	6,540	....	8	....	1·22	239	1,355	2	8	8·37	5·90
1938	15,374	107,262	23	229	1·50	2·13	765	7,305	1	9	1·31	1·23	288	1,643	4	12	13·88	7·30
1939	15,216	122,478	38	267	2·49	2·18	752	8,057	1	10	1·33	1·24	231	1,874	....	12	....	6·40
1940	14,593	137,071	25	292	1·71	2·13	713	8,770	3	13	4·21	1·48	193	2,067	....	12	....	5·81
1941	13,106	150,177	25	317	1·91	2·11	781	9,551	2	15	2·56	1·57	134	2,201	....	12	....	5·45
1942	8,123	158,300	18	335	2·21	2·12	822	10,373	2	17	2·43	1·64	155	2,356	....	12	....	5·10
1943	5,079	163,379	12	347	2·36	2·12	838	11,211	1	18	1·19	1·60	310	2,666	2	14	6·45	5·25
1944	4,614	167,993	7	354	1·52	2·11	880	12,091	1	19	1·13	1·57	436	3,102	1	15	2·29	4·83
1945	4,818	172,811	10	364	2·08	2·11	860	12,951	1	20	1·16	1·54	393	3,495	1	16	2·55	4·58
1946	6,961	179,772	10	374	1·44	2·08	955	13,906	1	21	1·05	1·51	708	4,203	....	16	....	3·80
1947	7,649	187,421	16	390	2·09	2·08	1,032	14,938	....	21	....	1·40	574	4,777	3	19	5·22	4·00
1948	7,178	194,599	10	400	1·39	2·06	1,064	16,018	....	21	....	1·33	578	5,355	2	21	3·46	3·92
1949	6,800	201,399	9	409	1·32	2·03	1,044	17,062	1	22	0·96	1·29	615	5,970	....	21	....	3·52

* Note—Figures for men employed in quarries not included.

TABLE C.

Fatal and Serious Accidents Showing the Causes and Districts in which they occurred.

District	Explosives.		Falls of Ground.		In Shafts.		Fumes.		Miscellaneous Underground.		Surface.		Total.	
	Fatal.	Serious.	Fatal.	Serious.	Fatal.	Serious.	Fatal.	Serious.	Fatal.	Serious.	Fatal.	Serious.	Fatal.	Serious.
1. East Coolgardie	....	3	1	33	1	6	....	1	1	349	1	83	4	475
2. Mt. Margaret	....	....	....	5	....	2	1	....	....	18	....	13	1	38
3. Coolgardie	....	1	....	4	1	1	....	....	....	10	....	13	1	29
4. North-East Coolgardie	....	....	....	....	....	....	....	....	....	....	....	....	....	....
5. North Coolgardie	....	....	....	....	....	....	....	....	....	1	....	3	....	4
6. Broad Arrow	....	....	....	....	....	....	....	....	....	....	....	....	....	....
7. Dundas	....	....	....	1	....	3	....	....	1	30	....	10	1	44
8. Yilgarn	....	....	....	....	....	1	....	....	....	2	....	6	....	9
9. Murchison	....	1	....	1	1	2	....	....	1	25	....	17	2	46
10. East Murchison	....	....	....	....	....	....	....	....	....	....	....	3	....	3
11. Peak Hill	....	....	....	....	....	....	....	....	....	....	....	1	....	1
12. Yalgoo	....	....	....	....	....	....	....	....	....	....	....	....	....	....
13. Northampton	....	....	....	....	....	....	....	....	....	....	....	....	....	....
14. Greenbushes	....	....	....	....	....	....	....	....	....	....	....	....	....	....
15. South-West	....	....	....	....	....	....	....	....	....	....	....	6	....	6
16. Phillips River	....	....	....	....	....	....	....	....	....	....	....	....	....	....
17. Collie	....	2	....	13	....	....	....	....	1	137	....	23	1	175
18. Pilbara and West Pilbara	....	....	....	....	....	....	....	....	....	8	....	5	....	13
19. Ashburton	....	....	....	....	....	....	....	....	....	....	....	....	....	....
20. Gascoyne	....	....	....	....	....	....	....	....	....	....	....	....	....	....
21. Kimberley and West Kimberley	....	....	....	....	....	....	....	....	....	2	....	27	....	29
Total for 1949	....	7	1	57	3	15	1	1	4	582	1	210	10	872
Total for 1948	1	4	4	79	....	16	....	1	3	582	4	213	12	895

On the coal mines the number of serious accidents was 175 (223), while the average number of men employed was 1,044 (1,064). The average accident rate per 1,000 men employed was thus 0.96 (0) for fatal and 167.62 (206.48) for serious accidents.

A classification of the serious accidents showing the nature of the injuries is given in Table A.

Table B shows the fatal accidents, the number of men employed and the death rate per 1,000 men employed for each year since 1929, classified according to employment in gold mines, coal mines and other mines and quarries. The progressive figures for each year are also given.

Accidents classified according to causes for the various districts are shown in Table C.

FATAL ACCIDENTS.

A brief description of fatal accidents reported during the year is given on page 19.

WINDING MACHINERY ACCIDENTS.

There were seven accidents involving winding machinery which are briefly described.

Overwind.—(1) The safety gear operated satisfactorily when a slight overwind occurred.

Rope Damage.—A rope was damaged when the cage was lowered on to chairs in the shaft and some extra rope paid out in error.

A rope pulled out of the capel by which it was attached to loaded skip. The skip fell from the surface to the bottom of the shaft to the sump below 31 level but comparatively little damage was done.

Falling Timbers.—On two occasions long materials (rails and pipes) caught in the shaft timbers. In both cases there was some damage to the shaft and in one case the cage was also damaged.

Miscellaneous.—A skip escaped while the hoisting engine was under repair. It fell from the surface to the bottom of the shaft below the 2,600 level. Considerable damage was done to the shaft principally by the rope.

A man was seriously injured when the skip was inadvertently moved while he was in the act of getting out.

PROSECUTIONS

Six persons were prosecuted under the provisions of the Mines Regulation Act. Three miners were prosecuted for firing at times other than those fixed by Regulation. One miner was prosecuted for drilling in a face when the broken ore from the previous firing had not been cleaned up. A miner was prosecuted for not taking the necessary steps to secure a misfire. The manager of a mine was prosecuted for breach of the regulations providing for the removal of fumes after blasting.

Five persons were prosecuted under the provisions of the Coal Mines Regulation Act.

Two miners were prosecuted for returning to a hole which had missed fire without taking the necessary precautions.

A miner was prosecuted for interfering with other men at their work.

An under-manager was prosecuted for permitting youths to enter underground workings before the pre-shift examination.

The manager of a mine was prosecuted for breach of the regulations relating to change rooms.

All prosecutions were successful.

SUNDAY LABOUR.

Permission for Sunday Labour was granted under the Mines Regulation Act on 17 Sundays for a total of 145 manshifts.

Permission was granted under the provisions of the Coal Mines Regulation Act on 47 occasions for a total of 620 manshifts.

EXEMPTIONS.

In accordance with the provisions of Section 46 of the Mines Regulation Act, 58 permits exempting the holders from the provisions of subsection (1b) of the same section were issued. The number of permits issued in 1948 was 48.

ADMINISTRATION.

Mines Regulation Act.

Goldfields and Mineral Fields to be covered by the Mines Regulation Act, 1946, were proclaimed as from 1st May, 1949, on the 15th September, 1949.

Regulations 23, 48, 71, 97, 100, 105, 107, 118, 124, 125, 130, 147, 154, 169, 205, 211, 214, 216, 217 and 222 have been amended to correct errors in typography and to modify or clarify them.

Regulations 172, 173, 179, 182, 184, 185, 186, 187, 188, 189, 190 and 192 which relate to the control of diesel locomotives underground were deleted by resolution of the Legislative Assembly and Regulation 252, which relates to Re-Admission Certificate, was also disallowed by resolution of the Legislative Assembly.

A new regulation, numbered 111A, to provide that cages or skips shall be supported while repairs are being effected to clutches or brakes of winding engines was gazetted on 16th September, 1949.

Coal Mines Regulation Act.

Regulation 126 (1) which refers to the pre-shift examination was redrafted.

Inspection of Machinery Act.

The scale of regulation charges was amended.

The regulations relating to the granting of certificates to engine drivers, crane and hoist drivers and boiler attendants were amended.

Mining Development Act.

Regulation 1 was amended to provide for the payment of subsidies on ore crushed at approved customs mills.

VENTILATION.

A considerable interest in ventilation has been shown by mining companies. Instruments for air measurement and dust estimation have been purchased and ventilation officers have been appointed and provided with suitable equipment.

The installation of apparatus to disperse aluminium dust in change rooms to combat silicosis has been commenced.

An outline of the ventilation of the principal mines is given below.

Lake View & Star.—Hannan's Star and Chaffers are in the main intake system of the western group and conditions are good. Further development work to connect these two shafts is in progress on 10 and 12 levels.

In the Horseshoe section where operations are confined to stoping, conditions have been satisfactory.

The current in the Ivanhoe shaft is now downcast. This improvement follows the installation of a large fan on the Ivanhoe South Extended shaft and considerable work within the mine.

The Lake View and Associated mines have continued under natural ventilation.

Secondary ventilation has been well maintained. Venturi blowers with 10in. pipes are used for distances up to 200 feet and 12 in or 16in. Meco fans for larger distances.

Great Boulder.—This mine is divided into several small districts and several fans are used. The main intake is by Hamilton Shaft. A detailed survey is in progress at the present time.

Boulder Perseverance.—The natural ventilation system was maintained in satisfactory condition. Auxiliary ventilation is by electricially driven limit load fans and by air driven "Meco" fans.

Kalgoorlie Enterprise.—The collapse of sand filled stopes above the 700 level has interfered with the return airways of this mine. An additional fan has been provided and a survey is in progress. Ventilation of development ends has been efficient.

Gold Mines of Kalgoorlie.—The Oroya, Iron Duke and New North Boulder have all operated under natural ventilation conditions with good equipment for auxiliary ventilation.

North Kalgoorlie.—Two winzes from the surfaces have improved the ventilation of this mine. A big development programme is in progress and this will involve changes in the ventilation system. Dust is controlled in the conveyor drift on No. 7 level by a suction fan and viscous filter. Venturi blowers 9½in. diameter are principally used for secondary ventilation although both air driven and electrically driven fans are used.

Paringa Mining & Exploration Company.—The ventilation of this mine has given some trouble and improvement is necessary.

Mount Charlotte.—The connection between Main and Charlotte shafts on the No. 5 level was completed and conditions have been improved by this. Conditions in development ends were satisfactory.

Hannans North—The ventilation of this mine has caused some trouble and a re-arrangement of the fans is proposed.

South Kalgurli.—Natural ventilation of this mine depends mainly upon intakes from other mines. The arrangements for secondary ventilation are good.

New Coolgardie.—Main fans for the Barbara and Surprise mines are on order.

Central Norseman.—A high standard of ventilation is maintained on this mine. Electrostatic precipitation of dust near ore pockets is to be tried.

Norseman Gold Mines.—Both main and secondary ventilation has been well maintained at the Iron King mine.

Sons of Gwalia.—Preparations for the installation of the new 78in. Aerex fan are complete but the fan has not yet been delivered.

Big Bell Mine.—The ventilation has been much improved by sinking shafts for return airways.

Hill 50.—After connection of the No. 6 level to the new shaft the position of the main fan will be changed. This will produce an improvement in the ventilation.

Attached is a tabulation of dust samples showing the comparative results obtained. The number of samples taken was 317.

The dust counts are tabulated under—

Development—giving an average count of 247 p.p.c.c.

Stoping—with an average of 235 p.p.c.c.

Level—with a count of 293 p.p.c.c.

The weighted average of these three categories gives a count of 245 p.p.c.c.

This figure compares very closely with the annual averages obtained over the past ten years which are given hereunder—

Year.	Weighted Average.	No. of Samples.
1939	321 p.p.c.c.	396
1940	262 "	365
1941	267 "	446
1942	216 "	298
1943	201 "	59
1944	142 "	71
1945	252 "	40
1946	257 "	527
1947	240 "	181
1948	279 "	227
1949	245 "	277

The weighted average of 2,887 samples taken over the years 1939 to 1949, inclusive, gives a count of 255 p.p.c.c. It is evident therefore, that little improvement has been made in reducing the dust concentrations in mine air over at least this period when our counts this year are 245 against the average for 11 years of 255. This is not unexpected as little improvement in dust control methods has been introduced into the mines during this time.

GOLDMINING.

The ore produced during the year was 2,468,297 tons and the gold yield was 649,572 fine ounces. The corresponding figures for the previous year were 2,447,545 tons for 662,741 fine ounces.

There has been a slight increase in the tonnage treated and a slight decline in the gold won. The average grade of 5.26 dwts. per ton is therefore less than the figure of 5.42 dwts. per ton for the previous year.

On the 19th September the devaluation of sterling in relation to dollar currency caused an increase in the Australian price of gold from £10 15s. 3d. to £15 9s. 10d. It was expected that this would stimulate gold production but the increase to date has not been very great.

The increase of tonnage treated is about 1 per cent. and is perhaps some indication that improved output may be expected.

The decrease in gold recovered is not of any great mining significance. The total lag was 13,169 ounces and the decrease of output in the large retreatment plants was 11,966 ounces. The grade produced by the Mountain View declined from 83.12 dwts. to 33.02 dwts.

All of the larger mines maintained the grade of the previous year except Paringa, which declined from 4.47 dwts. to 3.87 dwts., and South Kalgurli, which declined from 4.93 dwts. to 4.87 dwts. The average recovery by amalgamation at the State Batteries dropped from 12.03 dwts. per ton to 10.96 dwts. per ton.

YEARLY TABULATION OF DUST COUNTS, 1949.

Month.	Development.		Stoping.		Level.		Surface.		No. of Places showing count of 1000 p.p.c.c.			
	No. of Samples.	Average Count.	No. of Samples.	Average Count.	No. of Samples.	Average Count.	No. of Samples.	Average Count.	Development.	Stoping.	Level.	Surface.
January	8	216	23	221	2	104	3	351	....	2	3	....
February	3	129	8	171	2	568	2	204	....	1	1	....
March	5	209	5	269	....	....	....	....	....	....	1	....
April	14	219	11	314	1	280	....	....	1	....	....	....
May	8	245	19	240	1	148	....	....	2	3	1	....
June	14	206	26	253	4	209	....	....	2	....	2	....
July	7	209	20	247	3	350	....	....	....	....	3	....
August	8	201	12	186	1	424	....	....	4	....	1	....
September....	11	368	14	263	1	486	....	....	....	2	....	....
October	12	316	8	157	15	278	....	....	1	....	4	....
November....	2	348	8	203	1	363	....	....	1	....	....	....
December....	....	....	....	....	....	....	....	....	....	....	....	....
Totals	92	247	154	235	31	293	5	292	11	8	16	....

The tonnage treated was maintained by most mines at about the level for the previous year. Central Norseman increased its output from 118,763 tons to 132,930 tons and the average grade increased from 6.59 dwts. per ton to 7.05 dwts. per ton.

North Kalgurli increased its output from 211,784 tons to 231,836 tons and the grade improved from 5.36 dwts. per ton to 5.44 dwts. per ton.

Paringa output dropped from 100,642 tons to 91,811 tons and the grade declined from 4.47 to 3.87 dwts. per ton.

The output at the Sons of Gwalia rose from 60,093 to 81,395 tons but the grade fell from 6.03 dwts. to 5.79 dwts.

Mountain View treated 3,638 tons as compared with 1,395 tons in the previous year, but the grade declined from 83.12 dwts. to 33.02 dwts. per ton.

New Coolgardie commenced production in April and recovered 9,299 ounces from the treatment of 24,062 tons of ore, the average grade being 7.73 dwts. per ton.

The average number of men employed in the industry was 6,800, as compared with 7,178 employed in 1948. The tonnage treated and gold produced are 362.98 tons and 95.53 ounces, respectively, per man and both are higher than the corresponding figures, 340.93 tons and 92.31 ounces, for the previous year.

Shortage of labour remains as the most pressing of the problems confronting the industry. The position has been met by concentrating on methods which do not require a great deal of manpower and by the introduction of mechanical methods of working. Many more men are needed before the industry can expand to full production.

The calculated value of the gold produced is £A7,977,200 as compared with £A7,132,748 for the previous year. This is the highest return since 1942.

The value of this year's output at £15 9s. 10d. per ounce is approximately £10,000,000.

Statistics relating to Gold Mining are tabulated as follows:—

Table D.—Gold Production Statistics.

Table E.—Classification of Gold Output by Goldfields and Districts.

Table F.—Classification of Gold Output, 1945-1949.

Table G.—Mines producing 5,000 ounces and over for the past five years.

Table H.—Development Footages.

The number of mines producing 5,000 ounces and over in the last five years has been decreased by the removal of Edna May Amalgamated and Phoenix mines which have both closed down because of the exhaustion of their ore bodies. New Coolgardie has been added to the list, bringing the total number of these mines to 17.

Among the smaller mines the most successful were:—

	Tons.	Fine Ounces.
Altona	273	299
Albury Heath	336	627
Apples	48	305
Barton	645	600
Bellevue	231	551*
Big Bull	154	115
Blue Bird	21	112*
Boomerang	245	1,029
Burbidge	32,235	1,982
Centipede	550	300
Clamps Central	316	294
Constance Una	109	325
Daisy	644	535
Democrat	672	942
Edwards Find	5,364	2,115
Essex	266	321
Federation	187	116
First Hit (Menzies)	126	125
First Hit (Morleys)	242	596
Four Mile	18	121
Frances Furness	423	302
Gidgie	43	512
Grace Darling Extended	390	234
Haoma	1,242	817
Happy Find	213	938
Jessie Alma	430	2,072
Lady Betty	52	169
Lady Mary	129	384*
Lady May	349	311
Lancefield	5,275	769
Melva Maie	78	193
Mount Fisher East	74	159
New South Champion	120	200
New Mexico	123	515
Nullagine View	24	503*
Oakley	218	197
Paramount	350	478
Pegasus	225	255*
Rabbit	186	143
Radio	1,841	1,569
Two Chinamen	306	444
White Horse	116	347
Yalbalgo	42	220
Yilgangie Queen	1,180	2,088

* Includes dollied and specimen gold.

TABLE D.

Gold Production Statistics.

Year.	Tons Treated. (2,240 lb.)	Total Gold Yield.	Estimated Value of Yield.	Value of Yield per ton.	Number of Men Employed.	Average Value of Gold per oz.	Average Yield per ton of ore.
	tons.	fine oz.	£A.	shillings A.		shillings A.	dwt.
1929 ...	628,400	372,064	1,580,426	50·30	4,108	84·96	11·84
1930 ...	645,344	419,767	1,874,484	58·09	4,284	89·33	13·01
1931 ...	982,163	518,045	3,042,019	61·94	5,961	117·44	10·55
1932 ...	1,327,021	599,421	4,358,989	65·70	8,695	145·44	9·03
1933 ...	1,588,979	636,928	4,884,112	61·48	9,900	153·36	8·01
1934 ...	1,772,931	639,871	5,461,004	61·60	12,523	170·69	7·22
1935 ...	1,909,832	646,150	5,676,679	59·45	14,708	175·71	6·77
1936 ...	2,492,034	852,422	7,427,687	59·61	15,698	174·27	6·84
1937 ...	3,039,608	1,007,289	8,797,662	57·99	16,174	174·68	6·64
1938 ...	3,759,720	1,172,950	10,409,928	53·38	15,374	177·50	6·24
1939 ...	4,095,257	1,188,286	11,594,221	56·62	15,216	195·14	5·80
1940 ...	4,291,709	1,154,843	12,306,816	57·35	14,594	213·15	5·38
1941 ...	4,210,774	1,105,477	11,811,989	56·10	13,105	213·70	5·25
1942 ...	3,225,704	845,772	8,840,642	54·81	8,123	209·04	5·24
1943 ...	2,051,011	531,747	5,556,756	54·185	5,079	209·00	5·185
1944 ...	1,777,128	472,588	4,966,451	55·89	4,614	210·18	5·32
1945 ...	1,736,952	469,906	5,025,039	57·86	4,818	213·87	5·41
1946 ...	2,194,477	618,607	6,657,762	60·70	6,961	215·25	5·64
1947 ...	2,507,306	701,752	7,552,611	60·25	7,649	215·25	5·59
1948	2,447,545	662,714	7,132,748	58.28	7,178	215.25	5.42
1949	2,468,297	649,572	7,977,200	64.64	6,800	245.61	5.26

TABLE E.

Classification of Gold Output for 1949 by Goldfields and Districts.

Goldfield and District.	Unclassified, Sundry Claims, Alluvial, etc. (fine ozs.)	Under 100 ozs.		100–500 ozs.		500–1,000 ozs.		1,000–2,000 ozs.		2,000–3,000 ozs.		3,000–4,000 ozs.		4,000–5,000 ozs.	
		No. of Producers.	Gold (fine ozs.).	No. of Producers.	Gold (fine ozs.).	No. of Producers.	Gold (fine ozs.).	No. of Producers.	Gold (fine ozs.).	No. of Producers.	Gold (fine ozs.).	No. of Producers.	Gold (fine ozs.).	No. of Producers.	Gold (fine ozs.).
Kimberley Goldfield	269	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Ashburton Goldfield	....	1	70	....	....	....	....	....	....	....	....	....	....	....	....
Pilbara Goldfield—															
Marble Bar	83	10	256	5	583	....	....	1	1,686	....	....	....	....	....	....
Nullagine	437	12	500	1	283	3	1,885	....	....	....	....	....	....	....	....
Peak Hill Goldfield	4	6	326	1	255	....	....	....	....	....	....	....	....	....	....
East Murchison Goldfield—															
Wiluna	182	8	360	4	992	....	....	....	....	....	....	1	3,743	....	....
Lawlers	148	4	257	....	....	....	....	....	....	....	....	....	....	....	....
Black Range	16	4	159	2	689	....	....	....	....	....	....	....	....	....	....
Murchison Goldfield—															
Cue	348	5	166	1	128	1	512	1	1,156	....	....	....	....	....	....
Meekatharra	120	12	443	7	2,005	1	627	....	....	....	....	....	....	....	....
Day Dawn	222	3	33	....	....	....	....	....	....	....	....	....	....	....	....
Mt. Magnet	389	10	200	1	288	....	....	....	....	....	....	....	....	....	....
Yalgoo Goldfield	28	2	169	2	597	....	....	....	....	....	....	....	....	....	....
Mt. Margaret Goldfield—															
Mt. Morgans	103	2	44	2	633	2	1,751	....	....	....	....	....	....	....	....
Mt. Malcolm	158	5	165	3	425	....	....	....	....	1	2,072	....	....	....	....
Mt. Margaret	81	6	109	1	347	4	3,325	1	1,029	....	....	....	....	....	....
North Coolgardie Goldfield—															
Menzies	365	11	200	3	668	....	....	....	....	....	....	....	....	....	....
Ularring	76	5	166	6	1,430	2	1,039	....	....	....	....	....	....	....	....
Niagara	48	1	75	2	498	....	....	....	....	....	....	....	....	....	....
Yerilla	102	2	68	1	225	....	....	....	....	1	2,088	....	....	....	....
Broad Arrow Goldfield	674	9	384	6	1,348	3	1,880	....	....	....	....	....	....	....	....
North-East Coolgardie Goldfield—															
Kanowna	101	3	100	2	301	....	....	....	....	....	....	....	....	....	....
Kurnalpi	8	....	....	....	....	....	....	....	....	....	....	....	....	....	....
East Coolgardie Goldfield—															
East Coolgardie	739	19	417	9	2,045	2	1,351	1	1,427	....	....	....	....	....	....
Bulong	40	2	44	....	....	....	....	....	....	....	....	....	....	....	....
Coolgardie Goldfield—															
Coolgardie	904	21	656	6	1,015	2	1,341	....	....	....	....	....	....	....	....
Kunanalling	154	3	68	1	229	....	....	....	....	....	....	....	....	....	....
Yilgarn Goldfield	318	20	515	3	567	4	1,222	2	3,550	1	2,115	....	....	....	....
Dundas Goldfield	162	5	149	1	183	....	....	1	1,241	....	....	....	....	....	....
Phillips River Goldfield	4	2	26	....	....	....	....	....	....	....	....	....	....	....	....
West Pilbara Goldfields	87	1	7	....	....	....	....	....	....	....	....	....	....	....	....
State Generally	11	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Totals	6,381	194	6,132	70	15,734	24	14,933	7	10,089	3	6,275	1	3,743	....	....

Goldfield and District.	5,000–10,000 ozs.		10,000–20,000 ozs.		20,000–30,000 ozs.		30,000–40,000 ozs.		40,000–50,000 ozs.		50,000-100,000 ozs.		Over 100,000 ozs.	
	No. of Producers.	Gold (fine ozs.).	No. of Producers.	Gold (fine ozs.).	No. of Producers.	Gold (fine ozs.).	No. of Producers.	Gold (fine ozs.).	No. of Producers.	Gold (fine ozs.).	No. of Producers.	Gold (fine ozs.).	No. of Producers.	Gold (fine ozs.).
Kimberley Goldfield	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Ashburton Goldfield	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Pilbara Goldfield—														
Marble Bar	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Nullagine	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Peak Hill Goldfield	....	....	....	....	....	....	....	....	....	....	....	....	....	....
East Murchison Goldfield—														
Wiluna	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Lawlers	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Black Range	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Murchison Goldfield—														
Cue	....	....	....	....	....	....	....	....	....	....	1	56,071	....	....
Meekatharra	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Day Dawn	1	6,007	....	....	....	....	....	....	....	....	....	....	....	....
Mt. Magnet	....	....	1	13,128	....	....	....	....	....	....	....	....	....	....
Yalgoo Goldfield	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Mt. Margaret Goldfield—														
Mt. Morgans	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Mt. Malcolm	....	....	....	....	1	23,573	....	....	....	....	....	....	....	....
Mt. Margaret	....	....	....	....	....	....	....	....	....	....	....	....	....	....
North Coolgardie Goldfield—														
Menzies	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Ularring	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Niagara	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Yerilla	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Broad Arrow Goldfield	....	....	....	....	....	....	....	....	....	....	....	....	....	....
North-East Coolgardie Goldfield—														
Kanowna	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Kurnalpi	....	....	....	....	....	....	....	....	....	....	....	....	....	....
East Coolgardie Goldfield—														
East Coolgardie	....	....	4	57,794	1	20,654	1	32,529	1	41,071	2	146,310	1	132,984
Bulong	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Coolgardie Goldfield—														
Coolgardie	1	9,299	....	....	....	....	....	....	....	....	....	....	....	....
Kunanalling	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Yilgarn Goldfield	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Dundas Goldfield	....	....	....	....	....	....	....	....	1	46,865	....	....	....	....
Phillips River Goldfield	....	....	....	....	....	....	....	....	....	....	....	....	....	....
West Pilbara Goldfield	....	....	....	....	....	....	....	....	....	....	....	....	....	....
State Generally	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Totals	2	15,306	5	70,922	2	44,227	1	32,529	2	87,936	3	202,381	1	132,984

TABLE F.

Classification of Gold Output, 1945–1949.

Range of Output.	1949.			1948.			1947.			1946.			1945.		
	No. of Producers.	Production.	Percentage of Total.	No. of Producers.	Production.	Percentage of Total.	No. of Producers.	Production.	Percentage of Total.	No. of Producers.	Production.	Percentage of Total.	No. of Producers.	Production.	Percentage of Total.
Fine ozs.		Fine ozs.			Fine ozs.			Fine ozs.			Fine ozs.			Fine ozs.	
Over 100,000	1	132,984	20·5	1	137,502	20.7	1	141,436	20.1	1	119,992	19.4	....	....	....
50,000 to 100,000	3	202,381	31·2	3	190,031	28.8	1	94,051	13.4	1	87,343	14.1	2	159,901	34.1
40,000 to 50,000	2	87,936	13·5	1	40,412	6.1	2	86,657	12.2	....	....	....	....	....	....
30,000 to 40,000	1	32,529	5·0	3	74,814	11.3	3	107,047	15.3	3	110,878	18.0	2	66,080	14.0
20,000 to 30,000	2	44,227	6·8	1	22,508	3.4	2	46,415	6.6	3	123,100	19.9	5	115,034	24.5
10,000 to 20,000	5	70,922	10·9	7	107,634	16.2	7	103,154	14.7	5	73,179	11.9	2	30,389	6.5
5,000 to 10,000	2	15,306	2·4	1	5,789	0.9	4	24,826	3.5	5	36,670	5.9	8	57,364	12.2
4,000 to 5,000	....	....	....	1	4,225	0.6	1	4,645	0.7	2	9,946	1.5	....	....	....
3,000 to 4,000	1	3,743	0·6	1	3,174	0.5	2	7,448	1·1	....	....	....	1	3,779	0.8
2,000 to 3,000	3	6,275	1·0	3	7,438	1.1	2	4,359	0.6	2	5,234	0.8	1	2,739	0.6
1,000 to 2,000	7	10,089	1·5	7	11,300	1.7	6	8,754	1.2	7	7,929	1.3	4	5,331	1.1
500 to 1,000	24	14,933	2·3	18	11,335	1.7	11	8,428	1.2	13	8,847	1.4	8	5,736	1.2
100 to 500	70	15,734	2·4	96	20,812	3.1	75	16,510	2.4	83	18,528	3.0	57	12,771	2.7
Under 100	194	6,132	0·9	206	6,503	1.0	259	7,805	1.1	272	8,022	1.3	175	5,545	1.2
Sundry Claims, etc.	....	6,381	1·0	....	19,254	2.9	....	41,217	5.9	....	9,391	1.5	....	5,238	1.1
Total	315	649,572	100·0	349	662,740	100.0	376	701,752	100.0	399	618,607	100.0	214	469,907	100.0

TABLE G.

Mines Producing 5,000 ounces and over for the Past Five Years.

Mine.	1949.			1948.			1947.			1946.			1945.		
	Tons Treated.	Ounces Gold.	Dwts. per Ton.	Tons treated.	Ounces Gold.	Dwts. per ton.	Tons treated.	Ounces Gold.	Dwts. per Ton.	Tons Treated.	Ounces Gold.	Dwts. per Ton.	Tons Treated.	Ounces Gold.	Dwts. per Ton.
1. Big Bell Mines, Ltd.	424,525	56,071	2·64	424,584	51,770	2·44	357,623	41,048	2·30	153,588	19,633	2·55	....	....	....
2. Boulder Perseverance, Ltd.	133,000	32,529	4·89	135,832	32,324	4·76	137,456	33,498	4·88	101,144	29,106	5·75	85,806	23,666	5·52
3. Central Norseman Gold Corporation, N.L.	132,930	46,865	7·05	118,763	39,150	6·59	107,750	34,411	6·39	105,640	35,959	6·95	73,488	24,669	6·71
4. Comet Gold Mines, Ltd.	1,859	1,686	18·14	2,471	2,635	21·33	2,768	3,744	27·05	12,075	7,698	12·75	10,515	6,370	12·12
5. Gold Mines of Kalgoorlie	163,552	41,071	5·02	161,516	40,412	5·00	158,337	39,138	4·94	151,871	36,758	4·84	109,334	25,357	4·64
6. Great Boulder Gold Mines, Pty., Ltd.	333,109	83,259	5·00	326,685	81,457	4·99	367,293	94,051	5·15	343,506	87,343	5·09	276,778	71,560	5·17
7. Hannan's North (Broken Hill Pty. Ltd.)	42,490	13,027	6·13	42,963	12,878	6·00	44,307	13,893	6·27	36,504	13,047	7·15	....	....	....
8. Hill 50 Gold Mine, N.L.	49,230	13,128	5·33	50,771	13,417	5·28	50,659	13,673	5·39	44,842	12,819	5·72	31,108	8,430	5·42
9. Kalgoorlie Enterprise, Ltd.	52,489	16,981	6·47	53,884	16,692	6·20	57,277	17,807	6·22	51,112	16,530	6·46	40,889	11,861	5·80
10. Lake View and Star, Ltd.	501,261	130,169	5·19	502,534	131,387	5·23	518,431	141,436	5·46	453,317	119,992	5·29	279,579	75,602	5·41
11. Mountain View Gold N.L.	3,638	6,007	33·02	1,395	5,798	83·12	1,922	12,795	133·14	1,423	4,883	68·63	1,495	7,745	103·62
12. New Coolgardie Gold Mines N.L.	24,062	9,299	7·73	....	....	....	....	....	....	....	....	....	....	....	....
13. North Kalgurli (1912), Ltd.	231,836	63,051	5·44	211,784	56,804	5·36	151,710	44,608	5·87	123,550	38,160	6·18	107,737	31,064	5·77
14. Paringa Mining and Exploration, Ltd.	91,811	17,782	3·87	100,642	22,508	4·47	99,702	21,429	4·39	99,568	22,529	4·52	81,378	20,550	5·05
15. South Kalgurli Consolidated, Ltd.	84,785	20,654	4·87	77,395	19,037	4·93	79,173	19,503	4·93	75,915	18,571	4·89	63,253	18,528	5·85
16. State Batteries	41,171	22,555	10·96	40,634	24,451	12·03	49,168	33,147	13·48	45,477	23,671	10·41	20,078	18,113	18·04
17. The Sons of Gwalia	81,395	23,573	5·79	60,093	18,139	6·03	81,510	24,986	6·13	87,683	27,056	6·17	67,871	20,792	6·13
Total	2,393,143	597,707	5·00	2,311,946	568,859	4·92	2,265,086	589,167	5·20	1,887,215	513,755	5·44	1,249,309	364,307	5·83
Other Sources (excluding large retreatment plants)	75,154	29,476	7·84	135,599	59,527	8·78	242,220	76,895	6·35	307,262	79,022	5·14	487,283	84,782	3·48
Total (excluding large retreatment plants)	2,468,297	627,183	5·08	2,447,545	628,386	5·13	2,507,306	666,062	5·31	2,194,477	592,777	5·40	1,736,592	449,089	5·17
Golden Horseshoe Sands Retreatment	....	10,004	....	....	9,982	....	....	10,648	....	....	8,810	....	....	8,079	....
Lake View and Star Retreatment	....	2,815	....	....	6,113	....	....	7,330	....	....	12,212	....	....	12,738	....
Wiluna Gold Mines Retreatment	....	3,743	....	....	11,820	....	....	10,262	....	....	....	....	....	....	....
State Batteries Tailings Treatment	....	5,827	....	....	6,440	....	....	7,450	....	....	4,808	....	....	....	....
GRAND TOTAL	2,468,297	649,572	5·26	2,447,545	662,741	5·42	2,507,306	701,752	5·60	2,194,477	618,607	5·64	1,736,592	469,906	5·41

TABLE H.

Development Footage Reported by the Principal Mines.

Goldfield.	Mine.	Shaft Sinking.	Driving.	Cross Cutting.	Rising and Winzing.	Diamond Drilling.	Total.
		Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
Peak Hill	Horseshoe Lights	100	....	842	85	520	1,547
East Murchison	Moonlight	50	203	40	50	....	343
	Oroya	....	....	....	....	314	314
Murchison	Big Bell Mines, Ltd.	1,003	1,531	1,828	1,930	1,548	7,840
	Hill 50 Gold Mines, N.L.	459	873	511	400	....	2,243
	Mountain View	46	250	....	249	....	545
Mount Margaret	Sons of Gwalia, Ltd.	61	14	202	279	1,392	1,948
	Jessie Alma	125	30	25	10	....	190
	Boomerang Gold Mine	....	90	35	15	....	140
	Happy Find	54	130	85	30	....	299
	Lancefield Gold Mine	....	513	....	190	....	703
	Local Lady	50	203	40	50	....	343
North Coolgardie	Timoni (Goldfields Australian Development, Ltd.)	....	1,402	221	745	....	2,368
	Yilgangie Queen	....	107	....	66	....	173
East Coolgardie	Boulder Perseverance, Ltd.	....	....	3,299	2,020	11,578	16,897
	Kalgoorlie Enterprise, Ltd.	75	1,423	366	384	6,305	8,553
	Gold Mines of Kalgoorlie, Ltd.	....	3,782	2,869	2,531	20,196	29,378
	Great Boulder Pty. Gold Mines, Ltd.	....	3,272	941	3,250	10,974	18,437
	Lake View and Star, Ltd.	....	12,221	2,337	6,025	7,498	28,081
	South Kalgurli Consolidated, Ltd.	....	4,872	1,360	3,082	39,253	48,567
	North Kalgurli (1912), Ltd.	....	3,805	1,624	749	4,576	10,754
	Paringa Mining & Exploration Co., Ltd.	....	3,455	1,584	581	9,875	15,495
	Haoma	40	212	26	122	....	400
	Maranoa	42	188	137	30	....	397
Coolgardie	New Coolgardie G.M., N.L.	233	2,609	550	1,385	6,595	11,372
	Hampton Areas, Ltd.	347	243	192	....	....	782
Yilgarn	Copperhead Mine	....	200	140	5	83	428
	Sunshine Reward Amalgamated	258	164	20	....	....	442
Dundas	Central Norseman Gold Corporation, Ltd.	....	1,496	490	1,263	10,573	13,822
West Pilbara	Australian Blue Asbestos, Ltd.	....	3,885	....	....	1,407	5,292
Northampton Mineral Field.	Protheroe Lead Mine	142	430	50	63	....	685
	Totals	3,085	47,603	19,814	25,589	132,687	228,778

The Jessie Alma at Gwalia was found by a party of prospectors and has yielded some exceptionally rich ore from a short shoot.

The Apples at Sandstone, the Boomerang at Burtville and Nullagine View in the Pilbara and the Gidgie at Tuckanarra are noteworthy for the production of high grade ore.

The Daisy and Haoma at Mount Monger, The Radio at Bullfinch and the Democrat at Linden have produced good tonnages of high grade ore.

OPERATIONS OF THE PRINCIPAL MINES.

East Coolgardie Goldfield.—The total ore treated in this Goldfield during 1949 was 1,644,637 tons and the gold yield was 437,405 fine ounces, which is an average of 5.32 dwts. per ton. In the previous year, 1,622,259 tons were treated for a return of 433,257 fine ounces which is an average return of 5.35 dwts. per ton.

The number of men employed was 3,683, as compared with 3,678 in the previous year.

Slightly more than 67 per cent. of the State's production was derived from this Goldfield, the proportion being slightly higher than for the previous year.

East Coolgardie District produced 437,321 fine ounces from the treatment of 1,643,637 tons of ore which is an average grade of 5.32 dwts. per ton.

Lake View and Star with a production of 501,261 tons of ore yielding 130,169 fine ounces of gold at an average of 5.19 dwts. per ton was again the State's leading producer. Both tonnage and grade are slightly below the figures for last year.

Developments during the year have been satisfactory and the mine has improved its ore reserve. There has been a slight decrease in the reserve of broken ore.

Improvements in treatment methods have resulted in an increase in gold recovery.

Great Boulder treated 333,109 tons of ore for a return of 83,259 fine ounces at an average of 5.00 dwts. Both tonnage and grade are slightly above last year's figures and the mine is still the second largest producer in the State.

Normal mining operations have continued in all sections of the mine. Ore is now being hauled from the 3,250 level at Edward's Shaft.

The Hamilton Shaft head frame has been altered to provide for skip haulage.

An electrostatic precipitator to deal with waste gases is being added to the plant.

North Kalgurli, with improved output and grade, treated 231,836 tons for a return of 63,051 fine ounces at an average of 5.44 dwts. per ton and remains third on the list of producers.

Developments have been satisfactory and normal mining operations have continued at all shafts. Preparations have been made for the resumption of operations at the Croesus Proprietary shaft. A new shaft 27 ft. x 5 ft. 6 in. in the clear is now being put down in a position south of the Main Shaft.

Ore is handled on the 830 level by a belt conveyor and the dust is minimised by the use of an exhaust system with oil air filters.

Gold Mines of Kalgoorlie recovered 41,071 fine ounces from the treatment of 163,552 tons of ore, which is an average of 5.02 dwts. per ton. It is the sixth producer, being now below Central Norseman. The mine had a good year and both tonnage and grade were slightly above last year's figures.

An extensive development programme has been carried out from the lower levels of the North Boulder.

New brick buildings have been built for the general office and survey office and new staff change rooms have been provided.

The "Paringa Junction" has been added to the Company's holdings.

Boulder Perseverance showed a slight decline in tonnage treated but the grade improved a little and the return of gold was slightly higher. Production figures were 133,000 tons for 32,529 fine ounces at an average grade of 4.89 dwts. per ton.

Developments were satisfactory and mining operations were continued at all levels.

South Kalgurli treated 84,785 tons for a return of 20,654 fine ounces, the average grade being 4.87 dwts. per ton. The grade was down slightly but increased tonnage brought the yield above last year's figures.

Stoping was continued on the known ore bodies. Development was mostly in ore of low value.

Paringa mined 91,811 tons for 17,782 fine ounces at an average of 3.87 dwts per ton. Both tonnage and grade are the lowest for some time. Considerable development was done during the year but no outstanding body of ore was discovered.

Kalgoorlie Enterprise produced 52,489 tons of ore which yielded 16,987 fine ounces of gold, an average of 6.47 dwts. per ton. This is the highest grade of ore mined on the Kalgoorlie field.

Victoria shaft was sunk a further 95 feet and a plat cut on the No. 25 level.

Hannans North (Broken Hill Pty. Ltd.) treated 42,490 tons averaging 6.13 dwts. per ton for a return of 13,027 fine ounces. Tonnage was substantially as for last year but there was a rise in head values which gave an additional return of 150 ounces. The reserves of ore in this mine are limited.

Mount Charlotte continued development work at the 500 level and is sinking two winzes below that level.

At *Mount Monger*, the *Daisy* and *Haoma* were the principal producers and development work was pushed ahead on both mines.

Bulong District.—Very little work was done here, the total return being 84 fine ounces from the treatment of 487 tons of ore.

MURCHISON GOLDFIELD.

This Goldfield, with 81,844 fine ounces from the treatment of 489,112 tons of ore, was the second highest producer and obtained 12½ per cent. of the State's gold. The average return was 3.35 dwts. per ton.

In 1948 the yield from 534,816 tons of ore was 99,081 fine ounces, the average grade being 3.71 dwt. per ton.

The number of men employed was 780 as against 967 in the previous year.

Cue District with a production of 58,381 ounces from 427,385 tons at an average of 2.73 dwts. per ton, was the principal source and almost all of this came from the *Big Bell* mine which treated 424,525 tons of ore for a recovery of 56,071 fine ounces at an average of 2.64 dwts. per ton. In the previous year 424,584 tons of ore averaging 2.44 dwts. per ton was treated for a return of 51,770 fine ounces. The increase in grade is due partly to improved head values and partly to increased extraction.

Diamond drilling for blast holes is extensively used on this mine.

Big Bell is the fourth mine in the State on a gold production basis. On the basis of tonnage treated it is second only to Lake View and Star.

The *Gidgie* at Tuckanarra with 512 ounces from 43 tons was the only other producer of note.

In the *Meekatharra District* the ore treated amounted to 7,148 tons and the gold recovered was 3,196 ounces, the average yield being 8.94 dwts. per ton. Both tonnage and grade are lower than in the previous year when 9,234 tons of ore averaging 16.63 dwts. per ton yielded 7,678 ounces of gold.

Principal producers were the Fenian Group at Meekatharra.

Meekatharra Sands Treatment was reorganised and produced only 400 ounces.

Day Dawn District produced 6,260 fine ounces of gold from the treatment of 3,989 tons of ore averaging 31.39 dwts per ton. In the previous year 1,611 tons of ore was treated for 6,006 ounces at an average of 74.56 dwts per ton. The increased tonnage and reduced grade are a reflection of the increased output of ore at *Mountain View*. This Mine treated 3,638 tons of ore for 6,007 ounces at an average of 33.02 dwts. per ton as compared with 1,395 tons for 5,798 ounces at an average of 83.12 dwts. per ton in the previous year.

Mount Magnet District with 14,005 ounces from the treatment of 50,591 tons of ore averaging 5.53 dwts. per ton, was a little behind the figures for the previous year which were 15,316 ounces from 52,675 tons averaging 5.81 dwts. per ton.

The outstanding producer was *Hill 50* with 49,230 tons treated for a return of 13,128 ounces at an average of 5.33 dwts. per ton as compared with 50,771 tons treated for a return of 13,471 ounces, at an average of 5.28 dwts. per ton for the previous year. Sinking of the new shaft is well advanced.

DUNDAS GOLDFIELD.

This Goldfield produced 48,600 fine ounces of gold from the treatment of 136,311 tons of ore, averaging 7.13 dwts. per ton. The figures for the previous year are 40,074 ounces from the treatment of 120,849 tons, averaging 6.64 dwts. per ton. There is thus an increase in both tonnage and grade and this goldfield retains its position as third on the list of producers. The number of men employed was 456 as against 466 men the previous year.

Central Norseman Gold Corporation is the principle producer, this year's figures being 132,930 tons treated for 46,865 fine ounces of gold, the average return being 7.05 dwts. per ton. In the previous year this mine treated 118,763 tons of ore for a return of 39,150 fine ounces at an average of 6.59 dwts. per ton. It will be seen that both tonnage and grade have increased.

This mine is now fifth on the list of producers.

The new Regent Shaft has been sunk to an underlay depth of 2,680 feet and the 2,500 level is being equipped as the main haulage level.

Movement of ore in open stopes by sluicing was introduced on an experimental basis.

Developments on the *Princess Royal Mine* have been satisfactory and the Company has very satisfactory reserves of ore.

Additional power and crushing facilities to bring the through put to 180,000 tons per annum are to be installed.

Dundas Gold Mines treated 2,559 tons for a return of 1,241 fine ounces from the *Empress Mine.*

MOUNT MARGARET GOLDFIELD.

In this goldfield the treatment of 90,755 tons of ore averaging 7.45 dwts. per ton yielded 33,816 fine ounces of gold. In the previous year 68,049 tons of ore averaging 7.92 dwts. per ton yielded 26,940 fine ounces. There has thus been a considerable increase in tonnage although the grade is down nearly half a dwt. per ton. The average number of men employed increased from 464 in the previous year to 479.

Mount Morgans District produced 2,532 fine ounces from the treatment of 1,797 tons of ore averaging 28.19 dwts. per ton. The principal producers were the *Democrat, Local Lady* and *North Democrat* and treatment of sands at the Linden State Battery yielded 810 ounces.

Mount Malcolm District produced 26,393 ounces from the treatment of 82,693 tons of ore averaging 6.38 dwts. per ton. *Sons of Gwalia* was again the principal producer. This mine treated 81,395 tons for a return of 23,573 fine ounces at an average of 5.79 dwts. per ton. The figures for the previous year were 60,093 tons of ore treated for a return of 18,139 fine ounces at an average of 6.03 dwts. per ton. The increase in tonnage treated has resulted in an increased output of gold in spite of a slight drop in grade.

The Jessie Alma, which was discovered during the year by a party of prospectors produced some sensational values, the return from 429 tons being 2,072 fine ounces including 455 ounces of dollied and specimen gold. Small returns were obtained from the State Battery at Darlot, and Reefer Battery at Leonora.

The Mount Margaret District treated 6,265 tons for a recovery of 4,891 fine ounces, the average return being 15.61 dwts. per ton. The figures for the previous year were 3,736 tons treated for a return of 3,872 fine ounces at an average of 20.76 dwts. per ton. The increased tonnage is due mainly to the operation of the *Lancefield,* which treated 5,276 tons of ore for a return of 769 fine ounces, the average being 2.92 dwts per ton. The *Boomerang,* with 1,028 fine ounces from the treatment of 245 tons, and the *Happy Find,* with 938 fine ounces from 212 tons, produced a considerable proprotion of the gold and *United Gold Recoveries* and the State Battery produced, respectively, 635 fine ounces and 983 fine ounces of cyanide gold. The *White Horse* at Mount Barnicoat produced 347 fine ounces from the treatment of 116 tons.

COOLGARDIE GOLDFIELD.

This goldfield produced 13,664 ounces from the treatment of 41,261 tons of ore, the average grade being 6.62 dwt. per ton. In the previous year, the production from 24,529 tons of ore was 8,975 ounces at an average of 7.32 dwts. per ton. The increase is due principally to the operations of New Coolgardie Mines. The average number of men employed was 337, as against 283 men in the previous year.

The *Coolgardie District* treated 396,941 tons for a recovery of 13,214 ounces, the average return being 6.66 dwt. per ton.

New Coolgardie, with 9,299 ounces from the treatment of 24,062 tons averaging 7.73 dwts. per ton, was the principal producer. *Fairplay* produced 560 ounces from the treatment of 9,882 tons of ore and the State Battery obtained 781 fine ounces from the treatment of battery tailings. Prospectors in the Coolgardie area obtained 689 fine ounces.

The *Kunanalling District* produced 450 fine ounces from 1,568 tons, the biggest producer being the *Newhaven* at Kintore with 229 ounces from 835 tons.

YILGARN GOLDFIELD.

Production from 42,149 tons of ore was 8,287 fine ounces, the average grade being 3.93 dwts. per ton. In the previous year the treatment of 37,538 tons yielded 12,077 fine ounces, the average grade being 6.43 dwts. per ton.

This year has been the poorest experienced by this goldfield for many years. The increased tonnage is due to the operations of *Burbidge Gold Mines* where the ore treated was increased by 9,120 tons.

The flotation of *Great Western Consolidated* should bring into production several mines on which only exploratory work was done in the past year. The lack of satisfactory crushing facilities in the southern part of the field has handicapped the Marvel Loch district.

The number of men employed was 222 as compared with 330 in the previous year.

At Parker's Range the *Scots Greys* installed a cyanide plant but operations have been limited by shortage of water. *Constance Una* and *Centipede* operated continuously for fair returns.

The *Burbidge Gold Mines* at Marvel Loch treated 32,235 tons of lateritic ore for a return of 1,982 fine ounces. The average recovery of 1.23 dwts. per ton is the lowest grade of ore to be successfully treated. For the previous year 23,115 tons of ore were treated for the recovery of 2,089 fine ounces, the average return being 1.8 dwts. per ton. The increased tonnage of ore treated has almost maintained the gold production figures in spite of the lower grade.

Sunshine Reward treated 4,364 tons for a return of 2,115 fine ounces at an average of 9.69 dwts. per ton. The previous year's figures were 4,598 tons for 1,814 ounces averaging 7.89 dwts. per ton. In addition to this satisfactory result, a heavy development programme has been carried out. The new main shaft has been sunk to 273 feet and a crosscut put out to connect with the level drive. Extension of the existing drives developed satisfactory ore.

Additions to the treatment plant which will bring the capacity to 12,000 tons annually are in progress.

The *Marvel Loch* and *Firelight* mines have been re-opened.

The *Radio* mine at Bullfinch treated 1,841 tons for 1,569 ounces, the average return being 17.05 dwt. per ton. The figures for the previous year were 1,635 tons treated for a return of 1,769 ounces, the average value being 21.64 dwts. per ton. Developments were satisfactory. This mine uses tungsten carbide detachable bits.

NORTH COOLGARDIE GOLDFIELD.

Production from this goldfield has shown a considerable increase. The treatment of 5,347 tons of ore yielded 7,049 fine ounces of gold, which is an average of 26.37 dwts. per ton. In the previous year the ore treated was 6,414 tons and the gold recovered was 6,116 ounces, the average return being 19.07 dwts. per ton.

The number of men employed was 281 as compared with 310 in the previous year.

Menzies District produced 999 tons of ore which yielded 1,233 fine ounces, the average return being 24.69 dwts. per ton. The tonnage is considerably lower than for the previous year but the grade is a little bigger principally due to the greater proportion of retreatment gold. Figures for the previous year are 1,847 tons of ore averaging 23.49 dwts. per ton for a return of 2,169 fine ounces.

No ore was treated at the *Timoni* but some 5,000 tons of ore was stock piled and progress was made with the erection of the treatment plant.

In *Ularring District* 1,869 tons of ore yielded 2,712 fine ounces of gold, the average value being 29.02 dwts. per ton. The figures for the previous year were 1,822 tons of ore treated for 1,790 fine ounces at an average of 19.75 dwts. per ton. *The First Hit, Paramount* and *Two Chinamen* at Morleys Find all produced good tonnages of high grade ore.

Niagara District produced 818 tons of ore averaging 15.18 dwts. per ton for a return of 621 fine ounces. In the previous year, the treatment of 947 tons of ore returned 797 fine ounces, the average being 16.83 dwts. per ton. Crushings close to one ounce per ton in value were obtained from the *Altona* and *New South Champion* at Kookynie.

In the *Yerilla District* the return from 1,661 tons of ore averaging 29.90 dwts. per ton was 2,483 fine ounces. Production in the previous year was 1,789 tons of ore averaging 13.951 dwts. per ton for 1,252 fine ounces. The main supplier was the *Yilgangie Queen* where tributers obtained 2,088 fine ounces from 1,180 tons of ore. Development work continued at the *Porphyry* where additions were made to power units and housing and water supply were improved.

EAST MURCHISON GOLDFIELD.

The production in this goldfield was 6,546 fine ounces, which was obtained from the treatment of 3,216 tons of ore averaging 40.71 dwts. per ton. In the previous year 17,910 fine ounces of gold was obtained from the treatment of 11,800 tons of ore, the average grade being 30.36 dwts. per ton.

Production of ore has declined considerably. The high average grade is due to gold from retreatment at the Wiluna Gold Mines.

The number of men employed was 134 as compared with 183 men in the previous year.

Lawlers District obtained 405 fine ounces of gold from the treatment of 756 tons of ore at an average of 10.71 dwts. per ton. In the previous year 1,213 fine ounces was obtained from the treatment of 3,758 tons of ore averaging 6.46 dwts. per ton.

Wiluna District obtained 5,277 fine ounces from the treatment of 1,631 tons, the average being 64.71 dwts. per ton. Production for the previous year was 13,855 fine ounces from 5,292 tons at an average of 52.36 dwts. per ton.

The main centres of production were Corboy's and Wiluna, with *Mount Fisher East, Old Toscana* and *Essex* the most successful. Wiluna gold mines retreatment obtained 3,743 fine ounces.

The *Black Range District* produced 864 fine ounces from the treatment of 830 tons of ore averaging 20.82 dwt. per ton.

Production in the previous year amounted to 2,677 fine ounces from the treatment of 2,730 tons averaging 19.61 dwts. per ton. Although there has been some reduction in tonnage, the grade of ore produced is still very good. The best results were obtained by *Apples* at Hancocks and *Lady Mary* at Sandstone.

PILBARA GOLDFIELD.

Production in this field showed a serious decline. Ore treated amounted to 5,498 tons and the gold recovered was 5,712 fine ounces, equivalent to 20.78 dwts. per ton. In the previous year 11,173 tons of ore averaging 15.27 dwts. per ton was treated for a recovery of 8,529 fine ounces of gold.

The number of men employed was 102 as compared with 134 in the previous year.

In the *Marble Bar District,* the *Comet* Gold Mines treated 1,860 tons for a recovery of 1,686 fine ounces. There was no other outstanding producer, *Federation* with 116 fine ounces from 187 tons of ore being the best. The total production from the district was 2,608 fine ounces from 3,755 tons averaging 13.89 dwts. per ton. Production for the previous year was 3,848 ounces from the treatment of 4,844 tons averaging 15.88 dwts. per ton.

Production in the *Nullagine District* also declined. Ore treated amounted to 1,743 tons and the gold yield was 3,104 fine ounces which is an average of 35.61 dwts. per ton. In the previous year, the treatment of 5,329 tons of ore yielded 4,360 fine ounces, which is an average of 13.78 dwts per ton.

There was no production at *Blue Spec* but the mine is being reconditioned. The *Barton* and the *Nullagine View* both produced good tonnages of high grade ore.

BROAD ARROW GOLDFIELD.

In this goldfield 5,035 tons of ore averaging 17.03 dwts. per ton yielded 428 fine ounces. The tonnage produced is higher than in the previous year and there has been a slight decline in grade. The figures for the previous year are 4,155 tons of ore averaging 17.74 dwts. per ton treated for 2,686 fine ounces.

The number of men employed was 181, the same as for last year.

The most successful mines were the *Bellevue* at Black Flag and the *New Mexico* at Christmas Reef.

YALGOO GOLDFIELD.

In this goldfield the treatment of 1,771 tons produced 793 fine ounces of gold, the average grade being 19.28 dwts. per ton. The number of men employed was 25 as against 36 in the previous year.

PEAK HILL GOLDFIELD.

The ore treated in this goldfield amounted to 1,166 tons and the gold recovered was 585 ounces, which is an average of 10.03 dwts. per ton. In the previous year the output from 3,044 tons was 960 fine ounces, the average grade being 6.31 dwts. per ton. The number of men employed was 38 as compared with 48 in the previous year.

NORTH EAST COOLGARDIE GOLDFIELD.

The goldfield produced 511 fine ounces of gold from the treatment of 1,321 tons of ore, the average grade being 7.74 dwts. per ton.

In the previous year 908 fine ounces was obtained from the treatment of 791 tons of ore averaging 22.96 dwts. per ton. The number of men employed was 49 as against 58 in the previous year.

KIMBERLEY GOLDFIELD.

The production of 269 fine ounces of dollied gold was reported.

ASHBURTON GOLDFIELD.

The only producing mine in this goldfield is the *Star of the West* which treated 360 tons of ore for a recovery of 70 fine ounces of gold.

PHILLIPS RIVER GOLDFIELD.

The total production in this goldfield was 30 fine ounces.

WEST PILBARA GOLDFIELD.

Prospectors' operations produced 94 fine ounces of gold.

GASCOYNE GOLDFIELD.

No production was reported.

COAL MINING.

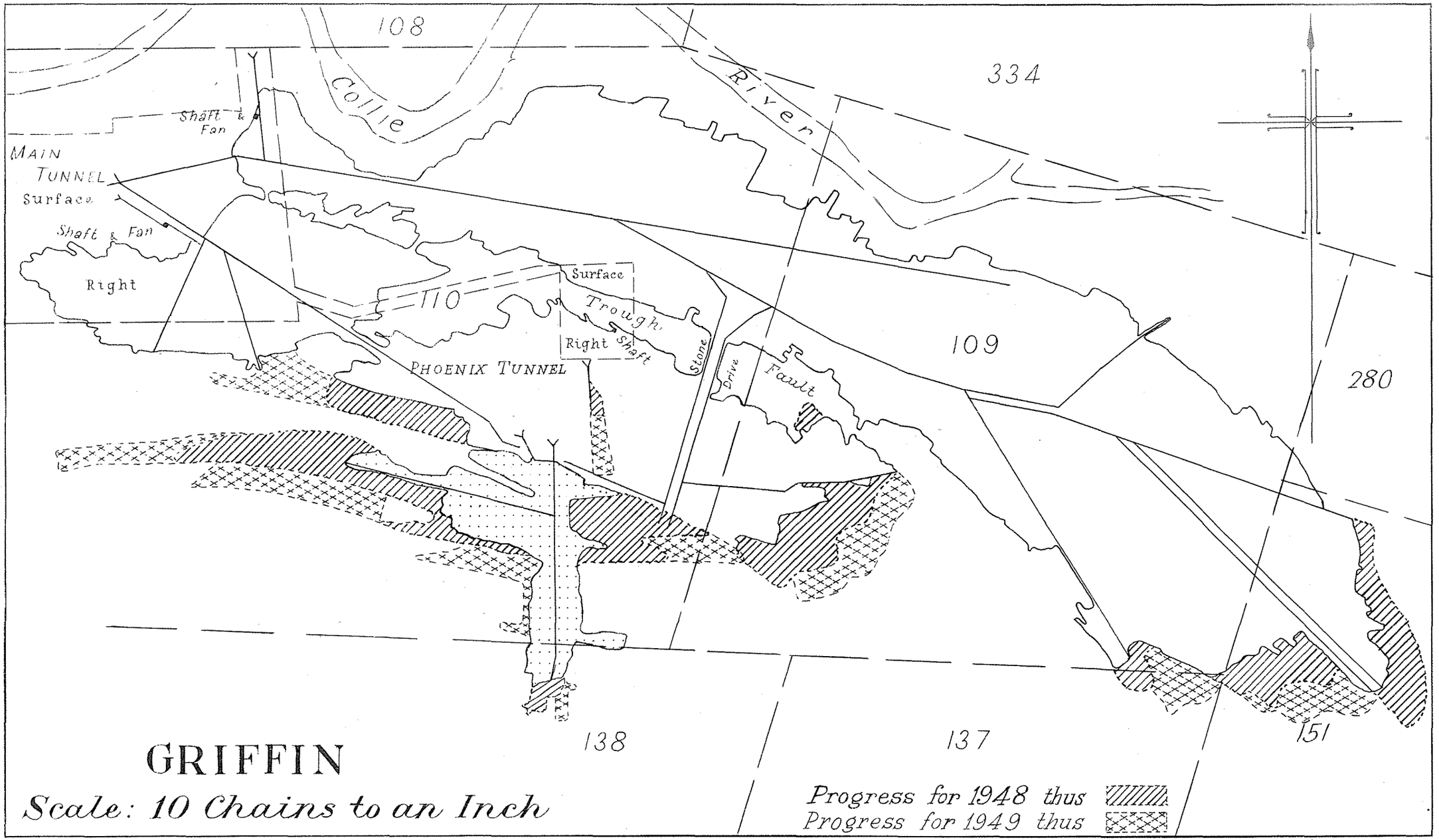
The output of coal from the Collie Coalfield during 1949 is compared with the output for 1948 in the following table:—

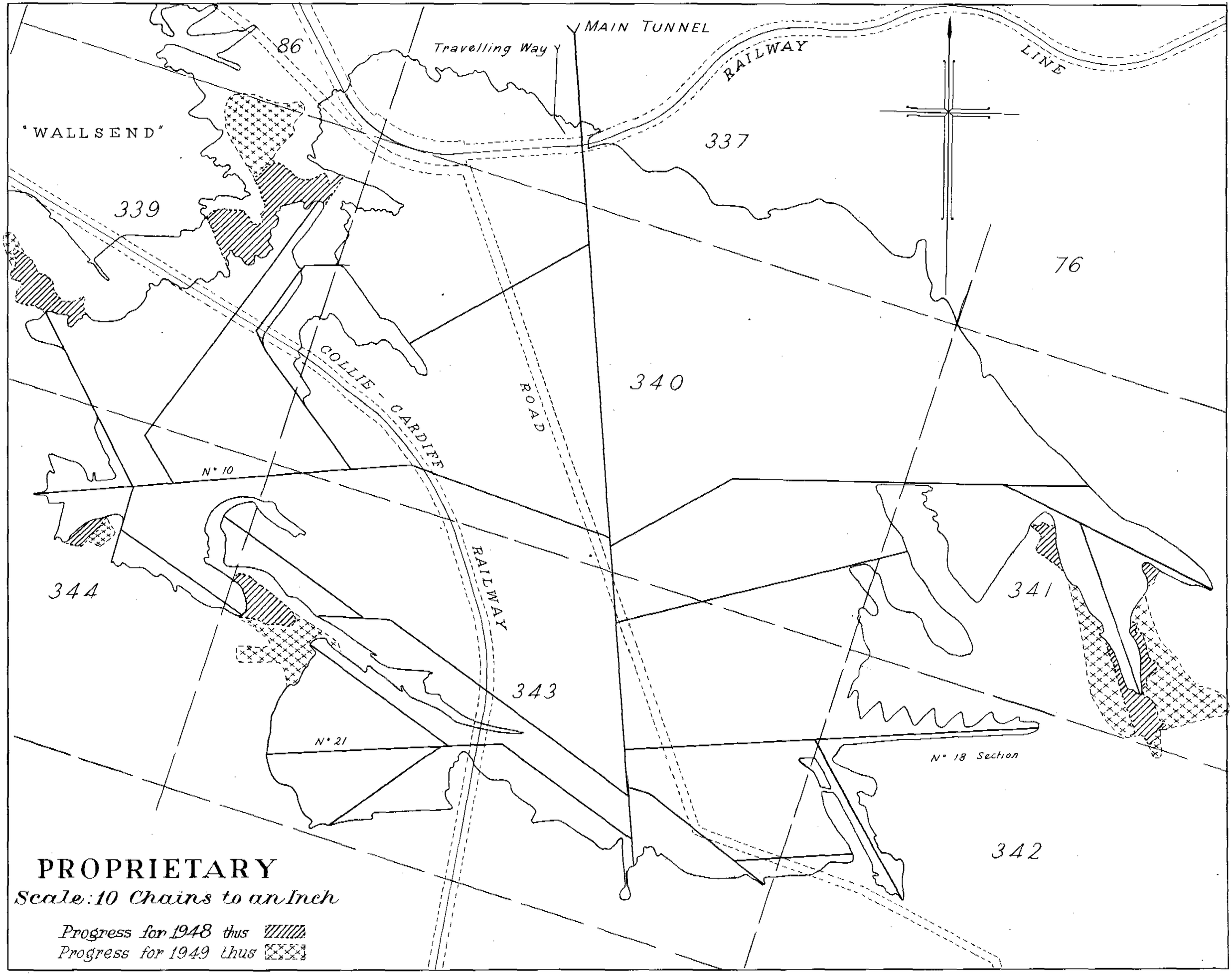
Mine.	1949.		1948.	
	Tons.	£A.	Tons.	£A.
Proprietary	135,804	175,959	139,616	167,804
Co-operative	77,531	97,151	80,885	96,062
Cardiff	108,038	139,134	97,135	116,043
Stockton	86,296	108,567	106,248	126,547
Stockton Open Cut	140,307	176,322	111,422	132,295
Wallsend Open Cut	....	....	34,421	40,876
Black Diamond Open Cut	66,344	84,581	105	124
Total, Amalgamated Collieries	614,320	781,714	569,832	679,751
Griffin	68,191	95,304	89,435	109,931
Wyvern	65,108	91,116	72,192	88,735
Phoenix	2,975	4,110	1,480	1,819
Total, Griffin Collieries	136,274	190,530	163,107	200,485
GRAND TOTAL....	750,594	972,244	732,939	880,236

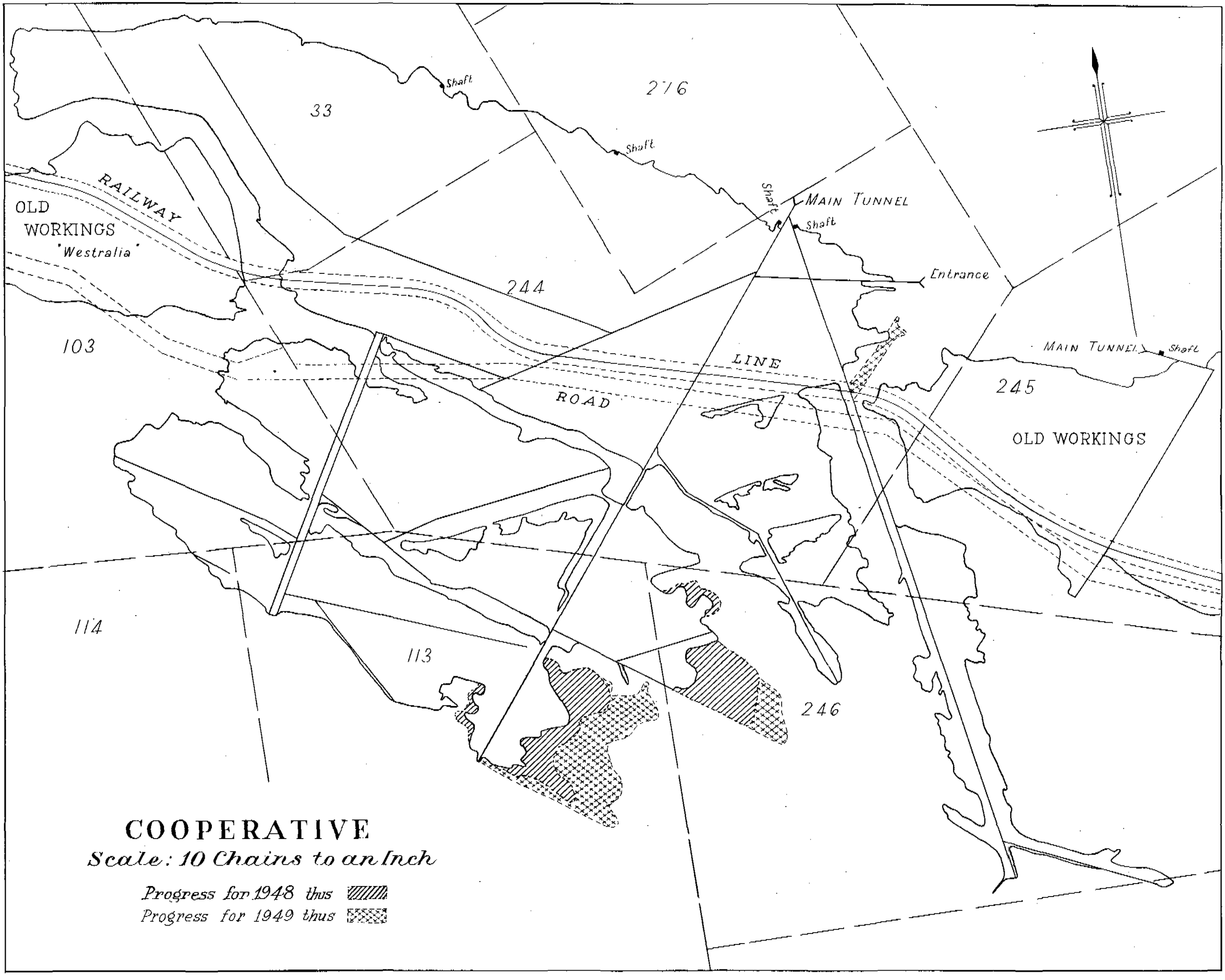
The total output for the year was 750,594 tons which, as it exceeds the previous year's total of 732,939 tons, is again a record. The output from the underground mines was 543,943 tons, which is a decrease of 43,048 tons as compared with 586,991 produced in the previous year.

Amalgamated Collieries produced 407,669 tons from underground mines, and this is less by 16,215 tons than the amount of 423,884 tons produced in the previous year from the same sources.

The output of the Griffin Collieries fell from 163,107 to 136,274—a decrease of 26,833 tons.


108
Collie
River
334
Shaft & Fan
MAIN TUNNEL Surface
Shaft & Fan
Right
110
Surface
Trough
Right Shaft
Stone
Drive
Fault
PHOENIX TUNNEL
109
280
138
137
151
GRIFFIN
Scale: 10 Chains to an Inch
Progress for 1948 thus
Progress for 1949 thus


MAIN TUNNEL
Travelling Way
RAILWAY
LINE
86
"WALLSEND"
339
337
76
340
COLLIE - CARDIFF
ROAD
RAILWAY
N° 10
344
343
341
N° 21
N° 18 Section
342
PROPRIETARY
Scale: 10 Chains to an Inch
Progress for 1948 thus
Progress for 1949 thus


Shaft
33
216
Shaft
RAILWAY
OLD
WORKINGS
'Westralia'
Shaft
MAIN TUNNEL
Shaft
Entrance
244
103
LINE
ROAD
MAIN TUNNEL
Shaft
245
OLD WORKINGS
114
113
246
COOPERATIVE
Scale: 10 Chains to an Inch
Progress for 1948 thus
Progress for 1949 thus

77

Loc 1383

288

289

79

TOP SEAM

291

78

Loc 4382

MAIN TUNNEL

OPEN CUT

357

358

271

Internal Shaft

TOP SEAM

359

360

STOCKTON

Scale : 10 Chains to an Inch

Progress for 1948

Progress for 1949

127

128

129

Loc

MAIN TUNNEL
Travelling Way

Air Shaft

4386

373

COLLIE

201

Extraction of Tops

ROAD

202

CARDIFF

Extraction of Tops

RAILWAY

203

224

225

203

CARDIFF

Scale: 10 Chains to an Inch

Progress for 1948 thus ////////

Progress for 1949 thus XXXXX

Open cut coal increased by 60,703 tons, from 145,948 tons to 206,651 tons.

The following table sets out the position:—

Source of Coal.	1949.	1948.	Remarks.
	Tons.	Tons.	
Amalgamated Collieries Mines	407,669	423,884	Decrease of 16,215 tons.
Griffin Mines	136,274	163,107	Decrease of 26,833 tons.
Total Underground Coal	543,943	586,991	Decrease of 43,048 tons.
Open Cut Coal	206,651	145,948	Increase of 60,703 tons.
GRAND TOTAL....	750,594	732,939	Increase of 17,655 tons.

A strike which lasted for three weeks is partly responsible for the lag in underground production. The only mine to record an increased production was the Cardiff.

Mechanical coal winning units consisting of arc-wall cutters, Joy loaders and shuttle cars have been purchased for two mines but neither set of equipment is yet in operation.

Supplies of coal have been sufficient for local requirements and new methods of utilising Collie coal have been developed.

Some progress has been made with the provision of amenities and cap lamps have been introduced in some mines.

In the *Proprietary Mine* work continued in 10 and 11 sections and some preparatory work was done in 21 section. A fault has been encountered between the workings from 11 section and 18 section.

In the *Co-operative Mine* the main workings were to the left near the bottom of the main dip and some development was done in No. 3 east section.

At the *Cardiff Mine* the extraction of top coal continued and this mine produced its largest output for several years. Development of the lower seam is proceeding.

The output from the *Stockton Mine* was considerably lower than for the previous year. A considerable proportion of this coal was won from the top seam.

In the *Griffin Mine* both the "loader" section and 10 slants were worked, the output being less than for the previous year.

Output at the *Wyvern Mine* was also down but considerable work has been done in preparing for the mechanisation of the left-hand workings.

Preliminary development work was continued at the *Phoenix*.

Stockton Open Cut again provided valuable coal at times when it was most needed and the *Black Diamond Open Cut* has opened up well.

Western Collieries are proceeding with preliminary arrangements but are not yet into production.

MINERALS OTHER THAN GOLD OR COAL.

The value of minerals other than gold or coal produced during the year was £645,001. This value is based on the shipments finalised during the year and would therefore contain certain shipments in transit at the end of 1948. It does not include shipments in transit at the end of 1949. The value of precious metals recovered from base metal concentrates is included.

Values are calculated on the basis of net return f.o.b. Fremantle or other port for exported minerals and f.o.r. at point of shipment for local minerals.

Silver included in gold bullion which totalled 194,721 fine oz. valued at £49,246 is not included in the above figure.

The value of minerals produced in 1948 was £503,802, so that there has been a very considerable increase in mineral production. The factors responsible have been the high prices offering for base metals and the keen demand for industrial minerals.

Notes on the various minerals are given below.

Alunite.

The State Allunite Industry treated 32,264 tons of Allunite at its works at Chandler for the recovery of 1,448 tons of crude potash valued at £43,417. In the previous year, 39,131 tons was treated for 1,778 tons of salts valued at £49,430. A process for the production of pure potassium chloride and sodium sulphate was further developed and confirmed. Costs have risen to such an extent that the economics of the proposed process are seriously affected. In December, production was suspended pending investigation of possible alternative processes.

Antimony.

The value of 9.49 tons of metallic antimony obtained during the year was £954. Concentrates from Blue Spec amounting to 5.88 tons yielded 1.28 tons of metal and 15.80 tons crude ore from the Nullagine district yielded 8.21 tons.

Arsenic.

Clean-up operations at Wiluna produced 32.75 tons of crude arsenic valued at £983.

Asbestos.

No anthophyllite asbestos was produced during the year. L. G. Hancock at Nunyerry produced 141 tons of Chrysotile valued at £8,503.

Australian Blue Asbestos produced 1,156 tons of Crocidolite valued at £116,828.

Corresponding figures for the previous year were 71 tons of Chrysotile valued at £5,591 and 607 tons of Crocidolite valued at £27,997.

The production figures include 151 tons of Crocidolite valued at £12,563 which was produced during 1948 but was not reported until this year.

Allowing for this, the increase in production amounts to 30 per cent. on the 1948 figure and the unit price has increased from £53 to £105 per ton.

Bentonite.

The production of bentonite from the Marchagee deposit was only 150 tons valued at £450, a decrease of 119 tons and £356 on the previous year's production.

Beryl.

The total production for the year was 20.45 tons containing 239.58 units and valued at £1,497. The average assay value was 11.7 per cent. BeO. In the previous year the corresponding figures were 35 tons containing 336 units valued at £2,034, the average assay value being 9.6 per cent. BeO.

Napier Downs Station in the West Kimberley Goldfield was the source of 3½ tons and the remainder was obtained from Yinnietharra.

No production was reported from the Pilbara Goldfield which has formerly produced a considerable amount of beryl.

Clays.

The total production of various clays amounted to 10,047 tons valued at £11,813. Of this total 4,131 tons valued at £8,262 was pottery clay mined at Goomalling and used by Brisbane & Wunderlich Ltd.; while the remainder was fireclay for the manufacture of firebricks etc., and a small quantity of bauxitic clay used in cement manufacture.

In the previous year production was 4,859 tons valued at £4,113, so that the current year's output is double that for the previous year.

Copper.

There has been little response to the increased price offering for copper and there is no operating mine of any size. The ore sent to smelters amounted to 49 tons containing 4.83 tons of metal valued at £630, the average grade being 9.9 per cent. Carbonate ores for use as fertiliser amounted to 254 tons valued at £2,821, the average grade being 9.8 per cent.

In the previous year 259 tons of ore averaging 11.36 per cent. and valued at £2,204 was used for fertiliser.

Dolomite.

The Mount Magnet deposit again supplied the requirements of the local steel foundaries. Production amounted to 49.5 tons valued at £248 as compared with 107 tons valued at £536 in the previous year.

Felspar.

Australian Glass Manufacturers Co. Pty. Ltd. produced 1,049 tons valued at £3,934 from the quarry at Londonderry. This is similar to the return for the previous year when 1,011 tons, valued at £3,538 was obtained.

Glass Sand.

From Lake Gnangara and Wanneroo amounted to 986 tons valued at £1,014, which is approximately double the output of 517 tons valued at £644 for the previous year.

Glauconite.

The Gingin deposits produced 1,018 tons of Greensand containing 204 tons of Glauconite, which is processed for use in water softeners. The estimated value is £5,287. In the previous year a somewhat higher production was reported, the figures being 1,595 tons valued at £7,975.

Gypsum.

From the dry lakes in the central part of the State is used in the manufacture of plaster board. Considerable increases were recorded both last year and the previous year, but this year the position has been more stable. The total production of 25,907 tons is valued at £18,610 as compared with 25,521 tons valued at £35,173 for the previous year.

Iron.

The State Charcoal Iron Industry at Wundowie smelted 12,524 tons of ore and produced 6,609 tons of pig iron valued at £66,296. In the previous year 7,222 tons of ore was smelted to produce 3,333 tons of pig iron valued at £26,165.

Ilmenite.

A parcel of beach sands, 72 tons in weight, has been exported for trial. There is no information as to the mineral content and it has been placed under this heading with a nominal value of £256.

Kaolin.

The Mount Kokeby deposits produced 80 tons valued at £160, as compared with 146 tons of similar value in the previous year.

Kyanite.

No production was reported.

Lead.

A total of 2,922 tons of ore and concentrate containing lead, silver and zinc was exported. These shipments contained 1,966 tons of lead, 35 tons of zinc and 9,992 ounces of silver. The value was £154,776. In the previous year 2,192 tons of concentrate valued at £114,331 was produced.

The principal producer, the Protheroe Mine at Nabawa, with 835 tons of concentrate valued at £54,044, was somewhat below last year's figures of 1,248 tons of concentrate worth £86,603.

The Northampton Mineral Field produced 1,835 tons, valued at £100,899.

Producers in Uaroo, Kooline and Wyloo areas shipped 720 tons, valued at £37,349.

In the Napier Range area 33 tons of ore valued at £1,482 was produced.

The price per ton of concentrate averages £53 for the current year and £52 for the past year. The slump which occurred early in the year resulted in a considerable loss but the position has been largely restored by currency changes.

Magnesite.

The Charcoal Iron Industry used 1,986 tons out of a total of 2,034 tons, valued at £4,714. The production in the previous year was 962 tons, valued at £3,176.

Manganese.

The Peak Hill deposits yielded 9,420 tons of manganese ore valued at £56,289. In the previous year 1,645 tons valued at £10,442 was produced.

Pigments.

The production of ochre amounted to 44 tons valued at £366 as compared with 566 tons valued at £6,792 in the previous year. Both yellow ochre (28 tons) and red ochre (16 tons) were obtained.

Pyrites.

Norseman Gold Mines produced 31,299 tons of ore and concentrate containing 12,981 tons of sulphur valued at £125,857. In the previous year 37,409 tons of ore and concentrate containing 15,729 tons of sulphur valued at £164,203 was obtained. Satisfactory reserves have been established.

Sillimanite.

No production was reported.

Silver.

In gold bullion amounting to 194,721 fine ounces and in lead concentrates, 9,992 fine ounces, making a total of 204,713 fine ounces.

Talc.

Universal Milling Co. Ltd. obtained 181 tons of talc valued at £2,375 from the Three Springs deposit.

Tantalite.

Magnetic treatment of the tin concentrates from Greenbushes yielded 2,606 lb. of tantalite valued at £286.

Tin.

The total production was 34.66 tons of concentrate valued at £13,079, as compared with 36.99 tons valued at £12,985 in the previous year. Greenbushes produced 3.14 tons, Cooglegong 6.44 tons, Moolyella 19.87 tons and other places in the Pilbara Goldfield 5.21 tons.

Tungsten.

The total production of concentrate was 1,294 lb. containing 36.94 units of WO_3 and valued at £219. In the previous year the production of 16,275 lb. of concentrates valued at £3,913 was reported.

Vermiculite.

Crude vermiculite amounting to 162 tons of which 139 tons was obtained at Young River and 23 tons at Bulong was mined during the year.

Perth Modelling Works treated 24.5 tons and the remainder was exported.

E. E. BRISBANE,
Assistant State Mining Engineer.

APPENDIX No. 1.

Coal Mines Regulation Act, 1946.

ANNUAL REPORT OF THE BOARD OF EXAMINERS FOR MINE MANAGERS, UNDER MANAGERS AND DEPUTIES.

Office of the State Mining Engineer,
Mines Department, Perth.
14th August, 1950.

Under Secretary for Mines:

We submit herewith, for the information of the Hon. Minister for Mines, the Annual Report of the Board of Examiners for the year 1949.

April Examination.—No candidates presented themselves for this examination,

October Examination.—There was one candidate who presented himself for a First Class Certificate of Competency as a Mine Manager. This candidate was unsuccessful.

Six candidates sat for the examination for Second Class Certificates as Under Managers, two of whom passed and were issued with certificates.

There were three candidates for Third Class Certificates as Deputies, and all of these passed and were issued with certificates accordingly.

The following is the list of successful candidates—

Second Class Certificate of Competency as Under Manager—

Cashmore, George.
Cullen, H. A.

Third Class Certificate of Competency as Deputy—

Elias, Jack.
Howden, Robert.
Gillespie, Joseph.

A First Class Reciprocal Certificate of Competency was granted to Mr. George Wainwright, who was the holder of a First Class Certificate of Competency granted in Great Britain.

Copies of the papers set for the examination held in October, 1949, are attached to this report.

JOHN S. FOXALL,
State Mining Engineer, Chairman.
H. A. ELLIS,
Government Geologist, Member.
JAMES GILLESPIE,
Senior Inspector of Mines, Collie, Member.

Western Australia.

Department of Mines.

The Coal Mines Regulation Act, 1946.

Examination for First Class Certificate of Competency as Mine Manager.

SUBJECT: ARITHMETIC.

Wednesday, 19th October, 1949—9 a.m. to 11 a.m.

Possible Marks.		
17	(1)	Using logarithms find the value of:— $\dfrac{7 \times 14 \times \sqrt{2008} \times 1856 \times 144}{3{\cdot}1416 \times \frac{19}{20} \times \frac{3056}{2737} \times \sqrt{102}}$
16	(2)	(a) Given PA — KSV^2, express V^2 in terms of the other factors. (b) Resolve into factors $X^3 - X^2 - X^4$. (c) Resolve into factors $12X^2Y - 8XY^2 - 4XY$.
17	(3)	A Colliery Company have taken up a piece of land for building houses at a lease fee of £20 per acre. A plot for housing scheme measures 140 yards long by 50 yards in depth, and it is proposed to erect 56 houses as double bungalows, in two back-to-back rows. What will be the fee for each house (to nearest shilling)?
		If wooden fence is erected between each double bungalow and along the bottom of each garden at a cost of 4s. 6d. per foot length, what would be the cost of the fence?
17	(4)	10 cubic inches of cast iron and 8 cubic inches of brass weigh 5 lb. in all; 5 cubic inches of cast iron and 9 cubic inches of brass weigh 4 lb. in all. Find the weight of a cubic inch of each.
16	(5)	A pump house is 18 feet in length; if it were 3 feet more in width area would be 234 square feet. Find its width.
17	(6)	A colliery reservoir is 100 feet long and 60 feet wide at the bottom 10 feet in height and the sides are at an angle of 45°. Find the number of gallons of water and the weight in tons it will contain when full.
100		

Western Australia.

Department of Mines.

The Coal Mines Regulation Act, 1946.

Examination for First Class Certificate of Competency as Mine Manager.

SUBJECT: GEOLOGY.

Wednesday, 19th October, 1949—11 a.m. to 1 p.m.

Possible Marks.		
20	(1)	Outline the geological processes associated with the formation of a coal field based on the assumption that the coal has been formed according to either the *in situ* theory or the drift theory.
20	(2)	Discuss briefly with sketches types of dislocations likely to be met with in coal seams.
20	(3)	Describe the following rock types— Sandstone. Grit. Shale. Conglomerate. Basalt. Granite.
20	(4)	What data would you use in an attempt to correlate coal seams intersected in bore holes in widely separated parts of a coal field?
20	(5)	Discuss irregularities in thickness likely to be encountered in coal seams.
100		

Western Australia.

Department of Mines.

The Coal Mines Regulation Act, 1946.

Examination for First Class Certificate of Competency as Mine Manager.

SUBJECT: MACHINERY.

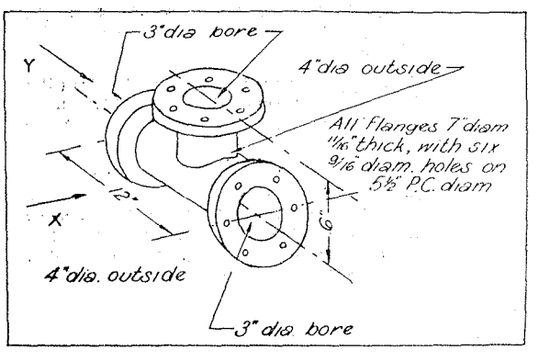
Wednesday, 19th October, 1949: 3 p.m. to 5 p.m.

Possible Marks.		
17	(1)	The accompanying sketch shows a pictorial view of a T-piece for an auxiliary length of steampipe. Draw, half size, the following views:— (a) An elevation looking in the direction of the arrow X.

(b) An end elevation to the right of (a) looking in the direction of arrow Y, drawn as a sketch through the centre line of the top branch.

(c) A plan.

Give dimensions and name each view.



16 (2) (a) Name three forms in which iron is used in engineering.

(b) Why is white metal used to line bearings?

(c) Name a material used for making the following:—

Chains, Bolt, Baseplates, Skip Wheels, Pipes.

17 (3) State and briefly discuss the causes of low factor in Colliery electrical plant. Give the usual methods by which low power factor may be improved.

17 (4) (a) Descripe a three-throw pump, giving full details of the merits of this pump.

(b) In a dip heading 200 yards long and dipping one in six it is necessary to pump 100 gallons of water per minute. What size and class of pump would you put in to deal with the water? What power would be required? Explain the arrangement for moving forward the pump.

16 (5) Describe briefly a system of "wet cleaning" of coal prior to being sold to a customer.

17 (6) What are double helical teeth? The speed of an electrical motor is 730 revolutions per minute, and on the motor shaft there is a pinion having 32 double helical teeth, the pitch being 10 inches diameter.

The motor is to drive a countershaft running at 240 revolutions per minute. State the number of teeth and diameter of pitch circle of toothed wheel required for the countershaft.

100

Western Australia.

Department of Mines.

The Coal Mines Regulation Act, 1946.

Examination for First Class Certificate of Competency as Mine Manager.

SUBJECT: MINING OF COAL.

Thursday, 20th October, 1949, 10 a.m. to 1 p.m.

Possible Marks.

34 (1) Describe—

(1) A machine that will cut and load simultaneously in bord and pillar work.

(2) A machine that will cut and load simultaneously on a long-wall face.

34 (2) Make a neat sketch of a lay-out to produce 1,000 tons per shift of 6½ hours working. Duck-bill loader conveyors and arc wall coal cutters to be used. Describe the sequence of work and say how many units will be required.

33 (3) Sketch and describe some method of stowage either pneumatic or mechanical in detail giving your reasons for preference.

33 (4) It is intended to sink two shafts but it is known that heavily watered strata has to be passed through which is met at a depth of 30 feet and is 150 feet thick. Describe the method you would adopt whilst sinking through this ground.

33 (5) Describe, with sketches, a system of belt conveyors from the bord faces to the surface, where the seam dips one in eight and the method of working is bord and pillar. Bords are 21 feet wide and pillars 14 yards by 22 yards with panels every 10 chains. The output required is 1,000 tons in 7 hours.

33 (6) Describe, by means of sketches how you would sink a shaft 20 feet inside diameter and lined with 14 inches of concrete to a depth of 2,000 feet. Give the sequence of the work in detail.

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Western Australia.

Department of Mines.

The Coal Mines Regulation Act, 1946.

Examination for First Class Certificate of Competency as Mine Manager.

SUBJECT: SURVEYING.

Thursday, 20th October, 1949, 2 p.m. to 5 p.m.

Possible Marks.

25 (1) Describe any method suitable for use in ascertaining the quantity of material removed from an irregularly shaped open cut.

25 (2) Set out a typical page of a field book recording observations made in running a line of levels between two stations necessitating not less than five changes of instrument set ups.

Plot the profile at suitable horizontal and vertical scales and calculate the angle of gradient between the two points.

25 (3) Calculate the bearing and distance of the last line in the following unclosed traverse. What precautions would you take in the field work if an expensive opening had to be made between the two points.

Stns.	Bearing.	Distance.
A-B	29° - 51′	200 feet
B-C	120° - 15′	361 "
C-D	192° - 24′	560 "
D-E	260° - 00′	231 "

25 (4) List the various types of plans required to be kept on any colliery in Western Australia and discuss the importance of keeping them up to date.

25 (5) Two continuous traverse lines on a railway survey bearing 05° - 20′ and 54° - 30′ are to be connected by a curve of 30 chains radius. Calculate the distance from the Intersecting Point to the Tangent Point and the angle of deflection required to lay off the curve in 1 chain chords.

25 (6) List the adjustments which it would be necessary to check before taking into a strange theodolite and level. Describe any one of them.

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Western Australia.

Department of Mines.

The Coal Mines Regulation Act, 1946.

Examination for First Class Certificate of Competency as Mine Manager.

SUBJECT: VENTILATION AND DANGEROUS GASES.

Friday, 21st October, 1949—10 a.m. to 1 p.m.

Possible Marks.

34 (1) In the deep coal fields it is essential to keep the relative humidity as low as possible. Why is this? Calculate the average daily extraction of water for a pit under the following conditions:—

	Downcast.	Upcast.
Dry bulb	40°F	60°F
Wet bulb	35°F	58°F
% Saturation	63%	88%

At 40°F 1,000 cubic feet of air contains 0.41 lb. water.

At 60°F 1,000 cubic feet of air contains 0.81 lb. of water.

33 (2) Discuss clearly the laws governing the circulation of air in mine roadways. What are the new standard units now largely used in mine ventilation problems?

33 (3) Describe clearly the composition of the atmosphere. Give the average percentage composition of a dry atmosphere by weight and volume. What will be the effect of a reduced oxygen percentage on men and light?

33 (4) What is silicosis? Describe how it may be caused in coal mines and the precautions that should be taken to reduce the dangers from this disease to a minimum.

33 (5) Describe—

(a) Velometer.

(b) Methane detector.

(c) Carbon-monoxide detector.

State how each works.

34 (6) What is meant by air-horse-power? A current of 200,000 cubic feet of air per minute is produced at a water-gauge of 4 inches. Calculate the air-horse-power if the efficiency is 60%. What power has to be supplied? Also what should be done to increase the volume of air by 20%?

200

Western Australia.

Department of Mines.

The Coal Mines Regulation Act, 1946.

Examination for First Class Certificate of Competency as Mine Manager.

SUBJECT: COAL MINES REGULATION ACT, 1946.

Friday, 21st October, 1949—2 p.m. to 4 p.m.

Possible Marks.

14 (1) What does the Coal Mines Regulation Act, 1946, say regarding interpretation of terms Division 1.

15 (2) What does Section 20 of the Act require in connection with supervision? State clearly.

14 (3) There are certain restrictions in regard to employment in coal mines as laid down in the Act. What does it say?

14 (4) What are the conditions when inflammable gas is reported and shot firing is to be done?

14 (5) What are the Regulations regarding securing of roof and sides?

14 (6) Enumerate the requirements of Division IX—Sanitation and Hygiene.

15 (7) Regulation 243 refers to provision of lighting. What does it say?

100

Western Australia.

Department of Mines.

The Coal Mines Regulation Act, 1946.

Examination for Second Class Certificate of Competency as Under-Manager or Overman.

SUBJECT: ARITHMETIC.

Wednesday, 19th October, 1949, 9 a.m. to 11 a.m.

Possible Marks.

14 (1) A coal lease of 320 acres has been proven to contain two seams of coal, the top seam being 10 feet which is to be worked by open-cut methods. If the specific gravity of the coal is 1.24, how many tons can be taken from the lease by open-cut methods?

15 (2) A seam of coal contains 12 per cent. foreign matter, the remainder being 34 per cent. small and the 54 per cent. large. Calculate how many tons will be produced in a bord 8 yards wide and 8 feet thick per yard advance if one cubic yard of coal weighs 19 cwt.

14 (3) If the value of large coal in question (2) is twenty-nine shillings and four pence (29s. 4d.) per ton, and small coal valued at twenty-four shillings and one penny (24s. 1d.) per ton, what would be the total value of coal produced if the face is advanced 10 feet?

14 (4) Ten (10) tons of coal were delivered to a works on a Saturday. The Boilerman began firing the coal on Monday and the daily firings were:—

Monday—18 cwts. 3 qrs.

Tuesday—1 ton 5½ cwts.

Wednesday—1 ton 3 cwts. 3 qrs.

Thursday—17 cwts. 100 lb

Friday—19 cwts. 1½ qrs.

Saturday—8 cwts. 86 lb

What is the average daily amount of coal fired? How much coal is left at the end of the week?

15 (5) A mine pump lifts 650 gallons per minute. After the pump has been standing 4 hours it runs 10 hours to reduce the water to the same level as at the time it started. What is the feeder of water per minute?

14 (6) A field in the form of a trapezoid has its parallel sides 266 yards and 185 yards in length. Their distance apart being 132 yards, find the area in acres, roods and poles.

14 (7) Calculate the value of T in the equation $2TS - PDF$, when $S = 100{,}000$, $P = 100$, $D = 96$, $F = 10$.

100

Western Australia.

Department of Mines.

The Coal Mines Regulation Act, 1946.

Examination for Second Class Certificate of Competency as Under-Manager or Overman.

SUBJECT: COAL MINES REGULATION ACT, 1946.

Wednesday, 19th October, 1949, 11 a.m. to 1 p.m.

Possible Marks.

17 (1) Section 17 of the Act provides for action to be taken by the Inspector in cases of danger not expressly provided against under the Act and Regulations. What are the provisions of this section?

17 (2) Division 6, Section 34 of the Act refers to Sunday labour. To what classes of labour does this section not apply?

17 (3) Division XI of the regulations deals with "Electricity in Mines." Regulation 171 refers to persons in charge. What are the provisions of this regulation?

17 (4) Rules have to be posted in change-houses. What do the regulations say in this regard?

16 (5) Regulation 241 makes reference to seams of coal thicker than 5 feet. What does it say?

16 (6) What do the Act and regulations say in regard to transport of workers underground?

100

Western Australia.

Department of Mines.

The Coal Mines Regulation Act, 1946.

Examination for Second Class Certificate of Competency as Under-Manager or Overman.

SUBJECT: ROADWAYS.

Wednesday, 19th October, 1949, 2 p.m. to 5 p.m.

Possible Marks.

16 (1) Describe the safety appliances and discuss what precautions to be taken to prevent accident on haulage roads.

17 (2) Define the terms Watt and Board of Trade unit. The direct pull on the rope of an endless-rope haulage is 16,000 lb. and the rope travels at 2 miles per hour. The haulage is driven by a D.C. motor having an efficiency of 85 per cent. If the mechanical efficiency of the haulage gear is 70 per cent., calculate the total power cost of the haulage for a running shift of 7 hours. The total cost of power is ¾d. per B.O.T. unit.

17 (3) Describe a method of enlarging a road through broken ground from 8 feet by 6 feet to 13 feet by 9 feet.

17 (4) Make sketches, comprising a plan and cross section, of the preparatory portions of a stopping suitable for sealing a district quickly in case of heating or fire, when the seam is 7 feet thick, dipping 1 in 3 with 2 feet of shale overlying the coal and 1 foot of soft fire clay beneath it.

16 (5) Systematic timbering is essential in coal mines. Describe clearly what this means, and give two examples of face and roadway timbering with which you are acquainted.

17 (6) Describe clearly a safe and efficient signalling system for use in an extensive haulage worked on the endless rope system in a fiery and dusty mine.

100

Western Australia.

Department of Mines.

The Coal Mines Regulation Act, 1946.

Examination for Second Class Certificate of Competency as Under-Manager or Overman.

SUBJECT: MINING OF COAL.

Thursday, 20th October, 1949—10 a.m. to 1 p.m.

Possible Marks.

17 (1) How would you lay out the workings in a seam of coal liable to spontaneous combustion? What precautions should be taken so that an outbreak can be promptly dealt with? What materials should be excluded from the workings in such a seam?

16 (2) Name some conditions that would affect your decision as to working first the higher or lower of two seams separated by a distance of 15 to 20 yards?

17 (3) What consideration would influence you in determining the site of a barrier to be left unworked in a seam of coal on dip side of workings containing a known dangerous head of water?

17 (4) To what particular points would you direct your attention in order to increase the output of coal per man from the coal face?

17 (5) A fault has been met with in a working place. What indications would guide you as to the nature of the fault and how would you proceed to prove its displacement?

16 (6) Sketch and describe the Hydrox shell and state the conditions under which it may be adopted to advantage in breaking down coal.

100

Western Australia.

Department of Mines.

The Coal Mines Regulation Act, 1946.

Examination for Second Class Certificate of Competency as Under-Manager or Overman.

SUBJECT: VENTILATION.

Thursday, 20th October, 1949—2 p.m. to 5 p.m.

Possible Marks.		
14	(1)	On analysis a sample of mine air was found to contain 1.5% of carbon dioxide; 0.02% of carbon-monoxide; 1.00% of methane; 19.5% of oxygen; 77.98% of nitrogen. Work out the proportion of "Black Damp" present, and account for the various impurities.
15	(2)	A fan produces 300,000 cubic feet of air per minute at a mine with a water gauge of 4 inches. Calculate the H.P. of ventilation. Assuming the fan has an efficiency of 65%, what power must be applied to the fan shaft to produce this result?
14	(3)	What are the Physical and Chemical factors which tend to produce spontaneous combustion in coal mines? What methods are generally adopted for preventing spontaneous combustion? How can it be detected and how is it generally dealt with?
14	(4)	Describe clearly the difference between— (a) Atmospheric air. (b) Mine air which has travelled through the workings of an average mine. How do you account for the difference?
14	(5)	How would you reduce the friction of an air-current in a mine? Take an actual or hypothetical case and follow the current from the inlet of the mine to the outlet of the fan on the surface.
14	(6)	Explosions have been caused by shot-firing. What should be done to prevent explosions from this cause?
15	(7)	Describe the meaning of the term natural ventilation. State whether or not natural ventilation plays any part in the ventilation of a mine already provided with a powerful ventilating fan; also whether it assists or hinders the work of the fan; and whether this assistance or hindrance is permanent or variable.
100		

Western Australia.

Department of Mines.

The Coal Mines Regulation Act, 1946.

Examination for Third Class Certificate of Competency as Deputy.

SUBJECT: ARITHMETIC.

Wednesday, 19th October, 1949—9 a.m. to 11 a.m.

Possible Marks.		
16	(1)	Find the tonnage of coal in a cut-through 12ft. wide, 7½ft. thick and 12yds. long (1 cubic yard = 1 ton)
16	(2)	Add $7\frac{3}{4} + 6\frac{1}{4} + 2\,2/7$.
17	(3)	Find the total coal loaded into a set of 10 skips when the gross weight is 34 tons. The tare of each empty skip being 12cwt. 3qr. 12lb.
17	(4)	The output from a mine is 520 tons per day. The mine works 9½ days for the fortnight. What would be the value of the fortnight's output if it were 23s. 4d. per ton?
17	(5)	A shaft 20ft. inside diameter has to be lined with 1ft. thickness of concrete. How many cubic yards of concrete per yard of depth will be required?
17	(6)	What is the cubic footage per minute of air travelling in an airway 8ft. high, 12ft. wide, when the velocity of air is 2.6ft. per second?
100		

Western Australia.

Department of Mines.

The Coal Mines Regulation Act, 1946.

Examination for Third Class Certificate of Competency as Deputy.

SUBJECT: MINING OF COAL.

Wednesday, 19th October, 1949—2 p.m. to 5 p.m.

Possible Marks.		
16	(1)	Sketch and describe how you ventilate a stone drive being driven through a fault.
17	(2)	How would you timber a place that has fallen up to a height of 30ft.?
17	(3)	As a deputy making your inspection you found coal heating. What action would you take to ensure safety?
		Gas Testing.
16	(1)	What is a hygrometer? What are its uses in coal mines?
17	(2)	In a naked light mine, describe and sketch some instrument which would determine the percentage of oxygen present in the air.
17	(3)	Flame safety lamps have to be of certain construction. What is the construction of such lamps? Make a neat sketch showing the several parts.
100		

Western Australia.

Department of Mines.

The Coal Mines Regulation Act, 1946.

Examination for Third Class Certificate of Competency as Deputy.

SUBJECT: COAL MINES REGULATION ACT, 1946.

Wednesday, 19th October, 1949—11 a.m. to 1 p.m.

Possible Marks.		
20	(1)	Section 20, subsection (3) deals with the appointment and duties of deputies. Detail the provisions of this subsection.
20	(2)	What is laid down in Regulation 99 regarding the provision of manholes?
20	(3)	What provisions are made in Regulations 87 and 123 regarding the use of brattice cloth?
20	(4)	Regulation 128 refers to temperatures, etc. What are the instruments mentioned and what does it say?
20	(5)	What does Regulation 116 lay down with regard to adequate ventilation?
100		

Appendix No. 2.

REPORT ON ACTIVITIES OF BOARD OF EXAMINERS FOR UNDERGROUND SUPERVISORS' AND MINE MANAGERS' CERTIFICATES FOR 1949.

School of Mines,
Kalgoorlie.
24th May, 1950.

The Chairman, Board of Examiners for Underground Supervisors' and Mine Managers' Certificates, Mines Department, Perth.

I hereby submit the annual report on the activities of the Board of Examiners for Certificates for Underground Supervisors and Mine Managers during the year 1949.

In accordance with Regulation 29 of the Mines Regulation Act, 1946, a Board of Examiners was constituted for the purpose of granting Mine Managers and Underground Supervisors Certificates of Competency and Service. The members of the Board are as follows:—

Mr. J. S. Foxall, State Mining Engineer, Chairman.

Mr. R. A. Hobson, Director, School of Mines, Kalgoorlie.

Mr. H. Verran, Senior Inspector of Mines, Kalgoorlie.

Mr. J. F. Breen, nominated by the Chamber of Mines, Kalgoorlie.

The first meeting of the Board was held on May 19th, 1949. Subsequently Mr. G. M. Lumb, Registrar of the School of Mines, was appointed to act as Secretary to the Board.

Four meetings of the Board were held during the year.

An examination for Underground Supervisors was held on October 3rd, the results of which were as follows:—

Number entered	36
Number passed	26

Candidates were examined at the following centres:—

Kalgoorlie	17
Coolgardie	2
Norseman	4
Meekatharra	1
Leonora	2
Big Bell	9
Marble Bar	1

The names of the successful candidates are as follows:—

Baalam, A. L.	McKenny, O. P.
Blaikie, N.	McDonald, T. G.
Cubit, J.	O'Connor, J. M.
Darch, L. J.	O'Sullivan, F.
Effler, E. A.	Otway, R. J.
Hopkins, R. A.	Phillips, J. A.
Horrocks, H. S.	Ralland, K. L.
Huxtable, D. A.	Sweet, F. B.
Hunter, S.	Simpson, W. D.
Harris, K.	Scarff, N. K.
Insley, G.	Spencer, A. D.
Martin, G. G.	Taaffe, H. C.
Murray, S. W.	Worth, D. E.

Copies of the examination papers are attached.

An examination in Mining Law for Mine Managers' Certificates was held at the same time as the Underground Supervisors' Examination, the results of which were as follows:—

Number entered	17
Number passed	14

The names of the successful candidates are as follows:—

Crocos, A. J.	Neuenkirchen, G. M
Haddow, J. F.	Power, F. W.
Holly, J.	Phillips, W. T.
Kennedy, H. L.	Royle, P. G.
Langford, J. N.	Thomas, P. C.
Leevers, J. C.	Wilson, A. Y.
Mitchell, J. A.	Yates, C.

Copies of the examination paper are attached.

Applications for Mine Managers' Certificates of Service totalled 57. Of these 37 were approved, 12 refused and 2 deferred.

The names of the successful applicants are as follows:—

Manners, J. E.	Bugg, L. C.
Bell, W. R.	Elvey, L. E.
Birrell, W. D.	Bardon, R. A.
Greenhill, T. W.	Lavater, G. T.
Richards, H. A.	Curtis, A. W.
Newman, H. B.	Thirloway, W. K.
George, A. E.	Sainsbury, R.
Morgan, G.	Charsley, P. A.
Thorn, J. F.	O'Brien, T. N.
Simpson, R. C.	Eddy, J. T.
Coleman, R. W.	Saunders, S. J.
Gamble, H. W.	Cameron, I. D.
Allen, E. T.	Harvey, J.
Anderson, G. F.	Hinchcliffe, W. J.
Holder, E. M.	Checker, L.
Walker, S.	Thomas, P. C.
Stokes, J. R.	Espie, F. F.
McLeod, A. A.	Dower, G. H.
Munro, W. E.	

Applications for Mine Managers' Certificates of Competency totalled 20. Of these 12 were approved, 4 refused and 4 deferred. The names of the successful applicants are as follows:—

Carroll, H. H.	Olive, L. C.
Breen, J. F.	Allen, C.
Terrell, J. H.	Mitchell, J. A.
Vierk, F. J.	Phillips, W. T.
Mundle, E. B.	Langford, J. N.
Newman, H. B.	Neuenkirchen, G. M

Two duplicate certificates for Underground Supervisors were issued during the year.

One reciprocal certificate for Underground Supervisor was issued to Mr. G. F. Anderson, who held a Queensland Mine Manager's First Class Certificate.

A course for Mine Managers' Certificates at the School of Mines was arranged and will commence in 1950. Particulars of the course are attached.

Reciprocity.—Particulars of the qualifications required in this State for the Mine Manager's Certificate were sent to the Boards of Examiners in Melbourne, Sydney, Brisbane and Hobart, with a request that recognition be given to the certificates issued by this State. No decisions had been received up to the end of the year. The Board of Examiners agreed that they would grant recognition to certificates issued by other States.

G. M. LUMB,
Secretary Board of Examiners

MINE MANAGER'S CERTIFICATE COURSE.

Preparatory subjects—Preparatory Mathematics, Preparatory Chemistry, Preparatory Drawing, Preparatory Physics, Preparatory Geology.

	Hours per week.
1st Year Subjects—	
Mathematics IA	4
Engineering Drawing I	4
2nd Year Subjects—	
Geology IB	3
Surveying I	3½
Mining I	3
3rd Year Subjects—	
Geology IA	4
Surveying IIA (2nd term only)	3½
Mining IIA (1st term only)	2
Mining IIC (3rd term only)	2
Metallurgy and Mineral Dressing	2
4th Year Subjects—	
Mining IIIA	3
Geology IIA	3
Practical Electricity	2
First Aid	—

Mines Regulation Act, 1946.

Examination for Certificate of Competency as Underground Supervisor.

MINING LAW.

October, 1949.

Time allowed—1½ hours.

Attempt FIVE Questions only.

1. What do the Regulations require regarding any TWO of the following?
   i. Handling of explosives.
   ii. Detonators.
   iii. Safety fuse.

2. Regulation 56 deals with "Misfires." What does the Regulation require?

3. What do the Regulations require regarding any THREE of the following?
   i. Men working alone.
   ii. Rises in mines.
   iii. Use of safety belts.
   iv. Winzes.

4. What do the Regulations require regarding:
   i. Ladders in shafts.
   ii. Ladders in winzes.

5. (i) The Regulations require that all used parts of a mine shall be adequately ventilated. Where the adequacy of the ventilation in any place is in dispute, by whom is a decision made? Is there any appeal from this decision?
   (ii) What do the Regulations require regarding:
   (a) The ventilation of development ends.
   (b) Water traps in compressed air mains.

6. (i) The Regulations make provisions for sanitary conveniences underground. What is required?
   (ii) What crib places must be provided?
   (iii) What must be done before an underground dam can be constructed?

Mines Regulation Act, 1946.

Examination for Certificate of Competency as Underground Supervisor.

MINING.

October, 1949.

Time allowed—Three hours.

Attempt SIX questions only.

1. Compare the various methods of taking water out of a mine, and state the conditions under which you consider each method suitable.

2. Describe, with sketches, a pent-house that is to be constructed at the 2,000 foot level where sinking is to proceed, and where 3-ton skips are in use, pulling stone from the working levels above. Give size of timber.

3. A wide stope has been opened up for a length of 600 feet. Describe the method of filling:
   (a) Flat back system.
   (b) Rill Stope system.

4. Describe, with sketches, methods that could be used to ventilate and mine a block of ore, 500 feet long, between two levels.

5. Give a brief description of:
   (a) Testing safety grippers on cages.
   (b) Examination and judging of the conditions of ropes used in winzes.
   (c) Use of venturi blowers and where they are placed.
   (d) Transport and handling of explosives underground.
   (e) Examination of ground after firing out.

6. Describe how you would work an underlay stope of about 40°, 200 feet long and 6 to 8 feet wide.
   (a) Where the ground is considered good.
   (b) Where the ground is considered bad.

7. Describe how you would proceed to rescue a man who:
   (a) Was caught by a fall of rock.
   (b) Fumed in a winze.

8. Describe fully, with sketches, how you would timber a leading stope 20 feet wide for shrinking system.

Mines Regulation Act, 1946.

Examination for Mine Manager's Certificate of Competency.

MINING LAW.

October, 1949.

Time Allowed, Three Hours. Attempt All Questions.

The Mining Act and its Regulations may be used at the Examination, but NOT the Mines Regulation Act.

In answering questions in the Mining Act, references to portions of the Act concerned should be stated.

1. (a) What records are required to be kept concerning the history of ropes?
   (b) What precaution would you adopt before using a second hand rope that had previously been used in a place beyond your control?
   (c) What routine examinations are required in connection with the "Examination of Ropes and Winding Appliances";

2. (a) Mention the conditions required for the establishment of a "main" and a "distributing magazine," and the allowable quantity of explosives in each case.
   (b) What action do you consider necessary in the case of a reported misfire resulting from a firing by a safety fuse or by electric firing?

3. (a) What ventilation standards are laid down in Mines Regulation Act regarding Purity, Temperature, and Quantity of fresh air necessary?
   (b) What steps should be taken to deal with moisture in compressed air?
   (c) State duties of an appointed ventilation officer and what records should be kept by such official.

4. (a) Give details of precautions to be taken in the installation and protection of cables in mines.
   (b) What plans and records are required to be kept of electrical installations on a mine?

5. What is the procedure in marking out application for, and granting of, Gold Mining Leases?
   At what stage do labour conditions have to be complied with?

6. Give your opinions in the following matter:—
   A Gold Mining Lease has been surrendered. A tailings dump and mining plant including the main shaft winder and headframe remain on the property.
   After an interval of two years the lease has been taken up again by a different applicant to the original one.
   (a) What steps should the first holder take to protect his interest in the tailings and machinery?
   (b) In the event of no protection being taken out over tailings or plant concerned, what is the position of the second applicant for the lease in the event of him wishing to retreat the tailings and unwater the main shaft?

7. Two adjoining leases are connected underground, but are held by different owners.
   The first lease owner is keeping both properties unwatered by using his own pumping machinery, to which the second holder refuses to contribute.
   What procedure is necessary by the first lease holder to compel the second lease holder to contribute towards the cost of keeping the mine unwatered, and to what extent can he be called on?

Appendix No. 3.

AUTHORISED MINE SURVEYORS.

Under the provisions of Regulation 226, Mines Regulation Act, 1946, certificates as Authorised Mine Surveyors were issued to the following:—

Name.	Certificate No.
Bell, W. R.	29
Birrell, W. D.	30
Boundy, C. A. P.	38
Boyd, J. P.	15
Cackett, W. S.	16
Clarke, L. D.	7
Crocos, A. J.	8
Crowe, I. F.	53
Crutchett, Edgar	32
Davis, F. A.	23
Denham, Ken. E.	61
Eddy, J. T.	39
Ewers, D. R.	35
Faichney, J. M.	33
Forster, E. T.	57
Fowler, R. W.	49
Foxall, J. S.	2
Greenhill, T. W.	3
Haddow, J. F.	18
Hamilton, F. G.	37
Hille, W. C.	13
Holder, Evan	48
Horseman, R. G.	47
Huxtable, D. A.	51
Inman, R. D.	41
Jensen, H. E.	42
Kingdon, H. T.	46
Langford, J. N.	9
Lavater, G. T. G.	31
Lee, G. S.	24
Leevers, J. C.	4
Lloyd, J. K. N.	60
McKenny, O. P.	26
McKern, J. G.	50
McLeod, A. A.	55
Manners, J. E.	20
Mead, G. F.	45
Mitchell, J. A.	28
Moore, H. L.	44
Mundle, E. B.	52
Munro, W.	17
Newman, H. B.	21
Olds. H. L.	62
Olive, L. C. A.	56
Osborne, Brian	54
Paterson, J. R.	22
Paterson, R. B.	10
Peek, K.	14
Powell, Thos.	58
Power, F. W. G.	59
Quartermaine, M. K.	5
Rowe, H. V.	43
Royle, P. G.	25
Ryan, M.	19
Scarff, N. K.	40
Simpson, R. C.	11
Sweet, F. B.	27
Terrell, J. H.	34
Wilson, R. C.	1
Wilson, A. Y.	12
Wreford, P. M.	36
Yates, C.	6

These are the first certificates as Authorised Mine Surveyors to be issued under the new Act. Surveyors previously authorised are entitled to certificates but the addresses of a number of them are unknown.

Certificates will be issued free of charge to these men on application to the State Mining Engineer.

(Sgd.) J. S. FOXALL,
State Mining Engineer,
Chairman of Survey Board.

Index to State Mining Engineer's Annual Report, 1949.

LIST OF TABLES.

Division III.

Report of the Superintendent of State Batteries

THE UNDER SECRETARY FOR MINES:

For the information of the Hon. Minister I submit herewith my report on the operations at State Batteries for the year ending December 31st, 1949.

Sixteen Batteries crushed 41,171.25 tons for an estimated yield of £331,727 as against 40,634 tons and £332,495 for the previous year.

The grade of ore crushed still remained high at 15 dwts. 12.6 grs. per ton a slight falling off from the 1948 figure of 16 dwts. 12.6 grs.

Particulars of the grade of ore at all batteries is shown on Schedule 2 attached to the report and it will be noted that the ore crushed at Yarri, Sandstone and Cue was mainly responsible for the high average, with values of 30 dwts. 13 grs. 27 dwts. 3 grs. and 25 dwts. 7 grs. per ton respectively.

The value of the bullion recovered estimated at £356,531 brings the value of production since inception to £13,958,331.

The tonnage of tailing treated was 33,010 and resulted in a working profit of £9,125 17s. 3d. The loss on milling was £28,014 10s. 0d. and that on all operations £18,888 12s. 9d. as against a loss of £21,030 4s. 1d. in 1948.

Capital expenditure was £2,078 14s. 6d. being spent from loan and £3,020 14s. 9d. from Revenue.

Schedules attached give the following information:—

Schedule 1.—Tonnage crushed and value per ton.
Schedule 2.—Yield and gross value.
Schedule 3.—Segregation of tailing.
Schedule 4 and 6.—Details of tailing treatment.
Schedule 5.—Purchase of tailing.
Schedule 7.—Details of Milling costs.
Schedule 8.—Details of tailing treatment costs.
Schedule 9.—Balance Sheet.

A comparison of the tonnage crushed and cyanided for the last 3 years is as follows:—

	1947.	1948.	1949.
Tons crushed	49,168	40,634	41,171
Tons cyanided	41,401	39,958	33,010

Estimated Value of Production since Inception excluding Value of Gold Tax paid to Commonwealth.

Production at Par—	£
By Amalgamation	7,911,054.753
Tailing Treatment	1,935,898.293
Gold Premium—	
By Amalgamation	3,101,416.965
By Tailing	915,506.472
	£13,863,876.483
Tin Production—	
Ore	93,883.160
Residues	572.000
	£13,958,331.643

DETAILS OF PRODUCTION.

Five hundred and forty-four parcels were milled at State operated plants averaging 75.68 tons as against 686 parcels and an average of 59.23 tons in 1949.

The value of the yield with 1948 figures in parenthesis was as follows:—

Bullion by Amalgamation 26,628.95 ozs. (28,851) worth £283,242.

Fine Gold by Tailing Treatment 5,827.04 ozs. (6,440.6) worth £73,289.

Total £356,531

GRADE OF ORE TREATED.

Forty-one thousand, one hundred and seventy-one tons crushed yielded 22,554 fine ozs. by amalgamation equal to 10 dwts. 22.9 grs. per ton. The average value of tailing produced was 4 dwts. 13.7 grs. bringing the overall value to 15 dwts. 12.6 grs. per ton.

The average value for 1948 was 16 dwts. 18.7 grs.

ESTIMATED PERCENTAGE RECOVERY.

The whole of the tailing produced was not treated during the year and approximately 8 per cent. of the total was cupiferous and untreatable but applying the average extraction obtained at our tailing plants viz. 78.06 to the average tailing value of 4 dwts. 13.7 grs. the estimated percentage extraction works out as follows:—

		dwt.	gr.	%
Head value	=	15	12.6	
Recovered by amalgamation		10	22.9	= 70.56
Recovered by tailing 78.06% of 4dwt. 12.8gr.		3	13.0	= 22.28
Total extraction		14	11.9	= 92.84

RECEIPTS AND EXPENDITURE.

Receipts from all sources were £55,440 15s. 11d. as against £57,526 18s. 5d. in 1948.

Expenditure amounted to £74,329 8s. 8d., the previous year's figure being £78,557 2s. 6d.

A comparative synopsis of receipts and expenditure under the different headings for 1949 and 1948 appears later in this report.

MILLING.

One 15-stamp, seven 10-stamp, and eight 5-stamp mills treated ore for the public.

Lake Darlot, Linden and 20-Mile Sandy Creek at Nullagine were operated under lease.

The Weerianna battery was run as a State plant for part of the year and one small round aggregating 178 tons was crushed. This plant is now under lease.

COST OF CRUSHING.

The gross working costs including administration decreased from 23s. 3.5d. in the previous year to 22s. 7.9d. per ton.

Increased tonnage and less costs on repairs and renewals were responsible for this decrease of 7.67d. per ton and managers did well to hold the cost within this margin.

A glance at Schedule 7 shows that Laverton with approximately 13 per cent. of the total tonnage crushed had the best cost at 16s. 1.8d. for 5,299 tons treated. Kalgoorlie and Cue were the only other batteries whose costs were below 20s. with 17s. 4.7d. and 18s. 3.5d. respectively.

MILLING REVENUE.

Receipts for milling amounted to £19,063 or 9s. 2.1d. as against £19,655 and 9s. 8.1d. per ton respectively on the previous year.

TAILING TREATMENT.

Eight plants handled 33,010 tons, Kalgoorlie heading the list with 9,742.

The average value of the tailing treated was 4dwt. 12.78gr. and the estimated residue 23.84gr., giving an actual extraction of 78.06 per cent. The figures for the previous year were 4.118dwt. and an extraction of 78.68.

COST OF TREATMENT.

The cost per ton rose from 15s. 7.5d. in 1948 to 16s. 1.1d. an all time high. Laverton and Kalgoorlie had the best cost figures of 13s. 5.7d. and 13s. 6.8d. respectively.

Repairs and renewals included a weighbridge for Kalgoorlie and the reconstruction of the mill and cyanide plant at Norseman.

Repairs and renewals and sundries including administration amounted to £4,815 6s. 8d. or 3s. 1.2d. per ton.

RECEIPTS.

Revenue amounted to £37,429 15s. 3d. or 22s. 8.1d. per ton and was 3s. 3d. per ton above the 1948 figure. This is also an all time high and more than offset the rise in the cost of treatment.

The increased revenue was due mainly to the increased price of gold for three and a half months as from September 19.

Schedule 3 gives details of the tailing produced at each battery and its segregation according to value based on 90 per cent. of the tonnage crushed.

The combined results are as follows:—

	Tons		%
Over 2dwt. 8gr. per ton	24,216	=	58.8
Between 1dwt. 18gr. and 2dwt. 8gr.	5,702	=	13.8
1dwt. 18gr. and under	7,856	=	19.0
Refractory	3,397	=	8.4
			100.0

The percentage of payable tailing or that over 2dwt. 8gr. was approximately 3 per cent. above the 1948 figure.

Three thousand three hundred and ninety-seven tons or 8.4 per cent. of the total contained too much copper for successful treatment.

COMPARATIVE SYNOPSIS OF RESULTS AT STATE BATTERIES FOR TWELVE MONTHS ENDED 31st DECEMBER, 1948 and 1949.

	1948.			1949.		
	Tonnage.	Expenditure per ton.	Revenue per ton.	Tonnage.	Expenditure per ton.	Revenue per ton.
		s. d.	s. d.		s. d.	s. d.
Milling	40,634	23 3·5	9 8·1	41,171·25	22 7·9	9 2·1
Cyaniding	39,958	15 7·5	19 5·5	33,010·00	16 1·1	22 8·1

RECEIPTS AMD EXPENDITURE.

	Tonnage.	Expenditure.	Revenue.	Profit or Loss.
		£ s. d.	£ s. d.	£ s. d.
Milling	41,171	47,078 4 8	19,063 14 8	*28,014 10 0
Cyaniding	33,010	27,251 4 0	36,377 1 3	†9,125 17 3
	....	74,329 8 8	55,440 15 11	*18,888 12 9

* Loss. † Profit.

CARTAGE SUBSIDIES.

State Plants.

Subsidies were paid on 9,818½ tons and amounted to £4,612 4s.

Private Plants.

Cartage subsidies including 2s. per ton feeding subsidy paid to prospectors amounted to £693 17s. 7d. for 1,729½ tons crushed, a large decrease in expenditure and a considerable decline in tonnage from the previous year's figure.

Comparative figures for the last three years are as follows:—

Year.	Tons Crushed.	State Batteries.			Private Batteries.		Total.
		Tons Claiming Subsidy.	Percentage of Ore Crushed.	Amount Paid.	Tons Claiming Subsidy.	Amount Paid.	
				£ s. d.		£ s. d.	£ s. d.
1947	49,168·25	18,204·25	37·0	8,154 5 2	5,416·5	1,257 5 10	9,411 11 0
1948	40,634·00	16,367	40·2	7,756 6 7	3,114	1,393 8 2	9,149 11 0
1949	41,171·25	9,818·50	23·8	4,612 4 0	1,729·5	693 17 7	5,306 1 0

CAPITAL EXPENDITURE.

Expenditure under this heading was £5,099 9s. 3d. of which £2,078 14s. 6d. was charged to General Loan Fund and £3,020 14s. 9d. to Consolidated Revenue Fund.

The details are as follows:—

General Loan Fund.

	£ s. d.
Three residue conveyors	45 13 3
Meekatharra additions, rock breaker, etc.	1,651 0 3
Norseman rotary hoe	382 1 0
	£2,078 14 6

C.R.F.

	£ s. d.
Purchase of horses	76 15 0
Coolgardie rotary hoe	382 1 0
Cyanide Plant, Meekatharra	614 19 1
Cyanide Plant, Norseman	1,720 6 8
Laverton Water Supply	186 5 0
Linden	40 8 0
	£3,020 14 9

REPAIRS AND RENEWALS.

	£ s. d.
Milling	6,857 15 0
Tailing plants	809 17 6
	£7,667 12 6

The bulk of the expenditure under this heading was devoted to the complete rebuilding of the Norseman plant and the installation of a weighbridge at Kalgoorlie. The Norseman plant is now in first-class order as far as the crushing and cyaniding sections are concerned. During the current year the gas engine will be replaced by an electric motor for which power will be purchased from Central Norseman.

STAFF.

During the year Manager Hogg retired. It is worth recording that this officer obtained his first battery experience at Coolgardie 52 years ago. Intermittent running caused by lack of ore still requires that managers and their staffs are called upon to operate more than one mill and are frequently transferred temporarily for the purpose. Such transfers, though unavoidable, are not in the best interests of either the industry or the managers, and it is hoped that the rise in the price of gold consequent upon devaluation will stimulate production to the extent where many of them can be eliminated.

ADMINISTRATION.

The expenditure under this heading was £7,063 16s. 4d. as against £6,076 4s. 6d. in 1948 and equalled an amount of 1s. 10.85d. for each ton crushed and cyanided.

Comparative details under the different headings for the two years are as follows:—

	1949			1948.		
	£	s.	d.	£	s.	d.
Salaries	4,084	17	1	3,549	10	9
Pay Roll Tax	1,087	9	6	1,121	15	10
Workers' Compensation	1,313	8	8	1,087	5	4
Travelling Expenses and Inspection	495	19	3	297	14	11
Sundries	82	1	10	19	17	8
	£7,063	16	4	£6,076	4	6

GENERAL REMARKS.

The most significant event during the year was the devaluation of currency of 19th September which had the effect of lifting the price of gold from £10 15s. 3d. to £15 9s. 10d. per fine ounce. As far as can be judged at this stage mill tonnages have increased as a result by approximately 30 per cent and a further increase is expected. It has been suggested that to offset our losses we may have to increase crushing charges which have remained constant for more than 40 years. It is interesting to note that in 1910 crushing receipts were 9s. 6.68d. per ton whereas for 1949 they were 9s. 2.1d. per ton. Crushing expenditure for 1910 was 9s. 2.52 but for 1949 it was 22s. 7.9d. Cyaniding charges, however, are in the form of deductions on gold content instead of in currency so that we get the benefit of any rise in gold prices. For 1949 our mills crushed at approximately 40 per cent. of their total capacity and there is no doubt that if tonnages could be lifted to somewhere near rated capacity our losses would almost completely disappear without increasing charges.

The recent tonnage increase has already been sufficient to enable us to review our policy with regard to leased mills. During 1949 Government-owned mills at Nullagine, Linden and Darlot, were operated by lessees. Such plants are only leased as a last resort in preference to closing them down when available ore drops to a few hundred tons per year. It is expected that Nullagine and Darlot will again operate as State batteries during the latter part of the current year.

There are not nearly as many prospectors and small mine operators in the field as there were 10 years ago. However the trend is definitely away from old hand labour methods which are being replaced by small units of modern plant, and this tendency has been directly fostered by the Mines Department, who have advanced the necessary finance in many cases. The net result is that higher tonnages can be produced by fewer men and lower grade ore becomes profitable. Provided that general conditions do not deteriorate too seriously 1950 should be a year of bright prospects for those whose operations in the goldmining industry do not call for either a large capital expenditure or a large labour force.

C. ADAMS,
Superintendent of State Batteries.

SCHEDULE 1.

Return showing Tons Crushed, Gold Yield by Amalgamation, Average per Ton in Shillings and Total Value without Premium for Year ended 31st December, 1949.

Battery.	Tons Crushed.	Gold Yield Bullion.	Value per Ton in Shillings and Pence.	Total Value without Premium.
		ozs.	s. d.	£ s. d.
Bamboo Creek	419	194·65	33 5·3	700 14 10
Boogardie	1,259	613·95	35 1·3	2,210 4 5
Coolgardie	4,185	1,798·85	30 11·4	6,475 17 2
Cue	6,790¾	8,402·70	89 1·0	30,249 14 5
Kalgoorlie....	8,635¼	2,680·50	22 4·2	9,649 16 0
Laverton	5,299¼	2,871·35	39 0·2	10,336 17 2
Marble Bar	255	61·15	17 3·1	220 2 9
Meekatharra	3,802¾	1,638·75	31 0·3	5,899 10 0
Norseman	865½	626·15	52 1·4	2,254 2 9
Ora Banda	3,930	3,106·50	56 10·9	11,183 8 0
Paynes Find	1,770½	884·70	25 11·9	3,184 18 5
Peak Hill	941	264·40	20 2·7	951 16 11
Sandstone	464¾	571·95	88 6·7	2,059 0 5
Weerianna	178	54·00	21 10·1	194 8 0
Wiluna	704½	113·55	11 7·3	408 15 7
Yarri	1,671	2,745·80	118 3·0	9,884 17 7
	41,171¼	26,628·95	46 6·8	95,864 4 5

SCHEDULE 2.

Number of Parcels Treated, Tons Crushed and Head Value for the Year ended 31st December, 1949.

No. of Parcels Treated.	Battery.	Tons Crushed.	Yield by Amalgamation. (Bullion.)	Yield by Amalgamation. (Fine Gold.)	Gross Contents of Tailings on 100% (including refractory).	Total Contents of Ore. (Fine Gold.)	Average per Ton (Fine Gold.)	Gross Value per Ton at £4 4s. 11½d. per Ounce.
			ozs. dwt.	ozs. dwt.	ozs. dwt.	ozs. dwt.	ozs. dwt.	£ s. d.
14	Bamboo Creek	419	194 13	164 17	74 16	239 13	11 11	2 8 8
18	Boogardie	1,259	613 19	520 0	357 16	877 16	13 23	2 19 4
72	Coolgardie	4,185	1,798 17	1,523 13	874 0	2,397 13	11 11	2 8 8
80	Cue	6,790¾	8,402 14	7,117 2	1,478 10	8,595 12	25 7	5 7 5
105	Kalgoorlie	8,635½	2,680 10	2,270 7	1,701 19	3,972 6	9 5	1 19 1
43	Laverton	5,299½	2,871 7	2,432 0	1,792 2	4,224 2	15 22	3 7 8
9	Marble Bar	255	61 3	51 16	117 7	169 3	13 6	2 16 4
40	Meekatharra	3,802¾	1,638 15	1,388 0	763 3	2,151 3	11 7	2 8 0
24	Norseman	865½	626 3	530 7	211 13	742 0	17 4	3 12 11
69	Ora Banda	3,930	3,106 10	2,631 4	1,162 2	3,793 6	19 7	4 1 11
10	Paynes Find	1,770½	884 14	749 7	112 6	861 13	9 18	2 1 5
11	Peak Hill	941	264 8	223 19	80 14	304 13	6 11	1 7 5
6	Sandstone	464¾	571 19	484 9	146 4	630 13	27 3	5 15 3
4	Weerianna	178	54 0	45 15	36 11	82 6	9 6	1 19 4
8	Wiluna	704½	113 11	96 4	276 17	373 1	10 14	2 5 0
31	Yarri	1,671	2,745 16	2,325 14	226 19	2,552 13	30 13	6 9 9
544		41,171¼	26,628 19	22,554 14	9,376 8 36 11	31,967 13	15 13	3 6 0

Average Tons per parcel .... 75·68.
Average Yield by Amalgamation per ton (fine gold) .... 10 dwts. 22·9 grs.
Average Value by Amalgamation per ton .... £2 6s. 6d. Australian £8 9s. 7d.
Average Head value of tailing (fine gold) .... 4 dwts. 13·7 grs.
Average value of tailing per ton .... 19s. 5d. Australian £2 11s. 5d.

SCHEDULE 3.

Segregation of Tailing Produced according to Value for the Year ended 31st December, 1949.

Battery.	Over 2 dwt. 8 grs.			2 dwt. 8 grs. to 1 dwt. 18 grs.			1 dwt. 18 grs. and under.			Refractory.			Total.		
	tons.	ozs.	dwt.	tons.	ozs.	dwt.	tons.	ozs.	dwt.	tons.	ozs.	dwt.	tons.	ozs.	dwt.
Bamboo Creek	278	63	2	38	3	19	103	7	15	....	....	....	419	74	16
Boogardie	784¾	326	4	....	....	....	474¼	31	12	....	....	....	1,259	357	16
Coolgardie	3,045½	782	9	511	50	5	628½	41	6	....	....	....	4,185	874	0
Cue	3,413½	1,125	14	1,346½	135	2	1,557¼	108	1	473¾	109	13	6,790¾	1,478	10
Kalgoorlie	4,106¾	1,382	6	1,006¼	103	4	3,522¼	216	9	....	....	....	8,635½	1,701	19
Laverton	5,204	1,783	11	34	3	11	45¼	2	19	15¾	2	1	5,299¼	1,792	2
Marble Bar	140¼	108	10	22	2	10	62½	4	2	30¼	2	5	255	117	7
Meekatharra	2,153¾	558	17	1,016	103	4	93¼	6	17	539¾	94	5	3,802¾	763	3
Norseman	531½	189	1	32	3	4	302	19	8	....	....	....	865½	211	13
Ora Banda	2,320¾	1,022	12	1,005	105	6	546¾	32	18	51½	1	6	3,930	1,162	2
Paynes Find	3½	6	11	....	....	....	....	....	....	1,767	105	15	1,770½	112	6
Peak Hill	181	47	5	30	2	15	233	8	3	497	22	11	941	80	14
Sandstone	200¼	118	15	241	26	2	23½	1	7	....	....	....	464¾	146	4
Weerianna	60	26	8	18	1	17	100	8	6	....	....	....	178	36	11
Wiluna	682	270	9	....	....	....	....	....	....	22½	6	8	704½	276	17
Yarri	1,104½	172	6	402½	44	10	164	10	3	....	....	....	1,671	226	19
	24,216	7,984	0	5,702	585	9	7,855¾	499	6	3,397½	344	4	41,171¼	9,412	19

SCHEDULE 4.

Details of Extraction—Tailing Treatment, 1949.

Battery.	Tons Treated.	Head Value.	Contents.	Tail Value.	Contents.	Recovery.	Call.	Recovery.	Shortage.	Surplus.
		dwts. grs.	dwts.	dwts. grs.	dwts.	%	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Coolgardie	6,301	3 19	23,782	 22	5,887	75	3,854 18 2	3,800 19 4	53 18 10	....
Cue	5,712	4 14	26,324	 22	5,196	80	4,442 15 9	4,489 13 1	....	46 17 4
Kalgoorlie....	9,742	3 17	35,987	 20	8,128	77	5,884 2 11	5,880 12 5	3 10 6	....
Laverton	3,552	6 23	24,699	1 3	4,065	84	4,227 19 10	4,409 2 3	....	181 2 5
Meekatharra	3,195	3 6	10,437	 21	2,820	73	1,659 11 0	1,617 13 2	41 17 10	....
Ora Banda	2,716	7 1	19,165	1 17	4,699	75	3,071 6 8	3,072 9 0	....	1 2 4
Wiluna	896	6 3	5,482	1 9	1,222	77	908 8 5	904 17 5	3 11 0	....
Yarri	896	4 4	3,744	 21	784	79	616 0 0	629 8 11	....	13 8 11
	33,010	4 12·78	149,620	.... 23·84	32,801	78·06	24,665 2 9	24,804 15 7	102 18 2	242 11 0

Head Value .... 4 dwts. 12·78 grains.
Tail Value .... 23·84 grains.
Theoretical Recovery .... 77·61%.
Actual Recovery .... 78·06%.

SCHEDULE 5.

Direct Purchase of Tailings, Year ended 31st December, 1949.

Battery.	Tons of Tailings Purchased.	Amount Paid at £4 4s. 11½d.	Amount Paid A/c. Premium.
		£ s. d.	£ s. d.
Bamboo Creek	250¼	90 19 0	529 3 7
Boogardie	231	148 6 10	747 19 4
Coolgardie	1,970¼	916 8 1	3,011 16 4
Cue	3,875¼	2,877 18 11	5,198 18 7
Kalgoorlie	3,704¼	2,536 9 3	6,083 6 1
Laverton	4,409½	3,136 13 6	6,564 6 2
Marble Bar	126¼	264 9 3	720 11 10
Meekatharra	2,049¼	790 4 1	2,479 11 5
Mt. Ida	....	....	102 10 2
Norseman	449½	337 12 9	916 10 10
Ora Banda	2,167¾	2,056 2 11	4,768 16 6
Paynes Find	58	22 6 2	14 9 1
Peak Hill	162¾	74 17 11	230 10 9
Sandstone	179¾	273 3 11	1,064 1 5
Wiluna	613¼	546 19 11	1,510 4 4
Yarri	956	129 18 7	502 18 3
20-Mile Sandy	590	272 3 1	695 18 5
	21,792¾	14,474 14 2	35,141 13 1

SCHEDULE 6.

Tailing Treatment, 1949.

Battery.	Tonnage.	Yield.	Value.	Premium.	Total.
		Fine ounces.	£	£	£
Coolgardie	6,301	894·76	3,800·968	7,108·209	10,909·177
Cue	5,712	1,056·40	4,489·655	8,644·614	13,134·269
Kalgoorlie	9,742	1,378·92	5,880·620	11,730·494	17,611·114
Laverton	3,552	1,031·70	4,409·111	10,108·999	14,518·110
Meekatharra	3,195	380·84	1,617·658	3,453·802	5,071·460
Ora Banda	2,716	723·31	3,072·448	4,712·199	7,784·647
Wiluna	896	213·03	904·870	1,761·441	2,666·311
Yarri	896	148·08	629·445	964·691	1,594·136
	33,010	5,827·04	24,804·775	48,484·449	73,289·224

SCHEDULE 7.

Statement of Receipts and Expenditure for Year ended 31st December, 1949.

MILLING.

Batteries.	Tonnage Crushed.	EXPENDITURE.									RECEIPTS.		Profit.	Loss.
		Management.	Wages.	Stores.	Total Working Expenditure.	Cost per Ton.	Repairs and Renewals.	Sundries.	Gross Expenditure.	Cost per Ton.	Receipts.	Receipts per Ton.		
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	s. d.	£ s. d.	£ s. d.	£ s. d.	s. d.	£ s. d.	s. d.	£ s. d.	£ s. d.
Bamboo Creek	419	125 4 9	389 12 5	123 14 4	638 11 6	30 5·7	57 16 6	85 0 9	783 8 9	37 4·7	244 2 9	11 7·7	....	539 6 0
Boogardie	1,259	190 16 2	511 7 1	169 2 8	871 5 11	13 10	208 4 11	268 19 4	1,348 10 2	21 5	608 5 4	9 7·9	....	740 4 10
Coolgardie	4,345	395 19 8	1,633 8 11	1,105 14 0	3,135 2 7	14 5·1	660 17 11	683 0 0	4,479 0 6	20 7·4	1,632 9 4	7 6·1	....	2,846 11 2
Cue	6,803½	330 4 1	2,897 12 0	1,481 3 3	4,708 19 4	13 10·1	647 3 6	867 19 10	6,224 2 8	18 3·5	3,344 18 7	9 9·9	....	2,879 4 1
Kalgoorlie	8,675½	657 4 6	1,887 14 3	2,395 2 10	4,940 1 7	11 4·6	362 12 7	1,242 12 5	7,545 6 7	17 4·7	3,362 2 0	7 9	....	4,183 4 7
Laverton	5,299½	362 2 2	2,146 12 3	771 17 10	3,280 12 3	12 4·5	127 14 11	871 9 9	4,279 16 11	16 1·8	2,580 7 0	9 8·8	....	1,699 9 11
Linden	....	....	....	....	....	....	59 4 4	....	59 4 4	....	92 4 3	....	32 19 11	
Marble Bar	255	136 17 11	151 15 0	67 9 5	356 2 4	27 11·1	116 6 10	73 12 5	546 1 7	42 9·9	165 13 0	12 11·9	....	380 8 7
Meekatharra	3,902½	393 17 1	1,942 15 2	1,205 13 3	3,542 5 6	18 1·8	607 16 8	609 11 4	4,759 13 6	24 4·6	1,714 9 6	8 9·4	....	3,045 4 0
Mt. Ida	....	....	12 11 5	....	12 11 5	....	12 10 0	9 4	25 10 9	....	....	....	....	25 10 9
Norseman	865½	383 18 7	726 2 7	426 19 8	1,537 0 10	35 6·2	926 17 0	233 3 9	2,697 1 7	62 3·8	452 9 2	10 5·4	....	2,244 12 5
Ora Banda	3,930	371 7 3	1,592 12 5	1,105 8 3	3,069 7 11	15 7·4	659 16 7	571 16 1	4,301 0 7	21 10·6	1,742 7 4	8 10·4	....	2,558 13 3
Paynes Find	1,808½	279 8 6	1,147 5 5	310 14 1	1,737 8 0	19 2·5	451 13 4	488 5 5	2,677 6 9	29 7·2	1,153 2 3	12 9	....	1,524 4 6
Peak Hill	971	223 0 1	785 18 8	238 5 10	1,247 4 7	25 8·2	228 13 0	360 14 7	1,836 12 2	37 9·9	410 14 3	8 5·5	....	1,425 17 11
Sandstone	464¾	127 14 10	454 16 2	110 10 0	693 1 0	29 9·8	106 3 2	149 16 7	949 0 9	40 10	250 10 4	10 9·3	....	698 10 5
Twenty Mile Sandy	....	....	....	....	....	....	....	48 9 10	48 9 10	....	....	....	....	48 9 10
Warriedar	....	....	11 12 0	....	11 12 0	....	....	....	11 12 0	....	....	....	....	11 12 0
Weerianna	178	68 4 8	82 2 4	84 17 7	235 4 7	26 5·1	7 7 6	104 0 6	346 12 7	38 11·3	72 6 11	8 1·5	....	274 5 8
Wiluna	704½	133 11 11	388 14 2	110 15 6	633 1 7	17 11·6	212 8 10	312 11 2	1,158 1 7	32 10·5	322 7 6	9 1·8	....	835 14 1
Yalgoo	....	....	....	....	....	....	....	7 19 3	7 19 3	....	....	....	....	7 19 3
Yarri	1,671	322 6 3	1,309 10 1	464 17 0	2,096 13 4	25 1·1	402 7 5	494 11 1	2,993 11 10	35 9·9	905 5 2	10 10	....	2,088 6 8
Youanmi	....	....	....	....	....	....	....	....	....	....	10 0 0	....	10 0 0	....
	*41,551¾	4,501 18 5	18,072 2 4	10,172 5 6	32,746 6 3	15 9·1	6,857 15 0	7,474 3 5	47,078 4 8	22 7·9	19,063 14 8	9 2·1	42 19 11	28,057 9 11
TOTAL LOSS	....	....	....	....	....		....	....	....	....	....	....	....	28,014 10 0

* Tonnage for costing purposes.

SCHEDULE No. 8.

Statement of Receipts and Expenditure for Year ended 31st December, 1949.

TAILING TREATMENT.

Batteries.	Tons Treated.	EXPENDITURE.									RECEIPTS.		Profit.	Loss.
		Management.	Wages.	Stores.	Total Working Expenditure.	Cost per Ton.	Repairs and Renewals.	Sundries.	Gross Expenditure.	Cost per Ton.	Receipts.	Receipts per Ton.		
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	s. d.	£ s. d.	£ s. d.	£ s. d.	s. d.	£ s. d.	s. d.	£ s. d.	£ s. d.
Bamboo Creek	....	20 5 3	....	3 17 10	24 3 1	....	....	....	24 3 1	....	....	....	....	24 3 1
Boogardie	....	....	20 5 0	6 0	20 11 0	....	....	19 3 5	39 14 5	....	51 0 5	....	11 6 0	....
Coolgardie	6,301	482 18 10	2,889 5 9	1,573 0 6	4,945 5 1	15 8·3	144 4 1	714 0 1	5,803 9 3	18 5·4	6,391 12 4	20 3·4	588 3 1	....
Cue	5,712	254 17 0	1,828 7 0	1,274 15 3	3,357 19 3	11 9	38 9 1	565 6 6	3,961 14 10	13 10·4	6,295 16 3	22 0·5	2,334 1 5	....
Kalgoorlie	9,742	558 1 3	3,200 5 11	1,761 9 6	5,519 16 8	11 3·9	99 3 6	992 0 11	6,611 1 1	13 6·8	8,912 12 3	18 3·5	2,301 11 2	....
Laverton	3,552	296 2 5	914 5 8	499 10 6	1,709 18 7	9 7·5	246 2 8	438 3 11	2,394 5 2	13 5·7	7,466 7 5	42 0·4	5,072 2 3	....
Marble Bar	....	68 5 0	....	8 15 4	77 0 4	....	....	137 12 9	214 13 1	....	8 4 5	....	....	206 8 8
Meekatharra	3,195	300 4 5	1,534 1 5	1,070 8 6	2,904 14 4	18 2·1	145 18 6	476 19 6	3,527 12 4	22 0·9	3,240 1 10	20 3·3	....	287 10
Mt. Ida	....	....	....	....	....	....	....	....	....	....	62 4 7	....	62 4 7	....
Norseman	....	....	72 12 9	19 1 1	91 13 10	....	39 19 3	68 13 10	200 6 11	....	....	....	....	200 6 11
Ora Banda	2,716	266 15 9	1,206 12 4	1,017 14 1	2,491 2 2	18 4·1	45 16 8	334 14 8	2,871 13 6	21 1·7	2,457 1 10	18 1·1	....	414 11 8
Paynes Find	....	....	13 0 0	6 11 5	19 11 5	....	28 2 0	....	47 13 5	....	....	....	....	47 13 5
Peak Hill	....	....	5 10 0	10 18 9	16 8 9	....	....	13 2	17 1 11	....	12 14 11	....	....	4 7 0
Sandstone	....	....	8 0 0	2 16 0	10 16 0	....	....	....	10 16 0	....	....	....	....	10 16 0
Wiluna	896	156 8 6	252 9 4	222 19 9	631 17 7	14 1·2	18 10 8	160 19 1	811 7 4	18 1·3	1,492 15 2	33 3·8	681 7 10	....
Yalgoo	....	....	....	....	....	....	....	11 0	11 0	....	....	....	....	11 0
Yarri	896	86 2 11	318 3 6	210 12 10	614 19 3	13 8·7	3 11 1	96 10 4	715 0 8	15 11·5	1,039 3 10	23 2·3	324 3 2	....
	33,010	2,490 1 4	12,262 18 8	7,682 17 4	22,435 17 4	13 7·1	809 17 6	4,005 9 2	27,251 4 0	16 1·1	37,429 15 3	22 8·1	11,374 19 6	1,196 8 3
Interest Paid to Treasury	....	....	....	....	....	....	....	....	....	....	1,052 14 0	....	....	1,052 14 0
Nett Receipts	....	....	....	....	....	....	....	....	....	....	36,377 1 3	....	....	2,249 2 3
													2,249 2 3	
TOTAL PROFIT	....	....	....	....	....	....	....	....	....	....	....	....	9,125 17 3	....

GENERAL WORKING ACCOUNT FOR YEAR ENDED 31st DECEMBER, 1949.

Compared with 1948.

	1948. Milling.	Cyaniding.	Total.		1948. Milling.	Cyaniding.	Total.
	£ s. d.	£ s. d.	£ s. d.		£ s. d.	£ s. d.	£ s. d.
To Wages	22,354 19 6	16,336 18 2	38,691 17 8	By Revenue	19,658 6 1	37,868 12 4	57,526 18 5
,, Stores	9,200 18 0	8,362 1 3	17,562 19 3	,, Loss Carried Down	24,605 13 8	....	24,605 13 8
,, Repairs and Renewals	7,723 5 10	2,186 19 8	9,910 5 6				
,, Battery Spares	1,260 10 1	....	1,260 10 1				
,, General Expenses....	3,724 6 4	1,330 19 2	5,055 5 6				
,, Profit Carried Down	....	9,651 14 1	9,651 14 1				
	44,263 19 9	37,868 12 4	82,132 12 1		44,263 19 9	37,868 12 4	82,132 12 1

	1949. Milling.	Cyaniding.	Total.		1949. Milling.	Cyaniding.	Total.
	£ s. d.	£ s. d.	£ s. d.		£ s. d.	£ s. d.	£ s. d.
To Wages	22,574 0 9	14,753 0 0	37,327 0 9	By Revenue	19,063 14 8	36,377 1 3	55,440 15 11
,, Stores	10,172 5 6	7,682 17 4	17,855 2 10	,, Loss Carried Down	23,949 13 11	....	23,949 13 11
,, Repairs and Renewals	6,857 15 0	809 17 6	7,667 12 6				
,, Battery Spares	1,186 3 1	....	1,186 3 1				
,, General Expenses....	2,223 4 3	1,006 8 11	3,229 13 2				
,, Profit Carried Down	....	12,124 17 6	12,124 17 6				
	43,013 8 7	36,377 1 3	79,390 9 10		43,013 8 7	36,377 1 3	79,390 9 10

Profit and Loss Account.

	1948. Milling.	Cyaniding.	Total.		1948. Milling.	Cyaniding.	Total.
	£ s. d.	£ s. d.	£ s. d.		£ s. d.	£ s. d.	£ s. d.
To Loss Brought Forward	24,605 13 8	....	24,605 13 8	By Profit Brought Down	....	9,651 14 1	9,651 14 1
,, Administration	3,065 13 9	3,010 10 9	6,076 4 6	,, Gross Loss Brought Down	27,671 7 5	....	27,671 7 5
,, Gross Profit Carried Down	....	6,641 3 4	6,641 3 4				
	27,671 7 5	9,651 14 1	37,323 1 6		27,671 7 5	9,651 14 1	37,323 1 6

	1949. Milling.	Cyaniding.	Total.		1949. Milling.	Cyaniding.	Total.
	£ s. d.	£ s. d.	£ s. d.		£ s. d.	£ s. d.	£ s. d.
To Loss Brought Forward	23,949 13 11	....	23,949 13 11	By Profit Brought Down	....	12,124 17 6	12,124 17 6
,, Administration	4,064 16 1	2,999 0 3	7,063 16 4	,, Gross Loss Brought Down	28,014 10 0	....	28,014 10 0
,, Gross Profit Carried Down	....	9,125 17 3	9,125 17 3				
	28,014 10 0	12,124 17 6	40,139 7 6		28,014 10 0	12,124 17 6	40,139 7 6

General Profit and Loss Account.

1948.	£ s. d.	£ s. d.	1948.	£ s. d.
To Gross Loss Milling	27,671 7 5		By Nett Loss Carried Down	46,632 14 5
,, *Less* Gross Profit Cyaniding	6,641 3 4			
		21,030 4 1		
,, Interest	....	18,540 3 5		
,, Sinking Fund	....	1,431 12 0		
,, Depreciation	....	4,299 8 4		
,, Superannuation	....	1,331 6 7		
		46,632 14 5		46,632 14 5
,, Balance Bought Forward		£1,490,814 15 9		
,, Loss for Year		46,632 14 5	,, Balance Carried Down	1,537,447 10 2
		£1,537,447 10 2		£1,537,447 10 2

1949.	£ s. d.	£ s. d.	1949.	£ s. d.
To Gross Loss Milling	28,014 10 0		By Nett Loss Carried Down	44,618 0 1
,, *Less* Gross Profit Cyaniding	9,125 17 3			
		18,888 12 9		
,, Interest	....	17,569 2 3		
,, Sinking Fund	....	1,434 0 0		
,, Depreciation	....	5,273 9 8		
,, Superannuation	....	1,452 15 5		
		44,618 0 1		44,618 0 1
,, Balance Brought Forward		£1,537,447 10 2		
,, Loss for Year		44,618 0 1	,, Balance Carried Down	1,582,065 10 3
		£1,582,065 10 3		£1,582,065 10 3

BALANCE SHEET AS AT 31st DECEMBER, 1949.
COMPARED WITH 1948.

(For the Year 1948.)

Liabilities—1948.	£ s. d.	£ s. d.	*Assets*—1948.	£ s. d.	£ s. d.
Capital provided from—					
General Loan Fund	412,846 6 9		Plant and Buildings	77,880 0 10	
Consolidated Revenue Fund	97,724 16 6		*Less* Depreciation	3,862 8 7	
Assistance Gold Mining Industry	28,621 13 5				74,017 12 3
Commonwealth Assistance Metalliferous Mining	13,786 8 0		Motors and Horses	2,107 19 9	
		552,979 4 8	*Less* Depreciation	436 19 9	
					1,671 0 0
Tailings—			Stores—		
Advanced by Treasury	22,000 0 0		Outstations	18,119 2 6	
			Head Office	148 0 5	
Sundry Creditors—					18,267 3 1
For Tailings	1,828 14 10		Sundry Debtors	....	6,507 7 2
For Premiums	2,135 12 7		Battery Spares	....	832 2 4
Estimated Balance of Premium Due	669 2 3				
		26,633 9 8	Tailings—		
			Tailings (not treated)	22,728 1 2	
Due to State Treasury—			Estimated Gold Premium	669 2 3	
Excess of Expenditure over Revenue	201,688 15 8		Cash Balance of Advance	3,236 6 3	
Superannuation—Employer's Contribution	4,034 6 6				26,633 9 1
Interest on General Loan Fund Capital	734,053 9 8		Profit and Loss Account	....	1,537,447 10 2
Sinking Fund on General Loan Fund	140,293 0 4				
		1,080,069 12 2			
Sundry Creditors—					
Ordinary Accounts	3,209 12 8				
Cash Orders	2,484 5 6				
		5,693 18 2			
		£1,665,376 4 8			£1,665,376 4 8

(For the Year 1949.)

Liabilities—1949.	£ s. d.	£ s. d.	*Assets*—1949.	£ s. d.	£ s. d.
Capital provided from—					
General Loan Fund	413,924 9 5		Plant and Buildings	78,088 10 0	
Consolidated Revenue Fund	100,736 11 3		*Less* Depreciation	5,043 2 5	
Assistance Gold Mining Industry	28,621 13 5				73,045 7 7
Commonwealth Assistance Metalliferous Mining	13,786 8 0		Motors and Horses	1,751 7 3	
		557,069 2 1	*Less* Depreciation	230 7 3	
					1,521 0 0
Tailings—			Stores—		
Advanced by Treasury	34,000 0 0		Outstations	17,451 3 8	
			Head Office	130 13 1	
Sundry Creditors—					17,581 16 9
For Tailings	2,543 10 3		Sundry Debtors	....	8,622 2 1
For Premiums	3,880 14 5		Battery Spares	....	893 19 11
Estimated Balance of Premium Due	18,198 14 4				
		58,622 19 0	Tailings—		
			Tailings (not treated)	36,280 17 3	
Due to State Treasury—			Estimated Gold Premium	18,198 14 4	
Excess of Expenditure over Revenue	223,118 8 4		Cash Balance of Advance	4,143 7 5	
Superannuation—Employer's Contribution	5,487 1 11				58,622 19 0
Interest on General Loan Fund Capital	751,622 11 11		Profit and Loss Account	....	1,582,065 10 3
Sinking Fund on General Loan Fund	141,727 0 4				
		1,121,955 2 6			
Sundry Creditors—					
Ordinary Accounts	1,720 13 0				
Cash Orders	2,984 19 0				
		4,705 12 0			
		£1,742,352 15 7			£1,742,352 15 7

ANNUAL PROGRESS REPORT OF THE GEOLOGICAL SURVEY BRANCH OF THE MINES DEPARTMENT FOR THE YEAR 1949.

Contents.

Plates.

The following List should be read in place of that printed:—

LIST OF FIGURES.

Division IV.

Annual Progress Report of the Geological Survey of Western Australia for the Year Ended 31st December, 1949.

Under Secretary for Mines:

I have the honour to submit, for the information of The Honourable the Minister for Mines, my report on the operations and progress of the Geological Survey for the year ended 31st December, 1949.

STAFF.

The active strength during and at the end of the year was as follows:—

			Total.
Professional.			
Ellis, H. A., B.Sc., A.O.S.M.	Government Geologist		
McMath, J. C., B.Sc. (Hons. London), F.G.S., M. Aust.Inst.M. & M.	Senior Geologist		
Lord, J. H., B.Sc., F.G.S.	Geologist, 1st Class		
Johnson, W., B.Sc. (Hons.)	Geologist, 1st Class		8
Gray, N. M., B.Sc.	Geologist, 2nd Class		
Gleeson, J., B.Sc.	Geologist, 2nd Class		
Sofoulis, J., B.Sc.	Geologist, 2nd Class		
de la Hunty, L. E., B.Sc.	Geologist, 2nd Class		
Clerical.			
Outtrim, I. F.	Clerk		
White, Miss S.	Typist (Temporary)		3
McComish, L.	Trainee Junior Clerk		
Laboratory.			
Fimmell, L.	Laboratory Assistant		1

Promotions, Resignations, New Appointments.

No promotions, resignations or new appointments affecting the permanent professional staff took place during the year.

Mrs. MacDonald occupied the position of technical typist and stenographer up to 5th August, when she resigned. Miss S. White was appointed to the position on 22nd August. I desire to express appreciation of the services rendered by these two ladies during the year, as a large volume of manuscript was effectively handled by them in respective periods of their employment.

N. M. Potts, trainee junior clerk, resigned on 7th February to accept an appointment with private enterprise and was replaced by L. McComish on 4th April.

Professional Staff.

Throughout the year, eight professional officers, including the Government Geologist, carried out the field work of the Survey. Most of the demands for urgent work were able to be met, but long term work of a regional nature could not be undertaken with this small staff. The following tabulated statement shows the relation between the area of the State and the availability of geologists during the year:—

Period.	Number of Geologists available including Government Geologist.	Area of State.	Square Miles per Geologist.	Population.
1949. Jan.-Dec.	8	sq. miles. 975,920	121,990	524,000

The demand for all kinds of geological investigations continues to grow, and the present staff has had a strenuous year meeting the most urgent of these demands.

ACTIVITIES OF PROFESSIONAL OFFICERS.

H. A. Ellis, Government Geologist.

In addition to head-office duties, the following field work was undertaken:—

Places Visited.	*Purpose of Visit.*	*Period.*
Day Dawn	Field work with H. J. C. Conolly in connection with deep-drilling project at Great Fingall	January
Northampton	Water Supply Investigation	February
Coast South of Ravensthorpe and Albany	Inspection of Kyanite claims and water supply investigation at Albany	March
Southern Cross, Edwards Find, Bullfinch, Coolgardie, Norseman	Inspection mining activities	April
Exmouth Gulf	Inspection, field work on oil survey	May
Irwin River	Inspection, field work on Irwin River coal survey	June
Norseman	Inspection, " Iron King " Mine	July
Pilbara and Ashburton Goldfields	Inspection, alleged Uranium deposit and examination of Kooline Lead Fields	August
Israelite Bay, Norseman and Edwards' Find	Field examinations for Sillimanite, Pyrite and Gold	Sept.-Oct.
Esperance, Mt. Monger and Norseman	Investigations for water supply at Esperance, Talc at Mt. Monger and Pyrite at Norseman	Oct.-Nov.
Edwards' Find	Inspection field work	Nov.-Dec.

J. C. McMath, Geologist.

January-August: Preparation of Coolgardie Bulletin. During this period the following inspections were made:—March—Doubtful Island Bay Beach Sands and Torbay Beach Sands; April—Beach Sands of Busselton Area.

August-December: Cue reconnaissance Survey and Great Fingall Project. During this period the following inspection was made:—November—Horseshoe Manganese Deposits, Peak Hill Goldfield.

June: A brief article, "Some Beach Deposits of W.A." was prepared for publication in the press.

J. H. Lord, Geologist 1st Class.

January: Leave.

February: Investigated a water supply problem at Bindoon Boys' Town. Visited Yanmah Kyanite deposit.

March-April: Routine work at Collie. Investigated oil possibilities on Location 2805 near Mt. Barker. Arranged the Moulding Sands Bulletin for printing.

May: Assisted Mr. Lennart of Brasserts Ltd., New York, to compile information regarding Collie. Surveyed area at Collie Burn for shallow drilling for possible open-cut coal.

June-July: Prepared Bulletin 95 for reprinting. Examined the Mt. Dick area near Northam for iron possibilities.

August-October: Investigated a reported radioactive mineral find in the Upper Helena River Valley. Examined an asbestos deposit 6 miles south of Donnybrook. Completed the compilation of the new Geological Map of W.A. Routine work at Collie.

November-December: Surveyed area 2½ miles east of Collie Burn for open-cut possibilities. Visited Collie with Mr. Wommer, of Brasserts Ltd., and compiled information for him. Carried out an examination of Edwards' Find, Yilgarn Goldfield. Initiated the geological survey of the Metropolitan Area.

The following work was carried out in addition to that enumerated above:—

The revision of the Standard Symbols of the Geological Survey of W.A.

Further preparations for the deep-drilling programme at Collie.

Supervision of the drilling of Prospecting Area 54 at Collie by Western Collieries.

Sampling new areas for supplies of moulding sands, etc.

W. Johnson, Geologist 1st Class.

January: Examination of Young River vermiculite deposits and Bandalup Creek magnesite deposits.

February-March: Writing report on the Young River vermiculite deposits and preparing for Irwin River and Eradu field survey.

April-September: In charge of geological survey of Irwin River and Eradu Districts.

September-December: Writing Interim Report and Bulletin on the Geological Survey of the Irwin River and Eradu Districts.

November: Selection of bore sites for water, Tootra Station.

N. M. Gray, Geologist 2nd Class.

January: Compilation of Annual Report.

February: Preparation of plans for drilling of the "Great Fingall" under Mr. H. J. C. Conolly.

March-June: Compilation of Bulletin on the Coolgardie Goldfield.

July: Iron Ore Survey, Northam, with Mr. Lord.

August-September: Compilation of Bulletin on the Coolgardie Goldfield.

October-November: Examination of the manganese deposits of the Phillips River and the Coolgardie Goldfields with Mr. Gleeson.

December: Office work in connection with the manganese surveys.

J. Gleeson, Geologist 2nd Class.

January-February: Assisting Mr. Johnson in the vermiculite deposit examination at Young River and the magnesite deposit at Bandalup Creek.

February-March: Preparation of data for projected survey of Irwin River Coal Basin.

April-September: In the field on mapping in connection with the survey of the Irwin River Coal Basin.

October: Preparation of data for Phillips River District manganese examination.

October-November: Assisting Mr. Gray in the examination of pyrite at Mt. McMahon, and of the manganese deposits in the Phillips River and Coolgardie Goldfields.

December: Office work, preparation of reports.

J. Sofoulis, Geologist 2nd Class.

January-April: Assisting American oil geologist E. Craig in connection with investigations carried out in the Exmouth Gulf Area for Ampol Petroleum Company. Geological surveys included Rough, Giralia, Cardabia Ranges, plus field and reconnaissance work in the Minilya River Area.

April: Assisting Mr. Lord at Collie.

May-October: Carrying out survey of the Cape Range in conjuction with Commonwealth geologists Johnstone and Perry. Inspection of bentonite clay deposit at Cardabia, and gravel deposits at Learmonth.

October-December: Compilation of reports. Assisting Mr. Lord in Collie Coal field work and in investigation of gold leases at Edwards' Find. Preparation of data plus field work in connection with survey of Metropolitan Area.

L. E. de la Hunty, Geologist 2nd Class.

January: Preparation of data for Irwin River Coal Survey.

February: Assisting Mr. Lord in contour mapping at Bindoon and examination of kyanite deposit at Yanmah.

March: Assisting Mr. McMath in examination of beach sand deposits at Doubtful Island Bay.

April-September: Geological surveying in the Irwin River District.

October: Preparation of plans in connection with Irwin River Survey.

November: Assisting the Government Geologist in water supply problem at Esperance and examination of talc deposit at Mt. Monger. Examination of shales and clay at Byford.

December: Preparation of plans and sections, and collection of bore data for bulletin on the Irwin River District.

FIELD WORK.

Major Field Work Completed during the Year and in Progress as at December, 31.

(1) The party engaged on the sampling of river sands in connection with th search for radioactive detrital minerals undertaken for the Commonwealth Bureau of Mineral Resources completed its programme on 10th February, and no further work on this project has been undertaken.

(2) The geological survey of the Irwin River Coal Basin was commenced and completed during the year.

(3) The officer (Mr. Sofoulis) participating in the oil survey in the Exmouth Gulf area was continuously in the field up to 6th October when field work for the year ended. It is not intended to continue our representation with this oil survey, which is being continued by geologists from the Commonwealth Bureau of Mineral Resources.

(4) Owing to a demand for information about the occurrence and distribution of industrial minerals and rocks in the vicinity of Perth, a decision was made to map a considerable area of country north, south and east of the city, and a start was made on this work in December. Messrs. A. J. Glance and W. E. Wheeler, students from the Department of Geology, University of W.A., were temporarily employed and commenced plane table work early in December, and the work will be continued by Survey geologists as opportunity offers.

(5) Pending the commencement of the deep drilling project at Day Dawn in search of a possible extension of the Gt. Fingall gold shoot, Mr. McMath, who has been seconded from the Survey as supervising geologist to the Gt. Fingall Exploration Company, commenced a regional reconnaissance of the Cue greenstone belt in August.

Diamond Drilling on the Gt. Fingall prospect commenced on December 12th, and will occupy a considerable part of Mr. McMath's time probably for the next two years.

Field Work for 1950.

(1) Continuation of the Geological Survey of an area surrounding the city of Perth.

(2) A search for iron ore deposits of a lateritic nature within a radius of 50 miles of Bunbury, in connection with the proposed establishment of a Steel Industry based on Bunbury.

(3) A search for limestone in the same area for the same purpose as stated in (2) above.

(4) Continuation of the Geological Reconnaissance of the Cue Greenstone belt and the supervision of the deep drilling project on the Gt. Fingall ore body at Day Dawn.

(5) Supervision of the Collie Coal Field deep drilling programme scheduled to commence in January of 1950.

(6) Supervision of shallow percussion drilling for coal in several parts of the Collie Coal Basin.

(7) If circumstances permit, detailed surveys will be carried out in the Mt. Magnet and Linden Gold Mining Centres as planned for 1949, but not carried out owing to pressure of more urgent work.

TRANSPORT.

Tabulated details of transport at present in use by the Geological Survey are as follows:—

Vehicle.	Make and Type.	Load.	Mileage as at 31–12–49.	Mileage for 1949.	Date Vehicle Purchased.	Remarks.
WAG 534	Dodge Utility	15 cwt.	108,650	7,275	1935 (new)	Includes 1,300 miles while speedometer not registering.
1053	Ford Utility	18 cwt.	60,282	5,047	1945 (used)	Includes 20 miles while speedometer not registering.
1060	International Utility	15 cwt.	54,605	6,281	1945 (used)	
1175	Ford Utility	15 cwt.	36,388	7,980	1946 (new)	
1194	Ford Utility	15 cwt.	35,760	9,740	1946 (new)	
1307	Chevrolet Utility	15 cwt.	77,062	4,114	1947 (used)	
1413	Chevrolet Utility	15 cwt.	30,448	10,747	1947 (new)	Includes 185 miles while speedometer not registering.
1421	Chevrolet Utility	15 cwt.	29,998	16,212	1947 (new)	

Total Miles: 67,396.

Total mileage for 1949 was 9,266 miles less than that of the previous year, and the average mileage per vehicle dropped from 9,582 in 1948 to 8,424 in 1949.

Running expenses for all vehicles totalled £1,505 6s. 6d. which was 5.36d. per mile compared with 76,622 miles costing £1,062 18s. 9d. at an average of 3.32d. per mile in 1948.

SERVICE TO THE GENERAL PUBLIC, MINING INTERESTS AND GOVERNMENT DEPARTMENTS.

Requests for information on the geology of the State, old mines and mining fields in general, continue to increase year by year, and much of this demand is met by Mr. Outtrim, Clerk to the Survey, whose extraordinary knowledge of our literature enables him to render a much appreciated service in this direction.

A steady supply of practical assistance to metal and coal mining interests has been maintained during the year per medium of geologists in the field. Other Government Departments constantly call on us for technical advice in matters concerning water supplies, dam sites, road making materials, etc.

ACTIVITIES OF THE COMMONWEALTH BUREAU OF MINERAL RESOURCES.

The examination and sampling of beach and river sands for deposits of detrital radio-active material undertaken by the Survey for the Commonwealth Bureau of Mineral Resources was completed in February, 1949, when the remaining party was disbanded.

Three separate parties of Commonwealth geologists were engaged in mapping sedimentary formations in the Fitzroy district (Kimberley Division), the Exmouth Gulf area (North-West Division) and the Wooramel River district (North-West Division) in connection with the search for potential oil-bearing horizons. Progress reports of these operations are made and copies passed to the Geological Survey. Another party of Commonwealth geologists carried out geological reconnaissance in the East Kimberley district in areas adjoining the border between Western Australia and the Northern Territory.

A Commonwealth geologist resident in Perth has also been engaged on miscellaneous mineral investigations throughout the year.

It is possible that members of the Commonwealth Bureau of Mineral Resources may have rendered professional services to mining interests but about which we would have no knowledge.

PUBLICATIONS.

Issued During 1949.

Annual Progress Report of the Geological Survey of Western Australia for 1946.

In the Press.

Annual Progress Report of the Geological Survey of Western Australia for 1947 and 1948.

Bulletin No. 102: The Greenbushes Mineral Feld, by R. A. Hobson, B.Sc. (Hons.) and R. S. Matheson, B.Sc.

Bulletin No. 103: Geology of Portion of the Mt. Margaret Goldfield, by R. A. Hobson, B.Sc. (Hons.) and K. R. Miles, D.Sc., with two atlases of maps.

Mineral Resources of Western Australia, Bulletin No. 5: Moulding Sands of Western Australia, by K. R. Miles, D.Sc., and H. A. Stephens, B.Sc.

Bulletin No. 104: Some Economic Aspects of the Principal Tantalum Bearing Deposits of the Pilbara Goldfield, by H. A. Ellis, B.Sc., A.O.S.M.

Bulletin No. 106: A Geological Reconnaissance of Portion of the Yalgoo, Murchison, Peak Hill and Gascoyne Goldfields, by W. Johnson, B.Sc. (Hons.).

Bulletin No. 95 (1st Reprint): The Physiography of Western Australia, by J. T. Jutson, B.Sc., LL.B.

Atlas of Maps to accompany Bulletin No. 101 (issued 1947).

Geological Sketch Map of Western Australia, Scale 40 miles = 1 inch.

Compiled and Awaiting Authority to Print.

Bulletin No. 107: A Re-Survey of the Coolgardie District, W.A., by J. C. McMath, B.Sc. (Hons. Lond.), F.G.S., M.Aust.I.M.M., and N. M. Gray, B.Sc.

Mineral Resources Bulletin No. 6: Silver, Lead and Zinc, by W. Johnson, B.Sc. (Hons.).

Mineral Resources Bulletin No. 7: Vermiculite, Talc and Soapstone, Fuller's Earth, Bentonite and Diatomite, by W. Johnson, B.Sc. (Hons.).

In Course of Preparation.

Bulletin No. 105: The Geology and Mines of the Collie Coalfield, by J. H. Lord, B.Sc.

Bulletin No. 108: The Geology of the Irwin River and Eradu Coal Basins, by W. Johnson, B.Sc. (Hons.), J. S. Gleeson, B.Sc., and L. E. de la Hunty, B.Sc.

I have pleasure in recording the completion of a satisfactory year's work, made possible by the united efforts of the office and professional staffs.

H. A. ELLIS,
Government Geologist.

January, 20, 1950.

KYANITE

At West Beach, 10 Miles West of Hopetoun, and near East Mt. Barren, 5 Miles West of Hopetoun.

Approx. Lat. 33° - 55′ S.
Approx. Long. 120° - 00′ E.

H. A. Ellis, B.Sc., A.O.S.M., Government Geologist.

Introduction.

Mineral claims 15, 16, 18, 19 and 20 and a prospecting area were recently pegged for kyanite in the rugged, hilly country from 5 to 10 miles west of Hopetoun. M.C. 15 is situated about half a mile east of East Mt. Barren and approx. 1 mile west of the sand-ridge blocked Culham Inlet, about 5 miles west of Hopetoun.

M.Cs 16, 18, 19 and 20 are a line of leases pegged in a general N.E. by E. direction along the landward side of what is known locally as West Beach. The prospecting area is located approximately 1 mile north of the eastern end of West Beach and adjoins the S.E. corner of Kent Location 770, Lands Dept. Litho., 433/80. The holdings were inspected on March 11, 12 and 13, 1949.

Access.

The West Beach locality is reached by a road and track of indifferent quality running in a general southerly direction from Ravensthorpe. Road distance to the beach is about 32 miles. The East Mt. Barren locality is reached by a sand track running west from the main Ravensthorpe-Hopetoun road about threequarters of a mile N. of Hopetoun.

General Geology.

The rocks of the area consist of highly folded, steeply inclined quartzites, mica schists, conglomerates and phyllites of the Mt. Barren series, of Pre-Cambrian age. They have all the appearances of rocks of the Mosquito Creek Series as typically exposed in the Mosquito Creek area east of Nullagine in the Pilbara Goldfield in the North-West part of the State. The quartzites form rugged ridges and hills oriented in the direction of the regional strike, which is N. 55° E. in this locality. Quartzites predominate, and the rocks have been invaded by non-auriferous quartz reefs. In both localities the beds comprise the south limb of a large anticlinal structure plunging about 30° to 35° to the South West. The northern limb of the structure was not observed to be present in the 30 chains of outcrop width inspected during the investigation. The beds dip at from 50° to 60° to the south, and extremely well defined fracture cleavage of a widespread nature, indicates that the whole structure is overturned to the north. Dragfolds give frequent confirmation of this interpretation.

It would be difficult to find a better series of exposures of metamorphic rocks so clearly demonstrating text book examples of minor structures as related to the interpretation of major structures, than those to be seen on the coast in these localities.

The Kyanite Occurrences.

It is not unusual for a series of metamorphic rocks comprising quartzites, sericite and biotite mica schists, phyllites and conglomerates to contain horizons in which the common metamorphic minerals andalusite, staurolite and kyanite are developed. In the present cases the schistose rocks usually outcrop to the south of the quartzites, and form the bulk of the exposures between tide marks. This is particularly the case at the West Beach claims, where, as far as the writer's examination was concerned, the bulk of the potential kyanite and staurolite bearing schists outcrop to the south of the pegged areas.

At West Beach the only kyanite bearing rocks exposed are those schists which outcrop actually at or near sea level. Here the kyanite is distributed in irregular narrow bands, mostly less than 2 inches wide, and is developed marginal to thin quartzite bands which, are actually metamorphosed sandstones, but which have the appearance of quartz veins developed parallel to the bedding planes of the enclosing schists. These quartzite bands with which the kyanite is associated seldom attain a thickness of 12 inches, and are mostly under 6 inches in width.

The kyanite occurrences are sporadic, and consist of a development of narrow but long (up to 3 inches) crystals of black kyanite arranged in an irregular manner in the enclosing mica schist, but with the long axes always oriented parallel to the bedding planes of the enclosing rocks. The Kyanite is not developed in the plane of maximum schistosity (that of the fracture cleavage) but is distinctly confined to the plane of lesser schistosity which is parallel to the bedding planes of the enclosing rocks. The kyanite bearing horizons are dragfolded on a minor and major scale, and owing to the steep westerly plunge of the structure, these horizons will give place on the strike to either quartzites or other overlaying barren beds. If a payable concentration did exist, its prospects would therefore lie in the direction of plunge if it did not have a workable strike length. No such concentrations are known, however.

The kyanite occurrence at the foot of East Mt. Barren on the western end of the beach facing Culham Inlet, is located right at high water mark, and has the same general manner of occurrence as that at West Beach.

Although the principal type of Kyanite found in both of these localities is a black coloured idiomorphic crystalline variety occurring in the manner previously described, occasional mosaics of pale blue kyanite occur as isolated concentrations, adjacent to quartzite bands in the mica schist. This type of occurrence is very rare.

Quality of the Kyanite.

Cleaned samples of the black and blue kanite were collected and analysed at the Government Chemical Laboratories, Perth, with the following results:—

Lab. No. 2006.

Black Kyanite.

	Per cent. on dry sample.
Alumina Al_2O_3	51.94
Silica SiO_2	34.63
Ferric Oxide Fe_2O_3	7.15
Ferrous Oxide FeO	3.39
Titania TiO_2	1.05

Lab. No. 2008.

Blue Kyanite.

	Per cent. on dry basis.
Alumina Al_2O_3	58.87
Silica SiO_2	34.27
Ferric Oxide Fe_2O_3	2.55
Ferrous Oxide FeO	1.61
Titania TiO_2	0.02

Kyanite, when used as a refractory, is usually required to conform to the following specifications:—

Alumina Al_2O_3, 63% - 66%
Silica SiO_2, 31% (minimum)
Ferric Oxide Fe_2O_3, 0.5% (maximum)
Titania TiO_2, 0.75% (maximum)

The black kyanite is the only type present in any quantity in the mica schist, and it contains far too much iron to meet the requirements of a good grade refractory kyanite.

The blue kyanite comes closer to the specifications, but its occurrence is more of mineralogical than commercial interest in the areas examined.

Quantity of Kyanite.

No detrital boulder kyanite has been found on the holdings occurring in a similar manner to that found at Yanmah, near Manjimup. The only occurrences so far known are the thin concentrations of the black crystals in the mica schist bands. Even if this kyanite was of commercial grade, it would have to be recovered from the parent rock by mining, crushing and probably floatation treatment. In the writer's opinion, the quantity of kyanite bearing rock is too small, the relative proportion of kyanite in the rock too little, and the grade of the kyanite too low to enable any consideration to be given to the development of these deposits. There are no accompanying deposits of clay or soil containing useful concentrations of kyanite.

REPORT ON AN ALLEGED URANIUM DEPOSIT ON M.C. 140, WODGINA

By H. A. Ellis, B.Sc., A.O.S.M., Government Geologist.

Introduction.

On 2nd August, 1949, a report appeared in "The West Australian," Perth's morning newspaper, that a Mr. W. D. Millar of Biloela, Central Queensland, had discovered a rich uranium-bearing deposit on M.C. 140, which is situated about 1.3 miles by track N. 30° E. from the main workings on M.C. 107 at Wodgina. The find was stated to be the richest deposit known in Australia, presumably a statement made by Mr. Millar.

On 27th July, 1949, an application for a prospecting area was lodged with the Mines Department, and the area pegged—45 acres, included a substantial portion of M.C. 140, owned by Tantalite Ltd. and taken up for tantalite. Mr. Millar used a portable Geiger-Muller counter on the field and brought to Perth specimens of radio-active material which were tested for radio-activity at the Government Chemical Laboratories with positive results. These specimens have not been seen by the writer.

The writer was on his way north at the time to inspect the Kooline leadfield and received telegraphic instructions at Onslow to visit the Wodgina locality and report on the alleged discovery.

No samples or specimens from the locality were submitted to the Government Chemical Laboratory by Mr. Millar for analysis or determination, and the basis on which the various percentages of uranium contained in the radio-active material quoted in subsequent articles in the Press was determined is unknown to the writer.

The area was examined on the 13th August, 1949, without the aid of a Geiger-Muller counter.

Locality.

M.C. 140 is situated approximately 60 chains N. 30° E. from the treatment plant on the main lode workings of M.C. 107, Wodgina. The distance by car track is about 1.3 miles, following the valley of the main creek on its course out of the Wodgina hills to the north-east for a considerable part of the distance. M.C. 140 was pegged many years ago by Tantalite Ltd. for tantalite, and is oriented in a nearly north and south direction. Prospecting Area 2311, the area pegged and applied for by Millar, has its datum peg about 7 chains south of the north-western corner of M.C. 140 and extends 15 chains east and 30 chains south of the datum peg, taking in approximately the southern 2/3 of M.C. 140 as well as additional country to the south.

Geology.

The area pegged in Prospecting Area 2311 consists mainly of gently undulating to low hilly country intersected by shallow east trending creek heads. The ground was obviously included as part of Mineral Claim 140 by the original peggers for Tantalite Ltd. on account of its potential eluvial and alluvial tantalite possibilities, besides taking in several strong pegmatite formations.

Bedrock on the gently undulating areas consists of schistose greenstone, while the hills are composed of the same material. The general strike of the schistosity is about N. 40° E. with steep dips to the north-west and there are structural indications that the rocks form portion of a steep south-westerly plunging structure.

Prospecting Area 2311 takes in several pegmatite dykes which have been prospected by Tantalite Ltd., and also covers alluvial and eluvial workings. The principal pegmatite dyke occurs in the north-west corner of Prospecting Area 2311, and runs south just inside the western boundary. It is some 800 feet long and attains a width of about 30 feet in places occasionally pinching out to only 6 inches wide and sometimes disappearing altogether. It is a typical Wodgina pegmatite dyke of extremely variable dimensions and attitude. Sometimes it has a vertical dip and is transgressively intrusive into the greenstone, other times it dips west at about 40° and is parallel to the schistosity. The general strike would be about N. 15° E. with a general dip of 45° to the west—a dip in the opposite direction to that of the main lode at Wodgina.

Several shallow potholes (maximum depth 8 feet) have been sunk on the dyke (NOT by Mr. Millar, but by the holders of Mineral Claim 140 many years ago) in or near the footwall, and occasional specks of tantalite in the dumps near these workings indicate that these were the only tantalite prospects found. The dyke consists of the usual quartz lenses in fine grained to coarsely crystalline aggregates of microline felspar, albite felspar, quartz, grossularite garnet, some biotite, occasional very small books of muscovite mica, and a wall development of "curly" albite which has contained the tantalite and ocasional concentrations of lithiophilite in narrow bands.

The shallow creek beds leading downhill from this dyke have been worked on a very small scale for alluvial tantalite, and the gently sloping ground below the dyke has been worked by dryblowing for eluvial tantalite. It is quite obvious that this dyke has contained only a very small quantity of tantalite.

Several other small patches of pegmatite near the centre of the area were noted, but none has ever been worked for tantalite.

Search for Radio-active Minerals.

The writer and his assistant (from the Geological Survey Laboratory) after the general inspection was completed, made a careful detailed inspection of the mineral content of all pegmatite outcrops, all workings on the area and some off it to the west, as well as the alluvial and eluvial ground. The writer's assistant was instructed to collect all black or coloured minerals other than quartz and mica and the writer himself collected samples of every black mineral on the area. No highly coloured minerals were seen and only one mineral not previously identified by the writer in the Wodgina district was found. This proved to be non-radio-active on subsequent examination at the chemical laboratory.

The writer is conversant with what is an unusual mineral in the Wodgina pegmatites, having spent many months in the district examining pegmatite dykes. He is also conversant with practically every known mineral-bearing pegmatite dyke in Western Australia and considers himself capable by experience of recognising any unusual mineral in a pegmatite dyke.

Six specimens were collected and subsequently examined under the Geiger-Muller counter at the Government Chemical Laboratory. These represent black minerals from various parts of the dyke, including wall rock, the alluvial and eluvial ground. Of these, one only—a sample of fine grained dyke material showing traces of tantalite—showed very slight radio-activity. The others showed no radio-activity at all.

The main pegmatite lode at Wodgina has been mined extensively for tantalite during perhaps the last 40 years. Throughout this period occasional discoveries of radio-active minerals such as pilbarite, hydrothorite, nicolayite and maitlandite, all uranium and thorium bearing minerals, have been made, but the minerals have been present in extremely small quantities only. Specimens of these minerals have been collected by the owners and form part of an unprotected mine office mineral collection similar to that usually seen in any mine office.

From inquiries made by the writer at the Wodgina Mine (now under exemption) it was learned from the caretaker (Mr. Gilbert) that Mr. Millar had had access to the mine's office collection in Mr. Gilbert's company, and that after Mr. Millar had returned to Perth, he wrote to Mr. Gilbert and asked him to send him some pilbarite. This was done, and it is understood that some of the material exhibited by Mr. Millar at the Government Chemical Laboratory was pilbarite. Mr. Gilbert informed the writer that he had been "helpful" to Mr. Millar.

The old workings showed recent occasional knapping marks, but no other sign whatever of mining activity in any form.

Conclusions.

(1) Although the ground was not examined by Geiger-Muller counter by the writer, it was very thoroughly and carefully examined for the presence of unusual minerals. No unusual minerals possessing radio-activity were found.

(2) No unusual minerals have ever been reported from this ground since it was first pegged and prospected, despite the fact that it has been under the care of a very competent investigator in Mr. Kennedy, until recently general manager for Tantalite Ltd. and long resident at Wodgina.

(3) No commercial deposit of uranium has as yet ever been found in pegmatite dykes. To quote Dr. C. F. Davidson, Chief Geologist of the Atomic Engery Division, Geological Survey of Great Britain, an investigator who has examined all known uranium occurrences in the world outside of the U.S.S.R.

> *"Unfortunately, no common pegmatite has yet been found to be capable of yielding a significant tonnage of uranium minerals at an economic price, although many attempts have been made to work such deposits in Tanganyika, Madagascar, Norway, U.S.A., Manchuria and elsewhere. Only where economics do not matter, or where production is possible as a by-product, is a small output of uranium ore from pegmatites likely to be practicable."

(4) Mr. Millar was definitely given some radio-active pilbarite from the main lode, M.C. 107, Wodgina, by the Mine Caretaker, Mr. Gilbert, and had access to the unprotected miscellaneous mineral collection in the mine office. This collection contained specimens of other radio-active minerals from the main lode. Legitimate doubts on the whereabouts of the locality from which Mr. Miller obtained radio-active specimens can be held, especially as it is understood by the writer that he had some pilbarite in his possession at the time of his visit to the chemical laboratory, and that after careful search no unusual minerals could be found in the pegmatites on the area pegged.

(5) In the writer's opinion, the ground pegged in Prospecting Area 2311 does not contain unusual concentration of uranium minerals. No evidence of the likely occurrence of such mineral could be found on a detailed inspection, and no worthwhile evidence has been produced by the applicant that the mineral exists on the area in any but faint traces, a not uncommon feature of any pegmatite dyke in the Wodgina district.

(6) Mineral Claim 140 was originally pegged for tantalite, and the tantalite occurs in the pegmatite dykes and in the eluvial and alluvial material shed from the dykes. Any radio-active mineral which may exist on P.A. 2311 would be found in the pegmatite dykes, and possibly in the eluvial and alluvial material. It is obvious that any prospecting for radio-active minerals on that portion of P.A. 2311 covering part of M.C. 140 could only be carried on in the pegmatite dykes and in the eluvial and alluvial material, the only possible repositories of the mineral for which M.C. 140 was originally pegged. Prospecting for radio-active minerals by the applicant for P.A. 2311 could therefore only be carried on to the detriment of the working by the claimholder of the mineral specified in the mineral claim, namely, tantalite.

* A Prospectors Handbook to Radioactive Mineral Deposits. Geological Survey of Great Britain, 1949. P. 14.

REPORT ON A RECONNAISSANCE EXAMINATION OF THE KOOLINE LEAD FIELD.

Ashburton River—Ashburton Goldfield.
North-West Division.

Approximate Lat. 23° 00′ S.
Approximate Long. 116° 30′ E.

By H. A. Ellis, B.Sc., A.O.S.M., Government Geologist.

Introduction.

The large post-war increase in the price of lead stimulated interest in lead deposits in Western Australia and made possible the re-opening of several deserted mines in the Northampton district, as well as the old Uaroo Mine in the Ashburton Goldfield. It led also to renewed interest in the country surrounding "Wyloo" Station, some 120 miles south-east of Onslow, on the Ashburton River, an area of pre-Cambrian rocks long known to this branch as containing auriferous quartz reefs and occasional specimens of quartz-galena ore. The presence of "floaters" of galena in the hilly country in this locality was also well known to the aboriginal stockmen of Wyloo and Kooline Stations, and most of the lead deposits subsequently worked were shown to the persons pegging the ground by the aborigines from these two stations.

The first prosepcting area for lead, No. 200, was taken out by Mr. W. G. Hamilton on October 13, 1947, Mr. Hamilton having gone into this area as a result of becoming interested in an extremely low grade quartz reef on Wyloo Station known as the "Monster" Lode. He received details about this lode from the Geological Survey, and was informed about the known occurrences of lead "floaters" in this country by the writer prior to his departure for the area.

On November 3, 1947, P.A. 204 was applied for by E. Byne of Northampton, and J. Kempton applied for P.A. 205 on the same day. These two prospecting areas subsequently became Mineral Leases 137 and 139, known as "The Silent Sisters."

Numerous prospecting areas were applied for in the southern portion of the field in November and early 1948. The first mineral leases were applied for by Dunlop and Camp in March, 1948, followed by applications for claims in the northern part of the field by Aerial Mining Syndicate (M.C. 5) in June and September of 1948.

To date (August, 1949) some 16 leases or claims have been granted on the southern area, three in the Central area and seven in the Northern area, none of which has as yet been surveyed (August, 1949). As at August, 1949, there were 28 persons working on the field, distributed over five operating prospects.

Two small treatment plants consisting of crushers and either rolls, jigs or concentrating tables, were in the early stages of operation, but difficulty was being experienced due to inadequate water supply or the inexperience of the operators. Up to the present (August, 1949) all production has

come from hand picked galena mined from short shoots and shallow depths (under 75ft.). Production to the end of August, 1949, can be summarised as follows:—

Shipments Finalised—

267.32 tons of ore containing 182.57 tons of lead and 1,969.16 oz. of silver valued at £A.16,687 f.o.b. Fremantle.

Shipments Made but not yet Finalised—

356.5 tons, estimated value £A.11,300, f.o.b. Fremantle.

A close approximation of total ore shipped is thus 623.82 tons valued at £A27,987 as at 31st August, 1949. Much of the ore is shipped to Antwerp, and most of the balance to the United Kingdom. It consists essentially of galena packed in light 44 gallon petrol drums, each drum containing approximately 1 ton of ore.

The examination was made in mid-August, 1949.

Location and Access.

What has become to be known as the Kooline Lead Field consists of three rather widely separated localities referred to in the previous section of this report as the Southern area, the Central area and the Northern area. A convenient point of reference is Wyloo Station, some 116 miles by road south-east of Onslow, the nearest shipping port. The road is a typical north-west inland road, good in places and extremely bad in others, and consists of the usual two wheel-track road up to 8 feet wide or less for long distances. It is not negotiable after moderate falls of rain, but will carry heavy loads when dry. The road passing through Wyloo and Kooline Stations continues to Ashburton Down Station and branches off the Onslow-Roebourne road some 18 miles south-east of Onslow.

The Southern area is siuated on Kooline Station some 16 miles S.-E. of the homestead. It is reached in about 10 miles of track which turns S.-W. from the Kooline Ashburton Downs road about 29 miles from Wyloo Station.

A track to the Central group ("Silent Sisters") turns north-east from almost the same point, the distance to the "Silent Sisters" from the turn-off being about 13 track miles. The Northern group is situated on a continuation of this track, and is distant some 16 track miles in a general north-easterly direction from the "Silent Sisters." There is a cleared area near the Northern group on which an Anson aeroplane can land and take off. The track continues on from the Northern group, and the distance to Wyloo Station from this group via the Rocklea Station track is about 37 track miles. The fortnightly Ashburton River mail service passes through the area.

Geology.

The country rocks of the field consist of slightly metamorphosed sedimentary rocks of the Mosquito Creek Series of Archean age, sometimes highly folded into vertically dipping beds, and frequently disposed in low dipping structures.

The regional strike is persistently about 280°, this strike prevailing throughout the entire field. Dips are frequently to the south, but some north dips were observed.

The dominating rock types are phyllites, grits (both fine and coarse), dolomite and conglomerate, similar in structure and regional strike to the beds of the same series east of Nullagine in which are located the "Blue Spec" antimony-quartz reefs, and numerous auriferous quartz reefs. No granite or gneiss was seen anywhere near the mineralised areas. The topography is generally of low relief (up to 200ft. above the general level of the surrounding country) consisting predominantly of east-west trending ridges and low hills separated by wide and narrow alluvial flats. Prominent high ridges and peaks such as Mt. Wall, Peak Edgar and Mt. De Courcey dominate the scene.

The area is drained by the Hardy and Ashburton Rivers and their tributaries, and in the northern portion carries a moderate growth of scattered mulga and snakewood, with eucalypts along the water courses. Vegetation is sparse in the Southern area.

The series has been intruded frequently by quartz reefs which have been emplaced in shears parallel or nearly parallel to the regional strike, and dipping with or slightly across the regional schistosity, as well as in obvious faults whose general trend is across the direction of regional schistosity at angles varying from 10° to 90°.

The nearly vertical schistosity of the phyllites where these rocks are associated with mineralisation, as they frequently are in the Southern area, and what looks like closely spaced nearly vertical jointing in the grits and dolomites, can frequently be observed to be imposed at marked angles to the bedding, which reveals that the beds are really sometimes dipping at moderate angles only. This results in an abrupt change of rock type when a mineralised shear with nearly vertical attitude is followed in depth, and this could have an important bearing on mineralisation in depth, though in the one instance noted, viz., on M.L. 135, no noticeable change except a slight steepening in attitude of the ore-body was observed.

Mining Timber.

Mining timber is scarce.

Water Supply.

There is no surface water, bore water or mine water on the Southern area, water for domestic purposes being carted from pools in the Ashburton River some four miles distant. Underground water in this area is reported to be of poor quality, according to the manager of Kooline Station. Two small treatment plants consisting of crushers, rolls and either jigs or concentrating tables were about to be erected here, but no one had any idea about the availability of water from underground sources. It was being taken for granted that adequate treatment water would be obtained. Experience in this class of country has shown that underground water can be difficult to obtain in suitable quantities for even small treatment plants. The owners of the properties on which the plants were to be erected, namely, M.Ls. 135 and 122, contemplated carrying their shafts to water level and prospects for quantity are certainly better from this potential source than from a bore hole.

In the Central area one small plant required water for one wilfley table, and a bore hole had failed to meet the requirements.

In the Northern area two holes had been drilled, one unsuccessful and the other only recently equipped, not having been sufficiently tested to judge its capacity.

Experience in other parts of the State in these latitudes establishes the fact that one bore hole sunk in the metamorphosed country rock is unable to withstand continual pumping as is required for treatment plants, even using return water systems, and provision had to be made to sink and equip several holes or wells, e.g., Wodgina, Strelley, Blue Spec and 20-Mile Sandy, to mention only some recent examples known to the writer.

Notes on Claims Being Worked at Time of Inspection.

At the time of inspection (August, 1949) mining operations were taking place on six claims, namely M.Ls. 121, 118, 135 and 122 on the Southern area, M.L. 137 in the Central area and M.C.5 in the Northern area. With the exception of M.L. 118, operations on these leases were being financed by loans of various sums of money from the Mines Department, mainly for the purchase of machinery. There were no other prospectors operating in the district.

The "Bilrose," M.L. 118.

Several interesting shears in phyllites had been worked to a depth of 45 feet over short lengths (under 100 feet). The shear system is nearly vertical with lode matter consisting of phyllite, quartz, and galena up to 3 feet wide, with galena veins up to 1 foot wide on the walls. The general strike is 285°. This prospect gave promise of further payable production. Shipments finalised to 31 August, 1949 amounted to 34.06 tons containing 22.14 tons of lead and 320.78 ounces of silver, valued at £A.2,086 F.O.B. Fremantle. Known shipments pending amounted to 13.13 tons at an estimated value of £A.550 F.O.B. Fremantle. All ore shipped had been hand picked galena.

The "South Kooline," M.L. 121.

Short shoots in nearly vertical shears in phyllites had been worked to a maximum depth of 50 feet. The thickest galena vein was 1 foot wide accompanied by quartz. The strike here is about N.-W.

Prospects for further payable production did not appear promising from the exposures seen in the workings, and the latest ore mined was not high grade. Shipments from this lease finalised as at 31 August, 1949, amounted to 31.94 tons of galena ore containing 22.63 tons of lead and 228.91 ounces of silver valued at £A.2,064 F.O.B. Fremantle. Known shipments pending amounted to 3.90 tons at an estimated value of £A.150 F.O.B. Fremantle. A parcel of "seconds" from this claim amounting to 11.08 tons contained 2.57 tons of lead and 28.80 ounces of silver, and was sold on a very low market at 12.4 cents. per lb. of lead, resulting in a substantial loss to the producer. Assay value was Pb. 23.20 per cent., Ag. 2.60 ozs. per ton.

An engine and compressor had recently been installed on these workings, having been bought from money advanced by the Mines Department.

The "Gift." M.L. 122.

A strong mineralised shear in slightly metamorphosed fine grained grits striking at 285° and dipping steeply to the north had been worked here to a maximum depth of about 40 feet over a short length (under 100 feet). Lode matter containing disseminated galena and quartz is up to 3 feet wide, with seams of galena up to 1 foot wide on the walls. Exposures in the workings gave promise of further payable production. Shipments finalised to August 31, 1949 amounted to 25.58 tons containing 17.49 tons of lead and 178.63 ozs. of silver valued at £A.1,879 F.O.B. Fremantle. Shipments pending are not known. An engine and compressor were being erected on this claim, and money had been advanced by the Miines Department for the erection of a treatment plant. No water supply had been obtained, and the owners contemplated sinking the shaft to water level, and securing treatment water from the mine workings. This is distinctly gambling with the water supply problem, which should be solved before erecting treatment plants.

The "June Audrey," M.L. 135.

A strong shear striking at 285° and dipping steeply to the south for the first 30 feet in depth and then vertically to a depth of 65 feet has been worked by open cut and a shaft over a length of about 200 feet. These were the deepest workings seen by the writer on this field. Lode matter up to 3 feet wide has been mined, with seams of galena on the walls up to 2 feet wide. The country rock is coarse and fine grained phyllites, the strike and dip of the schistosity of which is the same as that of the shear carrying the galena veins. The bedding, however, is not coincident with schistosity, dipping at a relatively low angle to the south. This results in a pronounced change from fine to coarse grained phyllites at about 30 feet vertical depth, when the attitude of the shear steepens to vertical. No noticeable change in the nature of the mineralisation took place however. Barite and manganese dioxide as well as calcite and quartz feature prominently in the gangue of the lode. Principal production has been from hand picked galena mined from the wall-seams of nearly pure galena. About 500 tons of lower grade ore consisting of disseminated galena in a quartz matrix and associated phyllite, barite and calcite, was in the mine dumps awaiting treatment at a plant in process of being erected at the time of inspection (August, 1949). The mine was equipped with a friction winch, engine and compressor, and jack-hammer, and gave promise of further profitable production. No water supply had been secured, and it was anticipated by the owners that adequate water for treatment purposes would be obtained by sinking the shaft. Shipments from this lease finalised as at 31 August, 1949 amounted to 29.30 tons of ore containing 20.24 tons of lead and 313.09 ounces of silver valued at £A.1,577 F.O.B. Fremantle. Known shipments pending were 133.65 tons of ore at an estimated value of £A.6,000. Provided adequate water supply was obtained and a suitable treatment plant installed, it appeared that this mine had the best chance of success on the Southern area. Installation of plant was being financed by the Mines Department.

The "Silent Sisters," M.L. 137.

This constitutes the only claim being worked in the Central area, and in the writer's opinion is the best prospect on the field. A strong vertical quartz and galena filled intersecting fracture pattern in slightly schistose dolomite, interbedded with slates which strike at 280° and dip steeply to the south (nearly vertical) has been opened up on the surface and by an adit tunnel at a depth of about 70 feet below the outcrop. The several branches of the fracture pattern have been explored on the surface for upwards of 200 feet, and encouraging concentrations of galena as well as good disseminated ore have been located. The matrix is hard quartz, with some barite, calcite, and manganese dioxide, as well as a hornfels resulting from the silification of the enclosing dolomite.

Where intersected in the adit level, approx. 70 feet below the outcrop, lead mineralisation is strong, as is the shear. Only a short length (under 50 feet) of driving had been carried out here at the time of inspection (August, 1949).

The principal elements of the fracture pattern are inclined at from 10° to 90° to the direction of regional schistosity, and in this locality the direction of strike and dip of the schistosity appears to be nearly co-incident with the bedding of the dolomite and accompanying slates.

The mine is equipped with engine, compressor and a machine drill, and a crushing plant consisting of cracker, rolls and a wilfley table. An adequate water supply had not been obtained from one bore hole, and treatment difficulty was being experienced owing to the hard nature of the disseminated ore and the presence of anglesite, cerussite and pyromorphite in the oxidised ore. It would appear that provision will have to be made for a fine grinding and flotation unit in any plant designed to effect a good recovery from this class of ore. Experience has shown that a crusher and rolls, followed by either a jig or concentrating table, is effective in beneficiating massive galena ore intergrown to a small extent with barite, calcite or quartz, but that this combination is not competent to deal with a hard ore in which the galena is disseminated as small particles intimately intergrown with the gangue.

The lease is being operated by the Ashburton Mining and Minerals Pty. Ltd., and the Mines Department is financing plant installation. Plant erection and mining operations reflect considerable credit on the manager, M. A. Nevill, and his workmen.

Shipments of ore from this lease finalised as at August, 1949, amounted to 21.87 tons containing 13.59 tons of lead and 92.44 oz. of silver valued at £A.1,348 f.o.b. Fremantle. No information is available about the quantity of ore shipped but not yet finalised. A considerable quantity of good grade ore was broken and awaiting treatment at the mine.

Prospects of future profitable production from this lease are good, provided water and treatment problems are overcome. The mine appears to have good prospects of being able to produce much more ore than the present plant can handle.

Aerial Mining Syndicate M.C.5.

This constitutes the only holding being worked in the northern area. In this part of the field there is much evidence of the existence of quartz filled fault zones trending in an approximate north-easterly direction, and some of them are of considerable length. Smaller structures of a similar nature were observed in the southern area, and some of these had produced spectacular but limited tonnages (up to 12 tons in one instance) of galena.

In the northern area these fault zones are characterised by a silification of the dolomite beds adjacent to the zones where these beds are traversed by the faults. Prominent and distinctive coloured outcrops result.

M.C.5 embraces one of these strong north-easterly trending fault zones cutting phyllites and dolomites in a nest of low rugged ridges and hills trending in an east-west direction. Dips of the beds are deceptive in this locality, but are at varying angles to the south. The schistosity of the phyllites is vertical or nearly so, but exposures near the mine workings reveal that these apparently vertically dipping phyllites are overlain by dolomite, the bedding of which dips at a low angle to the south. This dolomite contains occasional thin galena bearing quartz reefs.

The north-east trending fault zone is up to 400ft. wide in places and consists of crushed dolomite, contorted phyllite (now kaolinised), silicified dolomite and phyllite, bony quartz and white reef quartz with occasional concentrations of massive galena in the kaolinised phyllite. Quartz lenses with intergrown galena occur sporadically throughout the zone, and the principal workings consisting of short open cuts and a shaft 15ft. deep had been sunk in lode formation containing some of these lenses. The amount of galena showing in these workings was not impressive, and the nature of the deposit made it difficult to know where best to concentrate exploration. The urge to get shipments of high grade ore dictates the mining exploration policy here, as it has done in every other locality worked on the field.

The fault zone is possibly dipping steeply to the south-east, but there were not sufficient exposures to enable any opinion to be formed on the factors governing the localisation of galena veins. In clear cut shear or fracture patterns seen in other parts of the field, the galena lenses showed a marked tendency to be located on or near the walls.

A small cracker and jig had been erected and a small concentrating table was to follow, at the time of inspection (August, 1949). Sufficient water had just been obtained from a bore hole on the claim to operate this very small unit, but as the bore was uncased and had not been tested for capacity over a period of continuous plant operation, it is too early to consider the water supply problem as having been solved.

The prospects of profitable production from this claim did not impress the writer. Finance for plant erection was supplied by the Mines Department.

There is no record with the Mines Department of any shipments finalised as at 31st August, 1949. Official returns from this claim are in a very unsatisfactory condition, due to discrepancies in returns made to the Department by the owners, and ore-buyers' returns. Ore claimed to have been sold by the owners does not appear in ore-buyers' statements, and these latter are usually reliable documents. Known shipments pending finalisation amount to 34.42 tons of an estimated value of £A1,500 F.O.B. Fremantle.

Other Prospects Examined.

Three other prospects were examined briefly for the respective owners, namely, M.L's. 128 and 129, situated approximately 3 miles north of the Aerial Survey Syndicate's M.C.5, and a lease recently applied for called the "Big Chief" situated some 10 miles S.E. of the main group on the southern area, on the south side of the Ashburton River.

M.L's. 128 and 129 contained mineralised quartz reefs occupying N.-E. trending faults. The fault structures were strong, but the galena mineralisation weak, and the occurrences did not appear to the writer as being likely to develop into payable deposits when their location is taken into consideration.

The "Big Chief," M.L. 136, was pegged to include a quartz filled shear accompanied by disseminated galena ore in a lode formation in medium to fine grained grits striking at 285° and dipping into a ridge at 45°. An open cut some 30 feet long by 8 feet deep had been made on this formation, disclosing galena-bearing ore over a width of about 6 feet. This shoot has a possible extension of about another 30 feet in strike, and had produced a considerable quantity of good grade disseminated ore suitable for beneficiation in a fine grinding plant. A small proportion of this ore contained sufficient galena associated with quartz gangue in such a manner as to suggest that it could be beneficiated to a considerable extent in a plant consisting of cracker, rolls and concentrating table. The bulk of the ore, however, appeared to the writer to require fine grinding in order to free it of the associated gangue. The prospects of this deposit appeared to lie in further exploration in depth in the hope that richer concentrations of galena would be encountered. The deposit did not impress the writer as being one at all likely to develop into a large low grade ore body, but rather one on which it was worth doing up to 50 feet of sinking and some driving if prospects were still good at that depth.

Access to this claim is difficult, involving two crossings of the Ashburton River, which has very steep banks here. The owners have spent much time and labour on making access to this find, and the track and river crossings need a lot more attention to put them into fair condition only.

Production.

Producers from this field have been very lax in submitting returns required under the Mining Act, and the production data below are available only as a result of continuous effort on the part of Mr. Lester, Mines Department Statistician. Mr. Lester indicates that the figures are an approximation only, though probably reasonably close.

The approximate recorded overall production up to August 31, 1949, is 610 tons of lead ore valued at £A27,387 F.O.B. Fremantle. In view of the fact that the field was first worked in October, 1947, this is not a very imposing tonnage, despite the all time record high price of lead ruling for much of the time during production. There is some ore at the various claims, but not a large amount.

Prices ruling throughout the life of this field up to the present have fluctuated between 12 cents per pound (this being an American controlled market) of lead, equivalent to £A83.37 per ton and 21.5 cents per lb. of lead equivalent to £A149.37 per ton.

In January, 1948, the price of lead was 15 cents per pound, and it gradually rose until in early 1949 it was 21.5 cents. In March of 1949 a sharp drop took place to 12 cents per lb., and this had the effect of curtailing the activities of prospectors.

All ore sold to August, 1949, had been hand-dressed massive galena, mined from short rich shoots, the minimum lead content of any one parcel being 54 per cent., while the maximum was 77 per cent. The minimum silver content per ton was in the vicinity of 3 ounces, the maximum 15 ounces per ton, with an average of approximately 8 ounces per ton. (Pure galena contains 86.6 per cent. of lead). In the production table reproduced below it will be noticed that there was some production from holdings not mentioned in this report. None of these holdings is at present being worked, and the galena occurrences were short rich shoots quickly mined out.

SILVER—LEAD—KOOLINE FIELD.

	Shipments Finalised to 31st August, 1949.				Known Shipments Pending.	
	Assayed Metallic Contents.					
	N.D.W.	Lead.	Silver.	Value f.o.b. Fremantle.	Quantity.	Estimated Value f.o.b. Fremantle.
	Tons.	Tons.	Fine ozs.	£	Tons.	£
M.C. 5—Aerial Mining Syndicate	....	....	....	....	34.42	1,500
M.L. 123—"Phar Lap" (Camp and Party)	5·03	3·45	45·75	383	Not known	....
M.L. 124—"Silver King" (Camp and Party)	24·55	15·19	118·65	1,596	Not known	....
M.L. 128—"Beryl" (Camp and Party)	....	....	....	....	Not known	....
M.L. 129—"Silent Tom" (Camp and Party)	....	....	....	....	Not known	....
M.L. 137—Ashburton Mining and Minerals Pty., Ltd.	21·87	13·59	92·44	1,348	Not known	....
M.L. 139—"Silent Sisters" Lead Mine (late P.A's 204/5)						
M.L. 121—"South Kooline" (Mrs. E. M. Gray)	*31·94	22·63	228·91	2,064	3·90	150
M.L. 135 (late P.A. 213)—"June Audrey" (Holben and Party)	29·30	20·24	313·09	1,577	133·65	6,000
M.L. 118—"Bilrose"	34·06	22·14	320·78	2,086	13·13	550
Total Above Areas	146·75	97·24	1,119·62	9,054	285·10	8,200
Other Kooline Holdings.						
M.L. 119—"Bandy's Peak"	5·44	4·13	19·05	358	....	....
M.L's. 116/117—"Theady" Leases	4·55	3·37	15·47	329	....	....
M.L. 120—"Kooline Queen"	10·46	6·67	70·96	558	....	
M.L. 122—"Gift"	25·58	17·49	178·63	1,879	Not known	....
M.L. 126—"Ridge"	4·01	3·05	26·59	343	Not known	....
M.C. 3—Camp and Dunlop	16·05	11·92	121·24	1,103	....	....
P.A. 200—Hamilton, Dunlop and Camp	27·52	20·82	203·66	1,636	....	....
P.A. 230—Joy and Brennan	4·29	2·68	27·24	219	10·00	450
P.A. 232—Bellchambers, A. C.	6·70	4·65	64·99	518	....	....
P.A's. 236/7—Rooney and Smallpage	14·60	9·53	111·45	639	9·40	400
P.A. 244—Reck, E.	1·37	1·02	10·26	52	....	....
P.A. 233—Brennan, M.	....	....	....	....	7·85	350
P.A. 240—Ballard and Carson	....	....	....	....	6·40	300
Unidentified Areas.						
Wallace, Sandall and Dunlop	....	....	....	....	7·15	300
Wallace, E.	....	....	....	....	2·90	100
Shanks, E.	....	....	....	....	27·70	1,200
Total Other Kooline Holdings	120·57	85·33	849·54	7,633	71·40	3,100
TOTAL KOOLINE FIELD	267·32	182·57	1,969·16	16,687	356·50	11,300

* Final Statement for a parcel of seconds has just come to hand:—

N.D.W.	Lead.	Silver.	Value f.o.b.
Tons.	Tons.	Ozs.	Fremantle.
11·08	2·57	28·80	Nil

Assay was Pb. 23.20 % Ag. 2·60 ozs. p.l.t.

Sale was made at 12.4 cents per lb. Value of parcel was shown as C.I.F. Antwerp £A45 18s. 8d., which, after deducting £62 for freight from Fremantle, weighing, sampling and assaying at Works, and insurance, proved a distinct loss to the producer. It was shipped from Fremantle the beginning of April, so must have left the Mine when the market value was showing 21.5 cents.

Prospects of the Field.

Discoveries and production to date indicate that the Kooline lead field is not in any way a large rich field, but rather is one in which small rich deposits of galena capable of giving quick returns on easily won ore occur. Up to the time of inspection mining operations had consisted virtually of "gouging" lenses of galena from the various shears and faults occupied by galena bearing quartz; in no instance did the writer see any ore blocked out except perhaps for short distances on two sides only, and under no circumstances could any estimate of ore reserves be formed.

Although the Pre-Cambrian rocks contain numerous dolomitic limestone beds, any lead mineralisation in them is confined to intrusive quartz reefs and no occurrences of disseminated galena replacement of the dolomites on a large scale were known. This is in agreement with our Pre-Cambrian mineralisation all over Western Australia.

Several of the prospects examined gave promise of further profitable small scale production. The ore-bodies on M.L. 137, The "Silent Sisters", should develop well, and provided the treatment and water problems are overcome and the price of lead does not fall too far from 15 cents. per lb., this mine should turn into a steady small producer.

REPORT ON A TALC DEPOSIT ON M.C. 14E, MT. MONGER.

37.5 m. S.E. of Kalgoorlie, W.A.

By H. A. Ellis, B.Sc., A.O.S.M.

Locality.

This report is the result of a brief inspection of a reconnaissance nature made on November 14, 1949:—

M.C. 14E, of 88 acres, recently pegged by Prospector H. Bean, is situated immediately south of Gold Mining Lease 5961E (The "Loganberry" Lease), which includes most of the ground in the original "Lass O' Gowrie" G.M.L. 4803.

This locality is situated about four miles along the track S.E. from Creedon's Homestead in the direction of Mt. Monger Trig Station.

For previous reports on the area see G.S.W.A. Bull. No. 90 and Ann. Rep. G.S. 1943, pp. 10-11, in which latter report the present writer reports on the Talc and Soapstone Deposits on the "Loganberry" lease.

The Talc Deposits.

The country south of the original talc and soapstone deposits worked on the "Loganberry" lease is flat and soil covered, the soil depth varying from a few feet to a few inches. Numerous old gold prospecting shafts and costeans occur on it revealing talcose material of varying degrees of purity in the dumps.

Prospector H. Bean has located numerous small "floaters" of good grade foliated talc as small chips on the surface over an area of about 10 acres at a spot about 40 chains S.E. of the old main shaft on the "Lass O' Gowrie" lease.

At the time of inspection (November, 1949) he had sunk numerous shallow pits and one shaft 30 feet deep on these prospects. Most of the pits showed good grade foliated talc of varying thickness, but the amount of exploration work done was not sufficient to enable any idea to be formed of the length, breadth and depth of the various exposures.

The 30 feet shaft had been sunk in good grade foliated talc, the planes of foliation striking N. 25° W. and dipping steeply with a curving dip to the west. The thickness of talc proved in this shaft would be about 10 feet with the hanging wall not exposed. The shaft shows the lenticular nature of the best quality talc, and this lenticular habit can be relied upon to dominate the talc occurrences on this field. The particular talc horizon in which the shaft has been sunk has been located by shallow costeans over a length of about 300 feet, and there are several parallel developments of foliated talc exposed in other costeans nearby.

The talc is formed by the hydrothermal metamorphism of foliated serpentine, and must remain of a general foliated nature by virtue of this mode of occurrence. This is important when the possibility of obtaining furnace blocks from the deposit is being considered.

Quality.

The best quality talc is pale apple green in colour with a small proportion of incompletely talcicised original minerals, the natures of which have not yet been determined. It grinds to a smooth, grit free powder a shade off-white in colour and would be admirably suitable for use in the paper, paint and rubber industries or for any purpose where a high grade talc was required. Some of the talc exposed in the shaft appears to be of cosmetic grade.

The exposures available for inspection in November were naturally iron stained in parts, and red clay seams had developed along some of the foliation planes at a depth of 30 feet. These defects can be expected to disappear with depth.

It is most unlikely that the high grade foliated massive talc of this deposit will lend itself to cutting into blocks suitable for furnace linings. It is extremely likely to crack under heat along foliation planes.

Specimens are being submitted to the Government Chemical Laboratories for heat tests.

Ore Reserves and Prospects.

The known lenticular nature of the foliated massive talc which has already been exploited in the past on the "Loganberry" lease about half a mile north-west of this new talc locality, makes it inadvisable to compute any ore-reserves on existing exposures.

Briefly, the position is that not enough prospecting work has been done on the deposit to enable its grade or quantity to be assessed, but the occurrences seen constitute an excellent prospect, and give promise of supplying considerable quantities of foliated massive talc of good commercial grade suitable for use wherever a high grade, grit free, slightly off-white talc is required. It is confidently anticipated that selected parcels of talc suitable for cosmetic use will be available when the deposits are suitably explored.

Government Chemical Laboratory Report.

Report on Three Samples of Talc from M.C. 14 E., Mt. Monger, for the Government Geologist.

Lab. No. 6957/49. Mark No. 1.

Pale green foliated talc with a very small amount of chlorite and occasional crystals of rutile. The rock is readily crushed, the colour of minus 200 mesh powder being white with a faint greenish tinge. The very slight grittiness evident on grinding is not detectable in the finely-ground powder which is unctuous and adheres well to the skin.

Analysis.

	%	Mols.
SiO_2	59.52	91.0
Al_2O_3	1.48	14.5
Fe_2O_3	0.39	2.4
FeO	2.20	30.6
MnO	0.02	0.3
MgO	30.61	759.2
CaO	0.18	3.2
Na_2O	0.05	0.8
K_2O	Nil	Nil
H_2O—	0.08	
H_2O+	4.98	276.5
TiO_2	0.05	0.6
CO_2	0.03	0.7
P_2O_5	0.03	0.2
Cr_2O_3	0.26	1.7
V_2O_3	Nil	Nil
	99.88	

Analyst: B. W. Stenhouse.

Remarks.

If the slight greenish tinge of the finely ground powder is acceptable this could be classified as a cosmetic grade talc.

Lab. No. 6958/49. Mark No. 2.

Greenish foliated talc with flakes of chlorite and scattered crystals of rutile and dark green spots which consist of chlorite with remnant cores of iron ore.

The rock is readily crushed to a very slightly greenish white powder, the slight grittiness evident on crushing is not detectable in the fine powder which is unctuous and adheres well to the skin. This material is suitable for industries requiring a high grade, gritless talc powder such as in paint, rubber and industrial dust manufacture. One specification for talc for use in manufacture of vulcanised battery cases provides that the amount of manganese (Mn) present shall not exceed .005 per cent. The slight greenish tinge may be detrimental to its use as a high grade paper filler.

Lab. No. 6959/49. Mark No. 3.

Greenish foliated talc almost identical with 6958/49 above, but with no rutile present.

A sawn block when heated slowly in a muffle furnace disintegrated along foliation planes at a temperature of approximately 600° C. This result appeared to be due to segregations of chlorite in the block.

The talc is quite unsuitable for the manufacture of furnace blocks.

THE BROAD GEOLOGICAL STRUCTURE OF THE COUNTRY ABOUT COOLGARDIE.

Coolgardie Goldfield, W.A.

By J. C. McMath, B.Sc. (Hons. Lond.), F.G.S., M.Aust.I.M.M.

Prefatory Note.

This report by Mr. McMath is basically his chapter on Structural Geology taken from a Bulletin on the Geology of the Coolgardie District, which has been prepared but which is awaiting publication. Owing to the very long delay in the publishing of our Bulletins and the importance of this type of information to mining companies engaged in exploration work, it has been thought desirable to publish Mr. McMath's findings in the annual report for this year.

(Sgd.) H. A. ELLIS,
Government Geologist.

Resume of Contents.

The General Geological Structure.

Analysis of the distribution and mutual relations of the rocks of the area indicate that their present dispositions result from two major dynamic processes which have operated during Pre-Cambrian time. These are the processes of folding and the intrusion of major plutons. It is not always possible to separate cause from effect and these processes have been operative far beyond the boundaries of the area. Sufficient data have, however, been gleaned to enable the main outlines of the tectonic history to be deduced.

The following general observations upon the two dynamic processes are now made:—

(a) Folding.

The folding has been on a regional scale and is of the type associated with the flanks of major orogenic zones. Whilst anticlinoria and synclinoria of large amplitude have resulted, no mountain "root" structures, nappes, fenster, large low angle over-thrusting, and imbricate structures are present.

The anticlinoria and synclinoria have a general axial trend of N.-N.-W. and the limbs of these structures are occupied by tightly packed subsidiary folds which may often be isoclinal and overturned. These major folds appear asymmetrical.

A second system of folds, whose axial trend is E.-N.-E., is super-imposed upon the regional folding and may be coincident with, or slightly post date, the first folds. It is markedly less intense than the first folds and is of great importance in relation to gold deposition. These latter folds are termed "cross-folds." Two such major "cross-folds" are known in the area. They have, upon their limbs, subsidiary folds.

(b) Igneous Intrusion.

Associated with the folding are major granitic plutons with the normal range in type of apophyses—from micro-granite to pegmatites and quartz veins. These plutons appear to have completed their emplacement after the folding.

They are batholithic in nature; the granite "rocks" of the present land form being apices or cupolas of these subjacent masses. The granite gneisses may have been formed as a precursory phase in the emplacement of these plutons. A twofold importance attaches to these igneous bodies in that—

(i) their emplacement has been the cause of structural modification in the pre-intrusion rocks of the Area;

(ii) they are, most probably, the ultimate sources of the metallisation of the Area.

The oldest known rocks in the area are a succession of lava flows, pyroclastics, and sediments which have been termed the Yilgarn-Kalgoorlie system. The lower portion of the succession seen is dominantly igneous (the Older Greenstones) whilst the upper portion is dominantly sedimentary (the Eastern and Western Meta-sedimentary Series). Both the Older Greenstones and the Meta-sedimentary Series have been intruded by a suite of basic bodies which are tentatively correlated with the Younger Greenstones of Kalgoorlie. Neither the base nor top of the system is anywhere to be seen in the Area.

At one time these rocks were disposed horizontally or with small initial dips. The folding, earlier described, gave these rocks the form of anticlinoria and synclinoria of N.-N.-W. axial trend together with the E.-N.-E. axial trends of the "cross-folds."

Emplacement of the granite plutons then took place, though their initiation may well have preceded or been concurrent with the folding, together with the production of granitised rocks. Thus, at this stage, the effects of these two dynamic processes upon the rocks of the Yilgarn-Kalgoorlie System was the production of an elongated and complex dome centred about Coolgardie Town. These events are regarded as taking place during early (Archean) Pre-Cambrian time.

Since Archean time relative elevations of the land surface and cycles of erosion have combined to produce the present land form and to destroy all records of any intervening rock forming events. A vast unconformity separates the folded sediments and granite plutons form the Tertiary-Recent deposits.

The depth of erosion since Archean times which has led to the dissection, exposure and present day distribution of these ancient folded rocks and plutons cannot be assessed. It has resulted, however, in the production of a horizontal section through the domal structure, together with very limited vertical sections. It is these sections, together with sections exposed in mining operations, which furnish the key to structural interpretation.

The elongated and complex dome comprised of various members of the Yilgarn-Kalgoorlie System shows—

(i) that the central portion of the dome is occupied by rocks of granitic composition;

(ii) that to the westward, on the flanks of the dome evident former structural entities have been truncated by rocks of granitic composition.

The relations of the folded rocks to the surrounding country rocks are far from being capable of precise definition owing to the following factors:—

(i) Poor outcrop conditions in critical zones.

(ii) The paucity, and lack of continuity, of clear contacts; a few sharp intrusive contacts with magmatic granite are to be seen at Mungari, the Slate Rocks, Bonnie Vale, and in a few other instances.

(iii) Nowhere can the relation of the magmatic granites to the various gneisses be seen, although, in the east of the Area, in some instances a causal relation can be inferred between para-gneiss, migmagtites and the Mungari Granite. Such inferences are based upon proximity of the granite to these metamorphic types.

(iv) The basal rocks of the Yilgarn-Kalgoorlie System are nowhere to be seen. They may be represented in part by the gneisses. As suggested by Ellis[1], in the South Yilgarn Goldfield, this system may itself be but a horizon in a thick succession of arkoses, etc., now granitised.

[1] Bull. 97, G.S.W.A., 1939. The Geology of the Yilgarn Goldfields, South of the Great Eastern Railway—H. A. Ellis.

Hence it must be understood, apart from the instances mentioned, that the junction of the folded rocks and the areas marked Gr./Gn. on Plate 1 cannot be assumed to represent an intrusive contact—the foregoing factors precluding any such rigid conceptions.

There is apparent in the Area such a degree of parallelism in the major lithological and tectonic aspects with those of the South Yilgarn Goldfield[2], some hundred miles west of Coolgardie, that it is difficult not to conclude that the folded rocks of each locality have had the same dynamic processess impressed upon them and are, geologically speaking, contemporaneous. Apart from differences in lithological minutæ, the major difference between the two localities is that in the Coolgardie Area the structural remnants of the folded rocks are more continuous and complete than in the Yilgarn.

Regional Folding.

Recognition of the broad structural features of the Yilgarn-Kalgoorlie System as developed in the Area has been facilitated by the following:—

(i) The presence of such distinct components as the Older Greenstones and the Meta-Sedimentary Series.

(ii) The general character of the Older Greenstones which has permitted of the subdivision of this series into belts of Basic Lavas and Ultra-basic Rocks.

(iii) The presence of the Meta-Gabbro (? Younger Greenstones) which, within the Coolgardie sub-area, constitutes a major "marker" horizon.

(iv) The presence of thin inter and/or intra-formational beds of slates and graphitic schists in the Older Greenstones. These, though discontinuous, also act as "marker" horizons in elucidating structural detail.

(v) The presence within the Older Greenstones of drag-folding which has been of assistance in the elucidation of the axial directions of folds and enabled their plunge to be assessed.

(vi) The ever present effects of the regional folding which has impressed upon certain of the rocks a characteristic and remarkably constant schistosity.

The distribution of these features, brought out by regional mapping, shows that certain major elements of the N.N.W. trending regional folding are present. These elements take the form of complex folds of which, due to erosion and granitic intrusion, only the axial zones rather than axial lines are to be discerned. From west to east these complex anticlines and synclines are—

(i) a complex synclinal structure centred about Gibraltar—of which only the median zone remains;

(ii) a complex anticlinal structure centred about Coolgardie Town—the western limb and central portions of which are occupied by granite or gneiss;

(iii) East of Coolgardie Town, a synclinal whose axial zone is approximately about the 5 Mile on the Kalgoorlie-Coolgardie road;

(iv) an anticlinal whose axial zone approximates to the major axis of the Mungari Granite.

As indicated by the use of the word "complex," the general character of these folds is composite —they might be termed "anticlinoria" and "synclinoria" in the sense of Nevin[3] and Billings[4]— that is, they are major folds with subordinate folds upon their limbs. This subordinate folding, as far as can be ascertained, is tightly packed and, most probably, to judge from verticality of schistosity in many localities is largely isoclinal.

Overturning of these subordinate folds has, in some cases, taken place. The structure of the Yilgarn-Kalgoorlie System within the Area can best be considered in relation to the major regional folds already briefly discussed—this also furnishes a convenient broad sub-division of the Area—such sub-divisions will be termed "belts".

I—The Gibraltar Belt.

The belt ranges from the indeterminate soil covered terrain north of Coondarie, approximately four miles to the north of Ubini on the Great Eastern Railway, to some one and a half miles south of Gnarlbine, where it terminates in soils derived from granite or gneiss—an over all distance of 14 miles. Along the Eastern Highway section between Bullabulling and Ubini the belt has a width of some six miles but achieves its maximum width of 10 miles in the latitude of Grosmont.

Over the greater part of the belt outcrop conditions range from poor to bad. It possesses few elements of positive relief—amongst these positive elements are the Bullabulling "Rock" together with the meta-sediments of Reservoir (Toorak) Hill, the small knot of hills which includes Mercer's Find and the hills of the Gibraltar Groups. There is a general slope and drainage over the greater part of the belt to the south. The belt is comprised of three main elements:—

(a) The granite complex of Bullabulling and Gnarlbine on the west. Over the greater portion of its length the contact of this complex with the folded rocks is obscure. South-eastwards of the Rock Hotel (Bullabulling) it is definitely intrusive, showing marginal enclaves of the Older Greenstones and dyke apophyses. Southwards, at Gnarlbine, an intrusive contact may be inferred. Whilst elsewhere the contact is obscured, the presence, a mile west of Bullabulling in some quarries on the Great Eastern Railway, of sillimanitic schists and gneisses which grade northwards imperceptibly into more normal types of the Meta-sedimentary Series, suggests that the junction between the rocks mapped Gr/Gn is transitional between granitised members of the folded rocks and ungranitised members, and that the Gnarlbine and Bullabulling "Rocks" are apices of a batholithic subjacent granitic body.

(b) The Meta-sedimentary Series, developed in the north-west, and ultra-basic rocks of the median belt.

Recent deposits obscure the relation between the Meta-sedimentary Series and the Older Greenstones which are ultrabasic in character, being comprised of actinolitic and anthophyllitic schists and rocks, together with serpentines, hornblende schists and fuchsitic schists. No basic lavas occur, though minor intrusives of meta-gabbro (? Younger Greenstones) are to be seen, especially in the south of the Gibraltar Group. It has so far proven impossible to further subdivide the Ultrabasic Rocks in this locality. Lack of a distinctive rock type and lack of continuity of rock type along the strike has precluded the use of any particular rock as a "marker" horizon for structural purposes. The broad structural interpretation of this Gibraltar belt is based upon the relations of the Ultrabasic Rocks and the Meta-sedimentary Series, distribution of observed strikes and dips, the relation of the belt to the Coolgardie dome structure, and the group work carried out on the Gibraltar and Reform group of goldmining leases.

Hornblende and fuchsitic schists, rock types deriveable from sediments of appropriate composition, occur in the Sala Leases west of Grosmont, in the vicinity of Gibraltar and again (in a highly weathered state—and very ferruginous) south of the railway some three miles east of Bullabulling. Blatchford[5], on field evidence, regarded these rocks as sedimentary derivatives. In this view the author concurs. Accordingly it is considered probable that the relation between the Ultrabasic Rocks and the Meta-sedimentary Series may be one of conformable transition upwards.

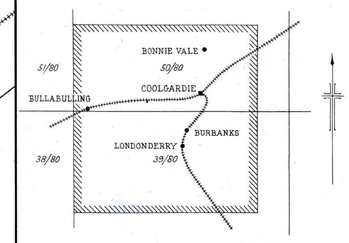
[2] Op. cit.

[3] Nevin, C. M., Structural Geology, Wiley & Sons, 1946.

[4] Billings, M. P., Structural Geology, Prentice-Hall, 1942.

[5] Bull. 53, G.S.W.A., 1913—T. Blatchford.

PLATE I



LEGEND

LATE TERTIARY OR RECENT	Soil-covered areas	The nature of the underlying rocks cannot be inferred with any degree of certainty	
	Ferruginous laterite		
PRE-CAMBRIAN			
EARLY PROTEROZOIC OR LATE ARCHAEOZOIC	Granite/gneiss, undifferentiated		
	Pegmatites		
ARCHAEOZOIC — YILGARN-KALGOORLIE SYSTEM	Younger Greenstone Series	Meta-gabbros and dolerites	
	?	Pre-folding porphyries	
	Whitestone Series	Eastern and Western meta-sedimentary series	
	Older Greenstone Series	Basic lavas	
		Ultrabasic rocks	

Base of system nowhere seen

REFERENCE

- Strike and dip of schistosity
- Strike of vertical schistosity
- Strike of schistosity with no observed dip
- Fault
- Geological boundaries assumed
- Geological boundaries approximate
- Anticlinal crossfold axes
- Synclinal crossfold axes
- Inferred axes
- Section lines

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

STRUCTURAL GEOLOGICAL MAP OF PORTION OF THE COOLGARDIE DISTRICT COOLGARDIE GOLDFIELD

Scale: 80 chains = 1 inch

80 60 40 20 0 80 160 240

Geology by R.S. Matheson, April to December 1946 and J.C. McMath, April to December 1947 and April to November 1948

These inter-series relations when considered together with observed strike and dip data, suggest that the folded rocks of this belt represent the remnants of a major syncline. Such a complimentary syncline to the west is necessitated by the indubitable anticlinal centred about Coolgardie Town.

Group work in the Lloyd George and Reform localities by Gray has brought forward evidence of the nature of an anticlinal limb. Isoclinal folding is to be deduced on G.M.L. 4504.

Thus this Gibraltar belt is regarded as the remnant of a synclinorium whose subsidiary folds are isoclinal—overturning, in view of steep dips, is a probability. An anomalous feature is to be found in the Reform Group where a narrow zone of arkosic meta-sediments is to be seen trending E.-W. This zone may be a sedimentary phase of the Ultra-basic Rocks or an infolded remnant of the Meta-sedimentary Series. On lithological grounds the latter seems more likely. The stratigraphic outcome of this structural view is that the latest phase of the Older Greenstones—the phase immediately preceding the deposition of the Meta-sedimentary Series was an ultrabasic phase.

(c) The intrusive granite of the east which ranges from the latitude of Coondarrie southwards through Ubini to approximately a mile north-west of Grosmont.

The intrusive nature of the junction of this granite with the folded rocks of the median belt is much more evident over its course than in the case of the Bullabulling and Gnarlbine granites. Small zones of granitised rocks are seen locally and, in general, the granite has a marginal gneissosity which is attributable to movement during the final stages of consolidation. Contacts with the folded rocks may be sharp, as at a point on the telegraph line a mile and a half north of Ubini and in the Gear's Find locality or may be inferred within narrow limits as its evident in the vicinity of Grosmont and some three-quarters of a mile north of Gibraltar on the pipe-line track to the Lloyd George Mine. Its apophyses include porphyries, aplites, micro-granites, pegmatites and quartz veins. The pegmatites are of the type which carry minerals of economic interest. Numbered amongst these pegmatites are those of Mercer's Find, Gibraltar and Grosmont.

Its intrusion appears to have certain structural effects upon the folded rocks of the belt—there being a rough parallelism in strike of folded rocks and minor acid intrusives with the contact of the granite. It is difficult to avoid concluding that the regional folding and the emplacement of the granite were dynamically related and overlapping processes.

II.—The Coolgardie Dome.

The major axis of the dome trends N.N.W. as determined by the regional schistosity and outcrop distribution, and ranges from Bonnie Vale in the north of the area southwards to Londonderry—a distance of approximately 20 miles. Its minor axis lies in the vicinity of Coolgardie Town, and extends from the intrusive contact with the granite at Calooli in the west to just east of the Barbara Gold Mine (Block 59, Hampton Plains) where it terminates against soil cover—an over all distance of some 12 miles. The central core is occupied by granite, which breaches the western limb at Calooli, and gneissic or granitised rocks.

Generally speaking outcrop conditions are optimum for the area—exensive soil cover occurring only in the central core and on the margins of the dome. The major positive relief elements of the Area are furnished by this structure.

Drainage tends to radiate from the dome but the Eastern Highway (Coolgardie-Kalgoorlie Road) forms an approximate dividing line between those drainage elements which find their way ultimately to the Kurrawang Lake system and the Jaurdi depression, and those which drain south to Brown Lake and beyond. In detail the drainage shows control by major structure.

The main elements comprising the dome are:—

(a) The rocks of the Yilgarn-Kalgoorlie System—of which only the Older Greenstones, and possibly the Younger Greenstones are developed.

It has been possible to sub-divide the Older Greenstones into alternating, and apparently conformable, belts of Basic Lavas and Ultrabasic Rocks. Within these belts thin and discontinuous horizons of meta-sediments (largely slates and graphitic schists) occur which are both inter and intra formational. Those exposed in the Three Mile Hill cutting on the Great Eastern Railway are fairly typical. A later sill-like body of meta-gabbro (? Younger Greenstones) has been intruded into a Basic Lava belt and maintains, as far as can be seen, the same horizon throughout the structure.

The regional schistosity of N.N.W. trend is well developed as also is dragfolding in the relatively less competent members of the Older Greenstones (usually to be seen in the Ultra-basic Rocks).

Thus there are present rocks of wide value as structural "markers" as well as rocks of limited or local value of which their distribution, when mapped, has indicated the anticlinorial nature of the structure. The structure plunges at both north and south ends—the northern plunge being the steeper—thus giving the dome structure.

Simple in essence, the major structure affords few clues as to the type of subsidiary folding on its flanks. Observed high easterly dips on the remnants of the western limb are suggestive of an overturning of this limb to the west between the Calooli and Grosmont localities. Southwards, at Londonderry, the subsidiary folding becomes very closely packed and talcose chloritic schists, usually dragfolded in some degree, are developed. This is especially noticeable in the Nepean outlier (where isoclinal folding and overturning is present) which forms the southernmost extremity of the elongated dome. In its relation to the distribution of gold this compressed southern portion of the eastern limb becomes significant between Burbanks and Londonderry.

(b) The granitic rocks which occupy the western margin and core of the structure. These rocks comprise both intrusive granites, granite gneisses and granitised members of the Older Greenstones. As before remarked, the junction mapped between the folded rocks and the granitic rocks cannot be considered as intrusive junction throughout its course. An intrusive contact is to be seen on the western margin of the folded rocks in the vicinity of Calooli on the Great Eastern Railway, at the Slate Rocks two miles east of Grosmont on the Coolgardie-Gnarlbine road, and on the Lord Bobs group of leases. The remainder of the core is extensively soil covered, but between the Lord Bobs leases and Coolgardie Town a zone of granitised Older Greenstones is present; the Bluff (Coolgardie) is similarly constituted; granitised Older Greenstones occur a mile S.S.W. of Alford's Gold Mine.

Intrusive granite bosses, which have been mapped as such, with clear contacts are seen in the South Grosmont and Bonnie Vale localities.

The general relations of the granitic rocks to the Older Greenstones of the Coolgardie dome are the same, then, as seen in the Gibraltar synclinal remnant and the same causative conclusion is drawn.

III.—The 5-Mile Synclinal.

Lying approximately five miles east of Coolgardie, and mainly confined to the Camel Paddock, is a belt of red lateritic earths and alluvium which is flanked on the west by Older Greenstones and on the east by both Older Greenstones and Metasedimentary Series. The belt trends N.N.W. and forms a main drainage zone northwards to the Salt Lake system. Topographically it is largely a zone of negative relief—the positive elements being confined to the small hills which trend N.N.W. from the vicinity of Dryden's Find and the Trigonometrical Point designated HK2 on Lands Department plans.

Such dips as were observed were either vertical or steeply inclined. Considerations of symmetry in the relation of this zone to the Coolgardie dome and the Mungari anticlinal require that this zone be synclinal. This requirement is supported where dip data are available—such data also indicate that subsidiary folding of a tightly packed nature is present. The steep dips also indicate that there is a possibility of some overturning of subsidiary folds. A southerly plunge to the structure can be inferred.

At the southern extremity of this synclinal is a narrow body of para-gneiss extending over a mile and a half. It may be of ultimate structural significance that its axial trend is that of the regional folding and that it is echeloned in relation to the Mungari Granite which lies approximately two miles a few degrees east of north.

IV.—The Mungari Anticlinal.

Lying eight miles east of Coolgardie, this structure has an over all exposed length of some eight miles, and a width of four miles from just south of the Seven Mile on the Kalgoorlie road to the Eastern boundary of the Area. Its trend is N.N.W., with the Mungari Granite occupying the axial zone.

Three lithological elements are present:—

(1) The Meta-sedimentary Series—which appear to be more argillaceous in character south and east of the Great Eastern Railway. These meta-sediments have been intruded by meta-gabbro minor intrusives (? Younger Greenstones).

(2) The Mungari Granite—whose intrusive nature into and contact metamorphic effects upon the meta-sediments has already been noted. This body occupies the core of the fold.

(3) Members of the Older Greenstones which "crossfolding"—later to be described—has brought to the present surface.

No suitable "marker" horizons were present in the members of Yilgarn-Kalgoorlie System. A schistose conglomerate at the base of the Meta-sedimentary Series proved, by reason of discontinuity along the strike, disappointing in this respect. The anticlinal nature of the structure has, perforce, to be based upon distribution of dips and general lithology. Again—high dips are the rule together with closely packed subsidiary folding as an inference.

In review, the consequences of the regional folding upon the rocks of the Yilgarn-Kalgoorlie System in the Area has been the production of a series of composite folds (anticlinora and synclinora) whose axes trend N.N.W. Four such folds are to be seen—the major one of which is the complex Coolgardie dome which dominates the Area by reason of its magnitude, internal complexity, contribution to the Area's positive relief elements, and (as will be remarked) from the economic aspect.

"Crossfolding."

The term "crossfolding" is of comparatively recent introduction into the geological literature (both official and unofficial) of Western Australia. It appears to have been first used by Gustafson and Miller in their work "Kalgoorlie Geology Reinterpreted."[6] These authors refer to the flexure of east-west trend which crosses the regional folding of N.N.W. trend as the "Australia East Crossfold." The "crossfold" was considered to ante-date the regional folding.

In official literature, use of the term "crossfolding" first occurs during the re-survey of the South Yilgarn Goldfield[7] by H. A. Ellis and is applied to a fold system whose axial trends were approximately N.N.E. This fold system had received mention in the Progress Report for 1935 although it had not then been specifically termed "crossfolding." Ellis considers the "crossfolds" of the Yilgarn Goldfield to be either coincident with or later than the regional folding.

[6] Gustafson, J. K. & Miller, F. S., Proc. Aust. I.M.M., No. 106—1937.

[7] Ann. Prog. Rept., G.S.W.A., 1936. Progress Report on the Geology and Mines of the Yilgarn Goldfield.

Super-imposed upon the regional folding of N.N.W. trend, the presence of "crossfolding" (whose axial trend is E.N.E.) in the Area has effected a convergence and divergence of the outcrop lines of members of the Yilgarn-Kalgoorlie System. This is particularly evident in the anticlinorial structure which has been referred to as the "Coolgardie dome"—the Older Greenstones of which have preserved in some measure the major detail of such folding. Two major axes of "crossfolding" have been established in the Area—one, as the result of group mapping by Matheson and Ward, in some detail. These axes are:—

(a) The Tindals "Crossfold."

The "crossfold," which is anticlinal and plunges steeply east-north-east, has an axis which appears to extend west-south-west through Grosmont to the southern end of the Gibraltar belt and east-north-eastwards to the south of Kalgoorlie, passing through the Mt. Robinson locality where it has the effect of bringing the Older Greenstones up from beneath the Meta-sedimentary Series. In the lowest formation of the Older Greenstones there is little evidence of "cross- folding," but folding becomes steadily more intense towards the top formations. From Plate I it will be seen that where the Hampton belt of ultrabasic rocks is encountered in the section, two folds have developed on the axis instead of one. This is again the case in the complementary structure of the Grosmont locality.

(b) The Bonnie Vale Anticlinal Crossfold.

In the northern end of the Area, passing just south of Bonnie Vale Townsite, a major anticlinal "crossfold" is discernible. It appears, however, not to show the intense effects seen in that of Tindals. The same stratigraphic members are present as in the Tindale axis.

Between these major "crossfolds" may be seen folds of a minor order and, in more detail flexures. Drag-folds in the least competent rocks, the ultrabasic rocks, may indicate reversed plunges. Plentiful though dragfolding is, it is not sufficiently so to place implicit faith over wide areas upon such determinations—dragfold data only being strictly relative to the movement and attitudes of the more competent formations enclosing the dragfolded formation; they are not unassailable criteria.

The general picture presented, then, is of two main "crossfold axes" of which the Tindals Axis is the major. These "crossfolds" are anticlinal in nature; their limbs carry subordinate folds and flexures; they must be connected by subordinate and complementary synclines, of which there is no field indication.

These "crossfolds" are determined principally by their effects upon the outcrop lines of members of the Older Greenstones Series which are situated upon the eastern limb of the Coolgardie dome. Their presence elsewhere in the Area is largely conjectural for lack of evidence—such conjectures are legitimate but, nevertheless, conjectures.

Apart from the Tindals and Bonnie Vale anticlinal "crossfolds," subsidiary "crossfold" axes have been inferred from outcrop lines and the demands of symmetry. The following, named from convenient mines or population centres (ref. Plate I), are of interest and fundamental in the control and distribution of gold:—

(i) Armidale G.M. axis—synclinal
(ii) Sydenham G.M. axis—anticlinal
(iii) Dunallen's G.M. axis—synclinal
(iv) Three Mile Hill axis—anticlinal } inferred
(v) South Three Mile Hill axis—synclinal
(vi) Londonderry G.M. axis—anticlinal

Whilst the major "crossfold" axes persist along the strike—the very subordinate axes or flexures are probably echeloned. These axes may be projected in both directions with interesting results in that these axes thus produced pass, in the west, through Gibraltar, Grosmont, and Gnarlbine. To the east an axis trends through Mungari. It must be remarked that the validity of these projections is always open to question.

Since individual axes of the N.N.W. trending anticlinorium of the Coolgardie dome are obscure, the detailed results of the intersection of the "crossfold" axes and the regional axes must, of necessity, remain the same. However—it would appear that a N.N.W. synclinal axis and a subordinate synclinal "crossfold" complementary to the Londonderry axis intersect to the north of the Londonderry Gold Mine, the nodal zone of intersection being reflected in a basin structure occupied by ultrabasic rocks. Similarly, the Lord Bobs Gold Mine appears to lie in the nodal zone of intersection of the Tindals axis (anticlinal) and a subordinate anticlinal axis of N.N.W. trend (regional). Elsewhere the general effects of the two fold systems are reflected in the complexities of the horizontal section of the Older Greenstones visible at the present day.

Faulting.

Whilst the distribution and disposition of the folded rocks of the Area, coupled with the absence of imbricate structures, shows that large scale thrust faulting associated with orogenic episodes (compare the thrust faulting associated with the Caledonian orogeny in the Pre-Cambrian rocks of N.W. Scotland[8]) is absent—the general intensity of folding suggests that faulting of some magnitude is likely to be present.

Field criteria for the ready recognition, or reasonable inference, of faulting are sparse by reason of poor outcrop conditions, and by the general physiographic maturity of the land surface. The postulation of "paper" faults to obviate anomalies is to be deprecated strongly, since such a practice only serves to further obscure the issue.

Faulting recognised within the area during the course of regional and mining group examination is small in scale and appears largely normal in character, although the nature of folding suggests that small low angle thrusts and reversed faults might preponderate. There is not sufficient weight of evidence to make further comment upon this point. Both strike and dip faults are known, together with small step faulting on the Bayley's leases. In general, with rare exceptions found in mining group examination, data as to the magnitude of the fault components has not been obtained.

Faulting is not confined to any particular members of the Yilgarn-Kalgoorlie system, and available evidence shows that a number of faults—e.g., those of the Phoenix Gold Mine (Coolgardie) and a faulted alaskite dyke in the Barbara Gold Mine indicate a post-gold mineralisation age for these faults.

In summary, then, no faulting on a regional scale has taken place, though the character of the folding suggests:—

(a) that faults of some magnitude should be present;

(b) that reversed faults and small low angle thrusts should be present.

Few data, except that resulting from mining group examination, as to displacements and attitudes are available from surface evidence. The observed faults, generally speaking, appear to be post-gold mineralisation in age.

Shearing and Jointing.

Shearing has been variously and complexly defined—a most clear and simple definition is that of Nevin[9] who states that "shearing is a parting, or tendency to part, under the action of two parallel but opposed stresses which are not in line with each other." Any heterogeneous mass of rocks such as the Yilgarn-Kalgoorlie System will show components of differing competency under the stresses which produce folding of the order seen in the Area. The relatively incompetent formations or horizons yield first by the development of schistosity and, ultimately, by shearing. Where the more competent formation would show faulting or fracture cleavage, the less competent ones would seek relief from stress by shearing. Such shearing ranges from the microscopic (dragfolded talc-schists from Nepean show, in thin section, microscopic folds whose limbs are attenuated into shears) to the large scale.

In particular the members of the Older Greenstones show a wide range in relative competency from the resistant Basic Lavas to the Ultrabasic Rocks which have behaved incompetently, as is witnessed by their development of schistosity and dragfolding in greater or lesser degree. Such phenomena are not so obvious in the Meta-sedimentary Series. The alternation of Basic Lavas and Ultrabasic Rocks within the Coolgardie sub-area —i.e., the Coolgardie dome—furnish an ideal environment for shear patterns to develop consequent upon folding.

Within the Area, the following are considered to be reasonable consequences to be expected as resulting from the two fold systems present:—

(i) Shearing will be found to predominate in the Ultrabasic Rocks—though shearing has been noted in Basic Lavas at the slate rocks (on the Coolgardie-Grosmont road) parallel to the regional strike, and is attributable to the intrusion of the granite; and again in Basic Lavas at Bonnie Vale on the contact with the Bonnie Vale Ultrabasic belt. Shearing has also been noticed in the Meta-gabbro on turning points of the Tindals structure—e.g. at Zadow's Find.

(ii) That, on the limbs of folds, shears will tend to be en echelon and parallel to the schistosity.

(iii) That, on the noses of folds, branching shear patterns may be expected.

(iv) That each fold system—i.e., the "crossfold" and regional systems—will have their individual shear patterns.

(v) That, in the nodal zones of intersection of axes of the two fold systems, shear patterns may be expected to be complex and anastomosing.

Unfortunately, poor outcrop conditions and a tendency to deep weathering of the Ultrabasic Rocks make recognition of shearing virtually impossible, with the exception of the cases already cited. The main evidence of the presence of shears and their nature is derived almost solely from the results of mine examination. In view, however, of the importance of shearing as affording channels for the introduction and location of ore material, it is felt that a review of the probability of shear distribution is justified.

The Cockshot, Prices, New Prices, and Reward reefs of the Bayley's Group, situated on the eastern margin of Coolgardie Town, occupy shear zones which offer an example of shears on a fold limb which are en echelon. The Group is structurally sited on the eastern limb of the north plunging Coolgardie anticlinorium and is traversed by a gentle "crossfold" flexure of anticlinal form. The shears are approximately parallel to the north-north-west regional strike and lie in Ultrabasic Rocks. The shears have a high dip to the east. A further example is to be found at Gnarlbine.[10]

The association of branching shears with the noses of folds is demonstrated in the Hampton Group. This Group lies mainly in the Hampton Ultrabasic Belt and falls in the axial zone of the Tindals "crossfield." The ultra basic rocks have been intruded by porphyries prior to folding. Upon

[8] Peach, B. N. & Horne, J. The Geological Structure of the North West Highlands of Scotland, Mem. Geol. Surv. Great Britain—1907.

[9] Nevin, C. M., Structural Geology, Wiley & Sons,—1936.

[10] Bull. No. 91, G.S.W.A., 1925. The Auriferous Lodes of the Gibraltar District.

folding, the ultrabasic rocks have behaved incompetently, and branching shears have developed in these rocks and are centred about the noses of the folded porphyries in a pattern tangential to the changes of strike. In the case of G.M.L. 319 (Lady Mary), G.M.L. 330 (Barbara) and G.M.L. 334, Hampton Location 59, these shears have undergone subsequent gold mineralisation to form the ore bodies on these leases.

Thus, so far, three of the consequences of folding of competent and incompetent rocks are to be seen in the Area. Sufficient data are not available to demonstrate the existence of the two remaining consequences postulated—they must, however, be borne in mind.

Jointing due to various causes is present in all rocks of the Area—ranging from the major tension joints seen in the granite intrusives to the small, closely spaced jointing of the Older Greenstones and Meta-sedimentary Series. Laterites are jointed as well. No detailed analysis was made of the various classes of joints—but the majority appear to be of tensional derivation due to—

(a) cooling of igneous rocks after emplacement or extrusion and the diagenesis of sedimentary rocks;

(b) the two systems of folds in the Area.

With regard to joint systems consequent upon folding—both compression and tension are operative. Adjustments to compressive stresses in the form of fracture cleavage have not been specifically observed (not that it is not present) but Matheson[11] suggests that a steep cross-jointing of the porphyries in the vicinity of the Tindals "crossfold" axis may represent fracture cleavage. A combination of jointing, schistosity, and fracture cleavage in the steeply dipping Basic Lavas of the Burbanks area and elsewhere (including Bonnie Vale) give rise to a "spearhead" arrangement of outcropping jointed rock in which the lines of intersection of the planes represented by flow and fracture cleavage together with normal jointing, form the edges and sides respectively of a parallelipiped. The laterite joints result from volume changes of the rock during its production and occasion no further comment.

Pre-Cambrian Movements.

At least four periods of movement can be discerned in the Pre-Cambrian rocks of the Area—

(i) that which occurred at formation junctions and elsewhere to accommodate the prefolding porphyries. It may have occurred in the initial stages of regional folding—but must have been completed early since the porphyries are themselves sheared, jointed, and folded;

(ii) regional folding (including "crossfolding"), accompanied by shearing, jointing, and readjustment along formation junctions. The openings for auriferous deposition were formed during this second period;

(iii) the presence of post-gold faults—as in the Phoenix Gold Mine, Coolgardie, and of alaskite dykes in shears cutting through ore bodies as in the Barbara Gold Mine (Hampton Group) indicates a third period;

(vi) the faulting of an alaskite dyke in the Barbara Gold Mine indicates a fourth period as does also the faulting of a pegmatite on the Lloyd George Leases, Gibraltar.

The General Relation between Structure and Gold Deposition.

The occurrence of metalliferous deposits in a region gives rise to three major questions regarding—

(i) the source, immediate or ultimate, of the metallisation;

(ii) the structural features of the host rocks which have favoured, or inhibited, the introduction of metalliferous solutions which have formed the ore deposits;

(iii) the physico-chemical factors which have led to certain rock types or horizons being specially favoured.

Granted an initial source of supply, the concentration and distribution of the metalliferous deposits within the host rocks is largely determined by the second and third factors, whilst their economic work is governed by the magnitude of the initial supply and/or subsequent processes of concentration (secondary enrichment) which may have operated. Discussion of these three questions in terms of the geological facts of the Area is considered to furnish the best basis for the clear presentation of the relations of structure and gold deposition within the Area.

I.—Sources, Immediate or Ultimate, of the Metallisation.

The distribution of past or present gold mining centres within the Area shows a general proximity of these centres to major granite intrusives, being rarely more than a mile and a half from a major granite. Gibraltar, Gnarlbine, Grosmont, Coolgardie Town (Bayley's Group), Londonderry, and Bonnie Vale are cases in point. The Mungari and Mt. Robinson localities are somewhat further removed and of very minor importance. An apparent exception occurs in the Hampton Group—no obvious association with a major granite intrusive is seen. In view of the community of character of the auriferous aplitic bodies of Tindals Gold Mine with the major granites, it is thought likely that a subjacent granite body may occupy the core of the Tindals "crossfold" in depth.

Both the Lord Bobs and the Bonnie Vale centres show auriferous quartz reefs in the gneissose margin of a major granite and in granite, respectively. At Gibraltar, in workings not now accessible, Feldtman[12] notes small pegmatite dykes as sometimes forming the hanging walls of ore bodies. The relation of these pegmatites, which may carry minerals of economic interest, to the main mass of the Gibraltar granite is clear—they are differentiates. The metalliferous nature of the Londonderry, Tantalite Hill, and Mercer's Find pegmatites require no further comment. From the above facts it is concluded that the ultimate source of gold deposition in the Area is to be sought in the major granite intrusives—a conclusion which is in accord with concensus of geological thought in general.[13]

The field occurrence and community of mineralogical character of these granites is indicative of a general equivalence of age; they are considered to be cupolas of a subjacent batholithic mass. This batholithic body may be considered as in the last phases of the epibatholic stage of erosion of Emmons[13a], in which portions of the roof of the batholith remain (the members of the Yilgarn-Kalgoorlie System), portions of the central core have been exposed, and some cupolas have been eroded below the "dead line"—the warped marginal zone on the surface of the batholith below which valuable deposits are absent.

This conception of Emmons presents a picture of the relation of the auriferous deposits of the Area to the granites which have, it is concluded, provided the source of auriferous deposition. Whilst other pictures are possible—the writer considers that the one presented approximates most closely to the as yet undeterminable truth.

There is no evidence of the depth at which, in general, granite underlies the folded rocks of the Area. Inference can be drawn that the depth, in some localities, may not be great. Such localities include Gibraltar, Londonderry, Grosmont, and Nepean where either gneissose granitic rocks or apophyses of the granite occur.

Of particular significance are the auriferous quartz reefs of the Lord Bobs centre (the reefs lie in the gneissose contaminated margin of the "Slate Rocks" granite) and of Bonnie Vale (the

[11] Ann. Prog. Rept., G.S.W.A., 1946. Progress Report on Resurvey of the Coolgardie District, Coolgardie G.F.

[12] Bull. 91, G.S.W.A., 1925. The Auriferous Lodes of the Gibraltar District, Coolgardie Goldfield.

[13] Lindgren, W., Mineral Deposits, McGraw-Hill—1933.
Bateman, A. M., Economic Mineral Deposits, J. Wiley & Sons—1942.
Emmons, W. H., Gold Deposits of the World, McGraw-Hill—1937

[13a] Op. cit.

reefs lie in the granite). These occurrences suggest that the postulated granite batholith underlying the Area may be "hooded" (the "hood" of a batholith being defined by Emmons[14] as that portion of the batholithic surface above the "dead line." Should such indeed be the case—the depths, in the localities remarked, to the warped surface bounding the junction of the granite and folded rocks become of economic interest. The means of ascertaining these depths and sub-surface configuration lie largely in the geophysical field.

II.—The Structural Features of the Host Rocks.

The rocks of the Area in which gold deposition has occurred are the members of the Yilgarn-Kalgoorlie System. Evidence has shown that these rocks were folded prior to the intrusion of the granites and before gold deposition.

Resulting from the N.N.W. folding (regional) and the "cross-folding" (E.N.E.) of these rocks of diverse character and relative competency, was a series of fold, shear, joint and fault patterns affording suitable channels of mineralisation. It would be anticipated, then, that the Area would show a relation of gold deposition to the major structural features and, in detail, to their attendant shear, joint, and fault patterns.

Examination of the distribution of gold mining leases and major gold producing centres (past or present) of the Area together with the structural trends reveals that:—

(a) The greater number of the leases are contained in the Coolgardie dome structure and are concentrated upon its eastern flank. This dome is anticlinorial in character.

(b) The major producing centres are grouped about "crossfold" axes of various orders of magnitude;

(c) of these gold producing centres, the major producers are associated with anticlinal "crossfold" axes—e.g., Tindals, Londonderry, Grosmont, Bonnie Vale, and Three Mile Hill. The Tindals axis is the major "crossfold" axis of the Area and the most satisfactorily known. The synclinal "crossfold" axes appear only of subordinate interest from the point of view of gold deposition. The evidence for the actuality of these "crossfolds" has been previously given.

Thus within the Coolgardie dome, the relation of gold deposition to folding, and "crossfolding" in particular, forms too constant a pattern to be considered entirely fortuitous. In the flanking structures to the east and west of the Coolgardie dome, such association of gold deposition and regional folding are far from clear—there being few criteria of use as "markers" in elucidating major structure. Local reversals of regional strikes and dips in the vicinity of the Gibraltar Group suggest that a "crossfold" axis is present. Projection of the known "crossfold" axes has interesting results, in that the gold-mining centres of Gibraltar, Gnarlbine, and Mungari are found to be situated on such projections. It must be borne in mind that the validity of such projections is always open to question. The control of gold deposition can only be regarded, then, as definitely shown in the case of the Coolgardie dome —outside this major structure available evidence does no more than suggest that similar controls may have been operative. It is significant, however, that recommendations as to areas likely to repay further prospecting, made during the course of fieldwork[15] and based (in part) upon the known control of gold deposition by structure the Coolgardie Area, have resulted in some measure of success—Baker's Find in the Tindals structure being a notable case. The recent (1948) find of the Baker Bros., in the Camel Paddock, some four miles east of Coolgardie Town, is a second example.

[14] Op. cit.

[15] Ann. Prog. Repts., G.S.W.A.—1946-1948 inclusive.

Within the Coolgardie dome it is evident that some structural control of gold deposition has been effected by folding, "crossfolding" in particular. It would be expected that minor flexures or folds on the flanks of major "crossfolds" would exercise a similar control.

The ancillary effects of folding—shearing, jointing, and faulting—have resulted in the provision of channels for subsequent mineralisation. Examples of this localisation in detail have been given already (p. 69).

Away from the major structural unit of the Area—the Coolgardie dome—this control is very much less evident. In particular is this so in the areas occupied by the Meta-sedimentary Series. No workings were seen in the Western Meta-sediments about Bullabulling, whilst in the vicinity of Mungari the workings in the Eastern Meta-sediments, though fairly widespread in a north-south zone, are small and have achieved no notable production. The few leases north of Mt. Robinson, the Rajah and Great Mogul amongst them, have an even more meagre record.

These Meta-sedimentary Series have taken part in the same folding episodes as the other members of the Yilgarn-Kalgoorlie System and are sheared, jointed, and faulted in much the same fashion. A suggestion of the presence of the eastward projection of the Tindals axis is seen in the relation of the Meta-sediments to the Older Greenstones around Mt. Robinson. They differ from the Older Greenstones lithologically, being composed of arkoses, grits, slates, mica schists. They contain quartz reefs associated with shear zones and faults, besides those directly connected with the Mungari granite. Regarding the Area from a three dimensional aspect—these Meta-sediments are at the top of the Yilgarn-Kalgoorlie succession in the Area. Their poverty in gold mineralisation then may result from either—

(a) their chemical and physical attributes, or

(b) their structural environment—being at the top of the succession, and thus at the possible vertical limit of gold deposition. They may also be at the lateral limit of mineralisation.

It is possible that both factors have been active, although the latter may be deemed as the dominating one. Briefly—gold deposition in the Area is considered to have been controlled in general and localised in particular by—

(i) folding—particularly "crossfolding";

(ii) the stratigraphical position of a particular horizon with respect to vertical and lateral limits of mineralisation.

(iii) the shear, joint, and fault patterns produced by the folding, in particular in association with "crossfold" axes.

III.—Rock Types or Horizons favoured by Chemical and/or Physical Factors.

Inspection of the distribution of gold mining leases and gold production in the Area has demonstrated the existence of preferred major and minor structural features in relation to gold deposition. Further preferences as to host rocks and horizons are also apparent in this distribution. The following are the major apparent preferences in order of merit:—

(i) Older Greenstones.
(ii) ? Younger Greenstones.
(iii) Meta-sedimentary Series.

As remarked under "Structural features of the host rocks" an element of this preference may be ascribed to the structural environment with regard to the stratigraphical succession. The remaining elements determining preference appear related to—

(i) the temperature—pressure conditions existing during the course of gold deposition—i.e., the energy level;

(ii) the individual chemical characteristics of the rocks which may have promoted or retarded gold deposition;

(iii) the individual physical characteristics of the rocks—other than the major effects of differential competency under stress already noted—such as texture, grain size, etc., which may have inhibited or promoted gold deposition.

These elements are intimately interwoven and, specialised studies being outside the scope of this work, no precise evaluation of their relative importance can be made. The following comments, however, can be made:—

(1) The general relation of major granite intrusions to gold distribution; the direct relation of gold-quartz reefs to granite as at the Bonnie Vale and Lord Bobs centres; the association of gold, arsenopyrites, pyrrhotite, and scheelite in the Phoenix Gold Mine (Coolgardie); the garnet-amphibolite gneiss with ptygamatically folded gold-quartz veins carrying zinc blende, pyrrhotite, and native bismuth as minor accessories at Burbanks; the economic pegmatites of the Area; and the great, but unknown, thickness of the cover (now the folded rocks of the Area) are all suggestive of a fairly high energy level. In general it is concluded that the deposits come into the mesothermal category of Lindgren[16], though Burbanks might be claimed as hypothermal.

(2) Apart from the purely structural considerations already advanced there is a marked preference for rocks of basic character—i.e., which are rich in iron and other precipitants of gold; such precipitation may be by catalysis or replacement. So marked is this preference that, of the Yilgarn-Kalgoorlie System it is the Ultra-basic Rocks of the Older Greenstones which have been dominantly favoured. Except under the temperature and pressure conditions which impressed upon them their present characteristics, these rocks are inherently unstable—symptomatic of which is their reaction to, and depth of, weathering. Such instability coupled with their chemical character is thought to favour reactions leading to the precipitation of gold. Some silicification and alteration are noticeable in the walls of lodes in these rocks—the ore bodies of Hampton Group are so affected. Some metasomatic introduction of gold into blockily jointed fine, even-grained ultra-basic rocks is to be seen on G.M.L. 2954 in the south Gibraltar district. Similar examples are to be seen elsewhere in the Area as on the Lucy's Luck G.M.L. (3837) at Mungari where the quartz reef and lode material is associated with a thin actinolitic schist horizon in the Meta-sediments.

The chemical factor is again seen in the ? Younger Greenstones where, in a specialised structural environment, sulphide metasomatism has taken place in the Meta-gabbro on its contact with the Basic Lavas. The specialised structural environment is situated on the nose of folds—the Meta-gabbro, a coarse grained rock, proving less competent than the fine grained, even textured, Basic Lavas, having sheared under stress. These ore bodies consist of sulphide metasomatised Meta-gabbro with an associated tension fracture system infilled with auriferous quartz which may carry pyrites as at Three Mile Hill. The Armidale and Sydenham Groups together with the Three Mile Hill Group and Zadow's Find, exemplify this factor. With the exception of Zadow's Find, these ore bodies are of a low, and at the time of writing (1949), uneconomic tenor. There is no information as to their dimensions.

Beyond slight silicification, the Basic Lavas of the Older Greenstones appear to have been chemically stable—perhaps by reason of their fine texture and relative competency under stress, affording few points of attack by ore carrying solutions. The control of such gold deposition as is found in these lavas appears conditioned by structural detail, and incompetent slate and graphitic schist horizons, which have afforded minor channels of mineralisation. The same remark applies to intra-formational slates, etc., in the Ultra-basic Rocks. There is the possibility that the graphite of the schists may have had some chemical role—many small workings on contacts of the igneous members of the Older Greenstones with these thin sedimentary bands testify to gold deposition in such environments—but the occurrences are small.

(3) Differences in conditions of extrusion and intrusion in the case of igneous rocks, and in conditions of sedimentation and pene-contemporaneous erosion with the members of the Yilgarn-Kalgoorlie System, have given rise to rocks differing widely in texture, grain size, porosity, etc., as well as in chemical composition. Hence there are within the Older Greenstones physical discontinuities in detail between members of the Basic Lavas and also between members of the Ultra-basic Rocks such discontinuities are evidenced in inter-flow surfaces, inter-flow and inter-formation sedimentary bands of slates and graphitic schists, and discontinuities between the several members of the Ultra-basic Rocks. Apart from the relative competency under stress of the horizons demarcated by these discontinuities, that the discontinuities have some influence upon gold deposition and its localisation is seen in the field by numerous lines of small workings which follow a particular horizon. The most noticeable horizons are those of the inter and intra-formational slates and graphitic schists which form thin and discontinuous bands both in the Basic Lavas and Ultra-basic Rocks. As far as records show, production has been low—"dabs" being the general order of occurrence. Both in the meta-sedimentary horizons on the contact of Basic Lavas and Ultra-basic Rocks in the Camel Paddock and again north of the Lady Miriam G.M.L. (west-south-west of Burbanks auriferous quartz is associated with these horizons, and some silicification of the meta-sediments has taken place. Similar examples are to be found elsewhere in the Area. It may be, then, that these horizons furnished a relatively impermeable barrier to ore bearing solutions—the suggestion, in view of lack of detailed studies, is only tentative. It is significant that although similar discontinuities exist in the Meta-sedimentary Series, no such association with gold deposition has been noted—that this is so is ascribed to the structural position in the succession of these Series.

In conclusion, although it is appreciated that the facts in detail are capable of alternative interpretations, it is felt that the general picture and principles adduced are of sufficient accuracy to furnish a useful basis in the search for further auriferous ore bodies and to assist in the understanding of ore bodies at present being mined. That the health of the gold mining industry is of paramount importance in the social and economic structure of the State, despite recent ex cathedra statements that gold is immaterial to Australian economy[17], must serve as an excuse for the economic bias of this presentation if excuse be needed.

BEACH SANDS OF THE BUSSELTON AREA.

By J. C. McMath, B.Sc. (Hons. Lond.), F.G.S., M. Aust. I.M.M.

Location.

The beaches examined briefly are located in the Busselton Area and are covered by Dredging Claims 19, 11, 13, 24, 31, 33 and may be located on L.O's. 413A/40, 413B/40. They range from Minninup in the north to Bunker's Bay in the south-west.

Special Remarks.

(a) Titles.

Each dredging claim is partially or totally comprised of alienated land. Hence some objections have been lodged with regard to the granting of these claims, especially D.C's. 31 and 33. The hearings were held on 29th April, but the outcome was not known.

(b) Activity.

The only activity encountered was at Wonnerup (D.C's. 13 and 24) where a subsidiary of I.C.I.A.N.Z. (Enterprise Explorations Co. Ltd.) was engaged in detailed sampling work.

[16] Lindgren, W., Mineral Deposits, McGraw-Hill—1933.

[17] See Prime Minister Chifley, Perth, 1947. Occasion of meeting with Chamber of Mines.

The Claims.

(a) General Remarks.

The low lying coast, the coastal plain backed by the Darling Ranges, shows in a small way the haff and nehrung phenomena associated with a coastline of emergence. "Fossil" beaches are present. This is particularly in evidence about the Wonnerup and Vasse Estuaries.

The "black" sands, which appear as lenses and/or disseminations reach their maximum development about the centre point of Geographe Bay (Wonnerup) and diminish in concentration northwards. The concentration in Bunker's Bay on the east side of Cape Naturaliste is ascribed to its position with regard to the Cape and coastal currents.

(b) Bunker's Bay.

About a mile long the bay is enclosed by headlands of granite-gneiss; to judge from the garnet concentration, these gneisses may in part be sedimentary. The beach averages 50ft. wide between tidemarks and the black sands of the beach showed a heavy and fairly uniform concentration. Several creeks enter the bay and show a fossil beach section with black sand some 9in. thick at the base. The overburden, which is vegetated, shows a dissemination of economic mineral. It is estimated that the fossil beach, whose width as far as could be seen was of the order of three chains, would contain some 200,000 tons of sand. In the event of the Wonnerup project coming to fruition, Bunker's Bay should repay detailed investigation. It lies approximately 25 miles south and west of Busselton.

(c) Wonnerup.

Wonnerup is located on the Vasse and Wonnerup Estuaries and is the scene of activities on the part of Enterprise Explorations Co. Ltd., who are engaged in investigating in detail the "fossil" beach (some 10-15 chains wide).

To date the values have averaged 9ft. in depth (water level) and take the form of lenses and disseminations. A concentration is found at water level. The investigation takes the form of grid sampling (50yds. x 25yds.) with post-hole auger, sand-pump, and casing. A small Wilfley table has been installed for test purposes.

Preliminary economic studies by the company indicate that—

(i) they look for a minimum of 200,000 tons of natural concentrates;

(ii) they propose treating, on the spot, 10,000 tons per year—i.e., some 30-40 tons per day;

(iii) they propose to instal two Humphrey Spiral Concentrators and a magnetic separator. Cost of plant £50,000 to be amortised over 20 years;

(iv) it is estimated that the cost of ilmenite concentrate on wharf at Busselton will be of the order of £2 per ton. Distance plant to wharf is four and a half miles;

(v) they estimate that values down to 4 per cent. ilmenite can be successfully treated;

(vi) rutile and zircon content are low in these sands; it is proposed to stock pile these elements. Travancore ilmenite concentrate (60 per cent. TiO_2) is at present selling at £3 2s. Australian per ton.

(vii) The Wonnerup ilmenite contains less than 0.04 Chromium. Thus Wonnerup shows—

(i) Permanent potential reserves in the fossil beach;

(ii) short distance to a shipping point.

It appears to be one of the few beach deposits of economic worth in the State—though Bunker's Bay and Minninup may become so.

(d) D.C. 33H—

D.C. 33H is situated at Siesta Park, some 5 miles south of Busselton. There are evidences of a fossil beach as seen in drains. Concentration of black sands appears to be low in the fossil beach. The present sea-beach shows higher concentrations at points where drains enter the sea. As a potential economic proposition it does not impress. A detailed sampling would be necessary to confirm this impression.

(e) Minninup Beach—

This beach has been the subject of a previous report in regard to the sea beach. Whilst the values in the sea beach were reasonable, they vary from season to season, but may be indicative in a general way of values which may exist in the "fossil" beach, evidences of which were inferred. A detailed sampling would be necessary to prove this beach. The "fossil" beach is on alienated land. Minninup lies some 11 miles south of Bunbury and 4 miles north of Capel.

APPENDIX I.

Report on Six Samples for the Government Geologist, Perth.

Lab. No.	2750	2751	2752
Marks	GS/W/1	GS/W/2	GS/W/3
Lab. No.	2753	2754	2755
Marks	GS/Si/1	GS/Si/2	GS/B/1

Approximate Percentages.

Rutile	1	1	0·3	0·2	trace	0·3
Ilmenite	46	43	15	7	0·4	46
Zircon	3	2	1	0·8	trace	3
Monazite	nil	trace	nil	nil	nil	trace

Localities.

Lab. No.	Mark.	Locality.
2750	GS/W/1	Wonnerup, Block 68, 0 ft.–2 ft. 7 in.
2751	GS/W/2	Wonnerup, Reynolds House, 0 ft.–4 ft. 8 in.
2752	GS/W/3	Wonnerup, Block 57, 0 ft.–3 ft. 2 in.
2753	GS/Si/1	D.C. 33H, 20 ft. above H.W.M. north end.
2754	GS/Si/2	D.C. 33H, mid point cut material from drain 150 ft. above H.W.M.
2755	GS/B/1	Bunkers Bay, Western Creek, 150 ft. above H.W.M.

NOTES ON BEACH SANDS OF TORBAY—W.A.

By J. C. McMath, B.Sc. (Hons. Lond.) F.G.S., M. Aust. I.M.M., L. E. de la Hunty, B.Sc.

Introduction.

At the instance of Mr. E. W. Perkins of Torbay, W.A., the beach was visited by the authors on 16th March, 1949, in order to determine whether black sands carrying economic mineral were present in exploitable quantity and tenor.

Mr. Perkins stressed the local "Coffee Rock" as the parent formation of the ilmenite, zircon, and rutile content of the beach sands. Sampling on a reconnaissance basis was carried out by post-hole auger (Ref. Appendix for sample analyses). Traces of black sand invariably cut out at water-level.

Ref. Maps and Location.

Torbay is situated about 16 miles west of Albany and, though accessible by gravel and sand tracks following the Albany-Denmark railway, is best approached by the main Denmark highway from Albany. Reference may be made to Lands Department Lithograph 457/80.

The Beach.

The beach examined lies between Port Hughes (at the entrance of Torbay Inlet) and Richard's Island (approx. ½ mile north of Forsyth Bluff)—a distance of some 2½ miles.

Of an average width of 1¼ chains the continuity of the beach is interrupted by two seaward projections of an injection gneiss complex.

Above high-water mark a belt of high fixed sand dunes separate the low lying swampy country inland from the beach.

At the base of these dunes lies the so-called "Coffee Rock" which is also well exposed for some 300 yards in a drain from the railway to the beach.

Thin veneers of black sand were seen in the swash marks between tide marks. Except at the mouth of the above mentioned drain, where a lense of thin streaks of black sand was noted, these traces of black sand did not persist below water-level.

The "Coffee Rock"—as far as could be determined—possibly represents a former shoreward extension of the beach. Soft and approximately 10-12 feet thick, this rock occurs between the seasonal levels of the water table, to the movement of which it owes its cementation. It varies in colour, which is due to humus material and iron oxide between light brown and dark brown or black. Its economic mineral content is low and is of NO economic value. This rock underlies at least 500 acres of the inland swampy country.

The injection gneiss, which forms the erosion surface upon which the beaches, dunes, and "Coffee Rock" lie, shows alternating bands of granitic rock injected into ancient basic sediments now schistose granulites. The strike and dip of gneissosity are 70° Mag. and 45° at 340° Mag. Fresh basalt dykes cut the gneiss complex, one of which was observed to strike at 300° Mag. and dip 80° at 210° Mag.

The provenance of such black sand as was seen is attributed to the injection gneiss complex.

Reference Appendix 1: Samples GS/T/1-3 inclusive represent the "Coffee Rock" whilst the remaining two samples represent the very *limited* concentration of black sand at the mouth of the drain.

Conclusions.

It is concluded that concentration of economic mineral in beach or "Coffee Rock" is not commercially exploitable under present conditions.

APPENDIX I.

Report on Five Samples ex Torbay for the Government Geologist, Perth.

Lab. No.	1880	1881	1882	1883	1884
Mark	GS/T/1	GS/T/2	GS/T/3	GS/T/4	GS/T/5
	Approximate Percentages.				
Ilmenite	x	x	x	2	8
Zircon	x	x	x	1	7
Rutile	nil	x	x	x	x
Total heavy minerals	0.3	0.2	0.2	4.8	17.5
Radio-activity	nil	nil	nil	slight	slight

x = present in amounts less than 0.1 per cent.

THE DOUBTFUL ISLAND BAY AND GAIRDNER RIVER.

Beach Sands.

By J. C. McMath, B.Sc. (Hon. Lond.), F.G.S., M. Aust. I.M.M., L. de la Hunty, B.Sc.

Summary.

The beaches were inspected and sampled on a reconnaissance basis during the period 9th-14th March, 1949. They had previously been sampled on behalf of the Commonwealth Bureau of Mineral Resources in December, 1947. Sampling was by post-hole auger, holes being taken to bedrock or water-level. General geological observations were made as well as an assessment of the economic potentialities of the sands with regard to ilmenite, rutile, and zircon.

Dredging Claims 27H to 30H, inclusive, have been taken up to cover the beach between Corner Cove and Point Ann. Each claim has a length of 200 chains, i.e., the four claims take in 10 miles of beaches.

At the time of inspection the beach had an average width, between tide-marks, of 50 feet and an average depth, at high-water mark, of 3½ feet to water-level or bedrock. The beach is backed by a zone of fixed dunes which show traces of a "fossil" beach.

Economic mineral ("black sand") appears concentrated about the centre of the beach, i.e., north and south of the Gairdner River. The black sands may show fine stratification to a depth of some 6 inches over limited areas; elsewhere there may be sufficient economic mineral disseminated through the deposit to give a grey colour to the otherwise white quartz and shell sand.

It was found that concentration of black sand cut out at water-level and that the beaches were liable to stripping during storms, thus making any estimates as to tenor and available quantity applicable only to the period of sampling.

The greatest concentration of economic mineral seen, a lens of very limited vertical and horizontal extent, was—

Ilmenite	800 lb. per cu. yard.
Rutile	Traces.
Zircon	80 lb. per cu. yard.

Overall values were—

Ilmenite	317 lb. per cu. yard.
Rutile	80 lb. per cu. yard.
Zircon	180 lb. per cu. yard.

Some 170,000 cubic yards were estimated to be available, i.e., 366,000 tons of natural concentrates.

Very low values were contained in the "fossil" beach where sampled. It is thought that these low values represent fairly closely the average content. Reference may be made to Appendix I for detail.

By reason of the low tenor of the beach, the probable negligible content of the "fossil" beach, together with the situation of the beach in relation to transport costs, the writer can only decline to consider that exploitation of these sands is likely to be an economic proposition.

Location.

Doubtful Island Bay and the Gairdner River, situated on the south coast of Western Australia, are some 115 miles east of Albany in E. Longitude 120° and S. Latitude 34° 20′ approximately.

Maps.

Reference maye be made to the following:—

(i) Lands Department Lithographs Nos. 447/80, 434/80, 433/80.

(ii) 4 Mile Strategic Series Australia, Bremer Bay, 1942.

(iii) Geological Sketch Map of W.A., G.S.W.A., 1932.

(iv) Appendix I.

Communications.

(a) Road.

(1) Via Ongerup-Jarramongup Station-Qualup Homestead-Doubtful Island Bay. Gravel road to Jarramongup, thence by reasonable track. The last six miles is through fixed sand dunes and is liable to occasion difficulty. Distance approximately 80 miles.

(2) Via Borden-Bremer Bay-Doubtful Island Bay. The writer has not been over this route but it is favoured for commercial haulage of fish from Doubtful Island Bay. Distance is approximately 90 miles.

(b) Beach Access.

(1) South of the Gairdner River—by means of the Qualup-Doubtful Island Bay track. Two tracks lead off to the beach:—

(i) A turn off 3 miles north of Doubtful Island Bay Homestead—thence half a mile through sand dunes to the beach.

(ii) A turn off 2 miles south of Qualup Homestead—thence 4½ miles along the south bank of the Gairdner River to the mouth.

Depending on the state of tide, a truck may be taken the length of the beach between the river mouth and Fishery Cove.

(2) North of the Gairdner River—by means of route (ii) above to the river mouth and thence northwards over the sand bar which seals the river mouth. Quicksand patches may be present at certain seasons.

The north end of the beach (Point Ann) is approached via the Overland Telegraph Line from Qualup Homestead and thence seawards along No. 2 Rabbit Proof Fence. The distance is approximately 14 miles. There was track on the north bank of the river to the mouth from Qualup; it is now overgrown to an extent impossible for the passage of a car.

(3) Access to intermediate stretches of the beach by car would require the construction of adequate tracks through the coastal sand dunes.

(c) Telephone.

Jarramangup Homestead is in telephonic communication with Ongerup Exchange. A station line runs to Qualup from Jarramangup.

General Geology.

The beach stretches from Hood Point northwards to Point Ann—a distance of some 14 miles. The general trend of the coastline is slightly east of north.

A zone of vegetated dunes covers the coastal plain and varies from a few hundred yards to about a mile in width. It achieves its maximum width approximately midway between the Gairdner River and Doubtful Island Bay. At this point is a zone of "live" dunes advancing inland and overriding the "fixed" dunes. The rate of advance is said to be about 10 yards per annum. These "live" dunes are considerably higher than the "fixed" dunes whose height ranges between 14 and 20 feet above mean sea level. These dunes, both "fixed" and "live" are echeloned parallel to the coast-line.

The Gairdner River, together with smaller drainage channels, have their seawards ends effectively blocked by sand. The Gordon Inlet is the drowned mouth of the Gairdner River—a feature common to south coast rivers. The river shows a well-defined meander belt together with some spectacular river cliffs of a cherty sandstone (Tertiary) at Qualup Homestead.

Despite the zone of sand dunes, bedrock is to be seen occasionally. The main lithological elements are as follows:—

I.—Hood Point and Fishery Cove Area.

Forming the Point and extending northwards to the Cove is an injection gneiss complex. Pegmatitic phases were present but scarce. Some drag-folding was noted and the regional strike was 70° Mag. A dip of 30° at 340° Mag. was deduced from the drag-folding which had a northerly pitch. It is to this injection gneiss that the provenance of such content of economic mineral in the sands is ascribed—the economic minerals being ilmenite, rutile and zircon.

II.—Central Portion of the Beach.

North and south of the Gairdner River outcrops of Tertiary limestones occur and form the pavement upon which the beach rests. Inland these limestones may sometimes be seen at the base of the dunes. They make no contribution to any economic value of the beach sands.

III.—Point Ann.

Point Ann and approximately 3 miles south show quartzites of the Mount Barren Series and, having no economic import, need no further mention.

The beach is divisible into three portions, two of which contain economic mineral.

(1) That exposed between tide marks. This has an average width of 50 ft., slopes seawards at 3 degrees, and has an average depth to bed-rock or water-level of 3½ ft. It is in this portion that economic mineral concentration, such as it is, occurs. Over very limited sections a 6 inch berm occurs at high water mark. This berm may show thin lenses of black sand—average thickness of individual lenses is of the order of 0.1 inches. Away from the berm, where developed, the sand may show black sand concentrations in the swash marks and slight concentrations may occur in depth. Values invariably terminate at water-level. In general, the colour of samples taken was pale grey—indicative of poverty of economic tenor.

(2) A seaward zone approximately 250 yards wide below low-water mark at which point the beach appeared to shelve steeply.

(3) A "fossil" beach zone at the base of the sand dunes. This zone was investigated as far as time and equipment permitted. It appeared to have an approximate width of 4 chains from high-water mark and to be confined to hollows in the surface of the bedrock. Horizontal continuity of this "fossil" beach over any distance did not appear probable. Concentration of economic minerals in this "fossil" beach were low in value and patchy in distribution.

Water Supplies.

At the time of inspection pools in the Gairdner River were too saline for domestic use. Domestic water supplies were confined to—

(i) Roof catchments at Qualup and Doubtful Island Bay Homesteads.

(ii) A shallow well, attributed to Matthew Flinders, in the sand dunes at Doubtful Island Bay Homestead. The well requires reconditioning but supplies some 10 people, at present, with brackish water.

(iii) Shallow wells in the coastal dunes should yield small supplies of brackish but potable water.

Sampling.

Sampling was carried out on a reconnaissance basis and was done by post-hole auger; the holes being taken to bedrock, water-level, or the available length of the auger extensions (in the case of the fixed dunes). In view of the beach being periodically stripped during storms, sampling results are only applicable to the date of sampling. This is borne out by comparison of the present results with those of 1947.

Reference may be made to Appendix I for results of this sampling.

Market Values.

Summary Reports 1 and 2 (1945) published by the Commonwealth Department of Supply and Shipping state:—

(a) Zircon Rutile Limited quote separated rutile, 95 to 97 per cent., guaranteed 92 per cent. TiO_2 at £36 per ton F.o.b. works Byron Bay in lots of 5 tons or more.

(b) Actarc Welding Processes have been selling rutile other than in small parcels for £40 per ton in Melbourne and ilmenite at £3 10s. per ton. Mixed zircon-rutile-ilmenite concentrates are sold at prices varying according to the rutile content, usually £7 10s. to £8 10s. per ton, and zircon-rutile concentrates at £11 4s. to £12 5s. per ton.

(c) Zircon Rutile Limited have supplied most of the Australian market for separated zircon—price £7 10s. per ton F.o.b. Byron Bay for lots of 10 tons or over.

(d) Actarc Welding Processes quote for separated zircon, other than in small parcels, £8 per ton in Melbourne.

(e) The selling price of unseparated products has varied according to composition and market conditions. Prices received for export during 1944 were usually £7 10s. to £8 10s. per ton for mixed zircon-rutile-ilmenite concentrates and £11 5s. to £12 5s. for zircon-rutile concentrates (50-55 per cent. zircon).

(f) The Australian Mineral Industry, Vol. 1, No. 3, 1948. Published by the Department of Supply and Development. Selling prices quoted by Zircon Rutile Limited, for rutile

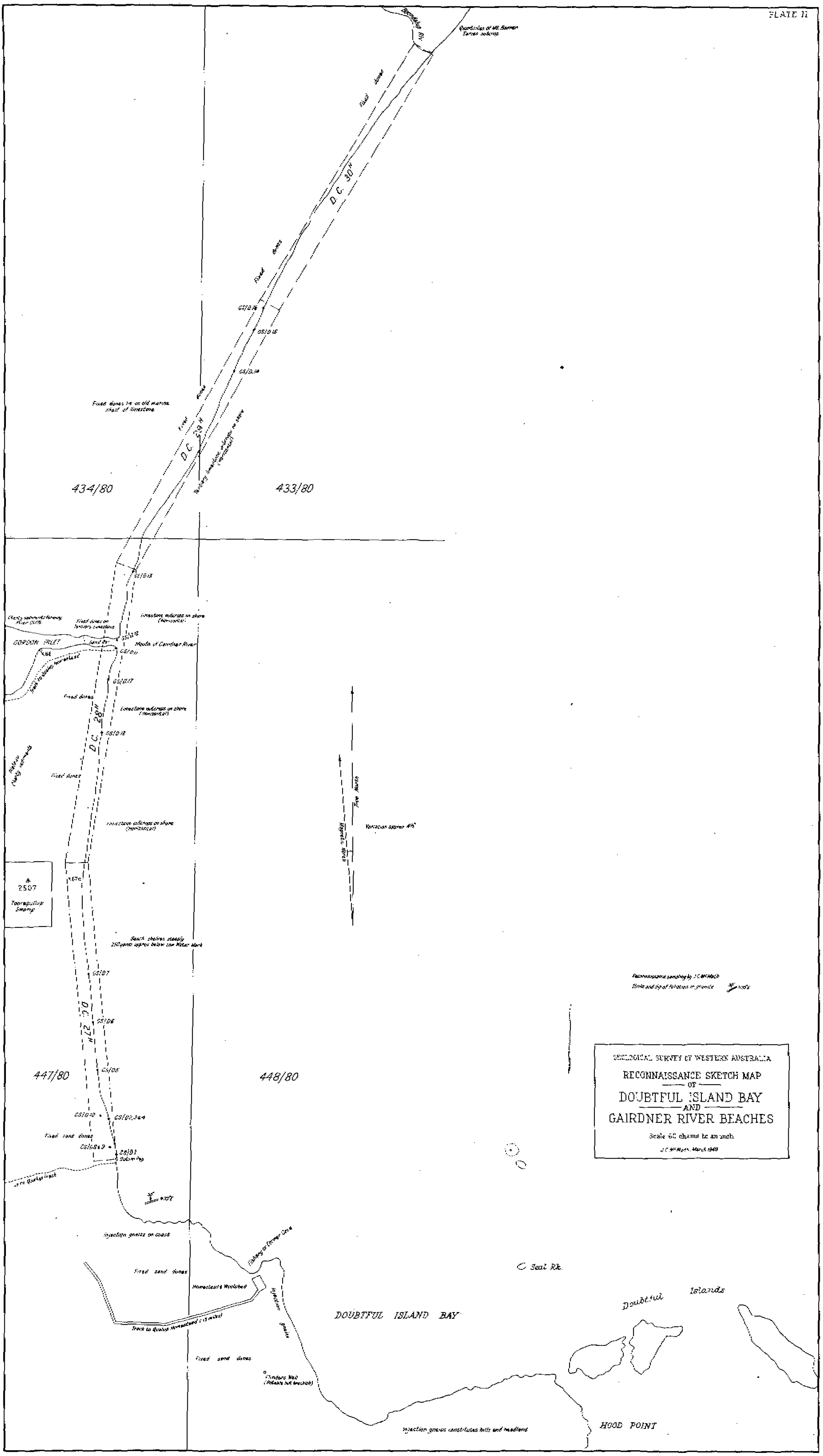


PLATE II
D.C. 30H
D.C. 29H
D.C. 28H
D.C. 27H
434/80
433/80
447/80
448/80
GORDON INLET
2507
True North
Magnetic North
GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
RECONNAISSANCE SKETCH MAP
OF
DOUBTFUL ISLAND BAY
AND
GAIRDNER RIVER BEACHES
Scale 60 chains to an inch
Seal Rk.
Doubtful Islands
DOUBTFUL ISLAND BAY
HOOD POINT

(95 per cent. concentrates) £20 per ton f.o.r. works Byron Bay and zircon (99 per cent. concentrates) at £10 per ton F.o.r. works Byron Bays.

For further details reference may be made to these publications.

Conclusions.

(1) That two main elements exist:—

(a) The present beach between tide-marks. The economic mineral content is low and liable to fluctuate during stripping and replacement by storms. The author is of the opinion that no very great increase in tenor can be expected at any time and that, in any case, these concentrations are a wasting asset.

(b) The "fossil" beach. An average lower tenor than that of the present sea-beach is indicated by samples. It is anticipated that detailed work would show this "fossil" beach to be present only in pockets on the erosion surface of the bed-rock. The economic value is considered negligible.

(2) In view of the low tenor of the beach, the sand dunes, which derive from the beach, are considered negligible.

(3) The only assessable quantities of economic mineral are confined to the sea-beach—a general order of magnitude, based upon samples, is:—

(a) Ilmenite, 317 lb. per cubic yard.
Rutile, 80 lb. per cubic yard.
Zircon, 180 lb. per cubic yard.

(b) Available cubic yards of sand is of the order of 170,000—i.e., 366,000 tons of natural concentrates of the tenor cited above of which 80 per cent. are considered recoverable.

(4) That considerable beneficiation would be required to produce a marketable concentrate.

(5) That the deposit cannot be considered as likely to prove an economic proposition.

APPENDIX I.

REPORT ON EIGHTEEN SAMPLES FOR THE GOVERNMENT GEOLOGIST, PERTH.

Doubtful Island Bay Sands.

Lab. No.	1862	1863	1864	1865	1866	1867	1868	1869	1870	1871	1872	1873	1874	1875	1876	1877	1878	1879
GS/D/No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	approximate percentages																	
Ilmenite	7	1	3	11	2	1	2	s	tr.	v.s.	2	3	5	8	10	7	1	4
Zircon	1	s	1	3	s	v.s.	s	tr.	tr.	tr.	s	2	2	4	2	2	s	1
Rutile	s	v.s.	v.s.	1	tr.	v.s.	tr.	tr.	tr.	tr.	tr.	tr.	v.s.	s	1	s	tr.	s

s = small amount, approx. 0·5 per cent. v.s. = very small amount, approx. 0·1 per cent.

Lab. No. 1871, GS/D/10/D.

The mechanical composition of this sand is typical of a beach sand and the presence of one or two per cent. of organic matter, diatoms and sponge spicules suggests that the sand has been deposited in a swampy environment into which it was carried from a nearby beach.

C. R. LEMESURIER,
Deputy Government Mineralogist.

REPORT ON TOWER HILL LEASES
Gwalia-Mt. Margaret G.F.

By J. C. McMath, B.Sc. (Hons. Lond.), F.G.S., M. Aust. I.M.M.

1.—Ref. Map.

Lands Department 136/80.

2.—Location.

Tower Hill lies some 60 chains due west of Mount Leonora and is readily accessible from the Leonora-Gwalia road.

3.—Geology.

Tower Hill consists of a low ridge parallel to the Leonora-Gwalia ridge and is made up of hornblende and chlorite schists together with quartz-sericite schists. The latter may be of sedimentary origin. The schists strike a few degrees west of north and have a variable (though usually high) easterly dip. These schists have been intruded parallel to strike and dip by quartz reefs (apparently lenticular in nature) which have been auriferous. Later epidioritic intrusions (noted in dumps) occur; also a small granite porphyry intrusion. The complex is Pre-Cambrian in age.

4.—Production and History.

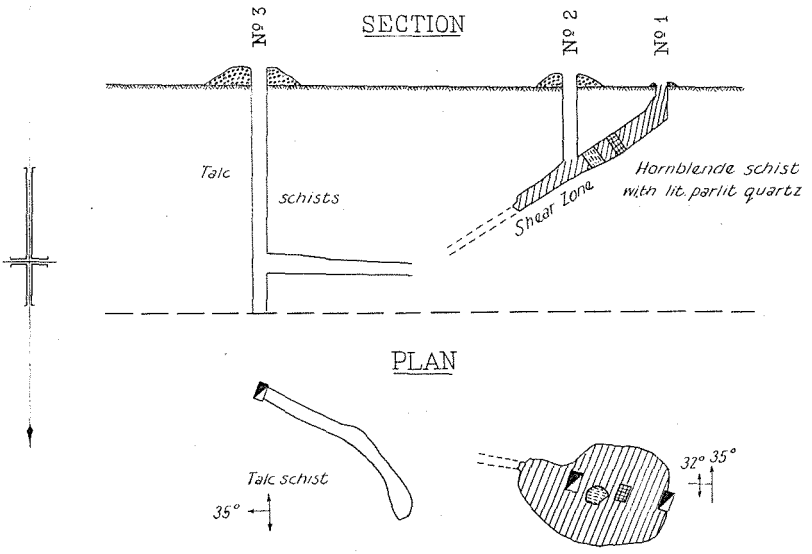
The hill has been exploited intermittently since 1899 on both a company basis and small "show" basis. Its history is evident from the following production figures:—

Date.	Lessee and/or Company.	Leases.	Ore Treated. Long tons.	Gold therefrom. Fine ozs.	Grade. Fine ozs. dwts.
1899 to 1904	Octagon Explorers, Ltd.	218c, 219c	5,000·0	1,569·68	6·26
1905 to 1908	Gt. Tower Hill G.M's., Ltd.	do.	62,255·0	20,034·56	6·42
1910 to 1911	Gwalia Proprietary, Ltd.	do.	244·0	111·12	9·1
1914 to 1915	Leonora Proprietary, Ltd.	1479c, 1480c (218c, 219c)	1,185·0	298·76	5·0
1915 to 1916	Lloyd George G.M.	do.	600·0	154·82	5·16
1933 to 1946	Leased to M. Flynn (deceased)	Leases becomes 1557c	526·55	125·81	4·7
1947 to 1949	H. Greyman	do.	104·5	19·63	3·7
1949	Girogi & Bowne Surrendered 20/8/49	do.	33·0	5·66	3·4

From the above figures some 69,948 long tons of ore have been treated for a recovery of 22,320 fine ounces of gold—an overall grade of 6.36 dwts.

Tower Hill Gold Mines, Ltd., in the period 1905-1908 carried the main shaft to 300 feet. Three levels were operated. A block of low grade ore (approx. 4 dwt. grade) remains unstoped in the bottom level. The Company put down 6 inclined bores along the strike of the reef to cut the reef at 250 feet. The results of the intersections are not known.

PLATE III



REFERENCE TO SIGNS

Pigsty
Pillar
Stoping

PLAN AND SECTION

OF

G.M.L. 1829c "JESSIE ALMA"

GWALIA

MT MARGARET G.F.

Scale 60 feet - 1 inch

Survey as at 31.7.49 by courtesy Sons of Gwalia G.M.

Geology by, J.C. Mc Math. B.Sc. July 1949.

5.—Conclusions.

The history and production of the leases show:—

(a) the former existence of a low grade ore body—repetitions may occur along the strike or in depth. To judge from the bottom level of the Tower Hill G.M. no better values could be anticipated;

(b) that, under prevailing economic conditions, no useful purpose would be served by exploration in depth by drilling or otherwise;

(c) history since 1933 suggests that "gouging" of the workings may result in small low grade crushings.

6.—Inspection.

29-31 July, 1949.

REPORT ON G.M.L. 1829c, "JESSIE ALMA," GWALIA AND ADJACENT LEASES OR P.A.'s MT. MARGARET G.F.

By J. C. McMath, B.Sc. (Hons. Lond.), F.G.S., M. Aust. I.M.M.

1.—Ref. Map.

Lands Department 136/80.

2.—Location and Access.

G.M.L. 1829c and adjacent leases or P.A.'s are situated some 25 chains due west of Gwalia Railway Station. They are accessible via the Recreation Ground track from the station.

3.—Title.

The title of G.M.L. 1829c is vested in Messrs. J. Goss and G. A. Mazza. At the date of inspection (31/7/49) various interests, working or sleeping, in the lease were held by a syndicate of seven.

4.—General.

The "Jessie Alma" was found in January, 1949, by Messrs. Goss & Mazza consequent upon loaming. The workings, from which spectacular specimen gold has been taken, lie in the oxidised zone. Subsequent to the "find" P.A.'s have been taken out surrounding the "Jessie Alma." Prospecting operations upon these P.A.'s have been neither remarkable in quality nor quantity. Since the surface features of these holdings add little or nothing to the geology of G.M.L. 1829c, they will only be mentioned further under prospecting recommendations.

5.—Geology.

I—General—

The area under discussion lies in a soil covered flat between the southern end of Tower Hill on the west and the Leonora-Gwalia ridge on the east. Tower Hill is comprised of hornblende and chlorite schists together with quartz-sericite schists which, from their appearance and field occurrence, may be meta-sediments. The general strike of schistosity is a few degrees west of north together with a variable (though usually high) easterly dip. Massive quartz reefs occur parallel to the schistosity and dip. The Leonora-Gwalia ridge consists of the above-mentioned rock types together with andalusite—quartz schists. Banded ferruginous quartz (?Jaspilite) forms a prominent feature of this ridge and extends from Gwalia in the south to north of Mt. George. This ferruginous quartz has the regional strike and dip.

These rocks have been intruded by later epidioritic bodies, the whole complex being Pre-Cambrian in age.

II.—G.M.L. 1829c, "Jessie Alma"—

The salient features of the lease are as follows:—

(a) The lease comprises flat soil covered terrain liable to sheet flooding. A small creek drains southwards through the lease and adjacent to the workings.

(b) No outcrops occur but sundry work suggests an average depth of overburden of 3 to 4 feet in thickness, though this may be exceeded in places.

(c) The workings expose oxidised meta-sedimentary schists on the west succeeded, in the eastern shaft, by green blocky talcose schists. The relation between these types was not seen.

(d) The meta-sedimentary schists strike a few degrees west of north and have an easterly dip of 35° which flattens in depth to 32°. Two sets of joints were noted, the first at 140° mag. and the second at 50° mag. Joint dips were vertical.

(e) The schist planes of the meta-sediments carry narrow films of quartz which pinch and swell both along the strike and down the dip, i.e., they are small dilation veins.

(f) A shear zone some 5-6 feet in width occurs parallel to the strike and dip of the meta-sedimentary schists. The zone material is much weathered and carries dilation veins of quartz (which may be ferruginous). As far as seen these veins tended to favour the stratigraphic footwall. It was from this shear and its quartz veins that the the somewhat spectacular specimen gold was obtained—as are also the present values.

(g) The distribution of values in detail was not apparent, no sampling or assay data being available. Such evidence as was available, together with information given by Messrs. Goss & Mazza, suggested that the values had a plunge a few degrees north of east.

(h) Exposures are confined to the underlay shaft and a small stope—consequently structural data are insufficient to obtain an accurate idea of controls of mineralisation or the characteristics of the shear zone. Such evidence as is available gives the impression that the shear zone is flexured in two directions—in the direction of the dip and approximately at right angles to the strike. Schistosity and joints suggest that the underlay shaft is on the axis of a minor anticlinal flexure in the latter direction. Information given by the leaseholders suggests that the chief values, now stoped out, occurred on this axis, i.e., there is a small ore shoot with a plunge slightly north of east.

(i) There is no information as to the nature of the values below water-level as yet.

6.—The Workings.

(Reference plate III.)

(a) No. 1 Shaft—shallow and vertical; intersects shear zone at 12 feet, from whence underlay shaft follows shear zone.

(b) No. 2 Shaft—shallow and vertical; intersects shear zone at 30 feet approximately.

(c) No. 3 Shaft—vertical—75 feet deep. Is being sunk to intersect shear zone at about 100 feet. A cross-cut has been put out at 65 feet to cut shear zone. It is not yet complete.

(d) The shear zone between shafts 1 and 2 has been stoped out.

(e) Apart from No. 3 shaft and crosscut, work has been confined to "keeping on gold."

(f) Water-level is about 65 feet.

7.—Plant on Lease.

(a) one small Malloch safety winch.

(b) one 4½ h.p. 4-inch pump, delivering 600 gallons per hour. Four hours pumping daily is necessary at present.

8.—Production.

Date.	Dollied Specimen.	Ore Treated.	Gold therefrom.	Grade per ton.
	Fine oz.	Long tons.	Fine oz.	Fine oz.
1949—				
Jan.	118·32	42	520·91	12·40
Feb.	....	49	220·98	4·50
March	....	92	123·41	1·34
April	....	74	212·88	2·88
May	....	42	83·27	1·98
	118·32	299	1,165·45	Overall Av. 3·827

9.—Conclusions.

Such geological fact as is available coupled with production figures (entirely from the zone of oxidation) indicate that development work is merited to determine—

(i) the more precise structural character of the shear zone both along the strike and in depth and the distribution of values therein;

(ii) the persistency of economic values below the zone of oxidation.

10.—Recommendations.

To obtain the information required the following work is considered the necessary minimum:—

(a) The shear zone should be opened up along the strike approximately 50 feet north and south of No. 1 Shaft if this is done by open cutting—or by the same amount of driving from No. 2 Shaft. It is essential that the drives or open cuts be properly sampled and records kept.

(b) The underlay shaft should be properly sampled and records kept.

This information is considered necessary, before any further work in connection with No. 3 Shaft is done, in order that the possibilities of the "show" may be more accurately appreciated and, if the results warrant, further development work in depth may be most efficiently laid out.

11.—Associated P.A.'s.

The adjacent prospecting areas are also soil covered. Transit of ore over this area in past years may possibly have resulted in a certain amount of "salting" of the area. The possibilities of ore occurrence are related to—

(a) north-south extensions of the "Jessie Alma" shear zone;

(b) shear zones parallel and possibly echeloned to that of the "Jessie Alma." Accordingly the area should be closely grid loamed, perferably and most easily by post-hole auger, and costeaned at any zone of values so located.

12.—Diamond Drilling.

(a) G.M.L. 1829c "Jessie Alma."—Until work of the nature suggested has been carried out and, if warranted by results, some further development has been done, there are no sound data upon which to base a shallow drilling programme —any such drilling undertaken at the present juncture would be merely "wild catting," expensive, unsatisfactory from the core recovery aspect, and probably abortive in results.

(b) Adjacent P.A's.—Is at the present juncture, unnecessary—cheaper, quicker, and more satisfactory methods of exploration have been indicated.

13.—Date of Inspection.

30-31 July, 1949.

NOTES ON THE HORSESHOE RANGE MANGANESE ORES.

Peak Hill Goldfield.

By J. C. McMath, B.Sc. (Hons. Lond.), F.G.S., M. Aust. I.M.M.

Location.

The Horseshoe Range, together with the abandoned townsite of Horseshoe, is located in 25°27′ S. Lat., 118°33′ E. Long. approximately.

Reference Maps.

(a) L.O. 72/300 of 1937.
(b) Sheet 1178—Peak Hill—Military 1″ = 8 miles Series.

Access.

Railhead is Meekatharra; thence 70 miles by good (in dry weather) gravel road to Peak Hill, form which the Horseshoe Range lies 16 miles N.W. by gravel road. Distance from railhead is 86 miles.

Existing Mineral Claims.

24P — 26P — 28P — 32P — 33P — 36P.
Their disposition is shown on the attached sketch. Plate IV.

Basic Literature.

(a) Mines Dept. of W.A., 1920—"Report on the Manganese Deposits at Horseshoe Range, Peak Hill Goldfield"—A. Montgomery, State Mining Engineer.

(b) An. Prog. Rept. Mines Dept. of W.A., 1929 —"Report on the Horseshoe Manganese Deposit" —T. Blatchford.

Physiography.

The Range takes its name from its arcuate shape and is concave westwards. It lies as an erosion residual on the "Old Plateau" of Jutson (Bull. 95, G.S.W.A.). Mt. Beasley, at the northern end of the range is the highest point, being approximately 2,600 feet above mean sea level.

Drainage is seasonal and ephemeral. At the time of inspection 125 points of rain in 36 hours caused creeks to run. The Range forms portion of the watershed between the Gascoyne and Murchison Rivers. On the eastern side of the Range, drainage is towards the Gascoyne River; on the west, towards the Murchison River. Existing wells in the area suggest that the water-table lies between 90′ and 150′.

A series of "breakaways" flank and abut the north-western side of the Range and define the "Old Plateau" above which the Range rises. These "breakaways" are well dissected; butte and mesa forms were noted; they are absent from the eastern side of the Range. The rocks comprising the "breakaways" are deeply lateritised, though original structures may not be entirely obliterated.

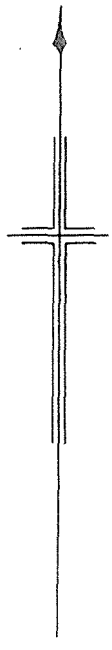
Lithology.

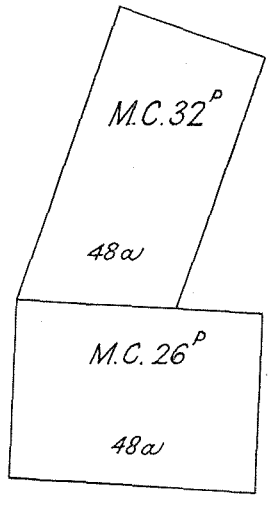
The Range consists of a series of metamorphosed sedimentary rocks (Mosquito Creek Series) which are cut by subsequent quartzose minor intrusives (principally quartz veins). These rocks include phyllites, black slates, amphibolitic schists, and banded cherts or quartzites. A hard, fine grained, blue-grey quartzite occurs at the base of the Range on the eastern side.

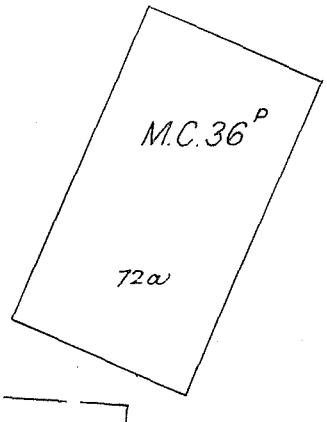
The rocks are deeply weathered with the production of ferruginous by-products and staining with manganese oxides. The slates and banded cherts appear, in the field, to carry a small original manganese content.

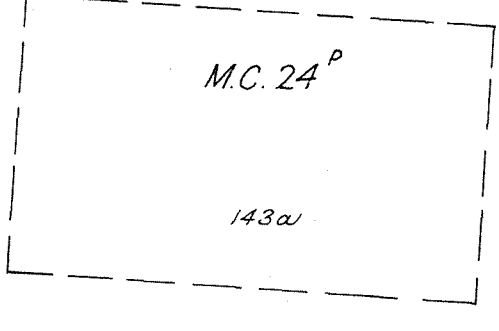
Structure.

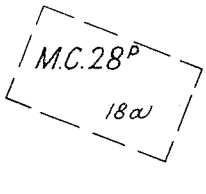
Mining Claim 24P lies approximately at the centre of concavity of the Range. North of this point the strike of regional schistosity is approximately N.25°E.—southwards the strike swings to approximately S.45°E. Dips are high and westerly.











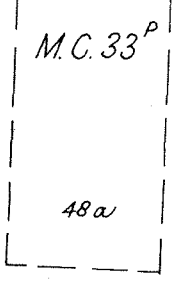
LOCALITY PLAN

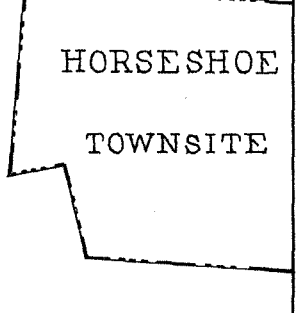
MINERAL CLAIMS FOR MANGANESE

HORSESHOE

PEAK HILL G. F.

Scale 20 chains to an inch





On the eastern face of the Range a series of subsidiary asymmetrical folds is to be seen. The axis of concavity of the Range is east-west, a direction to which the axes of the subsidiary folds approximate.

Thus two fold systems are seen:—

(a) Regional folding of approximate north-south trend. Lithology and structure at the Horseshoe Lights Gold Mine (10 miles east of the Range, and lying in the east-west axial zone of concavity) suggest that the Range may be the left limb of a regional anticlinorium.

(b) "Crossfolding" of east-west axial trend.

The Range would appear to consist of the nose of a west plunging anticlinorial "crossfold" with subsidiary folding on the flanks. Considerations of symmetry suggest that Peak Hill itself may lie in or on a synclinorial major "crossfold". The occurrence of gold and its distribution in the Horseshoe area suggests that this "crossfold" system may exercise some control of ore deposition —the axial zone lying between M.C. 24P and the Horseshoe Lights Gold Mine being of particular exploratory interest.

There is some suggestion that the major drainage features have undergone some degree of control by geological structure.

The Manganese Deposits.

The deposits lie on the north-western side of the Range and have their maximum development on the heavily lateritised "breakaways" which abut the Range. The grade diminishes as the higher slopes of the range are approached. The salient features of these deposits have been adequately recorded by Montgomery and Blatchford. They are essentially manganese gossans whose longer axes are east-west. They appear to be formed where "Crossfolding" has brought up manganiferous meta-sediments within the zone of oxidation. Thus the deposits are purely secondary in origin and very limited in depth. The manganese takes the form of pyrolusite, psilomelane and other hydrated oxides. Several such gossans exist, the chief one (under active exploitation) being contained in M.C. 24P.

Ore Reserves and Grade.

Estimates of reserves and tenor must be based upon adequate sampling data. Such work was outside the terms of reference of the inspection and is the concern of lease holders—or those interested in options.

The deposit contained by M.C. 24P, termed the "Southern Ore Body" by Montgomery, was partially systematically grid-sampled by Blatchford in 1929 and partial estimates of ore and tenor were made. These estimates are here reproduced in condensed form:—

Grade.	Tons.	Mn.	MnO_2.	Fe.	SiO_2.	Waste.
Over 50%	81,000	50·7	73·3	6·3	0·98	12·3
45%—50%	55,000	46·4	69·8	9·7	1·4	15·2
40%—45%	66,000	42·0	....	14·4	2·4	34·5

The first two categories are at present marketable as metallurgical ore. It is anticipated that the other ore-bodies may have a like tenor though adequate sampling is necessary to confirm this and to compute reserves. No obvious chemical ore was noted though, doubtless, sampling and selective mining might produce small parcels.

The Workings.

M.C. 24P is being exploited by Westralian Ores, Ltd., of Perth. It was understood, from the local manager, that Messrs. Bell Bros., of Guildford, hold a substantial interest in this venture. Quarrying methods are employed. The present face has the following approximate dimensions:—Length, 50ft.; breadth, 25ft.; depth, 15ft. From this face a grade of 50 per cent. Mn. is being obtained. This grade of ore has a maximum thickness of 21ft. in an adjacent sample pit.

Ore Reserves.

Those of Blatchford appear to have been accepted by the operators.

Plant.

The following plant is in operation upon the property:—

1 ¾yd. mechanical navvy.
1 1yd. dumper.
1 stationary 200 cubic feet compressor.
1 portable 100 cubic feet compressor.
1 grader (road maintenance).

Labour.

One local working manager and five others.

Production.

To the end of November, 1949, production has been 1,000 tons of 50 per cent. grade ore per month. This figure has now been stepped up to 1,500 tons per month.

Production Costs.

(a) To end of June, 1949—25s. per ton.
(b) August to October, 1949—10s. per ton.

Transport of Ore to Railhead.

Transport is by road to railhead (Meekatharra). Cartage contractors are Bell Bros. of Guildford. Eight diesel trucks are operated which, with trailers, move 20 tons each. Cost of cartage is 7d. per ton mile. Small contractors' cartage charge is said to be 9d. per ton mile.

Rail Charges.

W.A.G.R. freight schedule M is applied to manganese ore. The schedule operates as follows:—

M = 47s. 6d. per ton for first 100 miles.
100-250 miles = M—12½ per cent.
250 miles or over = M—25 per cent.

The schedule applies to parcels of 6 tons or more. Thus from Meekatharra to Fremantle or Geraldton the schedule is equivalent to 0.78d. per ton mile.

Cost F.O.B. port.

	Distance.	Rate.	Cost per ton.
			£ s. d.
Mine-Railhead	86 miles	7d.	2 10 2
Railhead-Geraldton	333 miles	0·78d.	1 1 8
Railhead-Fremantle	612 miles	0·78d.	2 0 0

Cost of mining is 10s. per ton,—hence total cost:—

(a) Geraldton is £4 1s. 0d. per ton.
(b) Fremantle is £5 0s. 2d. per ton.

Price obtained for 50 per cent. Grade Ore.

No figures were obtained from the local manager as to price realised for this grade of ore. To the above costs must be added:—

(a) Perth Office Administration charges.
(b) Amortisation charges.
(c) Taxation.

The capitalisation of the company is un-ascertained.

Some idea of the value at Geraldton can be gained from the October 1949 production of the Broken Hill Proprietary leases at Mt. Fraser (not visited by reason of time and weather). Production was 864 tons of 48 per cent. grade ore valued at £4,542 f.o.b. Geraldton—i.e. £5 7s. 0d. per ton.

Marketing.

The total production of M.C. 24P—1,500 tons per month—is taken by Broken Hill Proprietary for their Newcastle works. It is understood that Westeralian Ores Ltd. have an American contract for 15,000 tons per year in view, contingent upon the lifting of the export embargo on manganese ores.

Life of Ore body.

Based upon Blatchford's estimates and current production rate:—

Grade 50 per cent. or over—approximately 6 years.

Grade 45 per cent. to 50 per cent.—approximately 3½ years.

Water Supplies.

Domestic water is drawn from Craig's Well 6 miles north of M.C. 24P. Horseshoe Lights Gold Mine also draws from this source. No data are available but the supply is adequate at the present moment. Other wells available in the area are:—

Name.	Depth.	Water Level.	Capacity.
Horseshoe No. 1	150 ft.	140 ft.	10 g.p.h.
Horseshoe No. 2	101 ft.	....	....
Stink Well	109 ft.	12 ft.	....

The present condition of these wells is unascertained. It is considered that a domestic water supply could be obtained within a mile and a half of M.C. 24P.

Acknowledgments.

Operational data re M.C. 24P. by courtesy of manager, Mr. Davy. Other data are from official sources.

Summary.

The Horseshoe manganese deposits lie 86 miles north of Meekatharra (railhead). Shipment ports are Geraldton and Fremantle. The ore bodies consist of gossans formed where manganiferous metasediments have been brought within the zone of oxidation (? past or present) by erosion of "crossfold" structures. M.C. 24P. is the only lease under active exploitation. A monthly production of 1,500 tons 50 per cent. grade ore is being obtained. Production costs and freight give a value to this ore of £4 1s. 10d. and £5 0s. 2d. per ton at Geraldton and Fremantle respectively.

PETROLEUM POSSIBILITIES ON LOCATION 2805, PLANTAGENET DISTRICT SOUTH WEST DIVISION.

By J. H. Lord, B.Sc., F.G.S.

As a result of an urgent request from the Honourable the Minister for Industrial Development (Mr. A. F. Watts) the above location, in his electorate, situated approximately 10 miles North-West of the Mt. Barker townsite, was visited on March 28th, 1949. The owner, Mr. Arthur R. Carr, was interviewed.

For the accumulation of petroleum the following essentials are required:—

(a) Source.—There must be the correct type and sufficient quantity of source rocks present to produce the petroleum.

(b) Storage.—There must be the correct type of rocks present to store the petroleum.

(c) Structure.—The storage rocks must be arranged in a suitable manner to allow the petroleum to accumulate.

None of these requirements were found on or in the vicinity of Location 2805.

The area composed of Pre-Cambrian crystalline rocks (universally recognised as non-petroliferous) with shallow layers of Plantagenet or Tertiary sediments, overlying them in the gullies.

Mr. Carr stated that he had found no surface indications of petroleum. However, he proceeded to locate underground pools of petroleum and gas by divining. One pool extends over weathered granite. He can also obtain the same results without using a rod, and claims success at divining water and gold. Since geologists do not subscribe to this magical practice of divining, this evidence of Mr. Carr's cannot be accepted as proof of the existence of petroleum in preference to the solid geological evidence observed.

Petroleum Possiblities—NIL.

WATER PROSPECTS AT BINDOON BOYS' TOWN, BINDOON.

By J. H. Lord, B.Sc., F.G.S.

This property, which is on the Northern side of Bindoon Hill about 56 miles from Perth on the main Perth to Geraldton road, was inspected by the Government Geologist in February, 1948, with the object of ascertaining if underground potable water, in sufficient quantity to supply the needs of Boys' Town was available anywhere on the property. An area in the valley, which extends south-eastwards for some 2½ miles from the Town buildings, near the Toodyay road was selected as the only area worthy of more detailed investigation.

The area was mapped and contours constructed at 5 feet intervals. There are no outcrops in the area except laterite. The widest portion of the valley, which consists of grey clay soil covered with small wattle foliage, shows signs of being very boggy in winter. On the eastern side of this portion is a soak, which even at the end of this dry summer has a depth of four feet of potable water; however there is no sign of any soakage in the centre of the valley or elsewhere. According to reports, a considerable amount of water has been drawn from this soak for road making and military purposes at various times. Moving up the valley the clay soil gives way to yellow and white sand, of recent origin probably Miocene, near the Toodyay road. Apparently this covers some 80 acres and should form a good intake area for underground water.

Six sites were laid out near the soak. At these sites holes were to be sunk with a post-hole borer to a depth of 10 to 15 feet, the object being to establish the hydraulic gradient and to determine if water in the soak had its source in the sand intake area. Unfortunately the Boys' Town authorities could not sink these holes to the required depth due to the hardness of the clay. In consequence the valuable information regarding the hydraulic gradient could not be determined.

The only recommendation which can be made now is for a boring plant to be engaged to drill holes at the three sites A, B and C, as set out on Plate V, with no guarantee of obtaining the required supply of water. The cost of boring at present (April, 1949) as quoted by the W.A. Boring Company is 15s. per foot. The holes should be abandoned at a depth of 100 feet if water has not been struck or immediately on encountering any granitic rocks.

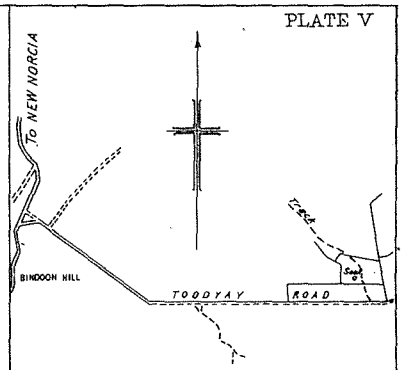
SHALLOW DRILLING ON A PORTION OF MINERAL LEASES 49 AND 50 (TEMPORARY RESERVE 1235H) AT COLLIE BURN FOR OPEN-CUT COAL.

By J. H. Lord, B.Sc., F.G.S., Geological Survey of Western Australia.

General Information.

The area, which has been investigated for open-cut coal, is a portion of Mineral Leases 49 and 50 (original numbers), on the east side of the south branch of the Collie River, opposite to the Collie Burn Townsite, as shown on Plate VI. The area has now been registered as Temporary Reserve (T.R.) 1235H.

PLATE V



—LOCALITY MAP—
—Scale 1 inch to 1 mile—

REFERENCE TO SIGNS

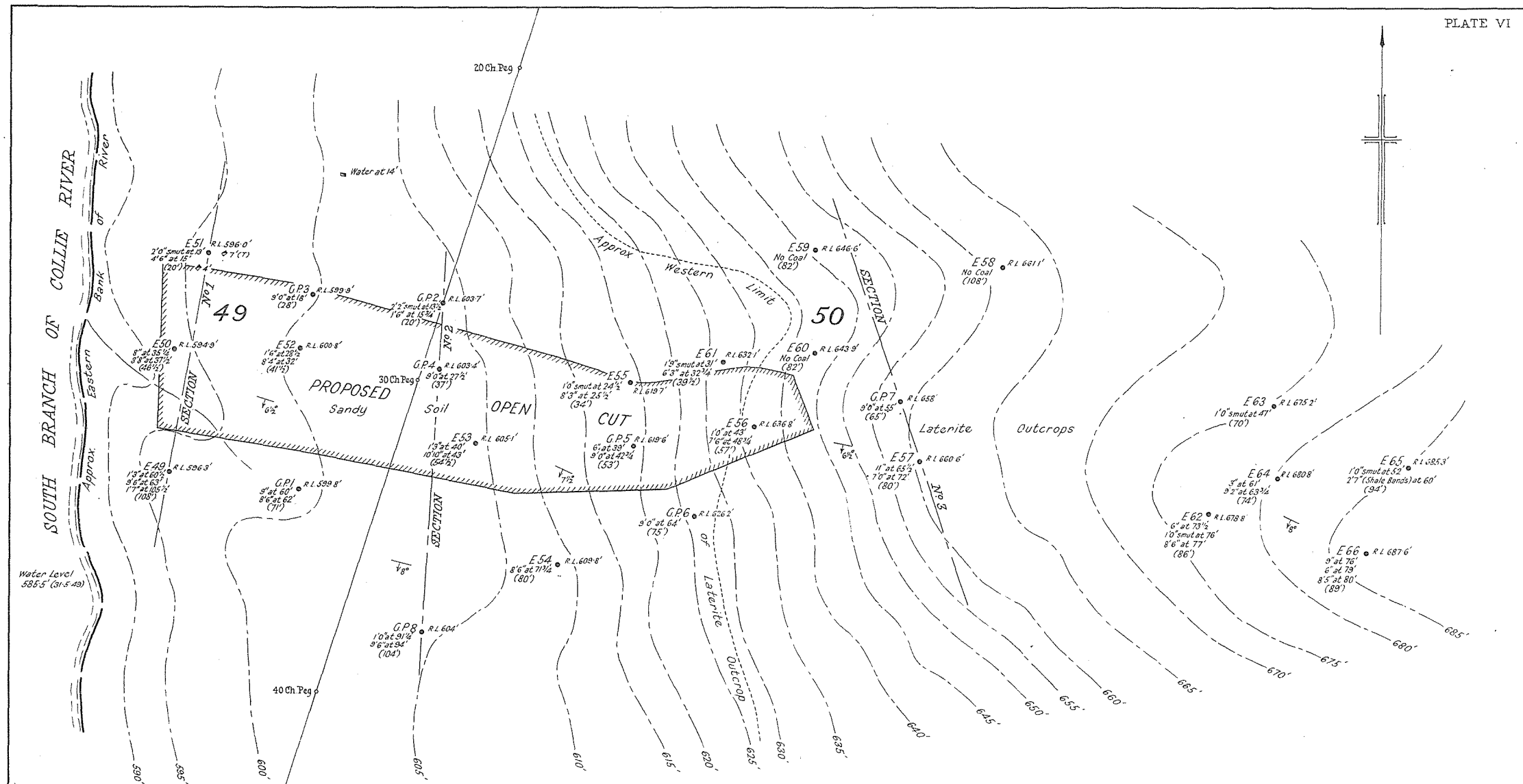
Fences (all types)
Contours 950'
Tracks
Suggested shallow holes
Suggested Bore Sites A

CONTOURED PLAN
— OF PORTION OF —
BINDOON BOYS' TOWN
SWAN LOC. 1372

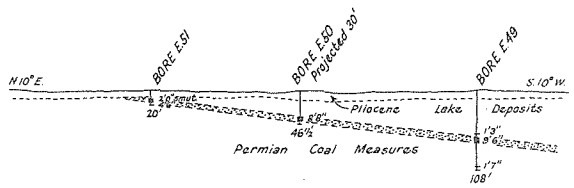
Scale 400 feet to an inch
200 0 200 400

Plane table and telescopic alidade survey by J.H. Lord, L. de la Hunty and J.S. Gleeson, Feb. 1949.

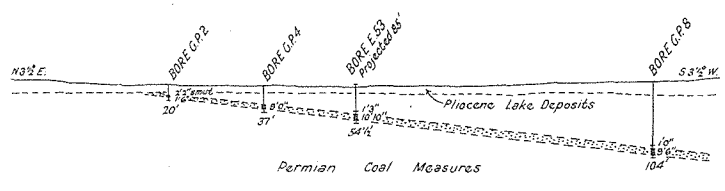
PLATE VI



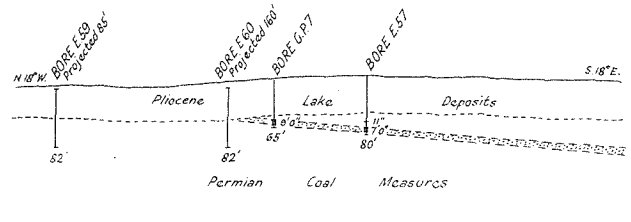
SECTION N° 1
Along Line Through Bores E.51 and E.49

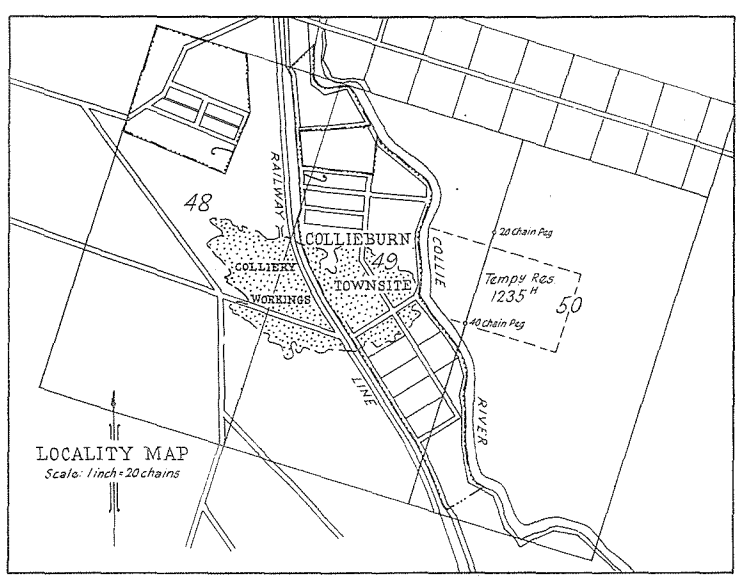


SECTION N° 2
Along Line Through Bores G.P.2 and G.P.8



SECTION N° 3
Along Line Through Bores G.P.7 and E.57





REFERENCE TO SIGNS

Borehole identification { Government Percussion Bore / Elias Hand Bore	G.P. / E.
Borehole - showing identification (G.P.3), reduced level (R.L. 599·9'), significant coal seam intersected (9'0" at 18'), and depth of borehole (28')	G.P.3 @ R.L 599·9' 9'0" at 18' (27')
Lease boundary	———
Contours (at 5' interval)	— — —
Line of Section	— ——— —
Approximate geological boundary	- - - - -
Strike and dip of coal seam from borehole data	⅓₆₀
Approximate position of coal seam in Section	
Area of Proposed Open Cut (Maximum ratio: 1 of coal to 6 of overburden)	

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

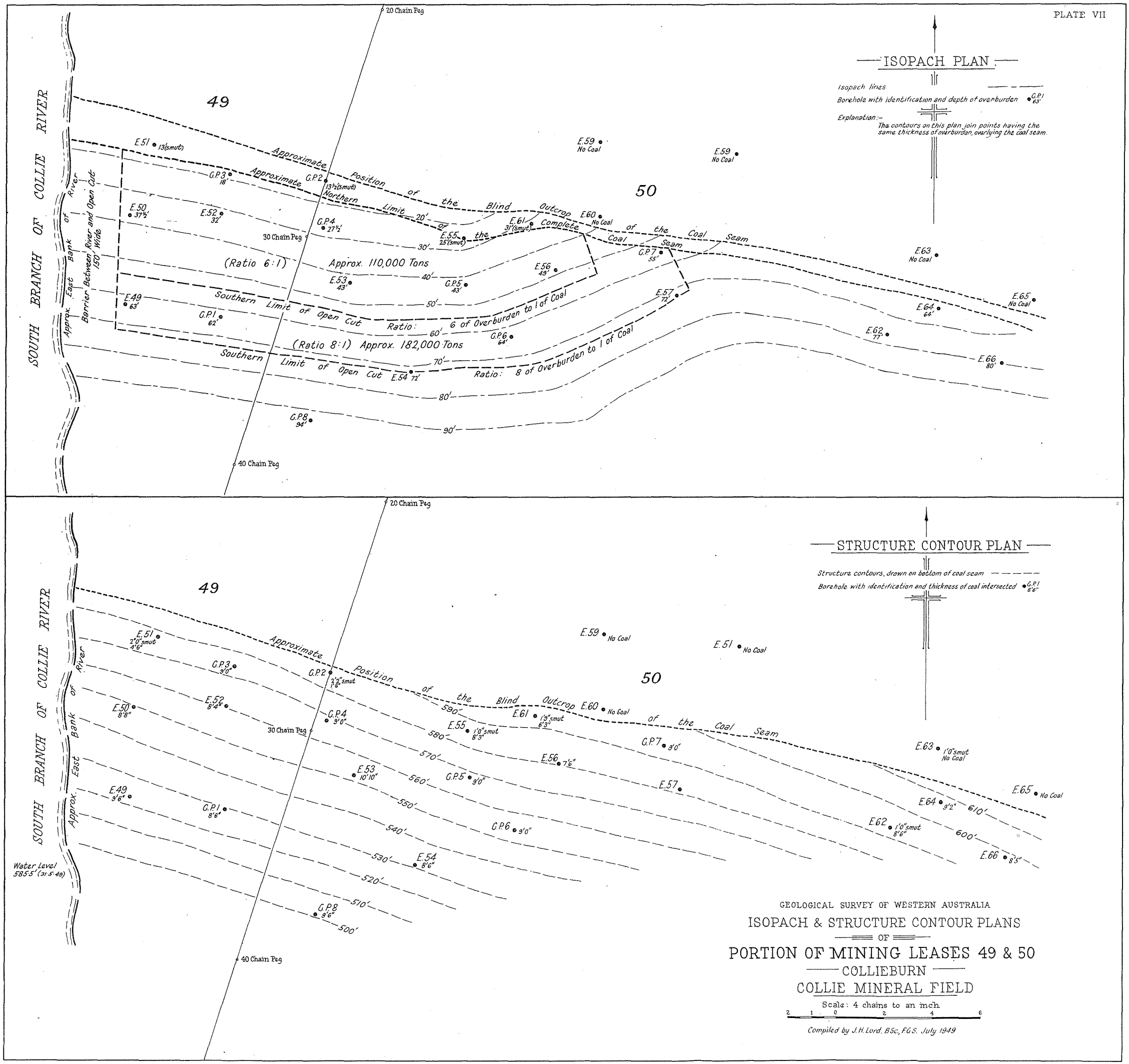
PLAN AND SECTIONS
OF
PORTION OF MINING LEASES 49 & 50
Showing Geology and Boreholes with Coal Intersected
COLLIEBURN
COLLIE MINERAL FIELD

Scale: 4 chains to an inch

2 1 0 2 4 6

Based on bore logs supplied by Amalgamated Collieries of W.A. Ltd. with additional bores by the Geological Survey of W.A.
Compiled and surveyed by J.H. Lord, B.Sc., F.G.S., July 1949

PLATE VII



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

ISOPACH & STRUCTURE CONTOUR PLANS OF PORTION OF MINING LEASES 49 & 50 COLLIEBURN COLLIE MINERAL FIELD

Scale: 4 chains to an inch

2 1 0 2 4 6

Compiled by J.H. Lord, B.Sc., F.G.S. July 1949

The only access to the T.R. is a timber track in very poor condition, which enters from the north-east. The Collie to Cardiff railroad passes approximately a quarter of a mile to the west of the river. In order to develop an open-cut on the area, it would be necessary to bridge the river and to construct a road to the railway.

The area has a moderate coverage of timber and vegetation, consisting chiefly of blackbutt, banksia, paperbark and blackboy.

This report supersedes the section of a report published in the Geological Survey's Annual Report for 1946 regarding this area.

History.

In 1897, the first bore was sunk on T.R. 1235H, namely Government Diamond Drill No. 3. Unfortunately, this hole, which was drilled to a depth of 271 feet, was located a few chains too far north to intersect the main coal seam. In 1903, the Collie Boulder Coal Co., Ltd., (afterwards the Scottish Co-operative Collieries Co. Ltd. and later the Scottish Collieries Ltd.) commenced a colliery on the opposite side of the river at Collie Burn, which worked until 1920, producing a total of 433,491 tons of coal. This company drilled a hole, known as the Collie Boulder Calyx No. 1 on T.R. 1235H, and encountered the seam, which they were mining on the opposite side of the river, at a depth of 30 feet, its thickness being 7 feet 9 inches. Other hand bores and several small shafts were sunk by the company, but no reliable records are available.

In 1946, Amalgamated Collieries of W.A. Ltd., sank 17 hand bores across Mineral Leases 49 and 50. In June, 1949, the Mines Department decided to drill the area to confirm the open-cut prospects.

Geology and Drilling Results.

Previous drilling on this area had indicated the existence of shallow coal. In consequence, the drilling programme, carried out by the Mines Department, was only to confirm its existence and to provide sufficient information for open-cut operations to proceed, when required.

Eight holes were drilled at points on a 2-chain grid, where additional holes were considered necessary. The original holes did not adhere to a grid system.

The seam examined is the No. 1 (or top) seam of the Collie Burn horizon. It is the identical seam, as worked in the Collie Burn Colliery, where the thickness averaged 9 feet, of which 8 feet were extracted, the dip of the workings being 7 degrees in the direction south 5° west. It is also considered to be the same seam as is being worked in the Wyvern Colliery still further to the west.

The coal measures in this area, like elsewhere at Collie, are covered unconformably by Pliocene lake deposits. Near the river these lake deposits are only 13 feet thick, but, eastwards as the ground surface rises, the lake deposits thicken, which is detrimental to the extension of open-cut operations in that direction (see Plate VI—sections). The surface is a grey sandy soil, which is replaced by a laterite capping as the ground rises to the east.

The coal measures, below the unconformity, are typical of the Collie Basin, consisting chiefly of soft sandstones, clayey sandstone and shales. The shales, which are confined mainly to 10-12 feet immediately above the coal seam, are overlain by clayey sandstone and loose sand.

In the holes drilled by Kent Bros. for the Mines Department with a percussion drill, the thickness of the coal seam varies from 8 feet 6 inches to 9 feet 6 inches. With this type of drill it is considered that the thickness can be determined accurately to within 3 inches. A summary of the drill logs is shown in Table 1.

TABLE I.

SUMMARY OF GOVERNMENT BORE LOGS ON T.R. 1235H.

(For Positions see Plate VI.).

Government Percussion Bore No. 1.	Reduced Level.	Depth Seam Intersected.	Thickness of Seam.	Depth of Hole.	Depth to Water.	Remarks.
	(M.S.L).	Feet.	ft. in.	Feet.	Feet.	
1	600	62	8 6	71	16	
2	604	13½	3 8 (smut and poor coal)	20	13	On the weathered blind outcrop of the seam.
3	600	18	9 0	28	10	
4	603	27½	9 0	38	24 ?	
5	620	42¾	9 0	53	24	
6	626	64½	9 0	75	30	
7	658	55	9 0	66	No water	
8	604	94	9 6	104	16	

From these and previous bores from that portion of the area suitable for open-cutting, the thickness of the coal seam is found to be 9 feet. The dip of the seam varies from 6½ to 8 degrees in a direction varying from South to South-South-West, as is shown by the structure contours (Plate VII), and appears to be uniform without any faults or rolls or a nature to affect open-cut operations.

The level at which the water stood in these holes is shown in Table 1 and it is considered that water will not hamper operations more than in other open-cuts at Collie, providing a sufficient barrier is left between the open-cut and the river.

This open-cut site is barred on the west by the river and on the east by an increase of thickness of lake deposits. To the east the seam is known to thicken to 12 feet again and there may be a possibility of locating further open-cut coal by drillng about 2 miles to the East-South-East of this area.

Quality of the Coal Seam.

Since the seam occurs in the Collie Burn (or middle) horizon of coal seams in the Collie Basin, it is "soft" coal whose coal is approximately the mean of the best and poorest coals at Collie.

The Collie Burn Colliery was sampled and analysed by I. H. Boas for the 1915 Royal Commission and the following was the average of the indivdual results:—

Proximate Analysis—

	%
Moisture	24.70
Ash	3.95
Volatiles	38.30

Calorific Values—

As received 9,354 B.Th.U.

Dry & Ash free 13,079 B.Th.U.

Ultimate Analysis—

	%
Carbon	73.3
Hydrogen	4.8
Oxygen	20.3
Nitrogen	1.47

It was shown in these analyses that the coal, occurring above a 2 inch shale band four feet from the floor, was better quality than that occurring below the band.

The coal seam was sampled in each of the bores sunk by the Mines Department. To obtain a clean sample from a percussion type drill is always difficult. In this instance the difficulty was aggravated by the existence of loose sand above the seam, which could not always be sealed off, despite the fact that the casing was seated onto the coal seam. Results of this difficulty are seen in the analyses, by the raising of the ash content and lowering of the calorific value.

The samples from Bore G.P. 6 were analysed by the West Australian Government Railways Laboratory, who removed all matter considered extraneous to the coal seam; the results are comparable with those of the Collie Burn Colliery. The dry-ash-free calorific value of the selected sample of the W.A.G.R. Laboratory compares favourably with the values obtained by the W.A. Government Chemical Laboratory on the other samples, when no extreneous matter was removed.

It is considered that the quality of the coal will be similar to that of the Collie Burn Colliery except that coal produced by open-cut methods is not usually as clean as colliery coal.

Table II sets out the details of the analyses of the coal from the bores on Temporary Reserve 1235H.

The following remark was included in the report by the Fuel Technologist of the W.A.G. Chem. Lab. (R. P. Donnelly):—"A feature of note is that all the ashes are white or faint pink and this indicates an absence of iron and probably the desirable characteristic of a high ash fusion point."

Coal Reserves.

Naturally, the coal reserves for open-cut mining vary with the depth to which the open-cut can be worked economically. At Collie the maximum ratio of overburden to coal, which has been worked, is 7½ to 1 in the Wallsend open-cut. As it is not known to what ratio this area will be worked, two cases are detailed below (a) ratio of 6 of overburden to 1 of coal and (b) ratio of 8 of overburden to 1 of coal.

As the river may cause some difficulty in operations, a 150 foot barrier has been left between the river and the proposed open-cut. It may be possible to work this barrier later.

The northern limit of the open-cut has been made at the line, which is considered to be the limit of the full thickness of the seam. Further north the coal thickness decreases as also does the quality, and is covered with smut (coal decomposed by weathering). It may be possible to win a small tonnage of coal from this area.

In all the estimates, it is assumed that the seam averages 9 feet in thickness and that 30 cubic feet of coal is equivalent to 1 ton.

The areas considered are shown on the Isopach Plan (Plate VII). This plan shows the contours joining points on the coal seam covered by equal thickness of overburden.

Ratio of 6 Overburden to 1 Coal.

Available coal = 110,000 tons.

Coal left as barrier to river = 16,000 tons.

(This compares with the estimate of 134,000 tons in the 1946 report.)

Overburden to be removed (including allowance for a 70° batter on the sides.) = 445,000 cubic yards.

Hence working to a maximum ratio of 6 to 1, an average of 4 cubic yards of overburden must be removed for each ton of coal produced.

TABLE II.

ANALYSES OF COAL FROM BORES ON T.R. 1235H, COLLIE.

Bore No. and Section Samples.	Proximate Analysis.				Calorific Value.	Calorific Value Dry Ash Free.	Sulphur.
	Moisture.	Ash.	Volatile Matter.	Fixed Carbon.			
					B.Th.U/lb.	B.Th.U/lb.	%
No. 1—							
62 –63½ ft.	20·00	3·45	30·31	46·24	9,900	12,930	0·32
63½–67½ ft.	20·00	8·65	28·84	42·51	9,210	12,900	0·32
67½–70½ ft.	20·00	12·10	27·62	40·28	8,650	12,750	0·37
Av. 62–70½ ft.	20·00	8·95	28·61	42·45	9,130	12,870	0·34
No. 3—							
18½–20 ft.	20·00	4·30	30·59	45·11	9,700	12,820	0·39
20 –24 ft.	20·00	16·54	25·93	37·53	8,170	12,860	0·35
24 –27 ft.	20·00	8·61	29·31	42·08	9,130	12,780	0·35
Av. 18½–27 ft.	20·00	11·58	29·10	40·50	8,780	12,830	0·36
No. 5—							
42¾–51¾ ft.	20·00	7·42	....	....	9,470	13,050	....
No. 6—*							
64½–68½ ft.	23·00 (20·00)	2·85 (2·95)	31·00	43·15	9,500 (9,870)	12,810	....
68½–73½ ft.	23·00 (20·00)	4·95 (5·15)	30·65	41·40	9,300 (9,660)	12,905	....
Av. 64½–73½ ft.	23·00 (20·00)	4·01 (4·17)	30·80	42·18	9,378 (9,753)	12,863	....
No. 7—							
55 –64 ft.	20·00	7·87	....	....	9,380	13,010	....
Average of All Analyses	20·00	8·00	....	....	9,300	12,925	....

* Analyst: W.A.G.Railways Laboratory, all other analysis by W. A. G. Chem. Laboratories.

Ratio of 8 Overburden to 1 Coal.

Available Coal = 182,000 tons.
Coal left as barrier to river = 23,000 tons.

Overburden to be removed (including allowance for a 70° batter on the sides) = 1,052,000 cubic yards.

Hence working to a maximum ratio of 8 to 1, an average of 5.7 cubic yards of overburden must be removed for each ton of coal produced.

Conclusions.

(1) Working to a maximum ratio of 6 of overburden to 1 of coal, there is 110,000 tons of coal available with an additional 16,000 tons if operations can be extended to the river.

(2) Working to a maximum ratio of 8 overburden to 1 of coal, there is 182,000 tons of coal available, with an additional 23,000 tons if operations can be extended to the river.

(3) The quality of the coal will be comparable with that of the closed Collie Burn (Scottish) Colliery, which was a "soft" coal with properties approximately equivalent to the mean of the best and poorest of Collie coals.

REPORT ON ASBESTOS ON P.A. 377P.P.

Six Miles South of Donnybrook.

By J. H. Lord, B.Sc., F.G.S.

As instructed, P.A. 377P.P. held by Messrs. Prowse, Norwood and Eddy was inspected on 29th August, 1949, with the two gentlemen first named. This P.A. is situated in the south-west quadrant of Location 3359, approximately 6 miles south of Donnybrook and 2½ miles west-north-west of Newlands.

2. Two small shafts are accessible. One approximately 22 feet deep, has bottomed on quartz after passing through some low-grade asbestos and mica; the other shaft about 20 feet to the south is only seven feet deep and has encountered similar low-grade material.

3. These workings are situated on a north-south belt of ultra-basic and amphibolite rocks, which has been metamorphosed to form occasional small lenses of talcose rocks containing low grade asbestos and mica. This is similar in mode of occurrence to other such minor deposits of asbestos found in the south-west of Western Australia. The mica appears to belong to the vermiculite group of micas, but when tested by heating, its property of exfoliation as compared with good vermiculite is very poor.

4. Other such small lenses of asbestos may be found along this belt of rocks but the poor quality of the asbestos precludes its being of an economic importance.

5. Two farmers, Messrs Wilkins and Mitchell, who own the property in this area and have pegged P.A's. requested advice regarding the prospects of the deposits. They were informed along the lines explained above.

REPORT ON EXAMINATION OF THE IRON DEPOSIT AT MT. DICK NEAR NORTHAM. W.A.

By J. H. Lord, B.Sc. F.G.S. and N. M. Gray, B.Sc.

General Information.

Mt. Dick (Latitude 31° 35' 13", Longitude 116° 41' 44") is situated approximately 5 miles north-north-east of Northam. It forms a prominent topographic feature to the east of the Northam-Goomalling road, about 1½ miles north of the railway crossing at Noggojerring siding; it is reached by entering Location 2044 and by following a track through the paddocks.

The area was examined by the writers during July, 1949, for iron ore, at the request of the Department of Industrial Development.

Geology.

Mt. Dick is at the southern end of a north-south ridge, about ½ mile in length, which stands above the surrounding area as a remnant of a former peneplain. Mt. Dick has an elevation of 940 feet above mean sea-level, with the surface falling away in all directions to an average elevation of 550 to 650 feet. Another such remnant is a mesa known as Crow's Nest (elevation 994 feet), approximately 2 miles to the north-east of Mt. Dick.

The slopes of Mt. Dick are steep and at the southern end there are features, which have been termed "fossil landslides." The position of one of these is shown on the map (Plate VIII), although the contour interval does not accentuate the profile. It consists of a mixture of rocks found to the north, with strikes and dips contrary to the observed regional strike and dip. The landslip evidently occurred before the present vegetation, but not long enough ago to allow erosion to smooth out the slope.

The principal rocks found in the area examined are a portion of the older meta-sedimentary rocks, which occur as a minor development in the vast complex of Archeozoic gneissic and granitic rocks of south-west of Western Australia. These rocks are overlain in places (see Plate VIII) by Cainozoic laterite.

The geological mapping was on broad lines, with an economic bias. More detailed mapping would produce many interesting petrological details. The following types or groups of rocks were recognised and mapped:—

Charnockites.

The chief rocks in this group were the plagioclase-hornblende-pyroxene-granulites and associated rocks but were not examined in detail. Professor Rex T. Prider identified these rocks as similar to those described in detail by him from Dangin (1945, Prider) and from Toodyay (1940, Prider). The extent of Charnockites at Mt. Dick is much larger than that at the two localities described by Prider. There are good outcrops of these rocks, and where they are soil-covered the soil is frequently spongy with irregular cracks. However, only a little magnesite was observed as a weathering product of these rocks.

Serpentines.

These rocks are developed over a wide area (see Plate VIII), but are frequently soil-covered or overlain by laterite. The typical decomposition products of serpentines, namely magnesite, opaline, silica and cellular quartz, are plentiful. A specimen of this serpentine was first described by the late Dr. E. S. Simpson in 1897. In 1903 the area was mentioned by H. P. Woodward, when examining the Northam area for gold. The old shaft, shown on Plate VIII was apparently sunk in these serpentines in search of gold.

The serpentines contain sufficient magnetite, which is easily visible in the outcrops, to affect the compass.

Ferruginous Quartzite.

To the west of the serpentines, a band of ferruginous quartzite occurs, as shown on Plate VIII. However, nowhere does it appear to be responsible for the formation of the iron deposit.

Garnet Rock.

On the western side of Mt. Dick and forming a southerly spur is a garnet rock, which is of doubtful origin. The rock, although weathered, has resisted erosion and lateritisation.

Granite-Gneiss Complex.

The above rocks are flanked and intruded by the granite-gneiss complex which has been mapped as such and undefferentiated in Plate V. It appears to consist of two distinct phases; the granite, almost pegmatitic in parts, is intrusive into the gneiss which is considered to be part of the old meta-sediments. The granite is small in extent in comparison with the gneiss. No information was obtained during the examination which would show whether the granite intruded the charnockites, but quartz veins, plentiful in the area, were found occasionally in them.

The regional strike of the Archeozoic rocks is northerly, with a dip to the east of 25 to 40 degrees. Contortions and a few drag-folds were observed in some of the rocks, givng the impression of their being the east limb of a south plunging anticline, but insufficient evidence was seen to be definite.

Laterite and Iron Formations.

The original laterite capping occurs only on the flat top of Mt. Dick and the small knoll to the south-west. The remaining area shown on Plate VIII as laterite consists mainly of residual boulder, rubble and laterite soil. The laterite in this area must have been formed on a surface sloping to the south-west at 6 to 7 degrees. Below the laterite capping, which varies from 0 to 10 feet in thickness, and above the underlying unaltered rocks is a zone of partial laterites and decomposition and it is at the top of this zone that the iron is concentrated.

This zone occurs only where the underlying rocks are serpentines, as it was formed by weathering and decomposition during Tertiary times, in a climate which was moister than the present climate and probably sub-tropical. The top or iron section of this zone is chiefly limonitic and hematitic soil, with occasional boulders of limonitic and hematitic laterite. In places where the laterite capping has been removed, these boulders form the surface. Although it is possible to find occasional hand-size specimens of almost pure hematite, the quantity of this mineral actually present in the deposit appears to be much greater than it really is, due to the characteristic reddish colour of the hematite, which tends to stain this section of the zone.

The formation of iron deposits by the decomposition of serpentine rocks, in a former subtropical climate, has not been recognised previously in Western Australia, but elsewhere in the world such deposits are found, particularly in Cuba (1947, Bateman), where they are immense, consisting of goethite (similar in appearance to limonite but with less water of hydration) and limonite with hematite formed as a lateritic residual deposit. Such iron deposits are characterised by their high alumina content, low silica, phosphorus and sulphur content and high (for iron ores) chromium and nickel content. The analyses of the Mt. Dick deposit show such characteristics, which, combined with the field evidence, place the origin of the deposit beyond doubt in the opinion of the writers.

Quality.

As stated previously, it is possible to find specimens of almost pure hematite, with the result that some analyses show a high metallic iron content. The economic quality of the deposit was demonstrated by a bulk sample of some 80 tons, which was hand-picked and treated at Wundowie. It had an approximate iron content of 50 per cent., silica 5-6 per cent. and alumina 10-12 per cent.; the remainder of the deposit would not be of any higher quality when bulked.

The following analyses were carried out by the Government Chemical Laboratories on selected specimens and should not be considered when gauging the true economic value of the deposit:—

Mt. Dick—Iron Ore Deposit.

Lab. No.	5363/48	3682/49	3683/49
Locality	Approx. 3m. N.E. of Northam	Mt. Dick from Eastern outcrop	Mt. Dick from Western outcrop
Date received	11/8/48	23/6/49	23/6/49
SiO_2	n.d.	5·55	2·98
Al_2O_3	n.d.	4·05	7·94
Fe	67·42	57·21	54·92
Mn	0·07	0·07	0·13
P	0·004	0·03	0·03
S	n.d.	0·08	0·08
Cr_2O_3	n.d.	0·05	2·46
Ti	0·05	trace	trace

I understand that the sample received on 11/8/48 (Lab. No. 5363/48) was from Mt. Dick; it contained approximately 25 per cent. magnetite. Samples Lab. Nos. 3682 and 3/49 appear to consist mainly of goethite the chromium in Lab. No. 3683 being in the form of fine, somewhat waterworn grains of chromite."

Economic Possibilities.

The extent of the iron ore is shown on the geological plan as the dotted portion of the laterite area. This ore is merely residual boulders mixed with a reddish soil, which on the knoll to the south-west of Mt. Dick is almost a red ochre. Hence to produce iron ore with a metallic iron content of 50 per cent., it is necessary to hand pick these boulders.

Although it is difficult to estimate the available ore in such a deposit, assistance was obtained here by the bulldozer cuttings into the slopes, which confirmed the writers' early ideas. As a result it is considered that the amount of ore available, averaging 50 per cent. metallic iron, would be in the vicinity of 1,200 tons.

In view of the small available tonnage, the expensive method of mining and the distance which the ore has to be transported to Wundowie, the deposit could not be worked economically.

Conclusion.

The iron deposit at Mt. Dick is a limonitic-hematitic residual ore produced by the decomposition of serpentine rocks. The portion of the deposit, which would bulk assay in the vicinity of 50 per cent metallic iron, would produce approximately 1,200 tons of ore, by the expensive hand-picking method of mining.

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PLATE VIII

—LEGEND—

- Laterite deposits including laterite capping, boulders and rubble
- Portion of laterite deposits with boulders and rubble, lemonite and hematite (iron ore)
- Granite-gneiss complex
- Chernockites
- Serpentines
- Ferruginous quartzite
- Garnet rock

—REFERENCE TO SIGNS—

- Location boundaries; (Lands Dept. Litho. 27C/40)
- Location boundaries, fenced
- Fences
- Contours, vertical interval 25 feet, datum MT. Dick 940 feet — 675'
- Form lines
- Tracks
- Creeks
- Approximate Geological boundary
- Doubtful or assumed Geological boundary --?--?--
- Outcrops
- Strike and dip of gneissosity or schistosity — N10°E 35°
- Locality and Number of Specimen — X 2/4296

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

GEOLOGICAL MAP

OF

Mt DICK IRON ORE DEPOSIT

AVON DISTRICT S. W. DIVISION

APPROX. 5 MILES NORTH OF NORTHAM

— Scale 5 chains to an inch —

5 4 3 2 1 0 5 10

Geology, planetable and telescopic alidade survey by, J.H. Lord, B.Sc; F.G.S. and N.M. Gray, B.Sc. July 1949.

LOC. 1977

LOC. 2007

LOC. 2044

LOC. 11338

LOC. 1667

Mt DICK

940'

585A

2/4297

2/4299

2/4296

2/4298

Soil covered

Phlogopite – anthophyllite rock

Gneissic rubble

Charnockite rubble

"Fossil" Landslip

Serpentine rubble and opaline quartz

Serpentine and Magnesite rubble

Magnesite in pothole

Magnesite and fe laterite

Shaft

Magnesite in costean

Quartz veins

Serpentine rubble

Weathered Serpentine

Some magnesite rubble

Rubble consisting of serpentine and ferruginous rocks with some cellular quartz

Opaline Quartz in ferruginous rubble

N10°E 35° Approx. position of gneiss in quarry

N10°E 40°

N5°E 25°

N5°E 85°

N5°E 35°

N20°E 25°

N10°W 25°

N10°E 40°

675' 700' 725' 750' 800' 825' 850' 875' 900' 925' 650' 625' 600'

Appendix.

Notes on examinations of two other iron ore deposits in the vicinity of Northam.

The locations of the deposits are:—

(a) On both sides of the Northam-Toodyay Road, north of the Avon River, about 3 miles west of Northam; Lands Department Litho 27/80, Loc. "a."

(b) About three quarters of a mile west of the York-Northam Road, 9 miles north of York, Lands Department Litho 2/80, Loc. "J."

These two deposits were visited at the request of the Department of Industrial Development.

The former is very similar to that at Mt. Dick in that it appears to have been formed from serpentine rocks, but it is much smaller in extent with a lower average iron content.

The latter deposit was probably formed from serpentines but the bulk of the outcrops were ferruginous quartzites. This deposit was very small.

Many such deposits are to be found in the south-west portion of this State, the majority of which have no economic value.

The deposits mentioned above are not of economic importance.

REPORT ON EXAMINATION OF LOCATION 21, 14 MILES SOUTH OF BAKER'S HILL AVON DISTRICT, SOUTH-WEST DIVISION FOR RADIO-ACTIVE MINERALS.

By J. H. Lord, B.Sc., F.G.S.

The exact locality and brief details of this area were described by the writer in a report on "A Reported Gold Find in the Upper Helena River Valley, 14 miles south of Baker's Hill, W.A." (See G.S.W.A. Annual Report 1948.) The area examined was the north-west corner of Location 21.

Mr. H. F. Dunn submitted some rock specimens to the Bureau of Mineral Resources through the C.S.I.R.O., some of which on their examination showed a trace of radio-activity. It was requested that the Geological Survey of Western Australia examine the site.

The area was visited by the writer accompanied by Mr. H. F. Dunn and Mr. D. Burns of the Government Chemical Laboratories with a Geiger-Muellar counter during August, 1949.

The position from which Mr. Dunn had taken his samples were tested, and the area between was traversed. Slight radio-activity was observed at his sites 2, 3 and 4, and specimens were collected at these sites, the type of rock showing most radio-activity being a medium-grained biotite schist, which occurs associated with gneiss. The following is the result of the examination of these specimens carried out by the Chemical Laboratories:—

Lab. No.	4743	4744	4745	4746
	Location 21, Upper Helena River.			
Mark	No. 2.	No. 3.	No. 4.	No. 6.
Minerals in heavy fraction (SG 3.3)	Magnetite with monazite and traces of xenotime and zircon	Magnetite with monazite and traces of xenotime	Hematite with monazite and trace of xenotime	Magnetite with monazite and touch of xenotime
Counts/sec above background (on Laboratory Geiger)	1·25	0·44	0·50	1·15

Note.—The count on Holleton biotite schist containing approx. 1 per cent. xenotime was 14·21 counts/sec. above background.

From their examination it is concluded that the slight radio-activity registered has been caused by the thorium present in the monazite (a phosphate of cerium minerals) and xenotime (yttrium phosphate). These two minerals occur as minor accessory minerals in rock formations such as that found in this area.

Monazite is a commercial source of thorium, when it has been eroded and concentrated in the form of beach or river sand deposits or placers. Although it is most unlikely that it could be located in this area in sufficient quantity to be workable, it has an academic interest.

REPORT ON EDWARD'S FIND, YILGARN GOLDFIELD, W.A.

Approx. Lat. 31° 30′ S.
Approx. Long. 119° 25′ E.

By J. H. Lord. B.Sc., F.G.S., and J. Sofoulis, B.Sc. Geological Survey of Western Australia.

General Information.

Edward's Find was examined at the end of November and in early December 1949 by the authors, the main purpose being to bring up-to-date the information concerning this mining area. This area has been worked continuously since the last detailed survey in 1935. The surface of all the existing leases was examined and mapped, while the underground workings on Leases 3942 and 3943, which comprise the interests of the Sunshine-Reward Amalgamated Syndicate, were examined in detail.

Government Geologist T. Blatchford inspected this area in 1932 shortly after its discovery. (See G.S.W.A. file 20/32.) Part of the area was examined by H. A. Ellis and recorded in the Annual Report of the Geological Survey for 1935 as a "Report on James, Nelson and Goodin's G.M.L. 13 P.P., Edward's Find Yilgarn Goldfield." Later in the same year R. S. Matheson examined the area in detail (now recorded in Bulletin 99 of the Geological Survey, pp. 67-76). Information from these reports has been used freely in this report, where applicable, but much has not been brought forward as this report is chiefly concerned with G.M.L's. 3942 (Edward's Reward) and 3943 (Sunshine).

The Edward's Find leases are situated approximately 9½ miles south-west of Marvel Loch on Jilbadji Location 450, which is temporarily reserved for mining. Access to the Find is gained via Southern Cross southwards along the Parker's Range road for 20 miles and then south-westwards for 7 miles. The road, which is graded gravel throughout, is in good condition. Although Marvel Loch is the nearest centre, with a post office, hotel and several stores, Southern Cross 27 miles away is the chief centre for supplies.

The climate is typical of the eastern goldfields of Western Australia, with an average rainfall of approximately 10 inches falling mainly in the winter months, when mild days are experienced with bitterly cold nights, the mean minimum temperature in July being 39°F. The summer is hot with occasional dust and thunder storms, the mean maximum temperature in January being 95°F.

Economic Position.

From an economic standpoint this mining centre is not very favourably situated, owing to the fact that it is 27 miles from the nearest railway and centre at Southern Cross.

Like all of the "outback," labour has been a problem, but as the syndicate has provided reasonable huts and a first-class boarding-house, the position is improving and should continue to do so.

Mining timber in the form of morrel, gimlet and salmon gum is abundant close to the mine. Wood for fuel is also plentiful, but preference is being given to oil.

The water supply has always been a problem. Originally two dams were constructed, but as operations developed these did not meet the demand. A sufficient supply for mining and treatment operations has since been obtained from a bore hole in the bottom of a winze on the 200-foot level at co-ordinate 3010 S. (see Plate X). The water now stands at a level of 240 feet below the surface. Tanks are used to catch rain water for domestic supply, but usually this supply is augmented by carting. The nearest certain supply of potable water is at Marvel Loch, which is connected by pipe line to the Goldfields Water Supply Scheme.

History.

Gold was discovered at Edward's Find in 1931 by an ex-miner, F. W. Edwards, Senior, who was endeavouring to develop the area as a wheat and sheep farm. A syndicate formed to develop the Find has, with minor alterations, worked the area ever since.

Originally the ore was carted 10½ miles to be treated at Howlett's battery, but at the end of 1935 the Syndicate installed a 5-head battery and cyanidation plant, which is still in use.

Numerous leases and prospecting areas other than Leases 3942 and 3943 have been pegged and worked at various times, but only these two have been worked continuously. At present (Dec. 1949) the only other work on the Group is some surface prospecting on Lease 13PP.

Many of the prospecting shafts, as shown on Plate IX, other than on Leases 3942 and 3943 have been unproductive. Most of these workings are inaccessible, and information regarding these has been taken from previous reports.

Gold production from Edward's Find is shown in Table I.

TABLE I—PRODUCTION.

Edward's Find, Yilgarn Goldfield.

Registered Name of Lease or Company.	No. of Lease or Prospecting Area.	Period.	Ore Treated.	Gold therefrom.	Grade.	Remarks.
			Long tons.	Fine ozs.	dwts./ton.	
Lady Luck....	33PP	1936–1940	331	179*	....	
W. A. Henkley	5971	1941	9	4	....	
Total	....	....	340	183	10·8	
Desert Rose	3925	1938	32	27	16·9	
Edwards' Reward North	4116	....	....	....	....	Exists—*see* Edwards' Reward Leases.
Lady Mary	24PP	1934–1938	281	168	....	
Vauxhall	4029	1941	84	27	....	
A. Gobetti	5653	1940	49	23	....	
Total	....	....	414	218	10·5	
Edwards' Reward Leases	3942, 3943, 4116, 4117, 4175	1938–1949	34,619	16,146	....	Exists.
Edwards' Reward	11PP (3942)	1933–1937	2,080	2,016	....	
Total	....	....	36,699	18,162	9·9	
Sunshine	12PP (3943)	1933–1938	3,866	2,385	12·3	Exists—*see* Edwards' Reward Leases.
Edwards' Reward East	4175	....	....	....	....	Exists—*see* Edwards' Reward Leases.
D. Lyttleton	P.A. 5791	1940	109	12	....	
D. Lyttleton	P.A. 5985	1941	36	4	....	
Total	....	....	145	16	2·2	
Cricket	13PP	1933–1942	1,616	922	11·4	Exists.
May	3914	1938–1940	145	46	6·3	
Sunshine South	4117	....	....	....	....	Exists—*see* Edwards' Reward Leases.
M. de Poole	P.A. 5454	1939	19	4	4·2	
Grand Total	....	....	43,275	21,961	10·3	

* Includes 1·32 ozs. of dollied and specimen gold.

No alluvial gold or silver has been reported, though the gold at Edwards' Find contains some silver in the unrefined product.

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

GEOLOGICAL MAP OF EDWARDS FIND

YILGARN GOLDFIELD

Scale: 300 feet to an inch

300 150 0 300 600

Geology, plane table and telescopic alidade survey by J.H. Lord & J. Sofoulis, Dec., 1949

Cleared
Whitestone
Partly cleared
Weathered greenstone
Kaolinised greenstone and pegmatite
Quartz rubble and boulders
Kaolinised greenstone and pegmatite
80' Greenstone
30'
20'
25'
Kaolinised pegmatite
Thick low scrub
Kaolinised greenstone and pegmatite
Ferruginous lateritic rubble
White pegmatite
Scattered potholes and small costeans
Kaolinised greenstone and pegmatite
Lateritic rubble
Greenstone and pegmatite
Thick low scrub
Gravel and quartz
Greenstone and quartz
Laterite and greenstone
Scrub
G.M.L. 4116
Quartz rubble
Quartz rubble
Quartz
Pegmatite rubble
Partly cleared
50' Greenstone
70' Greenstone
Cleared
Quartz
2'
Greenstone
1½'
1½'
1'
Lateritic clay
"Edwards Reward North"
Water at 15'
Greenstone
1½'
Lateritic clay
1½'
Reddish clay with quartz floaters
8'
4'
Greenstone
WHIP SHAFT
1½'
Lateritic clay
Greenstone and quartz
Greenstone
10' Greenstone
WHIP SHAFT
Greenstone
1'
Cleared
G.M.L. 3942
Cleared
Scattered greenstone rubble with a few quartz floaters in a brown clay
"Edwards Reward"
N30°W
60°
REWARD SHAFT
Dam (Water)
Cleared
Rubble with quartz and tourmaline
Dam (Water)
Greenstone boulders and rubble
Slimes
MAIN SHAFT
Office & Store
Blacksmith Shop
Battary (R.L. Floor 503·35')
SUNSHINE SHAFT
Compressor Shed
Cooling Tower
Settlers
Tank
Cyanide Vats
Slimes
Cyanide Vats
Cleared
G.M.L. 3943
18'
Greenstone
Cleared
Cleared
"Sunshine"
N30°W
Line of holes through to stope
Greenstone, quartz and pegmatite in dumps
Thick low scrub
Some quartz in lateritic rubble
Partly cleared
G.M.L. 4117
Scattered potholes
Lateritic rubble
2'
2'
Laterite
Greenstone
Quartz or quartzite
Pothole with quartz carrying tourmaline
Thick low scrub
Some small gums
Thick scrub
"Sunshine South"
Lateritic rubble with scattered boulders of laterite
Thick low scrub
Weathered greenstone
Pothole with quartzite
Potholes with lateritic gravel
Laterite gravel with quartzite and weathered grit (?)
Greenstone rubble
Potholes showing lateritic gravel
Kaolinised felspathic grit and quartzite
Thick low scrub
Laterite gravel
Low scrub and gums
Cleared
Greenstone
Mainly clay with quartz floaters
Max 2'
Greenstone
Scattered small potholes with greenstone
6' Greenstone
Greenstone
Pegmatite and weathered schist
Greenstone
Pegmatite boulders with scattered greenstone rubble
Greenstone
G.M.L. 4175
Scattered greenstone rubble
Pegmatite boulder
3' Clay
Cleared
Scattered greenstone rubble
Potholes. Ferruginous soil with some quartz and greenstone
with some quartz floaters
Greenstone
"Edwards Reward East"
Clay with quartz
Thick low scrub with a few low gums
Lateritic rubble
Thick low scrub and some small gums
Greenstone
Scattered outcrops of laterite
Potholes with quartz
Main Road to Southern Cross
Felspathic grit
Potholes with felspathic grit
Felspathic grit
Potholes with greenstone
Greenstone and quartz in dump
Road branches into numerous tracks
G.M.L. 13PP
Thick low scrub with a few small gums
Greenstone, quartz and pegmatite
Low scrub
Greenstone
Quartz
Lateritic rubble
N35°W
Greenstone and quartz
Greenstone, quartz and pegmatite
Greenstone
Small costeans and potholes
Greenstone and quartz
Quartz
"Cricket"
Thick low scrub
Weathered greenstone and quartz in dump
Quartz and quartzite in pothole
Quartz and lateritic gravel
Greenstone and quartz in dump
Greenstone and pegmatite in dump
Greenstone and quartz in dumps
Max depth 1'
All costeans and potholes show occasional quartz floaters in clay
Pothole with quartz
Weathered greenstone
Greenstone
Greenstone
Weathered greenstone and quartz pegmatite with tourmaline in dump
Whitestone and phyllite in dump
Clay whitestone in dump
G.M.L. 3914
Pothole with quartz and quartzite
Cleared
"May"
Scattered quartz and quartzite floaters in light brown soil
Partly cleared
Weathered greenstone
Thick scrub

LEGEND

- Ferruginous lateritic rubble
- Soil covered greenstones
- Quartz reefs

REFERENCE TO SIGNS

- Gold mining lease boundaries
- Shafts (accessible)
- Shafts (inaccessible)
- Costeans (showing depth)
- Potholes
- Buildings
- Assumed geological boundaries
- Strike and dip of schistosity
- Strike of vertical schistosity
- Strike and dip of bedding
- Strike of vertical bedding
- Outcrops with no observed strike and dip
- Open cut
- Track

COMPOSITE PLAN

GEOLOGICAL PLAN-Nº 1 LEVEL

GEOLOGICAL PLAN-Nº 2 LEVEL

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

PLANS AND SECTIONS OF UNDERGROUND WORKINGS
G.M.Lˢ 3942 & 3943
SUNSHINE REWARD AMALGAMATED G.M.

EDWARDS FIND
YILGARN GOLDFIELD

Scale : 60 feet to an inch

60 30 0 60 120

Plan supplied by Management. Geology by J.H.Lord & J.Sofoulis, Dec., 1949

REFERENCE

- Main shaft
- Accessible shaft
- Winze or pass
- Cross section of drive
- Observed geological boundary
- Assumed geological boundary
- Strike and dip of schistosity (N25°W 85°)
- Strike and dip of quartz reef (N70°W 76°)
- Quartz reef
- Pegmatite

G.M.L.3942
"Edwards Reward"

G.M.L.3943
"Sunshine"

REWARD SHAFT

NEW MAIN SHAFT

SUNSHINE SHAFT

Lease Boundary

2800'S 2900'S 3000'S 3100'S 3200'S 3300'S 3400'S 3500'S 3600'S 3700'S 3800'S

2400'W 2300'W 2200'W 2100'W 2000'W

40' LEVEL

Nº 1 (100') LEVEL

Nº 2 (200') LEVEL

Winze

Greenstone ahead of shears N10°W 75° E

N50°E Main shear with several minor shears

Joints N55°E. 8°N N45°W 65°

Quartz lode on roof of stope, cut off by shear, probably displaced eastwards

N20°W 81° E

Quartz on walls

N17°W 72° E

Quartz on wall with contact on to greenstone

N15°W 85° E

N35°W 85° E

N25°W 85° E

Quartz veinlets along walls

Quartz stringers and pegmatitic material on walls

N25°W 87° E

Quartz on wall

Pegmatitic material on wall

N25°W 70° E

Stoped

N40°W 56° E

Quartz stringers in wall

N25°W 73° E

Sump

Small pegmatite veins in wall

N10°W

N30°E Shears

N10°W 70° E

N15°W 75° E

Few stringers near footwall

12° N80°E Shears

Up to 12" of stringers

N10°W 80° E

N 72° E

Slip planes dipping 17°S.

18" on footwall becoming stringers in both directions

N7°W 77° E

Mineralised greenstone

Scattered stringers on roof

N22°W 71° E

N84°W 72° E Shears

Small stringers on roof

N35°W 82° E

Pegmatitic material on wall

N73°E 78° E

Strong shear, with a few parallel shears

N10°W 80° E

Quartz on wall

Quartz veinlets

N10°E

N35°E 83° E

Mineralised greenstone

Quartz on wall contact

N60°W 82° E

N5°E 65° E

N18°W 70° E

Quartz on wall

N25°W 85° E

Quartz veinlets

N25°W 85°

N5°W 37° Contact of pegmatite and greenstone

N5°W

Pegmatite dips slightly to west and thickens southwards

N5°W

Greenstone above pegmatite

Bottom of pegmatite Greenstone below

Pegmatite

Foor of pegmatite dips at 40°N. down wall

N70°W 76° Steepens to 86°W above

N15°W 82° E

Quartz on walls

N18°W 83° E

Dip steepens to 85°E approx. 15' above

Quartz on walls

Mineralised greenstone

N20°W 78° E

N2°W 88° E

Leading stope

Stoped

N5°E 83° E

N25°W 85° E

Mineralised greenstone

N18°W 82° E

Quartz stringers on wall

Quartz stringers

N1°W 84° E

N2°W 84° E

N26°W 73° E

N25°W 75° E

Quartz on wall

Leading

N8°W 78° E

N8°W 73° E

Mineralised greenstone

Leading stope

N5°W 75° E

Quartz stringers

Stoped

Shear on roof of leading stope may cut off lead

70° 88° 6" of stringers

N13°W 83° E

18" 24" 34" 40" 12" 11" 21" 20" Lagged 20" 20" 13" 12" 24" 18" 15 6 9"

2" stringer on wall

N17°W 81° E

N29°W 88° E

N23°W 83° E

N21°W 80° E

Width of lode is as shown on roof of drives

N8°W 77° E

Stoped

Quartz on wall 2" wide - thinning above thickening below 72°

N18°W 76° E

N4°W 79° E

N8°W 83° E

N5°E 73° E

N15°W 82° E

N10°W 70° E

N20°E 80° E

N15°W 77° E

4" stringers

Stringers

Quartz on wall Joints in quartz, N35°W 86°N, N60°E 65°S

N9°E 60° E

85° 1" wide

N15°W 85° E

N19°W 83° E

Joints N5°W 25°W N80°W Vert

N8°E 75° E

Quartz veinlets in wall

N2°W 80° E

N20°E N28°W 60° 65°

N8°W 66° E

Oxidised Greenstone Most of the Small shears, N42°E 22°W

Quartz vein 1" wide

N10°W 74° E

70° Quartz vein

Stoped

N12°E 77° E

Quartz veinlets

N17°W 80° E

Quartz has same strike & dip as country

N5°W 78° E

6" 2nd stringers 6" of stringers

N12°W 73° E

Numerous slip planes

1" stringers

1" stringers

N30°W 78° E

N25°W 64° E

Quartz stringers

N24°E 67° E

Stringer on wall

N35°W 86° E

N45°W 84° E

N35°W 83° E

Some quartz on wall

Quartz on wall Joints in quartz N67°E 73°, N35°W Vert

Lateral pressure

24°

Quartz vein 4" wide increasing in thickness higher

Stoped

Quartz stringers

N12°W 73° E

Few quartz stringers

N2°W 68° E

Ore Pass

65° 1" Quartz vein

N15°W 75° E

Quartz 2" wide in roof

N42°W 70° E

Numerous slip planes in oxidised greenstone country rock

SECTION A-A¹

SUNSHINE SHAFT

A S 73°W Surface N 73°E A¹

Greenstone

LODE LODE

Nº 1 LEVEL

MAIN LODE

Greenstone

EAST LODE

Nº 2 LEVEL

SECTION B-B¹

B S 73°W Surface N 73°E B¹

MAIN LODE

Greenstone

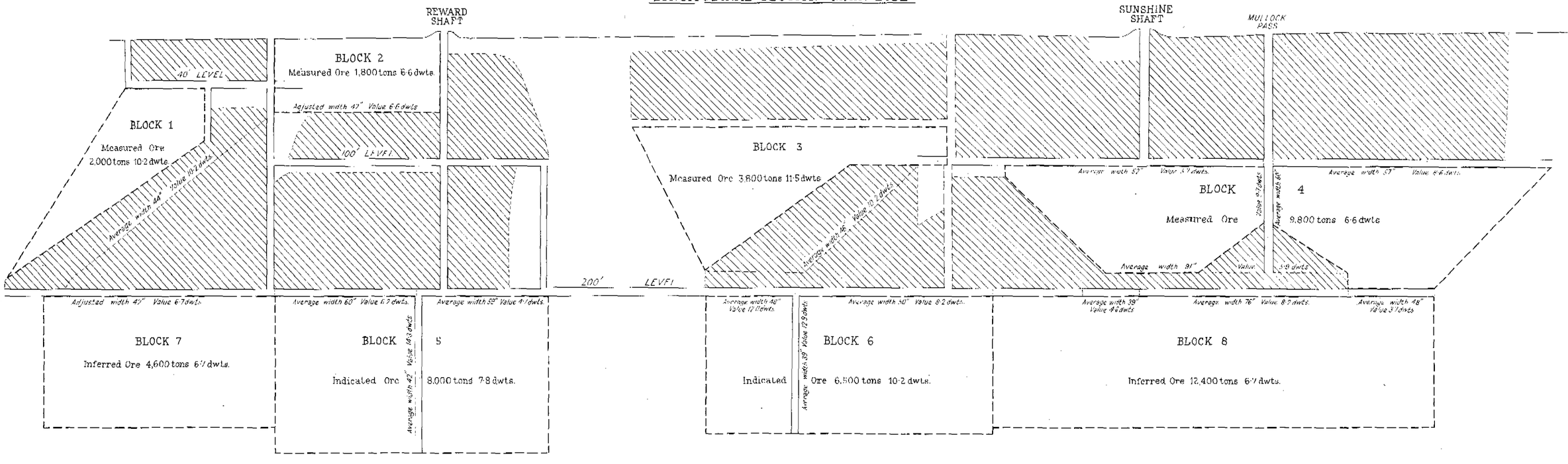
Nº 1 LEVEL

EAST LODE

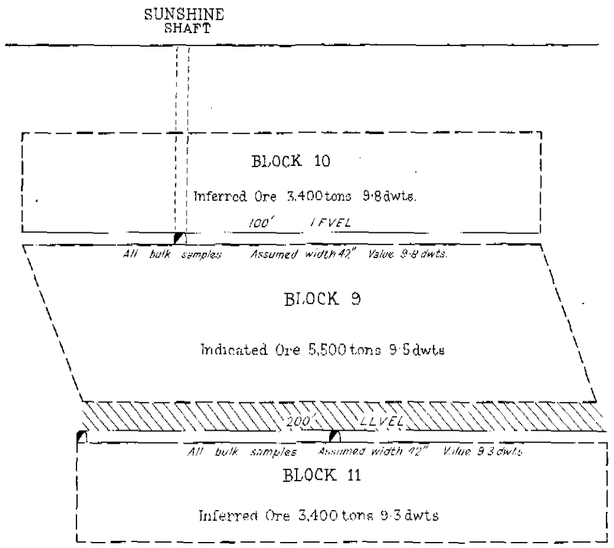
Greenstone

Nº 2 LEVEL

LONGITUDINAL SECTION - MAIN LODE



LONGITUDINAL SECTION - EAST LODE



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

LONGITUDINAL SECTIONS OF UNDERGROUND WORKINGS

G.M.Ls 3942 & 3943

SUNSHINE REWARD AMALGAMATED G.M.

SHOWING ORE RESERVES

EDWARDS FIND

YILGARN GOLDFIELD

Scale: 60 feet to an inch

60 30 0 60 120

Compiled by J.H. Lord, Dec., 1949

GEOLOGY.

Edward's Find is situated on gently undulating country comprised of the Whitestone Series of the Yilgarn System. A large portion of greenstones are interbedded with the whitestones and the workings are confined to ore bodies in the greenstones. The ore bodies and country rock have been intruded by numerous flat-dipping pegmatite dykes.

The surface consists of a red clayey soil and loose ferruginous laterite covering almost the entire area and obscuring all but a few scattered outcrops. Costeans on the various leases indicate that up to 15 feet of soil overburden (containing floaters of quartz, pegmatite and country rock) exists.

Lateritic rubble and boulders of ferruginous laterite mantles most of the low ridges present on the leases. Small outcrops and boulders of whitestone (on dumps) indicate that whitestone bands occur within the greenstones.

The existence of a north-west to south-east parallelism is indicated by the position of the existing or abandoned workings.

Attitudes taken on the ore bodies and country rock show a general strike trend of N.30°W. with dips oscillating about the vertical and ranging from 60°S.W. to 85°N.E.

Surface exposures are scarce, but attitudes taken suggest a synclinal structure, the Find being located almost at the intersection of the major synclinal cross-fold axis which passes through Burbidge, and the axis of a major north-west to south-east syncline. Dragfolds seen to the east of the group of leases indicate a regional plunge of 50° to 65° N.W.

Minor structures in the form of faults, shears, drags, etc. are common throughout the area.

Underground.

Rock Types.

The following general rock types were recognised:—

1. *Greenstones.*—These consist of banded amphibolite schists and massive amphibolite. The banding is closely spaced and in places strongly contorted. A variation from schistose to massive greenstone also occurs.

In the weathered zone (surface to approximately 130 feet below) the greenstone is brown, soft and flakey and workings in this upper zone are generally timbered. In its freshest state, the greenstone is grey to green, hard, fine to medium-grained, the coarser rock often containing pyrite as a minor constituent. It has probably been formed by the metamorphism of a basic sediment.

2. *Whitestones.*—Excepting a few bands, the whitestones (which consist of grey schists, quartzites and felspathic grits) occur outside the lease boundaries. The folding of the whitestone series appears to have been more drastic than that of the greenstone series and for this reason openings suitable for gold deposition have been less frequent.

3. *Dykes.*—The pegmatites form flatly-dipping irregular-shaped masses cutting through the country rock in different directions. These dykes are medium to coarse-grained containing black tourmaline. The reefs show little displacement by these post-gold intrusions. The pegmatites in some places have assimilated and replaced the quartz reefs.

4. *Ore Bodies.*—Quartz reefs and lode formations consisting of schistose greenstone with quartz stringers and lenses conformable with the schistosity of the enclosing greenstone, constitute the main producers of this group of leases. These ore bodies vary in thickness from a few inches of quartz stringers to 4-foot reefs. Some reefs occur in fault fissures, dragfolds and major joint planes in the greenstones. The ore bodies show a strong lenticular habit, with thickness and values varying considerably. Granular calcite is sometimes associated with the ore and in places the quartz contains vughs. The development of calcite was first noted on No. 2 Level about 30 feet south of mine plan co-ordinate 3010 S. It persisted in depth to the bottom of the winze at co-ordinate 3010 S., and no falling off in gold-values was reported as the result of this development of calcite.

G.M.L.'s 3942 and 3943.

The present workings are those accessible by the Reward Shaft on G.M.L. 3942 and the Main and Sunshine Shafts on G.M.L. 3943. At the time of inspection, all other workings on these and the remaining leases were inaccessible.

The main feature of the ore body on the present workings is the bifurcation just south of the new Main Shaft to form the "Main" and "East" lodes. Both branches are conformable with the schistosity of the greenstones, and variations in values and thickness along the strike and dip occur in both lodes. The variations may possibly be related to changes of attitude, but these are not conspicuous.

Both branches have been worked on the 100 and 200 foot levels. On the lower level the "Main" lode appears to bend in towards the "East" lode at 3610 S. (Plate X). The lode known as the "Cross" lode occurs at this bend and has probably been introduced along a channel between large blocks of greenstone country rock.

This "Cross" lode appears to pinch out approaching the upper level, as only quartz stringers were seen in the walls of the "East" and "Main" lode drives, but further development may locate it on this level.

At the time of inspection the only driving in progress was at the south end of the east lode on the 100ft. level (see Plate X) where the face showed 6in. of quartz lode. The crosscut from the Sunshine shaft on the 100ft. level did not cut further parallel ore bodies. On the 100ft. level, the south face of the drive from the Reward shaft shows a 3ft. dyke dipping flatly to the south-east. The north face of this drive shows 18in. of quartz lode. Remnants of pegmatite veins are seen in some places along the walls of this drive. The remaining drive faces on this level show several inches of lode, the roofs showing variations in lode thickness from a few inches up to 2ft. (Plate X).

Between the 3200 S. and 3100 S. (Plate X) on the 200ft. level, the lode consists of quartz stringers and contains low values. This portion of the drive is known locally as "the blank." Strong shears striking N.80°E. and dipping 12°N. mark the northern extremity of "the blank" whilst shears at N.73°E. and dipping 78°S. mark the southern extremity. Values at either end of "the blank" were said to be high against the face of the shears. This "blank" portion may be the result of lateral stresses which acted during the tectonic period and restricted the formation of suitable gold channels.

Beyond the northern extremity of the "blank," values are reasonable and the lode has been followed as far as the 2800 S. co-ordinate where it is cut off by a fault. Shears seen in this fault zone strike N.50°E. and dip 85°S.

As greenstone is present in the face of this drive, the lode has probably been displaced to the east, as most of the displacements which have occurred on these leases are in this direction and are of small magnitude.

The remaining faces of the drives on this level show quartz stringers.

Below the 200ft. level winzes sunk near the Reward and Main shafts show that the reef is maintained at depth, the width of ore averaging 3ft. of quartz and the assays indicating high grade ore for at least 100ft. below the 200ft. level.

The most favourable strike for ore deposition seems to have been N.10° to 20°W., but the lodes have also two other general directions of strike, namely, N.20° to 30° E. (Main lode, 3700 S. southwards on the 100ft. and 200ft. levels) and N.30°

to 40°W. (Cross lode and Main lode on the 100ft. level, 3760 S. southwards). A suitable explanation for the ore developing in these directions could not be definitely found, but it is probably due to the fracture pattern of the country. It would appear then, that there is no pronounced favourable strike or dip in this reef system.

Ore Reserves.

Ore reserves have been calculated for the portion of leases 3942 and 3943 which are being mined by the syndicate. In the calculations, assay results obtained by the Western Mining Corporation in 1946 during a complete sampling of the mine workings were supplemented by results of bulk sampling carried out by the syndicate.

The ore reserves were calculated conservatively, all high values being cut to 20 pennyweights. Where sample widths were excessive they were reduced, but where the widths were too narrow for stoping they were increased to a width of 42in. suitable for stoping, and the value decreased.

All results are in long tons based on the assumption that 13.5 cubic feet of ore is equivalent to one ton.

Ore reserves have been classified according to the geological survey standards, namely, measured, indicated and inferred ore, depending upon whether it has been tested on three or four sides, two sides or only one side. No ore classified is more than 100ft. from a sampled point.

The longitudinal sections on Plate XI show the locality of ore blocks mentioned in Table II below.

TABLE II.

ORE RESERVES—SUNSHINE-REWARD AMALGAMATED SYNDICATE-EDWARD'S FIND, DECEMBER, 1949.

Block.	Measured Ore. (Tested on three or four sides).		Indicated Ore. (Tested on two sides).		Inferred Ore. (Tested on one side).	
	tons.	dwts.	tons.	dwts.	tons.	dwts.
Main Lode—						
1	2,000	10·2	....		....	
2	1,800	6·6	....		....	
3	3,800	11·5	....		....	
4	9,800	6·6	....		....	
5	....		8,000	7·8	....	
6	....		6,500	10·2	....	
7	....		....		4,600	6·7
8	....		....		12,400	6·7
East Lode—						
9	....		5,500	9·5	....	
10	....		....		3,400	9·8
11	....		....		3,400	9·3
Total	17,400	8·1	20,000	9·1	23,800	7·5

Grand Total	Measured	17,000 tons at 8·1 dwts.
	Indicated	20,000 tons at 9·1 dwts.
	Inferred	23,000 tons at 7·5 dwts.
		60,000 tons at 8·3 dwts.

There are no reserves of broken ore.

Treatment Plant.

The ore which is produced on these leases is free-milling and presents no metallurgical problems in the extraction of the gold, according to an investigation conducted on ore from this mine by the Kalgoorlie School of Mines Metallurgical Laboratory.

The treatment plant operating at the time of inspection was the original one installed in late 1935. It is a 5-head stamp (1,000 lb. each) battery belt-driven by a 20 h.p. National Engine. The crushed ore is passed over copper plates and strakes. The sands pass into 2 settling tanks and the slimes into a slime paddock. There are twelve 15-ton leaching vats, which are hand filled with 50 per cent. sands and 50 per cent. slimes and emptied by hand. This plant handles 350 long tons per four-week period working 3 shifts a day for a 5-day week.

The initial installations were being made for a proposed new plant with a capacity to treat 1,000 tons per four-week period.* The proposed process will be fine-grinding with a jaw crusher, 5-head battery and ball mill, cyanidation, agitation and double filtration. The advantages of this process over the existing one are said to be:—Increased capacity, reduction in treatment costs and savings of labour.

* It has since been learnt that the Syndicate has decided to enlarge the existing plant by installing a 10-head battery. The chief reason for this decision is that the proposed process outlined above does not give an increased extraction over the process at present in use according to the School of Mines investigation.

Underground Workings.

Underground conditions on this mine are good. The unweathered greenstone forms good walls for stoping operations, while in the weathered zone, which is down to 130 feet, timbering has been necessary in places but the greater part of this zone has already been stoped out.

Water has been encountered in the two winzes and shaft below the 200-foot level. Water for the battery is drawn from the north winze on this level where it stands at approximately 240 feet below the surface.

Main Lode.

On the Main Lode most of the ore has been stoped out between the 100-foot level and the surface. 800 feet of driving has been done on the 100-foot level all of which is stoped above, except for 120 feet.

On the 200-foot level just over 1,000 feet of driving has been done and rill stoping is in progress above, except for 160 feet known as "the blank," where values were poor, and for another 50 feet which has only been leading stoped. Blocks of ore remaining to be stoped above the 200-foot level are shown on the longitudinal section (Plate XI).

Two winzes have been sunk from the 200-foot level on the lode disclosing good values to a depth of 120 feet.

A new main three-compartment shaft which is being sunk, was down to 265 feet (Dec. 1949) when inspected. The intention is to continue this shaft down, to open up the 300-foot level and to install a modern haulage system. At present the ore is hauled in 44-gallon drums through the prospecting shafts, Reward or Sunshine.

East Lode.

This lode is being developed and 270 feet of driving has been done on the 100-level, while 260 feet has been done on the 200-foot level and a leading stope taken down over the full length.

Cross Lode.

A cross lode located between the Main and East lode is being stoped above the 200-foot level between co-ordinates 3610 and 3650 S. Endeavours to locate this lode on the 10-foot level have not yet been successful.

The development of this mine is well advanced, but it will be necessary to expedite the driving and leading stoping on the new 300-foot level as soon as the new main shaft is sunk to that point. At the moment ore between the 300 and 200-foot levels is only classified as Indicated and Inferred Ore, but once the necessary development is done it is most likely that this will become Measured Ore.

Costs and Valuation.

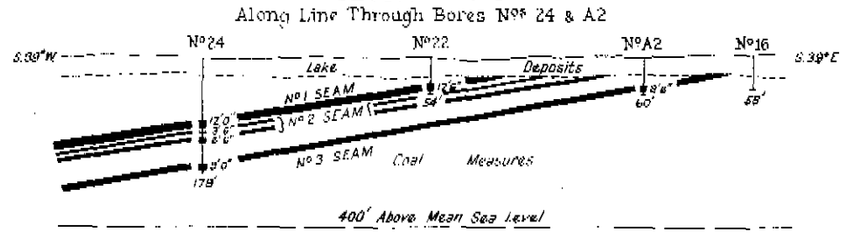
The costs in December, 1949, were:—

	Per ton.
Mining cost	29s. 5d.
Treatment cost	26s. 4d.
	55s. 9d.

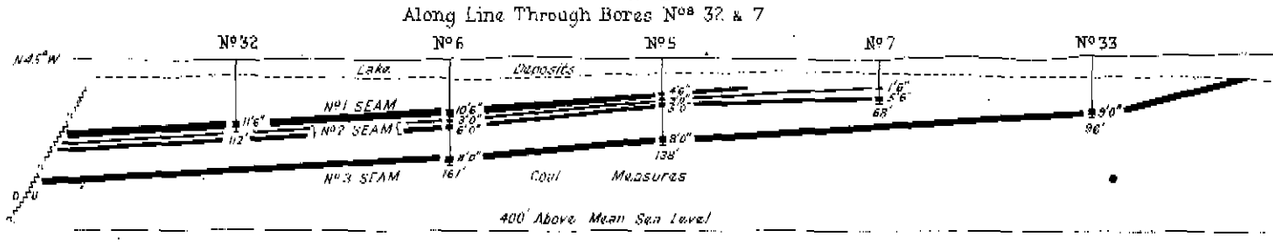
When the new main shaft is equipped with modern haulage, and with the consequent acceleration of underground production, mining costs should be reduced. The estimated treatment costs for the new plant, when installed, was stated in September, 1949, to be 20.05s. per ton, which includes capital charges at 12½ per cent. per annum, based on a 250 tons per week production.

PLATE XII

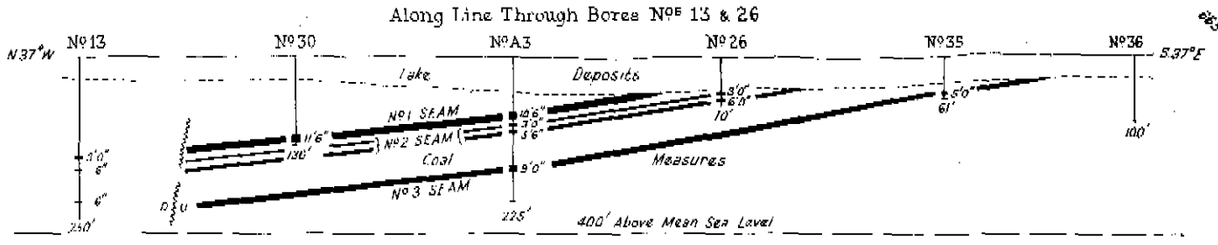
SECTION Nº 1
Along Line Through Bores Nºs 24 & A2

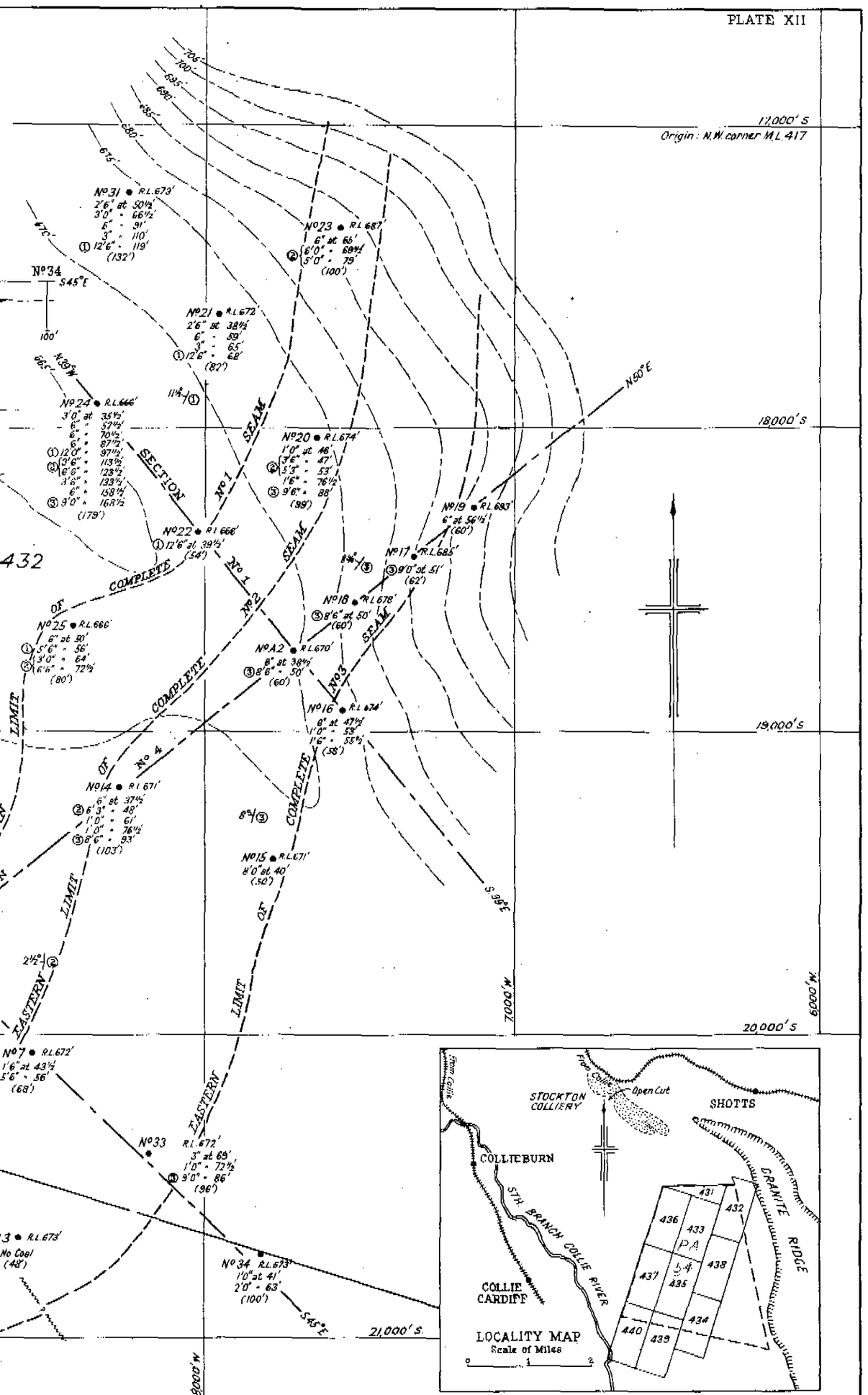


SECTION Nº 2
Along Line Through Bores Nºs 32 & 7



SECTION Nº 3
Along Line Through Bores Nºs 13 & 26





REFERENCE TO SIGNS

- Borehole - showing identification (NºA2) reduced level (R.L.670') significant coal seam intersected (8'6" at 50'), seam number (3), borehole depth (60') — NºA2 R.L.670' ③ 8'6" at 50' (60')
- Lease boundary
- Contours (at 5' intervals)
- Line of section
- Strike and dip and number of coal seam from bore data — 8°/③
- Fault, approximately located
- Fault, existence and position probable.

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

PLAN AND SECTIONS

— OF —

PORTION OF PROSPECTING AREA 54

(C.M.Lˢ 431 TO 440)

Showing Geology and Boreholes with Coal Intersected

SOUTH OF SHOTTS

COLLIE MINERAL FIELD

Scale: 4 chains to an inch

2 0 2 4 6

Based on bore logs and surveys supplied by Western Collieries Ltd
Compiled and correlated by J.H. Lord, B.Sc., F.G.S., March 1950.

SECTION Nº 4
Along Line Through Bores Nºs A2 & A3

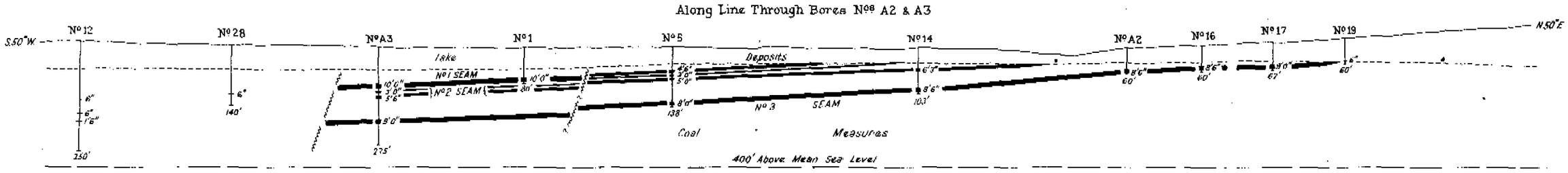


PLATE XIII

11,000'W 10,000'W 9,000'W 8,000'W 7,000'W

17,000'S
Origin: N.W. corner M.L. 417
18,000'S
19,000'S
20,000'S
21,000'S

APPROXIMATE LIMIT OF OPEN-CUT RATIO: 1 COAL TO 8 OVERBURDEN

APPROXIMATE LIMIT OF OPEN-CUT RATIO: 1 COAL TO 6 OVERBURDEN

RATIO: 1 TO 8

RATIO: 1 TO 6

750,000 TONS

1,250,000 TONS

345,000 TONS

235,000 TONS

438

432

Nos 1, 2 & 3 Seams – Average Total Thickness 28½ Feet
Ratio of Coal to Overburden varies from 1:4 to 1:6

No 1 SEAM

No 2 SEAM

No 3 SEAM

EASTERN LIMIT OF COMPLETE

No 2 & 3 Seams – Average Total Thickness 17½ Feet
Ratio of Coal to Overburden varies from 1:4.5 to 1:6

No 3 Seam – Average Thickness 8½ Feet
Ratio of Coal to Overburden varies from 1:5 to 1:10

A

B

C

D

N°1 N°2 N°3 N°4 N°5 N°6 N°7 N°8 N°12 N°13 N°14 N°15 N°16 N°17 N°18 N°19 N°20 N°21 N°22 N°23 N°24 N°25 N°26 N°27 N°28 N°30 N°31 N°32 N°33 N°34 N°35 N°36 N°A2 N°A3

—REFERENCE—

Roadside, position and number	N°5
Fault	
Position of blind outcrop of seam	
Limit of possible open cut	
Lease boundaries	

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

PLAN

—OF—

PORTION OF PROSPECTING AREA 54

(C.M.L.s 431 TO 440)

Showing Position of Possible Open Cut

SOUTH OF SHOTTS

COLLIE MINERAL FIELD

Scale: 4 chains to an inch

2 0 2 4 6

Compiled by J.H. Lord, 1950

It would appear that at the end of 1949, the new proposed installations would reduce costs by nearly 10s. per ton, but subsequent rises in the basic wage, extra industry allowance and rise in costs of stores make it hazardous to estimate any reduction in costs when the new plant and shaft are in operation.

The future of the gold industry is not sufficiently settled to make any accurate long-range estimates of the value of mining properties. There appears to be no slackening in the steady rise of the basic wage and the prices of mining, stores and materials. In addition there is the threat of appreciation of the Australian pound, which would greatly affect the gain made by the gold-mining industry due to devaluation of Sterling.

It is with reluctance that a value is placed on this mine examined at Edward's Find. In order to overcome the difficulties many assumptions have been made which time may prove to be incorrect. Although the total costs at the end of 1949 were 55s. 9d. per ton with the prospect of a reduction by 10s. a ton with the installation of new equipment, in estimating the value of the mine with a life of 4 to 6 years the costs have been increased to 60s. per ton. In order to account for the possible appreciation of the Australian pound, calculations have been made for the present price of gold (£A15 9s. 10d.) and for sterling.

In Table III below the value of the mine is calculated from when the new plant and equipment is installed and ready to operate.

TABLE III.

VALUATION OF SUNSHINE-REWARD AMALGAMATED SYNDICATE'S MINE.

	Measured and Indicated Ore.		Measured, Indicated and Inferred Ore.	
	With gold at £A15–9–10 an oz.	With Gold at Sterling.	With Gold at £A15–9–10 an oz.	With Gold at Sterling.
Tonnage (long) available	37,000	37,000	60,000	60,000
Value dwts/ton	8·6	8·6	8·3	8·3
Gold to be won assuming 93 per cent. extraction	14,800	14,800	23,000	23,000
Value of Gold	£230,000	£185,000	£355,000	£285,000
Costs for mining and treatment at 60s. per ton	£110,000	£110,000	£180,000	£180,000
Period required to mine above tonnage (years)	4	4	6	6
Gross Profit per annum	£30,000	£19,000	£30,000	£25,000
Value of mine with new equipment installed, to pay 15 per cent dividend and to return capital over the period (using Hoskold's Formula)	£75,000	£50,000	£100,000	£85,000

From the figures in the above table it can be readily seen that this mine is a safe small gold-mining venture even if the Australian pound is appreciated and the "inferred" ore of little use. The latter is most unlikely from a geological standpoint.

Future Development.

The future development of the mine has been already planned by the Syndicate along sound lines.

To increase the ore reserves of the mine prospecting is required firstly by proving the lodes to greater depths which can be carried out by winzing after the 300-foot level is established and secondly by proving the lodes over a greater length.

To implement the latter suggestion, driving southwards on the two lodes is recommended, as it is considered that the lodes will develop in that direction and connect with the old workings at the southern end of Lease 3943. Lateral prospecting southwards may find further lodes of similar occurrence to the East Lode and Cross Lode.

On the 200-foot level, prospecting westwards from the southern end of the drive may disclose that the drive is actually on the East Lode and that the Main Lode is to the west (see Section No. 2. Plate X).

Prospecting to the north beyond the fault which at present cuts off the lode may locate it again displaced eastwards; however, the continuation of the lode in this direction is not as promising as to the south. This prospecting, and other lateral prospecting mentioned above, could be easily carried out with some correctly located diamond drill holes.

Conclusions.

The Syndicate's faith in the mine as shown by the proposed installation of a more up-to-date treatment process and the sinking of a new shaft appears to be fully justified.

Geologically the future of the mine appears to be good, as the values are being maintained at depth and prospecting, particularly to the south will probably find that the lodes extend over a greater length than at present being worked.

REPORT ON A PORTION OF PROSPECTING AREA 54, COLLIE MINERAL FIELD, W.A.

By J. H. Lord, B.Sc., F.G.S.

Introduction.

The Goldfields Coal Syndicate (now Western Colleries Ltd.), after successfully prospecting P.A. 53 requested the assistance of the Geological Survey of W.A. in selecting a further prospecting area near Collie. In view of the new idea of the shape of the coalfield derived as a result of the Geological and Geophysical Survey in 1946 and 1947 (to be published in Bulletin No. 105) the writer suggested the area described below. The syndicate, in the name of Mr. E. Scahill, applied for the area on the 12th July, 1948, and requested that the gelogical survey provide geological direction for a drilling programme.

The area comprises some 3,160 acres to the south of the townsite of Shotts, as shown on the on the locality plan on Plate XII and was converted to Mineral Leases 431 to 440 (inclusive) on 19th July, 1949.

No roads have been made on this area, the only access being by timber tracks southwards from Shotts or eastwards from Collie Burn.

There is no recorded knowledge or evidence that prospecting by boring has ever previously been done on the area prior to the operation here described.

Geology.

P.A. 54, as can be seen on the locality map (Plate XII) is on the eastern side of the Main Collie Basin to the south-east of the Stockton Colliery. It was marked out with the object of locating the continuation of the lower or Collie horizon of coal seams from the Stockton, and also the continuation of the middle or Collie Burn horizon from the Collie Burn open-cut. To date only the former objective has been explored.

The coal seams in this area, as elsewhere at Collie, are covered unconformably by Pliocene lake deposits. Unfortunately for open-cut operations, these deposits are thicker here than usual, being 35 to 55ft. in thickness. The surface of the area investigated is chiefly light grey sandy soil with laterite on the ridges to the north-east and south-west. The centre of the area is a shallow valley which is swampy in winter, although during the winter of 1949 (drier than normal) it was passable throughout.

The second hole drilled (No. A3) intersected the Collie horizon of coal seams, after which boring was concentrated in that locality to test it for a possible open-cut site.

Drilling has disclosed the existence of seams with average thickness as follows:—11, 3½, 5½ and 8½ft. separated by an average of 4¼, 5½ and 42ft. of sediments, respectively. The first seam is named the No. 1 seam and is the equivalent of the Moira Seam. The next two seams have been bracketed for correlation purpose as No. 2 seam and are equivalent to the Dirty Seam. The fourth is known as the No. 3 seam and is equivalent to the No. 3 or Wallsend seam of the western portion of this basin. As elsewhere on the Collie Coalfield the nature and thickness of the sediments is variable, but the mean of both is shown diagramatically in Fig. 1, together with the type of roof and floor for each coal seam.

The chief structural feature of the area drilled is the fault at the south-west end, which cuts off the coal seams in that direction. This fault is probably the continuation of the fault which occurs on the south-west side of the Stockton Colliery. As it appears that the seams have been downthrown to the south-west, exploration to the south-east on that side of the fault may locate the blind outcrop of the seams again.

As shown on the plan (Plate XII) the dip and strike of the seams is variable, being largely influenced by the faulting which seems to have a slight rotational motion. The dip is variable from ½° to 11½°, while the strike varies from N.80°W. to N.20°W. The steeper dips occur at the northern end. It would appear as if this coal on the north-west of the fault dipping west-north-west could be a portion of a small synclinal structure formed by slumping, the opposite end being the Stockton Colliery with the seams dipping at approximately 5½° to the south-east at the lowest workings.

The summarised results of the bores encountering the seams are shown on Table I. Other bores which did not intersect the seams because of faults and other reasons can be seen on the plan (Plate XII). Detailed logs of the bores are not published but are on file at the Geological Survey.

Overburden.

For open-cut operations, it is considered that all the lake beds (thickness 35ft. to 50ft.) could be removed by shovel or dragline without blasting. The greater portion of the coal measures could probably be removed in a similar manner.

TABLE I.

CORRELATION OF COAL SEAMS ENCOUNTERED IN BORES ON P.A. 54.

Bore.			No. 1 Seam.		No. 2 Seam (upper).		No. 2 Seam (lower).		No. 3 Seam		Depth to Water.
No.	Reduced Level.	Depth.	Thickness.	Depth.	Thickness.	Depth.	Thickness.	Depth.	Thickness.	Depth.	
		(feet)	ft. in.	(feet)	ft. in.	(feet)	ft. in.	(feet)	ft. in.	(feet)	(feet)
A2	670	60	(a)	(a)	(a)	(a)	(a)	(a)	8 6	50	20
A3	678	225	10 6	86½	3 0	103	5 6	113	9 0	168½	34
1	675	80	10 0	68½	(b)	(b)	(b)	(b)	(b)	(b)	30
2	674	74	8 0	45½	4 0	58	5 6	66	(b)	(b)	25
5	673	138	4 6	55½	3 0	64	5 0	71½	8 0	128½	29
6	672	167	10 6	83½	3 0	98½	6 0	109	8 0	157½	25
7	671	68	(a)	(a)	(a) (?)	(a) (?)	5 6	56	(b)	(b)	20
8	671	124	10 6	90	3 0	104½	6 0	116	(b)	(b)	25
14	671	103	(a)	(a)	(a) (?)	(a) (?)	6 3	48	8 6	93	25
15	670	50	(a)	(a)	(a)	(a)	(a)	(a)	8 0	40	3
16	677	60	(a)	(a)	(a)	(a)	(a)	(a)	8 6	50	25
17	685	62	(a)	(a)	(a)	(a)	(a)	(a)	9 0	51	....
20	674	99	(a)	(a)	3 6	47	5 3	53	9 6	88	35
21	671	82	12 6	68	(b)	(b)	(b)	(b)	(b)	(b)	28
22	666	54	12 6	39½	(b)	(b)	(b)	(b)	(b)	(b)	25
23	686	100	(a)	(a)	6 0	69½	5 0	79	(b)	(b)	....
24	665	179	12 0	97½	3 6	113½	6 6	123½	9 0	168½	20
25	665	80	5 6	56	3 0	64	6 6	72½	(b)	(b)	25
26	677	70	(a)	(a)	3 0	54½	6 0	63½	(b)	(b)	35
30	678	136	11 6	124	(b)	(b)	(b)	(b)	(b)	(b)	31
31	672	132	12 6	119	(b)	(b)	(b)	(b)	(b)	(b)	35
32	673	112	11 6	99½	(b)	(b)	(b)	(b)	(b)	(b)	29
33	672	96	(a)	(a)	(a)	(a)	(a)	(a)	9 0	86	....
35	677	61	(a)	(a)	(a)	(a)	(a)	(a)	5 0	55	....

(a) Bore commenced below this seam in the stratigraphical succession.
(b) Bore stopped before reaching this seam.

Quality of the Coal.

The coal seams were sampled in all bores, and a selection analysed by the Western Australian Government Chemical Laboratories. Percussion samples are not entirely satisfactory, but it is considered that a reasonable sample was obtained be seating the casing onto the coal whenever possible and sampling the material brought up by the sludge pump, while drilling through the seam.

Since it has been considered that these seams intersected on P.A. 54 are members of the Collie or lower horizon of the Main Collie Basin, it follows that the quality of the coal should be equivalent to the better Collie coals.

The bottom or No. 3 seam, as elsewhere, is the best quality seam having, where analysed, an average calorific value of 9,952 B.Th.U's. and an average ash content of 4.65 per cent. on a 20 per cent. moisture basis.

Actually the upper portion of the No. 2 seam is the poorest coal of all, but when weighted and averaged with the lower portion of the No. 2 seam it has an average calorific value of 9,520 B.Th.U's., with an ash content of 7.05 per cent.

The top or No. 1 seam has an average calorific value of 9,350 B.Th.U's., with an average ash content of 7.77 per cent.

The three seams average a total of 28½ feet in thickness and the following is the weighted mean analysis for the three seams together:—

	%
Ash	6.6
Calorific Value (Dry Ash free)	13,060 B.Th.U.
Calorific value (20 per cent. moisture)	9,580 B.TH.U.

The detailed results of analyses are shown on Tables II, III and IV for seams Nos. 1, 2 and 3 respectively.

Fig. 1

AVERAGE STRATIGRAPHICAL SUCCESSION OF COAL SEAMS
— ON PORTION OF —
PROSPECTING AREA 54

DESCRIPTION OF STRATA	STRATA	AVERAGE THICKNESS (FEET)	AVERAGE ANALYSIS OF COAL		
			20% MOISTURE BASIS		DRY ASH FREE
			ASH %	CALORIFIC VALUE-B.T.U.	CALORIFIC VALUE-B.T.U.
Black Shale					
Coal No. 1 SEAM		11	7·77	9,350	12,950
Grey Sandy Shale		4¼			
No. 2 SEAM — Coal		3½	9·04	9,184	12,930
No. 2 SEAM — Grey Sandy Shale		5½			
No. 2 SEAM — Coal		5½	5·79	9,734	13,120
Black Shale Sandy Shale Grey and Black Shale with thin Coal Seams Sandstone		Weighted Mean for No. 2 Seam 42	7·05	9,520	13,050
Coal No. 3 SEAM		8½	4·65	9,952	13,210
Grey Sandy Shale					
Weighted Mean for Nos. 1, 2 and 3 Seams Total 28½′			6·6	9,580	13,060

TABLE II.

ANALYSES OF No. 1 SEAM FROM BORE SAMPLES.

Bore No.	Thickness of Seam. (feet.)	Proximate Analyses.				Calorific Value B.Th.U./lb.	Dry Ash-free.		Sulphur.	Ash.	
		Moisture %	Ash %	Volatile Matter %	Fixed Carbon.		Volatile Matter.	Calorific Value.		% Dry Basis.	Colour.
A3	Top 5	20·00	7·49	22·63	49·88	9,255	31·21	12,760	0·12	9·36	Fawn
	Bottom 5½	20·00	6·29	22·15	44·56	9,510	39·54	12,890	....	7·86	Fawn
1	10	20·00	6·17	22·97	50·86	9,450	31·11	12,810	0·07	7·72	Light brown
2	8	20·00	8·48	21·51	50·01	9,370	30·05	13,100	....	10·58	White
5	4½	20·00	7·18	23·87	48·95	9,550	32·77	13,120	0·18	....	Light brown
21	12½	20·00	8·02	23·73	48·25	9,380	32·98	13,020	0·13	10·02	Pale salmon pink
22	12½	20·00	8·60	23·83	47·57	9,320	33·37	13,060	0·03	10·74	Pale salmon pink
24	12	20·00	6·67	23·72	49·61	9,470	32·34	12,920	0·12	8·34	Red brown
31	12½	20·00	11·05	21·58	47·37	8,870	31·29	12,860	0·19	13·81	Light brown
Average	....	20·00	7·77	23·67	48·56	9,353	32·74	12,950	0·09	9·80	

TABLE III.

ANALYSES OF No. 2 SEAM FROM BORE SAMPLES.

Bore No.	Thickness of Seam. (feet.)	Proximate Analyses.				Calorific Value B.Th.U./lb.	Dry Ash-free.		Sulphur.	Ash.	
		Moisture %	Ash %	Volatile Matter %	Fixed Carbon.		Volatile Matter.	Calorific Value.		% Dry Basis.	Colour.
						Top Section.					
A3	3	20·00	9·50	23·14	47·36	9,060	32·82	12,840	....	11·89	Fawn
2	4	20·00	8·52	22·49	48·99	9,250	31·45	12,950	....	10·65	Cream
5	3	20·00	10·59	21·06	48·35	8,920	30·35	12,840	....	....	Light brown
23	6	20·00	4·74	24·63	50·63	9,940	32·73	13,200	0·10	5·92	Pale salmon pink
24	3½	20·00	11·84	21·27	46·89	8,750	31·20	12,830	0·11	14·80	Light brown
Average	....	20·00	9·04	22·52	48·22	9,184	31·71	12,932	....	10·81	
						Bottom Section.					
A3	5½	20·00	6·29	24·55	49·16	9,510	33·31	12,890	....	7·86	Fawn
2	5½	20·00	5·61	23·52	50·87	9,730	31·61	13,100	....	7·01	Fawn
5	5	20·00	3·78	25·06	51·16	10,140	32·88	13,300	....	....	Reddish brown
24	5	20·00	5·56	26·16	48·28	9,830	35·14	13,200	0·16	6·95	Pale salmon pink
25	6½	20·00	7·70	23·68	48·62	9,460	32·75	13,090	0·15	9·62	Light brown
Average	....	20·00	5·79	24·59	49·62	9,734	33·14	13,116	....	7·86	

TABLE IV.

ANALYSES OF No. 3 SEAM FROM BORE SAMPLES.

Bore No.	Thickness of Seam. (feet.)	Proximate Analyses.				Calorific Value B.Th.U./lb.	Dry Ash-free.		Sulphur.	Ash.	
		Moisture %	Ash %	Volatile Matter %	Fixed Carbon.		Volatile Matter.	Calorific Value.		% Dry Basis.	Colour.
A2	8½	20·00	5·36	27·34	47·30	9,880	36·64	13,230	0·22	6·70	Salmon
A3	9	20·00	3·18	26·11	50·17	10,010	34·00	13,040	0·19	3·98	Reddish brown
5	8	20·00	5·23	23·33	51·24	9,890	31·47	13,230	....	....	Light brown
16	8½	20·00	3·98	26·98	49·04	10,130	35·48	13,320	0·17	4·97	Pale slamon pink
24	9	20·00	5·52	25·41	49·07	9,850	34·11	13,230	0·21	6·90	Light brown
Average	....	20·00	4·65	25·83	49·36	9,952	34·34	13,210	0·20	5·64	

Coal Reserves.

This area has been investigated for open-cut operations, but as stated, the coal seams do not rise closer than 40 feet to the surface. As a result of this, if operations were commenced at the blind outcrop of No. 3 seam, the ratio would be 4 of over-burden to 1 of coal, which would increase working north-westwards to almost 10:1 before the blind outcrop of No. 2 seam is reached. Continuing operations north-westwards from the blind outcrop of No. 2 seam, the ratio would increase from 4.5:1 to 6:1 where the blind outcrop of No. 1 seam would be encountered, and the ratio reduced again to approximately 4:1, after which the ratio would increase as no further seams would be encountered.

The mining engineer will have to determine if and how the seams can be extracted. In consequnce the coal reserves are set out in two ways taking as the north-western limit the 6:1 ratio line of the three seams (see Plate XIII). The whole of this area can be classified as measured coal and the following quantity of coal is available in each seam (assuming 30 cubic feet of coal is equivalent to 1 ton).

	Tons.
No. 1 Seam (Top) 11′ thick	480,000
No. 2 Seam (Middle) 9′ thick	570,000
No. 3 Seam (Bottom) 8½′ thick	780,000
	1,830,000

It is considered that Area A (Plate XIII) containing the 3 seams and Area B containing 2 seams could be extracted by open cut methods as the ratio varies from 4:1 to 6:1. However, the Area C with only the No. 3 seam is doubtful as the ratio varies from 5:1 to nearly 10:1. These Areas, as shown on Plate II, contain the following amounts of coal:—

Area.	Seams.	Total Thickness.	Approx. Ratio.	Tonnage.
		(feet)		
A	1, 2 and 3	28½	4 : 1 to 6 : 1	1,250,000 (measured)
B	2 and 3	17	4·5 : 1 to 6 : 1	345,000 (measured)
C	3	8½	5 : 1 to 10 : 1	235,000 (measured)
			Total	1,830,000 (measured)
D	1, 2 and 3	28½	6 : 1 to 8 : 1	750,000 (inferred)
			Grand Total	2,580,000

If the operational costs permit, open-cut operations could be extended north-westwards beyond the 6:1 to the 8:1 ratio (Area D on Plate XIII) for another 750,000 tons of coal, but this is only inferred coal at present. Similarly it may be possible to extend operations further to the 10:1 ratio line.

Future Exploration.

Only a small portion of P.A.54 has been investigated in detail. The following are the future exploratory possibilities:—

1. The three seams can be investigated to the north beyond the ridge, which at present limits any open-cut operations in that direction.

2. Deeper holes can be drilled down the dip towards the Stockton Colliery to prove the seams in that direction. This could be combined with (1) above if there were a possibility of the coal being extracted by underground working.

3. Exploration could be done on the south-west side of the major fault to locate the 3 seams, either by deep drilling or shallow bores to the south-east.

4. Drilling could be carried out to locate and prove the Collie Burn horizon of coal seams, probably on Lease 437 (formerly 131).

Conclusion.

On the portion of P.A.54 investigated there is approximately 1,600,000 tons of measured coal available, working from a ratio of 4 of overburden to 1 of coal to a ratio of 6:1.

In addition there is 230,000 tons of measured coal with a ratio varying from 5:1 to 10:1, and 750,000 of inferred coal with a ratio varying from 6:1 to 8:1.

The quality of the coal is equivalent to the better Collie coals, the weighted average analysis for the three seams being:—

Ash 6.6%
Calorific Value (20% Moisture) 9,580 B.Th.U.
Calorific Value (Dry, ash free) 13,060 B.Th.U.

REPORT ON THE VERMICULITE DEPOSITS ON M.C. 187H, YOUNG RIVER, OLDFIELD DISTRICT, EUCLA LAND DIVISION OF WESTERN AUSTRALIA.

Approximate Latitude 33° 32'S.
Approximate Longitude 121° OO' E.

By W. Johnson (B.Sc. Hons.) and J. Gleeson (B.Sc.).

Introduction.

A geological and topographical map of M.C. 187H was prepared by the writer (W. Johnson) and Mr. Gleeson in January, 1949, with the object of determining if possible the structural control of the vermiculite deposition which has occurred in the rocks on M.C.187H and in the vicinity. On completion of the mapping and examination it was hoped to be able to lay down a diamond drilling programme to assist the owners of the claim (Perth Modelling Works Ltd.) in a search for other vermiculite lodes and extensions of the existing ones.

Locality and Access.

M.C.187H covers an area on the east bank of the Young River about 65 miles due east of Ravensthorpe. The claim is reached by a track turning off the main Ravensthorpe-Esperance road 60 miles east of Ravensthorpe. The distance from turn-off to claim is 17 miles by car speedometer. The nearest railhead and shipping port is Esperance 80 miles east by road. The vermiculite produced at the claim is transported by truck to Esperance and by rail from Esperance to the Company's works at East Perth. Rail distance Esperance-Perth is 585 miles. Road distance of the claim by shortest route from Perth is 410 miles. The worst of the roads and tracks are in sufficiently good condition to allow a heavily loaded motor truck to maintain an average speed of 13 miles an hour over them.

Physiography and Geology.

The physiography and geology of the country surrounding M.C.187H have been described by Ellis in a previous report[1]. As the present report results from a more detailed geological examination of the area, it is possible to add some information to Ellis' description.

Physiography.

The Young River flows in a wide valley entrenched below the surface of an uplifted peneplain. In the vicinity of M.C 187H the depth of entrenchment is 100 to 120 feet, and the height of the uplifted peneplain is estimated to be between 300 and 500 feet above sea level. The river course exhibits incised meanders, implying rejuvenation of an ancestral Young River, which before uplift of the peneplain must have been in the oldest stage of river history. The presence of at least two river terraces implies two pauses in the uplift of the peneplain.

Within observable distance of M.C. 187H and the track leading to the Ravensthorpe-Esperance Road, no hills project above the extremely level profile of the plateau.

The area drained by the ancestral Young River must have been a perfect peneplain.

Petrology.

A general description of the rock formations is given by Ellis (op. cit p. 7).

> On the Young River in the vicinity of the vermiculite deposits, where there are some good exposures, they (the biotite-hornblende-feldspar-quartz gneisses) can be seen to be intruded by basic rocks forming an actinolite-anthophyllite-hornblende complex.
>
> Here, the country rock is mainly biotite gneiss with interbedded hornblende granulite, which is sometimes gneissic and sometimes massive, The regional strike is north-south with a prevailing dip of from 40° to 50° to the east, and both the gneisses and intrusive basic rocks have been intruded by muscovite bearing granite, tourmaline-bearing pegmatite dykes, and quartz reefs.
>
> In the absence of definite proof as to age, the schistose and gneissic series is presumed to be of pre-Cambrian age, and from its general appearance in the field to be formed mainly from metamorphosed sediments.

The writer agrees with this general picture and is able to add some detailed information.

From field and microscopic examinations it appears likely that the extremely well foliated biotite gneiss has resulted from granitisation of pre-existing sediments. It is a replacement gneiss rather than a true para-gneiss.

[1] 1943 Ellis, H. A., The Young River Vermiculite Deposits, Young River, Eucla Division, W.A., Ann. Prog. Rep., G.S.W.A., 1943; pp. 6-9.

PLATE XIV

Lease Datum Peg R.L.504'

90° M. 25 Chains

00° M. 40 Chains

North Magnetic

Acid granite containing large felspar crystals

Gr

Hornblende granulite boulders

Mallet & ti-tree vegetation

Soil-covered slopes

Yate vegetation

Occasional fragments of actinolite rock in soil

Actinolite rock

Crest of hill

Fragments of biotite gneiss in soil

Gn

S

Quartzite

Y.R.A. R.L.500'

Boulders of actinolite rock

Hornblende granulite

Vermiculite seam

Vermiculite

Pegmatite dyke

Vermiculite in these workings

No 3 LODE

Working shaft. R.L.509' (Collar) Total depth 67'

No 4 LODE

Shaft R.L.554 (Collar)

Open cut

Acid granite gneiss

Boulders of hornblende granulite

Vermiculite in pothole

Boulders of actinolite rock in soil

Soil-covered slope

Soil-covered slopes

Boulders of actinolite rock outcrop along brow of hill

Vermiculite in East and West ends of costean

Vermiculite seam in East end of costean

Good quality vermiculite with magnesite

Track

Hornblende granulite

Outcrop of actinolite rock

Vermiculite seam in actinolite rock, in costean

Diamond drill holes Prospecting shaft site

Vermiculite seam in prospect hole

Actinolite rock and opaline silica boulders in soil

Vermiculite in prospect hole

Tourmaline bearing pegmatite dykes

Actinolite rock

Vermiculite seam in actinolite rock

Track in from Ravensthorpe-Esperance Road

Sandy alluvium

Remains of earlier river terrace

Y O U N G R I V E R

Weathered ultrabasic rocks

Main Camp Building

Vermiculite in prospect hole

Basic tuff?

Hornblende granulite

Yate vegetation

Hornblende granulite boulders

Vermiculite veins in holes.

Vermiculite in shaft

Remains of salt pool

Vermiculite prospect

Anthophyllite actinolite rock

Hornblende granulite containing limonite crystals which are pseudomorphic after garnet or are primary ilmenite crystals

Open cut VD 26'

Old workings

1A LODE SHAFT A

Main shaft. R.L.478' (Collar)

30' VD in biotite gneiss Ground water at bottom

Vermiculite prospect hole

Vermiculite prospect holes

Underlay shaft 16' deep Sunk on vermiculite seam Strike N5°W.

Lenticular bands of hornblende granulite outcrop in biotite gneiss No biotite in hornblende granulite and contact is quite sharp.

LEGEND

- Alluvium, clay, sand, ferruginous grit to 15 feet thick. ~
- Granite. Coarse grained acid, rudely foliated in part. Gr
- Hornblende granulite, metamorphosed basic intrusives.
- Gneiss. Replacement gneiss Gn
- Metamorphosed sediment. Remnant quartzite in replacement gneiss. S
- Actinolite granulite. Metamorphosed ultrabasic intrusive
- Pegmatite dykes. P

REFERENCE TO SIGNS

- Geological boundary observed
- Geological boundary approximate
- Geological boundary assumed
- Strike and dip of foliation in gneiss N15°E 70°
- Strike and dip of bedding N15°E 70°
- Outcrops with no observed strike and dip
- Open cut
- Accessible shaft
- Inaccessible shaft
- Elevation in feet with reference to assumed datum 450'
- Boundary of bed of Young River

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

GEOLOGICAL MAP OF M.C. 187H - YOUNG RIVER

OLDFIELD LAND DISTRICT

Lands Dept. Litho. 422/80, B1

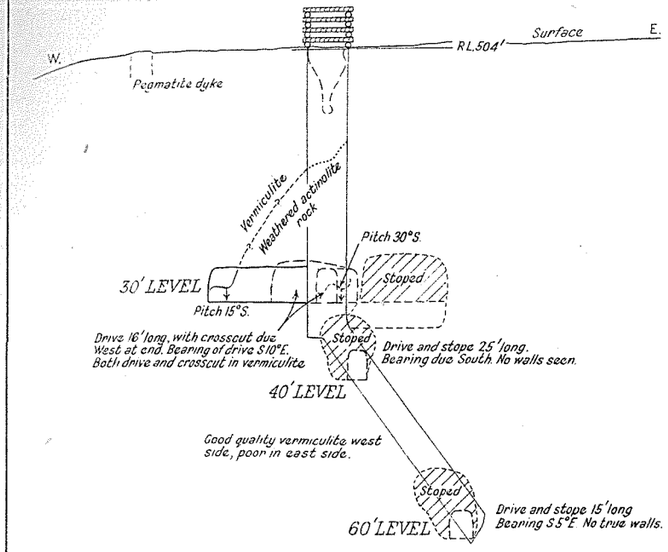
Scale: 100 feet to an inch

100 0 100 200

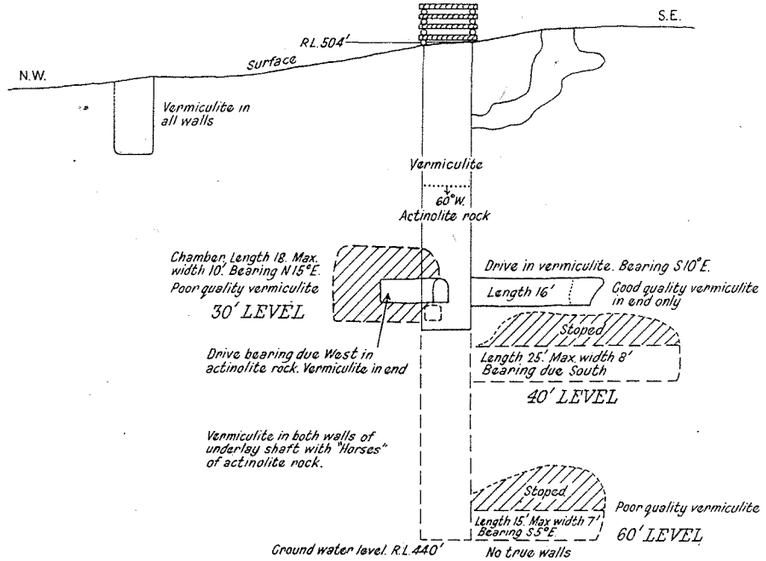
Geology, contours and plane table traverses by W. Johnson and J. Gleeson, Jan. 1949.
Assumed datum, Station YRA, 500 feet above Mean Sea Level

—No 3 LODE WORKINGS—

SECTION ALONG LINE BEARING DUE EAST AND WEST

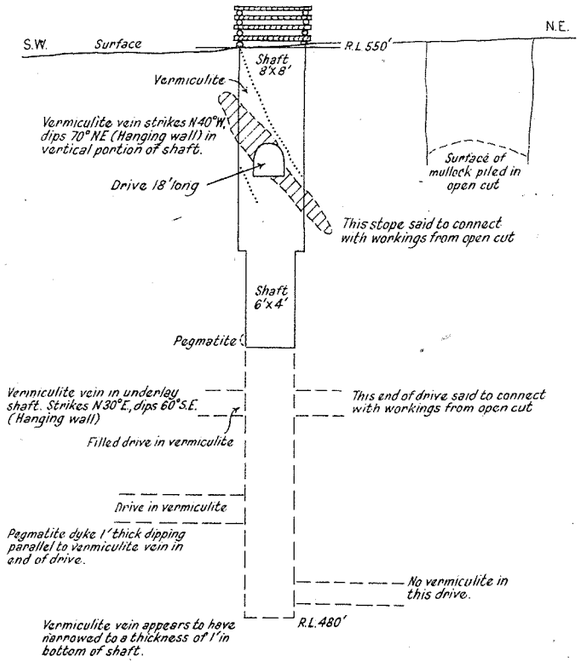


SECTION ALONG LINE BEARING N.37°W.

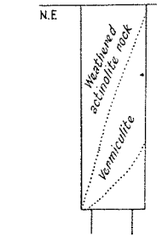


—No 4 LODE WORKINGS—

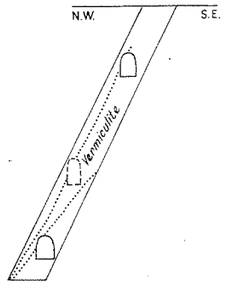
SECTION ALONG LINE BEARING N.42°E.



VERTICAL PORTION OF SHAFT SOUTH EAST FACE

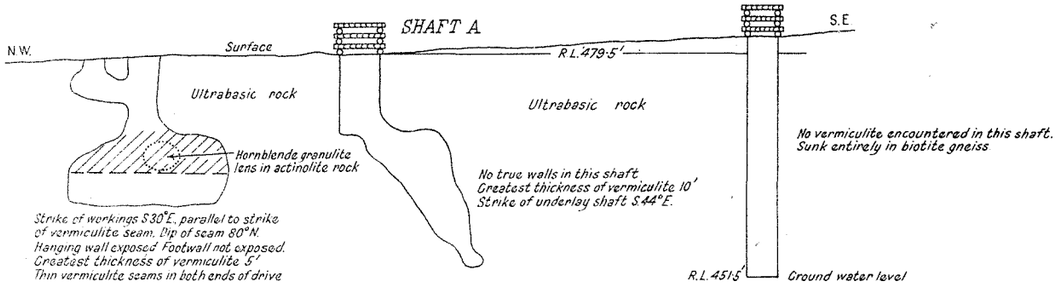


UNDERLAY PORTION OF SHAFT NORTH EAST FACE



—No 1A LODE WORKINGS—

SECTION ALONG LINE BEARING N.60°W.



—REFERENCE—

- Workings close to or in plane of section ———
- Workings at a moderate or large angle to plane of section. — — — —
- Observed geological boundaries .....
- Approximate geological boundaries --------
- Assumed geological boundaries --?----?--

GEOLOGICAL SECTIONS OF MAIN WORKINGS
VERMICULITE DEPOSITS
—M.C. 187H YOUNG RIVER—

Scale: 20 feet to an inch

Within the outcrop area of ultrabasic rocks on M.C. 187H are outcrops of elongated bodies of hornblende granulite. These bodies have a massive or rudely foliated texture and are identical in hand specimen with the interbedded hornblende granulite in the replacement gneiss.

Microscopically the two hornblende granulites show important differences. Those outcropping within the ultra-basic rocks have an approximate mineral composition 60-75 per cent. hornblende, 20-35 per cent. labradorite, 5 per cent. sphene, magnetite and apatite, with particularly abundant sphene. Foliation is barely noticeable in thin section.

The interbedded hornblende granulites have an approximate mineralogical composition 35 per cent. hornblende 30 per cent. quartz 30 per cent. labradorite—5 per cent. magnetite with abundant accessory apatite and some fragments of biotite and sphene. The foliation is marked in thin section.

One explanation of the mineralogical difference between the two types is that the hornblende granulite bodies within the ultrabasic rock represent contaminated xenoliths caught up during the intrusion of the ultrabasic magma into the metasediments. A difficulty confronting this hypothesis is the absence of any more acid remnants in the centre of the granulite bodies. In the field the centres are often the more basic part of the rock.

Another, and in the writers' opinion more feasible, hypothesis, is that the hornblende granulite bodies, both in the ultrabasic rock and replacement gneiss represent basic intrusives intruded before granitisation of the suite. Those within the ultrabasic intrusives being more protected from metasomatic alteration by the granitising agent. This hypothesis presupposes the intrusion of the ultrabasic magma prior to granitisation.

The economic significance of the hornblende granulite bodies in the ultrabasic rocks is that by providing strong, competent "ribs" they may have controlled the directions of shear within the ultrabasic rock and also may have localised belts of intense shattering (Plate XIV shows that the numerous vermiculite prospects around Nos. 1A and 3 lodes are almost confined to one side of the associated hornblende granulite body).

From their field relationship with the gneiss the ultrabasic intrusives appear to be concordant and possibly of laccolithic nature.

A brief summary of geological events in the area is as follows:—

A series of acid sediments derived from a terrain not exposed in this area was intruded by ultrabasic magma. This suite was then intruded by basic magma and the whole subjected to the process of granitisation, this process affecting the bedded rocks with thin concordant basic intrusives more deeply than the massive ultra-basic intrusives. After an undeterminable interval all these earlier rocks were intruded by acid granite, this latest intrusion being accompanied by shearing and the introduction of vermiculite forming solutions into the shears. The last igneous event was the intrusion of pegmatite dykes along shear zones.

A rock type worthy of mention is one consisting entirely of large poeciloblastic crystals of hypersthene in a medium grained ground mass of actinolite (Size of the hypersthene crystals varies from $\frac{1}{8}$ inch square by $\frac{1}{4}$ inch long to $\frac{3}{4}$ inch square by $1\frac{1}{2}$ inches long). Parts of the ultrabasic intrusive on M.C.187H and most of a large geographically distinct intrusion $\frac{1}{2}$ mile southwest of M.C.187H have been converted to this rock. This rock may be called an ultrabasic charnockite and its interest lies in the association of similar rock types with vermiculite at Dangin[2].

[2] 1945, PRIDER, R. T., Charnokitic and Related Cordierite Bearing Rocks from Dangin, Western Australia. Geol. Mag. Vol. LXXXII, No. 4, pp. 145-172.

Structural Geology.

The few minor dragfolds observed in the outcropping rocks and in underground workings have pitches to the South of varying degree, none steeper than 50°. This is the only indication of regional pitch. The relatively large dragfold depicted on the map, Plate XIV, suggests that the rocks in the vicinity of M.C.187H are on the west limb of an overturned anticline pitching south. The structural evidence is too meagre to forecast extensions on the pitch of the vermiculite veins so far discovered.

In the underground workings no obvious sign of pitch to the south was observed in the vermiculite ore bodies. This may be due to insufficient exposure of the ore bodies by the small extent of the workings.

The vermiculite veins all lie in shears and are themselves sheared, indicating that shearing continued while vermiculite was being formed.

The shears strike in all directions and dip at steep angles mostly greater than 55°. Most of the shears seem to be concentrated round one of three directions; N.40°W., due N., and N.40°E. The long axes of the elongated hornblende granulite bodies are in the same directions and it is thought that these bodies may have controlled the directions of shearing in the ultrabasic mass.

The dimensions of individual shears are not large. They have been traced for a maximum of 100 feet in length and 30 feet in depth but may be larger in both length and depth as workings have stopped before the limits of the shear have been reached.

The Vermiculite Deposits.

The present writer fully agrees with Ellis' ideas on the origin of the Young River vermiculite. It should be emphasised that in none of the deposits worked has there been any indication of the conversion of phlogopitic or biotitic micas into vermiculite. In all deposits vermiculite abutted on actinolitic—or hornblendic rock masses. Non-vermiculitic micas are scarce minerals in the vicinity of M.C.187H. Even the biotite replacement gneiss contains only 3%-4% of biotite.

It is therefore probable that the vermiculite at Young River was formed by direct metasomatic alteration of actinolitic rock along shear zones by potash rich emanations from the later granite. Anthophyllite rich zones have been formed at the edge of the vermiculate zones and the calcium expelled from the actinolite has formed plagi clase feldspar (Spec. G.S.W.A. 2/4309 is a "concretion" consisting entirely of actinolite and plagioclase feldspar found in the middle of a vermiculite vein).

In 1943 Ellis described two main workings, the Northern and Southern Deposits. To the end of 1943 total production was 725.55 tons of which 420 tons came from the Northern Deposit and 150 tons from the Southern Deposit. From Dec. 31, 1943, to Dec. 31, 1948, production was 556 tons, making a total of 1,281.55 tons.

This total was distributed approximately as follows:—

	Tons.
No. 4 Lode	600
No. 3 Lode	450
No. 1A Lode	200
Other workings?	30

The value of the 1281.55 tons as reported to the Mines Department was £7,755 equal to approximately £6, 0s. 9d. per ton. The 1949 price of the exfoliated vermiculite is £30 per ton.

Descriptions of individual workings follow.

No. 1A Lode.

The workings on this "lode" are 240 feet south-east from the open cut described by Ellis as being on the Southern Deposit. It is not likely that they are on a south-east continuation of the seam exposed in that open cut.

The most recent productive working is a combination vertical and underlay shaft (shaft A) of total vertical depth 27 feet. The strike and dip of the vermiculite seam in this shaft are not apparent. The bearing of the underlay shaft is

S.44°E., and its dip 50°. At right angles to this bearing a width of 10 feet of vermiculite has been exposed. Horses of actinolitic rock exist in the footwall of the underlay shaft but it cannot be assumed that this is the footwall of the seam. The quality of vermiculite in this shaft as in all other workings is extremely variable.

Twenty five feet north-west from shaft A is an older shaft 18 feet vertical depth with a drive each way from the bottom striking N.30°W length 9 feet and S.30°E, length 11 feet. Some overhand stoping has been done above these drives. The hanging wall only of the vermiculite has been exposed and the maximum thickness in the slope is 5 feet. Vermiculite is visible in both ends. The drives are parallel to the strike of the seam which dips 80° N.E. The projected strike of this seam would not carry it directly into the seam exposed in shaft A.

Forty five feet south-east of the shaft a vertical shaft has been sunk entirely in sheared biotite gneiss to a vertical depth of 30 feet. Ground water was encountered in the bottom of this shaft.

No. 3 Lode.

The main working on this deposit consists of a combination vertical and underlay shaft, total vertical depth 60 feet. The vertical portion extends from the surface to 35 feet; from the surface to 16 feet it is in weathered vermiculite and from 16 to 35 feet in weathered actinolite rock. The upper contact dips 60°W. The vermiculite seam entered at 30 feet apparently dips 50°E.

At the 30 feet level two drives and a chamber-like opening extend in various directions. One drive bearing due west and 12 feet long is in actinolite rock. This drive cuts the vermiculite-actinolite contact at a distance of 10 feet from the shaft. The contact exposed in the walls of the drive is dragfolded with a pitch 20°-30° S. The other drive bears S. 10°E and has a length of 16 feet. At its end a crosscut 9 feet long has been cut 9 feet due west. Both crosscut and drive are in vermiculite. The chamber-like opening has a long direction bearing N.15° E. All walls are composed of vermiculite, its length is 18 feet, maximum width 12 feet, height 10 feet. The vermiculite in the walls of this chamber is of poor quality.

The underlay shaft appears to follow a shear in the vermiculite. Drives extend due south at the 40 feet and 60 feet levels and limited overhand stoping has been carried out from them. The maximum stope width is 9 feet. True walls have not been exposed in any workings in the underlay shaft.

No. 4 Lode.

A considerable amount of work has been carried out on this deposit. An "open cut" length 50 feet, maximum width 20 feet, depth 18 feet is shown on the map, Plate XIV. This "open cut" is said to be the result of collapse of a "rabbit warren" of underground workings. Remains of vermiculite seams 1 foot to 3 feet wide can be seen in the ends, and sides of the open cut. The strike of these seams was apparently N. 40°W. and the dip steep both S.W. and N.E. The maximum width of vermiculite exposed in the old workings was 16 feet.

Sixteen feet west of the south and of the open cut a combination vertical and underlay shaft has been sunk to a vertical depth of 70 feet. The vertical part is 35 feet deep.

The vertical shaft cuts through a seam of vermiculite, strike N.40°W. and dip 70° N.E. (hanging wall). This seam has a maximum thickness of 8 feet and, has been driven on for a distance of 18 feet in the north-westerly direction. The drive is 16 feet below the ground surface. Both overhand and underhand stoping have been carried out from this drive 8 feet above the drive and 9 feet below. The underhand stope is said to have connected with workings from the "open cut." This seam passes into the north-east wall of the shaft at a depth of 25 feet from the surface.

The underlay shaft follows approximately the dip of a seam of vermiculite strike N. 30°E. dip 60°N.W. At the bottom of the shaft this seam has narrowed to a true thickness of 1 foot from a thickness of 4 feet, 30 feet higher up. One drive on the seam at a vertical depth 58 feet extends 17 feet on a bearing S. 25°W. At the end of this drive is a thin pegmatite dyke apparently dipping parallel to the vermiculite vein.

No apparent connection exists between the seams exposed in the vertical and underlay portions of the shaft. If the two are parts of the one seam the connection must be a pitching fold having a pitch either north or south.

Conclusion.

The detailed examinaton of M.C. 187H and workings has resulted in the following conclusions:—

(1) The vermiculite at Young River has formed by metasomatism of actinolite rock along shear zones by alkali-rich hydrothermal solutions.

(2) Shearing took place before, during, and subsequent to vermiculite formation.

(3) The exfoliating quality of the vermiculite is variable and cannot be adequately judged from appearance.

(4) None of the development openings have been made with sufficient method and of sufficient length to adequately prove the extent of the existing producing seams.

Reasons given by the owners for stopping development openings are, hardness of rock, presence of water and poor quality of vermiculite.

Recommendations.

The examination was carried out with the object of laying down a diamond drill exploration programme to search for extensions of the vermiculite ore bodies as the Company's ore reserves were getting low. In the writer's opinion the lack of reserves is due to unmethodical development of the deposits being worked, rather than exhaustion of vermiculite in these deposits. Therefore it will be more profitable and cheaper to systematically prove these deposits by proper development before looking for further deposits with a diamond drill. With this in mind a two fold programme is presented below with emphasis on the development programme.

Development.

To carry out this programme it will be necessary to provide adequate equipment to deal with hard rock and water (compressor, rock drill, pump). Also, encountering poor quality vermiculite in workings should be no excuse for stoppage of the drive crosscut etc., as the quality of the vermiculite is known to be variable over short distances.

Developments should be tackled in the order presented below.

No. 3 Lode.

(1) 40 feet level—

(i) Continue existing drive south on vermiculite to a total length of 100 feet from shaft or to a point where shear dies out.

(ii) Drive north 100 feet on vermiculite or to a point where shear dies out.

(iii) Crosscut due east and west at least 30 feet from shaft.

(2) 60 feet level—

(i) Continue existing drive south 100 feet from shaft or to a point where shear dies out.

(ii) Drive north 100 feet or to a point where shear dies out.

(iii) Crosscut east and west for 30 feet.

(3) Sink underlay shaft to a total vertical depth of 100 feet from the surface (inclined depth 82 feet from top of underlay portion.) If not on vermiculite, crosscut 30 feet east and west and drive on any vermiculite seams encountered.

No. 4 Lode.

1. At bottom of 8 feet by 8 feet portion of vertical shaft drive north-west and south-east on vermiculite for a distance of 50 feet.

2. In the underlay shaft at a vertical depth of 58 feet continue existing drive 50 feet on the present bearing and drive N. 25°E. for a distance of 50 feet.

3. Sink underlay shaft to a vertical depth 100 feet from surface (approximately 80 feet inclined depth from top of underlay portion). Cross cut north-west and south-east for 30 feet.

No. 1A Lode—

Abandon underlay portion of shaft A. Sink vertical portion to a depth of 50 feet. Crosscut 30 feet north and south. Drive on any vermiculite seam encountered.

Prospecting.

The available information on the vermiculite seams indicates that they are short in length both along the strike and down the dip and that their pitch if any may be at a shallow angle to the south.

The probable small dimensions of the seam and the indefiniteness of the regional pitch discourages any aiming for a specified target in the direction of regional pitch with a diamond drill.

Mr. Ellis, the Government Geologist has suggested verbally to the owners that they sink a shaft, in the middle of the most promising area, below the zone of weathering, and fan out a series of horizontal diamond drill holes from the bottom.

The most likely area to test by this method is that surrounding No. 4 Lode. Here there are a series of prospects running from 100 feet north of the main shaft to 600 feet south of the main shaft. Unfortunately the present main shaft is in the wrong position to adequately test the line of vermiculite prospects, and a new shaft should be sunk at the point marked on Plate XIV (D.D. Holes Prospecting Shaft Site) 310 feet S. 28°W. from the existing main shaft. This shaft would probably have to be at least 100 feet deep.

From the bottom of this shaft a series of horizontal holes should be put out to the capacity of the drill (recommended 350-400 feet) in the following directions and order (I) North (II) N.15°E. (III) N.30°E. (IV) N.60°E. (V) East (VI) S.75°E. (VII) S.45°E. (VIII) S.30°E. (IX) N.80°W. (X) N. 40°W.

The areas surrounding Nos. 1A and 3 lodes could be tested in a similar fashion when required. The shafts already in existence at these deposits if deepened would serve as drill sites.

The development and exploration programmes outlined above would necessitate the installation of adequate plant and provision on an enlarged labour force to operate it and would naturally involve the expenditure of a moderate sum of money.

The alternative to spending money on development and exploration is the rapid exhaustion of the easily won vermiculite and the complete abandonment of the deposits before they have been adequately explored, in other words rendering useless what may be a valuable asset.

REPORT ON THE BANDALUP CREEK MAGNESITE DEPOSIT, OLDFIELD DISTRICT, SOUTH-WEST LAND DIVISION OF W.A.

Approx. lat. 33° 37½′ S. Approx. long. 120° 18′ E.

By W. Johnson, B.Sc. (Hons.) and J. Gleeson, B.Sc.

General Information.

The Bandalup Creek Magnesite deposit is situated at the intersection of the Bandalup Creek with the Ravensthorpe-Esperance Road, 16.5 miles east of Ravensthorpe. The deposit was visited on the 28th and 29th of January to determine approximately, the quantity of magnesite, readily available.

The nearest township to the deposit is Ravensthorpe. The distance from Perth to Ravensthorpe is 330 miles by road through Newdegate, or 347 miles via Ongerup. Both roads are in good condition. It is a further 16.5 miles to the deposit. Newdegate, the nearest rail-head, is 100 miles from the deposit and Hopetoun, the nearest port, is 30 miles distant. Access to Hopetoun is by road through Kundip.

Bandalup Creek lies in the 15 inch to 20 inch rainfall belt. The drainage system consists of a number of small creeks, flowing southwards and linking up with the main Jerdacuttup river, which eventually discharges into the ocean east of Hopetoun. The creeks flow only after periods of excessive rainfall, at all other times consisting of isolated water-holes, some fresh, but most saline. At the time of examination the creeks and water-holes were completely dry and it would probably be necessary to cart water from Ravensthorpe for domestic and mining purposes.

Suitable mining timber is plentiful within a radius of 10 miles of the deposit.

The area was visited in 1940 by H. A. Ellis, Government Geologist.*

This report has been written by J. Gleeson but responsibility for the quantity estimate rests on both W. Johnson and J. Gleeson.

Geology and Physiography.

Bandalup creek traverses a meandering course through the great plateau, being entrenched to a maximum depth of 60 feet below the general level of the country. Its banks, though steep in many places are generally gentle enough to allow access by motor traffic to the bed of the stream. In the vicinity of the deposit the creek has a north-north-easterly trend.

The rocks near the road-crossing consist of a series of metamorphosed sediments, quartzites, quartz-mica schists and metamorphosed grits which strike east-west, and dip steeply to the south. The series has been intruded by basic rocks, probably both discordant to, and concordant with the strike of the sediments and it is most probable that the weathering of these basic rocks has yielded the magnesite. The basic intrusions seen, were small in comparison with the area covered by magnesite boulders which also cover large areas underlain by quartzites and mica schists.

The magnesite occurs in massive structureless bodies overlying all rock types. Its exact thickness could not be ascertained accurately as in all creek exposures the base of the deposit is overlain by talus. In these creek exposures the apparent thickness ranges from a few inches up to 25 feet. Elsewhere the magnesite becomes a thin superficial capping. The deposit, which is of very irregular outline, has a general trend parallel to the creek and nowhere was it found to outcrop at a greater distance than 30 chains from the bed of the creek.

This type of deposit is probably closely allied in its mode of formation to the commoner laterite deposits of other areas in the south-west of the State.

The magnesite is exceedingly fine-grained appearing amorphous in hand specimens. It breaks with a conchoidal fracture, fresh surfaces having the appearance of unglazed porcelain. Boulders of it, which have weathered from the main deposit are exceedingly hard and have a characteristic nodular surface.

The Deposits.

The Ravensthorpe-Esperance road, running in an east-west direction crosses the creek at right-angles and the deposit occurs in two parts, one on either side of the road. The southern outcrop of No. 1 deposit lies 300 feet north of the road, overspreading both banks of Bandalup Creek and its tributaries with a mantle of soil and rubble over an area of 90 acres. The northern limit of outcrop of No. 2 deposit is 30 feet south from the road. This deposit outcrops on

* 1940, ELLIS, H. A., "The Talc, Magnesite and Vermiculite Deposits of the South-West Division." Ann. Prog. Rep., G.S.W.A., 1940, p. 7.

the west bank only of the creek and covers an area of 4 acres. The sediments under-lying No. 1 deposit strike N. 82°W., dip 75° south, and those underlying No. 2 deposit strike from S. 80°W. to N. 85°W. and dip 70° south.

Type of Survey.

As an approximate estimate of quantity only, was required and a limited time was available for examination, a rapid pace and compass traverse of the deposit was used to determine the outcrop limits of the magnesite. Some small projecting portions of the main magnesite, boulder strewn areas were left out of the estimate. The magnesite outcrops were mapped over a total area of 94 acres. This figure is considered accurate to within 10 per cent.

It is impossible to determine a definite mean thickness in a deposit of this nature without a closely spaced grid of test pits. If the deposit has an average thickness of 1 foot and using a conversion factor of 12 cubic feet of magnesite to the long ton, it is calculated that there are 330,000 tons of magnesite available.

Sampling.

Five grab samples were taken to test approximately the quality of the deposits. Samples BA_1, BA_2, BA_3, BA_4, were taken from No. 1 deposit and sample BA_5 from No. 2 deposit. Localities and type of sample are given below.

Sample BA$_1$.—A sample taken from magnesite outcropping in a cliff slope facing Bandalup creek 10 chains north of the road crossing (Esperance-Ravensthorpe road). The sample was obtained by knocking chips off outcropping magnesite up a slope distance of 20 feet.

Sample BA$_2$.—Soil and magnesite boulders from the crest of a ridge formed by No. 1 deposit between Bandalup Creek and a tributary to the east. Sample locality about 150 feet east of locality of BA_1. Sample divided into two parts by passing through a 10 mesh sieve, BA_2a portion retained on the sieve 57 per cent. of BA_2 BA_2b portion passed through 43 per cent, of BA_2. Each portion was analysed separately.

Sample BA$_3$.—Chip sample similar to BA_1 but up an escarpment facing a tributary to the east of Bandalup Creek, 5 chains east of the locality of BA_1.

Sample BA$_4$.—Similar to BA_3 but 5 chains east of the locality of BA_4.

Sample BA$_5$.—Similar to BA's$_{1, 3}$ and $_4$, but on an east facing escarpment above Bandalup Creek 5 chains south of the road crossing.

The results of analysis of these samples are given in the table below. Analyses are by the Government Chemical Laboratories.

Lab. No.	790	791	792	793	794	795
Mark	BA 1	BA 2a	BA 2b	BA 3	BA 4	BA 5
	%	%	%	%	%	%
Silica, SiO_2	4·28	36·08	41·30	19·56	1·17	1·39
Alumina, Al_2O_3	0·38	2·63	6·35	0·43	0·16	0·26
Ferric oxide, Fe_2O_3	0·76	3·49	4·61	1·45	0·50	0·42
Lime, CaO	2·09	16·70	11·50	15·13	1·90	8·92
Magnesia, MgO	42·02	11·78	5·53	24·60	45·03	38·97
Carbon dioxide, CO_2 equivalent to	46·73	21·16	9·40	32·57	49·55	48·62
$CaCO_3$	3·73	29·80	20·52	27·00	3·39	15·92
$MgCo_3$	86·40	15·44	0·73	39·65	92·09	79·75
MgO otherwise combined	0·71	4·40	5·18	5·65	1·00	0·84

Conclusions.

1. If the deposits have an average thickness of 1 foot they contain approximately 330,000 tons of magnesite. However, magnesite, being a secondary product, has a notoriously erratic thickness and the amount of magnesite available may be much less than 330,000 tons.

2. The present market price (February, 1949) of magnesite is £3 4s. a ton f.o.b. ports. The nearest railhead is 100 miles distant and the prevailing motor haulage freight rate is 1s. per ton mile or £5 per ton for the 100 miles. These conditions would make it uneconomical to rail the magnesite to any of the existing ports. Direct road distance from the deposits to the nearest port Hopetoun is 30 miles, so that if sufficient magnesite could be raised to enable a ship cargo to be filled it might be an economical proposition to mine the magnesite and ship it to the consumers direct from Hopetoun. The economy of this scheme would be dependent on the average quality of the magnesite from the deposits.

3. The samples taken will give only an approximate idea of the average percentage of magnesium carbonate and impurities in the magnesite. The analyses show that the magnesium carbonate content of the samples is too low for use of the magnesite in the manufacture of Sorel cement. If sufficient magnesite exists with a magnesium carbonate content as represented by samples BA_1 and BA_4 this magnesite could be used in the manufacture of refractory bricks, etc.

4. If these deposits of magnesite are to be exploited a detailed pit sampling programme would be necessary to determine accurately the amount of magnesite available and its average chemical composition.

In the author's opinions under present conditions mining magnesite at Bandalup Creek would be an uneconomic proposition.

INTERIM REPORT ON THE GEOLOGY OF PARTS OF THE IRWIN RIVER, LOCKIER RIVER, AND GREENOUGH RIVER DRAINAGE BASINS.

By W. Johnson (B.Sc. Hons.), L. de la Hunty (B.Sc.), and J. Gleeson (B.Sc.).

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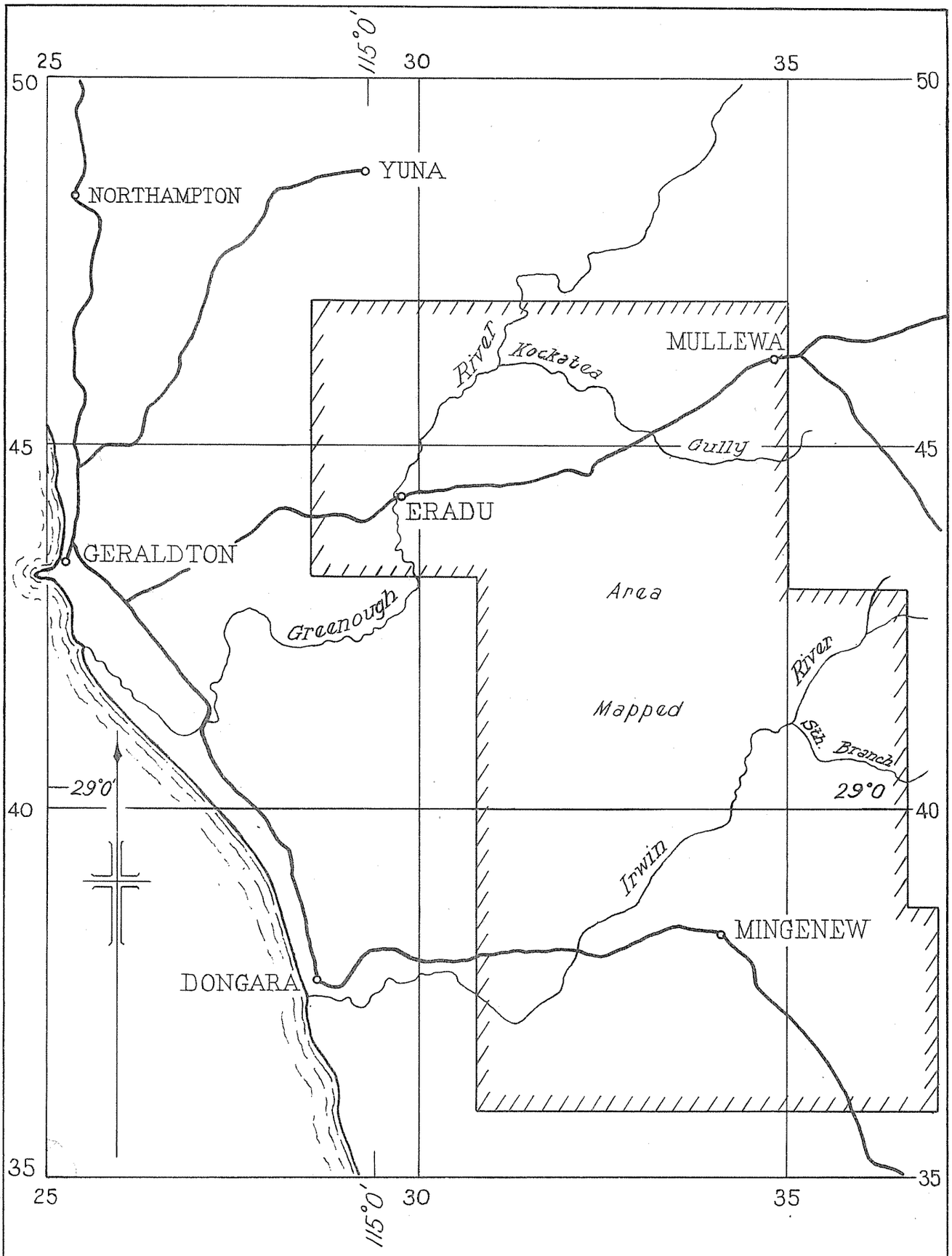

Fig. 2

LOCALITY PLAN

— OF —

AREA MAPPED

— IN —

IRWIN RIVER AND ERADU DISTRICTS

— Scale :- 10 miles to an inch —

B.D.

INTRODUCTION.

This report is a summary of the results obtained from a semi-detailed geological survey of those parts of the Irwin River, Lockier River, and Greenough River Basins delineated on the index map Fig. 1. This area is covered by the eastern half of Lands Department lithograph 157/80, the western halves of lithographs 156/80, 127/80 and the whole of lithograph 123/80.

The purpose of the survey was to examine the geology of the Area* and particularly of the Permian strata outcropping therein with the objects of determining the extent of the known Coal Measure Formation, the possibility of the occurrence of coal seams other than those already known, and the possibility of economic exploitation of the known coal seams. In addition to the field survey a great amount of information on coal analyses and results of boring in previous years in the Area has been collated from Geological Survey Reports and Files.

The Area was surveyed on a scale of 20 chains to 1 inch by plane table traversing, chain and compass traversing, pace and compass traversing and car and compass traversing. These varied methods were required by the very variable outcrop conditions. Outcrops are generally poor throughout the Area. Even in the best parts, in the north of the Irwin Valley, they are only half as good as the outcrops in the Goldfields of Western Australia. Thus structural mapping such as that accomplished at Coolgardie[1], and in the Yilgarn Goldfield[2], was impossible owing to impossibility of tracing formation boundaries.

This report is written by the senior geologist, W. Johnson, who was geologist-in-charge of the field survey, following full discussions with the junior geologists.

Grateful acknowledgment is made here of the co-operation of Mr. R. Wells on whose property the Geological Survey Camp was established and Mr. N. Ridgway, Secretary, Mingenew Road Board.

SUMMARY OF RESULTS.

The prime economic fact disclosed by examination of the outcropping coal seams and of the numerous analyses of the coal discovered in the Irwin River and Greenough River Basins is that this coal is of too poor quality to warrant expensive methods of extraction. If enormous quantities existed at comparatively shallow depths below the surface then possibly the coal would have some value. The geological survey has disclosed that in the Irwin River Basin and Eradu Basin the coal seams are too thin and lenticular, dip too steeply and have too great a depth of overburden to be mined by open cut, the only method which would be warranted in view of their poor calorific value and high ash content.

PREVIOUS WORK.

The coal seams outcropping in the Irwin River were discovered by the Gregorys in September, 1846[3].

Dr. F. von Sommer was commissioned to report on the "coal measures." His report is of doubtful value as he is stated to have said that the coal seams would outcrop at Shark Bay and Cape Riche. The first competent geologist to examine the Area was H. P. Woodward[4]. He gives a section of the coal measures and records the occurrence of "carboniferous" fossils.

The first and only comprehensive survey to the present was undertaken by W. D. Campbell[5], an officer of the Geological Survey.

The area which he covered was almost twice the size of the Area covered by this year's survey (2,000 square miles). Campbell's general geological conclusions hold to the present day and Bulletin 38 laid a firm foundation for future geological work in the Area.

Numerous smaller reports have been written on various parts of the Area. The most important of these are:—

1921 Maitland, A. G.—Progress of boring for coal on the Irwin River and surrounding district. *Ann. Prog. Rep., G.S.W.A., pp. 11-13, 52.*

1924 Woolnough, G. W., and Somerville, J. L.—A Contribution to the Geology of the Irwin River Valley of W.A. *Journ. Roy Soc. N.S.W., Vol. LVIII, pp. 67-112.*

1929 Blatchford, T.—Boring for Coal in the Eradu District. *Ann. Prog. Rep., G.S.W.A., pp. 15-19.*

1949 Clarke, E. de C., Prendergast, K. L., Teichert, C., and Fairbridge, R. W.— Permain Succession and Structure in the Northern part of the Irwin Basin, Western Australia. *Journ. Roy. Soc., W.A., Vol. XXXV., pp. 31-84.*

The last mentioned paper contains an extremely detailed stratigraphy of the Permain sediments in Irwin Basin and a structure map compiled largely from air photographs. It is a compilation of the work of various student parties of the Geology Department, University of Western Australia, over the period 1924 to 1949. Particular reference will be made to this publication.

PHYSIOGRAPHY.

General.

The Area lies wholly within the Swanland natural region of Jutson[6], and the Greenough natural region of Clarke[7]. From the writer's study of the physiography of the Area it would appear that Clarke's subdivision of Western Australia into natural regions is the more correct. The Area has too many differences from the rest of Jutson's Swanland to be included in it.

Topographically the Area consists mainly of a dissected plateau 50 feet to 100 feet lower than the Darling Plateau, a narrow strip of which forms the eastern border of the Area. This lower plateau is separated structurally from the Darling Plateau by the Darling Fault and is underlain almost wholly by sedimentary rocks younger than Permian. In the writer's opinion it constitutes a distinct physiographic entity and it is proposed to call it the Victoria Plateau as it lies wholly within the Victoria District of the South West Land Division of Western Australia.

The Area is drained by two river systems. The most northerly is the Greenough River—Kockatea Gully system and the southerly is the Irwin River—Lockier River system.

Only a small part of the Greenough River lies within the Area whereas the major parts of the Irwin River and Lockier River lie in the Area. The two constitute two physiographically, as well as geographically distinct drainage systems.

Topography.

Plateaux.

The whole area is part of a dissected plateau which it is proposed to call the Victoria Plateau. This Plateau is bounded on the east by the Darling Fault, on the west by the Moonyoonooka Fault[8] and the high sea cliffs north of Geraldton.

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* The Area actually mapped is hereafter referred to simply as the "Area."

[1] 1946, MATHESON, R. S., Progress Report on the Resurvey of the Coolgardie District, Goolgardie Goldfield. Ann. Prog. Rep. G.S.W.A., Plate VI.

[2] 1938, ELLIS, H. A., The Geology of the Yilgarn Goldfield, South of the Great Eastern Railway. G.S.W.A., Bull. No. 97., Plate II.

[3] 1846, GREGORY, A. C., and F. T., Journals of Australian Explorations, p. 8, Government Printer, Brisbane, 1884.

[4] 1895, WOODWARD, H. P., The Irwin Coalfield, Ann. Rep. Dep. Mines, 1895, pp. 19-21.

[5] 1910, CAMPBELL, W. D., The Irwn River Coalfield and adjacent districts from Arrino to Northampton, G.S. W.A. Bull. No. 38.

[6] 1934, JUTSON, J. T., The Physiography of Western Australia. G.S.W.A. Bull. No. 95, pp. 75-94.

[7] 1926, CLARKE, E. de C., Natural Regions in Western Australia. Journ. Roy. Soc. W.A., Vol. XII, pp. 117-132.

[8] 1924, WOOLNOUGH, W. G., and SOMERVILLE, J. L. A Contribution to the Geology of the Irwin River Valley of Western Australia, Journ. Roy. Soc. N.S.W., Vol. LVIII, pp. 106.

To the south the Plateau wedges out somewhat between the Moonyoonooka and Darling Faults and then grades into the Dandaragan Plateau[9]. To the north the Plateau probably terminates on the Murchison River.

The greatest width of the Victoria Plateau is 70 miles, average width 35 miles and its length 150 miles. Trigonometrical surveyed heights indicate that the average height above sea level is between 825 and 850 feet with the western edge lower than the eastern edge.

The marked differences between the Victoria Plateau and the Darling Plateau are:

(i) The Victoria Plateau is almost wholly underlain by sedimentary rocks of Permian or younger age.

(ii) No residual hills remain from the cycle of erosion which produced the peneplaned surface of the Plateau.

(iii) There is a distinct difference in average height above sea level, the Darling Plateau being 50 feet to 100 feet higher.

(iv) All rivers and streams cross the Victoria Plateau in deep trenches (300 feet to 400 feet deep).

Except for the 400 square miles of the Irwin Valley and the valleys of the Greenough, Irwin, and Lockier Rivers and their tributaries the whole of the Area mapped is occupied by the Victoria Plateau. Surveyed heights on isolated mesas and buttes in the Irwin Valley show that the plateau surface once extended over this part of the Area too.

Hills.

The only hills existing in the Area are those resulting from the dissection of the Victoria Plateau by the latest and existing cycle of erosion. None project above the surface level of this plateau, with the possible exception of Granite Hill (2 miles east of Yandanooka) and Bindoo Hill (12 miles N.N.W. from Tenindewa).

The true hills can be divided into two types. One type consists of those which owe their existence to the hard capping of duricrust and/or laterite which underlies the whole of the Victoria Plateau. These are confined to the Irwin Valley and are usually mesas and buttes. Good examples are Bugallie Hill, Gnoolowa Hill and Mt. Budd (buttes) and Mt. Melara, Mingenew Hill, Beere Hills (mesas) together with several conspicuous unnamed mesas at the northern end of the Irwin Valley.

The other type consists of true hills owing their existence to being composed of rocks more resistant to erosion than the soft shales which form the bed rock of most of the Irwin Valley. Examples are, the Nangetty Hills (composed of Nangetty Glacial Formation), the Brockman Hills (granite and gneiss) and the Yandanooka Hills (granite and gneiss and rocks of the Yandanooka Group).

The other "hills" marked on the map, such as Strawberry Hill, Irwin View, Mt. Lefroy, Wilmott's Bluff (Thurnoongnoo), are merely bluffs marking the upward termination of the valley slopes of the river systems of the Area.

Drainage.

The Area is drained by three rivers and their tributaries. These are the Greenough in the northern part and the Irwin and Lockier in the southern part.

The Greenough Drainage Basin.

A portion, about 30 miles long, of the Greenough flows through the north-eastern corner of the Area. In this distance it receives only one notable tributary, Kockatea Gully. As these two present distinct physiographic features they will be considered as separate entities.

The Greenough River course lies in a deep broad valley in the Victoria Plateau. Nowhere could this valley be considered a gorge as the average width from crest to crest is 3 miles and the average slope of the valley sides is 5°. The depth of the river bed below the average level of the plateau is 350 feet.

The river course is a meandering one, the straight line distance from Bindoo Spring to Eradu Railway Bridge being 16 miles and the river distance 23 miles. Apart from Kockatea Gully and Wicherina Brook the Greenough receives no tributaries longer than 1 mile, and consequently no subsidiary valleys exist and no spurs project into the main valley. The Greenough is in the youthful stage of development consequent on uplift of an "old age" stream flowing across a peneplain (shown by the entrenched meanders). That this uplift did not take place continuously is shown by the presence of at least two river terraces in the valley bottom.

The Greenough is an extremely intermittent stream. It did not flow during the 1949 field season and according to local reports had not flooded for two years previously. This rarity of flow is accounted for by the fact that it has few tributaries in the area of regular winter rainfall and in that portion of its course where it has numerous tributaries the rainfall is low and irregular.

Kockatea Gully is an anomalous stream in the Swanland natural region. For two miles upstream from its junction with the Greenough it flows in a narrow gorge 50 feet deep. From Kockatea School to the entrance of this gorge it flows in a meandering course across a broad valley in a trench 5 feet to 20 feet deep. The valley floor is formed of alluvium deposited by the stream. This is the typical Murchisonia[10] stream. The anomaly is increased by the fact that Kockatea Gully stream flows across the soft shale formations of the Permian series, in which, a few miles to the south, the Irwin and Lockier Rivers have carved a large valley.

The most feasible explanation of this anomaly is that until recent times the Kockatea Gully Drainage basin has been an internal drainage basin. That it is not yet completely converted to external drainage is shown by the existence of several salt pans and salt water drainage channels which overflow into Kockatea Gully only in times of flood.

The Irwin River—Lockier River Drainage Basin.

The Irwin and Lockier Rivers form two distinct river systems in the south-eastern quarter of the Area and join near the south-western corner. They will be discussed as two separate systems.

The Irwin River.—The lower Irwin* is physiographically identical with the Greenough River. It flows in a deep broad meandering trench in the Victoria Plateau. Its valley slopes are terminated by low cliffs. It receives no tributary other than the Sandplain Creek. Its valley has two river terraces.

The direction of the lower Irwin from the Mingenew-Mullewa road crossing to the western border of the area is generally south-west. Near the border it swings in a broad curve and flows north-west. This change in direction is coincident with the strike of the Moonyoonooka Fault and may be connected with the formation of that fault.

At Depot Hill the Irwin flows in a small gorge 100 feet high on the east side and 50 feet high on the west side. This gorge may be due to elevation of the valley floor by local faulting. From the tops of the river cliffs the slopes rise gradually to the normal low cliffs.

[9] 1948, FAIRBRIDGE, R. W., Preliminary Report on the Geology of the Coastal Plain and other Sedimentary Areas between Busselton and Geraldton, Western Australia. G.S.W.A. File 19/1948.

[10] 1934, JUTSON, op. cit. pp. 161-164.

* The terms lower, upper, and middle as applied to rivers in the Area are purely relative and refer to the geographical parts of the river within the Area only. For example the lower Irwin as referred to above means that portion of the Irwin between Nangetty Homestead and the western border of the Area.

The middle Irwin flows in a broad valley co-extensive with the valley of the middle Lockier. In this part of its course it receives numerous tributaries such as Mullewa Creek*, Nangetty Creek* and Beckett's Gully*. The river flows across the strike of the Permian rocks outcropping in the Valley. Some of these rocks, such as the Nangetty Glacial Formation, are relatively resistant to erosion and the river course must be regarded as one imposed from a pre-existing drainage system. On the comparatively flat broad floor of the valley the river has developed large meanders Aerial photographs show filled in ox-bow lakes and other features of the old age stage in river history although a few miles downstream the river is in the most youthfull stage following uplift of its bed. The reasons for this anomaly will be discussed in a later section.

The tributaries flowing into the middle Irwin from the north and northwest are largely subsequent. The courses of Nangetty and Mullewa Creeks are controlled by outcrops of the Nangetty Glacial Formation. The tributaries flowing in from the east, Beckett's Gully, Cat Creek* and unnamed creeks, flow at right angles to the strike of the underlying rocks. They are probably part of the original consequent drainage system.

The upper Irwin and its tributaries flow in gorge-like valleys relatively narrow and with steep sides. The reason for the sudden narrowing of the Irwin valley is that outcrops of the relatively resistant High Cliff Sandstone Formation prevented the rapid extension of the middle Irwin valley further east. The gorge of the upper Irwin is narrowest where the river flows across the High Cliff Sandstone and the Coal Measure Formations. Upstream the gorge widens out in the softer Carynginia Shales. The upper Irwin crosses the contact of the granitised gneiss and Permian shales in a waterfall 30 feet high. The river flows over the gneiss in a smaller gorge.

The major tributary of the upper Irwin is the South Irwin. The South Irwin has a course of variable direction. Except for two or three miles downstream from the Pre-Cambrian-Permian contact the South Irwin is adjusted to the strike of the underlying rocks. North of the South Irwin there are several unnamed tributaries and Carynginia Gully and Doghole Creek. All of these tributaries in their lower parts flow at right angles to the strike of the Permian rocks. They have formed consequent to the rapid deepening of the Irwin valley on uplift of the Plateau. The upper parts of those tributaries east of the upper Irwin flow in directions north or south parallel to, and often directly on, the contact between Pre-Cambrian and Permian.

The Lockier River.—Physiographically the Lockier River is almost identical with the Irwin. It can be divided into lower middle and upper parts which show the same characteristics as their counterparts on the Irwin.

The lower Lockier flows in an asymmetrical valley, the southern slope rising very gradually to the level of the Plateau with no capping scarp. The middle Lockier flows in a deep trench in deep alluvium. This alluvium is widespread and completely obscures the underlying Permian rocks. The upper Lockier flows in a gorge not so narrow as the Irwin gorge.

The Lockier has numerous long tributaries. Some such as Ebano Creek and Woolagah Creek are identical with the Lockier, their lower parts flow at right angles to the strike of the Permian rocks and their upper parts are partially adjusted to rock structure. Other tributaries such as Green Brook and Ikewah Brook are entirely adjusted to rock structure. These two streams flow along the eastern and western contact of the Permian rocks and Pre-Cambrian rocks composing the Yandanooka Hills.

The Irwin Valley.

This is the name given to the rather remarkable physiographic feature which is really the valley of two rivers, the Irwin and the Lockier, and their tributaries. The valley is 30 miles long and 8 miles wide, the long direction bearing north-north-west. The Lockier River divides the valley into two approximately equal parts.

The remarkable feature of the valley is its mode of origin. Though primarily due to erosion its dimensions and shape are influenced by geological structure.

The valley proper has been carved out in the soft shales of the Permian. Its western scarp is a reversed fault line scarp from 3 miles below Mingenew to 2 miles north-west of Urella Homestead. This is brought about by the Urella Fault along which relatively hard sandstone rocks on the west were downfaulted against the soft, Permian shales to the east. An earlier erosion cycle reduced the area to a peneplain and laid down a capping of duricrust over both sandstone and shale. On uplift and breach of the hard duricrust capping the Irwin and Lockier and their tributaries eroded the soft shale much more rapidly than the sandstone and formed a scarp facing in the opposite direction to the original fault scarp.

The eastern scarp of the valley is formed mainly by outcrops of the High Cliff Sandstone Formation of relatively resistant rock type. The direction of this scarp is approximately parallel to the strike of the Permian rocks. It has no connection with faulting. The northern boundary of the valley is formed by a scarp due entirely to the rate at which erosion has progressed northwards.

The southern boundary is an irregular one formed by outcrops of the Pre-Cambrian Archeozoic gneisses and Proterozoic tuffs and quartz grits. The Irwin Valley has long, finger-like tributary valleys extending into the Pre-Cambrian rocks parallel to their strike. Many of these valleys are resurrected Pre-Permian valleys. Some were probably excavated or deepened by Permian glaciers which deposited the glacial tillite which occupies the bottoms and sides of the valleys at the present time. Much of this tillite appears to be arranged in moraine like mounds along the valley sides and it is probable that a fossil landscape is being exposed by the present erosion cycle.

Springs.

Numerous springs, most of which are unnamed, occur within the Area. A large proportion of the unnamed springs are intermittent. Most of the permanent springs are named and some are important sources of water. Eyregulla and Mingenew Springs supply the township of Mingenew and the Midland Railway Company with water.

The types of springs occurring fall into three groups[11]:—

(i) Springs issuing from pervious veneer formations.

(ii) Springs issuing from interstratified pervious and impervious formations.

(iii) Springs issuing from fractures.

Springs issuing from Pervious Veneer Formations.

This type of spring is not common. Unnamed springs occur near the base of the piedmont plain deposits along the western scarp of the valley. They flow in pervious conglomeratic grit on a basement of impervious fine grained Permian shale. They are usually fresh and impermanent.

Springs Issuing from Interstratified Pervious and Impervious Formations.

This type make up the majority of the minor springs occurring in the Area. Most are in river beds and gullies in the Irwin Valley and they flow from outcrops of shale of the Nangetty Glacial and the Holmwood Shale Formations. All are too saline for human or stock use.

* Names awaiting acceptance by Lands Department.

[11] 1937, TOLMAN, C. F., Groundwater, First Edition, pp. 446-466.

Springs issuing from Fractures.

These are the only type of spring in the Area of any economic importance. Two of them, Mingenew and Eyregulla Springs, supply the township of Mingenew and the locomotive watering station of the Midland Railway Company at Mingenew. Water from them is very pure and should be suitable for any purpose. Rock outcrops are absent in the vicinity of most of the springs but they occur along lines (for example, Mooriary, Yurawana, and unnamed springs southwest of Mingenew) paralleling known fault lines in the Area and in topographic situations which make it unlikely that they are of Tolman's Class III Springs.[12]

GENERAL GEOLOGY.

For the purpose of describing the geology the Area is divided into two parts, the Greenough Basin and the Irwin Basin. The Irwin Basin constitutes all that part of the Area south of the Irwin River-Kockatea Gully Divide and a line extending due west from the northernmost point of the Irwin Valley. The Greenough Basin constitutes the remainder of the Area north of that line.

The Irwin Basin.

Outcrops of rock in this Basin average approximately 5% of the surface and over the western half comprise less than 2%. Naturally these outcrop conditions do not lead to accurate delineation of geological details. However rocks of 5, and probably 6, geological Periods are exposed in the Basin. The total thickness of sedimentary rocks younger than the Pre-Cambrian is not known. The Permian Group is from 3,500 feet to 5,000 feet thick but unfortunately no accurate figures can be given for the Jurassic and later rocks as it is not known to what extent they are disturbed by strike faults.

Archaeozoic.

Granites and gneisses of presumed Pre-Cambrian age outcrop in the Yandanooka Hills of which Mullingarra Hill, Mts. Misery and Muggawa are prominent peaks. These gneisses are named by Woolnough the Mullingarra gneisses[13]. They contain remnants of metamorphosed sediments and volcanics and everywhere dip 70° to 80° from the horizontal. Similar gneisses form the western border of the Darling Plateau in the eastern part of the Basin. Some copper bearing quartz veins occur in the gneiss near Yandanooka and Arrino.

Proterozoic.

Along the eastern edge of the Mullingarra Gneiss and in the vicinity of Mt. Scratch two groups of rocks outcrop which are tentatively assigned to the Proterozoic Era. They consist of comparatively unmetamorphosed volcanic rocks and erosion sediments with perhaps some concordant intrusions. The western group strike from N.40°E. to N.40°W. and dip from 12° to 25°E. The eastern group strike N.10°W. to N. 15°W. and dip 60°E. Insufficient mapping was done to ascertain the relationship of the two groups.

Neither contains limestone members nor are they intersected by broad aplite and pegmatite veins as stated by Woolnough and Somerville[14]. It is thought that these authors mistook the travertinous limestone which results from the weathering of the chocolate coloured volcanic rock (in places the travertine is well crystallised and appears to be bedded) for interbedded limestone, and concentrations of granite and pegmatite boulders (glacial moraines) on the valley sides around Mt. Scratch for intrusive aplite and pegmatite dykes.

[12] TOLMAN, op. cit. pp. 452, 453.

[13] 1924, WOOLNOUGH and SOMERVILLE, op. cit. p. 108.

[14] 1924, WOOLNOUGH and SOMERVILLE, op. cit. pp. 74, 75.

The western group lies unconformably on the Mullingarra Gneiss and as far as can be ascertained it is a purely erosional contact. Various members of both groups (known collectively as the Yandanooka Group) contain small veins of copper carbonate. The writer's opinion is that this copper was brought in during the period of volcanic activity which produced the "chocolate tuff" and the purple volcanic forming the chief constituent of the conglomerate member of the Group, i.e. the copper mineralization was post-granite.

The Pre-Cambrian rocks around Yandanooka and Mt. Scratch should provide a fruitful field for academic research.

Permian.

Since the Permian rocks in the Irwin Basin include the coal seams more attention was paid to them than the rocks of other periods. A very detailed description of the lithology and stratigraphy of the Permian is given by Clarke[15] *et al* and the reader is referred to that paper for details of the Permian geology.

As stated by those authors the Permian sequence consists of a series of varied sediments divided into the following formations (taken from their paper p. 39).

	Feet.
Wagina sandstone formation	+ 300
Carynginia shale formation	800
Irwin coal measure formation	160
High Cliff sandstone formation	110
Fossil Cliff formation	180
Holmwood shale formation	1,650
Nangetty Glacial formation	800
	(estimated)
Total	4,000

Their work was done in the northern part of the Irwin Basin but the same sequence with slight modifications can be observed in the south-eastern part of the Basin.

Estimates of the total thickness of the Permian strata are difficult to make because of the large amount of strike faulting and the variation in dip.

Clarke *et al's* estimate is 4,000 feet. The writers have measured a section in the vicinity of Woolagah Creek 20 miles to the south of the Irwin River and estimate the total thickness as lying between limits 3,860 feet and 5,110 feet. This variation is necessary because of unknown variations in the average dip of the Nangetty Glacial and the Holmwood Shale Farmations.

Individual thicknesses are as follows:—

	Feet.		Feet.
Wagina Sandstone	450		
Carynginia Shale	520		
Irwin Coal Measures	340		
High Cliff Sandstone ....}	210		
Fossil Cliff Formation ....}			
Holmwood Shale	1180	to	1800
Nangetty Glacial	1170	to	1790
Total	3870	to	5110

Nangetty Glacial Formation.—This formation has been traced discontinuously from 2 miles N.N.W. of Nangetty Homestead to the Dudawa Estate, a distance of 32 miles. In the vicinity of Mt. Scratch moraine-like masses of large and small boulders lie directly on the Proterozoic rocks in resurrected Permian valleys. Elsewhere in the Yandanooka area fine grained green tillite is the basal member of the Permian. It is obvious from the distribution of the boulder outcrops that the boulder beds are distributed irregularly throughout the Formation. The matrix of the Nangetty Glacial Formation is an ultra fine grained tillite of mauve grey, brown grey, or light green colour. Within this matrix are lenses of

[15] 1949, CLARKE, PRENDERGAST, TEICHERT, FAIRBRIDGE, op. cit. p. 39.

variable size of Fontainebleau sandstone, grey limestone showing cone-in-cone structure, calcareous shale, shaley sandstone, massive yellow sandstone, and boulder beds. The writer believes that except for the moraine like deposits in the vicinity of Mt. Scratch, the Nangetty Glacial Formation is predominantly a water laid deposit.

The thickness of the Formation was calculated from the section of Permian rocks outcropping from the Yandanooka Hills east to Woolagah Creek. It lies between 1,170 feet and 1,790 feet assuming that the average dip lies between 5° and 8°. The thickness of most of the lower Permian formations can only be estimated within wide limits because of the discontinuity of the sections exposed, the variability of the dip, the amount of strike faulting and the difficulty of obtaining an average dip.

Holmwood Shale Formation.—The lowest rocks of this Formation are not easily distinguishable from the shaley lenses in the Nangetty Glacial Formation. The boundary between the two, for field mapping purposes was taken as marked by the absence of boulders in the soil. As the occurrence of boulder beds within the Nangetty Glacial Formation is most irregular the boundary is not an accurate one. Little reliance can be placed on this boundary for the purpose of delineation of geological structure.

The thickness of the Holmwood Shale is estimated at between 1,180 feet and 1,800 feet. The most important fact about the Holmwood Shale is the occurrence in it of the horizon containing the goniatite *Metalegoceras jacksoni.* This horizon has a limited value in interpretation of geological structure. Fossiliferous limestone lenses were discovered elsewhere in the upper Holmwood Shales. They contained *Conularia, Parallelodon, Productids,* a dwarf goniatite and an orthocerid. These lenses are of academic interest only.

Fossil Cliff Formation.—This formation is defined by Clarke *et al* as comprising "sandy siltstones, shales and mudstones, with lenticles of limestones." It is overlain by the High Cliff Sandstone Formation and the contact between these two is quite definite. In the type locality they total 290 feet of which the Fossil Cliff Formation occupies 180 feet. However in the south the Fossil Cliff Formation disappears and the High Cliff Sandstone is in contact with the Holmwood shale. Owing to the discontinuous nature of its outcrops the Fossil Cliff Formation is little use in elucidating structure.

High Cliff Sandstone Formation.—In the vicinity of Woolagah Creek this Formation contains the Fossil Cliff ? fauna near its base otherwise it is of little interest structurally or economically.

Irwin Coal Measure Formation.—This formation is described and defined in great detail by Clarke, Prendergast, etc. It consists essentially of alternating coal seams, carbonaceous shales, grey and yellow shaley sandstones, and sandy limonite beds.

Numerous plant fossils have been recovered from the Formation but there is some doubt as to whether the rocks are of continental or marine origin. Different writers have reported various numbers of coal seams outcropping in the North Irwin. The number observed by the writer was six and these were overlain by alternating beds of sandy limonite and carbonaceous shale. The thickest of the coal seams was 6 to 8 feet and the rest between 2 and 3 feet. All from their appearance were of poor quality. Analyses of samples from the thick seams confirmed this appearance.

In the South Irwin two seams and 120 feet of alternating carbonaceous shale, yellow sandstone and limonite bands outcrop. The Coal Measure Formation has been identified in the Lockier River and in Woolagah Creek (20 miles south of the North Irwin Outcrops). In the Lockier three seams of impure lignite or carbonaceous shale outcrop. One of these is 8 feet thick. In Woolagah Creek one seam, only 1 foot thick of shaley lignite was observed though half a mile south in a tributary creek, two seams 9 inches and 1 foot 6 inches thick were observed.

Several bores have been put down on the South and North Irwin. Two, put down by the Public Works Department, penetrated the entire Coal Measure Formation. P.W.D. No. 1 penetrated 6 seams all less than 1 foot 9 inches thick. P.W.D. No. 2 cut 7 seams, one 5 feet thick, another 12 feet thick, and the rest less than 2 feet thick. P.W.D. Bore No. 1 was 40 chains south-west and P.W.D. Bore No. 2 110 chains south-west of the outcrops in the South Irwin. One private bore in the vicinity of the North Irwin outcrops showed that the top seam graded into a carbonaceous shale and several bores close to the outcrops in the South Irwin showed that these seams are much displaced by minor faulting.

The high percentage of ash in the coal, the marked lenticularity of the seams and the absence of a fossil soil under the seams indicate that the coal is of drift origin, that is, it formed from vegetable matter washed into a lake or estuary instead of from vegetation decaying in situ in a swamp. The significance of the origin of the coal is that it is not likely to extend very far west from the outcrops known in the North and and South Irwin and to the south. Thus bores in the western part of the Irwin Basin though cutting the Coal Measures would not be liable to locate coal seams.

The Coal Measures, like the Fossil Cliff and High Cliff Sandstone Formations, do not outcrop in the western part of the Irwin Basin. They are cut off by a large fault which brings Jurassic and Cretaceous sandstones (to the west) into contact with the Holmwood Shale.

Carynginia Shale Formation.—This formation outcrops in the North Irwin, Carynginia Gully, the South Irwin, the Lockier River, Ebano Creek and Woolagah Creek. The writer has measured sections in Carynginia Gully, the South Irwin, and Woolagah Creek. The measured thicknesses are: Woolagah Creek section 520 feet; South Irwin section 500 to 600 feet; Carynginia Gully section 500 feet. These thicknesses are 200 feet to 400 feet less than those measured by Clarke, Prendergast, Teichert and Fairbridge (900 feet in Carynginia Gully and 800 feet elsewhere). The greater thickness measured by these writers appears to be due to two misapprehensions, firstly that there is a sudden reversal in dip in the Carynginia Shales in the North Irwin from 10°E. to 10°-14°W., and secondly that the sandstone and conglomeratic grit overlying the shales belong to the Wagina Formation.

Field observations by the writer and his coworkers have shown that in the southern spur formed by Carynginia Gully and the North Irwin *horizontal* jarositic shales outcrop overlain *disconformably* by 20 to 30 feet of poorly bedded sandstone and conglomeratic grit. This sandstone formation extends east at the same average thickness as a capping on the shales, and several chains east of the point of the spur, while it remains horizontal, overlies shales dipping west at 5° to 10°. It evidently belongs to a much later period than the Wagina Formation.

The presence of horizintal Carynginia Shales where they would be expected to occur, near the axis of the Carynginia Syncline, removes the necessity for postulating a strike fault of considerable magnitude near the junction of Carynginia Gully and the North Irwin.

Like all formations above the Holmwood Shale the Carynginia Shale Formation does not outcrop on the west side of the Irwin Basin.

Wagina Sandstone Formation.—The writer has measured 450 feet of these predominantly white sandstones, mudstones and conglomeratic grits in the Woolagah Creek section. In this section the Formation commences abruptly with a 2 feet thick bed of red liminitic sandstone passing into white sandstone.

In the type section of Clarke and others in the South Irwin a rich fossil plant horizon was discovered and with careful searching the Woolagah Creek section may disclose plant fossils.

The distribution of the Wagina Sandstone is in the form of discontinuous segments along the Permian Pre-Cambrian contact due probably to basin like synclinal structures in the Permian rocks adjacent to the Darling Fault.

Post Permain.

Isolated outcrops of fossiliferous rocks are known on the western side of the Irwin Basin. At an early stage of the history of the Area plant fossils from a locality three miles due north of Mingenew were identified as belonging to the Jurassic Period. They occur in limonitic felspathic grit and from that occurrence all rocks outcropping west of that locality were assumed to be Jurassic. However, lithologically many of the rocks outcropping in the valleys of the Irwin and Lockier Rivers resemble the sandstone members of the various Permain Formations and some of these rocks may be Permain in age.

Recently Dr. R. W. Fairbridge and students have discovered plant fossils in a white shale one mile south of Yarragadee Homestead. These fossils are tentatively assigned by Dr. A. B. Walkom to the Cretaceous (personal communication from Dr. Fairbridge).

In addition to these well stratified rocks a poorly sorted, poorly bedded grit with a layer of conglomerate at the base including laterite boulders occurs over practically the whole area of the Irwin Basin. The thickness of this formation varies from 2 feet to 50 feet and it possibly ranges from Jurassic to Recent though in the writer's opinion it is post-Mesozoic. A rock of similar age outcrops in the bed of the Irwin River before it enters the Irwin Valley. This rock is a hard quartz conglomerate with a red gritty limonitic sandstone matrix.

Other rock occurrences worthy of note are the unsorted piedmont beds between Yarragadee and Urella Homesteads and the coarse quartz conglomerate overlying the Permian two miles south of Badgera Pool in the North Irwin. The economic importance of the post-Permain rocks lies in their potable water bearing potentialities.

The Greenough Basin.

The rocks of the Greenough Basin are even more poorly exposed than the rocks of the Irwin Basin. So far no fossiliferous localities have been discovered and evidence as to the age of the rocks composing the basin is mostly lithological and inferential. Archaeozoic granite and gneiss outcrop on the west and east borders of the basin. The eastern outcrops are part of the Darling Plateau and the western outcrops form part of the Northampton gneiss complex (lead bearing). Around the headwaters of Wicherina Creek the granite forms a distinct ridge and it is thought that this ridge continues under cover some distance to the north and south and that the rocks to the east of it are predominantly Permian in age.

Rocks which are correlated with the Yandanooka Group of Proterozoic age on lithologic grounds overlie the granite on Mt. Erin Estate (2 to 3 miles north-north-east of Northern Gully) and form Bindoo Hill 20 miles north-east.

In small valley in the Proterozoic sandstone which forms Bindoo Hill, moraine like deposits of glaciated boulders occur. These boulders can be seen in situ in bedded tillite in the south bank of the Greenough River at Bindoo Pool. There is little doubt that this boulder bed is the northerly extension of the Nangetty Glacial Formation. Outcrops of glaciated boulders occur also in Kockatea Gully on locations 6521, 6520, 7405, 4848 and south-east from Sinindawah Spring (location 2648). The Boulder bed on locations 6521 etc. was mistaken for the Archaeozoic granite basement by drillers boring for coal under the geological supervision of H. P. Woodward.[16]

[16] 1914, WOODWARD, H. P., Boring for coal upon the Murchison Railway line between Eradu and Mullewa. G.S.W.A. Bull. No. 59, Misc. Rep. No. 33.

In the Greenough Basin the only other outcropping rocks occur in the valley of the Greenough River. These consist of a series of sandstones, and grits and conglomerates of indeterminate age.

In a cliff forming the south bank of the Greenough 2½ miles on a bearing N.10°E. from Thurnoongnoo (Wilmot's Bluff) the following section is exposed.

TOP.

5 feet laterite.
12 feet quartz conglomerate with a yellow brown gritty sandstone matrix.

DISCONFORMITY.

6 feet fine grained white sandstone.
30 feet yellow ferruginous sandstone and grit.
20 feet coarse white sandstone and grit.

DISCONFORMITY OR UNCONFORMITY.

5 feet white sandstone.
1 inch limonite band.
2 feet purple shale.
+15 feet carbonaceous shale.

Assuming that the carbonaceous shales are Permian the overlying sandstones and grits may be of any later age. Thus the lower disconformity may be an inter-formational one within the Permian Period. Further downstream 3 miles N.N.E. from Eradu a bed of impure lignite is overlain by similar grits and sandstone without any appreciable disconformity. Unless fossils are found in the rocks along the Greenough valley within the Area the question of the age of the rocks overlying the coal seams is an insoluble problem.

Boring in the vicinity of Eradu revealed three coal seams all of poor quality and great lenticularity. One of these seams has a maximum thickness of 22 feet near Eradu Station but thins to 12 feet one mile to the north-west and either disappears or is faulted out to the east and south-east. The shallowest of these seams is 87 feet below the bed of the Greenough or 127 feet on the banks; also the overlying rocks are full of water. These facts coupled with the poor quality of the coal show that the coal is economically valueless.

STRUCTURAL GEOLOGY.

The following is a brief resume' of the structural geology of the Area.

Irwin Basin.

Campbell presented a section in Bulletin 38 which showed that he considered the Permian rocks of the Irwin Basin to be folded in a broad asymmetrical anticline with an axis striking N. 20°W. This anticline according to Woolnough and Somerville is modified by large strike faults. Recent work on air photographs of the Basin (Fairbridge and students) has shown that the rocks have been faulted in complex fashion and in the paper by Clarke, Prendergast, Teichert and Fairbridge the anticlinal structure is discarded altogether in favour of a series of fault blocks tilted to the east with a few minor drag folds close to the major faults.

The present writer cannot subscribe to the idea of the structure in the Irwin Basin being entirely due to faulting. Without going into the mechanism of how the folding was formed the authors consider that sufficient data is available to show that anticlinal and synclinal structures exist in the Permian rocks of the Irwin Basin. That these structures are profoundly modified by faults is not doubted.

Thus near the western edge of the Irwin Valley, east of the Urella fault more westerly dips were recorded than could be accounted for by drags due to faulting. In the valley of the Lockier River west of Mingenew Hill not one easterly dip was recorded in considerable sections of rocks exposed. Then north-west of Nangetty homestead there is the *Metalegoceras jacksoni* horizon in proper stratigraphic relationship to the Nangetty Glacial Formation if the structure is considered to be an anticline, but the relative position of the two is inexplicable on a purely faulting structural hypothesis.

It is considered that all of the faults shown by air photographs in the Irwin Valley are of very minor nature. The Urella Fault[17] (which incidentally does not show up on the air photographs) postulated by Woolnough and Somerville certainly exists. Its throw may be as much as 1,500 feet. This fault may be paralleled to the west by other faults of like magnitude (the Moonyoonooka Fault for example) and a series of fault blocks established. In the author's opinion these fault blocks are the result of regional warping and the faulting took place after the folding of the Permian rocks.

The question of whether the fault blocks are tilted to the west or east is one of considerable economic importance, is if they are tilted east the underground water conditions will be altogether different.

This discussion of geological structure is only an outline and will be amplified in a bulletin to be written later.

ECONOMIC GEOLOGY.

The main purpose of the survey was to determine the economic usefulness of the known coal seams of the Irwin River and Eradu Districts. At the outset it must be stated that investigations have disclosed that no hope can be held out for the exploitation of these coal deposits on an economic basis at the present time.

A great deal of money has been spent by the Government on gathering information about and testing the Irwin River and Eradu Coal Deposits mostly through the instrumentality of the Geological Survey. It is to be hoped that this previously gathered information plus the results of the present survey, will settle for a long time the question of the advisability of opening up the Irwin River and Eradu Coal Seams.

As the two districts are widely separated they will be dealt with separately.

Irwin River Coal Deposits.

These seams were the first discovered in Western Australia, the date being September 9th, 1846. In 1847 they were examined by Dr. F. von Sommer who reported thus[18]

"The coal even of the second seam (the first being about 5 ft. thick) did not contain bitumen in any perceptible degree and produced a large quantity of clayey ashes."

Nothing further was done until 1879 when a shaft was sunk without results and some time later Rev. C. G. Nicolay expressed the opinion after examining the deposits that the discovery was of no value owing to the poor quality of the coal and great quantity of ground water.

The coal seams discovered by the Gregorys appear to be those outcroppings in the South Irwin.

In 1888 coal seams were discovered in the North Irwin and considerable development work done on them. Coal taken from the adits was said to have steamed a small steamer from Geraldton to Fremantle and a train from Perth to Chidlow's Well but no confirmation of these reports is available.

Some analyses done in 1888 were probably of coal from the South Irwin (see table of analyses).

H. A. Woodward re-examined the Irwin River Coal Deposits in 1895 and reported that work should be done to develop them. No work was done to prove or disprove their value until 1917 when three shafts and several bores were put down near the outcrops in the South Irwin. Coal from one of the shafts (No. 3) gave a calorific value of 10494 B. Th. Us. This high value stimulated interest in the coal and a Departmental Officer, T. Blatchford, was sent up to take some check samples as the earlier analysis was done by a private analyst. Blatchford's specimen, which was not taken from the seam, but from the dump of one of the shafts, gave a calorific value of 10456 B. Th. Us. Unfortunately the seam from which these specimens came is only 2½ feet thick, a totally uneconomic thickness.

In the same area in 1941 the Mungedar Pastoral Company took a sample from a shaft at a depth of 30 feet from a seam 4 feet thick. The calorific value of this coal (analysed by the Chemical Laboratory of the West Australian Government Railways) was 7725 B. Th. Us./lb. It is not known whether this coal came from the same seam as that cut in No. 3 shaft but according to information on the Departmental files it must be regarded as a much more reliable sample than the two quoted above.

Shortly after Blatchford's examination in 1917, E. de C. Clarke, then a field geologist with the Geological Survey, laid out 5 bore sites to test the North and South Irwin Coal Seams. Two only of these were drilled. Bore No. 1 cut 6 seams, none thicker than 1 foot 6 inches. Bore No. 2 cut 7 seams, one 5 feet thick at a depth 451 feet, one 12 feet thick at a depth 525 feet and the remainder 2 feet or less thick. Analyses of the coal from the thicker seams (see Table of Analyses) gave a calorific value for the 5 feet seam of 7447 B. Th. U's./lb. and for the 12 feet seam 6886 B. Th. Us./lb. (maximum from the top 3 feet). The best of these is worse than the average for the worst of the Collie Coal seams (the Cardiff average calorific value 8200 B. Th. Us./lb).

Commenting on the results of this drilling and Clarke's geological examination, A. Gibb Maitland, then Government Geologist of Western Australia said[19]:—

> While local variations in quality may be expected and are always to be found in coal seams, the geological features of the coal-bearing portion of the Irwin River Field give a fair index of the type of seams occurring, and there is no reason whatever to anticipate any great improvement in quality should the coals discovered in the boring operations be opened out and worked.
>
> The geological structure of the field, being as it is so closely situated to the boundary (fault?) which marks the limits of the coal measures to the east, shows, as may be seen on the geological map (Plate I., Bulletin 38), that there is not any very large areas of coal-bearing ground remaining in the hands of the Crown.
>
> The coals of the Irwin River were deposited in shallow water under rapidly changing conditions, tending to result in the formation of very lenticular seams and beds of an erratic character. This feature may be observed in several places in the banks of the Irwin River and has been demonstrated by the boring which has been carried out.
>
> The deep boring already completed on the eastern margin of the Irwin River coalfield has been sufficient to determine the question of the likelihood of the occurrence of coal seams of commercial quality in this portion of the district.

The present writer is fully in agreement with that statement.

A practical test was made on the North Irwin coal in 1924 by the Railway Department with the results as quoted below[20]—

> They are definitely inferior to the Collie coals, but their geographical position has influenced the possibility of their use. The Railway Department in 1924 conducted locomotive tests against Proprietary Collie coal of Irwin River coal from a 5 foot seam. On a basis of coal per ton mile, the weights of coal used were in the ratio Irwin River to Proprietary 1.47:1. The coal was found to be free burning but yielded such a considerable bulk of ash as

[17] 1924, WOOLNOUGH and SOMERVILLE, op. cit. pp. 104-107.

[18] 1910, CAMPBELL, W. D., G.S.W.A. Bull. No. 38, pp. 46.

[19] 1921, GIBB MAITLAND, A., Progress of boring for coal on the Irwin River and surrounding district. Ann. Prog. Rep. G.S.W.A., p. 13.

[20] 1939, LIMB, J. M., and KENT, C. R., Western Australian Coal Resources and their Utilisation. Railway and Tramway Inst. Council.

to show its unsuitability as a locomotive fuel. It is considered, however, that this coal could, if necessary, be used locally for power station fuel with automatically fired grates and continuous ash discharge.

Between 1924 and 1944 no work was done on the Irwin River Coal Field other than geological examinations by parties of students from the University of Western Australia. In 1944 a tunnel was driven 180 feet down the dip of the thickest seam outcropping in the North Irwin. A complete series of reliable samples were taken and the samples analysed. The results show conclusively (see Table of Analyses) that this coal is an extremely poor one and that it does not improve in quality away from the outcrop as so often claimed by non-technical men. They also show that only the bottom 4 feet of the 6 feet thick seam could be utilised at all thus reducing it to an uneconomic thickness.

The figures in the table of collected analyses show that Irwin River coal fails to fulfil the prime requisite of any coal in Western Australia that it be of better quality than Collie coal. The only two analyses which are better than those of Collie coal are somewhat unreliable and are of coal from a seam of uneconomic thickness.

Information from bores and from geological surveys including the present one shows that the seams are extremely lenticular (not a feature desirable in a good coalfield) and are subject to much faulting.

All these factors combined are sufficient to condemn the Irwin River Coal Field as an economic mining venture.

The economic geology of the Irwin River coal deposits is dealt with briefly by Clarke, Prendergast etc[21]. Four analyses are published and the following sentences appear—speaking of the analyses:—

> the two analyses show that these coals are up to the level of the Griffin No. 1 and Cardiff seams from Collie (based on ultimate analyses and classified on the Ralston system).

and later—

> It would appear, however, that neither geological surveys nor drilling programmes have been sufficiently comprehensive to enable a just estimate of the value of the Irwin River coals seams to be made.

It is regrettable that statements such as these should be published under the name of reputable authors, for such statements are seized upon by interested parties to press for the institution of a drilling programme.

The Irwin River coal is in no way comparable with Collie coal for practical use, in spite of its comparability on an arbitrary system of classification of coals. Its average calorific value is 7000 B. Th. Us/lb. as compared with 8200 B. Th. Us/lb. for the Cardiff seam (worst of the Collie coal) and 9300 for Griffin coal while its average ash content is 17.55 per cent. as compared with 8.39 per cent. for the Cardiff seam and 3.91 per cent. for the Griffin seam. Also an independent test by the Railway Department has proved the unsuitability of Irwin River coal for locomotive use. These are the factors which count when considering the economic usability of the coal—not how the coal compares on an arbitrary classification system with any other coal.

With regard to the second statement, it has been amply demonstrated that sufficient work has been done to enable a just estimate of the value of the Irwin River coal seams to be made. And most of this work was done well before the date of publishing of the paper and before the commencement of the present survey. In fact in an unpublished report (on a Departmental file)—by one of the authors quoted above—the following statement appears:—

> If neither Bore No. 1 nor Bore No. 2 cut any payable seams then the value of the Upper South Irwin as a coal area is disproved.

[21] 1949, CLARKE, PRENDERGAST, TEICHERT, FAIRBRIDGE, op. cit. pp. 63-65.

The bores referred to are P.W.D. Bores Nos. 1 and 2 which were drilled and found to cut no payable seams. Other bores were recommended in the same report and the following statement made in conclusion:—

> That failing good results from P.W.D. Bore No. 1 all other bores are forlorn hopes which would not be recommended to a private company.

Hence since P.W.D. Bore No. 1 failed to cut payable seams the above mentioned unpublished report amounts to a condemnation of the Irwin River coal seams by one of the authors of the misleading statement quoted above.

Eradu Coal Deposits.

These deposits do not outcrop but became known as the result of some boring done in 1906 to find the northern extension of the Irwin River Coal Deposits. A calyx bore was put down to 297 feet, 1 mile north of Eradu in the Greenough River. It cut a seam of coal 7 feet thick but analyses showed this to be a poor coal (see Table of Analyses.) In 1926 and 1927 an extensive boring campaign was carried out and a great deal of information gained about the occurrence of the coal seams. All proved to be low grade coal with much lower calorific value than even the Irwin River coal.

Interest then lapsed till 1943 when two shafts were sunk under the direction of the State Mining Engineer. These shafts, when completed against grave difficulties owing to a large inflow of water, cut a seam of coal 17 feet 6 inches thick at 144 feet vertical depth. Samples were taken and analysed and bulk samples were distributed to various industrial users for practical tests.

The shafts were sunk close to No. 5 Calyx Bore site (one of those drilled in the 1926/27 boring programme) so an opportunity was given to test the results of the boring. A comparison is made in the table below. The analyses are reduced to a 30 per cent. moisture basis to give a truer comparison as the samples were subjected to varying degrees of air drying.

	Bore No. 5.	Morrow's Shaft.
Depth of Seam	135 feet	144 feet.
Thickness of Seam	17 feet 6 inches	17 feet 6 inches

Proximate Analyses.

Sample.	Moisture.	Volatiles.	Fixed Carbon.	Ash.	Calorific Value B.Th.U./lb.
Bore top 3 ft. 7 in.	30·00	20·86	30·16	17·08	....
Shaft top 4 ft.	30·00	20·23	26·10	23·67	5,466
Bore 3 ft. 7 in. to 7 ft. 2 in.	30·00	21·07	33·17	15·86	....
Shaft 4 ft. to 8 ft.	30·00	20·82	31·66	17·52	5,878
Bore 7 ft. 2 in. to 10 ft. 9 in.	30·00	20·19	31·59	18·22	....
Shaft 8 ft. to 12 ft.	30·00	21·91	34·67	13·42	6,239
Bore 10 ft. 9 in. to 14 ft. 4 in.	30·00	22·63	35·32	13·05	6,543
Shaft 12 ft. to 16 ft.	30·00	19·71	34·09	16·20	6,660
Bore 14 ft. 4 in. to 17 ft. 6 in.	30·00	21·09	31·08	17·83	....

The figures show that analyses from coal in bore cores are a reliable indication of the quality of the coal and that this coal is an extremely poor type.

Practical tests indicated the coal could be used for brick burning and for boilers with stoker grates and forced draught.

It is considered that the information supplied by the boring campaign, the shaft sinking, coal analyses and practical tests is sufficient to demonstrate that the Eradu coal seams are of too poor a quality to compete against Collie coal.

The seams are lenticular and grade into even poorer coal than that whose analyses are shown in the above table. Also to the south-east and east the seams either thin out altogether or are cut off by a fault with a throw of 100 feet or more.

COLLECTED COAL ANALYSES.

Sample No.	Description.	Location.	Publication Reference.	Proximate Analysis.					Date.
				Moisture.	Volatiles.	Fixed Carbon.	Ash.	Calorific Value B.Th.U.	
A.—Irwin River District.									
1	Outcrop of seam in river	South Irwin ?	G.S.W.A. Bulletin No. 67, p. 108	3′ 17·04	28·61	41·29	13·06	*	1888 (?)
				3′ 12·40	32·20	43·50	11·90	*	1888 (?)
				3′ 15·63	23·06	39·32	21·99	*	1888 (?)
2	Four inch seam at depth of 265 ft.	At N.E. corner of Location 688, Dongara	G.S.W.A. Bulletin No. 38 and G.S.W.A. Annual Report for 1922	13·13	29·47	49·40	8·00	....	1897
3	Lignite lumps from a shaft 4½ miles N. 25° E. from Depot Hill	Half mile west from where the Irwin River forms the western boundary of C.G. 810	G.S. File No. 41/1906	27·45	41·66	27·46	3·44	....	22–6–06
4	Five feet seam in tunnel	Reserve 2297, North Irwin River	G.S.W.A. Bulletin No. 67, p. 108	Top 22·04	23·84	37·25	16·87	7,020	1907
				Centre 24·74	27·12	31·98	16·16	7,182	
				Bottom 24·25	26·73	37·97	11·05	7,965	
5	do. do.	do. do. do.	do. do. do.	18·39	29·87	40·13	11·61	8,593	1912
6 (i)	2½ ft. coal at depth of 9 ft.	Shaft No. 1 on Reserve 900, South Irwin River	G.S.W.A. File No. 27/1900	14·92	14·68	56·9	13·5	7,920†	1917
(ii)	4 ft. coal at depth of 25 ft.	Shaft No. 2, 60 ft. away from Shaft No. 1	do. do.	Top 18·12	17·38	48·93	15·57	8,514†	
				Bottom 19·97	22·15	44·6	13·28	8,118†	1917
(iii)	2½ ft. coal at depth of 9 ft.	Shaft No. 1	do. do.	10·40	30·81	44·01	14·78	9,327	1917
(iv)	Shaft No. 3 at 40 ft.	Reserve 900	do. do.	8·97	29·51	47·61	13·91	9,603†	
				9·48	32·59	49·17	8·76	10,494†	1917
(v)	Dump of Shaft No. 3—collected by J. Blatchford	do.	do. do.	5·11	33·87	51·12	9·90	10,456‡	21–2–18
7 (i)	4 ft. 2 in. seam at depth of 451 ft. in P.W.D. Bore No. 2	On west bank of South Irwin River approx. ½ mile S.E. from S.E. corner of Reserve 900	G.S.W.A. Annual Report for 1922	Top 22·71	24·84	27·96	24·49	6,298	1921
				Centre 23·16	28·02	29·85	18·97	7,312	1921
				Bottom 24·86	28·60	26·06	20·48	6,966	1921
(ii)	18 in. seam at 460 ft.	do. do. do.	do. do. do.	26·52	26·40	32·98	14·10	7,447	1921
(iii)	12 ft. seam at 525 ft.	do. do. do.	do. do. do.	Top 24·30	25·92	31·98	17·80	6,886 (7,778)§	1921
				Upper Middle 21·06	27·94	27·11	23·89	5,887 (6,475)§	1921
				Lower Middle 20·42	28·48	27·50	23·60	6,121 (6,678)§	1921
				Bottom 21·46	24·92	28·38	25·24	5,722 (6,245)§	1921
8	No. 3 seam	North Irwin River	Journ. Roy. Soc. W.A. 1948–9, Vol. XXXV	18·5	27·05	35·45	19·0	7,195	1939
9	4 ft. coal at depth of 30 ft.	South Irwin River, ¾ mile east of the fords	Mines Dept. File No. 547/43	32·17	25·44	35·15	7·24	7,725	1941

* Analyses made in London. † Allsop & Don analyses. ‡ Air dried for a long time. § After drying for 5 days.

COLLECTED COAL ANALYSES.

Sample No.	Description.	Location.	Publication Reference.	Proximate Analysis.						Date.
				Moisture.		Volatiles.	Fixed Carbon.	Ash.	Calorific Value B.Th.U.	
10	Averaged from samples taken along each 10 ft. of the tunnel	Reserve 2297, North Irwin River	G.S.W.A. File No. 26/1947	Top 12″ 20·00 Next 12″ 20·00 Bottom 48″ 20·00		30·4 23·2 32·8	30·4 20·8 32·8	19·2 36·0 15·2	Air dried	1945
11	13 coal samples from the Irwin River Tunnel	Reserve 2297, North Irwin River	do. do.							
	(i) 19 ft. from outcrop	....		Top	12″ 4·93	30·48	39·35	25·24	....	June, 1945
					10″ 4·32	22·99	25·13	47·56	....	
					17″ 4·26	34·78	40·84	20·12	....	
				Bottom	24″ 5·69	32·71	42·71	18·89	....	
	(ii) 25 ft. from outcrop	....		Top	12″ 5·22	30·08	42·13	22·57	....	
					10″ 3·91	20·32	23·21	52·56	....	
					18″ 4·82	32·06	40·60	22·52	....	
				Bottom	31″ 6·34	31·95	46·48	15·23	....	
	(iii) 31 ft. from outcrop	....		Top	7″ 7·65	30·35	41·88	20·12	....	
					14″ 7·02	23·67	30·64	38·67	....	
					18″ 7·13	31·55	40·14	21·18	....	
				Bottom	28″ 8·17	32·32	43·00	16·51	....	
	(iv) 43 ft. from outcrop	....		Top	12″ 6·75	28·99	41·74	22·52	....	
					10″ 5·63	21·80	27·67	44·90	....	
					18″ 5·95	31·05	40·01	22·99	....	
				Bottom	32″ 6·92	30·54	45·98	16·56	....	
	(v) 50 ft. from outcrop	....		Top	8″ 10·85	25·93	39·46	23·76	....	
					19″ 9·55	21·79	29·07	39·59	....	
					17″ 12·90	29·89	40·50	16·71	....	
				Bottom	30″ 13·45	28·77	43·33	14·45	....	
	(vi) 90 ft. from outcrop	....		Top	12″ 5·84	28·74	41·41	24·01	....	
					12″ 4·87	22·83	28·95	43·35	....	
					10″ 6·91	31·49	48·19	13·41	....	
					14″ 5·68	32·83	42·71	18·78	....	
				Bottom	24″ 5·51	30·81	46·23	17·45	....	
	(vii) 104 ft. from outcrop	....		Top	12″ 6·82	29·47	41·15	22·56	....	
					12″ 6·11	23·74	31·58	38·57	....	
					10″ 8·49	31·17	47·88	12·46	....	
					14″ 6·13	30·09	38·25	25·53	....	
				Bottom	24″ 7·45	30·24	45·96	16·35	....	
	(viii) 115 ft. from outcrop	....		Top	12″ 11·08	27·66	38·33	22·93	....	
					12″ 9·49	22·30	29·26	38·95	....	
					10″ 13·08	30·35	44·89	11·68	....	
					14″ 11·95	29·26	39·41	19·38	....	
				Bottom	24″ 13·91	29·57	43·24	13·34	....	
	(ix) 125 ft. from outcrop	....		Top	12″ 11·75	28·89	40·70	18·66	....	
					12″ 9·97	23·90	30·08	36·06	....	
					10″ 13·15	30·59	44·65	11·61	....	

		(x) 140 ft. from outcrop	....	Bottom	14″	11·37	27·35	38·01	23·27	....	
				Bottom	24″	14·03	30·89	42·25	12·83	....	
				Top	12″	11·51	28·14	39·91	20·44	....	
					12″	9·29	21·82	29·22	39·67	....	
					10″	12·42	30·80	43·75	13·03	....	
					14″	12·97	29·99	42·62	14·42	....	
		(xi) 155 ft. from outcrop	....	Bottom	24″	13·50	27·97	41·97	16·56	....	
				Top	12″	12·71	27·81	38·41	21·07	....	
					12″	10·32	22·97	27·94	38·77	....	
					10″	13·57	30·08	43·58	12·77	....	
					14″	13·96	29·65	39·34	17·05	....	
				Bottom	24″	14·31	27·86	43·07	14·76	....	
		(xii) 170 ft. from outcrop	....	Top	12″	13·09	27·09	40·28	19·54	....	
					12″	10·46	21·42	29·44	38·68	....	
					10″	12·70	29·48	43·36	14·46	....	
					14″	10·53	27·37	36·44	25·66	....	
				Bottom	24″	13·64	28·19	44·34	13·83	....	
		(xiii) 180 ft. from outcrop	....	Top	12″	12·55	26·88	40·61	19·96	....	
					12″	10·08	21·01	28·29	40·62	....	
					10″	12·70	28·94	42·92	15·44	....	
					14″	12·54	27·98	37·62	21·86	....	
				Bottom	24″	13·49	28·46	43·27	14·78	....	
12	Samples by Assistant State Mining Engineer	North Irwin River—New Tunnel (1944)	G.S.W.A. File No. 26/1947								
		(i) On 6 ft. seam (top)	....	Top	2′	27·83	16·79	28·54	26·84	5,396	13–2–48
				Bottom	4′	31·64	18·98	34·8	15·20	6,560	
		(ii) On 4 ft. seam (lower)	....			22·15	24·78	35·63	17·44	7,415	
B.—Eradu District.											
1	Milne's calyx bore 8 ft. coal seam at 118 ft. depth	Close to east bank of Greenough River near S.W. corner of CG. 2806	G.S.W.A. File No. 149/1902	4 Samples		8·14	38·08	30·80	22·97	....	24–1–07
						9·59	40·26	37·97	12·16	9,900	
						6·99	30·05	27·06	35·90	....	
						8·24	36·13	31·97	23·66	....	
2 (i)	Coal from Blatchford's calyx bore No. 1	Approx. $\frac{5}{8}$ mile west of Greenough River on CG. 5688. No. 1 Bore	G.S.W.A. Ann. Prog. Rep. 1929, p. 16	170′–180′		13·66	36·41	24·74	25·19	....	24–12–26
				181½′–183′		10·67	31·32	30·69	27·32	5,493	
				188′–190′		7·78	26·65	29·00	36·57	....	
(ii)	No. 1 calyx bore samples by State Mining Engineer	do. do. do.	G.S.W.A. File No. 149/1902			25·22	22·51	16·02	36·25	....	1926
						6·08	12·47	9·78	70·94	....	
						19·20	27·19	35·49	18·12	6,911	
3	Calyx Bore No. 2	$\frac{2}{5}$ mile north of No. 1 Bore	G.S.W.A. Ann. Prog. Rep. 1929, p. 16	127′–135′		12·20	26·89	21·22	36·69	....	1927
				138½′–139½′		8·00	24·76	22·89	44·35	....	
				153′–156′		9·40	21·48	28·52	40·60	5,699	
4 (i)	Calyx bore No. 4, 19 ft. seam at 144 ft. depth	Close to west bank of Greenough River on CG. 2669	G.S.W.A. Ann. Prog. Rep. 1929, p. 17	Top	3′	32·33	24·11	35·64	8·02	7,028	June, 1927
					3′	35·78	22·64	33·81	7·77	6,155	
					3′	22·78	22·51	32·86	11·85	6,310	
(ii)	Seam 4 ft. 3 in. thick at 137 ft. depth	do. do. do.	do. do. do.	Bottom	3′	27·58	22·38	28·08	21·96	....	
						16·24	24·10	31·91	27·75	5,742	Aug., 1927

COLLECTED COAL ANALYSES.

Sample No.	Description.	Location.	Publication Reference.	Proximate Analysis.					Date.
				Moisture.	Volatiles.	Fixed Carbon.	Ash.	Calorific Value B.Th.U.	
5	Calyx bore No. 5, 17 ft. 6 in. seam at 135 ft. depth	½ mile east of Greenough River on CG. 2263	G.S.W.A. Ann. Prog. Rep. 1929, p. 18	Top 3′ 7″ 26·26	21·96	31·78	18·00	....	13–7–28
				3′ 7″ 28·90	21·31	33·69	16·10	....	
				3′ 7″ 27·70	20·85	32·63	18·82	....	
				3′ 7″ 28·87	23·07	34·82	13·24	6,649	
				Bottom 3′ 2″ 26·39	22·16	32·71	18·74	....	
6	Calyx bore No. 7, 2 ft. seam at 73½ ft. depth	⅖ mile west of Greenough River and close to S.W. corner of CG. 2514	do. do. do.	31·50	23·20	13·37	31·93	....	7–8–29
7 (i)	Calyx bore No. 8, seam at 172 ft. depth	Approx. 1 mile west of Greenough River, being ½ mile N.W. of S.W. corner of CG. 2723	do. do. do.	23·30	25·08	21·44	30·18	....	16–10–29
(ii)	7 ft. seam at 191 ft. depth	do. do. do.	G.S.W.A. Ann. Prog. Rep. 1929, p. 19	Top 22·21	22·11	33·63	22·05	....	16–10–29
				Middle 22·93	24·14	36·53	16·40	....	
				Bottom 15·21	21·79	20·79	42·21	....	
8	Samples for Eradu Coal Co., Ltd.	Location unknown	Mines Dept. File No. 1100/47	38·64	24·93	24·75	11·68	5,700	21–6–32
				19·46	20·03	24·98	35·53	....	5–8–38
				21·06	20·01	19·51	39·42	....	
9	Coal from shafts at Eradu, seams at 144 ft. depth	(i) Higgins' Shaft, 6 chains east of No. 5 calyx bore on eastern boundary of CG. 2263	do. do. do.	31·27	21·30	23·45	23·98	5,540	14–8–47
		(ii) Morrow's Shaft, 1 chain east of Higgins' Shaft	do. do. do.	35·26	23·82	22·12	18·8	5,450	
10	Coal from full width of seam at bottom of Morrow's Shaft—17 ft. 9 in. of coal	(i) Top 4 ft. of seam south face	do. do. do.	29·4	20·40	26·33	23·87	5,510	9–9–47
		(ii) 4 ft. 8 in. down east face	do. do. do.	38·45	18·3	27·83	15·42	5,170	
		(iii) 8 ft.–12 ft., east face	do. do. do.	35·82	20·2	31·56	12·42	5,720	
		(iv) 12 ft.–16 ft., east face	do. do. do.	40·8	16·6	28·87	13·73	5,630	
		(v) Spot sample at 13 ft. on east face for natural water content	do. do. do.	34·66	21·1	32·49	11·75	....	
		(vi) Sample from Higgins' soil bank	do. do. do.	33·2	22·4	31·1	13·3	....	
11	Coal from east wall of south drive, 15 ft. from south wall shaft	Morrow's Shaft, 7 chains east of No. 5 calyx bore and near eastern boundary of CG. 2263	Mines Dept. File No. 1560/47	Six Samples 31·7	19·9	30·1	18·3	5,995	12–1–48
				34·0	25·2	28·2	12·6	6,620	
				36·2	21·9	31·2	10·7	6,460	
				32·3	22·6	29·6	15·5	6,130	
				35·1	18·3	32·2	14·4	5,580	
				48·75	16·1	25·43	9·72	4,530‖	

NOTE.—Except where indicated analyses were made by Goverment Chemical Laboratory. ‖ Moisture content sample.

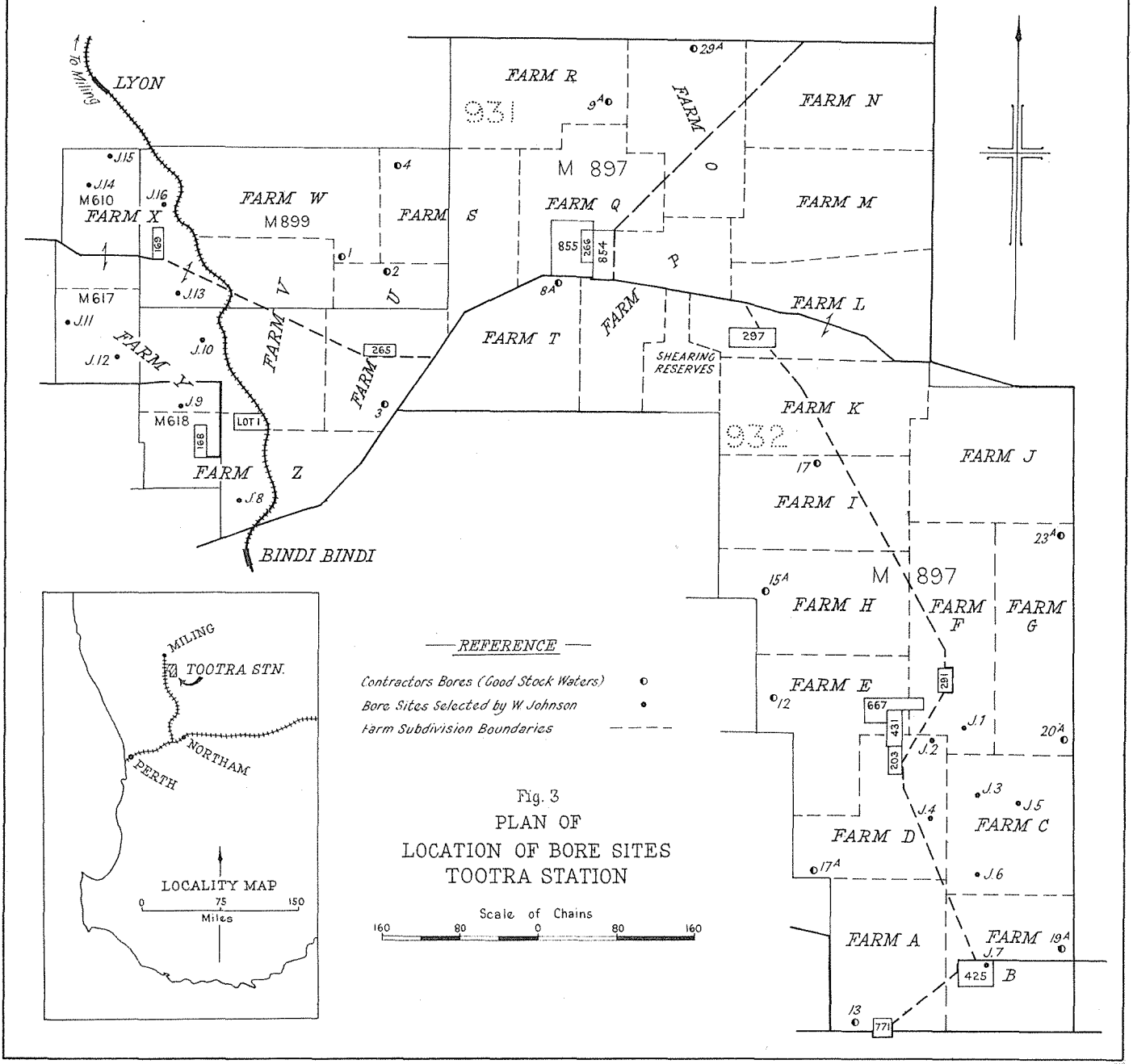

Fig. 3

PLAN OF

LOCATION OF BORE SITES

TOOTRA STATION

Economic Aspects.

While the above evidence should be sufficient to prove that both the Irwin River and Eradu coal deposits would be uneconomic to develop, it is proposed to discuss here the purely economic aspects of the utilisation of these deposits.

The only justifications for mining coal at either Eradu or Irwin River are that it would be sold cheaper than Collie coal and that it would save the use of railway rolling stock for transport to the northern districts.

Unbiased tests[22] by the Chemical Laboratory of the Railway Department have shown that the Irwin River coal (on account of its proportion of ash) is unsuitable for use in locomotives. Hence Eradu coal with a much higher ash percentage would also be useless. This immediately reduces the amount of Irwin-Eradu coal that could be used in the northern districts to almost negligible proportions. Even at a generous estimate the amount used by consumers other that the Railway Department would not exceed 2,000 tons a year, so that the saving in rolling stock would be negligible.

Collie coal can be landed in Geraldton at 69s. 1d. a ton (Amalgamated Collieries coal). Since Irwin River coal is equivalent to average Collie coal in the ratio 1.47:1 [23]Irwin River coal would have to be sold in Geraldton at 47s. 0d. a ton, and Eradu coal at correspondingly lower price, to compete with Collie coal.

To make mining profitable the 2,000 tons or less per year would have to be mined at an average cost sufficiently lower than 47s. per ton to pay a good dividend on capital invested in equipment. With such a low output no coal mining operation could possibly be profitable, not even open-cut coal mining.

Inevitably comparison between Irwin-Eradu coal and Leigh Creek coal (South Australia) will be made since the coals are of similar rank, ash content and heating value. However South Australia has no internal source of coal *better* than Leigh Creek, therefore a market exists for large quantities. Also Leigh Creek coal is to be used for gasification thus increasing the amount which can be consumed. Lastly Leigh Creek coal can be mined cheaply by open cut. (A seam 40 feet thick exists under 30 feet to 60 feet of overburden).

No open-cut sites exist in the Eradu or Irwin River coal fields hence even if a large quantity of coal could be consumed it is extremely doubtful whether it could be mined economically.

CONCLUSION.

This report shows that though the coal bearing formation of the Permian rocks in the Irwin River and Greenough River Basins are quite extensive geographically, the contained coal seams are of too poor a quality, are too lenticular, are too much displaced by faults to ever be developed as an economic mining venture, or as a means of assisting the development of the northern districts.

For the reasons laid out in this report and summarised above, it cannot be recommended that any drilling be done in any part of the Area covered by the report.

It is also recommended that on no account should any more money be spent by the Government in any way in investigating the Irwin River and Eradu coal deposits.

It is considered that this report has proved that it would be an uneconomic proposition to develop either of these two deposits.

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[22] LIMB and KENT, op. cit. p. 11.

[23] LIMB and KENT, op. cit. p. 11.

REPORT ON LOCATION OF WATER BORE SITES ON TOOTRA STATION, BINDI BINDI, MELBOURNE DISTRICT, SOUTH-WEST LAND DIVISION OF WESTERN AUSTRALIA.

By W. Johnson, B.Sc. (Hons.).

Until recently Tootra was a large pastoral property of approximately 50,000 acres situated near Bindi Bindi, a siding on the Perth-Miling Railway. Bindi Bindi is 100 miles N.N.E. from Perth. Tootra was purchased by the War Service Land Settlement Board and divided into 26 farms. This subdivision necessitated the finding of more water supplies. Fifty-seven bores were put down by a contractor, apparently at sites selected by himself. Only 15 of these bores found usable supplies of water, and 13 of the 15 were stock water only. The remaining 42 bores either struck "granite" (granite gneiss) or found water which was too salt to be of any use.

As a result of the failure of this boring programme the services of the Geological Survey were requested to locate suitable bore sites. Accordingly the writer examined the farms on the 31st October, and 1st November, 1949, and selected 16 sites on seven farms. The remaining 19 farms were said by the field supervisor of Tootra to have sufficient water supplies for present purposes. The approximate sites of these bores are indicated on Fig. 2.

All the farms are in an area underlain at a comparatively shallow depth by granite gneiss. This gneiss contains a few quartz veins and pegmatite dykes and more numerous dolerite dykes. It outcrops on the tops and near the crests of ridges but elsewhere is covered by soil and residual continental sediments. Bores have reached the solid rock at depths varying from 25 feet to 91 feet.

Soil or sediments overlie a zone of weathered gneiss under which is a zone of jointed gneiss. This zone of joints is important as in places it may be water bearing (some of the natural soakage wells are in jointed gneiss).

The area has a gently undulating topography. The valleys are 100 to 150 feet deep with gently sloping sides and are separated by rounded divides near the crests of which rock outcrops occur.

Almost all existing water supplies and successful bores are located varying distances up the slopes from the bottom of the valleys. Although exceptions occur the following conditions hold generally:—

(i) The longer the slope the larger the supply of water.

(ii) The closer to the bottom of the valley the larger the supply of water.

(iii) The closer to the bottom the more saline the water.

Data from the bores indicate that on Tootra underground water is held in the soil, weathered gneiss, and residual sediments in favourable positions on a hidden rock surface which roughly corresponds to the existing land surface.

Bore logs available are sketchy but one piece of interesting information is given.

"Farm 0.45ft. Salt water. Good water to 41ft. probably making 1,000 galls. daily. Water became too saline at 45ft."

This indicates that in this district bodies of fresh water may exist overlying saline water.

In boring at sites selected by the writer the following programme must be followed if best results are to be obtained from the bores:—

(i) Test each "make" of water in the hole for salinity and volume before boring deeper. In this way bodies of fresh water overlying saline water will be detected.

(ii) Bore at least 10ft. into the "solid granite gneiss" to test the jointed zone (that is if salt water has not already been encountered in the bore).

REPORT ON PYRITE—MT. McMAHON, PHILLIPS RIVER GOLDFIELD.

By N. M. Gray, B.Sc., and J. S. Gleeson. B.Sc.

Introduction.

Mt. McMahon is situated about 4 miles E.N.E. of Ravensthorpe (see Plate XVI). The examination was carried out while the party was in the district on the manganese survey, during October, 1949. The purpose of the examination of Mt. McMahon was to report on the possibilities of a pyrite deposit for use in manufacture of superphosphate at Albany.

Previous Information.

Montgomery[1] mentions that the Phillips River Gold and Copper Company diamond drilled into this hill for pyrite ore for use as a matte forming agent for their smelters. This bore traversed 490 feet in a direction of N.80°E. at an angle of inclination of 45° from the vertical. From 170 feet to 338 feet the bore passed through a pyrite ore body. Fig. 3 shows the general position of this bore (labelled 1) and of subsequent bores. Parts of this core have been assayed and two samples gave 44.37 per cent. and 45.68 per cent. iron and 35.91 per cent. and 30.70 per cent. sulphur respectively. These samples were supplied to Montgomery some time after the completion of the bore. It was stated, then, that the samples were not from parts of the core for which the highest assay values could be expected.

In 1915, the Mines Department commenced drilling the hill to prove the pyrite body. Their first hole (see fig. 3, drill hole 2) was set 66 feet south of the Company's bore with a downwards inclination of 30°. This bore traversed a length of 290 feet. Some small amount of pyrite was shown in the core but this was only to be expected as the entire length of the bore traversed the oxidised zone of weathering. The Department's second bore (see fig. 3, drill hole 3) was set 60 feet north of the Company's bore and 100 feet nearer the outcrop, and at an inclination of 45°. This hole, as was the first, was placed too high up in the oxidised zone. It reached a depth of only 42 feet when the bit was sheared off and could not be recovered. A shallow vertical shaft was then sunk to intercept the estimated position of the end of this hole to recover the diamonds but, it is understood, this was unsuccessful.

The directions of these two bores were not given, but it is probable that they were parallel to the original bore. Subsequently an adit some 50 feet long was driven under an ironstone outcrop which was considered to represent the gossan of the pyrite body. At about 20 feet from the entrance, a vertical shaft was sunk which reached a depth of 114 feet below the floor of the adit when work ceased. It has been estimated that another 50 feet of sinking would probably have been sufficient to reach the pyrite at a similar depth to where it was cut by the first diamond drill (i.e. the Company's)[2].

Geology.

Mt. McMahon is a small hill, well below the general height of the main ridge, and situated approximately a quarter of a mile west from the main ridge. It is on the northern end of a spur and is itself quite prominent.

In the vicinity of Mt. McMahon, the schists are highly weathered and iron-stained, and exact identification was not possible. However, southwards along the strike, this belt consisted of chlorite schists, mainly, with varying amounts of other low grade metamorphosed sediments. The other main rock type of the area is ferruginous quartzites. These ferruginous quartzites are very numerous and are capped by laterite which contain pebbles of the underlying quartzites. Mapping by Woodward and Talbot shows the general features and the distribution of the rocks of this area[3]. It is possible that this pyrite body has formed in one of these ferruginous quartzites.

The adit, which is on the west slope of Mt. McMahon, was examined as far as the shaft. The location of bore 3 was found but the locations of the other two were not. Fig. 3 shows diagramatically the positions of the bores and shafts[4].

Above the entrace to the adit is an iron rich outcrop which consists mainly of haematite and limonite. In the authors' opinion, this *may* represent a gossan of a pyrite body, but they wish to point out that such an outcrop is NOT necessarily indicative of a pyrite body at depth.

Economic and Other Considerations.

There is no doubt that a pyrite body does underlie this gossan below the oxidised zone (see "Previous Information" above). However, there are many other factors which must be considered, some of which are political in nature. In an economic geological report such as this, these factors must be considered.

W.A. has never been short of pyrite and the "Iron King" Mine at Norseman is in such a state of development that it can produce twice as much pyrite as the Superphosphate Companies can use at the present time. In all probability the production of this mine could be stepped up some six-fold without a very large increase in capital cost and with a corresponding decrease in working costs if and when the demand existed.

Although the presence of pyrite is known, it would take much expensive drilling to prove its relative position, as well as the expense of any shaft sinking, crosscutting and driving.

If it were proposed to mine this body, it would be some not inconsiderable time before equipment would be available.

The problem of transport is a big one. Shipping from Hopetoun is out of the question as the port was closed in 1935 and the jetty is in a state of disrepair. The nearest railhead is Newdegate (80 miles away) and the next is Ongerup (100 miles). The cost of road transport to either of these centres would be high, particularly to Ongerup, due to the poor state of the road. As far as transport facilities are concerned, the movement of ore is very poor when compared with Norseman.

Production at the "Iron King" Mine, Norseman, has been heavily subsidised by the Government. If work on this body at Ravensthorpe is carried out, no doubt financial help on a large scale would be requested from the Government.

Recommendations.

Unless it is the policy of the Government to prove, develop and subsidise the mining of pyrite at Ravensthorpe, the authors consider that this deposit does NOT warrant any further expenditure of public monies.

REPORT ON MANGANESE DEPOSIT NEAR MT. WALTON, COOLGARDIE GOLDFIELD.

By N. M. Gray, B.Sc., and J. S. Gleeson, B.Sc.

General Information.

The deposit is within late M.L. 78 and is about 15 miles north of Ryans Find and about 6 miles north-east of Wallangie Rock (see figs. 4 and 5). There are three practical routes to this area, two of which are through Coolgardie and the other through Yellowdine or Karalee. Of the two through Coolgardie, the one used by the authors is understood to be the better of the two, though somewhat longer. This route is via Carbine, "Credo" Station, Emu Rock and thence by the old Menzies-Southern Cross Road. It is approximately 30 miles from Carbine to the Menzies-Southern Cross Road

[1] MONTGOMERY, A.; Report on the Development of the Phillips River Auriferous Copper Mines. Department of Mines, 1914, p. 9.

[2] Mines Department File 381/15.

[3] WOODWARD, H. P., Geological Report upon the Gold and Copper Deposits of the Phillips River Goldfield. G.S.W.A. Bull. No. 35. Map 1.

[4] Figure based on sketches in Mines Department File 381/15.

FIG. 4

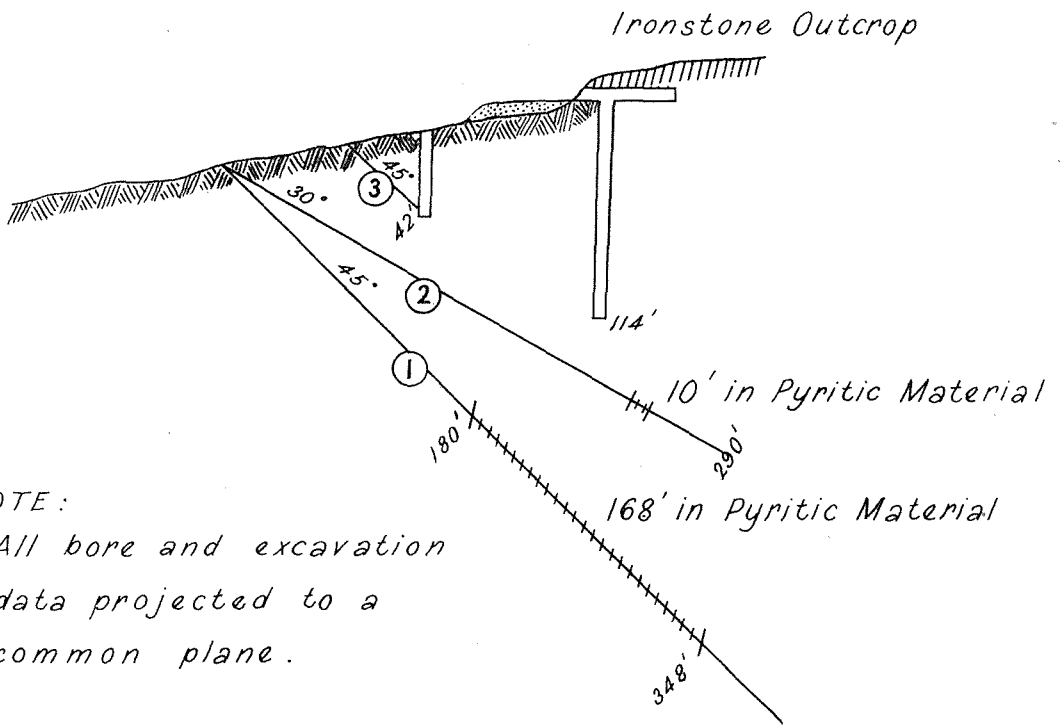
DIAGRAMMATIC SECTION

SHOWING LOCATION OF BORES AND SHAFTS ON Mt McMAHON

Phillips River Goldfield

Compiled from information contained in Mines Department File 381/15

SECTION EAST-WEST (APPROX)



NOTE:
All bore and excavation data projected to a common plane.

Approximate Scale: 100 feet to an Inch

Compiled by J.S. Gleeson. B.Sc.

FIG 5

LOCALITY MAP

SHOWING APPROXIMATE POSITION

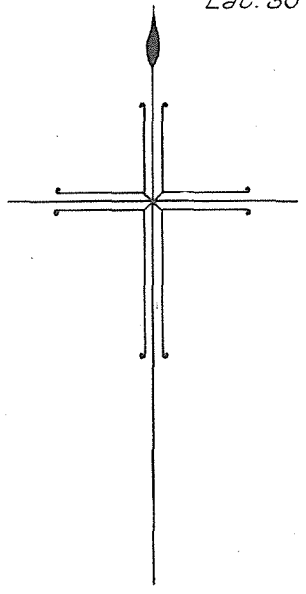
OF

THE MANGANESE DEPOSIT NEAR Mt WALTON

Coolgardie Goldfield

Scale : 10 Miles to an Inch

Lat. 30°35'S. Long. 120°5'E.



EMU ROCK

CREDO

CARBINE

UDARDUNGING SOAK

DEADMANS ROCK

Mt WALTON (PD) ROAD

Manganese Deposit

71 MILE ROCK (WELL)

WALLANGIE ROCK

KUNANALLING

JAURDIE HILLS

BREAKAWAY FIND

(Wallangie Leases)

DOODOOGOOING ROCK

MENZIES

RYANS FIND

WALLAROO ROCK

WALLANGERING

Mt WALTER

COOLGARDIE

SOUTHERN CROSS

WEOWANIE ROCK

OLD

YELLOWDINE

KARALEE

Based on Lands Dept Litho Sheet 5 (Kalgoorlie) Topographical Series

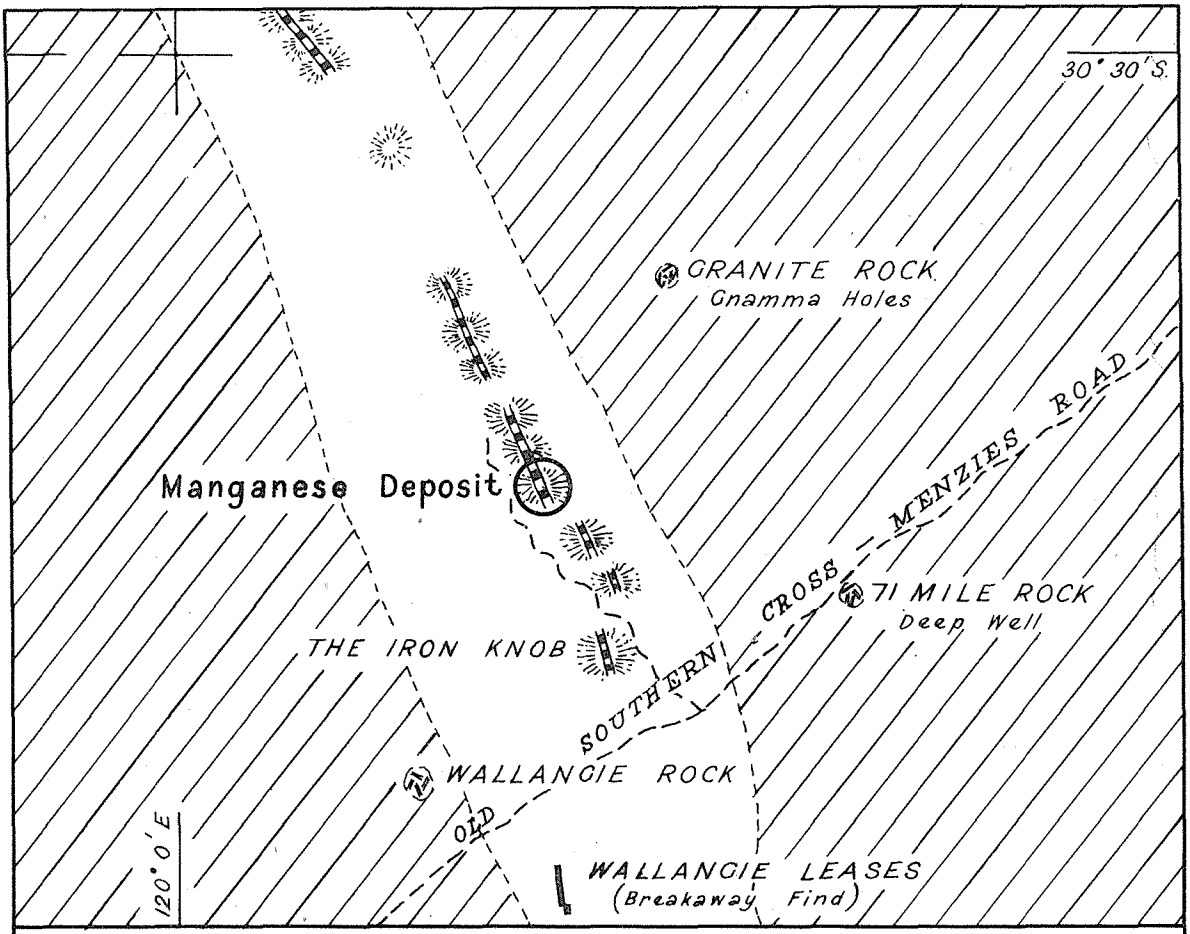


FIG. 6

LOCATION OF MANGANESE DEPOSIT AND GENERAL GEOLOGY

LEGEND

Granite

Greenstones

Jaspillites

Scale: 300 Chains to an Inch

From plans by H.W.B. Talbot, 1919.

With additions by K.R. Miles, 1941.

and about 28½ miles further to a branch track which leads northwards for about 5 miles to the deposit. It is possible to get within a few hundred yards of the deposit by motor vehicle. The total distance from Coolgardie by this route is about 100 miles and the track is in fair condition. The other route from Coolgardie is via the Jaurdi Hills Road to just south of the 20 mile peg whence an old timber tramline track is followed westward via Doodoogoing Rock, Wallaroo Rock, Ryans Find thence north to the old Menzies-Southern Cross Road. The third route is through either Yellowdine or Karalee via Weowonie Rock and the old Menzies-Southern Cross Road.

Good drinking water can be found in numerous rock catchments and adjacent to most granite outcrops after rain. During this trip (November 1949), made a few days after heavy rains fell in the area, excellent water was found at Emu Rock and a covered-in well was seen but not sampled at Udardunging Soak. The "71 mile well" was not seen but it is understood that the supply is permanent and of good quality.

Geology.

The deposit has been previously reported on by Wilson[1] and by Miles[2].

The manganese outcrops on the western slope of a prominent, ferruginous-quartzite ridge. The ridge is a series of north-north-west trending ridges that are associated with a belt of greenstone rocks which are found outcropping along a length of sixty miles, extending from south of Ryans Find to north of Mt. Walton. In the vicinity of the deposit, the rocks are red ferruginous schists (hematite schists); the manganese being intimately associated with these schists. The manganese is in the schists in fine stringers, many of which have followed the original bedding planes of the schists. Enrichment of the manganese is seen in the top few inches and the proportion of manganese to iron decreases rapidly with depth.

The regional strike is approximately N.N.W. What is considered to be fracture cleavage was seen in the ferruginous schists. This cleavage has a strike of N.5°W. approximately. It is considered that this fracture cleavage has been the structural control on the formation of the manganese deposit in a particular horizon, and, further, that in this particular area, manganese deposits will not be found along the strike unless this fracture cleavage is present.

Within the jaspilites, examples are occasionally seen where re-generated hematite has been intruded into and across the bedding planes of these quartzites. This is comparable with that found associated with the iron deposits and jaspilites of the Koolyanobbing Range, some 40 miles westward.[3]

The manganese was traced over an area of 15 feet by 10 feet and the workings gave exposures up to 4 feet. Most of the material is of low grade, however, and only in places where the stringers have coalesced, or at the surface, does the manganese approach the purity required by commercial buyers.

In the authors' opinion, the deposit is of secondary origin, the manganese having metasomatically replaced the pre-existing iron by capillary action. The manganese does not live to depth and the deposit grades into ferruginous schists devoid of manganese, as can be seen in the workings.

Wilson[4] mentions another deposit about 100 yards to the north and further up the hill from the one described above. This deposit though diligently looked for could not be found. (It could be pointed out here that locating these deposits is a matter of chance as no detrital is seen which would act as a guide to their location. Their very small size makes it necessary to walk right onto them to find them.) According to Wilson, this deposit has an area of 42 feet by 20 feet and consists mostly of folianite (MnO_2). Further, "deposits of this nature are frequently lateritic in character, i.e., forming a capping only of limited thickness." From the nature of the deposit examined, it can safely be predicted that this second deposit is of the same type—a replacement deposit of very limited depth, its formation having been controlled by fracture cleavage.

In an accompanying report on the manganese deposits in and adjacent to the Phillips River Goldfield, some detailed notes on the origin of the manganese and the formation of the deposits are given. These apply equally well to those referred to in this report.

Two samples were taken from the examined deposit. Number 6934 (Chemical Laboratory numbers) was taken from the outcrop and face of the workings. The other sample (number 6935) was taken from the dump. Both these samples were random grab samples.

The following are the partial analyses of these two samples:—

No.		Analysis.	%	
6934	....	MnO_2	50·69	
		MnO	7·05	
		Fe	6·20	
		SiO_2	22·45	
		P	trace	
		Total Mn	....	37·49%
6935	....	MnO_2	57·46	
		MnO	3·16	
		Fe	5·45	
		SiO_2	15·21	
		P	trace	
		Total Mn	....	38·75%

Neither of these samples approach anywhere near the purity required for either metallurgical or chemical manganese. (The specifications for metallurgical and chemical manganese are given in the report on the manganese deposits of the Phillips River Goldfield).

Economic Possibilities.

These two deposits are of small area and of very little depth so that the total tonnage available would be very small. Even if this was of good quality, the present economic conditions, particularly transport, would make the cost of mining prohibitive. Further, the assays show the deposit examined to be not of good grade, and it can be assumed that the other, as it is a similar type of deposit, will have a grade that will be, at the most, not much better.

The authors consider that these deposits are *not* of economic value and that it is unlikely that they will become so at any future date.

REPORT ON MANGANESE DEPOSITS IN AND ADJACENT TO THE PHILLIPS RIVER GOLDFIELD.

By N. M. Gray, B.Sc., and J. S. Gleeson, B.Sc.

[1] WILSON, R. C.; Manganese Ore at Mt. Walton, Coolgardie Goldfield. G.S.W.A. Ann. Prog. Pept., 1921, pp. 37.

[2] MILES, K. R.; Report on a Supposed Manganese and Hematite Deposit near Wallangie, Coolgardie Goldfield. Unpublished Report, G.S.W.A. File 57/1900.

[3] HOBSON, R. A.; Koolyanobbing (Trig Station M.Y.1) Iron Ore Deposits. G.S.W.A. Ann. Prog. Rept, 1945, pp. 10.

[4] Op. cit. pp. 37.

Introduction.

This report is divided into three sections, "General Information," "Geology" and "The Deposits." The first section deals with the locations of the deposits, sampling, specifications of ore, etc. The second is a summary of the geological features noticed from the examinations of the various deposits. In the last section, the individual deposits are discussed.

This report represents the work of both authors but its final form was not completed until after the resignation of Mr. Gleeson, so the other author (N.M.G.) accepts the responsibility for the facts and opinions expressed herein.

General Information.

Object of Examination.

The examination of the various deposits was carried out during October-November, 1949. This examination had become a necessity over the past few years owing to many inquiries—both political and private—being received at the Survey Office and the information at our disposal not being, by any means, complete enough to give a good evaluation of the manganese prospects. This interest in manganese has been largely brought about by the world shortage of both chemical and metallurgical manganese and the embargo which has been placed on its export.

Locations of Deposits.

Deposits at seven different localities were examined. These locations are as follows (see Plate XVI):—

(a) 4.5 miles north of Ravensthorpe;
(b) late M.L. 250—"Mt. Chester";
(c) 1½ miles E.S.E. of the "Elverdton" mine, late M.L. 95;
(d) 2¼ miles N.E. of Kundip;
(e) 5 miles east of Kundip;
(f) Hamersley River:—
Deposit near McCulloch's workings,
Creek deposit,
Gorge deposit—late M.L. 386;
(g) M.Ls. 377H, 378H, Copper Mine Creek.

Some of these deposits have been previously reported on:—*viz.* (b) above by Montgomery (1903, page 17) and Woodward (1909, pages 11, 74); (c), (f) and (g) by Blatchford (1918 (a), page 11 and 1925 page 66); (f) by Montgomery (1914, page 21). Gibb Maitland (1919) records a deposit near Culham Inlet. Its exact location is not known nor did questioning of people of the district yield any information.

It is a convenient place here for the authors to record their appreciation for the help given by people of the district. In particular, they would like to mention Messrs. G. Halbert and E. Williams who showed deposits which had not previously been recorded. Also, they would like to express their appreciation for the help given by Mr. G. R. Richardson of Eveready (Australia) Pty. Ltd. during the combined examinations of certain deposits.

Production.

Records of the Mines Department Statistical Branch show no production from any of the deposits. However, from other records (e.g. G.S.W.A. File 57/00) it is probable that 2 tons 3 cwts. of ore were mined and shipped from late M.L. 250, "Mt. Chester." This was prior to 1917. From the size of the dumps and depths of the shafts it is possible that ore has been removed from other leases i.e., the "Gorge" deposit—late M.L. 368, and M.L. 377H at Copper Mine Creek.

Sampling.

A total of 45 samples were taken and these were submitted to the Government Chemical Laboratories for analysis, the total percentage metallic manganese only being obtained in each case. Only one partial analysis (for MnO_2, MnO Fe, SiO_2, P and Co) has been made. This was a composite sample made up from the samples taken from outcrops in M.L. 377H at Copper Mine Creek. It was not considered worth while in the other cases to have further analyses done owing to the relatively poor grade of the manganese.

Most of the samples were random grab samples taken to represent an area of a deposit. Others were taken for particular purposes. In the reports on the deposits the method of sampling is given in each case.

Specifications.

Manganese has two main uses:—Metallurgical and chemical. Broken Hill Pty. Coy. Ltd. have kindly advised that prices are mutually arranged between the buyer and supplier, but a recent price given together with the required specifications (as at December, 1949) for metallurgical manganese are as follows:—

> £6 13s. 10d. per ton f.o.b. West Australian port for 48% Mn., subject to bonus or penalty of 2s. per unit above or below 48% and to a penalty of 3s. per unit from 45% to 40% Mn., and subject to the following deductions for excess impurities:—
>
> For each 1% silica above 8%—1s. 6d. per ton.
> For each 1% iron above 8·5%—3s. 6d. per ton.
> For each 0·01% phosphorus above 0·18%—9d. per ton.
>
> (Fractions of units pro rata in every case and analysis on dry basis in every case.)

The specifications for chemical manganese are more stringent. In consequence, buyers pay higher prices which, again, are on a mutual basis between the buyer and seller. The following specifications have been kindly supplied by Eveready (Australia) Pty. Ltd.

Specifications for Battery Grade Ore.

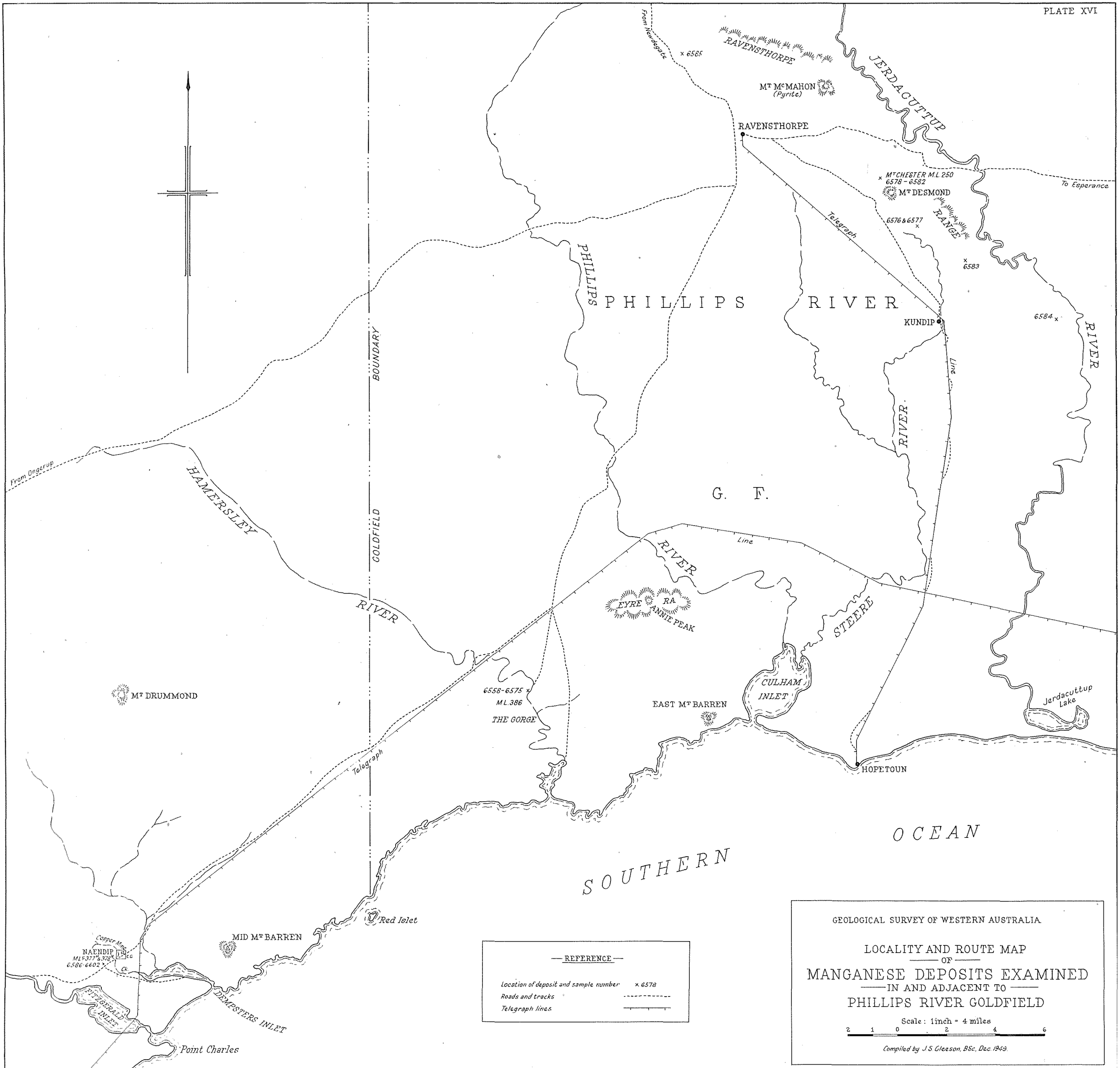
	Not to Exceed. %
Iron as Ferric Oxide	2.00 (i.e. 1.4% Fe)
Copper	0.03
Cobalt	0.15
Nickel	0.05
Arsenic and Antimony	0.05
Lead	0.10
Nitrates as Nitrogen	0.005
Moisture	1.00

It is understood that the presence of silica is not detrimental providing that its presence is not that plentiful to lower the manganese content below what is required. However, the percentage of manganese required is as high as possible, preferably greater than 80% MnO_2—the form in which the manganese is required—i.e. approximately 50% total Mn. (Pure pyrolusite—MnO_2—contains 63% Mn).

A third use to which this investigation has been directed is the use of cobaltiferous manganese to meet deficiencies of these elements in the agricultural areas.

Several composite samples were analysed quantitatively for cobalt. These composite samples were made up of equal proportions of selected samples from five of the deposits. The metallic cobalt of these varied from 0.07 per cent to 0.21 per cent.

PLATE XVI



— REFERENCE —

Location of deposit and sample number	× 6578
Roads and tracks	----------
Telegraph lines	—+—+—+—

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA.

LOCALITY AND ROUTE MAP
— OF —
MANGANESE DEPOSITS EXAMINED
— IN AND ADJACENT TO —
PHILLIPS RIVER GOLDFIELD

Scale : 1inch = 4 miles

2 1 0 2 4 6

Compiled by J.S. Gleason, BSc., Dec. 1949.

The presence of this cobalt is in far too small a quantity to be of use either as a "lick" or in superphosphate. "Manganese-super" contains only 3.8 per cent. Mn. so the presence of cobalt in such a superphosphate would only be a trace. This material used as a lick would be of no use as the manganese would be toxic to the animal by the time it had absorbed its required amount of cobalt. (Cattle require about 1 ounce of cobalt per year).

As a source of manganese for "manganese-super," some of these deposits may be of use. However, the authors consider that mining this material for this purpose would be uneconomic as better grade deposits are being mined. Also, the small quantity of manganese required each year for this purpose would not warrant the expense in mining.

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The following is a list of works to which reference is made in the text; these have been arranged in chronological order.

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1909—Fermor, L. L. The Manganese Ore Deposits of India. *Memoirs of the Geological Survey of India, Vol. XXXVII,* p. 285 et. seq.

1909—Woodward, H. P. Geological Report upon the Gold and Copper Deposits of the Phillips River Goldfield. *G.S.W.A., Bull. No. 35,* pp. 11, 74 and Maps I and II.

1914—Montgomery, A. Report on the Development of the Phillips River Auriferous Copper Mines. *Department of Mines.* p. 21.

1918 (a)—Blatchford, T. Manganese Deposits of the Hamersley River. *G.S.W.A., Ann. Prog. Rept., 1918.* p. 11.

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1942—Bateman, A. M.; Economic Mineral Deposits. *John Wiley and Sons,* pp. 161-5.

1948—Spencer, E.; The Manganese Deposits of the Jamda-Koira Valley. *Trans. of the Mining, Geological and Metallurgical Institute of India. Vol. 44, No. 2,* pp. 61-79.

Geology.

Regional Geology and Origin of Manganese.

The Ravensthorpe Series, forming the Ravensthorpe Range, have been accurately mapped by Woodward and Talbot (Woodward, 1909, Maps I and II). The three main rock types of this series are basic schists (chlorite and other low grade metamorphic sediments), jaspilites and serpentine rocks. The jaspilites and the schists are intimately associated together. This association was noticed at each deposit with the exception of the Hamersley River deposits where no undoubted jaspilites were seen and the deposit N.E. of Kundip. Further, these deposits were in the schists only a little distance from the jaspilites.

Jaspilites are considered to be chemical precipitants (McKinistry, 1939) and the author considers it probable that the original manganiferous sediments were themselves formed by chemical action. Similar views are implied by Spencer (1948) in that there is the association of the ferruginous quartzites with low grade schists. Bateman (1942), too, states that manganese is precipitated under certain conditions. Fermor (1909, page 285 et. seq.) gives detailed information about the method by which manganese is precipitated as oxides. He, also, gives detailed information of how these oxides are metamorphosed to rhodonite and spessartite and later retrogressively back to the oxides. From general observations, these processes well explain the formation of the manganiferous rocks. It must be pointed out, however, that the authors did not find any rhodonite or spessartite. In the "Gorge" deposit of the Hamersley River, some garnet rock was found within the manganese deposit but, owing to the highly weathered nature of the rocks, it cannot even be postulated that these garnets were the manganiferous variety. In the dump from the adit of the late M.L.250—"Mt. Chester," a piece of rock was found which may represent the original manganiferous sediment. The specimen appears slightly banded with traces of manganese.

It is possible that one particular horizon in the schists of the Ravensthorpe Range is manganiferous. Plotting the locations of the "Mt. Chester" deposit and the one E.S.E. of the "Elverdton" mine, Woodward's map (Woodward, 1909, Map II) indicates a strong possibility that these two deposits are on the same horizon. Detailed mapping would be required to prove this. It is not even possible to hypothesize regarding the other deposits.

Westward Extension of Ravensthorpe Series?

The Ravensthorpe Series has a general N.N.W. strike with steep south-westerly dips. The Barren Range Series strikes approximately at right angles (E.N.E.) to the other. These two series of rocks have been considered to be equivalent to the Greenstone Series and the Whitestone Series respectively. Along the south coast at the Hamersley River and the Copper Mine Creek, where manganese deposits were examined, three notable features were found. These are:—

(1) The rock types associated with the manganese deposits are chlorite and other low grade metamorphic schists with jaspilites, except that at the Hamersley River where no undoubted jaspilites were seen.

(2) Copper deposits (McCulloch's workings near the Hamersley River and the Naendip Copper Mine at Copper Mine Creek).

(3) The strike of the rocks being nearly E.-W., striking into the Barren Ranges. This has lead to a hypothesis that there is an extension of the Greenstone belt of the Ravensthorpe Series along part of the south coast. It cannot be assumed that the authors imply that this belt is continuous, for only detailed mapping can give the answer. In the "Gorge" at Hamersley River, outcrops clearly show a structural relationship between the schists and a quartzite. Whether this is an unconformity or due to faulting cannot be stated without detailed mapping.

The geology of these places is discussed in some detail when dealing with the deposits.

Structural Control.

In those cases where a deposit could be examined at some depth, i.e., below the enriched outcrop, even though most of the deposits were of necessity examined from the surface, some form of structural control was observed. Four deposits have workings in them, and in only one of these cases could no structural control be deduced.

A summary of the structural controls will be given here, the details can be gleaned from the various reports.

Name or Location of Deposit.	Type of Control.
Late M.L. 250—" Mt. Chester "	Fault.
1½ miles E.S.E. of the " Elverdton " mine	Not known.
" Gorge " deposit, Hamersley River, late M.L. 368	Quartz filled fracture system in highly folded rocks.
Copper Mine Creek, M.L. 377H	Fold.

It is considered that within the area or length of the deposits, the structures are not uniform or not developed in parts. For example, the outcrop of the "Mt. Chester" deposit is discontinuous so it is probable that the fault dies out and makes or its relative movement varies along the strike.

Types of Deposits.

The deposits may be broadly classified as to their mode of formation. The classification is only tentative as work at some future time may alter it. The various categories are not sharply defined as one deposit may well be described by more than one category and, similarly, one category may overlap another. The classification to be used is as follows:—structural, replacement, lateritic and surface. These will now be briefly defined.

Structural deposit is where the formation of the manganese has been controlled or localised by such structures as folds.

Replacement deposit is where iron has been metasomatically replaced by manganese.

Lateritic—replacement deposit—virtually a special type of replacement deposit—is where replacement of iron by manganese has taken place in the laterite on the surface with the laterite still retaining its pisolitic or nodular form.

Surface deposit is one of just isolated boulders on the surface which cannot be related to any particular rock or horizon nor is there any real outcrop. It may be the result of weathering of manganiferous sediments and the manganese forming boulders on the surface by capillary action.

It will be seen that a *lode* has *not* been included in the classification. No evidence of any hydrothermal minerals was seen in any of the deposits.

The classification is given in the following table:—

Name or Location of Deposit.	Type of Deposit.
Deposit north of Ravensthorpe	Surface
Mt. Chester deposit—late M.L. 250	Structural.
Deposit E.S.E. of the " Elverdton " mine	Lateritic-replacement.
Deposit N.E. of Kundip	Surface.
Deposit east of Kundip	Lateritic-replacement.
Hamersley River Deposits—	
(a) deposit near McCulloch's workings	Surface.
(b) creek deposit	Replacement.
(c) Gorge deposit—late M.L. 368	Structural
Copper Mine Creek deposit, M.L's. 377H, 378H	Structural-replacement.

Economic Possibilities.

In none of the deposits examined, with the possible exception of the Copper Mine Creek deposit which will be dealt with separately, does any evidence, geological, chemical or economic, lend support to any of the deposits being of commercial value. In the case of the Copper Mine Creek deposit one good value and several fair values were obtained, but the economic conditions apply equally well or more so to this deposit. Even if the deposits were of the quality required, the economics of labour and transport would make the deposits uneconomical to work. As regards transport, this is easily seen when it is realised that the nearest railhead is Newdegate, 80 miles from Ranvensthorpe, and shipping ore from Hoptoun is impracticable as the port was closed in 1935 and the jetty is in a state of disrepair.

Summarised, under the present economic conditions none of the deposits examined are of economic value (Dec. 1949) nor will they be likely to become so, except perhaps the Copper Mine Creek deposit, even if economic conditions improve.

Recommendations.

The authors do *not* recommend any detailed work on any of the deposits. If economic conditions improve, however, consideration could be given to the Copper Mine Creek deposit but no other.

The Deposits.

Deposit North of Ravensthorpe.

General Information.

This deposit is situated about 600 yards east of a point, 4.5 miles from Ravensthorpe, on the Ravensthorpe-Newdegate Road (see Plate XVI).

This deposit was shown by Mr. E. Williams of Hoptoun.

Geology.

The manganese occurs on the crest of a small hill, closely allied to an extensive laterite deposit. The manganese is found in small boulders and nodules scattered over an area of approximately 50 square yards, similar in form to the laterite and is of similar origin. Many boulders contained an intimate mixture of iron and manganese, with the manganese replacing the iron along cracks and fractures.

One random grab sample (Lab. No. 6585) was taken which gave 24.17 per cent. metallic manganese.

Economic Possibilities.

These are nil.

Mt. Chester Deposit—Late M.L. 250.

General Information.

This deposit is situated some 6 miles E.S.E. of Ravensthorpe (see Plate XVI) and access is best obtained from one mile S.W. of the lease on the Ravensthorpe-Hopetoun Road and then by walking cross country. An adit into this hill is clearly visible from the road.

Geology.

Montgomery (1903, page 17) mentions an outcrop of a manganese body on this hill and sampled it for possible use as a smelter's flux in place of iron when the latter, of good quality, was not available.

Woodward (1909, pages 10, 74) examined this deposit and considered that the outcrop was formed by replacement of the iron-bearing schists of the area. (These schists are considered to be mainly chlorite schists, meta-sediments, by the present authors). This outcrop was traced for about 250 yards. Work carried out at that time consisted of a costean across the outcrop which showed a width of 20 feet of manganiferous material and "with the object of testing this lode at a depth an adit level was driven for a distance of 424 feet into the steep hill face 90 feet below the outcrop" (Woodward, 1909, page 11). It should be pointed out that Woodward used the word "lode" for this body with an outcrop formed by the replacement of iron by manganese.

No further work was apparent to the present party on their inspection. The adit is in a remarkable state of preservation which facilitated the inspection.

The rock types seen in the adit were shales, small ferruginous quartzites and kaolin schists, somewhat gritty in certain bands from small particles of quartz. On the surface, the schists, particularly, were iron-rich and this iron had been leached out by the time the depth of the adit was reached as the rocks there contain very little iron. The further away from the entrance of the adit the less noticeable is the presence of iron. The adit is still in the zone of oxidation.

Woodward (1909, page 75) states that "at a distance of 300 feet from the entrance the manganese lode was cut, at which point, although consisting of a body 20 feet in width from wall to wall, it is composed of two veins of a more powdery character than they are at the surface, the largest of which is nine feet in width." At this point 300 feet in, the authors found a normal strike fault (strike approximately N.60°W.) and dipping about 45° S.W. The throw of the fault was small and could quite easily die out and remake along the strike. This is suggested by the discontinuity of the outcrop. There are several smaller parallel faults. The two veins mentioned above are considered to correspond with two deposits seen by the present authors, one on each side of the fault—the footwall deposit being the larger. The manganese is not a solid mass by any manner of means and some of it is in the form of manganiferous wad, the presence of which at a depth of 90 feet below the surface is very unusual. The authors consider that this deposit is NOT a lode—no hydrothermal mineralisation was seen—but a structural deposit in the schists, its location having been defined and controlled by the faulting. Projecting the fault to the surface would probably correspond with the outcrop but detailed mapping would be required to determine this.

At the entrance to the adit, the strike of the rocks was approximately N.60°W. and they dipped 80°S.W. Where observable, the dips along the walls of the adit were all of the same order.

The deposit may outcrop over a distance of 200 or more yards with a strike of N.60°W. It was traced fairly consistently from its northern end for about 160 yards and from then on it was only found with considerable gaps. Approximately 115 yards from its northern end is the costean mentioned above. Its length was 20 feet and it had a maximum depth of 2 feet. Some of the outcrop was very massive and large but it narrows down in parts to only a few scattered boulders and in others to nothing. The outcrop is a typical replacement type of iron by manganese with considerable secondary deposition in vughs. The outcrop gave no indication of the type, size or any information as to the nature of the underlying manganiferous bearing rocks.

The adit was sited near the northern end of the outcrop.

Five random grab samples were taken, four from the outcrop and one from the fault zone in the adit. The locations, numbers of the samples and their total metallic manganese content are given in the following table:—

Sample Chem. Lab. No.	Location of Sample.	Total Mn.
		%
6578	footwall of fault in adit	32·02
6579	140 yards from northern end of outcrop	29·58
6580	115 yards from northern end of outcrop (costean)	39·48
6581	50 yards from northern end of outcrop	46·89
6582	10 yards from northern end of outcrop	29·14

Samples 6579-6582 were combined in equal proportions to form a composite sample for a quantitative analysis for cobalt, the result being 0.07 per cent. metallic cobalt (the total manganese being averaged at 36.3 per cent.).

Economic Prospects.

From the above assays, it can be seen that none of the samples except 6581 approach the required manganese content. The low assay of the sample from the adit is only to be expected being 90 feet below the outcrop. The economic prospects are considered to be poor. In the authors' opinion the deposit does not warrant further exploration.

For agricultural purposes the economic prospects of this deposit are nil.

Deposit E.S.E. of the "Elverdton" Mine.

General Information.

This deposit is situated about 1.6 miles on a bearing of 107° from the old "Elverdton" mine—late M.L. 95 (see Plate XVI). This deposit was first examined by Blatchford (1918 (a) page 11). Difficulty was found in locating this deposit as he gave a bearing of 287° which led into granite country. The authors are indebted to Mr. G. Halbert for showing them the actual location of the deposit, thus saving considerable time in searching.

Access to the deposit is by road and track. The track branches east from the Ravensthorpe-Hopetoun Road near the "Elverdton" lease then travels east and south-easterly for approximately 1.6 miles. The deposit is then reached by foot being about 200 yards east of the track.

Geology.

The deposit is situated approximately a quarter of a mile south-west from a north-west trending ferruginous quartzite ridge. With these quartzites are associated a series of basic schists (unidentified) and laterite.

At the surface, manganiferous boulders were found intimately associated with iron oxides, both haematite and limonite. The outcrop, which grades into laterite to the north and south, is massive containing many nodules of manganese and is typically "laterite" in appearance. The deposit belongs to the lateritic replacement category, for not only is it lateritic in appearance but any piece of the rock when cracked open shows manganese on the surface and along cracks, and iron and clay forming the remainder.

The workings consist of two shafts, one 6 feet and the other about 35 feet deep, the latter being inaccessible at the time of the inspection. The shafts are about 95 feet apart on the strike of the rocks (N.40°W.). The rocks as seen in the shafts seem to be dipping nearly vertical. From the size of the dump of the deeper shaft it appears that some cross-cutting or driving has been done.

Blatchford (1918 (a) page 11) considered the deposit to be a "true lode." Though the deposit in the shaft was not distinct it appears to be of a replacement nature.

No structural features to control the deposit were seen.

Two random grab samples were taken, the details of location and assays are given in the following table:—

Chem. Lab. No.	Location of Sample.	Total Mn.
		%
6576	Outcrop 20 feet south of deeper shaft	34·08
6577	Dump of small shaft	24·76

A quantitative test for cobalt was carried out on a composite sample of the above two samples, the amount of metallic cobalt present being determined as 0.14 per cent.

Economic Prospects.

Owing to the low manganese and high iron content, the economic prospects are nil. Similarly, for agricultural purposes the prospects are nil.

Deposit N.E. of Kundip.

General Information.

This deposit is situated about 2¼ miles north-east of Kundip (see Plate XVI). Access to the deposit is by track which, at the time of the inspection, was in very poor condition. The track east from the Ravensthorpe-Hopetoun Road at Kundip passes just north of the "Gem Consolidated" (the "Beryl")—late G.M.L. 249, then heads west of north following the main series of ridges for about 1.1 miles. A branch track heading east is then followed for a half mile to the crest of a ridge. The deposit is then reached by foot being about 300 yards north-east of the track.

This deposit was shown by Mr. G. Halbert.

Geology.

The manganese occurs on the slope of a low ridge and is associated with quartzite. The rocks strike 320° and dip nearly vertical.

A small costean, one foot deep, shows that the manganese is superficial only and dies out with this shallow depth. No actual outcrops occur, isolated boulders only being found along a narrow belt approximately a hundred yards in length running down the slope into the creek bed.

The deposit is possibly a deposit formed on the surface by weathering processes.

One grab sample was taken from the costean and gave 49.06% total Mn.

Economic Possibilities.

Even though the assay showed high grade manganese, the deposit is too insignificant in size to be of value.

Deposit East of Kundip.

General Information.

The deposit is about 5 miles east of Kundip and about one mile west of the Jerdacuttup River (see Plate XVI). Access is obtained by track from Kundip. The track follows an easterly course throughout and is in very bad condition.

This deposit was shown by Mr. G. Halbert.

Geology.

The manganese occurs high up on the southern slope of a small ridge. The ridge consists of bands of quartzite and shales with the manganese confined to the shale beds. Down the slope of this ridge are outcrops of serpentine rocks—opaline silica was seen scattered over a wide area. The shales are much drag folded but their general strike is N.15°W. and their dip nearly vertical. The deposit is of very limited extent with the bulk of the manganese occurring within a length of 30 feet. The outcrop is full of iron-rich manganese nodules and is typically "lateritic" in appearance. It can be classified as a lateritic-replacement deposit.

In the hand specimen, the manganiferous rock is seen to be too rich in silica and iron to be of value. One random grab sample was taken and this gave 39.69% total Mn.

Economic Possibilities.

These are nil.

Hamersley River Deposits.

General Information.

These deposits are about 23 miles S.S.W. of Ravensthorpe (see Plate XVI). The route is via Moir's farm and at about 23 miles out the track divides, the left (southerly) one leads to the estuary of the Hamersley River and the coast, the centre one to the deposits and the right one (south-westerly) to the Copper Mine Creek area. Near this track junction remains of the old overland telegraph line can be found. From this track junction it is about three miles to the deposits.

Geology.

The Hamersley River in this vicinity flows roughly N.-S. It is non-perennial but there are many large pools, some of considerable length. The water was not potable. About a mile to the south of where the track meets the river is what is known locally as the "Gorge". Here the east face rises very steeply from the river giving good exposures. The west slope is more gentle. Some of the outcrops on the east face show very strong drag folding with complete anticlines and synclines. This folding has a strike of nearly E.-W. and the general structure as indicated by this folding would be an easterly plunging anticline, the amount of plunge being estimated at about 30°.

The general rock types with which the deposits are associated are chlorite schist and allied rocks; some of these are also cupriferous. No undoubted ferruginous quartzites were seen. These rocks and the association of manganese and copper with them are exactly similar to those of the Ravensthorpe Range and it is suggested that this greenstone belt may extend westward, though not necessarily continuously, to this area and further westwards to the Copper Mine Creek. (There are other rocks of minor importance such as basic igneous rocks or ultra-basic rocks, as indicated by magnesite. Other mineralisation has been recorded and this will be dealt with below.)

A hundred yards or so to the south of the drag folds mentioned above is a large massive quartzite and it appears typical of that of the Barren Range rocks (Whitestone Series). Though no detailed investigation was made, the contact between the quartzite and the schists does not appear to be conformable, though this may be due to faulting. Detailed mapping would be required to decide this.

Though the regional strike of the manganiferous rocks in the vicinity of the Gorge is of the order of E.-W., variations were found up to N.50°E.

The regional strike of the Barren Ranges is approximately E.N.E. to N.E.

Blatchford (1918 (b) page 12) mentions some "underlying rocks of undetermined age." From his description of these rocks, it would appear that they would correspond with the mineralized rocks mentioned above. However, although the strikes correspond (E.-W.) he records low dips of 25°-30° while those obtained by the present party were closer to vertical. With the folding known in this area, it is quite possible to have such a variation in dips.

The Deposits.

There are three known deposits in this area. These have previously been reported on by Montgomery (1914, page 17 et. seq.). Blatchford (1918) (a), page 11) sampled one of the deposits.

For the purpose of description, these deposits will be designated as follows:—

"Deposit near McCulloch's workings,"
"Creek deposit," and
"The Gorge deposit"—late M.L. 386.

Fig. 6 is a field sketch map based on one given by Messrs. Scott and Dixon who were prospecting in the locality at the time of the examination. This figure shows the approximate locations of the deposits, workings, creeks and other information. The party is indebted to these two prospectors for indicating the deposits and thus saving considerable time normally spent in such searches.

The geology of these deposits will now be given.

Deposit near McCulloch's Workings.

Montgomery (1914, page 21) reported "a big manganese outcrop" a few chains westward of McCulloch's old working (copper). He quoted an assay which was obviously a picked specimen giving 43.99 per cent. metallic Mn. Examination disclosed that there was *no outcrop* let alone *big*. There are numerous scattered small boulders and rubble distributed over a large area. All pieces could easily be removed from the soil. The host rocks appear to be mainly chlorite schists. The deposit is a superficial deposit.

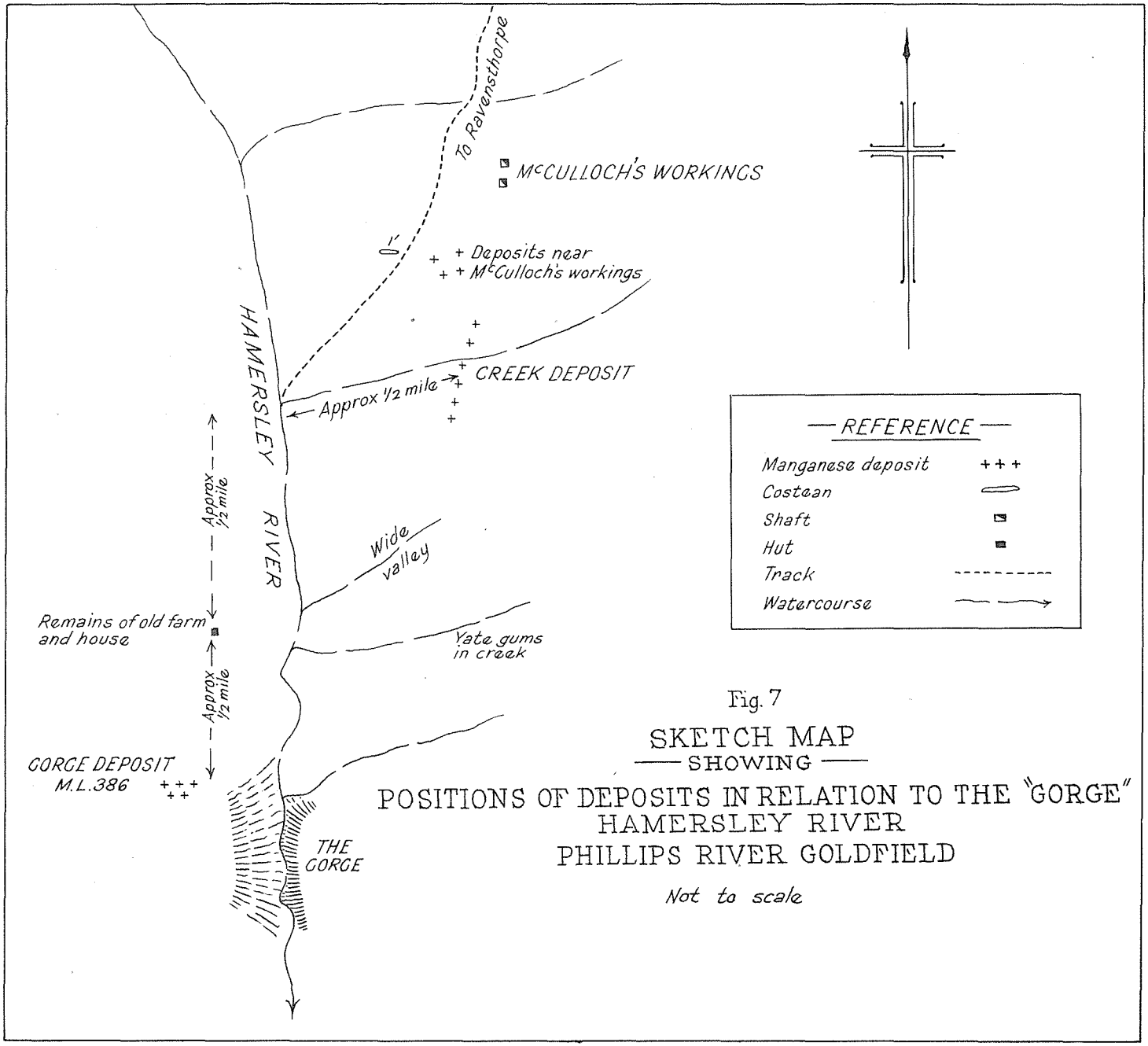


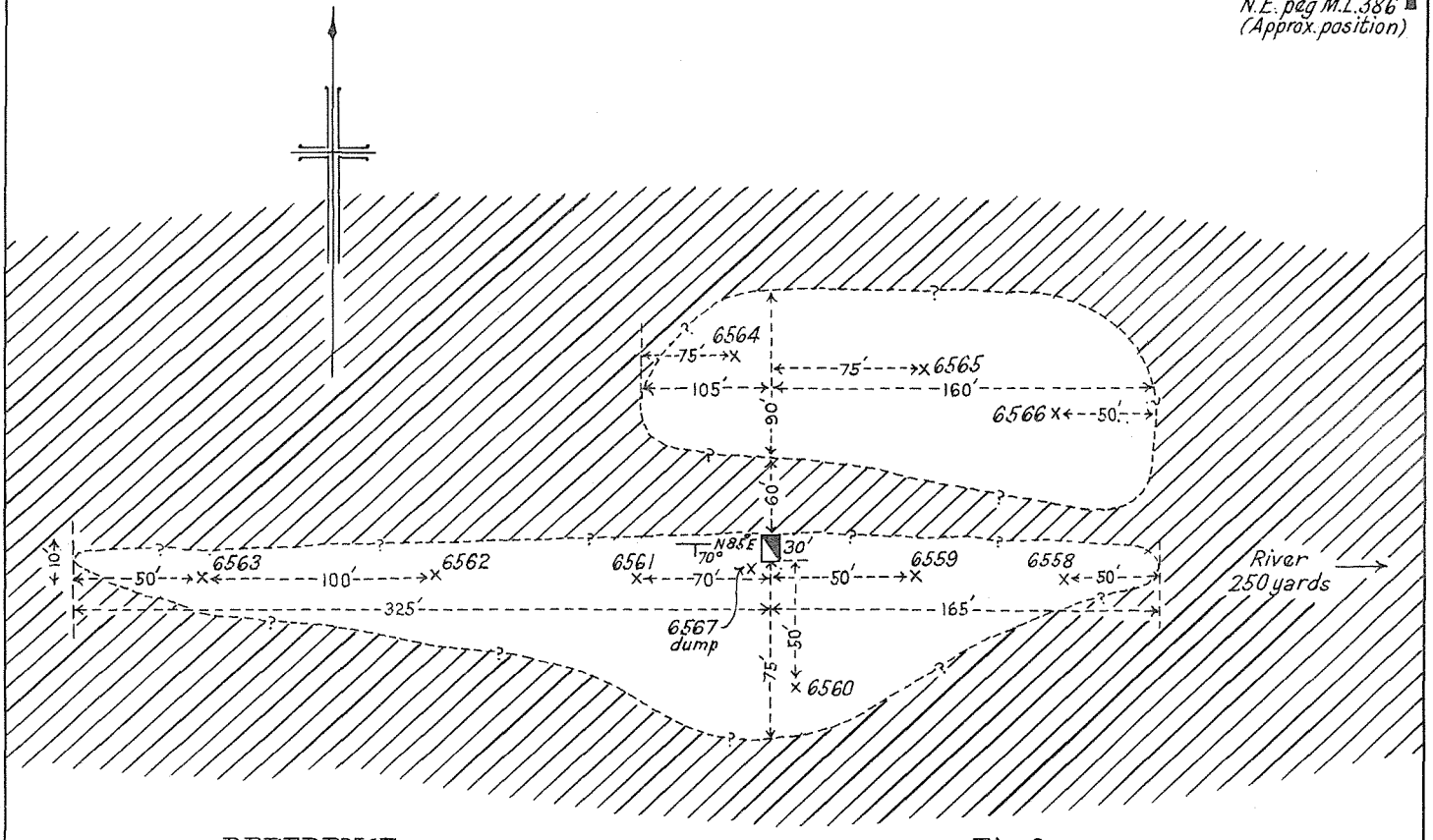
Fig. 7

SKETCH MAP

— SHOWING —

POSITIONS OF DEPOSITS IN RELATION TO THE "GORGE"
HAMERSLEY RIVER
PHILLIPS RIVER GOLDFIELD

Not to scale



—REFERENCE—

Geological boundary doubtful or assumed	---?---
Strike and dip of bedding	N85°E / 70°
Shaft	▣
Manganese bodies	
Metamorphosed sediments	
Location and number of sample	× 6566

Fig. 8

GEOLOGICAL SKETCH MAP & SAMPLING PLAN
"GORGE" DEPOSIT - HAMERSLEY RIVER
PHILLIPS RIVER GOLDFIELD

Scale : 1 inch = 100 feet

100 50 0 100 200

Compass and pacing survey by N.M. Gray & J.S. Gleeson, Oct., 1949

About a third of a mile past McCulloch's workings on the right of the track leading to the river is a costean. A grab sample (Chem. Lab. No. 6569) of the manganese material was taken approximately 240 yards on a bearing of N.70°E. from the costean. This sample assayed 37.03 per cent. metallic Mn.

The slope of the ground, on a cursory glance, may possibly give an idea that these boulders are orientated in a certain direction so giving a false impression of an outcrop.

Creek Deposit.

About a mile west of McCulloch's workings towards the Gorge in a creek bed (see fig. 6) is this deposit. Montgomery (1914, page 21) considered that as this body was associated with quartz this strengthened "the probability of its being of the nature of a lode."

This deposit was found to outcrop over a distance of about 400 yards. It had a strike of N. 50°E. The enclosing rocks are iron-rich low grade schists. The outcrop is a lateritic replacement type and is intimately associated with quartz stringers. The presence of these stringers is not considered to be indicative of a lode and the outcrop gives no indication of any depth to the deposit.

The north-eastern end of the outcrop passes into iron-rich meta-sediments and, traversing along the strike south-easterly, traces of manganese can be seen deposited on the surface of the rocks and gradually spreading along the planes of schistosity. The first north-eastern 100 yards was considered too iron-rich to warrant sampling and the first sample (Chem. Lab. No. 6570) was taken some 20 yards up from a creek on its north-east side. Thereafter, samples were taken at about 50 yard intervals. Six samples were taken in all (Nos. 6570-6575). The last sample was taken about 50 yards on the north-east side of a second creek. The outcrop could be traced as far as this second creek but a search on the south-west side failed to reveal any further outcrop. The outcrop was not continuous and varied in width from about one to three feet.

The following table gives the total % Mn. of these samples.

Chem. Lab. No.	Total Mn.
	%
6570	41·53
6571	42·56
6572	38·63
6573	29·07
6574	39·68
6575	35·80

A composite sample of the above was tested quantitatively for cobalt and the metallic cobalt present was found to be 0.21 per cent., total metallic manganese 37.9 per cent.

Gorge Deposit—Late M.L. 386.

This deposit is located on the west side of the Gorge and about 250 yards from the river (see fig. 6). It consists of two bodies separated by chlorite schists. The larger or southern body outcrops over a distance of about 490 feet with a maximum width of 85 feet. The northern one is about 265 feet long with a maximum width of about 90 feet. These bodies are by no means a solid manganese mass. There are considerable amounts of meta-sediments within them, so much so that detailed mapping may even sub-divide these two bodies. Some 150 feet from the west end of the southern body, unaltered schists were found and within this body there are some garnet rocks. It is not possible even to postulate whether the garnets are the manganiferous variety (spessartite). Along the northern edge, particularly, of the southern body are many quartz veins and stringers cutting across the strike of the body. Montgomery (1914, page 21) states that "some quartz veins carrying a little chalcopyrite and galena were seen . . . " No such association, though diligently looked for, was seen by the present party. He previously stated (see "Creek deposit" above) that association of quartz with the manganese made it probable that that deposit was a lode and it has been inferred that this was equally applicable here (see Blatchford, 1918 (a), page 11). However, the authors disagree with this argument and consider that the deposit is NOT a lode but a replacement deposit, the replacement being controlled by a fracture system which was subsequently filled with quartz which was itself pre-formation of the deposit. This fracture system has probably resulted from the strong folding as exhibited on the other side of the Gorge.

There is a shaft (inaccessible) some 30 feet deep on the northern edge of the southern body some 325 feet from its western end. The body strikes N.85°E. and dips 70°S.

Ten samples were taken from the deposits and the locations of them are shown in fig. 7 which is a geological sketch map of the deposit. Another sample (Chem. Lab. No. 6568) was taken from the other side of the Gorge where the deposit is seen to outcrop. These samples were random grab samples taken to represent an area of the body. The best sample was No. 6567 which was taken from the dump and not from the outcrop. The following table shows the total % Mn. of these samples. This should be read in conjunction with fig. 7.

Chem. Lab. No.	Total Mn.
	%
6558	37·71
6559	32·10
6560	27·27
6561	33·17
6562	28·94
6563	37·92
6564	25·34
6565	33·78
6566	25·99
6567	42·00
6568	30·70

A composite sample of samples 6558-6566 was made and the metallic cobalt present was determined to be 0.21 per cent. (total manganese 31.4 per cent.).

Economic Possibilities.

As the deposit near McCulloch's workings are no more than scattered boulders, the economic possibilities are nil.

The Creek deposit is low grade with high iron and silica, so this too has no economic possibilities.

The Gorge deposit has always been known to be low grade (see Blatchford, 1918 (a), page 11). Even if the manganese content was high enough, the presence of the quartz veins would prevent its being of use as an economic deposit.

For agricultural purposes, these deposits are not economic prospects.

Copper Mine Creek Deposit—M.Ls. 377H, 378H.

General Information.

This deposit is about 42 miles S.W. of Ravensthorpe close to the Copper Mine Creek (see Plate XVI). Access is obtained by the Hamersley River track taking the right hand track at the junction of three tracks about 23 miles out from Ravensthorpe. This track follows the old overland telegraph line nearly all the way to the Copper Mine Creek. On reaching the "Naendip" Copper Mine, the leases can be found as the datum peg of both

leases is 50 chains S.W. from the S.W. corner of C.G.12 "Naendip." The lease is a few hundred yards to the north of where the track, which continues westwards, crosses the Copper Mine Creek.

Geology.

Between the "Naendip" and the deposits the Copper Mine Creek flows approximately N.-S. and, a few hundred yards further on, it enters Dampsters Inlet. This creek is not large and is youthful in age. It has cut through the overlying flat or slightly dipping sediments of the Plantagenet Series into the pre-Cambrian rocks below.

The rock types associated with the manganese deposits and the "Neandip" Copper Mine are jaspilites, low grade, highly weathered schists and shales. (A good section is exposed in the Copper Mine Creek between the "Neandip" and the manganese deposits.) These rocks strike approximately N.80°W. and the continuation of their strike eastwards leads into the Mid Mt. Barren. The Barren Range Series have a rough strike of E.N.E. Here is definite evidence to support the hypothesis given earlier of the possible extension of the greenstone belt of the Ravensthorpe Series westwards against the Barren Range Series.

At the deposit itself, the rocks are very highly weathered which makes identification difficult, but elsewhere they are known to be shales and schists. No jaspilite was recognised at the deposit itself, but nearby, as above, it outcrops in the creek bed and also at the "Naendip." Blatchford (1925, page 66) mentions "sandstones, and probably very basic tuffs or interbedded basic lavas. The presence of basic members is evidenced by the frequent occurrence of magnesite." Scattered magnesite was noticed but the poor outcrops and the highly weathered nature of the rocks prevented detailed identification.

To the east of the deposit is a small ridge running approximately N.-S. This is capped by weathered flat lying or slightly dipping sediments of the Plantagenet Series. To the west of the deposit extensive areas of these rocks were noticed and good sections were seen where creeks have cut through these rocks.

The main deposit is in M.L. 377H. The workings consist of two shafts about 35 feet deep, a few costeans and pot holes. Fig. 8 is a geological sketch map and shows the layout of the workings and the sampling plan. The east shaft was examined and sampled but the west shaft was not descended owing to its inaccessible nature. In the figure, the shafts have been plotted in reference to the datum peg from chain and compass traverses. Compass and tape was used for the creek bed outcrops, underground workings, and those workings near the shafts. The other information is by compass and pacing.

The outcrops are typically surface enriched deposits. Examination of the cross cut of the east shaft showed that at least some of the deposit was replacement. The end of the south cross cut passes into a clayey rock and the end of the north cross cut replacement in the schists by manganese can be clearly seen. The cross cut has a width of 42 feet in manganese. There are several parallel bodies of smaller size. All these bodies outcrop in the creek bed. Between these bodies the country rock outcrops. The size of the bodies and the country rocks are shown in Fig. 8. Only the main body can be followed to the west of the creek and then only for a few yards past the shaft. Up the slope to the west, scattered outcrops only are found. Detailed mapping would be required to correlate these with those on the east side of the creek. Downstream along the creek bed, the last outcrop of manganese is typically lateritic, the iron of the nodules being replaced by the manganese.

The only evidence of any structural control was seen in a wall of the west shaft. This structure is a fold which strikes N.75°E., as far as could be determined, and dips about 65°N. About 15 feet below the collar of the shaft it swings south with a similar dip. This structure makes the deposit all the more probably a replacement deposit. The absence of hydrothermal minerals also strengthens this replacement formation.

Seventeen samples were taken. Of these, one (Chem. Lab. No. 6602) was a random grab sample from the dump of the west shaft. Samples 6597, 6598 were taken 5 feet from the end of the cross cut and 5 feet from the shaft (east shaft) in the south cross cut. Similarly, 6600 and 6601 were taken from the north cross cut. These were not channel samples but chips taken every few inches up the walls and along the backs of the cross cuts. Sample 6599 was taken in a similar manner from the walls of the east shaft about 6 feet from bottom. Samples 6588 and 6589 were from costeans and samples 6590-6593 were from outcrops. Sample 6594 was from the top of an 8 feet deep shaft and 6595 was from the bottom of this shaft. The above samples were all from M.L. 377H. Sample 6586 was from the bottom of an 8 feet deep shaft and 6587 from an outcrop. These two samples were from M.L. 387H. All these samples were random grab samples except where the method of sampling has been described above and samples 6591, 6592 and 6596 which were from the creek bed and were chips taken every foot or so along the outcrop. The locations of these samples are indicated in Fig 8. The following table shows the total % Mn. in samples.

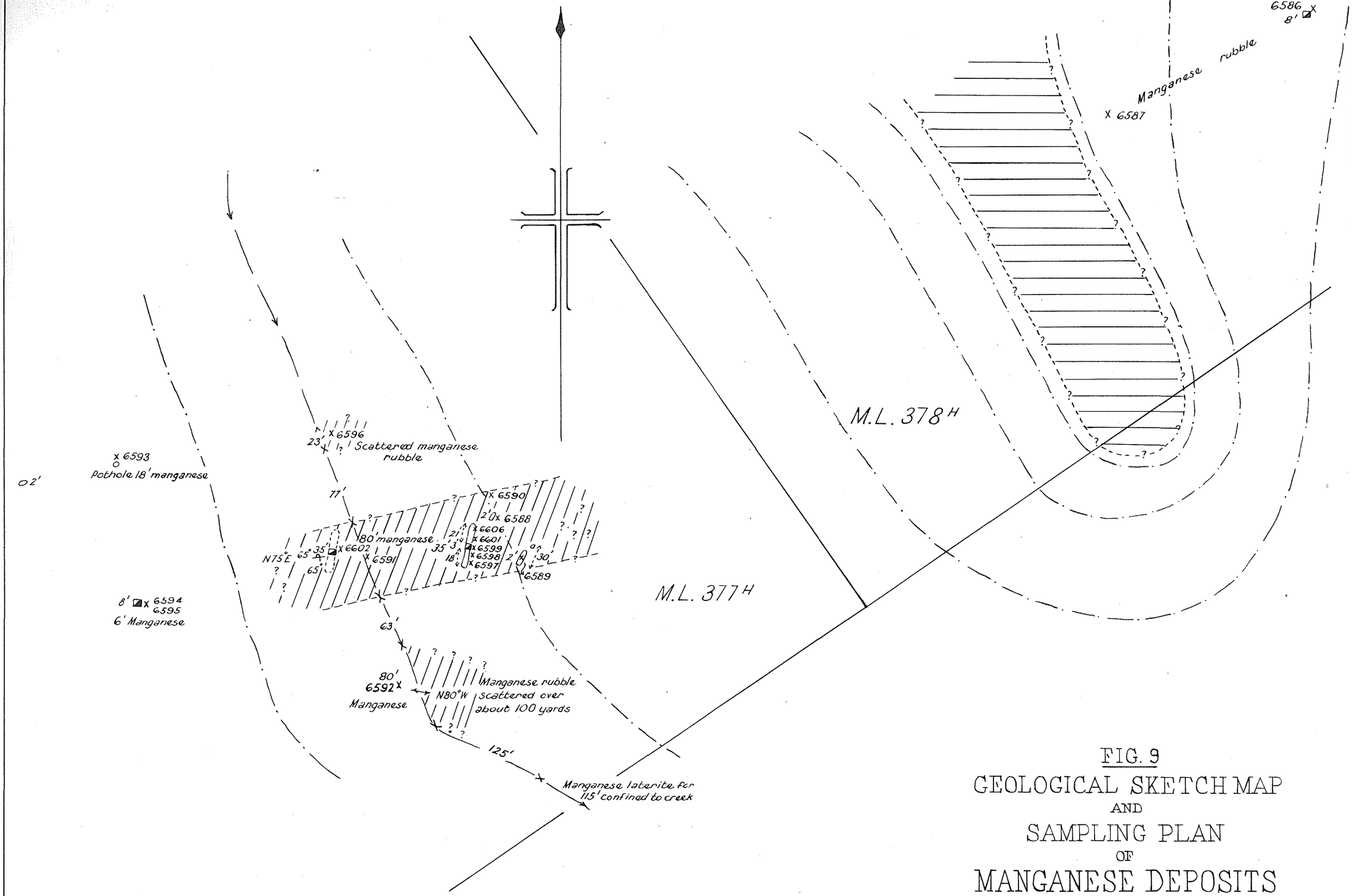
Chem. Lab. No.	Total Mn.
	%
6586	39·48
6587	46·20
6588	56·25
6589	42·22
6590	37·28
6591	43·39
6592	42·84
6593	47·17
6594	41·25
6595	38·04
6596	34·99
6597	37·39
6598	27·99
6599	41·65
6600	23·51
6601	31·93
6602	45·38

The outcrop samples (Nos. 6588-6594 and 6596) were grouped together in equal parts to form a composite sample and a partial analysis has been carried out on the composite sample dried at 105°C. The result of this analysis is as follows:—

	Per cent.	Per cent.
Manganese dioxide, MnO_2	62·85	44·00 total Mn
Manganese oxide, MnO	5·51	
Silica, SiO_2	11·31	
Iron, Fe	5·21	
Phosphorus, P	0·09	
Cobalt, Co	0·15	

Economic Possibilities.

Sampling has shown that only two areas can be considered as containing manganese material of the required percentage or approximating to the required percentage of metallic manganese. The partial analysis above indicates that the manganese does not conform to the requirements of either chemical or metallurgical manganese. Furthermore, for agricultural purposes, the manganese is of no use for cobalt and it is considered that it would be uneconomical to mine the deposit for manganese.



— LEGEND —

Tertiary sediments

PRE-CAMBRIAN
- Manganese bodies
- Country rock

— REFERENCE TO SIGNS —

- Shaft and crosscut
- Costean
- Creek
- Strike of bedding — N80°W
- Strike and dip of overturned bed — N75°E, 65°

FIG. 9

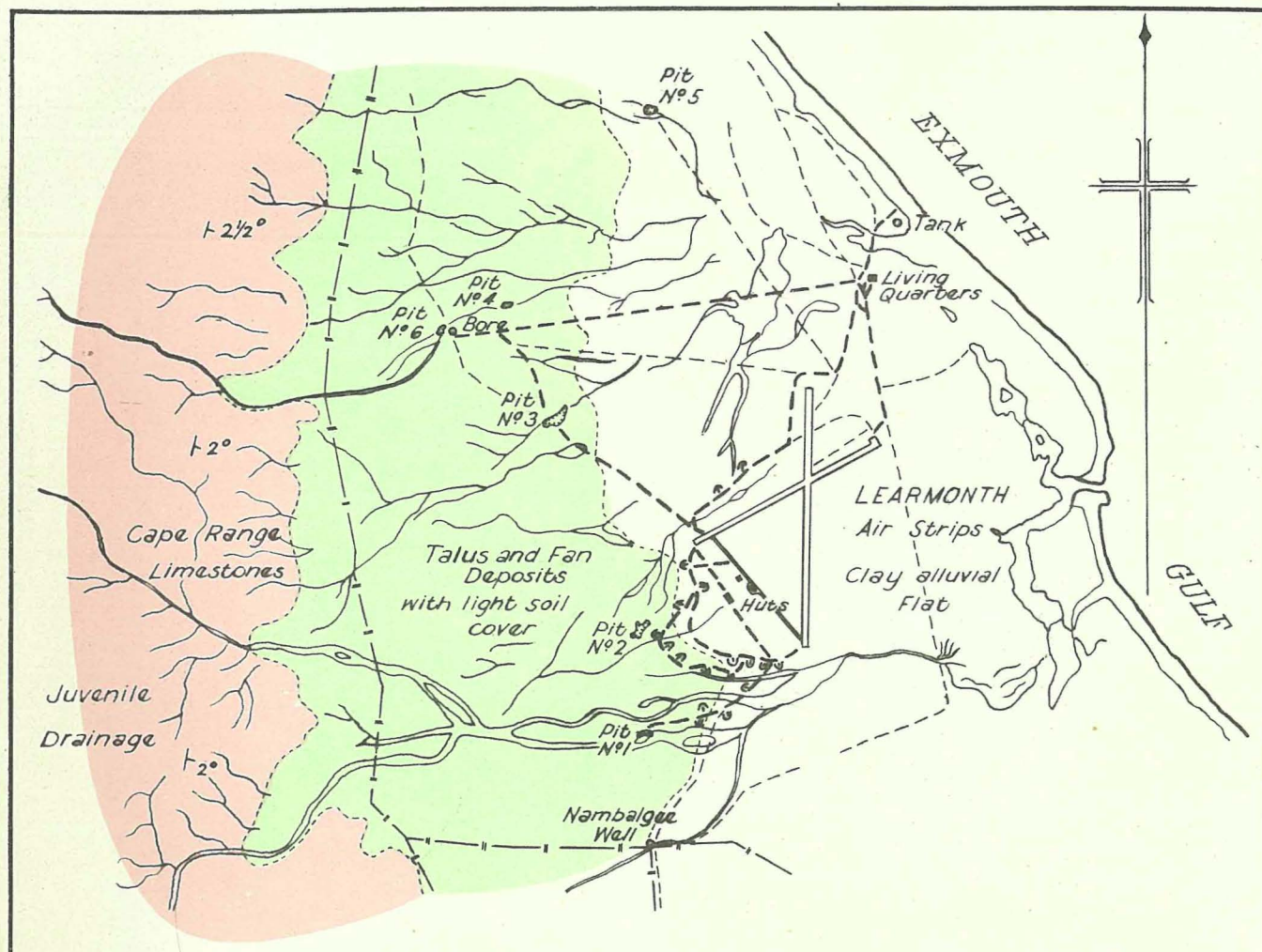
GEOLOGICAL SKETCH MAP AND SAMPLING PLAN OF MANGANESE DEPOSITS AT ML^S 377^H AND 378^H COPPER MINE CREEK

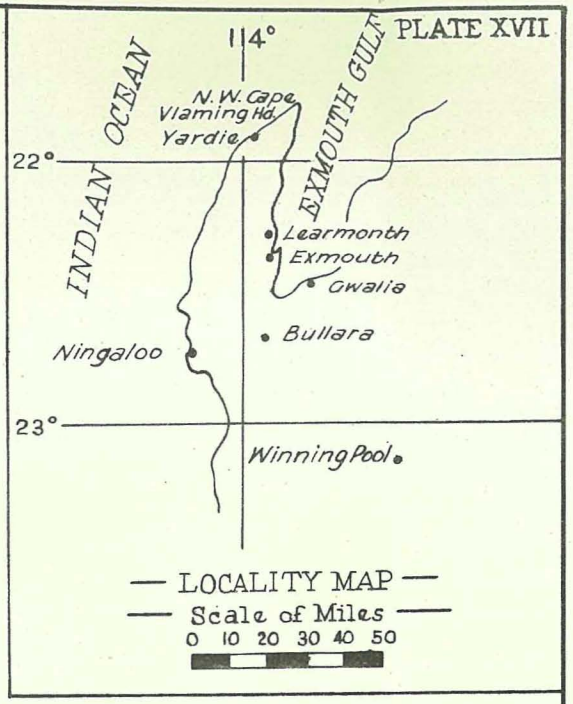
100 50 0 100 200

Scale 100 feet to an inch

Survey by compass, chain, tape and pacing, by, N. M. Gray, B. Sc; and J. S. Gleeson, B. Sc; Oct. 1949.

PLATE XVII





— LEGEND —

RECENT { Talus and Gravel
Clay Alluvium

MIOCENE Limestone

— REFERENCE TO SIGNS —

Geological boundary

Gravel pits

Constructed roads

Tracks

Dispersal bays

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

PLAN

— OF —

GRAVEL DEPOSITS

LEARMONTH W.A.

Scale: 1 inch = 1 mile

0 1 2

Map compiled from air photo and field notes.
Geology by, J. Sofoulis, B.Sc. August. 1949.

REPORT ON GRAVEL DEPOSITS, LEARMONTH.

By J. Sofoulis, B.Sc.

General Information.

Learmonth, built as a military base during the war, is situated on the east side of the Cape Range and on the south-west side of the Gulf of Exmouth approximately 200 miles north of the port of Carnarvon. At present the site is controlled by Ampol Petroleum Company, who are carrying out a programme of oil exploration in this area. Learmonth itself lies in a pastoral lease held by E. J. Lefroy & Sons of Exmouth Gulf station.

A MacRobertson Miller Anson passes through Learmonth on its weekly service between Perth and Pt. Hedland, and the N.W. Transport Company has a weekly stores and mail run from Carnarvon. Urgent communications are despatched and received by wireless.

Water for domestic purposes is pumped from a bore sunk at the foot of the Cape Ra. to the living quarters 2½ miles distant.

During the establishment of this base, several gravel pits were opened up and used as a source of material for the construction of roads, runways, and U shaped mounds (dispersal bays) for the housing of fighter aircraft. The gravel pits were all abandoned at the completion of this work.

As very little official information is available regarding the locations, physical and petrographical character of the deposits, the excavations were inspected during August, 1949, and brief notes are given below.

Geological Information.

The Cape Ra. structure is skirted by a low lying plain varying from ½ to 3 miles in width and consisting of red clayey soil (terra rossa) derived from the Cape Ra. limestone during the present cycle of erosion.

Many narrow steep walled creeks cut the terrain of the Cape Ra. and torrential action has debouched deposits of gravel beds from them onto the adjacent lowland.

The deposits are built up as alluvial fans (up to 1 mile radius) at the mouth of each valley and are often confluent with one another along the foot of the range.

Talus and limestone outcrops occur at the foothills and in places a travertinised sand has effectively cemented the surface of both the talus and fan deposits.

To the north, around the Vlaming Head vicinity and down the west side of the Cape Ra. are outcrops of an elevated "recent" coral reef limestone. These outcrops are generally isolated and covered with talus and drift sand.

All stream channels cutting through the coastal strips to the sea are laden with gravel for almost their entire length. The streams are dry but some of the larger ones do flow after heavy rainfall.

The Gravel Deposits.

These deposits are stratified, the bedding being torrential showing an alternation of coarse bedded gravel and thin, more or less horizontal laminae and lenticles of red clayey soil.

The gravel itself consists of white to pinkish, hard, fine grained, massive crystalline foraminiferal limestone derived from the more durable fragments of the Cape Ra. limestone. The fragments have a dull polish, are rounded-subrounded and range in size from 1 foot boulders to ¼ inch pebbles, the greater proportion being of cobble grade (2in. - 8in.) and averaging 2½ inch on the plain, increasing to 3½ inches at the foothills. A fine grained reddish clayey soil fills the interspaces between the cobbles. With the exception of shape and size, the cobbles are uniform and show no alteration. Only one sample (N16) from pit No. 2 was collected.

Soil Cover.

This consists of a reddish fine grained clayey soil which mantles many of the fan and stream deposits. The soil cover varies from 0-10 feet and supports a light growth of spinifex, saltbush and occasional clumps of grass.

Development.

All gravel pits are situated in stream channels where the overburden and soil matrix is least. The presence of the clayey soil causes the pit walls to stand up well.

A table supplied gives the approximate dimensions of the pit excavations. The column representing the percentage volume of soil matrix in the gravel includes the thin laminae of red clayey soil present.

The deposits bottom on red clayey soil similar to the thin laminae and soil cover.

A loading ramp present in pit No. 2 suggests bulldozers were used for excavating, handling and loading the material on to vehicles. No evidence of crushing or screening was noticeable in any of the pits or constructions.

Roads constructed of this gravel are shown on the accompanying map. They are quite firm, in good condition and capable of taking heavy loads. A few show signs of deterioration along the sides, and grasses are gradually encroaching over disused portions. The sealed roads (including air strips) require some attention where the bitumen is cracking and lifting.

No estimate of the amount of material present was attempted but large tonnages are available and all existing gravel pits could be extended both upstream and down and new pits could be established in the many stream channels present along the east and west coastal strips of the Cape Ra. peninsula.

Pit.	Length.	Average Width.	Thickness of Gravel only.			Overburden.			% Vol. of Soil in Gravel.	Amount of Gravel Removed.
			Max.	Min.	Average.	Max.	Min.	Average.		
	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)	%	(cub. yds.)
No. 1	600	60	15	7	12	3	0	1	7	16,500
No. 2	800	220	10	6	8	4	0	2½	7	51,000
No. 3	1,000	300	12	6	9	4½	0	3	7	100,000
No. 4	700	100	8	5	7	*	*	*	20	18,000
No. 5	400	270	9	5	8	*	*	*	9	32,000
No. 6	100	40	....	....	6	*	*	*	8	900

Above figures are approximate only. * Occurring as thin bands.

NOTES ON WATER SUPPLY, EXMOUTH GULF AREA.

N.W. Division.
Approx. lat. 22°30′ S.
Approx. long. 114° E.

By J. Sofoulis, B.Sc.

Introduction.

The area concerned in this report lies west of the 21 north-south grid line shown on the 1237 Yanrey military map 4 mile series. This report deals chiefly with the water supplies found in the immediate vicinity of the Cape and Rough Ranges and gives a few additional remarks on the Giralia-Cardabia Area. Further information concerning water possibilities in the Cardabia area has been given by F. G. Forman in the Annual Progress Report for 1938.

It is not proposed in this report to deal with waters obtained from sand dune and artesian sources.

Geological Information.

Structurally, the area consists of two major arches, the Cape and Giralia-Cardabia Ranges, with the Rough Range forming a minor arch between these. The arches are arranged en echelon with their long axes oriented in a north-south direction. The upper sediments of the arches consist of Tertiary limestones and sandstones. Where exposed, these sediments exhibit strong jointing.

Relative to the Cape and Rough Ranges, the Giralia-Cardabia Range has suffered much erosion and Mesozoic sediments are exposed along the axial region.

The flanks of the structures are cut by many stream channels which drain into the Indian Ocean and the Gulf of Exmouth. Many streams of the Giralia-Cardabia Range terminate before reaching the coast.

Cape Ra.—Rough Ra. Area.

Three sheep stations are located on the plain which skirts the ranges. These are Exmouth and portion of Yardie on the east side of the peninsula, and Yardie and Ningaloo on the west side, the total number of sheep supported on all three properties being in the vicinity of 24,000 head.

The arched terrains of both structures are cut by steep walled drainage channels and their many tributaries. All drainage channels are filled with gravel and alluvium for almost their entire lengths. The drainage channels usually support a dense growth of vegetation and eucalypts are generally confined to these channels and their banks.

No springs or waterholes are known in the interior of either structure, but after heavy rain some pools remain in the headwaters of the streams and some of the streams do flow for short periods. The present sources of water supplies are wells, bores, and roof catchments.

A study of the wells and bores put down in this area has revealed the following:—

(1) All successful wells and bores are located on the plain, on or very close to drainage channels.

(2) On the plain, the water table lies approximately at sea level (± 20′) and most waters are obtained from this level.

(3) All water sites located close to the ranges and alongside drainage channels yield ample supplies suitable for both humans and stock.

(4) Sites located away from drainage channels yield (if any) saline water.

(5) Sites located at the focus of a converging system of short drainage channels tend to yield better water than those sites located alongside long drainage channels.

(6) Analyses carried out in 1942-43 by the Department of Army show that for sites located alongside long drainage channels, the amount of dissolved impurities varies from 30-60 grains per gallon near the foothills, and this amount increases up to 200+ grains per gallon approaching the coast.

(7) Irrespective of position, the waters obtained at distances less than one mile (approx.) from the coast are saline and barely suitable for stock.

The above may be interpreted as follows:—

During rain periods the "run off" contributes directly to the gravel and alluvium drainage channles and saturates them with water. The water, as it moves down the slope is mostly lost to sight by percolation through the gravel and this results in a seaward flow of fresh water along the bottoms of the gravel laden drainage channels. (This is generally referred to as underflow.)

As the upper rock formations are strongly jointed, the interconnected joint planes beneath the gravel streams are probably acting as channels for the underflow, and although surface flow has long ceased, the underflow supply is continually being augmented by seepages of water from the gravel stream beds.

Wells and bores selected in and alongside the drainage channels have intercepted this underflow at the water table and although the streams are intermittent, the underflow is perennial and good supplies have resulted.

Away from drainage channels, the "ground water" is more or less stationary and as it is not freshened by underflow, the wells and bores at such locations yield poor supplies of saline water.

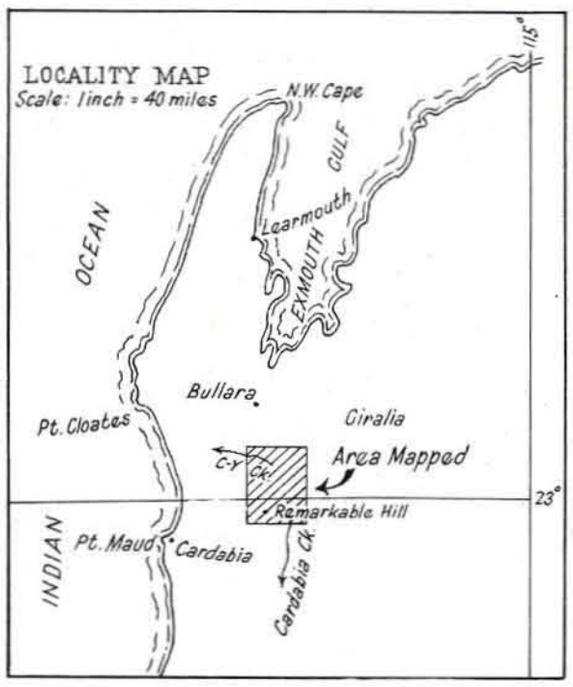
The salinity increase as the coast is approached is probably due to long travelled waters containing greater amounts of dissolved impurities, a decrease in the quantity of underflow, and to sea water contamination. The mile wide saline coastal strip is due to direct contamination by sea water. The Ningaloo-Yardie side of the Cape Ra. is unfortunate in having a narrow coastal strip and most waters obtained from this side are suitable for stock uses only.

The bores and wells now supplying the area have been listed below. Depths were obtained from logs and information gathered from station owners. Collar elevations were obtained by barometric means.

Exmouth.			Yardie.			Ningaloo.		
Name of Bore or Well.	Collar Elevn.	Depth.	Name of Bore or Well.	Collar Elevn.	Depth.	Name of Bore or Well.	Collar Elevn.	Depth.
	ft.	ft.		ft.	ft.		ft.	ft.
Bunbury	255	245	Mowbowra	18	30	Ningaloo	72	86
Patterson's	296	309	Akoubra	16	15	S. Mill....	22	20
Dingo	169	160	Cape	17	22	Jarvis	21	30
South	90	97	Ned's	50	37	6 Mile	?	70
West	94	75	Tantabiddy	8	8			
Cashen's	23	25	5 Mile	?	25			
Woggati	110	116	Milyering	?	15			
Potshot or Wolcott	65	82	Tulky	?	18			
Trealla	52	80	Pilgramana	22	26			
Nabalgee	27	35	Yardie	25	37			
No. 2	53	75	S. Yardie	?	60			
No. 1	21	30						

PLATE XVIII

GIRALIA STN.



C-Y CREEK

No 10 Bore

117°

123°

Fold

Major Anticlinal

CARDABIA Axis of

CREEK

S1 Old Camp Site

S2

S3

S4A

S4B

S5

S6

60°
0123d
1½°

0123c
37°

0123b
42°
2°

0123a

C32

C33

C34

C23

REMARKABLE HILL
750'

— LEGEND —

PLIOCENE — Sandy Limestone

CRETACEOUS — Inoceramus Beds
Gypsite
Siltstone

REFERENCE

Observed geological boundaries
Approximate geological boundaries
Strike and dip of bedding 2°
Fences
Watercourses
Locality of samples • S6

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

GEOLOGICAL MAP
OF
EAST CARDABIA AREA
NORTH WEST DIVISION

Scale: 1 inch = 1 mile

1 ½ 0 1 2

Compiled from air photo and field maps, with geology by J. Sofoulis, May, 1949

J.McL 6/49

Giralia-Cardabia Area.

This area includes portions of Giralia, Bullara, Cardabia and Marrilla properties which lie in the immediate vicinity of the structure.

Here, the "best water" and most useful shallow bores and wells (Jubilee, No. 10 Bore, Bundawin, etc.) are located in, or alongside drainage channels, and it is possible that conditions here may be similar to those found in the Cape Ra.-Rough Ra. area. Although not as deeply trenched, the drainage channels of the Giralia-Cardabia Ra. have large intake areas and would be well supplied with "run off" waters during wet periods.

Conclusions.

Reservoirs of useful shallow waters exist beneath the drainage channels of the Exmouth Gulf Area. Should further supplies be required, such sources could be utilised. Air photographs would be of great assistance in selecting sites where a paucity of drainage channels exists, and where channels are so shallow and alluvium covered that they are apt to be missed from the ground.

POSSIBLE BENTONITIC DEPOSITS.

East Cardabia Area.

North-West Division.

By J. Sofoulis, B.Sc.

Introduction.

Whilst engaged in field work in the Cardabia Area, North-West Division, in February and March 1949, under Mr. E. K. Craig, geologist for Ampol Petroleum Coy., a clay believed to be of bentonitic character was encountered. Following instructions from the Government Geologist, the area was revisited on May 16th-17th, 1949, for the purpose of collecting samples and examining the economic possibilities of the deposit.

Location and Access.

The locality can be reached from Carnarvon by the coast road which passes through Cardabia station. Cardabia homestead is 153 road miles north of Carnarvon and about 2 miles from the landing near Maud Point. The deposit lies in the north-east corner of the pastoral lease held by French and Company of Cardabia Station and is approximately 7 miles south of the junction of the east-west Cardabia-Bullara and the north-south Bullara-Giralia boundary fences.

Access to the deposit is by a moderately good sand track which branches off the main Cardabia-Bullara road at Bundawin outcamp and runs to No. 10 Bore. This bore is 28 miles by road north-east from Cardabia homestead. The track from No. 10 Bore to the deposit locality is shown on the accompanying map (Plate XVIII). This track from No. 10 Bore to the old camp site (16.8 road miles) is poor, although used occasionally by station vehicles, improvements are necessary, namely the crossing at No. 10 Bore and Cardabia Creek. There are no tracks north of the old camp site but the topography is flat and the streams shallow so that the S.4* area would not be difficult of access. All stream channels are dry, but after heavy rains a few pools remain and often persist for several months. There is an ample supply of good water at No. 10 Bore and brackish water at a bore 4.2 miles west of No. 10 Bore. Vegetation (30-40 per cent. covering) is mostly spinifex with a few stunted scrubs in the sandier areas.

Geology.

The deposit occurs on the deeply eroded crest of a broad anticlinal fold which is the southerly continuation of the Giralia anticline. The axis of the fold in this area strikes N.10°E.

The western flank of this structure stands out above the surrounding area as high buttes and westerly dipping cuestas. Dips measured on this flank are constant at 1-1½ degrees west, the general strike being N.28°E. These high hills which form the west flank of the anticline are known locally as the Cardabia Range. The more resistant Inoceramus limestone caps the cuestas and is underlain by 30 feet of Inoceramus marl. On this denuded western limb, and in the northern central portion of the structure, the cuestas form a scarp which rises 65 feet above the axial region where the deposit occurs. The higher hills which stand above the Inoceramus limestone are made up of Upper Cretaceous and Tertiary beds.

The eastern flank is marked by a low series of hills 20-30 feet above the general central level. Only portions of the Inoceramus beds are exposed on this flank. The higher beds being covered by an abutting flat-easterly dipping Tertiary sandy linestone. The general strike of this flank is N.8°E., and dips taken on the Inoceramus limestone vary from only a few degrees up to 70° E., minor flexures being common along this limb.

The central or axial portion of the anticlinal fold has been deeply eroded so that the lower beds of the Cretaceous sequence are extensively exposed.

The Deposit.

The deposit is found on the central eroded portion of the anticline immediately below the Inoceramus beds. Where measured, the thickness of the "bentonitic" clay has not been less than 5 feet. The writer's estimate of the true thickness is 10 feet ± 2 feet and the clay would bottom on radiolarian siltstone.

The deposit consists of:—

A. Soil cover and gypsite 6ins. to 6ft. +
B. Gypsite and "Bentonite" 15in. (Transition layer)
C. "Bentonite" 5 ft. +

A and B are highly gypseous; C contains gypsum (5-10 per cent.) concentrated along vertical and horizontal planes. The "bentonite" is a fine-grained, dark brown clay and when cut the fresh material has a waxy lustre which becomes dull on drying. The best exposure of the "bentonite" is in the S4-S5 area. Here the headwaters of the C-Y Creek have deeply trenched the surface resulting in gently sloping south banks, and scarps 7-10 feet high forming the north banks. The lower 5-6 feet of these scarps is composed of "bentonite." A similar scarp exists on a tributary of the Cardabia Creek at S1.

With the equipment available, the true thickness of "bentonite" and overburden could not be ascertained, but from field observations, the overburden (comprising both A and B) at S1 is 3 feet. This probably increases gradually toward S2. From S2 the overburden decreases westwards, being 3 feet at S4 and 6 inches at S5. Beyond a mile south of S5 and down the west side as far as the Remarkable Hill vicinity, the streams are shallow and the clay is not exposed.

Samples of "bentonite" and overburden collected from this area have been forwarded to the Government Chemical Laboratories for analyses.

Estimate of Tonnage.

It is considered desirable to present some estimate of the quantity of "bentonitic" clay likely to be contained in this area. The estimate which follows is influenced by the following factors:—

(1) Boundaries marked on the map are only approximate.
(2) In the opinion of the writer, the association gypsite—"bentonite"—siltstone is the result of siltstone decomposition. If this is so, the thickness of useful "bentonite" would depend on the degree and depth of decomposition.

* These numbers refer to positions on Plate XVIII where the deposit was sampled.

(3) The possibility that the gypsite, through transportation processess, may not be underlain everywhere by the "bentonite." (Especially about the gypsite—siltstone boundary.)

Assuming that the area marked gypsite is underlain by the "bentonite," for the purpose of computation the deposit can be taken as 38 square miles (approximately). Taking the useful thickness of "bentonite" to be only 5 feet, the tonnage available would be in the vicinity of 300,000,000 tons.

Economic Considerations.

If material of this composition is required by industry, the following factors are relevant.

1. There is at least 3 feet of worthless overburden covering most of the "bentonitic" area.
2. The material would have to be bagged and hauled either 210 miles approximately by road to Carnarvon, or 200 miles approximately by road to Onslow. Although Onslow is the nearer port, Carnarvon has the lower shipping costs and is the most frequented.
3. The material could be transported to either Maud's Landing (30 road miles from No. 10 ore) or the whaling station at Point Cloates (64 road miles from No. 10 Bore) where lighters would be required to transfer the bagged material to freighters.
4. The North West Transport Company, operated by a Mr. N. Morgan has a weekly mail and runs stores from Carnarvon to the North West Cape. Normal freight from Carnarvon to Cardabia is £6 per ton, backloading may possibly be cheaper. At present there is no transport running from Onslow to this area.

Other Possible Deposits.

The "bentonite" is thought to be a derivative of the siltstone. It is therefore possible that other deposits may occur in areas where the siltstone is exposed. The writer has seen siltstones, identical with those of the east Cardabia area outcropping throughout the Winning Station and as far South as the Minilya River. Gypsite has also been observed in the Cundy dam excavations near the Wandagee Woolshed.

Conclusions.

Should the deposit prove to be of suitable composition, this area can be considered as a potential source of bentonite. Suitable scarps present would offer ideal faces for development and open cut methods could be effectively employed.

NOTES ON SUITABILITY OF CARDABIA BENTONITE AS A SOURCE OF DRILLING MUD.

1. A sample of Cardabia Bentonite has been examined as a possible source of drilling mud with the following results:—

(i) Composition.

The sample is positive both to benzidine and to zinc uranyl acetate. The principal mineral of the clay fraction, therefore, is probably one of the montmorillonite group. There is an appreciable content of gypsum which is not desirable in clays to be used for drilling mud, but does not completely rule them out.

(ii) Mixing of Aqueous Suspensions.

The bentonite breaks down readily in water. In order to make drilling mud the easiest method would be to soak the roughly crushed bentonite in water (or in brine—see Chemical Treatment below) for 24 hours and then to "gun" the suspension to the required viscosity.

Mixed in this way a 75 lb. mud may be made of suitable viscosity for drilling. Stability, however, is only moderate and wall-building properties are poor. After repeated gunning, however, the viscosity of the mud increases and stability greatly improves. The same process will take place when the mud is in use in the hole. It would be a good idea to use freshly prepared mud in the early stages of a hole, if the strata are reasonably well consolidated, and later to remove it and store it for further treatment and subsequent use in the more difficult stages of drilling.

(iii) Range of Usefulness.

As an ordinary drilling mud for "straight drilling" conditions the bentonite will give a 75 lb./cu. ft. mud when freshly mixed and 72-73 lb. mud when matured, in both cases without chemical treatment.

If the bentonite is required as an additive to a clay mud it should be treated first of all as explained below.

(iv) Chemical Treatment.

This might be considered under two headings:—

(a) Treatment designed to give a drilling mud made up of bentonite, water, chemicals but no other clay.

(b) Treatment intended to give a product suitable for addition to other clay muds in the same manner as e.g., "Aquagel."

Taking (a) first, a number of possibilities exist. Simplest is to prepare the mud in the ordinary way and add 0.1%-0.2% of gum arabic, or glue by weight of mud. Addition of gum may be made using a hopper, the gum being added as the mud is passed through the jet. A certain amount of preservative has also to be added. 0.05% of phenyle by weight should be ample. Results of this treatment will be a 70 lb. mud, of gelling tendencies and with good wall-building properties. Adding a small quantity (ca 0.2%) of soda ash may give an even better mix.

A rather more elaborate but more effective way of securing a light mud would be to use the soda ash/starch technique. According to this a portion of the mud is taken in a tank and up to 2% by weight of starch (calculated on all the mud to be treated) is added through a hopper. Sufficient caustic soda solution is then added until the starch has dissolved and pH is 11.0. The very thick mass thus resulting is diluted with the remainder of the mud and well stirred by "gunning." This will give a 68-70 lb. mud of good all-round quality.

The presence of gypsum in the bentonite and the fact that the raw bentonite is a calcium bentonite, militate against the preparation of first-class muds. The effect of gypsum* can be negatived in the following way:—

> When making up mud from fresh bentonite use a 5% brine solution instead of water. After 24 hours gun thoroughly and allow to stand. After 4 hours remove supernatant water, add fresh water and gun again. Allow to stand 8 hours. Run off supernatant water and repeat the procedure. After 2-3 washings it will be found that the bentonite no longer settles. Now add 2% by weight of soda ash and gun thoroughly.

Other means of offsetting gypsum require the use of "calgon" (sodium hexametaphosphate) or "pyro," (sodium pyrophosphate), or a tannin (still better tannin plus soda ash). The object of such treatment is to precipitate the gypsum in solution as insoluble calcium salts.

In the same class of treatment comes the sodium silicate treatment. On adding sodium silicate to Cardabia bentonite the first noticeable effect was an increase in viscosity due to formation of calcium silicate gels. Later these gels break down, calcium silicates precipitate and the mud becomes thin but stable. The most useful feature of this method of treatment is that on addition of sodium silicate the sand in the mud is thrown out. The disadvantage is that the treated final product is liable to be over-thixotropic.

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*It is not absolutely necessary to remove gypsum when the gum treatment is employed, but, naturally, if it is done, the results will be much better.

STANDARD SYMBOLS

As adopted by Geological Survey of Western Australia
1950

GEOLOGICAL BOUNDARIES OR CONTACTS

- Observed geological boundary or contact showing dip — 25°
- Approximate geological boundary or contact
- Assumed geological boundary or contact ---?---?---

BEDDING

- Strike and dip of bedding — 35°
- Strike of vertical bedding
- Strike and dip of overturned beds — 75°
- Horizontal beds
- Bedding with curving dip — 60° / 30°
- Plunge of slickensides with strike and dip of beds — 35° / 60°
- Generalised strike and dip of crumpled, plicated, crenulated or undulating beds. — 50°
- Top of beds as indicated by cleavage and bedding relationship.
- Top of beds as indicated by cross bedding
- Top of beds as indicated by gradation and grain size

JOINTS

- Strike and dip of joints — 75°
- Strike of vertical joints
- Horizontal joints

FAULTS

- Faults, showing dip (Dashed where approximately located). — 55°
- Fault with vertical dip
- Fault, probable or doubtful existence
- Fault, showing bearing and plunge of grooves, striations or slickensides
- Fault, indicating dip, vertical and horizontal components of movement. (U, upthrown side; D, downthrown side). — U / D, 20°

FOLDS

- Axial plane of major fold
- Axis and direction of plunge of major fold
- Approximate axis and direction of plunge of major fold
- Anticlinal axis
- Synclinal axis
- Strike and plunge of dragfold — 50°
- Dip of axial plane on dragfold — 50° / 60°
- Plunge of minor anticline
- Plunge of minor syncline
- Plunge of fold axis — F.A.
- Horizontal fold axis — F.A.
- Overturned anticline; showing trace of axial plane, direction of dip of limbs and bearing and plunge of major fold. — 30°
- Overturned syncline

FOLIATION AND CLEAVAGE

- Strike and dip of foliation — 50°
- Strike of vertical foliation
- Horizontal foliation
- Strike and dip of cleavage — 75°
- Strike of vertical cleavage
- Horizontal cleavage
- Strike and dip of schistosity (Flow cleavage) — 70°
- Strike of vertical schistosity
- Strike and dip of fracture cleavage — 85°
- Strike of vertical fracture cleavage

BOUNDARIES AND MARKS

- State Boundary
- Land Divison Boundary
- Land District Boundary
- Goldfields Boundary
- Location, Mining Holding or Prospecting Area Boundary
- Trig Station. First Class. Altitude relative to Mean Sea Level — △463′
- Trig Station. Second Class. " " do. " " " — △367′
- Trig Station. Third Class. " " do. " " " — ⊙297′
- Spot Heights. " " do. " " " — ·275′
  (Sloping figures indicate altitude relative to an assumed datum)
- Locality and number of specimen — X 2/1762

LINEATIONS

(Including flow lines, alinement of minerals, inclusions, streakings, elongation of pebbles etc.)

- Bearing and plunge of lineation — 30°
- Strike and dip of foliation and plunge of lineation — 30° / 50°
- Vertical lineation
- Horizontal lineation
- Rake – term and symbol if the lineation is measured in the plane of foliation – i.e. not in vertical plane as for plunge — 50° / 55°

MINING FEATURES

- Main shaft (showing number of compartments)
- Shaft – accessible
- Shaft – inaccessible
- Head of rise or winze
- Foot of rise or winze
- Inclined shaft.
- Cross-section of cross-cut or drive approaching observer
- Cross-section of cross-cut or drive receding from observer
- Open cut
- Costean or trench, showing depth — 4′ / 4′
- Dry blown area
- Dump
- Portal of tunnel or adit

WORKS AND STRUCTURES

- Major road
- Minor road
- Track
- Railroad
- Telegraph or Telephone line
- Electric transmission line
- Fence, on surveyed boundary
- Fence, not on surveyed boundary
- Building
- Wind pump
- Bore — B
- Spring — S
- Well — W
- Tank — T
- Dam — D
- Standpipe
- Cutting
- Embankment

GEOLOGICAL FEATURES

- Quartz — Q
- Jasper (not jaspilite) — J
- Jaspilite (banded iron formation) — QFe
- Outcrops with no observed strike or dip
- Direction in which lava flow tops face

TOPOGRAPHICAL FEATURES

- Bluffs and breakaways
- Watercourses (perennial)
- Watercourses (non-perennial)
- Swamps and marshes
- Form lines
- Contour lines — 450′
- Approximate contour lines — 450′

Turning to (b) treatment to produce an e.g., "Aquagel" substitute the line of approach is to carry out the salt treatment as outlined above, sun-dry the mud resulting and grind. Alternatively the mud may be allowed to dry partly in the sun, giving eventually a very thick mud which can be mixed with the other clay and water in the desired proportions.

2. It is hoped to do further work on the wall-building properties of the Cardabia bentonite when the filtration equipment now on order comes to hand. Tests on the preparation of high gravity (100 lb./cu. ft. and over) muds will also be made.

(Sgd.) A. REID,
Chief Industrial Chemist.

REPORT ON SHALES AND CLAY ON LOCATION 310, BYFORD

By L. E. de la Hunty, B.Sc.

General Information.

Location 310 is a little more than half a mile east of the Perth-Bunbury highway and its northern boundary is about 19 chains south of the southern boundary of the State Brick Works. It is inaccessible to motor transport, at present, but could be reached by a track cut in from the north. Beenyup Brook flows past the southern boundary of the location—thus cutting it off from the adjacent road.

The shales and clays occur in an area of about 30 acres which extends through the location from north to south, in a strip about 12½ chains wide. The eastern edge of the strip starts 1 chain west of the S.E. corner of location 632.

The northern half of the area slopes gradually to the south west, while the lower half falls away rapidly to Beenyup Brook. This lower half is covered with soil and alluvium. The difference in elevation from north to south is about 100ft. and the southern boundary is at approximately the same elevation (300ft.) as the kilns of the State Brick Works. (Mr. Lord's party is at present making a contoured geological map of this area.)

Geology.

The area is bounded to the west by ferruginous sandstone, sand and low level laterite. Clay occurs in the western half of the area and shales outcrop to the east. East of the shales is sandstone while, east of this sandstone, is quartz, then granite.

These shales lie along the strike of those quarried at the State Brick Works and bear a similar relationship to the greenstone clay as do those mapped by Ward[1].

Comparison with sections, drawn by Lord[2], of the Cardup Series to the south, also indicate that these shales are Lower Cardup in age. The Lower Cardup shales dip steeply to the west and are overlain by a greenstone (epidiorite) sill which weathers to a red clay.

Shales.

The shales outcrop over a distance of 13 chains from the northern boundary of location 310 in a direction approximately S.5°E. They probably persist down into the valley under the alluvial soil.

The shales occur as small outcrops associated with numerous small boulders and chips. The shales are hard at the surface. The shales consist mainly of the greyish-pink variety with minor amounts of blue shale. The pink shale is considered excellent for the manufacture of bricks but the blue shale is useless.

No boundary is visible between shales and clay, due to the cultivated soil cover, but shallow boring would soon reveal their limits.

Clay.

A sample of clay was taken near the western boundary of the area at a depth of 15 inches. It was a reddish-brown grit-free clay and was received very favourably by the manager of the State Brick Works.

This sample was taken from a small test hole dug on instructions from the late Mr. Kitching (the previous manager of the State Bricks Works.) The hole was part of a sampling programme which lapsed with the death of Mr. Kitching.

Summary.

1. The area of outcropping shales and clay is about 16 acres, while the total area of presumed, and visible, shales and clay in location 310 is about 30 acres.

2. Both the shales and the clay are of good quality for brick-making.

3. The deposits are close to the State Brick Works and are easily accessible from there.

4. Boring is necessary to determine the limits of the shales and clay.

[1] WARD, H. J., Report on the Availibility of shale at the State Brick Works, Byford. G.S.W.A. Ann. Prog. Rep., 1945, pp. 57.

[2] LORD, H. J.; Report on the Examination for Brick-Making Materials of the Cardup Area—Cockburn Sound, South West Division. G.S.W.A. Ann. Prog. Rep., 1948 (in press).

STANDARD SYMBOLS.

As adopted by the Geological Survey of Western Australia.

Plate XIX of this Report is a compilation of Standard Symbols and Conventional Signs which will be used on all Geological Plans published by the Geological Survey of Western Australia as from 1st January, 1950.

This will supersede the table of Standard Symbols published in the Annual Progress Report for the year 1938.

Index to Geological Survey Annual Report for 1949.

Division V.

School of Mines, Western Australia.

The Under Secretary for Mines.

I forward herewith, for the information of the Hon. Minister for Mines, my Annual Report for 1949.

1. SCHOOL OF MINES, KALGOORLIE.

Enrolments.

The total number of students enrolled during 1949 was 360. Individual enrolments and class enrolments for 1947, for 1948 and for 1949 are given in Table I. For 1949 the total number of students enrolled decreased by 60 by comparison with the previous year. This decrease is accounted for by the smaller number of full-time C.R.T.S. students.

TABLE I.

ENROLMENTS, 1947, 1948, and 1949.

Year.	1st Term.		2nd Term.		3rd Term.	
	Individual.	Class.	Individual.	Class.	Individual.	Class.
1947	546	1,807	533	1,551	513	1,374
1948	397	1,491	358	1,365	310	1,253
1949	344	1,077	307	958	258	841

The number of students enrolled in the various subjects is given in Table II.

The total enrolment of 360 students was made up as follows:—

1. Students who are not returned servicemen, and who are—				
(i) Paying class fees or laboratory fees	Full-time	8		
	Part-time	64		
		—	72	
(ii) Paying only a registration fee (5s. per year) or who are exempt from fees	Full-time	7		
	Part-time	97		
		—	104	
2. Students who are returned servicemen, and who are exempt from fees (General Regulation 5). Not enrolled under C.R.T.S.	Full-time	—		
	Part-time	80		
		—	80	
3. C.R.T.S. students	Full-time	52		
	Part-time	52		
		—	104	
		Total	360	

TABLE 2.

CLASS ENROLMENTS.

Subject.	1st Term.	2nd Term.	3rd Term.
Preparatory Chemistry	32	21	15
Chemistry IA.	29	23	20
Chemistry IB.	2	2	2
Analytical Chemistry I.	21	21	18
Analytical Chemistry II.	5	5	5
Applied Chemistry	15	15	15
Metallurgy I.	13	10	10
Metallurgy II.	13	13	13
Assaying	11	10	10
Mineral Dressing	21	21	19
Metallography	8	8	8
Preparatory Drawing	31	29	24
Drawing I.	3	8	8
Engineering Drawing I.	37	32	26
Engineering Drawing II.	17	16	14
Mechanical Engineering I.	14	14	11
Mechanical Engineering II.	16	16	16
Practical Electricity	12	6	5
Electrical Engineering I.	30	26	24
Electrical Engineering II.	17	16	14
Internal Combustion Engines	39	37	33
Workshop Practice I.	26	27	25
Workshop Practice II.	9	8	7
Welding	39	33	28
Engine Driving	15	13	10
Structural Engineering I.	16	16	15
Structural Engineering II.	19	19	18
Hydraulics	15	15	14
Machine Design	17	16	15
Materials of Construction	8	8	7
Preparatory Mathematics	31	23	17
Mathematics IA.	63	53	44
Mathematics IIA.	58	52	44
Mathematics IIB.	17	16	12
Applied Mathematics	33	32	30
Preparatory Physics	26	18	14
Physics IA.	27	25	21
Physics IB.	42	39	33
Trade Mathematics I.	43	27	22
Trade Mathematics II.	5	5	5
Mining I.	13	11	11
Mining II.	18	20	17
Mining III.	12	11	10
Surveying I.	18	18	17
Surveying II.	20	20	19
Technical English	27	20	19
Preparatory Geology	21	14	10
Geology IA.	12	12	12
Geology IB.	25	23	21
Geology II.	13	12	11
Geology III.	1	1	1
Petrology	1	1	1
Mining and Economic Geology	1	1	1
Total Class Enrolments, 1949	1,077	958	841
Total Class Enrolments, 1948	1,491	1,365	1,253

The revenue for the year was from students enrolled under groups 1(i), 1(ii), 3, and from fees received for diplomas and certificates.

The number of correspondence class students was 20. These students were enrolled through Perth Technical College Correspondence School, and the conditions of enrolment remained as in

the previous year, i.e., except for students enrolled before a certain date the correspondence students were not eligible to sit for School of Mines examinations. Towards the end of 1949 approval was given for certain School of Mines subjects to be available to "external" students and the preparation of the necessary notes was commenced.

Revenue.

The total revenue from school fees, including fees from C.R.T.S., was £1,464 1s. 9d. Fees received for work done in the Metallurgical Research Laboratory amounted to £254 6s. 9d.

Staff.

It is pleasing to record that Mr. D. A. Sivyer was awarded a Nuffield Foundation Scholarship in extraction metallurgy during 1949. To take up this scholarship he left Kalgoorlie on Wednesday, 30/11/49, and returned on Wednesday, 15/2/50. Between these dates he visited various metallurgical works and teaching institutions in U.S.A. and Canada.

During the Christmas vacation Mr. W. C. Cleverly undertook a course of study under Dr. Stillwell of the Minerographic Section of the C.S. and I.R.O. in Melbourne. Mr. Cleverly brought back with him useful information regarding the study of minerals by reflected light.

Mr. C. H. S. Meharry was appointed to the position of Senior Research Metallurgist in the Research Laboratory, and resigned from the position of Assistant Lecturer in the Metallurgy and Chemistry Department. He commenced his new duties on Wednesday, 4/1/50.

Mr. R. W. Wilson's appointment as Senior Research Metallurgist was terminated as from Friday, 22/4/49.

Mr. Le Mesurier resigned from the position of Assistant Lecturer in the Department of Metallurgy as from Tuesday, 3/1/50 to accept a position with the P.W.D., Perth.

Mr. J. P. Reynolds, a graduate of Sydney University, was appointed to the position of Temporary Assistant in the Geology Department, and commenced duties on Tuesday, 8/3/49. At the end of the school year it was arranged that Mr. Reynolds should go to Norseman in 1950.

Mr. A. F. Griffin commenced duties as assistant in the Metallurgical Research Laboratory on Tuesday, 21/6/49.

In May a new position of Laboratory assistant was created in the Research Laboratory, and Mr. J. W. Green was appointed. He commenced duties on Monday, 16/5/49.

Mr. S. R. H. Gibb resigned from the position of laboratory assistant in the Metallurgy and Chemistry Department on Friday, 1/7/49, to accept a similar position with the University of W.A., and Mr. A. T. Miles was appointed to the vacant position. Mr. Miles commenced duties on Thursday, 14/7/49.

A new position of fitter and turner was created in the Engineering Department in May, and Mr. J. M. Williams was appointed. He commenced duties on Monday, 9/5/49.

On Friday, 21/10/49, Miss M. A. Maher resigned from the position of senior typist to get married. Miss Maher has been with the school since March, 1942, and gave excellent service to the school. She was a cheerful and willing worker at all times, and it is a pleasure to place on record her good services to the school.

To fill the vacancy created by Miss Maher's resignation Miss Phillips was appointed temporary senior typist. She commenced duties on Tuesday, 8/11/49.

Cadet N. B. Creagh ceased duties at the close of school year at Norseman, and has commenced duties as cadet in the Department of Mathematics and Physics at Kalgoorlie.

Mr. W. Sherlock ceased duties as cleaner on Friday, 17/6/49, and Mr. A. Walton was appointed to the vacant position. He commenced duties on Monday, 18/6/49.

Advisory Committee.

During 1949 the Advisory Committee met on nine occasions. Mr. W. R. Mathews replaced Mr. C. T. Oliver as representative of the A.W.U. on the committee. Otherwise the committee remained as in 1948. The Registrar continued to act as secretary.

In August the Chamber of Mines agreed to make a further grant of £1,000 to the Apparatus and Equipment Trust Fund and the Department contributed a like amount. This fund has enabled additional equipment to be purchased for the School. To the end of 1949 equipment to the value of approximately £2,907 has been authorised for purchase from this fund.

Courses of Study.

The courses of study for 1949 remained as for 1948.

In May the amended regulations under the Mines Regulation Act, 1946, were proclaimed. To meet the requirements of these regulations a Mine Manager's Certificate Course at the School was prepared and has been introduced in 1950. The course requires four year's part-time study after the necessary preparatory standard has been reached. Holders of Mine Manager's Certificates from the school are exempted from further examinations, except in Mining Law for the Mine Manager's Certificate of Competency issued by the Mines Department.

Diplomas and Certificates.

The following Diplomas and Certificates were issued during 1949:—

Associateship Courses—	
Metallurgy	6
Mining	10
Engineering	4
Mining Geology	....
Total	20
Certificate Courses—	
Assayers	6
Surveyors	8
Draughtsmen	....
Electrical Technicians	....
Industrial Chemists	5
Geologists	2
Electricians	....
Engine Operation and Maintenance Course	1
Total	22

Annual examinations.

The annual examinations were held in evenings from Monday, 31/10/49, to Wednesday, 16/11/49. The number of entries received was 1,131, which represents 66 per cent. of the class enrolments received throughout the year. Of the students entering for the examinations 75 per cent. were successful. This figure is the same as that for 1948. Details are given in table 3, in which the subjects are arranged according to the percentage of students sitting for the final examination. The table shows, as would be expected, that the greatest loss of students during the year is in the preparatory subjects and in some of the trade subjects. In seven subjects the loss was greater than 50 per cent., and in another 16 subjects the loss was between 25 and 50 per cent. The total number of subjects taught was 51.

Detailed examination results are given in appendix 2.

Supplementary examinations.

At the end of 1948 the total number of supplementary examinations granted was 120. For the examinations, which were held from Wednesday 16/2/49, to Thursday, 24/2/49, the total number of entries received was 83. The number of passes at these examinations was 36 i.e 43 per cent. of the entries.

Scholarships and prizes.

No entries were received for any of the Mines Department Scholarships in 1949. The Entrance Scholarship, awarded to L. I. Smith in 1948, was renewed for 1950.

During the year the conditions for the Mines Department Scholarships were revised, and the values of these Scholarships increased. The revised conditions will become effective during 1950. The principal changes made in the conditions are indicated below:—

(i) The Junior Scholarship was abolished.

(ii) Two Entrance Scholarships are now available, instead of one. The value of each of these scholarships is now £60 for the first year, £80 for the second year, and £100 for the third year. They are awarded on the results of the annual examinations in the preparatory subjects, and the conditions generally remain similar to those in force to the end of 1949. The scholarships are open to students from anywhere in the State, and applications close approximately one month before the annual examinations.

(iii) The Senior Scholarship is now awarded to the applicant gaining the highest aggregate marks in three of the following subjects: Mathematics IA, Physics IA, Applied Mathematics, Chemistry IA. The scholarship is valued at £80 for the first year and £100 for the second year, and is open to students from anywhere in the State. The subjects listed above are of Leaving Standard, and it is hoped that this will attract students other than those already attending the School of Mines.

The new conditions for the Chamber of Mines Scholarships became effective in 1949, and four scholarships were available. Only three awards were made, as no student qualified for the scholarship in Mining Geology. It is pleasing to record that one of these scholarships was awarded to a student of the Norseman school.

TABLE 3.

ANNUAL EXAMINATIONS, 1950.

Kalgoorlie.

Subject.	Total Enrolments.	Students Sat Final Exam.		Students Passed Final Exam.		Supp. Exam. Granted.	Students Passed Theory only.	Students Passed Practical only.
		Number.	%	Number.	%			
Practical Electricity	12	3	25	3	100	....	....	....
Preparatory Geology	22	8	36	7	88	....	....	....
Preparatory Chemistry	33	13	36	9	69	4	....	....
Preparatory Mathematics	36	15	42	6	40	2	....	....
Trade Mathematics I.	43	19	44	11	58	2	....	....
Engine Driving	18	8	44	8	100	....	....	....
Mathematics IA.	63	31	49	12	39	4	....	....
Preparatory Physics	26	13	50	10	77	2	....	1
Chemistry IA.	29	15	52	5	33	3	....	2
Preparatory Drawing	37	20	54	15	75	....	....	....
Workshop Practice II.	11	6	54	4	66	....	....	1
Metallography	9	5	55	3	60	2	....	....
Welding	40	23	57	22	96	....	....	5
Engineering Drawing I.	47	27	58	27	100	....	....	....
Mathematics IIA.	61	36	59	14	39	8	....	....
Internal Combustion Engines	42	26	62	24	92	1	....	....
Engineering Drawing II.	21	13	62	13	100	....	....	....
Mining I.	14	9	64	8	89	....	....	....
Geology II.	14	9	64	8	89	1	....	3
Physics IA.	29	20	69	9	45	3	....	8
Metallurgy II.	13	9	69	6	67	....	....	....
Analytical Chemistry I.	22	16	73	9	61	1	2	3
Geology IB.	25	18	72	15	83	....	2	....
Structural Engineering I.	16	12	75	10	83	2	....	....
Mathematics IIB.	17	12	76	6	50	3	....	....
Mineral Dressing	21	16	76	14	87	2	....	....
Physics IB.	42	32	76	23	72	6	....	....
Workshop Practice I.	30	23	77	23	100	....	....	....
Mining III.	13	10	77	8	80	....	....	....
Mechanical Engineering I.	14	11	79	10	91	....	....	....
Electrical Engineering I.	30	24	80	20	83	3	....	....
Electrical Engineering II.	17	14	82	12	86	2	....	....
Assaying	11	9	82	8	89	....	....	....
Geology IA.	12	10	83	8	80	1	....	....
Analytical Chemistry II.	6	5	84	5	100	....	....	....
Mining II.	21	18	86	17	94	1	....	....
Surveying II.	21	18	86	13	72	3	....	....
Materials of Construction	8	7	88	7	100	....	....	....
Technical English	27	21	88	12	57	4	....	....
Applied Mathematics	34	31	91	15	48	4	....	....
Metallurgy I.	13	12	92	12	100	....	....	....
Surveying I.	18	17	94	12	70	3	....	....
Hydraulics	16	15	94	14	94	1	....	....
Machine Design	17	16	94	15	94	....	....	....
Structural Engineering II.	19	18	96	18	100	....	....	....
Applied Chemistry	15	13	97	7	54	2	....	....
Trade Mathematics II.	5	5	100	4	80	....	....	....
Mechanical Engineering II.	16	16	100	15	94	1	....	....
Geology III.	1	1	100	1	100	....	....	....
Petrology	1	1	100	1	100	....	....	....
Mining and Economic Geology	1	1	100	1	100	....	....	....
1949	1,131	748	66	559	75	71	4	23
1948	1,097	....	....	....	75	....	....	....

Two students—one from Norseman—tied for the C. A. Hendry prize. Mr. Hendry generously made available the full value of the prize to each student.

A list of awards made is contained in Appendix I.

In 1916 an amount of £100 was made available by Mr. R. Falconer for a research scholarship. The student to whom the award had been made was not able to accept it, and the money remained in the Savings Bank. By 1949 interest on the original £100 has increased the money available to £217 17s. 6d. No further award of the research scholarship has been made. The above facts were brought to Mr. Falconer's notice, and he generously agreed that the money standing to the credit of the account should be used for the benefit of the students of the school. After consideration it was agreed that the money should be invested in Commonwealth bonds, and that the interest should be used to provide two prizes—known as the Robert Falconer Prizes—each year. These prizes will be awarded to the two students, who comply with the conditions set down, and who gain the highest aggregate marks and next-to-highest aggregate marks in any three of the preparatory subjects. The prizes are valued at five guineas and two and a half guineas respectively.

Commonwealth Reconstruction Training Scheme.

Trainees enrolled under this scheme continued to attend the school, both as full-time and as part-time students. The numbers decreased by comparison with 1948. Details are given below:—

	1948.	1949.
Full-time	117	52
Part-time	61	52
	178	104

For most full-time trainees 1949 was the last year of full-time training available, and it is expected that the number of full-time trainees enrolled during 1950 will be small. Throughout the year the work of C.R.T.S. trainees was generally satisfactory. For full-time trainees more detailed information is given below:—

	Numbers of trainees.	Re-enrolled 1950.
Recommended for re-enrolment 1950	2	2*(1P/T)
Course of study completed	11	—
Training period expired. Course not completed. Not included below	30	22†(P/T)
Year's work not successful. Recommended for part-time study at own expense 1950, with right to resuming full-time study 1951 if successful 1950	2	2†(P/T)
Year's work not successful. Recommended for termination of full-time training	0	—
Transferred to part-time training during year at trainee's request	4	3‡(1F/T)
Course abandoned during year	3	—
Totals	52	29

*1 Part-time. †Part-time. ‡1 Full-time.

Services to the Public.

In addition to its normal teaching activities the School continued to provide a number of services to the public.

The work of the Metallurgical Laboratory will be described in more detail in a later section of this report. The number of samples submitted for investigation was 37.

During the year 399 samples were submitted by prospectors for assay or determination—an increase of 86 by comparison with 1948. Of these 269 were for gold assay and 19 for assay for metals other than gold. The remaining samples—111—were for mineral determination.

Because of the poor response to the 1948 prospector's course this course was not held during 1949.

The Director continued to act as Local Secretary for the University Annual Examinations and for the University Public Examinations. The examinations were held at the School and were supervised by members of the staff. Supervision and accommodation were also provided for examinations held by various other examining bodies, including the Australian Music Examinations Board.

Meetings of various professional bodies such as Australasian Institute of Mining and Metallurgy, The Institution of Engineers, The Institute of Mine Surveyors, continue to be held at the School.

Buildings.

During the year minor improvements were made to the buildings, which are, generally, in good condition.

Towards the end of the year a commencement was made with the erection of the building from Wiluna. This will again be referred to in a later section of this report.

Library.

During 1949 Mr. Reynolds of the Geology Department acted as librarian to the School. In the 1949 report it was pointed out that no central library was available, and that libraries had been established in the various Departments. During 1949 the system of recording was improved, book storage was partly reorganised, and a number of periodicals were bound. The general library position was considerably improved, but much still remains to be done.

The provision of a central library can be regarded as one of the major requirements of the School. Unfortunately this would require a new building, and it is realised that this is impracticable at the present time. Such a library would mean that books were readily accessible to students, that proper supervision of books would be possible, and that a quiet study room would be available to students.

Principal requirements of the School.

During 1949 new equipment previously ordered was delivered to the School, and further equipment was ordered. In all Departments the apparatus and equipment position was considerably improved. All outstanding major items of equipment already ordered should be delivered during 1950, and by the end of that year most of the immediate major requirements of the School will have been satisfied. More details are given in the following paragraphs.

It is pleasing to record that progress has been made with all the major requirements listed in the 1948 Annual Report. The position regarding these at the end of 1949 was as follows:—

(1) Electrical Installations.—In December the re-organisation of the electrical installations at the School was commenced, and this work should be completed during 1950.

(2) Transport.—The utility provided during 1948 continued to give good service.

(3) Additional Laboratories, Metallurgy and Chemistry Department.—Late in the year the transfer of the Wiluna building was commenced, and this building should be in use during 1950. It will enable practical work in metallography and mineral dressing to be available to students. The building should prove a valuable addition to the School buildings.

(4) Fume Cupboards.—These are still very unsatisfactory, but during the year approval was given for these to be reconstructed and for a mechanical exhaust system to be fitted. This is very essential and is to be regretted progress has not been more rapid.

(5) Workshop.—During the year two new lathes were purchased for the workshop and a commencement was made with the general re-organisation of the workshop. The grinding machine ordered in 1947 has not yet been delivered. Delivery of this machine is expected early in 1950. By the end of 1950 the re-organisation of the workshop should be complete.

(6) Electrical Engineering Laboratory.—Most of the equipment ordered has now been delivered and a start has been made with the switchbord and the installation of the generators.

Metallurgical Research Laboratory.

The work done in the laboratory throughout the year was similar to that done in previous years. The number of samples received was 37—a decrease of 4 by comparison with 1948. One investigation was cancelled. Of the 37 investigations, 28 has reference to gold and the remaining 9 to other minerals, both metallic and non-metallic.

During the year all outstanding work from previous years was completed and the affairs of the laboratory were by the end of the year in a satisfactory state. For this work credit is due to Mr. E. E. Hughes, who was Acting Senior Research Metallurgist from April to December.

Assays of 288 samples for prospectors were done in the laboratory during the year.

2. SCHOOL OF MINES, NORSEMAN.

The total number of students enrolled was 78, which is a decrease of 24 by comparison with 1948. Although the number of students decreased the proportion of students enrolled for definite courses increased. It is also pleasing to record that two prizes were awarded to students of the Norseman Branch School. These prizes were open for competition among either Kalgoorlie or Norseman students. Details regarding enrolments are given in Table IV.

TABLE 4.

ENROLMENTS, NORSEMAN.

Year.	1st Term.		2nd Term.		3rd Term.	
	Individual.	Class.	Individual.	Class.	Individual.	Class.
1947	51	75	50	68	44	56
1948	96	165	84	122	89	139
1949	71	139	65	128	57	113

The revenue received was £56. As in previous years many students were under 21, and consequently did not pay class fees. Other students were returned soldiers and exempt from the payment of fees.

It is with very great regret that I record here the death of Reginald Clive Dowson, at Norseman, on Wednesday, 2nd November, 1949. Mr. Dowson was, at the time of his death, in charge of the School at Norseman. From 1936 to 1938 and from 1945 to 1946 Mr. Dowson was a student at Kalgoorlie. In addition to his studies he took a keen interest in student affairs and was president of the Students' Association in 1946. In August, 1946, he was appointed to the position of science assistant at Kalgoorlie and early in 1947 he was transferred to Norseman as full-time instructor. He was the first full-time instructor at Norseman. From the commencement of his duties he took a very keen interest in the affairs of the School and in the students at Norseman. At all times he worked very hard—very often long after his official hours of duty—and the students at Norseman owe a lot to his work. He had a very keen sense of fairness and fought hard against anything which he believed to be unjust. He made very many improvements at Norseman and during the time he was there placed the School on a very solid foundation. Mr. Dowson was held in high regard by all members of the staff of the School, both at Kalgoorlie and at Norseman and also by students. He will be remembered for his work at Norseman.

TABLE 5.

ANNUAL EXAMINATIONS, 1949.

Norseman.

Subject.	Total Enrolments.	Students Sat Final Exam.		Students Passed Final Exam.		Supp. Exam. Granted.	Students Passed Theory only.	Students Passed Practical only.
		Number.	%	Number.	%			
Preparatory Physics	5	1	20	0	0	....	....	1
Practical Electricity	5	1	20	1	100	....	....	....
Mining I.	5	2	40	2	100	....	....	....
Welding I.	16	7	44	7	100	....	....	....
Mechanical Drawing I.	4	2	50	2	100	....	....	....
Mechanical Drawing II.	2	1	50	1	100	....	....	....
Geology IB.	7	4	57	4	100	....	....	....
Trade Mathematics I.	20	12	60	6	50	2	....	....
Preparatory Drawing	10	6	60	6	100	....	....	....
Preparatory Mathematics	8	5	62	2	40	2	....	....
Engine Driving	4	3	75	2	66	....	....	....
Trade Mathematics II.	8	6	75	5	83	1	....	....
Internal Combustion Engines	5	4	80	3	75	1	....	....
Surveying I.	5	4	80	4	100	....	....	....
Workshop Practice I.	11	9	82	7	77	....	....	1
Geology IA.	6	5	83	4	80	....	1	....
Electrical Engineering I.	4	4	100	2	50	....	....	....
Mathematics IIA.	1	1	100	1	100	....	....	....
Welding II.	4	4	100	3	75	....	....	....
Workshop Practice II.	4	4	100	4	100	....	....	....
Totals	140	89	64	67	75	6	1	2

Mr. A. W. Thomson, A.W.A.S.M., was appointed temporary assistant at Norseman in February and gave good service throughout the year. He resigned at the end of the year and left for Canada to join his people there. Mr. Thomson was an old student of the School and left for Canada with the good wishes of members of the staff and the students.

Cadet Creagh finished duties at Norseman at the end of the year, and commenced duties at Kalgoorlie as cadet in the Department of Mathematics and Physics in 1950. His work at Norseman was very satisfactory, and he was of great assistance to Mr. Dowson.

The part-time instructors at Norseman continued to give good service, and, as pointed out in the previous year's report the School could not carry on without their assistance. The part-time instructors give appreciable amount of their leisure time to assist the School.

The subjects taught at Norseman last year totalled 20, and are listed in table 5. The annual examination results were quite satisfactory, and the details are given in table 5. Of the students who enrolled in the various subjects 64 per cent. sat for the examinations, and of these 75 per cent. were successful. These figures compare very closely with the corresponding figures for Kalgoorlie.

The building at Norseman is in a satisfactory condition. No progress has been made with the proposed additions to the building, and without these further expansion of the school is impossible. Minor improvements to the buildings and grounds are urgently required. These have been delayed until a decision has been made regarding the additions to the School.

As in previous years Workshop Practice I and II, and Welding I and II have been held in the workshop of Central Norseman Goldmines or Norseman Gold Mines, and the thanks of the Department are due to these mines.

The Advisory Committee has continued to meet under the chairmanship of Mr. Dutton, and to take a lively interest in the affairs of the School. The mines and townspeople of Norseman have also continued to take an interest in the School.

Acknowledgments.

In conclusion I would like to acknowledge the assistance given by the Registrar, Mr. Lumb, and by Mr. Ace in preparing information for this report. I would also like to acknowledge the assitance and work of the staff, both at Kalgoorlie and Norseman throughout the year. Appreciation is also due to the Advisory Committees at Kalgoorlie and at Norseman. Throughout the year excursions have been arranged to mines both in Kalgoorlie and in Norseman, and every assistance was received from the staffs of the mines.

R. A. HOBSON,
Director, School of Mines.

APPENDIX I.

SCHOLARSHIPS AND PRIZES.

Junior Scholarship—
Not awarded.

Entrance Scholarship—
L. I. Smith (renewed for 1950).

Senior Scholarship—
Not awarded.

Chamber of Mines Scholarships—
Metallurgy—H. R. Walker.
Mining—J. G. O'Connell.
Engineering—R. A. Flottman.
Geology—Not awarded.

Students' Association Scholarship—
J. G. Eddy.

Institute of Mine Surveyors—
£10 prize—R. J. Watson.
£5 prize—K. Dodd.

Associates' Association Scholarship—
R. J. Watson.

C. A. Hendry Prize—
H. G. Ritchie.
E. T. Coles.

Wesley Ladies Guild Prize—
I. F. Cliff.

Mining Standard Prizes—
J. P. Smailes.
A. T. Miles.

APPENDIX II.

School of Mines of W.A.

ANNUAL EXAMINATIONS, 1949.
PASS LIST.
Names are in order of merit.
(E) Denotes equal.

PREPARATORY CHEMISTRY

Credit—
Steer, D. W.
Wall, P.
Shanahan, J. P.

Pass—
Beer, J.
Bartlett, M. S.
Basmussen, R.
Baker, I. A.
D'Alton, A. J.
Stevens, B. E.

CHEMISTRY IA.

Pass—
McLeod, J. K. A.
McRae, R. K.
Gee, P. G.
Martin, D. J.
Gillson, R. S.

Pass Practical only—
Beveridge, A. W.
Ritchie, S. J.

APPLIED CHEMISTRY.

Credit—
Tasker, E.
Gittos, A. J.

Pass—
Smith, L. I.
Walker, H. R. C.
Smith, C. T.
Spencer, W. J.
Rich, H. J.

METALLOGRAPHY.

Credit—
Casserly, F. A.
Franklyn, R. P.

Pass—
Harvey, J. J.

ANALYTICAL CHEMISTRY I.

Pass—
Haddow, J. F.
Miles, A. T. } E
Moriarty, C. J. }
Brabazon, W. M.
Sarell, R. G.
Smith, L. I.
Sublet, G. H.
Harvey, J. J. } E
Spencer, W. J. }

Pass Practical only—
McMullan, W. R.
Rich, H. J.
Tanner, A. C.

Pass Theory only—
Green, J. W.

ANALYTICAL CHEMISTRY II.

Credit—
Walker, H. R. C.
McGlashan, G.

Pass—
Webb, H. J.
Spencer, W. J.
Quadrio, J. S.

ASSAYING.

Pass—
Weedon, R. P. J.
Kingsbury, C. J.
Manners, J. E. L.
McRae, R. K.
Sublet, G. H.
Basden, L. R. } E
Tanner, A. C. }
Smith, C. T.

Perth Technical College Students.

Pass—
Laird, A.
Williams, G.
Taylor, R.
Patterson, R.

Pass Practical only—
Stack, R.

MINERAL DRESSING.

Credit—
Weedon, R. P. J.
Crawford, J. H.

Pass—
Manners, J. E.
Baster, L. R.
Abotomey, J.
Tanner, A. C.
Quan, L. E.
Smith, C. T.
Smith, L. I.
Flanagan, J. C.
Rich, H. J.
Cranston, A. G.
Sublet, G. H.
McMullan, W. R.

METALLURGY I.

Pass—
Miles, A. T.
Rich, H. J.
Walker, H. R.
Hickey, L. G.
Smith, L. I.
Sublet, G. H.
Moriarty, C. J.
Smith, C. T.
Flanagan, J. C.
McMullan, W. R.

METALLURGY IA.

Pass—
Dodd, K. C.
Hicks, E. J.

METALLURGY II.

Credit—
Quadrio, J. S.
Gittos, A. J.
Casserly, F. A. } E
Green, E. J. }

Pass—
McGlashan, G.
Brabazon, W. M.

PREPARATORY MATHEMATICS.

Credit—
Steer, D. W.

Pass—
Bennett, J. M.
D'Alton, A. J.
Beveridge, A. W. } E
Phillips, J. A. }
Scott, S. J.

MATHEMATICS IA.

Credit—
Shanahan, J. P.

Pass—
Billing, F. L.
McLeod, J. K. A.
Ritchie, H. G.
Ion, C. E.
Poole, R. H. } E
Field, D. V. }
Cedro, J. A. } E
Toms, H. E. }
Taylor, R. J. }
Timoney, E. G. } E
Nelli, W. M. }
Smailes, J. P.

MATHEMATICS IIA.

Credit—
Flottman, R. A.

Pass—
Watson, R. J.
Holtzman, V. R. } E
Steel, W. D. }
Abotomey, J.
Boylen, R. S.
Quadrio, J. S. } E
Saunders, N. L. }
Metcher, I. S. } E
Colgan, J. G. }
Smith, L. I. } E
Walker, H. R. C. }
Harvey, J. J. } E
Quan, L. E. }

MATHEMATICS IIB.

Credit—
Dodd, K. C.

Pass—
Flottman, R. A.
Doran, R. R. H.
Saunders, N. L. } E
Colgan, J. G. }
Edgar, K. R.

APPLIED MATHEMATICS.

Credit—
Webb, H. J.
Farriss, T. W. L.
McLeod, J. K. A.
McGlashan, G.

Pass—
Antulov, V.
Rasmussen, G. P.
Manners, M. D. L.
McRae, R. K.
McLellan, G. K.
Flanagan, J. C.
Nelli, W. M.
Yurisich, T.
Harlond, B. C.
Beer, J. } E
Shaw, S. C. }

TRADE MATHEMATICS I.

Credit—
Beckett, R. H. } E
Miller, J. B. }

Pass—
Halse, E. J.
Scales, J. N.
McKain, D.
Jones, A. D.
Moore, R. R.
Taylor, E.
Annear, R. J.
Miller, E. J.
Reibel, K.

TRADE MATHEMATICS II.

Credit—
Sullivan, A. D.
Byrne, P. J.

Pass—
MacGregor, C. C.
Read, R. A.

PREPARATORY PHYSICS.

Credit—
Steer, D. W.
D'Alton, A. J.

Pass—
Rasmussen, R.
Frank, B.
Scott, S. J.
Weir, D. J.
Bartlett, M. S.
Chamberlain, H.
Jones, A. D.
Dickinson, E.

Pass Practical only—
Beckett, R. H.
Ardagh, J.

PHYSICS IA.

Credit—
McLeod, J. K. A.

Pass—
Tennant, E. M.
Shanahan, J. P.
Finucane, P. J.
Harper, D. G.
Jacobs, N. A. } E
Slade, L. K. }
Glenister, C. J.
Harlond, B. C.

Pass Practical only—
Bower, J. K.
Cook, V.
Hosie, A.
Ion, C. E.
Lewis, P. G.
Madin, R.
Ritchie, S. J. L.
Warburton, J. C.
Green, E. D.

PHYSICS IB.

Credit—
Flottman, R. A.
Watson, R. J.

Pass—
Metcher, I. S.
Moriarty, C. J.
Colgan, J. G.
Kingsbury, C. J.
Sublet, G. H. } E
Tanner, A. C. }
Tennant, E. M. }
McGlashan, G. } E
Fariss, T. W. L. }
Harris, J. W. } E
MacGregor, D. D. }
Smith, L. I.
Toms, H. E.
Flanagan, J. C.
Harper, D. G.
Smith, C. T.
Antulov, V. } E
McMullan, W. R. }
Walker, H. R.
Cant, R. G.
Miles, A. T.

PREPARATORY ENGINEERING DRAWING.

Credit—
Shanahan, J. P.
Gamble, V. R.
Compton, G. S.
McLeod, J. K.
Steer, D. W.
Bennett, J. M.

Pass—
Leyland, E. C.
Moore, R. R. } E
Zuvich, J. }
Scott, S. J.
Scales, J. N.
Rasmussen, R. F.
Cameron, D. C.
Hug, R. L.
Taylor, E.
Jenkins, G. J.

ENGINEERING DRAWING I.

Credit—
Cliff, I. F.
Smailes, J. P.
Eddy, J. G.
Gard, R. C.
Cedro, J.
Basden, L. R.

Pass—
Edgar, G. S.
Poole, R. H.
Kingsbury, C. J.
Shenton, E. F.
Isle, R. F. } E
Taylor, R. J. }
Zuvich, J. J.
McRae, R. K.
Reibel, K.
Timoney, E. G.
Bailey, W. J.
Chamberlain, H. I.
Lewis, P. G.
Selkirk, L. A.
Steel, W. D.
Finucane, P. J.
Boylen, R. S.
Simmons, M. R.
Frank, B. W.
Brennan, T. H.
Casserly, F. A.

ENGINEERING DRAWING II.

Credit—
Siggins, A. M.
Flottman, R. A.
Skerry, T. F.
Kanther, H. I.
Thomas, A. V.
Stronach, B. J.
Cant, R. G.

Pass—
Slade, L. K.
Baster, L. R.
Field, D. V.
Verran, R.
Glenister, C. J.
Gillson, R. S.

MECHANICAL ENGINEERING I.

Credit—
Royle, P. G.
Verran, R. J.
Manners, J. E. L.
Casserly, F. A.
Colgan, J.

Pass—
Zehnder, J. W.
Eddy, J. G.
McMullan, W. R.
Manners, M. D. L.
Antulov, V.

MECHANICAL ENGINEERING II.

Credit—
Skerry, T. F.
Kanther, H. I.
Thomas, A. V.
Saunders, N. L.
Metcher, I. S. } E
Flottman, R. A. }
Newton, R. J.

Pass—
Fariss, T. W. L.
Moir, G. A.
Doran, R. R. H.
Clark, A. M.
Edgar, K. R.
Thompson, A. F.
Toms, H. E.
Holland, A. J.

ELECTRICAL ENGINEERING I.

Credit—
Flottman, R. A.
Verran, R. J.
Manners, J. E. L.
Hogg, J. M. } E
Lloyd, K. }
Royle, P. G.

Pass—
Boylen, R. S.
Haddow, J.
Long, B. W.
Colgan, J. G.
Crawford, J. H.
Hille, W. C.
Moir, G. A.
Huxtable, D. A.
Fariss, T. W. L.
Harvey, J. J.
Spencer, W. J.
Harper, D. G.
Thompson, A. F.
Cranston, A. G.

ELECTRICAL ENGINEERING II.

Credit—
Dodd, K. C.
Skerry, T. F.
Darroch, I. N. D.
Thomas, A. V.

Pass—
Kanther, H. I.
Newton, R. J.
Cant, R. G.
Metcher, I. S.
Braithwaite, A.
Toms, H. E.
Holland, A. J.
Clark, A. M.

MACHINE DESIGN.

Credit—
Dodd, K. C.
Metcher, I. S.
Kanther, H. I.
Skerry, T. F.
Flottman, R. A.
Newton, R. J.

Pass—
Holland, A. J.
Thomas, A. V.
Verran, R. J.
Ritchie, H. G. } E
Taylor, S. R. }
Cant, R. G.
Toms, H. E.
Edgar, K. R.
MacGregor, D. D.

STRUCTURAL ENGINEERING I.

Credit—
Royle, P. G.

Pass—
Verran, R. J. } E
Ritchie, H. G. }
Colgan, J. G.
Kingsbury, C. J.
Yurisich, T.
Nelli, W. M. } E
Faichney, J. M. }
Manners, M. D. L.
Morris, L. W.

STRUCTURAL ENGINEERING II.

Credit—
Morgan, D. C.
Dodd, K. C.
Flottman, R. A.
Skerry, T. F. } E
Kanther, H. I. }
Metcher, I. S.
Darroch, I. N. D.

Pass—
Holland, A. J.
Saunders, N. L. } E
Thomas, A. V. }
Clark, A. M. } E
Doran, R. R. }
Oakley, D. J.
Edgar, K. R.
Moir, G. A.
Newton, R. J. } E
Toms, H. E. }
Fariss, T. W. L.

MATERIALS OF CONSTRUCTION.

Pass—
Franklyn, R. P.
Royle, P. G.
Morgan, D. C.
Ritchie, H. G.
Rasmussen, G. P.
Gardner, J. A.
Colgan, J. G.

HYDRAULICS.

Credit—
Spencer, W. J.
Skerry, T. F.
Webb, H. J.
Doran, R. R. H.

Pass—
Casserly, F. A.
Gittos, A. J.
McGlashan, G.
Toms, H. E.
Harvey, J. J.
Thomas, A. V.
Franklyn, R. P.
Cant, R. G.
Yurisich, T.
Long, B. W.

PRACTICAL ELECTRICITY.

Credit—
Church, E. G.

Pass—
MacGregor, C. C.
Byrne, P. J.

WORKSHOP PRACTICE I.

Credit—
Walker, H. R. C.
Goddard, R. L.
Selkirk, A. J.

Pass—
Smith, L. I.
Genge, A. B.
Moriarty, C. J.
Verran, R. J.
Casserly, F. A.
Flanagan, J. C.
Rich, H. J.
Steer, D. W.
Mason, F. E.
Marshall, R. C.
Tanner, A. C.
Smith, C. T.
Moore, R. R.
Cliff, I. F.
Shanahan, J. P.
Frank, B.
Lewis, P. G.
Miller, E. J.
Finucane, P. J.
Bingley, R.

WORKSHOP PRACTICE II.

Credit—
Darroch, I. N. D.
Newton, R. J.

Pass—
Moseley, J. H.
Hosie, A.

Pass Practical only—
Masson, J. W.

INTERNAL COMBUSTION ENGINES.

Credit—
MacGregor, D. D.
Skerry, T. F.
Verran, R. J.
Kanther, H. I.
Casserly, F. A.
Beer, J.
Cant, R. G.
Edgar, K. R. } E
Gilbert, G. E. }
Gilbert, W. B.
McGlashan, G.

Pass—
Hudson, H. R.
Jacobs, N. } E
Taylor, S. R. }
Goddard, R. L.
Bolton, F. E.
Doyle, C. E.
Boughton, E. G.
Wylie, J. T.
Frank, B.
Krige, W.
Adams, R. A.
Warburton, J. C.
Bingley, R.

ENGINE DRIVING.

Credit—
Yirrell, L. W.
Rochester, A.
Cahill, T. J.
Kiely, J. A.

Pass—
Taylor, E.
Treloar, N. R.
Masson, J. W.
Astbury, R.

WELDING.

Credit—
O'Connor, A. J.
Darroch, I. N. D.
Flottman, R. A.
MacGregor, D. D.
Kanther, H. I.
Oakley, D. J.
Fariss, T. W. L.

Pass—
Newton, R. J.
McKain, D.
Skerry, T. F.
Horn, H. L.
Thomas, A. V.
Sullivan, A. D.
Church, E. G.
Verran, R. J.
Selkirk, L. A.
Holland, A. J. } E
Hudson, H. R. }
Saunders, N. L.
Lee, A. T.
Taylor, S. R.
Bingley, R.

Pass Practical only—
Hosie, A.
Hughes, G. D.
O'Dea, P. K.
Annear, R. J.
Argus, J. T.

PREPARATORY GEOLOGY.

Pass—
Steer, D. W.
McLeod, J. K.
Basden, L. R. } E
Shenton, E. F. }
Gee, P.
Shanahan, J. P.
Rasmussen, R. F.

GEOLOGY IA.

Credit—
Watson, R. J.

Pass—
Boylen, R. S.
Eddy, J. G.
Crawford, J. H.
Ritchie, S. J.
Tennant, E. M.
Stevens, B. E.
Amm, R. A.

Pass Theory only—
Cranston, A. G.

GEOLOGY IB.

Credit—
Watson, R. J.
Quadrio, J. S.
Crawford, J. H.
Eddy, J. G.

Pass—
Flanagan, J. C.
Boylen, R. S.
McRae, R. K.
Smith, L. I.
Smith, C. T.
Slade, L. K. } E
Amm, R. A. }
Rich, H. J. } E
Stevens, B. E. }
Ritchie, S. J. L.
Cranston, A. G.

Pass Theory only—
Stronach, B. J.
McMullan, W. R.

GEOLOGY II.

Pass—
Baster, L. R.
Huxtable, D. A.
Pinnock, J. H.
Hicks, E. J.
Abotomey, J.
Morris, L. W.
Carter, K. J.

Pass Practical only—
Burrows, H. L.
Turrell, R. M.
Myers, E. O.

GEOLOGY III.

Pass—
Sarell, G. G.

PETROLOGY.

Pass—
Weedon, R. P. J.

MINING AND ECONOMIC GEOLOGY.

Pass—
Weedon, R. P. J.

MINING I.

Credit—
Smailes, J. P.

Pass—
Reid, A. J.
McLeod, J. K. A.
Zuvich, J. J.
Stevens, B. E.
Field, D. V.
Ibbotson, A. W.
Eiffler, E. A.

MINING II.

Credit—
Watson, R. J.
Eddy, J. G.
Manners, J. E. L.
Kingsbury, C. J.
Quan, L. E.

Pass—
Steel, W. D.
Boylen, R. S.
Slade, L. K.
Hicks, E. J.
Stevens, B. E.
Manners, M. D. L.
McDermott, J. C.
Pegler, A. V.

MINING IIA.

Pass—
Timoney, E. G.

MINING IIB.

Credit—
Holtzman, V. R.

Pass—
Zehnder, J. W.

MINING III.

Credit—
Compton, G. R.
Manners, M. D. L.
Manners, J. E. L.
Baster, L. R.

Pass—
Faichney, J. M.
Amm, R. A.
Huxtable, D. A.
Crawford, J. H.

SURVEYING I.

Credit—
Watson, R. J.
Darroch, I. N. D.
Oakley, D. J.

Pass—
Reid, A. J.
Toms, H. E.
Zuvich, J.
Cant, R. G.
Metcher, I. S.
Martin, D. J.
Gilbert, W. B.
Colgan, J. G.
Clark, A. M.

SURVEYING II.

Credit—
Dodd, K. C.
Manners, J. E. L.
Crawford, J. H.
Steel, W.

SURVEYING I—*continued.*

Pass—

Baster, L. R.
Boylen, R. S.
Eddy, J. G.
Quan, L. E.
Antulov, V.
McDermott, J. C.
Hicks, E. J.
Pegler, A. V.
Harper, D. G.

TECHNICAL ENGLISH.

Pass—

Flanagan, J. C.
Smith, L. I.
Quan, L. E.
Crawford, J. H. } E
Hicks, E. J. }
Huxtable, D. A. }
Darroch, I. N. D.
Holland, A. J.
Smith, C. T.
Pinnock, J. H.
Doran, R. R. H.
Oakley, D. J.

THESES ACCEPTED.

MACHINE DESIGN.

Thomson, A. W.
Hair, D. N.

ELECTRICAL ENGINEERING II.

Thomson, A. W.
Hastings, R. W.

SURVEYING II.

Hille, W. C.
Wells, T.
Gibson, A. A.
Brodie-Hall, L. C.
Hogg, J. M.
Crowley, P. J.
Considine, D. C.
Inman, R. D.
Olive, L. C.
Forster, E. T.

MINING AND ECONOMIC GEOLOGY.

Mead, G. F.
Weedon, R. P. J.
Matheson, W. R.

ASSOCIATESHIP COURSE IN MINING.

Clarke, L. D.
Olive, L. C.
Royle, P. G.
Sweet, F. B.
Collin, A.
Huxtable, D. A.

ASSOCIATESHIP COURSE IN METALLURGY.

Hillier, G.
Ewing, D. A.
Martin, J. D.
Brodie-Hall, L. C.

ASSOCIATESHIP COURSE IN ENGINEERING.

Kanther, H. I.
Metcher, I. S.
Oakley, D. J.
Skerry, T. F.

ANNUAL EXAMINATIONS, 1948.

(Deferred to February, 1949.)

The following students passed in the subjects given below:—

MECHANICAL ENGINEERING II.

Braithwaite, A.

SURVEYING I.

Cranston, A. G.

MINING I.

Watson, R. J.

SUPPLEMENTARY EXAMINATIONS, February, 1949.

The following students passed in the subjects indicated below:—

MATHEMATICS IA.

Amm, R. A.
Thomas, R. P.
Bird, C. R. *(Algebra Section)*

MATHEMATICS IIA.

Kingsbury, C. J.
Gittos, A. J.
Faichney, J. M.
Forster, E. T.
Naumoff, G. S.

APPLIED MATHEMATICS.

Colgan, J. G.
Ritchie, H. G.
Walker, H. R.

PREPARATORY CHEMISTRY.

Finucane, P. J.

CHEMISTRY IA.

Rich, H. J.

PREPARATORY GEOLOGY.

Stevens, B. E.

GEOLOGY IB.

Bell, B. W.

MECHANICAL ENGINEERING I.

Christopher, L. F.
Fariss, T. W. L.

MECHANICAL ENGINEERING II.

Harlond, B. C.

STRUCTURAL ENGINEERING I.

Myers, E. O.

STRUCTURAL ENGINEERING II.

Taylor, S. R.

ELECTRICAL ENGINEERING I.

Carew-Reid, D. M.

INTERNAL COMBUSTION ENGINES.

Cooper, S. J.

HYDRAULICS.

Clark, A. M.
Gilbert, W. B.

METALLURGY I.

McGlashan, G.

PHYSICS IA.

Milligan, R. J.

SURVEYING I.

Slade, L. K.
Callow, R. D.

SURVEYING II.

Poole, R. H.
Low, W. H.

MINING I.

Murphy, A. J.
Milligan, R. J.

TECHNICAL ENGLISH.

Carew-Reid, D. M.

YEAR'S FEE SCHOLARSHIPS.

PREPARATORY CHEMISTRY.

Steer, D. W.

APPLIED CHEMISTRY.

Tasker, E.

ANALYTICAL CHEMISTRY II.

Walker, H. R. C.

METALLOGRAPHY.

Casserly, F. A.

METALLURGY II.

Quadrio, J. S.

MINERAL DRESSING.

Weedon, R. P. J.

PREPARATORY MATHEMATICS.

Steer, D. W.

MATHEMATICS IA.

Shanahan, J. P.

MATHEMATICS IIA.

Flottman, R. A.

MATHEMATICS IIB.

Dodd, K. C.

APPLIED MATHEMATICS.

Webb, H. J.

TRADE MATHEMATICS I.

Miller, J. B.

TRADE MATHEMATICS II.

Sullivan, A. D.

PREPARATORY PHYSICS.

Steer, D. W.

PHYSICS IA.

McLeod, J. K. A.

PHYSICS IB.

Flottman, R. A.

PREPARATORY ENGINEERING DRAWING.

Shanahan, J. P.

ENGINEERING DRAWING I.

Cliff, I. F.

ENGINEERING DRAWING II.

Siggins, A. M.

MECHANICAL ENGINEERING I.

Royle, P. G.

MECHANICAL ENGINEERING II.

Skerry, T. F.

ELECTRICAL ENGINEERING I.

Flottman, R. A.

ELECTRICAL ENGINEERING II.

Dodd, K. C.

MACHINE DESIGN.

Dodd, K. C.

STRUCTURAL ENGINEERING I.

Royle, P. G.

STRUCTURAL ENGINEERING II.

Morgan, D. C.

HYDRAULICS.

Spencer, W. J.

PRACTICAL ELECTRICITY.

Church, E. G.

WORKSHOP PRACTICE I.

Walker, H. R. C.

WORKSHOP PRACTICE II.

Darroch, I. N. D.

INTERNAL COMBUSTION ENGINES.

MacGregor, D. D.

ENGINE DRIVING

Yirrell, L. W.

WELDING.

O'Connor, A. J.

GEOLOGY IA.

Watson, R. J.

GEOLOGY IB.

Watson, R. J.

MINING I.

Smailes, J. P.

MINING II.

Watson, R. J.

MINING III.

Compton, G. R.

SURVEYING I.

Watson, R. J.

SURVEYING II.

Dodd, K. C.

SUPPLEMENTARY EXAMINATIONS.

(To be held February, 1950.)

The following are eligible to sit for the Supplementary Examinations to be held from 13th to 15th February next, entries for which close on 27th January.

PREPARATORY CHEMISTRY.

Bennett, J. M.
Boughton, E.
Murphy, A. J.
Weir, D. J.

CHEMISTRY IA.

Amm, R. A.
Christopher, L. F.
Pinnock, J. H.

ANALYTICAL CHEMISTRY I.

Flanagan, J. C.

APPLIED CHEMISTRY.

Carew-Reid, D. M.
Sublet, G. H.

METALLOGRAPHY.

Carew-Reid, D. M.
Spencer, W. J.

ASSAYING.

Glasson, A. J. (P.T.C.).

MINERAL DRESSING.

Moriarty, C. J.

PREPARATORY MATHEMATICS.

Weir, D. J.
Rasmussen, R.

MATHEMATICS IA.

Hug, F.
Miles, A. T.
Shenton, E. F.
Vukobratich, S.

MATHEMATICS IIA.
Cant, R. G.
Fariss, T. W. L.
Harper, D. G.
Harris, J. W.
MacGregor, D. D.
Power, F. W.
Sublet, G. H.
Tennant, E. M.

MATHEMATICS IIB.
Fariss, T. W. L.
Tennant, E. M.
Metcher, I. S.

TRADE MATHEMATICS I.
Reeks, F. W.
Wylie, J. T.

APPLIED MATHEMATICS.
Baker, I. A.
Braithwaite, A.
Jacobs, N. M.
Amm, R. A.

PREPARATORY PHYSICS.
Ardagh, J.
Regan, V. T.

PHYSICS IA.
Bower, J. K.
Ion, C. E.
Gard, R. C.

PHYSICS IB.
Faichney, J. M.
Manners, M. D. L.
Rich, H. J.
Taylor, S. R.
Yurisich, T.

MECHANICAL ENGINEERING II.
Gilbert, W. B.

ELECTRICAL ENGINEERING I.
Faichney, J. M.
Hosie, A.
Henderson, D. C.

ELECTRICAL ENGINEERING II.
Edgar, K. R.
Taylor, S. R.

STRUCTURAL ENGINEERING I.
Amm, R. A.
Zehnder, J. W.

HYDRAULICS.
Holland, A. J.

INTERNAL COMBUSTION ENGINES.
Regan, V. T.

GEOLOGY II.
Myers, E. O.

MINING IIB.
Mathews, W. A. R.

SURVEYING I.
Gardner, J. A.
McDermott, C. J.
Taylor, S. R.

SURVEYING II.
Gillson, R. S.
Manners, M. D. L.
Vukobratich, S.

TECHNICAL ENGLISH.
Harper, D. G.
Tanner, A. C.
Thomas, A. V.
Walker, H. R. C.

NORSEMAN SCHOOL OF MINES.

LIST OF PASSES.

PREPARATORY PHYSICS.
Pass Practical Only—
Harris, R. K.

PREPARATORY MATHEMATICS.
Pass—
Cotterell, K. K.
Silvester, S. W.

TRADE MATHEMATICS I.
Credit—
Morton, N. R.

Pass—
Franklyn, D. C.
Rew, H. E.
Harris, R. K.
Swain, W. T.
Jones, R. N.

TRADE MATHEMATICS II.
Credit—
Kerr, P. H.
Pugh, D. D.
Kerr, R. N.

Pass—
Dillon, J. D.
Parker, A. W.

MATHEMATICS IA.
Pass—
Coles, E. T.

MATHEMATICS IIA.
Credit—
Creagh, N. B.

GEOLOGY IA.
Pass—
Orton, J. E. R.
Roach, B. M. (Miss).
O'Brien, T. N.
Morton, J. L.

Pass Theory Only—
Warne, R.

GEOLOGY IB.
Pass—
Orton, J. E. R.
Morton, J. L.
Warne, R.
Roach, B. M. (Miss).

MINING I.
Credit—
O'Connell, J. C.

Pass—
Turner, R. H.

SURVEYING I.
Credit—
O'Connell, J. C.

Pass—
Creagh, N. B.
Silvester, S. W.
Coles, E. T.

PREPARATORY ENGINEERING DRAWING.
Credit—
Rew, H. W.

Pass—
Harris, P. K.
Stone, L. J.
Jones, N.
Trotter, R. N.
Stubbs, J. H.

ENGINEERING DRAWING I.
Pass—
Dillon, J. D.
Silvester, S. W.

ENGINEERING DRAWING II.
Pass—
O'Connell, J.

PRACTICAL ELECTRICITY.
Pass—
Dillon, J. D.

ELECTRICAL ENGINEERING I.
Credit—
Creagh, N. B.

Pass—
Kerr, R. N.

WORKSHOP PRACTICE I.
Pass—
Mayberry, A. J.
Dillon, J. D.
Brookes, G.
Smith, D. J.
Wood, R.
Hall, J.
Jones, R. N.

Pass Practical Only—
Trotter, R. H.

WORKSHOP PPRACTICE II.
Credit—
Creagh, N. B.

Pass—
Kerr, P. H.
Swain, W. T.
Young, J. R.

INTERNAL COMBUSTION ENGINES.
Credit—
Creagh, N. B.

Pass—
Vaughan, H.
Winston, J. T.

ENGINE DRIVING.
Pass—
Knowler, B. C.
Pugh, D. D.

WELDING I.
Credit—
Mayberry, A. J.
Cottrell, K. K.
Creagh, N. B.

Pass—
Brookes, G.
Morton, N. R.
Parker, A. W.
Jones, R. N.

WELDING II.
Credit—
Wilson, S. E.

Pass—
Bullen, E. H.
Guest, A. I.

Pass Practical Only—
Bach, D. J.

YEAR'S FEE SCHOLARSHIPS.

TRADE MATHEMATICS I.
Morton, N. R.

TRADE MATHEMATICS II.
Kerr, P. H.

MATHEMATICS IIA.
Creagh, N. B.

PREPARATORY ENGINEERING DRAWING.
Rew, H. W.

ELECTRICAL ENGINEERING I.
Creagh, N. B.

WORKSHOP PRACTICE II.
Creagh, N. B.

INTERNAL COMBUSTION ENGINES.
Creagh, N. B.

WELDING I.
Mayberry, A. J.

WELDING II.
Wilson, S. E.

MINING I.
O'Connell, J. C.

SURVEYING I.
O'Connell, J. C.

SUPPLEMENTARY EXAMINATIONS.

(To be held February, 1950.)

The following are eligible to sit for the Supplementary Examinations to be held from 13th to 15th February next, entries for which close on 27th January.

TRADE MATHEMATICS I.
Newman, M. F.
Wood, R.

TRADE MATHEMATICS II.
Kerr, W. J.

PREPARATORY MATHEMATICS.
Orton, R. J.
Chegwidden, S. J.

INTERNAL COMBUSTION ENGINES.
Kerr, W. J.

Division VI.

Annual Report of the Inspection of Machinery Branch of the Mines Department for the Year 1949.

OPERATIONS UNDER THE INSPECTION OF MACHINERY ACT, 1921.

ANNUAL REPORT OF THE CHIEF INSPECTOR OF MACHINERY AND CHAIRMAN OF THE BOARD OF EXAMINERS FOR ENGINE-DRIVERS FOR THE YEAR ENDED 31st DECEMBER, 1949, WITH STATISTICS.

The Under Secretary for Mines:

For the information of the Hon. Minister for Mines, I submit the report of the Deputy Chief Inspector of Machinery on the administration of the Inspection of Machinery Act, 1921, for the year ended 31st December, 1949.

JOHN S. FOXALL,
Chief Inspector of Machinery.

Section 1.

INSPECTION OF BOILERS, MAINTENANCE, ETC.

See Returns Nos. 1, 2, and 3.

Under the Act "Boiler" means and includes—

(a) any boiler or vessel in which steam is generated above atmospheric pressure for working any kind of machinery, or for any manufacturing or other like purposes;

(b) any vessel used as a receiver for compressed air or gas, the pressure of which exceeds 30 lb. to the square inch, and having a capacity exceeding five cubic feet; but does not include containers used for transport;

(c) any vessel used under steam pressure as a digester, and

(d) any steam jacketed vessel used under steam pressure for boiling, heating, or disinfection purposes.

It also includes the setting, smoke stack, and all fittings and mountings, steam and other pipes, feed pumps and injectors, and other equipment necessary to maintain the safety of the boiler.

Return No. 1 gives the type and country of origin of the 246 boilers which were registered during the year. Most of the boilers shown in this return are of new construction and when types are considered it would appear that quite a number of fairly large boilers have been manufactured in this State. This is not so as the 4 Cornish boilers shown are 2 h.p. designed for use in dairies and the 21 water tube boilers which average 6 h.p. are also for dairying and general purposes. The 6 vertical stationary boilers shown are in 2 h.p. and 4 h.p. sizes and have the unusual feature of being fitted with a totally submerged uptake. These boilers are manufactured by a local firm and are covered by patent. They are manufactured for general purposes and are used by Butchers, Bakers, Dairymen, Dry-cleaners, Honey Extractors and Vulcanising Firms, etc. Over the past 3 years quite a number of these boilers have been made and they appear to be very satisfactory.

Return No. 2 gives the number of boilers in proclaimed districts as 6,107 as against 5,892 for 1948. The number of out of use boilers for 1949 being 3,415 as against 3,267 for 1948. Quite a number of the out of use boilers are still serviceable, but as they are scattered over the length and breadth of the State and in some instances are many miles from the railway, there is little likelihood of more than a small percentage of them being brought back into commission. Another factor militating against quite a number of these boilers being brought back into service is their age and low pressure.

Return No. 3 shows the operations concerning boilers for the year ended 31st December, 1949. Repair notices issued for 1949 were 516 as compared with 476 for 1948.

MAINTENANCE, ETC,

There is still a serious shortage of boiler quality steel plate and copper plate and tubes are in short supply also. In some instances it has been necessary to use good conditioned plate from selected parts of condemned boilers for minor repairs. Steam piping is in very short supply.

With very few exceptions boiler repairs have been well carried out and due to the very close departmental supervision the method of effecting repairs has been satisfactory.

In some instances boilers have been almost completely rebuilt. This applies more particularly to boilers used for sawmilling purposes and chaff-cutting.

Until the introduction of diesel engines into the sawmilling industry for use as prime movers on spot mills, the portable type of steam engine ranging from 10h.p. to 30h.p. was in great demand; and although the diesel engine has in many instances displaced the steam engine there are still a number of small mills powered by steam. One advantage the diesel has over the steam engine is connected with certificated control. Providing the area of the cylinder or the combined areas of the cylinders of an internal combustion engine does not exceed 200 square inches it is not compulsory under the act that the driver should hold an internal combustion engine driver's certificate, whereas a steam engine independent of its size must be under the control of a qualified driver as required by the act. An internal combustion engine has the additional advantage over the steam engine where suitable boiler feed water is not available at the mill site.

BOILER FUEL.

Throughout the year coal has been strictly rationed and is only made available to boiler owners who found it impossible to burn other types of fuel. It is becoming increasingly difficult to obtain wood fuel more particularly for the metropolitan area, and in some country districts where cheese and butter factories are located the supply of wood is a problem caused by the shortage of labour and the disinclination of cutters to operate. The difficulty in procuring coal or wood has forced quite a number of boiler owners to instal oil firing equipment which in some instances is automatically controlled. Whilst admitting that oil fuel is dearer than other types of fuel it cannot be denied that it has offsetting advantages when used in the metropolitan area. The dust nuisance is almost eliminated, there is considerably less bunker space to provide for and there are no ashes to dispose of.

Owing to the heavy demand for building materials quite a lot of timber which previously found its way into the boiler furnaces is now placed on the market and as a result, sawmill owners in a big way have in some instances fitted up their boilers with step grate furnaces to burn saw dust and others are proposing to follow suit. Where the step grates have been installed, the burning of saw dust has proved to be satisfactory. On account of the saw dust coming straight from the saws it contains a fair percentage of moisture which would appear to make it difficult to burn satisfactorily, but by the careful arrangement of the grate angle this problem disappears.

BOILER FEED WATER.

A badly scaled boiler has the effect of increasing fuel costs and owing to the shortage of fuels owners are now paying more attention to boiler cleaning and feed water treatment. Although a considerable improvement is observed in the descaling of boilers and the methods of treating the water, there is room for further improvement and this can only be accomplished by a careful analysis of the feed water by a qualified chemist and close adherence to any corrective treatment recommended.

RETURN No. 1.—SHOWING THE NUMBER OF BOILERS OF EACH TYPE, AND COUNTRY OF ORIGIN OF NEW REGISTRATION FOR THE YEAR ENDED 31ST DECEMBER, 1949.

Type.	Country of Origin.					Total.
	United Kingdom.	U.S.A.	Eastern States.	W.A.	Unknown Sources.	
Cornish	....	....	....	4	....	4
Vertical Stationary	2	....	3	6	....	11
Vertical Multi. Stat.	2	....	....	....	....	2
Locomotive	....	....	....	....	1	1
Return Multi. Stat. Underfired	....	....	2	2	1	5
Return Multi. Stat. Internally Fired	....	....	....	....	4	4
Water Tube	....	....	1	21	....	22
Saddle Back	....	....	....	6	....	6
Digester	....	....	....	12	41	53
Vulcaniser	....	....	14	1	....	15
Steam Jacketed Vessel	1	....	2	11	2	16
Steriliser	....	....	5	28	1	34
Air Receiver	12	3	11	30	9	65
Gas Receiver	4	....	....	....	....	....
	17	3	38	129	59	246

RETURN No. 2.—SHOWING CLASSIFICATION OF VARIOUS TYPES OF USEFUL BOILERS IN PROCLAIMED DISTRICTS ON 31ST DECEMBER, 1949.

Types of Boilers.	Districts Worked from PERTH.	Districts Worked from KALGOORLIE.	Totals.	
			1949.	1948.
Lancashire	44	53	97	96
Cornish	154	461	615	614
Semi-Cornish	11	37	48	48
Vert. Stationary	394	347	741	739
Vert. Portable	70	15	85	87
Vert. Multi. Stat.	48	25	73	70
Vert. Mult. Port.	18	3	21	21
Vert. Pat. Tubular	48	....	48	48
Loco. Rect. Firebox Stat.	91	62	153	156
Loco. Rect. Firebox Port.	259	64	323	320
Loco. Circ. Firebox Port.	139	8	147	147
Locomotive	82	36	118	118
Water Tube	325	116	441	424
Return Multi. Underfired Stat.	209	60	269	268
Return Multi. Underfired Port.	1	8	9	9
Return Multi. Int. Fired Stat.	50	12	62	58
Return Multi. Int. Fired Port.	2	....	2	2
Egg ended and other types not elsewhere specified	358	29	387	351
Digesters	250	9	259	209
Air Receivers	902	489	1,391	1,329
Gas Receivers	15	....	15	7
Vulcanisers	334	10	344	330
Steam Jacketed Vessels	446	13	459	441
Total Registrations Useful Boilers	4,250	1,857	6,107	5,892
Total Boilers Out of Use, 31st December, 1949	1,947	1,468	3,415	3,267

RETURN No. 3.—SHOWING OPERATIONS IN PROCLAIMED DISTRICTS DURING YEAR ENDED 31ST DECEMBER, 1949.

(*Boilers Only.*)

	Districts Worked from PERTH.	Districts Worked from KALGOORLIE.	Totals.	
			1949.	1948.
Total number of useful boilers registered	4,250	1,857	6,107	5,892
New boilers registered during year	237	9	246	222
Boilers reinstated	....	....	....	3
Boilers converted	....	....	....	....
Boilers inspected—				
Thorough	2,322	394	2,716	,651
Working	312	3	315	161
Boilers condemned during year—				
Temporarily	21	1	22	24
Permanently	19	9	28	23
Boilers sent to other States during year	1	1	2	4
Boilers sent from other States during year	....	....	....	9
Boilers sent to other Countries	1	....	1	....
Transferred to other Departments	3	....	3	....
Transferred from other Departments	2	....	 2	10
Number of Notices for Repairs issued during year	486	30	516	476
No. of Certificates issued including those issued under Section 30 during the year	2,303	389	2,692	2,625

SECTION 2.

Explosions and Interesting Defects.

I have only one complete failure of a vessel to record. This concerns a cast iron pressing head which was used in a seaport laundry. An investigation into the cause of the failure showed that this head had been in use on the day of the mishap from 8 a.m. to 11 a.m. in the normal work of pressing shirts. The laundress had just left the machine when without warning the head blew to pieces, and although quite a number of

girls were working in the vicinity at the time, no one was injured. During the course of the investigation it was learnt that the head, which is of cast iron and made in two halves held together by studs, was made from patterns supplied to a local firm during the last war by the United States Navy. It appears that a number of pressing heads were made for the United States Navy; but the only one in existence in this State is the one that failed. These pressing heads usually work at approximately 70 lb. pressure and when computed it was found that the factor of safety at 70lb. was very low. This head had been in use at the laundry for five years and previous to the day of the failure it was coupled up to a boiler carrying 80lb. pressure. The owner had just completed the installation of another boiler certified at a working pressure of 130lb. per square inch and on the day of the mishap he turned on the steam from this boiler to the pressing head. When the head burst the pressure gauge on the boiler was registering 120lb. per square inch. No reducing valve was fitted in the steam line and the boiler was coupled up to the head without the knowledge of the District Inspector. The exhaust lines were fitted with traps. It could not be determined with satisfaction whether the head burst as the result of a water hammer or fatigue set up due to weakness of construction.

Explosion No. 2 was attended with fatal results. In this instance a saw mill was built on a site where a previous mill had been burnt down and part of the equipment included two boilers and a steam engine. The installation of the boilers and steam engine had almost been completed and during a trial run the installing fitter was badly scalded when a combination starting and governor valve casting blew off the side of the cylinder block. The scalded man died three days afterwards. In this case the engine was coupled to the boilers by 50ft. of 5in. dia. steam piping. When the accident was investigated it was found that on the day of the mishap about 10 a.m., with 25lb. pressure showing on the boiler gauge, the fitter decided to give the engine a turn over and on a knock developing it was decided to wait for full boiler pressure of 100 lb. per square inch before further test. The crown valve on the boiler was left open and a further test was commenced about 2 p.m. The fitter apparently had some difficulty in opening the throttle valve and from the evidence of those who witnessed the accident, it came open very suddenly and there immediately followed a roar of escaping steam. The crown valve on the boiler was immediately shut off and the fitter was found lying on his back, well saturated, with the casting weighing about 2 cwt. beside him. When the steam pipe arrangement was checked it was found that no provision had been made for draining any condensate that might accumulate and as the crown valve on the boiler had been left open from 10 a.m. at 25lb. per square inch until 2 p.m. at 100lb. per square inch it is beyond doubt that the casting was blown off the cylinder block by the effects of water hammer. The sudden opening of the throttle valve would cause the water hammer to act with terrific force. This installation had not been examined and passed by an Inspector prior to the mishap. It is to be regretted that the fitter lost his life through not making the necessary provision for drainage during the installation. The steam pipe arrangement has now been altered to the satisfaction of this Department.

Explosion No. 3 concerns the failure of a nipple connection between a stop cock and a screw down valve fitted to the blow off pipe of a Lancashire boiler. In this instance it appears that the blow off cock had become defective and a screw down type of valve was added to keep the boiler from losing its water. When attempting to blow the boiler down, the engine driver had just eased the screw down valve off its seat and then opened the stop cock, when without warning the nipple carried away and he was badly scalded about the legs and arms. An examination of the nipple showed it to be badly corroded and totally unfit for holding steam pressure. The fitting of the second valve to the blow down line was done as a temporary measure to keep the boiler in commission until it could be conveniently shut down for repairs, but this Department was not informed of the fact. The engine driver ultimately recovered.

Included with the boiler equipment of the East Perth Power House are three tri drum water tube boilers made by the International Combustion Co. of England in 1938 for a maximum working pressure of 665 lb. per square inch. All three boilers developed a number of radial cracks at the feed water inlets. The drums are solid drawn of 3⅜in. thickness reduced by recessing to 2 5/16in. at the feed inlet which is 4in. diameter. The drum has two feed inlets and the metal at all inlets is affected in a similar manner. As the boiler temperature is from 650F to 700F and the feed water temperature is from 300F to 380F, it would appear that the defect has been caused by temperature difference localised at the feed inlet opening. When these boilers are shut down they are often fed with cold water and in all probability this is the time when most of the damage would be done. As opportunity offers the feed inlets will be bored out beyond the cracks and special stand pipes which are being supplied by the makers will be fitted. This defect must be known to the makers as it is noticed on the later boilers of the same design manufactured by them, the feed inlet arrangement has been designed to eliminate this fault.

SECTION 3.

INSPECTION OF MACHINERY.

See Returns Nos. 4, 5 and 6.

The machinery groups on the register for 1949 are 24,041 compared with 22,537 for 1948 showing an increase of 1.504 groups.

RETURN No. 4.—SHOWING CLASSIFICATION ACCORDING TO MOTIVE POWER OF GROUPS OF MACHINERY IN USE OR LIKELY TO BE USED IN PROCLAIMED DISTRICTS AND WHICH WERE ON THE REGISTER DURING THE YEAR ENDED 31ST DECEMBER, 1949.

Classification.	Districts Worked from PERTH.	Districts Worked from KALGOORLIE.	Totals.	
			1949.	1948.
No. of Groups driven by steam engines	443	525	968	970
No. of Groups driven by oil engines	1,387	965	2,352	2,311
No. of Groups driven by gas engines	64	192	256	251
No. of Groups driven by compressed air	....	62	62	62
No. of Groups driven by electric motors	16,485	3,914	20,399	18,938
No. of Groups driven by hydraulic pressure	4	....	4	5
	18,383	5,658	24,041	22,537

RETURN No. 5.—SHOWING OPERATIONS IN PROCLAIMED DISTRICTS DURING YEAR ENDED 31ST DECEMBER, 1949.

(*Machinery Only.*)

Classification.	Districts Worked from PERTH.	Districts Worked from KALGOORLIE.	Totals.	
			1949.	1948.
Total registrations useful machinery	18,383	5,658	24,042	22,537
Total inspections made	11,427	2,858	14,285	13,818
Certificates (bearing fees)	2,919	460	3,379	3,835
Certificates (steam without fees)	38	....	38	31
No. of extension certificates issued under Section 42 of the Act	....	....	....	....
Notices issued (Machinery dangerous)	325	7	332	302

RETURN No. 6.—SHOWING CLASSIFICATION OF LIFTS ON 31ST DECEMBER, 1949.

Types.	How Driven.	Totals.	
		1949.	1948.
Passenger	Electrically driven	196	196
	Hydraulically driven	1	1
Goods	Electrically driven	99	99
	Hydraulically driven	3	3
	Belt driven	4	4
Service	Electrically driven	43	42
		346	345

ACCIDENTS TO MACHINERY.

A spectacular and expensive accident occurred at the Edwards Shaft of the Great Boulder Mine, Kalgoorlie. The south skip on the shaft ran away from the surface to the bottom a distance of approximately 2,800 feet. The drum burst and flew in pieces for a distance of 200 yards, some pieces passed through the ore bin and continued on for a distance of 50 yards. The brake donkey was smashed and the driver's platform was demolished, two air receivers in the vicinity were severely damaged and one slightly damaged and the winding engine room was almost wrecked. The circumstances leading up to the accident are as follows. The rope at the drum had been cut and it was decided to get the fitter to adjust the brakes and during the adjustment a broken pin was discovered. To enable the winder to finish the work engaged on, a temporary pin was fitted. The fitter instructed the driver to jack off the brakes when winding operations were finished, so that a new pin could be fitted. Before leaving for the change house the driver engaged the clutch and told the foreman to shut off the steam. When in the change room the driver heard the skip running away and there was nothing he could do to stop it. In this instance no attempt was made to chair the skip. An investigation into this accident showed that the clutch had become disengaged and with the brakes jacked off, the skip went to the bottom at a terrific speed. It is assumed that the clutch was not forced hard home by the driver and it worked out after the steam had been shut off from the donkey. The particulars of the winding engine are as follows. Twin vertical tandem compound condensing first motion engine 16in. diameter and 28in. diameter x 42in. stroke with drums 10ft. diameter x 3ft. wide. Brake path 11ft. diameter x 9in. wide. Steam clutch and reversing engines. Weight of empty cage about 37 cwt. Rope 1⅛in. diameter. Fortunately no-one was injured as the result of the accident.

As the result of the finding of a special Board of Inquiry appointed to determine the cause of the mishap the driver of the winding engine was severely censured for leaving his engine in an unsafe condition when ceasing duty and a recommendation was made to the Mines Department and also owners that at all times when repairs are being effected to any winding engine the skip or cage should be resting on chairs.

SECTION 4.

Prosecutions for Breaches of the Act.

During the year there were no prosecutions for breaches of the Act to record.

SECTION 5.

Accidents to Persons.

Return No. 7 includes only those accidents caused by working machinery subject to the provisions of the Act, which are classed as serious, that is those which prevented the injured person from following his or her usual occupation for a period of two weeks or more. Accidents which occurred on timber mills which are subject to the provisions of the Timber Industry Regulation Act, 1926, are not included.

It will be noticed that three fatal accidents are recorded in a total of 55 listed.

Fatal Accident No. 1.—In this accident a girl aged six years was drawn by the belt of a diesel engine driving a generator into the flywheel pit and fatally injured. According to the evidence of the driver in charge of the engines at the power station, a number of young children had become a nuisance by playing round the power house and sometimes invading it. On the night of the accident about 8 o'clock the children were particularly troublesome and were chased away several times. On the last occasion the little girl ran into the engine room and attempted to crawl between the floor and the moving belt which was guarded in a satisfactory manner.

Fatal Accident No. 2.—In this accident a man of 59 years of age was fatally injured through being crushed between a retaining wall and a transporter at a charcoal iron plant. This transporter runs in a trench approximately 3ft 6in. deep x 200ft. long x 53ft. wide and travels at a speed of 2½ miles per hour. It is operated by two electric motors, one for longitudinal travelling and one for traversing and its functions being to transport the buggies of wood from the wood line to the preheaters and the retorts and then on to the pits. The deceased person taking advantage of the transporter being stationary was taking a short cut across the trench to a flight of steps leading out of it, when the transporter was set in motion and trapped him. On account of the construction of the transporter and the function it performs it is impossible for the driver to get a clear vision of the track and therefore he works to a code of signals. The vision of the driver is also obscured by a metal hood provided to protect him against the heat of the retorts. As a result of this accident warning bells have been installed on the transporter and are sounded at all times before moving. Warning notices have been placed in prominent positions at each end of the transporter pit and a warning notice has been painted on the transporter itself. It has been found impossible to reconstruct the driver's cabin to give him a full view of the track.

Fatal Accident No. 3.—This accident has already been dealt with under section 2 covering explosion No. 2. The deceased person although a fitter of very wide and long experience lost his life through not taking the usual precaution of draining the condensate out of the steam line before starting up the engine. This fatal accident very clearly demonstrated the terrific power of a water hammer and also the need for provision to prevent it happening.

Reference to return No. 7 will show that the greatest number of accidents has been caused by belts and shafting followed by circular saws and metal pressing machines.

Considering there were 24,041 groups of machinery and 6,107 boilers on the registers for the year ended 31/12/49 the number of accidents recorded is very few.

Although a certain amount of credit must be given to the officers of this Branch for their very close attention to the matter of guarding and accident prevention, it must be admitted that the growing tendency to instal individually driven machines and do away with line shaft drives has been a big factor in the limiting of accidents.

It must also be recognised that in the design of individually driven units, manufacturers have incorporated what they consider to be all essential guards.

The experience of this Branch is that it is impossible to guard against the human element and therefore a number of accidents due to boilers and machinery must occur.

During the year only one serious accident was caused during the winding operations of a winding engine. In this instance a platman employed on one of the gold mines at Kalgoorlie sustained the following injuries:—

(1) Divarication of pubic symphysis, dislocation of left sacro-iliac joint, and fracture of the left ilio-pubic ramus.

(2) Injury to nerves, presumably of left lumba-sacral plexus lying on the sacro-iliac joint, resulting in.

(3) Loss of ability to empty bladder and partial loss of sensation in left lower extremity.

(4) Dislocation of left shoulder.

(5) Crushing and abrasions of the face.

This man was very badly injured and the accident is a most regrettable one. From enquiries made it appears that ore was being pulled from an underground bin and as the ore in the bin was hanging badly the injured person decided to go up to another level to procure rods and fracteur and on returning to the bin loading station the winding driver slightly overshot the mark indicated on his winding drum and as the injured person was getting out of the skip the driver attempted to correct the skip position with the result that the platman was badly crushed. At a Board of Enquiry it was found that the engine driver did not take sufficient care in reading the indicator marks on his drum and there was also some doubt that he gave the necessary signal when he decided to correct the level of the skip. Neither the injured person nor the man assisting him at the bin loading station heard any signal given. The driver had his certificate suspended for three months.

During the year only one accident was recorded as having been caused by a lift. In this instance a lad of 14 years of age had a toe crushed when using an automatic lift. The well of this lift is fairly well flushed with a clearance of 1¼in. to 1½in. This accident proves the necessity of fitting all automatic lifts with electrically contacted car gates preferably power operated.

RETURN No. 7.—SHOWING NUMBER OF SERIOUS ACCIDENTS BOTH FATAL AND NON-FATAL WHICH OCCURRED IN PROCLAIMED DISTRICTS DURING THE YEAR ENDED 31ST DECEMBER, 1949.

(F) denotes FATAL.

	Woodworking and Furniture.	Leather Goods.	Metal Working and Engineering.	Printing and Allied Industries.	Flour Milling.	Laundry.	Fertiliser Manufacturing.	Architectural Modelling.	Butchering.	Food Processing.	Crown Seal Manufacturing.	Refrigeration.	Chemical Industry.	Mining.	Power House.	Other.	Totals per Type of Machine.
Circular saw	4	1	....	....	....	....	....	....	....	....	....	1	....	....	....	....	6
Leather cutting press	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Printing Machine	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	1
Press (Metal)	....	....	4	....	....	....	....	....	....	....	....	....	....	....	....	....	4
Docking saw	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Crown seal assembler	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	1
Mincer	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	1
Spindle moulder (shaper)	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Steam piping	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1 (F)	1 (F)
Band saw	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Boiler	1	....	....	....	....	....	....	....	....	....	....	....	2	....	....	....	3
Belts and shafting, etc.	1	....	1	....	2	....	1	1	....	....	....	....	1	....	1 (F)	3	11 1 (F)
Lift	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1
Cork rod machine	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	1
Rolls	....	....	....	....	....	....	....	....	....	2	....	....	....	....	....	....	2
Stapler	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	2
Ironing machine	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	1
Envelope machine	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	1
Buzzer	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3
Elevator	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	1
Hogger	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	1
Leather hammering machine	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Wiredrawing machine	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Nailing machine	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	1
Emery wheel	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Transporter	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1 (F)	1 (F)
Winding engine	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	1
Radial drill	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	1
Totals per Industry	13	4	8	4	2	1	1	1	1	2	3	1	5	2	1 (F)	6 2(F)	55 (3F)

SECTION 6.

Examination of Engine Drivers.

In this Return it will be noticed that certificates granted to Internal Combustion Engine Drivers for the year 1949 was 79 as against 57 for the previous year. This rise in the number of certificates granted can be attributed to the gradual displacement of the steam engine as a prime mover by the Diesel engine.

There is also a considerable rise in the number of crane and hoist drivers' certificates granted in 1949 as compared with 1948 and this can be accounted for by the number of power driven excavators now in use in open cut coal mining and their general use in quarries and brick yards.

Owing to the limited application of regulations 17 and 18 governing winding engine drivers under the Act and the increasing use of the electrically driven winding engines throughout the mining industry it was found necessary during the year to amend these regulations to give them a broader scope and make provision for the training of men as electric winding engine drivers who are not in possession of any steam experience, but who are the holders an an internal combustion engine drivers certificate with a certain amount of elementary electrical experience.

RETURN No. 8.—SHOWING TOTAL OF ENGINE DRIVERS' AND BOILER ATTENDANTS' CERTIFICATES (ALL CLASSES) GRANTED IN 1949 COMPARED WITH 1948.

	No. Granted.	
	1949.	1948.
Winding Competency, including certificates issued under Regulation 40 and Section 60 of the Act	11	13
First Class Competency, including certificates issued under Regulations 40 and 45 and Sections 60 and 63 of the Act	14	39
Second Class Competency, including certificates issued under Regulation 40 and Section 60 of the Act	22	21
Third Class Competency, including certificates issued under Regulations 40 and 45 and Sections 60 and 63 of the Act	38	26
Locomotive Competency, including certificates issued under Regulation 40 and Section 60 of the Act	18	5
Traction Competency, including certificates issued under Regulation 40 and Section 60 of the Act	3	....
Internal Combustion Competency, including certificates issued under Regulation 40 and Section 60 of the Act	79	57
Crane and Hoist Competency, including certificates issued under Regulation 40 and Section 60 of the Act	39	18
Boiler Attendant Competency, including certificates issued under Regulation 40 and Section 60 of the Act	101	109
Interim	1	....
Copies	6	5
Transfer	....	....
	332	293

SECTION 5.

Staff.

During the year Mr. G. Moore who joined the service in 1921 and for a number of years held the position of Deputy Chief Inspector of Machinery was retired.

Two Inspectors of Machinery of the permanent staff have resigned and gone back to the sea. Both these men are Marine Engineers. These men were replaced with two others, but the services of one of them was dispensed with as he was found to be unsuitable for the position.

Mr. H. W. Gibson, the Senior Officer on the clerical staff was retired during the year.

RETURN No. 11.

Engine Drivers' and Boiler Attendants' Board Matters, 1949.

Examinations in Perth 4, Kalgoorlie 4, Bunbury 2, Mount Magnet 2, Collie 2, Geraldton 1, Leonora 1, Special Examinations 4.

Examinations were held at all advertised centres.

Twenty-one days spent on actual examination by Travelling Board.

Thirty-nine days spent in Perth dealing with applications for Competency Certificates, examination papers and enquiries, etc.

Twenty-six days spent in travelling and looking into matters connected with engine drivers and boiler attendants.

*Three hundred and twenty-five applications received, 332 certificates granted.

Revenue—£583 17s. 6d.

*Apparent discrepancy due to carry over from late applications in 1948 and late examination in 1949.

I wish to thank all members of this Branch for the loyal support and assistance given to me during the time I have been occupying the position of D.C.I.M. and also wish to record my appreciation of the co-operation and courtesy of all other branches of the W.A. Government with whom I have had occasion to work in association. My association with Commonwealth officers leaves nothing to be desired and I wish to record that it has been a pleasure to co-operate with them.

ROBERT J. ROSS,
Deputy Chief Inspector of Machinery.

RETURN No. 9 SHOWING REVENUE AND EXPENDITURE FOR YEAR ENDED 31ST DECEMBER, 1949.

Revenue.			Expenditure.		
	1949.	1948.		1949.	1948.
	£ s. d.	£ s. d.		£ s. d.	£ s. d.
Fees for Boiler Inspections	4,093 9 3	3,240 18 6	Salaries	12,026 0 5	10,720 8 1
Fees for Machinery Inspections	7,223 1 3	6,048 12 11	Incidentals	3,799 18 1	2,465 13 0
Engine Drivers' Fees	583 17 6	427 4 0	Engine Drivers	190 10 5	90 5 6
Incidentals	53 19 3	58 1 10			
Increase, £2,179 10s.	11,954 7 3	9,774 17 3	Increase, £2,740 2s. 4d.	16,016 8 11	13,276 6 7

RETURN No. 10.—SHOWING DISTANCES TRAVELLED, NUMBER OF INSPECTIONS MADE AND AVERAGE MILES TRAVELLED PER INSPECTION FOR THE YEAR ENDED 31ST DECEMBER, 1949.

Areas Traversed.	Rail Miles.			Road Miles.			Water Miles.			Air Miles.			Total Miles.			Total number of Inspections.			Average miles per Inspection.		
	1949.	As compared with 1948.		1949.	As compared with 1948.		1949.	As compared with 1948.		1949.	As compared with 1948.		1949.	As compared with 1948.		1949.	As compared with 1948.		1949.	As compared with 1948.	
		Increase.	Decrease.		Increase.	Decrease.		Increase.	Decrease.		Increase.	Decrease.		Increase.	Decrease.		Increase.	Decrease.		Increase.	Decrease.
Districts worked from Perth	52	....	1,490	49,609	5,503	....	190	4	....	5,229	....	947	54,480	3,070	....	14,086	419	....	3·87	·11	....
Districts worked from Kalgoorlie	....	....	....	16,280	1,776	....	....	....	....	....	....	....	16,280	1,776	....	3,255	292	....	5·00	·11	....
Totals	52	....	1,490	65,289	7,279	....	190	4	....	5,229	....	947	70,760	4,846	....	17,341	711	....	4·07 = Average all Districts, 1949.		
																			3·96 = Average all Districts, 1948.		
Increases or Decreases	Decrease 1,490			Increase 7,279			Increase 4			Decrease 947			Increase 4,846			Increase 711			Average ·11 = increase mile per inspection.		

Annual Report of the Government Chemical Laboratories for 1949.

Contents.

Division VII.

Annual Report of the Government Chemical Laboratories.

The Under Secretary for Mines:

I have the honour to present for the Hon. the Minister for Mines, my report on the operations of the Government Chemical Laboratories for the year ending 31st December, 1949.

STAFF.

The staff as at 31st December, 1949, numbered 49 and consisted of 38 professional, 5 clerical and 6 general officers.

There were a number of staff changes during the year due to resignations, retirements, promotions, etc. The following resignations were received:—Misses M. Anderson, W. A. Hales and E. G. Kirk from the office staff and Mr. A. G. Turton and Mr. H. J. Manns, Chemists and Research Officers of the Agricultural and Mineral Divisions respectively.

I have to record with regret the death of Mr. F. E. Chapman, librarian of these laboratories. Mr. Chapman was an efficient chemist for many years in the Food and Drug Division during which period he made many useful contributions to Chemistry and Spectroscopy. During the latter period of his service for health reasons he acted as Librarian.

The following officers commenced duty during the year:—Chemists—Messrs. M. B. Costello, G. H. Grahame, F. R. W. Lindsey, B. G. Pearce, M. T. Sloss, S. Woodman, J. C. Weir. Promotions during the year were as follows:—R. A. Broadbent to Fuel Chemist and Research Officer and R. C. Gorman to Chemist and Research Officer.

ACCOMMODATION.

The volume of work now undertaken and the increase in the activities of the laboratories necessitates increased accommodation in the near future. These include increased accommodation for the three older Divisions, Mineral, Food and Drugs, Agriculture, as well as an increase for Refectory, Administration, Stores, etc.

It is hoped that the first part of the accommodation for the Industrial Chemistry Division, namely the Unit Process plant and attendant laboratory testing laboratories will be commenced next year. When this is completed the Division should be able to undertake investigations of projects for the development of secondary industry in this State. Our natural resources can be examined critically both by chemical assessment and market research. If warranted laboratory work can be carried out, the result of which will determine whether to carry out further investigation to Unit Process and Pilot Plant scale.

This is a logical approach to the subject and will give some means of protection against failure of any full scale project.

The problem of housing the staff is becoming acute. The three older divisions are already overcrowded and increased working space should be seriously considered immediately the Industrial Chemistry laboratory is commenced.

ADMINISTRATION.

The volume of work undertaken continues to expand and the numerical strength of the staff during the year has increased by 7 professional officers and 1 general.

The number of samples received was slightly less than the previous year due to the reduction in the number of samples received from the Government Geologist's beach and river sand survey. The work of advisory nature for Government Departments and the General Public has, however, increased, consequently administrative duties are heavy.

The chief activities of the 5 divisions comprising these laboratories are as follows:—

Food and Drug Division.

More use is being made of the facilities provided by this division in the examination of food samples for the Public Health Department and the Government Tender Board. There is, therefore, a measure of protection given to the general public and Government Institutions, ensuring that samples are up to standard and comply with the Food and Drug Regulations.

The chief expansion in the work of this division was in connection with the Swan River Pollution Survey. The usual work was undertaken as in past years in connection with chemical sewage control for the Metropolitan Water Supply, Sewerage and Drainage Department and examination of specimens and exhibits for the Police Department.

Agriculture Division.

The chief function of this division is to undertake all chemical work for the Department of Agriculture and primary producers in connection with agricultural problems and research. There has been an increase in the number of water samples received from farmers, graziers, market gardeners, etc., and advice has been given as to their suitability for stock, irrigation and domestic purposes.

Mineral Division.

The development of the mineral industry in this State is an important function of this division. In this respect a large number of minerals were examined for their identification and economic value. A number of samples of metals and alloys were received from other Government Departments and Institutions in connection with the study of corrosion problems. Advice has been given on the methods of prevention or the use of substitute materials. This important aspect of the work of this division has led to the formation of a corrosion committee consisting of two representatives of these laboratories and representatives of Engineers of the Public Works Department.

Fuel Technology Division.

This division still continues to do valuable work in connection with the study of the fundamental properties of Collie coal and problems associated with its utilisation. It has been found that certain of these coals can be successfully used in a carburetted water gas plant for the manufacture of town gas.

A comprehensive survey of the Collie Field was commenced towards the end of the year. The analysis of these samples, when collection is complete, will give a reasonable picture of the properties of the coal resources of the Collie Field.

Industrial Chemistry Division.

The activities of this division have been seriously curtailed owing to the lack of proper accommodation. A good deal of consultative work however, has been done for State Industries and private industry. The division has been able to establish a good index and reference system in regard to industry in general and industrial products. The chief investigations undertaken were—preparation of marketable salt from natural salt lake deposits, possibility of blackboy gum production, building boards, plaster of Paris, insecticides and polishes.

EQUIPMENT.

Equipment ordered is now coming to hand more freely and there are very few items outstanding from past years.

Amongst the new apparatus received during the year were: Bone and Wheeler gas analysis apparatus, Boy's Calorimeter, two Balances, Lovibond Comparator, Cambridge pH meter, Raymond Laboratory Mill, Abbe Refractometer, K_2 Fusion Testing Furnace and a Major Oil Fired High Temperature Furnace. The two latter items are valuable acquisitions as they enable tests on refractory materials such as under load tests to be carried out.

GENERAL.

As in previous years, a considerable amount of chemical information and advice has been given to Government Departments and the general public. Close co-operation is being maintained with other departments and much consultative and specialised work has been done by the Divisional Heads.

Officers continue to act on the various departmental committees already established in co-operation with other departments.

During the year several new committees were formed, namely Metal Corrosion Committee, Pyrite Committee, Alunite-Lime Sinter Process and Lurgi Gas Special Committee. The work of these new committees, with the exception of the Metal Corrosion Committee, was concluded during the year and reports issued. The latter committee will continue to function as the necessity arises.

A number of visits and inspections were carried out during the year. Mr. J. C. Hood attended a meeting of the sectional committee of the Standards Association of Australia on Edible Gelatine. Dr. L. W. Samuel attended a number of field days with officers of the Department of Agriculture. Mr. Donnelly visited Collie on a number of occasions in connection with his work and Mr. Reid visited Norseman with the Pyrite Committee and The Charcoal Iron and Steel Industry at Wundowie.

TABLE SHOWING SOURCE OF SAMPLES FOR 1949.

Source of Samples.	No.
Chemical Laboratories	39
State Mining Engineer	75
State Batteries	200
Government Geologist	177
Explosives Branch	16
Interdepartmental Irrigation Committee	8
Interdepartmental Tobacco Investigation	126
Wood Distillation, Charcoal Iron and Steel Industry	20
Bureau of Mineral Resources, Atomic Mineral Survey	63
Public Health Department	124
Hospitals	24
Agriculture Department	1474
War Service, Land Settlement Scheme	83
Police—	
Coroners	175
Criminal Investigation Branch	24
Liquor Inspection Branch	5
Government Stores and Tender Board	66
Metropolitan Water Supply, Sewerage and Drainage Department	3146
Department of Works and Labour	387
Industrial Development Department	40
Chief Inspector of Factories	10
Fisheries Department	1
Prisons Department	2
Education Department	1
Department of Supply and Development, Mineral Resources Bureau	20
Council for Scientific and Industrial Research Organisation Division of Plant Industry	2
Free	553
Pay Public	1110
„ State Sawmills	8
„ State Housing Commission	5
„ State Brickworks	1
„ State Electricity Commission	3
„ State Shipping Service	5
„ Royal Australian Air Force	3
„ Department of Civil Aviation	4
„ Aeronautical Inspection Directorate	18
„ State Gardens Board	3
„ Forests Department	17
„ Postmaster General's Department	1
„ Perth Hospital Construction	11
„ Western Australian Government Railways	39
„ Local Governing Bodies	6
„ Main Roads Department	2
„ Commonwealth Works and Housing Department	7
„ British Phosphates Commission	39
„ Crown Law Department	4
„ Chamber of Mines	1
„ Rural and Industries Bank	4
	8152

H. P. ROWLEDGE,
Director.

FOODS, DRUGS, TOXICOLOGY AND INDUSTRIAL HYGIENE DIVISION.

ANNUAL REPORT FOR THE YEAR ENDED 31st DECEMBER, 1949.

By J. C. Hood, B.E.M., A.A.C.I., Deputy Government Analyst.

FOOD.

The number of samples of foodstuffs submitted during the year amounted to 152 of which 40 represented inspectional samples and the remainder from other sources, chiefly the Department of Agriculture, and the Government Tender Board.

Milk.

The number of milk samples from inspectional sources and those examined in the capacity of referee continues to be lamentably small, amounting to only 29 in number, of which 5 failed to comply with the standards of the Food and Drug Regulations.

Milk—Investigational.

An investigation into the relationship between the freezing point determinations of milk, refractive indices of soured serums, etc., as a means of detecting added water, was initiated during the year, and is still proceeding. The investigation included the analyses of milks for analytical confirmation of dilutions of soured milks and reproduceability of results under varying conditions of analysis and storage of samples.

Dairy Products.

Forty-five samples of cheese were received from the Department of Agriculture for the purpose of checking the quality and grading of products produced in various factories within the State.

Edible Gelatine.

Owing to the alleged presence of excessive quantities of arsenic and metals in edible gelatine, a survey of available supplies was made, which showed that the poisonous metals content in all the imported gelatines was within the allowable limits of the regulations.

Miscellaneous food samples.

Amongst miscellaneous foodstuffs examined were cordials, cream substitutes, wild honey, canned peas, sugar, sausages, self-raising flour, sauces and pickles, vinegars and jams. Many of these samples were submitted by the Government Tender Board for compliance with food regulations, Government specifications or for expression of opinion as to suitability for use in Government institutions.

Fruit products.

Some experimental work in collaboration with the Department of Agriculture was carried out on the effects, observed elsewhere, of reducing acidity of oranges by spraying trees with lead arsenate. Oranges from trees sprayed and unsprayed were examined for acidity during the early stages of maturity, and during the ripening period without disclosing any marked variations.

Bananas from consignments imported from other States, which are required during certain months to be treated with salicylanilide, were submitted for analysis to ascertain if the required treatment had been carried out.

DRUGS AND MEDICINES.

Anaesthetic ether.

In all 60 samples of anaesthetic ether were examined, of which 47 consisted of preservatised ether drawn from Government supplies. In all cases the preservatised ether complied with the British Pharmacopoeia tests for purity.

Drugs.

Tablets reputed to have been found in a packet of prepared infant food were shown, on analysis, to consist of ½ grain phenobarbitone. As this drug should only be administered under medical prescription, the occurrence was reported to appropriate authority to ascertain whether maliciously or inadvertently added to the foodstuffs.

A quantity of hypodermic tablets were submitted by the Department of Public Health from a country hospital, which were stated to produce toxic symptoms suggesting substitution or admixture with drugs causing nausea and vomiting spasms. On examination the tablets were all found to be true to label with the active constituent within the prescribed dosage and containing no other foreign or poisonous substance.

A cigarette obtained in circumstances which suggested it might contain marihuana was submitted for analysis. Microscopical examination of the material revealed features suggestive of the presence of marihuana, but it was not possible to confirm this by chemical tests.

TOXICOLOGY.

Human poisoning cases.

The fatal poisoning cases numbered 42 in connection with which a total of 157 exhibits were received. The common poisons found were —barbiturates, 4; strychnine, 5; cyanides, 4; potassium permanganate, 1; carbon tetra-chloride, 1; atropine, 1; phenoloids, 3; eucalyptus oil 1; and Fehling's solution 1.

Following the enactment of legislation requiring an autopsy in cases of still births, a number of specimens were submitted to ascertain if the drug dosage of the mother had resulted in toxic concentrations of the drug in the foetus. In no cases were significant amounts recovered.

Blood alcohol.

During the year, in collaboration with the District Medical Officer, the systematic examination of blood from persons who had met violent deaths has been started to determine the concentration of alcohol in blood circulating at the time of death. Improved analytical techniques have made these tests wholly reliable as a means to ascertain whether a small or a large amount of alcohol had been consumed. The amount of alcohol found when applied to scales accepted by numerous authorities elsewhere permits a reasonable classification of the degree of intoxication to be implied. To date 20 specimens have been examined and in the case of five the value of the tests as an authentic negative have been demonstrated.

Criminal investigation.

A case of some interest concerned the death of a man from strychnine poisoning through drinking beer from a sealed bottle found by chance by his children whilst on a visit to a country township.

The composition of the beer did not correspond with the batch or brand on the label suggesting the original contents had been replaced by poison added to "slops" or waste beer—a supposition which was supported by the presence of a violet colouring which is a compulsory addition to drip trays.

A number of exhibits were submitted by the Criminal Investigation Branch in connection with a case of criminal abortion. These concerned the identification of materials used and their association with certain appliances. Evidence tendered at a subsequent court action contributed to a successful conviction.

As the result of an explosion occurring under mysterious circumstances at a North-West station, a number of exhibits were forwarded for expert advice to determine, if possible, the cause.

The origin of the explosion undoubtedly occurred in, or adjacent to, an opened tin of phosphorus rabbit poison. From the consideration of all the evidence and examination of the exhibits for identifiable residuals, phosphorus appeared to be the only potentially explosible material implicated.

The reported damage however, appeared to be excessive for the amount of phosphorus preparation stated to have been present.

Animal toxicology.

In all, 14 specimens in connection with animal poisoning were received, nine of which were real or suspected poisonings by baits, etc.

Baits used in experiments in poisoning euro kangaroos carried out by the Vermin Branch of the Department of Agriculture, were submitted for analysis in an endeavour to correlate composition and toxicity of the poisons with observed effects.

Poison plants.

During the reconditioning of wells on the Broome-Derby Stock route some concern was expressed at the presence of reputedly poisonous plants in the vicinity of some of the wells.

These were botanically identified as Erythrophloem chlorostachys (camel poison) and Velleia panduriformis, respectively.

An alkaloid which proved to be toxic to guinea pigs was separated from the leaves and twigs of the camel poison in an amount approximating to 0.2 per cent. of the material as received. This alkaloid appeared similar to Erythrophleine and would undoubtedly prove toxic to stock if consumed in the absence of more attractive foodstuffs.

No poisonous substance could be detected in the Velleia but considerable evidence is available as to its toxic nature at particular stages in the growth of the plant.

INDUSTRIAL HYGIENE.

Lead and arsenic hazards in industry.

A total of 64 samples of urine and faeces were examined as routine checks on workers exposed to lead or arsenic hazards or forwarded by medical practitioners, to support diagnosis of suspected chronic poisoning by these metals.

In continuation of a survey of working conditions and assessment of the potential lead hazard during assaying operations, dust and fume collected by the District Inspector of Mines at one assay office was submitted for analysis. The quantities of lead retained by filter on aspirating 1/3 cubic metre of air during various operations was as follows:—

	Lead Milligrams.
Knocking out moulds	0.075
Weighing and fluxing	2.50
Mixing fluxes	30.7
Mixing fluxes	16.7
Withdrawing from pot furnace and pouring	0.130

The services of the Division were made available to assist in an investigation by mining interests into the possibilities of removing mine dust from ventilation currents by an electrostatic dust collecting unit and re-circulating the cleaned air. Analysis of the air and the concentration of toxic gas remaining in the mine air were determined at various times after firing with explosives when 20 per cent. of the vitiated air was rejected and made up with fresh air.

Summarised, the results of the analysis showed a concentration of 0.011 per cent. of carbon monoxide at the end of 15 minutes, at 20 minutes this had fallen below 0.01 per cent. and at 30 minutes had been further reduced to 0.002 per cent. which would be harmless for all practical purposes. The concentrations of oxides of nitrogen from 15 minutes until 75 minutes after firing were never present in amounts which would have any physiological significance.

The composition of the air at the end of 30 minutes was maintained at a satisfactory standard and indicated that the rejection and make-up of 20 per cent. of the air reduced toxic gases to a safe limit.

Work of a miscellaneous nature associated with industrial hygiene consisted in the examination of the composition of welding rods reputed to be the cause of sickness amongst welders also by a series of analyses determining the degree of protection afforded by non-combatant type of respirations to workers encountering arsenic dust in pest destruction.

INSECTICIDES.

A number of D.D.T. preparations for use as fly sprays and liquid concentrates dispersible in water for use in a campaign directed towards the eradication of Argentine ants, have been examined. The emulsified concentrates most frequently failed to comply with specifications with respect to the physical state, failing to maintain homogeneous solutions.

The introduction of an ever-expanding list of complex organic insecticides or pesticides continue to provide acute problems from the analytical point of view. Attention, however, is directed to the more pressing need for a control administration fully cognisant with the toxicity of these preparations, advising on and controlling the distribution, safe use and hazards to horticulturists and the general public.

ASPHALTIC MATERIALS.

Further specimens of bituminous material found in the vicinity of the Ord River were found, in common with previous specimens for this area, to be asphaltic pyro-bitumens derived from the metamorphosis of petroleum.

The physical and analytical features of the specimens characterised the material as being similar to impsonite representing the final stage in metamorphosis of asphaltic and asphaltic pyro-bitumens.

NATURAL PRODUCTS.

The falling off in the area of linseed under cultivation resulted in a considerable drop in the samples examined for determination of oil content, only 15 being submitted.

Whale oils produced at the newly established whaling station at Point Cloates were examined for the Department of Industrial Development to ascertain if the various grades complied with the specifications of the British Ministry of Food.

The oils were of good quality and complied substantially with the requirements.

SWAN RIVER POLLUTION.

The collection of samples (212) for chemical and bacteriological examination in the survey of Swan River pollution has been continued at monthly intervals throughout the year.

Additional sampling points, bringing the total to 35, have been added and extending up-river beyond Guildford to Woodbridge Creek at control points, recognised swimming areas and in the vicinity of places of known or suspected pollution.

The survey of the upper reaches of the river has shown that the normal drainage from low-lying land, grazing paddocks, industrial and storm water drains, etc. causes discoloured and muddy water and undoubtedly shows evidence of chemical and bacteriological pollution even before receiving the gross pollutional discharges of the gas works and the Claisebrook drain.

Perth water receives further storm water and industrial discharges and just beyond the confines of the Narrows, the industrial and sewage treatment effluents of the Swan Brewery.

In the enormous dilution provided by the large expanses of Matilda Bay, Melville Water, Freshwater Bay however, the river has great recuperative powers, where by natural processes and oxidation evidence of pollution is almost entirely removed. This is shown throughout the year by analyses for dissolved oxygen, absorbed oxygen, ammonia and phosphorus supported by the bacteriological examinations carried out by the Director of Medical Laboratories, which indicate that between Crawley and Fremantle traffic bridge the river is chemically and bacteriologically free from pollution.

Although showing esturine influence over the whole of the sampling points, the salinity varies in the summer months from that approximating to, or slightly higher than, sea water to a concentration somewhat less than half this amount at Woodbridge Creek. During the winter months the salinity at all sampling points is relatively low. The alternating salinity undoubtedly has a profound effect on the algal growth in the river as evidenced by the masses of floating algae thrown up on the beaches during early summer. This aspect of pollution involving the life history of river flora calls for early botanical and biological investigation.

CHEMICAL SEWAGE CONTROL.

Weekly and Fortnightly Routine.

A total of 2,205 samples were collected and examined as part of the chemical control work undertaken for the Metropolitan Water Supply, Sewerage and Drainage Department. These samples were taken in the weekly inspection of the two main treatment works at Subiaco and Swanbourne and examined for reaction (pH), solids in suspension and combustible solids in raw and digested sludge and also the influents and effluents from each of the Subiaco, Swanbourne and Fremantle works fortnightly for biochemical oxygen demand (B.O.D.) suspended solids and reaction.

The average figure for the B.O.D. for these works for the year are:—

	Parts per Million.
Fremantle—	
Influent	521
Effluent	334
Swanbourne—	
Influent	487
Effluent	193
Subiaco—	
Influent	326
Effluent	180

Complete Analysis.

Twelve complete analyses were also made of the sewage from each of the works at six monthly intervals. These analyses supported the frequent routine tests and indicated generally, the treatment plants may be considered to be working satisfactorily.

Investigational.

The deviation constructed to permit the reconditioning of the old main sewer from Mongers Lake to the Subiaco Treatment works was completed during the year.

Opportunity therefore was taken by the Metropolitan Water Supply, Sewerage and Drainage Department to invite Messrs Davy and Parker, Research Engineer and Senior Chemist and Bacteriologist respectively of the Melbourne and Metropolitan Board of Works to visit Perth to gain an appreciation of the hydrogen sulphide problem of the Perth sewerage system and exchange experiences of conditions and testing techniques. In collaboration with these experts consequently a comprehensive series of tests were carried out on the sulphide content, generation and emission of hydrogen sulphide both in the old main prior to deviation of flow and subsequently in the new rising main. Corroded concrete from selected points in the sewerage system was also taken for chemical analysis and samples also forwarded for bacteriological examination in Melbourne.

To the end of the year 646 samples were examined as part of this investigation and the standardised testing techniques adopted are being continued at frequent intervals. The results to date have provided valuable information and the testing will be extended to other localities in the Metropolitan areas.

Ocean Outfall and Beach Surveys.

One ocean outfall and four ocean beach surveys were carried out during the year, during which 174 samples were taken for chemical and bacteriological examination.

The ocean survey samples were taken at surveyed positions determined, according to the wind direction, on a grid, north and south of the sewage outfall together with samples of the emerging effluent and ocean water remote from any source of pollution for the purpose of reference.

Both the chemical and bacteriological examinations showed the pollutional influence of the outfall to be limited and to the usual extent.

Beach surveys conducted quarterly at recognised beaches extending from Marmion beach to Naval Base beach also showed no discernible pollution of the beaches by sewage effluent. Localised pollution from the Herdsman Lake drain whilst flowing was indicated during the September survey and on beaches adjacent to storm water drains between Howard Street and South Beach, Fremantle, during the December survey.

Trade Wastes.

Fifty samples of trade wastes including brewery and malting house wastes, gas works effluents, foundry, battery, electroplaters, modelling works, tallow and lye wastes and effluents from tomato processing, were submitted for analysis to determine whether acceptable for sewer disposal. Advice was tendered where preliminary treatment was indicated and investigational work carried out on methods for reduction of B.O.D. or the elimination of undesirable constituents.

The examination of many of these wastes was in continuation of the policy of diverting to sewer disposal effluents which at present contribute to river pollution by way of storm water drains.

TABLE I.

FOODS, DRUGS, TOXICOLOGY AND INDUSTRIAL HYGIENE DIVISION.

Source and Description of Samples received during 1949.

	Public Health Department.	Agricultural Department.	Metropolitan Water Supply, Sewerage and Drainage Department.	Police and Coroner.	Police C.I.B.	Police L.I.B.	Works and Labour Department.	Industrial Development Department.	Royal Perth Hospital.	Government Stores and Tender Board.	Explosives Branch.	Prisons Department.	State Mining Engineer.	Factories Chief Inspector.	Charcoal, Iron, Wood, Distillation Industry.	Fisheries Department.	Free.	Pay—Public.	Pay—Perth Hospital Construction.	W.A. Government Railways.	Aeronautical Inspection Directorate.	State Electricity Commission.	Crown Law Department.	Main Roads Department.	State Housing Commission.	Chamber of Mines.	State Sawmills.	Commonwealth Works and Housing.	Royal Australian Air Force.	TOTAL.
Foods—																														
Cows Milk	25	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3	....	....	....	....	....	1	29
Cheese	....	45	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	45
Jelly Crystals and Gelatine	6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	6
Cordials	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Canned Peas	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
S.R. Flour	....	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3
Barley (Ceresan treated)	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	1
Wild Honey	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Salt	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3	1	....	....	....	....	....	....	....	....	....	....	....	4
Sea Pilchards	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Kitty Kitchen Whip	1	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Bananas	....	8	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	8
Oranges	....	26	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	26
Mandarin (? Poison)	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Supa Whip Cream	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Chutney	....	....	....	....	....	....	....	....	....	6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	6
Tomato Sauce	....	....	....	....	....	....	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Pickles	....	....	....	....	....	....	....	....	....	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3
Worcestershire Sauce	....	....	....	....	....	....	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Malt Vinegar	....	....	....	....	....	....	....	....	....	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	4
Imitation Vinegar	....	....	....	....	....	....	....	....	....	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	4
Bread, Dough and Bread Mix	....	....	....	....	....	....	....	....	....	....	....	....	....	6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	6
Bakamilk Substitute	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Jam	....	....	....	....	....	....	....	....	....	8	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	8
Sugar	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Sausages	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	1
Soda Water	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Human Toxicology—																														
Exhibits—Deaths	4	....	....	143	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	151
Anaesthetics	1	....	....	12	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	13
Blood and Urine (Alcohol)	....	....	....	14	6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	20
Hair, Nails and Urine	3	....	....	....	....	....	....	....	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	6
Animal Toxicology	1	11	....	....	....	....	....	....	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	14
Welding Rod	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Urine and Faeces	18	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	7	....	39	....	....	....	....	....	....	....	....	....	64
Dust—Assay Office	....	....	....	....	....	....	....	....	....	....	....	....	5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5
Respirator Canister	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Sewage—																														
Weekly Routine	....	....	2,205	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2,205
Trade Waste	....	....	50	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	50
Investigational	....	....	23	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	23

TABLE I—*continued.*

	Public Health Department.	Agricultural Department.	Metropolitan Water Supply, Sewerage and Drainage Department.	Police and Coroner.	Police C.I.B.	Police L.I.B.	Works and Labour Department.	Industrial Development Department.	Royal Perth Hospital.	Government Stores and Tender Board.	Explosives Branch.	Prisons Department.	State Mining Engineer.	Factories Chief Inspector.	Charcoal, Iron, Wood, Distillation Industry.	Fisheries Department.	Free.	Pay—Public.	Pay—Perth Hospital Construction.	W.A. Government Railways.	Aeronautical Inspection Directorate.	State Electricity Commission.	Crown Law Department.	Main Roads Department.	State Housing Commission.	Chamber of Mines.	State Sawmills.	Commonwealth Works and Housing.	Royal Australian Air Force.	TOTALS.
Complete	....	....	12	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	12
Neutralizer Liquor	....	....	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....	....	....	....	....	....	....	....	....	....	....	4
Survey (Parker)	....	....	646	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	646
General Sewage	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	1
Ocean Beach Survey	....	....	174	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	174
River Pollution	....	....	....	....	....	....	212	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	212
Drugs and Medicines—																														
Ether—Supplies	....	....	....	....	....	....	....	....	21	26	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	47
Tablets	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Eupad Powder	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Water (Fluorine)	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	4
Water	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3	....	....	....	....	....	....	....	....	....	....	....	5
Water (Poison)	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	1
Dangerous Drugs—																														
Morphine	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	4
Cigarette (Marihuana)	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Criminal Cases—																														
Explosion (Corrunna)	....	....	....	6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	6
Abortion (Stamp)	....	....	....	....	14	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	14
Brine	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	....	....	....	....	....	....	....	....	....	....	2
Methanol and Tar	....	....	....	....	....	....	....	....	....	....	....	....	....	....	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	4
Growth Aerated Water	....	....	....	....	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Specimen of Material	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	1
Mine Air	....	....	....	....	....	....	....	....	....	....	....	....	2	....	....	....	12	....	....	....	....	....	....	....	....	1	....	....	....	14
Carbon Monoxide Detector	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Insecticides	2	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	6
Flyspray	5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5
Liquors—																														
Brandy	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Wine	....	....	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Beer	....	....	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Sheep and Cattle Dip	....	24	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	26
Sandsoap	....	....	....	....	....	....	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
" Tup " Soap Powder	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Apple Wraps	....	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3
Human Milk	22	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	22
Crayfish Meal (D.D.T.)	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Chemicals (Identification)....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	17	....	....	....	....	....	....	....	....	17
Pigments (Colour)	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3	....	....	....	....	....	....	....	....	....	....	....	3
Poison Plants	....	....	....	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Paint	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3	....	2	....	....	....	1	....	6
Sodium Bromide	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Explosives and Fireworks	....	....	....	....	....	....	....	....	....	....	16	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	16
Still Birth Specimens	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3
Preservatised Timber	....	....	....	....	....	....	....	5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	7	....	....	12
Whale Oil	....	....	....	....	....	....	....	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	4
Floor Polish	....	....	....	....	....	....	....	....	....	7	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	7
Aluminium (Corrosion)	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	1
Hydrochloric Acid	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Neats Foot Oil	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	1
Lubricating Oil	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Linseed (Oil Content)	....	15	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	15
Material (Identification)	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
	114	143	3,114	175	24	5	215	11	24	66	16	2	7	8	4	1	16	21	2	39	18	3	4	2	1	1	7	2	1	4,046

AGRICULTURE, FORESTRY AND WATER SUPPLY DIVISION.

ANNUAL REPORT FOR THE YEAR ENDED 31st DECEMBER, 1949.

By L. W. Samuel, Ph.D. (Lond.), F.A.C.I., A.R.I.C., Deputy Government Agricultural Chemist.

SOILS.

Of the 234 samples of soil examined during 1949 one half were in connection with a laboratory experiment by the Department of Agriculture to determine whether the application of a zinc salt and superphosphate to a soil affected the nitrogen status of the soil. The soil used was from the Lake Grace area and samples treated with varying rates of zinc and superphosphate were analysed at fortnightly intervals for nitrogen in the form of ammonia, nitrite and nitrate. The results showed no evidence of an effect of zinc salt and/or superphosphate on the nitrogen status of this soil under the conditions of the experiment.

A group of 15 soils were analysed for acid soluble phosphate in connection with the "die-back" of jarrah trees in the South-West of the State.

A series of determinations of pH value (using the glass electrode) was undertaken for the Animal Health and Nutrition Laboratory of the Department of Agriculture to ascertain any change in pH value with time of storage of the soil sample. No consistent material change in soil pH was observed, irrespective of whether the soils were stored at the original moisture content (as high as 36 per cent.) or allowed to air-dry before storage.

Work is being continued on the high pH soils from the Carnarvon area, referred to in my report for 1948. The Department of Agriculture is conducting experiments with various soil treatments to reduce the alkalinity of the soils and samples of the soils from these experiments are being examined in these Laboratories for pH value, water soluble salts, sodium chloride and replaceable bases.

WATERS.

The total of 1,241 samples of water examined for the year is slightly less than for the previous year but there has been an increase in the number submitted by farmers, graziers and market gardeners, etc. for examination for suitability for stock, irrigation and domestic purposes. Waters for analysis for primary producers are received from the Department of Agriculture, the War Service Land Settlement Scheme, the Interdepartmental Irrigation Water Committee and the Rural and Industries Bank, as well as direct from the primary producers.

(a) The routine examination of existing water supplies to towns and cities has been continued and involved the analysis of 27 samples from the Canning Dam, Churchman's Brook, Victoria Reservoir, Wungong Pipe-head Dam and Mt. Eliza Reservoir supplying the Metropolitan area; 47 samples from Mundaring Weir, Mt. Charlotte Reservoir and the Kalgoorlie Reticulation for the Goldfields Water Supply; five samples from the Wellington Dam.

A total of 81 samples of water was examined for country towns from the Forrest and Ord Rivers in the North to Albany in the South.

(b) The determinations of the quantity of silt carried by the Ord River were continued and 20 samples were examined. This investigation is in connection with the proposed Ord River Dam and irrigation project in the Kimberley District. The water from these samples is also examined chemically, as are samples from the Kimberley Research Station, for suitability for irrigation. All samples examined have been suitable for all purposes.

(c) A number of samples were examined specifically for irrigation purposes including 7 from the Geraldton District for the Interdepartmental Committee on Standards for Irrigation Waters and 25 samples from bores at Wiluna for the large scale growing of peanuts under irrigation.

(d) No further samples were tested for the survey of the rivers and streams in the South West of this State, but the available information was collected and collated and appears as an appendix to this report.

(e) Of the large number of miscellaneous samples of water tested the most interesting were:

A number from the dairy area of the State, tested in connection with the abnormally low blood phosphorus of the cows in the district;

A sample of "distilled" water from a solar still. A "distilled" water of 27 grains of total dissolved solids per gallon was obtained from sea water, and was thus very satisfactory for drinking.

FERTILISERS.

Analyses were made of 24 samples of fertilisers for compliance with the Fertiliser Act, 1928, and only 13 samples complied with their registered analysis. The deficiencies were:—

	Samples.
In Nitrogen	3
Water soluble potash	2
Acid soluble phosphoric acid	2
Total phosphoric acid	3
Fine material	3

Of the 16 miscellaneous samples of fertiliser material analysed during the year interest attaches to:

Two samples of wood ashes forwarded in the condition in which they were available as fertilisers. These samples were very low in both the major fertilising elements and in "trace" elements, due mainly to admixture of soil, approximately three-quarters of one sample being sand.

A sample of whale material which contained more than 10 per cent. of nitrogen and less than 1 per cent. of potash (K_2O) and of phosphoric acid (P_2O_5).

A sample of blast furnace residue, which contained negligible amounts of fertilizer elements, both major and "trace."

Five samples of fertilisers examined spectroscopically and chemically for trace elements. Negligible quantities of trace elements were found in these samples of blood and bone, zinc sulphate, Lake Chandler sulphate of potash, Palestine muriate of potash and German sulphate of potash.

PASTURES AND FEEDING STUFFS.

(a) In continuation of the investigation of the composition of pastures under differing rates and times of applicaton of superphosphate to irrigated and non irrigated land in the South-West dairy areas the dry weight, calcium, nitrogen, phosphorus and potassium were determined on 64 samples of pasture cuts.

These analyses confirmed that variations in the relative abundance of different pasture species in the sward caused greater variation in the chemical composition of the sward than did variations in fertiliser treatment per se.

(b) Further samples of barrel clover were analysed for nitrogen, calcium and phosphorus in connection with experiments to determine the best conditions for the establishment of barrel clover on the light land at the Merredin and the Wongan Hills Agricultural Research Stations.

One series of 28 samples were of plants inoculated with 9 strains of bacteria and sown with super or basic super at the Merredin Agricultural Research Station. There was no consistent difference in the calcium or phosphorus contents of plants grown with super or with basic super but the nitrogen content of the plants sown with basic super was generally higher than that for the plants sown with super. There was no marked

difference between the calcium, nitrogen or phosphorus contents of plants inoculated with different bacterial strains or between plants from seed sown immediately after mixing seed and fertilizer or held for 3 hours between mixing seed and fertilizer and sowing.

A series of 9 samples of barrel clover showed no consistent, marked difference in nitrogen or phosphorus content when sown with superphosphate, basic superphosphate, or superphosphate after soil liming with or without trace elements.

At the Wongan Hills Agricultural Research Station a series of 12 samples showed a higher phosphorus content of plants sown with superphosphate than those sown with basic superphosphate, or with superphosphate after liming the soil, but there was no material difference in nitrogen content with fertilizer treatment.

(c) Pasture species grown in the Kimberley Division of the State have been analysed to assess their feeding value. Nearly all of the samples were grown at the Kimberley Research Station on the Ord River and all were analysed for the usual feeding stuffs components and total calcium and phosphorus. The following grasses have been analysed from plots grown with and without 1½ cwts. superphosphate per acre:—

Andropogon gayanus.
Blue panic grass.
Cenchrus ciliarus (2 types).
Guinea grass.
Para grass.
Paspalum scrobiculatum.
Urochloa bulbodes.
Birdwood grass.
Buffel grass.
Elephant grass.
Panicum antidotale.
Paspalum dilatatum.
Rhodes grass (2 strains).

Other samples of 6 of these grasses have also been analysed, and also samples of Clitoria (leaves, small stems and pods) and samples of meadow hay consisting mainly of Flinders grass or Mitchell grass respectively.

As a legume for the district, cowpeas (17 samples) were analysed, being 6 varieties grown with 0, ½ or 1½ cwts. superphosphate per acre in a variety and manurial trial.

(d) A number of other fodders were analysed for calcium, phosphorus and the usual feeding stuffs constituents. These included mixed pasture (12 samples) meadow hay (4 samples), vetch (7 samples), tree lucerne (6 samples) sub-clover (7 samples). The clover samples were taken at various stages of growth, before flowering, at full flower, just wilting and completely dry and showed with increasing age of the plant an increase in crude fibre from 11 per cent. to 31 per cent. a fall in protein from 27 per cent. to 9 per cent. and a decrease of phosphorus (expressed as P) from 0.25 per cent. to 0.04 per cent.

(e) Fodders for the wheat belt area which were analysed as feeding stuffs and for calcium and phosphorus included:—

(i) Eight samples from the Pasture Renovation Experiment at the Chapman Agricultural Research Station, a cultural and fertiliser experiment to maintain a pasture of Wimmera Rye grass and subterranean clover on an area sown to wheat every fourth year without fallow. A number of these samples were heavily contaminated with soil.

(ii) Five samples from the Wimmera Rye grass maintenance experiment at the Merredin Agricultural Research Station, a cultivation and fertilising trial on the maintenance of a Wimmera Rye grass pasture.

(iii) Cereal grazing and recovery trial at the Avondale and the Merredin Agricultural Research Stations.

At Avondale, pasture cuts were made late in July and late in August, of 2 oat varieties and 4 barley varieties. There was little difference in composition between the 6 varieties in either the July or August cuts, except that the barleys had a higher calcium content than the oats. Comparing the July and August cuts the August cut had approximately one-third less protein, less phosphorus and more crude fibre than the July cut.

At Merredin, pasture cuts were made early in August and late in August of 5 oat varieties and 2 barley varieties and the analysis showed similar features to those from the similar experiment at Avondale except that the decrease in protein content from early August to late August was not so marked as at Avondale.

(f) The Feeding Stuffs Act, 1928-1948, requires the registration of:—

minimum crude protein content;
minimum crude fat content for a feed not of animal origin;
maximum crude fat content for a feed of animal origin;
maximum crude fibre content.

In addition, the manufacturer or agent may register the content of any other substance of reputed nutritional value.

Except for bran and pollard and some poultry mashes there are no "Government" standards to which a feed must conform but any feed sold must conform to the registered composition. My report for 1948 noted the practical impossibility of a commercial feed conforming to a registered analysis for e.g., calcium, phosphorus, sodium chloride, to the second decimal place, and recommended that such registration should be for a maximum or a minimum, or both. This recommendation has been partially implemented and some, but not all, registrations show a maximum or minimum or both for all registered analyses.

During 1949 a further anomaly in the registration of feeding stuffs occurred in that although the Fertiliser Act, 1928, prescribes the fineness of grinding of some fertilisers, there is no similar provision for any feeding stuffs, except pollard. It seems desirable that a "fineness" provision should be made for feeds containing appreciable quantities of bone, particularly if the feed is described as a bonemeal or bone flour. One sample of bone flour contained over 80 per cent. of material which would not pass through a No. 20 I.M.M. sieve. A sample of meat and bone meal contained over 20 per cent. of similar sized particles and a sample of bone and meatmeal contained some particles which would not pass through a three-sixteenths inch circular hole sieve and over 40 per cent. of material which would not pass through a No. 20 I.M.M. sieve.

Of the 181 samples of feeding stuffs analysed during 1949 for compliance with the Act, only 80 complied with the legally required registration of crude protein, crude fat and crude fibre. Only 32 samples complied with all of the components registered by the manufacturer or agent.

The reasons for non-compliance were:—

Deficient in crude protein	23
Deficient in crude fat	38
Excess of crude fat	3
Excess of crude fibre	35
Excess of sodium chloride	39
Deficiency of sodium chloride	8
Deficiency of phosphoric acid (P_2O_5)	17
Excess of phosphoric acid (P_2O_5)	13
Excess of sulphur	1
Deficiency of sulphur	1
Excess of lactose	1
Not sufficiently finely ground (for pollard only)	23
Excess of ash (for bran and pollard only)	12
Excess of moisture (for bran and pollard only)	19

PLANT NUTRITION.

Apple Leaves.

The analyses of apple leaves were mainly for either the zone of absorption of fertilisers or for trace elements from fertiliser experiments or as a diagnostic aid.

In a comparison of the use of zinc oxide and zinc sulphate as sources of zinc there was no material difference in the copper or zinc contents of the leaves.

For three trees, (i) healthy, (ii) treated with borax, (iii) treated with potash, there was no material difference in boron, copper or zinc content of the leaves but leaves from the healthy tree had considerably the more potassium.

In a fertiliser experiment using various combinations of nitrogen, phosphorus and potassium fertilisers the nitrogen, phosphorus and potassium contents of the leaves were practically constant, irrespective of fertiliser treatment. This was confirmed in a much smaller experiment with a phosphatic fertiliser only and also for a comparison of superphosphate and a mixed manure using two varieties of apple trees.

A comparison of local application and broadcasting of fertiliser in spring and autumn with two varieties of apple trees showed no difference in the nitrogen, phosphorus or potassium contents of the leaves with type or time of application. The two varieties had very similar nitrogen and phosphorus contents but one had a much higher potassium content than the other.

A series of 22 samples of leaves from trees to which magnesium sulphate and magnesium carbonate had been applied at different soil depths some two years previously were analysed for magnesium. There were no differences in magnesium content of the present leaves consistent with either the source of magnesium or the depth at which it was applied.

Different rates of manganese sulphate were placed 15 in. deep to four apple trees and the leaves sampled four and eight months after application and analysed for manganese. At each sampling the manganese contents of the leaves of the four trees were in the same order, the absolute quantities being greater in the second sampling, but were not consistent with the rates of application of manganese sulphate.

A further series of leaf samples from trees to which manganese sulphate had been applied at different depths some 15 and 19 months previously showed greater absorption of manganese from the 15 in. to 18 in. level than from the 6 in. level and this in turn was greater than from a surface application.

A further 24 samples from two experiments on the application of manganese did not however show consistent increases in the manganese content of the leaves of the treated trees.

Similar experiments using superphosphate and potassium sulphate each applied separately at 6 in. and at 15 in. showed greater phosphorus and potassium contents respectively of the leaves with the greater depth of application when the leaves were sampled 15 months after the fertiliser had been applied.

Barley.

Very few samples of barley plants were analysed from trace element fertilisers experiments but one series of zinc oxide fertiliser treatments of Prior barley sampled when the plants were 6in. to 8in. high did not show the same effects as with wheat and oats in that there was no appreciable change in the phosphorus, nitrogen, copper, or manganese contents. The zinc content, however, was increased to approximately twice that of the superphosphate only plots. In addition to the chemical estimations, direct spectrographic comparison was made of 5 samples of barley plants.

Cauliflower.

Further to the use of molybdenum fertiliser for the control of whiptail in cauliflower, monthly samples of cauliflower plants were received from a rate of fertiliser experiment. There were 10 treatments, 0, 25, 50, 100, 200lb. per acre of crude sodium molybdate and 0, 12.5, 25, 50, 100lb. per acre of pure molybdic acid applied to the seed bed. The relative rates of molybdic acid and of crude sodium molybdate were designed to supply the same quantity of molybdenum. At the initial sampling in May the average dry weight of each seedling was less than 1 gram, but molybdenum contents ranged from 14 to nearly 1,800 parts per million. At subsequent samplings in June, August and September the dry weight increased and the molybdenum content decreased. For the September sample the dry weight of individual plants varied from 164g. to 268g. and the molybdenum content varied from 0.3 to 3.0 p.p.m. The mature plant was sampled in October when the dry weights of individual plants varied from 359g. to 646g. The plants were divided into root, leaves and curd and these analysed separately for molybdenum. The molybdenum contents of the dry matter varied from 0.2 to 4.5 p.p.m. for the roots, 0.4 to 1.1 p.p.m. for the leaves and 0.2 to 0.7 p.p.m. for the curd.

Flax.

The 12 samples of flax analysed were from a "trace" element fertiliser experiment using zinc, copper, molybdenum and roaster residues. The fertiliser treatments had no marked effect on the phosphorus, potassium, copper, manganese or zinc contents but the use of molybdenum fertiliser or roaster residues markedly increased the molybdenum content of the plants, the former fertiliser having the greater effect.

Hop Leaves.

Two series of samples of hop leaves from fertiliser experiments were analysed at approximately monthly intervals. In one series the treatments were (a) the farmer's normal fertiliser practice and (b) twice this rate of application.

For both fertiliser treatments there was an increase in calcium and magnesium from December to February and a decrease in March but while there was little difference in the calcium values for both normal and heavy dressings the magnesium content was consistently higher for the heavy dressing than for the normal rate.

Nitrogen decreased progressively from December to March for both treatments and there was little difference between treatments. Phosphorus decreased from the December sampling to a steady value in the January, February and March sampling for both treatments and there was little difference between treatments. The potassium content was relatively uniform both for time of sampling and for treatment.

There were no systematic differences either with time of sampling or with rate of fertiliser for copper, manganese, molybdenum or zinc. The only irregularity in the data were a high manganese content in the leaves of the March sampling of the heavy dressing and lower molybdenum values for the March sampling of both fertilizer treatments.

The second series of leaves was from a comparison of the farmer's own fertiliser practice with potash (broadcast and trenched), superphosphate, and copper ore (broadcast and trenched). Samples of leaf were taken in January, February and March. This series agreed with the previous one in increase in calcium from January to February in all treatments but there was not a uniform decrease in March and the magnesium content did not show such well defined changes. As in the previous series, nitrogen decreased progressively from January to March with no marked effect of treatment. The phosphorus changes were similar to those of the previous series but later in time, there being an increase from January to February and a decrease in March. The farmer's own fertiliser treatment generally had a lower phosphorus content than did the other treatments. The potassium changes differed from the previous series in showing an increase from January to February and a decrease in March thus paralleling the phosphorus variations.

There were no consistent changes in copper, manganese molybdenum or zinc contents of the leaves, either with time of sampling or with fertiliser treatment. Where copper ore was not applied there was an increase in copper content for the February sampling, except in the farmers own fertiliser treatment, and a decrease in the March sampling. Where copper ore had been applied the copper content of the leaves was more constant over the period of sampling. There was evidence of an increase in zinc content from January to February and a decrease in March but this decrease did not occur where copper ore had been used.

Lucerne.

Two samples of lucerne analysed showed an increase in potassium content from the use of a potash fertiliser and, of three samples, those two which had shown a field response to a manganese fertiliser showed a marked increase in manganese content compared with the control.

Nectarine Leaves.

Two samples of nectarine leaves were analysed for copper, manganese and zinc; one sample was of healthy leaves and the other of yellowed leaves suspected as being manganese deficient. The yellowed leaves were lower in manganese and higher in zinc than the healthy leaves.

Oats.

The analyses of oat plants have been mainly at an early stage of growth for the "trace" elements, either from fertiliser experiments or as a diagnostic aid. Occasional analyses have been for the major elements nitrogen, phosphorus and potassium and in all 50 samples have been analysed.

The application of zinc fertiliser in the absence of other trace element fertilisers has caused an increase in the zinc content of Fulghum oat plants. The use of a molybdenum fertiliser raised the molybdenum content of these plants by as much as 100 fold.

The use of copper, manganese, molybdenum and zinc fertilisers on Guyra oats on light land resulted in a reduction in nitrogen, phosphorus, potassium, copper and manganese contents. For Dale oats similar effects were noted except that there was no reduction in copper content.

Other experiments with Ballidu oats with zinc, or zinc and copper fertiliser confirmed the effect of a zinc fertiliser in reducing the phosphorus and manganese contents. Similar results were obtained with Dale oats sampled when 9 in. to 12 in. high when the phosphorus content of some plants fertilised with zinc was less than half of that of plants receiving superphosphate only.

Ballidu oats at the Wongan Hills Research Station sampled when 12 in. high showed the effect of zinc oxide fertiliser in reducing the phosphorus content of the plant (and increasing the zinc content) but there was no consistent effect on the nitrogen, copper or manganese contents.

The effect of zinc fertilising in reducing the phosphorus content of young oat plants persisted to the year after the fertiliser was applied. Guyra oats sown with superphosphate only in 1949 on plots fertilised with zinc and zinc plus copper in 1948 showed less than half the phosphorus in the zinc or zinc plus copper plots (applied 1948) as in the superphosphate only plots.

In addition to the chemical estimations, direct spectrographic comparisons were made of six samples of oat plants.

Orange Leaves.

Four samples of orange leaves were analysed for copper, manganese and zinc. Two samples were of yellowed leaves and two of healthy leaves. The yellowed leaves had higher manganese and lower zinc contents than their directly comparable healthy trees.

Subterranean Clover.

Of the 35 samples analysed 28 were of mid-season subterranean clover from potash and zinc fertiliser trials on four separate properties. These trials agreed that the use of potash fertiliser did not increase the potassium content of the plant early in its growth but that the application of a zinc fertiliser increased the zinc content, this increase being less marked in the early growth stages. These effects persisted in the second year for subterranean clover grown in 1948 on the 1947 potash and zinc fertiliser trial site showed no effect of potash fertiliser on potassium content of the plant but an increase in zinc content where zinc fertiliser had been applied the previous year.

Sudan Grass.

Seven samples of Sudan grass leaves from a fertiliser experiment were analysed but there was no marked effect of fertiliser treatment on potassium, copper and zinc contents. The use of a copper fertiliser did not appreciably affect the copper content of the leaves.

Wheat.

The analysis of wheat plants has been mainly at an early stage of growth for the "trace" elements, boron, copper, manganese, molybdenum and zinc either from fertiliser experiments or as an aid to diagnosis of unhealthy plants. Occasionally determinations were also made of the "major" elements, calcium, magnesium, nitrogen, phosphorus and potassium. In all 71 samples were analysed.

Differing rates of application of sulphur to the light land at the Agricultural Research Station at Wongan Hills did not result in any appreciable differences in the copper, manganese, phosphorus or zinc contents of Wongoondy wheat plants (sampled when three months old).

Applications of sulphur to the soil did not affect the copper, manganese or zinc content of Bencubbin wheat sampled when the plants were about 6 in. high, but reduced the phosphorus content. The use of manganese, with or without sulphur, increased the manganese content of these samples and reduced the phosphorus content. The same plots sampled some seven weeks later showed no material effect of treatment on potassium, copper, manganese or molybdenum content, but the use of manganese with or without sulphur had decreased the nitrogen, phosphorus and zinc contents.

The use of a zinc and copper fertiliser on Koorda wheat sampled when 9 in. high showed similar reductions in manganese content to those found with oats, but did not show a comparable reduction in phosphorus content. A similar experiment with Koorda wheat at the Wongan Hills Agricultural Research Station did not show such a marked reduction in manganese content of the young plant by the use of copper and zinc fertilisers.

Using zinc oxide as the source of zinc for an experiment with Kondut wheat in 1949, sampled when the plants were 3in. to 5in. high showed an increase in zinc content but no marked consistent reduction in phosphorus or manganese content.

In addition to the chemical estimations direct spectrographic comparisons were made of five samples of wheat plants.

Vines.

Samples (39) of vine leaves were analysed for phosphorus, potassium, copper, manganese and zinc, being samples from trace element experiments on three vineyards. In one experiment the use of fertilisers containing nitrogen, phosphorus, potassium, zinc and other trace elements did not affect the leaf composition for the elements estimated. In another experiment the use of a zinc swab on vines in a fertiliser experiment involving nitrogen, phosphorus, potassium, zinc and other trace element fertilisers did not affect the zinc content of the leaves or the average phosphorus and potassium contents. The vines swabbed with a zinc solution had, however, a higher average copper and lower average manganese content than the vines not swabbed. In this experiment, sampled some four months later, the leaves of the vines receiving a zinc fertiliser in addition

to nitrogen and phosphorus had a higher phosphorus, lower potassium, lower copper, lower manganese and higher zinc content than for any other fertiliser treatment. In another experiment the leaves from vines receiving a zinc swab had lower phosphorus and potassium contents than the other fertiliser treatments involving phosphorus, potassium, magnesium, nitrogen and trace elements.

For a series of five samples of passion vine leaves, treatment with copper had not consistently affected the copper content of the leaves.

Two samples of currant fruit were examined spectroscopically for direct comparison of good and of poor quality fruit. The samples were separated into fruit and fruit stalks and these examined separately. There were no consistent differences between the spectrograms of good and poor quality fruit except that for both fruit and stalks the sodium lines were stronger in the poorer quality.

Wimmera Rye Grass.

Five samples of Wimmera rye grass were analysed because of field observations of zinc deficiency in two areas. In one area there was no significant difference in the zinc content of healthy and unhealthy plants but in the other area the healthy plants contained more than twice as much zinc as the unhealthy plants. In both areas the plants showing symptoms of zinc deficiency contained much more phosphorus than the apparently healthy plants and this may be compared with the effect of zinc fertilisers on the phosphorus content of cereals.

WESTERN AUSTRALIAN f.a.q. WHEAT.

Samples of the Western Australian official f.a.q. wheat sample for the 1948-49 season and of flours milled experimentally from it were analysed for the Department of Agriculture. The wheat was milled on an experimental stone mill and on an experimental roller mill.

	Wheat.	Flour.	
		Stone Mill.	Roller Mill.
Moisture % (1 hour at 130°C.)	10·8	12·3	12·2
Protein % (N x 5·83)	10·3	....	....
(N x 5·7)	....	8·8	9·0
Ash %	1·40	0·50	0·50
Gluten % wet	....	31·4	31·7
dry	....	9·8	10·1
Maltose figure (Kent-Jones)	....	1·29	1·83

The analyses of the two flours differ only in the higher maltose figure for the roller mill flour. This latter difference does not conform to previous experience in these Laboratories where it has been found generally that the flour from the stone mill has a higher maltose figure than that from the roller mill.

TOBACCO.

Following discussions at the 27th meeting of the Australian Agricultural Council (April 1946) the Commonwealth Government approved of an annual grant to the States for a five year period for experimental and demonstration work in connection with tobacco leaf production. The programme of work planned by the Western Australian Department of Agriculture included chemical work on tobacco quality. As practically no work of this kind had previously been done in this State a chemist was appointed to these Laboratories early in 1948. As the appointee was a recent graduate from the University and as there was no experienced tobacco chemist to provide guidance most of 1948 was occupied familiarising the chemist firstly with the field aspects of tobacco growing and this included visits to the Tobacco Research Station of the Department of Agriculture at Manjimup at various times during the growth and handling, curing and grading of the leaf; secondly with laboratory techniques of tobacco analysis and this was greatly facilitated by the kindness and courtesy of the British Australasian Tobacco Co. in allowing the chemist to work in their factory in Sydney for a period of two months.

A number of tobacco leaf samples have been analysed for the more common elements to provide basic data on the chemical composition of West Australian leaf. These samples have been drawn from the Department of Agriculture fertiliser and management trials at the Manjimup Tobacco Research Station and from prospective tobacco growing areas.

A series of 90 samples of cured leaf was received from fertiliser experiments of the 1947-1948 season, on two soil types, being from a comparison of—

(a) alternative types of nitrogenous fertilisers (sodium and potassium nitrates and ammonium sulphate);
(b) split dressings of nitrogenous fertiliser;
(c) alternative types of potassium fertiliser (potassium nitrate and sulphate).

All samples were analysed for water soluble chloride and then a selection of samples based on leaf position and time of picking and high or low chloride were analysed for calcium, magnesium, phosphorus and potassium. Check analyses of samples ashed with a base showed that all the chlorine present in the leaf was present as water soluble chloride.

The chloride contents were high, ranging from 0.51 per cent. of the dry matter for a sample of top leaf to 3.89 per cent. for a bottom leaf. The bottom leaf contained the largest percentage of chloride; the middle and top leaves contained approximately equal amounts. There was no regular change in chloride content with further growth of the leaf and leaves from soil type 2 contained much more chloride than leaves from soil type 1.

No consistent effect of fertiliser treatment on chloride content was discernible.

There was a very good correlation between the calcium and magnesium contents of the leaves. The ratio of calcium to magnesium was practically constant for each soil type but the ratio was higher (more calcium) in soil type 1 than in soil type 2. That is, high chloride content was associated with a low calcium magnesium ratio. Generally, both the calcium and magnesium contents decreased from the bottom to the top of the plant and for each set of leaves there was an increase with growth of the plant.

Leaves from soil type 2 contained more potassium than did leaves from soil type 1. For neither soil type was there clear evidence of difference in potassium content with the position of the leaf on the plant but there was a decrease in potassium content with growth.

The phosphorus content of the leaves was relatively constant for each soil type irrespective of the position of the leaf or of the stage of growth, but leaves from soil type 2 contained nearly twice as much phosphorus as did leaves from soil type 1.

Thus leaves from soil type 2 were higher in chloride, magnesium, potassium and phosphorus but lower in calcium magnesium ratio than were leaves from soil type 1.

In general the data indicated that local leaf was relatively very high in chloride, high in magnesium, low in calcium and very low in potassium and phosphorus.

A further series of 126 samples of cured leaf were received being—

45 samples from the rate of application of potassium fertiliser in the 1946-47 season;
41 samples from the rate of application of potassium fertiliser in 1947-48 season;
16 samples from the rate of application of magnesium fertiliser in the 1947-48 season;
24 samples from exploratory plots in the West Coastal Districts, 1947-48 season.

Because previous work in the Commonwealth had suggested that the poor quality of Western Australian tobacco leaf was due to high chloride content, all of these samples were analysed for water soluble chloride. The chloride content of leaf from replicate plots in both potassium fertiliser experiments was very variable, more so for the 1946-47 season than for the 1947-48 season but there was no evidence that increasing rates of application of potassium fertiliser affected the chloride content of the leaf.

Similarly the replicates from the rate of magnesium fertiliser 1947-48 season showed variable chloride content but no evidence that the rate of application of magnesium sulphate affected the chloride content of the leaf.

Leaf from the exploratory plots from the West Coastal Districts showed variable chloride contents but compared with samples from Manjimup it was clear that closeness to the sea was not a dominant factor in chloride content of the leaf.

Comparing the three fertiliser experiments, the samples from the potash experiment 1946-47 season had approximately twice the chloride content of those from the similar experiment in the 1947-48 season. The leaf from the magnesium experiment 1947-48 season had a very high chloride content (range 2.76 to 4.81 per cent. on dry basis), approximately three times that of samples from the potash experiment 1947-48 season.

Throughout this series of samples of cured leaf there were many divergences from the previously found increase in chloride from the middle and top leaves to the bottom leaves.

All of these samples were also analysed for total nitrogen and there was no regular effect of rate of application of either potassium or magnesium fertiliser on total nitrogen content. The nitrogen content of leaf from the potash experiments were relatively uniform, both between replicate plots in each experiment and between the two seasons. The nitrogen content of leaf from the magnesium experiment was distinctly higher than that of leaf from either of the potash experiments.

In view of the high chloride content of all leaf samples analysed, samples of the fertilisers used were analysed for water soluble chloride but only negligible amounts were found. Systematic soil sampling of the Research Station was undertaken late in 1949 with a view to determining soil chloride but these analyses have not yet been completed.

The 126 samples were also analysed for potassium and for ash (total, acid soluble and acid insoluble). As for the previous series the potassium content was very low on world standards (range 0.80 to 2.53 per cent K_2O on the dry matter). The potassium content of samples from replicate plots was very variable and there was no evidence of a consistent trend with either the position of the leaf on the plant or the rate of application of potassium or magnesium fertilisers.

The total ash of the samples was high; range 8.5 to 12.0 per cent. on dry basis for top leaves, 8.9 to 15.3 per cent. for middle leaves and 11.2 to 20.7 per cent. for lugs. The values were relatively uniform in each experiment for each position of the leaf on the plant. The samples from the 1947-48 season had distinctly lower ash contents than the samples from the 1946-47 season and samples from both seasons show a progressive decrease in ash content from the bottom to the top leaves of the plant.

The rate of application of potassium fertiliser did not affect the total ash content but there was evidence that increasing rates of application of magnesium fertiliser decreased the total ash content, particularly of the middle leaves.

The proportion of the total ash soluble in acid was relatively constant at 90 per cent. or more of the total ash.

These samples were also analysed for calcium and magnesium and there was a decrease in both elements from the bottom to the top position of the leaf on the plant but it was doubtful whether the use of a potassium fertiliser had affected the calcium and magnesium contents of the leaves. There was evidence that increasing rates of application of a magnesium fertiliser increased the magnesium content of the leaves and decreased the calcium content.

The examination of these samples for organic constituents is being continued.

TABLE 2.

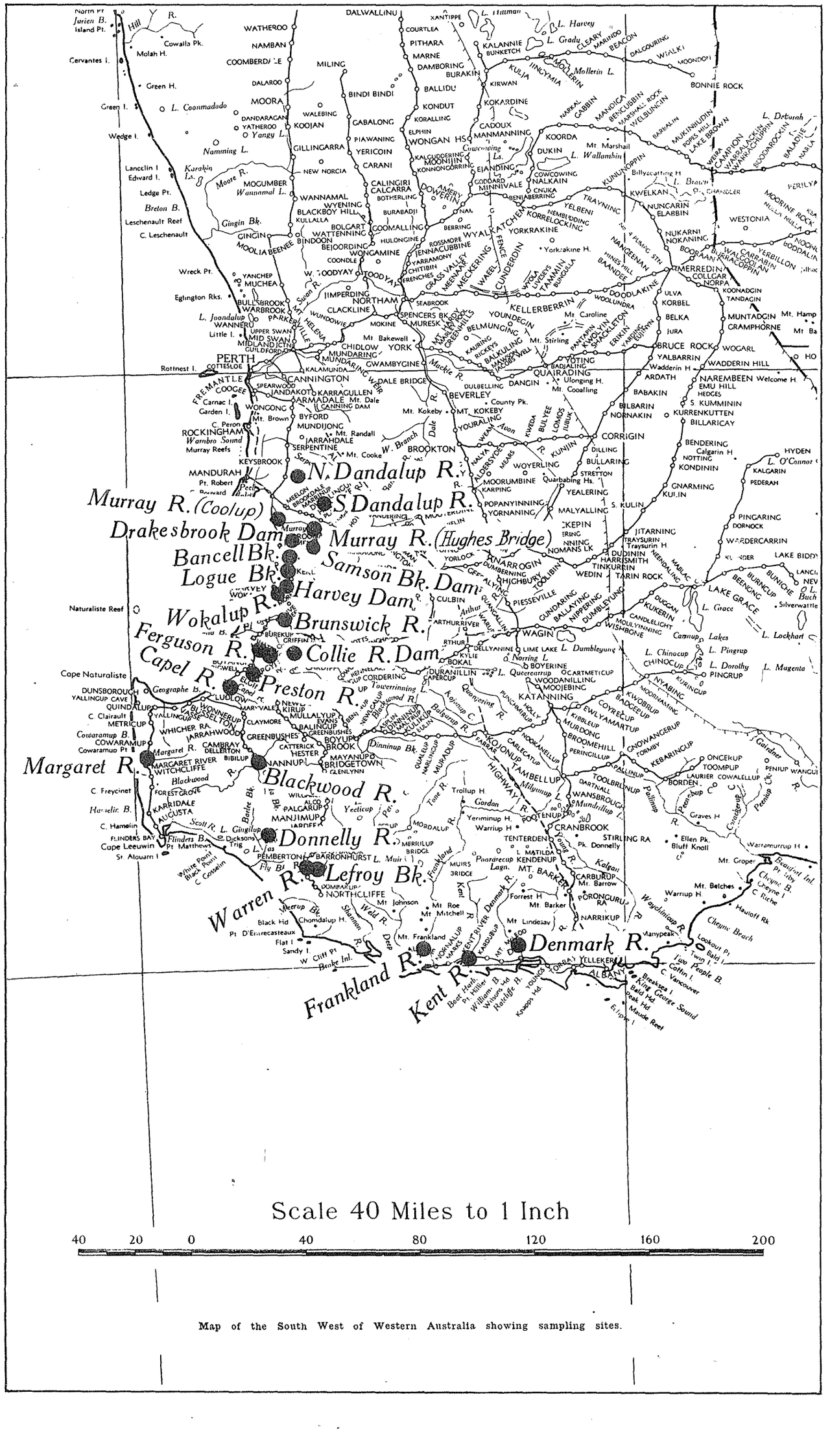
AGRICULTURE, FORESTRY AND WATER SUPPLY DIVISION—SOURCE AND DESCRIPTION OF SAMPLES RECEIVED DURING 1949.

	Department of Agriculture.	Metropolitan Water Supply, Sewerage and Drainage Department.	Department of Works and Labour.	War Service Land Settlement Scheme.	Interdepartmental Irrigation Committee.	Department of Public Health.	Department of Industrial Development.	Education Department.	Government Geologist.	Wood Distillation, Charcoal, Iron and Steel Industry.	P.W.D.—Perth Hospital Construction	Departmental—Director, Government Chemical Laboratories.	C.S.I.R.O. (Division of Plant Industry).	Interdepartmental—Tobacco Investigation.	Free.	Pay—Public.	Commonwealth Works and Housing Department.	Rural and Industries Bank.	Local Governing Bodies.	Department of Civil Aviation.	State Sawmills.	Forests Department.	State Gardens Board.	Royal Australian Air Force.	Post Master General's Department.	TOTAL.
Water	19	27	148	83	8	7	4	1	3	3	1	1	2	....	4	902	5	4	6	4	1	2	3	2	1	1,241
Fodders—																										
Feeding Stuffs Act Samples	211	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	211
Bran, Feeding Stuffs Act	20	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	20
Pollard, Feeding Stuffs Act	23	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	23
Pasture	142	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	142
Wimmera Rye Grass	5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5
Sub-Clover	49	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	49
Lupins	16	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	16
Vetch	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	4
Lucerne	5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5
Tree Lucerne	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Kikuyu Grass	5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5
Sudan Grass	7	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	7
Cow Peas	17	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	17
Meadow Hay	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Oaten and Pea Hay	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Pea Silage	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Meatmeal	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	....	....	....	....	....	....	....	....	4
Whale Meatmeal	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Poultry Laying-Mash	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3
Kimberley Pastures—																										
Buffel Grass	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3
Rhodes Grass	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	4
Birdwood Grass	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Cenchrus ciliarus	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3
Panicum antidotale	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3
Pasture	43	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	43
Wimmera Rye Grass	5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5
Elephant Grass	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Cereals—																										
Oats	48	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	48
Wheat	71	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	71
Barley	16	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	16
Flour	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Soils—																										
Farm	184	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	23	....	....	....	....	....	....	....	....	207
Plantation	21	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	15	....	....	36
Fertilisers—																										
Fertiliser Act Samples	55	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	55
Fertiliser	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	3
Animal Fertiliser	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Anthill Material	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	1

TABLE 2—*continued.*

AGRICULTURE, FORESTRY AND WATER SUPPLY DIVISION—SOURCE AND DESCRIPTION OF SAMPLES RECEIVED DURING 1949—*continued.*

	Department of Agriculture.	Metropolitan Water Supply, Sewerage and Drainage Department.	Department of Works and Labour.	War Service Land Settlement Scheme.	Interdepartmental Irrigation Committee.	Department of Public Health.	Department of Industrial Development.	Education Department.	Government Geologist.	Wood Distillation, Charcoal, Iron and Steel Industry.	P.W.D.—Perth Hospital Construction.	Departmental—Director, Government Chemical Laboratories.	C.S.I.R.O. (Division of Plant Industry).	Interdepartmental—Tobacco Investigation.	Free.	Pay—Public.	Commonwealth Works and Housing Department.	Rural and Industries Bank.	Local Governing Bodies.	Department of Civil Aviation.	State Sawmills.	Forests Department.	State Gardens Board.	Royal Australian Air Force.	Postmaster General's Department.	TOTAL.
Fertilisers—*continued.*																										
Whale Material	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Wood Ash	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	2
Blood and Bone	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	2
Blast Furnace Residue	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Roaster Residue	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Kangaroo Carcase	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3
Lime Sand	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Fruit Investigations—																										
Apple Leaves	155	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	155
Vine Leaves	56	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	56
Vine Fruit	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Nectarine Leaves	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Passion Fruit Leaves	5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5
Vegetable Investigations—																										
Cauliflower Leaves and Plants	76	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	76
Hops	24	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	24
Tobacco Leaf	....	....	....	....	....	....	....	....	....	....	....	....	....	126	....	....	....	....	....	....	....	....	....	....	....	126
Boiler Scale	....	....	7	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	7
Brine and Brine Sludge	....	....	....	....	....	....	....	....	....	....	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3
Standardising—																										
Soda Solution	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
	1,328	27	155	83	8	7	5	1	3	3	4	1	2	126	4	931	5	4	6	4	1	17	3	2	1	2,731



Map of the South West of Western Australia showing sampling sites.

SOURCE	No of SAMPLES	PERIOD
Bancells Brook	17	9 8 40 to 22 1 48
Blackwood River	19	21 5 40 " 19 1 48
Brunswick River	8	29 11 45 " 14 10 47
Capel River	19	10 7 40 " 5 12 46
Collie River	8	10 7 40 " 5 7 44
Denmark River	15	5 6 40 " 28 1 48
Donnelly River	19	6 8 40 " 20 1 48
Frakesbrook	17	10 8 40 " 13 2 48
Ferguson River	19	23 4 40 " 21 1 48
Frankland River	18	4 6 40 " 27 1 48
Harvey River	18	2 7 40 " 1 3 48
Kent River	17	4 6 40 " 27 1 48
Lefroy Brook	19	14 5 40 " 20 1 48
Logues Brook	18	24 4 40 " 22 1 48
Margaret River	15	23 1 39 " 9 10 47
Murray River	21	31 5 40 " 30 1 48
Nth Dandalup R	19	31 5 40 " 30 1 48
Preston River	20	23 4 40 " 21 1 48
Samsons Brook	18	26 8 38 " 13 2 48
Sth Dandalup R	18	24 7 40 " 30 1 48
Warren River	19	14 5 40 " 20 1 48
Wokalup River	11	2 7 40 " 3 7 47
22	381	

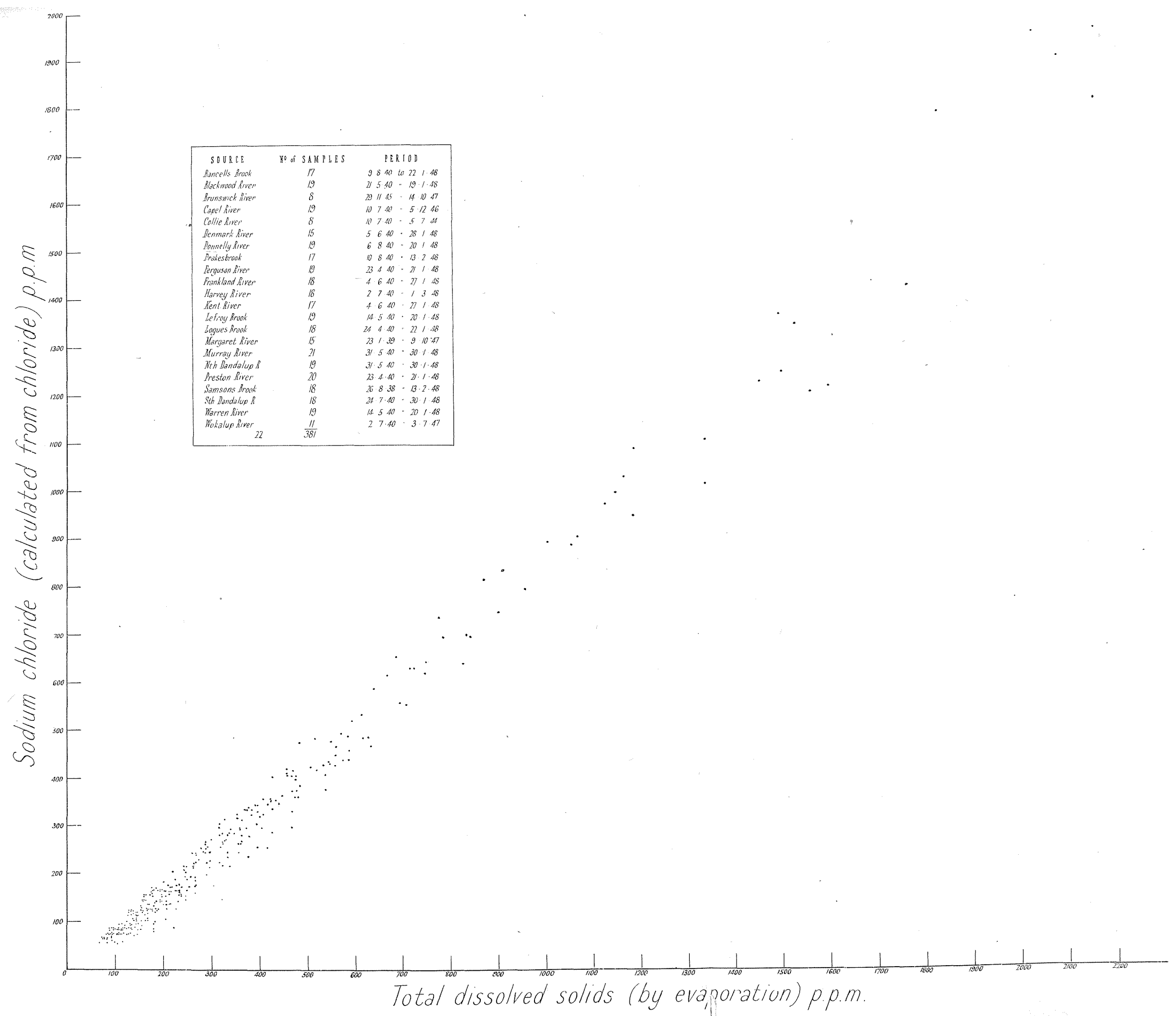


Fig. 1.
Relationship between total dissolved solids (by evaporation) and sodium chloride (calculated from chloride ion) for water samples from rivers and streams in the South West of Western Australia.

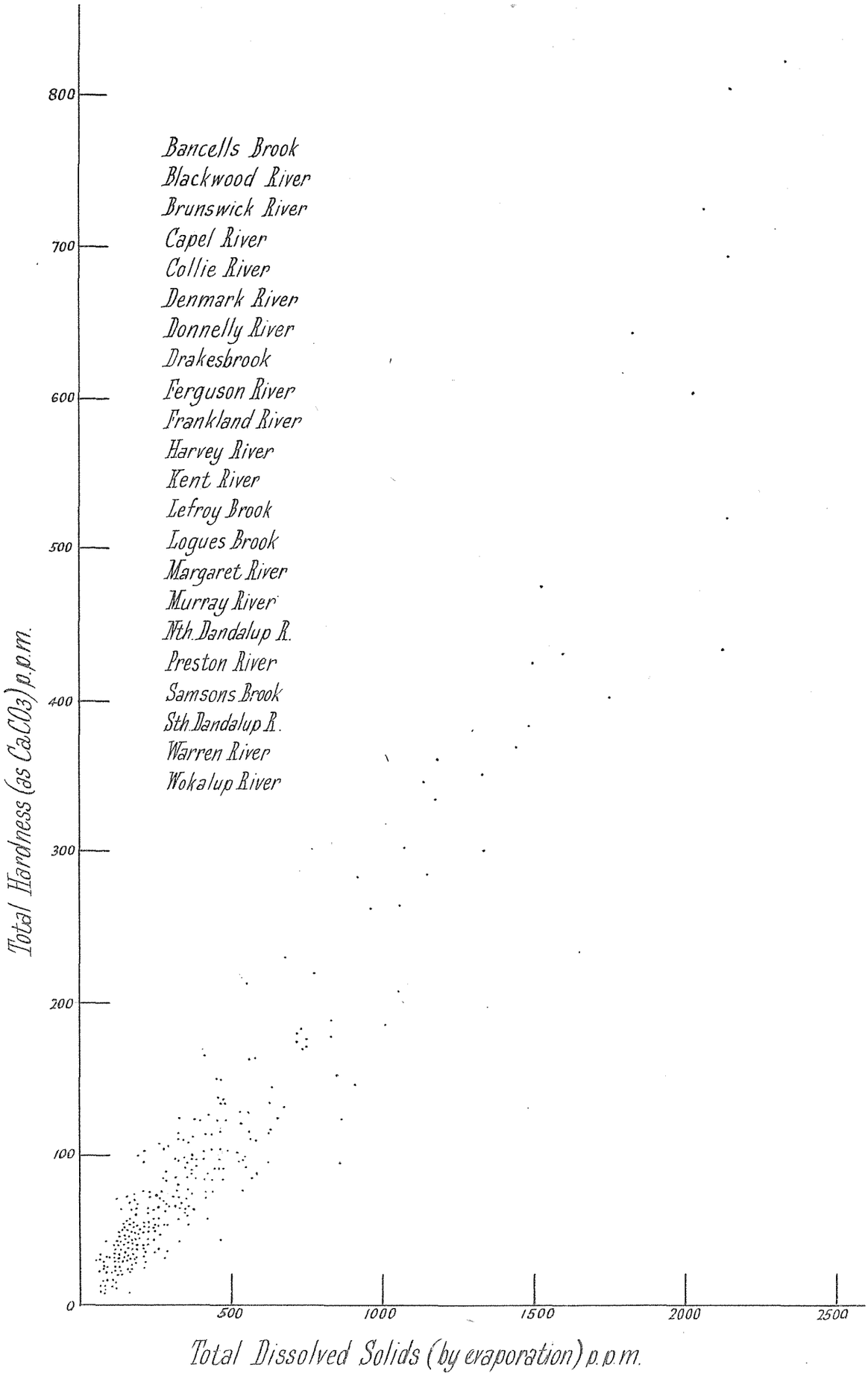


Fig. 2.
Relationship between total dissolved solids (by evaporation) and total hardness (as calcium carbonate) for water samples from rivers and streams in the South West of Western Australia.

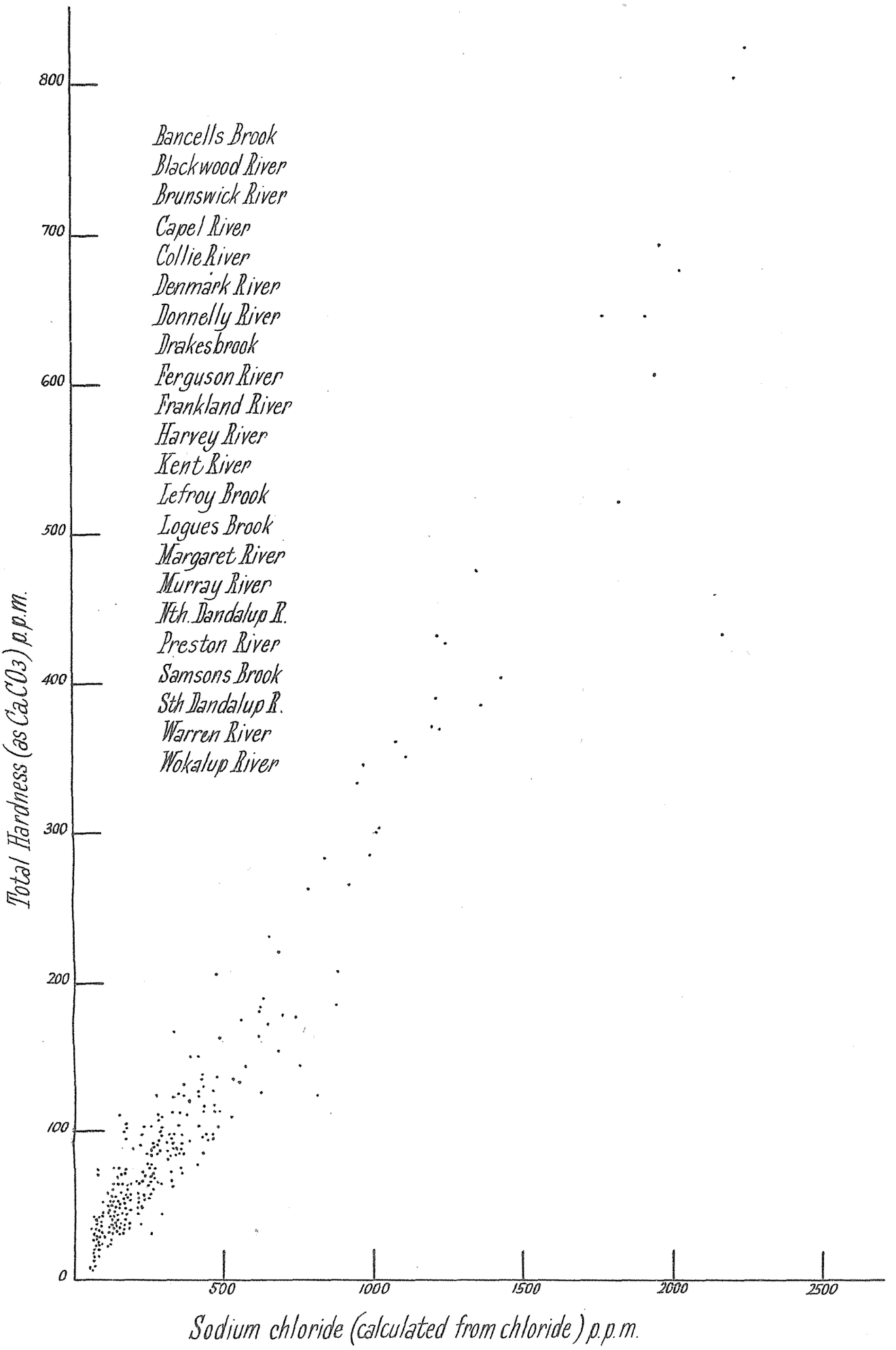


Fig. 3.
Relationship between sodium chloride (calculated from chloride ion) and total hardness (as calcium carbonate) for water samples from rivers and streams in the South West of Western Australia.

APPENDIX.

THE SALINITY AND HARDNESS OF SOME RIVERS AND STREAMS IN THE SOUTH-WEST OF WESTERN AUSTRALIA.

L. W. Samuel, Deputy Government Agricultural Chemist.

Introduction.

The supply of suitable water for domestic, industrial and agricultural purposes is a major problem in Western Australia. The problem is particularly acute in the lower rainfall agricultural areas and in the late summer it is frequently necessary to rail large quantities of water to these areas, more than 2.5 million gallons having been railed in one week.

The agricultural areas of the State are not well supplied with rivers and streams but it is important to know the quality of the water from these rivers and streams. In furtherance of this policy systematic sampling of rivers and streams in the South-West was commenced late in 1938 by the Goldfields and Country Water Supply Department and the samples analysed in the Government Chemical Laboratories.

Materials and Methods.

The original plan was for samples to be obtained at approximately three-monthly intervals and of the four samples taken in any one year three were to be analysed for reaction, pH, total dissolved solids (by evaporation) sodium chloride (calculated from the chloride ion), calcium and magnesium for the calculation of total hardness, and iron. The fourth sample was for "complete" analysis, for reaction, pH, calcium, magnesium, sodium, potassium, bicarbonate, carbonate, sulphate, chloride, nitrate, silica, iron oxide and aluminium oxide. From these results were calculated the assumed combination on exaporation at normal temperature and pressure, the total hardness, the bicarbonate hardness, the non-carbonate hardness, the calcium hardness and the magnesium hardness (hardness expressed as calcium carbonate).

The plan was modified by war conditions and a number of the samples were analysed only for reaction, pH, total dissolved solids and sodium chloride, and are not reported in this appendix.

The location of the rivers and streams and the sampling sites are shown on the accompanying map of the South-West of Western Australia.

Results.

The data for total dissolved solids, sodium chloride and total hardness (as calcium carbonate) are shown in Table I for 381 samples from 22 of the rivers and streams during the period 1940-1948. Of the data not reported, (a) the silica, iron and alumina were uniformly low, the iron content being sufficiently low not to constitute a detriment for normal use of the waters, (b) only five of the samples contained carbonate, Blackwood River, 30th October, 1945; Capel River, 16th April, 1945; Drakes Brook, 26th April, 1945; Frankland River, 23rd October, 1945, and Preston River, 29th November, 1945.

There are considerable differences in salinity and hardness not only between rivers but between samples from the same river at different periods of the year. The changes in individual rivers follow the normal course of increasing salinity and hardness through late summer and early winter, and decreasing salinity and hardness through winter to early summer, due to the effects of the winter rains. This variation between streams and between samples from the same stream at different times is summarised in Table 2 which shows the range for each of the analyses reported here.

The relationships between the various analytical data were examined by "scatter" diagrams for each river and for all samples together and showed the normal relation for the agricultural areas of this State, that the sodium chloride is approximately three-quarters of the total dissolved solids except for the "purer" waters, i.e., less than 200 parts per million (14 grains per gallon) of total dissolved solids. A further interesting and valuable ratio is that for the waters containing more than 200 p.p.m. of dissolved solids the total hardness expressed as calcium carbonate is approximately one-third of the sodium chloride content or one-quarter of the total dissolved solids. The relationship between total dissolved solids (by evaporation) and sodium chloride (calculated from chloride ion); between total dissolved solids and total hardness (expressed as calcium carbonate); between sodium chloride and total hardness is shown graphically in Figures 1, 2 and 3 for all samples.

The correlation coefficients between total dissolved solids and sodium chloride; between total hardness and total dissolved solids; and between total hardness and sodium chloride were calculated for each river and are shown in Table 3. For only one stream, Bancell Brook, is the correlation between total dissolved solids and sodium chloride not significant and for this stream the maxima of total dissolved solids and sodium chloride are 140 and 87 parts per million respectively. Similarly for the other streams where there is either no correlation or a poor correlation between total hardness and either total dissolved solids or sodium chloride, the values of these latter two data are low, generally less than 200 p.p.m. (Drakes Brook, Harvey River, Lefroy Brook, Logue Brook, Samson Brook). The correlation coefficients for all samples taken together were:—

Total dissolved solids and sodium chloride	0.9989
Total dissolved solids and total hardness	0.9937
Sodium chloride and total hardness	0.9961

Where the correlation coefficient exceeded 0.5 the regression equation was calculated. For individual rivers, this equation is shown in Table 3. For all samples taken together the equations were (data expressed as parts per million):—

Sodium chloride = — 10.8 + 0.8527 (total dissolved solids).

Total hardness = — 5.4 + 0.2656 (total dissolved solids).

Total hardness = — 2.2 + 0.3119 (sodium chloride).

As the scatter diagrams and the correlation coefficients show poor or no relationship between total dissolved solids, sodium chloride and total hardness for the "purer" rivers, the statistical data were calculated for all samples except those with less than 200 p.p.m. (14 g.p.g.) of dissolved solids or of sodium chloride.

For all those samples containing more than 200 p.p.m. of total dissolved solids, or of sodium chloride, the correlation coefficients and regression equations were (data expressed as parts per million):—

Total dissolved solids and sodium chloride 0.9994.

Sodium chloride = — 8.7 + 0.8468 (total dissolved solids).

Total dissolved solids and total hardness 0.9966.

Total hardness = — 10.6 + 0.2685 (total dissolved solids).

Sodium chloride and total hardness 0.9961.

Total hardness = — 8.2 + 0.3119 (sodium chloride).

It was expected that there would be a relation between total hardness and either the ratio between or the difference between total dissolved solids and sodium chloride but no such relation was found.

Grateful acknowledgment is made to the Forests Department for the statistical calculations.

TABLE I.

Analyses of Rivers and Streams in the South-West of Western Australia.

Date sampled.	Total dissolved solids.	Sodium chloride calculated from chloride.	Hardness calculated as calcium carbonate from calcium and magnesium.
	PARTS PER MILLION.		
Bancell Brook.			
24/4/40	140	70	9
9/8/40	115	87	72
18/7/41	84	67	33
2/10/42	83	64	14
13/1/43	88	85	29
11/4/43	88	82	28
18/6/43	104	75	28
13/4/45	106	71	22
22/6/45	116	59	12
29/11/45	84	58	36
23/2/46	134	73	36
16/5/46	112	84	41
29/8/46	91	68	21
12/12/46	118	77	23
3/4/47	82	71	26
4/7/47	115	84	34
10/10/47	78	67	11
22/1/48	72	69	23
Blackwood River.			
21/5/40	960	795	261
6/8/40	1190	1086	360
12/7/41	2026	1956	607
16/9/42	395	344	123
18/1/43	1188	949	336
5/4/43	1598	1214	431
14/6/43	1528	1345	475
11/7/44	1500	1246	426
28/3/45	1072	903	263
3/7/45	468	299	42
30/10/45	1495	1365	383
12/3/46	1452	1226	369
8/5/46	1169	1029	301
20/8/46	1150	997	285
4/12/46	2152	1814	520
18/3/47	1764	1422	401
24/6/47	783	696	220
8/10/47	1338	1105	352
19/1/48	1560	1201	392
Brunswick River.			
1/7/40	266	187	38
8/8/40	172	158	63
6/8/41	96	74	18
9/10/42	124	100	28
14/4/43	196	153	46
14/6/43	216	172	56
13/7/44	182	140	65
5/7/45	92	69	17
29/11/45	134	125	38
12/3/46	166	129	55
6/6/46	237	154	76
21/8/46	114	87	36
18/12/46	184	129	37
22/4/47	304	176	71
2/7/47	108	76	11
14/10/47	222	88	28
Capel River.			
10/7/40	628	485	117
24/7/40	594	520	110
7/8/40	363	312	95
10/7/41	198	143	49
16/9/42	142	97	35
12/1/43	520	418	97
14/4/43	572	439	95
22/6/43	468	403	135
12/7/44	328	270	88
16/4/45	588	469	87
2/7/45	148	81	74
31/10/45	318	280	85
11/3/46	534	429	98
7/5/46	509	423	130
21/8/46	180	134	46
5/12/46	632	469	118
19/3/47	586	439	84
23/6/47	132	76	36
9/10/47	324	219	66
Collie River.			
10/7/40	324	263	71
8/8/40	324	264	111
4/8/41	242	215	49
9/10/42	159	142	53
2/2/43	262	212	65
6/4/43	272	230	71
18/6/43	284	247	84
5/7/44	374	297	100
Denmark River.			
5/6/40	842	696	156
15/7/41	373	331	92
23/9/42	142	112	33
7/4/43	548	430	99
14/6/43	484	384	93
18/7/44	321	148	114
20/6/45	416	254	59
23/10/45	319	302	80
19/2/46	692	559	134
15/5/46	749	651	173
26/8/46	349	282	63
26/3/47	668	617	125
26/6/47	176	128	48
7/10/47	290	222	38
28/1/48	542	434	92
Donnelly River.			
13/5/40	176	162	54
6/8/40	169	138	39
29/7/41	134	106	41
15/9/42	142	89	31
18/1/43	160	153	59
5/4/43	268	177	106
4/6/43	180	167	60
11/7/44	166	123	41
28/3/45	208	141	49
3/7/45	180	97	42
30/10/45	155	147	35
20/2/46	238	157	63
13/5/46	204	163	98
20/8/46	144	105	47
4/12/46	246	151	54
18/3/47	234	157	49
24/6/47	102	71	40
8/10/47	194	146	34
20/1/48	160	156	56
Drakes Brook.			
10/8/40	199	152	73
22/8/41	133	87	35
8/10/42	107	87	23
3/2/43	152	124	36
11/4/43	132	124	48
18/6/43	232	165	52
26/4/45	178	167	31
24/7/45	180	86	23
29/11/45	130	97	36
14/3/46	144	111	35
5/6/46	146	120	53
29/8/46	112	81	28
13/12/46	166	109	41
11/4/47	184	129	32
8/7/47	144	101	44
14/10/47	152	126	32
13/2/48	172	126	32
Ferguson River.			
23/4/40	400	320	121
3/7/4 0	448	362	93
13/8/41	162	115	39
9/10/42	179	135	44
18/1/43	296	248	61
5/4/43	288	253	70
18/6/43	268	243	76
19/7/44	296	213	90
26/4/45	428	334	88
5/7/45	128	88	41
29/11/45	262	221	74
—/3/46	356	246	78
4/6/46	340	294	110

Date sampled.	Total dissolved solids.	Sodium chloride calculated from chloride.	Hardness calculated as calcium carbonate from calcium and magnesium.
	PARTS PER MILLION.		
	Ferguson River—*continued.*		
19/8/46	154	101	58
18/12/46	334	237	69
31/3/47	288	263	69
2/7/47	155	91	44
15/10/47	260	216	54
21/1/48	268	240	78
	Frankland River.		
4/6/40	570	491	111
15/7/41	288	252	57
23/9/42	323	282	97
18/1/43	408	324	166
6/4/43	336	218	59
16/6/43	220	205	63
18/7/44	248	194	63
20/3/45	618	483	95
19/6/45	376	237	57
23/10/45	458	420	139
19/2/46	432	354	114
14/5/46	352	319	99
27/8/46	714	630	180
3/12/46	560	466	128
26/3/47	418	346	82
25/6/47	722	630	181
7/10/47	828	631	189
27/1/48	482	473	138
	Harvey River.		
2/7/40	196	158	39
8/8/40	164	158	31
6/8/41	90	74	41
9/10/42	109	94	39
21/4/43	210	177	40
23/6/43	216	163	52
11/7/44	238	171	52
14/4/45	268	194	54
27/6/45	92	60	33
29/11/45	127	122	67
28/2/46	204	137	53
28/5/46	214	164	102
3/9/46	139	101	28
18/12/46	212	137	39
22/4/47	266	177	47
3/7/47	120	91	23
14/10/47	186	132	35
1/3/48	214	138	31
	Kent River.		
4/6/40	1008	894	185
15/7/41	407	357	98
22/9/42	138	118	32
19/1/43	458	406	121
6/4/43	66	59	27
16/6/43	384	335	90
20/3/45	874	814	121
19/6/45	396	257	64
23/10/45	377	340	112
19/2/46	834	700	179
14/5/46	1059	886	209
27/8/46	351	324	61
3/12/46	474	360	85
26/3/47	902	746	143
25/6/47	194	147	54
7/10/47	360	263	60
27/1/48	614	533	137
	Lefroy Brook.		
14/5/40	228	166	43
6/8/40	184	142	43
18/8/41	142	109	36
15/9/42	118	82	28
18/1/43	200	136	52
11/4/43	212	159	50
15/6/43	228	176	75
11/7/44	178	123	36
28/3/45	194	141	40
4/7/45	120	86	34
30/10/45	142	114	51
21/2/46	208	127	77
14/5/46	191	146	70

Date sampled.	Total dissolved solids.	Sodium chloride calculated from chloride.	Hardness calculated as calcium carbonate from calcium and magnesium.
	PARTS PER MILLION.		
	Lefroy Brook—*continued.*		
19/8/46	149	99	56
4/12/46	182	120	48
25/3/47	166	129	30
24/6/47	110	73	39
8/10/47	164	117	30
20/1/48	128	120	40
	Logue Brook.		
24/4/40	180	80	14
9/8/40	97	87	20
18/7/41	88	71	13
2/10/42	79	65	29
13/1/43	92	77	24
11/4/43	134	94	20
18/6/43	104	82	31
18/7/44	92	86	31
27/4/45	108	78	17
22/6/45	100	57	32
31/10/45	84	76	17
16/5/46	100	83	36
22/8/46	77	64	32
12/12/46	90	74	9
1/4/47	88	71	17
27/6/47	78	61	9
10/10/47	94	76	11
22/1/48	160	156	35
	Margaret River.		
23/1/39	230	199	75
7/8/40	193	165	40
9/7/41	260	243	56
9/10/42	124	100	30
12/1/43	200	183	43
13/4/43	296	247	57
21/6/43	236	158	52
12/7/44	160	146	38
2/7/45	136	121	28
31/10/45	132	122	28
7/5/46	470	417	117
20/8/46	139	122	28
5/12/46	204	154	43
23/6/47	144	120	40
9/10/47	168	129	30
	Murray River.		
31/5/40	360	292	64
9/8/40	1828	1783	644
9/8/40	2160	2204	807
18/7/41	2123	2176	434
25/7/41	2334	2259	821
1/10/42	559	499	161
15/1/43	456	410	151
9/4/43	2708	2038	678
19/6/43	2152	1963	694
7/7/44	2076	1903	724
10/4/45	746	620	164
27/6/45	468	330	99
16/11/45	685	654	231
22/2/46	478	374	136
10/5/46	361	280	108
22/8/46	585	488	162
29/11/46	1128	971	345
3/4/47	442	349	103
27/6/47	914	834	284
10/10/47	1342	1011	300
30/1/48	706	563	175
	North Dandalup River.		
31/5/40	232	164	40
9/8/40	185	170	47
18/7/41	153	130	40
1/10/42	136	106	26
29/1/43	229	165	36
9/4/43	248	147	38
18/6/43	192	146	47
21/7/44	176	160	54
10/4/45	248	216	52
23/6/45	112	72	16
16/11/45	152	132	35
22/2/46	226	169	61

Date sampled.	Total dissolved solids.	Sodium chloride calculated from chloride.	Hardness calculated as calcium carbonate from calcium and magnesium.
	PARTS PER MILLION.		
North Dandalup River—*continued*.			
10/5/46	164	146	47
22/8/46	114	96	26
29/11/46	170	137	39
3/4/47	194	169	28
27/6/47	136	102	32
10/10/47	186	123	26
30/1/48	176	171	47
Preston River.			
23/4/40	480	360	122
9/5/40	392	344	85
3/7/40	556	427	116
7/8/40	408	368	114
13/8/41	198	169	100
9/10/42	233	171	59
18/1/43	396	330	99
5/4/43	356	312	91
24/6/43	476	398	150
26/4/45	422	357	73
5/7/45	204	106	13
29/11/45	383	323	99
21/2/46	468	374	92
4/6/46	550	477	214
19/8/46	190	127	60
11/12/46	440	346	76
31/3/47	370	334	74
2/7/47	163	101	51
15/10/47	380	278	77
21/1/48	424	354	87
Samson Brook.			
26/8/38	133	115	45
10/8/40	156	120	32
22/8/41	157	122	41
8/10/42	109	82	29
3/2/43	148	112	37
11/4/43	182	100	28
12/6/43	152	132	48
26/4/45	168	119	22
24/7/45	128	74	20
29/11/45	97	82	33
14/3/46	152	84	31
5/6/46	126	113	38
22/8/46	87	73	29
12/12/46	124	86	28
11/4/47	168	102	21
8/7/47	115	84	34
14/10/47	104	53	22
13/2/48	118	84	20
South Dandalup River.			
24/7/40	638	579	142
9/8/40	774	737	178
18/7/41	517	481	101
30/9/42	225	189	37
15/1/43	226	165	56
9/4/43	202	165	39
12/6/43	264	217	64
21/7/44	316	299	98
22/6/45	132	94	22
16/11/45	329	313	73
15/2/46	250	166	68
10/5/46	196	167	67
22/8/46	247	203	44
29/11/46	300	271	66
3/4/47	218	171	39
27/6/47	243	208	49
10/10/47	538	409	78
30/1/48	254	174	35

Date sampled.	Total dissolved solids.	Sodium chloride calculated from chloride.	Hardness calculated as calcium carbonate from calcium and magnesium.
	PARTS PER MILLION.		
Warren River.			
14/5/40	260	214	58
5/8/40	291	257	82
21/7/41	339	286	65
14/9/42	189	167	76
18/1/43	258	194	59
6/4/43	538	377	120
15/6/43	428	401	127
11/7/44	394	304	94
28/3/45	250	189	56
4/7/45	316	224	72
30/10/45	289	269	32
20/2/46	290	200	89
13/5/46	330	271	124
19/8/46	334	280	116
4/12/46	362	269	88
25/3/47	242	206	53
24/6/47	287	246	106
9/10/47	426	286	93
20/1/48	266	225	67
Wokalup River.			
2/7/40	476	403	104
8/8/40	297	227	106
6/8/41	118	86	29
9/10/42	178	153	56
21/4/43	360	295	87
23/6/43	320	257	87
27/6/45	148	72	22
28/5/46	404	297	102
3/9/46	192	143	47
5/12/46	334	243	41
3/7/47	134	84	26

TABLE 2.

VARIATION IN RIVERS AND STREAMS IN THE SOUTH-WEST OF WESTERN AUSTRALIA.

Stream.	Total dissolved solids.	Sodium chloride calculated from chloride ion.	Hardness calculated as calcium carbonate from calcium and magnesium.
	Range. Parts per million.	Range. Parts per million.	Range. Parts per million.
Bancell Brook	72–140	58–87	9–72
Blackwood River	395–2152	299–1956	42–607
Brunswick River	92–304	69–187	11–76
Capel River	132–632	76–520	35–135
Collie River	159–374	142–297	49–111
Denmark River	142–842	112–696	33–156
Donnelly River	102–268	71–177	31–106
Drakes Brook	107–232	81–167	23–73
Ferguson River	128–448	88–362	30–121
Frankland River	220–828	194–631	57–189
Harvey River	90–268	60–194	23–102
Kent River	66–1059	59–894	27–209
Lefroy Brook	110–228	73–176	28–77
Logue Brook	77–180	57–156	9–36
Margaret River	124–470	100–417	28–117
Murray River	360–2708	280–2259	64–821
North Dandalup River	112–248	72–216	16–61
Preston River	163–556	101–477	13–214
Samson Brook	87–182	53–132	20–48
South Dandalup River	132–774	94–737	22–178
Warren River	189–538	167–401	32–124
Wokalup River	118–476	72–403	22–106

TABLE 3.

Correlation coefficients and regression equations for total dissolved solids (by evaporation), sodium chloride (calculated from chloride ion), and total hardness (calculated as calcium carbonate) for rivers and streams in the South-West of Western Australia.

c.c. is correlation coefficient.
r.e. is regression equation.
T is total dissolved solids.
S is sodium chloride.
H is total hardness.

Stream.		Total dissolved solids and sodium chloride.	Total dissolved solids and total hardness.	Sodium chloride and total hardness.
Bancell Brook	c.c.	0·2670	0·1373	0·5781
	r.e.	....	....	H = —41·4 + 0·9478S
Blackwood River	c.c.	0·9790	0·9530	0·9676
	r.e.	S = —47·3 + 0·8831T	H = —13·1 + 0·2742T	H = 3·5 + 0·3087S
Brunswick River	c.c.	0·8208	0·6763	0·7880
	r.e.	S = 35·5 + 0·5148T	H = 4·8 + 0·2155T	H = —7·8 + 0·4004S
Capel River	c.c.	0·9876	0·8017	0·8378
	r.e.	S = —18·3 + 0·8313T	H = 33·2 + 0·1306T	H = 34·5 + 0·1621S
Collie River	c.c.	0·9897	0·7808	0·7648
	r.e.	S = 33·7 + 0·7141T	H = 2·1 + 0·2622T	H = —7·7 + 0·3559S
Denmark River	c.c.	0·9737	0·8890	0·8600
	r.e.	S = —40·5 + 0·8910T	H = 11·5 + 0·1774T	H = 24·0 + 0·1875S
Donnelly River	c.c.	0·7097	0·5961	0·6133
	r.e.	S = 46·4 + 0·4984T	H = 2·1 + 0·2771T	H = —3·2 + 0·4060S
Drakes Brook	c.c.	0·7498	0·4234	0·5200
	r.e.	S = 19·8 + 0·6219T	....	H = 9·6 + 0·2460S
Ferguson River	c.c.	0·9635	0·8220	0·8243
	r.e.	S = 13·9 + 0·8443T	H = 15·6 + 0·1992T	H = 20·8 + 0·2279S
Frankland River	c.c.	0·9661	0·8070	0·8540
	r.e.	S = 0·8 + 0·831T	H = 13·4 + 0·2127T	H = 11·0 + 0·2616S
Harvey River	c.c.	0·9204	0·3290	0·3960
	r.e.	S = 21·9 + 0·6290T	....	....
Kent River	c.c.	0·9520	0·9260	0·8860
	r.e.	S = —14·8 + 0·8757T	H = 19·5 + 0·1626T	H = 29·6 + 0·1692S
Lefroy Brook	c.c.	0·9181	0·5690	0·4830
	r.e.	S = 7·7 + 0·6839T	H = 7·8 + 0·2247T	....
Logue Brook	c.c.	0·5877	0·0750	0·3220
	r.e.	S = 30·5 + 0·4817T	....	....
Margaret River	c.c.	0·9801	0·9420	0·9350
	r.e.	S = —6·5 + 0·8809T	H = —4·3 + 0·2487T	H = —1·1 + 0·2747S
Murray River	c.c.	0·9826	0·9490	0·9580
	r.e.	S = —49·5 + 0·9362T	H = —23·6 + 0·3161T	H = —4·2 + 0·3351S
North Dandalup River	c.c.	0·8203	0·5555	0·7661
	r.e.	S = 24·1 + 0·6599T	H = 11·4 + 0·1519T	H = 1·5 + 0·2605S
Preston River....	c.c.	0·9741	0·7082	0·7525
	r.e.	S = —33·8 + 0·8988T	H = 0·8 + 0·2450T	H = 31·4 + 0·2022S
Samson Brook	c.c.	0·6799	0·0869	0·6164
	r.e.	S = —16·6 + 0·8401T	....	H = 7·6 + 0·2429S
South Dandalup River	c.c.	0·9875	0·9169	0·9415
	r.e.	S = —37·4 + 0·9680T	H = 1·5 + 0·2093T	H = 8·8 + 0·2192S
Warren River	c.c.	0·8962	0·6333	0·6338
	r.e.	S = 42·6 + 0·6662T	H = 16·2 + 0·2084T	H = 11·2 + 0·2806S
Wokalup River	c.c.	0·9858	0·8364	0·8578
	r.e.	S = —27·8 + 0·8664T	H = 2·2 + 0·2307T	H = 8·9 + 0·2693S

MINERAL, MINERAL TECHNOLOGY AND GEOCHEMISTRY DIVISION.

Annual Report for the year ended 31st December, 1949.

By C. R. LeMesurier, A.W.A.S.M., A.A.C.I., Deputy Government Mineralogist.

One thousand, two hundred and eighty six (1,286) samples were entered for examination during the year, a decrease of 1,143 from the previous year's total. While the decrease is largely accounted for by the cessation of sampling in connection with the Radio-Active Mineral Survey, there has however, been a general reduction in samples received.

The main sources of samples were as follows, the corresponding figures for the previous year being given in brackets:—Assays and determinations for the general public, free, 531 (664); pay, 148 (198); State Batteries, 200 (231); Government Geologist, 145 (313) and Radio-Active Minerals Survey, 63 (827).

ALLOYS AND METALS.

Alloys and metals submitted for analysis included ferro-silicon from an engineering works, pig-iron from Wundowie and silicon from the State Implement Works. In addition numerous samples of constructional materials were submitted as a result of corrosion problems brought about by the enforced use of substitutes for the normal materials in short supply.

Of the available substitutes, aluminium, by reason of its relative abundance, has been extensively used and advice has been sought as to its suitability for various purposes in the building trade.

Aluminium in Domestic Water Service.

Because of its ability to form a protective oxide layer, aluminium is not subject to normal atmospheric corrosion, but as it is anodic when coupled with nearly all the common metals and their alloys, galvanic corrosion may become serious. The following tests carried out in this laboratory on the effect of brass and plated brass couplings on

aluminium tube in a domestic water service illustrate this point. Tap water was used throughout, the pH of which remained constant at between 7.0 and 7.5. Acceleration was effected by aeration with air freed of carbon dioxide.

Results of Tests.

1. *Brass—Aluminium.*

Unaerated water—Aluminium corrosion products were noticeable 12 hours after commencement of test.

Aerated water—Duration of test—7 days.

Corrosion of the aluminium was rapid, resulting in a copious formation of aluminium hydrate and severe pitting, the deepest pit being 1/3rd the wall thickness.

2. *Nickel-plated brass—aluminium.*

Aerated water—Duration of test—7 days.

Corrosion was extensive but not as severe as in (1).

3. *Tin-plated brass—aluminium.*

Aerated water—Duration of test—20 days.

Corrosion though evident was much less severe than (1) or (2). In one sample the coating had been damaged during assembling with consequent increase of corrosion.

4. *Cadmium-plated brass—aluminium.*

Aerated water—Duration of test—20 days.

After seven days the aluminium appeared little affected but the cadmium coating was darkened and had lost its metallic lustre. At the conclusion of the test the cadmium had darkened further and brass was showing in places, particularly at the edges, while tubercules were forming on the aluminium, indicating incipient pitting.

5. *Aluminium-brass in Service Test.*

Duration of test—9 weeks.

A specimen of aluminium tubing which was coupled with brass under service conditions was submitted for examination. The interior of the tubing was uniformly covered with a thick film of aluminium hydroxide while in places concentrations of the hydroxide indicated incipient pitting.

Remarks.

Aeration greatly increases the rate of corrosion as shown by the concentration of pitting where air bubbles impinge on the test specimens. This effect would be greatly reduced under normal service conditions.

The ratio of cathodic (brass, etc.) to anodic (aluminium) areas influences the rate of corrosion. In these tests the ratio was high and corrosion rate correspondingly increased.

Conclusions.

Brass or nickel-plated brass fittings cause rapid corrosion when coupled with aluminium.

Tin-plating of the brass reduced the rate of corrosion very considerably. Cadmium plating gave the best protection while the coating was intact. Cadmium is, however, subject to fairly rapid attack if brass is exposed either through porosity of the coating or mechanical damage.

Coatings, whether of tin or cadmium, to be effective must be dense and free of pin holes and of sufficient thickness to ensure that no brass is exposed during coupling.

A long term test is being carried out to determine the suitability of aluminium vent stacks to sewer house connections.

Aluminium in Acetic Acid Condenser System, Wundowie.

Aluminium tube used in the condenser system of the acetic acid plant at Wundowie failed by pitting after a few months service. The tubes are encased in a mild steel shell and cooling water is drawn from a general sump receiving water from the cooling tower to which is added make-up water from the main goldfields supply. Analysis of the make-up and sump waters by the Deputy Government Agricultural Chemist are as follows:—

Description:	Make-up Water	Water from Sump
Reaction, pH	7.32	7.50
Mineral Matter	Parts per Million	
Calcium, Ca	9	13
Magnesium, Mg	17	24
Sodium, Na	116	170
Potassium, K	5	4
Bicarbonate, HCO_3	21	31
Carbonate, CO_3	—	—
Sulphate, SO_4	17	25
Chloride, Cl	223	322
Nitrate, NO_3	1	1
Silica, SiO_2 / Iron oxide, Fe_2O_3 / Aluminium oxide Al_2O_3	4 / —	11 / —
Total	413	601
Assumed Combination on Evaporation at N.T.P.		
Calcium carbonate, $CaCO_3$	17	25
Magnesium carbonate, $MgCO_3$	—	—
Sodium carbonate, Na_2SO_4	—	—
Calcium sulphate $CaSO_4$	7	10
Magnesium sulphate, $MgSO_4$	15	23
Sodium sulphate, Na_2SO_4	—	—
Magnesium chloride, $MgCl_2$	55	76
Sodium chloride, NaCl	293	432
Potassium chloride, KCl	10	8
Sodium nitrate, $NaNO_3$	1	1
Hardness Calculated as Calcium Carbonate.		
Total hardness	92	131
Bicarbonate (temporary) hardness	17	25
Non - carbonate (permanent) hardness	75	106
Calcium hardness	22	32
Magnesium hardness	70	99

It will be seen that considerable concentration of the salts present in the make-up water takes place and that the sump water will be strongly aerated. Tests carried out on aluminium-mild-steel couples using tap water concentrated to give an equivalent salt content showed that after nine days immersion in de-aerated water little attack took place while in aerated water pitting was pronounced and a considerable volume of corrosion product consisting of a mixture of aluminium hydroxide and basic aluminium sulphate was formed. The corrosion product from the condenser was of similar composition.

Incorporation of magnesium and zinc protective anodes reduced corrosion to an almost negligible amount, but wastage of anodes was considerable.

Copper in Solvent Extraction Plant, Wundowie.

Copper tubes from the heat exchanger and copper sheet and bubblers from the top section of the solvent extractor in the same plant were also badly corroded. The dilute solvent—acid liquor treated contains 1-2% acetic acid and the temperature in this part of the system is between 70°C and 75°C. The bottom of the extractor, where the temperature is about 110C° showed little apparent corrosion although the "sweet water" passing through was of approximately the same acid content.

Tests carried out showed that at a temperature of 75° both the solvent-acid liquor and "sweet water" were corrosive but that on neutralising with calcium carbonate no attack took place.

Welded Copper Tube.

Samples of copper tube representing three different welding fillers were submitted by the Mechanical and Plant Engineer to determine relative corrosion resistance to delta-brine. Two series of tests were made.

(a) With test pieces immersed in delta-brine in which circulation and aeration was effected by an air lift using air free of carbon dioxide.

(b) By rotation of test pieces in delta-brine solution, the circumferential speed of rotation being approximately 30 ft. per minute.

The pH of the delta-brine supplied was 7.6. Period of test, 14 days. pH of brines at conclusion of test (a) = 7.3; (b) = 7.1.

Results are as follows:—

Weld.	Nature of test.	Total area. dm^2	Total loss in weight. Mgm	Loss. mgm/dm^2	Condition of weld.
Silver brazing alloy	Stationary	0·481	115·3	239·8	Slight attack
	Moving	0·436	166·9	382·8	Slight attack
Phosphor copper	Stationary	0·647	151·6	234·3	No attack
	Moving	0·424	138·6	325·5	No attack
Deoxidised copper	Stationary	0·536	127·5	327·9	Very slight attack
	Moving	0·374	129·7	346·9	Very slight attack

The high rate of overall corrosion of all test pieces and the absence of localised intensive attack indicates erosion-corrosion attack, to which copper is particularly susceptible, as the chief agency. The appearance of the tube material after test indicates that grain size is not affected by welding with the silver brazing alloy or phosphor-copper but is considerably coarsened in the the case of the deoxidised copper weld.

Tobin Bronze Weld.

A sample of tobin bronze (high zinc) weld in copper tube from a refrigeration system circulating delta brine, on examination showed almost complete dezincification with consequent failure of the weld.

Galvanised Tubing.

Samples of galvanised tubing were submitted by the Metropolitan Water Supply Department for test as to effectiveness of coating. Tests showed that the galvanising was coherent, was free from pin holes or discontinuity of surface and adheres reasonably well to the pipe.

Stainless Steel.

Samples of stainless steel, to be used in the construction of formalin baths for preserving large specimens were submitted for test. No attack was apparent after six months' immersion in Kaiserling solution.

Ceramics.

Clays.

Clay tests were carried out on nine samples of clay from various localities. Four red alluvial clays from Irwin were tested for suitability for brick making. Two were deficient in clay substance and valueless. Results of tests on the remaining two clays are as follows:—

Mechanical Analysis.

	No. 1.	No. 3.
	Per cent.	
Clay substance	52.95	53.25
Grit —90 mesh	34.37	34.62
Grit —60 +90 mesh	10.03	7.18
Grit —30 +60 mesh	1.68	2.70
Grit +30 mesh	.97	2.25
	100.00	100.00
Ashley Plasticity Figure:	87/100	138/100
Designation:	lean brick clay	brick clay

Working Qualities:

Both clays soften readily in water and mould well to a firm smooth briquette which dries to a strong though slightly distorted body showing some drying cracks.

Burning Tests.

Temperature. °C.	Time.	Linear Shrinkage from air dry.		Porosity.		Colour.	
		No. 1.	No. 3.	No. 1.	No. 3.	No. 1.	No. 3.
	Hours.	%	%	%	%		
950°C.	7	·1	·27	13·8	13·5	Brownish buff	Terra-Cotta
		expansion	expansion				
1050°C.	14	·2	·64	13·6	12·8	Terra-Cotta	Terra-Cotta
			expansion				
1150°C.	21	1·7	·1	10·9	10·5	Dark Red	Reddish Brown
1250°C.	28	4·3	3·0	5·1	4·9	Brownish Red	Reddish Brown

Remarks.

Both clays show some distortion on burning owing to fineness of the grit present and it would be necessary to add a proportion of Grog i.e., crushed burnt brick to the mixture to reduce this. When burnt to 1150°C they give a body which though somewhat porous would be suitable for housebrick or roofing tiles.

A light brown, very plastic clay from Piesseville burnt to a steel hard, terra cotta body at 1050°C, which however, was badly warped and cracked. Blended with a gritty lean clay it could be used in the manufacture of roofing tiles and terra cotta ware.

A white siliceous clay from a large deposit about 3 miles north of the Murchison River, opposite the old South Geraldine Mine, contained approximately 25 per cent. quartz grit and 1 per cent. common salt. After washing out the salt the clay burnt at 1150°C to a good white body which showed incipient vitrification and was just under steel hard, while at 1250°C it was creamy white and steel hard with a few black specks. If precautions were taken to prevent vanadium staining which is evident after immersion in boiling water and drying, this clay should be a useful constituent of white porcelain ware. There is some evidence that the clay has been used as a source of refractory bricks in the construction of the old smelter south of the river.

A cream coloured unctuous and almost gritless kaolin from private property at Kalamunda burnt to a very porous good white body at 1250°C and would be suitable as the refractory ingredient in the manufacture of porcelain ware and for dusting powders.

Kyanite.

Nine samples of kyanite bearing rock from West Beach, 10 miles west of Hopetoun were examined for the Government Geologist, and analysis made on two of the samples.

Magnesite.

Six samples of magnesite from the vicinity of the junction of Bandalup Creek and the Ravensthorpe-Esperance Road were submitted by the Government Geologist for analysis and two samples of ground magnesite were analysed for a milling firm.

Ochres and Mineral Pigments.

Sixteen samples of natural mineral pigments from various localities were examined, but few were sufficiently high in pigmenting substance to be of value. A red ochre from Marble Bar, containing 45.7 per cent. ferric oxide and with tinting power of 75/100 compared to standard red oxide formed a bright red paint of fair density with oil. Other red ochres examined were deficient in ferric oxide or too brown in colour to be marketable.

Metallic Ores and Minerals.

Beryl.

Only two samples of beryllium ore (beryl) were received for analysis during the year, although several specimens were submitted for identification, one of which, from Fraser's Range, Central Division, is from a new locality. It occurs as sparsely distributed small green crystals in a coarse grained pegmatite associated with tourmaline and garnet and is not of economic importance.

It is regrettable that no new economically exploitable occurrences of this extremely valuable mineral have been located since the increase in the price of the ore to nearly £A8 per unit contained BeO, or approximately £100 per ton for high grade ore, encouraged a search for fresh deposits.

Copper Ores.

Forty-seven samples of copper ore were received for assay during the year, but few were of sufficiently high grade to be marketable without prior concentration. However, two samples were received which, if representative of the lode indicate a payable deposit. One, from about 4 miles west of Wodgina, consisting mainly of bornite and chrysocolla assayed 42.7 per cent. copper and 48 oz. of silver per ton and the other from about 8 miles east of the Government Well at old Pilbara contained 23.1 per cent. copper mainly as cuprite and assayed 15 oz. of silver per ton.

In addition 33 samples of cupriferous gold ores were submitted by the State Mining Engineer for assay for gold and copper.

Gold.

About 300 samples were assayed for gold. Of these 102 were gold ores, 32 umpire tailings, 149 battery tailing checks and the balance copper ores.

Heavy Sands.

One hundred and thirty-nine samples of heavy sand were examined for mineral content, of which 63 were for the Radio-Active Mineral Survey, 41 for the Government Geologist, and 35 for the general public. Trial parcels of beach sand ilmenite have been shipped to companies manufacturing titanium white pigments for test, but at the present time no information as to possible markets and prices is available.

Iron Ores.

Eight samples of iron ore were received for analysis and 19 for determination and value. Some of the latter were high grade haematite, but too inaccessible to be of value.

Lead Ores.

Sixteen lead ores and eight lead concentrates were submitted for assay and eight specimens received for determination and value contained lead minerals. This is a serious decline since last year when 80 samples of ore and concentrates were submitted for assay as well as numerous specimens, and reflects the lessened interest in lead mining due to falling prices.

Manganese Ores.

The increase in price from £4 15s. to £6 16s. per ton for ore of 48 per cent. manganese content offered by B. H. P. and the interest in battery grade pyrolusite displayed by Eveready Pty. Ltd. have resulted in considerable prospecting activity in this field, although unfortunately no new deposits equal in grade and extent to the Horseshoe formation at Peak Hill have been proven. Seventy-five samples, of which 49 were submitted by Government Geologist, were received during the year, these were mainly from the Hamersley Gorge in the Phillips River Goldfield.

Tin Ores and Concentrates.

Despite the high price offered for tin ores only 13 samples of ores and concentrates, mainly from the Greenbushes area, were received during the year.

Other Economic Ores and Minerals.

Samples received during the year included asbestos, bentonite, glauconite sands, graphite, limestone, talc and vermiculite.

Graphite.

Flotation tests were carried out on a sample of graphite lode material from private property approximately three miles from Nyabing townsite, 38 miles east of Katanning on the Pingrup line. The sample assayed 12.6 per cent. graphite, with which is associated biotite mica, felspar, quartz, talcose material and a little limonite. Flake is fine and it is necessary to crush through a 30 mesh screen to free it from gangue.

It was found that pine oil frother with kerosene promoter gave better results than either Cyanamid frothers B-23 or No. 60, the products appearing to settle more quickly and being better defined, although all these reagents gave good results. Sodium silicate and citric acid were used as gangue depressants.

Results showed that a product of 90 per cent. carbon with a recovery of over 90 per cent. was obtainable after three cleaner flotations and the regrinding of the cleaner concentrates, screen analysis being as follows:—

		Per cent.
— 30 mesh	+ 60 mesh	25
— 60 "	+ 80 "	41
— 80 "	+200 "	23
—200 "		11
		100

The flake is too fine for use in the manufacture of crucibles but would be suitable for foundry facings, dry cell manufacture, lubricants, stove polish, etc.

Talc.

A sample of strongly sheared, mottled greenish grey talc from P.A. 4709, Mt. Monger, which is adjacent to the old Lass O'Gowrie leases was received for test. The material grinds easily to pass a 200 mesh tyler screen without any evidence of grittiness. The fine powder is white with a faint greenish tinge, has an unctuous feel and adheres well to the skin, and should be suitable for industries requiring a high grade, gritless talc powder such as in cosmetic, paint, rubber and insecticidal dust manufacture. The strongly developed foliation of the material renders it unsuitable for the manufacture of lava ware or insulating blocks.

Complete Analysis of Rocks and Minerals.

Complete analyses were made on 15 samples of rocks from the Coolgardie district and one sample of talc from Mt. Monger submitted by the Government Geologist. Analyses were also made of standard samples of granite and basalt supplied by the Massachusetts Institute of Technology which, jointly with the Geophysical Laboratory in Washington, is carrying out an investigation of the relative accuracy of various techniques, such as linea analysis of thin sections and spectrographic analysis of major constituents, used in determining the chemical composition of rocks. To quote from the letter initiating the project, "any satisfactory comparison of these two methods with standard chemical analyses requires information on the variation in results obtained by a number of analysts using portions of a standard sample. As this has never been done to my knowledge on a scale adequate for statistical study I am writing to ask, etc.", therefore the results of this investigation will be of considerable interest to this laboratory.

Complete analyses were also made of titaniferous magnetite from Gabanintha, about 25 miles east of Nannine and of limonite capping from Mt. Dick, near Northam. The mineralogical composition of the former is interesting as it is reported by Dr. Dunn of the Bureau of Mineral Resources that the vanadium occurs as the vanadium-bearing magnetite coulsonite and the presence of magnesia and absence of alumina suggest that the magnesia is in the form of magnesian magnetite.

Analysis is as follows:—

	Per cent.	Mols.
SiO_2	1.94	32
Al_2O_3	Nil	—
Fe_2O_3	63.52	398
FeO	12.55	175
MnO	0.03	—
MgO	1.17	29
CaO	0.14	3
Na_2O	0.09	2
K_2O	0.04	—
H_2O—	0.37	—
H_2O+	1.68	93
TiO_2	15.74	197
P_2O_5	0.94	7
FeS_2	0.17	1
Cr_2O_3	0.54	4
V_2O_3	0.72	5
	99.64	

Minerals and Rocks for Determination.

Four hundred and thirty-seven specimens of minerals and rocks were received for determination of mineral composition and possible value, of which 373 were examined free of charge for the general public. In addition to those already described above the following are of interest.

Alunite (hydrous sulphate of potassium and aluminium).

From a lake approximately 30 miles south of Coonana, a station on the Trans-Australian line 100 miles from Kalgoorlie, samples were considerably lower in grade than the Lake Campion material. Lake bed alunite has not previously been reported so far east of the main Salt Lake system.

Aragonite (calcium carbonate).

From Yinnietharra Station, North-West Division, occurs as interlocking fan shaped, aggregates of acicular crystals with a somewhat silky lustre and showing wavy colour bands.

"Brown" hornblende.

From Moore's Find near Calyerup, via Ongerup, South-West Division. The hornblende differs from that commonly found in the Goldfields of this State in that it appears brown rather than green in thin section and is quite black in the hand specimen. The mineral exhibits typical cleavages, rather strong pleochroism (X = pale yellowish brown; Y = dark brown; Z = dark brown) γ lies between 1.67 and 1.68, birefringence is rather strong, extinction angle Z $\wedge$ c = 22° (—)2V — 80°. The hornblende is associated with diopside and a calcic plagioclase felspar.

Chalcanthite (hydrous copper sulphate).

From Twin Peaks Station about 80 miles northwest of Mullewa, in the Murchison Division; occurs associated with natro-jarosite (hydrous sulphate of iron and sodium) and a little chrysocolla (hydrous copper silicate), quartz and opal. This is the first reported occurrence of chalcanthite from this locality, it has however, been found at Coodardy, 100 miles to the east. This is a new locality also for natro-jarosite the sole other reported occurrence in the Murchison being at Callytharra Spring on the Wooramel River to the north.

Kyanite (aluminium silicate).

From beach at east end of Cheyne Bay, South West Division; occurs as large bladed crystals encrusted on both sides of a flat lens of quartz and is associated with staurolite and biotite.

Mimetite (lead chloroarsenate).

Wilfley table seconds from concentration of lead ore from the "Silent Sisters" lead mine at Kooline Lead Field, Ashburton River, North-West Division, contained mimetite associated with galena, pyromorphite, magnesite and dolomite. A new locality.

Monazite (phosphate of cerium, etc. containing thorium).

Portion of a wedge-shaped crystal measuring 1.3 inches on the long axis and one inch on the shorter and weighing about 30 grammes was received from Yinnietharra, North-West Division. It is reported to occur associated with a narrow vein of columbite at the junction of beryl and quartz in a pegmatite being worked for beryl. This is a doubly interesting occurrence as besides being a new locality, it is the first reported find in Western Australia of monazite in situ in the pegmatite host.

Native Copper.

From the Ophthalmia Range, North-West Division, occurs in a soft carbonated shale associated with malachite, cuprite and chalcocite, a new locality.

Plumbo-jarosite and beudantite.

From about 11 miles north-east of the trig on the Paterson Range. These two minerals, the former a hydrous sulphate of iron and lead and the latter a hydrous sulphate and arsenate of iron and lead occur in an altered gossany material and are associated with cerrussite, anglesite, limonite and quartz. This is the second recorded occurrence of these minerals in Western Australia, the first being from Mt. Stuart Station, 8 miles north-north-east of Mt. McGrath, Ashburton District.

Prehnite (hydrous calcium aluminium silicate).

Prehnite is a common secondary constituent of the basalts of the East Kimberley Division. Specimens from the vicinity of Ivanhoe Station consisted of prehnite amygdules in basalt and also of prehnitised basalt. In the latter all the felspar and ferro magnesian minerals originally present are completely replaced by prehnite, the ferromagnesium relicts carrying abundant haematite inclusions.

Scheelite (calcium tungstate).

From about 12 miles north-east of the trig on Paterson Range, West Kimberley Division. It occurs as small grains associated with cassiterite. This is the first recorded occurrence of scheelite in the Kimberley Division.

Spodumene (silicate of lithium and aluminium.)

From Kathleen Valley, Central Division; occurs as elongated flattened prisms, deeply striated, in quartz from a pegmatite dyke. The first record of spodumene from this locality.

Valentinite (antimony trioxide.)

From the Comet Gold Mine, Marble Bar; occurs as white, finely acicular crystals associated with stibnite. The first record of the mineral from this locality.

Constructional Materials.

Cement.

Analyses made on samples of local tested and English Tunnel brand Cement are interesting as results show little difference in composition and the specific surface as determined by the air percolation method is identical, as follows:—

Chemical Analysis.	Local Tested Cement.	English Cement.
	%	%
SiO_2	23.07	21.70
Al_2O_3	4.33	5.92
Fe_2O_3	3.39	2.79
TiO_2	0.43	0.37
CaO	62.65	62.85
MgO	1.09	1.25
SO_3	1.18	1.30
Ignition loss	3.50	3.31
	99.64	99.49
Insoluble residue	1.01	0.33
Density gms/cc	3.07	3.13
Specific surface sq. cm/gm	2820	2820

The low figure for insoluble residue in the English cement indicates better grinding and mixing before burning resulting in almost complete combination in the kiln.

Three samples of cement rendering from a house being constructed for the State Housing Commission were analysed for cement-sand ratio. In two cases this was about 1 : 6, in the third the ratio could not be determined as lime had been added to the mix. The rendering was of poor quality and crumbled readily.

Cement Mortars.

A series of sand-cement mortars incorporating various types of cement and fillers was submitted by the Chief Architect for acid resisting tests in connection with the construction of the new abattoirs at Midland Junction.

Cements tested were:—

1. Ciment Fondu (high alumina.)
2. Portland.
3. Portland with fly ash.
4. Nonporite formula acid resisting.

Tests were carried out in (a) running acidified water of pH between 3 and 6 and (b) in still 0.1 per cent. HCl changed every 24 hours.

After two months test the ciment fondu mortar showed slight attack, the surface being roughened by partial removal of the latence all other test pieces were appreciably attacked.

Corroded Sewer Pipes.

A section of pipe from a badly corroded sewer line was examined with a view to lining with ciment fondu. The cement in the inner wall had largely altered to calcium sulphate, the surface layer of which is soft and easily removed by water jetting, while at depth it has set to a hard plaster in which the coarse aggregate is firmly imbedded. Tests showed that a 1 : 3 ciment fondu mortar bonded firmly to the cleaned surface, a pull of approximately 97lb. per square inch being necessary to break the bond.

Gypsum and Plaster.

Analyses were made of five samples of gypsum; 3 of them submitted by the Director of Agriculture for examination as to suitability as soil dressing and two for plaster test. Determinations of total water content were made on four samples of plaster for a firm commencing plaster manufacture.

Industrial Dust Hazard.

During the year 10 samples of industrial dusts and raw materials were examined to determine free silica content and particle size. Of these, five samples were mine dusts submitted by the management of the Western Mining Corporation in connection with an investigation instituted by them into means of controlling dust in the various mines under their control, three were clays used in the manufacture of stoneware pipe and tiles and the remaining two were parting powders submitted by the Chief Inspector of Factories.

TABLE 3.

MINERALOGY, MINERAL TECHNOLOGY AND GEOCHEMISTRY DIVISION.

Source and Description of Samples received during 1949.

	Pay.	Free.	Superintendent State Batteries.	State Mining Engineer.	Government Geologist.	Departmental—Director, Government Chemical Laboratories.	Department of Industrial Development.	Radio-Active Mineral Survey.	Department Supply and Development, Mineral Resources Bureau.	Department of Works and Labour.	Department of Agriculture.	Chief Inspector of Factories.	Metropolitan Water Supply, Sewerage and Drainage Department.	Public Health Department.	P.W.D.—Perth Hospital Construction.	Charcoal-Iron, Wood Distillation Industry.	Pay—State Brickworks.	Pay—State Housing Commission.	Pay—British Phosphate Commission.	Pay—State Shipping Service.	TOTAL.
Metals and Alloys	1	....	....	....	....	1	1	....	....	....	....	....	....	....	....	....	....	....	....	....	3
Ceramics—																					
Clays	....	8	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	9
Kyanite	....	....	....	....	9	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	10
Magnesite	....	....	....	....	6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	8
Natural Mineral Pigments—																					
Ochres and Oxides	7	8	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	16
Metallic Ores and Minerals—																					
Atomic Minerals	2	10	....	....	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	16
Beryllium	5	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	8
Copper Ores	16	28	....	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	47
Gold Ores	12	38	1	46	2	....	....	....	....	....	....	....	....	....	....	3	....	....	....	....	102
Gold Concentrate	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Gold Umpire	....	....	32	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	32
Gold Tailings	2	....	147	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	149
Heavy Sands	11	24	....	....	41	....	....	63	....	....	....	....	....	....	....	....	....	....	....	....	139
Iron Ore	....	3	....	....	....	1	3	....	....	....	....	....	....	....	....	4	....	....	....	....	11
Lead Ores	2	10	....	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	16
Lead Concentrate	5	2	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	8
Manganese	14	12	....	....	49	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	75
Tantalite	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Tin Ores	9	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	10
Tin Concentrates	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3
Other Economic Ores and Minerals—																					
Alunite Residue	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Asbestos	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Bentonite	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Glauconite Sands	....	....	....	....	6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	6
Graphite	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Limestone	1	....	....	....	....	....	4	....	....	....	....	....	....	....	....	....	....	....	....	....	5
Phosphates	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	39	....	39
Roaster Residues	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Talc	2	....	....	....	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5
Vermiculite	....	1	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3
Minerals and Rocks Complete Analyses—																					
Burnt Lime	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Iron Ore	....	....	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Rocks	....	....	....	....	14	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	16
Mineral Specimens for Determination	34	373	....	2	8	....	....	....	20	....	....	....	....	....	....	....	....	....	....	....	437
Miscellaneous—																					
Caustic Lime	1	....	10	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	11
Firebrick	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	4	4
Waters	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Abattoirs Products	....	....	....	....	....	....	....	....	....	5	....	....	....	....	....	....	....	....	....	....	5
White Material (Bore)	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Zinc Ash	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Copper Sulphate	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Constructional Materials (Cement, Mortars, etc.)	7	....	....	....	....	3	4	....	....	12	3	....	4	....	....	....	1	4	....	1	39
Balance Weights and Riders	....	....	10	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	10
Rocks	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	4
Corrosion—																					
Boiler Scale	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Metals	....	....	....	....	....	....	8	....	....	....	....	....	1	....	5	....	....	....	....	....	14
Industrial Hazard—																					
Clay	....	....	....	....	....	....	....	....	....	....	....	....	....	3	....	....	....	....	....	....	3
Dusts and Ores	....	5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5
Parting Powder	....	....	....	....	....	....	....	....	....	....	....	2	....	....	....	....	....	....	....	....	2
	146	531	200	57	145	10	22	64	20	17	3	2	5	3	5	7	1	4	39	5	1,286

FUEL TECHNOLOGY DIVISION.

Annual Report for the year ended 31st December, 1949.

By R. P. Donnelly, M.A., B.Sc. (Oxon)., A.M.I. Chem. E.; M. Inst. Fuel; M. Inst. Gas. Eng., A.A.C.I.

Fuel Technologist.

The principal subjects worked and reported upon during the past year have been:—

The manufacture of Carburetted Water Gas from Collie coal.

Completion of work on methods of analysis of Collie coal in relation to water determination and volatile matter content.

Consideration has been given to the use of Collie coal in the production of iron and the manufacture of steel, and this includes—

(a) use of raw Collie coal on a blast furnace;
(b) briquetting and subsequent coking of Collie coal;
(c) the direct reduction of high grade iron ore with coal chars to produce sponge iron (i.e. pure iron powder).

Work was done at the request of the Crown Law Department to elucidate the behaviour of thick films of oil on harbour waters and their ignitability in connection with a claim against the Fremantle Harbour Trust for £300,000 for damages suffered by a ship through fire.

A total of 71 samples of miscellaneous origin have been analysed inclusive of coals, charcoals, gas samples, limonites for gas purification and oil for water gas carburettion. This number does not include samples taken and analysed in the course of the several major investigations enumerated above.

Use of Collie Coal in Carburetted Water Gas Plants.

Hard coal is frequently used as an alternative to coke as a fuel for the manufacture of carburetted water gas and although Collie coal has been used experimentally on small plants at low rates of gasification for the manufacture of water gas there has been some doubt that its friability and lack of strength when heated would bring about a marked degree of disintegration which would preclude its use at commercial rates of gasification on standard carburetted water gas plants. There is also the further possibility that the high reactivity of Collie coal would be associated with a big wastage of fuel during the blow period of the water gas process and a low thermal efficiency would thereby result. The matter has, therefore, waited the opportunity of a commercial trial.

Such an opportunity has occurred during the past year when, at the request of the Fremantle Gas Company, comparative gas making trials using coke and Proprietary coal were conducted on a new 500,000 cubic feet per day plant hand clinkered and hand charged but automatically operated otherwise as to the valve changes of the gas making cycle. The work was done in conjunction with the engineers of Messrs. Power Gas Corporation (Australia).

The trials have demonstrated that the rate of gas making is reduced by not more than 15 per cent. when coal is substituted for coke, and that the gas making efficiency is not sensibly different from standard figures for such plant when using coke. Figures in support of this opinion are set out in the accompanying tables, and from these it will be noted that the set was adjusted to produce a gas containing a fairly high percentage of inerts which, since this is brought about by inclusion of a percentage of the blow gases in the make, appreciably assists the gas making results. As this result has been obtained without an undue increase in gravity of the gas and as increase in inerts stabilise water gas as to combustion characteristics, the feature can be accepted.

The Fremantle Gas Company has been sufficiently satisfied with the results obtained to continue the use of Proprietary coal in their plant over a period of six months; no operational difficulties have been encountered and the economy of the application is apparently satisfactory.

Accordingly it has been possible to recommend the use of Collie coal in conjunction with gas oil for the production of carburetted water gas for towns gas supply. The recommendation has, however, at the present time, to be limited to the harder coals from the Co-operative series. The coal must also be large lump coal of about +2 —6″ grade.

Attempts to use the softer coals of higher volatile matter content from the Collieburn (or Griffin) Horizon have not been successful. The higher tar content and the liquor contents of these coals bring about excessive cooling of the plant when they distil over immediately after charging to an extent such that liquid particles leave the superheater top during the blow. This feature might perhaps disappear if the coal were fed regularly in small quantities on each cycle, instead of periodically at the end of several cycles, so that the top of the fire is not blacked out by a large mass of raw coal. A decision on this point awaits the outcome of further plant trials.

Other plant is available in the State to which the present work can be extended. One trial made on a plant which differed in respect of possessing a carburettor packed with chequer bricks instead of being of the flash type of carburettor on the Fremantle plant, has operated successfully under our observation with Proprietary coal as a fuel, but as the plant was deficient in a number of respects, no quantative results of value were obtained. This further work also served to show that production of carburetted water gas from Collie coal on a scale of several million cubic feet per day, has to envisage delivery of lump coal of standard size to the plant, and handling of such coal through all stages into the automatic chargers of such plant with a minimum production of fines. Additionally there is the problem of storage without undue disintegration to be considered. But these matters do not constitute insuperable problems.

CARBURETTED WATER GAS PLANT—FREMANTLE.

Results from Collie coal and from Gasworks Coke.

TABLE 1.

Fuel.	Proprietary Coal.	Griffin Coal.	Coke from Vertical Retorts.
Period of Test, hours	17·75	....	5·25
C.W.G. made, cub. ft.	337,900	....	119,800
Gas made, cub. ft./hr.	19,000	....	22,850
Weight of fuel gasified, lb.	12,750	....	4,200
Oil consumption, gals.	820·50	....	260·40
Number of cycles	284·00	....	100·00
Duration of cycle	3′ 45″	....	3′ 8″
C.V. of gas, B.Th.U./cub. ft.	532·00	....	511·00
Clinker and ash, lb./100 lb.	4·83	....	12·05
C.W.G. cub. ft./ton of fuel	59,400	....	63,900
B.W.G. cub. ft./ton of fuel	47,400	....	53,500
Fuel, lb./1,000 cub. ft. of C.W.G.	37·80	....	35·00
Fuel, lb./1,000 cub. ft. of B.W.G.	47·40	....	41·90
Oil, gals./1,000 cub. ft. C.W.G.	2·45	....	2·17
Therms/gal. of oil	1·32	....	1·40
C.V. of B.W.G., B.Th.U./cub. ft.	262·00	....	252·00
Therms B.W.G./1,000 lb. of fuel	55·60	....	60·20
Blue gas efficiency—Therms B.W.G./ Therms in fuel/100, %	58·00	....	58·20
Analysis of Finished Gas.			
CO_2	7·80	7·10	6·20
CnHm	9·10	8·40	8·30
H_2	39·20	39·90	38·30
CO	22·20	22·50	27·80
C_2H_6	1·20	1·80	2·20
CH_4	11·10	8·10	5·40
N_2	9·40	12·10	11·40
Specific gravity	0·65	....	0·68
Maximum rate of carburettion Gals./Oil/cycle	5·70	....	5·70
Theoretical evaporation from waste gas, lbs. of steam from and at 212°F. per 1,000 cub. ft. C.W.G.	50·00	....	50·00

TABLE 2.

Analysis of Blue and Blow Gases.

Fuel.	Proprietary Coal.	Coke.
Uprun—	%	%
CO_2	6·0	5·1
CnHm	0·1	....
H_2	45·4	52·0
CO	39·0	40·0
C_2H_6	0·8	....
CH_4	2·3	....
N_2	7·4	2·9
H_2O vols./100 vols.	42·4	18·9
% steam decomposed	51·7	73·0
Back Run—		
CO_2	13·4	10·0
H_2	61·4	55·0
CO	24·0	35·0
N_2	1·8	....
H_2O vols./100 vols.	61·4	85·9
% steam decomposed	41·7	39·0
Blow Gas—		
CO_2	10·4	13·0
H_2	7·6	4·0
CO	16·7	15·0
N_2	64·8	68·0

TABLE 3.

Details of Cycle and Quantities.

Fuel.	Proprietary Coal. Time.	Proprietary Coal. Per cent.	Coke. Time.	Coke. Per cent.
Total time	3′ 45″	100	3′ 8″	100
Blow	67″	30	68″	36
Up Run	108″	48	80″	42·5
Back Run	50″	22	40″	21·5
	Per cycle.	Per 1,000 cub. ft. C.W.G.	Per cycle.	Per 1,000 cub. ft. C.W.G.
Air to Generator cub. ft. S.T.P.	1,300	1,093	1,520	1,268
Air to Carbur. cub. ft. S.T.P.	923	775	918	766
Steam Up Run, lb.	26·0	21·9	19·0	15·9
Steam Back Run, lb.	20·5	17·2	18·0	15·0
Air/Steam ratio	30·6	....	41·0	....
Temperatures °C. (Generator Top).				
Blow	500	....	560	....
Up Run	450	....	525	....
Back Run	470	....	560	....
Carburettor	710	....	770	....
Superheater bottom	810	....	786	....
Superheater top	730	....	761	....
Superheater average top	770	....	756	....
Superheater blow	720	....	756	....
Generator Base Back Run	290	....	170	....
Heat available for carburettion (therm)	0·639	....	0·64	....
Minimum rate of oil injection (gallons)	5·7	....	5·7	....
Theoretical evaporation from waste heat in Blow gases (lbs. of steam from and at 212°F. for 1,000 cub. ft. C.W.G.)	50	....	50	....

TABLE 4.

Coal, Coke, Ash and Flier Analysis.

Fuel.	Proprietary Coal.	Griffin Coal.	Coke.
H_2O, %	20·66	17·18	16·00
Ash, %	7·17	6·88	11·95
Volatile matter, %	21·73	28·10	3·18
Fixed carbon, %	50·40	47·84	68·87
Carbon from ultimate anlaysis, %	55·60	....	68·79
Calorific Value as received	9,620	10,100	11,334
Cinker and Ash.			
Ash, %	56·48	....	90·57
Fixed carbon, %	43·52	....	9·43
Fliers.			
Ash, %	30·09	....	13·90
Volatile matter, %	8·81	....	3·70
Fixed carbon, %	61·10	....	82·40

Carbon Distribution.	Per cycle.	Per therm B.W.G.	Per cycle.	Per therm B.W.G.
Gasified in Run, lb.	9·21	4·42	12·00	4·76
Gasified in Blow, lb.	14·32	6·83	15·82	6·30
Discarded in Clinker, ash and fliers	1·42	0·68	1·18	0·47

Oil Analysis.	
Initial Boiling Point	212°C.
Mean Boiling Point	290°C.
Per cent. over at 360°C.	95
Paraffins, %	68·0
Unsaturated, %	4·0
Aromatics, %	20·0
Naphthenes, %	8·0
Evaluation Number	72·0

TABLE 5.

HIGH TEMPERATURE GRAY KING ASSAYS (900°C.).

(Cracking Zone at 500°C. (± 20°C.). Results expressed A.R. basis).

Sample.	Coke. %	Coke. Cwt./ton.	Tar. %	Tar. Gals/ton, S.G. = 1	Liquor (1) Total (2) Combined.* %	Liquor Gals/ton.	Gas. Mls/gram, S.T.P.	Gas. Cu. ft./ton, S.T.P.	CO_2.	CnHm	H_2.	CO.	C_2H_4.	CH_4.	N_2.	C.V. calc. B.Th.U. Cu. ft.
Proprietary (Composite† of 4 samples)	57·1	11·4	3·65	8·2	(1) 25·1	56·3	194·1	6,965	15·7	0·4	46·0	13·6	1·7	16·8	5·8	397
					(2) 4·6	10·3			1,093	28	3,201	947	118	1,170	404	
Griffin	54·3	10·8	5·46	12·2	(1) 23·6	52·9	200·0	7,175	13·9	1·6	41·6	14·4	2·3	20·7	5·5	466
					(2) 6·4	14·4			997	115	2,981	1,033	165	1,484	394	

* Total moisture less moisture evolved below 106°C.

† Four samples air dried mixed in equal parts (average moisture = 18·23 per cent.). For purpose of conversion to " as received " basis the A.R. moisture of the four Proprietary samples were averaged (20·54 per cent.).

The Ignition of Oil Films on Water Bearing on the S.S. Panamanian Fire.

This investigation relates to the ignition of films of fuel oils on water when the oil is allowed to spread freely under still conditions. The thickness of film then formed approximates to 0.1-0.2". The investigation was undertaken to elucidate a fire which took place on 17th January, 1945, in Fremantle Harbour, W.A. which had originated in the ignition of oil on the harbour water by a piece of smouldering burlap which had been thrown overboard from a ship, the s.s. Panamanian. The fire was a serious one. The Panamanian herself, was extensively damaged. The matter ultimately became the cause of an action on behalf of those interested in the Panamanian against the Fremantle Harbour Trust and the Commonwealth of Australia, on the grounds that the oil involved in the fire came from submarines under the control of the defendants. The following investigation supported by photographic evidence had a considerable bearing on the hearing and eventually the suit was rejected by the Supreme Court of Western Australia.

One view held was that the oil present on the harbour was diesel distillate spilt from submarines which was readily inflammable. The investigation enabled the writer to give evidence that heavy fuel oil such as could have been spilt by the Panamanian herself in pumping out her bilges or from some overflow of her tanks was more probably responsible for the fire.

In either case it should be made clear that the kind of oil film involved was not a slick of molecular thickness such as is formed on water disturbed by waves or ripples nor a film such as is formed on a perfectly clean water surface. The harbour water was substantially still inward of ships berthed along the Fremantle wharfs and it was not superficially pure in the sense of being free from surface active agents. Under such conditions it was found that diesel distillate oil (S.G. 0.85 and Viscosity 100°F 36" Redwood) assumed a stable thickness of 0.08" on seawater while Heavy Fuel Oil (S.G. 0.93 and Viscosity 100°F—360" Redwood) formed films 0.24" in thickness. Two independent observers agreed on these characteristic film thicknesses and it is probable that the active contaminant which preserves the oil in lenses of such thicknesses is contained in the oil itself and therefore oils, when spilt on to still water in gross quantities, have characteristic film thicknesses.

If such oil films are ignited the thin distillate film burns for about 1-1½ minutes and thicker fuel oil burns for about 3-4 minutes and appears to have the denser, heavier flame of greater intensity. Fuel oil films have therefore a greater incendiary potentiality than distillate films.

Either kind of oil film is readily set on fire by contact with burning fabric which can act in the nature of a wick. The action as a wick implies that the flame on a piece of burning fabric lying on the oil film will rapidly be fed by oil drawn up the fibres of the fabric by capillary action and this will augment the original flame to such a degree that the main body of the oil film is raised to its Open Fire Point (I.P.T. definition) and when this occurs the flame travels from the original wick to the oil surface itself and thereafter spreads rapidly to encompass the whole oil surface. The oil film then burns fiercely, much like an ordinary oil fire, until it becomes so thin that the rate at which heat is conducted downward through it is sufficient to boil the underlying water and so to break up and quench the oil fire.

The burlap material, a piece 6ft. x 8ft., which was cast overboard from the Panamanian in a smouldering condition was well suited to act as a wick. Burlap is a heavy type of jute fabric used for heavy duty sacks. In spinning, spindle oil is introduced into the thread; this oil renders it difficult to put out the smouldering material, it flames up easily again and the charred fibre has considerable residual strength.

It was found experimentally that pieces of burlap of moderate size—2ft. x 2ft. will ignite fuel and diesel oil films by wick action. Evidence was therefore given that the action of the burlap as a wick and not the highly inflammable character of any oil was the real cause of the fire.

A final and weighty piece of evidence in the case was a calculation of oil quantities involved. It was part of the plaintiff's case that the whole of a large area of underwharf water space was contaminated with distillate oil. An estimation based on the area under the wharf and the characteristic diesel oil film thickness of 0.08" gave an improbably high figure for oil spillage from submarines of about 1,000 gallons per submarine per fuelling. On the other hand it was suggested on behalf of the defendants that if the Panamanian had pumped her bilges or otherwise discharged any oil on the morning of the fire any oil which came out could, under the particular calm water conditions of the day of the fire, have lain around her for a period of hours up to the time of the fire and a quantity of only. 100-500 gallons would have sufficed to give a large patch of oil of 0.24in. thick or more. Thick oil films of such nature, it was shown, would hang on to the sides of a ship with some degree of tenacity. Such an oil patch would have considerable incendiary potentiality. There was evidence given that the Panamanian pumped out her bilges whilst in the harbour and had thick black oil similar to fuel oil round her at the time of the fire.

One matter which was elucidated in the course of the investigation was the explanation of how a relatively thin layer of oil can burn readily on water. The surface of the oil must be at its open fire point perhaps 300°-400°F. Despite the steep temperature gradient between top and bottom of the oil film the heat flow away from the burning surface is very slight as the film presents the case of a liquid heated from its surface when convection is absent and heat is transferred by conductivity alone. The thermal conductivity of oil is given in tables as 3.0 x 10.4 C.G.S. units which is half that of asbestos.

TABLE 6.
PROPERTIES OF OILS USED.

	Distillate.	Fuel Oil.
Specific Gravity	0.860	0.931
Viscosity, 100°F .... (Redwood seconds.)	36	360
Flash Point—		
Closed °F	196	224
Open °F	236	314
Fire Point °F	252	334
Distillation °C—		
Initial Boiling Point	220	238
10%	244	310
20%	255	347
30%	264	365
40%	272	369
50%	281	—
60%	289	—
70%	300	—
80%	312	—
Final Boiling Point	364	363
Mean Boiling Point	281	—

USE OF COLLIE COAL IN THE PRODUCTION OF IRON AND STEEL.

The non-coking character of Collie coal and its low fixed carbon content make this coal unsuitable for iron and steel production based on the blast furnace. Raw coal was formerly used on blast furnaces and Collie coal is probably sufficiently robust to be used in this way. Its high reactivity however, appears to preclude its use. During the past year Collie coal has been tried on a cupola to find out if it would generate sufficient heat to melt cast iron. It has also been tried on the blast furnace at Wundowie.

The experiment on the cupola using coal to the extent of three times the normal coke charge showed that Collie coal smelted iron much more slowly than coke and did not produce so high an iron temperature. It was surmised that far too much coal was lost in the form of producer gas and although advantage of this circumstance might be taken on a cupola with secondary tuyeres above the hearth the indication was that on a blast furnace Collie coal would be of slight value.

At Wundowie, up to 18.2 per cent. of the carbon charged to the furnace was provided, in one series of experiments, by Collie coal. This was charged in lump form (about 6 in.). It did not interfere with the operation of the blast furnace nor produce measurable amounts of tar or pitch in the top gas. On the other hand it did not improve the furnace performance. The results are inconclusive but taking them in conjunction with the experiments on the cupola and general experience in the iron industry, the value of going further with them is doubtful. The results of the trial are reported at the end of this section.

If raw coal cannot be worked on the blast furnace the alternative is a briquetted fuel. Briquettes are made from coal by bonding them with pitch. If a sufficient percentage of coking coal is incorporated in the briquette the latter will retain its form and be bonded or coked together if it is carbonised. Ten per cent. of a coking coal plus 5-10 per cent. of pitch is said to suffice for briquetting and coking. From such experiments as we have carried out, it also seems probable that with higher percentages of pitch, of the order of 25 per cent., coking coal can be eliminated and a sufficient bond obtained from the carbonised products of the pitch alone. Pitch, when carbonised by itself, leaves a coke the weight of which is normally about 20 per cent. of the original pitch. It is however, unusual to incorporate large percentages of pitch in briquettes as it is an expensive constituent which may be in limited supply.

If iron ore is heated to 900-1,000°C with reactive coal chars such as can be produced by carbonising Collie coal, the resultant product is iron powder. If the original iron ore is pure and the coal char is low in sulphur and sulphur is further eliminated by use of dolomite or lime in the reducing process, the iron powder made by this method is sufficiently pure to be used as melting stock for steel manufacture. Iron ore from Yampi Sound in conjunction with Collie coal chars appears suitable for production of pure iron powder in this way. It is indeed probable that iron powder must be made in this way to support a steel industry in Western Australia as one of the major requirements of steel manufacture is a supply of scrap iron and steel which is unlikely to be forthcoming. Iron powder, in such circumstances, is said to be an economic replacement for scrap.

Preliminary work has been carried out which shows that Collie coals reduce iron ore readily. Further development calls for technical work along lines already worked out by the U.S. Bureau of Mines to the stage of pilot plant operation.

This method of iron production cannot, however, completely replace blast furnace production of pig iron, as pig iron is required by foundries, and a proportion of pig iron is needed in steel furnaces. As pig iron production however, seems to be the most technically difficult and for that reason the operational process which may have to be carried out on the most limited scale where the use of Collie coal is involved in iron and steel production, it is of value to know that the demands for pig iron can be restricted by use of large proportions of more readily obtained iron powder. According to views expressed by the U.S. Bureau of Mines Metallurgists. they themselves have yet to carry U.S. steel manufacture with them in this.

One further valuable feature of iron powder production is that in the manufacture of the coal char required the tar and gas from the coal are available for other purposes. From the tar useful quantities of pitch will be obtainable which can be used in briquetting. If, for instance, four tons of coal are carbonised, 60 gallons of tar may be anticipated from some Collie seams, together with two tons of coal char. One ton of char can then be used for iron powder production, and the remaining ton may then be briquetted, and to some extent coked by use of the whole residual quantity of tar.

Equally, where iron is made, using charcoal as a fuel, charcoal powder and fines screened from the coal may also be used in the direct reduction of iron ore which, if of high purity, is of priority value for manufacture of high grade steels, for such special purposes as tool making.

In addition to the foregoing generalised investigation of the problems associated with iron and steel production in Western Australia, considerable work has been carried out on the blast furnace and wood carbonising ovens at Wundowie, which is grouped together under the general headings of gas analysis and carbonisation assays.

Results with Proprietary coal in a blast furnace trial are set out below:—

Trials with Proprietary Coal in Blast Furnace at Wundowie—21st to 27th November, 1949.

Coal was used in a ratio to the total fuel of 25 per cent., and the ratio of carbon from the coal to carbon in the total fuel was 18.2 per cent. No trouble was experienced during the trial and there was no evolution of tar in the top gas. The production of iron was not increased by the addition of the coal. This was in part due to the poor quality of charcoal used, and additionally no attempt was made to drive the furnace harder. The top temperature fluctuated between 200°F and 500°F and averaged 350°F.

The coal was unloaded fresh from the trucks, and put in the bins without delay. It was broken as necessary into 3in. - 6in. lumps and picked up with a fork to eliminate smalls. The percentage under 1in. averaged 14 per cent. and that over 3in., 40 per cent.

The charcoal averaged 30 per cent. under 1in. and contained 78 per cent. fixed carbon. It was, therefore, not satisfactory fuel.

The top gas in all these trials with coal was slightly enriched by the inclusion of distillation gases from the coal. The calorific value appears to have been raised from a value of 130 B.Th.U./cu. ft. to 140 B.Th.U. The hydrogen and methane contents are higher by about 2 per cent. each. The CO_2 content is lower, but so also is the CO, so that it is not easy to decide if there is a higher rate of carbon solution with coal in the stock column.

Results:—

AMOUNTS OF COAL AND CHARCOAL.

Date.	Charcoal.	Coal.	Coal as per cent. of total fuel.	Carbon in coal as per cent. of total carbon in fuel.	Iron Produced.
	lb.	lb.			tons.
21-11-49	56,795	*Nil*	....	....	19·35
22-11-49	45,473	7,825	15	10·0	17·65
23-11-49	48,950	14,575	23	17·0	19·35
24-11-49	46,922	16,300	26	18·8	18·3
25-11-49	46,345	15,500	25	18·2	17·85
26-11-49	43,582	15,400	26	18·7	17·95
27-11 49	47,474	5,700	Coal worked out	....	18·85

FURNACE FIGURES.

Date.	Air.	Blast Pressure.	Top Temperature.	Remarks.
	cu. ft./min.	lb.	°F.	
21-11-49	22,000	4	450	Furnace free
22-11-49	22,500	4	300	Furnace free
23-11-49	22,500	3·8	300	Furnace free
24-11-49	20,500	4·5	300	Furnace binding

FUEL GRADING.

	Coal.				Charcoal.			
Date	23rd.	24th.	25th.	Av.	23rd.	24th.	25th.	Av.
Size	%	%	%	%	%	%	%	%
+ 3"	40	37	46·5	41·2	4·0	3·0	3·0	3·0
3"—2"	18	26·2	17·0	20·4	30·0	24·5	23·0	21·5
2"—1"	28	21·0	21·5	23·5	36·0	29·0	45·0	39·5
—1"	14	15·8	15·0	14·9	30·0	43·5	29·0	36·0

ANALYSIS OF COAL AND CHARCOAL.

	Coal.		Charcoal.	
Date	14/17–11–49.	22/25–11–49.	14/17–11–49.	22/25–11–49.
	%	%	%	%
H_2O	19·0	17·76	2·73	2·14
Ash	8·27	9·06	2·81	1·69
V.M.	23·11	22·58	19·66	17·66
Fxd. C.....	49·62	50·60	74·80	78·51

$$\text{Ratio: } \frac{\text{Carbon in coal}}{\text{Carbon in Charcoal}} = \frac{66}{100}$$

i.e. 66 lb. of charcoal is equivalent to 100 lb. of coal without allowing for the poor metallurgical value of excessive smalls in the charcoal.

TOP GAS ANALYSIS.

Date	24–11–49.	25–11–49.	Earlier figures on charcoal alone.
	%	%	%
CO_2	7·64	7·94	9·2
O_2	0·0	0·0	0·0
CnHm	0·0	0·04	0·0
H_2	7·77	9·79	5·5
CO	28·88	27·26	31·3
C_2H_6	0·06	0·0	0·4
CH_4	2·44	2·28	0·7
N_2	53·28	52·70	52·9
Calorific Value— BTh.U./cu. ft.	142	141	132·6

Blast Furnace Dust—Wundowie.
(Lab. No. 3511/49.)

This consists mainly (66%) of charcoal, largely of coarse (+20) mesh. Limestone (14.65%), appears to contribute the main mineral constituent followed by silica (9.1%). Iron or iron oxide total only 3.9%; of this 0.9% is in the ferrous state and 3.0% in the ferric state corresponding closely to composition of magnetite.

Composition of Dust.	Per cent.
Charcoal	66.0
$CaCO_3$	14.65
$MgCO_3$	1.45
CaO	1.5
SiO_2	9.1
Fe_2O_3	3.0
Al_2O_3	1.7
FeO	0.9
N.D.	1.7
	100.00

Similar dust collected in ash trials contained no determinable amounts of tar.

GAS ANALYSIS.

During the past year a continuous flow and also a Bone and Wheeler constant volume gas analysis apparatus have been constructed in the laboratory, and it has been possible to carry out a considerable number of gas analyses.

A series of analyses on an oven carbonising eucalypt wood was made for the State Charcoal Iron Works at Wundowie and a number of blast furnace gas analyses. A large number of gas analyses have also been made of gas evolved in the carbonisation assay of a variety of fuels which are reported under the heading of "Carbonisation Assays." A sample of gas originating with a mass of decaying seaweed was also analysed; it was of high methane content and was found to react on the copper oxide catalyst along with carbon monoxide and hydrogen when this catalyst was at 295°C but it did not at 280°C. Gases of high methane content can therefore give misleading results unless minimum temperatures are maintained on the Bone and Wheeler low temperature furnace.

Charcoal Iron Plant, Wundowie, Western Australia.

The analyses of distillation gases from wood carbonising retorts and of blast furnace gas set out below were carried out on a Gooderham continuous flow gas analysis apparatus as modified in the W.A. Government Fuel Technology Laboratory.

The samples were collected by displacement over pyroligneous liquor, the outflow of which was regulated by means of Edwards' bottles. The use of pyroligneous liquor reduced losses due to solubility of the CO_2 present in high percentages in this gas. This high percentage of CO_2 also introduced the difficulty in analysis that after its absorption the flow and the speed of flush out of the gas analysis apparatus used is very much reduced and minor inaccuracies may therefore be introduced such as the variations in oxygen figure which are not always in balance with nitrogen. The figures obtained are, however, typical of wood carbonisation and charcoal blast furnace practice.

A feature of all the analyses is that the air free carbon dioxide figure of the calculated combusted gas is in excess of 21.0% arising from release of CO_2 in the distillation of the wood and in the case of the blast furnace gas, it is due to carbon dioxide released from the ore and added limestone.

TABLE 7. *NON CONDENSABLE GAS FROM No. 6 OVEN (Charged at 3 a.m. 3/3/49.)*
Samples commenced at 9.0 a.m., Thursday, 3rd March and taken over 2 hourly periods until charge drawn:—

Sample.	Temp. °C.	CO_2.	O_2.	CnHm.	H_2.	CO.	C_2H_6.	CH_4.	N_2.	Calculated Calorific Value (gross) B.Th.U./Cu. ft. S.T.P.
		%	%	%	%	%	%	%	%	
1.—9–11 a.m.	320–317	65·9	0·4	1·6	0·8	24·9	1·7	n.d.	n.d.	....
2.—11–1 p.m.	317–345	61·5	0·5	1·0	0·0	26·4	0·3	8·5	1·8	200
3.—1–3 p.m.	345–355	59·2	0·6	1·0	0·0	30·1	0·9	6·4	1·8	201
4.—3–5 p.m.	355–380	55·5	0·5	1·2	0·0	33·1	1·3	9·5	0·9	253
5.—5–7 p.m.	380–395	49·1	0·0	0·4	0·0	34·7	2·1	12·8	0·9	284
6.—7–9 p.m.	395–410	48·7	0·6	1·4	0·0	34·0	1·7	12·0	1·5	293
7.—9–11 p.m.	410–420	38·3	0·3	1·0	0·8	38·8	2·8	15·9	1·2	358
8.—11–1 a.m.	420	35·3	0·0	2·1	2·4	37·7	3·0	18·0	3·2	413

SAMPLES OF NON-CONDENSABLE GAS TAKEN.

(1) Tuesday, 1st March, 1949, 11–12 a.m.—from all ovens.
(2) Wednesday, 9th March, 1949, 4.15–5.15 p.m.—from all ovens.
(3) Thursday, 10th March, 1949, 9.15–10.15 a.m.—from No. 5 oven. Gas just starting.

Sample.	CO_2.	O_2.	CnHm.	H_2.	CO.	C_2H_6.	CH_4.	N_2.	Air free CO_2.	Calorific Value (gross) B.Th.U./Cu. ft. S.T.P.
	%	%	%	%	%	%	%	%	%	
1	38·2	2·7	1·7	3·6	29·0	2·8	16·8	10·9	....	....
2	38·2	0·7	1·5	3·4	33·5	2·1	16·8	2·8	28·75	360
3	50·15	2·8	0·3	1·1	17·6	0·0	18·3	9·7	....	249

TABLE 8.

TOP GAS ANALYSES—WUNDOWIE CHARCOAL BLAST FURNACE.

Date	10–3–47.	13–7–49.	14–7–49.	14–7–49.
Time	11.30–12.30 p.m.	11.30–12.30 p.m.	11.20–12.20 p.m.	11.25–12.25 p.m.
	%	%	%	%
CO_2	9·3	7·9	9·3	9·6
H_2	4·1	5·0	6·7	6·4
CO	29·4	33·3	31·1	31·6
C_2H_6	0·0	1·5	0·2	0·0
CH_4	2·1	0·0	0·0	0·9
N_2	54·9	52·3	52·7	51·5
	100·0	100·0	100·0	100·0
Air-Free CO_2	23·35	23·4	24·4	24·9

Samples of Gas Received from Emu Point and Characterised as Being the Decomposition of Organic Plant Material Such as Seaweed.

	Per cent.
*CO_2 + H_2S	40.2
O_2	0.6
H_2	0.2
CO	0.2
C_2H_6	1.2
CH_4	51.8
N_2	4.9

*Strong smell of hydrogen sulphide.

Carbonisation Assays of Eucalypt Charcoals and Chars from Collie Coals Related to Iron Production.

Samples of charcoal from retort carbonisation to 450°C of eucalypt woods (chiefly jarrah *E. marginata* and marri *E. calophylla)* have been subjected to carbonisation assay to 900°C without a cracking zone in the Gray King apparatus. The charcoals were samples from batches of a number of carbonisations. The volatile matters and the gas yields from them are considerable and the hydrogen content of the gas is high. It has been of interest to calculate the amount of iron oxide which the gas from a ton of charcoal would reduce. The theoretical amount of iron which could be produced in this way by gaseous reduction approximates to 0.5 tons per ton of charcoal over and above any iron produced through the reducing power of the carbon substance of the charcoal.

A similar kind of result is obtained when the gas content of low temperature carbonised Collie coal chars is considered.

If charcoal fines and chars from Collie coal are used in direct reduction of iron ore, either as briquettes or in rotary kilns, the reducing powers of the occluded gases in these fuels will, to some extent, be developed and require consideration in such application.

TABLE 9.

CARBONISATION ASSAYS AT 900°C. OF EUCALYPT CHARCOALS.

Sample.	Moisture.	Liquor.	Volatile* Matter.	Gas (at S.T.P.).	
				mls./gm.	cu. ft/ton.
1. Test Sample collected 24–11–48	5·21	5·3	22·92	261·0	9,360
2. 1545/49	2·40	....	11·26	253·0	9,080
3. 1546/49	1·86	1·7	6·30	172·2	6,200
4. 1547/49	4·00	2·8	14·84	235·3	8,440
5. 1794/49 Test Rake 6	3·10	2·9	14·60	231·4	8,300
6. 1795/49 Test Rake 14	2·00	1·7	10·85	205·5	7,370
7. 1796/49 Test Rake 16	1·75	1·9	10·23	202·6	7,270

* i.e. gas plus liquor.

Table 10 refers to the complete gas analyses of the gas samples from the foregoing assays. The analyses have been carried out on a continuous flow gas analysis apparatus.

TABLE 10.

ANALYSES OF GAS SAMPLES FROM CARBONISATION ASSAYS TO 900°C. OF EUCALYPTUS CHARCOALS PREPARED AT ABOUT 500°C.

Sample.	1. Test Sample Collected 14–11–48.	2. 1545/49	3. 1546/49	4. 1547/49	5. 1794/49 Test Rake 6	6. 1795/49 Test Rake 14	7. 1797/49 Test Rake 16
Volume of gas cu. ft./ton (Cu. ft. Table)	9,360	9,080	6,200	8,440	8,300	7,370	7,270
CO_2	12·0	7·7	2·2	5·4	5·2	5·6	5·6
O_2	....	....	....	....	....	....	....
CnHm	....	....	....	....	....	....	....
H_2	41·9	56·2	65·8	52·1	52·5	59·3	59·8
CO	24·1	13·1	9·6	20·5	21·3	12·2	14·3
C_2H_6	0·6	0·9	0·5	....	....	....	....
CH_4	21·4	22·2	21·2	22·05	21·4	22·7	19·9
N_2	....	....	....	....	....	....	....

Average air free CO_2 from charcoal = 20·0.

Table 11 refers to the amount of iron ore which the gases evolved from the charcoal can reduce theoretically. The amounts are surprisingly large.

TABLE 11.

POTENTIAL IRON PRODUCTION OF RESIDUAL GASES IN THE CHARCOAL.

Sample No.	Oxygen demand of residual gas per ton of charcoal for formation of water and carbon monoxide.		Weight Fe_2O_3 to supply oxygen demand.	Iron produced in the reduction.
	Vol. cu. ft.	lb.	lb.	lb.
1	5,172	429	1,426	998
2	5,774	479	1,592	1,113
3	4,088	339	1,126	788
4	4,990	414	1,376	962
5	4,845	404	1,344	940
6	4,695	389	1,294	904
7	4,344	360	1,196	836

PROXIMATE ANALYSES OF CHARCOALS.

Lab. No.	1545*	1546*	1547*	1794	1795	1796
Marks	Wandoo.	Jarrah.	General.	Test Rake 6.	Test Rake 14.	Test Rake 16.
Proximate Analysis (Per cent. as received)—	%	%	%	%	%	%
Moisture	2·40	1·86	4·00	3·10	2·00	1·75
Ash	1·60	0·12	0·52	n.d.	n.d.	n.d.
Volatile matter	11·25	6·30	14·92	14·60	10·85	10·23
Fixed carbon	84·75	91·72	80·59	82·30	87·15	88·02
	100·00	100·00	100·00	100·00	100·00	100·00
Gross Calorific Value B.Th.U./ lb. charcoal as received	14,220	14,720	13,660	13,860	14,340	14,510

* The volatile matters in these charcoals were obtained by adding one drop of benzole and heating in a crucible shielded with asbestos for seven minutes at 925°C. ± 5°C. in a vertical tube furnace. The asbestos shield reduced the rate of heating and so prevent loss of carbon by entrainment. This procedure gives a maximum and reproducible figure for volatile matter.

TABLE 12.

GAS ANALYSES OBTAINED IN CARBONISATION ASSAYS OF COLLIE COAL AND EUCALYPT WOOD CHARCOAL.

Origin of Sample.	Low Temperature 560°C.										High Temperature (560–900°C.).								
	Total Gas cu. ft./ ton at S.T.P.*	Gas Analysis. (1) Per cent. (2) Cu. ft./ton at S.T.P.								Total Gas cu. ft./ ton at S.T.P.	Gas Analysis. (1) Per cent. (2) Cu. ft./ton at S.T.P.*							
		CO_2.	O_2.	CnHm.	H_2.	CO.	C_2H_6.	CH_4.	N_2.		CO_2.	O_2.	CnHm.	H_2.	CO.	C_2H_6.	CH_4.	N_2.
Griffin GS/C1–5	3,200	(1) 43·2	....	2·1	12·2	15·9	3·1	19·2	4·2	4,885	(1) 6·2	....	1·0	54·8	13·3	....	18·6	6·1
		(2) 1,382	....	67	390	509	99	614	134	....	(2) 303	....	49	2,680	650	....	909	298
Griffin GS/C 6–18	3,036	(1) 45·4	....	1·8	9·2	18·8	4·1	20·3	0·3	5,230	(1) 5·4	....	0·2	56·5	13·5	....	20·5	3·9
		(2) 1,378	....	55	279	571	124	616	9	....	282	....	10	2,955	706	....	1,072	204
Co-operative GS/C 22–41	2,385	(1) 44·9	....	1·3	13·2	15·2	4·5	20·9	....	5,145	(1) 5·7	....	0·6	58·6	13·2	0·4	16·5	5·0
		(2) 1,070	....	31	315	362	107	498	....	....	293	....	31	3,013	679	21	849	257
Proprietary GS/C 57–62	2,465	(1) 58·6	....	0·4	12·4	13·6	2·0	13·0	....	5,090	(1) 7·9	....	0·1	51·3	11·9	0·5	17·1	5·2
		(2) 1,390	....	19	294	323	48	309	....	....	(2) 402	....	5	2,915	605	26	870	264
Eucalypt wood charcoal	....	(1) 38·2	0·7	1·5	3·4	33·5	2·1	16·8	2·8	....	(1) 5·3	....	....	57·6	15·2	0·3	21·6	....

*S.T.P. = 60°F. + 30 in. Hg. saturated.

TABLE 13.

CARBONISATION ASSAYS OF COALS TO 600°C.

(Gray King Apparatus—Returned on Basis of 20 per cent. Water in Coals).

Lab. No.		6106/49.	7203/49.
Origin		Black Diamond Bottom 12 ft.	Wyvern.
Solid Residue	%	60·8	54·3
	cwts/ton	12·2	10·85
Liquor	%	22·4	25·0
	Gals/ton	50·17	55·9
Tar	%	2·27	8·6
	Gals/ton	5·08	19·3
Gas	Ml/100 gm.	6,870	9,480
	cu. ft./ton	2,465	3,400
	calorific value		
	B.Th.U./cu. ft.	439	623
	Therm/ton	10·8	21·2
Gas Analysis—		%	%
CO_2		36·52	22·0
O_2		0·0	0·0
CnHm		1·02	3·0
H_2		12·87	18·6
CO		22·46	14·3
C_2H_6		3·98	6·8
CH_4		23·17	32·6
N_2		0·0	2·7

ANALYSIS OF COLLIE COAL.

Refinements of techniques in the moisture and volatile matter determinations of sub-bituminous Collie coal have been further investigated.

Moisture Determination.

Collie coal oxidises too rapidly for accurate moisture figures to be obtained by weight loss in drying ovens even of the commercial vacuum type. The Dean and Starke method of azeotropic distillation of the water with a petroleum fraction solvent of boiling point 105 — 110°C is therefore used. It is found that this method agrees with the moisture displaced by nitrogen and determined by absorption from the nitrogen by anhydrone. The determinations by the Dean and Starke method are made on 100 gram samples and those using the nitrogen displacement method on 5 gram samples. The complementary determination of the loss in weight of the coal dried in nitrogen does not agree in any determination with the results of the foregoing two methods. The nitrogen used in the determinations was substantially pure containing less than 0.1 per cent. of oxygen as determined by a modified Winkler method. Such a quantity of oxygen in the 7.0-10 litres of nitrogen passed over the coal if it reacted fully and was entirely retained by the coal, would not account for more than half the discrepancy noticed between the direct and indirect methods of water determination. Nor can such a discrepancy arise from systematic weighing errors as they are of the order of 0.05 grams. It must therefore be assumed that nitrogen is absorbed in replacement of part of the desorbed water. This suggestion offers scope for further investigation and the results substantiate the unreliability of moisture determination by weight loss of the coal itself.

TABLE 14.

Sample.	1. Moisture by Dean & Starke.	2. Moisture displaced by N_2 and collected in an hydrone	3. Loss of weight of coal dried in N_2 in (2).
	%	%	%
Co-op. Mine, Moira Seam	15·36	15·32	14·69
Co-op. Mine, East Side	15·22	15·15	14·37
Griffin Mine	14·32	14·35	13·93
Cardiff Mine, *ex* E.P. Power Station	21·55	21·57	20·96
Proprietary Mine	15·29	15·22	14·82

Volatile Matter.

Collie coal decrepitates and is displaced from the crucible by evolved water and gases in the B.S.S. method of volatile matter determination. It has been found that if the coal is first preheated to 425°C for an exact optimum period of 10 minutes the further standard 7 minutes heating at 925°C then gives an accurate and reproducible figure for volatile matter. The standards of accuracy are two fold: (1) agreement with the Bone and Silver determination in which coal in a small tube is heated gradually up to 925°C in its own atmosphere of evolved gases and then cooled again in the same way (2) a minimum value for volatile matter which is not greatly increased by increased time of heating which indicates that though there has been no adventitious entrainment loss volatile matter removable in the standard B.S.S. method is complete.

A temperature of 425°C has been selected as the right temperature for preheating as this temperature gives almost complete elimination of moisture but does not initiate tar and gas evolution to any marked degree. It may be suggested that water could be as easily eliminated by oven drying of the sample prior to volatile matter determination. With Collie coals, however, oven drying causes oxidation of the coal and apparently additional coal is made removable (as by CO_2 formation) in the volatile matter determination. In consequence the volatile matter determined after oven drying is found to be systematically about 1.0 per cent. higher than by our accepted method of preheating to 425°C.

Initially determinations were made in two muffle furnaces but subsequently a furnace with twin tubes of 1.75 in. i.d. silica tube was used in which one tube was maintained at 425°C and the other at 925°C. A series of determinations made in this furnace check against the Bone and Silver method. In this latter series of determinations the crucible was heated both with and without

TABLE 15.

Coal Sample.	Method of Volatile Matter Determination.	Result.	Remarks.
	Muffle Furnace Determinations.		
A	Bone and Silver to 925°C.	28·61	Indicates agreement with Bone and Silver and degree of completeness of volatiles removal.
A	10 mins. at 450°C. and 7 mins. at 925°C.	28·45	
A	10 mins. at 450°C. and 8 mins. at 925°C.	28·97	
A	10 mins. at 450°C. and 9 mins. at 925°C.	28·97	
A	Dried in oven for 1 hr. at 106°C. and then determined directly at 925°C.	29·27	Influence of oven drying.
B	10 mins. at 420°C. and 7 mins. at 925°C.	28·13	Correct result.
B	Dried 1 hr. at 106°C., 7 mins. at 925°C.	29·23	Increase of 1·1% through oven drying.
	Tube Furnace.		
C	Bone and Silver to 925°C.	25·72	....
C	7 mins. at 410°C., 7 mins. at 925°C. Unshielded crucible	26·20	Insufficient preheat.
C	10 mins. at 410°C., 7 mins. at 925°C. Unshielded crucible	25·70	Sufficient.
C	10 mins. at 460°C., 7 mins. at 925°C. Shielded crucible	25·31	Too high preheat.
C	10 mins. at 425°C., 7 mins. at 925°C. Shielded crucible	25·42 25·55 25·61 25·63 25·61 25·62	Repeatable though 0·1% low on Bone and Silver.

a shield without affecting the results by more than 0.1 per cent. A shield consisting of a nickel crucible lined with asbestos paper was therefore adopted as a convenient way of supporting the V.M. crucible, in the furnace, and as an extra insurance against shock heating. (Full details of the furnace used and the schedule of operation are available from the Government Chemical Laboratories, Perth, W.A. and will be published subsequently.)

Activities of Limonites in Gas Works Purification.

Samples of limonite iron oxide from Wundowie and Clackline deposits show between 1.0 and 6.0 per cent. absorption of sulphur from reaction with hydrogen sulphide when exposed for a period of five minutes reaction time. Both the less and the more active samples appear to be equally effective in gas purification.

TABLE 16.

Time of Contact.	Percentage of Sulphur taken up by oxide from :		
	Works A.	Works B.	Wundowie Fines.
mins.			
¼	0·82	0·61	0·56
½	0·92	1·53	0·71
1	1·05	2·60	0·87
1½	1·11	3·31	0·97
2	1·17	3·82	1·07
3	1·22	4·63	1·17
4	1·28	5·25	1·30
5	1·37	5·81	1·40
10	1·66	7·79	1·73
15	1·88	9·20	1·93
20	....	10·50	....

Absorptions measured in an atmosphere of 35% H_2S : 65% N_2.

Evaluation of Gas Oils.

Analyses of Gas Oils used in Western Australia in production of Carburetted Water Gas show that the oil available at present from Abadan is superior to that from North Borneo. Evaluation is made on the basis of per cent. of the oil distilling below 360°C and on its paraffin and unsaturated hydrocarbon content.

TABLE 17.

Source.	Abadan.	North Borneo.
Initial Boiling Point, °C.	200	218
Mean Boiling Point, °C.	282	275
Percentage distilling below 360°C.	96	80
Analysis of Distillate below 360°C.	%	%
Unsaturateds	5·0	7·0
Aromatics	17·4	23·7
Naphthenes	13·6	25·0
Paraffins	65·0	44·3
	100·0	100·0
Valuation (Paraffins + Unsaturateds)	70·0	51·3
Probable therms. per gallon of oil	1·3	1·2

MISCELLANEOUS COAL SAMPLES—PROXIMATE ANALYSIS OF CALORIFIC VALUE.

Distinguishing Number.	Origin.	As Received Basis.					Ash Dry Basis.	Dry Ash Free Basis.	
		Moisture.	Ash.	Volatile Matter.	Fixed Carbon.	Calorific Value.		Volatile Matter.	Calorific Value.
		%	%	%	%	B.T.U./lb.	%	%	B.T.U./lb.
2568/49	Moira Seam	16·63	9·53	22·87	50·97	9,920	11·43	30·85	13,440
6105/49	Black Diamond Top 6 ft.	48·1	13·91	20·25	17·74	Soft unwashed coal of no commercial use.			
6106/49	Black Diamond Bottom 12 ft.	23·79	4·08	20·85	50·38	9,300	6·53	29·27	13,050
7203/49	Wyvern Coal	20·25	3·66	30·52	45·57	10,130	4·59	40·10	13,310
3861/49	From Collieburn* GS/C311	20·0	3·45	30·31	46·24	9,900	4·31	39·59	12,930
3862/49	,, GS/C341	20·00	8·65	28·84	42·51	9,210	10·80	40·47	12,900
3863/49	,, GS/C307	20·0	12·10	27·62	40·28	8,650	15·12	40·67	12,750
3864/49	,, GS/C317	20·0	12·06	31·71	36·23	6,980	15·08	46·67	10,270
3865/49	,, GS/22	20·0	4·30	30·59	45·11	9,700	5·37	40·41	12,890
3866/49	,, GSC/46	20·0	16·54	25·93	37·53	8,170	20·66	40·85	12,860
3867/49	,, GSC/51	20·0	8·61	29·31	42·08	9,130	10·76	41·06	12,780
3868/49	,, GSC/328	20·0	16·61	22·48	40·91	8,190	20·76	35·48	12,920
4293/49	,, GSC/313	20·0	7·42	29·27	43·31	9,470	9·27	40·34	13,050
4294/49	,, GSC/352	20·0	7·87	29·52	42·61	9,380	9·84	40·93	13,010
8167/48	From Shotts* Bore A_3 at 81½ ft.	20·0	7·49	22·63	49·88	9,255	9·36	31·21	12,760
8168/48	,, 86½ ft.	20·0	6·29	29·15	44·56	9,510	7·86	39·54	12,890
8169/48	,, 103 ft.	20·0	9·50	23·14	47·36	9,060	11·87	32·82	12,840
8170/48	,, 115 ft.	20·0	6·29	24·55	49·16	9,510	7·86	33·31	12,890
8171/48	,, 150½ ft.	20·0	3·18	26·11	50·71	10,010	3·98	34·00	13,040
8172/48	From Shotts* Bore A_5 at 200 ft.	20·0	2·24	27·59	50·17	9,850	2·81	35·48	12,070
8173/48	,, 264 ft.	20·0	9·36	26·42	44·22	8,920	11·70	37·39	12,620
8174/48	,, 65½ ft.	20·0	2·67	29·17	48·16	9,620	3·33	37·72	12,440
8175/48	,, 97 ft.	20·0	2·28	31·05	46·67	9,590	2·85	39·94	12,340
8176/48	,, 116 ft.	20·0	3·91	30·79	45·30	9,310	4·89	40·45	12,230
214/49	....	20·0	6·17	22·97	50·86	9,450	7·72	31·11	12,810
215/49	....	20·0	8·52	22·49	48·99	9,250	10·65	31·45	12,950
216/49	....	20·0	5·61	23·52	50·87	9,730	7·01	31·61	13,100
217/49	....	20·0	8·48	21·51	50·01	9,370	10·58	30·05	13,100
1273/49	From Shotts* Bore No. 5 at 55½ ft.	20·0	7·18	23·87	48·95	9,550	8·98	32·77	13,120
1274/49	,, 64 ft.	20·0	10·59	21·06	48·35	8,920	13·23	30·35	12,840
1275/49	,, 71 ft.	20·0	3·78	25·06	51·16	10,140	4·72	32·88	13,300
1276/49	,, 128½ ft.	20·0	5·23	23·53	51·24	9,890	6·53	31·47	13,230
6668/49	From Shotts* Bore A_2 at 50 ft.	20·0	5·36	27·34	47·30	9,880	6·70	36·64	13,230
6669/49	From Shotts* Bore No. 16 at 50 ft.	20·0	3·98	26·98	49·04	10,130	4·97	35·48	13,320
6670/49	,, 21 at 68 ft.	20·0	8·02	23·73	48·25	9,380	10·02	32·98	13,020
6671/49	,, 22 at 39½ ft.	20·0	8·60	23·83	47·57	9,320	10·74	33·37	13,060
6672/49	,, 23 at 69½ ft.	20·0	4·74	24·63	50·63	9,940	5·92	32·73	13,200
6673/49	,, 23 at 79 ft.	20·0	5·56	26·16	48·28	9,830	6·95	35·14	13,200
6960/49	,, 24 at 35 ft.	20·0	6·75	24·38	48·87	9,330	8·44	33·29	12,740
6961/49	,, 24 at 97 ft.	20·0	6·67	23·72	49·61	9,470	8·34	32·34	12,920
6962/49	,, 24 at 113 ft.	20·0	11·84	21·27	46·89	8,750	14·80	31·20	12,830
6963/49	,, 24 at 123 ft.	20·0	7·70	23·68	48·62	9,460	9·62	32·75	13,090
6964/49	,, 24 at 133 ft.	20·0	8·01	22·89	49·10	9,390	10·02	31·79	13,040
6965/49	,, 24 at 168 ft.	20·0	8·52	25·41	49·07	9,850	6·90	34·11	13,230

* Analyses returned on a 20 per cent. moisture basis as the samples as received were washed, precussion drill samples containing variable amounts of free water.

INDUSTRIAL CHEMISTRY DIVISION.
Annual Report for the Year Ending 31st December, 1949.

By A. Reid, M.A., B.Sc., A.R.I.C., Chief Industrial Chemist.

Classification of Work.

Activities of the Division fall under four main headings:—

i. assistance to State Industries;
ii. consultative work;
iii. production difficulties;
iv. laboratory research.

(i) Assistance to State Industries.

Mr. M. T. Sloss was lent to Wundowie for a few days in October during a temporary staff shortage at the Charcoal Iron Works. On a number of occasions assistance was given to the Acting Chief Chemist in locating references to literature.

(ii) Consultative Work.

A large number of enquiries on a variety of topics were dealt with by 'phone or by interview. Prices and sources of supply of materials, potential markets for new products, and information on the properties of various substances, featured largely in the enquiries.

An intending manufacturer of insecticides, fertilisers and general garden products consulted the Division on methods of manufacture and on general formulation. Some experimental work was done in this connection, particularly on emulsions. This manufacturer has now a well-established business.

A client marketing a waterproof paint requested advice on certain aspects of his product. It was possible to make a few suggestions for improvement. The paint has recently been used successfully in a major job in Sydney.

Some experimental work on magnesia cements was begun and is being continued, as a result of enquiries by a maker of pre-fabricated structures. A difficulty in connection with the adhesion of Portland cement to pre-fabricating moulds was overcome by selection of a suitable oil for painting the moulds.

Advice was given a client working on fibre boards. In the course of some preliminary experiments, it was found that a wax of interesting possibilities could be extracted from Guildford grass and a new method found for preparing strong line fibre from the grass. It is hoped further to investigate this matter when circumstances permit.

The Division was consulted by an intending maker of roofing materials the principal ingredient of which was bitumen.

Two manufacturers of polishes were given advice and help in connection with preparation of their products.

A suitable red dye was found for a maker of plastic artificial eyes.

Some work was done and small samples prepared of a marketable salt from Widgiemooltha. Experiments on Rottnest salt were also conducted on a small scale.

Advice on Indian bentonites and on bentonites generally was given to a gentleman interested in their commercial application.

The Division co-operated with the Mineral Division in examining samples of plaster of Paris. It was found in the course of simple experiments that plaster of Paris can be very successfully made using the fluid bed technique. This it is hoped to develop later, on a rather larger scale.

Samples of a proprietary type of plastic piping were examined on behalf of the Public Works Department. The piping appeared to be of the methacrylate type and to have certain disabilities in use under W. A. conditions.

The possibilities of resuming production of black-boy gum were raised by Department of Industrial Development and at the same time the Division received enquiries from two private individuals. For their information a report was prepared covering past work on this topic and reviewing present trends. The outlook is not promising.

A shortage of barium carbonate led to an investigation as to its manufacture in this State. A report on the subject was submitted to Department of Industrial Development. Suitable raw material in quantity does not appear to be available.

A proposal to re-open a lime burning works at Dongara was looked into from the economic angle. Consumption of lime in the Geraldton area is too small to warrant operation of the kiln and transport charges are too high to allow the lime to compete with that which is made in the metropolitan area.

At the same time, the possibility of making lime-sand bricks at Dongara and in Perth was raised. The difficulty lies in the cost of equipment required but the lime sand brick is suited to W.A. conditions and its manufacture should not be ruled out on the high initial cost of equipment alone.

(iii) Production Difficulties.

Staining of plaster in a Perth works was traced to the growth of some types of mould in the plaster itself. It appeared that spores carried in the air were responsible for the infection. Certain remedial measures were suggested, and the obtaining of the opinion of a mycologist on the matter recommended.

The Division was consulted on a matter of laundry waste removal and a few suggestions were made.

A city store experienced difficulty in laying linoleum on bar tops. The difficulty was due in part to insufficient cleaning of the surface of the bar and partly to the method of application of the proprietary adhesive used. When these matters were attended to, the difficulty was overcome.

(iv) Laboratory Research.

Other duties left the staff little time for research, particularly as one officer had a lengthy period of sickness during the year. It was, however, possible to continue some work on Marchagee bentonite, from which it was concluded that the chief mineral was aluminium saponite, a conclusion which was separately verified by X-ray and other investigations by Dr. R. E. Grim of Illinois Geological Survey. Now that the principal mineral is known, it is possible to determine to what extent and in what manner the bentonite may best be beneficiated.

As a result of work on bentonite samples from Cardabia it has been tentatively concluded that the principal mineral is beidellite; this it is hoped to verify by other methods. The Cardabia bentonite can be used as oil-well drilling mud and its potentialities in foundry sand work are to be tested in actual practice. More work on the Cardabia bentonite is projected.

Some preliminary tests on fluid-bed treatment of minerals such as magnesite and limestone indicate that the technique has great possibilities. It is hoped circumstances will permit the continuance of this work.

Chief Industrial Chemist has served on two Government Committees during the year, the Pyrites Committee and the Committee appointed to consider the application of the lime-sinter process to Chandler Alunite.

As in previous years it is a pleasure to record the courtesy and co-operation of manufacturers and suppliers in the course of the work of the Division.

FUTURE PROSPECTS.

The most encouraging feature of the year has been the increasing number of small manufacturers to whom it has been possible to give advice and help. The prosperity and soundness of secondary industry in this State depends on the successful promotion of a relatively large number of comparatively small manufacturing establishments, more than on the lodgment of isolated large manufacturing interests, important as the latter may be. The State seems to have many "small" men willing to "have a go," and in quite a few cases with sufficient ability to attain their objective. It is on such men that the future true industrial prosperity of W.A. will largely depend.

Division VIII.

Annual Report of the Chief Inspector of Explosives for the Year 1949.

The Under Secretary for Mines:

I have the honour to submit for the information of the Hon. Minister for Mines, in compliance with Section 45 of the Explosives Act, 1895, my report on the working of the Branch for the year 1949.

The quantity of explosives imported into the State during the year is shown in Table No. 1, and Table No. 2 giving a comparison of the quantities imported during the past five years.

TABLE No. 1.

Importation of Explosives into Western Australia During 1949.

	lb.
Gelignite	3,098,900
Gelatine Dynamite	437,500
Permitted Explosives	932,500
Blasting Powder	55,000
	4,523,900

	lb.
Detonators No. 6 Number	2,800,000
Detonators (Electric)	950,000
Fuse (Yards)	4,845,600

TABLE No. 2.

Explosives.	1945.	1946.	1947.	1948.	1949.
	lb.	lb.	lb.	lb.	lb.
Gelignite	1,634,850	3,038,950	3,379,650	2,817,700	3,098,900
Gelatine Dynamite	235,300	297,500	548,800	346,650	437,500
Permitted Explosives	945,250	472,250	443,750	621,600	932,500
Powder (Blasting and Pellet)	15,000	15,000	22,500	35,500	55,000
Detonators No. 1	1,814,000	2,543,500	3,360,000	3,514,000	3,750,000
Fuse (Yards)	3,768,000	4,318,533	5,344,800	5,085,600	4,845,600

The following tests were made during the year for the purpose of determining the suitability for use, chemical stability, and velocity of detonation of explosives:—

Explosives	1,622
Fuse	348

The following table shows the number of Licenses issued during the year:—

Magazines on Government Reserves	53
Magazines used in Government Departments and on private property	112
Store Licenses Mode A	75
Store Licenses Mode B	1
Fireworks Licenses	317
Importation Licenses	2

The quantity of explosives used in the different classes of industry for the year 1948 and 1949 is given hereunder.

	1948 lb. Used.	1949 lb. Used.
Gold Mining	3,263,150	3,241,300
Coal Mining	268,600	261,000
Agricultural	73,800	85,600
Quarrying	132,650	156,200
Mining and Base metals	65,400	66,500
Government Departments	58,650	65,570
Miscellaneous	61,850	90,280
	3,924,100	3,966,450

Owing to pressure of other work, it was impracticable this year to inspect all magazines and licensed stores in the State. Those visited were found generally to comply with requirements, and where such was not the case there was a ready response to instructions intended to rectify unsatisfactory features. Close attention has been accorded the magazines at Woodman's Point Explosives Reserve, where repairs ranging from minor work to partial rebuilding were recommended and placed in hand following a visit from one of Messrs. Nobels' technical officers. A check on numerous small magazines operated by quarrymen and lime burners, mainly foreigners, has also been conducted. Some of these licensees, pleading ignorance, have on occasions moved their magazines to other properties or have sold out without notifying the Department.

At the request of the Midland Junction Police, a small quantity of gelignite badly affected by exposure was destroyed. Apart from this and the routine disposal of samples after heat testing, no other destruction was necessary during the year.

As in 1948, the issuing of firework licenses both for importation and sale, and the sampling and examination of the goods, entailed much clerical and technical work from about mid-July till early November.

A total of 32 shipments from England and China involved the examination of 533 samples at Woodman's Point testing laboratory, and 14 detailed chemical analyses were undertaken by the Government Chemical Laboratories. Several small consignments of Victorian manufacture arrived by rail. In this latter instance, it is usual to release for sale on the Victorian Explosives Department's certificate of compliance with State regulations, which are somewhat more stringent than our own. Through the year, several English manufacturers submitted with their initial consignment for the season a sample box of fireworks, certified to represent each line in the accompanying and future shipments. Where the samples comply with the Act in a chemical sense and are otherwise satisfactory, immediate release in an emergency may be permitted, but the right to examine and if need be to withhold any fireworks from sale is retained and exercised.

It is felt that fees for the examination of fireworks are due for revision. At present, the authority to import is issued gratuitously, the only charge being one guinea per shipment for sampling, examination and furnishing of the release note. Some consignments, notably those from China, might comprise but half a dozen varieties, whilst in others between 30 and 40 samples have to be collected. Apart from travelling time, this task can occupy two hours, and a similar period is required for testing in the observation laboratory at the Explosives Reserve. Where detailed chemical analysis becomes necessary, further consumption of time and materials must be taken into account. From the Departmental viewpoint a more equitable though still inadequate scale would comprise the existing flat rate plus a surcharge of one shilling for each sample beyond 20. An alternative system, perhaps fairer to the small importer, might base the fee on both the number of samples and the total weight of a consignment.

Pursuant to decisions at Conferences of Australasian and New Zealand Chief Inspectors of Explosives held at Melbourne in 1948 and 1949, Victoria and New South Wales have already promulgated amended firework regulations. Simi-

lar action being contemplated in Western Australia, it is hoped shortly to submit for approval a draft almost identical with the Eastern States code. Although the Explosives Act empowers the Inspector to ban any firework considered dangerous, it restricts chemical composition only insofar as disallowing admixed sulphur and chlorate. For the guidance of manufacturers and importers, and in conformity with conference resolutions, it is believed that additional specific prohibitions should be embodied, thereby leaving the drag-net clause to be invoked only in situations not at present envisaged. The main points under consideration are the limiting of explosive charge weights, extending the list of prohibited chlorate admixtures to include aluminium, magnesium, phosphorus and sulphide, and the rejection of fireworks which after ignition are liable to be projected on an erratic or unpredictable flight.

A fireworks factory, intended primarily for the manufacture of display lines and set pieces, was licensed by the Department recently. The licensee, who was formerly associated with the pyrotechnical trade in Europe, is at present operating only on a small scale, but it is nevertheless hoped that his enterprise will form the nucleus of a local industry.

Extensions to the Woodman's Point jetty are expected to be completed by about the end of April, 1950. Several set-backs, including the unavailability of a pile driving float and the sinking of a barge following a collision during bad weather have delayed the work. The lengthened structure will readily accommodate Messrs. Nobels' diesel engined vessel, "Taranui," whose licensed capacity is 400 tons or 16,000 cases of explosives. Compared with present shipments averaging half this quantity, all of which has to be lightered from Gage Roads, economies should be effected when the "Taranui" is regularly employed on explosives traffic to Western Australia.

The second conference of Chief Inspectors of Explosives of Australia and New Zealand was held in Melbourne commencing April, 26th. Further discussions along the lines adopted at the inaugural meeting took place and considerable additional material was introduced. Messrs. Nobels' new factory in the course of construction was visited, and an inspection of the Victorian Explosive Department's laboratory was undertaken. At the Altona Reserve some interesting tests on the stability of packaged fireworks to impact were conducted. Similar experiments in which boxed dummy explosives were dropped from varying heights on to a hard floor yielded useful information as to the holding qualities of nails, strength of the boxes and inner linings, and security of the carton wrappings.

The stimulus to gold mining consequent upon devaluation brought about renewed interest in the question of importing explosives through Esperance. A summary of information available at the time, presented briefly in the 1948 annual report, perhaps conveyed an impression of simplicity, and indeed protagonists of the scheme have been apt to assess its advantages in terms of reduced railway freight resulting from shorter haulage rather than to view the manifold issues involved. To clarify the situation an analysis of costs and other aspects was undertaken toward the close of the year. Considering that commercial explosives importations only amount to about 85,000 cases or 2,200 short tons annually, the cost of providing facilities either for lightering from a roadstead or direct discharge over a deep-water jetty would be out of all proportion to the volume of traffic. To quote one major item—that of a suitable jetty—investigations have established the cost at £107,000 which, without interest, depreciation, maintenance, etc., would be tantamount to a surcharge of one shilling per case on all explosives imported through Esperance for the next 30 years. The saving in rail freight to Kalgoorlie compared with the longer journey from Woodman's Point is but 10.6 pence per case. In the instance of ships from the Eastern States carrying explosives with or without other cargo for Esperance, economy would be effected by elimination of the return journey of about 1,000 miles to Fremantle. The practicability of this, however, appears to be contingent upon suitable back-loading from Esperance. Everything considered, and in view of the fact that the cost of instituting a full scale scheme would be at least £174,000 it is obvious that the practice of unloading direct from shallow-draft vessels at Woodman's Point Explosives Reserve is the more economical.

The juxtaposition of two large explosives consignments in September threatened to tax the storage capacity of the magazines. The matter was adjusted by increased railages to Kalgoorlie, where a temporary overloading was authorised until the goods passed into consumption. Although disconcerting at the time, the situation at present stands in gratifying contrast to that of October, 1948, when shortages of several lines left no option but to institute a certain amount of rationing for several months.

Known originally as Deer Park Explosive No. 1, but later renamed Semigel, a semi-gelatinous explosive roughly intermediate to Quarry Monobel and A.N. Gelignite 50 was introduced on an experimental scale last November. Observations on trials in the Lake View and Star and Great Boulder Proprietary Gold Mines, at which I was present in company with two of Messrs. Nobels' technical officers, indicate a decided preference for the new explosive. Reports later to hand from the underground managers mentioned that although Quarry Monobel and Semigel brought down roughly the same quantity of ore in stopes and drives, the improved fragmentation reduced the need for secondary blasting. Additional remarks dealt with the excellent tamping properties of Semigel, and one manager expressed the opinion that it should replace AN Gelignite 50 and a certain proportion of the 60. Several other mines are also interested in its potentialities. Further supplies of Semigel are expected in 1950, and application has been made for its authorisation.

Several fires in which magazines were destroyed without explosion of their contents are under investigation. It seems difficult to reconcile the quiescent burning of confined explosives without detonation occurring, but admittedly knowledge of the modern ammonium nitrate explosives in this regard is fragmentary. Their behaviour is obviously different from that of their prototypes containing sodium and potassium nitrates.

There has been improvement in the standard of packaging explosives, with the result that relatively few cases leave the ships' holds in damaged condition. Two years ago, on isolated occasions, the incidence of breakage reached 1.3 per cent. In the instance of binding wires missing from numerous cases in one oversea shipment, investigation placed the blame on Liverpool stevedores, who removed the wires to facilitate sliding of the cases. Under our local regulations the offence would have been viewed seriously and treated accordingly, but all that could be done in the circumstances was the directing of the British authorities' attention to the matter.

Small quantities of bulk-packed explosives continue to reach the State. The practice has been accorded some measure of approbation by large consumers, although for prospectors, farmers and others using small quantities the conventional carton-packaging is desirable. Slight economy in the size and weights of cases could be effected if bulk packing were more general. On one occasion through the year, plugs of bulk-packed gelignite showed deformation to an extent of assuming a roughly triangular section. So far the matter has not been fully explained, and is remarkable in that other recent bulk-packed consignments have not thus deteriorated in physical form.

Through the year the staff have given efficient and loyal service both in the office and at the Explosives Reserve. I must also endorse last year's remarks as to the cordial relationship existing between this branch and those manufacturing, importing and using explosives, and refer appreciatively to help extended by several Government Departments and particularly by fellow officers in the Mines Department.

F. F. ALLSOP,
Chief Inspector of Explosives.

Division IX.

Report of Chairman, Miner's Phthisis Board, and Superintendent, Mine Workers' Relief Act.

Under Secretary for Mines:

I have the honour to submit, for the information of the Honourable Minister for Mines, my report on this Branch of the Mines Department for the year 1949.

Under arrangements similar to previous years the Commonwealth Health Department continued the periodical examination of mine workers, the work being carried on continuously by the Health Laboratory at Kalgoorlie, and by a mobile Laboratory which visits the mining centres in the various Goldfields. The Goldfields not visited during the year were the Ashburton, Gascoyne, Kimberley and Phillips River, which are all remote and contain few mine workers.

Mine Workers' Relief Act.

The examinations under the Mine Workers' Relief Act during the year totalled 5,489, compared with 5,134 for the previous year, an increase of 355. The results of the examinations for 1949 together with those for the previous years are shown in the Tables annexed hereto. A graph is also attached illustrating the trend of the examinations since their inception in 1925. In explanation of these figures I desire to make the following comments.

Normal, etc.

These number 5,162 or 94.03 per cent. of the men examined, and include men having first class lives or suffering from Pneumoconiosis only, the figures for the previous year being 4,827 and 94.02 per cent.

Early Silicosis.

These number 263, of which 24 were new cases, and 239 had been reported previously, these figures being the same as those for the previous year. Early silicotics represent 4.79 per cent. of the men examined, the percentage for the previous year being 5.12 per cent.

Advanced Silicosis.

Of the 51 cases reported 20 were men who advanced from early Silicosis during the year, the other 31 having been previously reported. Advanced Silicotics represent 0.93 per cent. of the men examined, the percentage for the previous year being 0.68.

Silicosis plus Tuberculosis.

Six cases were reported, compared with four for the previous year, and represent 0.13 per cent. of the men examined.

Tuberculosis Only.

Seven cases were reported, compared with five for the previous year and represent 0.13 per cent. of the men examined.

General.

A new Mobile x-ray unit was purchased during the year and should be in operation during 1950. This will be a big improvement on the old plant as it will have its own transport and power and will be able to visit centres which were inaccessible to the old Unit.

Mines Regulation Act.

Examinations under the Mines Regulation Act totalled 2,198. This was in addition to the 5,489 examinations under the Mine Workers' Relief Act. These show an increase of 704 compared with the previous year.

The 2,198 men comprise 1,411 new applicants and 787 re-examinees for the Initial Certificate.

Particulars of the examinations are as follows:

New Applicants—

Normal	1,269
Pneumoconiosis	30
Silicosis Early	1
Silicosis Advanced	—
Query Tuberculosis	23
Tuberculosis	3
Pneumoconiosis plus Query Tuberculosis	1
Pneumoconiosis plus Tuberculosis	—
Silicosis Early plus Query Tuberculosis	1
Silicosis Early plus Tuberculosis	—
Silicosis Advanced plus Query Tuberculosis	—
Silicosis Advanced plus Tuberculosis	—
Other conditions	83
	1,411

Of the above applicants for admission into the industry 1,269 received the Initial Certificate (Form 2) 43 received Special Certificates (Form 9) 25 received temporary rejection Certificates (Form 3) and 74 received Rejection Certificates (Form 4). Thus of 1,411 new applicants, 1,269 were eligible for employment anywhere in a mine, 43 were eligible for surface employment and 99 were not eligible for any employment.

Re-examinations—

Normal	531
Pneumoconiosis	140
Silicosis Early	19
Silicosis Advanced	1
Query Tuberculosis	29
Tuberculosis	6
Pneumoconiosis plus Query Tuberculosis	6
Pneumoconiosis plus Tuberculosis	—
Silicosis Early plus Query Tuberculosis	2
Silicosis Early plus Tuberculosis	2
Silicosis Advanced plus Query Tuberculosis	—
Silicosis Advanced plus Tuberculosis	—
Other conditions	51
	787

These men had previously been examined and some were engaged in the industry prior to this examination. 531 received the Initial Certificate (Form 2) six received temporary Rejection Certificates (Form 3) 24 received Rejection Certificates (Form 4) 58 received Re-admission Certicates (Form 6) 167 received Special Certificates

(Form 9) and one received a Prospectors Certificate. Thus of the 787 men examined, 589 were eligible for employment anywhere on a mine, 167 were eligible for surface employment and 30 were not eligible for any employment.

Grouping the two sets of figures discloses that the following Certificates were issued under the Mines Regulation Act.

Initial Certificate (Form 2)	1,800
Rejection Certificate Temporary (Form 3)	31
Rejection Certificate (Form 4)	98
Re-admission Certificate (Form 6)	58
Special Certificate (Form 9)	210
Prospectors Certificate	1
	2,198

The percentage of men of normal health to the number examined was 82 compared with 79 for the previous year.

Under the new Mines Regulation Act and Regulations which came in to operation on the 1st May, 1949 the Special Certificate (Form 9) was abolished and this Certificate can now only be issued to those persons who held it prior to the date the new Act came into operation.

Miner's Phthisis Act.

The amount of compensation paid during the year totalled £27,482 1s. 0d. compared with £29,198 12s. 3d. for the previous year, a decrease of £1,716 11s. 3d. which is due to the death of some of the beneficiaries and the attainment of the age of 16 years by some of the dependant children.

The number of beneficiaries under the Act on the 31st December was 240 being 37 ex miners and 203 widows.

J. THOMAS,
Superintendent, Mine Workers' Relief Act.
3/3/50.

TABLE SHOWING RESULTS OF PERIODICAL EXAMINATION OF MINE WORKERS FROM INCEPTION OF EXAMINATIONS (1925) TO 31st DECEMBER, 1949.

First Examination (1925–26).

		Per cent
Normal, etc.	3,239 =	80·5
Silicosis Early	459 =	11·4
Silicosis Advanced	183 =	4·5
Silicosis plus Tuberculosis	131 =	3·3
Tuberculosis only	11 =	·3
Total number of men examined	4,023 =	100·0

Second Examination (1927).

			Per cent.
Normal, etc.—			
Previously reported as normal, etc.	2,290		
New cases (*i.e.*, cases examined for the first time)	826		
		3,116 =	83·6
Silicosis Early—			
Previously reported as early	348		
New cases	33		
		381 =	10·2
Silicosis Advanced—			
Previously reported as Advanced	85		
New cases	8		
		93 =	2·5
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	13		
Previously reported as Silicosis Early	27		
Previously reported as Silicosis Advanced	62		
New cases	26		
		128 =	3·4
Tuberculosis only		10 =	·3
Total number of men examined		3,728 =	100·0

PERIODICAL EXAMINATION OF MINE WORKERS—*continued.*

Third Examination (1928).

			Per cent.
Normal, etc.—			
Previously reported as Normal, etc.	2,738		
New cases	239		
		2,977 =	85·5
Silicosis Early—			
Previously reported as Normal, etc.	47		
Previously reported as Silicosis Early	303		
New cases	12		
		362 =	10·4
Silicosis Advanced—			
Previously reported as Normal, etc.	1		
Previously reported as Silicosis Early	16		
Previously reported as Silicosis Advanced	79		
New cases	2		
		98 =	2·8
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	10		
Previously reported as Silicosis Early	14		
Previously reported as Silicosis Advanced	10		
New cases	8		
		42 =	1·2
Tuberculosis only—			
Previously reported as Normal, etc.	3		
New cases	1		
		4 =	·1
Total number of men examined		3,483 =	100·0

Fourth Examination (1929).

			Per cent.
Normal, etc.—			
Previously reported as Normal, etc.	2,099		
New cases	21		
		2,120 =	81·9
Silicosis Early—			
Previously reported as Normal, etc.	100		
Previously reported as Silicosis Early	224		
New cases	2		
		326 =	12·6
Silicosis Advanced—			
Previously reported as Silicosis Early	34		
Previously reported as Silicosis Advanced	60		
		94 =	3·6
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	8		
Previously reported as Silicosis Early	14		
Previously reported as Silicosis Advanced	19		
		41 =	1·6
Tuberculosis only—			
Previously reported as Normal, etc.		7 =	·3
Total number of men examined		2,588 =	100·0

Fifth Examination (1930).

			Per cent.
Normal, etc.—			
Previously reported as Normal, etc.	2,751		
New cases	34		
		2,785 =	81·9
Silicosis Early—			
Previously reported as Normal, etc.	133		
Previously reported as Silicosis Early	247		
New cases	3		
		383 =	11·3
Silicosis Advanced—			
Previously reported as Silicosis Early	22		
Previously reported as Silicosis Advanced	43		
New cases	2		
		67 =	2·0
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	6		
Previously reported as Silicosis Early	60		
Previously reported as Silicosis Advanced	46		
New Cases	2		
		114 =	3·3
Tuberculosis only—			
Previously reported as Normal, etc.	47		
New cases	3		
		50 =	1·5
Total number of men examined		3,399 =	100·0

Sixth Examination (1931).

			Per cent.
Normal, etc.—			
Previously reported as Normal, etc.	2,530	=	84·0
Silicosis Early —			
Previously reported as Normal, etc.	94		
Previously reported as Silicosis Early	252		
		346 =	11·5
Silicosis Advanced—			
Previously reported as Silicosis Early	18		
Previously reported as Silicosis Advanced	35		
		53 =	1·8
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	4		
Previously reported as Silicosis Early	35		
Previously reported as Silicosis Advanced	19		
		58 =	1·9
Tuberculosis only—			
Previously reported as Normal, etc.		25 =	·8
Total number of men examined		3,912 =	100·0

PERIODICAL EXAMINATION OF MINE WORKERS—*continued.*

Seventh Examination (1932).

			Per cent.
Normal, etc.		3,835 =	89.5
Silicosis Early—			
Previously reported as Normal, etc.	35		
Previously reported as Silicosis Early	338		
		373 =	8.7
Silicosis Advanced—			
Previously reported as Silicosis Early	6		
Previously reported as Silicosis Advanced	47		
		53 =	1.2
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	3		
Previously reported as Silicosis Early	9		
Previously reported as Silicosis Advanced	4		
		16 =	.4
Tuberculosis only—			
Previous reported as Normal, etc.	8	8 =	.2
Total number of men examined		4,285 =	100.0

Eighth Examination (1933).

			Per cent.
Normal, etc.		2,920 =	86.5
Silicosis Early—			
Previously reported as Normal, etc.	57		
Previously reported as Silicosis Early	322		
		379 =	11.2
Silicosis Advanced—			
Previously reported as Normal, etc.	1		
Previous reported as Silicosis Early	15		
Previously reported as Silicosis Advanced	44		
		60 =	1·8
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	2		
Previously reported as Silicosis Early	9		
Previously reported as Silicosis Advanced	4		
		15 =	.4
Tuberculosis only—			
Previously reported as Normal, etc.	3	3 =	.1
Total number of men examined		3,377 =	100.0

Ninth Examination (1934).

			Per cent.
Normal, etc.		5,140 =	92.4
Silicosis Early—			
Previously reported as Normal, etc.	54		
Previously reported as Silicosis Early	315		
		369 =	6.6
Silicosis Advanced—			
Previously reported as Normal, etc.	1		
Previously reported as Silicosis Early	24		
Previously reported as Silicosis Advanced	12		
		37 =	.7
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	6		
Previously reported as Silicosis Advanced	6		
		12 =	.2
Tuberculosis only—			
Previously reported as Normal, etc.	5	5 =	.1
Total number of men examined		5,563 =	100.0

Tenth Examination (1935).

			Per cent.
Normal, etc.		4,437 =	92.3
Silicosis Early—			
Previously reported as Normal, etc.	35		
Previously reported as Silicosis Early	303		
		338 =	7.0
Silicosis Advanced—			
Previously reported as Silicosis Early	24		
Previously reported as Silicosis Advanced	2		
		26 =	.6
Silicosis plus Tuberculosis—			
Previously reported as Silicosis Early		5 =	.1
Tuberculosis only—			
Previously reported as Normal, etc.	2	2 =	.0
Total number of men examined		4,808 =	100.0

Eleventh Examination (1936).

			Per cent.
Normal, etc.		6,972 =	94.7
Silicosis Early—			
Previously reported as Normal, etc.	29		
Previously reported as Silicosis Early	323		
		352 =	4.8

(Note.—Of the 352 cases of Early Silicosis reported 23 were already suffering from Early Silicosis and 4 from Pneumoconiosis when re-admitted to the industry on the Re-Admission Certificate under Regulation 7 of the Mines Regulation Act, 1906).

Silicosis Advanced—			
Previously reported as Normal, etc.	1		
Previously reported as Silicosis Early	15		
Previously reported as Silicosis Advanced	4		
		20 =	.3
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	3		
Previously reported as Silicosis Early	8		
		11 =	.1
Tuberculosis only	8	8 =	.1
Total number of men examined		7,363 =	100.0

PERIODICAL EXAMINATION OF MINE WORKERS—*continued.*

Twelfth Examination (1937).

			Per cent.
Normal, etc.		7,487 =	95.4
Silicosis Early—			
Previously reported as Normal, etc.	15		
Previously reported as Silicosis Early	319		
		334 =	4.3

(Note.—Of the 334 cases of Early Silicosis reported 37 were already suffering from Early Silicosis when re-admitted to the industry on the Re-Admission Certificate under Regulation 7 of the Mines Regulation Act, 1906.)

Silicosis Advanced—			
Previously reported as Silicosis Early	14		
Previously reported as Silicosis Advanced	4		
		18 =	.2
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	1		
Previously reported as Silicosis Early	10		
		11 =	.1
Tuberculosis only	2	2 =	.0
Total number of men examined		7,852 =	100.0

Thirteenth Examination (1938).

			Per Cent.
Normal, etc.		6,833 =	95·68
Silicosis Early—			
Previously reported as Normal, etc.	13		
Previously reported as Silicosis Early	266		
		279 =	3.91

(Note.—Of the 279 cases of Silicosis Early reported, 32 were already suffering from Early Silicosis and 4 from Pneumoconiosis when re-admitted to the industry on Re-admission Certificates under Regulation 7 of the Mines Regulation Act, 1906.)

Silicosis Advanced—			
Previously reported as Normal, etc.			
Previously reported as Silicosis Early	15		
Previously reported as Silicosis Advanced	2		
		17 =	.24
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	1		
Previously reported as Silicosis Early	8		
Previously reported as Silicosis Advanced			
		9 =	.13
Tuberculosis only—			
Previously reported as Normal, etc.	3	3 =	.04
Total number of men examined		7,141 =	100.00

Fourteenth Examination (1939).

			Per Cent.
Normal, etc.		6,670 =	95.63
Silicosis Early—			
Previously reported as Normal, etc.	18		
Previously reported as Silicosis Early	264		
		282 =	4.04

(Note.—Of the 282 cases of Early Silicosis reported, 28 were already suffering from Early Silicosis and one from Pneumoconiosis when re-admitted to the industry on Re-Admission Certificates under Regulation 7 of the Mines Regulation Act, 1906.)

Silicosis Advanced—			
Previously reported as Normal, etc.			
Previously reported as Silicosis Early	7		
Previously reported as Silicosis Advanced	3		
		10 =	.14
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	1		
Previously reported as Silicosis Early	9		
Previously reported as Silicosis Advanced	1		
		11 =	.16
Tuberculosis only—			
Previously reported as Normal, etc.	2	2 =	.03
Total number of men examined		6,975 =	100.00

Fifteenth Examination (1940).

			Per Cent.
Normal, etc.		7,023 =	96.218
Silicosis Early—			
Previously reported as Normal, etc.	12		
Previously reported as Silicosis Early	245		
		257 =	3.521

(Note.—Of the 257 cases of Early Silicosis reported, 23 were suffering from Early Silicosis and 12 from Pneumoconiosis when re-admitted to the industry on Re-Admission Certificates under Regulation 7 of the Mines Regulation Act, 1906.)

Silicosis Advanced—			
Previously reported as Normal, etc.			
Previously reported as Silicosis Early	10		
Previously reported as Silicosis Advanced	1		
		11 =	.151
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.			
Previously reported as Silicosis Early	4		
Previously reported as Silicosis Advanced			
		4 =	.055
Tuberculosis only—			
Previously reported as Normal, etc.	4	4 =	.055
Total number of men examined		7,299 =	100.000

PERIODICAL EXAMINATION OF MINE WORKERS—*continued.*

Sixteenth Examination (1941).

			Per cent.
Normal, etc.		6,840	= 95.785
Silicosis Early—			
Previously reported as Normal, etc.	32		
Previously reported as Silicosis Early	248		
		280	= 3.921
Silicosis Advanced—			
Previously reported as Normal, etc.	....		
Previously reported as Silicosis Early	11		
Previously reported as Silicosis Advanced	3		
		14	= .196
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	....		
Previously reported as Silicosis Early	....		
Previously reported as Silicosis Advanced	....		
Tuberculosis only—			
Previously reported as Normal, etc.		7	= .098
Total number of men examined		7,141	=100.000

Seventeenth Examination (1942).

			Per cent.
Normal, etc.		5,469	= 93.905
Silicosis Early—			
Previously reported as Normal, etc.	61		
Previously reported as Silicosis Early	264		
		325	= 5.580
Silicosis Advanced—			
Previously reported as Normal, etc.	....		
Previously reported as Silicosis Early	20		
Previously reported as Silicosis Advanced	5		
		25	= 0.430
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	....		
Previously reported as Silicosis Early	2		
Previously reported as Silicosis Advanced	....		
		2	= 0.034
Tuberculosis only—			
Previously reported as Normal, etc.		3	= 0.051
Total number of men examined		5,824	=100.000

Eighteenth Examination (1943).

			Per cent.
Normal, etc.		3,932	= 91.47
Silicosis Early—			
Previously reported as Normal, etc.	63		
Previously reported as Silicosis Early	262		
		325	= 7.57
Silicosis Advanced—			
Previously reported as Normal, etc.	....		
Previously reported as Silicosis Early	25		
Previously reported as Silicosis Advanced	7		
		32	= 0.75
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	....		
Previously reported as Silicosis Early	5		
Previously reported as Silicosis Advanced	....		
		5	= 0.12
Tuberculosis only—			
Previously reported as Normal, etc.		4	= 0.09
Total number of men examined		4,298	= 100.00

Nineteenth Examination (1944).

			Per cent.
Normal, etc.		4,079	= 91.51
Silicosis Early—			
Previously reported as Normal, etc.	70		
Previously reported as Silicosis Early	270		
		340	= 7.45
Silicosis Advanced—			
Previously reported as Normal, etc.	....		
Previously reported as Silicosis Early	21		
Previously reported as Silicosis Advanced	14		
		35	= 0.76
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	1		
Previously reported as Silicosis Early	7		
Previously reported as Silicosis Advanced	....		
		8	= 0.15
Tuberculosis only—			
Previously reported as Normal, etc.		6	= 0.13
Total number of men examined		4,468	= 100.00

Twentieth Examination (1945).

			Per cent.
Normal, etc.		3,071	= 92.11
Silicosis Early—			
Previously reported as Normal, etc.	54		
Previously reported as Silicosis Early	166		
		220	= 6.60
Silicosis Advanced—			
Previously reported as Normal, etc.	....		
Previously reported as Silicosis Early	26		
Previously reported as Silicosis Advanced	10		
		36	= 1.08

PERIODICAL EXAMINATION OF MINE WORKERS—*continued.*

Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	3		
Previously reported as Silicosis Early	2		
Previously reported as Silicosis Advanced	....	5	= 0.15
Tuberculosis only—			
Previously reported as Normal, etc.	....	2	= 0.06
Total number of men examined		3,334	= 100.00

Twenty-first Examination (1946).

			Per cent.
Normal, etc.		5,294	= 94.43
Silicosis Early—			
Previously reported as Normal, etc.	89		
Previously reported as Silicosis Early	172		
		261	= 4.66
Silicosis Advanced—			
Previously reported as Normal, etc.	1		
Previously reported as Silicosis Early	36		
Previously reported as Silicosis Advanced	2		
		39	= 0.69
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	3		
Previously reported as Silicosis Early	1		
Previously reported as Silicosis Advanced	2		
		6	= 0.11
Tuberculosis only—			
Previously reported as Normal, etc.		6	= 0.11
Total number of men examined		5,606	= 100.00

Twenty-second Examination (1947).

			Per cent.
Normal, etc.		6,021	= 93.34
Silicosis Early—			
Previously reported as Normal, etc.	101		
Previously reported as Silicosis Early	237		
		338	= 5.24
Silicosis Advanced—			
Previously reported as Normal, etc.	....		
Previously reported as Silicosis Early	49		
Previously reported as Silicosis Advanced	9		
		58	= 0.90
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	13		
Previously reported as Silicosis Early	11		
Previously reported as Silicosis Advanced	1		
		25	= 0.30
Tuberculosis only—			
Previously reported as Normal, etc.		8	= 0.12
Total number of men examined		6,450	= 100.00

Twenty-third Examination (1948).

			Per cent.
Normal, etc.		4,827	= 94·02
Silicosis Early—			
Previously reported as Normal, etc.	24		
Previously reported as Silicosis Early	239		
		263	= 5·12
Silicosis Advanced—			
Previously reported as Normal, etc.	....		
Previously reported as Silicosis Early	18		
Previously reported as Silicosis Advanced	17		
		35	= 0·68
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	1		
Previously reported as Silicosis Early	3		
Previously reported as Silicosis Advanced	....		
		4	= 0·08
Tuberculosis only—			
Previously reported as Normal, etc.		5	= 0·10
Total number of men examined		5,134	= 100·00

Twenty-fourth Examination (1949).

			Per cent.
Normal, etc.		5,162	= 94·03
Silicosis Early—			
Previously reported as Normal, etc.	24		
Previously reported as Silicosis Early	239		
		263	= 4·79
Silicosis Advanced—			
Previously reported as Normal, etc.	....		
Previously reported as Silicosis Early	20		
Previously reported as Silicosis Advanced	31		
		51	= 0·93
Silicosis plus Tuberculosis—			
Previously reported as Normal, etc.	3		
Previously reported as Silicosis Early	2		
Previously reported as Silicosis Advanced	....		
Previously reported as Silicosis plus Tuberculosis	1		
		6	= 0·12
Tuberculosis only—			
Previously reported as Normal, etc.		7	= 0·13
Total number of men examined		5,489	= 100·00

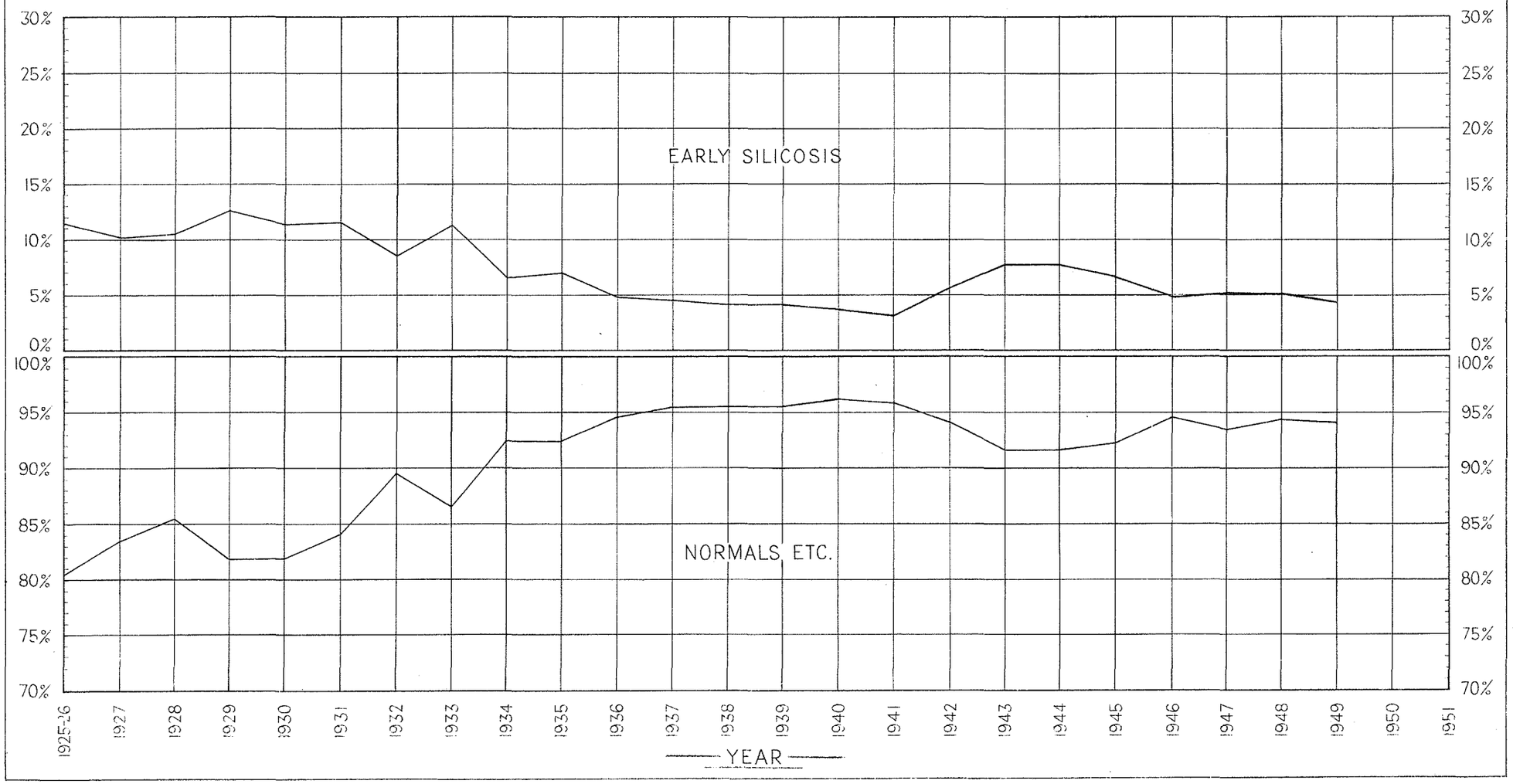
Men employed in the outlying districts were not examined during 1929 or 1931 ; only those employed in Kalgoorlie and surrounding districts being examined. The increase in numbers diagnosed as Early Silicosis and Tuberculosis in 1930 was due to the improved plant and radiographic technique.

Only new miners and those whose previous diagnosis warranted review were examined in the outlying districts, during 1933.

PERIODICAL EXAMINATION OF MINE WORKERS

GRAPH No.1

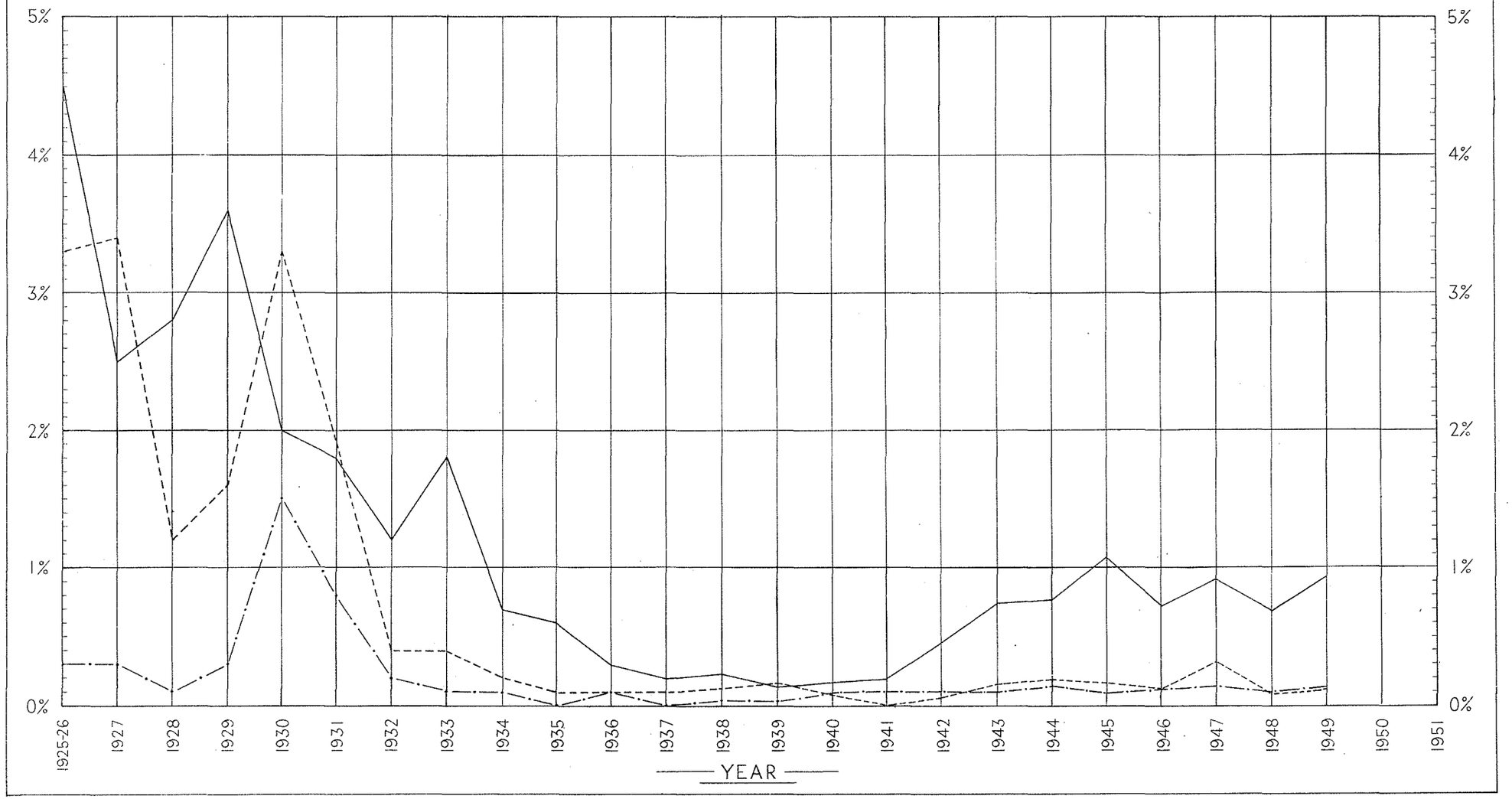
Showing Percentages of Normals and Early Silicotics, from 1925-26 onwards



PERIODICAL EXAMINATION OF MINE WORKERS

GRAPH No 2

Showing Percentages of Silicosis Advanced, Silicosis plus Tuberculosis and Tuberculosis only, from 1925-26 onwards



Silicosis Advanced ———— *Silicosis Plus Tuberculosis* - - - - - - - - *Tuberculosis Only* —·—·—·—

Mining Statistics to 31st December, 1949.

TABLE OF CONTENTS.

TABLE I.

PRODUCTION OF GOLD AND SILVER FROM ALL SOURCES, SHOWING IN FINE OUNCES THE OUTPUT AS REPORTED TO THE MINES DEPARTMENT DURING 1949, AND THE TOTAL PRODUCTION TO DATE.

(*Note.*—Lease numbers in brackets indicate that the holding was *voided* during the year.)

(*Note.*—* denotes mainly derived from treatment of tailings.)

Mining Centre.	Number of Lease.	Registered Name of Company or Lease.	Total for 1949.					Total Production.				
			Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.
			Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.
Kimberley Goldfield.												
Brockman	109	Mt. Bradley	....	....	....	....	....	....	....	193·00	50·94	....
		Voided leases	....	....	....	....	....	....	....	1,352·75	1,404·40	....
		Sundry claims	....	....	....	....	....	7·62	7·62	2,484·00	1,871·92	....
Hall's Creek	....	Voided leases	....	....	....	....	....	....	....	423·00	477·76	....
		Sundry claims	....	....	....	....	....	27·73	....	204·55	159·68	12·64
Mt. Dockrell	95	Irish Lass	....	....	....	....	....	9·17	13·66	341·00	266·75	....
		Voided leases	....	....	....	....	....	....	....	832·70	939·34	93·00
		Sundry claims	18·59	11·28	....	....	....	18·89	31·31	160·00	89·64	....
Panton	114, etc.	Granite Leases	....	....	....	....	....	....	....	8·25	1·77	....
		Voided leases	....	....	....	....	....	....	....	34·70	138·70	....
		Sundry claims	....	....	....	....	....	....	....	6·15	18·01	....
Ruby Creek	98	Goliath	....	....	....	....	....	....	....	120·70	103·72	....
	97	Ruby Queen	....	....	....	....	....	....	....	2,919·25	1,631·30	2·14
	100	St. Lawrence	....	....	....	....	....	....	....	10·00	11·32	....
		Voided leases	....	....	....	....	....	....	16·05	12,771·50	9,504·78	....
		Sundry claims	....	....	....	....	....	12·71	....	281·25	183·30	....
The Mary	....	Voided leases	....	....	....	....	....	....	....	399·00	210·03	....
		Sundry claims	....	....	....	....	....	....	....	46·85	53·66	....
		From Goldfield generally :—										
		Sundry claims	....	....	....	....	†5·90	....	....	....	....	†5·90
		Reported by Banks and Gold Dealers	101·31	137·78	....	....	....	8,434·59	839·10	·75	1·54	....
		Totals	**120·20**	**149·06**	....	....	**5·90**	**8,510·71**	**907·74**	**22,589·40**	**17,118·56**	**113·68**
West Kimberley Goldfield.												
Napier Range	M.C. 29	Devonian Silver Lead Mine	....	....	....	....	†191·76	....	....	....	....	†49,53·87
		From Goldfield generally :—										
		Sundry claims	....	....	....	....	....	1·30	24·68	1·00	2·49	....
		Totals	....	....	....	....	**191·76**	**1·30**	**24·68**	**1·00**	**2·49**	**4,953·87**

Pilbara Goldfield.

MARBLE BAR DISTRICT.

Bamboo Creek	850	Federation	....	8·22	187·00	107·82	....	....	8·22	1,963·00	1,592·26	....
	707	Kitchener	....	....	44·00	8·17	·75	....	....	10,013·50	13,726·79	·75
	1010	Mickey	....	....	17·00	9·28	·50	....	....	1,714·00	463·13	1·08
	(740), (794)	Mt. Prophecy Leases	....	....	12·00	2·83	....	....	....	8,322·50	8,357·28	....
	740	(Mt. Prophecy)	....	....	....	....	....	....	1·11	1,040·50	1,898·07	....
	794	(Perseverance)	....	....	....	....	....	....	....	290·50	584·21	....
	817	Prince Charlie	....	....	60·00	18·38	3·30	....	3·68	3,140·004	3,358·68	33·41
	1075	Queen	....	....	24·00	9·12	....	....	....	220·00	146·95	....
	924	True Blue	....	....	36·00	·68	....	....	....	2,093·25	85·22	....
		Voided leases	....	....	....	....	....	13·54	559·08	24,265·85	27,865·67	....
		Sundry claims	....	....	39·00	10·07	4·50	8·97	307·83	5,023·85	2,988·06	4·50
Boodalyerrie	....	Voided leases	....	....	....	....	....	....	292·07	120·25	587·86	....
		Sundry claims	....	....	....	....	....	....	7·16	....	....	....
Braeside	....	Sundry claims	....	....	....	....	†657·24	....	....	....	....	†657·24
Lalla Rookh	....	Voided leases	....	....	....	....	....	....	4·78	3,612·00	4,696·33	574·01
		Sundry claims	....	....	....	....	....	....	....	7,943·00	7,675·09	....
Marble Bar	1091	Alethia	....	....	101·00	9·22	·45	....	....	101·00	9·22	·45
	927, etc.	Comet Gold Mines, Ltd.	....	....	1,859·50	1,686·42	138·81	....	....	110,941·44	101,044·69	151·17
	930, etc.	Prior to transfer to present holders	....	....	....	....	....	....	....	2,195·75	1,235·42	....
	1063	General	....	....	....	....	....	....	....	230·50	476·45	·29
	912	Homeward Bound	....	....	....	....	....	....	....	6,292·25	3,111·75	....
	1054	Illareen	....	....	....	....	....	....	....	40·00	6·32	·36
	1089	Repeater	....	....	548·20	123·83	6·26	....	....	548·20	123·83	6·26
		Voided leases	....	....	....	....	....	....	199·09	40,129·05	40,234·06	·09
		Sundry claims	....	....	62·50	13·10	·76	67·08	251·77	19,788·29	12,446·62	·93
North Pole	1040	Australian Mining and Industrial Finance Pty., Ltd.	....	....	225·00	72·04	44·43	....	....	225·00	72·04	44·43
	1040	Prior to transfer to present holders	....	....	....	....	....	....	....	69·00	31·07	....
		Voided leases	....	....	....	....	....	....	....	548·00	400·52	....
		Sundry claims	....	....	....	....	....	....	....	549·75	286·38	....
North Shaw	....	Voided leases	....	....	....	....	....	7·53	....	1,072·45	996·29	....
		Sundry claims	....	....	....	....	....	2·84	567·06	179·75	121·72	....
Pilgangoora	....	Voided leases	....	....	....	....	....	16·65	....	2,255·00	403·60	....
		Sundry claims	....	....	....	....	....	161·08	8·13	481·60	146·39	....
Sharks	1080, etc.	Table Top Leases	....	....	154·00	82·99	3·69	....	....	154·00	82·99	3·69
		Voided leases	....	....	....	....	....	1·43	....	1,720·75	1,951·08	....
		Sundry claims	....	....	....	....	....	163·14	47·93	1,128·75	1,651·21	·97
Talga Talga	....	Voided leases	....	....	....	....	....	....	93·15	1,799·00	1,760·68	....
		Sundry claims	....	4·35	....	....	....	76·17	85·18	1,975·90	1,499·86	·70
Tambourah	....	Voided leases	....	....	....	....	....	....	73·90	1,576·50	1,882·29	....
		Sundry claims	....	....	....	....	....	89·52	294·75	3,742·25	2,689·78	....

† From Silver Lead Ore.

TABLE I.—*Production of Gold and Silver from all sources, etc.*—continued.

PILBARA GOLDFIELD—*continued.*

MARBLE BAR DISTRICT—*continued.*

Mining Centre.	Number of Lease.	Registered Name of Company or Lease.	Total for 1949.					Total Production.				
			Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.
			Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.
Warrawoona	1087	Town Talk	....	....	....	91·22	9·54	....	....	300·45	127·91	13·34
	1013	Trump	....	....	267·50	69·92	7·09	....	....	3,028·80	558·81	8·22
		Voided leases	....	....	....	....	....	....	16·99	12,748·80	18,830·50	....
		Sundry claims	....	....	22·00	5·97	·08	70·98	623·67	6,619·79	4,240·69	·08
Western Shaw	....	Voided leases	....	....	....	....	....	....	....	1,222·50	957·80	....
		Sundry claims	....	....	....	....	....	22·34	67·47	71·50	81·49	....
Wyman's Well	1084	New Copenhagen	....	....	50·00	37·33	·19	....	....	350·00	45·08	·19
		Voided leases	....	....	....	....	....	....	42·86	2,977·29	1,258·44	....
		Sundry claims	....	....	46·50	11·67	·47	4·47	51·52	2,549·46	1,272·45	1·21
Yandicoogina	....	Voided leases	....	....	....	....	....	....	140·76	3,159·20	6,218·83	....
		Sundry claims	....	....	....	....	....	4·32	239·89	574·50	642·82	....
		From District generally :—										
		Sundry parcels treated at :										
		Bamboo Creek State Battery	....	....	....	....	....	....	....	40·00	*10,225·54	181·04
		Marble Bar State Battery	....	....	....	*188·25	....	....	....	12·00	*10,582·99	....
		Braeside Lead Claims	....	....	....	....	†1,156·62	....	....	....	....	†1,156·62
		Ironclad Battery	....	....	....	....	....	....	....	....	*237·71	....
		The Great North-Western Gold Co., Ltd., Cyanide Plant	....	....	....	....	....	....	....	....	*271·37	·65
		Various Works	....	....	....	....	....	....	....	237·95	*1,391·56	....
		Reported by Banks and Gold Dealers	29·81	4·09	....	3·56	·66	14,274·88	440·85	....	4·46	3·06
		Totals	**34·16**	**12·31**	**3,755·20**	**2,561·87**	**2,035·34**	**14,984·94**	**4,428·90**	**301,398·62**	**303,638·31**	**2,844·74**
		NULLAGINE DISTRICT.										
Eastern Creek	276L	Rose	....	....	57·50	49·01	·82	....	....	140·00	145·73	1·86
		Voided leases	....	....	....	....	....	8·96	8·19	5,261·00	9,567·00	11·77
		Sundry claims	....	....	....	....	....	....	12·74	1,409·10	1,600·71	16·90
Elsie	....	Voided leases	....	....	....	....	....	....	....	586·25	1,675·91	....
		Sundry claims	....	....	....	....	....	....	8·28	58·00	188·08	....
McPhee's Creek	....	Voided leases	....	....	....	....	....	....	....	113·00	137·92	....
		Sundry claims	....	....	....	....	....	....	....	134·00	197·09	....

Middle Creek	279L	All Nations	....	....	82·00	24·85	....	....	....	920·50	280·36	·15
	229L	Barton	....	....	645·00	664·57	·28	1·22	....	3,311·00	1,467·69	1·63
	231L, etc.	Blue Spec leases	....	....	....	*781·53	....	....	....	25,613·39	14,094·35	....
	299L	Lady Jess	....	....	85·00	14·38	7·42	....	....	85·00	14·38	7·42
	267L	Little Wonder	....	....	207·50	42·26	....	....	....	3,601·50	932·61	....
		Voided leases	....	....	....	....	....	....	1·02	13,143·65	10,317·81	·08
		Sundry claims	....	....	300·50	83·35	....	....	....	5,235·60	2,228·77	....
Mosquito Creek	....	Voided leases	....	....	....	....	....	1·07	30·12	8,232·30	12,814·22	....
		Sundry claims	....	....	9·50	5·47	....	....	181·64	3,702·44	3,785·88	....
Nullagine	292L	Alice	....	48·21	22·50	43·95	5·90	....	126·52	35·00	85·41	12·86
	(295L)	Chrysler South	....	....	30·00	31·85	....	....	....	157·00	95·11	....
	(283L)	Grant's Hill	....	....	....	4·78	·16	....	....	35·00	12·80	·20
	294L	Nullagine View	....	246·84	24·00	256·47	13·05	....	289·63	41·00	397·35	23·69
	297L	Mundella	....	....	11·50	88·69	....	....	....	11·50	88·69	....
	289L	Paul's Leader	....	20·35	6·00	49·78	3·07	....	269·40	20·50	325·05	12·60
	(293L)	Valentine	....	....	8·00	2·99	....	....	....	8·00	2·99	....
		Voided leases	....	....	....	....	....	....	40·56	8,802·75	12,388·03	....
		Sundry claims	....	35·49	60·50	37·15	·32	315·53	668·82	5,909·55	10,242·41	5·24
Twenty-Mile Sandy	256L	Bill Jim	....	....	....	....	....	....	....	1,982·50	1,022·55	....
	298L	Two Twins	....	13·77	....	....	·32	....	13·77	....	....	·32
		Voided leases	....	....	....	....	....	....	3·20	5,221·20	7,971·21	....
		Sundry claims	....	....	193·00	160·19	1·12	33·10	30·50	7,604·85	6,235·21	2·76
	From District generally :—											
	Sundry parcels treated at :											
	M.A. 17L, Shamrock Battery	....	....	....	....	....	....	....	....	....	*24·44	1·00
	Twenty-Mile Sandy Cyanide Plant	....	....	....	*282·99	....	....	....	....	12·00	*1,726·31	·37
	Various Works	....	....	....	....	....	....	....	....	112·50	*6,340·55	....
	Reported by Banks and Gold Dealers	114·24	·83	....	....	1·94	9,583·88	98·28	....	29·81	5·08
	Totals	**114·24**	**365·49**	**1,742·50**	**2,624·26**	**34·40**	**9,943·76**	**1,782·67**	**101,500·08**	**106,436·43**	**103·93**

Ashburton Goldfield.

Belvedere	....	Voided leases	....	....	....	....	....	....	9·88	1,560·00	435·86	176·48
Dead Finish	47	Star of the West	....	....	360·00	70·29	....	....	....	1,290·50	544·72	....
		Voided leases	....	....	....	....	....	....	....	281·50	279·51	....
		Sundry claims	....	....	....	....	....	....	11·89	78·75	235·31	....
Melrose	....	Voided leases	....	....	....	....	....	....	....	2,704·00	840·26	213·11
		Sundry claims	....	....	....	....	....	12·41	21·88	562·00	262·78	6·40
Mt. Edith....	....	Sundry claims	....	....	....	....	....	....	....	5·00	3·97	....
Mt. Mortimer	....	Sundry claims	....	....	....	....	....	364·63	315·64	44·50	40·25	74·47
Uaroo	....	Voided leases	....	....	....	....	....	....	....	....	....	†7,713·22
	From Goldfield generally :—											
	Sundry claims	....	....	....	....	†7,050·07	....	....	....	....	†8,252·21
	Reported by Banks and Gold Dealers	....	....	....	....	....	8,884·23	120·11	....	7·12	....
	Totals	....	....	**360·00**	**70·29**	**7,050·07**	**9,261·27**	**479·40**	**6,526·25**	**2,649·78**	**16,435·89**

† From Silver Lead Ore.

TABLE I.—*Production of Gold and Silver from all sources, etc.*—continued.

Gascoyne Goldfield.

Mining Centre.	Number of Lease.	Registered Name of Company or Lease.	Total for 1949.					Total Production.				
			Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.
			Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.
Bangemall	....	Voided leases	....	....	....	....	....	....	6·22	350·70	313·82	....
		Sundry claims	....	....	....	....	....	88·97	33·55	36·30	203·47	....
		From Goldfield generally :—										
		Reported by Banks and Gold Dealers	....	....	....	....	....	604·47	1·80	....	....	....
		Totals	....	....	....	....	....	**693·44**	**41·57**	**387·00**	**517·29**	....

West Pilbara Goldfield.

Croydon	....	Voided leases	....	....	....	....	....	....	....	8·00	5·44	....
Hong Kong	....	Voided leases	....	....	....	....	....	....	....	331·00	442·45	....
		Sundry claims	....	....	....	....	....	21·40	·02	9·00	3·15	....
Lower Nicol	....	Voided leases	....	....	....	....	....	....	1·10	753·20	402·22	....
		Sundry claims	....	....	....	....	....	10·44	2·71	10·00	11·51	....
Malline	....	Voided leases	....	....	....	....	....	....	....	141·60	128·44	....
Nicol	....	Voided leases	....	....	....	....	....	....	....	30·00	11·47	....
Pilbara	....	Voided leases	....	....	....	....	....	....	48·12	267·00	413·59	....
		Sundry claims	....	....	....	....	....	1·11	86·24	163·00	255·42	....
Roebourne	68H, etc.	Corderoy Mines, Ltd.	....	....	....	6·57	....	....	....	1,954·50	458·01	10·79
		Voided leases	....	....	....	....	....	....	....	442·36	952·91	374·36
		Sundry claims	....	....	384·00	68·27	2·43	15·47	3·29	1,934·85	754·91	114·06
Station Peak	....	Voided leases	....	....	....	....	....	177·74	41·37	10,936·00	11,347·42	....
		Sundry claims	....	....	....	....	....	....	....	37·50	48·19	....
Towranna	....	Voided leases	....	....	....	....	....	....	2·62	3,965·80	5,187·51	....
		Sundry claims	....	....	....	....	....	....	....	22·00	12·35	....
Upper Nicol	....	Sundry claims	....	....	....	....	....	....	....	6·50	2·57	....
Weerianna	....	Voided leases	....	....	....	....	....	....	....	3,200·15	3,214·45	....
		Sundry claims	....	....	179·00	19·00	1·29	....	....	243·00	81·90	1·29

Whim Creek	....	Voided leases	....	....	....	....	....	....	....	....	....	....	....	....	883·80
	From Goldfield generally :—														
	District generally :—														
		Sundry claims	....	....	....	....	†44·08	....	....	....	....	....	....	†44·08
		Various Works	....	....	....	....	....	....	....	....	....	....	102·39	4·90
		Reported by Banks and Gold Dealers	....	....	....	....	....	6,086·74	170·45	103·50	228·32	·11
		Totals	....	....	**563·00**	**93·84**	**47·80**	**6,312·90**	**355·92**	**24,458·96**	**24,064·62**	**1,433·39**

Peak Hill Goldfield.

Bulloo Downs	M.L. 63P	Keep It Dark	....	....	....	....	†50·09	....	....	....	....	†50·09
Egerton	556P	Pegasus	....	70·47	225·00	184·28	....	....	193·77	1,654·00	3,591·37	....
		Voided leases	....	....	....	....	....	60·86	30·91	5,077·25	2,842·45	....
		Sundry claims	....	....	....	....	....	235·35	23·51	1,501·77	791·34	....
Horseshoe	568P	Horseshoe Lights	....	....	270·00	59·19	....	....	....	2,967·75	667·33	....
	575P	Labourchere Main Lode	....	....	....	....	....	....	....	535·00	60·38	....
	565P	Nathan Bitter	....	....	....	....	....	....	....	518·00	138·87	....
		Voided leases	....	....	....	....	....	15·57	1,975·37	3,798·38	2,512·94	2·00
		Sundry claims	....	....	....	....	....	20·12	829·58	1,812·05	691·38	....
Jimblebar	....	Voided leases	....	....	....	....	....	....	172·75	7,526·25	2,561·95	·58
		Sundry claims	....	....	....	....	....	13·79	65·95	1,048·05	574·16	....
Mt. Fraser	....	Voided leases	....	....	....	....	....	....	....	389·50	320·96	....
		Sundry claims	....	....	....	....	....	88·28	40·61	400·75	341·14	....
Mt. Seabrook	....	Voided leases	....	....	....	....	....	....	5·05	620·25	428·26	....
		Sundry claims	....	....	....	....	....	....	....	1,079·10	798·80	....
Peak Hill	512P	Atlantic	....	....	63·00	9·28	....	1·69	2·87	4,535·25	578·96	....
	511P	Commercial	....	....	....	....	....	....	....	2,838·75	487·90	....
	584P	Dazzle Star	....	....	34·00	29·62	...	....	....	98·00	34·36	....
	567P	Miner Bird	....	....	128·00	73·97	....	....	....	887·00	480·24	....
	553P	Morning Star	....	....	....	....	....	....	4·43	2,768·25	373·29	....
	506P	No. 1 North	....	....	407·00	55·87	....	....	86·47	6,464·20	1,508·53	....
	492P	North Star	....	....	....	....	....	23·20	69·63	13,147·50	2,064·51	....
		Voided leases	....	....	....	....	....	7·39	920·21	521,519·33	247,005·56	2,285·63
		Sundry claims	....	....	39·00	3·92	....	61·51	306·63	34,064·85	8,924·29	....
Ravelstone	....	Voided leases	....	....	....	....	....	....	101·64	4,219·85	3,117·68	....
		Sundry claims	....	....	....	....	....	....	....	553·60	283·17	....
Wilgeena	572P	O.K.	....	....	....	....	....	....	....	5·000	3·35	....
		Voided leases	....	....	....	....	....	....	23·54	128·50	146·79	....
Wilthorpe	....	Voided leases	....	....	....	....	....	....	....	47·00	20·93	....
		Sundry claims	....	....	....	....	....	....	....	89·00	25·71	....
Yowereena	....	Voided leases	....	....	....	....	....	....	....	19·50	36·46	....
		Sundry claims	....	....	....	....	....	....	....	117·25	205·16	....

† From Silver Lead Ore.

TABLE I.—*Production of Gold and Silver from all sources, etc.*—continued

PEAK HILL GOLDFIELD—*continued.*

MINING CENTRE.	NUMBER OF LEASE.	REGISTERED NAME OF COMPANY OR LEASE.	TOTAL FOR 1949.					TOTAL PRODUCTION.				
			Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.
			Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.
		From Goldfield generally :—										
		Sundry Parcels treated at :—										
		State Battery, Peak Hill	....	....	....	*98·44	....	....	3·05	15·00	*6,954·13	....
		Australian Machinery & Investment Co.	....	....	....	....	....	....	....	....	*1,677·23	....
		Various Works	....	....	....	....	....	....	....	30·00	*5,661·37	23·12
		Reported by Banks and Gold Dealers	....	....	....	....	....	2,846·65	444·36	....	12·51	....
		Totals	....	**70·47**	**1,166·00**	**514·57**	**50·09**	**3,374·41**	**5,300·33**	**620,520·93**	**295,921·46**	**2,361·42**

East Murchison Goldfield.

LAWLERS DISTRICT.

Kathleen Valley	1330	Beth Heno	....	....	203·50	98·24	....	....	....	1,115·83	567·76	....
		Voided leases	....	....	....	....	....	....	144·85	79,222·83	48,388·30	....
		Sundry claims	....	....	88·00	59·05	....	14·37	526·03	5,518·75	2,443·79	....
Lawlers	1236, etc.	Australian Gold Productions, Ltd.	....	....	230·00	74·43	....	....	....	240·00	111·87	....
	1236, etc.	Prior to transfer to present holders	....	....	....	....	....	13·02	....	336,532·18	83,317·15	452·00
		Voided leases	....	....	....	....	....	6·71	692·45	1,285,355·22	491,414·15	14,350·93
		Sundry claims	....	....	102·00	74·44	....	400·21	403·52	17,307·48	9,564·81	268·34
Sir Samuel	1333	Vanguard	....	....	....	....	....	....	....	1,566·00	206·03	....
		Voided leases	....	....	....	....	....	....	359·03	273,477·55	141,386·56	10,227·52
		Sundry claims	....	....	132·00	14·07	....	53·89	64·96	7,302·00	4,471·79	....
		From District generally :—										
		Sundry parcels treated at :										
		Australian Machinery and Investment Co.	....	....	....	....	....	....	....	5·00	*4,291·25	29·00
		Prior to transfer to present holders	....	....	....	....	....	....	....	....	*1,371·33	15·64
		Australian Machinery and Investment Co., Ltd. (McPherson's Cyanide Plant)	....	....	....	....	....	2·12	....	12·03	*4,265·25	....
		Great Eastern Mining Syndicate	....	....	....	....	....	....	....	....	*352·19	·12
		Tallon Doon Battery	....	....	....	....	....	....	....	....	*101·50	....
		Vanguard Cyanide Plant	....	....	....	*78·01	....	....	....	4·00	*970·32	3·18
		State Battery Sir Samuel (J. A. McLean)	....	....	....	*6·65	....	....	....	53·50	*2,356·81	....
		Various Works	....	....	....	....	....	....	2·35	1,699·50	*26,067·02	936·09
		Reported by Banks and Gold Dealers	....	....	....	....	....	6,400·91	101·91	·05	9·84	....
		Totals	....	....	**755·50**	**404·89**	....	**6,891·23**	**2,295·10**	**2,009,411·92**	**821,657·72**	**26,282·82**

WILUNA DISTRICT.

Coles	662J	Blackadder	....	....	111·50	48·85	....	....	....	1,689·00	809·50	....
		Voided leases	....	....	....	....	....	....	....	830·50	156·85	....
		Sundry claims	....	....	....	....	....	....	21·03	3,844·50	1,507·23	....
Corboys	(671J)	Barwidgee	....	....	135·00	41·12	....	....	....	485·00	208·36	....
	680J	Mount Fisher East	....	....	74·00	158·50	....	....	....	74·00	158·50	....
	435J	Old Toscana	....	....	45·50	71·52	....	5·24	....	1,037·00	972·64	....
	(669J)	Vinaurum	....	....	....	*89·37	....	....	....	683·00	500·85	....
		Voided leases	....	....	....	....	....	....	1·25	12,428·29	8,667·18	5·00
		Sundry claims	....	....	90·00	128·38	....	21·58	....	8,930·35	5,113·21	....
Gum Creek	....	Voided leases	....	....	....	....	....	20·75	....	1,380·00	595·73	....
		Sundry claims	....	....	....	....	....	....	1·36	407·25	131·08	....
Mt. Eureka	....	Voided leases	....	....	....	....	....	....	....	142·25	96·36	....
		Sundry claims	....	....	....	....	....	....	....	783·75	548·56	....
Mt. Keith....	....	Voided leases	....	....	....	....	....	....	44·54	20,259·50	13,551·08	....
		Sundry claims	....	....	....	....	....	4·81	227·29	3,862·50	2,480·03	....
New England	....	Voided leases	....	....	....	....	....	5·74	95·70	5,364·25	3,490·87	....
		Sundry claims	....	....	....	....	....	9·31	5·78	4,534·75	3,111·97	....
Wiluna	674J	Essex....	....	....	266·00	320·78	....	....	....	2,249·00	758·83	....
	631J	Gypsy Goldmines	....	....	80·00	16·34	....	....	....	135·50	38·63	....
	631J	Prior to transfer to present holders	....	....	....	....	....	....	....	1,962·75	267·42	....
	676J	International	....	....	....	*299·35	....	....	....	3,491·50	1,180·82	....
	679J	Lone Hand	....	....	640·50	50·46	....	....	....	640·50	50·46	....
	677J	Lucky Hit	....	....	8·75	1·81	....	....	....	407·75	73·00	....
	194J etc.	Wiluna Gold Mines, Ltd.	....	....	....	3,743·00	752·00	....	....	7,345,465·00	1,333,704·47	8,409·41
		Prior to transfer to present holders	....	....	....	....	....	....	....	341,730·57	133,457·92	89·32
		Voided leases	....	....	....	....	....	....	574·76	1,080,186·08	318,101·32	1,349·40
		Sundry claims	....	....	179·35	53·77	....	105·39	219·08	26,607·90	10,716·50	·33
	From District generally :—											
	Sundry parcels treated at :											
		Black Adder Battery	....	....	....	....	....	....	....	....	*154·02	....
		Coolgardie Brilliant Battery	....	....	....	....	....	....	....	....	*235·23	....
		Toscana Cyanide Plant	....	....	....	....	....	....	....	....	*2,577·90	....
		Waratah Cyanide Plant	....	....	....	....	....	....	....	....	*753·10	....
		Wiluna East Battery	....	....	....	*40·63	....	....	....	....	*71·50	....
		State Battery, Wiluna	....	....	....	*213·03	....	....	....	637·00	*22,821·93	218·70
		Various Works	....	....	....	....	....	....	....	....	*1,237·68	12·68
		Reported by Banks and Gold Dealers	....	....	....	....	....	49·54	56·58	....	58·49	....
		Totals	....	....	**1,630·60**	**5,276·91**	**752·00**	**222·36**	**1,247·37**	**8,870,249·44**	**1,868,359·22**	**10,084·84**

BLACK RANGE DISTRICT.

Barrambie	972B, 976B	Sheelite Leases	....	....	....	....	....	....	....	886·25	952·68	....
	972B	(Sheelite)	....	....	....	....	....	....	....	105·50	108·88	....
	976B	(Sheelite North)	....	....	....	....	....	....	....	92·75	92·83	....
		Voided leases	....	....	....	....	....	....	22·49	17,359·42	16,200·76	125·60
		Sundry claims	....	....	....	....	....	5·07	170·20	833·55	915·51	....

TABLE I.—*Production of Gold and Silver from all sources, etc.*—continued.

EAST MURCHISON GOLDFIELD—*continued.*

BLACK RANGE DISTRICT.—*continued.*

Mining Centre.	Number of Lease.	Registered Name of Company or Lease.	Total for 1949.					Total Production.				
			Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.
			Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.
Bellchambers	....	Voided leases	....	....	....	....	....	....	111·80	4,349·27	3,130·56	....
		Sundry claims	....	....	....	....	....	....	....	1,008·30	547·06	....
Berrigrin	....	Voided leases	....	....	....	....	....	....	820·68	12,042·93	15,086·09	....
		Sundry claims	....	....	....	....	....	....	179·92	2,487·55	1,238·22	....
Curran's Find	....	Voided leases	....	....	....	....	....	18·24	222·89	7,252·25	3,116·68	....
		Sundry claims	....	....	....	....	....	....	29·38	2,158·75	827·18	....
Errolls	....	Voided leases	....	....	....	....	....	14·17	152·29	14,170·50	9,328·92	....
		Sundry claims	....	....	....	....	....	6·53	399·11	964·75	595·45	....
Hancock's....	1074B	Apples	....	....	47·50	305·08	....	....	443·79	857·25	2,805·80	....
		Voided leases	....	....	....	....	....	....	6,524·37	32,624·50	33,433·33	55·72
		Sundry claims	....	....	....	....	....	4·21	142·89	8,459·10	3,219·53	....
Maninga Marley	....	Voided leases	....	....	....	....	....	....	195·20	60,833·48	48,494·40	22·55
		Sundry claims	....	....	....	....	....	....	158·16	3,079·65	1,768·16	....
Montagu	967B, (998B)	North End Leases	....	....	365·00	78·63	....	....	....	38,832·95	5,369·48	....
		Voided leases	....	....	....	....	....	....	100·17	39,672·65	16,888·02	....
		Sundry claims	....	....	....	....	....	....	71·09	5,041·35	3,171·19	....
Nunngarra	1085B	Sonny James	....	....	13·00	9·81	....	....	....	25·25	12·11	....
		Voided leases	....	....	....	....	....	25·94	952·34	9,483·75	3,643·38	....
		Sundry claims	....	....	....	....	....	50·27	1,458·06	7,636·40	2,953·69	....
Sandstone	959B, etc.	(Atlas Gold Mines, Ltd.)	....	....	....	....	....	....	....	986·75	180·56	....
	959B	Prior to transfer	....	....	....	....	....	....	136·06	537·75	686·59	....
	1076B, 1080B	Black Range Gold Mines, Ltd.	....	....	....	....	....	....	....	84·00	14·34	....
	1075B	Doolette South	....	....	241·00	65·82	....	....	217·54	2,019·50	2,286·83	....
	958B	Lady Mary	....	266·30	129·00	118·00	·07	....	383·35	7,165·76	7,119·35	2·35
		Voided leases	....	....	....	....	....	4·75	4,010·09	692,530·07	444,309·77	11,754·22
		Sundry claims	....	....	34·25	15·93	....	44·95	1,421·07	15,406·95	6,808·08	....
Youanme	1046B	Camberra	....	....	....	4·61	....	....	....	1,501·00	447·74	....
		Voided leases	....	....	....	....	....	·36	126·92	729,996·55	273,437·23	10,474·10
		Sundry claims	....	....	....	....	....	1·07	18·79	6,258·55	1,814·66	....

From District generally :—													
Sundry Parcels treated at :—													
State Battery, Sandstone	....	....	....	....	....	....	....	....	....	290·50	*23,005·08	59·53
State Battery, Youanme	....	....	....	....	....	....	....	....	....	40·00	*5,461·83	....
North End Battery Cyanide Plant	....	....	....	....	....	....	....	....	....	....	*4,934·14	....
Various Works	....	....	....	....	....	....	....	....	....	2·50	*6,510·12	....
Reported by Banks and Gold Dealers	....	....	....	....	....	1,459·55	52·23	....	20·38	....
Totals	....	**266·30**	**829·75**	**597·88**	**·07**	**1,635·11**	**18,520·88**	**1,727,167·97**	**950,936·61**	**22,494·07**

Murchison Goldfield.

CUE DISTRICT.

Big Bell	2050, etc.	Big Bell Mines, Ltd.	....	....	424,525·00	56,070·99	21,933·64	....	....	3,586,539·00	459,137·44	162,496·72
	2050	(Little Bell)	....	....	....	....	....	....	4·49	579·75	60·95	....
		Voided leases	....	....	....	....	....	....	....	401·00	422·83	....
		Sundry claims	....	....	17·00	13·16	....	·39	6·32	376·50	352·57	....
Cuddingwarra	....	Voided leases	....	....	....	....	....	10·59	132·46	102,035·16	56,141·91	100·71
		Sundry claims	....	....	96·25	29·08	....	18·46	379·49	9,504·64	5,501·75	9·00
Cue	2247	Victory	....	....	54·50	14·36	....	....	....	215·75	122·49	....
		Voided leases	....	....	....	....	....	202·71	911·60	288,796·44	221,102·80	69·11
		Sundry claims	....	....	436·25	152·52	....	252·92	894·70	43,832·49	19,756·85	....
Eelya	2241	Eagle Hawk	....	....	465·50	128·49	....	....	....	546·50	145·12	....
		Voided leases	....	....	....	....	....	....	8·78	1,069·00	1,811·26	....
		Sundry claims	....	....	39·00	13·74	....	6·20	143·81	1,756·15	992·48	....
Mindoolah	....	Voided leases	....	....	....	....	....	3·07	2·54	9,380·28	5,672·31	42·97
		Sundry claims	....	....	13·25	3·00	....	....	29·30	3,143·85	2,304·25	....
Reedy	2253	Rand No. 3	....	....	913·75	65·05	....	....	....	3,402·25	1,251·25	....
	1977, etc.	Triton Gold Mines, N.L.	....	....	50·25	7·75	....	....	....	702,459·25	221,082·97	20,461·06
	1977, etc.	Prior to transfer to present holders	....	....	....	....	....	....	....	16,338·50	7,471·50	5·00
		Voided leases	....	....	....	....	....	1·46	214·65	6,552·93	10,128·90	1·22
		Sundry claims	....	6·09	366·50	63·15	....	170·71	136·54	5,931·50	2,449·45	....
Tuckabianna	2237	Gidgie	....	....	43·00	511·98	....	....	....	2,646·65	1,523·51	....
	2244	Winston	....	....	184·00	42·83	....	....	198·46	309·25	100·63	....
		Voided leases	....	....	....	....	....	649·70	297·68	12,908·48	7,321·43	....
		Sundry claims	....	....	95·75	48·65	....	143·17	481·47	4,708·60	2,625·79	....
Tuckanarra	....	Voided leases	....	....	....	....	....	85·37	3,511·10	19,490·00	22,828·99	172·77
		Sundry claims	....	....	....	....	....	115·23	789·31	9,904·55	10,254·69	....
Weld Range	2256	Never-Can-Tell	....	....	58·25	35·90	....	....	....	67·50	41·01	....
		Voided leases	....	....	....	....	....	....	23·64	1,714·75	938·99	....
		Sundry claims	....	....	26·25	12·51	....	....	3·90	1,390·25	1,122·89	....

TABLE I.—*Production of Gold and Silver from all sources, etc.*—continued.

MURCHISON GOLDFIELD—*continued.*

CUE DISTRICT—*continued.*

Mining Centre.	Number of Lease.	Registered Name of Company or Lease.	Total for 1949. Alluvial. Fine ozs.	Dollied and Specimens. Fine ozs.	Ore treated. Tons (2,240 lb.).	Gold therefrom. Fine ozs.	Silver. Fine ozs.	Total Production. Alluvial. Fine ozs.	Dollied and Specimens. Fine ozs.	Ore treated. Tons (2,240 lb.).	Gold therefrom. Fine ozs.	Silver Fine ozs.
Weld Range—*contd.*		*From District generally :—*										
		Sundry Parcels treated at :—										
		State Battery, Cue	....	....	....	*1,155·91	....	....	....	76·25	*23,434·09	110·22
		State Battery, Tuckanarra	....	....	....	....	....	....	....	518·50	*5,535·57	....
		Various Works	....	....	....	....	....	....	....	7,158·52	29,387·81	1,147·77
		Reported by Banks and Gold Dealers	6·10	....	....	....	....	3,364·31	103·62	....	22·62	....
		Totals	**6·10**	**6·09**	**427,384·50**	**58,369·07**	**21,933·64**	**5,024·29**	**8,273·86**	**4,843,754·24**	**1,121,047·10**	**184,616·55**

MEEKATHARRA DISTRICT.

Abbotts	....	Voided leases	....	....	....	....	....	....	26·45	36,841·35	38,775·28	....
		Sundry claims	....	....	....	....	....	....	5·29	3,720·77	2,266·62	....
Burnakura	1849N	New Alliance	....	....	....	....	....	....	....	132·25	114·39	....
		Voided leases	....	....	....	....	....	....	3,247·59	39,040·45	30,775·77	26·90
		Sundry claims	....	....	22·75	19·26	....	17·03	129·24	2,384·05	1,274·45	1·54
Chesterfield	....	Voided leases	....	....	....	....	....	29·02	420·32	6,875·26	7,500·57	·80
		Sundry claims	....	....	....	....	....	....	42·19	960·55	740·97	....
Gabanintha	1854N	Golden Star	....	....	....	....	....	....	....	290·50	268·46	....
	1896N	Mab	....	9·32	260·50	89·84	....	....	9·32	507·25	511·51	....
	1933N	Magpie	....	....	84·25	24·44	....	....	....	84·25	24·44	....
	1725N	New Brew	....	....	140·50	44·25	....	....	....	4,330·35	5,818·59	....
		Voided leases	....	....	....	....	....	11·79	28·82	23,826·75	14,039·87	815·57
		Sundry claims	....	·11	243·50	52·94	....	16·78	159·05	4,423·75	2,628·45	....
Garden Gully	1927N	Sabbath	....	....	....	....	....	....	....	33·75	17·03	....
		Voided leases	....	....	....	....	....	26·36	74·91	30,238·32	21,847·71	1,102·59
		Sundry claims	....	....	....	....	....	....	18·74	2,905·44	1,695·15	....
Gum Creek	....	Voided leases	....	....	....	....	....	25·27	91·96	3,893·08	3,819·91	....
		Sundry claims	....	....	....	....	....	4·37	84·86	727·25	636·85	....
Holdens	1551N	New Waterloo	....	....	....	....	....	....	·99	1,468·00	918·92	....
		Voided leases	....	....	....	....	....	....	18·00	16,593·00	6,401·50	....
		Sundry claims	....	....	....	....	....	164·95	49·07	425·15	279·25	....

Jillawarra	1871N	Werribie	....	....	....	....	....	....	128·85	451·25	749·62	....
		Voided leases	....	....	....	....	....	....	1,134·68	1,548·55	2,815·78	....
		Sundry claims	....	....	....	....	....	173·02	150·04	440·75	403·14	....
Meeka Pools	....	Voided leases	....	....	....	....	....	....	....	111·58	82·27	....
		Sundry claims	....	....	....	....	....	....	2·84	233·57	205·38	....
Meekatharra	1861N	Adele May	....	....	....	....	....	....	....	24·00	28·00	....
	1922N	Albury Heath	....	....	333·00	627·40	....	....	....	373·50	673·93	....
	1855N	Commodore	....	....	11·75	2·13	....	....	....	1,077·00	371·58	....
	1553N	Consols North	....	....	....	....	....	....	....	659·75	1,359·33	....
	1571N	Coolgardie Brilliant, N.L.	....	....	1,517·11	298·72	....	....	....	2,392·11	536·56	....
	1571N	Prior to transfer to present holders	....	....	....	....	....	....	....	8,107·50	4,907·48	....
	1900N	Danube	....	....	....	....	....	....	....	368·75	73·09	....
	814N, 1894N	Fenian Leases	....	....	18·00	57·97	....	....	....	329,424·69	261,787·67	....
	(477N)	Fenian	....	....	....	....	....	....	....	8,831·75	18,289·22	....
	1893N	Halycon	....	....	1,213·75	157·76	....	....	·78	4,347·50	632·73	....
	1888N	Haveluck	....	....	785·75	152·08	....	....	56·94	2,207·75	732·79	....
	1559N	Ingliston	....	....	11·75	16·59	....	....	498·32	1,810·05	1,640·38	....
	1542N	Ingliston Alberts	....	....	....	....	....	....	....	305·50	446·00	....
	(1542N)	Ingliston Alberts Leases	....	....	....	....	....	....	....	2,983·70	1,283·06	....
	1895, etc.	Ingliston Consols Extended Leases	....	....	....	....	....	....	....	873,719·47	357,046·42	....
	475N	Prior to transfer	....	....	....	....	....	....	....	1,536·25	4,248·25	·30
	1920N	Ingliston South	....	....	95·75	99·60	....	....	....	355·50	368·17	....
	(1918N)	King-of-the-Hills	....	....	118·50	30·49	....	....	....	118·50	30·49	....
	1547N	Lady Central	....	....	....	....	....	....	19·36	32·75	26·05	....
	1547N	(Meekatharra Central Gold, N.L.)	....	....	....	....	....	....	5·29	4,842·25	2,463·30	....
	1547N	(Lady Central Leases)	....	....	....	....	....	....	11·06	2,951·42	5,198·33	....
	1899N	Marmont	....	....	....	21·58	....	....	89·33	60,425·20	43,192·98	....
	1906N	Marmont Extended	....	....	....	....	....	....	....	1,748·95	1,813·96	....
	580N	Marmont Extended Leases	....	....	....	....	....	....	....	152·00	129·61	....
	1577N	Mopoke	....	....	....	....	....	....	12·47	1,338·25	820·16	....
	1860N	New Gwalia	....	....	....	....	....	....	....	544·50	127·40	....
	1923N	Peter Pan	....	....	209·00	18·87	....	....	....	209·00	18·87	....
	1529N	Prohibition	....	....	1,100·00	418·57	....	....	....	3,950·00	1,794·02	·04
	1529N	(Prohibition Gold Mining Co., N.L.)	....	....	....	....	....	....	....	24,844·25	4,978·31	11·83
	1529N	Prior to transfer	....	....	....	....	....	....	....	29,422·00	4,971·30	....
	1934N	United	....	....	50·50	22·28	....	....	....	50·50	22·28	....
		Voided leases	....	....	....	....	....	3·88	1,337·17	394,280·98	218,390·45	2,454·74
		Sundry claims	....	5·91	108·00	17·90	....	229·71	628·85	24,247·70	9,573·39	....
Mistletoe	....	Voided leases	....	....	....	....	....	4·15	1,000·24	417·00	486·21	....
		Sundry claims	....	....	....	....	....	119·14	71·85	19·75	2·03	....
Mt. Maitland	....	Voided leases	....	....	....	....	....	....	....	88·00	80·11	....
		Sundry claims	....	....	....	....	....	....	....	420·75	240·86	....
Munara Gully	....	Voided leases	....	....	....	....	....	....	....	13,283·50	6,559·93	....
		Sundry claims	....	....	....	....	....	....	34·23	1,009·75	373·74	....
Nannine	1872N	Blue Pedro	....	....	....	....	....	....	....	8,571·40	1,961·01	....
	1580N	Caledonian	....	....	....	....	....	....	2·18	2,176·09	885·12	....
	(1919N)	Devils Dice	....	....	14·50	5·52	....	....	....	497·55	116·2;	....
		Voided leases	....	....	....	....	....	37·25	826·58	113,407·34	72,397·86	167·45
		Sundry claims	....	....	....	....	....	120·08	1,248·76	6,109·43	5,658·63	....

TABLE I.—*Production of Gold and Silver from all sources, etc.*— continued.

MURCHISON GOLDFIELD—*continued.*

MEEKATHARRA DISTRICT—*continued.*

Mining Centre.	Number of Lease.	Registered Name of Company or Lease.	Total for 1949.					Total Production.				
			Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.
			Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs
Quinn's	....	Voided leases	....	....	....	....	....	7·30	1,186·50	33,356·91	13,464·37	90·70
		Sundry claims	....	....	....	....	....	15·07	1,289·65	3,841·67	2,718·33	....
Ruby Well	....	Voided leases	....	....	....	....	....	....	43·46	7,461·00	4,046·70	....
		Sundry claims	....	....	....	....	....	1,015·87	409·39	520·25	629·60	....
Stake Well	....	Voided leases	....	....	....	....	....	....	200·12	21,362·00	9,566·18	....
		Sundry claims	....	....	....	....	....	31·91	4·73	1,003·60	584·54	....
Star-of-the-East	....	Voided leases	....	....	....	....	....	....	....	27,244·00	20,305·40	....
		Sundry claims	....	....	....	....	....	....	....	127·62	94·97	....
Yaloginda	1853N	Bluebird	....	....	680·00	191·57	....	....	....	4,967·00	1,439·48	....
	1898N	Rocklee	....	....	....	....	....	....	....	72·00	41·37	....
		Voided leases	....	....	....	....	....	19·03	1,972·23	28,103·54	14,567·99	8·68
		Sundry claims	....	....	117·75	21·60	....	61·89	647·51	10,433·17	4,882·73	....
	From District generally :—											
	Sundry Parcels treated at :—											
	State Battery, Meekatharra		....	....	11·00	*385·92	....	....	....	99·50	*24,948·47	19·00
	Meekatharra Sands Treatment and Mining, N.L.		....	....	....	*400·55	....	....	....	....	*3,882·56	....
	Various Works		....	....	....	....	....	....	....	172·75	*6,729·60	342·17
	Reported by Banks and Gold Dealers		2·49	....	....	....	....	12,159·05	179·70	13·50	40·66	....
	Totals		**2·49**	**15·34**	**7,147·61**	**3,177·83**	....	**14,292·92**	**17,629·91**	**2,254,949·31**	**1,288,292·12**	**5,042·31**

DAY DAWN DISTRICT.

Day Dawn	678D	Creme D'or	....	....	131·75	28·03	....	....	....	131·75	28·03	....
	573D, etc.	Mountain View Gold, N.L.	....	....	3,638·00	6,006·62	7·33	....	....	5,032·60	11,804·74	19·96
	573D	Prior to transfer to present holders	....	....	....	....	....	....	94·05	10,060·78	32,623·97	....
	576D	(New Fingall)	....	....	....	....	....	6·12	6·84	3,230·00	1,226·01	....
		Voided leases	....	....	....	....	....	160·64	826·65	1,921,956·61	1,225,566·28	169,210·44
		Sundry claims	....	....	162·25	97·09	....	96·42	508·85	13,061·51	6,490·03	....
Lake Austin	....	Voided leases	....	....	....	....	....	613·00	3,079·62	36,872·20	50,050·49	....
		Sundry claims	....	....	....	....	....	59·07	965·49	3,215·69	1,262·84	....
Mainland	....	Voided leases	....	....	....	....	....	·41	3,296·77	7,575·62	25,026·07	....
		Sundry claims	....	....	....	....	....	17·85	771·56	1,337·95	701·31	....

Pinnacles	670P	Eclipse North	....	....	25·75	·49	....	....	....	25·75	·49	....		
	679D	Table Mine	....	....	10·25	4·79	....	....	....	10·25	4·79	....		
		Voided leases	....	....	....	....	....	4·90	1,213·68	18,117·00	9,869·29	....		
		Sundry claims	....	12·83	21·00	79·68	....	62·93	509·50	4,316·92	1,736·49	....		
		From District generally :—												
		Sundry parcels treated at :												
		Various Works	....	....	....	....	....	....	16·61	988·00	1,988·33	....		
		Reported by Banks and Gold Dealers	32·47	....	....	....	....	2,163·04	37·30	....	12·57	....		
		Totals	**32·47**	**12·83**	**3,989·00**	**6,216·70**	**7·33**	**3,184·38**	**11,326·92**	**2,025,932·63**	**1,369,391·73**	**169,230·40**		

MOUNT MAGNET DISTRICT

Jumbulyer	1410M	Gold Bug	....	·75	147·20	20·62	....	....	2·20	476·20	198·16	....		
		Voided leases	....	....	....	....	....	....	13·37	680·10	361·74	....		
		Sundry claims	....	....	....	....	....	20·32	116·27	1,198·45	870·22	....		
Lennonville	1308M	Empress	....	....	....	....	....	....	....	460·00	167·30	....		
	1379M	Galtee Moore	....	....	55·00	7·47	·80	....	....	6,026·00	1,583·06	·80		
	1430M	Souvenir	....	....	46·50	38·64	....	....	....	413·00	589·99	....		
		Voided leases	....	....	....	....	....	....	3,226·91	144,603·55	126,227·93	458·82		
		Sundry claims	....	....	32·30	16·72	....	23·30	108·82	13,979·32	5,438·99	....		
Mt. Magnet	1255M, 1415M	Edward Carson Leases	....	....	....	....	....	....	....	17,890·50	12,783·83	7·00		
	1286M	Evening Star	....	....	47·85	5·64	....	....	36·37	3,157·17	1,228·81	....		
	1287M	Havelock	....	....	....	....	....	....	11·05	4,332·50	840·14	....		
	1282M, etc.	Hill 50 Gold Mining Co., N.L.	....	....	49,230·00	13,128·05	242·38	....	....	468,553·90	134,555·27	1,451·40		
	1246M	Prior to transfer to present holders	....	....	....	....	....	....	829·41	8,787·65	4,122·61	·21		
	1361M	Jupiter	....	....	34·30	5·75	....	....	·83	571·30	236·47	....		
	1444M	Late Comer	....	....	158·50	77·00	....	....	....	258·50	149·69	....		
	1447M	Morning Star	....	....	75·90	24·71	....	....	....	110·90	32·44	....		
	1441M	Perseverance	....	....	68·75	8·38	....	....	....	475·75	52·32	....		
	1281M, etc.	Saturn Leases	....	....	....	7·95	....	....	101·24	37,484·75	5,918·59	....		
	1322M	Three Boys	....	....	....	....	....	....	231·11	500·78	668·29	....		
		Voided leases	....	....	....	....	....	29·26	9,442·82	792,155·61	304,795·96	851·39		
		Sundry claims	....	....	694·45	369·94	....	122·27	2,626·24	59,288·90	29,320·07	4·49		
Mt. Magnet, East	....	Voided leases	....	....	....	....	....	63·29	764·53	5,522·28	2,811·75	....		
		Sundry claims	....	....	....	....	....	....	37·22	418·25	428·29	....		
Moyagee	1355M	Moyagee	....	....	....	....	....	....	....	2,621·25	5,106·19	375·25		
	1355M (1398M)	Moyagee Leases	....	....	....	....	....	....	....	4,641·00	5,489·13	382·52		
		Voided leases	....	....	....	....	....	....	23·59	5,132·35	7,617·85	....		
		Sundry claims	....	....	....	....	....	14·44	176·21	1,516·25	1,746·42	....		
Paynesville	....	Voided leases	....	....	....	....	....	....	1,613·34	449·77	1,116·15	....		
		Sundry claims	....	....	....	....	....	3·36	540·21	882·57	1,372·00	....		
Winjangoo	....	Voided leases	....	....	....	....	....	·99	191·88	72·00	69·98	....		
		Sundry claims	....	....	....	....	....	....	223·32	237·53	71·58	....		

TABLE I.—*Production of Gold and Silver from all sources, etc.*—continued.

MURCHISON GOLDFIELD—*continued.*

MOUNT MAGNET DISTRICT—*continued.*

MINING CENTRE.	NUMBER OF LEASE.	REGISTERED NAME OF COMPANY OR LEASE.	TOTAL FOR 1949.					TOTAL PRODUCTION.				
			Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.
			Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.
Winjangoo—*contd.*		*From District generally :—*										
		Sundry parcels treated at :										
		State Battery, Boogardie	....	....	....	....	....	....	....	125·26	*33,652·05	4·20
		Palmer & Dewar Cyanide Plant, L.T.T. 1124H	....	....	....	*288·47	....	....	....	....	*288·47	....
		B. Caratti Cyanide Plant, L.T.T. 1048H	....	....	....	....	....	....	....	3·00	*30·38	....
		Empress Battery	....	....	....	....	....	....	....	....	*36·98	....
		Heine's Tailings Treatment Plant, L.T.T. 1080H	....	....	....	*3·26	....	....	....	....	*165·96	3·78
		Heine's Tailings Treatment Plant, L.T.T. 1046H	....	....	....	....	....	....	....	....	*48·68	5·26
		Welcome Cyanide Plant	....	....	....	....	....	....	....	10·00	*941·39	....
		Various Works	....	....	....	....	....	....	....	43·06	*17,428·06	1·00
		Reported by Banks and Gold Dealers	1·91	....	....	....	....	2,261·16	88·43	8·00	64·95	·22
		Totals	**1·91**	**·75**	**50,590·75**	**14,002·60**	**243·18**	**2,538·39**	**20,405·37**	**1,583,087·40**	**708,628·14**	**3,546·34**

Yalgoo Goldfield.

Bilberatha	....	Voided leases	....	....	....	....	....	1·27	90·94	3,384·50	1,845·05	....
		Sundry claims	....	....	....	....	....	....	6·64	3,075·05	1,401·56	....
Carlaminda	....	Voided leases	....	....	....	....	....	1·28	3·39	2,056·57	862·42	3·30
		Sundry claims	....	....	....	....	....	....	....	1,368·50	600·68	....
Field's Find	907	Brown's Reward	....	....	....	....	....	....	....	300·00	75·91	....
	907, etc.	Brown's Reward Leases	....	....	....	....	....	....	....	4,540·55	3,800·16	....
	1119	Field's Find Central West	....	....	....	....	....	....	....	121·00	29·65	·80
	1119 (1114)	Field's Find Central West Leases	....	....	....	....	....	....	....	4,625·00	1,074·53	56·69
	1207	Rose Marie	....	....	....	....	....	....	....	201·67	153·38	....
		Voided leases	....	....	....	....	....	....	226·72	40,635·41	28,671·03	....
		Sundry claims	....	9·13	....	....	....	5·77	188·67	5,445·75	1,766·79	....
Goodingnow	1063	Ark	....	....	340·00	99·15	....	....	1·23	1,586·00	711·85	....
	1102	Astor	....	....	423·50	199·96	....	....	....	5,939·25	3,174·15	....
	1198	Astor South	....	....	....	....	....	....	....	498·50	114·17	....
	1025	Carnation	....	....	....	....	....	....	....	18,016·55	13,359·33	....
	1206	Orchid	....	....	....	....	....	....	....	157·50	33·74	....
	1145	Oversight	....	....	....	....	....	....	....	2,053·35	709·40	....
	1208	Oversight South	....	8·03	940·00	388·97	....	....	8·03	1,537·00	595·83	....
	1085	Sweet William	....	....	....	....	....	....	2·97	792·00	249·45	....
		Voided leases	....	....	....	....	....	146·70	277·66	49,369·06	46,525·98	....
		Sundry claims	....	....	50·00	5·55	....	152·96	169·70	10,132·25	5,086·17	....

Gullewa	1189	King Solomon Mine	....	....	....	....	....	....	....	....	315·00	135·89	5·79
	1189, etc.	(King Solomon Mines, Ltd.)	....	....	....	....	....	....	....	....	5,130·10	2,101·25	26·49
		Voided leases	....	....	....	....	....	....	....	19·05	34,468·50	18,729·37	81·42
		Sundry claims	....	....	....	....	....	....	....	170·45	4,391·25	1,918·24	....
Kirkalucka	....	Voided leases	....	....	....	....	....	....	....	....	61·25	45·10	....
		Sundry claims	....	....	....	....	....	....	....	17·79	257·30	126·29	....
Messenger's Patch	1197	Gnow's Nest	....	....	....	....	....	....	8·64	....	115·00	248·42	....
		Voided leases	....	....	....	....	....	....	....	349·71	39,721·51	28,314·92	1,083·01
		Sundry claims	....	....	....	....	....	....	463·12	333·98	1,595·10	588·36	·07
Mt. Farmer	....	Voided leases	....	....	....	....	....	....	....	....	64·00	40·19	....
		Sundry claims	....	....	....	....	....	....	....	....	462·90	145·06	....
Mt. Gibson	....	Voided leases	....	....	....	....	....	....	....	6·44	526·50	888·70	....
		Sundry claims	....	....	13·50	6·44	....	1·03	44·72	1,086·35	488·36	1·00
Ningham	....	Voided leases	....	....	....	....	....	....	....	10·00	1·41	....
		Sundry claims	....	....	....	....	....	....	....	324·75	123·28	....
Noongal	1201	Hard-to-Find	....	....	....	....	....	....	....	114·00	111·83	....
	1203	Revival	....	....	....	....	....	....	....	80·00	132·93	4·04
		Voided leases	....	....	....	....	....	7·88	31·96	11,069·75	5,526·90	....
		Sundry claims	....	....	....	....	....	39·32	310·31	8,499·05	3,561·25	....
Nyounda	....	Voided leases	....	....	....	....	....	....	217·63	416·00	183·91	....
		Sundry claims	....	....	....	....	....	....	30·88	722·00	180·83	....
Pinyalling	1217	Broken Doll	....	....	3·55	69·56	....	....	200·30	3·55	69·56	....
		Voided leases	....	....	....	....	....	....	93·80	2,296·35	959·50	....
		Sundry claims	....	....	....	....	....	3·13	134·09	1,463·00	844·00	....
Retaliation	....	Voided leases	....	....	....	....	....	....	....	5,089·25	1,872·98	....
		Sundry claims	....	....	....	....	....	....	....	778·25	304·71	....
Rothsay	....	Voided leases	....	....	....	....	....	....	24·06	40,680·75	10,775·84	....
		Sundry claims	....	....	....	....	....	....	·73	6,469·50	2,562·03	....
Wadgingarra	....	Voided leases	....	....	....	....	....	....	....	691·11	650·63	....
		Sundry claims	....	....	....	....	....	....	....	2,131·30	559·83	....
Warda Warra	....	Voided leases	....	....	....	....	....	....	....	10,760·50	5,862·04	....
		Sundry claims	....	....	....	....	....	....	....	933·75	369·87	....
Warriedar	....	Voided leases	....	....	....	....	....	....	....	13,661·50	4,607·88	7·30
		Sundry claims	....	....	....	....	....	....	2·84	8,782·85	1,892·46	....
Yalgoo	....	Voided leases	....	....	....	....	....	....	3·23	6,314·50	9,965·18	....
		Sundry claims	....	....	....	....	....	....	23·56	2,622·75	1,010·02	....
Yuin	....	Voided leases	....	....	....	....	....	....	127·12	68,139·50	27,908·57	130·13
		Sundry claims	....	....	....	....	....	....	4·70	335·50	67·53	....

TABLE I.—*Production of Gold and Silver from all sources, etc.*—continued.

YALGOO GOLDFIELD—*continued.*

Mining Centre.	Number of Lease.	Registered Name of Company or Lease.	Total for 1949. Alluvial. Fine ozs.	Dollied and Specimens. Fine ozs.	Ore treated. Tons (2,240 lb.).	Gold therefrom. Fine ozs.	Silver. Fine ozs.	Total Production. Alluvial. Fine ozs.	Dollied and Specimens. Fine ozs.	Ore treated. Tons (2,240 lb.).	Gold therefrom. Fine ozs.	Silver. Fine ozs.
		From Goldfield generally :—										
		Sundry Parcels treated at :—										
		State Battery, Payne's Find	....	....	....	....	....	....	....	38·50	*4,529·92	....
		State Battery, Warriedar	....	....	....	....	....	....	....	....	*6,503·21	....
		State Battery, Yalgoo	....	....	....	....	....	....	....	....	*1,193·63	....
		P. W. Nevill's Rothsay Cyanide Plant	....	....	....	....	....	....	....	....	*291·65	72·23
		Various Works	....	....	....	....	....	9·42	....	664·00	*3,033·35	27·61
		Reported by Banks and Gold Dealers	6·44	....	....	....	·09	941·98	58·32	....	34·44	·20
		Totals	**6·44**	**17·16**	**1,770·55**	**769·63**	**·09**	**1,782·50**	**3,181·62**	**437,122·18**	**260,302·55**	**1,500·08**

Mt. Margaret Goldfield.

MOUNT MORGANS DISTRICT.

Australia United	....	Voided leases	....	....	....	....	....	....	1,911·63	15,913·69	23,305·76	1·76
		Sundry claims	....	....	....	....	....	....	580·98	1,307·50	2,227·65	....
Eucalyptus	....	Voided leases	....	....	....	....	....	....	2,878·56	1,603·85	3,251·01	....
		Sundry claims	....	....	16·00	17·16	....	....	588·28	2,145·30	1,990·31	....
Linden	522F	Ailsa	....	....	....	....	....	....	....	1,025·00	525·35	....
	539F	Democrat	....	....	672·00	941·58	....	....	1·19	4,618·25	7,712·04	....
	554F	Devon	....	....	....	....	....	....	....	11·50	13·39	....
	553F	Local Lady	....	....	665·50	319·55	....	....	....	2,019·50	2,429·02	....
	521F	North Democrat	....	....	172·00	313·82	....	....	....	2,954·75	5,762·90	....
	529F	Second Fortune	....	....	....	....	....	....	....	517·00	282·05	....
		Voided leases	....	....	....	....	....	7·53	565·78	60,096·31	48,051·10	·68
		Sundry claims	....	....	67·75	19·86	....	132·11	244·96	19,029·85	13,679·97	....
Mt. Margaret	M.A. 12F	United Aborigines Mission	....	....	....	....	....	113·08	18·87	403·00	133·14	·09
		Voided leases	....	....	....	....	....	12·13	1·89	8,900·39	5,291·51	12·55
		Sundry claims	....	....	....	....	....	25·22	111·18	1,771·35	657·36	....
Mt. Morgans	511F, etc	Morgans Gold Mines, Ltd.	....	....	....	....	....	....	....	4,466·80	13,776·04	....
	399F, etc.	Prior to transfer to present holders	....	....	....	....	....	....	16·66	779,578·43	354,225·86	5,552·63
	547F	Vodice	....	....	80·25	22·99	....	....	....	623·75	138·93	....
		Voided leases	....	....	....	....	....	17·95	148·79	60,730·75	34,647·60	77·86
		Sundry claims	....	3·37	69·75	40·06	....	36·41	398·78	4,959·57	3,311·89	....
Murrin Murrin	....	Voided leases	....	....	....	....	....	10·43	231·35	136,940·22	104,029·97	29·60
		Sundry claims	....	....	....	·65	....	51·15	557·24	6,425·33	4,433·63	....

Redcastle	557F	Trixie	....	....	34·00	21·31	....	....	....	96·00	27·58	....
		Voided leases	....	....	....	....	....	4·49	436·54	4,107·20	4,043·41	....
		Sundry claims	....	....	....	....	....	....	113·84	1,133·57	636·03	....
Yundamindera	510F	Landed-at-Last	....	....	....	....	....	....	....	4,332·00	683·02	....
		Voided leases	....	....	....	....	....	....	110·93	74,153·85	49,211·33	5·82
		Sundry claims	....	....	20·00	5·80	....	3·01	271·93	6,494·35	4,738·94	....
	From District generally :—											
	Sundry parcels treated at :											
	C. C. Crocker Cyanide Plant, M.A. 14F		....	....	....	....	....	....	....	10·00	*18·70	....
	Hillend Cyanide Plant on 482F				....	....	....	....	....	....	*556·95	....
	Rymer's Cyanide Plant on 395F		....	....	....	....	....	....	....	....	*1,162·22	....
	Turbett's Cyanide Plant		....	....	....	....	....	....	....	....	*1,232·20	....
	State Battery, Linden		....	....	....	*809·88	....	....	9·16	293·29	*14,855·25	....
	Various Works		....	....	....	....	....	....	....	1,257·81	*5,587·82	99·97
	Reported by Banks and Gold Dealers		15·97	....	....	....	....	2,971·51	141·84	10·30	95·75	·68
	Totals		**15·97**	**3·37**	**1,797·25**	**2,512·66**	....	**3,385·02**	**9,340·38**	**1,207,930·46**	**712,725·68**	**5,781·64**

MOUNT MALCOLM DISTRICT.

Cardinia	(1808c)	Inglewood	....	....	50·00	4·81	....	....	....	275·00	27·37	....
	1795c	Rangoon	....	....	....	....	....	....	6·49	250·00	118·60	....
	1805c	Wonghi	....	....	280·00	18·28	....	....	....	280·00	18·28	....
		Voided leases	....	....	....	....	....	13·87	1,591·66	4,600·24	3,979·15	....
		Sundry claims	....	2·08	....	....	....	4·25	121·91	1,865·25	575·01	·66
Diorite	1786c	Puzzle	....	....	58·00	102·10	....	....	....	2,563·00	2,641·87	....
		Voided leases	....	....	....	....	....	....	945·65	36,103·03	32,335·98	33·18
		Sundry claims	....	....	....	....	....	11·21	329·32	4,623·80	4,427·56	....
Dodger's Well	....	Voided leases	....	....	....	....	....	....	57·90	1,373·30	1,936·52	....
		Sundry claims	....	....	....	....	....	·95	28·32	1,440·25	904·23	....
Lake Darlot	(1823c)	Billie	....	....	29·00	46·50	....	....	....	142·00	272·66	....
	1814c	British King	....	....	....	....	....	....	....	25·00	3·24	·33
	1784c	British King West	....	....	39·00	20·08	....	....	....	1,043·00	1,090·34	7·20
	1820c	The Dragon	....	....	94·00	75·59	....	....	....	767·00	474·41	....
		Voided leases	....	....	....	....	....	....	4,482·18	68,750·46	50,105·37	·03
		Sundry claims	....	....	183·00	92·47	....	67·68	557·70	7,923·34	5,265·70	2·60
Leonora	1829c	Jessie Alma	....	454·52	429·50	1,617·63	....	....	454·52	429·50	1,617·63	....
	1594c	Leonora Central G.M. Co., N.L.	....	....	....	....	....	....	....	8,621·00	853·23	....
	1788c	Little Gwalia	....	....	....	....	....	....	....	740·00	57·83	....
	1341c, etc.	Sons of Gwalia, Ltd.	....	....	81,395·00	23,572·58	1,962·78	....	....	5,395,525·53	2,191,097·87	154,831·04
		Prior to transfer to present holders	....	....	....	....	....	....	....	109,081·00	55,989·21	8·66
		Voided leases	....	....	....	....	....	....	1,866·86	166,178·00	89,768·33	94·57
		Sundry claims	....	3·31	91·00	37·91	....	37·73	354·70	18,007·25	11,557·79	....
Malcolm	....	Voided leases	....	....	....	....	....	11·65	47·07	62,656·53	47,563·43	....
		Sundry claims	....	....	22·50	8·77	....	5·75	33·39	4,371·47	2,670·09	·12
Mertondale	....	Voided leases	....	....	....	....	....	....	....	89,024·75	60,935·32	1,497·58
		Sundry claims	....	....	21·50	6·23	....	1·82	85·74	3,216·41	2,295·52	....

TABLE I.—*Production of Gold and Silver from all sources, etc.*—continued.

MT. MARGARET GOLDFIELD—*continued.*

MOUNT MALCOLM DISTRICT.—*continued.*

Mining Centre.	Number of Lease.	Registered Name of Company or Lease.	Total for 1949.					Total Production.				
			Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.
			Fine ozs.	Fine ozs.	Tons (2,240 lbs.).	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Tons (2,240 lbs.).	Fine ozs.	Fine ozs.
Mt. Clifford	....	Voided leases	....	....	....	....	....	....	1,623·35	9,556·96	16,492·17	....
		Sundry claims	....	....	....	....	....	53·98	351·65	5,534·70	3,481·75	....
Pig Well	....	Voided leases	....	....	....	....	....	....	....	13,587·32	14,676·58	63·68
		Sundry claims	....	....	....	....	....	....	34·61	2,896·65	1,225·46	....
Randwick	1794c	Mighty Splash	....	....	....	....	....	....	7·27	759·00	79·01	....
		Voided leases	....	....	....	....	....	....	239·49	10,141·65	9,653·78	....
		Sundry claims	....	....	....	....	....	66·57	164·02	2,488·64	1,307·45	....
Webster's Find	....	Voided leases	....	....	....	....	....	30·30	....	22,167·50	14,377·65	....
		Sundry claims	....	....	....	....	....	36·84	695·68	2,356·15	1,530·56	....
Wilson's Creek	....	Voided leases	....	....	....	....	....	....	....	333·50	168·27	....
		Sundry claims	....	....	....	....	....	·70	4·24	316·00	261·12	....
Wilson's Patch	....	Voided leases	....	....	....	....	....	....	99·38	28,863·35	13,050·19	1·05
		Sundry claims	....	....	....	....	....	4·68	50·57	1,572·16	1,389·46	....
	From District generally :—											
	Sundry parcels treated at :											
	State Battery, Darlot (K. Millbank)		....	....	....	*222·41	....	....	....	10·00	*759·54	....
	Reefer Cyanide Plant		....	....	....	*100·30	....	....	....	20·00	*2,918·55	22·38
	Various Works		....	....	....	....	....	....	....	789·50	*22,175·93	135·97
	Reported by Banks and Gold Dealers		7·36	....	....	....	....	3,452·98	249·87	21·50	51·57	....
	Totals		**7·36**	**459·91**	**82,692·50**	**25,925·66**	**1,962·78**	**3,800·96**	**14,483·54**	**6,091,290·69**	**2,672,181·58**	**156,699·05**

MOUNT MARGARET DISTRICT.

Burtville	2446T	Boomerang	....	....	244·50	1,028·76	161·25	....	....	1,112·00	6,519·70	299·03
	2476T	Happy Find	....	....	212·50	937·93	100·00	2·60	....	855·50	3,179·76	149·83
	2138T	Nil Desperandum	....	....	53·75	44·24	....	....	5·30	1,579·37	3,348·60	....
	2463T	Tempest	....	....	15·75	4·45	....	....	....	15·75	4·45	....
		Voided leases	....	....	....	....	....	2·29	413·80	69,272·08	104,970·08	275·27
		Sundry claims	....	....	53·00	34·45	....	2·65	208·27	7,278·91	5,416·82	....
Duketon	....	Voided leases	....	....	....	....	....	5·35	3,216·10	31,889·42	22,542·63	....
		Sundry claims	....	....	5·00	4·45	....	....	528·26	2,402·65	2,164·55	29·76

Eagle's Nest	....	Voided leases	....	....	....	....	....	....	....	145·34	534·50	1,238·22	....
		Sundry claims	....	....	....	....	....	24·07	487·05	1,046·35	360·11	....
Erlistoun	(2345T)	Morgood	....	....	....	4·44	....	....	....	532·50	508·96	....
		Prior to transfer	....	....	....	....	....	....	....	160,057·00	75,902·56	4,316·81
	2500T	Westralia	....	....	....	....	....	....	....	....	1·56	....
		Voided leases	....	....	....	....	....	10·07	393·41	49,966·15	24,897·96	11·00
		Sundry claims	....	....	....	....	....	1,181·65	148·23	5,464·59	3,715·76	....
Euro	....	Voided leases	....	....	....	....	....	....	65·14	91,821·50	37,678·25	....
		Sundry claims	....	....	5·00	3·78	....	4·87	73·04	1,313·50	797·32	....
Laverton	2216T	Beria Main Lode	....	....	90·00	36·49	....	....	4·74	6,640·35	1,553·38	....
	2245T, etc.	Lancefield Leases	....	....	5,275·50	769·42	....	....	....	13,871·75	2,796·08	....
	2245T	Lancefield Extended West	....	....	....	....	....	....	....	881·25	846·77	....
	2489T	Wedge	....	....	....	....	....	....	....	222·00	21·19	....
	2478T	Lancefield North	....	....	....	....	....	....	....	1,923·00	388·41	....
	2499T	Pinnacles	....	....	17·50	2·16	....	....	....	29·00	5·21	....
	2507T	Roka	....	....	114·75	17·50	....	....	....	114·75	17·50	....
		Voided leases	....	....	....	....	....	28·59	2,024·11	2,068,422·27	811,609·61	56,923·16
		Sundry claims	....	....	42·75	13·40	....	215·58	1,475·35	17,034·25	9,042·70	....
Mt. Barnicoat	2506T	White Horse	....	....	115·50	346·66	....	....	....	115·50	346·66	....
		Voided leases	....	....	....	....	....	....	23·08	1,788·50	654·65	....
		Sundry claims	....	....	19·75	23·91	....	....	·68	1,240·25	1,078·14	....
Mt. Shenton	....	Voided leases	....	....	....	....	....	....	....	15·00	26·65	....
		Sundry claims	....	....	....	....	....	....	....	279·25	209·67	....
	From District generally :—											
	Sundry Parcels treated at :—											
	United Gold Recoveries Pty., Ltd.	....	....	....	*634·51	412·18	....	....	....	*1,306·28	835·64
	State Battery, Laverton	....	....	....	*983·45	....	....	....	....	97·50	*9,996·31	15·64
	D. Cable's Plant, L.T.T. 976H, etc.	....	....	....	....	....	....	....	....	....	*1,335·70	....
	J. Shepherd's Plant, M.A. 23T	....	....	....	....	....	....	....	....	....	*99·55	....
	Various Works	....	....	....	....	....	....	....	....	159·50	*17,961·14	·24
	Reported by Banks and Gold Dealers	·59	....	....	....	....	2,508·22	108·08	....	26·76	....
	Totals	**·59**	....	**6,265·25**	**4,890·00**	**673·43**	**3,985·94**	**9,319·98**	**2,483,975·89**	**1,152,569·65**	**62,856·38**

North Coolgardie Goldfield.

MENZIES DISTRICT.

Comet Vale	5732Z	Central Coonega	....	....	25·00	5·13	....	....	....	83·00	20·16	....
		Voided leases	....	....	....	....	....	....	419·74	266,639·72	193,083·79	5,351·38
		Sundry claims	....	....	54·00	34·03	....	....	40·19	1,895·91	995·96	....
Goongarrie	5740Z	Gull's Blow	....	....	124·75	35·36	....	....	....	209·75	105·46	....
	5735Z	Pretty Easy	....	....	....	....	....	....	1·22	....	....	....
		Voided leases	....	....	....	....	....	·94	1,384·04	29,828·79	18,060·05	....
		Sundry claims	....	....	34·00	14·92	....	46·46	2,054·17	2,625·27	3,063·12	....

TABLE 1.—*Production of Gold and Silver from all sources, etc.*—continued

NORTH COOLGARDIE GOLDFIELD—*continued.*

MENZIES DISTRICT.—*continued.*

MINING CENTRE.	NUMBER OF LEASE.	REGISTERED NAME OF COMPANY OR LEASE.	TOTAL FOR 1949.					TOTAL PRODUCTION.				
			Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.
			Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.
Menzies	5543z	Black Swan	....	....	18·00	13·78	....	....	....	1,000·63	1,633·52	9·08
	5736z	Bodington	....	....	25·00	10·18	....	....	2·82	45·00	51·13	....
	5694z	Dark Horse	....	....	....	....	....	....	....	83·00	293·76	....
	5511z	First Hit	....	....	126·00	125·37	....	....	....	1,798·75	4,813·06	....
	5511z, etc.	(First Hit Gold Mine (1934), N.L.)	....	....	....	....	....	....	....	68,473·70	49,060·96	6,676·23
	5542z	Good Block Lease	....	....	....	....	....	....	7·32	1,491·00	2,319·67	....
	5714z	Lady Harriet North	....	....	....	....	....	....	....	21·00	4·01	....
	5549z	Lady Harriet	....	....	....	....	....	....	....	548·00	164·46	....
	5520z	Mignonette	....	....	25·00	9·03	....	....	....	478·50	345·92	....
	5741z	New Start	....	....	5·00	3·85	....	....	....	12·00	8·57	....
		Voided leases	....	....	....	....	....	45·42	1,125·41	934,253·50	725,616·80	13,586·39
		Sundry claims	....	....	532·75	196·07	....	49·50	597·55	32,530·69	24,775·89	776·49
Mt. Ida	5537z, etc.	Goldfields Australian Development Co., Ltd.	....	....	....	....	....	....	....	12,682·00	7,208·07	332·63
	5537z, etc.	Mt. Ida Gold Mines, Ltd.	....	....	....	....	....	....	....	17,638·50	8,075·96	558·74
		Prior to transfer	....	....	....	....	....	....	....	1,512·75	737·95	....
		Voided leases	....	....	....	....	....	....	92·21	68,731·17	72,679·14	106·63
		Sundry claims	....	66·28	13·50	52·18	....	48·14	406·19	15,818·91	8,108·91	·12
Twin Hills	....	Voided leases	....	....	....	....	....	....	....	582·30	574·93	....
		Sundry claims	....	....	....	....	....	....	....	97·80	86·69	....
	From District generally :—											
	Sundry Parcels treated at :—											
	Gold Tailings, Ltd. (on Menzies Con. G.M.)		....	....	....	....	....	....	....	....	*345·87	5·84
	Lady Harriet Battery		....	....	....	*391·69	....	....	....	279·50	*17,896·77	30·00
	State Battery, Mt. Ida		....	....	....	*73·08	·05	....	....	1,866·25	*6,902·12	·05
	P. W. Maher's Plant, L.T.T. 1130H		....	....	....	*4·96	....	....	....	....	*4·96	....
	P. W. Maher's Plant, L.T.T. 1100H		....	....	....	*3·98	....	....	....	....	*9·37	....
	C. Kirkham's Plant, L.T.T. 1106H		....	....	16·00	2·93	....	....	....	16·00	2·93	....
	B. W. Sander Cyanide Plant, L.T.T. 1135H		....	....	....	*38·04	46·39	....	....	....	*38·04	46·39
	Sanders Cyanide Plant, L.T.T. 1107H		....	....	....	*150·99	110·29	....	....	....	*241·76	224·87
	Various Works		....	....	....	....	....	....	....	2,512·30	*38,206·49	2,754·98
	Reported by Banks and Gold Dealers		1·08	....	....	....	....	1,440·72	382·80	35·00	7·72	....
	Totals		**1·08**	**66·28**	**999·00**	**1,165·57**	**156·73**	**1,631·18**	**6,513·66**	**1,463,790·69**	**1,185,543·97**	**30,459·82**

ULARRING DISTRICT.

Davyhurst	1016U	New Callion	....	....	....	....	....	....	....	....	5,293·30	2,002·37	119·67
	(1136U)	New Golden Pole	....	....	40·00	10·24	....	....	2·63	1,247·00	206·65	....	
		Voided leases	....	....	....	....	....	2·93	150·01	165,536·32	125,804·71	5,408·47	
		Sundry claims	....	....	....	....	....	....	208·48	13,309·44	5,612·88	....	
Morley's	1101U	Emerald	....	....	....	....	....	....	26·24	674·00	1,188·88	....	
	1094U	First Hit	....	....	242·00	595·69	....	....	....	1,362·25	3,926·65	....	
	1081U	Mabel Gertrude	....	....	290·00	181·92	....	....	....	936·00	1,007·71	....	
	1155U	Mountain Dew	....	....	52·00	16·74	....	....	....	52·00	16·74	....	
	1089U	Paramount	....	....	350·00	478·08	....	....	....	2,106·50	2,172·87	....	
	1078U	Rabbit	....	....	185·50	142·70	....	....	265·66	760·00	1,200·12	....	
	1074U	Two Chinamen	....	....	306·00	443·59	10·54	....	3,466·48	1,567·50	3,838·38	10·54	
		Voided leases	....	....	....	....	....	....	122·80	484·50	775·48	....	
		Sundry claims	....	....	52·00	36·43	....	2·16	932·23	1,567·25	2,398·17	....	
Mulline	1107U	Ajax West	....	....	43·50	38·86	....	....	1·37	582·75	1,093·17	....	
	1070U	Riverina	....	....	....	....	....	....	....	35·00	7·18	....	
	1068U, etc.	(Riverina Gold Mines, Ltd.)	....	....	....	....	....	....	....	32,085·50	11,669·45	·07	
	1154U	Shirley Patricia	....	....	7·00	2·23	....	....	....	7·00	2·23	....	
		Voided leases	....	....	....	....	....	....	274·09	102,630·22	103,358·09	530·75	
		Sundry claims	....	....	65·00	38·51	....	10·82	198·67	10,615·89	8,705·54	1·10	
Mulwarrie	1153U	Four Mile	....	....	18·00	121·49	....	....	....	18·00	121·49	....	
	1113U	Oakley	....	....	218·00	196·62	....	....	....	879·50	976·12	....	
		Voided leases	....	....	....	....	....	....	165·29	19,480·68	26,369·21	38·47	
		Sundry claims	....	....	....	....	....	·80	282·29	3,102·33	2,704·43	....	
Ularring	....	Voided leases	....	....	....	....	....	....	563·34	9,771·60	13,907·76	....	
		Sundry claims	....	....	....	....	....	....	....	671·50	309·48	....	
	From District generally :—												
	Sundry parcels treated at :												
	State Battery, Mulline	....	....	....	....	....	....	....	639·99	*16,459·89	....	
	State Battery, Mulwarrie	....	....	....	....	....	....	....	613·18	*6,564·16	....	
	M.A. 13U, E. Rowe	....	....	....	....	....	....	....	....	*21·65	....	
	Two Chinamen Battery	....	....	....	*309·52	....	....	....	....	*309·52	....	
	Waihi Battery	....	....	....	*98·29	....	....	....	5·00	*790·28	....	
	Waihi-Golden Pole Cyanide Plant	....	....	....	....	....	....	....	....	*936·58	....	
	Prior to Amalgamation	....	....	....	....	....	....	....	....	*5,032·24	....	
	Various Works	....	....	....	....	....	....	15·82	233·15	*1,784·67	....	
	Reported by Banks and Gold Dealers	·86	....	....	....	....	112·68	63·08	100·00	22·67	....	
	Totals	**·86**	**....**	**1,869·00**	**2,710·91**	**10·54**	**129·39**	**6,738·48**	**376,367·35**	**351,297·42**	**6,109·07**	

NIAGARA DISTRICT.

Desdemona	....	Voided leases	....	....	....	....	....	....	7·12	9,809·00	7,555·81	12·04	
		Sundry claims	....	....	....	....	....	....	8·99	2,225·45	892·48	....	
Kookynie	928G	Altona	....	....	272·75	298·61	....	....	....	622·25	687·03	....	
	911G	Cosmopolitan South	....	....	174·00	74·97	....	....	....	1,475·00	699·06	....	
	925G	New South Champion	....	....	120·00	199·77	....	....	....	270·00	416·81	....	
		Voided leases	....	....	....	....	....	3·35	347·30	744,557·21	394,129·55	5,375·97	
		Sundry claims	....	1·94	85·00	14·21	....	56·74	105·34	8,827·55	6,538·86	·18	

TABLE I.—*Production of Gold and Silver from all sources, etc.*—continued.

NORTH COOLGARDIE GOLDFIELD—*continued.*

NIAGARA DISTRICT.—*continued.*

Mining Centre.	Number of Lease.	Registered Name of Company or Lease.	Total for 1949.					Total Production.				
			Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.
			Fine ozs.	Fine ozs.	Tons (2,240 lbs.).	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Tons (2,240 lbs.).	Fine ozs.	Fine ozs.
Niagara	....	Voided leases	....	....	....	....	....	....	104·54	85,876·50	52,365·05	....
		Sundry claims	....	....	166·50	31·19	....	28·10	97·22	14,486·16	8,103·42	....
Tampa	....	Voided leases	....	....	....	....	....	....	41·58	50,477·57	23,287·71	174·24
		Sundry claims	....	....	....	....	....	32·60	283·40	8,041·33	4,113·02	....
		From District generally :—										
		Sundry parcels treated at :										
		M.A. 65G, Owen Bros.' Plant	....	....	....	....	....	....	....	....	*31·91	....
		Grafter Battery, Tampa	....	....	....	....	....	....	....	....	*137·63	....
		Niagara State Battery (P. J. Ward)	....	....	....	....	....	....	....	....	*10·08	....
		Various Works	....	....	....	....	....	....	....	1,220·50	*16,226·67	41·17
		Reported by Banks and Gold Dealers	·29	....	....	....	....	1,591·87	823·66	....	63·53	....
		Totals	**·29**	**1·94**	**818·25**	**618·75**	....	**1,712·66**	**1,819·15**	**927,888·52**	**515,258·62**	**5,603·60**

YERILLA DISTRICT.

Edjudina	1011R, etc.	Paget Gold Mines of Edjudina, Ltd.	....	....	....	....	....	....	....	841·50	187·51	....
		Prior to transfer to present holders	....	....	....	....	....	....	....	738·75	559·80	....
		Voided leases	....	....	....	....	....	....	18·44	33,943·45	42,627·48	37·79
		Sundry claims	....	....	14·00	17·44	....	....	26·89	6,887·58	4,806·37	....
Patricia	....	Voided leases	....	....	....	....	....	....	....	4,158·50	5,396·40	25·40
		Sundry claims	....	....	....	....	....	....	....	47·00	20·78	....
Pinjin	....	Voided leases	....	....	....	....	....	....	48·34	17,463·30	10,742·77	....
		Sundry claims	....	....	....	....	....	....	154·86	5,623·59	3,466·70	....
Yarri	1320R	Margaret	....	....	123·00	32·65	....	....	....	319·00	93·20	....
	1126R, etc.	Porphyry (1939) G.M., N.L.	....	....	....	....	....	....	....	66,715·00	9,867·95	261·86
		Prior to transfer to present holders	....	....	....	....	....	....	....	30,344·50	5,448·82	507·51
	1319R	Valerie May	....	....	42·00	35·83	....	....	....	102·00	172·47	....
		Voided leases	....	....	....	....	....	6·30	87·08	44,196·75	21,056·75	2·00
		Sundry claims	....	....	211·00	55·30	....	·87	5·93	15,568·05	5,763·39	....
Yerilla	....	Voided leases	....	....	....	....	....	....	3,107·25	16,481·43	12,925·74	13·93
		Sundry claims	....	....	....	....	....	19·30	54·93	2,742·58	1,567·83	....

Yilgangie	1176R, etc.	Western Mining Corporation	....	....	1,180·00	2,087·54	111·48	....	....	2,579·75	3,250·50	111·48
		Prior to transfer to present holders	....	....	....	....	....	....	·85	1,244·75	1,830·28	....
		Voided leases	....	....	....	....	....	....	9·94	2,432·75	1,500·80	....
		Sundry claims	....	....	91·00	29·55	·63	121·67	98·20	3,252·80	1,987·50	·63
		From District generally :—										
		Sundry parcels treated at :										
		State Battery, Yarri	....	....	....	*224·64	....	....	....	271·50	*7,938·00	3·50
		State Battery, Yerilla	....	....	....	....	....	....	....	....	*43·52	....
		Various Works	....	....	....	....	....	2·17	....	642·25	*6,049·24	....
		Reported by Banks and Gold Dealers	....	....	....	....	....	1,161·37	160·08	....	4·11	....
		Totals	....	....	**1,661·00**	**2,482·95**	**112·11**	**1 311·68**	**3 772·79**	**256,596·78**	**147,307·91**	**964·10**

Broad Arrow Goldfield.

Bardoc	(2256w)	Zorastrian	....	....	12·00	1·21	....	....	....	12·00	1·21	....
		Voided leases	....	....	....	....	....	....	2,335·41	85,358·59	55,698·29	203·60
		Sundry claims	....	....	274·75	57·08	....	54·95	1,194·11	15,890·28	7,859·19	....
Black Flag	2229w	Bellevue	....	7·26	230·50	543·34	....	....	44·80	432·00	734·75	....
		Voided leases	....	....	....	....	....	27·81	405·90	48,223·79	28,152·20	....
		Sundry claims	....	....	17·00	14·53	....	712·92	251·59	7,574·21	4,705·66	....
Broad Arrow	2039w	Golden Arrow	....	....	....	....	....	....	....	5,647·50	829·20	....
	2254w	Grace Darling Extended	....	....	389·50	233·69	....	....	....	389·50	233·69	....
	2260w	Hill End	....	....	53·00	18·36	....	....	....	53·00	18·36	....
	1771w	North Duke	....	....	....	....	....	....	1,670·51	236·80	634·35	....
		Voided leases	....	....	....	....	....	70·32	8,782·21	147,215·59	117,403·80	20·23
		Sundry claims	....	17·24	369·50	145·90	....	1,007·72	3,044·51	31,449·39	16,304·56	·11
Canegrass	....	Voided leases	....	....	....	....	....	....	27·77	669·82	460·72	....
		Sundry claims	....	....	....	....	....	....	227·55	717·45	505·06	....
Carnage	....	Voided leases	....	....	....	....	....	176·04	659·31	2,402·00	2,170·67	....
		Sundry claims	....	....	....	....	....	....	6·61	1,840·08	874·56	....
Cashman's	....	Voided leases	....	....	....	....	....	67·51	813·76	8,172·15	7,090·91	....
		Sundry claims	....	....	116·00	10·80	....	....	40·31	1,151·52	332·96	·05
Christmas Reef	2175w	New Mexico....	....	....	122·75	514·65	....	....	....	909·60	2,514·10	....
		Voided leases	....	....	....	....	....	....	29·68	794·77	216·24	....
		Sundry claims	....	116·61	....	1·36	....	....	423·76	2,792·39	2,594·88	....
Fenbark	2188w	Golden Penny	....	....	80·50	32·06	....	....	....	2,648·50	556·45	....
	2228w	New Fenbark	....	....	189·25	34·93	....	....	....	578·25	121·04	....
		Voided leases	....	....	....	....	....	....	4·42	3,319·50	1,959·75	....
		Sundry claims	....	....	116·50	14·56	....	....	51·96	2,819·02	966·48	....
Grant's Patch	2242w	Lady Agnes	....	....	153·50	51·79	....	....	2·11	735·50	260·60	....
	2227w	Magpie	....	....	43·75	58·25	....	....	....	385·25	575·29	....
	1962w, etc.	Ora Banda Amalgamated Mines, N.L.	....	....	617·25	362·55	....	....	....	168,179·25	62,651·57	175·00
		Prior to transfer to present holders	....	....	....	....	....	....	....	12,424·50	9,540·07	....
	2208w	Wentworth	....	....	398·25	165·83	....	....	....	1,585·75	555·86	....
	2224w	Whip Pole	....	6·73	238·25	79·28	....	....	6·73	628·25	293·89	....
		Voided leases	....	....	....	....	....	....	258·52	14,783·10	4,672·25	....
		Sundry claims	....	....	223·50	48·19	....	....	356·66	5,828·29	2,891·66	....

TABLE I.—*Production of Gold and Silver from all sources, etc.*—continued.

BROAD ARROW GOLDFIELD—*continued.*

Mining Centre.	Number of Lease.	Registered Name of Company or Lease.	Total for 1949.					Total Production.				
			Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.
			Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.
Ora Banda	1336w, etc.	Associated Northern Ora Banda, N.L.	....	....	54·25	17·97	9·80	....	....	2,786·50	453·45	21·07
		Prior to transfer to present holders	....	....	....	....	....	....	....	315,958·95	123,252·22	1,664·70
	1943w, etc.	Ora Banda United Mines, Ltd.	....	....	363·50	62·11	....	....	....	2,545·75	136·91	....
		Prior to transfer to present holders	....	....	....	....	....	....	....	76,612·22	14,630·93	....
		Voided leases	....	....	....	....	....	....	845·72	24,580·60	12,604·69	....
		Sundry claims	....	....	293·25	70·05	....	....	336·76	12,705·50	4,270·57	....
Paddington	2122w	Pakeha	....	....	239·00	107·19	....	....	....	2,865·90	982·20	....
		Voided leases	....	....	....	....	....	5,566·30	463·31	189,669·41	84,534·17	18·96
		Sundry claims	....	....	96·00	25·12	....	1,714·16	291·43	16,114·98	9,057·13	....
Riches' Find	2255w	New Pole	....	....	75·75	40·09	....	....	....	75·75	40·09	....
	2257w	Yalbalgo	....	....	41·50	220·37	....	....	....	76·00	328·30	....
		Voided leases	....	....	....	....	....	....	7·01	7,395·84	5,323·36	71·36
		Sundry claims	....	21·69	107·00	58·45	....	....	242·58	1,728·30	1,823·40	·13
Siberia	2248w	Beauty	....	....	....	....	....	....	....	53·00	217·34	....
		Voided leases	....	....	....	....	....	1·07	2,649·28	28,875·97	31,534·00	....
		Sundry claims	....	....	69·00	22·55	....	289·03	1,233·18	20,641·79	12,712·45	....
Smithfield	....	Voided leases	....	....	....	....	....	....	....	4,700·71	1,174·69	....
		Sundry claims	....	....	50·25	22·78	....	....	123·37	2,581·84	1,011·99	....
	From District generally :—											
	Sundry parcels treated at :											
		State Battery, Ora Banda	....	....	....	*814·61	....	....	....	128·05	*20,018·27	....
		Golden Arrow Battery	....	....	....	*258·63	....	....	....	36·00	*3,526·26	....
		Ora Banda Tailings Syndicate Retreatment Works	....	....	....	....	....	....	....	....	*38·64	....
		Minnie Palmer Battery and Cyanide Plant	....	....	....	....	....	....	....	....	*3,082·62	....
		Various Works	....	....	....	....	....	2,275·66	1·24	16,967·02	*46,350·24	3,103·45
		Reported by Banks and Gold Dealers	9·20	....	....	....	....	9,972·31	131·39	61·68	90·35	....
		Totals	**9·20**	**169·53**	**5,035·25**	**4,108·28**	**9·80**	**21,935·83**	**26,963·46**	**1,303,009·35**	**711,584·54**	**5,278·66**

North-East Coolgardie Goldfield.

KANOWNA DISTRICT.

Gindalbie	1540x	Lady Betty	....	35·49	51·75	133·15	....	....	1,132·05	441·00	1,075·99	....
	(1570x)	Lady Geraldine	....	....	195·75	66·01	....	....	....	195·75	66·01	....
		Voided leases	....	....	....	....	....	....	19·94	44,126·78	39,530·69	38·31
		Sundry claims	....	....	....	....	....	....	716·52	4,914·27	2,787·84	....

Gordon	1568x	Mt. Eba	....	....	149·38	29·07	....	....	....	338·13	84·15	....
	1532x	Sirdar	....	....	....	....	....	....	92·66	4,838·60	3,423·44	517·61
		Voided leases	....	....	....	....	....	....	589·88	48,723·78	16,562·53	....
		Sundry claims	....	....	....	....	....	....	177·38	2,044·45	1,170·95	....
Kalpini	....	Voided leases	....	....	....	....	....	....	38·73	13,543·50	6,753·78	·07
		Sundry claims	....	....	....	....	....	24·70	269·72	1,492·50	1,026·37	....
Kanowna	1572x	Kanowna Red Hill	....	....	353·75	132·69	....	....	....	353·75	132·69	....
	(1566x)	Lady Robinson	....	....	17·25	5·28	....	....	....	41·25	21·99	....
		Voided leases	....	....	....	....	....	24·94	4,515·69	685,374·85	380,401·56	2,482·24
		Sundry claims	....	3·52	525·50	90·31	....	118·94	2,157·89	25,304·77	11,440·39	1·50
Mulgarrie	....	Voided leases	....	....	....	....	....	....	1,216·63	6,902·26	4,197·98	....
		Sundry claims	....	....	....	....	....	....	16·78	1,261·75	631·40	....
Six Mile	....	Voided leases	....	....	....	....	....	....	1,603·72	559·00	767·72	....
		Sundry claims	....	2·37	20·00	3·54	....	....	56·51	759·25	229·10	....
	From District generally :—											
	Sundry Parcels treated at :—											
	Various Works	....	....	....	....	....	330·42	867·52	158,935·05	*153,205·89	....
	Reported by Banks and Gold Dealers	1·25	....	....	....	....	105,993·77	36·91	·50	104·96	....
	Totals	**1·25**	**41·38**	**1,313·38**	**460·05**	....	**106,492·77**	**13,508·53**	**1,000,151·19**	**623,615·43**	**3,039·73**

KURNALPI DISTRICT.

Jubilee	....	Voided leases	....	....	....	....	....	....	145·13	2,122·50	1,465·16	....
		Sundry claims	....	....	7·50	5·72	....	25·57	13·52	1,226·75	517·35	....
Kurnalpi	....	Voided leases	....	....	....	....	....	371·18	3,166·80	4,052·51	3,957·71	6·27
		Sundry claims	....	....	....	....	....	324·12	727·39	4,305·36	2,089·90	....
Mulgabbie	....	Voided leases	....	....	....	....	....	....	1,402·66	226·75	7,845·87	4·95
		Sundry claims	....	....	....	....	....	8·06	2,770·97	1,263·45	2,221·03	....
	From District generally :—											
	Sundry Parcels treated at :—											
	Various Works	....	....	....	....	....	....	....	101·50	*388·63	....
	Reported by Banks and Gold Dealers	....	2·11	....	....	1·49	12,104·93	70·70	....	2·35	1·49
	Totals	....	**2·11**	**7·50**	**5·72**	**1·49**	**12,833·86**	**8,297·17**	**13,298·82**	**18,488·00**	**12·71**

East Coolgardie Goldfield.

EAST COOLGARDIE DISTRICT.

Binduli	6025E	Bell-of-Kalgoorlie	....	....	39·25	3·68	....	....	....	527·50	69·10	....
		Voided leases	....	....	....	....	....	....	....	803·10	385·19	....
		Sundry claims	....	....	29·00	2·36	....	....	13·01	4,904·02	1,659·03	....
Boorara	5486E	Olympian	....	....	71·50	9·60	....	....	....	1,675·25	937·05	3·01
		Voided leases	....	....	....	....	....	....	459·07	306,930·82	171,842·83	408·36
		Sundry claims	....	....	95·50	6·86	....	·49	145·56	2,901·84	1,416·91	....

TABLE I.—*Production of Gold and Silver from all sources, etc.*—continued.

EAST COOLGARDIE GOLDFIELD—*continued.*

EAST COOLGARDIE DISTRICT—*continued.*

Mining Centre.	Number of Lease.	Registered Name of Company or Lease.	Total for 1949.					Total Production.				
			Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.
			Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.
Boulder	6145E	Boomerang	....	....	....	....	....	....	....	77·00	8·00	....
	5690E	Boulder Perseverance, Ltd.	....	....	133,000·02	32,529·25	14,865·35	....	....	2,330,932·17	908,319·48	290,097·28
		Prior to transfer to present holders	....	....	....	....	....	....	....	3,306,942·88	1,841,159·00	203,821·43
	6077E	Brown Hill Consols	....	....	....	....	....	....	....	66·00	5·87	....
	5472E	Golden Key	....	....	....	....	....	18·27	22·78	432·25	165·02	....
	5692E, etc.	Gold Mines of Kalgoorlie, Ltd.	....	....	163,552·44	41,071·09	7,384·71	....	....	1,632,076·30	450,979·61	126,897·77
	5466E	South Star	....	....	....	....	....	....	233·46	4,237·43	1,494·78	....
	5466E, etc.	Prior to transfer to present holders	....	....	....	....	....	....	5·22	1,835·75	748·78	....
	5159E, etc.	Lake View South (G.M.K.), Ltd.	....	....	....	....	....	....	....	62,278·38	21,536·66	....
		Prior to transfer to present holders	....	....	....	....	....	....	545·23	527,790·53	568,643·05	4,844·50
	4366E, etc.	Great Boulder Proprietary G.Ms., Ltd.	....	....	333,109·00	83,259·31	45,377·28	....	1·53	9,108,545·97	5,045,241·57	995,222·03
	5845E	Happy Returns	....	....	2,050·25	401·18	....	....	....	2,496·25	514·00	....
	5345E, etc.	Kalgoorlie Enterprise Mines, Ltd.	....	....	52,489·49	16,981·13	1,526·53	....	....	653,346·49	203,666·17	19,754·22
		Prior to transfer to present holders	....	....	....	....	....	....	....	15,320·68	8,957·01	....
	4334E, etc.	Lake View and Star, Ltd.	....	....	501,261·00	132,983·52	29,308·31	....	....	8,754,940·30	2,861,692·86	249,654·25
		Prior to transfer to present holders	....	....	....	....	....	....	8·49	15,792,500·38	9,149,223·80	1,348,055·82
	6230E	New Look	....	....	45·75	6·98	....	....	....	45·75	6·98	....
	5431E, etc.	North Kalgurli (1912), Ltd.	....	....	231,835·56	63,050·63	9,662·37	....	111·55	2,341,861·83	779,945·80	204,436·32
	5405E, etc.	North Kalgurli (1912), Ltd. (Croesus Pty. Group)	....	....	....	....	....	....	51·20	90,159·00	19,261·22	....
	5891E	(New Croesus)	....	....	....	....	....	....	....	193·00	48·74	....
	5700E, etc.	Prior to transfer to present holders	....	....	....	....	....	43·99	....	4,018,436·01	2,815,911·21	97,625·03
	5429E, etc.	North Kalgurli United Mines, Ltd.	....	....	....	....	....	....	....	4,661·51	928·18	232·93
		Prior to transfer to present holders	....	....	....	....	....	....	....	131·74	76·74	....
	5853E, etc.	Paringa Junction North Leases	....	....	....	....	....	....	7·82	1,686·79	701·11	....
	5853E	(Paringa Junction)	....	....	....	....	....	....	....	123·75	17·77	....
	5854E	(Paringa Junction North)	....	....	....	....	....	....	....	60·50	10·64	....
	5855E	(Paringa Junction South)	....	....	....	....	....	....	....	1,473·25	228·42	....
	5434E, etc.	Paringa Mining and Exploration Co., Ltd.	....	....	91,810·75	17,781·97	2,437·33	....	....	1,022,967·30	241,747·21	19,088·10
		Prior to transfer to present holders	....	....	....	....	....	1·07	·79	57,618·03	24,452·83	....
	6095E	Raymond	....	....	....	....	....	....	....	115·50	17·89	....
	5695E, etc.	South Kalgurli Consolidated, Ltd.	....	....	84,784·97	20,653·68	....	....	....	2,725,456·73	1,039,993·47	25,866·58
		Prior to transfer to present holders	....	....	....	....	....	....	....	1,344,254·70	531,792·77	17,722·97
		Voided leases	....	....	....	....	....	109·90	11,998·25	626,615·98	473,927·47	6·83
		Sundry claims	....	....	....	....	....	24·58	210·25	11,539·99	4,267·18	....
Cutter's Luck	6056E	New Black Cat	....	....	18·00	8·22	....	45·87	112·75	62·25	230·06	....
		Voided leases	....	....	....	....	....	....	20·83	12·25	9·13	....
		Sundry claims	....	....	36·75	5·18	....	8·11	501·65	829·15	371·37	....

Feysville	....	Voided leases	....	....	....	....	....	....	110·93	561·30	394·24	....		
		Sundry claims	....	....	....	....	....	....	199·00	1,117·10	620·09	....		
Hampton Plains	P.P.L. 55	R. J. Beavis	....	....	36·25	7·41	....	....	....	36·25	7·41	....		
	P.P.L. 311	Dawn Hope	....	....	....	....	....	....	....	993·75	89·23	....		
	P.P.L. 1	Consolidated Gold Areas, N.L.	....	....	....	....	....	....	....	140,704·23	37,087·38	5,835·85		
	P.P.L. 9	Consolidated Gold Areas, N.L.	....	....	....	....	....	....	....	215·75	4·27	....		
	P.P.L. 86	Golden Hope, N.L.	....	....	....	....	....	....	....	5,964·00	2,006·14	....		
	P.P.L. 192	Golden Hope North	....	....	....	....	....	....	....	353·00	201·02	....		
	P.P.L. 177	Great Northern	....	....	27·50	7·62	·23	....	....	57·25	12·98	·23		
	P.P.L. 12	Junction Extended	....	....	....	....	....	....	....	3,581·75	527·74	....		
	P.P.L. 227	McGrath's Lease	....	....	....	....	....	....	....	215·75	47·87	....		
	P.P.L. 289	Hampton Syndicate	....	....	....	....	....	....	....	....	*157·41	....		
	P.P.L. 252	Mount Martin	....	....	....	....	....	....	....	14,953·75	5,574·11	....		
	P.P.L. 279	Mutooroo	....	....	....	....	....	....	....	6,151·88	1,087·26	....		
	P.P.L. 175	F. C. Schoppe Lease	....	....	1,066·75	138·58	....	....	....	1,459·25	181·50	....		
	P.P.L. 277	New Hope	....	....	1,467·00	140·32	....	....	17·23	59,675·55	10,854·24	....		
	P.P.L. 371	Victory	....	....	....	....	....	....	....	1,717·50	224·47	....		
	P.P.L. 81	Villers Brettaneaux	....	....	....	....	....	....	....	3,562·02	1,435·55	....		
		Voided leases	....	....	....	....	....	4,565·62	203·94	110,492·44	36,077·27	69·60		
		Sundry claims	....	....	....	....	....	2·68	70·85	46,386·16	8,494·60	....		
Kalgoorlie	5927E	A.I.F.	....	....	....	....	....	....	....	31·00	10·34	....		
	6048E	Auld Acquaintance	....	....	....	....	....	....	....	7·50	2·36	....		
	5519E	Barbican Corporation, Ltd.	....	....	....	....	....	....	....	362·00	79·80	....		
	5735E	Bonnie Lass	....	....	....	....	....	....	....	250·50	74·67	....		
	5449E, etc.	Broken Hill Proprietary Co., Ltd.	....	....	42,490·00	13,026·77	....	....	3·99	438,578·01	166,443·56	1,843·28		
		Prior to transfer to present holders	....	....	....	....	....	....	....	1,558·49	316·58	....		
	(6046E)	Colleen Bawn	....	1·89	24·00	2·16	....	....	1·89	540·00	85·92	....		
	5867E	Concord	....	....	....	....	....	....	8·64	184·75	67·72	....		
	5839E	Coronation	....	....	....	....	....	....	....	40·00	9·03	....		
	5913E	Devon Consols	....	....	203·25	69·27	....	....	93·19	1,635·46	549·29	....		
	5924E	Federal	....	....	....	....	....	....	....	36·25	4·51	....		
	5737E	Golden Mile Channel	....	....	46·00	2·89	....	....	·97	2,677·25	207·65	....		
	5878E	Lady May	....	....	349·00	310·90	....	....	62·05	2,964·00	994·75	....		
	6091E	Lesanben	....	30·38	....	....	....	....	123·98	56·25	114·93	....		
	4547E, etc.	Mt. Charlotte (Kalgoorlie) Gold Mines, Ltd.	....	....	....	....	....	....	....	1,234·00	252·17	....		
		Prior to transfer to present holders	....	....	....	....	....	....	5·72	48,292·60	13,930·79	....		
	5437E	North End Extended	....	....	....	....	....	....	996·89	367·85	528·94	....		
	5852E, etc.	Pedestal Leases	....	....	87·00	8·46	....	....	....	700·25	155·02	....		
		Prior to transfer to present holders	....	....	....	....	....	....	....	1,667·50	481·60	....		
	5468E	Phar Lap	....	....	....	....	....	....	....	487·50	352·57	....		
	5415E, 5803E	Return Leases	....	....	....	....	....	....	5·64	3,723·50	649·47	....		
	5934E, etc.	Sceptre Leases	....	....	....	....	....	....	....	28·00	4·63	....		
		Voided leases	....	....	....	....	....	242·48	9,559·74	964,052·95	397,677·76	44,017·12		
		Sundry claims	....	....	103·79	9·66	....	232·41	1,122·17	59,288·83	22,959·41	....		
Wombola	6051E	Big Bull	....	....	154·00	115·16	....	....	....	283·50	239·32	....		
	5688E, 5967E	Caledonian Leases	....	....	235·00	109·94	....	....	....	543·00	247·27	....		
	5688E	(Caledonian)	....	....	....	....	....	....	....	4,275·00	3,632·98	....		
	5967E	(North Caledonian)	....	....	....	....	....	....	1·27	22·25	8·15	....		
	5500E, 5497E	Daisy Leases	....	....	644·00	534·88	....	....	....	2,014·25	1,332·80	5·92		
	5500E	(Happy-Go-Lucky)	....	....	....	....	....	....	....	2,075·25	1,675·85	....		
	5497E	(Daisy)	....	....	....	....	....	....	....	6,282·25	5,031·93	....		

TABLE I.—*Production of Gold and Silver from all sources, etc.*—continued.

EAST COOLGARDIE GOLDFIELD—*continued.*

EAST COOLGARDIE DISTRICT—*continued.*

MINING CENTRE.	NUMBER OF LEASE.	REGISTERED NAME OF COMPANY OR LEASE.	TOTAL FOR 1949.					TOTAL PRODUCTION.				
			Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.
			Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.
Wombola—*contd.*	6032E	Dry Mount	....	....	92·50	57·06	....	....	....	504·00	836·96	....
	4766E	Great Hope	....	....	68·00	21·34	....	....	....	96·00	28·09	....
	4766E	(Great Hope Pericles G.M., Ltd.)	....	....	....	....	....	....	358·11	4,728·03	19,305·86	....
	5689E, 5525E	Haoma Leases	....	....	1,242·00	816·55	....	....	....	9,237·50	6,212·69	....
	5525E	(Xmas Flat)	....	....	....	....	....	....	....	330·25	264·74	....
	5689E	(Haoma)	....	....	....	....	....	....	....	2,168·00	1,948·36	....
	6043E	Launa Doone	....	....	429·00	154·97	....	....	....	963·50	414·39	....
	(5872E), 6043E	(Launa Doone Leases)	....	....	....	....	....	....	....	32·50	42·76	....
	5961E	Loganberry	....	....	....	....	....	....	....	288·25	101·02	....
	6224E	Lucky Strike	....	....	30·00	6·10	....	....	....	30·00	6·10	....
	5798E	Maranoa	....	....	96·00	37·18	....	....	32·17	2,852·50	1,523·50	....
	5493E, etc.	New Milano, N.L.	....	....	....	....	....	....	·25	17,390·75	11,622·24	479·00
		Prior to transfer to present holders	....	....	....	....	....	....	....	4,614·75	12,615·82	....
	6213E	Pauline	....	....	51·00	84·08	....	....	....	51·00	84·08	....
	5866E	Rosemary	....	....	21·00	17·54	....	....	....	53·50	84·73	....
	6107E	Spinifex	....	....	18·00	4·31	....	....	....	101·00	39·79	....
		Voided leases	....	....	....	....	....	....	2,106·67	21,459·56	20,254·81	....
		Sundry claims	....	....	406·00	172·74	....	....	711·10	22,049·18	13,660·50	....
	From District generally:											
		Sundry claims	....	....	....	....	....	11,014·57	465·61	5,440·46	2,541·10	....
	Sundry Parcels treated at:—											
		Broken Hill Pty., Kalgoorlie, L.T.T. 1120H	....	....	....	*260·61	....	....	....	....	*260·61	....
		A. J. Cavalier Treatment Works	....	....	....	*30·96	....	....	....	10·50	*181·02	....
		Prior to transfer to present holders	....	....	....	....	....	....	....	....	*1,538·16	1,507·65
		Golden Horseshoe (New), Ltd.	....	....	....	*10,003·87	15,444·96	....	....	....	*296,398·21	299,886·11
		Pericles Mill....	....	....	....	*413·37	....	....	....	....	*3,569·19	....
		Polkinghorne's Cyanide Plant	....	....	....	....	....	....	....	....	*149·38	....
		J. F. Poynton, M.A. 1	....	....	....	....	....	....	....	9·50	6·06	....
		State Battery, Kalgoorlie	....	....	21·00	*1,426·98	....	....	....	345·70	*25,035·72	39·40
		Various Works	....	....	....	....	....	384·36	64·70	41,115·02	*264,211·65	12,606·81
		Reported by Banks and Gold Dealers	25·63	....	....	516·86	....	16,777·00	9,956·00	355·65	4,454·56	....
		Totals	**25·63**	**32·27**	**1,643,637·27**	**437,263·18**	**126,007·07**	**33,471·40**	**40,732·14**	**56836552·02**	**28,583,210·61**	**3,970,028·40**
BULONG DISTRICT.												
Balagundi	....	Voided leases	....	....	....	....	....	....	2,408·98	1,110·68	1,473·73	12·92
		Sundry claims	....	....	....	....	....	3·51	291·91	769·51	484·97	....

Bulong	1311Y	Blue Quartz	....	....	....	....	....	....	....	....	784·00	214·24	....
	1308Y	Southern Cross	....	....	252·75	42·09	....	....	1·30	2,702·50	459·79	....
		Voided leases	....	....	....	....	....	107·54	8,524·82	104,806·80	85,230·44	....
		Sundry claims	....	....	175·75	30·05	....	1,655·86	1,607·89	15,129·73	17,521·87	....
Majestic	....	Voided leases	....	....	....	....	....	19·45	63·91	1,317·94	647·62	....
		Sundry claims	....	....	....	....	....	42·88	154·58	1,926·55	948·06	....
Morelands Find	....	Sundry claims	....	....	35·00	9·50	....	....	·13	308·75	81·84	....
Mt. Monger	....	Voided leases	....	....	....	....	....	....	2,771·39	1,437·85	1,256·10	....
		Sundry claims	....	....	....	....	....	215·60	....	379·05	308·48	....
Randalls	....	Voided leases	....	....	....	....	....	....	60·04	33,180·35	11,100·46	....
		Sundry claims	....	....	....	....	....	20·70	8·11	4,814·31	1,211·05	....
Taurus	....	Voided leases	....	....	....	....	....	2·06	3·70	1,765·10	909·84	....
		Sundry claims	....	....	....	....	....	112·69	51·88	2,608·35	1,037·88	....
Trans Find	P.P.L. 308A	Dawn of Hope	....	....	23·25	2·27	....	....	2·87	1,141·50	328·80	....
		Voided leases	....	....	....	....	....	....	....	983·92	865·71	....
		Sundry claims	....	....	....	....	....	....	5·93	795·25	330·72	....
	From District generally :											
	Sundry Parcels treated at :											
	Various Works		....	....	....	....	....	....	....	6,102·15	*6,675·38	....
	Reported by Banks and Gold Dealers		....	....	....	....	....	25,198·12	70·15	·01	28·44	....
		Totals	....	....	**486·75**	**83·91**	....	**27,378·41**	**16,027·59**	**182,064·30**	**131,115·42**	**12·92**

Coolgardie Goldfield.

COOLGARDIE DISTRICT.

Bonnivale	5596, etc.	Coolgardie Gold Mines, Ltd.	....	....	492·30	289·20	....	....	....	574·80	363·06	·83
	5596	(Jenny Wren)	....	....	....	....	....	....	182·45	989·30	1,165·40	4·17
	5622	Lucky Hit	....	....	26·10	31·13	....	....	....	867·35	437·43	....
	4600	Melva Maie	....	....	78·00	193·27	....	....	....	2,069·40	3,514·43	1·70
		Prior to transfer to present holders	....	....	....	....	....	....	....	614·50	1,099·21	11·63
	5767	Victory Explorations, N.L.	....	....	934·00	159·83	....	....	....	934·00	159·83	....
	5767	(Red Ridge)	....	....	....	....	....	....	....	108·00	53·63	....
		Voided leases	....	....	....	....	....	....	30·03	352,675·34	188,804·77	....
		Sundry claims	....	....	....	....	....	....	161·29	6,232·43	4,595·51	....
Bulla Bulling	....	Voided leases	....	....	....	....	....	....	....	776·81	668·19	....
		Sundry claims	....	....	....	....	....	5·21	15·98	1,318·26	561·29	....
Burbanks	5838	Bell Bird	....	....	26·00	5·50	....	....	....	26·00	5·50	....
	5605	Burbanks Deeps	....	....	....	....	....	....	....	103·00	53·46	....
	5443	New Gift	....	....	....	....	....	....	2·00	625·50	228·69	....
		Voided leases	....	....	....	....	....	14·90	372·17	415,756·21	304,615·58	521·06
		Sundry claims	....	....	62·95	17·92	....	55·05	477·11	14,891·80	8,665·11	....

TABLE 1.—*Production of Gold and Silver from all sources, etc.*—continued.

COOLGARDIE GOLDFIELD—*continued.*

COOLGARDIE DISTRICT—*continued.*

Mining Centre.	Number of Lease.	Registered Name of Company or Lease.	Total for 1949.					Total Production.				
			Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.
			Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.
Cave Rocks	5645	Gold Coin	....	....	428·97	119·14	....	....	....	3,086·47	697·19	....
	5833	Squeaker	....	....	426·50	141·36	....	....	....	426·50	141·36	....
	5793	Two Cees	....	....	....	....	....	....	....	56·00	9·01	....
		Voided leases	....	....	....	....	....	....	....	3,081·05	750·60	....
		Sundry claims	....	....	....	....	....	....	50·00	4,223·90	1,015·48	....
Coolgardie	5679	Ada	....	....	....	....	....	....	....	1,130·25	107·11	....
	5822	Brilliant	....	....	147·50	10·97	·06	....	....	187·50	15·82	·06
	5637	Caledonia	....	....	90·00	8·90	....	....	7·30	2,648·25	497·16	....
	5297, etc.	Consolidated Gold Mines of Coolgardie, Ltd.	....	....	....	....	....	....	....	282,560·70	50,610·27	4,812·12
		Prior to transfer to present holders	....	....	....	....	....	....	4·55	1,946·35	547·45	3·22
	5653	Gleesons	....	....	....	....	....	....	....	1,925·00	922·37	....
	5598	King Solomon	....	....	63·25	4·18	....	2·69	....	856·25	129·66	....
	5713	Lady Grace	....	....	124·00	35·12	....	....	....	286·75	233·44	....
	5643	Lloyd George South	....	....	....	....	....	....	....	....	10·25	....
	5743	Moya Jan	....	....	227·25	82·96	....	....	....	1,495·00	596·42	....
	5239, etc.	Phoenix Gold Mines Pty., Ltd.	....	....	....	17·00	....	....	....	240,385·00	66,736·54	2·54
		Prior to transfer to present holders	....	....	....	....	....	....	2·74	167·56	237·80	....
		Voided leases	....	....	....	....	....	1,299·02	4,660·89	573,173·18	327,511·82	·96
		Sundry claims	....	5·40	1,483·65	683·90	....	205·49	2,681·77	66,890·35	24,754·51	....
Eundynie	5624	Eundynie	....	....	....	....	....	....	....	54·00	76·35	....
		Voided leases	....	....	....	....	....	·92	16·09	31,697·20	16,423·28	1·75
		Sundry claims	....	....	11·68	118·90	....	....	10·18	669·87	433·59	....
Gibraltar	5723	Lloyd George	....	....	200·00	21·94	....	....	....	570·00	105·54	....
	5684	Winston Churchill	....	....	....	....	....	....	....	60·00	12·96	....
		Voided leases	....	....	....	....	....	....	33·97	38,592·63	20,097·49	....
		Sundry claims	....	....	171·00	24·30	....	1·39	50·76	3,206·95	1,332·57	....
Gnarlbine	....	Voided leases	....	....	....	....	....	....	13·95	2,731·75	1,341·60	....
		Sundry claims	....	....	....	....	....	....	4·90	1,186·10	504·18	....
Hampton Plains	P.P.L. 419	Chatanooka	....	....	452·00	69·47	....	....	....	1,201·25	283·47	1·10
	P.P.L. 1328	Daniel Finn	....	....	....	....	....	....	....	19·75	11·18	....
	P.P.L. 338	Dry Hill	....	....	....	....	....	....	....	43·00	58·42	....
	P.P.L. 427	Easter Gift	....	....	....	....	....	....	....	21·75	3·04	....
	P.P.L. 119	Golden Eagle	....	....	....	....	....	....	7·63	2,807·59	2,548·42	....
	P.P.L. 348	Hampton Gold Mining Areas, Ltd.	....	....	....	....	....	....	....	43·75	4·69	....
	P.P.L. 348	Goldfields Australian Development Co., Ltd.	....	....	....	....	....	....	....	78·00	12·89	....

	P.P.L. 334	Hampton Gold Mining Areas, Ltd.	....	....	....	....	....	....	....	....	1,538·25	453·60	....
	P.P.L. 454	Hampton Gold Mining Areas, Ltd.	....	....	....	....	....	....	....	....	48·75	7·53	....
	P.P.L. 435	Lady Jess	....	....	....	....	....	....	2·79	151·00	30·47	....
	P.P.L. 355	Lady Marie	....	....	71·75	4·20	....	....	....	445·00	113·78	....
	P.P.L. 319	Lady May	....	....	....	....	....	....	....	1,742·25	981·39	....
	P.P.L. 389	Lassie Come Home	....	....	....	....	....	....	....	30·00	6·54	....
	P.P.L. 458	Mac	....	....	11·00	60·85	....	....	....	11·00	60·85	....
	P.P.L. 315	Malvern Star	....	....	....	....	....	....	....	16·00	10·14	....
	P.P.L. 436	May	....	....	....	....	....	....	....	4·50	1·35	....
	P.P.L. 429	Maureen Anne	....	....	....	....	....	....	....	14·75	2·15	....
	P.P.L. 430	Melba	....	....	10·00	3·51	....	....	....	10·00	3·51	....
	P.P.L. 361	Mistletoe	....	....	....	....	....	....	....	20·00	5·11	....
	P.P.L. 316, 330	New Coolgardie Gold Mines, N.L.	....	....	24,062·00	9,298·86	1,363·53	....	....	24,062·00	9,298·86	1,363·53
	P.P.L. 330	(Barbara)	....	....	....	....	....	....	....	2,157·75	1,655·63	....
	P.P.L. 316	(Surprise G.M.)	....	....	....	....	....	....	....	7,189·00	3,425·59	....
	P.P.L. 437	Two Crows	....	....	....	....	....	....	....	15·00	5·57	....
		Voided leases	....	....	....	....	....	....	403·05	8,518·25	7,798·76	....
		Sundry claims	....	....	....	....	....	1·63	132·06	1,738·25	799·38	....
Higginsville	5647	Fair Play	....	....	9,882·00	560·16	·02	....	....	22,550·00	2,651·91	·02
	5293	Two Boys	....	....	....	*88·70	....	....	....	460·00	*1,039·67	·01
	5293	(Two Boys)	....	....	....	....	....	....	....	6,888·00	3,193·95	....
		Voided leases	....	....	....	....	....	....	373·93	38,141·35	17,438·49	159·50
		Sundry claims	....	....	·03	22·50	....	....	187·25	3,638·26	1,942·64	....
Larkinville	....	Voided leases	....	....	....	....	....	22·77	54·44	2,335·16	3,256·49	....
		Sundry claims	....	....	....	....	....	....	147·20	448·53	1,029·03	....
Logan's	5324, etc.	Spargo's Reward Gold Mine (1935), N.L.	....	....	....	....	....	....	....	105,397·50	26,320·67	....
		Voided leases	....	....	....	....	....	....	....	1,263·31	607·26	....
		Sundry claims	....	....	....	....	....	....	128·95	1,881·35	888·61	....
Londonderry	....	Voided leases	....	....	....	....	....	....	95·04	34,155·35	22,238·37	·35
		Sundry claims	....	....	....	....	....	16·68	38·72	3,199·17	2,466·94	22·42
Mungari	....	Voided leases	....	....	....	....	....	....	17·71	1,872·50	458·43	....
		Sundry claims	....	....	....	....	....	1·77	153·24	2,443·44	697·15	....
Paris	5311, etc.	Lister's Gold Mine	....	....	....	....	....	·88	....	5,280·00	3,489·96	75·95
	5311, etc.	(Lister's Gold Mine)	....	....	....	....	....	....	....	8,582·00	4,423·84	....
	5311, etc.	(Paris Central)	....	....	....	....	....	....	....	113·00	24·16	....
		Voided leases	....	....	....	....	....	....	4·30	1,342·00	614·08	3·24
		Sundry claims	....	....	....	....	....	....	....	2,104·25	515·32	....
Red Hill	....	Voided leases	....	....	....	....	....	14·87	1,551·81	40,797·40	31,070·65	....
		Sundry claims	....	....	....	....	....	15·29	90·33	1,403·02	724·13	....
Ryan's Find	....	Voided leases	....	....	....	....	....	....	....	54·16	151·69	....
		Sundry claims	....	....	....	....	....	....	·44	116·44	355·83	....
St. Ive's	5628, etc.	Ive's Reward Leases	....	....	....	....	....	....	....	1,617·00	450·47	....
		Voided leases	....	....	....	....	....	63·34	146·87	37,701·46	15,756·31	....
		Sundry claims	....	....	....	....	....	211·25	944·85	4,158·56	1,453·58	....
Wannaway	....	Voided leases	....	....	....	....	....	....	28·61	1,831·95	1,465·70	....
		Sundry claims	....	....	8·00	4·91	....	....	193·79	1,305·82	1,275·31	....

TABLE I.—*Production of Gold and Silver from all sources, etc.*—continued.

COOLGARDIE GOLDFIELD—*continued.*

COOLGARDIE DISTRICT.—*continued.*

Mining Centre.	Number of Lease.	Registered Name of Company or Lease.	Total for 1949.					Total Production.				
			Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.
			Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.
Widgiemooltha	5794	Blue Bird	....	58·52	21·29	53·51	....	....	111·78	29·29	62·73	....
	5663	Bobs	....	....	....	....	....	....	....	16·00	4·94	....
	5702	Cardiff Castle	....	....	22·00	5·68	....	....	....	1,757·05	442·31	....
	(5835)	Crackerjack	....	....	41·37	32·09	....	....	....	41·37	32·09	....
	5834	Harper's	....	....	7·00	28·25	....	....	....	7·00	28·25	....
	5451	Host Group	....	....	1·80	85·30	....	....	12·75	1,602·80	524·21	....
	5837	St. Fairy	....	....	40·00	5·05	....	....	....	40·00	5·05	....
		Voided leases	....	....	....	....	....	9·42	1,114·94	20,848·70	11,364·28	·17
		Sundry claims	....	....	70·25	15·96	....	46·49	456·07	15,871·11	6,741·70	·07
		From District generally :—										
		Sundry parcels treated at :										
		State Battery, Coolgardie....	....	....	....	*780·62	....	....	....	771·01	*34,747·79	9·65
		Australian Machinery and Investment Co., Ltd.	....	....	....	....	....	....	....	....	*3,044·44	86·31
		Ajax Treatment Plant	....	....	....	*32·69	....	....	....	....	*43·26	....
		Lister's Cyanide Plant	....	....	....	....	....	....	....	....	*269·23	....
		Paris Central Cyanide Plant	....	....	....	....	....	....	....	....	*77·64	....
		M.A. 96, N. C. Parry	....	....	....	....	....	....	....	....	*23·77	....
		Widgiemooltha Battery	....	....	....	....	....	....	....	....	*1,165·31	....
		Various Works	....	....	....	....	....	7·75	....	3,897·61	*28,149·90	223·06
		Reported by Banks and Gold Dealers	32·68	....	....	....	....	14,833·98	718·84	48·25	74·95	·60
		Totals	**32·68**	**63·92**	**39,693·64**	**13,117·83**	**1,363·61**	**16,830·79**	**15,895·52**	**2,489,795·27**	**1,291,227·72**	**7,306·02**
		KUNANALLING DISTRICT.										
Carbine	970s	Carbine	....	....	....	....	....	....	....	13,820·00	7,047·96	....
	970s, etc.	Carbine Leases	....	....	....	....	....	....	687·98	51,991·86	39,862·25	....
		Voided leases	....	....	....	....	....	....	....	20,116·00	5,470·81	....
		Sundry claims	....	....	....	....	....	136·08	93·96	5,932·28	2,012·75	....
Chadwin	....	Voided leases	....	....	....	....	....	....	....	4,781·55	5,232·25	2·50
		Sundry claims	....	....	221·00	86·39	....	14·28	78·02	5,893·55	2,915·24	·25
Dunnsville	....	Voided leases	....	....	....	....	....	....	828·58	17,548·85	8,657·45	....
		Sundry claims	....	....	26·20	23·23	....	3·35	1,034·08	2,584·26	1,955·68	....
Jourdie Hills	....	Voided leases	....	....	....	....	....	....	18·00	28,009·74	19,401·09	28·45
		Sundry claims	....	....	....	....	....	1·86	49·81	1,673·00	819·25	1·05

Kintore	1036s	Newhaven	....	....	835·00	228·81	....	....	....	835·00	228·81	....
		Voided leases	....	....	....	....	....	18·70	169·33	54,829·39	39,579·50	677·88
		Sundry claims	....	....	326·50	41·15	....	111·91	102·70	3,983·63	2,334·77	....
Kunanalling	(1024s)	Kioro....	....	....	59·75	42·33	....	....	....	551·20	347·44	....
	(1035s)	Olympic	....	....	17·75	8·29	....	....	....	17·75	8·29	....
	(1034s)	Victory	....	....	81·50	16·91	....	....	....	365·50	98·75	....
		Voided leases	....	....	....	....	....	86·13	1,734·92	129,369·16	100,358·25	40·77
		Sundry claims	....	....	....	....	....	216·53	808·12	14,222·17	9,402·36	....
Kundana	....	Voided leases	....	....	....	....	....	....	....	465·00	68·12	....
		Sundry claims	....	....	....	....	....	....	....	431·50	50·37	....
	From District generally :—											
	Sundry Parcels treated at :—											
	Goldfields Australian Development, M.A. 31s....		....	....	....	....	....	....	....	....	*548·07	....
	Various Works		....	....	....	....	....	42·23	....	1,782·26	*5,061·33	....
	Reported by Banks and Gold Dealers		2·73	....	....	....	....	861·44	17·93	....	5·85	·49
		Totals	**2·73**	....	**1,567·70**	**447·11**	....	**1,492·51**	**5,623·43**	**359,203·65**	**251,466·64**	**751·39**

Yilgarn Goldfield.

Blackbourne	....	Voided leases	....	....	....	....	....	....	....	1,282·50	341·37	....
		Sundry claims	....	....	....	....	....	....	....	392·50	81·15	....
Bullfinch	3345, etc.	Copperhead	....	....	....	....	....	....	....	7,427·32	2,076·32	....
	3378, etc.	Copperhead Deeps	....	....	....	....	....	....	....	13,554·65	4,102·83	....
	3337, etc.	Easter Gift Leases	....	....	....	....	....	....	....	1,597·00	472·43	....
		Prior to transfer to present holders	....	....	....	....	....	....	48·03	3,594·26	1,169·82	....
	3400, etc.	Francis May	....	....	....	....	....	....	7·74	8,683·55	3,341·69	....
	3397, etc.	Goldfinch	....	....	....	....	....	....	6·73	6,488·03	2,643·99	....
	3350, 3965	Rising Sun	....	....	....	....	....	....	2·30	37,059·53	10,837·80	....
		Voided leases	....	....	....	....	....	....	10·14	490,361·07	185,489·03	27,958·41
		Sundry claims	....	....	5·00	8·33	....	8·47	37·04	7,338·75	3,973·53	....
Corinthian	3398, 3425	Corinthian Leases	....	....	....	....	....	....	....	3,081·83	1,770·09	....
	3398	(Corinthian)	....	....	....	....	....	....	....	7,383·75	2,543·16	....
	3425	(Corinthian North)	....	....	....	....	....	....	....	3,951·00	1,934·78	....
	4180	Deliverance	....	....	....	....	....	....	....	327·00	127·29	....
		Voided leases	....	....	....	....	....	....	23·46	138,241·40	33,293·21	....
		Sundry claims	....	....	....	....	....	....	2·68	1,088·35	640·61	....
Eenuin	4020	Birthday	....	....	....	·97	....	....	2·25	45·00	194·94	·01
	4129	Birthday West	....	....	44·00	26·34	....	....	....	57·00	34·12	....
	4042	Birthday South	....	....	36·00	7·04	....	....	1·03	51·00	57·54	....
	4246	Lone Pine	....	....	24·00	8·50	....	....	....	24·00	8·50	....
	3936	Newfield Central	....	....	....	....	....	....	....	343·00	526·82	....
	3936	(Yellowdine Gold Areas, N.L.)	....	....	....	....	....	....	....	7,341·50	7,605·06	....
		Voided leases	....	....	....	....	....	....	178·46	1,980·56	2,004·90	....
		Sundry claims	....	....	29·00	31·19	....	2·50	73·97	2,396·60	1,685·70	....

TABLE I.—*Production of Gold and Silver from all sources, etc.*—continued.

YILGARN GOLDFIELD—*continued.*

Mining Centre.	Number of Lease.	Registered Name of Company or Lease.	Total for 1949.					Total Production.				
			Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.
			Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.
Evanston	3868, etc.	Evanston Gold, N.L.	....	....	....	25·64	....	....	....	12,333·20	5,383·76	....
		Prior to transfer to present holders	....	....	....	....	....	....	....	48,359·30	25,905·04	10·14
	3895	Blue Peter	....	....	....	....	....	....	....	1,288·00	285·84	....
	3997	Gravel Pit	....	....	....	....	....	....	79·27	238·80	160·25	....
		Voided leases	....	....	....	....	....	....	....	2,247·76	1,310·63	....
		Sundry claims	....	....	55·00	10·88	....	4·98	....	638·35	159·55	....
Forrestonia	....	Voided leases	....	....	....	....	....	....	....	1,185·00	298·15	....
		Sundry claims	....	....	....	....	....	....	....	372·00	141·78	....
Golden Valley	4173	Inspiration	....	....	25·00	38·05	....	....	....	104·00	166·26	....
	4247	Lily-of-the-Valley	....	....	160·00	33·50	....	....	....	160·00	33·50	....
	2994, etc.	Radio Leases	....	....	1,841·00	1,568·59	99·81	....	2·70	22,900·80	44,203·73	492·93
		Voided leases	....	....	....	....	....	....	36·34	36,525·92	28,500·83	10·99
		Sundry claims	....	3·69	64·50	63·30	....	4·58	237·85	6,529·27	4,847·26	1·02
Greenmount	....	Voided leases	....	....	....	....	....	45·99	21·62	125,002·64	31,575·09	944·50
		Sundry claims	....	....	13·00	5·75	....	·46	4·27	2,989·58	794·33	....
Holleton	37P.P.	Brittania	....	....	290·00	179·18	....	....	....	906·00	910·76	....
	4169	Holleton East	....	....	....	....	....	....	....	160·00	31·36	·15
		Voided leases	....	....	....	....	....	....	9·33	44,700·25	13,037·52	34·53
		Sundry claims	....	....	....	....	....	....	3·75	3,464·05	923·78	·20
Hopes Hill	3414	Pilot	....	....	....	....	....	....	....	19,446·12	2,948·68	....
		Voided leases	....	....	....	....	....	....	74·78	132,617·55	36,547·49	1·00
		Sundry claims	....	....	79·00	10·39	....	18·67	44·35	4,535·02	1,403·79	....
Kenny Ville	3875	Victoria	....	....	83·00	27·47	....	....	....	4,388·00	1,001·83	·63
		Voided leases	....	....	....	....	....	....	18·76	55,876·63	21,625·66	·59
		Sundry claims	....	....	20·00	7·07	....	....	5·06	8,498·50	2,282·48	....
Koolyanobbing	....	Voided leases	....	....	....	....	....	....	·99	1,768·05	972·77	....
		Sundry claims	....	....	....	....	....	·26	1·21	656·10	329·20	....
Marvel Loch	3987, etc.	Burbidge Gold Mines, N.L.	....	....	32,235·00	1,981·72	....	....	....	159,772·00	13,901·65	....
	3987	(Grand National)	....	....	....	....	....	....	....	19,739·00	2,647·30	....
	4243	Christmas Gift	....	....	....	....	....	....	1·82	....	....	....
	3957	Comet	....	....	....	....	....	....	....	1,199·50	677·52	6·85
	13P.P.	Cricket	....	....	....	....	....	....	....	1,616·00	921·75	....
	4039	Cromwell	....	....	75·00	14·92	....	....	....	370·00	56·29	....
	3966	Donovan's Find	....	....	....	....	....	....	....	200·05	56·02	....
	3942, etc.	Edward's Reward Leases	....	....	4,364·00	2,115·11	....	....	....	34,618·50	16,146·05	....

	3942	(Edward's Reward)	....	....	....	....	....	....	....	2,083·00	2,016·32	....
	3943	Sunshine	....	....	....	....	....	....	....	3,866·00	2,384·79	....
	4034	Firelight	....	....	380·00	65·52	....	....	....	1,969·00	483·54	....
	3724	Frances Firness	....	....	423·00	302·09	....	....	....	10,273·00	4,508·27	....
	3718	Kurrajong	....	....	....	....	....	....	....	9,221·00	3,271·73	....
	3914	May	....	....	....	....	....	....	....	145·00	45·85	....
	3970	Mountain Queen	....	....	....	....	....	....	....	661·00	382·37	....
	3390, etc.	N.G.M., Ltd.	....	....	....	....	....	....	....	4,369·22	499·06	2·00
		Prior to transfer to present holders	....	....	....	....	....	....	....	2,675·00	459·60	....
	4068	Try Again	....	....	....	....	....	....	....	1,618·00	519·20	....
	4035	Undaunted	....	....	40·00	7·19	....	....	....	792·00	102·70	....
	4251	Union Jack	....	....	....	10·06	....	....	....	....	10·03	....
		Voided leases	....	....	....	....	....	....	1,494·77	640,549·21	186,507·41	2,465·10
		Sundry claims	....	....	8·00	2·57	....	11·35	230·20	34,435·86	13,044·47	·02
Mt. Jackson	3418	Clamp's Central	....	....	316·00	294·43	....	....	....	927·00	653·95	....
		Prior to transfer to present holders	....	....	....	....	....	....	....	8,456·50	7,122·93	6·34
		Voided leases	....	....	....	....	....	....	180·85	45,783·28	32,130·27	2,307·43
		Sundry claims	....	....	239·00	82·31	....	6·44	52·87	10,922·95	4,872·16	70·74
Mt. Palmer	....	Voided leases	....	....	....	....	....	....	....	305,883·40	158,450·55	....
		Sundry claims	....	....	50·00	10·43	....	1,643·48	18·19	445·25	378·38	....
Mt. Rankin	3555	No Trumps	....	....	....	....	....	....	....	5,271·37	829·74	....
		Voided leases	....	....	....	....	....	3·84	5·20	495·00	122·17	....
		Sundry claims	....	....	....	....	....	....	....	491·00	117·59	....
Parker's Range	4191	Centipede	....	....	550·00	300·24	....	....	17·85	834·50	505·37	....
	4174	Constance Una	....	....	108·50	324·95	....	....	....	453·50	1,184·84	....
	4198	Maroomba	....	7·68	106·00	48·87	....	....	99·57	233·00	165·82	....
	4201	Scot's Greys	....	....	208·00	44·33	....	....	....	401·00	78·01	....
	4248	Vance	....	....	8·00	5·81	....	....	....	8·00	5·81	....
		Voided leases	....	....	....	....	....	·42	149·33	59,633·35	29,539·61	26·40
		Sundry claims	....	23·29	69·00	44·91	....	6·59	301·38	11,218·80	4,984·79	·08
Southern Cross	4082	Day Dawn	....	....	....	....	....	....	....	83·00	9·16	....
	4018	Frasers	....	....	....	....	....	....	....	1,353·50	162·12	....
	3944	Nil Desperandum	....	....	....	....	....	....	....	1,533·00	216·77	....
	3444, etc.	Western Mining Corporation	....	....	....	....	....	....	....	533·00	92·63	....
		Prior to transfer to present holders	....	....	....	....	....	....	....	22,621·25	4,145·66	1·26
		Voided leases	....	....	....	....	....	4·89	261·35	454,906·63	215,351·50	364·41
		Sundry claims	....	....	....	....	....	95·90	642·09	8,163·63	2,623·21	....
Westonia	(3308, etc.)	T.L. 132, Edna May (W.A.) Amalgamated G.Ms., N.L.	....	....	17·00	30·84	....	....	....	145,417·00	62,905·37	5,072·49
		Prior to transfer	....	....	....	....	....	....	....	4,092·00	2,867·26	....
	4023	Green Finch	....	....	39·50	6·19	....	....	....	649·15	478·46	....
	4252	Corio	....	....	106·00	60·42	7·57	....	....	106·00	60·42	7·57
		Voided leases	....	....	....	....	....	....	4·06	445,495·49	314,459·63	21·78
		Sundry claims	....	....	39·00	13·35	....	9·51	64·96	3,921·16	2,530·93	·45

TABLE I.—*Production of Gold and Silver from all sources, etc.*—continued.

YILGARN GOLDFIELD —*continued.*

Mining Centre.	Number of Lease.	Registered Name of Company or Lease.	Total for 1949. Alluvial. Fine ozs.	Dollied and Specimens. Fine ozs.	Ore treated. Tons. (2,240 lb.).	Gold therefrom. Fine ozs.	Silver. Fine ozs.	Total Production. Alluvial. Fine ozs.	Dollied and Specimens. Fine ozs.	Ore treated. Tons. (2,240 lb.).	Gold therefrom. Fine ozs.	Silver. Fine ozs
		From Goldfield generally :—										
		Sundry parcels treated at :										
		M.A. 43, Butcher Bird Battery	....	....	....	*37·15	....	....	....	....	*170·06	....
		Centenary Cyanide Plant	....	....	....	....	....	....	....	....	*472·85	....
		Copperhead Plant	....	....	....	....	....	....	....	....	*16,809·79	....
		Holleton Cyanide Plant	....	....	....	*8·34	·55	....	....	....	*699·68	48·05
		Howlett's Battery	....	....	....	....	....	....	....	110·00	*13,405·34	....
		Invermay Cyanide Plant	....	....	....	....	....	....	....	....	*608·49	3·57
		Kurrajong Battery	....	....	....	....	....	....	....	....	*409·57	....
		Pilot Cyanide Plant	....	....	....	....	....	....	....	30·00	*3,753·59	....
		Queen Ann Battery	....	....	....	....	....	....	....	....	*169·05	....
		Radio Deeps Cyanide Plant	....	....	....	....	....	....	....	....	*1,588·67	....
		Scot's Greys Cyanide Plant	....	....	....	*169·38	....	....	....	....	*169·38	....
		Three Boys Cyanide Plant	....	....	....	*218·73	....	....	....	7·00	*2,864·18	....
		Wesley Cyanide Plant	....	....	....	....	....	....	....	....	*1,251·05	....
		Various Works	....	....	....	....	....	....	....	181·28	*62,756·69	53·78
		Reported by Banks and Gold Dealers	....	....	....	....	....	314·38	70·45	....	30·85	....
		Totals	....	**34·66**	**42,149·50**	**8,252·11**	**107·93**	**2,182·71**	**4,529·03**	**3,753,002·45**	**1,693,407·86**	**39,914·42**
		Dundas Goldfield.										
Buldania	....	Voided leases	....	....	....	....	....	....	3·02	846·05	708·99	....
		Sundry claims	....	....	....	....	....	....	39·25	1,324·27	861·36	·72
Dundas	....	Voided leases	....	....	....	....	....	1·88	28·02	6,103·48	2,545·38	155·02
		Sundry claims	....	....	....	....	....	·76	413·85	2,071·75	1,097·94	18·32
Norseman	....	1596 Abbotshall	....	....	....	....	....	....	....	2,511·45	1,096·71	754·37
		1468 Bronzewing	....	....	319·00	182·90	2·95	....	33·89	3,573·25	2,338·95	146·83
		1617 Caesar	....	....	....	....	....	....	....	54·00	42·72	....
		1319, etc. Central Norseman Gold Corporation, N.L.	....	....	132,930·00	46,865·47	31,423·58	....	....	1,224,682·20	437,922·34	379,810·65
		Prior to transfer to present holders	....	....	....	....	....	....	1,663·32	69,819·83	47,892·08	16,508·85
		1716 Cumberland Central	....	....	12·50	2·75	·02	....	....	12·50	2·75	·02
		1421 Dundas Gold Mines, N.L.	....	....	2,559·00	1,240·84	373·37	....	....	6,228·75	3,405·35	815·18
		1421 (Empress Gold Mines, N.L.)	....	....	....	....	....	....	....	567·50	516·08	54·61
		1315, etc. Norseman Gold Mines, N.L.	....	....	....	....	....	....	....	964,099·00	240,900·95	353,206·54
		Prior to transfer to present holders	....	....	....	....	....	....	....	20,657·00	3,909·60	4,981·00
		1422 Onkaparinga	....	....	....	....	....	....	....	624·75	1,178·29	110·42
		1422, 1468 (Onkaparinga)	....	....	....	....	....	....	....	843·00	1,396·98	3·62

	(1530)	Second Try	....	....	....	2·02	....	4·96	4·37	2,096·50	1,282·85	147·49
	1667, etc.	Sun Leases	....	....	187·50	97·92	5·66	....	....	951·50	706·74	53·44
	1624	Valhalla	....	....	....	....	....	....	....	547·25	386·63	20·23
		Voided leases	....	....	....	....	....	9·31	10,562·89	893,877·72	587,965·41	36,787·67
		Sundry claims	....	....	303·00	162·08	2·86	1,052·09	3,393·11	45,870·95	21,904·94	193·21
Peninsula	....	Voided leases	....	....	....	....	....	....	24·29	9,584·89	6,100·73	12·20
		Sundry claims	....	....	....	....	....	....	....	217·25	119·32	·97
	From Goldfield generally :											
	Sundry Parcels treated at :—											
	State Battery, Norseman	....	....	....	....	....	....	....	405·39	*24,627·10	1,050·37
	J. P. D. Parker, L.T.T. 1108H	....	....	....	....	....	....	....	12·00	3·80	·07
	Princess Royal Cyanide Plant, L.T.T. 1118H	....	....	....	*41·28	8·94	....	....	....	*41·28	8·94
	(Princess Royal Cyanide Plant, L.T.T. 1022H)	....	....	....	*4·53	....	....	....	47·00	*123·29	106·89
	(Princess Royal Cyanide Plant†, L.T.T. 456H)	....	....	....	....	....	....	....	....	*1,949·04	1,571·78
	(R. and E. Matson Cyanide Plant, L.T.T. 1022H)	....	....	....	....	....	....	....	....	*53·80	40·79
	Various Works	....	....	....	....	....	....	54·52	603·14	*12,880·21	844·36
	Reported by Banks and Gold Dealers	....	....	....	....	....	1,181·77	48·76	47·50	18·62	·70
	Totals	....	....	**136,311·00**	**48,599·79**	**31,817·38**	**2,250·77**	**16,269·29**	**3,258,279·87**	**1,403,980·23**	**797,405·26**

Phillips River Goldfield.

Hatters Hill	....	Voided leases	....	....	....	....	....	....	4·38	1,499·55	1,182·75	....
		Sundry claims	....	....	....	....	....	74·91	21·69	5,225·60	2,720·90	26·09
Kundip	263	Hillsborough	....	....	258·00	20·44	·05	....	....	258·00	23·21	·05
		Voided leases	....	....	....	....	....	113·28	556·17	84,866·58	60,584·54	4,008·81
		Sundry claims	....	....	....	....	....	90·27	73·02	6,434·68	1,951·87	54·65
Mt. Desmond	....	Voided leases	....	....	....	....	....	....	1·40	9·00	†3,905·46	6,891·59
		Sundry claims	....	....	50·00	4·09	....	....	....	50·00	†36·90	51·01
Ravensthorpe	....	Voided leases	....	....	....	....	....	....	141·80	24,723·55	26,070·94	4,384·07
		Sundry claims	....	....	....	....	....	163·96	7·68	7,261·57	3,195·67	41·12
West River	....	Voided leases	....	....	....	....	....	....	....	....	10·34	31·06
		Sundry claims	....	....	....	....	....	....	....	....	†6·60	3·44
	From Goldfield generally :—											
	Sundry Parcels treated at :—											
	Cardingup Copper Smelters, L.T.T. 1079H	....	....	....	5·31	2·97	....	....	....	*22·05	7·24
	Cardingup Cyanide Plant	....	....	....	....	....	....	....	....	*909·37	4·36
	Floater Cyanide Works	....	....	....	....	....	....	....	12·00	*245·95	....
	Daw and Toleman Cyanide Plant	....	....	....	....	....	....	....	....	*342·19	....
	Kundip Cyanide Plant	....	....	....	....	....	....	....	15·00	15·25	....
	Various Works	....	....	....	....	....	....	....	....	1,932·66	496·46
	Reported by Banks and Gold Dealers	....	....	....	....	....	164·69	12·14	....	....	....
	Totals	....	....	**308·00**	**29·84**	**3·02**	**607·11**	**818·28**	**130,355·53**	**103,156·65**	**15,999·95**

* Denotes mainly derived from treatment of tailings. † From Copper Ore.

TABLE I.—*Production of Gold and Silver from all sources, etc.*— continued.

OUTSIDE PROCLAIMED GOLDFIELD.

MINING CENTRE.	NUMBER OF LEASE.	REGISTERED NAME OF COMPANY OR LEASE.	TOTAL FOR 1949.					TOTAL PRODUCTION.				
			Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Silver.
			Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.
Burracoppin	....	Voided leases	....	....	....	....	....	....	....	710·85	706·38	....
		Sundry claims	....	....	....	....	....	....	....	372·75	213·97	....
Donnybrook	....	Voided leases	....	....	....	....	....	23·24	....	1,613·30	816·23	....
		Sundry claims	....	....	....	....	....	44·01	43·03	119·50	15·71	15·18
Jimperding	1P.P. Avon	Hillsdale	....	....	....	....	....	....	....	1,261·75	298·05	....
Northampton	....	Sundry leases and claims	....	....	....	....	†826·46	....	....	....	....	†826·46
		From State generally :—										
		Sundry Parcels treated at:										
		Fremantle Smelters, Ltd.	....	....	....	....	....	....	....	....	*1,879·08	1,109·06
		Various Works	....	....	....	....	....	....	....	27·00	*7,130·67	30,412·67
		Sundry Specimens	....	....	....	....	....	4·24	56·85	....	....	....
		Miscellaneous Voided leases and sundry claims	....	....	....	....	....	245·83	16·83	200·60	41·09	....
		Reported by Banks and Gold Dealers	7·97	2·62	....	....	....	1,083·35	860·51	....	294·38	59·99
		Totals	**7·97**	**2·62**	....	....	**826·46**	**1,400·67**	**977·22**	**4,305·75**	**11,395·56**	**32,423·36**

* Denotes mainly derived from treatment of tailings. † From Silver Lead Ore.

TABLE II

PRODUCTION OF GOLD AND SILVER FROM ALL SOURCES, SHOWING IN FINE OUNCES THE OUTPUT, AS REPORTED TO THE MINES DEPARTMENT DURING THE YEAR 1949.

Goldfield.	District.	DISTRICT.						GOLDFIELD.					
		Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Total Gold.	Silver.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Total Gold.	Silver.
		Fine ozs.	Fine ozs.	Tons (2,240 lb.)	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Tons (2,240 lb.).	Fine ozs.	Fine ozs.	Fine ozs.
Kimberley	....	....	....	....	....	....	....	120.20	149.06	....	....	269.26	5.90
West Kimberley	....	....	....	....	....	....	....	....	....	....	....	....	191.76
Pilbara	Marble Bar	34.16	12.31	3,755.20	2,561.87	2,608.34	2,035.34	148.40	377.80	5,497.70	5,186.13	5,712.33	2,069.74
	Nullagine	114.24	365.49	1,742.50	2,624.36	3,103.99	34.40						
West Pilbara	....	....	....	....	....	....	....	....	....	563.00	93.84	93.84	47.80
Ashburton	....	....	....	....	....	....	....	....	....	360.00	70.29	70.29	7,050.07
Gascoyne	....	....	....	....	....	....	....	....	....	....	....	....	....
Peak Hill	....	....	....	....	....	....	....	....	70.47	1,166.00	514.57	585.04	50.09
East Murchison	Lawlers	....	....	755.50	404.89	404.89	....	....	266.30	3,215.85	6,279.68	6,545.98	752.07
	Wiluna	....	....	1,630.60	5,276.91	5,276.91	752.00						
	Black Range	....	266.30	829.75	597.88	864.18	.07						
Murchison	Cue	6.10	6.09	427,384.50	58,369.07	58,381.26	21,933.64	42.97	35.01	489,111.86	81,766.20	81,844.18	22,184·15
	Meekatharra	2.49	15.34	7,147.61	3,177.83	3,195.66	....						
	Day Dawn	32.47	12.83	3,989.00	6,216.70	6,262.00	7.33						
	Mt. Magnet	1.91	.75	50,590.75	14,002.60	14,005.26	243.18						
Yalgoo	....	....	....	....	....	....	....	6.44	17.16	1,770.55	769.63	793.23	.09
Mt. Margaret	Mt. Morgans	15.97	3.37	1,797.25	2,512.66	2,532.00	....	23.92	463.28	90,755.00	33,328.32	33,815.52	2,636.21
	Mt. Malcolm	7.36	459.91	82,692.50	25,925.66	26,392.93	1,962.78						
	Mt. Margaret	.59	....	6,265.25	4,890.00	4,890.59	673.43						
North Coolgardie	Menzies	1.08	66.28	999.00	1,165.57	1,232.93	156.73	2.23	68.22	5,347.25	6,978.18	7,048.63	279.38
	Ularring	.86	....	1,869.00	2,710.91	2,711.77	10.54						
	Niagara	.29	1.94	818.25	618.75	620.98	....						
	Yerilla	....	....	1,661.00	2,482.95	2,482.95	112.11						
Broad Arrow	....	....	....	....	....	....	....	9.20	169.53	5,035.25	4,108.28	4,287.01	9.80
N.E. Coolgardie	Kanowna	1.25	41.38	1,313.38	460.05	502.68	....	1.25	43.49	1,320.88	465.77	510.51	1.49
	Kurnalpi	....	2.11	7.50	5.72	7.83	1.49						
East Coolgardie	East Coolgardie	25.63	32.27	1,643,637.27	437,263.18	437,321.08	126,007.07	25.63	32.27	1,644,124.02	437,347.09	437,404.99	126,007.07
	Bulong	....	....	486.75	83.91	83.91	....						
Coolgardie	Coolgardie	32.68	63.92	39,693.64	13,117.83	13,214.43	1,363.61	35.41	63.92	41,261.34	13,564.94	13,664.27	1,363.61
	Kunanalling	2.73	....	1,567.70	447.11	449.84	....						
Yilgarn	....	....	....	....	....	....	....	....	34.66	42,149.50	8,252.11	8,286.77	107.93
Dundas	....	....	....	....	....	....	....	....	....	136,311.00	48,599.79	48,599.79	31,817.38
Phillips River	....	....	....	....	....	....	....	....	....	308.00	29.84	29.84	3.02
Outside Proclaimed Goldfields	....	....	....	....	....	....	....	7.97	2.62	....	....	10.59	826.46
		....	....	....	....	....	....	423.62	1,793.79	2,468,297.20	647,354.66	649,572.07	195,404.02

TABLE III.

RETURN SHOWING TOTAL PRODUCTION REPORTED TO THE MINES DEPARTMENT, AND RESPECTIVE DISTRICTS AND GOLDFIELDS FROM WHENCE DERIVED, TO 31ST DECEMBER, 1949.

Goldfield.	District.	DISTRICT.						GOLDFIELD.					
		Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Total Gold.	Silver.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Total Gold.	Silver.
		Fine ozs.	Fine ozs.	Tons (2,240lb.).	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Tons (2,240lb.).	Fine ozs.	Fine ozs.	Fine ozs.
Kimberley	....	....	....	....	....	....	....	8,510.71	907.74	22,589.40	17,118.56	26,537.01	113.68
West Kimberley	....	....	....	....	....	....	....	1.30	24.68	....	....	25.98	4,953.87
Pilbara	Marble Bar	14,984.94	4,428.90	301,398.62	303,638.31	323,052.15	2,844.74	24,928.70	6,211.57	402,898.70	410,074.74	441,215.01	2,948.67
	Nullagine	9,943.76	1,782.67	101,500.08	106,436.43	118,162.86	103.93						
West Pilbara	....	....	....	....	....	....	....	6,312.90	355.92	24,458.96	24,064.62	30,733.44	1,433.39
Ashburton	....	....	....	....	....	....	....	9,261.27	479.40	6,526.25	2,649.78	12,390.45	16,435.89
Gascoyne	....	....	....	....	....	....	....	693.44	41.57	387.00	517.29	1,252.30	....
Peak Hill	....	....	....	....	....	....	....	3,374.41	5,300.33	620,520.93	295,921.46	304,596.20	2,361.42
East Murchison	Lawlers	6,891.23	2,295.10	2,009,411.92	821,657.72	830,844.05	26,282.82	8,748.70	22,063.35	12,606,829.33	3,640,953.55	3,671,765.60	58,861.73
	Wiluna	222.36	1,247.37	8,870,249.44	1,868,359.22	1,869,828.95	10,084.84						
	Black Range	1,635.11	18,520.88	1,727,167.97	950,936.61	971,092.60	22,494.07						
Murchison	Cue	5,024.29	8,273.86	4,843,754.24	1,121,047.10	1,134,345.25	184,616.55	25,039.98	57,636.06	10,707,723.58	4,487,359.09	4,570,035.13	362,435.60
	Meekatharra	14,292.92	17,629.91	2,254,949.31	1,288,292.12	1,320,214.95	5,042.31						
	Day Dawn	3,184.38	11,326.92	2,025,932.63	1,369,391.73	1,383,903.03	169,230.40						
	Mt. Magnet	2,538.39	20,405.37	1,583,087.40	708,628.14	731,571.90	3,546.34						
Yalgoo	....	....	....	....	....	....	....	1,782.50	3,181.62	437,122.18	260,302.55	265,266.67	1,500.08
Mt. Margaret	Mt. Morgans	3,385.02	9,340.38	1,207,930.46	712,725.68	725,451.08	5,781.64	11,171.92	33,143.90	9,783,197.04	4,537,476.91	4,581,792.73	225,337.07
	Mt. Malcolm	3,800.96	14,483.54	6,091,290.69	2,672,181.58	2,690,466.08	156,699.05						
	Mt. Margaret	3,985.94	9,319.98	2,483,975.89	1,152,569.65	1,165,875.57	62,856.38						
North Coolgardie	Menzies	1,631.18	6,513.66	1,463,790.69	1,185,543.97	1,193,688.81	30,459.82	4,784.91	18,844.08	3,024,643.34	2,199,407.92	2,223,036.91	43,136.59
	Ularring	129.39	6,738.48	376,367.35	351,297.42	358,165.29	6,109.07						
	Niagara	1,712.66	1,819.15	927,888.52	515,258.62	518,790.43	5,603.60						
	Yerilla	1,311.68	3,772.79	256,596.78	147,307.91	152,392.38	964.10						
Broad Arrow	....	....	....	....	....	....	....	21,935.83	26,963.46	1,303,009.35	711,584.54	760,483.83	5,278.66
N.E. Coolgardie	Kanowna	106,492.77	13,508.53	1,000,151.19	623,615.43	743,616.73	3,039.73	119,326.63	21,805.70	1,013,450.01	642,103.43	783,235.76	3,052.44
	Kurnalpi	12,833.86	8,297.17	13,298.82	18,488.00	39,619.03	12.71						
East Coolgardie	East Coolgardie	33,471.40	40,732.14	56,836,552.02	28,583,210.61	28,657,414.15	3,970,028.40	60,849.81	56,759.73	57,018,616.32	28,714,326.03	28,831,935.57	3,970,041.32
	Bulong	27,378.41	16,027.59	182,064.30	131,115.42	174,521.42	12.92						
Coolgardie	Coolgardie	16,820.79	15,895.52	2,489,795.27	1,291,227.72	1,323,954.03	7,306.02	18,323.30	21,518.95	2,848,998.92	1,542,694.36	1,582,536.61	8,057.41
	Kunanalling	1,492.51	5,623.43	359,203.65	251,466.64	258,582.58	751.39						
Yilgarn	....	....	....	....	....	....	....	2,182.71	4,529.03	3,753,002.45	1,693,407.86	1,700,119.60	39,914.42
Dundas	....	....	....	....	....	....	....	2,250.77	16,269.29	3,258,279.87	1,403,980.23	1,422,500.29	797,405.26
Phillips River	....	....	....	....	....	....	....	607.11	818.28	130,355.53	103,156.65	104,582.04	15,999.95
Outside Proclaimed Goldfields		....	....	....	....	....	....	1,400.67	977.22	4,306.75	11,398.05	13,775.94	32,423.36
		....	....	....	....	....	....	331,487.57	297,831.88	106,966,915.91	50,698,497.62	51,327,817.07	5,591,690.81

TABLE IV.

TOTAL OUTPUT OF GOLD (BULLION AND CONCENTRATES ENTERED FOR EXPORT AND GOLD RECEIVED AT THE ROYAL MINT, PERTH), FROM 1ST JANUARY, 1886 TO 31st DECEMBER, 1949; SHOWING IN FINE OUNCES THE QUANTITY CREDITED TO THE RESPECTIVE GOLDFIELDS.

Year.	Export.	Mint.	Total.	Export.	Mint.	Total.
		KIMBERLEY.			PILBARA.	
	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.
Prior to 1946	22,422·06	13,619·44	36,041·50	147,847·19	333,352·88	481,200·07
1946	....	168·08	168·08	2,671·75	10,536·27	13,208·02
1947	....	350·75	350·75	2,645·68	7,733·88	10,379·56
1948	....	438·32	438·32	1,864·05	4,630·05	6,494·10
1949	....	272·06	272·06	1,766·22	4,113·43	5,879·65
Total	22,422·06	14,848·65	37,270·71	156,794·89	360,366·51	517,161·40
		(*a*) WEST PILBARA.			ASHBURTON.	
Prior to 1946	4,351·11	26,760·61	31,111·72	4,104·96	5,915·09	10,020·05
1946	....	....	....	....	54·21	54·21
1947	....	....	....	....	150·76	150·76
1948	....	....	....	....	11·00	11·00
1949	....	....	....	....	60·46	60·46
Total	4,351·11	26,760·61	31,111·72	4,140·96	6,191·52	10,296·48
		(*b*) GASCOYNE.			(*c*) PEAK HILL.	
Prior to 1946	304·55	163·89	1,368·44	41,102·76	203,438·05	244,540·81
1946	....	4·28	4·28	....	949·93	949·93
1947	....	....	....	....	1,086·25	1,086·25
1948	....	....	....	....	847·41	847·41
1949	....	....	....	....	285·80	285·80
Total	304·55	1,068·17	1,372·72	41,102·76	206,607·44	247,710·20
		EAST MURCHISON.			MURCHISON.	
Prior to 1946	258,865·32	2,942,697·69	3,201,563·01	1,573,715·33	2,950,983·48	4,524,698·81
1946	97·59	29,563·16	29,660·75	248·07	39,065·42	39,313·49
1947	70·79	22,591·28	22,662·07	125·56	89,592·05	89,717·61
1948	5·33	16,546·16	16,551·49	726·92	99,099·78	99,826·70
1949	31·91	7,185·88	7,217·79	366·15	85,443·83	85,809·98
Total	259,070·94	3,018,584·17	3,277,655·11	1,575,182·03	3,264,184·56	4,839,366·59
		(*d*) YALGOO.			(*e*) MT. MARGARET.	
Prior to 1946	13,573·15	190,980·13	204,553·28	692,567·78	3,630,192·71	4,322,760·49
1946	20·97	608·95	629·92	569·82	28,775·41	29,345·23
1947	24·08	1,117·24	1,141·32	222·01	28,525·15	28,747·16
1948	17·77	1,177·31	1,195·08	683·02	22,691·66	23,374·68
1949	....	682·09	682·09	297·27	28,609·32	28,906·59
Total	13,635·97	194,565·72	208,201·69	694,339·90	3,738,794·25	4,433,134·15
		(*f*) NORTH COOLGARDIE.			(*g*) BROAD ARROW.	
Prior to 1946	263,223·76	1,984,516·63	2,247,740·39	122,449·50	410,897·31	533,346·81
1946	57·05	5,869·50	5,926·55	17·67	3,751·69	3,769·36
1947	18·31	6,744·87	6,763·18	79·39	7,704·06	7,783·45
1948	62·57	5,104·50	5,167·07	24·26	3,569·00	3,593·26
1949	48·29	5,098·20	5,146·49	47·87	4,015·49	4,063·36
Total	263,409·98	2,007,333·70	2,270,743·68	122,618·69	429,037·55	552,556·24
		(*f*) NORTH-EAST COOLGARDIE.			(*f*) EAST COOLGARDIE.	
Prior to 1946	235,876·16	456,782·87	692,659·03	7,022,142·20	21,604,178·17	28,626,320·37
1946	11·85	500·01	511·86	1,334·89	425,167·70	426,502·59
1947	....	827·76	827·76	1,253·91	462,611·28	463,865·19
1948	4·18	386·07	390·25	709·52	448,958·23	449,667·75
1949	1·50	96·02	97·52	792·52	445,291·23	446,083·75
Total	235,893·69	458,592·73	694,486·42	7,026,233·04	23,386,206·61	30,412,439·65
		(*h*) COOLGARDIE.			YILGARN.	
Prior to 1946	662,908·10	1,170,589·51	1,833,497·61	219,055·99	1,487,416·45	1,706,472·44
1946	48·49	13,817·57	13,866·06	322·25	9,525·64	9,847·89
1947	20·98	13,620·32	13,641·30	259·88	19,909·27	20,169·15
1948	54·14	8,070·99	8,125·13	268·15	10,529·09	10,797·24
1949	118·73	13,355·55	13,474·28	172·67	6,563·75	6,736·42
Total	663,150·44	1,219,453·94	1,882,604·38	220,078·94	1,533,944·20	1,754,023·14
		(*i*) DUNDAS.			(*j*) PHILLIPS RIVER.	
Prior to 1946	169,361·25	1,188,514·66	1,357,875·91	40,602·39	62,626·90	103,229·29
1946	424·24	41,801·85	42,226·09	4·52	22·13	26·65
1947	204·09	35,441·76	35,645·85	....	29·13	29·13
1948	65·92	37,609·08	37,675·00	....	28·44	28·44
1949	257·69	42,540·32	42,798·01	3·21	34·56	37·77
Total	170,313·19	1,345,907·67	1,516,220·86	40,610·12	62,741·16	103,351·28
		¶ DONNYBROOK.			OUTSIDE PROCLAIMED GOLDFIELDS.	
Prior to 1946	282·21	557·53	839·74	21,618·54	36,389·14	58,007·68
1946	....	....	....	260·98	691·72	952·70
1947	....	....	....	295·41	630·48	925·89
1948	....	....	....	167·89	634·98	802·87
1949	....	....	....	269·11	604·49	873·60
Total	282·21	557·53	839·74	22,611·93	38,950·81	61,562·74

(*a*) Prior to 1st May, 1898, included with Pilbara, and from 12th July, 1929, to end of 1949, included with Outside Proclaimed Goldfields.
(*b*) Prior to March, 1899, included with Ashburton. (*c*) From 1st August, 1897. (*d*) Prior to 1st April, 1897, included with Murchison.
(*e*) From 1st August, 1897. (*f*) Prior to 1st May, 1896, included with Coolgardie. (*g*) From 1st September, 1897. (*h*) Declared 5th April, 1894, to which date included with Yilgarn. (*i*) Prior to 1893, included with Yilgarn, (*j*) Prior to 1902 included with Outside Proclaimed Goldfields. ¶ Abolished 4th March, 1908,

TABLE V.

TOTAL OUTPUT OF GOLD BULLION, CONCENTRATES, ETC., ENTERED FOR EXPORT AND RECEIVED AT THE PERTH BRANCH OF THE ROYAL MINT.

FROM 1st JANUARY, 1886.

Year.	Export.	Mint.	Total.	Estimated Value.
	fine ozs.	fine ozs.	fine ozs.	£A.
1886	270·17	...	270·17	1,147
1887	4,359·37	...	4,359·37	18,518
1888	3,124·82	...	3,124·82	13,273
1889	13,859·52	...	13,859·52	58,871
1890	20,402·42	...	20,402·42	86,664
1891	27,116·14	...	27,116·14	115,182
1892	53,271·65	...	53,271·65	226,284
1893	99,202·50	...	99,202·50	421,385
1894	185,298·73	...	185,298·73	787,099
1895	207,110·20	...	207,110·20	879,749
1896	251,618·69	...	251,618·69	1,068,808
1897	603,846·44	...	603,846·44	2,564,977
1898	939,489·49	...	939,489·49	3,990,697
1899	1,283,360·25	187,244·41	1,470,604·66	6,246,732
1900	894,387·27	519,923·59	1,414,310·86	6,007,610
1901	923,686·96	779,729·56	1,703,416·52	7,235,654
1902	707,039·75	1,163,997·60	1,871,037·35	7,947,661
1903	833,685·78	1,231,115·62	2,064,801·40	8,770,719
1904	810,616·04	1,172,614·03	1,983,230·07	8,424,226
1905	655,089·88	1,300,226·00	1,955,315·88	8,305,654
1906	562,250·59	1,232,296·01	1,794,546·60	7,622,749
1907	431,803·14	1,265,750·45	1,697,553·59	7,210,750
1908	356,353·96	1,291,557·17	1,647,911·13	6,999,881
1909	386,370·58	1,208,898·83	1,595,269·41	6,776,274
1910	233,970·34	1,236,661·68	1,470,632·02	6,246,848
1911	160,422·28	1,210,445·24	1,370,867·52	5,823,075
1912	83,577·12	1,199,080·87	1,282,657·99	5,448,385
1913	86,255·13	1,227,788·15	1,314,043·28	5,581,701
1914	51,454·65	1,181,522·17	1,232,976·82	5,237,352
1915	17,340·47	1,192,771·23	1,210,111·70	5,140,228
1916	26,742·17	1,034,655·87	1,061,398·04	4,508,532
1917	9,022·49	961,294·67	970,317·16	4,121,646
1918	15,644·12	860,867·03	876,511·15	3,723,183
1919	6,445·89	727,619·90	734,065·79	3,618,509
1920	5,261·13	612,581·00	617,842·13	3,598,931
1921	7,170·74	546,559·92	553,730·66	2,942,526
1922	5,320·16	532,926·12	538,246·28	2,525,812
1923	5,933·82	498,577·59	504,511·41	2,232,186
1924	2,585·20	482,449·78	485,034·98	2,255,927
1925	3,910·59	437,341·56	441,252·15	1,874,320
1926	3,188·22	434,154·98	437,343·20	1,857,715
1927	3,359·10	404,993·41	408,352·51	1,734,572
1928	3,339·30	390,069·19	393,408·49	1,671,093
1929	3,037·12	374,138·96	377,176·08	1,602,142
1930	1,753·09	415,765·00	417,518·09	1,864,442
1931	1,726·66	508,845·36	510,572·02	2,998,137
1932	3,887·07	601,674·33	605,561·40	4,403,642
1933	2,446·97	634,760·40	637,207·37	4,886,254
1934	3,520·40	647,817·95	651,338·35	5,558,873
1935	9,868·71	639,180·38	649,049·09	5,702,149
1936	55,024·58	791,183·21	846,207·79	7,373,539
1937	71,646·91	928,999·84	1,000,646·75	8,743,755
1938	113,620·06	1,054,171·13	1,167,791·19	10,363,023
1939	98,739·88	1,115,497·76	1,214,237·64	11,842,964
1940	71,680·47	1,119,801·08	1,191,481·55	12,696,503
1941	65,925·94	1,043,391·96	1,109,317·90	11,851,445
1942	15,676·48	832,503·97	848,180·45	8,865,495
1943	6,408·34	540,067·08	546,475·42	5,710,669
1944	1,824·99	464,439·76	466,264·75	4.899 997
1945	5,029·38	463,521·34	468,550·72	5,010,541
1946	6,090·14	610,873·52	616,963·66	6,640,069
1947	5,220·09	698,666·29	703,886·38	7,575,574
1948	4,653·72	660,332·07	664,985·79	7,156,909
1949	4,173·14	644,252·48	648,425·62	7,962,808
Total	11,536,511·40	41,315,597·50	52,852,108·90	305,632,035

	1948. £A	1949. £A.
Estimated total par value of above production	221,747,099	224,501,434
Premiums received on sales of gold during 1920–1924 and 1930–1949 (approximate)	75,922,128	81,130,601
Estimated Total	£A297,669,227	£A305,632,035
Gross estimated value of gold won (including £161,448, bonus paid under the Commonwealth Bounty Act, 1930)	£A297,830,675	£A305,793,483

TABLE VI.—MINERALS OTHER THAN GOLD.

GENERAL RETURN OF ORE AND MINERALS, OTHER THAN GOLD, SHOWING THE QUANTITY PRODUCED AND THE VALUE THEREOF AS REPORTED TO THE MINES DEPARTMENT FROM THE RESPECTIVE GOLDFIELDS AND MINERAL FIELDS, DURING 1949, AND PREVIOUS YEARS.

Period.	ABRASIVE SILICA STONE.		ALUNITE (CRUDE POTASH).		ARSENIC.†		ANTIMONY.*		
	Murchison Goldfield. (Mt. Magnet District).		Yilgarn Goldfield.		East Murchison Goldfield. (Wiluna District).		East Murchison Goldfield.		
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Conc.	Metal.	Value.
	tons.	£	tons.	£	tons.	£	tons.	tons.	£
Prior to 1946	....	....	2,302·00	38,326	35,611·70	679,056	7,282·26	3,564·86	143,317
1946	....	....	1,735·80	41,658	1,624·50	33,935	601·40	306·07	13,981
1947	....	....	1,724·70	41,212	§1,191·13	28,738	....	....	....
1948	....	....	1,778·30	49,430	214·00	4,494	....	....	....
1949	1·50	9	1,447·80	43,417	32·75	982	....	....	....
Total	1·50	9	8,988·60	214,043	38,674·08	747,205	7,883·66	3,870·93	157,298

* By-product of Gold Mining. † By-product by Wiluna G.Ms., Ltd. § Includes 1·13 tons Arsenic valued at £24 from Yilgarn Goldfield.

Period.	ANTIMONY*—*continued.*						ASBESTOS.	
	Pilbara Goldfield.			Total.			Ashburton Goldfield.	
	Conc.	Metal.	Value.	Conc.	Metal.	Value.	Quantity.	Value.
	tons.	tons.	£	tons.	tons.	£	tons.	£
Prior to 1946	70·69	30·96	1,358	†7,373·73	3,607·38	145,166	10·10	959
1946	388·53	155·94	9,477	989·93	462·01	23,458	....	....
1947	281·78	117·82	9,622	§287·23	119·82	9,731	....	....
1948	114·16	41·90	3,582	114·16	41·90	3,582	....	....
1949	21·68	9·49	954	21·68	9·49	954	....	....
Total	**876·84**	**356·11**	**24,993**	**8,786·73**	**4,240·60**	**182,891**	**10·10**	**959**

* By-product of Gold Mining. † Includes 20·78 tons conc. containing 11·56 tons Metal valued at £491 from West Pilbara Goldfield. § Includes 5·45 tons conc. containing 2·00 tons Metal valued at £109 from West Pilbara Goldfield.

Period.	ASBESTOS—*continued.*							
	Pilbara Goldfield.		West Pilbara Goldfield.		Outside Proclaimed Goldfield.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	1,226·91	56,006	3,347·34	122,381	136·86	1,471	*4,725·96	180,837
1946	....	....	365·56	13,404	5·00	100	†374·06	13,525
1947	·50	7	967·56	36,398	75·00	988	1,043·06	37,393
1948	....	....	678·61	33,588	284·24	4,173	962·85	37,761
1949	....	....	1,297·14	125,332	....	....	1,297·14	125,332
Total	**1,227·41**	**56,013**	**6,656·21**	**331,103**	**501·10**	**6,732**	**8,403·07**	**394,848**

* Includes 4·75 tons valued at £20 from East Coolgardie Goldfield. † Includes 3·50 tons valued at £21 from East Coolgardie Goldfield.

Period.	BARYTES.		BENTONITE.		BERYL ORE.			
	North-East Coolgardie Goldfield.		Outside Proclaimed Goldfield.		Pilbara Goldfield.		Murchison Goldfield.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	....	....	647·63	1,566	786·77	23,264	24·53	928
1946	10·00	50	62·00	186	15·49	581	....	....
1947	....	....	44·75	134	16·04	513	....	....
1948	....	....	268·75	806	30·17	1,767	....	....
1949	....	....	150·00	450	....	....	....	....
Total	**10·00**	**50**	**1,173·13**	**3,142**	**848·47**	**26,125**	**24·53**	**928**

TABLE VI.—*Minerals other than Gold*—continued.

Period.	BERYL ORE—*continued.*							
	Coolgardie Goldfield.		West Kimberley Goldfield.		Outside Proclaimed Goldfield.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	47·94	1,465	....	....	86·37	2,544	945·61	28,201
1946	....	....	....	....	....	....	15·49	581
1947	28·85	1,012	....	....	....	....	44·89	1,525
1948	4·68	267	....	....	....	....	34·85	2,034
1949	....	....	3·50	297	16·95	1,200	20·45	1,497
Total	**81·47**	**2,744**	**3·50**	**297**	**103·32**	**3,744**	**1,061·29**	**33,838**

Period.	BISMUTH.		CLAYS (CEMENT, POTTERY AND FIRECLAY).					
	Outside Proclaimed Goldfield.		Collie Mineral Field.		Outside Proclaimed Goldfield.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	lb.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	5,506·40	1,800	1,050·80	738	8,762·75	4,466	9,813·55	5,204
1946	....	....	....	....	2,682·00	1,341	2,682·00	1,341
1947	....	....	....	....	6,277·50	6,064	6,277·50	6,064
1948	....	....	....	....	4,858·50	4,113	4,858·50	4,113
1949	....	....	....	....	10,047·00	11,813	10,047·00	11,813
Total	**5,506·40**	**1,800**	**1,050·80**	**738**	**32,627·75**	**27,797**	**33,678·55**	**28,535**

Period.	COAL.		COPPER ORE.					
	Collie Coalfield.		West Kimberley Goldfield.		Pilbara Goldfield.			
					Marble Bar District.		Nullagine District.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	17745234·87	12,366,510	109·52	1,709	32·87	386	14·00	480
1946	642,286·70	730,104	....	....	....	....	....	....
1947	730,506·32	840,249	....	....	....	....	....	....
1948	732,938·42	880,236	....	....	....	....	....	....
1949	750,594·06	972,245	....	....	....	....	....	....
Total	**20601560·37**	**15,789,344**	**109·52**	**1,709**	**32·87**	**386**	**14·00**	**480**

Period.	COPPER ORE—*continued.*							
	West Pilbara Goldfield.		Ashburton Goldfield.		Peak Hill Goldfield.		East Murchison Goldfield. Lawlers District).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	82,745·45	748,482	353·07	6,431	1,043·35	32,632	284·31	5,052
1946	....	....	....	....	....	....	....	....
1947	....	....	....	....	....	....	....	....
1948	....	....	....	....	....	....	....	....
1949	....	....	1·30	13	8·19	498	....	....
Total	**82,745·45**	**748,482**	**354·37**	**6,444**	**1,051·54**	**33,130**	**284·31**	**5,052**

Period.	COPPER ORE—*continued.*							
	Murchison Goldfield.		Yalgoo Goldfield.		Northampton Mineral Field.		Yandanooka Mineral Field.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	1,042·02	11,290	82·35	811	24,026·25	119,497	171·55	1,889
1946	....	....	....	....	....	....	....	....
1947	....	....	....	....	....	....	....	....
1948	....	....	....	....	....	....	....	....
1949	....	....	....	....	....	....	....	....
Total	**1,042·02**	**11,290**	**82·35**	**811**	**24,026·25**	**119,497**	**171·55**	**1,889**

TABLE VI.—*Minerals other than Gold*—continued.

Period.	COPPER ORE—*continued.*							
	Mt. Margaret Goldfield.		North Coolgardie Goldfield (Menzies District).		East Coolgardie Goldfield (East Coolgardie District).		Phillips River Goldfield.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	47,860·52	230,846	6·12	51	50·67	379	95,757·64	588,935
1946	....	....	....	....	....	....	74·00	105
1947	....	....	....	....	....	....	....	....
1948	....	....	....	....	....	....	....	....
1949	....	....	....	....	....	....	40·00	119
Total	**47,860·52**	**230,846**	**6·12**	**51**	**50·67**	**379**	**95,871·64**	**589,159**

Period.	COPPER ORE—*continued.*						CUPREOUS ORE (Fertiliser).	
	Yilgarn Goldfield.		Outside Proclaimed Goldfield.		Total.		West Pilbara Goldfield.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	16·00	77	5·11	56	253,600·80	1,749,003	....	....
1946	....	....	....	....	74·00	105	....	....
1947	....	....	....	....	....	....	....	....
1948	....	....	....	....	....	....	....	....
1949	....	....	....	....	49·49	630	133·98	1,844
Total	**16·00**	**77**	**5·11**	**56**	**253,724·29**	**1,749,738**	**133·98**	**1,844**

Period.	CUPREOUS ORE (Fertiliser)—*continued.*						DIAMONDS.	
	Peak Hill Goldfield.		Yalgoo Goldfield.		Total.		Pilbara Goldfield. (Nullagine District).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	carats.	£
Prior to 1946	....	....	....	....	....	....	....	24
1946	....	....	....	....	....	....	....	....
1947	*917·00	6,071	....	....	*917·00	6,071	....	....
1948	258·65	2,204	....	....	258·65	2,204	....	....
1949	113·00	929	7·00	48	253·98	2,821	....	....
Total	**1,288·65**	**9,204**	**7·00**	**48**	**1,429·63**	**11,096**	....	**24**

* Includes 409 tons valued at £2,968 late reported for years 1944, 1945, 1946.

Period.	DIATOMACEOUS EARTH.		DOLOMITE.		EMERALDS.		EMERY.	
	Outside Proclaimed Goldfield.		Murchison Goldfield (Mt. Magnet District).		Murchison Goldfield (Cue District).		Outside Proclaimed Goldfield.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	carats (cut and rough).	£	tons.	£
Prior to 1946	85·00	810	263·86	1,297	18,373·00	1,609	13·00	130
1946	....	....	98·09	490	....	....	....	....
1947	5·00	50	56·85	285	....	....	....	....
1948	....	....	107·25	536	....	....	....	....
1949	540·00	950	49·50	247	....	....	....	....
Total	**630·00**	**1,810**	**575·55**	**2,855**	**18,373·00**	**1,609**	**13·00**	**130**

Period.	FELSPAR.						GADOLINITE.	
	Coolgardie Goldfield.		Outside Proclaimed Goldfield.		Total.		Pilbara Goldfield (Marble Bar District).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	33,505·30	84,881	528·00	1,050	34,033·30	85,931	1·00	112
1946	1,793·00	6,282	....	....	1,793·00	6,282	....	....
1947	1,226·00	4,291	....	....	1,226·00	4,291	....	....
1948	1,011·00	3,538	....	....	1,011·00	3,538	....	....
1949	1,049·00	3,934	....	....	1,049·00	3,934	....	....
Total	**38,584·30**	**102,926**	**528·00**	**1,050**	**39,112·30**	**103,976**	**1·00**	**112**

TABLE VI.—*Minerals other than Gold*—continued.

Period.	Glass Sand.		Glauconite.		Graphite.		Gypsum.	
	Outside Proclaimed Goldfield.		Outside Proclaimed Goldfield.		Outside Proclaimed Goldfield.		Dundas Goldfield.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	835·55	934	2,829·50	34,721	18·10	97	1,401·00	351
1946	180·50	227	366·50	9,162	....	....	212·00	317
1947	364·40	469	350·50	8,763	....	....	376·00	564
1948	516·90	644	319·00	7,975	....	....	....	....
1949	986·15	1,014	203·50	5,286	....	....	10·00	6
Total	**2,883·50**	**3,288**	**4,069·00**	**65,907**	**18·10**	**97**	**1,999·00**	**1,238**

Period.	Gypsum—*continued.*						Ilmenite Sand.	
	Yilgarn Goldfield.		Outside Proclaimed Goldfield.		Total.		Outside Proclaimed Goldfield.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	11,374·00	10,892	114,865·49	137,326	127,640·49	148,569	....	....
1946	4,012·00	6,018	11,126·16	14,819	15,350·16	21,154	....	....
1947	8,953·50	13,430	10,952·00	14,780	20,281·50	28,774	....	....
1948	15,870·00	24,527	9,651·50	10,646	25,521·50	35,173	....	....
1949	15,962·00	11,181	9,935·30	7,423	25,907·30	18,610	71·95	255
Total	**56,171·50**	**66,048**	**156,530·45**	**184,994**	**214,700·95**	**252,280**	**71·95**	**255**

Period.	Iron Ore.		Jarosite.		Kaolin.		Kyanite.	
	Outside Proclaimed Goldfield.		Phillips River Goldfield.		Outside Proclaimed Goldfield.		Outside Proclaimed Goldfield.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	*58,064·35	37,048	....	....	3,433·48	3,625	19·95	100
1946	....	....	....	....	....	....	139·74	568
1947	....	....	9·54	37	581·00	310	2,931·00	14,597
1948	7,222·20	26,165	....	....	146·00	292	1,125·00	6,516
1949	12,524·13	66,296	....	....	80·00	160	....	....
Total	**77,810·68**	**129,509**	**9·54**	**37**	**4,240·48**	**4,387**	**4,215·69**	**21,781**

* Includes 450 tons valued at £247 from East Coolgardie Goldfield. Includes 100 tons valued at £300 from West Pilbara Goldfield. Includes 84·35 tons valued at £128 from Yilgarn Goldfield.

Period.	Lead Ore and Concentrates.							
	Northampton Mineral Field.		West Pilbara Goldfield.		Outside Proclaimed Goldfield.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	417,953·32	1,281,294	106·57	1,529	12·19	13	418,072·08	1,282,836
1946	36·21	1,068	....	....	....	....	36·21	1,068
1947	5·89	326	....	....	....	....	5·89	326
1948	1,345·19	92,492	....	....	....	....	1,345·19	92,492
1949	1,834·87	100,899	....	....	....	....	1,834·87	100,899
Total	**421,175·48**	**1,476,079**	**106·57**	**1,529**	**12·19**	**13**	**421,294·24**	**1,477,621**

TABLE VI.—*Minerals other than gold*—continued.

Period.	MAGNESITE.							
	East Coolgardie Goldfield. (Bulong District).		Coolgardie Goldfield.		Outside Proclaimed Goldfield.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	924·75	1,141	291·65	342	....	....	1,216·40	1,483
1946	10·50	26	....	....	....	....	10·50	26
1947	73·00	73	....	....	....	....	73·00	73
1948	....	....	466·75	1,691	495·07	1,485	961·82	3,176
1949	26·71	74	21·00	57	1,986·05	4,583	2,033·76	4,714
Total	**1,034·96**	**1,314**	**779·40**	**2,090**	**2,481·12**	**6,068**	**4,295·48**	**9,472**

Period.	MANGANESE ORE.		MICA.		OCHRE.			
	Peak Hill Goldfield.		Outside Proclaimed Goldfield.		West Pilbara Goldfield		Murchison Goldfield. (Cue District).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	lb.	£	tons.	£	tons.	£
Prior to 1946	* 76·74	436	†31,676·25	2,641	2,997·40	36,105	124·00	883
1946	....	....	....	....	354·05	5,133	505·85	4,398
1947	....	....	....	....	191·20	2,635	823·40	8,123
1948	*1,644·85	10,442	....	....	185·00	2,682	381·37	4,109
1949	9,420·31	56,289	§1,253·75	1,343	15·60	225	7·55	38
Total	**11,141·90**	**67,167**	**32,930·00**	**3,984**	**3,743·25**	**46,780**	**1,842·17**	**17,551**

* Includes 20 tons valued at £180 from Mt. Margaret Goldfield and 24·85 tons valued at £112 from Outside Proclaimed Goldfield. † Includes 7,868 lb. Crude Mica. § Includes 31·25 lb. Mica valued at £5 from West Kimberley Goldfield.

Period.	OCHRE—*continued.*							
	Pilbara Goldfield.		Yalgoo Goldfield.		East Coolgardie Goldfield.		North-East Coolgardie Goldfield.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	....	....	....	....	35·35	126	....	....
1946	....	....	....	....	....	....	....	....
1947	2·10	15	....	....	....	....	10·40	83
1948	....	....	....	....	....	....	....	....
1949	....	....	11·00	66	10·00	37	....	....
Total	**2·10**	**15**	**11·00**	**66**	**45·35**	**163**	**10·40**	**83**

Period.	OCHRE—*continued.*		PETALITE.		PHOSPHATIC GUANO.		PYRITES.	
	Total.		Coolgardie Goldfield.		Outside Proclaimed Goldfield.		Dundas Goldfield.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	*3,192·75	37,222	....	....	10,799·73	59,174	143,870·56	235,574
1946	859·90	9,531	....	....	....	....	36,127·00	107,250
1947	1,027·10	10,856	....	....	....	....	44,337·00	187,621
1948	566·37	6,791	....	....	....	....	37,499·00	164,203
1949	44·15	366	5·19	52	....	....	31,299·00	125,857
Total	**5,690·27**	**64,766**	**5·19**	**52**	**10,799·73**	**59,174**	**293,132·56**	**820,505**

* Includes 36 tons valued at £108 from Outside Proclaimed Goldfield.

TABLE VI.—*Minerals other than gold*—continued.

Period.	SILLIMANITE.		SILVER LEAD ORE AND CONCENTRATES.					
	Outside Proclaimed Goldfield.		Kimberley Goldfield.		Pilbara Goldfield.		West Pilbara Goldfield.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	....	....	....	....	195·35	3,658	....	....
1946	....	....	....	....	....	....	....	....
1947	....	....	....	....	16·47	626	....	....
1948	2·00	13	4·07	197	....	....	2·07	63
1949	....	....	2·46	161	235·15	11,424	15·32	456
Total	**2·00**	**13**	**6·53**	**358**	**446·97**	**15,708**	**17·39**	**519**

Period.	SILVER LEAD ORE AND CONCENTRATES—*continued.*						SILVER LEAD ZINC ORE AND CONCENTRATES.	
	Ashburton Goldfield.		Peak Hill Goldfield.		Total.		West Kimberley Goldfield.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	2,973·78	37,905	....	....	3,169·13	41,563	....	....
1946	....	....	....	....	....	....	....	....
1947	....	....	....	....	16·47	626	....	....
1948	126·76	7,159	....	....	132·90	7,419	713·46	14,358
1949	719·92	37,349	5·50	295	978·35	49,685	33·38	1,482
Total	**3,820·46**	**82,413**	**5·50**	**295**	**4,296·85**	**99,293**	**746·84**	**15,840**

Period.	SILVER LEAD ZINC ORE AND CONCENTRATES—*contd.*				SOAPSTONE.			
	Northampton Mineral Field.		Total.		Greenbushes Mineral Field.		Outside Proclaimed Goldfield.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	....	....	....	....	517·00	1,778	10·00	25
1946	....	....	....	....	....	....	....	....
1947	....	....	....	....	....	....	....	....
1948	....	....	713·46	14,358	....	....	....	....
1949	75·53	2,710	108·91	4,192	....	....	....	....
Total	**75·53**	**2,710**	**822·37**	**18,550**	**517·00**	**1,778**	**10·00**	**25**

Period.	SOAPSTONE—*continued.*		TALC.					
	Total.		East Coolgardie Goldfield.		Outside Proclaimed Goldfield.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	527·00	1,803	110·55	227	....	....	110·55	227
1946	....	....	389·41	1,499	....	....	389·41	1,499
1947	....	....	213·00	813	....	....	213·00	813
1948	....	....	72·00	732	....	....	72·00	732
1949	....	....	....	....	181·00	2,375	181·00	2,375
Total	**527·00**	**1,803**	**784·96**	**3,271**	**181·00**	**2,375**	**965·96**	**5,646**

TABLE VI.—*Minerals other than gold*—continued.

Period.	TANTALITE.							
	Pilbara Goldfield (Marble Bar District.)				Greenbushes Mineral Field.			
	Quantity.			Value.	Quantity.			Value.
	Lode.	Stream.	Total.		Lode.	Stream.	Total.	
	tons.	tons.	tons.	£	tons.	tons.	tons.	£
Prior to 1946	63·26	201·45	264·71	130,391	....	11·51	11·51	9,079
1946	....	·36	·36	281	....	....	....	....
1947	....	....	....	....	....	....	....	....
1948	....	·53	·53	166	....	3·78	3·78	973
1949	....	....	....	....	....	1·16	1·16	286
Total	**63·26**	**202·34**	**265·60**	**130,838**	....	**16·45**	**16·45**	**10,338**

Period.	TANTALITE—*continued.*				TIN.			
	Total.				Pilbara Goldfield (Marble Bar District).			
	Quantity.			Value.	Quantity.			Value.
	Lode.	Stream.	Total.		Lode.	Stream.	Total.	
	tons.	tons.	tons.	£	tons.	tons.	tons.	£
Prior to 1946	*66·07	212·96	279·03	141,979	372·62	5,563·31	5,935·93	554,093
1946	....	·36	·36	281	....	13·99	13·99	2,750
1947	....	....	....	....	....	17·90	17·90	4,109
1948	....	4·31	4·31	1,139	....	34·99	34·99	12,389
1949	....	1·16	1·16	286	....	31·52	31·52	11,980
Total	**66·07**	**218·79**	**284·86**	**143,685**	**372·62**	**5,661·71**	**6,034·33**	**585,321**

* Includes 2·81 tons valued at £2,509 from Coolgardie Goldfield.

Period.	TIN—*continued.*							
	Greenbushes Mineral Field.				Total.			
	Quantity.			Value.	Quantity.			Value.
	Lode.	Stream.	Total.		Lode.	Stream.	Total.	
	tons.	tons.	tons.	£	tons.	tons.	tons.	£
Prior to 1946	350·96	11,006·55	11,357·51	1,002,498	†724·57	*16,575·33	17,299·90	1,557,259
1946	....	14·53	14·53	3,088	....	28·52	28·52	5,838
1947	....	5·73	5·73	1,456	....	23·63	23·63	5,565
1948	....	2·00	2·00	596	....	36·99	36·99	12,985
1949	....	3·14	3·14	1,099	....	34·66	34·66	13,079
Total	**350·96**	**11,031·95**	**11,382·91**	**1,008,737**	**724·57**	**16,699·13**	**17,423·70**	**1,594,726**

* Includes ·60 tons valued at £143, 4·72 tons valued at £360 and ·15 tons valued at £15 from Kimberley, Murchison and Coolgardie Goldfields respectively. † Includes ·60 tons valued at £46 and ·39 tons valued at £103 from Yilgarn and East Murchison Goldfields respectively.

Period.	SCHEELITE.							
	Murchison Goldfield.		Yalgoo Goldfield.		Broad Arrow Goldfield.		Coolgardie Goldfield.	
	Conc.	Value.	Conc.	Value.	Conc.	Value.	Conc.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	·16	59	2·99	1,050	1·01	175	16·76	4,167
1946	....	....	....	....	....	....	·40	150
1947	....	....	....	....	....	....	·47	130
1948	....	....	....	....	....	....	·41	196
1949	....	....	....	....	....	....	·58	219
Total	**·16**	**59**	**3·99**	**1,050**	**1·01**	**175**	**18·62**	**4,862**

TABLE VI.—*Minerals other than gold*—continued.

Period.	SCHEELITE—*continued.*							
	North Coolgardie Goldfield. (Menzies District).		Yilgarn Goldfield.		Dundas Goldfield.		Total.	
	Conc.	Value.	Conc.	Value.	Conc.	Value.	Conc.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	6·45	1,030	85·80	30,258	·08	19	113·25	36,758
1946	....	....	4·27	1,402	....	....	4·67	1,552
1947	....	....	9·81	3,710	....	....	10·28	3,840
1948	....	....	6·86	3,717	....	....	7·27	3,913
1949	....	....	....	....	....	....	·58	219
Total	**6·45**	**1,030**	**106·74**	**39,087**	**·08**	**19**	**136·05**	**46,282**

Period.	WOLFRAM.							
	West Kimberley Goldfield.		Murchison Goldfield. (Cue District).		Yalgoo Goldfield.		Broad Arrow Goldfield.	
	Ore and Conc.	Value	Ore and Conc.	Value.	Ore and Conc.	Value.	Ore and Conc.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	28·48	331	238·64	1,148	·72	115	·28	88
1946	....	....	....	....	....	....	....	....
1947	....	....	....	....	....	....	....	....
1948	....	....	....	....	....	....	....	....
1949	....	....	....	....	....	....	....	....
Total	**28·48**	**331**	**238·64**	**1,148**	**·72**	**115**	**·28**	**88**

Period.	WOLFRAM—*continued.*		VERMICULITE.					
	Total.		East Coolgardie Goldfield (Bulong District).		Outside Proclaimed Goldfield.		Total.	
	Ore and Conc.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£
Prior to 1946	268·12	1,682	95·40	677	907·55	5,511	†1,022·95	6,248
1946	....	....	2·50	12	201·00	1,206	203·50	1,218
1947	....	....	....	....	82·00	492	82·00	492
1948	....	....	*5·00	*28	91·00	546	*96·00	*574
1949	....	....	23·22	155	138·75	832	161·97	987
Total	**268·12**	**1,682**	**126·12**	**872**	**1,420·30**	**8,587**	**1,566·42**	**9,519**

* Adjusted figures. † Includes 20 tons valued at £60 from Yilgarn Goldfield.

TABLE VII.

Quantity and Value of Minerals, other than Gold and Silver, reported during year, 1949.

Number of Lease, Claim, or Area.	Goldfield or Mineral Field.	Registered Name of Producer.	Quantity.	Metallic Content.	Value.
		ABRASIVE SILICA STONE.	tons.		£A.
M.L. 12M (Mt. Magnet)	Murchison	Sherrifs, G. W.	1·50	....	(a) 9·00
		ALUNITE.		Crude Potash recovered. tons.	
M.L's. 38, etc.	Yilgarn	State (W.A.) Alunite Industries	32,263·50	1,447·80	(b) 43,417·10
		ANTIMONY.	Ore and Con-	Antimony.	
G.M.L's. 231L, etc.	Pilbara	Blue Spec G.M's., N.L.	5·88	1·28	(d) 60·00
P.A. 657L	Pilbara	Roberts and Kinunnen	14·35	7·46	(d) 812·21
P.A. 664L	Pilbara	Roberts, R.	1·45	·75	(d) 81·52
			21·68	9·49	953·73
		ARSENIC.			
G.M.L's. 667J, etc.	East Murchison	Wiluna G.M's., N.L.	32·75	....	(d) 982·50
		ASBESTOS (CHRYSTOTILE).			
M.C's. 48, 68	West Pilbara....	Hancock, L. G.	141·27	....	(f) 8,503·41
		ASBESTOS (CROCIDOLITE).			
M.C's. 54, etc.	West Pilbara....	Australian Blue Asbestos, Ltd.	*1,155·87	....	d 116,828·11
			1,297·14	....	125,331·52
		BENTONITE.			
M.C's. 282H, 397H (Marchagee)	O.P.G.	Fennell, W. G.	150·00	....	(a) 450·00
		BERYL ORE.		BeO Long Ton Units.	
M.C. 413H (Yinnietharra)	O.P.G.	North West Metals & Minerals Pty., Ltd.	6·66	74·23	(d) 429·25
P.A. 891H (Yinnietharra)	O.P.G.	Symonds, H. H.	4·38	52·62	(d) 401·90
Crown Lands (Yinnietharra)	O.P.G.	Spicer, C.	5·91	73·88	(d) 369·40
Crown Lands	West Kimberley	Stuart, J.	3·50	38·85	(d) 296·70
			20·45	239·58	1,497·25
		CLAY (FIRECLAY).			
M.C's. 380H, etc. (Clackline)	O.P.G.	Clackline Refractories, Ltd.	4,123·00	....	(c) 2,061·50
Private Property (Glen Forrest)	O.P.G.	Darling Range Firebrick Co. Pty., Ltd.	1,350·00	....	(c) 1,256·90
			5,473·00	....	3,318·40
		CLAY (POTTERY CLAY).			
M.C. 109H (Goomalling)	O.P.G.	H. L. Brisbane & Wunderlich, Ltd.	4,131·00	....	(c) 8,262·00
		CLAY (CEMENT).			
M.L. 357H (Mt. Helena)	O.P.G.	Swan Portland Cement, Ltd.	443·00	....	(c) 232·58
			10,047·00	....	11,812·98

TABLE VII—*continued.*

Quantity and Value of Minerals, other than Gold and Silver, Reported During Year 1949.

Number of Lease, Claim, or Area.	Goldfield or Mineral Field.	Registered Name of Producer.	Quantity.	Metallic Content.	Value.
		COAL.	tons		£A.
M.L's. 314, etc.	Collie	Griffin Coal Mining Co., Ltd.—			(*g*)
		Griffin Mine	68,190·90	....	95,304·20
		Wyvern Mine	65,108·10	....	91,116·10
		Phoenix Mine	2,975·40	....	4,110·30
M.L's. 85, etc.	Collie	Amalgamated Collieries of W.A., Ltd.—			
		Cardiff Mine	108,037·91	....	139,134·18
		Co-operative Mine	77,530·82	....	97,150·86
		Proprietary Mine	135,804·01	....	175,959·54
		Stockton Mine	86,296·51	....	108,566·80
		Stockton Open Cut	140,306·72	....	176,321·69
		Black Diamond Open Cut	66,343·69	....	84,581·22
			750,594·06	....	972,244·89
		COPPER FERTILISER.		Copper. %	
Freehold Property	West Pilbara	Walters, I.	133·98	8·88	(*c*) 1,843·75
M.C. 27P	Peak Hill	Oma, E. C.	60·00	12·73	(*a*) 573·00
L.T.T. 1P/49 (1132H)	Peak Hill	Wright, A. E.	53·00	8·72	(*a*) 356·00
M.C. 7	Yalgoo	Dower, H. J. and Party	7·00	10·39	(*a*) 48·00
			253·98	9·80	2,820·75
		COPPER ORE.		tons.	
P.A. 199	Ashburton	Shanks, E.	1·30	·19	(*d*) 12·50
M.C. 34P	Peak Hill	White, A. F.	8·19	3·73	(*d*) 498·25
L.T.T. 1079H	Phillips River	Wehr Bros.	40·00	·91	(*d*) 119·35
			49·49	4·83	630·10
		DIATOMACEOUS EARTH.		Calcined Content.	
M.C. 241H (Lake Gnangara)	O.P.G.	H. L. Brisbane & Wunderlich, Ltd.	540·00	54·00	(*c*) 950·00
		DOLOMITE.			
M.L's. 11M, etc. (Mt. Magnet)	Murchison	Atkinson and Giles	49·50	....	(*a*) 247·50
		FELSPAR.			
M.L's. 80, etc.	Coolgardie	Australian Glass Manufacturers Co. Pty., Ltd.	1,049·00	....	(*d*) 3,933·75
		GLASS SAND.			
M.C. 365H (East Wanneroo)	O.P.G.	Leach, R. J.	301·15	....	(*c*) 448·05
M.C's. 161H, etc. (Lake Gnangara)	O.P.G.	Leach, W. M.	225·00	....	(*c*) 290·00
M.C's. 417H, etc. (Lake Gnangara)	O.P.G.	Australian Glass Manufacturers Co. Pty., Ltd.	460·00	....	(*c*) 276·00
			986·15	....	1,014·05
		GLAUCONITE.	Greensand treated.	Glauconite recovered.	
Private Property (Gingin)	O.P.G.	Brook, G. E.	1,017·50	203·50	(*d*) 5,286·50
		GYPSUM.			
M.C's. 30, etc.	Yilgarn	Ajax Plaster Co., Ltd.	4,065·00	....	(*a*) 3,150·34
M.C's. 280H, etc. (Lake Brown)	O.P.G.	H. B. Brady Co. Pty., Ltd. and Saunders, G. R. (Jnr.)	2,829·00	....	(*a*) 2,121·75
M.C's. 395H, etc. (Lake Brown)	O.P.G.	A. H. Jose & Co.	480·00	....	(*a*) 480·00
M.C's. 31H, etc. (Baandee)	O.P.G.	Millars Timber & Trading Co., Ltd.	1,610·00	....	(*a*) 1,690·00
M.C's. 126H, etc. (Baandee)	O.P.G.	Perth Modelling Works, Ltd.	3,043·00	....	(*a*) 1,673·65
M.C's. 8, etc.	Dundas	Perth Modelling Works, Ltd.	10·00	....	(*a*) 6·50
M.C's. 9, etc.	Yilgarn	Perth Modelling Works, Ltd.	11,897·00	....	(*a*) 8,030·46
M.L. 52P.P. Avon (Hines Hill)	O.P.G.	Feineler, K. J.	1,103·25	....	(*a*) 606·75
M.C. 293H (Woolundra)	O.P.G.	Ripper, P.	617·65	....	(*a*) 692·67
P.A. 884H (Hines Hill)	O.P.G.	Ripper, W. H. L.	252·40	....	(*a*) 157·72
			25,907·30	....	18,609·84

Plaster of Paris reported as manufactured during the year being 18,635·00 tons from 25,705·50 tons of Gypsum by five factories.

TABLE VII—*continued.*

Quantity and Value of Minerals, other than Gold and Silver, Reported During Year 1949.

Number of Lease, Claim, or Area.	Goldfield or Mineral Field.	Registered Name of Producer.	Quantity.	Metallic Content.	Value.
ILMENITE SAND.					
D.C's. 9H, 10H (Cheyne Bay)	O.P.G.	Rare Metals Pty., Ltd.	71·95	....	(*d*) 255·50
IRON ORE.				Pig Iron.	
Crown Lands (Wundowie)	O.P.G.	The Charcoal Iron and Steel Industry	12,524·13	6,609·17	(*b*) 66,295·92
KAOLIN.					
M.C. 247H (Mt. Kokeby)	O.P.G.	Linton, J. B.	80·00	....	(*c*) 160·00
LEAD ORES AND CONCENTRATES. *See foot of Table.*					
MAGNESITE.			tons.		£A.
M.C. 10Y	East Coolgardie	The Broken Hill Pty. Co., Ltd.	26·71	....	(a) 74·00
M.L's. 87, etc.	Coolgardie	Scahill & Gibbons	21·00	....	(d) 57·00
Private Property (Northam)	O.P.G.	The Charcoal Iron and Steel Industry	†1,986·05	....	(c) 4,583·18
			2,033·76	....	4,714·18
MANGANESE ORE.					
M.C. 24P	Peak Hill	Westralian Ores Pty., Ltd.	4,426·59	....	(e) 30,065·85
M.C's. 28P, etc.	Peak Hill	The Broken Hill Pty. Co., Ltd.	4,993·72	....	(e) 26,222·72
			9,420·31	....	56,288·57
MICA.			lb.		
P.A. 58	West Kimberley	Stuart, J.	31·25	....	(a) 4·62
P.A. 893H (Yinnietharra)	O.P.G.	Miller, D. F.	380·00	....	(a) 400·00
P.A. 895H (Yinnietharra)	O.P.G.	Woodman, S. J.	842·50	....	(a) 938·70
			1,253·75	....	1,343·32
OCHRE (RED).					
M.L. 239	West Pilbara	Smith, R. J.	15·60	....	(d) 225·00
P.A. 2435	Yalgoo	Fienberg & Crosse	11·00	....	(a) 66·00
			26·60	....	291·00
OCHRE (YELLOW).					
M.C. 30 (Cue)	Murchison	Ryan & Seivwright	7·55	....	(a) 37·75
M.C. 12E	East Coolgardie	Smith, F. R.	10·00	....	(a) 37·50
			17·55	....	75·25
			44·15	....	366·25
PETALITE.				Li_2O. lb.	
M.L's. 80, etc.	Coolgardie	Australian Glass Manufacturers Co. Pty., Ltd.	5·19	464·84	(d) 51·89
PYRITES ORE AND CONCENTRATES.				Sulphur recovered. tons.	
G.M.L's. 146, etc.	Dundas	Norseman G.M's., N.L.	31,299·00	12,980·96	(a) 125,857·00
TALC.					
Private Property (Three Springs)	O.P.G.	Universal Milling Co., Ltd.	181·00	....	(b) 2,375·00

TABLE VII—*continued.*

Quantity and Value of Minerals, other than Gold and Silver, Reported During Year 1949.

Number of Lease, Claim, or Area.	Goldfield or Mineral Field.	Registered Name of Producer.	Quantity.	Metallic Content.	Value.
		TANTALITE.	tons		£A.
			Tantalo-Columbite Concentrates (Mixed). lb.	Assay. %	
M.C. 56, etc.	Greenbushes	Freeman, F. E. D.	2,606·00	65·30	(d) 286·00
		TIN CONCENTRATES.			
D.C. 26	Pilbara	Johnston, E.	5·60	....	(d) 2,028·00
D.C's. 16, etc.	Pilbara	Hansen & Johansson	1·50	....	(d) 577·86
Crown Lands	Pilbara	Sundry Persons....	24·42	....	(d) 9,373·87
M.C's. 58, etc.	Greenbushes	Spring Valley Tin, Ltd.	2·93	....	(d) 1,026·10
Crown Lands	Greenbushes	Sundry Persons....	·21	....	(d) 72·85
			34·66	....	13,078·68
		TUNGSTEN (SCHEELITE CONCENTRATES).	lb.	WO_3 lb.	
G.M.L. 5666	Coolgardie	Urlich, M.	1,099·00	725·54	(a) 193·50
M.L. 1 (Loc. 59, Hampton Plains)	Coolgardie	Baker, J. P.	195·00	101·92	(a) 25·30
			1,294·00	827·46	218·80
		VERMICULITE.			
M.C. 3Y	East Coolgardie	Jones, R. L.	23·22	....	(a) 154·50
M.C. 187H (Young River)	O.P.G.	Perth Modelling Works, Ltd.	138·75	....	(c) 832·50
			161·97	....	987·00

Yearly Disposal—(Perth Modelling Works, Ltd.).
Local exfoliation 24·50 tons producing 19·72 tons "Gold Flake."
Crushed and sized ore exported from State—106·80 tons.

LEAD ORE AND CONCENTRATES.

Number of Lease, Claim or Area.	Goldfield or Mineral Field.	Registered Name of Producer.	Ore and Concentrates.	Lead.	Zinc.	Silver.	
			tons.	tons.	tons.	fine oz.	(d)
M.L's. 205, etc.	Northamptom	Galena Lead Mines, N.L.	537·38	333·96	19·52	583·83	24,266·10
M.L's. 31PP, etc.	Northampton....	Northampton Mining & Development Co. Pty., Ltd.	333·90	210·94	6·72	152·97	15,703·65
Private Property (Loc. 119)	Northampton....	Protheroe Lead Mine	834·64	634·89	....	....	54,044·10
Sundry Claims and Leases	Northampton....	Sundry Persons....	128·95	91·38	....	20·53	6,884·92
			1,834·87	1,271·17	26·24	757·33	100,898·77
		SILVER LEAD ORE AND CONCENTRATES.					
M.L. 135	Ashburton	Holben and Party	140·39	104·30	....	1,220·88	7,162·65
M.C. 2	Ashburton	Ibbotson, G. R.	168·25	90·72	....	2,799·05	7,630·80
Sundry Claims and Leases	Ashburton	Sundry Persons....	411·28	275·37	....	3,030·14	22,555·56
M.C. 189	Pilbara	Moore, R. O.	108·95	76·95	....	1,033·30	5,891·60
Sundry claims	Pilbara	Sundry Persons....	126·20	82·54	....	780·56	5,532·10
Sundry Claims	Kimberley	Sundry Persons....	2·46	1·78	....	5·90	161·25
Sundry Claims	West Pilbara	Sundry Persons	15·32	7·96	....	44·08	456·50
Sundry Claims	Peak Hill	Sundry Persons	5·50	4·30	....	59·95	294·65
			978·35	643·92	....	8,973·86	49,685·11
		SILVER LEAD ZINC ORE AND CONCENTRATES.					
M.L. 224	Northampton....	Colley & Willison .... Murchison View Syndicate	75·53	37·68	9·22	69·13	2,710·35
M.C. 29	West Kimberley	Devonian Pty., Ltd.	33·38	19·51	....	191·76	1,482·40
			108·91	57·19	9·22	260·89	4,192·75

O.P.G. denotes Outside Proclaimed Goldfield. * Includes 158·03 tons valued at £12,563 under reported for 1948.
† Used as flux in Iron Industry at Wundowie. Reference, Lead, Silver Lead and Silver Lead Zinc Ores and Concentrates, (1) Only results from shipments finalised during the year are shown (outstanding shipments not recorded until Final Statements are received). (2) Metallic Content calculated on assay basis. (3) Value expressed includes any payment made for metallic contents other than Lead. Points of Value—(a) F.O.R. (b) At Works. (c) Landed at Works. (d) F.O.B. Fremantle. (e) F.O.B. Geraldton. (f) F.O.B. Port Samson. (g) Pithead.

TABLE SHOWING AVERAGE NUMBER OF MEN EMPLOYED ABOVE AND UNDER GROUND IN THE LARGER GOLDMINING COMPANIES OPERATING IN WESTERN AUSTRALIA DURING THE YEARS FROM 1940 TO 1949 INCLUSIVE.

Compiled from Quarterly Figures furnished by Companies concerned to the Mines Department up to 1942 and Monthly Figures thereafter.

COMPANY.	1940.			1941.			1942.			1943.			1944.			1945.			1946.			1947.			1948.			1949.		
	Above.	Under.	Total.	Above.	Under.	Total.	Above.	Under.	Total.	Above.	Under.	Total.	Above.	Under.	Total.	Above.	Under.	Total.	Above.	Under.	Total.	Above.	Under.	Total.	Above.	Under.	Total.	Above.	Under.	Total.
Boulder Perseverance, Ltd.	160	149	309	158	157	315	144	102	246	117	96	213	116	101	217	127	115	242	178	148	326	195	159	354	185	148	333	171	135	306
Broken Hill Pty. Co., Ltd.	47	95	142	48	93	141	32	54	86	5	....	5	4	....	4	11	2	13	33	82	115	38	95	133	38	84	122	36	73	109
Consolidated Gold Area, N.L.	22	51	73	24	38	62	27	33	60	13	16	29	1	....	1	1	....	1	2	....	2	2	....	2	2	....	2	1	....	1
Golden Horseshoe (New),Ltd.	50	....	50	50	....	50	41	....	41	39	....	39	38	....	38	39	....	39	45	....	45	46	....	46	45	....	45	43	....	43
Gold Mines of Kalgoorlie, Ltd.	96	174	270	105	167	272	91	108	199	95	96	191	90	98	188	103	114	217	144	171	315	169	158	327	166	173	339	175	179	354
Great Boulder Pty., Ltd.	340	620	960	350	608	958	281	408	689	249	329	578	226	305	531	237	344	581	310	469	779	325	496	821	316	418	734	312	392	704
Kalgoorlie Enterprise, Ltd.	....	87	87	....	103	103	....	74	74	....	55	55	....	53	53	....	74	74	....	99	99	....	118	118	1	105	106	7	103	110
Lake View and Star, Ltd.	426	812	1,238	410	792	1,202	256	323	579	218	186	404	225	214	439	246	242	488	337	422	759	366	468	834	414	465	879	454	441	895
North Kalgurli (1912), Ltd.	91	220	311	82	286	368	48	154	202	37	91	128	42	107	149	52	131	183	62	173	235	66	213	279	76	265	341	79	304	383
Paringa Mining and Exploration Co., Ltd.	66	152	218	72	149	221	59	115	174	59	88	147	78	82	160	69	103	172	76	113	189	83	117	200	87	134	221	79	134	213
South Kalgurli Consolidated, Ltd.	158	153	311	151	143	294	131	98	229	67	77	144	43	74	117	51	80	131	80	91	171	103	105	208	107	111	218	110	105	215
Kalgurli Ore Treatment Co., Ltd.	76	....	76	80	....	80	67	....	67	65	....	65	67	....	67	68	....	68	73	....	73	69	....	69	69	....	69	74	....	74
New Milano, N.L.	15	13	28	29	17	46	20	15	35	6	8	14	1	....	1	2	....	2	2	1	3	2	2	4	2	1	3	1	....	1
Comet Gold Mines, Ltd.	43	28	71	44	36	80	59	31	90	54	28	82	47	30	77	42	33	75	43	32	75	17	7	24	7	10	17	9	13	22
Blue Spec Gold Mines, N.L.	10	11	21	9	4	13	6	4	10	5	4	9	28	7	35	32	12	44	38	17	55	36	24	60	17	12	29	1	....	1
Wiluna Gold Mines, Ltd.	267	361	628	255	342	597	247	292	539	255	282	537	237	244	481	214	196	410	168	96	264	117	5	122	69	....	69	49	....	49
Moonlight Wiluna Gold Mines, Ltd.	37	113	150	38	105	143	29	81	110	18	61	79	16	44	60	4	5	9	....	....	....	....	....	....	....	....	....	....	....	....
Emu Gold Mines, Ltd.	47	87	134	48	21	69	33	43	76	33	32	65	29	28	57	34	38	72	38	40	78	36	35	71	9	6	15	....	....	....
Youanmi Gold Mines, Ltd.	68	164	232	56	140	106	10	12	22	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Big Bell Mines, Ltd.	185	259	444	180	237	417	165	162	327	29	11	40	14	1	15	29	16	45	171	143	314	186	198	384	188	193	381	197	210	407
Triton Gold Mines, N.L.	83	239	322	82	223	305	36	74	110	4	10	14	8	15	23	11	23	34	41	66	107	83	178	261	64	95	159	7	....	7
Hill 50 Gold Mine, N.L.	31	40	71	33	41	74	28	42	70	32	42	74	32	41	73	41	45	86	55	48	103	49	55	104	55	67	122	68	78	146
Mt. Magnet Gold Mines Ltd.	38	42	80	9	4	13	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Sons of Gwalia, Ltd.	132	253	385	124	241	365	97	163	260	101	125	226	101	115	216	104	106	210	122	160	282	108	128	236	98	109	207	92	143	235
First Hit Gold Mine, N.L.	22	17	39	20	14	34	18	12	30	17	15	32	21	14	35	20	15	35	7	7	14	4	5	9	2	1	3	1	1	2
Gold Fields Australian Development Co., Ltd.	9	11	20	13	15	28	12	15	27	10	10	20	4	2	6	2	....	2	13	11	24	18	20	38	13	20	33	18	18	36
Ora Banda Amalgamated, Ltd.	30	45	75	30	45	75	26	38	64	22	26	48	7	5	12	4	....	4	11	20	31	23	44	67	5	4	9	3	1	4
Consolidated Gold Mines of Coolgardie, Ltd.	64	107	171	67	86	153	45	53	98	37	44	81	20	23	43	8	1	9	2	....	2	1	....	1	1	....	1	1	....	1
Phoenix Gold Mines, Ltd.	44	79	123	54	65	119	43	40	83	35	36	71	40	38	78	48	33	81	50	30	80	50	30	80	33	22	55	....	....	....
Burbidge Gold Mines, N.L.	....	....	....	38	....	38	25	2	27	3	....	3	....	....	....	....	....	....	....	....	....	18	....	18	15	4	19	14	4	18	18	4	22
Yellowdine Gold Development, Ltd.	60	84	144	57	74	131	41	47	88	30	28	58	13	9	22	2	....	2	4	....	4	2	....	2	2	....	2	2	....	2
Edna May Amalgamated, N.L.	40	61	101	39	62	101	29	35	64	30	35	65	35	36	71	33	34	67	29	42	71	28	33	61	11	9	20	....	....	....
Evanston Gold, N.L.	21	21	42	31	32	63	19	21	40	5	7	12	....	....	....	....	....	....	28	32	60	37	26	63	2	....	2	2	....	2
Central Norseman Gold Corporation, N.L.	107	333	440	112	223	335	91	148	239	82	117	199	72	115	187	77	135	212	103	201	304	111	251	362	117	268	385	133	246	379
Norseman Gold Mines, N.L.	161	233	394	148	195	343	110	151	261	101	104	205	87	72	159	98	56	154	105	79	184	12	19	31	....	....	....	....	....	....
Sunshine Reward Amalgamated Leases	6	6	12	6	6	12	4	5	9	5	6	11	5	5	10	4	3	7	5	7	12	8	9	17	9	10	19	9	14	23
Dundas Gold Mines, N.L.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1	2	4	13	17	9	22	31	7	17	24	11	15	26
Mountain View Gold, N.L.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	7	9	16	11	8	19	10	14	24
Mt. Charlotte (Kalgoorlie) Gold Mines, N.L.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	1	3	18	18	36	24	28	52
Porphyry (1939) Gold Mines, Ltd.	5	....	5	29	17	46	27	23	50	5	4	9	1	....	1	6	....	6	13	5	18	15	10	25	17	4	21	20	....	20
New Coolgardie Gold Mines N.L. Hampton Plains ...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	6	7	13	56	64	120
All other Operators	3,362	3,054	6,416	2,790	2,454	5,244	1,447	1,301	2,748	599	495	1,094	511	437	948	599	388	987	1,002	674	1,676	1,174	993	2,167	1,133	974	2,107	987	825	1,812
State Average (incl. Diggers)	6,419	8,174	14,593	5,871	7,235	13,106	3,844	4,279	8,123	2,488	2,591	5,079	2,266	2,348	4,614	2,424	2,394	4,818	3,416	3,545	6,961	3,612	4,037	7,649	3,416	3,762	7,178	3,260	3,540	6,800

By Authority: WILLIAM H. WYATT, Government Printer, Perth.