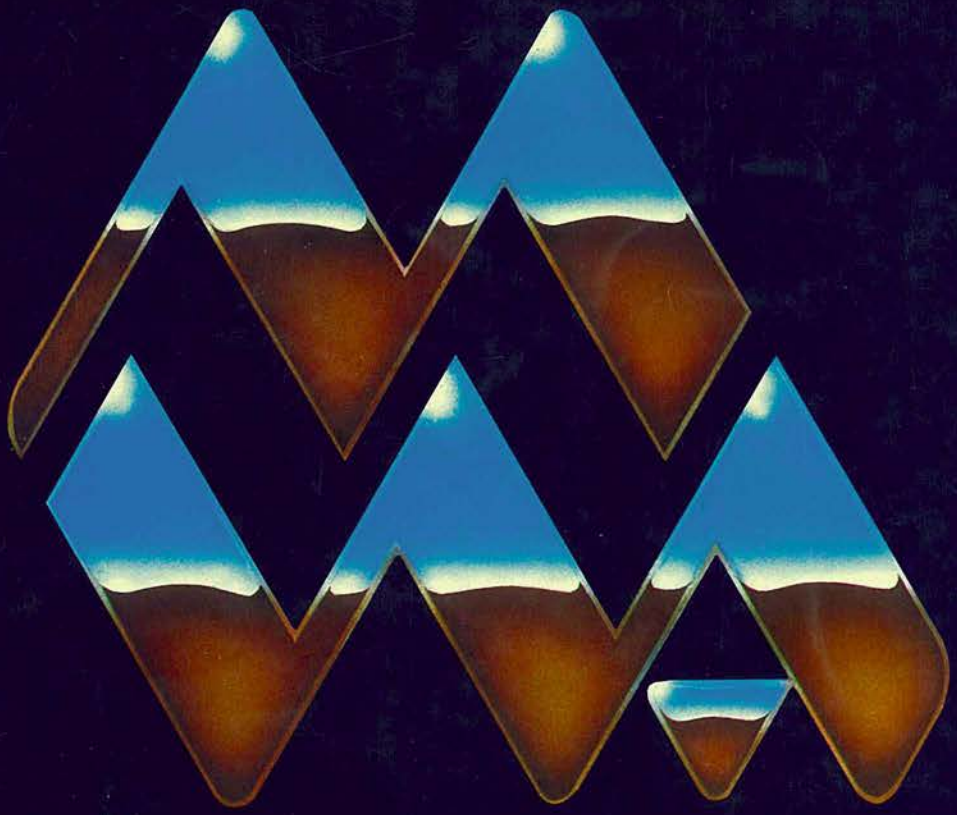
DEPARTMENT OF MINES
WESTERN AUSTRALIA



ANNUAL REPORT 1982

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DEPARTMENT OF MINES

WESTERN AUSTRALIA

PERTH, 1983

PRESENTED TO BOTH HOUSES OF PARLIAMENT

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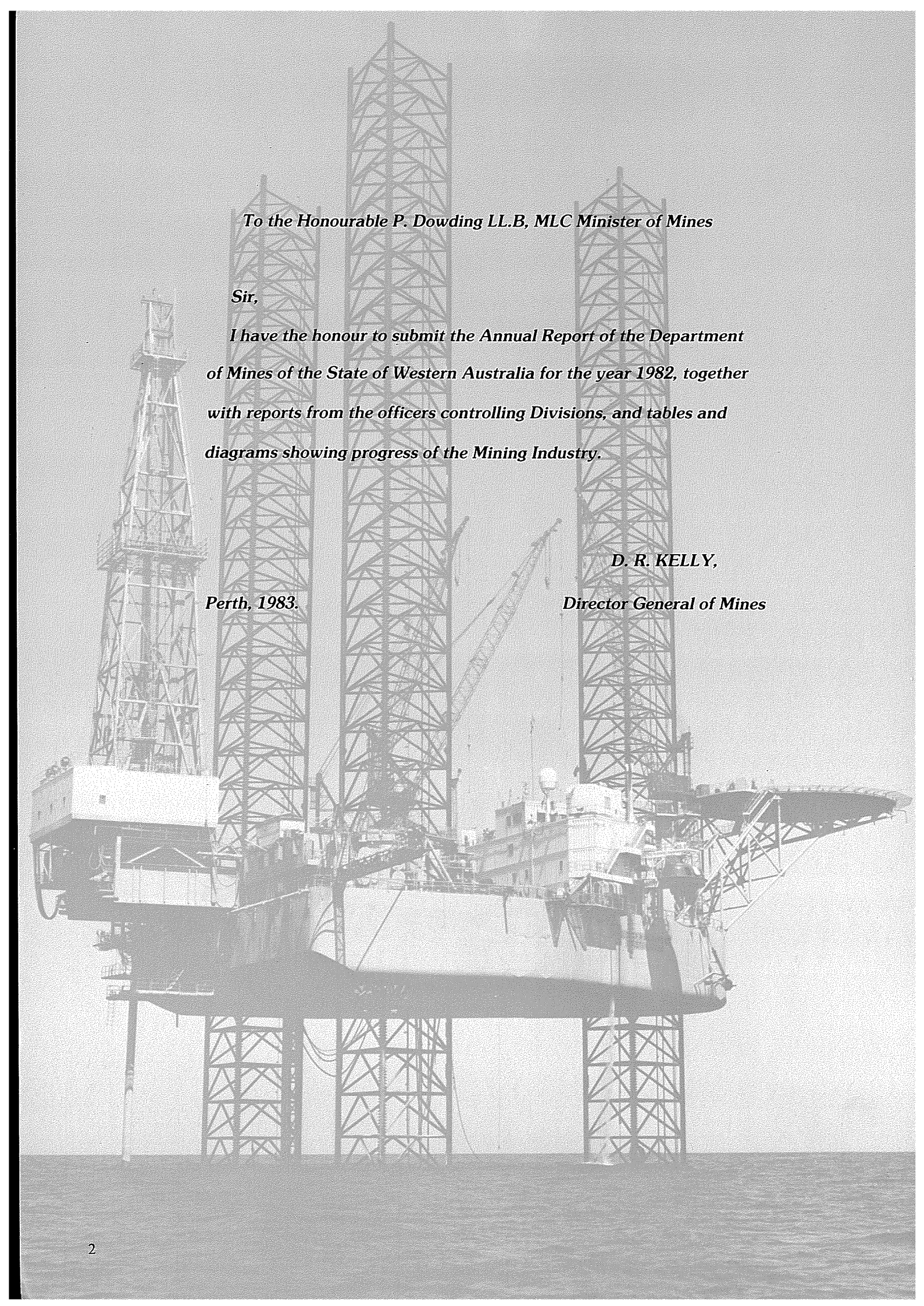


To the Honourable P. Dowding LL.B, MLC Minister of Mines

Sir,

I have the honour to submit the Annual Report of the Department of Mines of the State of Western Australia for the year 1982, together with reports from the officers controlling Divisions, and tables and diagrams showing progress of the Mining Industry.

D. R. KELLY,

Perth, 1983. *Director General of Mines*

CONTENTS

THE MINING ACT 1978-1982 — the first year

On December 11, 1981, the Mining Act 1978 was proclaimed to come into force on January 2, 1982.

The Act had one of the longest and stormiest gestations of any Act brought before Parliament, taking 10 years from introduction to final proclamation. In contrast, the first year of operation proceeded smoothly, and after some hesitation, the Act was generally well accepted by industry.

It is natural that industry should have been wary of the ramifications of the new Act because fore-shadowed amendments were not finalized until December 1982; thus it was almost the end of the first year of operation before the mining law was clearly known.

Nevertheless, 10.9 million hectares of land were applied for as mining tenements under the new Act. Of this, some 2.8 million hectares were old Act tenements converted to the new Act whilst 8.1 million hectares were new ground taken up. This situation is comparable to the boom years of 1980 and 1981 when 11.4 and 12.8 million hectares of ground respectively were the subject of application. The 8.1 million hectares of new ground applied for in 1982 greatly exceeds the total of 5.1 million hectares applied for in the 3 year period from 1974 to 1976.

During the first year no major problems evolved in the substantial area of work involving the transition of tenements from the old Act to the new Act.

Under the circumstances the activity during 1982 was extremely pleasing because industry was doubtful all the while whether the new legislation would be allowed to carry on albeit that it had been proclaimed; and many companies had stepped up their pegging programmes in the second half of 1981 (contributing to the figure of 12.8 million hectares applied for during that year) before the 1904 Act was to be repealed—a case of "the Devil you know".

The successful introduction of the new Act reflects the efforts of a number of Divisions of the Department of Mines, particularly the Registration Division and the outstation offices.

In November, 1981 a Mining Registrars' Conference was held in Perth at which all outstation registrars were fully briefed on the provisions on the new Act and they in turn, took this knowledge back with them to the country centres to pass on to the public.

An information centre was established in Mineral House at which personal or telephone enquiries could be made and information brochures on all aspects of the new legislation were prepared and distributed free of charge to the public.

Problems facing the Department

It is not as if it has been possible to introduce the new Act at a quiescent time in the history of the Department; rather it followed a period of intense activity by the mining industry when the resources of the Department were overstretched.

In the 2 year period just prior to the commencement of the new Act 29 478 and 24 936 applications were received in the years 1980 and 1981 respectively. At the end of 1981, a backlog of 29 331 applications remained to be processed to completion under the old Act before they could be transitioned to the new Act, in accordance with the transitional provisions. This huge total of applications under the old Act had to be processed in conjunction with all new applications under the new Act.

At the end of December 1982 this backlog had been reduced to 15 422 and it is anticipated all old Act applications will be finalized by mid 1984.

In the period during which the Department is required to process simultaneously applications under both the old and new Acts problems will obviously arise where tenements applications for the same ground are being made. When the 1904 Act has finally been put to rest, a significant improvement in administration will be possible, particularly as the new Act will permit the application of computer techniques.

The mining and mineral processing industry in Western Australia and the Department of Mines, in serving that industry, faced difficult times in 1982. There is hope that 1983 may see an improvement in this situation.

The mining and mineral processing industry

The Western Australian mineral industry continued to experience increasing difficulties throughout 1982. The full effects of the world recession in trade and industry were not felt in Australia until 1982.

High inflation, increasing unemployment and a deferral of capital expenditure are the most common features of the recession. The construction and manufacturing industries were first to show the symptoms but the effects have now flowed into the mining and mineral processing industries.

Despite the recession production of the major mineral commodities has generally been higher in 1982 compared to the low levels of 1981. In a number of cases, however, prices have dramatically and progressively slumped through the year. The main tasks of most companies have been to counter rising production costs and to try to maintain markets in an increasingly competitive world, where there is an oversupply of most commodities. Overall the mineral industry in Western Australia appears to have kept its position in the market somewhat better than other major sources of supply, notably North America. Many companies' profitability has been drastically reduced; this reflects not only falling prices and rising production costs, but high capital charges and seriously under-utilized capacity resulting from investment decisions made 3 or 4 years ago.

Exploration activity

The full effects of the recession are evident in mineral exploration activity in the State. A widespread reduction in profitability has severely cut available funds for exploration. Certain companies in the State have closed their exploration branches and in most of the others there have been major cutbacks. Nevertheless, 2 968 applications were received for mining tenements during the year, comprising 10.8 million hectares which is only marginally less than the 11.4 and 12.8 million hectares applied for in the very active years of 1980 and 1981. Undoubtedly this was due, at least in part, to the improvement in the price of gold towards the end of the year which has stimulated interest in gold exploration.

Petroleum exploration was also affected by the adverse change in world-wide economic conditions. Exploration activity, although the highest ever for the State, was about 15% less than expected. It is anticipated that this record level of petroleum exploration will not be maintained and a 15-20% fall in activity is forecast for 1983.

Mineral production and royalties

Production

A comparison of 1981 and 1982 statistics of production and value does not reflect the depressed state of the mineral industry. The value of Western Australian mineral output (including fuels and gold) amounted to $3 334 million in 1982, an increase of 24% on 1981, whilst production of the major commodities—iron ore, nickel, gold, the main mineral sand products, coal and base metals all increased in 1982 by comparison with the previous year, as shown in the adjoining table.

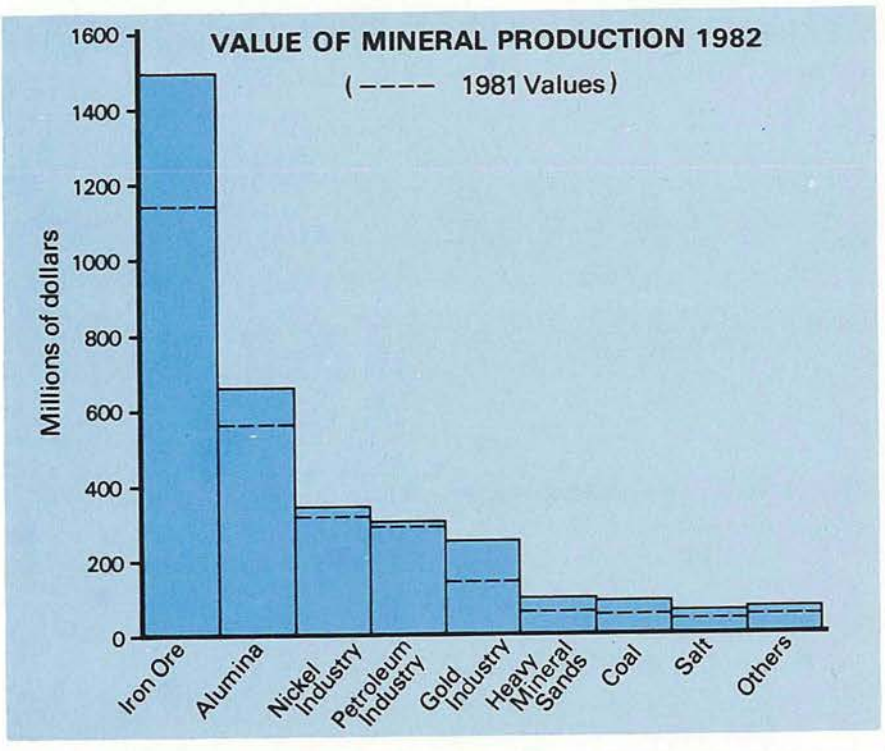
The overall rise in value of mineral output is to a large extent a reflection of improvements in two commodities; iron ore (+ 32% in

Mineral	(Units)	Production		% Difference
		1981	1982	
Iron Ore	(Mt)	75.3	78.2	+3.8
Alumina	(Mt)	3.7	3.7	0
Nickel				
Concentrate	(kt)	405.9	457.8	+12.8
Ore	(kt)	85.9	98.2	+14.3
Petroleum				
Oil	(ML)	1 439.3	1 278.0	-11.2
Natural Gas	($m^3 \times 10^6$)	831.9	881.2	+5.9
Condensate	(kt)	2.0	2.7	+35.0
Gold	(t)	12.0	20.8	+73.3
Mineral Sands				
Ilmenite	(kt)	936.1	1 075.9	+14.9
Rutile	(kt)	61.6	80.2	+30.2
Zircon	(kt)	226.5	297.1	+31.2
Others	(kt)	26.6	31.6	+18.8
Coal	(Mt)	3.3	3.7	+12.1
Salt	(Mt)	3.6	3.4	-5.6
Base metals (Primary)				
Copper conc.	(kt)	5.2	61.4	+1 080.8
Zinc conc.	(kt)	10.1	101.8	+907.9
Silver	(t)	10.6	50.3	-374.5
Tin concentrates	(t)	922.0	720.0	-21.9
Tantalite concetrates	(t)	298.0	20.4	-93.2

value and + 4% in production level on 1981) and gold (+ 61% in value and + 72% in production level on 1981). Without these two major commodities, the improvement for 1982 in all other commodities is down to 13%; a level only slightly above the effects of the high inflation rate for the year.

Apart from the tin-tantalum industry which experienced a severe slump in 1982 the order of importance of the various mineral industries in the State remained the same as the previous year. Relative percentages changed, most notably that of iron ore which increased from 42% to nearly 45% of the total value of the State's mineral production. The relevant figures are shown in the adjoining bar chart.

Details of production and value for all minerals produced in Western Australia are tabulated in the Statistical Digest on page 103.



Royalties

The year of 1982 saw the first effective operation of the new royalty rates, which came into effect on 1 December, 1981. These rates are being constantly reviewed so that there can be a fair return to the State, without at the same time causing undue difficulties to industry. As a result some reductions were effected in mid-year: for example, royalty for nickel is now assessed on the actual price being realized by producers, rather than on a posted price; and the rates applicable to base metals and tantalum were halved to give temporary relief to two industries under stress.

Royalty revenue for the year amounted to $94.76 million, $19.0 million more than 1981. This partly reflects the adjusted rates, but is mainly due to the increase in production (+ 4%) and price (+ 17%) of iron ore.

Because the major industries (e.g. iron ore, bauxite/alumina, oil and gas) are covered by special agreement acts and the Petroleum Act, they are not affected by the new rates introduced under the Mining Act and hence there has not been so dramatic a change overall. The accompanying histogram shows the total trend in royalty revenue for the last decade, with the relative importance of the major industries of the State.

World and Western Australian mineral industries

Current situation

Western Australia has an export-oriented-economy and is a significant supplier of minerals to the international market. The minerals are either exported directly or they first undergo processing within the State and in the Eastern States, before being sent overseas. Mineral exports make up over 50% of the export earnings of the State. The accompanying diagram illustrates the 1982 movement of minerals from the State.

The world mineral industry. The world recession of the last 2 years continued in 1982 and was accompanied by low industrial growth. The troubles have been experienced in varying degrees by almost all metals and minerals producers. The situation, which was perhaps initially only obvious in the "developed" or industrialized nations, has spread to the "developing" nations, particularly those of Latin America, which, in a number of mineral commodities, is a competitor of Western Australia.

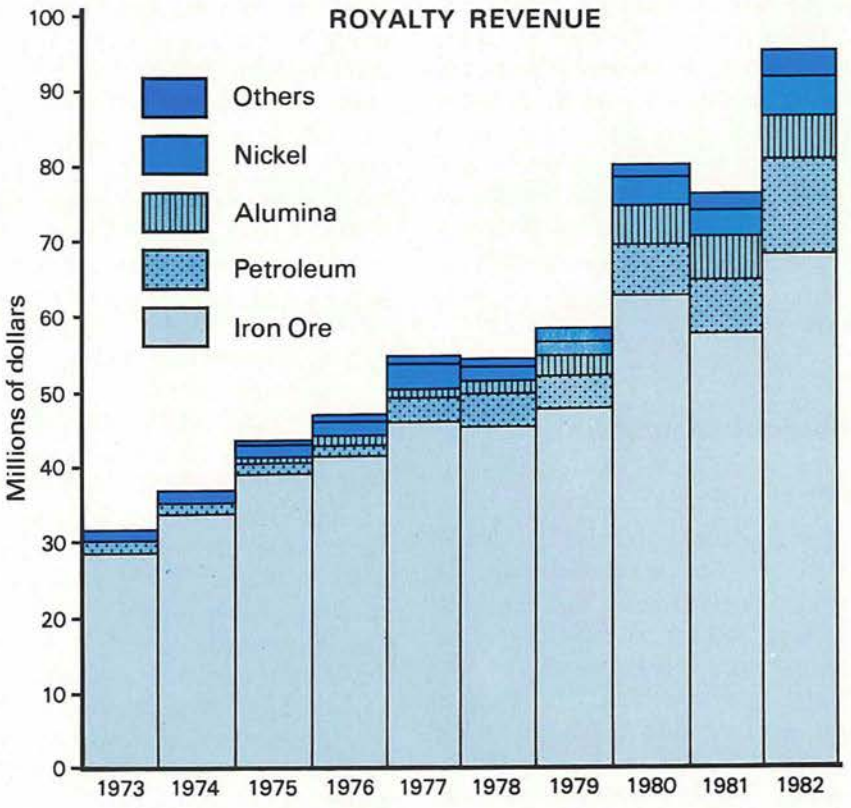
The main features of the world mineral industry in the past year although essentially interdependent can be enumerated as follows:

—there was a weak demand for mineral output with a corresponding slow down in developments;
—major cutbacks by closures of N. American mines were not followed elsewhere resulting in high stock levels;
—with the exception of iron ore, prices have slumped;
—high inflation rates have resulted in big rises in production costs;
—strict monetary policies have resulted in high unemployment; and
—there have been high interest rates on borrowings and disincentives for investment commitments.

A combination of these factors has resulted in large reductions in company profitabilities. Protectionary measures for commodities in various regions and countries are being considered, especially in steel.

The Western Australian mineral industry. In Western Australia, the major industries have been subject to differing results in 1982, as described in the mineral commodities section.

High inflation, labour costs, and interest payments on bor-



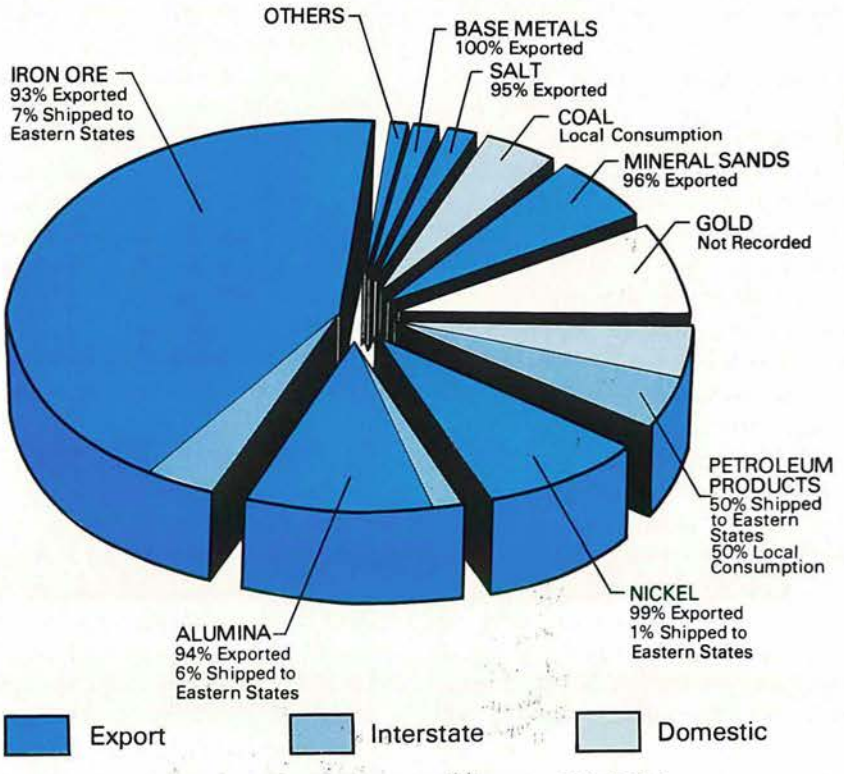
rowings are probably the major factors which have affected the larger companies, where in most cases profits are significantly down; although world oversupply and low prices have been the most serious factors in the slump in the nickel and tin/tantalum industries.

Inflation in 1982 for Australia was 11% and for Perth 9.5%; the overall figures were improved by lower inflation in the last quarter of the year. The year for the minerals industry has been one of containment of costs, by increasing efficiency and introducing economies, in order to survive in an increasingly competitive and diminishing market. The depreciation of the Australian dollar against the US dollar has moderated the effect by improving cost competitiveness for Australian goods on the world market.

The "boom" periods of 1978-79-80 encouraged massive commitment to expansion and new development in the Western Australian mineral industry. There were major investments in iron ore beneficiation plants at Hamersley and Mt Newman, nickel developments at Windarra and Carnilya Hill, the startup of the Teutonic Bore mine, which is the only primary base-metals operation in the State, and the two new alumina projects, Wagerup and Worsley. Such investments requiring high borrowings are now resulting in high interest repayments at a time of limited opportunity for market expansion. These investments yield little return in most cases; and this has contributed to the major drop in company profitability.

Western Australia and Australia in general were late to feel the effects of world recession, but in 1982 much of the mining and mineral processing industry experienced difficulties. For 1982 and the immediate future the theme is "survival". Large companies and those making big profits in 1979-80 have managed to hold on, but a number of smaller operations have closed. In general, the chance of survival for the small-scale, new developer must be low, if the current trend continues. However most industries have managed to sustain their share of the market at 1981 levels, although it must be noted that in 1981 there was a significant under utilization of capacity. The endurance of our major nickel producers in particular is remarkable in view of the very low operating level of other major producers around the world.

The gold industry does not have the marketing problems or necessity for massive capital invest-



DESTINATION OF MINERAL OUTPUT

ment of most other industries and has price as the main ruling factor. With the improvements in price in the latter part of the year (to over US$460/oz from below US $300/oz), there has been a reversing of the trends of 1981 and early 1982, to give a slightly improved situation. However, the volatile nature of the price is dictating a cautious reaction in contrast to the rush of 1980.

In the latter part of the year, many companies moved into gold exploration and development to sustain better cash flow in the shorter term and to diversify from their major commodities.

Diamond exploration continued at a high level during 1982. The imminent move into diamond mining marks the development of a major new industry for the State.

The State Government has continued to encourage the development of downstream processing within the State. This is evidenced in the iron ore industry, where both Hamersley and Newman have installed beneficiation plants in the last 2 years. Similarly the Agreement Act for the development of the Argyle diamond deposits stipulates that further processing must be developed within 5 years of operating the AK1 pipe.

Future outlook

It is difficult to forecast anything but continued depressed growth, in the short term, in the Western Australian and indeed World mineral industries. There have been downward movements in US interest rates, a prime factor in mineral industry activity, but the prospects of a continuation of this trend are being viewed with caution. High stock levels in most commodities do not augur well for 1983 prices and it could take at least another 2 years to redress the balance.

The Western Australian minerals industry is learning to be an efficient, lean industry. Providing it can successfully survive the present downturn, the mining industry will be well placed to take full advantage of new opportunities when improvements eventuate. Investment over the past 4 to 5 years has meant that there is at present a large unused capacity in modern efficient plant; and with the North West Shelf Gas Project to provide a new energy source from the middle of the decade the long term future of the Western Australian minerals industry is better than that of most other parts of the world.

Mineral commodities

Iron ore

Australia ranks third in the list of world iron ore producers, and is the second largest exporter of this commodity. Almost all of the ore exported comes from Western Australia, and it is therefore not surprising that changes in the world demand for steel have a significant impact on the economy of this State.

In 1982 the world steel production fell to a 10-year low, with output estimated at no more than 650 Mt compared to almost 750 Mt in 1979. As a result, the Western Australian producers were again operating well below installed capacity, at about a 65% level, although output was slightly improved over 1981.

Japan, the destination of about 75% of our iron ore, has suffered a severe contraction in its economy because of protective measures imposed on Japanese imports by the USA and EEC, and its steel production in the 1983 fiscal year is expected to drop below 100 Mt, the lowest level since 1971.

Although the Japanese steel mills continued to take, on average, 48% of their iron ore from Australia, there were times during the year when imports fell below this level. A possibly significant trend that emerged was the increasing proportion of Japanese ore imported from Brazil. The Japanese have also made loans and guarantees totalling US$500 million to assist the development of the massive Carajas iron ore deposits in Brazil. Financing and approval for this project have now been obtained, and its initiation can only be seen as further delaying the development of another iron ore mine in Western Australia.

Local producers anxious to lower their dependence on Japan, have been seeking markets elsewhere in Asia, but apart from some success in South Korea, and to a minor extent China and Taiwan, results have been poor owing to the general oversupply of iron ore.

Although Western Australian iron ore production was only slightly improved in 1982 compared to 1981, income and royalties rose significantly due to a 17% price increase negotiated early in the year. Most producers are understood to have operated profitably despite the higher unit costs caused by working well below capacity, and increased costs of production due to inflation. Significant increases in efficiency are reported by the major producers.

The Robe River operation, which probably suffered least from the cutbacks in Japanese imports, was able to develop its East Deepdale deposit during the year.

Goldsworthy Mining closed down its depleted Mount Goldsworthy pit and moved its entire operation to Shay Gap/Sunrise Hill. Additional contracts secured for Sunrise Hill ore, together with backlog tonnages not taken by Japan during the contract period, will enable Goldsworthy to continue its operation beyond April 1983, the date at which its original contracts were to expire.

The closure of the Australian Iron and Steel blast furnace at Kwinana in April forced the BHP's Koolyanobbing mine to cut back on production for most of the year. Present production is being shipped to Whyalla. Operations at BHP's Yampi Sound mines also continued at a reduced level.

In an attempt to assist the industry, and as an aid to future planning, the State Government supported studies on the feasibility of establishing a direct reduction and semi-finished steel plant using North West Shelf gas, and refurbished pelletizing facilities. The

State Government has also commissioned a review of the long term potential of the State's iron ore industry.

Bauxite/alumina

Recession of the world aluminium industry, characteristic of 1981, continued throughout 1982 and was exemplified by plant closures and substantial reductions in levels of production notably in Japan, Europe and USA. In contrast, installation or expansion of production facilities in several South American, African and South East Asian countries are proceeding or forecast, illustrating a significant shift in production developments to areas with relatively cheap energy supplies.

The Western Australian bauxite/alumina industry has not escaped the effects of this recession. Although alumina production levels were maintained close to capacity at Alcoa's Kwinana and Pinjarra refineries' their third plant at Wagerup, where construction was completed in May 1982, was put in mothballs awaiting market improvements.

Unlike many world suppliers in the industry, Alcoa did record a profit although at a level 40% down on last year.

International markets show few signs of improvement in the short term—spot prices have dropped 30% since 1980, there was a 15% drop in Western World production in 1982 and current stocks exceed 3 months consumption. However, more optimism is expressed for long term prospects of aluminium and alumina than for many other mineral commodities. Demand for aluminium is expected to grow at an annual rate of 4-5% until the year 2 000 compared with 9.1% during the 1960s and 5.2% in the 1970s. If realized this rate of growth will be much more rapid than for other base metals. Aluminium has maintained its competitive edge over alternative materials and continues its gradual substitution for steels and alloys in many end-product uses. Significantly, however, aluminium is itself running into competition from plastic in certain fields of manufacture, particularly transport and packaging.

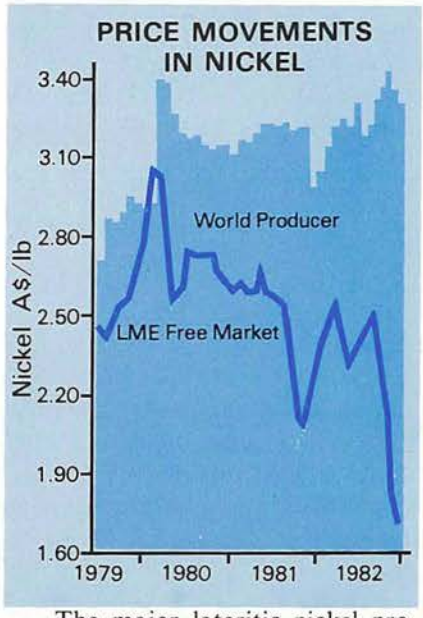
Initial problems encountered by joint venture partners relating to marketing of alumina to be produced at the Worsley refinery have been largely overcome and construction of mining and refining facilities nears completion. Commissioning of the refinery is due to commence in early 1983 and it is expected to reach its initial capacity of 1 million t.p.a. later in the year.

Evaluation of the Mitchell Plateau bauxite deposit in the Kimberley is nearing completion. The main exploration programme has been completed, bulk bauxite samples have been taken and consideration has been given to location of the alumina refinery. The feasibility study is expected to be completed in the second half of 1983, although it has been announced that the proposed design and construction stage has already been delayed beyond 1984.

South Korean representatives have expressed interest in becoming involved in the construction of a power station and aluminium smelting development in the South West of the State. Feasibility studies relating to construction of an 800 megawatt coal-fired power station south of Perth are to be completed in early 1983. Ultimately it is intended to develop a facility using 600 megawatts of power and 450 000 tonnes of alumina per annum to produce 220 000 tonnes of aluminium for South Korean markets.

Nickel

The continuing recession in the world steel industry, particularly for stainless steel, has plunged the nickel industry into new lows of price and demand. World production levels are at about two thirds of capacity and although the "producer price" has remained at around US$3.20 per pound of metal, increasing competition has prompted aggressive discounting by major world producers so that few if any sales have realized this "official price". In late 1982 the free market price plummeted below US$1.60 per pound — the lowest since 1973/4. Contracted supply prices realized just under US$2.00 per pound. The accompanying graph serves to illustrate price movements over the last 3 years.



The major lateritic nickel producers, with their high energy requirements, hence high cost, were the first to suffer. However even major sulphide producers such as INCO of Canada, with the well established mines at Sudbury, have been drastically affected, and high losses have lead to major closures and cutbacks in operations.

Western Mining Corporation, the major producer in the State, has fared better than many world producers and during the year managed to finalize a long term contract with Japan worth at least $750 million over the next decade. However, in the latter part of the year stock reductions, spending cuts, and increases in production grades were all signs of the company having to exercise financial restraint in the face of the recession.

The State's other major producer, Agnew Mining Company, appears to have overcome the metallurgical problems with its concentrator and is now producing acceptable grade concentrates. The company was reportedly breaking even at the year end, despite the

steady decline in general market conditions.

The other producer, Metals Exploration announced in December that the Nepean mine would be placed on a care-and-maintenance basis pending an improvement in market conditions.

In the review of the State's royalties in mid-1982, the royalty on nickel was singled out for change because an inequitable price situation had developed. The "INCO producer price" in the formula for royalty calculations had progressively become less representative of the price at which nickel was actually being sold, so it was replaced by the actual realized price.

In spite of the downturn in demand, exploration has continued in various parts of the State, albeit at a reduced level. The more significant discoveries that have been made are a small deposit of high-grade mineralization in the vicinity of the previously known extensive low-grade mineralization in the Mt Keith area, and finds in the Kambalda-Kalgoorlie area outside areas of known mineralization.

The recent finds must, of course, be regarded as very long-term development prospects which will remain dormant in anticipation of future long-term improvements in market conditions.

In the short term, large stocks, particularly in Canada, plus excess capacity are giving a 3-year oversupply prediction; whilst at present no major long-term upturn in the market can be foreseen.

Copper-lead-zinc-silver

The drastic cutbacks in capacity in the base metal industry throughout the world over the last few years have in some ways curbed stock build-ups at a time of weak demand. There have been prospects of price escalations, but these have never really eventuated. Copper reached its lowest real price level for 50 years in mid-1982 but peaked again at the year end. Although zinc metal consumption remained low through the year, there were improved mine performances due to a squeeze in the availability of concentrates. Lead prices continued a steady decline throughout the year.

Teutonic Bore, owned by Seltrust Holdings Ltd and Mount Isa Mines Ltd, is the States' only primary producer of copper, zinc and silver. The mine completed its first full year of operation in 1982. Marked improvements in production and the firming-up of silver and copper prices in the latter part of the year allowed a profit situation to be reached. At the combined grades of the deposit the outlook for Teutonic Bore should be healthy, although anticipated extensions of reserves have not been found and the operation is restricted to a short, 5—6 year life.

At the State's largest copper-zinc prospect, Golden Grove, 225km east of Geraldton, exploration continued and upgraded reserves were announced. The property includes Gossan Hill, a copper prospect with 15.6 million tonnes of ore at 3.2% copper and 18.7 gms/tonne silver and the Scuddles prospect with combined copper and zinc reserves of 26.1 million tonnes at about 1-2% copper, 9% zinc and 70 gms/tonne silver. No plans for development have been put forward by the joint venture partners, Esso, Amax, EZ Industries and Aztec Exploration, but at such grades and tonnages, any long-term improvement in the base metal industry must see this deposit developed at an early stage.

Interest in carbonate-hosted lead-zinc deposits remained high during 1982 with major drilling programmes undertaken in the Napier and Pillara Ranges in the West Kimberley by a BHP-Shell Australia joint venture and in the East Kimberley at Sorby Hills, near Kununurra. This latter project received new impetus in March 1982 with the announcement that St Joe Bonaparte, a subsidiary of St Joe Minerals Ltd, has agreed to spend up to $16.8 million to prove up and explore for extensions of the known mineralization. They are in a joint venture partnership with Aquitaine Australia Minerals Pty Ltd and Mount Isa Mines Ltd.

Tantalum, tin and lithium

Western Australia is a major supplier of tantalum to the western world. Interest generated by extremely high prices in 1980/81, and the announcement of a major discovery at Greenbushes, stimulated much exploration and several new developments. However, 1982 saw prices for tantalite plummet from US $120 to US $35 per pound, with the result that several mines either closed down permanently or suspended operations. Those operators who did carry on in 1982, had to stockpile most of their product, with the result that only 20 tonnes of tantalite were sold (298 tonnes in 1981).

Among the casualties were the operations of Pilgan Mining at Pilgangoora, and Goldrim Mining at Wodgina. Even the main world supplier Bernic Lake, in Canada, had to suspend operations. From the State's point of view the principal set-back was the suspension of underground development on Greenbushes' Primary Pegmatite where reserves of 28 million tonnes of ore were delineated, estimated at 16% of world tantalite reserves. The operator, Greenbushes Tin Ltd failed in its attempt to finance this work through a joint venture, and has decided to raise additional capital on the share market.

Tin prices reached a peak of £9 000/tonne in February, as a result of support by a mystery group manipulating the LME but then slumped to £5 900/tonne in April-May. As a result, export quotas were imposed on producing countries by the International Tin Council, preventing miners from compensating for lower unit returns by increasing throughput. This resulted in the closure of the Endeavour Resources operation at Moolyella and the Futuris Corporation mine at Friendly Creek. Production of tin concentrate from Greenbushes rose in 1982 due to the operator concentrating on the tinrich parts of the orebody in the absence of a market for tantalite.

In an attempt to develop a short-term cash flow by breaking into the lithium market at this depressed time for tantalum and tin, Greenbushes Tin Ltd have shipped two bulk samples of spodumene concentrates to the world markets.

Mineral sands

Despite the fall in world demand for ilmenite and rutile, heavy mineral sands maintained its position as the sixth most valuable mineral product in Western Australia. Sales value was up 32% on 1981 figures partly as a result of generally increased production, partly through price movements and partly by switches of sales to higher proportions of the better priced zircon and monazite. Flexibility of product has given Western Australian producers an advantage over their Eastern States counterparts where the marketing of rutile, the main heavy mineral in the East, has caused problems.

World demand and prices strongly influence the Western Australian heavy mineral sands industry, as most of the production is exported. Despite the availability of cheaper products from the Richards Bay installation in South Africa and from Sierra Leone, the Western Australian output has been partially stabilized by long-term contracts and overseas marketing to major shareholders.

The price of ilmenite has steadily improved from mid-1981 and stabilized around $27/tonne in the second half of 1982. Zircon price has progressively risen through 1981 and 1982, from $70/tonne to a present level of around $115/tonne. Conversely rutile fell from around $300/tonne to $255/tonne in the year.

These variations in price, demand, and product have led to variable financial results from the individual Western Australian producers. Allied Eneabba and Westralian Sands have managed to record profits in their last financial year, whilst Associated Minerals Consolidated recorded a loss. In all cases extensive reorganization and improvements in plant efficiency have been implemented to counter rising production costs. The producers express little confidence for the immediate future of the industry.

Although Target Minerals' Port Gregory garnet operation is a heavy mineral sand operation by virtue of geology, extraction and primary processing, it is a separate and distinct industry by reason of the market—primarily in abrasives. After a slow development phase (start up 1977) the project has entered the commercial stage even though it is so far only in the lower-priced end of the market: that of "blast grade" material. Production and market research into high-priced, high technology products is proceeding, and it is this sector that is seen as an important step in the company plans. Reserves of 5 million tonnes of contained garnet have been identified.

Salt

World consumption of salt is closely linked to the degree of economic activity and hence the poor demand in the year. The Western Australian suppliers, all from the North West—Shark Bay, Lake McLeod, Dampier and Port Hedland—have their main market in the Japanese chemical industry. They also provide about 45% of S.E. Asian consumption.

Traditionally Western Australian producers have supplied to the export market whilst the Eastern States producers have satisfied the domestic consumption and the eastern Pacific. In 1982 there was low demand, and a radical change in demand to downstream processed materials. There was an increasingly competitive overseas market during the year, with price under-cutting by the Eastern States as well as the Yemen and China.

Lake McLeod, with quality control problems, is going through an extremely difficult time and is currently operating at levels significantly below capacity. This, together with the investment burden after cyclone devastation some years ago has resulted in the company incurring high losses, although the company's other operation at Dampier is capable of picking up the shortfall and is operating at 2.1 million t.p.a. out of an effective 2.4 million t.p.a. capacity.

Oil and gas

Petroleum exploration activity in the State reached a record level in 1982. Of 67 wells drilled during the year, 16 were discoveries to give a very high success ratio of almost 1 in 4. Of particular significance were the discoveries of apparently large gas accumulations at North Scott Reef 1 and North Gorgon 1 and the production of good oil flows from the testing of two zones at South Pepper 1. In 1983 exploration levels are expected to be high although there are signs that there could be difficulties in finding finance in the coming years.

The world oversupply situation has continued as a result of a decline in industrial activity and energy conservation policies. The major world oil suppliers have effected production cutbacks, with little relief to prices until the latter part of the year. However lack of agreement within OPEC appears to have opened the door to significant price-cutting in 1983.

The only oil production in the State is from Barrow Island which continues its gradual decline from 6 500 kL per day in the early 1970's to about 3 500 kL per day in 1982, a 6% reduction on 1981 levels. In the Canning Basin, the recently discovered Blina field will be in production in late 1983 at a rate of 130 to 160 kL per day.

Most of the State's gas comes from Dongara, but 1982 saw start up in the Woodada field in the West Perth Basin. Reserves at Woodada are estimated at 0.68 billion m^3 of gas.

North West Shelf gas development is proceeding on schedule and the gas should be onshore at Dampier in 1984 at an estimated investment cost of $5 000 million. Markets, both domestic and for export, are continuing to be a worry with little optimism being forecast for a world economic recovery.

There is, therefore, some uncertainty as to when export of LNG will commence and when the planned production level of 6 million tonnes of LNG per annum will be reached.

Coal

Production at Collie, the only operating field in Western Australia, increased by 14% in 1982 from the previous year. This, together with a gradual rise in price, resulted in a 28% overall improvement in realized value for the year. However to put it in context, coal provides only one quarter of total revenue from energy sources in the State.

The coal is used almost entirely for domestic power generation and therefore the industry is largely shielded from the overall demise of the world coal industry, or more specifically coking coal industry.

Exploration for coal continued at steady levels through 1982. Renison Goldfields announced that reserves at their Eneabba deposit comprised 123 million tonnes of shallow steaming coal. Further exploration is continuing. A number of significiant deposits of lignite have been outlined in the Tertiary basins in the Southeast Yilgarn and West Eucla areas; whilst CRA's continuing exploration programme in the Perth Basin has shown prospects with significant increases in rank from west to east. However these deposits are long term prospects and the installation of the Dampier gas pipeline to the metropolitan area and the South West in general could have consequences for coal exploration, development and production.

Uranium

Most of the predictions made in the mid-seventies of future needs for uranium were highly optimistic. For example the predicted annual demand for uranium in 1980—made in 1973—was 267 000 tonnes but the forecast of annual demand made in 1980 was 26 000 tonnes. Over-optimistic demand predictions have led to a market plagued by oversupply when there is a world wide slump in consumption of the metal. This has led to a continuing decline in price from over US$43/lb U_3O_8 in 1979 to a current spot price level of about US$17.50/lb. However 90% of market supplies are on long-term contracts commanding US$30/lb U_3O_8. These conditions are unlikely to ease before the end of the decade.

There are unusual difficulties in predicting demand for uranium. During a relatively short history of consumption, there have been extreme fluctuations in demand and supply of uranium. Call for the metal is determined by intangible factors such as the economic well-being of the western world, the development of breeder reactor technology which is less dependent on uranium supply, and opposition to any aspect of uranium technology by sections of the community. These uncertainties invalidate long-term demand predictions, and underline recent changes in company participation in the two largest Western Australian uranium projects, Yeelirrie and Lake Way.

In 1982 the Esso Company, which held a 15% stake in Yeelirrie withdrew from the project. However, France which has a very large nuclear power programme, showed strong interest in Yeelirrie. WMC has held discussions with French power utility representatives. By September, metallurgical testing of Yeelirrie ore at the Kalgoorlie Research Plant was completed and the project feasibility study prepared. The production (2 500 t.p.a. U_3O_8) and shipping stage is expected to be reached in about 4 years. Investment is estimated at $300 million.

In late 1981 the Wyoming Mineral Corporation (Westinghouse Electric Corporation) withdrew from the Lake Way uranium project. This was offset by the purchase of the Delhi International Petroleum Pty Ltd interest of 53.5% by Associated Australian Resources Ltd, a subsidiary of CSR Ltd. AAR Ltd now hold the deposit in partnership with Vam Ltd.

In January 1982 the Federal Government gave approval for the Lake Way project to move to development. However it could be a long time before this takes place as the orebody is small and low grade by comparison with Yeelirrie.

At the Manyingee Hills prospect south of Onslow uranium is found in sandstones rather than in calcretes as at Yeelirrie and Lake Way. Investigations of groundwater conditions have been made by Minatome Australia Pty Ltd as a precursor for solution mining trials.

Gold

Although gold has essentially been demonetized, it nevertheless remains as an important reserve in the International Monetary System. The price of gold continued its 1981 decline during the early part of 1982 and for a time dropped below US$300/oz. However, the latter half of the year saw a significant reversal in this trend, and by the end of December the price was over US$460/oz. Short-term price movements are difficult to predict. Movements are related to any destabilizing effect to the world economic system such as industrial demand, production levels, currency fluctuations, interest rates, international tension and periodic "releases" from the reserves of the major powers.

The present price is above that required for the profitable mining of most of the State's larger deposits, but future short-term fluctuations will no doubt continue to present problems to small, undercapitalized operations. Some small to medium operations, initiated during the high price levels of 1979-80, have been unable to withstand the dramatic price decline of 1981-82, but the surviving projects are starting to get on a firmer footing.

Most of the State's gold production came from four mining areas: Telfer, Mount Charlotte, Norseman and Fimiston (Golden Mile). Exploration and development partly recovered in the latter part of the year, and projects in various stages of development, reorganiza-

tion, expansion and commencment include North Kalgurli's Fimiston, CSR's Paringa Leases, and a joint venture between Australian Occidental-Black Hill Minerals and others at Mount Charlotte East, all on the Golden Mile. Other notable redevelopments occurred at Mount Magnet, Victory (Kambalda), Lancefield (Laverton), Big Bell (west of Cue) and Kia Ora (Marvel Loch).

The dramatic rise in gold price during the last 3 months of the year prompted many of the State's major mining and exploration companies to switch their exploration efforts from other commodities to gold.

Diamond

The Ashton Joint Venture, managed by CRA, entered into an agreement towards the end of 1981 with the State Government (through the instrumentality of the Department of Resources Development) to develop the Argyle diamond field in the Kimberley Region. Evaluation work has continued through 1982, and mining and marketing proposals for the rich alluvial deposits of Upper Smoke Creek and Limestone Creek were approved with the intention of moving into production early in 1983. The plan is to follow-up from 1985-86 with the major operation of the AK1 diamond pipe at an output level of 25 million carats per annum.

The diamonds are of low quality by world standards, valued at US$11/carat in the alluvials and US$6.50/carat in the pipe, but of very high concentrations in the pay dirt. The quality split falls into:

	gem	cheap gem	industrials
alluvials	10%	35%	55%
AK1 pipe	5%	25%	70%

At full output the project will have a very great effect on the quantity of diamonds on the world market; increasing it by 40% in total and in industrials alone by 75%. However in value the effect is greatly reduced, increasing the total value by only 4%, but the value of industrials by 60%.

Marketing of diamonds from Argyle will initially be largely through the Central Selling Organisation (95% of output), but ultimately the partners are planning to market some of the products themselves.

Of significance to the Department is the establishment of a profit-based royalty system, a departure from the standard *ad valorem* or per tonne of output basis; although in early years of low or zero profits actual payments will be at minimum *ad valorem* rates. To assist the Department in the administration of royalties the services of a diamond valuer are to be engaged.

Other minerals

A host of industrial minerals are produced to serve the domestic markets around the main centres of population, but with the recession severely affecting the construction and manufacturing industries, the levels of output are generally down on previous years. For example limestone output is down by 19% on 1981.

The only barytes production in the State came from the North Pole Mine in the Pilbara, but this ceased operation early in 1982 due to weak market demand.

The gypsum industry of the South West largely serves local plaster of paris and cement production, but over 80% of the State's output is produced at Agnew Clough's Shark Bay operation for export. Levels of output in 1982 were up by 20% on the previous year.

The large build-up of talc stocks in latter years was alleviated in 1982 when sales from the two operations at Three Springs and Mt Seabrook were up almost three-fold on 1981 figures.

Mines Department

The workload of a number of divisions of the Department, largely stemmed from the first year of operation of the new Mining Act 1978-81 and its Regulations, which was introduced on 1 January, 1982. Overall the new Act has stood up well to its first year of operation.

Other divisions of the Department not directly serving the mining industry such as the Government Chemical Laboratories and the Explosives and Dangerous Goods Division experienced a busy time as demands from the community for their services continued to expand at a much greater rate than the available resources.

Staff

At year's end, there were 600 Public Service Act positions in the Department, comprising 219, 256 and 125 in the Administrative and Clerical, Professional and General Divisions respectively.

The reduction in opportunities in the private sector resulted in a high level of demand for advertised positions and this is reflected in only 39 positions falling vacant during the year (c.f. 108 in 1981) representing a turn-over of 6.5% (18.25%) with up to 15 (50) positions being vacant at any one time.

The Reservoir Engineer position in the Petroleum Division remains vacant despite re-advertising and this situation underlines the high value placed by industry on specialist knowledge, which is also critical to the needs of the Department.

A significant event in the history of the Department was the creation of the position of Manager, Computer Services to which Mr. T. Pye was appointed in September. A complete review of the Department's E.D.P. plans have been undertaken and the stage has been reached where only funding is required to enable major advances to be made by the Department in this area.

The 1982/83 Budget did not include any new staff items and this is restricting the ability of the Department to provide services in a number of areas.

Year's activities

Highlights of the year are set out below.

Future

An extensive integrated word processing system was introduced to the Department in 1982. It is expected that new technology, particularly in the field of computerization, will have a great influence on the role of the Department in the future.

Planning of Mineral House Stage 2 will proceed and hopefully funds will be available to complete it, enabling staff to be brought back from the 5 satellite city offices presently in use.

The operation of the new Mining Act will continue to present a challenge in 1983, but most of the backlog of tenement applications under the 1904 Act should be finalized.

THE YEAR OF 1982

The Mining Act, 1978 was introduced on 1 January, 1982 and the first leases and licences were issued to replace familiar titles such as mineral claims and prospecting areas. A total of 2 968 tenements were applied for under the new Act for a total area of 10.9 million hectares.

A continuing review of Royalties resulted in relief to some mineral producers, particularly nickel producers.

The Geological Survey of WA organized a series of lectures on Australian geology, mineral deposits and mining legislation. These formed part of a course in mineral exploration being conducted by WAIT and the Australian Development Assistance Bureau for the training of geologists from developing countries.

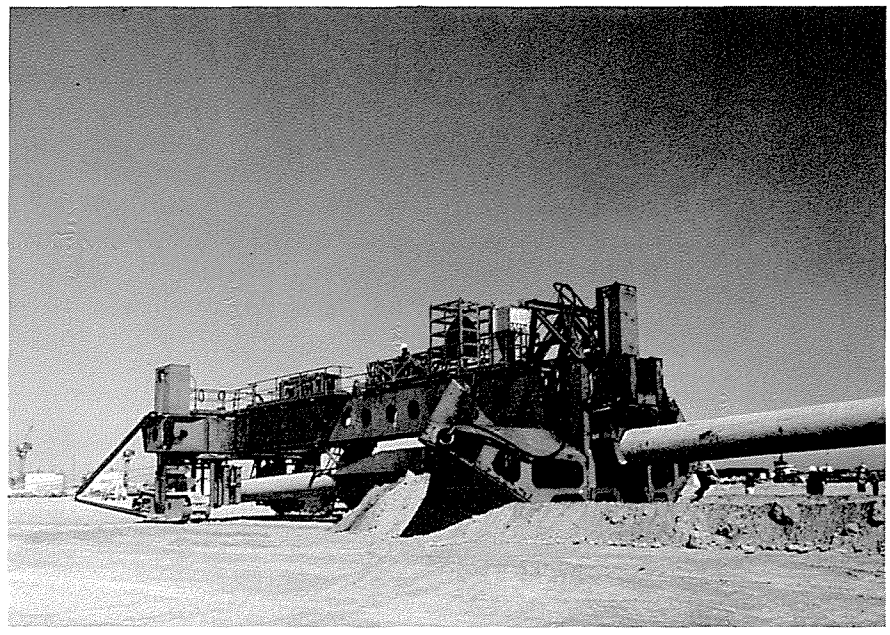
The Woodada field started producing gas into the Dongara to Perth pipeline at the rate of 566 x 10^3 m^3 per day (20MMCFD).

On the North West Shelf gas project the North Rankin "A" platform neared completion. Laying of the offshore pipeline was completed. The pipeline is 134 km long and was laid on the seabed by a pipe-laying barge. A trench was commenced using a submarine plough and a rock-dumping vessel began burying the pipeline.

Teutonic Bore, the only primary producer of copper-zinc-silver in the State, completed its first full year of operation.

The Chief Inspector of Explosives and Dangerous Goods represented all the Chief Inspectors of Australia at the Health and Safety Executive's explosives testing facility at Buxton, England. Specially packaged electric delay detonators were being tested prior to export to Australia.

At the largest copper-zinc prospect in the State, Golden Grove, the Scuddles prospect was delineated and shown to have ore reserves of 26 million tonnes containing 1-2% copper, 9% zinc and 70 gm/per tonne silver.



Surface testing of Woodside's submarine pipeline plough.

The gold price dropped below US$300 per ounce in mid-year but rose again to over US$460 per ounce at the end of the year. This increase stimulated renewed interest in gold exploration and a flood of applications for mining tenements in Kalgoorlie and adjacent regions.

The first explosives classified 1.5D were authorized in Western Australia. These explosives are very insensitive but, when initiated, they have a mass explosion hazard. Their introduction represented a significant change in the philosophy of handling and use of explosives.

A record number of 67 petroleum exploration wells were drilled of which 16 were classed as either gas or oil discoveries. This is a success rate of nearly 1 in 4.

A procedure using gas chromatography was developed in the Government Chemical Laboratories to measure the alkaloid content in sweet lupinseed. The seed has a high protein content and is used in stockfeed and, as lupin flour, is used in bread for human consumption.

A combination shaft drill commenced operating at Agnew in March, drilling the largest diameter shaft ever drilled in Australia. By the end of the year the 4.26 metre diameter shaft had reached the depth of 630.35 metres.

A crushing/grinding/flotation pilot plant was installed in the Government Chemical Laboratories' building in Perth to extend facilities for test work to develop the State's mineral resources.

In line with Government undertakings given when the 1978 Mining Act was introduced, a number of amendments to the legislation were passed in the latter part of the year.

Argyle Test Plant Complex for processing diamond bearing surface deposits (Ashton Mining Ltd)

A ten-station word processing system was installed in the Mines Department at a cost of $162 000 to cope with increasing typing workload whilst reducing costs and improving efficiency.

State Battery crushing facilities at Marble Bar and Marvel Loch were increased from 5 head to 10 head.

Iron ore exported overseas totalled 78 million tonnes, up 3 million tonnes on the previous year. This output represents about 65% of the total industry capacity.

Approval was given for the appointment of a Government Diamond Valuer to advise the Government on value of diamonds and diamond markets when the Ashton Joint Venture commences production.

The annual output of coal at Collie in 1982 was 3 702 197 tonnes, a record for the third successive year.

Approval was given for the mining and marketing of diamonds from the Argyle deposit. The Ashton Joint Venturers announced an increase in alluvial processing plans from 2 000 to 6 000 tonnes per day.

CIRCULAR SHAFTS — current practices in W.A.

With three major circular shaft projects well under way, W.A. has finally broken with tradition and now leads Australia in the development of new shaft construction techniques for the hard rock mining industry.

During 1982 the Agnew No. 1 Shaft was fitted out with steel sets to form the various haulage and service compartments. The 7.6 m diameter, concrete lined shaft was completed in December 1981 at a depth of 1 162 metres. Installation of the winders and headframe, which towers 56.45 m above the collar, is nearing completion. Operational status is anticipated for mid 1983.

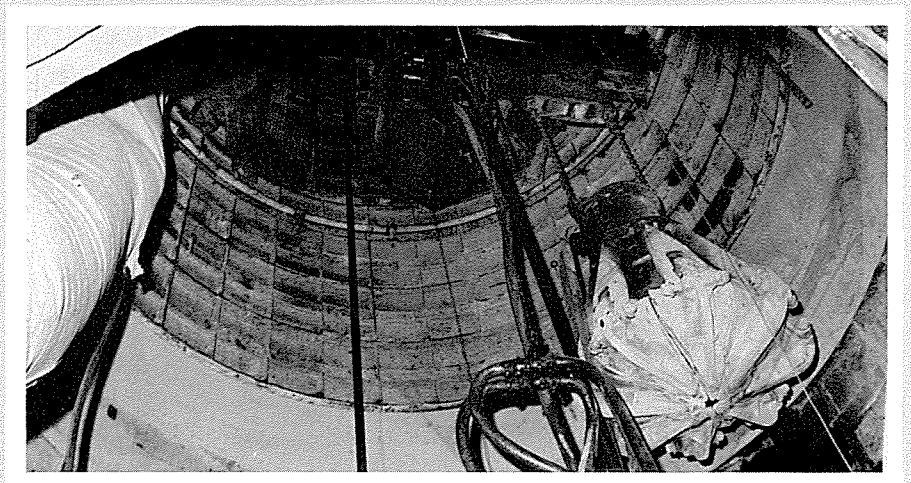
The Cassidy Shaft, now being sunk at the Mt Charlotte Gold Mine, is a 6.5 metre, concrete lined shaft with a planned depth of 1 170 metres.

A number of innovative ideas and techniques designed to speed up the project were introduced. The 45 metre pre-sink was concrete lined in one around-the-clock operation by the Slip Form Concrete Lining Method. This consisted of a circular platform fitted with formwork being accurately positioned at the bottom of the shaft, and as the concrete pour progressed the platform was slowly raised by 10 climbing jacks mounted on steel rods, which remained in the concrete as reinforcement. Rate of advance varied from 300 mm to 1 000 mm per hour, and total pouring time was 82 hours.

The next phase of the project was to strip a 1.8 metre diameter raise bore hole to a depth of 600 m (Mt Charlotte 20 level). This task, including concrete lining, was achieved in a little under 12 weeks. Drilling of the stripping holes was done with a 4 boom shaft jumbo on a pattern designed to blast the bulk of each cut into the bore hole.

Bogging out was done with a centrally mounted lashing unit fitted with a compressed air operated cactus grab attached to the radial arm. This unit, the first of its type to be brought to Australia, is fast and highly manoeuverable. The broken dirt was pulled from the bore hole by a diesel loader on each of three access levels.

Full face shaft sinking below the 20 level commenced in November 1982.



Lashing unit suspended below sinking stage, Cassidy Shaft

Probably the greatest step forward in hard rock shaft development in Australia is the technique of blind shaft drilling being used for the Agnew No. 1 Ventilation Shaft. At 4.26 metres in diameter it is by far the largest shaft ever drilled in Australia and probably the Southern Hemisphere. The shaft has a planned depth of 1 030 metres and will not be lined.

The Australia Shaft Drilling Company is undertaking the project with the Hughes CSD 300 rig. This is the first of a new series of shaft drilling rigs designed for hard rock conditions. Basicially, the rig consists of a hydraulically driven rotary head supported by four hydraulic cylinders and fixed between two steel towers. The bit assembly can weight up to 200 tonnes and consists of a 50 tonne bit body upon which cast iron collars (doughnuts) are placed to provide the downward forces necessary to fracture the rock. Roller cones fitted with tungsten carbide inserts are mounted beneath the flat bottomed bit body. Rotation and support of the bit assembly is through 508 mm O.D. drill pipes. Drilling is always undertaken with the drill string held in tension such that the downward force on the cutters is maintained at a level consistent with maximum penetration of the particular rock being drilled.

Drill cuttings are brought to the surface in an inner pipe in the drill string utilizing an air lift. The system is assisted by maintaining a very high static head of fluid in the shaft.

Some problems were encountered during the operation of the rig. At a depth of 358 metres, 23 days were lost in recovering the 50 tonne bit body from the bottom of the shaft, and later in the year further serious problems arose when major cracking occurred in the yoke and rotary tilt assemblies.

Repairs were effective, and presumably design modifications will correct the problem. Even so, the achievement in the 9 months since drilling began has been spectacular when it is realized that 556 metres of shaft were completed without one man having gone underground and not one serious accident having occurred. It is to be hoped the mining industry will further support the development of blind shaft drilling as the potential advantages are considerable.

STATE MINING ENGINEER

J.K.N. LLOYD, STATE MINING ENGINEER

The mining activities of the Division were mainly directed at ensuring that the various types of operations complied with mining legislation, and in promoting the safety and health of persons employed in the industry.

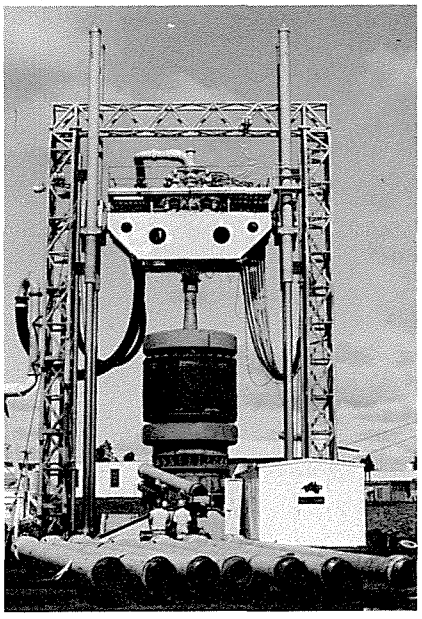
The drilling operations of the Division extended from the South West to the Pilbara region. As part of the Statewide groundwater investigation programme 5 686 metres of hole were drilled and 38 bores were scanned with the Down-the-hole T.V. camera.

The value of mineral production for the year (excluding petroleum and construction materials) was $3 039 632 114 and the number of persons engaged in the industry was estimated to be 23 628.

Mining Activities

Alumina

Alcoa of Australia (W.A.) Ltd mined a total of 13 675 138 tonnes of bauxite at Jarrahdale, Del Park and Huntly minesites. A total of 165.6 hectares of ground was mined to an average depth of 3.65 metres. When treated at the Kwinana and Pinjarra refineries 3 867 385 tonnes of alumina were produced with a value of $647 822 717.



Hughes CSD 300 Rig

A total of 249 hectares of land was rehabilitated.

The minesite at Willowdale and the Wagerup refinery are being kept on care-and-maintenance until the demand for alumina improves.

Construction of the refinery for *Worsley Alumina Pty Ltd* continued.

Alunite

The operations of *Chandler Clay Pty Ltd* were upgraded and 1 140 tonnes of alunite and 6 600 tonnes of absorbent material were produced.

Attapulgite

Mallina Holdings Ltd treated 14 769 tonnes. The acid treatment plant was commissioned and 6 806 cubic metres of low carbonate attapulgite was excavated at Lake Nerramyne for use in the plant. The acid-activated clay is used for purification of edible oils, fats, waxes and hydrocarbons.

Barite

There was no mining at the North Pole mine of *Dresser Minerals Inc.* and only stockpiled ore was carted to Port Hedland for treatment.

Bauxite

Bell Basic Industries mined about 10 000 tonnes of bauxite for use in the cement manufacturing industry. The minesite is at Canningdale.

Clays and shales

The production of clays and shales was significantly lower this year due to the decreased demand for clay products for use in the building industry.

Midland Brick Co. Pty Ltd operated pits in the Shires of Swan, Toodyay and Chittering and obtained 860 850 tonnes.

Monier Brick operated pits in the Byford-Cardup area, and *Whitemans Brick Pty Ltd, Orange Grove Bricks Pty Ltd* and *Bristile Ltd,* obtained their brick making material from various sites close to the metropolitan area.

Clackline Refractories manufactured fire bricks with clay mined from a pit close to their factory at Clackline.

Coal

For the third successive year coal production exceeded 3 million tonnes with a record 3 702 197 tonnes valued at $87 460 644. Opencut mines produced 2 961 574 tonnes or 80% of the total output.

There were 1 163 persons, including clerical, administrative staff, and those in coal handling plants, employed at Collie.

Western Collieries Ltd. The former East Extended Workings of the No. 2 mine is now known as No. 6 mine and the company works the two mines as separate operations.

No. 2 mine. Mining has been completed in several of the deeper areas of the widespread districts and the old workings are being permitted to flood to eliminate spontaneous combustion risks and avoid the need to ventilate, support, and maintain access to the areas. Wherever practicable sealing is practised when abandoned areas are not amenable to flooding. A barrier pillar, at least 40-45 m wide will be left intact between the workings of 3B West A Panel and the workings to the west. This barrier will separate flooded old workings from the North Western reserves where future production will be concentrated.

No. 6 mine. Opening out of portals for this mine (previously the East Extended Area) began in May 1976 and coal production commenced a few months later. An aquifer depressurization-dewatering programme has been undertaken with good results being obtained from the zone immediately above the roof for a height of about 25 metres.

The trials appear to have improved mining conditions in the West Dips where two Alpine continuous miners have made good progress on development work.

No. 7 mine. Preparatory clearing and ancillary civil works began on 21 December. New portals will be driven down dip to the south from the east end of the Collie Burn open cut, to the Collie Burn No. 2 seam.

No. 5 Open Cut. The output of 940 371 tonnes of coal was an increase on the previous year by 105 318 tonnes.

This mine is spread very wide as the output is mainly won from the Cardiff and Neath seams which have an average thickness of about 4m and 1.8m respectively. The series of excavations now extend for about 6 kilometres.

A Demag H241 Hydraulic Excavator, with a $14m^3$ bucket on overburden and $19m^3$ bucket on coal, was brought into service in June and made impressive progress on coal exposure when complemented with four Komatsu 120 tonne dump trucks.

The Griffin Coal Mining Co. Ltd produced from the Muja, and Chicken Creek open-cut mines. Muja was operated throughout the year but the Chicken Creek Mine was only reopened at the end of August after being closed down for about 9 months.

Muja Open Cut. A new record output of 1 820 157 tonnes was achieved in the year even though unseasonal heavy rains in January caused flooding in some areas of the excavation, including the old underground galleries of the Hebe mine. About 54% of production was won from the Hebe seam.

Requirements for safe working of the open-cut excavations over the old galleries of the Hebe Colliery were reviewed and steps were taken to reinforce safety measures and precautions.

A dump area at a location adjacent to the Muja Power Station is being prepared for trial rehabilitation purposes.

Chicken Creek Open Cut. During the short period of production 201 046 tonnes of coal were obtained from the operation. The excavation is about 1 kilometre long and about 100m in width. The depth of excavation on the highwall is approximately 8m to the seam floor in areas where the seam is about 3.5m thick.

Depressurization/dewatering of the ground using bore wells and well point systems enabled good progress to be made on overburden removal. Topsoil was recovered prior to the removal of the overburden.

Cobalt

The production of 533 tonnes comes as a by-product of nickel mining.

Copper

The open pit at the Teutonic Bore Mine, operated jointly by *Seltrust Mining Corp. Ltd and Mount Isa Mines Ltd* was completed in October to its programmed depth of 120m. The decline, commenced on the eastern side, was also completed to 87m below the floor of the open cut. Ore treated from the open cut was 310 000 tonnes, and 13 900 tonnes of copper, 45 500 tonnes of zinc and 52 800kg of silver in concentrate were recovered.

Diamond

The operations at the Lake Argyle alluvial deposits have been of an exploratory nature but with the approval given by the State Government to the Ashton Joint Venturer's marketing plans the way has been opened for commercial mining to commence from 1 January, 1983. The work force employed on all operations by Argyle Diamonds Pty Ltd at the end of the year was 189 persons.

Dimension stone and aggregate.

Included in the term dimension stone, are sandstone deposits at Mt Barker and Donnybrook; granite of special quality at Mt Magnet, Mundaring, York, and Albany; Toodyay stone which is coloured quartzite; and a black granite (basalt) which is being developed at Bridgetown. Rock comprised of basalt, granite and diorite, is used for railway ballast, road construction, armour stone and aggregate for concrete. Demand for these products decreased considerably due to the downturn in the building industry.

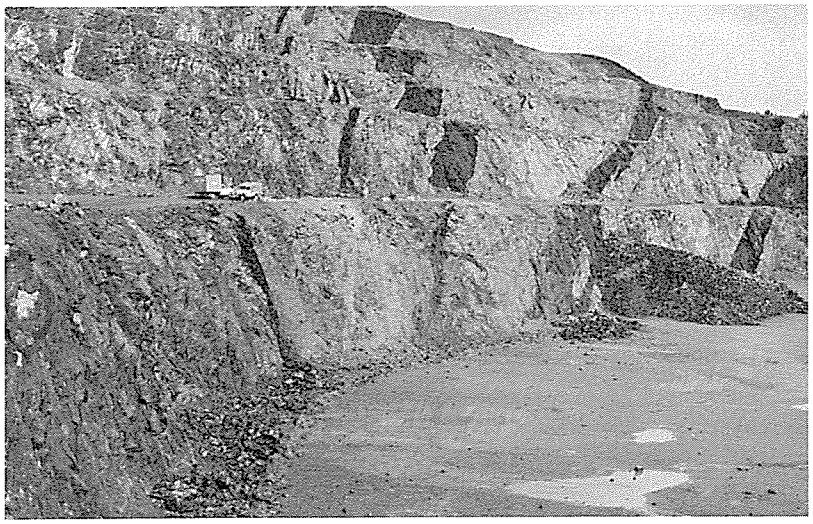
The principal operators in this field are as follows.

The Readymix Group, whose base quarry is at Gosnells, operated quarries and crushing plants at Gelorup, Chris Hill, Walkaway, Albany, Boulder and Esperance. The Gelorup quarry was very active because of the Worsley Alumina project. This quarry is close to a new residential area and in order to be acceptable it was necessary to cut down on noise generated in the crushing plant and to relocate the stockpiles on to the floor of the quarry below surface level.

Pioneer Concrete (W.A.) Pty Ltd continued with their Herne Hill quarry and operated small quarries at Byford and at Walkaway. Dust control, and other areas in the crushing plant at Herne Hill have been improved. Quarries were established by this company for the Worsley Alumina project at Fernbrook and Gelorup.

Bell Basic Industries operated their major quarry at Maddington for the whole of the year. They are currently developing a new quarry up the valley from their existing operation.

Quarry Industries Ltd operated quarries at Narrogin and Worsley, and at four locations along the Eyre Highway to provide road metal.



Readymix Group—Gosnells quarry

The Shire Councils of Kellerberrin and Bruce Rock operated quarries to provide sufficient aggregate for their own needs.

John Holland Constructions worked in the P.W.D. quarry at Roelands to produce about 15 000 tonnes of armour stone for port works at Bunbury.

Magnet Industries Pty Ltd recovered quartz from the rescreening of waste dumps at their Mukinbudin quarry.

Feldspar

Magnet Industries Pty Ltd during the rescreening of waste dumps at Mukinbudin also obtained feldspar and *Unimil Pty Ltd* mined feldspar at their Londonderry quarry south of Coolgardie.

Garnet

Target Minerals N.L. improved their garnet recovery at the Port Gregory minesite by the addition of two Wilfley tables. Facilities for drying, screening and packaging are at Geraldton.

Gold

Gold mining activities fluctuated due to variations in the price of gold.

Pilbara Mining District. The Telfer mine operated by *Newmont Holdings Pty Ltd* produced 5 040.75 kg of gold from 460 090 tonnes of ore. This is a surface operation and the waste material is removed by a contractor, Quest Mining, before the company mine the flat dipping ore and extract the gold in their treatment plant.

Peak Hill Mining District. *Pima N.L.* has now been restructured and renamed Horseshoe Lights Gold Pty Ltd. The operation has been on care-and-maintenance for most of the year but mining is expected to commence in 1983.

Peak Hill Gold Mines are still erecting their treatment plant, but have obtained some gold from alluvial material in their sluicing plant.

Murchison Mining District. *Whim Creek Consolidated N.L.* introduced economies in their operation and these proved beneficial. Underutilized equipment was removed and the carbon circuit was modified. Due to the improved gold price the company is to expand the treatment plant to provide for increased ore tonneage to come from the Prophecy mine.

Bond Resources sold their gold mining operations to *Endeavour Resources Ltd* and developments continued at the Ingliston and Nannine sites. At the Ingliston mine the 6 level stope was mined out and about three quarters of the ore reserve above the 7 level was also mined. The treatment plant has been enlarged by the addition of a carbon-in-pulp circuit and a desorption system. A complete powerhouse comprised of three generator sets, an electric compressor, a changehouse, and an office have been installed.

At the Nannine mine a new headframe (20m high), and a hoisting installation were added. The shaft has been sunk for 78 metres and is now equipped to the No. 5 level. Some development on this level has been commenced. A generating set identical to that at Ingliston has been installed at the Nannine mine.

Some of the smaller companies operating in the Meekatharra area suspended operations during the year.

At Mt Magnet, *Hill 50 Gold Mines N.L.* obtained ore from the Morning Star and Water Tank Hill underground mines and the Saturn, Brown Hill, Brown Hill East, and Lucky Reaper open cuts. Underground mines produced 92 932 tonnes and 70 924 tonnes came from the open cuts. The company carried out 1 321 metres of development, most of it on the Morning Star mine. The main shaft was dewatered to about 6 metres below the No. 2 level to permit sampling and diamond drilling to be undertaken.

The treatment plant operated by *V. & D. Ridolfo Pty Ltd* was used to treat open-cut ore from a joint venture at Mt Magnet and 2 161 tonnes of underground ore from the Pinnacles mine near Cue.

Other small mines in the vicinity of Mt Magnet to be reopened were Lindsay's Reward and the Gold Giant at Lennonville, and the Leap Year.

Yalgoo Mining District. Parcels of about 230 tonnes each with good gold returns were obtained from the Carnation and Daffodil mines at Paynes Find. The Ark gold mine, operated by *Aaron Minerals* had treatment plant difficulties and ceased operations. A small tonneage was obtained from a mine at Mt Gibson, and a syndicate is to reopen the Rosemary mine at Warriedar.

East Murchison Mining District. Mining in the district was dormant for most of the year but an upsurge appeared imminent towards the end of the year.

Goldstock Mines Pty Ltd retreated tailings at Youanmi and *Gold Tailings of W.A.* did the same at Sandstone.

Mt Margaret Mining District. The gold treatment plant at the Windarra Nickel Project was commissioned and 200 000 tonnes of ore from the Lancefield mine and open cut of W.M.C. Ltd were treated. The sink of the Eyer's shaft reached 391 metres before ground problems temporarily halted it.

Five thousand tonnes of ore were mined at the Tower Hill mine after 15 000 tonnes of overburden were removed.

Several small shows in the vicinity of the old Sons of Gwalia mine were also worked.

North Coolgardie Mining District. *Jones Mining N.L.* deepened the Goodenough mine shaft 17.5 metres, drove on the orebody and broke in excess of 400 tonnes of ore.

The operations of the Aspacia mine of *Greenbushes Tin N.L.* were closed in August after only 1 000 tonnes had been mined.

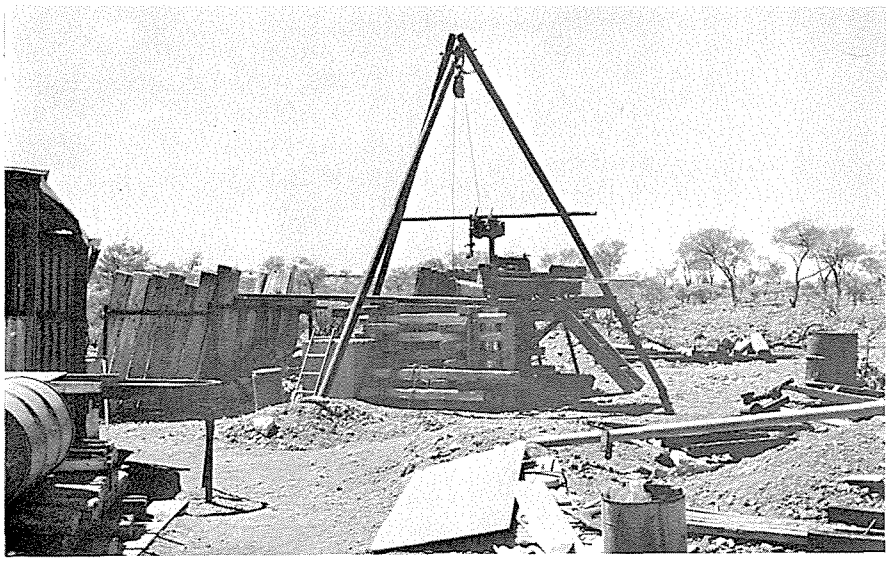
Tributors at the Timoni mine broke several small rich crushings.

Tailings from the First Hit and Lady Harriet mines were retreated but the plant sited at the Yunndaga tailings was inactive.

There was not much activity in the Edjudina area after the Yilgangie Queen mine closed in April.

Broad Arrow Mining District. Very little gold was mined from this district but there are drilling and other exploration programmes under way at Paddington and Ora Banda. The Sand King open-cut mine was operated by W.M.C. Ltd. Over half a million tonnes of overburden were removed and 31 700 tonnes of ore were carted to Kambalda for treatment.

North East Coolgardie Mining District. There has been only a small amount of activity at Gordons, Pinjin and Kanowna in this district.



Prospector's mine at Little Bell via Cue

East Coolgardie Mining District. Ore from the Great Boulder open cut was treated at the Kambalda gold plant. This open cut is worked as part of the operation of *Great Boulder Holdings*—a subsidiary of W.M.C. Ltd.

North Kalgurli Mines Ltd increased production to twice that of last year by treating ore from open cuts on their leases and 62 000 tonnes of stockpiled ore from underground sources. Considerable development was carried out from the Main and Croesus shafts.

C.S.R. Gold Resources Pty Ltd has almost completed the erection of a plant at the Paringa mine to treat 180 000 tonnes per annum. The company completed 568 metres of development on various levels of the Paringa South shaft.

The ore from the Mt Charlotte operation of *Kalgoorlie Mining Associates* treated at the Oroya plant amounted to 929 134 tonnes and 4 171.5kg of gold were recovered.

The main underground decline developed below the No. 9 level had almost reached the No. 23 level at the end of the year. A mass blast of the F3 stope crown and rib pillars is scheduled for early in 1983.

The sinking of the 6.5m diameter concrete lined Cassidy shaft progressed satisfactorily. By the end of the year, the contractors, Thyssen Mining Construction, had stripped a 1.8m diameter raise drill hole for 572 metres and sunk 98 metres by benching. The shaft is to be completed to 1 170 metres.

At the Fimiston operations the production from both the Lake View and Perseverance mines continued to increase, and 337 380 tonnes of ore were treated to yield 1939 kg of gold. The shafts of these mines are still being rehabilitated with the Lake View being worked to the 22 level and Perseverance to the 16 level.

Several small mines were worked at Mt Monger including the Rosemary where a stamp battery and a powerhouse etc. have been installed.

Coolgardie Mining District. The Victory open cut is a *Western Mining Corporation Ltd* gold operation about 20km south of Kambalda. Overburden taken from the open cut totalled 1 680 800 tonnes. A decline was commenced in the north west corner of the cut and will give access to the deeper gold ore when the limit of the cut is reached. The gold ore is treated at a new carbon-in-pulp plant installed at the Kambalda nickel concentrator.

A total of 1 800 tonnes of ore from the Paris gold mine was treated at the plant built by *Tryaction.*

Epoch and Paul treated 28 000 tonnes of tailings at Burbanks, and *Jones Mining N.L.* treated 8 260 tonnes of ore from an open cut at the same locality. There were other

operations on low-grade material in the District and some tailings were treated.

Yilgarn Mining District. *The Kia Ora Gold Corporation N.L.* operated throughout the year in the Marvel Loch area. Development of the Nos. 5 and 6 levels off the Marvel Loch shaft took place, and the Frances Furness shaft was sunk to 128m where No. 4 level was established. The plant treated 28 440 tonnes of ore and 211kg gold were recovered.

Fecund Gold Associates have leased the treatment plant at the Radio mine and will retreat tailings and any other ore available.

Tailings at the Fraser's mine site are being retreated by the *Crucis Gold Syndicate*, and *Boomalli Ltd* treated stockpiled ore.

Prospectors were active in the Parkers Range area and open pits at the Centipede, Buffalo and Mopoke mines were worked.

Dundas Mining District. The major gold producer was *Central Norseman Gold Corporation Ltd* with 2 586kg gold produced.

The bulk of the underground ore came from the Regent mine but the main source of ore was the Royal open cut. Renovation of the Ajax shaft was completed and skip loading stations were installed below the 7 and 14 levels. Crosscuts to the Valkyrie, Norseman and Mararoa reefs were commenced on various levels and towards the end of the year these reefs were intersected and driving had started. Rehabilitation of the Brown, Viking and Mildura shafts was carried out to allow dewatering of old workings above the Ajax development. The O.K. shaft was rehabilitated and development commenced on the 2 and 5 levels.

Australis Mining N.L. is mainly concerned with retreatment of tailings at Norseman in a carbon-in-pulp plant with a desorption unit. At their Mt Henry mine, about 20 km south, a portable crushing plant has been installed and the crushed rock will be carted to Norseman for treatment.

Small gravity type gold recovery plant set up on an alluvial prospect

Gypsum

The *Building Materials* division of *C.S.R.* obtained gypsum from the dune system at Lake Seabrook, and *H. B. Brady & Co. Pty Ltd* used Lake Brown as their source. *Swan Portland Cement Ltd* obtained gypsum from Lake Hillman near Kalannie.

A deposit of gypsum at Useless Loop near Shark Bay is mined by the *Shark Bay Salt Joint Venture.* Drilling and blasting is necessary to obtain this mineral. A new pit is being developed about 10km south and will be in full production in 1983.

Iron Ore

Production of 78 182 395 tonnes was an increase of 2.8 million tonnes on the output for 1981.

Australian Iron and Steel Pty Ltd ceased operations at their blast furnace at Kwinana in April. Activities are restricted to the receival and storage of a small amount of ore delivered by rail from Koolyanobbing.

The annual production from *B.H.P. Minerals Ltd* at Koolyanobbing was reduced to 450 000 tonnes and only two trains per week are needed. Mining has been confined to the "A" deposit which is about 5km from the crushing plant.

Hamersley Iron Pty Ltd produces ore from open-cut mines at Tom Price and Paraburdoo.

During the year 68.6 million tonnes of material comprising 31.9 million tonnes of high-grade ore, 17.9 million tonnes of low-grade ore, and 18.8 million tonnes of waste were mined by the company. The amount of 27.33 million tonnes exported by the company was slightly down on last year.

Bench height at each mine varied slightly with 15m height at Tom Price and 14m at Paraburdoo. Six exploration winzes totalling 230 metres were sunk in the areas to obtain bulk samples and for geological purposes.

At Dampier an upgrade of the Parker Point berth was completed so that 140 000 DWT vessels could be accommodated.

An average of 3 842 persons were employed at all their operations.

Mt Newman Mining Co. Pty Ltd mines ore from a vast haematite orebody at Mt Whaleback and from the nearby Marra Mamba ore deposit. Material moved at Mt Whale-

back amounted to 86.2 million tonnes of which 29.19 million tonnes were ore. A total of 1.02 million tonnes of Marra Mamba ore were also handled. Low-grade ore totalling 3.88 million tonnes was treated in the benefication plant.

This ore is railed to Port Hedland for further screening before being shipped. The company exported 28.7 million tonnes. The company employs 3 615 persons.

Loading a large grader for transportation to Newman

Cliffs Robe River Iron Associates moved their main operations from the Robe mesas to the Eastern Deepdale mesas during the year. This required the construction of 24km of railway and another load out facility. There is still ore to be mined on the Robe mesas but this will be done at a later time. All the material mined is ore with no waste to be handled. A total of 14.44 million tonnes was mined. Benching methods will be needed on the Deepdale mesas as the depth of ore is greater. C.R.R.I.A. exported 13.3 million tonnes through their port at Cape Lambert and employed 1 590 persons in their whole operation.

Goldsworthy Mining Ltd mined ore at Goldsworthy, Shay Gap and Sunrise Hill.

In December the mining of ore from the Goldsworthy pit was completed as all economically mineable ore had been removed. The pumps have been removed and flooding has commenced. The final excavation is 1 600 metres long, 700 metres wide and 274 metres deep. It is anticipated that water will rise to the water table about 170 metres above pit bottom.

In future, iron ore will come from the Shay Gap and Sunrise Hill orebodies. In 1982, 228 000 tonnes came from Shay Gap and 3.7 million tonnes from Sunrise Hill. An additional 7.5 million tonnes of waste had to be moved to produce this ore.

Additions have been made to the Shay Gap townsite to accommodate the workforce relocated to this site. The company employed 1 297 persons.

B.H.P. Minerals Ltd mined at Koolan and Cockatoo Islands in Yampi Sound throughout the year. At Koolan 8.05 million tonnes of material was mined but only 1.86 million tonnes of ore resulted. At Cockatoo only 0.82 million tonnes of material was mined for 0.72 million tonnes of ore. A total of 558 persons were employed at both minesites.

Lime

Kalgoorlie Lime and Chemical Co. brought their plant at Parkeston into use to treat limestone which is quarried at Kitchener about 265km east of Kalgoorlie.

Limestone

The main use for this stone is in road building and cement production but there has been a revived demand for its use in agriculture. There are 16 active limestone quarries in the metropolitan area and about 15 in country areas.

Mica

Pilbara Mica Corporation Pty Ltd operated for a major part of the year but were closed from September to November, until a renewed demand from the drilling industry occurred.

Mineral sands

Sales of mineral sands products increased to $95.3 million due to a draw off stockpiles built up in the previous year.

Allied Eneabba Pty Ltd have begun the installation of a conveyor system to replace truck haulage in the mine. Modifications have been made to the drying circuit to enable natural gas to be used, and another pump has been installed to double the distance which tailings can be pumped. A pilot plant to recover kyanite has been incorporated into the mineral separation plant at Narngulu, near Geraldton.

Australian Minerals Consolidated Ltd operated throughout the year at Eneabba and Capel. At Capel a 400 tonne per hour bucket wheel excavator has been installed to replace the fleet of front-end loaders used to dig the sand. Production has been curtailed and the operation of the small benefication plant to upgrade ilmenite has been stopped.

Westralian Sands Ltd continued to mine the ore deposits at North Capel and Yoganup Extended. The monazite handling circuit in the plant was upgraded.

Cable Sands Ltd handled the high clay content in the Prowse deposit successfully due to alterations to the processing plant. The rotary drying kilns have been converted to coal firing now, and the monazite

circuit has been isolated and modified to confine and limit the radiation from this product.

Nickel

The difficult times experienced by base metal producers showed no signs of improving. *Western Mining Corporation Ltd* had difficulty in disposing of their nickel product.

During the year 1 372 503 tonnes of nickel ore were treated and 313 396 tonnes of concentrate resulted.

Kambalda Nickel Operations treated 1 250 641 tonnes of ore which was mined at these operations: Jan, Silver Lake, Long, Durkin-Gibb and Mt Edwards shafts, and Foster, Hunt, Fisher, McMahon and Otter-Juan declines. Additional ore was obtained from the Carnilya Hill mine which is worked as a joint venture with B.H.P. Ltd. The sinking of shafts at the Foster and Victor mines was deferred until an improvement occurred in the market for nickel.

The Otter-Juan mine has the major role in ore production now but it is expected that the Long mine will assume that mantle soon.

The Windarra Nickel Project joint venture milled 440 000 tonnes of ore in the year and the concentrate was sent to the smelter.

The 3 metre diameter raise bore hole from about the 467 metre horizon was equipped as a haulage shaft, and an underground crusher was installed.

The Metals Exploration Ltd mine at Nepean is to be placed on a care-and-maintenance basis early in 1983. In excess of 107 000 tonnes of ore was sent to Kambalda for treatment at the concentrator. During the year a heavy media separation plant was installed at the mine to pre-treat the ore and cut down the amont of it to be transported to Kambalda.

Agnew Mining Co. Pty Ltd spent most of the year on equipping the main shaft with headframe, winding engines, and electrics, etc. The drilling of a 4.26m diameter shaft to be used for ventilation purposes was proceeding and had reached 630 metres at the end of the year. Mining of 480 000 tonnes of nickel ore took place in the decline mine and this was treated to produce a concentrate.

Kalgoorlie Nickel Smelter which is owned and operated by W.M.C. Ltd treated concentrates from all of the nickel mines in the State. The total concentrate treated was 422 267 tonnes. A new system for exhausting gases at the converter units has improved working conditions in the furnace building.

Kwinana Nickel Refinery is also owned and operated by W.M.C. Ltd. Production was up about 9% on the previous year. By-products of the operation were ammonium sulphate, copper sulphide and mixed sulphides.

Salt

Dampier Salt (Operations) Pty Ltd added six crystallizers this year bringing the total to 36 at the Dampier Division. Lake Macleod Division operated as previously.

Leslie Salt Company operates at Port Hedland.

Shark Bay Salt Joint Venture harvested and exported salt from their Useless Loop operations. Some ageing equipment was replaced during the year.

Sand

Production of this material was notably reduced.

Bell Basic Industries and *The Readymix Group* wash, size and upgrade silica sand from a deposit at Jandakot for export, whilst the *Australian Glass Manufacturers* obtain their sand from Gnangara for local use. Sand is also used for the manufacture of a lime and sand brick used in the building industry.

Cockburn Cement Ltd supplement its requirements for cement manufacture by dredging lime sand from Cockburn Sound.

Spodumene

Greenbushes Tin N.L. produced 84 tonnes of spodumene concentrate from the upgrading of ore quarried in the main open cut.

Talc

Westside Mines Pty Ltd continued operations at the Mt Seabrook minesite.

Three Springs Talc Pty Ltd is now known as the *Western Mining Corporation Ltd Talc Joint Venture.* Normal operations continued, with the development of Pit C proceeding satisfactorily.

Tin and tantalite

The price for tantalite continued to be low and the tin quota was cut.

Greenbushes Tin N.L. stopped their underground project which was aimed at mining a large tantalite deposit, and ceased the retreatment of a large tin-tantalite tailings dump. However 701 454m^3 of surface ore and 16 129 tonnes of underground ore were processed. Although some surface and underground drilling was undertaken early in the year it was necessary to stop this also.

Pilgan Mining Pty Ltd operations were on a care-and-maintenance basis for most of the year.

Goldrim Mining Australia Ltd treated alluvials at their plant at Wodgina to recover 6.8 tonnes of tantalite concentrate and 5.8 tonnes of tin concentrate.

Futuris Corporation Ltd kept their operations at Friendly Creek, 100km south west of Port Hedland on care-and-maintanence.

Endeavour Resources Ltd concentrated their activities in the eastern sector of the Moolyella field. About 400 000 tonnes of ore was treated and 186 tonnes of tin concentrate and 11.1 tonnes of tantalite concentrate were recovered but not all of it was sold.

Kincora Pty Ltd established a tin mining operation near the Shaw River about 100km south west of Marble Bar in February. Alluvial ore amounting to 170 000 tonnes was treated for 63 tonnes of tin concentrate.

Vanadium

The vanadium ore mine at Coates, near Wundowie, operated by *Agnew Clough Ltd* was kept on a care-and-maintenance basis for all of the year.

Vermiculite

The Young River mine of *Vermiculite Industries* is only worked intermittently as the demand fluctuates. Production amounted to 187 tonnes this year.

Operations

Kalgoorlie

In this Inspectorate there was a significant increase in gold exploration and in the number of extraction plants erected at old gold tailing dump sites. Firming of the price for gold at the end of the year was encouraging for these operators.

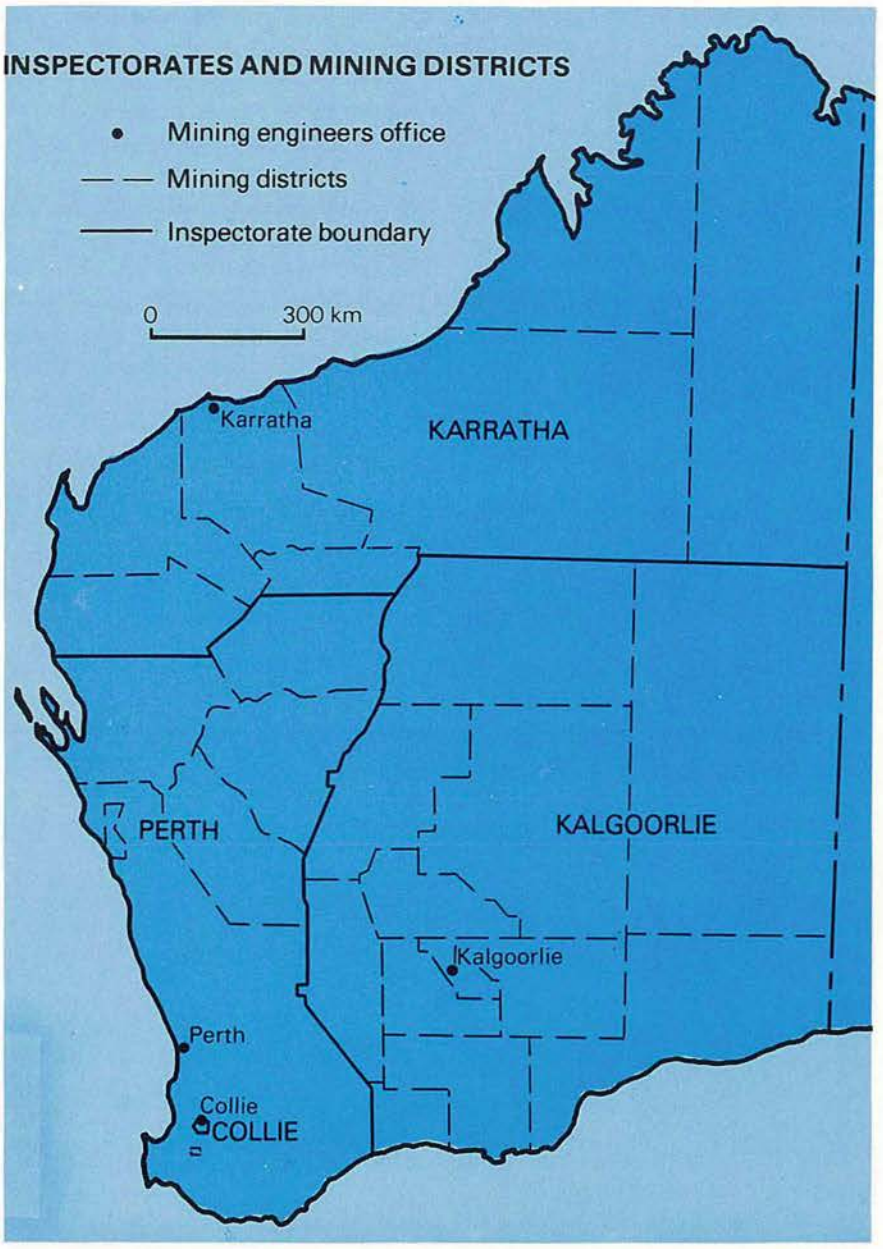
Several complaints were received about the vibrations from production blasts at the Mount Charlotte mine of Kalgoorlie Mining Associates, but tests made with the vibration measuring equipment (seismograph) indicated that the vibrations came within the limits recommended by the Sandards Association of Australia and damage was unlikely to occur.

Mining Engineers of the Division were called out several times to effect rescues from small mine shafts. The rescues are made easier by using a mobile crane hired from an engineering or transport company whenever possible.

Information was given to the Public Works Department on the presence of underground workings in areas being considered for the erection of water tanks for additional reservoir capacity.

Several subsidences occurred in the Kalgoorlie-Boulder local government areas and an officer of this inspectorate was called upon to supervise the work of making the subsidences safe.

A "Jack Catch" arrangement to prevent a kibble falling down a shaft in the event of an overwind



and a subsequent detaching of the kibble from the rope, has been incorporated in the suspension gear for a sinking kibble. It is in use at the Cassidy shaft sink and will be required as standard equipment in future shaft sinking projects.

Ventilation. A total of 369 gravimetric dust samples were collected from underground and surface work places. Of the 86 personal total dust samples 9.3% exceeded the Standard of Purity and 16.6% of the 283 personal respirable dust samples exceeded the Standard of Purity.

The undiluted exhaust gas emissions of 405 diesel engined vehicles were tested for concentrations of carbon monoxide and oxides of nitrogen and all results were satisfactory. This is attributed to the regular rigid workshop maintenance procedures adopted by the mining companies. Measurements of the airflow at workplaces were made to ensure that these were sufficient to dilute the diesel exhaust emissions to the prescribed standard. Ninety seven permits for the use of diesel engined vehicles underground in mines were issued.

Recirculation of the secondary airflow to a working place was found to be a main cause for the 2.4% of high temperatures recorded during inspections.

Two gas emissions were reported. One was encountered during dewatering of an old shaft at Pad-

dington and the other was a minor flow of methane from a surface drill hole.

Fifteen confirmed or suspected fuming accidents were reported, and were investigated.

Perth

A good coverage of mining in the inspectorate was maintained by the Mining Engineers of the Division. Previous levels of gold prospecting and mining in the Murchison and Yalgoo Districts were maintained and there are prospects for some minor expansion in the coming year.

One of the Mining Engineers advised the Metropolitan Water Authority about mining safety during the driving of the Wungong Tunnel which was completed in March.

At Big Bell, where there is interest in reopening the mine, modern visual aids were used to ascertain the condition of the main shaft without waiting to pump all the water from the mine. An underwater TV camera attached to a hoist rope was lowered down the shaft and the direction of the camera, and depth, were controlled from the surface. It is understood that the company considers it will have sufficient information to assess the work required to rehabilitate the shaft.

Ventilation. The table below shows the results of dust samples taken in the inspectorate. In addition to these, nine samples of lead dust were taken in assay laboratories of which three exceeded the Standard of Purity. Twelve samples of attapulgite and talc dust were taken to evaluate if fibres were present. All results were below the Standard of Purity. Dust emissions at hard rock quarries and crushing and screening plants showed a general improvement.

Inspections of the use of toxic and corrosive chemicals at some mines were made with the assistance of a chemist from the Chemical Laboratories. The use of bromoform and tetrabromoethane in laboratories at some mineral sands operations is still a hazard but improvements are being made.

Forty eight diesel engined vehicles for use in mines in the Kalgoorlie inspectorate were tested for compliance with gas emission requirements.

Karratha

The dominant activity in this inspectorate is still iron ore mining, but operations continue to be restricted due to the world-wide decline in industrial activity.

"Licorne Atlantique", the largest ship to visit an Australian port, was loaded at Cape Lambert with 165 000 tonnes of iron ore for the European market in October.

Summary of Dust Sample Results

	Total Dust		Respirable Dust		Positional
	-SoP	+SoP	-SoP	+SoP	
Hard Rock Quarries	12	—	54	26	—
Mineral Sands	22	1	10	1	23
Talc	9	18	—	1	25
Aluminium	7	—	—	—	9
Gold	42	22	—	—	1
Iron	2	—	—	—	4
Nickel	4	—	—	—	—
Vanadium	—	1	—	—	16
Tin	5	—	1	—	—
Limestone	11	1	—	—	—
Miscellaneous	12	7	7	8	15
Totals	126	50	72	36	93

-SoP—Less than the Standard of Purity
+SoP—greater than the Standard of Purity

Upgrading of the tertiary crusher complex at Nelson Point for the Mt Newman Mining Co. was completed in November.

The iron ore mine at Mt Goldsworthy operated by Goldsworthy Mining Ltd was mined out and closed in December after about 17 years of operation. (The first shipment of ore from the Pilbara was obtained from this mine and shipped in the "Harvey S. Mudd" on 3 June, 1966). The company will continue to produce iron ore from deposits at Shay Gap and Sunrise Hill.

Hamersley Iron Pty Ltd's operations continued in normal fashion and it is reported that winzes were sunk at both Tom Price and Paraburdoo for geological bulk sampling purposes.

Solar salt operations continued at three main sites in the area and provided employment for 350 persons.

The major gold operation is the Telfer project of Newmont Holdings Pty Ltd in the Paterson Range and operations continued as normal.

Ventilation. The volume of work accomplished was adversely affected by a staff shortage but most mines were inspected and 53 personal gravimetric dust samples were taken on mine workers at various sites to test compliance with the regulations. A positional gravimetric sample was also taken. Dust suppression and control in iron ore mining has continued to improve. There has been increased use of water reticulation along haul roads and practically all drilling is undertaken with water injection whilst some drills are equipped for foam injection. The practice of washing down the work area before maintenance work commences has restricted the exposure to high dust concentrations for some maintenance workers.

The results of dust sampling are shown in the table overleaf.

Collie

The Inspectorate is in need of additional mining engineering staff to deal adequately with the work as-

Summary of Dust Sample Results

	Total Dust		Respirable Dust		Positional
	-SoP	+SoP	-SoP	+SoP	
Hard Rock Quarries	—	—	2	—	—
Gold	—	—	12	2	—
Iron Ore	18	11	5	1	1
Miscellaneous	2	—	—	—	—
Totals	20	11	19	3	1

-SoP—less than the Standard of Purity
+SoP—greater than the Standard of Purity.

sociated with the increased coal production, the introduction of mechanical equipment for coal extraction, the means for improving the percentage recovery of coal, overseeing rehabilitation of the coal field and the revision of the coal mining regulations.

The commencement of the No. 7 underground mine is warranted to ensure that development is well in advance of main production mining and that underground coal will be available when required.

The provision of large excavating and haulage equipment has assisted with the removal of the large quantities of overburden overlying the coal seams in all open-cut operations.

It is noteworthy that both coal mining companies introduced schemes to train and prepare persons for jobs in the coal industry.

Training and mine rescue facilities are being provided on the surface at the Western No. 2 mine and will be available for fire fighting, re-opening sealed areas, or other emergencies.

Officers from the Public Health Department visited Collie and made a health survey of miners during March-April. Measurements were made of noise levels at the mines and gravimetric dust samples were collected at the open-cut mines. Results indicated that generally satisfactory conditions prevailed.

Mining accidents

Six men were killed in accidents on mines during the year. Three accidents were associated with nickel mining, one was at an alumina refinery, another at an iron ore mine and another during the underground development at a copper-zinc-silver mine. Details appear on page 87.

The table below shows the accidents sustained in the industry in the year and are segregated according to the mineral mined and processed. Other statistics relating to fatal and serious accidents appear on pages 85 and 86.

Mineral	Number of Persons Employed	Accidents		
		Fatal	Serious	Minor
Bauxite (alumina)	3 847	1	62	173
Coal	1 163	—	47	571
Gold	2 358	—	113	406
Ilmenite etc.	703	—	13	85
Iron	11 084	1	142	546
Nickel	3 015	3	128	257
Salt	350	—	22	76
Tin/tantalite	275	—	6	18
Copper, silver, zinc	146	1	3	8
Other minerals	398	—	2	2
Rock quarries	289	—	9	21
Totals	23 628	6	547	2 163

Machinery on mines

The slump in gold prices during the year resulted in a reduction in the number of new or refurbished shafts being brought into operation. A considerable amount of time was spent reviewing headframe and winding engine design for the Cassidy shaft sink, and equipping the Agnew No. 1 shaft. Design submissions reviewed and completed during the year were: Agnew No. 1 shaft of Agnew Mining Co. Pty Ltd; O.K. Shaft of Central Norseman Gold Corporation Ltd; Gordon's gold mine—north east of Kalgoorlie; Elephant shaft at Payne's Find; Sweet William shaft at Payne's Find; Cassidy shaft sink of Kalgoorlie Mining Associates at Kalgoorlie; Frances Furness shaft of Marvel Loch Gold Mines; and the winding engines proposed for Victor shaft and Foster shaft of Western Mining Corporation Ltd. (Kambalda Nickel Operations).

The five Special Inspectors of Mines (Machinery) carried out the general inspection of machinery on mines throughout the State and completed the certification of:

2 272 pressure vessels (including boilers);
927 cranes;
17 lifts;
49 power shovels; and
56 winding engines.

Examinations for the following Certificates of Competency were conducted:

81 Crane drivers;
10 Engine drivers;
24 Power shovel operators;
13 Locomotive drivers;
6 Boiler attendants; and
2 Winding engine drivers.

Winding machinery accidents.

Eighteen mishaps were reported. Three were due to overwinds; nine hang-ups occurred in various shafts; five mishaps were due to miscellaneous causes; and there was one derailment in an underlay shaft.

The actions necessary to repair the damage and eliminate any hazards to safety were taken immediately.

Electrical inspections

Special Inspectors of Mines (Electrical) from the State Energy Commission made the electrical inspections on mine sites for this Division.

980C Caterpillar Loader and 769B Caterpillar Truck. 18 level No.11 Mill Hole, Mt Charlotte

A total of 718 inspections covering 283 mining operations throughout the State were made including bi-annual inspections and those required when new plant and equipment was installed or major alterations effected.

Reorganization within the Commission's Inspection Branch is to occur in the coming year and is expected to result in improved capacity to carry out the inspection functions.

Rehabilitation

Although nearly all of the mining industry experienced reduced profits or losses, rehabilitation of disturbed areas continued at a similar rate to previous years. Extra effort was noted with companies encouraging the planting of trees around mines, workshops, administration and residential areas, as part of an involvement with the "Year of the Tree" programme. A large amount of expenditure went into refilling previously mined areas and recontouring in order to restore the land to a form suitable for the planting of vegetation. Large areas that seemed to be neglected were transformed once the correct profile was achieved.

Iron Ore Mining. Over 6 000 trees were planted within the leases of the Pilbara iron ore mining companies. All companies are continuing their attempts to encourage regrowth on their waste dumps, borrow pits and other areas disturbed by earthworks.

Mining at the Goldsworthy Open Cut ceased at the end of the year but before earthmoving equipment is removed the surface of the waste dumps will be ripped to ensure maximum retention of rainfall, and run-off will be restricted so as to cause only the minimum of erosion. The roughened surface will trap wind blown seed to enable natural revegetation to occur over the next few years. The waste dump already has considerable regrowth which demonstrates that the regeneration of plants is possible on this material.

The Mt Newman Mining Company is continuing with "moonscaping"—a rehabilitation method involving steep slopes being sloped to about 25° before sheeting with seed-bearing topsoil. Pockets are created in the slopes with a bulldozer to restrict run-off and enhance seed and water retention. Where topsoil cannot be spread, seed from indigenous species is broadcast over the slopes.

Hamersley Iron are experimenting with replacing the species that previously grew under similar conditions, into their borrow pits at Tom Price. At Hearson's Cove, near Dampier, dunes of limesand are being reshaped to a lesser slope and seeded.

Cliffs Robe River Iron Associates are progressively rehabilitating the top of those mesas which have been mined.

Nickel mining. Since nickel mining commenced in this State in 1966, a policy of preserving existing vegetation within mine and township areas has been established and this is most evident at Kambalda, Leinster and Windarra. The recently reopened Lancefield mine, near Laverton, is being dressed with trees to overcome the barrenness of the site and although there is not an abundance of fresh water in the area, the mine water is being used in an endeavour to establish ground cover.

Bauxite mining. Alcoa of Australia (W.A.) Ltd rehabilitated 249 hectares of previously mined land during the year. Apart from the planting of trees within their pits and areas disturbed by mining activities, the company has been involved with a regional rehabilitation and replanting scheme and has supplied 120 000 trees to various organizations and agreed to provide technical assistance and distribute newsletters to organizations committed to long term tree planting programmes.

Tin-tantalum mining. Greenbushes Tin N.L. continued to backfill old mining pits as their main rehabilitation work, and shifted overburden to previously mined areas to return the ground to a profile similar to that existing orginally so that topsoiling and replanting could commence.

Mineral sands mining. In the Capel area the three operating companies

rehabilitated about 120 hectares of the land in which mining has been completed, but work on restoring the Prowse mine, operated by Cable Sands Ltd is not expected to start until 1983.

At Eneabba rehabilitation of the land to the orginal "heathland" type vegetation (as near as possible) is being undertaken. Trees planted at the edge of mined areas, and along road verges etc., will provide a shield for new vegetation from the harsh easterly winds common to this locality.

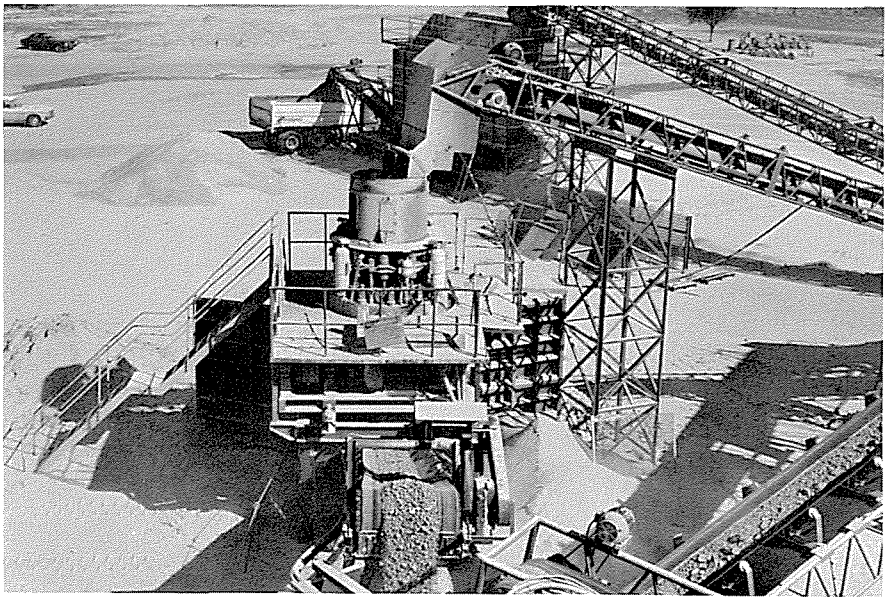
Coal mining. At Western Collieries the open cuts are being backfilled to a suitable profile, covered with topsoil, and seeding and tree planting is being undertaken. Extensive backfilling into the Muja open cut worked by the Griffin Coal Mining Co. is proceeding.

The allocation of funds to the Department of Mines for the annually recurring hot ash problem and to tidy old mining areas was utilized at the site of the old Co-operative mine near the western end of the Collie townsite.

The Readymix Group sought to ascertain the extent of vibrations when they blasted with larger size holes at their Gosnells quarry but used the same quantity of explosives. Tests were also made of blasting at the Gelorup quarry, also operated by Readymix, to monitor the effect on housing areas in the vicinity. All vibrations were within the limits recommended by the Standards Association of Australia. Before issuing an Extractive Industries licence for a quarry to operate in the Harvey Shire, the Council requested a test blast in the quarry (near Roelands) to monitor the possible effect of blasting on property in the district.

Pillar blasts in the underground workings of the Mt Charlotte mine at Kalgoorlie were monitored and the results were satisfactory.

In order to establish the extent of ground vibrations, as a precaution against complaints, the Metropolitan Water Authority and Westrail had vibration recordings made when excavators, compactors, locomotives and rolling stock were operating.



Readymix Group Quarry—crushing plant

Vibration measurements

The Dallas ST4 Seismograph was used to monitor quarry and underground blasts and to measure vibrations from mechanical equipment used on construction work.

Drilling

The Drilling Branch was responsible for drilling 5 686 metres in 146 bores, the development of aquifers in 132 bores, and the testing of aquifers in 11 bores. Experiments in jet development at 6 bores and coring operations in 22 bores were undertaken. Thermal logging, in conjunction with G.S.W.A. was carried out on 5 bores, and 38 bores were scanned using the borehole television camera.

The total metreage drilled was less than in 1981 due to the need to limit expenditure on the G.S.W.A. programme in order that sufficient finance to provide efficient deep drilling is available on alternative years.

The Statewide groundwater investigation programme being undertaken by the G.S.W.A. was continued at the: Gillingarra Line—consists of 8 sites with project depth of 1 200 metres. Three holes have been completed but the five remaining holes have been deferred until suitable blowout prevention equipment is obtained.

Harvey Deep Line—consists of 4 sites with project depths between 600 and 1 800 metres. The sites have been prepared and it is expected that two or three will be completed in 1983; Harvey Shallow Line—work has continued for most of the year. It is required to provide data on stratigraphy and groundwater conditions to a projected depth of 40 metres at selected sites; and Fortescue Valley—20 bores were drilled and 10 pump tested in 1982 to provide data on stratigraphy and groundwater conditions over a large area of the valley. It is expected that work on the flood plain of the Fortescue River will be started in 1983.

The scanning of boreholes with the TV camera was undertaken for a number of clients. The majority of the work was to facilitate repairs or recovery of lost pumps etc., but some was to determine the condition of the bores or provide an "as-constructed" record of them. The table on page 84 gives details of the drilling work and the purpose and methods used for such work. The camera and equipment were taken to Victoria to examine two bores for the Geelong Water Trust.

Ventilation Board

Mr D. Sykes, a Scientific Officer with the Public Health Department, joined the Board in place of Mr R. Powell.

The Board held seven meetings and made an inspection visit to the Pilbara region.

A regular function at the Board meetings was the consideration of dust sampling results submitted by all mining companies in the State under the "Mindust" system.

The new "Contam" system which is to replace "Mindust" will embrace all the contaminants which occur in the mining industry, and whilst some progress has been made with its development, it will not be brought into operation until late in 1983.

The Board believes that the efforts of the industry should now be directed to those areas which most need attention and the new sampling strategy on contaminants at working places should effect this. It is not intended to increase the number of samples to be taken.

The accuracy of the determinations made for free silica in some dust samples was queried by Board members but checks made during the year revealed a close correlation between organizations making these determinations. The Board proposes having comparison checks made more frequently.

Boards of Examiners—Certificates of Competency

Certificates for First Class Mine Managers, Underground Supervisors, Quarry Managers, Restricted Quarry Managers, Coal Mining, and Authorized Mine Surveyors issued in 1982 are shown in Tables on pages 87 and 88.

Organization

Staff. Mr A. W. Ibbotson retired as Mining Engineer/Senior Inspector of Mines in November after almost 31 years of service in the Division.

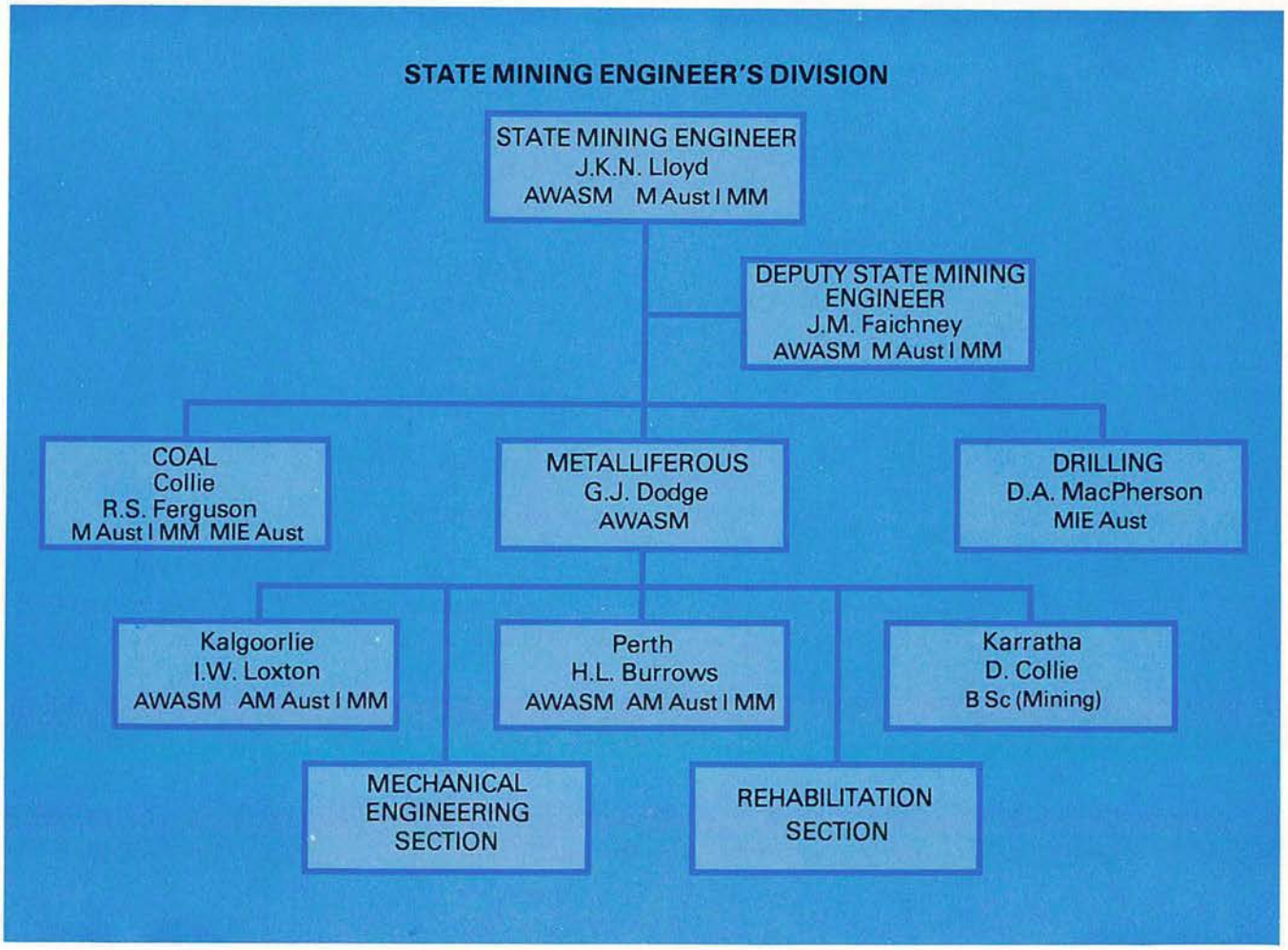
Three appointments were made to fill vacancies at Kalgoorlie and one vacancy in Perth for a Mechanical Engineer.

Mr D. Collie was promoted to the position of Mining Engineer/Senior Inspector of Mines at Karratha.

One vacancy for a Mining Engineer/District Inspector of Mines exists at Karratha but it is expected that this will be filled early in 1983.

Another Workmen's Inspector of Mines was elected for the coal mining industry at Collie following the decision of the previous inspector to return to work for a mining company.

The map of Western Australia on page 24 depicts the mining districts of the State and shows the manner in which they have been grouped to form the inspectorates based on Perth, Karratha, Kalgoorlie and Collie for the purposes of the Mines Regulation Act and the Coal Mines Regulation Act.



TAILINGS TREATMENT

The State Batteries Division operates ore treatment plants at 15 locations in Western Australia. These were established so that prospectors could have small parcels of gold ore bulk tested for commercial viability.

To the end of 1982 some 4 247 889 tonnes of gold ore has been treated at State Batteries.

The recent escalation of gold price and development of the carbon-in-pulp cyanidation process has re-focussed attention on the value of recoverable gold in tailings. Tailings are the residue of crushed rock remaining after extraction of all or most of the valuable component of an ore.

Tailings from gold ore treatment at State Batteries contain a gold content viable under present gold prices and can be re-treated to recover most of this gold. An outline of the initial crushing and amalgamation process and secondary cyaniding and carbon-in-pulp processes practised by State Batteries appears at page 42 in the Annual Report of the Department of Mines in 1981. Eventually it is hoped to have modern tailings treatment facilities installed at all State Batteries.

Tailings issue from a State Battery in the form of a slurry that can be pumped to a holding location (tailings dam) where its average gold content can be determined by assay.

It is interesting to examine the ownership of tailings and the way in which their value is realized.

In 1909, if the gold content of the tailings was less than 4.59 grams per tonne then the tailings automatically became the property of the State Batteries. However, if a battery was not equipped for cyanidation then the ore owner could either retain ownership and remove the tailings or abandon them to State Batteries ownership. Needless to say, very few owners abandoned worthwhile tailings.

Typical tailings settling dam

Where the battery was equipped with cyanidation facilities and the tailings contained more than 4.59 grams per tonne the Government offered to buy the tailings from the ore owner. Shortly after agreement on the assay value, the Department arranged to pay part of the contained gold value. The balance (less treatment charges) was repaid to the owner after cyanidation was completed, which was often much later.

The amount deducted for treatments in 1912 was set at 4.59 grams per tonne (then expressed as 3 pennyweights per ton). This had been reduced to 2.7 grams per tonne by 1980 after which (January, 1981) the costs were set at a flat rate of $12 per tonne which has been increased to the current rate of $15 per tonne.

It should be noted that $15 per tonne at the average 1982 gold price ($370.75 per ounce) represents a grade of 1.26 grams per tonne.

Over the years State Batteries have acquired considerable quantities of now payable sands. Revenue derived from treating this material is used to redeem prospectors' equities and benefit the Consolidated Revenue Fund.

Recent attention to tailings treatment for present-day ore-producers has reduced the payment delay to prospectors at most batteries except Marble Bar and Paynes Find where there are still excessive delays. These delays should be significantly reduced in the future, although in the case of Paynes Find this may depend on finding an adequate water supply.

The adoption of the carbon-in-pulp technique has already substantially lowered tailings treatment costs. This technique is already available at Kalgoorlie, Coolgardie and Meekatharra.

Further benefits have been derived from the hydraulic feed system, piloted at Kalgoorlie, which is now being engineered at Meekatharra. This system has the ability to handle wet sticky feed which is difficult to handle by other means. It can also handle rubbishy material and has a lower mechanical and capital content.

The ideal system for tailings treatment would be a hydraulically fed 50-tonne pachuca system at all operating batteries to provide wet operation from a settling dam.

This unit could be worked in times of lay-by of the battery to produce revenue and stabilize a small workforce. This will be the ultimate goal for State Battery treatment of crushing tailings.

STATE BATTERIES

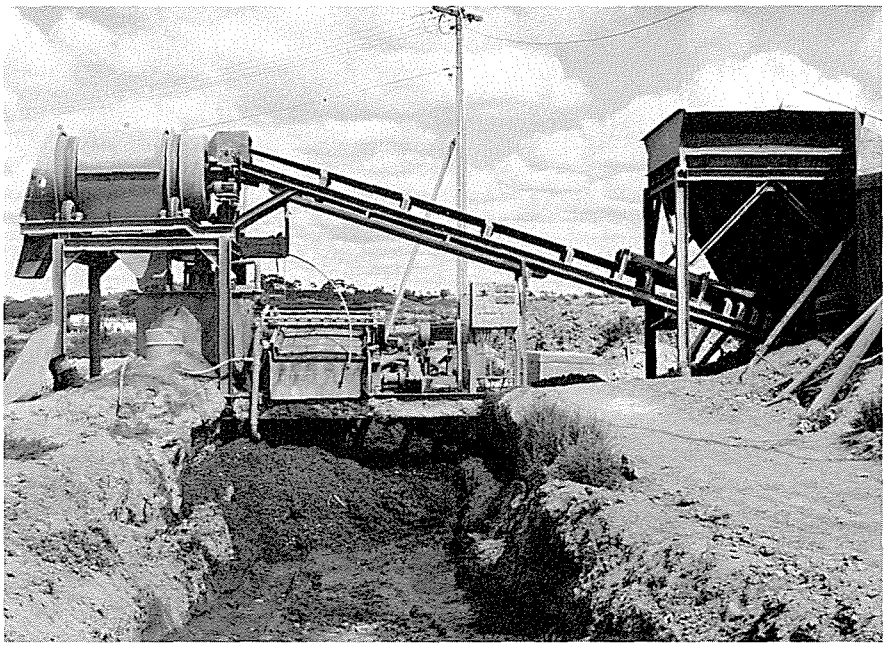
E.J. GREEN, SUPERINTENDENT

The average price for gold during 1982 was $370.75 per ounce, a reduction of $28.50 on the previous year.

Carbon-in-pulp facilities for the treatment of Battery tailings were extended with a resultant increase of tonneage treated and a reduction in the amount of prospector owned tailings waiting to be treated. Operation costs by the carbon-in-pulp method are less than half the normal vat treatment costs.

During the year 5-head battery extensions made at Marvel Loch and Marble Bar were started up and have already begun to reduce the waiting period for prospectors.

The tonneage of gold ore treated in 1982 by State Batteries was the lowest for many years because generally gold prices were at a break even point for most mines. Many producers found difficulty in maintaining operations.



Carbon in Pulp loading module, Coolgardie

A new system for the handling of difficult tailings has been incorporated in a pilot plant at Kalgoorlie. Its success in handling clay and trashy material has resulted in prototype unit being designed for installation at Meekatharra. This new tailings handling system will work in conjunction with a new 50 tonne pachuca and the existing ball-mill.

A new 50 tonne pachuca tank was installed at Kalgoorlie together with a new compressor unit. The original flat bottomed pilot plant pachuca at Kalgoorlie was found to aggravate settling problems and was converted to a cone base in the shutdown period at the end of the year.

Buildings and housing of the division were upgraded by the installation of a new office and stores at Kalgoorlie and a new Manager's house at Meekatharra. Unexpected assistance came from a cyclone which demolished a structure at Boogardie and stripped a building of its cladding in Kalgoorlie. These buildings are in the process of rebuilding and repair.

During the year 80 428.2 tonnes of sand were allocated under contract for treatment and charges of $170 596.11 were collected. Fees of $1 340.00 were collected for rights to sample various tailing dumps.

Operations

Crushing gold ores

One 20-head, seven 10-head and six 5-head mills crushed 32 947.2 tonnes of ore made up of 296 separate parcels an average of 111.3 tonnes for each parcel. The bullion recovered by amalgamation amounted to 236.9578 kilograms estimated to contain 201.414 kilograms of fine gold equal to 6.1 grams per tonne of ore. The average value left after amalgamation was 3.1 grams per tonne fine gold, giving an average value of ore received of 9.2 grams per tonne fine gold; in addition 230 smelts produced 161.3128 kilograms of bullion estimated to contain 137.116 kilograms of fine gold.

In total 338.53 kilograms of fine gold was produced compared to 415.24 kilograms of fine gold in the previous year from amalgamation and smelting activities in the State Batteries.

The gross cost of crushing 32 947.2 tonnes of ore was $61.08

Carbon in Pulp pachuca tank, Coolgardie

per tonne. In 1981 45 989.6 tonnes of ore were crushed at the gold plants for a cost of $45.65 per tonne. This year the net cost of crushing was $51.03 per tonne compared with $37.05 per tonne in 1981.

Cyanidation

State Batteries at 7 separate locations treated 63 826 tonnes of tailings by vat and carbon-in-pulp methods for a production of 75.902 kilograms of fine gold. In addition part treatment of the Laverton tailings supplied another 2.942 kilograms of gold giving in all 78.844 kilograms of fine gold of which 41.243 kilograms were paid out to prospectors. The average content was 1.689 grams per tonne before cyanidation and the residue 0.466 grams per tonne giving a theoretical recovery of 78.05%.

However, since larger tonneages are treated by carbon-in-pulp, resulting in larger amounts of gold remaining in the carbon-in-pulp circuit and because the tonneages are estimated, the actual recovery is only 70.39%.

In addition a total of $7 500 was collected for the contract stripping of 8 batches of carbon which produced 18.660 kilograms of bullion estimated to contain 15.861 kilograms of fine gold.

Of the total tonneage of tailings treated by cyanidation during the year 51 643 tonnes were treated by carbon-in-pulp plants at Kalgoorlie, Coolgardie and Meekatharra for a production of 64.398 kilograms of fine gold at a cost of $11.20 per tonne.

The vat treatment plants treated a total of 12 183 tonnes at a cost of $30.53 per tonne.

Treatment of ore other than gold

The Northampton battery crushed a quartz sample of 8.39 tonnes. The Marble Bar magnetic plant cleaned 2 tonnes of tin concentrate to 1.32 tonnes of saleable concentrate.

Value of production

The estimated value of production from the State Batteries in 1982 and the total since their inception, excluding the value of gold tax paid to the Commonwealth is shown in the following table:

	1982 ($)	Since inception ($)
Gold	5 164 113	70 106 004
Other metals		
Silver	1 745	12 413
Tin (concentrate)	9 020	515 385
Tungsten (concentrate)	—	97 674
Copper (ores for agricultural use)	—	11 932
Lead and zinc (concentrate)	—	1 650 865
Tantalite (columbite concentrate)	—	207 030
Garnet (concentrate)	—	131 001
Other metals Total	10 765	2 626 300
Grand Total	5 174 878	72 732 304

Capital expenditure was incurred as shown in the following table:

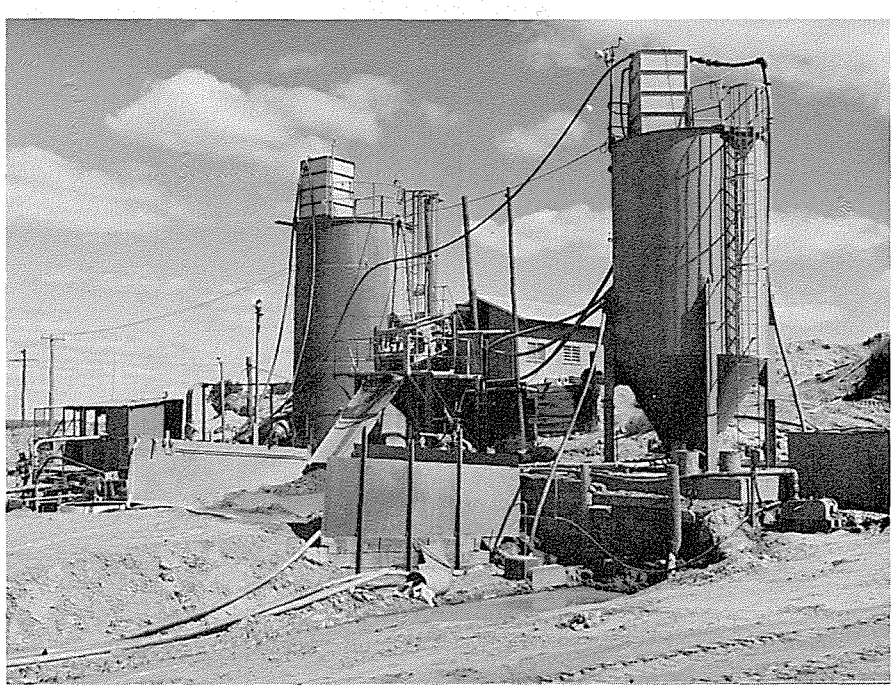
Battery	Project	Total
KALGOORLIE	Purchase feeder module $41 000 F.E. loader $35 842 Feed bins progress $33 969 Complete pachuca tank $9 076 New office and shed $40 287 Fencing $3 000 Mobile compressor $5 047 New lathe $5 658 Compressor $8 000	$181 879.00
BOOGARDIE	Conversion motors $9 424 Generator set $14 010	$23 434.00
COOLGARDIE	Experimentation Barker Mill $3 100	$3 100.00
MARBLE BAR	Extra 5-Head installation $53 000	$53 000.00
MEEKATHARRA	New house $37 272 Auto feeder $1 844 Start new C.I.P. Installation $3 333	$42 449.00
MENZIES	Deutz generator set $14 251	$14 251.00
ORA BANDA	Deutz generator set, motor and starter $15 974	$15 974.00
ALL BATTERIES	Spares etc. for housing, electrical and engineering maintenance Water supply upgrading	$59 000.00 $42 279.00
		TOTAL: $435 366.00

Administrative expenditure for 1982 was $404 339 equal to $3.97 per tonne crushed and cyanided compared with an expenditure of $396 490 ($5.12) for 1981.

Organization

Battery manpower. During 1982 an average of 112 men were employed at State Batteries throughout the State. This figure does not include the Superintendent of State Batteries. The average number employed is made up of a monthly average of 85 wages staff and 27 ministerial appointments. Due to the fluctuating supplies of ore to be treated the total number of personnel employed ranged between 106 and 125.

During the year Manager C. Solly was promoted. Foremen R. L. Bell and M. P. Spain were promoted to Managers and A. Barrett and C. Hodgeson were promoted to Foremen. Manager R. Bell was transferred from Norseman to Marble Bar and Manager R. Wade from Marble Bar to Norseman.



Carbon in Pulp installation, State Battery, Kalgoorlie

MINERAL DEPOSITS MAP — an aid to mineral search

Western Australia is endowed with a wealth of mineral deposits and new discoveries are continually reported in the press. It is therefore not surprising that the general public, and even people involved in the mineral industry, can become confused by the proliferation of mine and propsect names, and be vague about the exact whereabouts of many new projects. For this reason and to provide a guide to prospectors, the Geological Survey of Western Australia has issued a 1:2 500 000 scale Mineral Deposits Map of Western Australia.

This is the first such map issued by the Geological Survey since 1919, when an annual series of maps showing mineral deposits was terminated.

In the long interim period the Department has filled this obvious gap in its publications by issuing a series of maps showing mineral occurrences as derived by the Government Chemical Laboratories from samples submitted. These maps served a useful purpose as demonstrated by their large sales. However, the uncertain nature of the information on which they were based, meant that many deposits were inaccurately located and that no assessment of the economic significant of occurrences was attempted. In addition gold deposits were not shown.

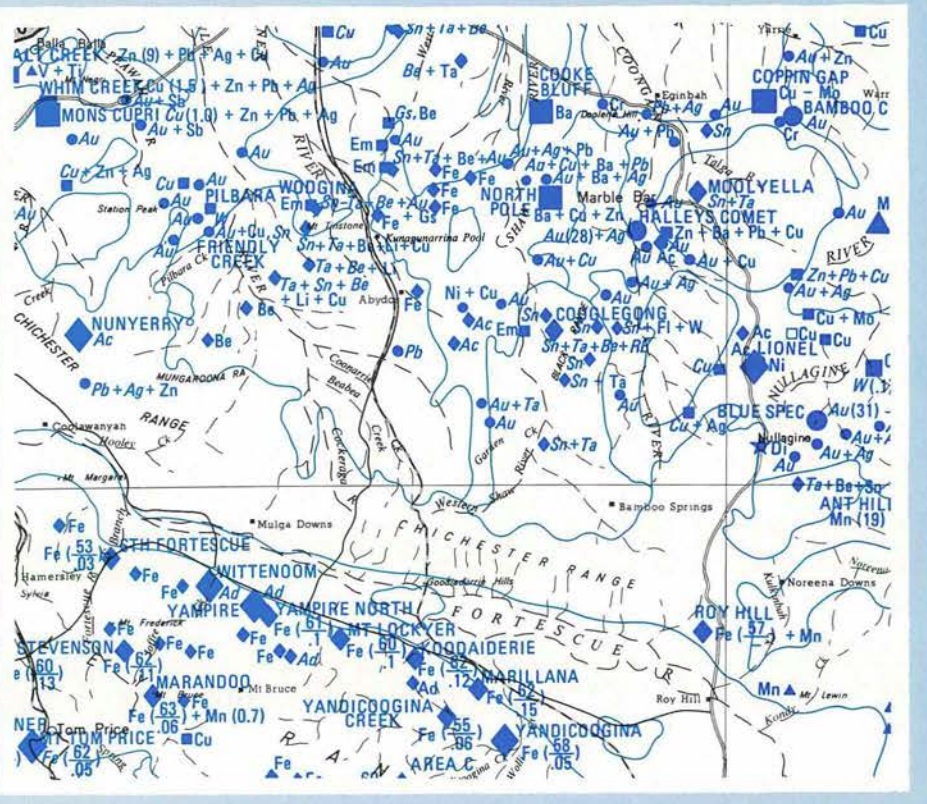
The present map attempts to rectify these shortcomings. All deposits shown have been accurately located either by Geological Survey field work or from company reports. Deposits not considered to have economic potential are omitted unless they have some historical or metallogenic significance. Many gold deposits are also shown, either individually or grouped into centres.

The map has been issued in two forms: a coloured paper version; and a black and white edition on transparent plastic which can be overlain on the State geological map. Preparation of the Mineral Deposits Map presented the Geological Mapping Section of the Surveys and Mapping Branch with problems not previously met on maps of this scale. Some 70 different mineral commodities had to be distinguishable, not only in colour, but also on the black and white overlay. The figure below, shows how well these problems were overcome, even in an area as extensively mineralized as the Pilbara.

The use of different sized symbols serves to distinguish major deposits of particular minerals from those of lesser importance. The size refers to the actual amount of metal or saleable mineral in the deposit and not necessarily to the amount of actual ore. In addition, the grade of the major deposits is indicated alongside the symbols where this information is available. On the coloured map different minerals are distinguished by the use of symbols of various shape and colour, the colours being chosen to link groups of related commodities. A letter symbol (e.g. Ni for nickel) is also used and allows the uncoloured symbols on the black and white edition to be identified. Colour is also used to pick out drainage features and to indicate, in a subdued form, the geological setting of the mineral deposits.

The Mineral Deposits Map does indicate fundamental relationships between geology and different types of mineralization although it is not intended as a metallogenic map distinguishing deposits of different geological origins. As such it is of service to both prospectors and exploration companies who can use it in planning their campaigns.

The popularity of the map can be judged by its sales which have exceeded 1 100 copies since its release in May. It is intended that updated versions of the map should appear at regular intervals in the future. Certainly we do not intend to allow another gap of 62 years to elapse before producing a further edition!



GEOLOGICAL SURVEY

A.F. TRENDALL, DIRECTOR

Almost all professional staff vacancies were filled by early 1982 and there were a few resignations. As a result 1982 was a most satisfactory working year.

At the same time there has been a significant increase in the demands made on the Survey which is already undersized in relation to the size of the State, output of the mineral industry and the amount of private sector exploration. In particular there has been a call for more professional advice in many aspects of administering mining legislation and in monitoring environmental effects of mineral extraction.

The replenishment of staff numbers allowed a number of pending projects to be finalized or taken up again. One such was the compilation of 1:250 000 scale regional geological maps of the wheat belt area. This was completed during the year to finally achieve complete coverage of the State at this scale. The Darling Range bauxite study, which had been delayed by resignations and the need to complete regional maps, was recommenced using expertise brought to the Division by new staff.

The skills of a new appointee were used to help set up a stable isotope facility at the Western Australian Institute of Technology to assist the Division's studies of groundwater movement and recharge.

A new initiative taken by the Survey during 1982 was the setting up of a joint project to study the Devonian and Carboniferous carbonate rocks of the Kimberley Region in relation to their potential for petroleum and base metals. The project involves mining companies, the Bureau of Mineral Resources, the Western Australian Institute of Technology and WAMPRI.

Other highlights of the year include the introduction of word processors to facilitate preparation of manuscripts, the organization of a workshop on Australian Proterozoic Basins on behalf of the Government Geologists' Conference, and the running of one week of a 3-month course on mineral exploration for the Australian Development Assistance Bureau.

Mineral and Petroleum Exploration Activity

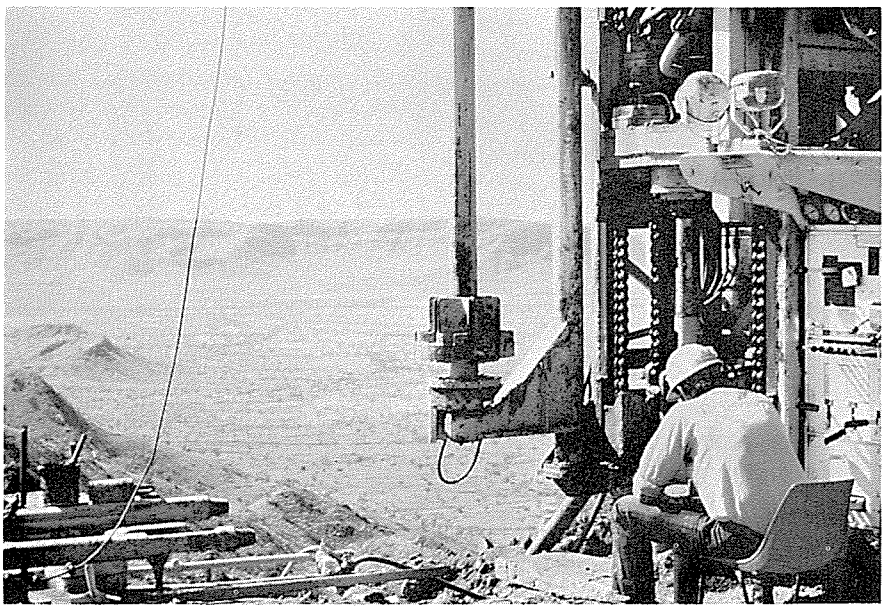
As the full effect of the world recession was felt in Western Australia during 1982 there was a marked fall-off in exploration by mining companies. Several major operators laid off geologists and some overseas companies pulled out of the State entirely. Of the metallic minerals only gold retained the impetus of the 1980-81 period. Exploration for coal continued at earlier rates and there was a greatly increased effort in the search for hydrocarbons.

Evaluation of the Argyle diamond deposits continued throughout the year and included further structural drilling on the AK1 kimberlite and bulk sampling of both kimberlite and alluvium. Exploration for diamonds continued throughout the State.

Despite low base metal prices exploration on 3 carbonate-hosted lead-zinc-silver deposits in the Kimberley region continued at a high level during the year, and various models for mineralization in Proterozoic rocks were applied with some success. The partners exploring the copper-zinc deposits at Golden Grove announced that they were preparing a feasibility study for the development of these prospects.

A world wide over-supply of tantalum forced Greenbushes Tin NL to suspend work on the underground development of its large pegmatite reserves discovered in 1980. It also reduced the exploration rate for this metal in other parts of the State, notably in the Pilbara where several small mines closed.

The recession in the Japanese steel industry continued to affect the major Pilbara iron ore mines which on average operated at only about 60 per cent of their capacities. Goldworthy Mining Associates succeeded in securing contracts to supply ore from its recently discovered reserves at Sunrise Hill. Most iron ore exploration was aimed at delineating known deposits rather than locating new ones. How-



Diamond drill operated by the Ashton Joint Venture, testing the western margin of the AK1 Kimberlite Pipe

ever, some innovative regional work did continue, and one such project resulted in a stratigraphic hole through a considerable part of the Marra Mamba Iron Formation.

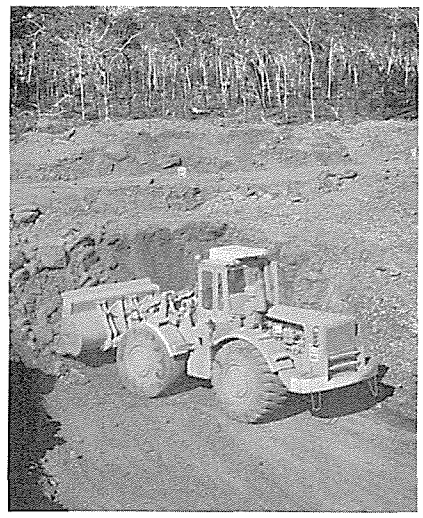
Development of the Yeelirrie uranium deposit continued during the year, despite the withdrawal of one of the partners. The Manyingee sandstone-type uranium deposit southeast of Onslow was the subject of laboratory tests and groundwater investigations to determine parameters for in-situ leaching methods of extracting the uranium. Exploration for uranium continued in such localities as the eastern Kimberley and the Ashburton Trough.

Lower gold prices in the middle of the year caused a temporary recession but a subsequent rise in values brought new life to the industry and there are many gold exploration projects under way throughout the State. Among the more notable of these were the drilling of the Big Bell mine, near Cue, by Australian Consolidated Minerals and Amax; the testing of the Mystery Lode near Mt Charlotte by Black Hills/Occidental; and the development of the Paringa leases at Kalgoorlie by CSR. The search for strata-bound gold deposits gained momentum during the year with the principal targets being Archaean banded iron-formations and Precambrian conglomerates.

Work has continued, at a somewhat reduced rate, on new alumina refineries at Worsley and Wagerup. The Mitchell Plateau bauxite deposit was re-evaluated by a consortium which included CRA, and a bulk sample of some 20 000 tonnes was excavated for metallurgical trials.

Nickel exploration was subdued during 1982, due to the world oversupply of this metal. Interest was mainly focussed on Mt Keith where some high-grade intersections were reported, and the Kalgoorlie-Kambalda area where the discovery of the Leeks' (or Wildcatter's) prospect was announced. Exploration also took place in the Widgiemooltha Dome, and the Forrestania and Bremer Range greenstone belts.

Exploration for coal continued throughout 1982 although no major new discoveries were made. The main areas of activity were the Perth Basin (both in the north around Eneabba and in the south near Busselton), southern Carnarvon Basin, Bremer Basin (in the Esperance region) and the western margin of the Eucla Basin.



Excavating a bulk sample of bauxite on the Mitchell Plateau

Oil shale exploration is continuing on four Exploration Permits (3 in the Eastern Goldfields, 1 in the Perth Basin) issued under the Petroleum Act 1967. New exploration for oil shale must be done on Exploration Licences taken out under the Mining Act 1978-81.

Petroleum exploration activity increased during the year with a record number of wells being drilled. Sixty-seven exploratory wells were completed in 1982; these included 4 shallow pool tests and 6 extension wells on Barrow Island where in addition, 38 development wells were drilled. At the end of the year 10 exploratory wells were still drilling or testing.

On shore, Blina 4 well in the Canning Basin was completed as an oil well. The joint venturers announced plans to develop the Blina field at an initial production rate of 130-160 kL/day; the oil will be transported by a 30 km pipeline to the Great Northern Highway, trucked to Broome and transported by ship to the Kwinana refinery.

In the Perth Basin, testing of the suspended Mt Horner 5 well continued the work on the Mt Horner oil accumulation. Production testing of the Woodada wells took place during the year and gas reserves are estimated to be 1.34 x 10^9 m^3. Indoon 1 well, drilled 10 km south of the Woodada field, flowed gas at 85 x 10^3 m^3/day; it is not known whether this is a new pool or an extension of the Woodada gasfield.

Off shore most of the drilling activity was in the Carnarvon Basin. At the beginning of 1982, testing of Goodwyn 6 produced a flow of oil at up to 500 kL/day; this is the first oil to be found in the "main block" of the Goodwyn gas field. Oil was also found in Novara 1 well which flowed 5-6 kL/day of 16° API oil on test. At the end of the year, two wells were being tested. North Gorgon 1, drilled 24 km north of the Gorgon 1 gas well, flowed gas of up to 297 x 10^3 m^3/day. South Pepper 1 well encountered both oil and gas. On test it flowed 240 kL/day of 45° API oil.

In the Browse Basin, North Scott Reef 1 produced gas at up to 1.7 x 10^6 m^3/day. There appears to be a common gas-water contact with Scott Reef 1 which suggests that the field could be very large.

Geophysical activity increased above the 1981 level. On shore 13 seismic crews operated throughout the State and 4 gravity surveys and 1 aeromagnetic survey were also undertaken. Seven survey ships carried out marine seismic surveys with up to 4 ships operating in adjacent waters at the same time.

Operations

During 1982, the Geological Survey Division organized the first meeting of the Working Group on Proterozoic Rocks. This Group comprises representatives from various State Geological Surveys and the Bureau of Mineral Resources. Its aims are to correlate Proterozoic rocks across State Boundaries, and to coordinate studies onthe geochronology

and mineral potential of these rocks. The 2 day meeting was followed by an 8 day field excursion through the Proterozoic successions of the Western Australian Shield.

In September the Division arranged a 1 week course on Australian geology, mineral deposits and mining legislation for a group of overseas Geologists sponsored by the Australian Development Assistance Bureau.

A Regional Office was established at Karratha in April. The one Geologist so far stationed at it will concentrate mainly on hydrogeological investigations. He will be joined by an Engineering Geologist in April 1983. The Kalgoorlie Regional Office was brought up to full strength in May.

Geological Survey field camp, Canning Basin

Hydrogeology Branch

The aggregate depth drilled for groundwater exploration and assessment in 1982 fell to 4958 metres from 9800 metres in the previous year in response to continuing cost pressures and severe financial constraints. This decline has severely affected the Perth Basin deep drilling programme for which only 1 bore, drilled to a depth of 997 metres, was completed on the Gillingarra line.

Considerable progress has been made with the evaluation of shallow groundwater resources in the coastal plain between Pinjarra and Bunbury with the completion of 104 piezometer and pumping bores for the Harvey shallow drilling project. Only a small amount of work remains before completing the whole of this programme.

A further 11 artesian monitoring bores were drilled by contractors to the Metropolitan Water Authority under geological supervision. The information collected has improved the definition of the geological structures affecting contained aquifers and has provided the means of monitoring hydraulic head variations with time. Continued technical support has been provided for the management of the confined and unconfined groundwater resources in the Metropolitan Region. An important reassessment has been made of the shallow groundwater resources of the southern Perth area.

Advice about the best means of dewatering excavations for sewerage construction at Applecross, Bateman and East Rockingham has been given to the Authority through groundwater modelling and other studies.

Two important new research projects were commenced during the year: a joint study with the Metropolitan Water Authority of the water balance in urban areas; and research into rates of recharge to the shallow aquifers which are being progressively developed as a public water supply source. The recharge study includes the application of isotopic techniques for which a laboratory facility has been established within the Chemistry Department of the Western Australian Institute of Technology in co-operation with the Survey.

A further 20 exploratory bores have been drilled east of Millstream in the Pilbara to depths of up to 120 metres. These complete the present programme of exploration in support of a comprehensive evaluation of the major groundwater resources of the central Fortescue and Upper Robe regions.

At the request of the Public Works Department, hydrogeological investigations were undertaken for a number of small towns, including Laverton, Nabawa, Yalgoo, Derby, Bremer Bay; for coastal development between Mandurah and Bunbury; and for Aboriginal reserves or stations at Noonkanbah, Yungngora, Nguranwaana, Mt Margaret and Coonana.

Advice continued to be provided to the Public Works Department on the disposal of Laporte factory effluent at Australind and on the hydrogeological conditions at a number of industrial waste disposal sites. A survey has been completed of the major liquid waste disposal sites in the metropolitan area, and a number of investigations have been undertaken with respect to effluent licences. The demand for advisory services from other Government departments and Local Government continues to rise. Seven investigations for water supplies for road reconstruction were undertaken for the Main Roads Department, 4 reports were provided to local Government bodies on land drainage, optimization of sanitary land-fill sites and water supplies. Three reports were also prepared for the Department of Agriculture. The number of farm inspections for private owners declined to 31.

Systematic hydrogeological mapping has commenced with the Perenjori and Marble Bar 1:250 000 map sheets.

Engineering and Environmental Geology Branch

Engineering geology investigations can be grouped into:
(a) Dam site investigations

These included investigations relating to dams at Harris River, Brunswick, Wungong, North Dandalup, Little Dandalup, Victoria and Harding Rivers.

(b) Other site investigations

These included work relating to a breakwater and excavated harbour at Jurien Bay, a breakwater at Hopetoun, quarries at a number of locations, a new water tank at Kalgoorlie and tunnels at Wungong and Bibra.

(c) Route investigations

Geological studies were undertaken for proposed rail routes from Gingin to Eneabba, Hyden to Lake Grace and Bruce Rock to Merredin. Advice was provided in relation to a new route for the Great Northern Highway between Port Hedland and Newman.

(d) Foundation studies

General geological advice and material searches were undertaken for water storage facilities at a number of locations in the south west of the state, for sewerage facilities at Port Hedland, Collie, Broome and Swan View; for a bridge at Ascot in the Perth metropolitan area; and in relation to the Palace Hotel site in the heart of Perth.

(e) Earthquake risks and hazards continued to be the subject of investigation throughout the state.

Activities of the Environmental Geology Section covered a wide range but can be divided into the following principal areas.

(1) Environmental geology maps

Final compilation and/or publication was achieved of maps covering Bunbury-Burekup, De Witt—Picard, Harvey—Lake Preston, Port Hedland—Boodarie. Geological mapping and/or preliminary compilation of environmental geology maps of Yanchep, Muchea, Fremantle and Serpentine was also undertaken.

(2) Review of environmental reports

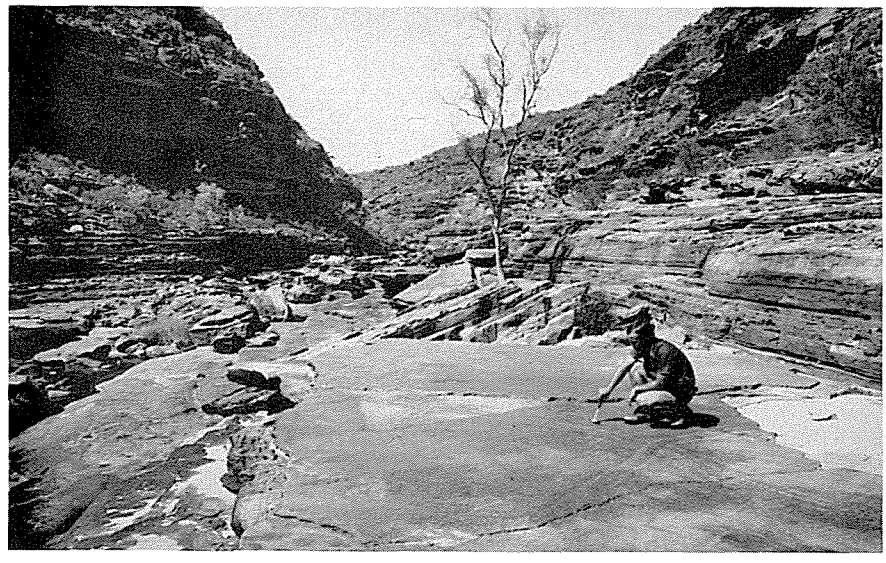
These included reports from the Department of Conservation and Environment dealing with System 6, from the Darling Range Study Group, from the Forest Department, on coastal management, on the Perth Airport Master Plan, the Mandurah Canal Estate, the Harding Dam site and the Collie Coal Basin.

(3) Preparation of reports and committee work

Reports were made on amendments of various town planning schemes and meetings were held with other organisations concerning basic raw material studies, national conservation strategy and mining and management planning for bauxite operations in the Darling Range.

(4) General

Miscellaneous duties carried out in connection with environmental geology included reporting on mining tenement applications, geological mapping of jarrah and dieback sites, commenting on development proposals and conditions of exploration in nature reserves and provision of information for the 1982 report to the Australian Geoscience Council. An interim report on the bauxite deposits of the Darling Range was prepared for use by the Mineral Resources Branch.



Geological Survey geologist examines eurypterid tracks in the Tumblagooda Sandstone (Silurian). Murchison River Gorge

Regional Geology Branch

The first edition 1:250 000 scale map sheets of Corrigin, Dumbleyung and Kellerberrin were compiled, and these complete the coverage of the State at this scale.

Compilation of the Peak Hill (2nd edition) 1:250 000 map sheet was completed. Field work for the Wyloo (2nd edition) 1:250 000 map sheet was completed and part of the Edmund sheet was remapped. Mapping of the Cue (2nd edition) 1:250 000 map sheet was commenced and nearly completed. Field work on the Widgiemooltha and Boorabbin (2nd editions) 1:250 000 map sheets was continued by officers based in the Kalgoorlie Regional Office.

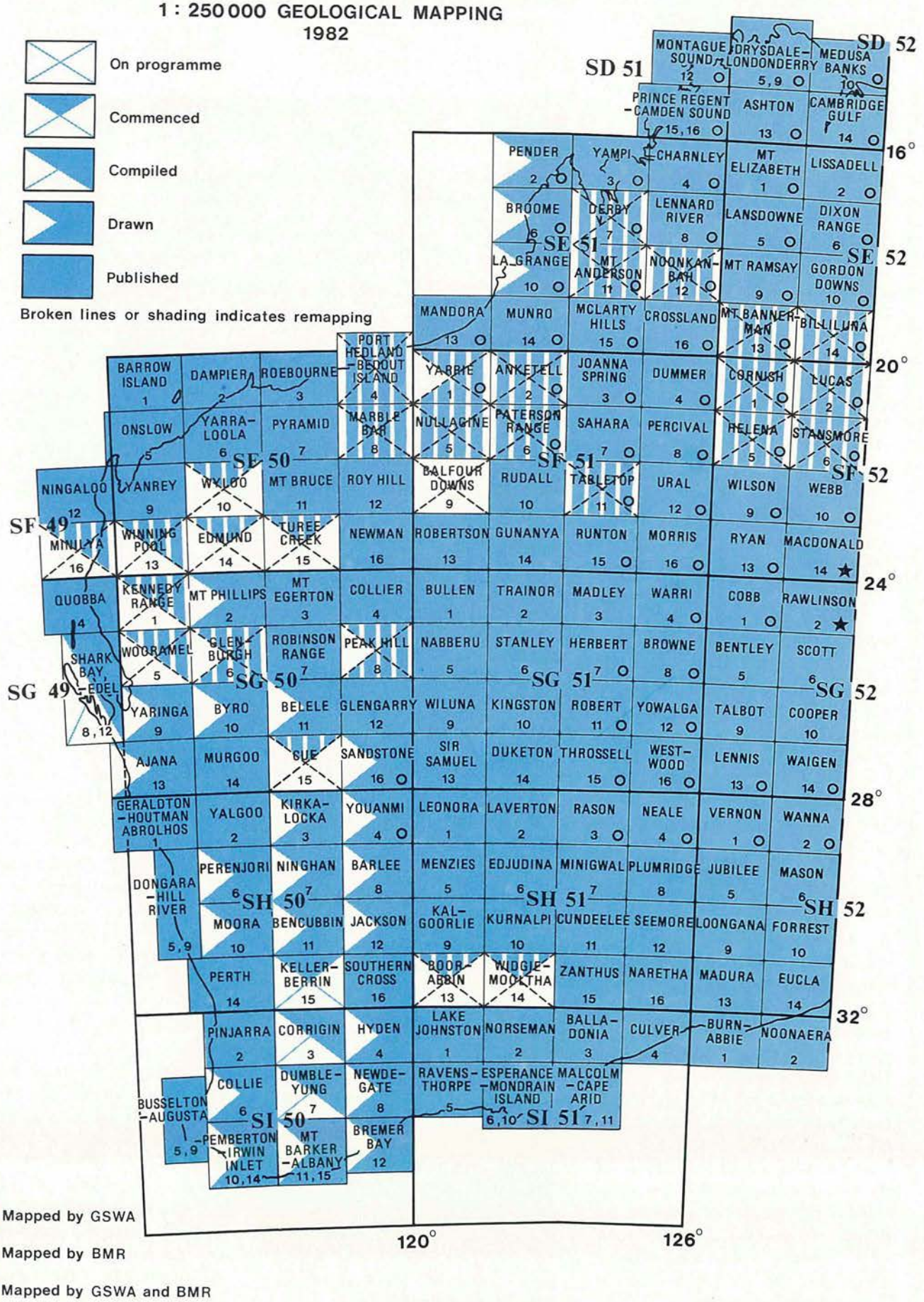
Detailed mapping continued in the Mt Narryer region of the Byro 1:250 000 map sheet, and the Fraser Range Complex and Hyden fault scarp were investigated briefly. Bulletins were completed on the Nabberu Basin and Gascoyne Province.

Sedimentary Geology Branch

The evaluation and processing of data received from coal and petroleum exploration companies continued on a routine basis. Requests for data have remained at a high level and there have been many requests to examine core and cuttings samples at the Dianella Core Library. Map compilation and explanatory note writing for the Carnarvon Basin 1:250 000 map sheets were essentially completed during the year. The Carnarvon Basin bulletin manuscript is nearing completion.

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

1 : 250 000 GEOLOGICAL MAPPING
1982



Field work in the Bonaparte and Ord Basins was completed during the year. Maps and a bulletin dealing with these two basins are being prepared. Field work and office studies on the geology and coal reserves of the Collie Basin have continued throughout the year.

Mineral Resources Branch

During 1982 reports on mineral exploration by industry reached a record level as a result of the boom of the previous two years and the number of requests for data on terminated projects was also high. Because of staff turnover the number of reports microfilmed for our open file declined.

Work on the Darling Range bauxite study was recommenced when new staff became available. The Murchison metallogenic study, which had been deferred because of staff shortages was begun during the year.

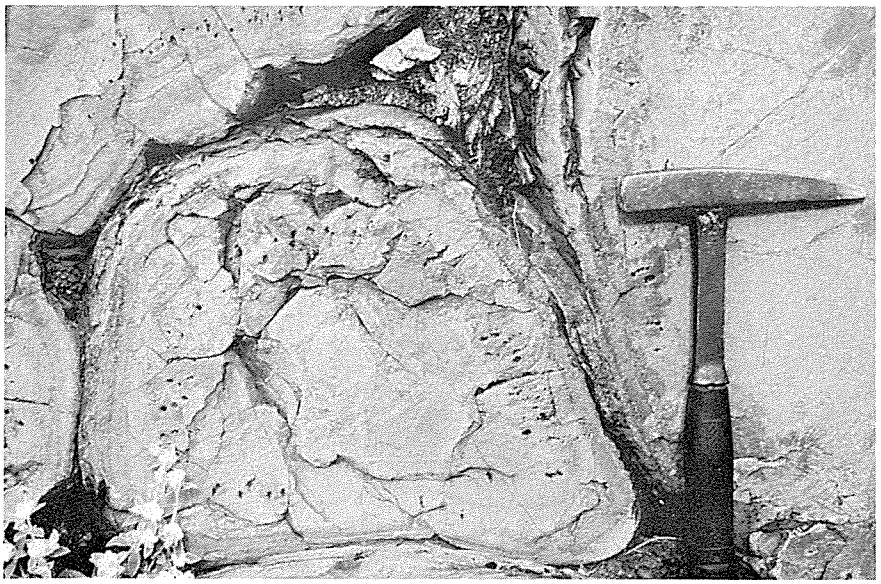
The Lower Fortescue Group study was terminated when the officer concerned resigned. His maps and report on work completed will be published. Work began on a study of the carbonate hosted lead-zinc deposits of the Kimberley region. The project is part of a larger one involving WAIT and the BMR and is partly sponsored by WAMPRI.

Preparation of reports on Mt Monger and the Warriedar Fold Belt continued.

Miscellaneous investigations included: another inspection of the Minninup uranium anomaly; inspections of the Mitchell Plateau bauxite and Argyle diamond projects; visits to WMCs operations at Kalgoorlie, Kambalda and Norseman in connection with statutory reporting; an assessment of the ore reserves on the North Kalgurli gold mine; studies relating to levels of mineral royalties in Western Australia; investigations of computer indexing and retrieval used by interstate surveys and some major companies; and the organization of two geological excursions.

Common Services Branch

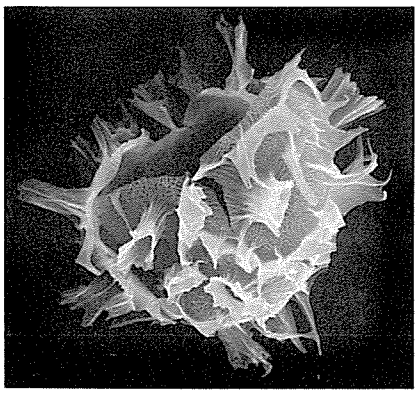
Petrology. Demand for service petrological work eased during 1982, when 60 reports were completed, covering 1 295 samples.



Pillow structures in Archaean basalt; formed by quenching of lava extended on the ancient sea floor

Petrology staff were directly involved in the preparation of three articles and one extended abstract published during the year. Topics included the petrology of kimberlite, geochemistry of the Mount Edgar Batholith, geochronology of the Windimurra mafic complex and a summary of geochronological studies in Western Australia. Studies on kimberlite, alkaline granite, and regional metamorphism continued through the year.

Palaeontology. Forty reports were written during the year covering: (1) Mesozoic and Palaeozoic palynology from throughout the State for the Hydrogeology and Sedimentary branches; (2) Precambrian and Palaeozoic stromatolites for the Regional Geology and Sedimentary branches; and (3) Devonian brachiopods for the Sedimentary branch.



Early Cretaceous dinoflagellate cyst from the South Perth Shale

Geophysics. During 1982, 256 water bores with an aggregate depth of 59 200 metres were logged. A stripping head to facilitate logging of flowing bores was put into service. Seismic refraction surveys were undertaken at the Jurien Bay Boat Harbour, Wellington Dam Catchment, North Dandalup Dam Site, Harris River Dam Site and a tank site at Caddup. Further seismic surveys were undertaken in connection with northern wheatbelt salinity investigations near Dalwallinu.

A gravity survey aimed at delineating the perimeter of the Collie Basin in the north eastern part of the Collie township was also undertaken.

Geochemistry. Reports completed and/or in press during 1982 comprise a study of shale and iron-formation in core RD1, a statistical assessment for prospecting of the trace compositions of ironstones from the northeast Pilbara (with the Mineral Resources branch), chemical composition of Precambrian iron-formations, geochemical needs for the Geological Survey for the

next 5 years, stratabound axinite in the Weeli Wolli Formation and its occurrence in related dolerites (with the Government Chemical Laboratories); and a regional geochemical and petrographic study of the Mount Edgar Batholith (with the Petrology section).

Work in progress at the end of 1982 comprised geochemical and petrographic studies of the Corunna Downs Batholith, Weeli Wolli Formation core, the Jeerinah Formation and Marra Mamba Iron Formations of the Hamersley Basin; and the granite and greenstones of the Pilbara Block. A start was made on a study of trace elements in Collie coals in conjunction with Sedimentary Branch and material was collected from the Mount Clement gold-silver-lead-arsenic prospect in the Ashburton Trough.

Technical Information. Bulletin 127 on the geology of the Pilbara Block and its environs, and Bulletin 129 on the stromatoporoids of the Devonian reef complexes of the Canning Basin are in press. Bulletin 128 on the Bangemall Basin and a Bulletin on stromatolites from the Nabberu Basin are in the final stages of preparation, and will be sent for printing early in 1983. Mineral Resources Bulletin 14 on nickel mineralization in Western Australia is with the printer, and Memoir 2 is being reprinted.

Report 11 on the Cadoux earthquake was issued in May 1982. Another Report containing the professional papers that in the past have been included in the Annual Report, has been sent to the Government Printer.

Sixteen full-colour maps of the 1:250 000 scale series with accompanying Explanatory Notes have been issued (listed on p. 42) and 8 are currently being printed. Three more have been received from the printer and will be available early in 1983. One full-colour map of the same series has been issued without accompanying Explanatory Notes.

Five Records (see p. 42), including one Explanatory Notes to accompany a preliminary map of the 1:250 000-scale series, have been published. The preliminary edition of the Mount Barker—Albany 1:250 000 scale map has been released—the accompanying Record 1982/7 will be available in January 1983. A map of the mineral deposits of Western Australia has been published in two forms: as a coloured paper map and as a transparent overlay.

The second editions of the Gemstones and Aluminium Pamphlets were issued and the second edition of the Iron Ore Pamphlet is in press. The Nickel and Copper Pamphlets have been rewritten and are being edited and prepared for printing.

A 1:50 000 scale Urban Geological Map of Bunbury—Burekup was issued in November 1982.

The Publications Catalogue has been updated and is ready for reprinting.

Interest in gold remained at a normal level during 1982, and public enquiries were correspondingly manageable.

The library was well used by members of the public many of whom made use of the microfilm reading and printing facilities.

Organization

Staff

Apart from the reclassification of one position in the Common Services Branch there were no significant changes to the structure of the Geological Survey in 1982.

A major restructuring proposal designed to meet additional demands for services and to give increased salaries and promotional opportunities was approved in 1982 subject to the availability of funds and hopefully will be implemented in 1983/84. When finally effected the restructuring will allow professional staff numbers to be increased from 63 to 81 officers with a commensurate rise in the numbers of general staff.

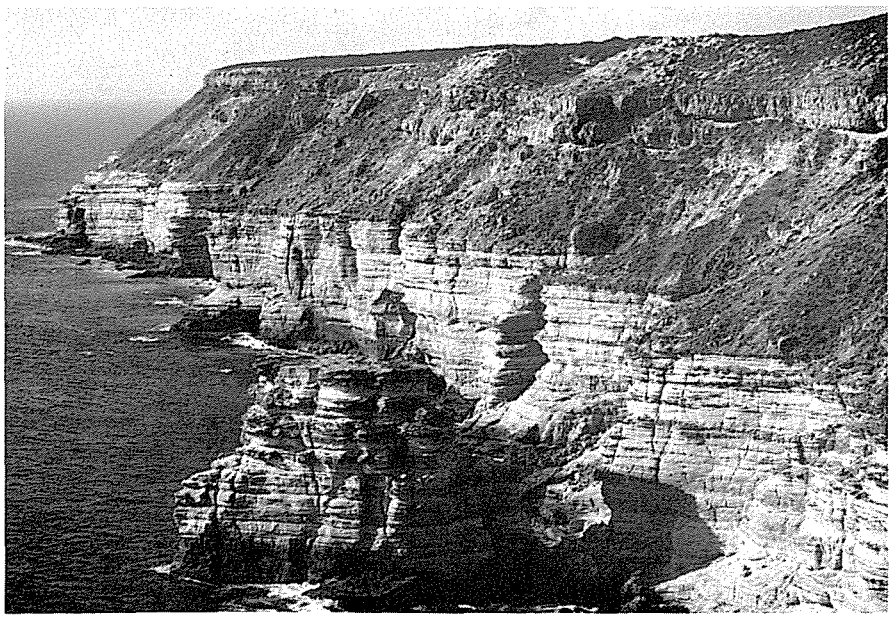
The general economic climate during 1982 brought about a further reduction in the number of resignations of members of the professional staff. There were only 5 resignations compared with 13 appointments bringing professional staff to almost full strength. Dr. J. S. Myers B.Sc.(Hons), Ph.D., ARCS, DIC, FIGS was appointed supervisor of the Regional Geology branch, the Palaeontologist, Dr. A. E. Cockbain, was promoted to supervisor of the Sedimentary Geology branch on the retirement of Mr. M. H. Johnstone from that position, and Dr. S. K. Skwarko, M.Sc. (Hons), Ph. D. was appointed as the Palaeontologist. At the end of 1982 only three senior positions in the Sedimentary branch remained to be filled.

Within the clerical and general staff 4 resignations and 3 outward transfers were balanced by 6 appointments and 1 inward transfer so that staffing levels in this section remained constant throughout the year.

Massive debris-flow deposit, Upper Devonian reef complex, Dingo Gap area, Canning Basin

Accommodation

The Geological Survey continues to be housed in 2 buildings separated by some 10 minutes walk. The situation will become worse during 1983 when the Regional Mapping branch moves into yet another building situated across the road from Mineral House. The problem is unlikely to be resolved until extensions to Mineral House are completed.



Coastal Cliffs of Tumblagooda Sandstone (Silurian) overlain by Tamala Limestone (Pleistocene). South of Kalbarri

Publications

The following publications were issued during 1982.

Geological maps at 1:250 000 scale with explanatory notes for the following sheet areas (see map on p. 39 for location by International Grid Reference):
Anketell—SF 51-2.
Collier—SG 50-4.
Derby—SE 51-7.
Glengarry—SG 50-12
Joanna Spring—SF 51-3
Mandora—SE 51-13
McLarty Hills—SE 51-15
Mount Anderson—SE 51-11
Munro—SE 51-14
Nabberu—SG 51-5
(without Explanatory Notes)
Noonkanbah—SE 51-12
Onslow—SF 50-5
Paterson Range—SF 51-6
Quobba—SG 49-4
Southern Cross—SH 50-16
Stanley—SG 51-6
Wiluna—SG 51-9

Information Pamphlets: Aluminium, and Gemstones in W.A.

Mineral deposits map of Western Australia (1:2 500 000)

Mineral deposits of Western Australia (1:2 500 000 transparency)

Preliminary geological map of Mount Barker—Albany 1:250 000 sheet (International Grid SI 50-11,15).

Records:
1982/2 The geology and hydrogeology of the Quindalup borehole line, southern Perth Basin, Western Australia; by P. H. Wharton.
1982/3 Wells drilled for petroleum exploration in Western Australia to the end of 1981; by A. Janssens.
1982/4 Geology of the Wongan Hills; by S. L. Lipple.
1982/5 Explanatory notes on the Hyden 1:250 000 geological sheet, R. Chin, A. H. Hickman and R. Thom.
1982/6 The potential for geothermal energy development in Western Australia; by T. T. Bestow.

Report 11 The Cadoux earthquake, 2 June, 1979; by J. D. Lewis, N. A. Daetwyler, J. A. Bunting and J. S. Moncrieff.

Urban Geological map 1:50 000 of Bunbury—Burekup.

In press

Bulletin 127—Geology of the Pilbara Block and its environs.

Bulletin 129—Stromatoporoids of the Devonian reef complexes of the Canning Basin, Western Australia.

Explanatory notes to accompany the Nabberu 1:250 000 geological map (International Grid SG 51-5).

Geological map at 1:250 000 scale with Explanatory Notes for the following sheet areas:
Ajana—SG 50-13.
Belele—SG 50-11.
Broome—SE 51-6
(BMR publication)
Byro—SG 50-10.
Collie—SI 50-6.
Glenburgh—SG 50-6
Kirkalocka—SH 50-3
Lagrange—SE 51-10
(BMR publication).
Moora—SH 50-10.
Mount Phillips—SG 50-2
Ninghan—SH 50-7.
Pender—SE 51-2
Yaringa—SG 50-9.

Information Pamphlet—Iron Ore

Memoir 2 (Reprint)—The geology of Western Australia.

Mineral Resources Bulletin 14—Nickel mineralization in Western Australia.

Records:
1982/7—Explanatory notes on the Mount Barker—Albany 1:250 000 geological sheet, Western Australia.
1982/8—Gravity traverses across the Warriedar Belt.
1982/9 Explanatory notes on the Winning Pool—Minilya 1:250 000 geological sheet, Western Australia.

Report 12—Geological Survey of Western Australia scientific reports 1983.

Urban-geology maps, 1:50 000: de Witt—Picard and Harvey—Lake Preston.

In preparation

Bulletin 128—Geology of the Bangemall Group—the evolution of a Proterozoic intra-cratonic sedimentary basin.

Bulletin 130—Biostratigraphic studies of stromatolites from the

Proterozoic Earaheedy Group, Nabberu Basin, Western Australia.

Information Pamphlets—Copper, Nickel.

Publications Catalogue—2nd edition

Geological maps, 1:250 000 scale, with explanatory notes, the field work having been completed: Barlee, Bencubbin, Bremer Bay, Corrigin, Dumbleyung, Hyden, Jackson, Kellerberrin, Newdegate, Pemberton-Irwin Inlet, Perenjori, Port Hedland—Bedout Island, Sandstone, Shark Bay—Edel, Yarrie, Youanmi.

Record 1982/10 Statistical assessment for prospecting purposes of the trace-element composition of caprock ironstones in the northeast Pilbara.

Record: A geochemical study of the Mount McRae Shale and the upper part of the Mount Sylvia Formation in Core RD1, Rhodes Ridge, Western Australia.

Report: Geological evolution of the Gascoyne Province.

Urban-geology maps 1:50 000: Boodarrie and Port Hedland.

Papers in outside publications

Ahmat, A. L., and De Laeter, J. R., 1982, Rb-Sr isotopic evidence for Archaean-Proterozoic crustal evolution of part of the central Yilgarn Block, Western Australia: constraints on the age and source of the anorthositic Windimurra Gabbroid: Geol. Soc. Australia Jour., v. 29, p. 77-190.

Allen, A. D., and Davidson, W. N., 1982, Review of groundwater resources in fractured rocks in Western Australia: Australian Water Resources Council Conference Series No. 5, p.1-2.

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Griffin, T. J., 1982, Granitoids of the Tertiary continent—island arc collision zone, Papua New Guinea *in* Roddick, J. R. (ed), Circum-Pacific Plutonism: Geol. Soc. America, Special Paper 193.

Jaques, A. L., Gregory, G. P., Lewis, J. D., and Ferguson, J., 1982, The ultrapotassic rocks of the West Kimberley region, Western Australia, and a new class of diamondiferous kimberlite: Terra Cognita, v.2, no. 3, p.251-252.

Lipple, S. L., 1982, Geology of the Ninghan Fold Belt, Mount Singleton, W.A., *in* Archaean Geology of the Southern Murchison: Geol. Soc. Australia, Western Australian Division, Special Publication, p.6-14.

Lipple, S. L., 1982, The Wydgee Fold Belt, *in* Archaean Geology of the Southern Murchison: Geol. Soc. Australia, Western Australian Division, Special Publication, p.28-30.

Lipple, S. L. and Baxter, J. L., 1982, The Koolanooka Synform, *in* Archaean Geology of the Southern Murchison: Geol. Soc. Australia, Western Australian Division, Special Publication, p.79-80.

Mory, A. J., 1982, A review of Early Carboniferous stratigraphy and correlations in the northern Tamworth Belt, N.S.W.: Linnean Soc. New South Wales Proc., v.105, p.213-236.

Mory, A. J., 1982, The Early Carboniferous palaeogeography of the northern Tamworth Belt, New South Wales: Geol. Soc. Australia Jour., v.29, p.357-366.

Mory, A. J., and Crane, D. T., 1982, Early Carboniferous *Siphonodella* (Conodonta) faunas from eastern Australia: Alcheringa, v.6, p.275-303.

Nazarov, B. B., Cockbain, A. E., and Playford, P. E., 1982, Late Devonian radiolaria from the Gogo Formation, Canning Basin, Western Australia: Alcheringa, v.6, p.161-173.

Playford, P. E., 1982, Devonian reef prospects in the Canning Basin: implications of the Blina oil discovery: APEA Jour. v.22(1), p.258-271.

Smurthwaite, A. J., 1982, Urban geology and resource occurrence, *in* Basic Raw Materials Planning for the Future Seminar, Perth, June 17 & 18, Proceedings: Western Australian Regional Planning Authority, p.5-13.

NORTH WEST SHELF GAS PROJECT — 1982 diary

January

Fabrication of the main structure for the North Rankin "A" production platform at the N.K.K. shipyard at Tsu, south of Nagoya in Japan is virtually complete.

Drilling, production and accommodation modules and the flare tower and bridge are well under way at yards in Singapore, Jervoise Bay, Geraldton and Adelaide.

On the Burrup Peninsula, weight and corrosion coating of 55 per cent of the 12 500 sections of the submarine pipeline is complete, construction of the supply base and preparation of the site of the onshore gas treatment plant at Withnell Bay continues.

In Mermaid Sound, a trench for the submarine pipeline is being dredged.

Woodside and the Joint Venturers announce postponement of North Rankin "B" production platform.

February

The rock laying vessel "Rocky Giant" arrives in Mermaid Sound.

March

Target date for sales of LNG to Japanese electricity and gas utility companies delayed until April 1987. The "Rocky Giant" begins to lay rock to prevent seabed scour at the platform site.

April

The main jacket is complete and begins the 8 000 km journey south from Japan to Australia. Corrosion and weight coating of the submarine pipeline is completed.

May

The derrick barge "Thor" arrives in Mermaid Sound for use during installation of the jacket including driving 32 piles 120 metres into the seabed, lifting and positioning 21 permanent modules besides providing accommodation for 370 persons during the installation phase.

The jacket reaches Mermaid Sound where a final inspection is made prior to installation.

The pipelaying barge "ETPM 1601" arrives in Mermaid Sound and laying of the 134 kilometre submarine pipeline begins.

June

The North Rankin "A" jacket structure is placed on location on the seabed above the North Rankin gas field; piling of the jacket to the seabed commences.

The main contractor for the onshore gas treatment plant, a consortium of M. W. Kellogg Co., J.G.C. Corporation and Raymond Engineers Australia Pty Ltd is appointed.

July

Fabrication and equipment commissioning of drilling modules in Singapore is complete and the modules are loaded onto barges.

August

The wellhead and accommodation modules and helideck at Geraldton are completed, loaded out onto a barge and the tow to Mermaid Sound commences.

The flare tower is launched in Adelaide and the tow across the Great Australian Bight commences.

September

The flare bridge tow from Adelaide commences.

The wellhead and accommodation modules, helideck and flare tower arrive in Mermaid Sound.

October

The tow of drilling modules from Singapore commences.

The flare bridge arrives at Mermaid Sound.

The flare tower is installed and piling completed.

The pipelaying barge completes laying the submarine pipeline. Production modules from Jervoise Bay are loaded and towed to Mermaid Sound.

November

A hyperbaric "tie-in" is completed at the 7.8 km point on the submarine pipeline.

The submarine plough towed by pipelaying barge "DLB 1601" commences the trench for the pipeline.

The rock dumping vessel "Rocky Giant" commences burial of the pipeline in Mermaid Sound.

Module installation commences and 17 modules are positioned.

December

The submarine plough completes the trench for the pipeline.

The flare bridge is installed.

Module installation continues and the remaining modules, temporary living quarters, offices and material storage containers are positioned.

Divers prepare to complete the hyperbaric "tie-in" of the pipeline to the platform riser.

Woodside—NW Shelf Project. North Rankin 'A' platform. December 1982.

PETROLEUM

A.J. SHARP, DIRECTOR

Exploration and Development

In 1982 a record number of exploratory wells were drilled (67 compared to 38 in 1981) and total penetration amounted to 151 948 metres compared to 86 268 metres in 1981. Of these wells 16 were classed as discoveries (8 oil, 8 gas), to give a high success ratio for the year of almost 1 in 4. Seismic surveys totalled 58 372 line kilometres, an increase of 58 per cent over 1981. Highlights of the year were the discovery of gas at North Scott Reef 1 and North Gorgon 1 and the discovery of oil at South Pepper 1.

In the Perth Basin, Hudbay Oil (Australia) Ltd drilled 2 Extension Tests, Woodada 5 and 6, both of which were completed as suspended gas wells in the limestone member of the Permian Carynginia Formation. Commercial gas production commenced in 1982 from the Woodada 1 and 2 wells. Hudbay also were successful at Indoon 1, 10 km south of the Woodada field where a flow of gas at 85 x 10^3m^3/day was obtained from the Carynginia Formation. Further study is needed to determine if this is an extension of the Woodada field or a separate pool.

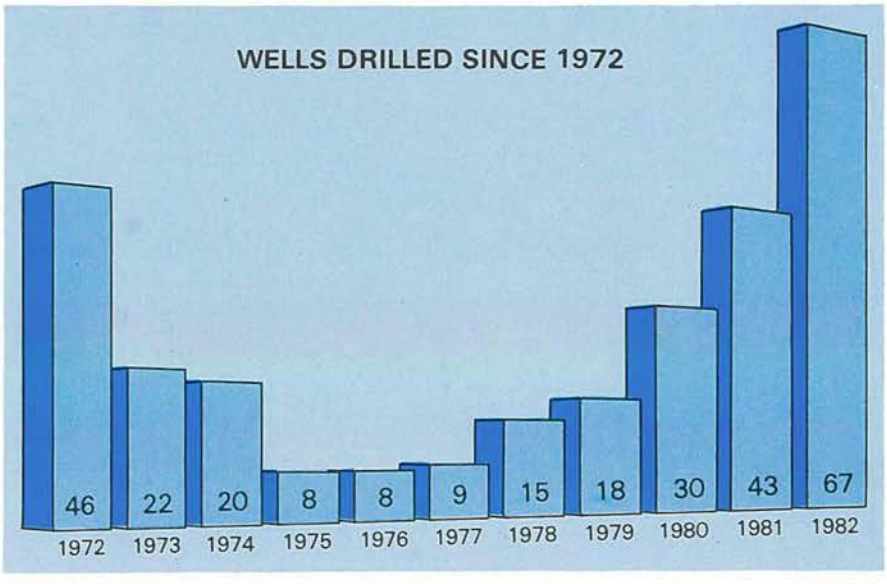
In the Barrow Sub-basin of the offshore Carnarvon Basin, Mesa Australia Ltd discovered gas and oil in its South Pepper 1 well. Good oil flows were obtained from two zones, 1 in the upper part of the Barrow Group (241 kL/day) and 1 in the lower part of the section (82 kL/day). Gas was produced from the Dupuy Member of the Dingo Claystone at 8.5 x 10^3m^3/day and from the upper part of the Barrow Group, above the oil column, at 310 x 10^3m^3/day.

In the Carnarvon Basin, WAPET had a significant gas discovery at North Gorgon 1. This was drilled to test a structural high about 25 km north of the Gorgon 1 gas discovery of 1981. Evaluation of the well was proceeding at the end of the year. Goodwyn 6, an appraisal well, drilled near the end of 1981, was tested early in 1982. This well was suspended for further testing at a later date after flowing both oil and gas, the oil at rates of up to 500 kL/day. This is the first oil discovered in the "main block" of the Goodwyn field.

In the Canning Basin, Home Energy Ltd completed Blina 4 as an oil well. In 1983 the oil from Blina field will go on commercial production. A further possible oil discovery has been made by Home at Sundown 1. This well was suspended because of the wet season and is to be tested in 1983.

In the Browse Basin a major gas discovery was made by Woodside Petroleum Development Pty Ltd at North Scott Reef 1. The Triassic, which contains the reservoir section at Scott Reef 1 was tight, but producton testing of the Jurassic sequence gave flow rates of up to 1 700 x 10^3m^3/day. There appears to be a common gas-water contact with Scott Reef 1 which suggests the field could be very large.

In the Bonaparte Basin Australian Aquitaine Petroleum Pty Ltd completed Tern 2 as a suspended gas well with flows of up to 400 x 10^3m^3/day. A third well, Tern 3 however, encountered water saturated Permian reservoirs.

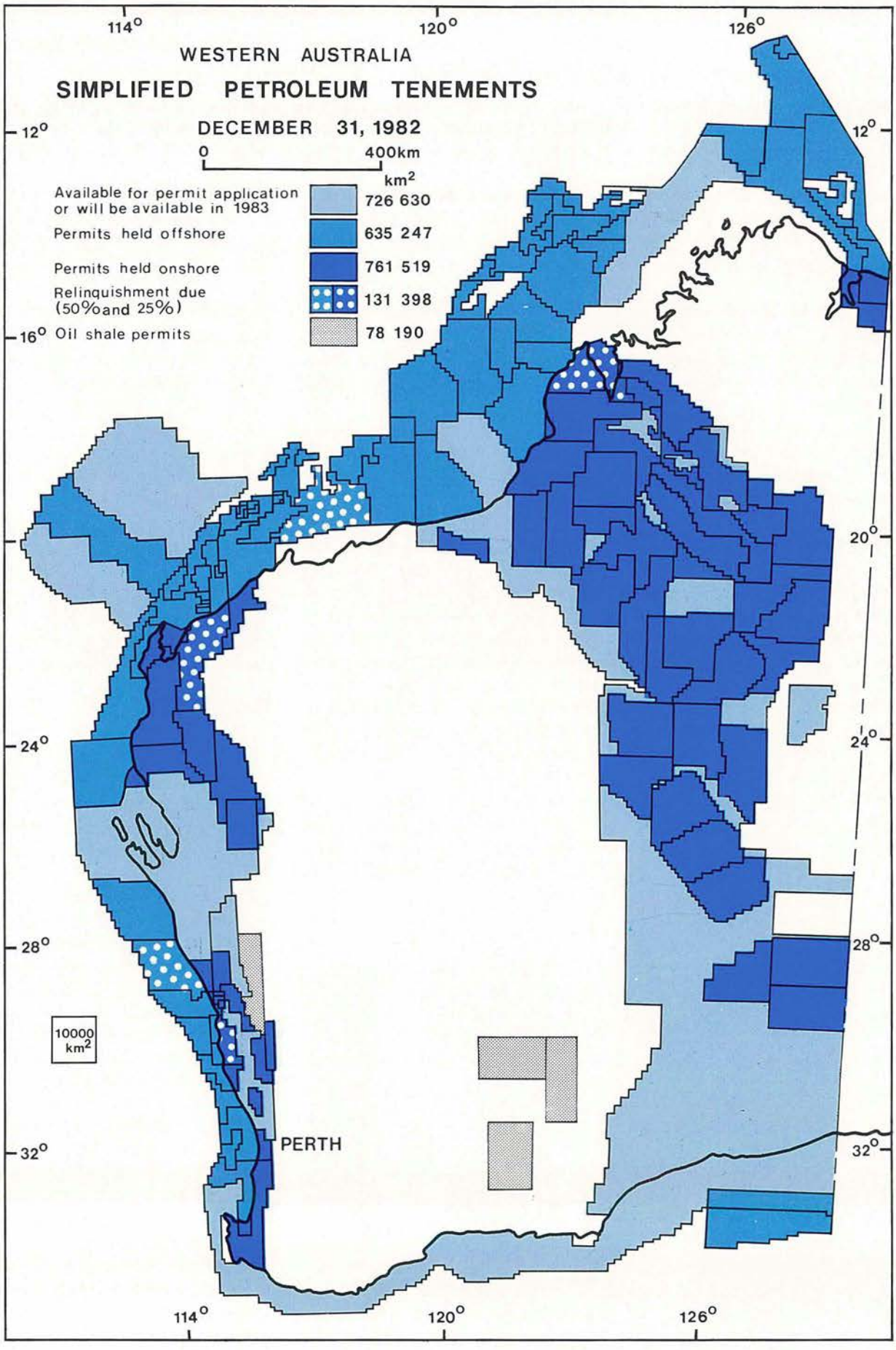


Tenements

At the end of 1982 there were 139 permits to explore for petroleum in Western Australia including 59 offshore and 80 onshore. The permit area held comprises 1 396 766 square kilometres made up of 635 247 square kilometres offshore and 761 519 square kilometres onshore. The accompanying map shows in simplified form the petroleum tenements at December 31, 1982.

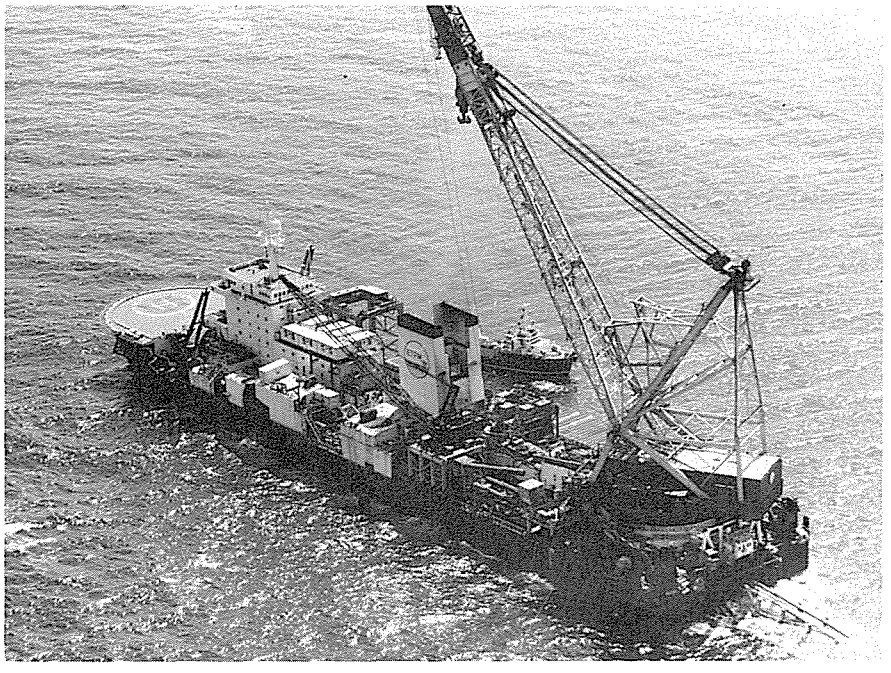
A summary comparison of permit dealings in the years 1981 and 1982 is tabulated on page 93. At the end of the year 4 applications (2 onshore, 2 offshore) were being processed. The area still available for application totals 371 500 square kilometres.

There was a general decrease in permit applications during 1982 but the area and number of permits held remained at about the same level as in 1981. The number of permits surrendered and cancelled are balanced by the number of new


WESTERN AUSTRALIA
SIMPLIFIED PETROLEUM TENEMENTS
DECEMBER 31, 1982
0
400km
km²
Available for permit application or will be available in 1983
726 630
Permits held offshore
635 247
Permits held onshore
761 519
Relinquishment due (50%and 25%)
131 398
Oil shale permits
78 190
114°
120°
126°
12°
16°
20°
24°
28°
32°
10000 km²
PERTH

areas granted and the backlog of applications pending at the end of 1981 was reduced from 50 to 4 at the end of 1982.

In 1983 several areas of the State will become available due to the relinquishment provisions of the legislation prior to renewal of a permit term.



Submarine pipelaying barge DLB 1601 (WA Newspapers Ltd)

Appraisal and development

On Barrow Island West Australian Petroleum Pty Ltd (WAPET) drilled 48 wells during 1982 in a delineation and development programme which had been initiated in 1978 following the introduction of import parity for oil prices. Most of these wells were part of an infill (40 acre spacing) drilling programme including 36 in G-block. This programme resulted from the computer modelling of the Windalia reservoir carried out between 1978 and 1981.

Ten of the wells drilled on Barrow were classified as exploratory (4 shallower pool tests, 6 extension tests). These included L76M, L54M, L56M and L58M which were successful follow-ups to L45M where oil was discovered in the Muderong M3 zone in 1980. Two wells, S84 and Q11, were completed as Windalia Sandstone oilwells, and 4 wells, R17, R27, Q21 and Y23M were awaiting evaluation at the end of the year. One well, Y35M, was waiting on completion at the close of 1982.

In 1983 WAPET plans to drill a maximum of 32 wells, including 14 Muderong tests, 2 Windalia tests on the flanks of the main pool, 2 Gearle wells, and 2 wells in the R-block extension area, as well as up to 12 infill wells.

A major project on Barrow Island in 1983 will be the construction of a large power station with gas driven turbines.

The status of the 650 wells on Barrow Island to the end of 1982 is shown in the table on page 93. Of these wells 318 are completed in the Windalia Sandstone which is the principle reservoir of the Barrow Island field.

In the northern Perth Basin, 3 fields are operated by WAPET (Dongara, Mondarra and Yardarino) and one by Hudbay (Woodada). The Woodada field was discovered by Strata Oil N.L. in 1980 (now operated by Hudbay Oil (Australia) Ltd). Gas is produced from fractured limestones of the Permian Carynginia Formation. In 1982 Woodada 1 and 2 underwent prolonged production testing into the Dongara-Perth pipeline.

No development drilling was conducted by WAPET in the Perth Basin in 1982. The company had maintenance problems particularly with the oil-producing wells due to wear and tear of the old facilities. In 1982 three Dongara gas wells (Nos. 18, 20 and 25) were successfully acid stimulated resulting in a 60 per cent increase in production from these wells. A major job for 1983 will be an acid stimulation programme of other gas wells in the Dongara field. Mondarra production, which was reduced in 1982, will be restored in 1983 after compressor restaging. Yardarino 1 is producing at a very high water to gas ratio but is still producing satisfactorily.

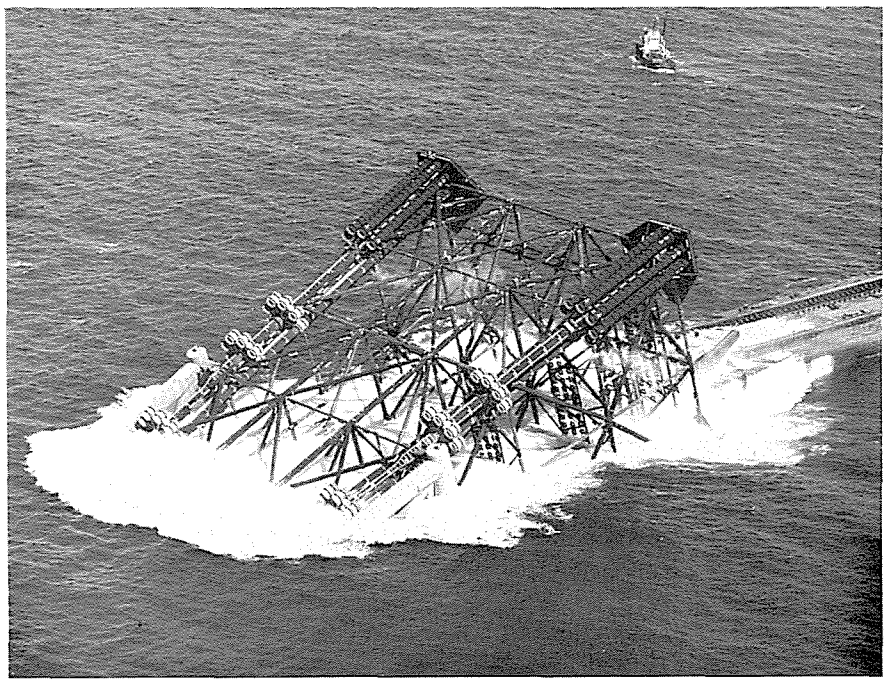
On the North West Shelf 1 appraisal well, Goodwyn 6, which was drilled towards the end of 1981, was tested early in 1982, and discovered the first oil to be found in the "main block" of the Goodwyn field.

The North West Shelf Gas project involving the development of the North Rankin Field is now at an advanced stage. The North Rankin "A" platform is nearing completion and the laying of the offshore pipeline has been completed. The construction of onshore facilities is proceeding on schedule and construction of the onshore pipeline to Perth should commence in 1983. Progress on the North West Shelf project is described more fully on page 44.

Long term production testing of Blina 1 and 2 was continued by Home Energy in 1982, the oil being trucked to the refinery at Kwinana. In 1983 the oil from Blina field will be moved by a 30 km pipeline to the Great Northern Highway, trucked to Broome and then shipped by sea to Kwinana. A fourth well was successfully completed in the field in 1982.

Petroleum Production

The total production of crude oil from the Barrow Island field during 1982 was 1 260 917 kilolitres, a decrease of about 6 per cent compared to 1981. The smaller decrease in production compared to 1981 was mainly due to tankers being more readily available in 1982 and to the discovery of new oil particularly in the Muderong Shale sequence. During 1982 the infill and development



Launching the jacket for North Rankin 'A' platform

wells drilled since 1978 contributed about 190 000 kilolitres of crude oil, or about 15 per cent of the oil production for the year. Small amounts of natural gasoline and liquid petroleum gas were also extracted from associated gas which has no direct market outlet on Barrow Island. About 10 per cent of the associated gas is used as field fuel and the remainder is processed for the extraction of plant products such as liquid petroleum gas and natural gasoline. The natural gasoline is blended with the crude oil for sale and the liquid petroleum gas is sold to markets in the northwest of the State as LPG or is blended with the crude oil for sale to the refinery. A small amount is used as vehicle fuel on Barrow Island.

A breakdown of annual and cumulative production for the reservoirs of the Barrow Island field is shown in the table on page 94.

This table also shows the annual and cumulative production for Dongara Mondarra and Yardarino fields. Cumulative production of natural gas from fields currently in production amounts to 9.0 x 10^9 m^3 since October 1971 when commercial production averaged 2 332 x 10^3 m^3 per day from these three fields during 1982. It is estimated that about 70 per cent of the reserves of these fields has now been produced. Oil production averaged about 50 kilolitres per day during 1982. The table on page 94 also shows the 1982 cumulative production.

During the latter half of 1982 an extensive testing programme was conducted by Hudbay on the Woodada field (Woodada 1 and 2 only). The gas was produced at an average rate of 229 x 10^3 m^3 per day into the Dongara-Perth pipeline and 83 527 x 10^3m^3 was produced in 1982.

In the Canning Basin, Home Energy also conducted a prolonged production test on the Blina field resulting in production of 3 280 kL of oil of which 3 245 kL was trucked to the Kwinana Refinery.

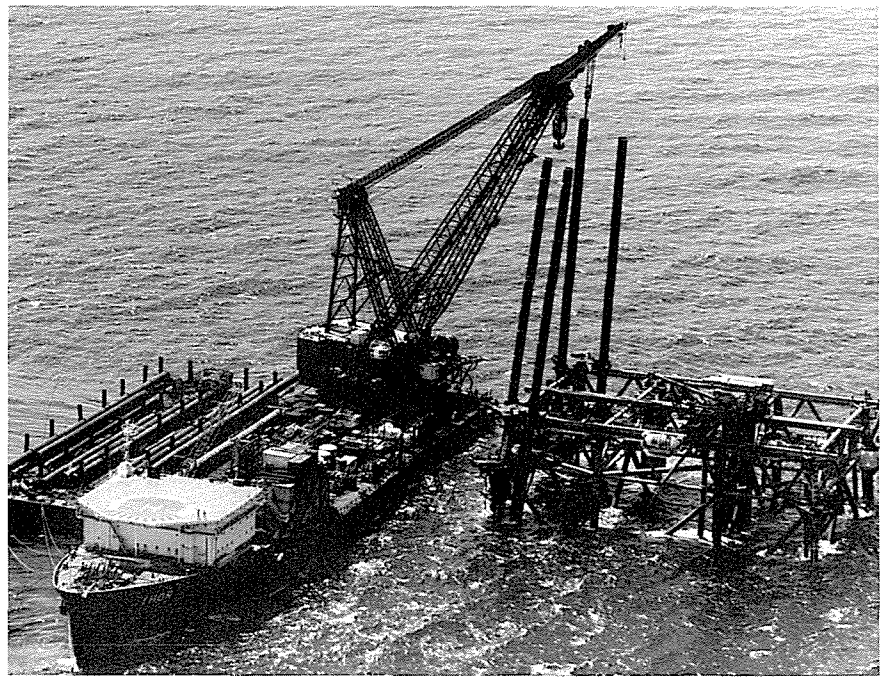
Royalties

Total royalty paid on Barrow Island crude oil sales during 1982 was $11 993 401 an increase of $5 828 758 or 49 per cent over 1981. Most of this increase is due to the royalty rate being increased in 1982 from 5 to 10 per cent of the value at the well-head for Barrow crude.

Royalty paid by WAPET from the Northern Perth Basin fields during the year was $1 711 638 an increase of $184 637 or 12 per cent over 1981.

Royalties paid by Hudbay on the Woodada field amounted to $472 242.

Royalties totalling $8 458 were paid by Home Energy on the Blina Field.



Platform piling from installation barge 'THOR' (WA Newspapers Ltd)

Total royalties paid on petroleum in 1982 amounted to $14 188 870 compared to $7 691 654 in 1981.

A table showing royalties paid and disposal of petroleum in 1982 appears on page 95.

Reserves

The total recoverable reserves of the State at the end of 1982 are estimated with a probability of greater than 25 per cent to be at least 13.82 x 10^6 m^3 of crude oil, 56.81 x 10^6 m^3 of condensate, 29.36 x 10^6 m^3 of liquid petroleum gas and 579.91 x 10^9 m^3 of natural gas. The table on page 94 shows details of these reserves.

The main changes to the gas reserve estimates for 1982 are the addition of Tern, Woodada and Tubridgi fields. As far as oil reserves are concerned the small Blina field has been added to the total, and at Barrow there was additional oil from the extension of Windalia production area, and increases due to successful Muderong M3 stepout wells. A reduction in oil has been made at Dongara because performance indicates existing wells are not capable of producing as previously estimated.

Operations

Engineering

The petroleum engineering (construction) section continued appraising the design, construction and installation of the pipeline and facilities for the Woodada gas field, the North Rankin 'A' offshore platform and the 134 km long submarine pipeline to bring the gas and consensate ashore to the treatment plant at Withnell Bay on the Burrup Peninsula.

Activities offshore started with trenching for the submarine pipeline in Mermaid Sound. They build up in June with the arrival from Japan of the 23 000 tonne jacket structure and its launching and installation on the seabed in 125 metres depth of water over the North Rankin gas field. This event coincided with the arrival of the pipelaying barge "DLB 1601" and the start of pipelaying of the submarine pipeline which was complete in November, followed by the submarine ploughing which created a furrow so the pipeline will lay below the seabed as protection from anchor drag and cyclone generated currents. Over 60 vessels have been employed by the various contractors during these activities.

Natural Gas Pipeline from Government Departments, instrumentalities and other parties were processed during 1982 compared to 238 in 1981.

There were five encroachments on the pipeline during the year, 2 by Telecom and 3 by the State Energy Commission.

Modules under tow from Jervoise Bay to Karratha (WA Newspapers Ltd)

Diving operations associated with offshore construction have involved some divers working in water depths of up to 125 metres and, wherever possible, underwater inspection was carried out using remote controlled television cameras.

By the beginning of December contracts and purchase orders worth $1 102 million had been let by the Joint Venturers for the North West Shelf Gas Project, of which 58 per cent were in Western Australia, 10 per cent in other parts of Australia and 32 per cent overseas.

Accidents

Figures relating to accident statistics in the petroleum, exploration and production industry are shown in the table on page 95.

Pipelines

A total of 227 work proposals relating to the Dongara to Pinjarra

Organization

During 1982 there were 2 appointments, 3 promotions and 1 resignation, and at the end of the year the positions of Reservoir Engineer and Petroleum Engineer (offshore construction) were vacant.

As in the previous year the high level of activity in the industry has caused difficulties in attracting and retaining the experienced professional staff necessary for the efficient functioning of the Division.

Other Activities

During December Mr D. L. Schonhut (Petroleum Engineer, Construction) attended a United States Government sponsored "Inspector Diving Orientation Course for Petroleum Personnel" at Belle Chaise, Louisiana, U.S.A.

MAPS — information in a framework

The pleasing appearance of maps may sometimes disguise their serious nature and intent as even those which are designed to be pictorial or illustrative are about data or facts. Most maps are produced for a variety of resource, environmental or socio-economic reasons and in the hands of a specialist are a magnificent tool. Maps should be a mine of information, but as the saying goes—"all maps aren't maps". A map which carries data from one source or from one discipline which cannot be cross-correlated with data from another or to which new data cannot be matched is really no map at all.

Most maps represent specific data about a portion of the earth's surface; therefore they must have a mathematical framework and a basis of reference points which are in place on the ground and which can be represented in correct relationships on the map.

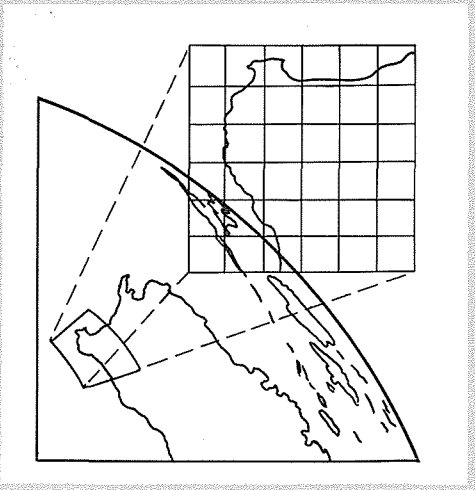
The earth's surface is so great that many reference points are required and they should be permanent and available for future users. These reference points must relate to a network of co-ordinates from a common origin accurate down to a metre in all directions. It is possible in practice to apply a co-ordinate down to fractions of a metre.

Such a network and system does exist throughout Australia and some associated islands and ocean areas, although it was only achieved in comparatively recent times. Each point no matter where, has a known relationship to each other point in the network.

The horizontal network, known as the Australian Map Grid (AMG), was established in 1966 and the uniform vertical network, known as the Australian Height Datum (AHD), was established in 1971.

The national network and its adjustment is part of the science of geodesy, the determination of points with respect to this is the work of the surveyor, whilst the construction of maps and the depiction of the data is the role of the cartographer. The co-ordinated action of these groups ensures that the data of other disciplines can be properly integrated and presented with precision.

Information of a global nature requires the entire earth and its oceans to be portrayed. At these scales the earth can usually be considered to be spherical and the mathematics is comparatively simple.



In fact the earth is not spherical. It has a very awkward shape. It resembles an oblate spheriod—a rotating sphere flattened at the top and bottom (the poles) and bulging at the middle (the equator). It has many bumps and hollows. Such a shape is known as a geoid. It is plastic and subject to influences of movement, some subtle, some more pronounced.

These factors have made it difficult to make accurate measurements. Prior to 1966 the limitations of existing equipment and the time consuming mathematical correlation processes resulted in many uncorrelated survey datums throughout the continent. The advent of accurate and rapid electronic measuring devices, large computers and a national effort directed to the task has brought about the present accurate network.

Surveyors have since recognized that a further set of international co-ordinates, based on a global concept and making use of artificial satellites, would be more appropriate. However, for data and map purposes the AMG will probably remain the vehicle for everyday users.

Included in these everyday users are members of the mining industry. They need to know the precise location of a mining tenement, particularly relative to other tenements and other owners. A commercial mineral deposit may be worth tens or even hundreds of millions of dollars so its position needs to be determinable beyond doubt. In the same way the mining industry spends millions of dollars in collecting information from geological surveys, boreholes and other forms of exploration and this money is wholly wasted if the information acquired at such expense cannot be properly located.

All new maps of the Department are now produced on the AMG basis and accordingly they carry the now familiar values and graticules of this system. Lines of latitude and longitude are also shown, sometimes in association with the metre values and sometimes on their own.

It is important that gatherers of new data and makers of new surveys relate their information directly to the fixed points of the AMG and to do this within acceptable accuracies. Map co-ordinates should be properly understood so that new data will be compatible with data already within the map base.

Maps should not be taken for granted. The earth is so large, and data such as topography, mining tenements, geology, water resources or cultural information is so important and subject to change that constant up-keep is required.

An unrevised map series is a decaying national and state asset whose replacement will inevitably be at a greatly increased cost.

SURVEYS AND MAPPING

W.R. MOORE, SUPERINTENDENT

The public plans of the Department and the principles of boundary survey have evolved over the years in response to the constantly changing needs of those using the Mining Act, day by day. For the first time in almost 80 years, the mining public were faced with adapting to a variety of new tenements under a new Act. Much planning was undertaken by the Division in preparation for the new Act and a gradual change-over from the old to the new has been the adopted strategy for the year. In spite of the innovations and changes embodied in the new Act, underlying all mining tenements there are certain unchangeable, and yet largely unwritten, principles concerning land ownership and land description which mean that radical changes in the mapping of tenements is not really a possibility. This is fortunate indeed, because with about 1 700 public plans a complete change of system, even in 5 years would require a replacement rate of 70 plans per week—about 12 times the present capacity to draw them.

The greatest effect of the new Act on the operations of this Division has been the advent of much larger tenements. These now cover not only Crown Land as previously but all types of land tenure. In addition the descriptions and plans of tenement boundaries are now prepared by the applicant and the adequacy of these will only be tested if a survey is required to settle any boundary dispute. No problems arose during the year but more time is needed before an objective evaluation can be made.

Tenement surveys

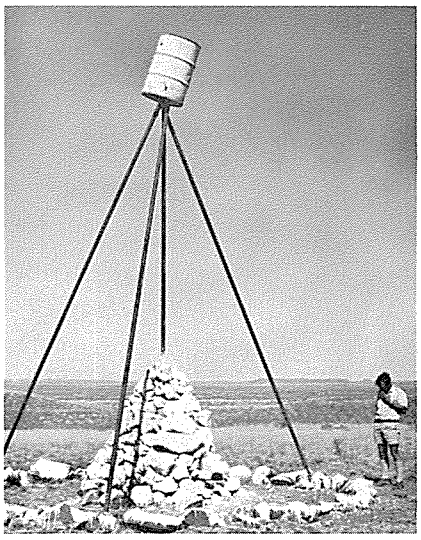
Field surveys of mining tenements were carried out at 60 localities throughout the State, ranging from Carlton in the North Kimberley to Ravensthorpe near the south coast. They were undertaken by 30 surveyors from 20 private survey firms on a contractual basis.

As shown in the table, the number of tenements completed in 1982 is considerably less than the number in 1981, although the latter figure is higher than normal, due to a carry-over of tenements from the previous year. The lower than expected figure for 1982 is partly due to the low level of exploration activity in the first months of the new Mining Act, and some hesitation by industry about the consolidation of smaller gold mining leases into larger tenements. These factors caused considerable difficulty in arranging surveys for issue to surveyors.

In the latter half of the year this situation changed and it was possible to resume the survey of tenements at about the normal rate and of the arrears. By the end of the year mining leases under the new Act were being applied for at a reasonable rate and this seems likely to continue in 1983.

The increase in surveying cost per tenement from $397 in 1981 to $472 in 1982 is attributed to an increase in surveyors charges (+8%) as from March coupled with further increases (+11%) associated with additional travelling for surveys undertaken in remote localities. The average size of tenements continued to decrease from 39.15 hectares in 1981 to 33.80 hectares in 1982.

	1982	1981
No. of tenements surveyed	**577**	2 183
Cost per tenement	**$472**	$397
No. of f.b.'s lodged	**135**	310
Total boundary line run	**816 km**	2 618 km
Total traverse line run	**173 km**	187 km
Total area delineated by survey	**25 755 ha**	85 428 ha
Distance travelled (positioning)	**43 455 km**	68 675 km
Total value of cadastral surveys	**$395 052**	$806 960
Total value of geodetic surveys	**$64 828**	$87 775
Total value of special surveys	**$1 387**	$1 885
Total value of all surveys	**$461 267**	$896 620



Cairn and tripod adjacent to Standard Survey Mark G45-2 at Main Dome, Telfer, Paterson Range. Established 1974.

By the end of December instructions for the survey of 548 tenements had been given to surveyors and further significant numbers are being prepared for issue early in 1983. The work performed by the various survey pratitioners is listed in the table. The office examination of 2 397 tenement surveys was completed during the year, reducing the backlog of unfinalized surveys to 2 569.

Field inspections. Senior Draftsman D. Stewart inspected pegging at Coolgardie on two separate occasions and also undertook reconnaissance for an extension of control for survey connection purposes through and beyond Kurnalpi.

One contract Surveyor reported a significant breach of survey practice to the Division, concerning some recent surveys of gold mining leases southeast of Sandstone, and the report was serious enough to warrant a formal investigation. A

check survey of these leases was made by Inspecting Surveyor, Mr L. Heavey of the Lands and Surveys Department and Mr D. Stewart of this Department and this showed a substantial fabrication of work by the surveyor. The Lands and Surveys Licensing Board was informed of this problem and the deficiencies in the survey were remedied by the Surveyor to the Department's satisfaction.

Company	Surveyor(s)	No. of Surveys
Markey, Campbell & Thomson (Aust)	T. Markey	
	W. Thomson	17
Fisher—Lewis	M. Fisher	
	E. Still	
	N. Harrison	
	K. Dufty	106
Ranieri, Bateman & Ingram	P. Lengkeek	
	G. Bateman	
	K. Sim	81
McKimmie, Jamieson & Partners Pty. Ltd.	C. Bloomfield	14
J. Zuideveld & Assoc.		Drafting Services
McGay Surveys	D. McGay	
	P. Watt	34
F. R. Rodda	F. Rodda	
	L. Silby	Control Projects
A. R. Williams & Assoc.	A. Williams	
	R. Beardman	38
Kanther & Shipp	L. Kanther	5
D. F. V. Wilson & Assoc.	D. F. V. Wilson	63
Maguire, Lowe & McKellar	K. Maguire	35
Hille & Thompson	P. Hille	
	J. Delfos	3
Agnew & Machin	R. Agnew	Tenements included 1981 Report.
K. F. Paterson & Assoc.	C. Parker	49
Benetti, Croghan & Assoc.	R. Benetti	40
K. M. Edwards & Assoc.	K. Edwards	29
R. G. Lester	R. Lester	25
North West Surveys	B. McNamara	21
I. M. Gordon	I. Gordon	11
Australian Aerial Mapping (WA) Pty. Ltd.	P. Byrne	3*
Compiled	—	3
20	30	577

*Designated Areas—Ashton Joint Venture (Argyle Diamonds)
Note: Perimeter Surveys of 116 Mineral Claims and 7 Gold Mining Leases included in above schedule as 3 surveys only.

This opportunity was taken to formally spot-check various other Departmental surveys at Paynes Find and Nungarra, and these checks revealed an adequate standard of accuracy and marking.

An important part of contract survey work is the maintenance of professional standards and peer group pressure encourages this. The infrequency of the need to call in the Inspecting Surveyor indicates that this approach is effective in maintaining standards.

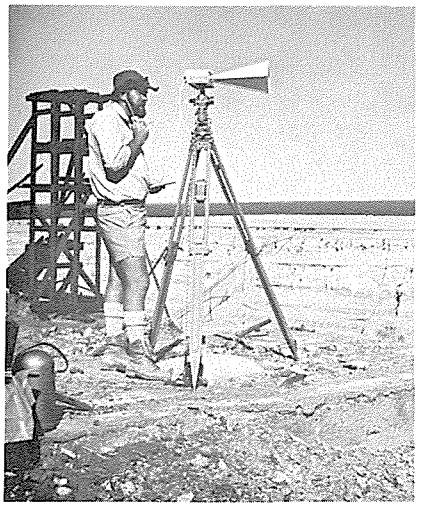
Another unusual incident was a confrontation that occurred when a pastoralist illegally denied access to a surveyor, claiming excessive damage to property and vegetation. The conflict resulted in damage to the surveyor's vehicle with consequential police intervention and charges.

Other surveys

Levelling. Levelling to obtain reduced levels of 48 bores in the Pinjarra, Lancelin and Waroona areas was carried out by officers of the Surveys Branch using spirit-level traverses to the water bores totalling 88 kilometres. They also undertook traverses to 198 gravity sites at Collie totalling 22 kilometres.

Control surveys and co-ordinate traversing. Six project areas were completed, 5 were commenced and 13 are in progress. Australian Map Grid co-ordinates are being introduced into a large number of tenement surveys. A table detailing this work appears on page 96.

New standard plans. Additional time could be allocated to this work in 1982 as a result of the downturn in survey activity in the first half of the year. Forty new plans were compiled, comprising 3 at 1:10 000, 8 at 1:25 000 and 29 at 1:50 000.



Surveying a mining tenement—Golden Mile area.

Petroleum activity

The level of interest in maps used in petroleum activity remained about the same as last year; 1 200 copies of the Petroleum Tenements Map were sold of which 460 were the regular quarterly distribution to 115 subscribers.

The Western Australian Petroleum (Submerged Lands) Act was assented to on 27th May, 1982. This Act applies to the territorial sea adjacent to the State. The Act anticipates resolution of legal ramifications concerning sovereignty of this area. It will require a proclamation by the Governor General under subsection 7 (1) of the Seas and Submerged Lands Act 1973 (Commonwealth) in which he will determine a base line for the inner

limit of the territorial sea of Australia. This determination, in its turn, will establish the outer limits of the territorial sea of Western Australia as being at a distance of 3 nautical miles (5 556 metres) seaward from the base line. The proclamation will establish, *inter alia*, the base line as being the level of lowest astronomical tide along the coast and enclosing certain configurations thereof, such as bays, and will establish sets of co-ordinates which encompass certain areas of fringing islands and other features.

Whilst the legal principles will be thereby resolved the long-term practical problem of charting these features remains. Discussions with the Surveyor General have been held. A great deal of detailed investigation of charts and maps will be neccessary and it is hoped that some resolution of the problems and work involved can be achieved in the next 12 months.

Cartographic computing

This activity for 1982 has been directed towards small projects and the consolidation of present developments, pending the appointment of a Computer Services Manager for the Department.

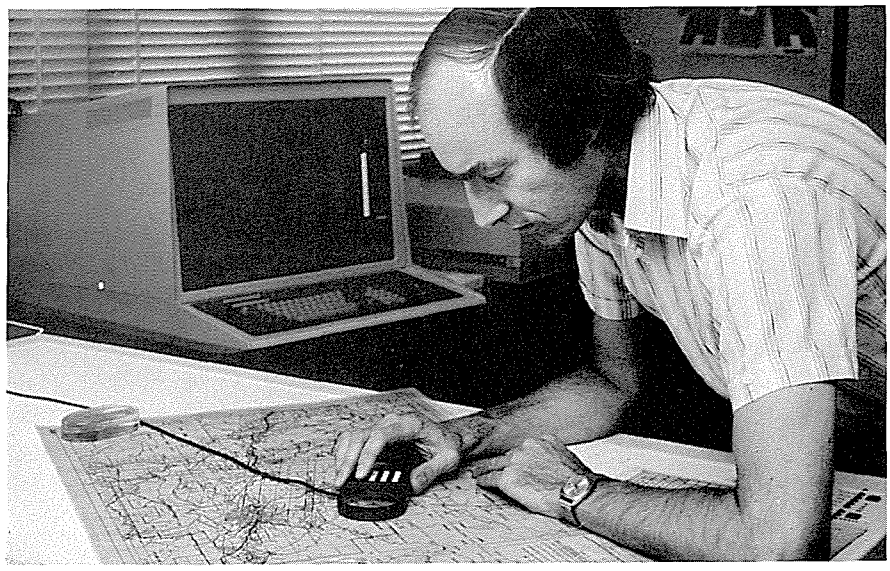
Following the involvement in the Mining Tenement Information System (MTIS) pilot study during the latter half of 1981, two officers continued preliminary analysis of existing manual procedures within the Registration and the Surveys and Mapping Divisions. Further development into a System Requirements Definition Stage was suspended.

Interfacing of the TALOS 648 digitizer with the TEKTRONIX 4054 and an upgrading to a different level of firmware on the digitizer meant considerable time was spent testing the output format produced under the new configuration.

A programme on the TEKTRONIX 4054 for producing graphs showing the monthly statistical returns on tenements applied for and processed was prepared for the use of the Registration Division.

The Survey Account System (SURVACT) was reviewed and redeveloped for the use of the Survey Branch on the CYBER computer at the Main Roads Department (MRD).

The SURFACE graphics package on the MRD CYBER computer was used for the generation of computer contour plots. Support for the MINDUST System and supervision of systems and maintenance of programmes for geodetic calculations was continued.



A digitizer being used to gather information from a map for processing in a computer.

To monitor the anticipated increase in computer activity, an internal Computer Applications Working Group was set up.

Cartography

Geological regional series—1:250 000 scale. Five full colour first editions were printed—Moora, Yaringa, Ajana, Ninghan and Kirkalocka, as were four preliminary editions in two colours: Mt Barker—Albany; Hyden; Dumbleyung and Wooramel. There is an extensive programme planned for this series with 26 maps in various stages of production. Two full colour sheets—Paterson Range and Port Hedland—and two sheets in preparation—Yarri and Youanmi, are being produced jointly with the BMR.

Geological urban series—1:50 000 scale. The only colour map in this series printed during the year was Bunbury—Burekup. Picard—De Witt is scheduled for printing early in the new year with Harvey—Lake Preston to follow. Port Hedland and Boodarrie are in preparation and will complete the series in the Pilbara region. A new programme of environmental geology maps comprising six sheets covering the Metropolitan region is being developed.

Project and thematic maps. Coloured geological maps were prepared for the Nickel Bulletin and also for the Reports for the Warriedar Fold Belt, Mt Monger Area and Lower Fortescue Group.

Cartographic preparation for the Mineral Deposits Map of W.A. at a scale of 1:2 500 000 was completed. This map uses a new approach to symbolization as all deposits of minerals of economic significance are indicated by the use of symbols and colour.

The nomenclature and cultural detail of the basic 1:1 000 000 series is being reviewed. The updated base will be used for preparation of a revised edition of the 1:2 500 000 State map and for other uses.

Maps in the thematic series at scale 1:5 000 000 have been in demand. The previous editions of the Mineral Production Map and the Administrative Map were revised

and reprinted as a third edition. It is interesting to note these maps are being used by people seeking employment (the maps carry names and address of mine and petroleum operators); suppliers of plant and equipment services also use these maps.

Mulga survey post placed in November 1935 to mark the SW corner of GML 2038W—Ora Banda. Photo: June 1973.

A Mineral Exports map and a map showing information about oil and gas in W.A. are also being prepared.

Publication and display. Originally formed to handle a range of geological publications, this section now produces material for all divisions. Work ranges from illustrations for reports, publications and lectures to graphic design. A total of 859 figures for publications were completed and 235 slides and overhead transparencies were prepared during the year.

Cadastral plans. The following maps were completed:

(1) 36 maps at 1:100 000 to complete coverage of the Ashburton and Gascoyne Mineral Fields;
(2) 11 maps at 1:25 000 in heavily pegged mineralized areas;
(3) 3 maps at 1:50 000 out of a total of 19 required to cover areas in the South West Mineral Field. These are being derived from maps from other Departments.

An area of work which has received scant attention in the past but which must figure more strongly in the future is revision of original copy to update and incorporate new topographic information.

Reprographic work. Items of equipment purchased for this work during the year to improve quality and increase output were:

(1) an ammonia plan printer, model METEM 1620;
(2) an automatic film processor, model PAKO RA48;
(3) a SPEEDMASTER TRC-60DG densitometer;
(4) an ELINCHROM DIA photographic slide duplicator;
(5) a TOSHIBA BD-4511 plain paper copier.

However, the activities of the Reprographic area are still hampered by difficult working conditions. Further improvements are planned for 1983.

A large volume of work was again carried out by the section this year, the Geological Survey, Government Chemical Laboratories and Engineering Divisions being the main users of the services provided. Most of the plan printing in the section related to seismic information for petroleum exploration.

Public plans

The public plans of the Department have been adequate to cope with tenements under the new Mining Act but some changes to the usual processing and land tenure appraisal systems have been necessary.

Contrary to the concept of the Act as originally framed the Prospecting Licence is the most numerous tenement. Fortunately it is a pegged tenement and pegs are available for identification should disputes arise.

A new system to monitor the progress of tenements being chartered on the plans has commenced. A register of all old Prospecting Areas was completed during the year and all of the 28 450 Prospecting Area applications were filed and colour coded.

During 1983 an extensive programme of public plan replacements is planned to accommodate the large numbers of conversions of smaller tenements under the old Act to larger tenements under the new Act.

The numbers of plans and documents being maintained for the recording of mining tenements is shown on page 97.

Technical information

Considerable interest is being shown in the positions of old mining prospects and the plans of the mines themselves. Surface and underground plans from 57 mining operations, representing 27 mining companies were received during the year.

The Division holds sets of plans for about 840 mining operations, and locality diagrams showing the extent of the workings and tenement boundaries are being prepared. So far 450 of these plans have been completed.

Other activities

Mr D. T. Pearce, Assistant Superintendent was appointed Australia's delegate to the 11th Conference of the International Cartographic Association held in Warsaw in July, 1982.

This conference was attended by delegates from 37 countries.

At the National and International Exhibitions held there many new and exciting maps were displayed. Australia's contribution, which included maps drawn by staff of this department, was one of the largest, and with Canada, was considered to be the best in showing new trends.

Following the conference Mr Pearce visited 14 major mapping establishments in 8 countries includ-

ing the Soviet Union and East Germany concluding with attendance at a meeting of the United Nations in Geneva on the standardization of geographical names.

held in Canberra between 19th and 23rd April, 1982, and was attended by the Superintendent, Mr W. R. Moore, with Mr D. T. Pearce and Mr P. Shaw.

The new plan printer—METEM 1620.

A senior cartographer, Mr P. A. Shaw, visited four mapping establishments in Canberra, Sydney, Dandenong and Bendigo to gain valuable up-to-date information on automated mapping systems already in operation.

The First Australian Congress on Surveying and Cartography was

The Chief Cartographer, Mr G. R. Sharp, was the Department's delegate to the 11th Conference of Geological Cartography held in Sydney from 24th to 26th November. This conference is an adjunct to the Government Geologists Conference and meets to discuss items of common concern in geological mapping and drafting office procedures with State Mines Departments. This group had the task of compiling a technical publication "Guidelines for Preparation of Visual Aids". This task has been completed and the publication has been printed and is ready for distribution through the various State Departments and the B.M.R.

Mr Sharp also visited Mercury-Walch in Hobart to discuss continued contract map printing arrangements for multicoloured geological maps compiled by this Department.

Inspection of the plans and procedures in the Department's District Offices at Broome, Kununurra, Mt Magnet, Cue and Meekatharra was conducted. Formal meetings of the Nomenclature Committee and the State Survey and Mapping Committee were attended during the year.

The Division participated in a map display at the Royal Show between 1st and 10th October. Thirteen Government and other Agencies participated, the aim being to inform the public of the range of maps available and to display departmental contributions to mapping. The display was considered to have achieved these aims.

KALGOORLIE METALLURGICAL LABORATORY

For the first time since its inception in 1923, the Kalgoorlie Metallurgical Laboratory has acquired new modern premises. Construction of the original building commenced in 1920 and the first experiments were in progress by 1922. Since then, the Kalgoorlie Metallurgical Laboratory has had a distinguished history of involvement with metallurgical testing of the State's mineral resources, especially of gold, nickel and tin-tantalite.

The Commonwealth Scientific and Industrial Research Organization (CSIRO) agreed to provide an additional officer for the Kalgoorlie Metallurgical Laboratories staff in 1935. Mr. George Payne, appointed under this agreement, occupied the first CSIRO position to be established in Western Australia.

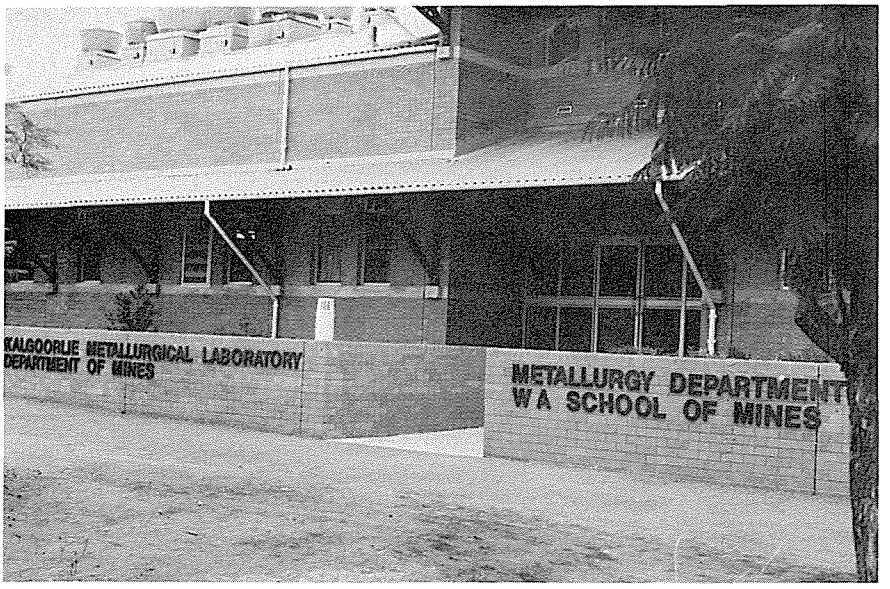
By 1940 Kalgoorlie Metallurgical Laboratory staff were testing active charcoal (fore-runner of the current carbon-in-pulp boom) for the recovery of gold from cyanide solutions. In 1944 they demonstrated that recovery of ilmenite, rutile and zircon from the south coast beach sand deposits was feasible.

In the early 70's they were testing ores for the nickel boom and contributed to testwork for the Telfer gold mine. By 1973, they were investigating the modern carbon-in-pulp process.

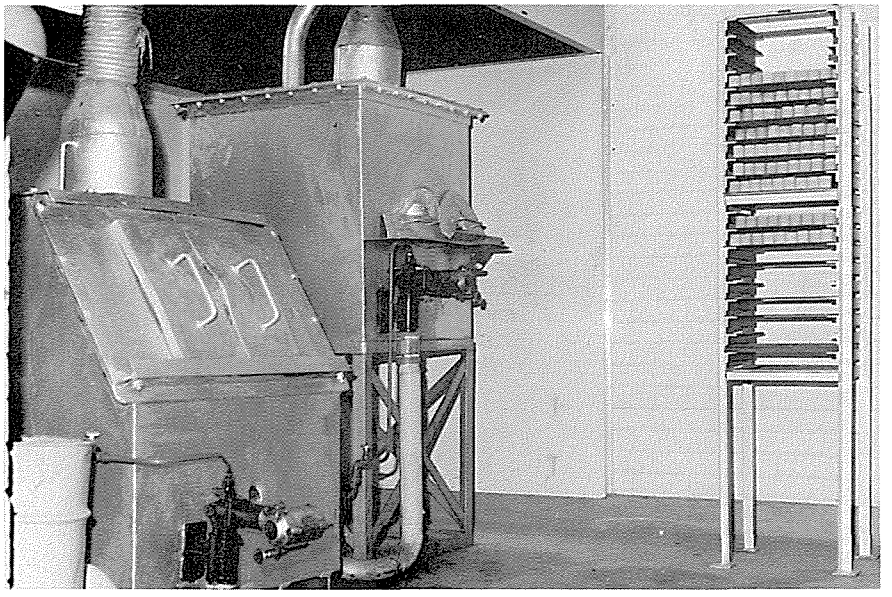
The Kalgoorlie Metallurgical Laboratory came under the jursidiction of the Government Chemical Laboratories in 1971, and today is still heavily involved with gold ore testing and further equipped to test a wide variety of other ores.

The Laboratory maintains its reputation for excellence in the practical treatment of the ores of the Eastern Goldfields. It provides technical advice and facilities for metallurgical testwork for prospectors, and mining and exploration companies.

The new Laboratory retains its separate identity, but is contiguous with the metallurgy wing of the West Australian School of Mines. The two organizations continue to co-operate closely as in the past, and share certain facilities. The premises cost more than $700 000 and are one facet of the continued support given to the mining industry by the government through the Department of Mines.



Entrance to Joint Metallurgy Complex.



Gold assay furnaces and cupel-racks.

GOVERNMENT CHEMICAL LABORATORIES

R.C. GORMAN, DIRECTOR

The demands on the Laboratories services grew dramatically in 1982, sample submission increased by 24% over 1981. Over the last 10 years submitted work has grown at an average of 10% per year while staff growth has averaged only 1% per year. The greater work load is illustrated in the graph on this page showing the samples received for the period 1960 to 1982.

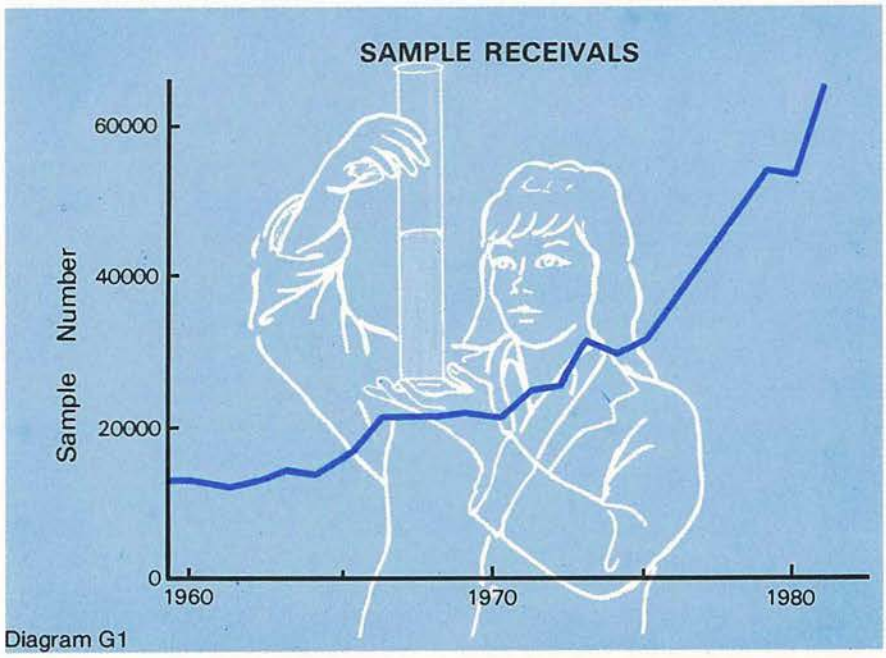


Diagram G1

There were major increases in the work required by the Department of Agriculture, Public Works Department and the Police Department in particular in 1982.

The Laboratories have been able to cope with this greatly increased work load without increasing the reporting time and backlog of urgent work, only through automation of procedures and the dedication and efficiency of staff. However this year the effort that could be put into further developmental work has had to be severely restricted because of the greater sample load.

The Scientific Co-ordinating and Advisory Committee, which was set up to look at all Government analytical laboratories as a result of earlier reviews of our functions, commenced operations this year. The several meetings held to date have established points of policy on matters that should be referred to this Committee. All equipment costing over $40 000, all increases of staff over two per year and all major alterations to existing laboratories or construction of new laboratories are to be referred to this Committee. It is hoped that, when the Committee has fully taken up its task, it will make a major contribution towards overcoming the various problems that have affected these Laboratories for a number of years.

A major problem currently confronting the Laboratories is the need for additional laboratory accommodation. This can no longer be obtained as in the past, by ad hoc additions to the existing buildings. Because of site limitations a decision on future expansion is necessary for both short and long term planning. Proposals have been put to the Government Accommodation Committee for either a staged redevelopment on the present site for three storey laboratory buildings or for a staged shift to a new site. The Public Works Department policy of limiting laboratory building to no more than three storeys because of fire and safety risks would not prevent a sensible redevelopment on the current Plain Street-Hay Street site. A new site near the Western Australian Institute of Technology has been suggested as very practical, to allow close association with that Institute both in facilities and personnel. A decision on where, when and how such new laboratory space will be provided is still pending.

The major highlight of the year was the move by the Kalgoorlie Metallurgical Laboratory into a completely new building. This is referred to in greater detail on page 56.

Laporte effluent disposal. The report to the Government by the Laporte Effluent Disposal Committee on which we are represented was published in October. This report includes details of various chemical treatments examined by the Laboratory. Our section of the report initially made in 1975 and updated in 1977 was further updated to 1981 for the purpose of the overall report. None of the range of chemical treatments from simple limestone dosing through to sophisticated evaporation and roasting to give acid recovery could be recommended because of high capital and operating costs. While chemical treatment appears to be attractive from an environmental viewpoint, the cost of such treatments compared with other options outweigh any such advantages.

Swimming pool stabilization chemicals. The use of isocyanurates in swimming pool water to stabilize and increase the effective life of chlorine dosing is now a common practice. However while this joint effect can be satisfactory for controlling bacteria and algae, there is concern that the stabilization effect of isocyanurates lowers the level of true free chlorine at normal dose levels, to such an extent that control of amoeba would be jeopardized.

Naeglaria fowlerii, the amoeba responsible for amoebic meningitis, has been shown by work in South Australia to require residual free chlorine levels of at least 0.4 mg/L for effective kills.

Work done in the Laboratories during the year showed that, both with higher pH levels and higher doses of isocyanuric acid, greater amounts of chlorine had to be added to pools to give a satisfactory residual free chlorine. Recommendations were made to the Public Health Department that levels of up to 3 mg/L of chlorine needed to be added to maintain satisfactory levels of residual free chlorine in the presence of isocyanurates. Swimming pool chemicals in this State will in future be required to be labelled showing the amount of chlorine that needs to be added in relation to varying levels of pH and isocyanuric acid to maintain the correct free residual chlorine dose for killing amoeba.

Occupational health monitoring of 2,4-D. there are no recommended monitoring tests in the literature for checking on exposure of workers making or using 2,4-D. In fact the World Health Organisation has suggested that there are no specific surveillance tests for monitoring exposure to 2,4-D.

Because of local concern over worker exposure, a study was made into interpreting levels of 2,4-D in the urine of exposed workers. This was necessary because urine levels that were higher than the arbitrary action level of 0.1 mg/L used in N.S.W. had been found in workers who showed no clinical symptoms of 2,4-D exposure. This N.S.W. level was subsequently found to have very limited scientific basis; there, experience had shown that workers using 2,4-D had been generally found to have levels lower that 0.1 mg/L. Because 2,4-D is not metabolized in the body and is all excreted in the urine, with a body half-life of 24 hours, it was possible here to calculate from known acceptable daily intakes of 2,4-D, an "acceptable daily excretion" level. Since the acceptable daily intake has an appreciable safety factor of at least 10-100, this same safety factor would apply to the "acceptable daily excretion" level for the day after exposure. Levels of 0.3 mg/kg body weight/24 hours were shown to be acceptable; for a 70 kg man excreting an average 1.5 litres per day of urine this would represent a concentration of 14 mg/L. That this level would be conservative was confirmed by later information published by the United States Environmental Protection Authority on "no observable effect level" of 2,4-D in urine.

A similar study was made for 2,4,5-T based on acceptable daily intakes of 2,4,5-T and its similar body metabolism to 2,4-D. An "acceptable daily excretion" for 2,4,5-T was found to be 0.1mg/kg body weight/24 hours or for a 70kg man excreting 1.5 litres per day of urine, a concentration of 5mg/L, in a 24 hour sample taken the day after last exposure.

Operations

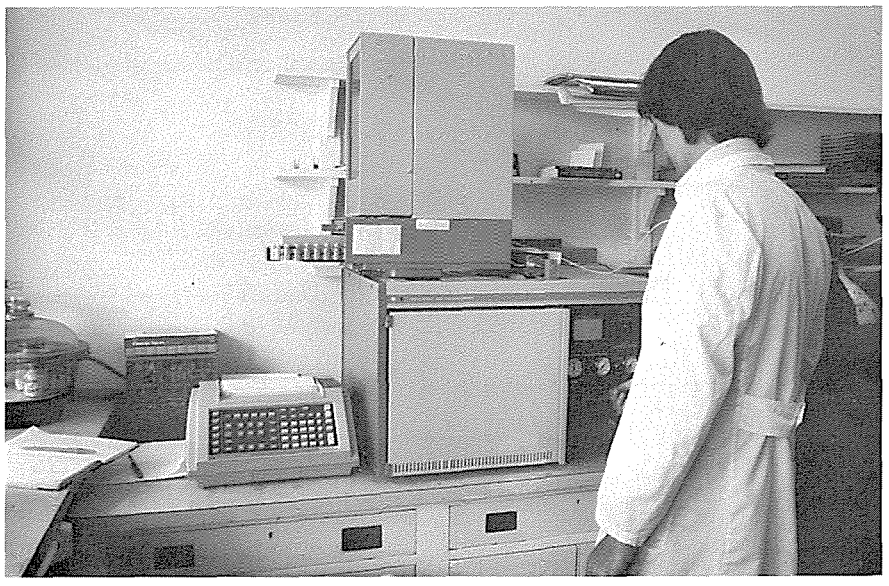
Agricultural Chemistry

The intake of work for 1982 rose dramatically, being about one third greater than the previous year. Demand for services has risen two-fold over the past 5 years due to the high level of research activity to which the Agriculture Department is committed and requests for assistance with environmental problems.

Lupinseed alkaloids. A capillary gas chromatograph funded by Rural Credits Development Fund allowed excellent progress in development of a rapid procedure for estimation of low levels of alkaloids in W.A. sweet lupinseed cultivars. Introduction of the method was timely; it found immediate application for provision of certificates for marketing of seed to overseas buyers where a guarantee for low levels of alkaloids is required.

Fertilizers and manures. Certificates of Analysis were issued for 153 samples examined under the Fertilizers Act. Eleven per cent were below guaranteed registered content. There was a successful prosecution of 1 manufacturer for 7 deficiencies in 4 fertilizers.

Potting mixes. Chemical evaluation was made of pine and jarrah wastes to assist with development of alternatives to expensive imported organic materials used for preparation of potting mixtures by local nurseries and for export of native plants to the Middle East. Pine bark or sawdust appeared to be better than jarrah sawdust.



Research on alkaloids in lupinseed is conducted with this automatic gas chromatograph.

Peanuts. Calcium concentrations in peanut kernels from Ord River trials closely correspond to amounts of limestone or gypsum added to the soil, and to soil calcium levels as measured by extraction with dilute acid. The soil test, devised for this work, is useful for predicting the need or otherwise for calcium fertilizer at pre-planting.

Fluoride. A study of the fluoride levels in various bones from the skeleton of a pig which was fed a diet containing fluoride confirmed that metatarsal and metacarpal bones are good indicators of skeletal fluoride burden.

Dam construction materials. Over 100 samples from the Harding River damsite were investigated to assist in selection of the most suitable materials for construction of the earth wall and to identify areas which would minimize the large transport costs involved.

Peel Inlet—Harvey Estuary study. Large numbers of estimations of total phosphorus were made on soils from trials designed to monitor the movement of leachable phosphorus from farm paddocks into drainage channels leading to the estuary. The results will give the study group a better appreciation of the comparative rates of release of phosphorus from a range of fertilizers including slowly soluble rock phosphate, various grades of lime-superphosphate, and highly soluble triple superphosphate.

Trace elements. An upturn in diagnostic and experimental work on trace elements in pastures in the South West continued during the year as a result of reviews by Agriculture Department officers of the roles of various trace elements for optimum production of sheep and cattle in the district. Cadmium and lead levels in pastures grown on soils treated with fly ash from the Bunbury Power Station were checked to ensure that there was no threat to animal health.

Poison plants. Fluoroacetate content of leaves of heart leaf poison (*Gastrolobium bilobum*) was twice the level of the highest value previously reported. The unknown toxic principle of lamb poison (*Isotropis forrestii*) was shown not to be an organo fluorine compound as judged by the low concentrations of total and inorganic fluoride, although it has been suggested that it is related to the Gastrolobia species.

Engineering Chemistry

The economic downturn continued to restrict the extent of work done for companies but a wide variety of samples and requests was dealt with during the year. Some of the more significant projects tackled during the year are described below.

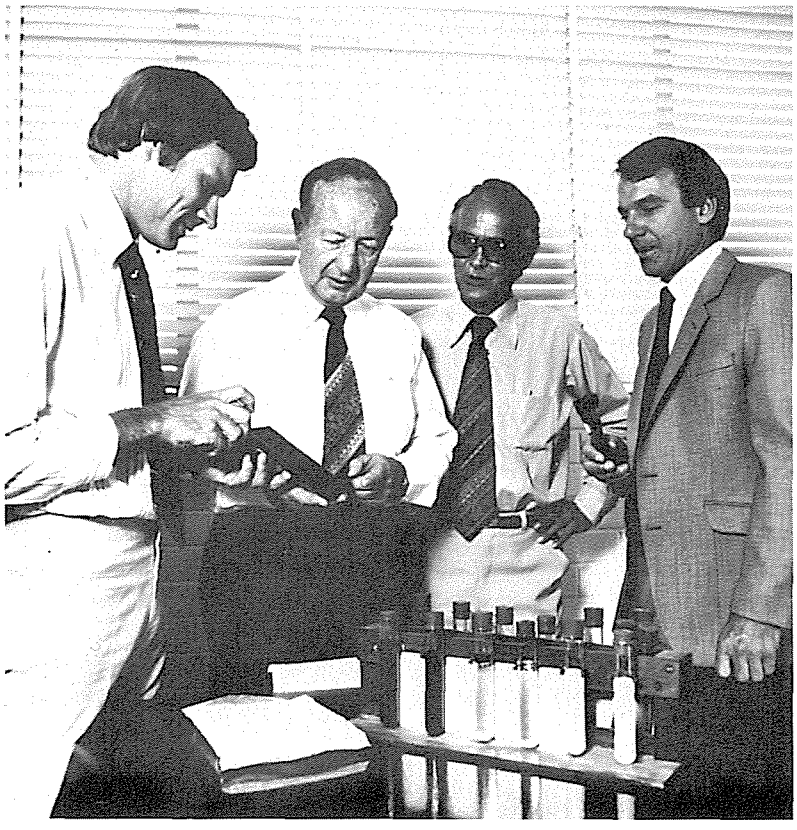
Attapulgite. Previously work has been done on a method for activating attapulgite to form a bleaching earth. The company concerned developed the process to the pilot plant stage and built a batch plant.

Samples of attapulgite activated in the batch plant were received for evaluation as bleaching earths. The results have assisted the company to understand the processing parameters which influence the efficacy of its product.

Other projects. Other contract projects were conducted on ores of vanadium and graphite, and tests were commenced on the uses of natural gas for fluid bed reduction of ilmenite.

Soil stabilization for brick making. Testwork had shown that cement stabilized compacts could be produced from soils occurring in areas centred on Kununurra, Port Hedland, Karratha, Carnarvon and Broome. Investigation established that a wide range of soil types responded satisfactorily to stabilization and that there was no significant correlation between clay content and the compressive strength of the stabilized soil.

A Broome businessman has since established a works. Some of his early products have been exam-



Bleaching efficiency of activated attapulgite is demonstrated to representatives of Mallina Holdings Ltd. (Photo courtesy of Mallina Holdings Ltd.)

ined and they are aesthetically pleasing. As expected, their strength is adequate but not as high as for the laboratory product. This effect should diminish as manufacturing experience is gained.

Flotation. The Crushing-grinding-flotation equipment has now been set up as an integrated circuit. Care has been taken to make the system versatile and flexible so that although the system is integrated, the individual units are accessible for separate use. By year's end, it was possible to schedule for January 1983 the flotation of samples of scheelite ore which had been obtained for that purpose in mid-1982.

The flotation facility is a significant addition to our ore processing equipment and to its project capability, for flotation is, on a tonnage basis, the most widely used of all mineral technology unit processes.

Gas producer. The burning of waste biomass materials in gas producers to supply power for small commercial applications was investigated.

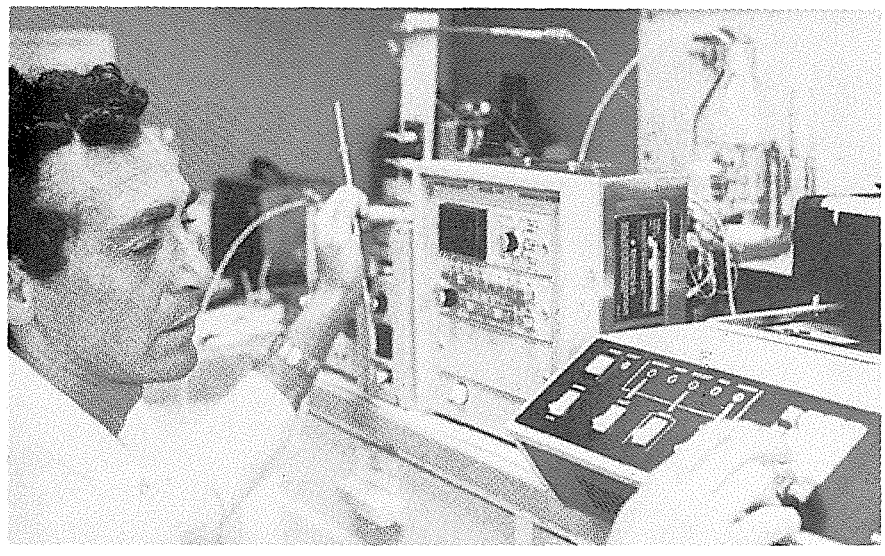
Fuels such as charcoal, coke, sawdust (free and compacted), wood chips, horse manure and pig manure (free and compacted) were used. These fuels were used with varying degrees of success and the gas generated was, on occasion, used to supplement diesel oil in firing a generator. The results confirmed the decision to proceed to the design and manufacture of our own gas producer. This was accomplished during the year and the unit was commissioned with charcoal as fuel.

Food and Industrial Hygiene

Foods. Samples of cream filling from cream cakes and buns were examined to find if they were indeed filled with genuine cream. Two of the samples were filled with genuine cream, one with a mixture of cream and vegetable oil and the other three were solely of vegetable origin.

Both the Department of Agriculture and the Public Health Department have submitted batches of honey for examination. The samples were examined by high performance liquid chromatography for their various sugars content. All the samples described as honey were found to be genuine but two samples described as honey and glucose were mixtures of honey and other sugars. It appears that the glucose used in the mixtures has, by the presence of a high proportion of maltose, been made by the acid hydrolysis of edible starch.

Pesticide residues. Samples of eggs taken from poultry free-ranging in orchards have been found to contain high levels of organo chlorine residues. DDT, aldrin, dieldrin and heptachlor were at one time recommended for the treatment of tree butts against termites or to control moths in orchards. Poultry can readily pick up appreciable quantities of the applied pesticide which in turn finds its way into the eggs.



Estimation of sugars in honey by high performance liquid chromatography.

Industrial hygiene. The area in and around the gold room of a gold mine treatment plant was found to have high mercury levels. Examination of the records showed that large amounts of mercury were lost each time mercury amalgam was retorted. The seal and condenser of the retort were found to be faulty and ineffective. Also the ventilation system in the gold room was not functioning properly. When these problems were rectified the mercury levels in the area dropped to below the threshold level value and the loss of mercury from the retorting operation dropped dramatically.

A worker from the Mint was found to have a high level of mercury in his urine. This lead to a joint inspection of the Mint by officers of Public Health, Occupational Health and ourselves. By measuring mercury levels during the inspection, trouble spots were pinpointed and corrective measures recommended.

With only a few exceptions each of the eggs had concentrations of DDT, dieldrin and heptachlor well in excess of the maximum residue limit. The Department of Agriculture have advised orchardists who keep poultry not to allow them to free range but confine them to a poultry run which has not been treated with organo chlorine pesticides. No excessive levels of these pesticides have been found in eggs from commercial producers.

Animal toxicology. Some horses and cattle were inadvertently pastured on an area that had been treated with heptachlor. Although the death of some of the animals is regretted it has afforded an opportunity to study the decline of heptachlor and its metabolites in the surviving animals. The animals are being monitored by analysis of their blood, biopsy fat, faeces, urine and those animals that are lactating by their milk. This work is being carried out

in conjunction with officers of the Department of Agriculture who are also studying the effect of various feeding patterns on the rate of elimination of heptachlor.

Miscellaneous. A mineral dietary supplement was found to be a potassium iodide solution. The instructions on the label suggest an initial daily dose for 2 or 3 weeks followed by a twice monthly maintenance dose. The initial daily dose contains 1 800 times the recommended daily intake of iodine prescribed by the NH and MRC. Similarly the maintenance dose is far in excess of body requirements.

In conjunction with Public Health, Clean Air Section the stack gases from an incinerator burning PCB's have been monitored. The low level PCB's found in the stack gases indicate that in excess of 99.995% of the PCB's were consumed by the incinerator but there was no provision for neutralizing the hydrochloric acid produced in the furnace.

A small child had lost consciousness while in the toilet of a block of flats. The toilet was on the third storey of the flats and it was found that the lower flats had a common ducting system for their gas hot water heater and gas stoves which passed through this toilet. During the day when no gas was in use the toilet contained no carbon monoxide but when the evening meals were being prepared the level of carbon monoxide showed a marked increase. The ducting system has been modified and the various burners serviced to prevent a reoccurrence.

Forensic Chemistry

Since its formation as a separate entity in 1976, there has been continued growth each year both in the volume and the scope of activities undertaken by this Division. 1982 was no exception with the major growth areas being the examination of physical evidence from crime scenes particularly in connection with arson, and cases involving the examination of paint and paint flakes from scenes of crime.

Alcohol, drugs and driving. In addition to the usual analysis of blood for alcohol in connection with drink driving offences, specific requests for further analysis of some of the bloods resulted in the detection of the following drugs: oxazepam, quinalbarbitone, thioridazine, canabinoids and benzodizepine metabolites.

Routine monitoring of blood from fatal traffic victims continued to show a high incidence of alcohol in the blood of drivers. Of all motor vehicle drivers fatally injured in traffic accidents 48% had blood alcohol levels in excess of 0.08% and 34% greater than 0.15%. These figures show little variation from the results of the past 6 years.

Scientific examination of the paint left on the above bicycle by a motor vehicle led to the apprehension of a hit/run driver.

Alcohol appears also to play its part in the number of pedestrians killed on the road. Of the 25 fatalities, the blood alcohol level of 10 was in excess of 0.15%.

Drugs. The high level of drug activity of 1981 continued in 1982 with a slight increase in the number of cases submitted by the police. There was a decrease in the number of detections of cannabis as many cases, particularly cultivations, are submitted to the Herbarium for botanical identification. However, there was an increase in the detections of other drugs of abuse particularly heroin which increased by 25%.

A case of note involved the analysis of a seizure of 2 kilograms of raw opium. The opium, which had allegedly been imported from Turkey, represented the first seizure of this type by the Drug Squad for over 10 years.

Toxicology. Although there was only a slight increase in the number of cases received in this category in 1982, there was a 30% increase in the number of positive identifications of drugs or poisons necessitating far more time consuming quantitative analysis than in previous years.

Doping control of sport. Blood and urine samples continued to be moni-

tored and an advisory service provided in connection with doping control programmes carried out by racing, trotting and greyhound authorities.

Criminal investigations. Casework in relation to fire scenes and break-/enter theft cases were major contributors to the large increase in the scientific assistance given to the police in connection with the investigation of crime. The significant increase in arson work (80% greater than in 1981) possibly reflects the formation of the Arson Squad and the increase in arson offences in the community. In 27% of cases accelerants including petrol, kerosene, mineral turpentine and diesoline were found in the debris from fires, petrol being the most common.

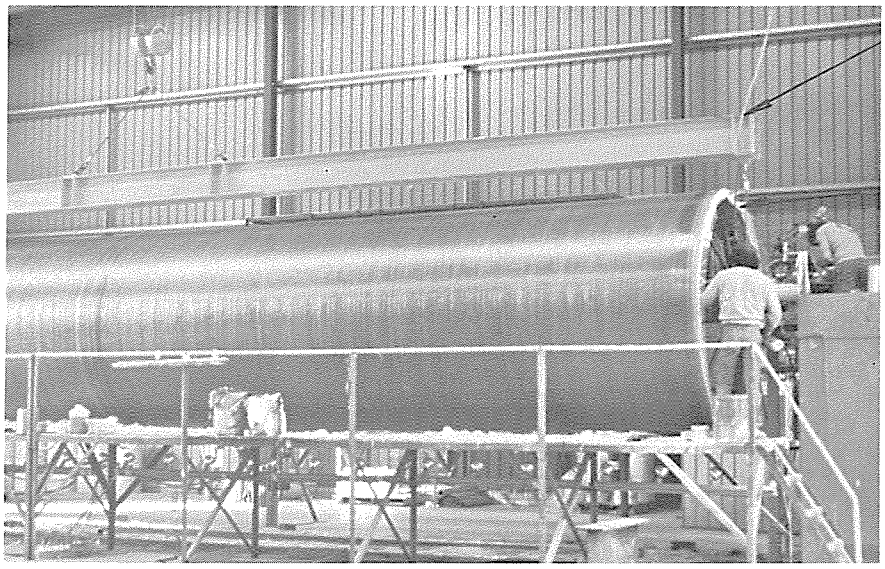
Casework involving paint and paint flakes from scenes of crime has increased to an extent that it now represents the greatest proportion of the work load of the Physical Evidence Section. Arising from this, a research project on organic pigment analysis was initiated to improve discrimination of automotive paint samples particularly in hit and run traffic accidents.

Industrial Chemistry.

Paints. Tender Board and random check samples were examined for compliance with specification. The Tender Board contracts were awarded to the West Australian manufacturers offering the best value for money, subject to their product having Government Paint Committee approval. Of paint failures investigated, only one incidence was found to be due to poor quality paint the others being due to misuse and poor applications.

Plastics. The work mentioned in last year's annual report concerning assistance with the Bibra Lake sewer tunnel continued and will be completed early in 1983, with 26 samples, principally of fibreglass reinforced plastic being examined both physically and chemically for glass content, chemical resistance of the laminate and its flexural strength.

Building materials. Twenty-eight floor coverings of various kinds were examined, 9 being submitted by the Bureau of Consumer Affairs arising from customer-supplier disputes, the other 19 being from various Government Departments seeking quality assessment and comparison. In 5 of the consumer affairs cases the complaints were found to be valid.



Fibreglass reinforced plastic liner for Bibra Lake sewer tunnel being made on the filament winding machine.

Miscellaneous. A significant increase in detergent related work occurred during the year. Field trials were undertaken in the laundry and dishwashing detergent areas. Gross wastage of dishwashing detergents was revealed during these trials. New specifications for cleaning compounds were drafted and adopted by the State Tender Board and other Government authorities. A saving of approximately $20 000 per year was estimated by one single user. Tenders for cleaning compounds for the State Tender Board were assessed as usual.

Assistance to industry. During the year a number of small manufacturing industries were given technical assistance. These included a reflectorized vehicle registration plate manufacturer, an iron oxide pigment producer, an evaporative air conditioner manufacturer, and a contractor manufacturing iron ore carriers for the North West.

Kalgoorlie Metallurgical Laboratory.

Metallurgical investigations. Testwork for North Kalgoorlie Mines Ltd to determine gold recoveries for payment to clients who use their custom mill was again a major function. Most of this work was on refractory ores.

Ore beneficiation testing was carried out for Gold Resources Pty. Ltd. in relation to their decision to establish a treatment plant at Paringa on the Golden Mile. The plant that was being established during 1982 consists of gravity/amalgamation flotation roasting of concentrates and cyandiation of the flotation tailings and the calcine. Test work undertaken was to confirm plant design and to assess the variation in gold recovery obtained by eliminating one or more of the processes in this plant stream.

Mineral Division of the Laboratories

Examination of rocks and ores were related to projects undertaken by the Geological Survey of W.A. Silicate analyses were as usual most time consuming, requiring multiple procedures to meet the required sensitivities and limits of detection.

To provide for current and future demands it will be necessary to add to the techniques available to allow greater automation. Planning in this area includes the use of Inductively Coupled Plasma spectrometry to relieve pressure on existing X-ray fluorescence equipment.

Special surveys which have required development of techniques include a major review of coal from the Collie Basin to determine the concentration of trace elements within single seams and between different seams of coal. Initial orientation work has been completed.

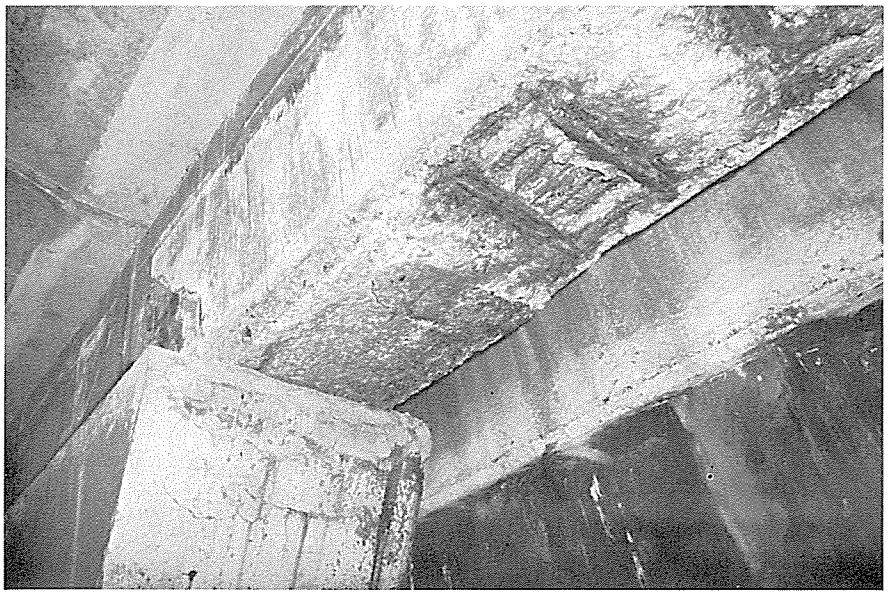
A survey of bauxite occurrences in the Darling Ranges has commenced which will include chemical and mineralogical assessment of aluminous minerals present. Platinoid concentrations are part of a survey of chromite associated specimens from the Division's mineral collection and field excursions. These include gossans, sulphides, sediments, mafic and ultramafic rocks and shales as well as chromites.

Gold. A change has occurred this year in the handling of gold ores, because of the intense demand for space within the Laboratories. Our fire assaying facilities in Perth have been temporarily closed to allow use of the space for other purposes. Samples are now transmitted to the Kalgoorlie Metallurgical Laboratory for inclusion with their work. Fire assaying continued in the early part of the year and assessments of nuggets are still undertaken at Perth.

Building materials. Building materials examined consisted largely of concretes in service and several interesting investigations were undertaken.

Damage to concrete beneath the North Container Wharf at Fremantle Harbour was related to penetration of chlorides from sea spray. Apart from a general decreasing gradient of chloride content with depth from the surface, several interesting patterns were evident. Higher levels occur in beams adjacent to the land backed wall and a concentration is associated with the lower surfaces of beams. Areas of high and low risk were identified allowing prediction of the time of future damage.

Monitoring of drainage waters from Canning Dam since its construction have indicated leaching of lime from the concrete. A question of some importance was whether it came from the mass of the concrete or from a localized area adjacent to the contact of wall concrete and the bedrock. No evidence of localized leaching at the interface or at any other point was found. The passage of carbonated water along numerous seepage paths in the mass of the concrete was indicated by the occurrence of calcium carbonate and of semi-crystalline hydrated calcium silicate minerals. Variation in composition of cement used in successive pours was indicated, consistent with the known poorer control of cement manufacture in earlier years.



Damage to concrete due to penetration of chloride to reinforcement. Container Wharf, Fremantle Harbour.

Dusts and other hazards to health. Some change of pattern occurred with dust examinations although as previously over 50% of the work related to free silica in mine dust and at industrial sites, together with iron ore dust from the vicinity of one plant.

Efforts to standardize performance in asbestos fibre counting throughout Australia was continued by circulation of standard fibre mounts. This and other inter-laboratory checks have confirmed confidence in our results.

Water Division of the Laboratories.

The increased work load in 1982, as shown by the 24% increase in samples received over 1981, greatly reduced the amount of time that could be spent on developing more efficient methods to handle such increases in future. Development of computerization and automation had to be neglected because of the increased sample load.

Water quality. Iron in water continued as the most common cause of impaired water quality for many country town and private supplies. Novel iron removal approaches using bore field storage tanks as sedimentation basins at Geraldton and Albany appear to have averted consumer complaints of red water.

Taste and odour problems happen in most water supplies from time to time. A particularly elusive and as yet undefined one in the metropolitan area has at least been more clearly observed through good use of a taste panel under a Metropolitan Water Authority steering

committee on which we were represented. As a result, the responsible groups of bores have been identified and can be turned off if the problem becomes widespread. Some country supplies have no alternative and the water must be treated. Some success resulted from such treatments at Greenbushes and Kojonup.

Laporte effluent. Preventing pollution by the effluent from the Laporte factory at Australind has been an ongoing problem for many years. Continued monitoring of the sand dunes disposal site this year gave an improved picture of the sulphate and iron contents of the ground water around the lagoon disposal sites. A better understanding of the fixation of iron in sand dunes, through studies at Murdoch University, has given greater confidence in the use of the sand dune lagoons as an effluent disposal option.

Estuary monitoring. The three major estuaries the Swan, Peel and Leschenault continued to be regularly monitored. The major concern has been the eutrophication of the Peel Inlet-Harvey Estuary through phosphorus run-off from agriculture causing algal blooms. Experimental work was carried out on chemical precipitation reduction of phosphorus levels in drains running into the estuary.

Country town sewerage schemes. Scrutiny of the efficiency of a number of country wastewater treatment plants by the Public Works Department has been responsible for part of the increased work load.

Mundaring-Goldfield water mains. Increased chlorination in the supply to control Naeglaria fowlerii amoeba has resulted in significant reduction of the pH of the water. This would have been expected to increase corrosion of domestic plumbing fittings. Examination of this possibility at Mundaring, Northam, Cunderdin and Merredin showed no increase in corrosion above what is expected in the metropolitan area.

Organization

Seven separate laboratories comprise the Government Chemical Laboratories. Six of these namely Agricultural Chemistry, Food and Industrial Hygiene, Forensic Chemistry, Industrial Chemistry, Mineral and Water are located at Plain Street whilst Engineering Chemistry is at Bentley except for its Kalgoorlie Metallurgical Laboratory. Laboratories are organized so that they serve where possible one or two major client Departments. For example, Agricultural Chemistry gets 95% of its work from the Department of Agriculture whilst Forensic Chemistry gets the majority of its work from the Police Department. This client orientated function is effective in providing a good service and in maintaining close liaison with Departments. At the same time co-operation between laboratories based on work of a similar nature independent of origin, makes best use of facilities and staff expertise.

Staff.

Over the past 4 years, there has been no increase in staff despite our greatly increased work loads.

Dr M. J. Wort was appointed to the position of Chief of Engineering Chemistry Laboratory to fill the vacancy in 1982. At least one, possibly two, Chief of Laboratory positions will become vacant in 1983 due to the retirement of the present occupants.

Accommodation.

A critical shortage of space exists in the Agricultural Chemistry, Food and Industrial Hygiene and Forensic Chemistry laboratories. This is causing major concern for both efficiency and safety. Because of the need to estimate small quantities of residues and contaminants which are of environmental and health importance, the cramped conditions create concern over possible cross contamination. With respect to safety, a separate laboratory area where carcinogenic chemicals such as aflatoxins, dioxin and polycyclic hydrocarbons can be determined, is a high priority requirement.

Equipment

Major pieces of equipment purchased during the year included:

—a Hewlett Packard 5880 gas chromatograph for lupin alkaloid work;
—a Tecator fat extraction apparatus for rapid oil seed analysis;
—a twin channel Technicon Autoanalyser for plant analysis;
—a Herraeus centrifuge;
—a Christy and Norris 20 cm grinding mill;
—a compression system, injection and detection for a Waters high performance liquid chromatograph for food analysis;
—a Perkin Elmer Sigma 2000 gas chromatograph for hydrocarbon, food and pesticide residue work;
—a Jouan refrigerated centifuge;
—a Perkin Elmer scanning spectrofluorimeter for drug identification;
—a Struen mineral section polishing machine; and
—a Perkin Elmer atomic absorption spectrophotometer for heavy metal determinations in water.

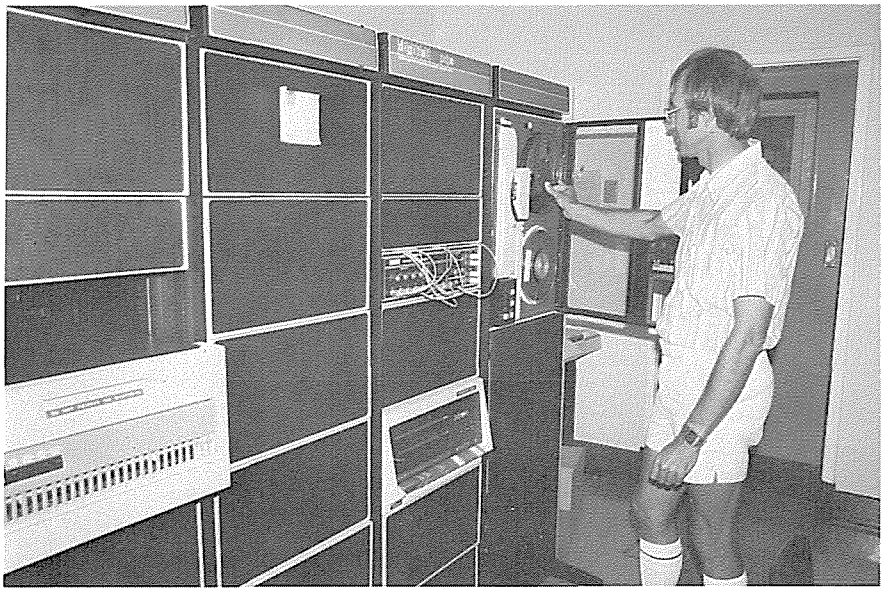
Computing facilities

Additional facilities allowing 8 more terminals to be attached to the PDP 11/40 computer and 5 terminals were purchased during the year. Although it has been recommended that uses by other Divisions of the Department be transferred from the computer, no progress has been made towards this as yet.

The reliability of the computer is now far from satisfactory. This can be attributed partly to the age of the computer which has now been running continuously for 7 years. A complete replacement is going to be required within 2-3 years. Without a reliable and efficient computing facility our ability to cope with the major increase in work that has occurred, would become impossible.

Other Activities

Committees. A major function of the Laboratories is the professional contribution made by staff in nearly 409 inter and intra departmental as well as external committees. While some of these committees meet infrequently, others impose an additional heavy workload on the officers involved.



The PDP 11/40 Computer which services the Laboratories' automated analytical systems.

Major contributions were made by staff in 1982 to the following external committees. Effluent Licensing Panel of the Rights in Water and Irrigation Act, Food and Drug Advisory Committee, Paint Advisory Committee of the Government Tender Board, National Council and Chemical Registration Advisory Committee of the National Association of Testing Authorities, Pesticide Advisory Committee, Poisons Advisory Committee, Scientific Advisory Committee of the Clean Air Act, Industrial and Biological Committees of the Swan River Management Authority, Waste Disposal Technical Committee and Heavy Mineral Sands Chemical Analysis Committee of the Standards Association of Australia.

Additionally many staff serve on the executive of a number of professional scientific societies as an extra-mural activity related to the wide range of functions served by the Laboratories.

Conferences and workshops. To keep abreast with developments in both chemistry and overlapping disciplines in the wide area covered by the Laboratories, attendance by specialist officers at specific conferences were made during the year. The more important of those attended were:
Forensic Chemists meeting in Adelaide attended by J. M. Challinor; conferences on Forensic Toxicology and on Illicit Drugs in Melbourne attended by C. M. Polanski; meeting of Association of Official Racing Veterinarians and Analysts in Hobart attended by V. J. McLinden and A. M. Stenhouse; Carbon-in-Pulp Conference in Perth and Kalgoorlie attended by R. Mitchell and J. George; Chemeca 82, The Institute of Chemical Engineering conference in Sydney attended by L. Brennan and R. McKinnon; Government Chemists meeting in Brisbane attended by the Director; conference of Australian Institute of Occupational Hygienists in Melbourne attended by M. B. Rowe; and Symposium on Computers for Laboratory Work in Melbourne attended by K. Browne.

Publications and Lectures. During the year the following publications or lectures were made or given:
Challinor, J. M. (in press), Forensic applications of pyrolysis capillary gas chromatography. Forensic Science International.
Pryce, M., Hodge, R. C., and Embrey, P. G. (in press) Jeppeite a new K-Ba-Fe Titanate from Walgedee Hills. American Mineralogist.
Terry, K. W., Van Riessen, A., and Lynch, B. F. Criminology and Research Council Project 9/80.
"Some aspect of paint failures" given by W. Carnell and D. J. Ingraham to the W.A. Group of the Oil and Colour Chemists Association.
"Some applications of chemistry in detection and prevention of crime" given by B. F. Lynch to the Analytical Group of the Royal Australian Chemical Institute.
"Mercury exposure in a gold room" given by M. B. Rowe to the Australian Institute of Occupational Hazards, Melbourne.
"Practical Laboratory Automation" given by B. J. Codling to 7th National Convention of the Royal Australian Chemical Institute, Canberra.

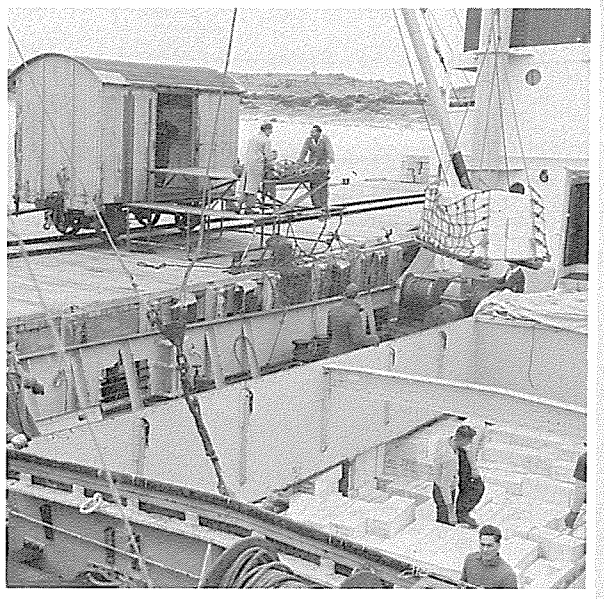
CONTAINERIZATION OF EXPLOSIVES

One of the many duties of the Inspectors of the Explosives and Dangerous Goods Division is to oversee the transportation of explosives and ensure every reasonable precaution is taken to minimize the danger to the public of accident by fire or explosion.

For many years, up until the late 1960s, explosives were imported into Western Australia at the Woodman Point Explosives Reserve Jetty. Unloading a ship at that time was a very labour intensive, time consuming operation. It could take up to a week to shift a typical 300 tonne consignment.

By the early 1970s, most explosives were being transported into Western Australia by rail. This resulted in a significant decrease in the number of times the consignment had to be handled as the rail wagons could be shunted direct to the magazine into which the explosive was to be stored. The explosives were mostly manufactured in Victoria, New South Wales or Queensland and subsequently consigned to Western Australia. For most blasting explosives this procedure was satisfactory but slow, although detonators continued to present problems.

The possibility of transporting explosives by containers had been considered for many years, but the idea had long been resisted by explosives experts who have learned caution from years of bitter experience. Container terminals are generally crowded and the consequences of an explosion at such a location was thought to be so bad as to outweigh any benefits which might derive from the use of containers. Then, in 1981, ICI Australia Operations Pty Ltd working in conjunction with its parent company in the United Kingdom developed a packaging method which enormously reduced the danger of mass explosion in consignments of detonators.



Explosives being unloaded from the 'Blythe Star', mid-1960's.

A trial shipment of one container of detonators was made from Tilbury docks, London to the Fremantle Container Terminal. Using the FPA container handling equipment a container holding a quarter of a million detonators was unloaded and removed from the wharf area within 30 minutes of the ship docking. The transport operation went so smoothly that 1982 saw the establishment of containers as a regular transport medium for the importation of detonators and the export of seismic explosives to South East Asia: 3 container lots of explosives passed over Western Australian wharfs during 1982 and arrangements were made for a further 6 containers early in 1983. Regular shipments are anticipated into the indefinite future.

Understandably all equipment used in the transfer operation was thoroughly checked before it was used to handle the container and additional factors of safety applied to lifting gear, etc., as the consequences of failure of the equipment could be disastrous. Most of the precautions applicable to earlier consignments of explosives by ship were also followed.

The biggest single advantage in using containers is the enormous reduction in handling time at the wharf area. Even when the ship's lifting gear is used—as must be done at all Western Australian ports other than the Fremantle Container Terminal—containers can easily and swiftly be removed from the ship on to a waiting truck and then transported out of the wharf area. In addition the number of people handling the explosives is reduced considerably, the stock arrives in better condition, and costs are reduced.

As we become familiar with the procedures for handling explosives in containers we can look forward to a significant improvement in safety with explosives in transport in this State.

Unloading a container of explosives at Fremantle North Quay, 1981.

EXPLOSIVES AND DANGEROUS GOODS

H. DOUGLAS, CHIEF INSPECTOR

1982 was another demanding year for the staff of the Explosives and Dangerous Goods Division. Work continued on the draft Dangerous Goods (Road Transport) Regulations to ensure that they represented current thinking and conformed to decisions by the Australian Transport Advisory Council; container transportation of explosives was established; explosives classification tests held in the United Kingdom were reviewed by the Chief Inspector; and significant changes were made in the Australian Standard for the transport of flammable liquids by road.

The year was not without its disappointments as the long awaited Dangerous Goods (Road Transport) Regulations had not been gazetted by year's end. Many sectors of the transport industry contributed to the drafting of these Regulations and, as the industry is fully aware that new vehicles will require some modification to convey dangerous goods, there has been some consternation at the absence of definitive guidelines.

The advantages of container transport have been discussed in the feature article on page 66. Transportation of explosives by this method increased significantly in W.A. in 1982. A load of about 250 000 detonators was unloaded under Divisional supervision at Port Hedland during the year and 2 other containers were exported from the Bulk Cargo Jetty.

In April the Chief Inspector attended the UK Health and Safety Executive's explosives testing facility in Buxton, England, to oversee the testing of specially packaged electric delay detonators intended for export to Australia. Mr Douglas was representing the Chief Inspectors of Australia at these tests, which contributed towards the acceptance of containers for the transport of explosives between the United Kingdom and Australia.

BP Super Tanker (42 kilolitre tanker designed to AS2016:1982).

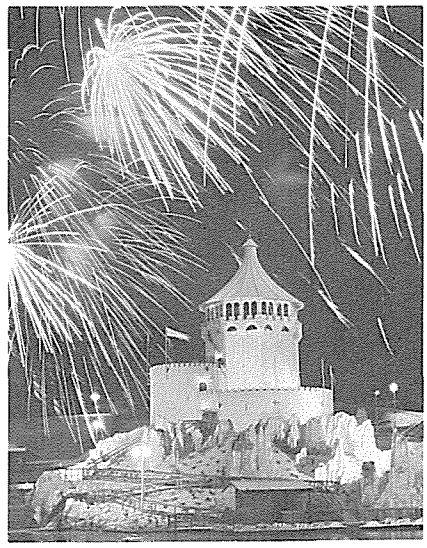
One of the benefits to Western Australia of the increasing use of container transport of explosives will be a greater use of Western Australian ports.

During the year an important change was made to Australian Standard 2016 (which relates to the transportation of flammable liquids) with the removal of the 37 000 litre upper limit on road tanker capacity. This means that tankers may now carry the maximum payload allowed according to road conditions and vehicle axle loadings as specified by the National Association of Australian State Road Authorities. Tankers are now being used to convey up to 42 000 litres on Western Australian roads without any significant decrease in public safety but with overall cost savings.

In 1982 the Division made the first successful prosecution of a service station operator for storing excessive quantities of swimming pool chlorinating agent. The Division lays down common sense guidelines for the storage of swimming pool chemicals at service stations and most operators abide by these. The storage guidelines require that the product be stored in small quantities well removed from any flammable materials. As the offender had been warned several times over a number of years that his storage of swimming pool chemicals was contrary to the Divisional guidelines, there was no alternative but legal action.

A special effort was made during the year to ensure that Inspectors were present at fireworks displays. As a result, one type of firework has been banned because it is a threat to public safety. Other fireworks were seen to fire in an unusual manner and information was requested from the Australian manufacturers.

Most fireworks displays occur outside normal working hours and the fact that most displays were attended by an Inspector is an indication of the dedication of the Inspectorate to their duties.



One of the public displays of fireworks conducted by licensed display operator J. Cardile (courtesy Adventure World, Bibra Lake).

Operations

Legislation

In October the Schedule of Dangerous Goods was gazetted. This Schedule classifies and lists all dangerous goods and is essential to the operation of the Dangerous Goods (Road Transport) Regulations.

Flammable Liquids Regulations. Amendments were made to the Regulations to, inter alia, adjust the licence fees; more rigorously prescribe the conditions for testing of equipment such as fire extinguishers, containers and dispensing equipment; and delete the necessity for Local Authority approval of a site before a licence to store could be issued. The last amendment was made following advice that the regulation which required Local Authority approval was beyond the legal authority of the Explosives and Dangerous Goods Act. Where the storage of flammable liquids may contravene Local Authority By-Laws it is now the responsibility of the Local Authority to take appropriate action. However, close liaison is still maintained between the Division's Inspectors and the Local Authority officers.

Explosives Regulations. Additions were made to the Regulations to enable fees to be charged for: the issue of Entry Permits and Certificates of Release for the importation of explosives; the testing of equipment used in connection with the detonation of explosives; the examination of explosives vehicles; the examination of potential shotfirers; the issue of permits for fireworks displays and the adjustment of other fees charged by the Division.

1982 saw the authorisation of the first Sub-class 1.5D explosives in Western Australia. The explosives Tovex Extra and Tovex E, are manufactured by DuPont Australia Ltd and were tested in New South Wales under conditions prescribed by the Australasian Conference of Chief Inspectors of Explosives. These explosives meet all the relevant criteria for Sub-class 1.5D and are very insensitive, although when initiated, they have a mass explosion hazard.

The explosives Magnaprimers, Anzomex Primers, Anzomex Seismic Primers and Hydromex were added to the list of authorised explosives. Amendments were made to the United Nations identification number of six other explosives.

Examination of one of the 3645 vehicles which passed through the Woodman Point Explosives Reserve's gates during the year.

Explosives reserves

Woodman Point. The long awaited transfer of explosives from the Woodman Point Explosives Reserve to Baldivis has still not taken place. Recreation adjacent to the Reserve is unfavourably affecting the operations at the Reserve and it has been necessary to impose restrictions on the recreational facilities for safety reasons. The construction of new fencing to prevent the public from encroaching on the explosives storage areas alleviates the problem but the threat of a bush fire sweeping through the entire area is a major cause of concern.

One break-in occurred at the Reserve during the year and approximately 3 kilograms of explosives were stolen.

Port Hedland. The Pippingarra Explosives Reserve at Port Hedland is no longer considered to be of any practical use to the Department and arrangements are being made for it to be relinquished. No explosives have been stored at the Reserve in the past 8 years.

Kalgoorlie. New magazines were installed on two 20-tonne sites at the Kalgoorlie Explosives Reserve during the year. An estimated 100 000 deteriorated detonators were found in and near the Kalgoorlie Explosives Reserve and a major operation was mounted by ICI Australia Operations Pty Ltd and the Department's Inspectorate to render the detonators safe. The Company accepted financial responsibility for the illegal dumping of the detonators.

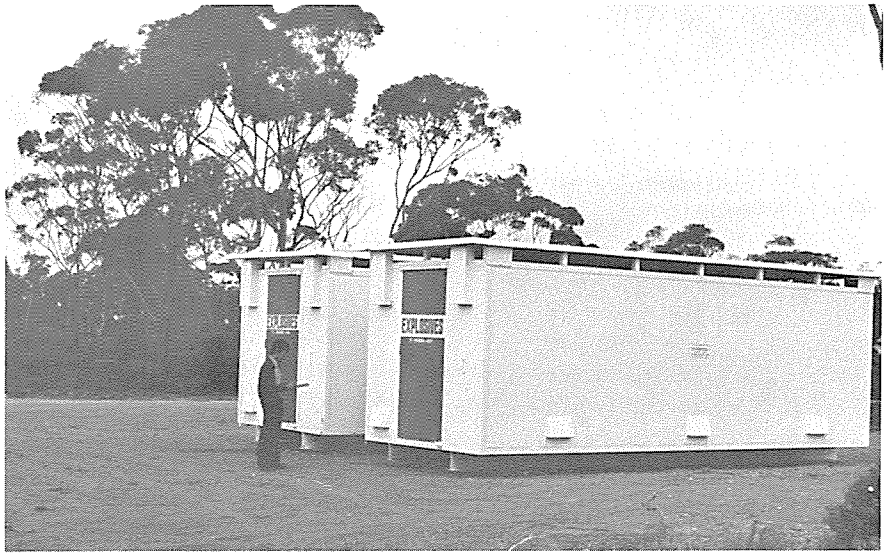
Inspectoral activities

Licensed premises. The number of premises licensed to store flammable liquids decreased from 4 825 to 4 754 in 1982, continuing a slight downward trend that has been evident for several years. As the decrease is less than 2 per cent of the total number of premises it is not significantly affecting the operations of the Division. There was an increase of around 8 per cent in the number of licences and permits issued for the control of explosives throughout the State.

EXPLOSIVES LICENCES AND PERMITS

	1981	1982
Import	8	6
Manufacture	9	9
Blasting Agents	393	406
Storage Mode A	36	37
Storage Mode B	6	7
Magazine (1 000 kg)	44	45
Magazine (5 000 kg)	42	47
Magazine (no limit)	75	87
Sell	31	26
Convey	88	86
Portable Magazines	89	108
Storage of Detonators	4	1
Shotfirers Permits	1 592	1 727
Fireworks Displays	35	35
Entry Permits	26	60
TOTALS:	2 478	2 687

The 4 additional Inspectors who joined the Division mid-way through the year ensured that there was a significant increase in the number of premises visited during the year. For example, more shotfirers working in the metropolitan area were visited and their operations and storage facilities were



DuPont's new magazines installed at the Kalgoorlie Explosives Reserve.

more rigorously checked. Closer attention was given to vehicles used for the conveyance of flammable liquids and to the standard of the tanks mounted on those vehicles. Flammable liquid tanker designs were also much more rigorously reviewed.

Shotfirer training. The approval procedure for granting Shotfirers' Permits was streamlined during the year to enable the faster issue of permits. The majority of successful candidates were promptly issued with a probationary permit which entitled them to use restricted quantities of explosives for a specified length of time. Upon successful completion of the 1 year probationary period the probationary restrictions are lifted and the permit holder may then use explosives subject only to normal regulatory controls. During the year 135 new Shotfirers' Permits were issued.

Explosives found, stolen, destroyed. Approximately 70 kilograms of explosives and almost 5 000 detonators were collected from 31 different locations throughout the State and destroyed at various sites by the Inspectorate. Some 100 000 electric delay detonators abandoned at Kalgoorlie were destroyed or rendered safe on site.

Several minor thefts were reported including a small quantity of explosives stolen from a shotfirer's work box, 12 railway fog signals stolen from the lunch box of a railway worker and two thefts of explosives from mine sites.

Of greater importance, 2 youths and a boy were charged with the theft of explosives from a mine at Munglinup. The explosives were used to create 4 explosions at and near the Cannington High School.

A very old magazine at Meekatharra was broken into and 50 kilograms of gelignite were stolen. This magazine has now been replaced with one constructed to the security specifications of the Australian Standard.

Analysis and testing. Regular testing of prilled ammonium nitrate (6 samples), safety fuse (7), and nitroglycerine based explosives (601), continued through the year and all samples tested were satisfactory and approved for use.

A total of 225 Asahi photoelectric circuit testing meters were checked and approved for use.

Special approval was given to the Julius Kruttschnitt Mineral Research Centre, University of Queensland to use a Nissan F-3-30 Exploder and an electronic timing circuit combination for research work at a Pilbara iron ore mine.

Following favourable test reports, general approval was given to DuPont (Australia) for the use of the Reo-5000 Sequential Exploder in Western Australia.

Tests on the Nissan D-3-100 Electronic Exploder showed that it did not comply with the requirements of AS 2187 and it was rejected as unsuitable for use in Western Australia.

Dangerous goods. The Divisional Officers continued to collect and dispose of small quantities of dangerous goods for Government Departments: approximately 10 kilograms of chemicals including nitrocellulose, flammable solvents, alkali metals and picric acid were safely destroyed.

Generally, enquiries to the Division about dangerous goods concern the Draft Regulations but many also request advice on the best methods of storing dangerous goods. For example:

- a fuel company wanted to know the placarding requirements for fuel tankers on airfields;
- a chemical firm based in Britain needed information on the labelling requirements which applied in Australia;
- a Japanese firm was reassured that their portable gas cookers and disposable cylinders would be acceptable for use in Western Australia. The cookers and cylinders had been tested and approved in New South Wales;
- numerous fuel companies and sign manufacturers were warned of the limited usefulness of adhesive backed signs on tanker vehicles. The signs present problems as they cannot be readily removed when the vehicle is used to convey goods which are not dangerous;
- the Forests Department wished to store up to 2 tonnes of potassium permanganate, a Class 5 Dangerous Good;
- Co-operative Bulk Handling were given preliminary information concerning the conveyance of a variety of pesticides by road;
- a chemical manufacturing company discussed the use of Intermediate Bulk Containers

to distribute concentrated pesticides among the farming community; and

— the Public Health Department were told that waste chemicals, flammable liquids and poisons were items subject to control by the draft transport regulations.

Several firms requested confirmation that there were no legally enforceable regulations which applied to the conveyance of cyanide.

Accidents and incidents. 1982 was a bad year for accidents in Western Australia with 5 fatalities and 18 people suffering injuries—8 of whom needed hospitalization. Several flammable liquids accidents might have been averted if driver training had been more rigorous, and the Draft Dangerous Goods (Road Transport) Regulations may assist in overcoming this problem.

Wherever practicable Inspectors from the Division attend accident sites to determine the cause of the accident and ascertain if the event could have been avoided by strict adherence to the Regulations. If an officer of the Division is unable to attend we rely on Police or company Safety Officers to provide detailed reports.

Explosives. Three separate accidents were reported in which youths were badly injured when mixtures of chemicals they were playing with exploded prematurely. There is no practical way to legislate against these events. Although the victims are guilty of contravening the Explosives and Dangerous Goods Act because they are illegally manufacturing explosives, the Division does not usually prosecute offenders, believing the injuries suffered in the accident are a form of summary justice.

The isolated nature of seismic work can result in a slackening of safety standards which very nearly caused injury to a surveyor who was within 5 metres of a shot hole when it was fired. Legal and logistical complications prevented prosecution of the company concerned for breach of the Explosives Regulations.

In the other 2 accidents reported to the Division, 3 people were slightly injured by flyrock during blasting operations.

Flammable liquids. Approximately 2 kilolitres of petrol was spilled when the outlet pipe from a tanker vehicle fractured during a delivery operation at a service station. The pipe broke upstream of the external valve and as the internal valve was defective the flow of fuel could not be stopped.

Internal valves on tankers are designed to escape accidental damage so that the outlet from the tanker may be closed in an emergency. During the subsequent enquiry it was found that internal valves frequently malfunction because foreign objects such as pens, spectacles, rags etc., lodge in the valve seat. Consequently the Standards Association of Australia has been requested to modify the design of tanks to safeguard against this problem.

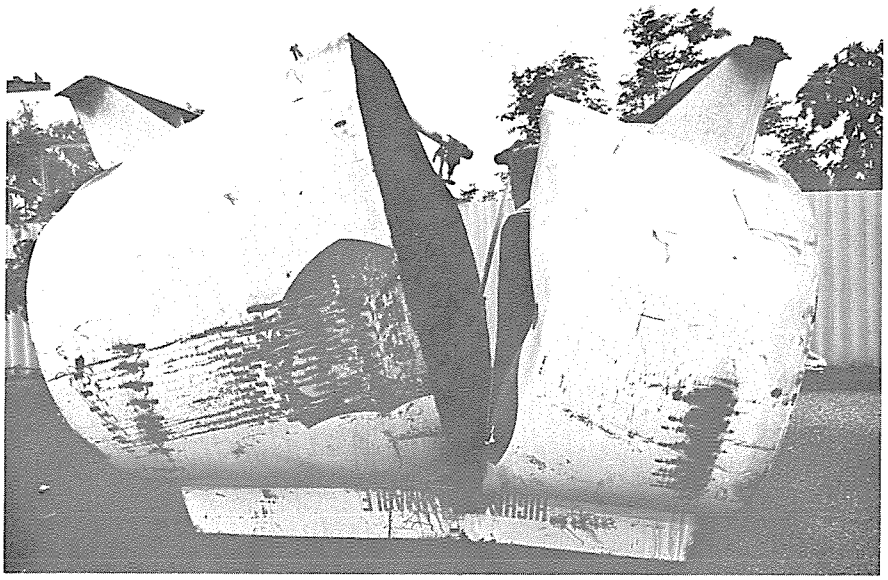
Three accidents between tanker vehicles and other road users were reported and in all cases, investigation by the Police indicated that the tanker driver was taking all reasonable precautions and the accidents were the responsibility of the other road user.

Five single tanker vehicle accidents were reported to the Division, 2 of which resulted in the death of a passenger in the vehicle. Two of the accidents resulted from tyre failure and 2 others were due to driver fatigue or lapse of concentration. The fifth occurred when a trainee driver lost control of a vehicle on a bend and the vehicle overturned killing the instructor.

A collision occurred between a tanker vehicle and a train in the Pilbara. The driver of the tanker was subsequently found guilty of proceeding across a level crossing when it was not safe to do so. Evidence from the driver of the train indicated that the tanker driver did not stop at the stop sign before the crossing.

Five incidents were reported where explosion and fire resulted from using unprotected equipment in a location where flammable vapours were present. The most common of these were welding or cutting operations on containers that had previously held flammable or combustible liquids.

A fire at a petrol dispensing installation destroyed the pump and hose when a temporary power line ignited fuel from the pump. Another fire occurred in a dispensing instal-



The fuel/air mixture inside this 8000 litre tank exploded with dramatic results when an attempt was made to repair a small leak by welding.

lation when a car hit the pump shifting it some 6 metres from its base. The car and pump were both burned out by the fire but no people were injured. Fires in petrol pumps at service stations are rare and it is most unusual that 2 of them should occur in one year.

A tanker vehicle lost 150 litres of lighting kerosene when the hose attached to the pump split while the vehicle was in motion. No fire resulted from the incident and the tanker owner will ensure that the valve is maintained in a closed position when the vehicle is moving in future.

An 8 year old boy was hospitalized because of burns he received when petrol he was using to spread a grass fire flashed back and set fire to his clothes.

A man was fatally burned when petrol he was using to wash down vehicle engine parts ignited. A tin containing the petrol fell across the vehicle's battery terminals and the resultant sparks ignited the fumes with tragic consequences. The use of petrol as a cleansing fluid is extremely dangerous.

Prosecutions. Three companies were prosecuted for 4 breaches of the Flammable Liquids Regulations; one company committed 2 breaches concerning unsafe conveyance on a tanker vehicle; the second company was illegally permitting the dispensing of petrol in a bulk fuel depot; the third company was prosecuted for the unsafe storage of swimming pool chlorinating agents at a service station.

Three operators of explosives vehicles were each prosecuted for the illegal conveyance of explosives. A fourth person was also prosecuted by the police for using explosives contrary to the Explosives Regulations.

Organization

Staff. Four new inspectors and 2 new clerical officers were appointed to the Division during the year to assist with the increasing work load and responsibilities of the Division.

Training. All Inspectors participated in training courses on the identification, use and handling of fire extinguishing equipment. Intra-divisional training sessions were also held on tanker vehicle inspections, interpretation of the Regulations, the hazards and disposal of dangerous goods, and the use and handling of explosives.

Several hundred deteriorated detonators are safely disposed of under controlled conditions by an Inspector.

Lectures. Inspectors delivered lectures and participated in discussions with interested parties in the transport industry who requested detailed information on the Draft Dangerous Goods (Road Transport) Regulations.

Other activities

The Chief Inspector attended the 17th Conference of Chief Inspectors of Explosives which was held in Hobart. Also, he continued to actively participate in committees which affect the operations of the Division. These included: the Western Australian Transport of Dangerous Goods Advisory Committee; the Standards Association of Australia Committees ME/15 (LP Gas), ME/17 (Storing of Flammable Liquids), AU/17 (Tanker Vehicles for Dangerous Goods); the Australian Association of Port and Marine Authorities; the ATAC Advisory Committee on the Transport of Dangerous Goods by Road and Rail; the Environmentally Hazardous Chemicals Committee and its Emergency Procedures Sub-Committee; and the Fire Prevention and Public Safety Review Committee.

In July 1892 Bayley and Ford rested at Coolgardie, and while their horses grazed, prospected at a place they named "Fly Flat" where Ford picked up a 1/2 oz. gold nugget.

Some three weeks, and 200 oz. later, they returned to Southern Cross for provisions and, careful not to mention the strike, headed back to Fly Flat where they uncovered the Bayley's reef and dollied over 500 oz.

Estimating the reef contained some 2 000 oz. they immediately pegged a lease over the area just before Foster and Baker who, having tracked them from Southern Cross, arrived and pegged the adjoining land.

Leaving Ford to guard the show, Bayley headed for Southern Cross and lodged the lease application with the Warden, on 17th September, 1892.

When Bayley returned to Coolgardie this time he was not alone, Warden Finnerty and most of the town went with him: "the Mining Registrar's office and even his quarters were besieged by a multitude of able bodied men, all anxious to secure miners rights" and those that accompanied Bayley "were better equipped with miners rights than provisions" (Battye, 1924).

Thus began the service and assistance to the miners and the Coolgardie community by outstation officers of the Mines Department. They shared the hardships of those early days, including accommodation in tents and a lack of water.

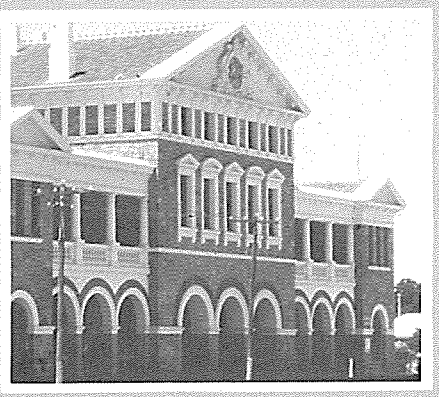
The town developed quickly and substantial buildings were erected as a testimony of the faith the community had in the prosperity of the field: "The increase in the size and population of the town of Coolgardie has been very great, especially since the opening of the railway. Substantial buildings of brick or stone are fast taking the place of the galvanised iron shanties first erected. The streets of the town are now at night illuminated by electric light; in fact Coolgardie is fast becoming a city.

The population of the town and suburbs I calculate at about 6,000; the population of the whole goldfield being about 13,000" (Finnerty, 1896).

The Court House and Mining Registrar's office, completed in 1898, is a lasting memorial to that faith and is now classified by the National Trust.

"Warden's Tent", Hannans 1894

In 1982 budgetary restraints led to consideration being given to the closure of the Coolgardie Office, and the equally historic office at Cue.



Court House and Mining Registrar's Office, Coolgardie

The reaction of the local communities to the prospect of these closures was swift and persuasive, prompting a close look at the functions of the Mining Registrar. The investigation confirmed that the traditional functions and service to the community were still being carried out, including those of:

Clerk of Courts;
Registrar of Births, Deaths and Marriages;
Electoral Officer;
and numerous agency functions such as Public Trustee, State Insurance etc.

As a result the offices did not close, and their staff continue to provide service to the district. They remain an essential point of contact, both with the prospector and mining company representatives alike, where the real mining takes place —in the field.

Battye, J. S., 1924, History of Western Australia: Oxford University Press.

Finnerty, J. M., 1896, Warden's Report on Coolgardie, 1896: West. Australia Dept. Mines. Ann. Rept. for 1895.

REGISTRATION

W. PHILLIPS, PRINCIPAL REGISTRAR

The resources of the Registration Division were fully taxed during 1982 which was a year of significant change for the Division.

Its officers were faced with the difficult task of ensuring a smooth introduction for new mining legislation. In addition a huge backlog of tenements applications from the boom years of 1980-81 remained to be processed.

The new Mining Act took effect on 1st January, 1982 and the Information Centre set up by the Division operated until mid April, dealing with hundreds of enquiries on the legislation. Information was also disseminated to industry and other interested groups by Divisional officers at lectures and meetings.

In line with Government undertakings given when the Act was introduced, a number of amendments were passed in 1982. The Division assisted in the formulation of these amendments, and up-dated "Information Pamphlets" to explain the changes.

The problem of phasing out the 1904 Mining Act also had to be tackled, as the new Act set up a transition period of several years for tenement holders to convert their titles.

Increased pressure was placed on limited Warden's Court facilities, both in Perth and country centres, to resolve disputes over applications for mining tenements. In many instances additional court sitting days had to be arranged to accommodate the Court listings.

Amidst all this activity word processing machines were installed in the Division's Perth office, and preparations made for the first stage implementation of a computerized Mining Tenment Information System.

These initiatives are but first steps towards the up-dating of mining administration in this State.

Operations

Apart from its administrative functions, the Division dealt with applications and dealings under the:
Mining Act, 1904;
Mining Act, 1978;
Petroleum Acts;
State Agreement Acts.

A summary of these activities by the various Branches of the Division is as follows.

Applications Branch

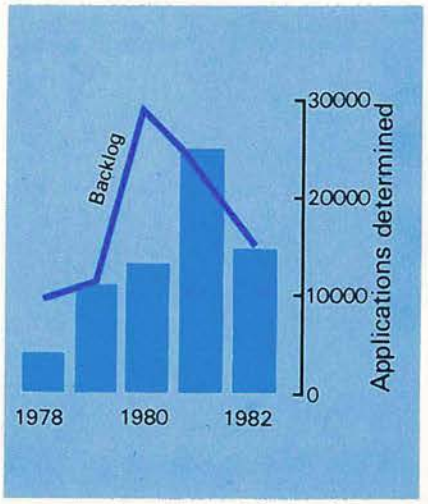
A total of 2 968 tenements were applied for in 1982 under the Mining Act 1978-82 for a total area of 10.9 million hectares. An estimated 2.8 million hectares represented a transition of tenements previously held under the old Mining Act.

Tenement receivals over the last 5 years are recorded in the figure below.

Regarding the 1982 receivals:
8.1 million of the 10.9 million hectares applied for was new ground;
there was an upsurge of applications in the traditional gold provinces late in the year which can be linked to the increased price of gold; and
although few applications were received early in the year, approximately 50 per cent of the total received were finalized in 1982.

The backlog of 29 331 outstanding applications as at 1st January, 1982 was reduced to 15 422 by the end of the year.

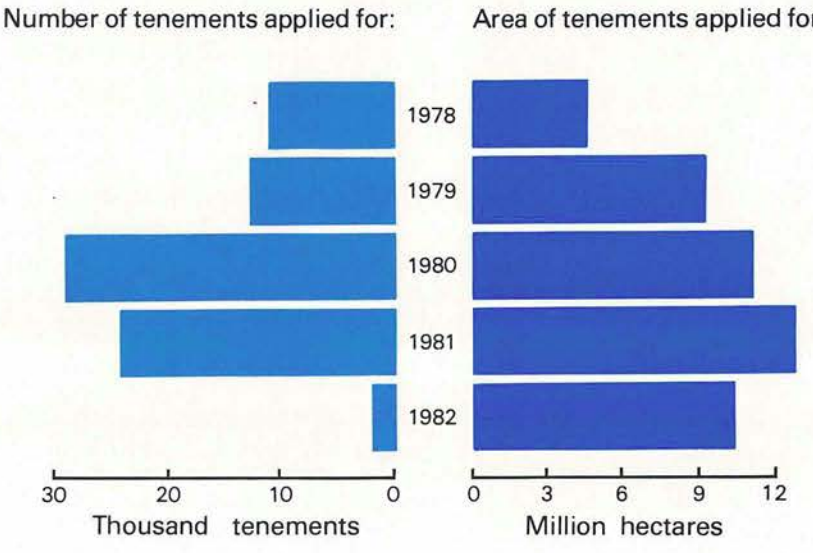
The following graph shows the applications determined during the 5 year period from 1978 to 1982, together with the numbers outstanding each year.

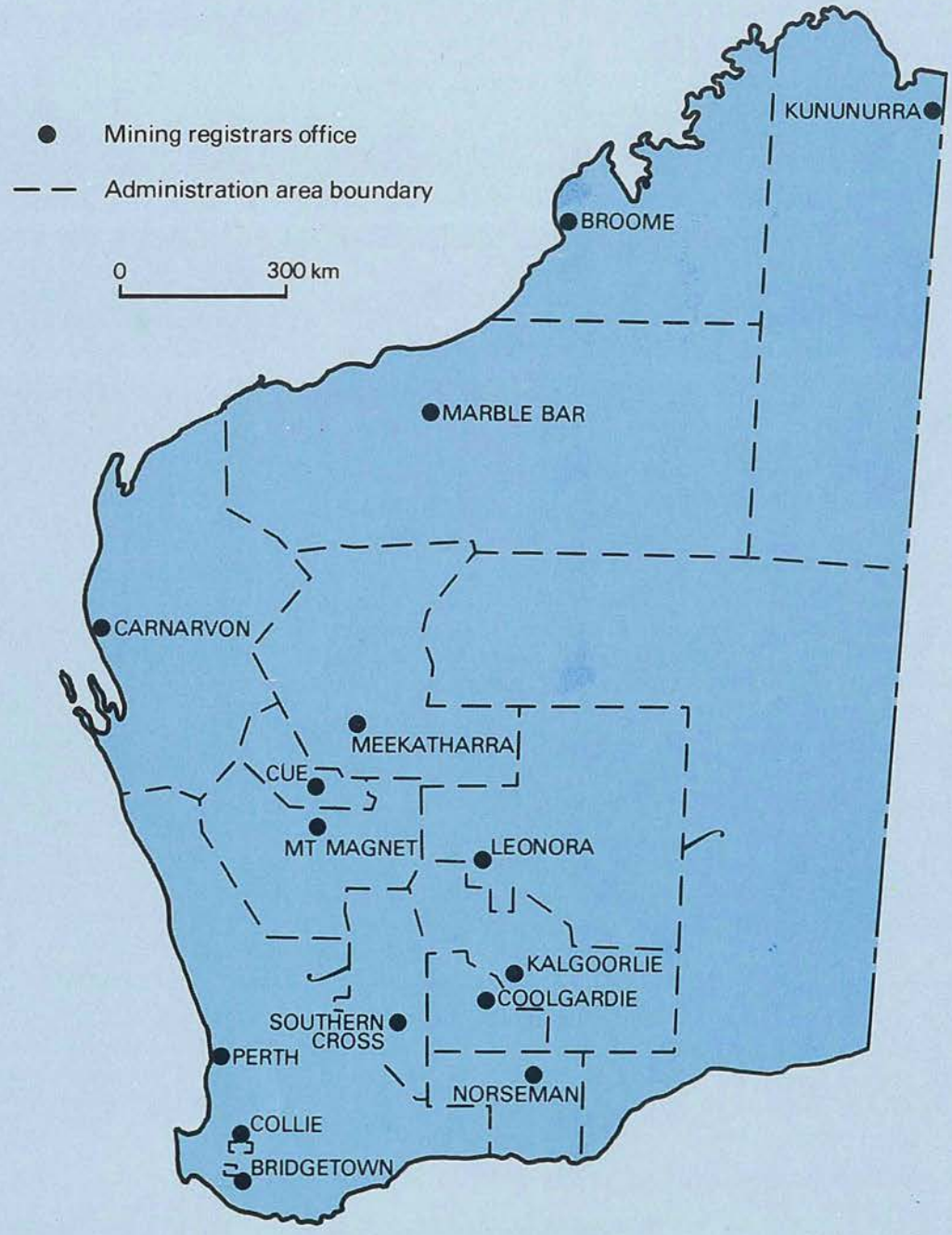


The following information on mining tenements appears in the Statistical Digest:

a table showing applications made in 1982 by tenement type and general locality; and

a graph showing the number and area of mining tenements in force over the past 5 years.





REGISTRATION DIVISION

STAFF DIRECTORY

PRINCIPAL REGISTRAR	Bill Phillips
DEPUTY PRINCIPAL REGISTRAR	Ken Street
ASSISTANT PRINCIPAL REGISTRAR	Peter Henderson

BRANCHES

DEALINGS	Roy Burton	GENERAL	Bill Smith
APPLICATIONS	Chris Clegg	PETROLEUM	Bill Mason

OUTSTATION MINING REGISTRARS

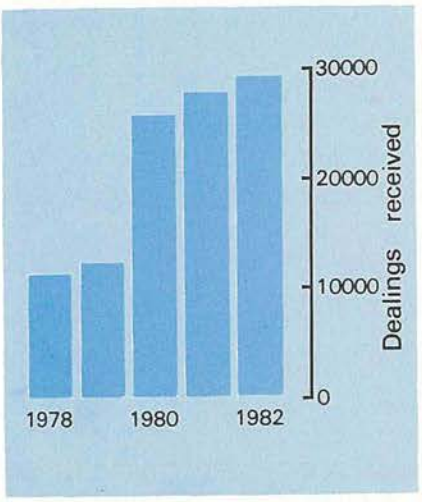
BRIDGETOWN*	Bob Allan	CUE	Mike Wyss	MEEKATHARRA	Peter Winter
BROOME*	Bob Franchina	KALGOORLIE	Ross Collins	MT MAGNET	Robin Humberston
CARNARVON*	Ross Johnson	KUNUNURRA*	John Manning	NORSEMAN	Garry Simmons
COLLIE*	Rod Ambrose	LEONORA	Jeff Hayles	SOUTHERN CROSS	Frank Wladyka
COOLGARDIE	Dave Brooks	MARBLE BAR	Peter Duffy		

* In these centres, the Mining Registrar is employed by the Crown Law Department.

Dealings Branch

A total of 27 672 dealings (caveats, withdrawals, transfers etc) were received in 1982, the majority relating to 1904 Act tenements.

Receivals in the last 5 years are illustrated in the diagram below.



These reflect the high level of activity in recent years when compared with the annual average intake of 7 906 during the previous 3 year period from 1975 to 1977.

Registry procedures were modified to incorporate the new Act requirements and streamline the processing of dealings. Staff at Head Office and the Outstations were issued with a revised "Dealings Manual".

The Dealings Branch also received and processed applications to transition existing homestead leases and other non-mining titles of the 1904 Act to appropriate Land Act titles.

General Branch

The level of public counter activities increased from previous years mainly due to enquiries concerning procedures under the new Act.

The royalties and other general revenue collected on behalf of the Department exceeded $100 million for the year.

In February, 1982 the administration of the Northampton Mineral Field was transferred to the Perth Office. The General Branch now receives and processes mining tenement applications, dealings and related matters for the Northampton Mineral Field, as well as for the South West, Warburton and Phillips River Mineral Fields.

Legislation was passed in 1982 to reflect the constitutional settlement agreed between the Commonwealth and the States over the baseline and the 3 nautical mile outer limit to the territorial sea. When this legislation comes into effect in early 1983, the State will gain sole control over the territorial sea and an increased area of internal waters.

Mining Registrar, Frank Wladyka (left) with Principal Registrar Bill Phillips during a visit to the Southern Cross Mining Registrar's Office

Petroleum

Applications for permission to drill wells and conduct seismic surveys for both onshore and offshore areas continued at the 1981 level.

As in 1981, the number of transfers and agreements lodged for registration exceeded 200 and in order to facilitate the early processing of these dealings, a procedures document was drafted in liaison with the Australian Mining and Petroleum Law Association. This document was forwarded to the Standing Committee of the Australian Mining and Energy Council for adoption on an Australia wide basis.

Organization

Staff

There were no staff increases during the year and the Division comprises a total staff of 99 including 39 outstation officers. In addition, Crown Law Department officers played an important role as Mining Registrars in Broome, Kununurra, Carnarvon, Bridgetown and Collie.

During the year a number of changes occurred in outstation staffing. The senior staff placements at the end of 1982 are shown on page 74.

WORD PROCESSING — streamlining written communications

Until 1982 all technical reports produced by the Mines Department were manually typed through their various stages by numerous typists. Each alteration necessitated time consuming retyping, sometimes of the entire script. Furthermore, processing of countless documents of similar type such as certificates of title, required tedious and repetitious typing even though the differences between each document might only be slight. For those documents requiring only changes in name and address this problem could be partly overcome by photocopying a standard letter, although typed insertions onto a duplicated form are usually conspicuous.

To overcome these problems and to alleviate the ever increasing typing load, the use of word processing was considered. A word processor consists of a memory, a screen on which the text can be viewed, and a keyboard similar to a typewriter and a printer. Collectively the keyboard and screen is known as a terminal. Word processors allow major or minor alterations to a text and can produce a succession of corrected versions with a minimum of effort. Any section of the text can be summoned on the screen from the memory by keying in the appropriate code. Alterations to letters, words, sentences or paragraphs can be made using the keyboard and the re-arrangement and pagination of the whole text is automatically adjusted. This facility allows the mass production of letters of similar format, each of which is as presentable as an individually typed letter. A short-term memory is used for adjustments during typing of a text, and a permanent memory enables the long-term storage of documents.

In 1982, after two years of preparatory work, a word processing system was installed in the Mines Department. The system is one of the largest to be installed in a Western Australian Government Department. The initial phase of the Mines Department system consists of 2 central processing units, 10 visual display units and 6 printers. These are located in the Registration, Geological Survey, Petroleum, Explosives and Administration Divisions, they having the greatest need.

The main function of the word processor in the Registration Division is the production of standard letters. There are currently several hundred standard formats including rent demand notices for mining tenements, notification of Warden's Court hearings, and transfer letters relating to the transfer of leases. Another important use of the word processor is the issue of certificates of title to applicants for tenements. Each title certificate includes conditions appropriate to that title, which are extracted from a long list of conditions jointly covering all titles. Many conditions are common to most certificates of title, and word processing eliminates repetitious retyping.

Word processing workstation—8th Floor, Mineral House

In the Geological Survey the word processing units facilitate the production of scientific reports. The deletion, amendment or addition of subject matter, even at a late stage causes few problems. Where only a few copies of a report are required these can be directly reproduced by the word processor.

In the Petroleum Division the word processor handles the updating of monthly reports and tables concerning wells drilled and oil production in W.A. It also produces standard letters, legal documents, permits and grants to drill, and technical reports.

The Explosives Division produces lists of explosive chemcials that can more easily be updated at frequent intervals. Permits to carry dangerous goods are renewed annually at the rate of 500 per month, and explosive licences are also renewed annually.

In Administration the word processor is used for the typing of executive letters and for producing Management Services and Computer Services Reports.

With the installation of word processing a Co-ordinator of Typing Services, was appointed and an extensive programme of retraining typists was carried out.

Plans for the future of the word processing system include expansion of the storage capacity, and the provision of terminals and printers in the State Mining Engineer's Division, the Government Chemical Laboratories, and additional equipment in Registration and Administration. An interesting development will be the streamlining of procedures between the Mines Department and the Government Printer. In future completed texts may be recorded onto magnetic tape which interfaces with a type-setting computer at the Government Printing Office. The text can then be automatically printed with identical punctuation, spelling, word spacing and pagination to the version committed to tape in the Mines Department, thus eliminating the need for a succession of proofs.

Already word processing has greatly improved efficiency within the Mines Department and the future promises even greater benefits.

ADMINISTRATIVE SERVICES

A. MISTILIS, ADMINISTRATIVE OFFICER

The Division provided a wide range of services to the other Divisions of the Department, assisting them to carry out their activities effectively and efficiently.

Records Branch introduced colour coding for easier tenement file identification upon commencement of the new Mining Act titles in January, 1982.

A telex machine was installed in Records during the year resulting in time saving by the early receival of data, particularly petroleum exploration reports.

An improvement in the processing of staff vacancies resulted in 94% occupancy of all positions at the end of 1982.

A major review of Departmental Accommodation was completed culminating in a detailed report to the Public Works Department to process the proposal for construction of a second stage of Mineral House adjacent to the existing building.

Staff increases were contained by the implementation of word processing for the Department's typing services and Divisions were able to utilize the system to process many applications that could only be performed manually in the past.

Following the appointment of a Manager for the newly established Computer Services Branch, a review of departmental E.D.P. activities was undertaken. This resulted in the acceptance in principle by the Western Australian Government Computing Policy Committee of a Deparmental E.D.P. programme for the ensuing 5 years.

During the year amendments were made to the Coal Miner's Workers (Pension) Act which provided for an optional retirement age for all workers with an extension of the retirement age being offered to Senior Staff.

A Systems Audit programme for the Department was developed and approved by Treasury Inspectorate and Audit.

An ongoing review of royalty rates continued throughout the year to ensure a proper balance between revenue and impact on industry.

Records

The Records Branch created 4 234 files in 1982 compared to 32 000 files in 1981. This was achieved by the streamlining effect of the 1978 Mining Act which came into operation in January, 1982 and provides for larger title areas.

The Mining Act 1978 tenement files are now jacketed in contrasting colours, according to the type of tenement and are thus more easily identifiable. Improved procedures for preparation and recording of these files resulted in a more efficient operation.

The role of the Records Branch as a training ground for young officers was reflected in a 50% turnover in staff. It is considered, however, that the efficiency of the young recruits is enhanced by this training. Some of the more tedious duties of Records work will be alleviated by computer aids.

Plans are also being made to upgrade accommodation, and provide more specialized photocopying and switchboard facilities, which all form part of the services provided by the Records Branch.

Personnel

The Branch was, for the major part of the year, without the permanent Personnel and Staff Clerk, and relieving officers handled the large volume of work.

The workload of the Staff Branch has increased since the Department's salaries went onto the Treasury State Public Service payroll System in November, 1981, as all adjustments and most salaries enquiries are now channelled through the Staff Branch.

Management Services

During 1982 the Branch implemented a large word processing system consisting of 2 central processing units and 10 workstations. The project involved drawing up the specifications, the calling and evaluation of tenders and the installation of equipment in conjunction with the supplier and the Department's Co-ordinator of Typing Services who was appointed in May.

Reviews of accommodation requirements were conducted during the year culminating in recommendations to the Public Sevice Board to relocate some staff from Mineral House to leased accommodation in Adelaide Terrace to improve working conditions and to provide space within Mineral House for the newly formed Computer Services Branch.

A detailed brief was also completed to enable architects to revise plans for the construction of a second stage of Mineral House and to refurbish the existing building.

Many minor system and equipment reviews were completed and the Management Services Officer continued to provide assistance and secretarial support to the Mines Department Computer Co-ordinating Committee.

Computer Services

With the appointment of a Manager Computer Services during 1982, a complete review of E.D.P. activities within the department was undertaken and planning commenced for the next 5 years.

The Department will utilize the Land Information System VAX computer while the merits of attaining an in-house computer facility are investigated.

Work on the Mining Tenement Information System, enhancement of the mine contaminates system, analysis of an explosives and dangerous goods licensing system

and reclaiming of Divisional programmes from the Government Chemical Laboratories computer will commence in 1983 when the Manager and three other full time staff will be available.

Finance

During the year the Branch supervised the continued implementation of a computerized system of accounting, which aims to provide better budgetary control and more detailed performance analysis.

Consolidated Revenue Fund expenditure for the financial year 1981/1982 was $16.152 million and revenue collected amounted to $13 million.

Coal Mine Workers Pensions

During the year amendments to the relevant legislation provided for optional retirement at 58 years for all workers and allowed extension of the retirement age from 60 to 62 years for Division A (Senior Staff).

Mine Workers Relief

Under the Mine Workers Relief Act, lump sum payments continued to be paid to beneficiaris during 1982 and changes made to the Act in 1982 will assist in the effective winding down of the Fund in April, 1984.

Mining Phthisis

Only 10 persons were receiving benefits through the Miners Phthisis Act which was superseded by the Mine Workers Relief Act in 1932.

Coal Mining Industry Long Service Leave

There are currently 1 137 coal industry workers covered by the Coal Mining Industry Long Service Leave Act.

System Audit

After much consultation with Treasury Officers, the internal audit programme was completed and approved during the year.

Progressively the programme is moving towards system-based audits and away from traditional transaction-based checks.

Royalties and Statistics

The Royalty and Statistics Branch assessed and collected $94.76 million as royalties on mineral production, for the year 1982. The Branch recorded the production of mineral commodities to a total value of $3 334 253 000 for the calendar year 1982 and tables summarizing this production are shown in the statistical appendix.

Royalty rates continued to be reviewed throughout the year to ensure a proper balance between revenue and impact on industry.

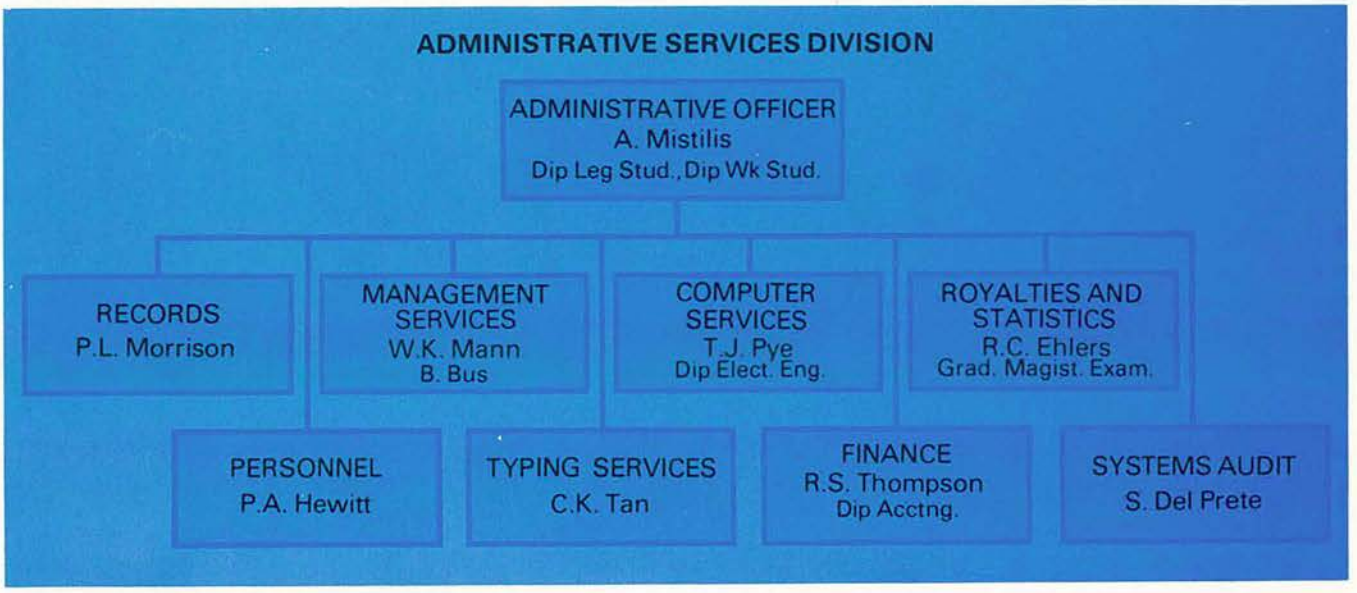
Considerable work was carried out during the year in relation to the royalty provisions for the Ashton diamond project. The royalty provisions for this project contain the first profit-related royalty system to be implemented in this State.

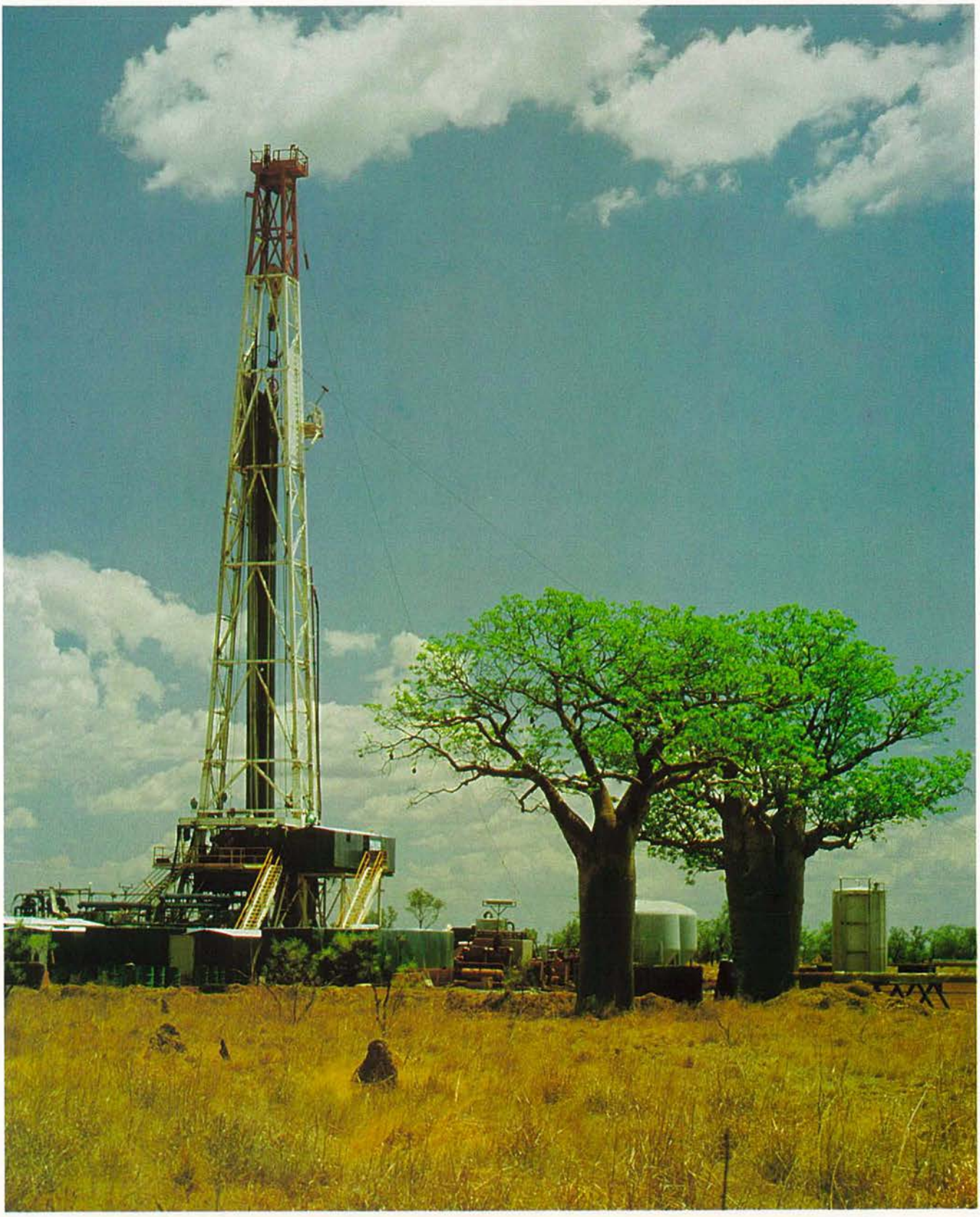
Arrangements were also finalized for the appointment, under contract, of a Government Diamond Valuer to advise on diamond values and the state of markets—a position that will be overseen by the Department.

These activities only serve to reinforce the need for the creation of a senior position of Administrator of Royalties to handle matters of increasing importance and value to the State, and action in this respect is to continue in 1983.

Western Australian Mining and Petroleum Research Institute

The Division contributes to the effective operation of WAMPRI by continuing to provide the institute with a range of administrative services.





SUNDOWN No. 1

Westbridge Drilling Pty Ltd's Rig 220 drilling Sundown No. 1 for Home Energy in the Canning Basin. Companies participating in this project were Home Energy Pty Ltd, Australia Occidental Pty Ltd and Vamgas Ltd.

The well which was a probable oil discovery, was being drilled at a location about 30 kilometres west of Blina oilfield. It reached a total depth of 2 736 metres at the end of November but had to be suspended because of the onset of the wet season. Small amounts of oil were recovered on test from 4 intervals between 898 and 1 610 metres.

Investigation field camp

Diamond drilling to investigate spillway

Upstream of dam site

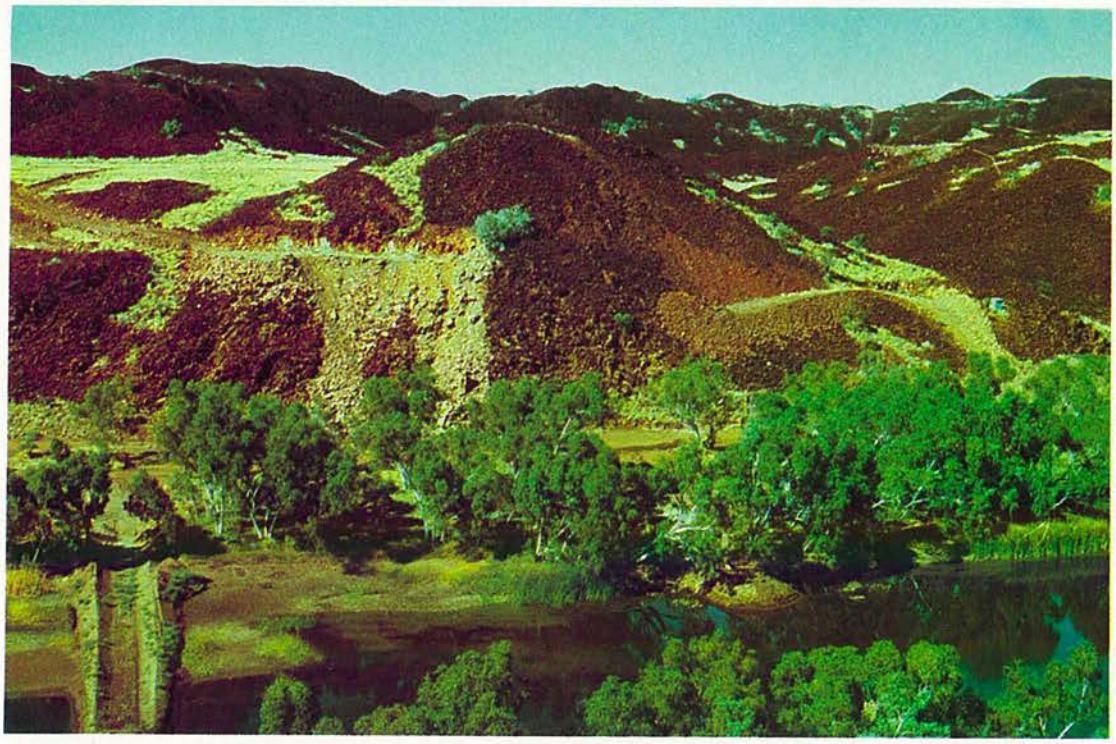
HARDING RIVER DAM

The Harding Dam site is located on the Harding River, 23 kilometres south of Roebourne. The dam is required to meet increasing domestic and industrial water needs in the West Pilbara region. When completed the dam will be 45 metres high, with a full supply level reservoir capacity of 114 million cubic metres.

The Geological Survey Division of the Department of Mines has acted as consultant to the Public Works Department to provide geological information essential to the investigation, design, and construction of the dam.

Detailed geological mapping of this site, and others for comparison, has been carried out intermittently since 1968, with subsurface investigations including diamond drilling and geophysical investigations since 1972.

During the construction period 1983-1985, Geological Survey Geologist Dr C. F. Swindells will be based at the Karratha Regional Office to provide on-site geological advice and prepare a geological record of the foundations.



South bank at dam wall

Redrawing photo-scale geological compilations

Scribing linework

Colour separation using peelcoat

GEOLOGICAL MAP PRODUCTION

Production of high-quality coloured geological maps, that present the data compiled by geologists from air-photo interpretation and field examination of a region, is an exacting task undertaken by draftsmen of the Regional Mapping Section of the Surveys and Mapping Division.

The geologist's photo-scale geological compilation is first redrawn to a suitable standard for reduction to 1:250 000 and printing of a preliminary edition. This map achieves early release and forms the base for later production of the full colour version.

For the coloured editions, clear sharp linework is achieved by a scribing technique using a range of chisel pointed hardened needles to cut through the opaque emulsion on a transparent plastic base sheet.

Lettering of differing styles is used to designate the various features on a map. Feature names are typeset on clear film which is stuck onto a positive transparent copy of the scribe sheet.

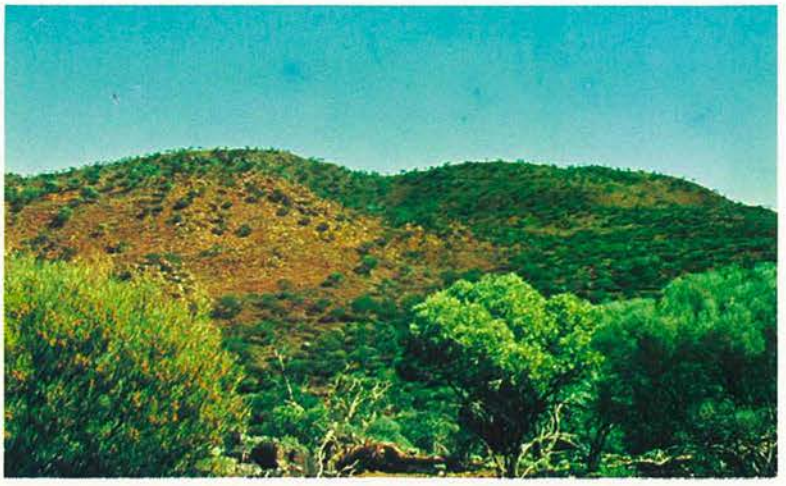
Colour separation is achieved by lifting off the photo-opaque thin plastic film layer in selected areas on a peelcoat sheet on which the geological boundaries have been photographically transposed from the scribe sheet. One peelcoat sheet is prepared for each of up to 16 printing ink colours used and the many additional colour hues are achieved by combinations of screens and overprints.

24685—6

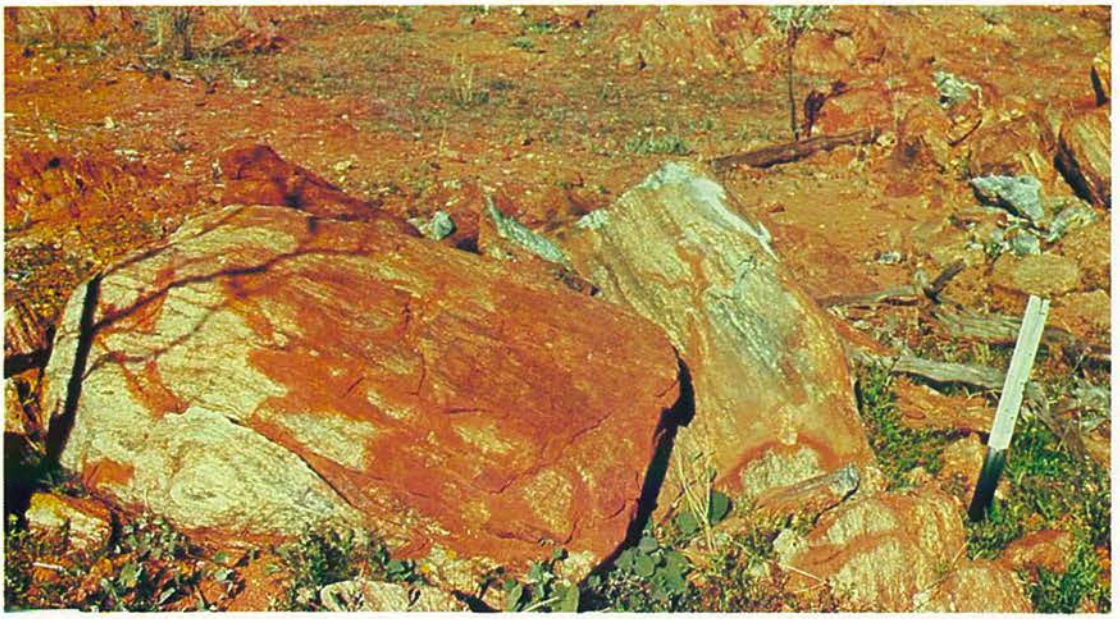
Western side of Mt Narryer

MT NARRYER

Mt Narryer lies within the Western Gneiss Terrain of the Yilgarn Block, 250km NNE of Mullewa and has been mapped in detail by the Geological Survey. The mountain consists of quartzite and meta-conglomerate which is surrounded by banded adamellite gneiss. Samples of the adamellite gneiss were dated at WAIT as 3.6 b.y. old by the Sm/Nd method, and are the oldest known rocks in Australia. The quartzite and meta-conglomerate are probalby younger but were deformed and metamorphosed together with the gneiss 3.3 b.y. ago.



Eastern side of Mt Narryer



Banded gneiss from which samples were collected

As in the Annual Report for 1981, this section contains tables that used to appear in the Divisional Reports. This year, however, the statistical digest has been substantially reduced mainly by the omission of many of the tables relating to tenements held and applied for under the various petroleum Acts.

Any reader who now finds the statistical information inadequate for his purposes may inquire directly to the Statistics Branch of the Administrative Services Division where detailed records are maintained.

For convenience the tables summarizing annual mineral production and royalties and comparing these with last year are grouped together at the end of the statistical digest.

Legislation Administered by Department of Mines

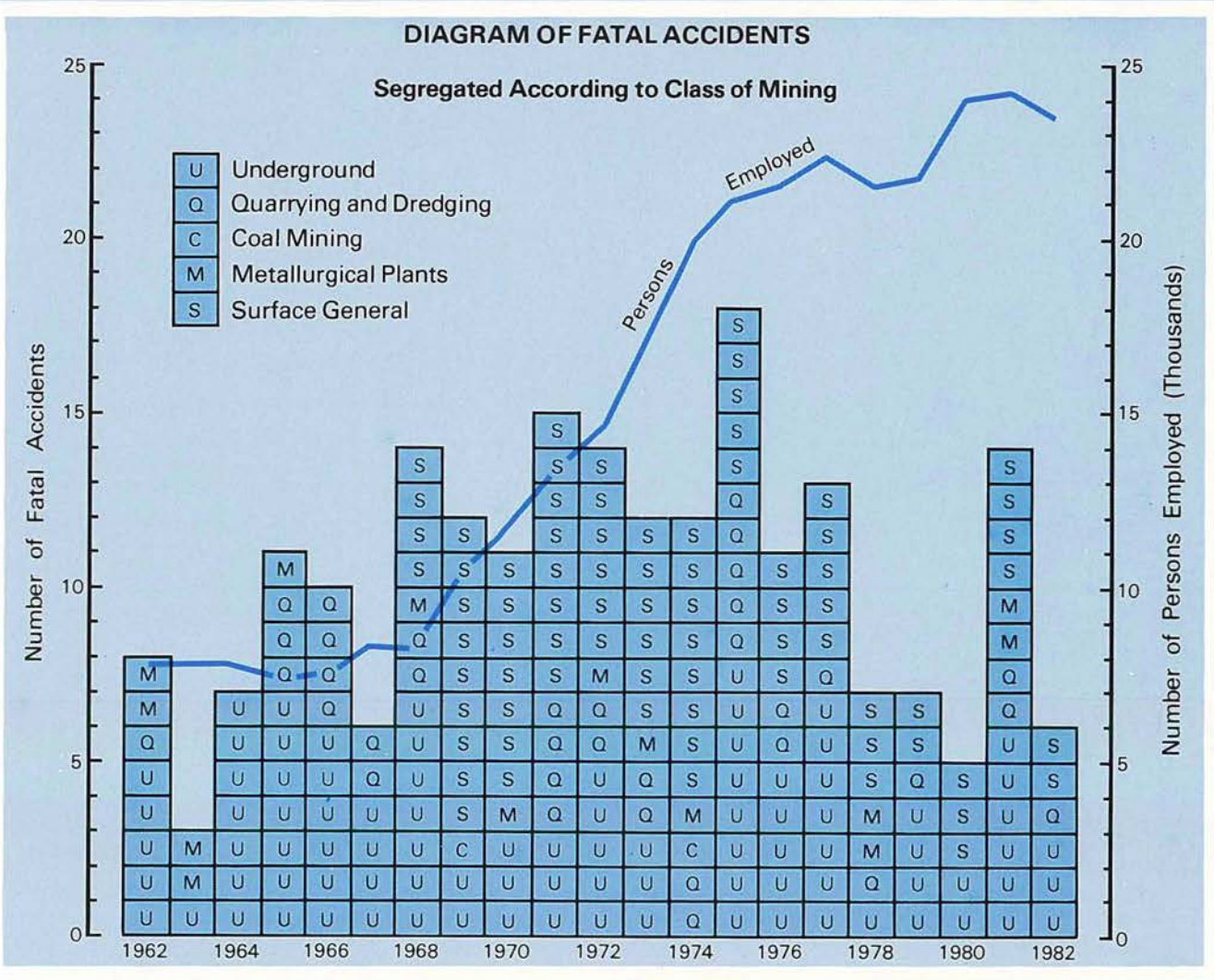
Coal Miners' Welfare Act
Coal Mines Regulation Act
Coal Mine Workers (Pensions) Act
Coal Mining Industry Long Service Leave Act
Explosives and Dangerous Goods Act
Miners Phthisis Act
Mines Regulation Act
Mines Workers' Relief Act
Mining Act
Mining Development Act
Petroleum Act
Petroleum (Registration Fees) Act
Petroleum Pipelines Act
Petroleum (Submerged Lands) Act
Petroleum (Submerged Lands) Registration Fees Act
Western Australian Coal Industry Tribunal Act

STATE MINING ENGINEER'S DIVISION
Drilling carried out by Mines Department in 1982.

Place	Purpose	Type of Work	Number of Bores	Meterage
Gillingarra	Groundwater investigation	Rotary drilling Development	1 1	976
Harvey Deep	Groundwater investigation	Rotary drilling Developed Pump tested Abandoned	6 5 1 1	192.5
Harvey Shallow	Groundwater investigation	Rotary drilling Developed Abandoned	106 103 3	2 243.10
Fortescue	Groundwater investigation	Rotary drilling Developed Pump tested Abandoned	20 19 10 1	1 668.6
Gnangarra	Vibro coring for radio isotope tracing	Rotary drilling Vibro coring	9 18	319.62 149.83
Applecross	Trial of multipoint peizometric bore	Rotary drilling Developed	1 1	21
Gwelup	Met. Water Authority	Jet develop	6	
Donnybrook		Coring	4	79.39
South Perth	Recreation area watering	Rotary drilling Developed	2 2	12
Nth Dandalup	Recreation area watering	Rotary drilling Developed	1 1	24
Various	Groundwater investigation	Thermal Logging	5	
Various	Various	TV camera scan	38	
			Total	5 686.04

Fatal and Serious Accidents Showing Districts and Causes, 1982.

DISTRICTS	Explosives		Falls		Shafts		Fumes		Miscellaneous underground		Surface		Total	
	Fatal	Serious	Fatal	Serious	Fatal	Serious	Fatal	Serious	Fatal	Serious	Fatal	Serious	Fatal	Serious
West Kimberley												1		1
Pilbara												52		52
West Pilbara											1	95	1	95
Peak Hill												11		11
Gascoyne												10		10
Murchison										2		3		5
East Murchison				1						1		5		7
Mount Margaret	1	1		3		1				9	1	14	2	28
East Coolgardie		1		1		4				63		25		94
Coolgardie			2	12		2				53		17	2	84
Yilgarn										4		2		6
Dundas										5		6		11
Greenbushes										1		5		6
South West											1	90	1	90
Collie				2						31		14		47
Total for 1982	1	2	2	19		7				169	3	350	6	547
Total for 1981		1	3	40	1	7			2	203	8	419	14	670



Serious Accidents for 1982.

Class of Accident	Inspectorate				Totals	
	Perth	Karratha	Kalgoorlie	Collie	1982	1981
Major injuries (exclusive of fatal)—						
Fractures:						
Head	—	—	2	—	2	6
Shoulder	1	—	1	—	2	4
Arm	3	1	5	1	10	23
Hand	3	7	5	4	19	7
Spine	—	—	1	—	1	2
Rib	1	3	3	—	7	4
Pelvis	1	—	1	—	2	2
Thigh	—	—	—	—	—	1
Leg	1	3	7	2	13	14
Ankle	4	1	1	—	6	12
Foot	3	1	6	—	10	14
Amputations:						
Arm	—	—	1	—	1	1
Hand	—	—	—	—	—	1
Finger	2	3	5	—	10	5
Leg	—	—	1	—	1	—
Foot	—	—	—	—	—	—
Toe	—	—	1	—	1	—
Loss of eye	—	—	—	—	—	—
Serious internal	—	—	—	—	—	1
Hernia	4	4	5	—	13	14
Dislocations	—	—	—	—	—	1
Other Major	9	—	2	—	11	3
Total major injuries	32	23	47	7	109	115
Minor injuries—						
Fractures:						
Finger	4	6	16	1	27	30
Toe	3	1	3	—	7	5
Head	1	5	2	3	11	17
Eyes	14	2	4	—	20	14
Shoulder	—	6	8	3	17	21
Arm	—	7	11	—	18	30
Hand	4	34	35	—	73	82
Back	23	42	53	18	136	168
Rib	—	5	2	—	7	7
Leg	14	22	26	6	68	108
Foot	8	6	18	2	34	40
Other minor	3	4	6	7	20	33
Total minor injuries	74	140	184	40	438	555
Grand Total	106	163	231	47	547	670

NOTE: The Perth, Karratha and Kalgoorlie Inspectorates comprise the following Mining Districts:

PERTH—South West, Greenbushes, Collie, Northampton, Yalgoo, Murchison Mining Districts, that portion of the Gascoyne Mining District south of latitude 25° South, and that portion of the Peak Hill Mining District south of latitude 24° South.

KARRATHA—Kimberley, West Kimberley, Pilbara, West Pilbara, Ashburton Mining Disricts, that portion of the Gascoyne Mining District north of latitude 25° South, and that portion of the Peak Hill Mining District north of latitude 24° South.

KALGOORLIE—East Murchison, Mt Margaret, North Coolgardie, North East Coolgardie, Broad Arrow, East Coolgardie, Coolgardie, Yilgarn, Dundas, Eucla, Warburton, Nabberu and Phillips River Mining Districts.

Summary Description of Fatal Accidents Reported during 1982

Name Occupation Date of Accident	Mine/Details and Remarks
P. C. Heath Dozer Driver 9/1/82	Hamersley Iron Pty Limited, Mt. Tom Price. The cause of death was a fractured skull sustained when he was thrown from a bulldozer which passed over the edge of a new development bench and careered down a hill side.
W. J. Plunkett Underground Haulage Driver 4/5/82	Seltrust Mining Corporation Pty Ltd. Teutonic Bore. Death was due to multiple, internal injuries sustained when he was caught beneath a fall of rock from the back of the decline truck parking bay.
M. M. Benetti Labourer/Construction Worker 11/8/82	Western Mining Corporation Limited, Windarra Minesite. Mr Benetti was working on top of a partly erected steel structure when it collapsed. He sustained fatal injuries when crushed beneath a steel panel.
G. F. Smith Timberman 15/9/82	Western Mining Corporation Limited, Otter-Juan, Kambalda. Death was due to multiple, internal injuries sustained when he was caught beneath a fall of rock from the back of the 1311 stope.
G. K. White Security Guard 28/9/82	Alcoa of Australia Ltd, Kwinana Alumina Refinery. Graham White died on October 6, 1982 of Hypostatic Pneumonia following a head injury sustained when he fell, hitting his head on the floor of the Guard House.
R. J. Renton Miner 14/12/82	Western Mining Corporation Limited, Long Shaft, Kambalda. The deceased sustained fatal injuries when caught beneath a fall of rock from the back of the 802/2 sub-level leading stope.

Metalliferous Mining Certificates of Competency issued 1982

First Class Mine Managers

		Certificate Number			Certificate Number
Nitschke,	J. S.	131	Whitman,	D.	141
Fiore,	F. J. P.	132	Stubley,	C. D.	142
Reed,	M. R. F.	133	Chilton,	P. D.	143
Sullivan,	M. A.	134	Cowie,	W. J.	144
Cox,	R. C.	135	Ingle,	D. A.	145
Eaton,	B. J.	136	Matwiejew,	P.	146
Hancock,	A. W. J.	137	O'Neill,	A. M.	147
Coughlan,	S. J.	138	Tombs,	S. L.	148
Sheffield,	D. W.	139	Grogan,	R. A.	149
Dumma,	K.	140	Larke,	R.	150

Underground Supervisors

		Certificate Number			Certificate Number
Mikalj,	A.	A204	Mayerhofer,	K. G.	A221
Whitman,	D.	A205	Silvester,	S. A.	A222
Comerford,	E.	A206	Van Hyum,	P. J.	A223
Forrest,	J.	A207	Vucemillo,	G	A224
Harding,	R. A.	A208 (Restricted)	Cartwright,	R. G.	A225
Atkinson,	A. B. M.	A209 (Restricted)	Trotter,	K	A226
Cook,	C. M.	A210	Cockbain,	G.	A227
Warren,	R. E. B.	A211	Hartley,	R. E.	A228
Allan,	B. R.	A212	Atkinson,	A. B. M.	A229
Carling,	G. F.	A213	Davies,	D. J. C.	A230
Chaundy,	K.	A214	Gregg,	D. K.	A231
Felton,	S. R.	A215	Harding,	R. A.	A232
McDonnell,	P. G.	A216	Small,	L. O.	A233
Rodan,	M. B.	A217	Wilson,	P.	A234
Blake,	W. R.	A218	Bice,	K. W.	A235
Deacon,	A. J.	A219	Lattimore,	R. A.	A236
Hensen,	H. J.	A220	Middleton,	G. R.	A237
			Suessenback,	H.G.W.	A238

Quarry Managers

		Certificate Number			Certificate Number
King,	S. D.	50	Messenger,	O. S.	57
Harvey,	J. D.	51	Adam,	R. A.	58
Gasparovic,	M.	52	McKinney,	D.	59
Dean,	W. G.	53	Hancock,	A. W.	60
McKenzie,	G. E.	54	Bailey,	S. G.	61
Nolan,	P. S.	55	Dick,	I. D.	62
O'Leary,	C. B.	56	Schultz,	P. R.	63

Restricted Quarry Managers

		Certificate Number			Certificate Number
Lawson,	L.	82	Barnhoorn,	W. P.	95
Hill,	W. F.	83	Broad,	J.	96
McPhail,	G. D.	84	Mitchell,	D.	97
Heseltine,	F. W.	85	Daley,	K. E.	98
Farlie,	T. A.	86	Bralich,	K.	99
Mach,	G.	87	Sharpe,	I.	100
Phillips,	K. J.	88	Marsh,	B.	101
Isherwood,	M. J.	89	Drobnick,	P. A.	102
Thomsa,	R. J.	90	Brown,	I. H.	103
Spence,	W.	91	Jones,	R. J.	104
Buckley,	J.	92	Davies,	L. R.	105
Dalton,	P.	93	McHugh,	K.	106
Baker,	M. R.	94	Buttery,	J. M.	107

Coal Mining Certificates of Competency issued 1982

		Certificate Number			Certificate Number
First Class Mine Manager			**Open Cut Mine Manager**		
Douglas,	K. F.	47	Mumme,	B. J.	10
Hughes,	R. L.	48			
			Deputy (Open Cut)		
Third Class (Deputy)			Roseveare,	G. J.	14
Szyszka,	K.	101	Saunders,	K. R.	15
Clayton,	G. W.	102	Williams,	K. R. M.	16

Authorized Mine Surveyors Certificates issued 1982

		Certificate Number			Certificate Number
Meumann,	A. H.	58	Sawyer,	M. E.	61
Pivac,	A. M.	59	Paynter,	G. R.	62
Pigott,	I. C.	60	Birch,	J. M.	63

STATE BATTERIES DIVISION
Schedule No. 1
Number of Gold Ore Parcels Treated—Tonnes Crushed—Gold Yield by Amalgamation and Head Values for the Year Ending 1982

Battery	Smelt Bullion kilograms	Yield by Amalgamation				Amalgamation Tailings Content Fine Gold Kilograms	Contents of Ore-Fine Gold	
		Number of Parcels Treated	Tonnes Crushed	Bullion Kilograms	Estimated Fine Gold Kilograms		Kilograms	Grams Per Tonne
BOOGARDIE	11.6206	20	2 370.8	15.6279	13.2837	6.5291	19.8128	8.36
COOLGARDIE	3.1727	47	4 013.1	20.1806	17.1535	9.0657	26.2192	6.53
KALGOORLIE	33.911	67	8 453.0	41.418	35.2053	14.4496	49.6549	5.87
LAVERTON	0.0358	17	1 167.5	5.5878	4.7496	2.9755	7.7251	6.61
LEONORA	27.4784	31	4 739.0	31.3750	26.6687	13.8641	40.5328	8.55
MARBLE BAR	24.7918	11	1 600.0	37.6472	32.0001	7.810	39.8101	24.88
MARVEL LOCH	0.4839	16	2 264.9	13.5977	11.5580	27.3040	38.8620	17.16
MEEKATHARRA	46.236	20	1 845.0	10.1540	8.6309	3.6835	12.3144	6.67
MENZIES	9.8576	10	2 016.7	16.1738	13.7477	5.8467	19.5944	9.72
NORSEMAN	—	23	1 882.0	12.687	10.7839	3.6820	14.4659	7.77
ORA BANDA	2.816	12	1 255.2	15.8165	13.4440	4.4836	17.9276	14.28
PAYNES FIND	0.692	7	564.0	13.3536	11.3505	1.6393	12.9898	23.03
SANDSTONE	—	4	420.0	1.2907	1.0871	0.6490	1.7461	4.16
YARRI	0.217	11	356.0	2.048	1.7408	0.7049	2.4457	6.87
	161.3128	296	32 947.2	236.9578	201.4138	102.6870	304.1008	9.23
FINE GOLD	137.116							

Average per parcel ..... 111.3 tonnes
Average yield by Amalgamation (fine gold) ..... 6.1 grams per tonne
Average Tailing (fine gold) ..... 3.1 grams per tonne

Schedule No. 2
Details of Extraction—Tailings Treatment by State Batteries in 1982

Battery	Estimated Tonnes	Head Value		Tail Value		Calculated Recovery		Actual Recovery	
		Grams Per Tonne	Total Content Kilograms	Grams Per Tonne	Total Content Kilograms	Kilograms	Per cent	Kilograms	Per cent
Coolgardie (C.I.P.)	27 876	1.184	33.005	.387	10.788	22.217	67.3	21.831	66.1
Kalgoorlie (C.I.P.)	19 087	1.229	23.458	.312	5.955	17.503	74.6	17.081	72.8
Kalgoorlie (Vat)	2 300	2.265	5.210	0.564	1.2975	3.9125	75.1	3.934	75.5
Leonora	4 800	4.012	19.260	1.016	4.879	14.381	74.6	14.080	73.1
Marvel Loch	2 553	3.478	8.878	0.869	2.218	6.660	75.0	6.586	74.18
Meekatharra (C.I.P.)	4 680	2.360	11.045	0.557	2.607	8.438	76.4	7.486	67.8
Menzies	530	4.204	2.228	1.624	0.861	1.367	61.3	1.372	61.5
Ora Banda	2 000	2.371	4.742	0.584	1.169	3.573	75.3	3.532	74.4
Total	63 826	1.689	107.826	0.466	29.7745	78.0515	72.4	75.902	70.39
Laverton (Part Treated)		—	—	—	—	—	—	2.942	—

Schedule No. 3
Direct Purchase of Tailings by State Batteries in 1982

Battery	Tailings Purchased Tonnes	Initial Payment $	Gold Paid to Prospectors Kilograms
Boogardie	215.1	651.44	10.034
Coolgardie	523.5	1 835.33	6.028
Kalgoorlie	585.8	1 411.73	2.171
Laverton	12.6	17.82	2.947
Leonora	756.7	1 845.22	6.755
Marble Bar	1 260.0	2 875.55	—
Marvel Loch	334.05	1 427.63	3.138
Meekatharra	1 979.4	2 983.57	3.365
Menzies	26.8	46.25	1.099
Norseman	250.2	801.70	—
Ora Banda	100.8	399.64	3.534
Paynes Find	3.6	21.38	—
Sandstone	—	—	—
Nullagine	—	—	2.172
Total	6 035.55	14 317.26	41.243

Schedule No. 4
Statement of Receipts and Expenditure for Milling at State Batteries in 1982

Battery	Tonnes	Management Super-vision	Wages	Stores	Expenditure Total Working	Cost Per Tonne	Repairs Renewals	Sundries	Gross Expenditure	Cost Per Tonne	Receipts	Receipts Per Tonne	Profit	Loss
Boogardie	2 370.8	31 341.66	38 569.52	31 533.94	101 445.12	42.78	11 761.14	23 787.22	136 993.48	57.78	19 766.30	8.33		117 227.18
Coolgardie	4 013.1	32 022.59	78 751.18	54 505.72	165 279.49	41.18	22 351.08	31 519.80	219 150.37	54.60	38 515.63	9.59		180 634.74
Cue	—	—	—	—	—	—	—	—	—	—	—	—	2 040.00	—
Kalgoorlie	8 453.0	69 072.60	100 947.44	103 600.99	273 621.03	32.36	41 314.90	75 850.49	390 786.42	46.23	71 268.29	8.43		319 518.13
Laverton	1 167.5	19 353.51	48 322.97	13 615.20	81 291.68	69.62	5 124.10	12 832.45	99 248.23	85.00	22 285.17	19.08		76 963.06
Leonora	4 739.0	19 992.37	76 176.03	19 749.65	115 918.05	24.46	11 643.38	35 696.55	163 257.98	34.44	59 632.41	12.58		103 625.57
Marble Bar	1 600.0	21 554.67	89 103.12	22 252.53	132 910.32	83.06	6 609.42	13 310.89	152 830.63	95.51	18 418.08	11.51		134 412.55
Marvel Loch	2 264.9	21 788.18	80 740.77	26 980.39	129 509.34	57.18	10 097.32	27 912.36	167 519.02	73.96	13 156.83	5.80		154 362.19
Meekatharra	1 845.0	34 394.09	85 182.55	20 710.06	140 286.70	76.03	6 329.53	16 478.73	163 094.96	88.39	16 103.75	8.72		146 991.53
Menzies	2 016.7	17 074.28	85 417.79	21 381.09	123 873.16	61.42	6 300.49	21 338.61	151 512.26	75.12	19 189.43	9.51		132 322.83
Norseman	1 882.0	31 491.19	57 615.36	19 788.08	108 894.63	57.86	10 763.37	14 880.06	134 538.06	71.49	15 575.00	8.27		118 963.06
Ora Banda	1 255.2	15 373.18	41 429.28	23 707.93	80 510.39	63.83	5 648.83	14 763.03	100 922.25	80.40	9 835.84	7.83		91 086.41
Paynes Find	564.0	8 101.95	20 971.22	5 366.73	34 439.90	61.06	284.96	8 019.60	42 744.46	75.78	4 698.75	8.33		38 045.71
Sandstone	420.0	7 421.71	19 086.10	5 372.61	31 880.42	75.90	2 194.94	5 414.52	39 489.88	94.02	650.00	1.54		38 839.88
Yarri	356.0	1 269.42	29 399.39	9 557.43	40 226.24	112.99	4 969.18	5 247.96	50 443.38	141.69	3 324.75	9.33		43 818.63
Head Office	—	—	—	—	—	—	—	—	—	—	—	—	16 661.79	—
Sub Total	32 947.2	330 251.40	851 712.72	378 122.35	1 560 086.47	47.35	145 392.64	307 052.27	2 012 531.38	61.08	312 420.23	9.48	18 701.79	1 700 111.15
Mag Plant	2.0	—	—	—	—	—	—	—	—	—	60.00		60.00	
Northampton	8.4	17 263.57	22 517.58	4 716.64	44 497.79	5 297.36	1 729.55	1 404.32	47 631.66	—	592.31	—		47 039.35
Total	32 957.6	347 514.97	874 230.30	382 838.99	1 604 584.26	48.69	147 122.19	308 456.59	2 060 163.04	62.52	313 072.54	9.50	18 761.79	1 747 150.50

Schedule No. 5
Statement of Receipts and Expenditure for Cyaniding at State Batteries in 1982

Battery	Tonnes	Management Super-vision	Wages	Stores	Expenditure Total Working	Cost Per Tonne	Repairs Renewals	Sundries	Gross Expenditure	Cost Per Tonne	Receipts	Receipts Per Tonne	Profit	Loss
Kalgoorlie	2 300	4 148.34	61 466.08	33 638.56	99 252.98	43.15	6 972.60	28 947.24	135 172.82	58.77	52 605.66	22.87		82 567.16
Laverton	—	—	144.48	8 579.75	8 724.23	—	84.11	—	8 808.34	—	6 109.96	—		2 698.38
Leonora	4 800	1 267.96	60 851.33	27 421.16	89 540.45	18.65	1 224.25	13 558.96	104 323.66	21.73	131 021.55	27.29	26 697.89	—
Marvel Loch	2 553	—	27 432.36	5 858.17	33 290.53	13.03	5 054.50	5 769.75	44 114.78	17.27	40 277.11	15.77		3 837.67
Menzies	530	4 562.00	7 624.68	4 551.30	16 737.98	31.58	—	3 136.47	19 874.45	37.49	4 944.03	9.32		14 930.42
Norseman	—	—	—	1 593.32	1 593.32	—	194.44	—	1 787.76	—	—	—		1 787.76
Ora Banda	2 000	4 006.26	28 103.56	9 802.45	41 912.27	20.95	241.55	15 740.77	57 984.59	28.94	4 570.21	2.28		53 324.38
Sub Total	12 183	13 984.56	185 622.49	91 444.71	291 051.76	23.88	13 771.45	67 153.19	371 976.40	30.53	239 528.52	19.66	26 697.89	132 447.88
Coolgardie C.I.P.	27 876	—	88 840.07	88 750.58	177 590.65	6.37	11 423.57	34 496.48	223 510.70	8.01	194 712.51	6.98		28 798.19
Kalgoorlie C.I.P.	19 087	17 312.16	78 511.78	127 756.40	223 580.34	11.71	51 347.45	24 517.16	299 444.95	15.68	237 023.16	12.41		62 421.79
Meekatharra C.I.P.	4 680	—	30 003.39	14 587.12	44 590.51	9.52	2 671.17	8 663.12	55 924.80	11.94	64 332.83	13.74	8 408.03	
Sub Total	51 643	17 312.16	197 355.24	231 094.10	445 761.50	8.63	65 442.19	67 676.76	578 880.45	11.20	496 068.50	9.60	8 408.03	82 811.95
Special Agreements	—	—	—	—	—	—	—	—	—	—	124 530.20	—	124 530.20	
Boogardie Contract	5 000	60 000.00	—	—	60 000.00	12.00	—	—	60 000.00	12.00	47 405.91	9.48		12 594.09
Total All Special Agreements	5 000	60 000.00	—	—	60 000.00	12.00	—	—	60 000.00	12.00	171 936.11	—	124 530.20	12 594.09
Total	68 826	91 296.72	382 977.73	322 538.81	796 813.26	11.57	79 213.64	134 829.95	1 010 856.85	14.69	907 533.13	13.18	159 636.12	103 323.72
												Less Interest Paid to Treasury		4 320.00
												Total		107 643.72

PETROLEUM DIVISION

Summary Comparison of Exploration Permit Dealings (1981-1982)

	1981		1982	
	No.	Area (km^2)	No.	Area (km^2)
AREA ADVERTISED				
Onshore	2	5 580	1	82
Offshore	16	126 521	—	—
Totals	18	132 101	1	82
PERMITS GRANTED				
Onshore	14	170 125	9	89 033
Offshore	11	94 527	6	39 861
Totals	25	264 652	15	128 894
PERMIT APPLICATIONS (pending at year end)				
Onshore	43	240 662	2	325
Offshore	7	35 121	2	16 760
Totals	50	275 783	4	17 085
PERMITS HELD				
Onshore	79	799 686	80	761 519
Offshore	56	664 206	59	635 247
Totals	135	1 463 892	139	1 396 766
PERMITS SURRENDERED				
Onshore	1	13 930	7	96 770
Offshore	4	71 935	3	68 820
Totals	5	85 865	10	165 590
PERMIT RENEWALS				
Onshore	1	85	14	45 525
Offshore	—	—	—	—
Totals	1	85	14	45 525
PERMITS CANCELLED				
Onshore	—	—	1	15 200
Offshore	—	—	—	—
Totals	—	—	1	15 200

Barrow Island—Well Completion Status by Reservoir on 31st December, 1982

Horizon/Pools	On Production	On Injection	Shut In			Abandoned (3)	Total
			Producers (1)	Injectors	Miscellaneous (2)		
Tertiary Carbonates (4)	—	8	1	—	—	—	9
Early Cretaceous							
Gearle	4	—	8	—	1	—	13
Windalia Radiolarite	—	—	1	—	—	—	1
Windalia Sandstone	318	174	55	20	6	5	578
Muderong	17	—	5	—	1	—	23
Flacourt (Oil)	1	—	—	—	—	—	1
Flacourt (Water Source)	5	—	5	—	—	1	11
5 500 to 6 200' sands	—	—	3	—	—	—	3
Late Jurassic	2	—	4	—	—	—	6
"Other Jurassic"	—	—	—	—	1	1	2
Middle Jurassic	—	—	3	—	—	—	3
Totals	347	182	85	20	9	7	650

(1) Shut-in producers includes wells where attempts to obtain commercial production have been unsuccessful.

(2) Miscellaneous includes wells cased but not currently perforated plus wells completed in the water leg for observation.

(3) Abandoned wells are fully plugged and abandoned.

(4) Includes salt water disposal.

NOTE: Recompleted wells are included in horizon/pool of current completion.

Petroleum Production During 1982

Field or Reservoir	No. of Producing wells at 31/12/82	Production for Year 1982						Cumulative Production					
		Gas ($10^3 m^3$)	Condensate (kL)	LPG (kL)	Natural Gasoline (kL)	Oil (kL)	Water (kL)	Gas ($10^3 m^3$)	Condensate (kL)	LPG (kL)	Natural Gasoline (kL)	Oil (kL)	Water (kL)
Barrow Island													
Gearle	4	711	—	—	—	3 925	6 556	16 933	—	—	—	77 183	18 630
Windalia	318	103 574	—	3 554	5 461	1 203 992	954 838	2 443 575	—	43 084	47 262	29 179 374	10 245 993
Muderong	17	8 084	—	—	—	46 762	35 957	52 129	—	—	—	321 329	146 967
Flacourt	1	136	—	—	—	1 071	10 460	335	—	—	—	2 302	13 994
Early Cretaceous	—	—	—	—	—	—	—	96 050	—	—	—	16 639	44 103
Late Jurassic	2	2 157	—	—	—	5 167	33 696	159 972	—	—	—	335 577	414 349
Middle Jurassic	—	—	—	—	—	—	—	60 324	—	—	—	1 896	616
Total Barrow	342	114 662	—	3 554	5 461	1 260 917	1 041 507	2 829 318	—	43 084	47 262	29 934 300	10 884 652
Northern Perth Basin													
Dongara	20	825 234	2 240	—	—	18 062	23 068	8 368 754	33 702	—	—	104 415	85 225
Mondarra	—	17 212	274	—	—	—	334	536 545	7 578	—	—	—	4 987
Yardarino	1	8 812	273	—	—	—	5 780	102 848	358	—	—	1 858	10 590
Total Wapet (N. Perth)	21	851 258	2 787	—	—	18 062	29 182	9 008 147	41 638	—	—	106 273	100 802
Woodada	2	83 527	757	—	—	—	—	83 527	757	—	—	—	—
Mt Horner	1	—	—	—	—	305	197	—	—	—	—	305	197
Canning Basin													
Blina	—	10	—	—	—	3 280	—	10	—	—	—	3 280	—
Grand Total	366	1 049 457	3 544	3 554	5 461	1 282 564	1 070 886	11 921 002	42 395	43 084	47 262	30 044 158	10 985 651

Summary of Identified Recoverable Reserves at 31st December 1982

	Oil ($10^6 m^3$)		Gas $C_1 + C_2$ ($10^9 m^3$)		LPG $C_3 + C_4$ ($10^6 m^3$)		Condensate $C_5 + C_6$ ($10^6 m^3$)	
	P1	P2	P1	P2	P1	P2	P1	P2
PRODUCING FIELDS								
Carnarvon Basin								
Barrow Island	10.24	12.03	0.23	0.26	0.06	0.06	0.06	0.06
Perth Basin								
Dongara	0.07	0.07	2.88	2.88	—	—	0.01	0.01
Mondarra	—	—	0.06	0.06	—	—	neg	0.01
Yardarino	—	—	0.01	0.01	—	—	—	—
Woodada	—	—	0.52	0.68	—	—	—	—
Canning Basin								
Blina	0.37	0.37	—	—	—	—	—	—
Total		12.47		3.89		0.06		0.08
UNDEVELOPED FIELDS								
Angel	—	—	22.80	43.60	—	—	—	—
Goodwyn	0.17	0.17	63.10	86.00	8.70	11.10	4.77	17.17
Gorgon*	—	—	4.09	84.11	—	—	0.01	0.30
North Rankin	—	—	201.00	235.00	15.80	18.20	19.23	22.10
Tidepole	0.96	1.18	13.03	17.21	—	—	2.26	2.99
West Tryal Rocks*	—	—	8.25	58.94	—	—	0.55	3.94
Tubridgi	—	—	1.08	2.16	—	—	—	—
Tern	—	—	40.00	49.00	—	—	—	—
Total		1.35		576.02		29.30		56.73
Total Reserves		13.82		579.91		29.36		56.81

P1 probability 75%; P2 probability 25%. *Excludes inerts

Disposal of Petroleum 1982

Field	Gas Sold ($10^3 m^3$)	Oil Sold (kL)	LPG Sold (kL)	Natural Gasoline Sold (kL)	Condensated Sold (kL)	Water (kL) Injected 1982	Cumulative Water (kL) Injected	Royalty Paid 1983 $
Barrow Island	16 278*	1 256 586	3 073**	5 461*	—	2 633	64 382	11 993 401
Dongara, Mondarra, Yardarino	830 476	17 493	—	—	2 751	—	—	1 711 638
Woodada	83 527	—	—	—	658	—	—	472 242
Mt Horner	—	229	—	—	—	—	—	3 131
Blina	—	3 245	—	35*	—	—	—	8 458
Total	930 281	1 277 553	3 073	5 496	3 409	2 633	64 382	14 188 870

* Field Fuel
** 890 kL blended with crude

Accident Statistics Relating to the Petroleum Exploration, Production and Pipeline Industry During 1982

Nature of Injury	Petroleum Industry Categories				
	Drilling Activities		Barrow Island Oil Field	North West Shelf Project	Total
	Onshore	Offshore			
Head	1	9	4	15	29
Eye	2	10	10	31	53
Trunk	16	25	19	53	113
Arm	3	14	6	21	44
Hand	19	27	7	45	98
Leg	15	19	9	64	107
Foot	5	4	2	20	31
Occupational	0	0	0	0	0
Other	0	0	0	5	5
Totals	61	108	57	254	480
Agency of Injury					
Machinery in Operation	11	7	3	5	26
Vehicles	1	0	0	0	1
Hand Tools	1	3	0	2	6
Power Tools	0	0	1	2	3
Manual Handling	2	9	18	23	52
Harmful Contacts	5	3	3	25	36
Persons Falling or Striking	17	27	11	72	127
Objects Falling or Flying	13	25	10	51	99
Other	7	25	7	63	102
Magnitude of Injury					
Minor	38	67	30	185	320
Serious	19	32	23	58	132
Fatal	—	—	—	—	—
Time Factor					
Manhours Exposure	554 400	1 324 800	416 300	2 538 328	4 833 828
Manhours Lost	7 200	16 750	9 600	33 680	67 230

SURVEYS AND MAPPING DIVISION

Control Projects and Co-ordinate Traversing

Projects	Kilometres		Stations Established	Length Traverse	Points Co-ordinated
	NS	EW			
Completed 1982					
Jundee-Mt Joel	100	80	7	1 134	1 116
Mt. Phillipson-Weebo	113	56	10	892	848
Cue	70	90	12	2 278	5 912
Laverton-Duketon Extension	54	45	—	734	786
Yinnietharra	55	40	7	502	471
Noonkanbah	45	40	2	280	226
Projects Proceeding					
Peak Hill	75	75	11	—	—
Warda Warra	55	35	5	—	—
Yalgoo	40	25	4	—	—
Mt. Magnet	140	60	15	—	—
Callion-Day Rock	70	60	15	—	—
Copperfield	40	15	—	—	—
Bullfinch-Southern Cross	50	30	—	249	715
Marvel Loch	83	47	Existing control	1 899	3 036
Marble Bar (Phase 1)	35	32	8	—	—
Bridget	6	12	2	47	59
Boobina-Spinaway	15	25	Existing control	138	185
Dockrell	44	28	7	—	—
Lynas	6	3	2	—	—
New Projects					
Sandstone	92	120	6	—	—
Shovelanna	40	30	6	—	—
Depot Springs	55	60	5	—	—
Kurnalpi	20	40	3	—	—
Marble Bar (Phase 2)	15	32	4	—	—

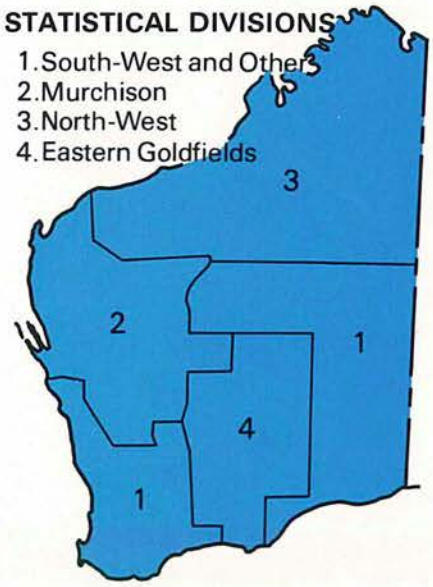
Plans and Documents in Use

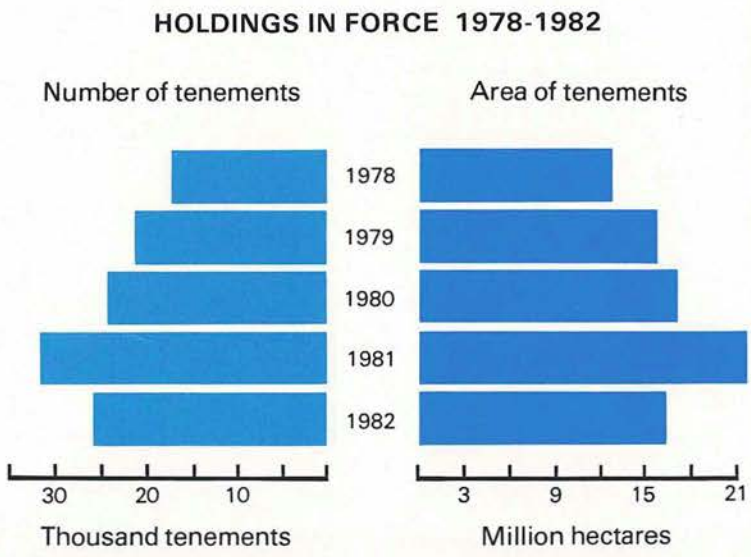
Public Plans	Current	Archived
Index Plans RF:1: 1 000 000	14	121
Temporary Reserve Series RF: 1: 1 000 000	14	61
Petroleum Series RF: 1: 1 000 000	34	39
Public Plans RF: 1: 250 000	84	414
Public Plans RF: 1: 100 000	189	110
Public Plans RF: 1: 50 000 and 1: 25 000	1 256	2 836
Large Scale Series	14	36
Lands Old Series (Imperial)	130	893
Mines Old Series (Miscellaneous)	7	497
Lands Old Series (T.M.)	14	182
Old Index Sheets (10 Mile)	—	137
Petroleum Map (M175)	1	78
Totals	1 757	5 404
Standard Plans		
Index RF: 1: 1 000 000	14	28
Index (10 Mile)	—	19
Old Projection (20 Chain)	509	214
Transverse Mercator	209	10
Australian Map Grid	—	—
RF: 1: 100 000	1	—
RF: 1: 50 000	251	2
RF: 1: 25 000	37	6
RF: 1: 10 000	46	—
Provisional (All Scales)	357	75
Totals	1 424	354
Survey Plans		
Diagrams (Imperial)	49 880	
Diagrams (Metric)	10 125	
Original Plans (Imperial)	292	
Original Plans (Metric)	841	
Totals	61 138	
Field Books		
Cadastral Surveys	6 782	

REGISTRATION DIVISION

Number and Area of Mining Tenements Applied for in 1982

Statistical Divisions		Exploration Licence	Prospecting Licence	Mining Lease	Other	Totals
1. South West and Other	No. Applied for	199	91	32	1	323
	Area (ha)	2 594 052	10 914	5 217	1	2 610 184
2. Murchison	No. Applied for	218	374	54	7	653
	Area (ha)	2 666 915	36 247	4 120	739	2 708 021
3. North West	No. Applied for	295	293	52	10	650
	Area (ha)	3 796 649	39 722	8 237	8 667	3 853 275
4. Eastern Goldfields	No. Applied for	135	1 013	164	30	1 342
	Area (ha)	1 681 134	107 282	10 092	1 049	1 799 557
Totals	No. Applied for	847	1 771	302	48	2 968
	Area (ha)	10 738 750	194 165	27 666	10 456	10 971 037





ADMINISTRATIVE SERVICES DIVISION
Average number of men employed in mining operations in Western Australia during 1982

Company	Location	Above ground	Below ground	Total
ALUMINA				
Alcoa of Australia Ltd	Jarrahdale/Kwinana	1 676	—	
	Del Park/Huntly/Pinjarra	1 643	—	3 422
	Wagerup	103	—	
COAL				
Griffin Coal Mining Co Ltd	Collie	421	—	421
Western Collieries Ltd	Collie	310	338	648
COPPER-SILVER-ZINC				
Seltrust Mining Corporation Pty Ltd	Teutonic Bore	137	11	148
GOLD				
Central Norseman Gold Corp.	Norseman	226	147	373
Great Boulder Mines (W.M.C.)	Boulder	12	—	12
Hill 50 Gold Mines N.L.	Mt Magnet	66	101	167
Kia Ora Gold Corporation	Marvel Loch	30	20	50
Kalgoorlie Lake View-Boulder	Boulder	260	271	531
Kalgoorlie Lake View-Mt. Charlotte	Kalgoorlie	22	162	184
Lancefield Joint Venture	Windarra	16	59	75
Newmont Pty Ltd	Telfer	111	—	111
North Kalgurli Mines Ltd	Boulder	162	101	263
WMC Great Boulder Holdings	Kambalda	26	11	37
WMC Sand King	Ora Banda	10	—	10
Whim Creek Consolidated	Meekatharra	32	—	32
All Other Operators	State Generally	876	306	1 182
IRON ORE				
BHP Minerals Ltd	Yampi	558	—	558
	Koolyanobbing	77	—	77
	Kwinana	418	—	418
Cliffs Robe River	Pannawonica/Cape Lambert	1 384	—	1 384
Goldsworthy Mining Ltd	Pilbara/Port Hedland	1 178	—	1 178
Hamersley Iron Pty Ltd	Tom Price-Paraburdoo/Dampier	4 041	—	4 041
Mt Newman Mining Co Ltd	Newman/Pt. Hedland	3 794	—	3 794
MINERAL BEACH SANDS				
Allied Eneabba Pty Ltd	Eneabba	204	—	204
Cable Sands Pty Ltd	Capel	82	—	82
Associated Minerals Consolidated Ltd	Eneabba	136	—	136
	Capel	122	—	122
Westralian Sands Ltd	Capel	139	—	139
NICKEL				
Agnew Mining Co Pty Ltd	Leinster	210	78	288
Metals Exploration N.L.	Nepean	83	92	175
Western Mining Corporation	Kambalda	730	746	1 476
	Kalgoorlie	364	—	364
	Kwinana Refinery	405	—	405
WMC & Shell Co of Australia	Mt. Windarra	197	151	348
PETROLEUM-CRUDE OIL				
West Australian Petroleum Pty Ltd	Barrow Island	133	—	133
	Dongara	9	—	9
Hudbay Oil (Australia) Ltd	Woodada	45	—	45
SALT				
Dampier Salt Ltd	Dampier	173	—	173
	Lake McLeod	117	—	117
Leslie Salt Co	Port Hedland	49	—	49
Shark Bay Joint Venture	Shark Bay	98	—	98
All Other Minerals (including rock quarries)		683	—	683
	Total:	21 568	2 594	24 162

Open cut workers classed as above ground.

Quantity and Value of Minerals Produced During 1981 and 1982 in Western Australia

Minerals	Quantity Unit	1981		1982		Increase or decrease for year compared with 1981	
		Quantity	Value $	Quantity	Value $	Quantity	Value $
Alumina (from Bauxite)	Tonne	3 678 480	548 093 520	**3 676 385**	**647 822 717**	-2 095	+99 729 197
Barytes	"	24 668	1 109 904	**6 643**	**281 749**	-18 025	-828 155
Base Materials							
Aggregate	"	-	-	**7 836**	**32 070**	+7 836	+32 070
Gravel	"	-	-	**5 470**	**30 635**	+5 470	+30 635
Rock	"	-	-	**109 307**	**218 616**	+109 307	+218 616
Sand	"	-	-	**21 673**	**54 371**	+21 673	+54 371
Sandstone	"	-	-	**50**	**1 250**	+50	+1 250
Building stone	"	4 367	158 944	**4 273**	**96 304**	-94	-62 640
Clays	"	275 130	205 100	**242 971**	**337 440**	-32 159	+132 340
Coal	"	3 254 403	68 251 534	**3 702 197**	**87 460 645**	+447 794	+19 209 111
Cobalt (by-product of nickel mining)	"	609	7 689 911	**534**	**5 314 179**	-75	-2 375 732
Copper (by-product of nickel mining)	"	2 858	3 240 056	**3 390**	**2 899 106**	+532	-340 950
Copper concentrates	"	5 205	1 154 174	**61 373**	**12 491 102**	+56 168	+11 336 928
Feldspar	"	3 181	145 799	**1 914**	**79 613**	-1 267	-66 186
Garnet Sands	"	1 344	151 517	**3 266**	**222 726**	+1 922	+71 209
Glass Sands	"	113 239	56 343	**122 905**	**115 768**	+9 666	+59 425
Gold	Kilogramme	12 047	153 313 613	**20 757**	**247 418 210**	+8 710	+94 104 597
Gypsum	Tonne	354 836	1 444 659	**426 543**	**4 070 915**	+71 707	+2 626 256
Iron ore (pig-iron recovered)	"	3 763	526 820	-	-	-3 763	-526 820
Iron ore	"	75 302 640	1 129 628 976	**78 182 395**	**1 495 065 014**	+2 879 755	+365 436 038
Limestone	"	637 350	2 028 155	**514 252**	**1 659 214**	-123 098	-368 941
Manganese	"	1 196	29 885	**74**	**1 852**	-1 122	-28 033
Mica	"	354	94 751	**300**	**84 241**	-54	-10 510
Mineral beach sands							
Ilmenite	"	963 128	29 636 688	**1 075 861**	**34 285 775**	+112 733	+4 649 087
Monazite	"	10 715	4 148 454	**16 236**	**6 823 064**	+5 521	+2 674 610
Rutile	"	61 595	18 141 673	**80 199**	**21 823 610**	+18 604	+3 681 937
Leucoxene	"	15 786	3 202 746	**15 318**	**3 047 564**	-468	-155 182
Zircon	"	226 463	16 974 854	**297 105**	**29 324 196**	+70 642	+12 349 342
Xenotime	"	58	187 219	-	-	-58	-187 219
Nickel concentrates	"	405 946	306 484 456	**457 785**	**332 138 957**	+51 839	+25 654 501
Nickel ore	"	85 894	17 869 788	**98 187**	**19 411 692**	+12 293	+1 541 904
Ochre	"	839	14 281	-	-	-839	-14 281
Palladium (by-product of nickel mining)	Kilogramme	401	1 254 422	**416**	**1 112 023**	+15	-142 399
Platinum (by-product of nickel mining)	"	65	868 736	**74**	**933 357**	+9	+64 621
Petroleum—crude oil	Kilolitre	1 439 274	278 612 808	**1 278 000**	**258 602 636**	-161 274	-20 010 172
Petroleum—natural gas	10^3m^3	831 929	28 927 638	**881 154**	**36 018 694**	+49 225	+7 091 056
Petroleum—condensate	Tonne	2 050	N.A.	**2 552**	**N.A.**	+502	N.A.
Salt	"	3 624 031	39 074 797	**3 422 159**	**47 673 788**	-201 872	+8 598 991
Semi precious stones	Kilogramme	4 228	7 114	**6 676**	**39 907**	+2 448	+32 793
Silver	"	10 627	3 082 411	**50 307**	**10 832 182**	+39 680	+7 749 771
Talc	Tonne	133 996	N.A.	**92 182**	**N.A.**	-41 814	N.A.
Tanto/Columbite ores & concentrates	"	298	13 179 471	**20**	**464 754**	-278	-12 714 717
Tin concentrates	"	922	10 260 637	**720**	**6 275 268**	-202	-3 985 369
Vanadium	"	-	-	**167**	**971 300**	+167	+971 300
Vermiculite	"	-	-	**429**	**7 040**	+429	+7 040
Zinc concentrates	"	10 129	2 899 744	**101 787**	**18 709 900**	+91 658	+15 810 156
Totals			2 692 151 598		**3 334 253 444**		+642 101 846

Comparison of Royalties Collected in 1981 and 1982

Mineral	Royalty collected		Increase or decrease compared with 1981
	1981	**1982**	
	$	**$**	$
Alumina	5 675 188.39	**5 500 745.27**	-174 443.12
Aggregate	—	**2 775.50**	+2 775.50
Amethyst	22.45	**2 344.31**	+2 321.86
Baryte	1 504.74	**326.90**	-1 177.84
Building Stone	477.36	**1 918.79**	+1 441.43
Chalcedony	.10	**1.65**	+1.55
Clay	14 469.34	**75 993.99**	+61 524.65
Coal	75 655.34	**431 029.09**	+355 375.75
Cobalt	24 970.38	**74 400.41**	+49 430.03
Copper	—	**164 462.77**	+164 462.77
Emerald	150.00	—	-150.00
Feldspar	208.24	**2 991.02**	+2 782.78
Garnet Sands	1 484.70	**11 588.85**	+10 104.15
Glass Sand	6 111.67	**47 266.91**	+41 155.24
Gold	9 915.02	**34 038.57**	+24 123.55
Gravel	—	**1 737.50**	+1 737.50
Gypsum	15 649.62	**31 887.91**	+16 238.29
Ilmenite	492 175.88	**499 500.73**	+7 324.85
Iron Ore	57 237 793.49	**67 959 246.04**	+10 721 452.55
Leucoxene	71 497.36	**43 243.25**	-28 254.11
Limestone	32 122.50	**210 773.31**	+178 650.81
Manganese	136.29	**184.10**	+47.81
Mica	265.74	**5 086.69**	+4 820.95
Monazite	110 354.26	**116 516.31**	+6 162.05
Moss Opal	8.12	**109.54**	+101.42
Natural Gas	1 382 454.94	**1 983 827.15**	+601 372.21
Natural Gas (Condensate)	18 426.56	**27 725.27**	+9 298.71
Nickel	3 478 284.53	**5 033 875.75**	+1 555 591.22
Ochre	36.75	**5.25**	+31.50
Oil (Crude)	5 585 755.88	**10 865 289.56**	+5 279 533.68
Palladium	1 841.85	**7 485.00**	+5 643.15
Platinum	1 841.84	**7 908.73**	+6 066.89
Rock	—	**31 720.45**	+31 720.45
Rutile	588 109.06	**343 134.11**	-244 974.95
Salt	302 601.43	**241 968.97**	-60 632.46
Sand	—	**4 611.54**	+4 611.54
Silver	—	**86 187.90**	+86 187.90
Talc	6 514.14	**23 477.96**	+16 963.82
Tanto-Columbite	72 785.50	**43 728.28**	-29 057.22
Tin	147.52	**53 833.03**	+53 685.51
Vanadium	4 972.35	**4 740.67**	-231.68
Vermiculite	11.25	**195.80**	+184.55
Xenotime	473.14	**1 000.79**	+527.65
Zinc	2 022.68	**186 619.28**	+184 596.60
Zircon	531 084.71	**594 561.67**	+63 476.96
Totals	75 747 535.12	**94 760 066.57**	+19 012 531.45

Production of Gold and Silver from all Sources Showing in Kilograms the Output as Reported to the Department of Mines during the Year 1982

Goldfield	District	District						Goldfield					
		Alluvial Kg	Dollied and Specimens Kg	Ore Treated Tonnes	Gold Therefrom Kg	Total Gold Kg	Silver Kg	Alluvial Kg	Dollied and Specimens Kg	Ore Treated Tonnes	Gold Therefrom Kg	Total Gold Kg	Silver Kg
West Kimberley		—	—	—	—	—	—	—	—	—	—	—	—
Kimberley		—	—	—	—	—	—	4.888	1.084	—	—	5.972	—
Pilbara	Marble Bar	28.282	6.601	461 636.00	5 074.156	5 109.039	220.547						
	Nullagine	14.646	5.569	717.00	48.649	68.864	.266	42.928	12.170	462 353.00	5 122.805	5 177.903	220.813
West Pilbara		—	—	—	—	—	—	.790	1.532	200.00	.198	2.520	—
Ashburton		—	—	—	—	—	—	5.695	.846	—	.133	6.674	.597
Gascoyne		—	—	—	—	—	—	.576	.243	291.00	3.914	4.733	.061
Peak Hill		—	—	—	—	—	—	14.200	.925	5 176.00	4.888	20.013	.074
East Murchison	Lawlers	.171	.130	—	—	.301	—						
	Wiluna	.655	.939	13.00	7.586	9.180	—						
	Black Range	5.163	2.377	586.00	88.538	96.078	6.090	5.989	3.446	599.00	96.124	105.559	6.090
Murchison	Cue	26.657	10.909	2 214.00	4.115	41.681	.305						
	Meekatharra	19.800	4.750	235 020.00	514.763	539.313	4.272						
	Day Dawn	4.813	—	2 166.00	13.847	18.660	—						
	Mt Magnet	3.079	1.473	149 626.00	891.503	896.055	92.083	54.349	17.132	389 026.00	1 424.228	1 495.709	96.660
Yalgoo		—	—	—	—	—	—	5.397	1.306	5 942.00	94.095	100.798	5.258
Mt Margaret	Mt Morgans	6.241	3.049	2 927.00	35.403	44.693	—						
	Mt Malcolm	14.941	7.220	6 943.00	51.431	73.592	1.139	31.958	17.555	184 430.00	947.684	997.197	3.133
	Mt Margaret	10.776	7.286	174 560.00	860.850	878.912	1.944						
North Coolgardie	Menzies	.558	—	7 002.00	138.173	138.731	2.773						
	Ularring	—	—	537.00	3.521	3.521	.255						
	Niagara	.957	.348	514.00	2.641	3.946	—						
	Yerilla	.484	.162	875.00	9.505	10.151	1.061	1.999	.510	8 928.00	153.840	156.349	4.089
Broad Arrow		—	—	—	—	—	—	.029	—	64 941.00	246.638	246.667	.267
North East Coolgardie	Kanowna	—	2.554	592.00	1.503	4.057	.093						
	Kurnalpi	3.080	—	51.00	.210	3.290	.720	3.080	2.554	643.00	1.713	7.347	.813
East Coolgardie	East Coolgardie	3.619	5.081	1 619 842.00	7 723.449	7 732.149	1 322.137						
	Bulong	.374	.743	214.00	11.302	12.419	—	3.993	5.824	1 620 056.00	7 734.751	7 744.568	1 322.137
Coolgardie	Coolgardie	3.183	4.346	452 460.00	1 659.106	1 666.635	284.608						
	Kunanalling	8.933	.170	2 507.00	4.570	13.673	—	12.116	4.516	454 967.00	1 663.676	1 680.308	284.608
Yilgarn		—	—	—	—	—	—	1.236	.423	43 167.00	344.537	346.196	72.526
Dundas		—	—	—	—	—	—	.462	—	211 126.00	2 641.803	2 642.265	640.943
Phillips River		—	—	—	—	—	—	—	—	599.00	8.860	8.860	—
South West Mineral Field		—	—	—	—	—	—	.285	.251	60.00	.031	.567	—
Northampton Mineral Field		—	—	—	—	—	—	—	—	—	—	—	—
State Generally		—	—	—	—	—	—	3.669	2.880	—	—	6.549	—
Outside Proclaimed Goldfield		—	—	—	—	—	—	—	—	—	—	—	—
Totals								193.639	73.197	3 452 504.00	20 489.918	20 756.754	2 658.069

Quantity and value of minerals reported during the year 1982

Number of Lease Claim or area	Producer	Centre	Goldfield or Mineral Field	Quantity (Tonnes unless otherwise stated)	Metallic Content	Value $
Alumina						
ML 70/1 S.A.	Alcoa of Australia (WA) Ltd	Del Park	South West	2 157 371		381 062 471
ML 70/1 S.A.	Alcoa of Australia (WA) Ltd	Jarrahdale	South West	1 519 014		266 760 246
				3 676 385		647 822 717 (1)
Barytes						
ML 45/1522	Dresser Minerals International Inc.	North Pole	Pilbara	6 643		281 749 (b)
Base Materials						
Aggregate						
DC 08/15	D C McAulley	Onslow	Ashburton	392		5 080
QA 45/60, 61	Calsil Ltd	Port Hedland	Pilbara	3 056		11 634
QA 47/79	J Stove	Roebourne	West Pilbara	4 388		15 356
				7 836		32 070 (c)
Gravel						
QA 80/2, 3, 13, 14, 15, 16	C & M Guerinoni	Kununurra	Kimberley	1 122		8 580
QA 80/5, 6, 7	R G Harvey	Kununurra	Kimberley	370		2 960
QA 04/52	Brenel Pty Ltd	Broome	West Kimberley	3 978		19 095
				5 470		30 635 (c)
Rock						
MC 47/156-161, 175-177, 187	Specified Services Pty Ltd	Mt Regal	West Pilbara	109 307		218 616 (c)
Sand						
QA 45/78	Cottiers Pty Ltd	Port Hedland	Pilbara	343		4 536
QA 45/60-61	Calsil Ltd	Port Hedland	Pilbara	4 068		15 129
QA 04/120-121	Jones D	Derby	West Kimberley	60		300
MC 47/45-47, 52-53	Specified Services Pty Ltd	Maitland	West Pilbara	16 202		32 406
MC 1224H	Silicon Quarries Pty Ltd	Jandakot	South West	1 000		2 000
				21 673		54 371 (c)
Sandstone						
QA 04/9, 12, 32, 33, 46, 47, 48, 49	Kimberley Colourstone Industry Pty Ltd	Derby	West Kimberley	50		1 250 (c)
						336 942

Number of Lease Claim or Area	Producer	Centre	Goldfield or Mineral Field	Quantity (Tonnes unless otherwise stated)	Metallic Content	Value $
Building Stone						
Quartz						
MC 70/2110	Snowstone Pty Ltd	Mukinbudin	South West	2 045		85 359
MC 70/1921	Cutts J E	Manjimup	South West	1 784		2 140
Quartzite						
MC 70/1158-9	House R P	Toodyay	South West	444		8 805
				4 273		96 304 (a) (c)
Clays						
Cement Clay						
MC 70/788	Bell Bros Pty Ltd	Armadale	South West	25 118		62 795
Fire Clay						
MC 70/436-7	Midland Brick Co. Pty Ltd	Bullsbrook	South West	215 504		258 607
MC 70/304 etc	Clackline Refractories Ltd	Clackline	South West	938		1 876
White Clay—Ball Clay						
MC 70/109, 540, 70/13193	Bristile Ltd	Goomalling	South West	1 176		12 750
Kaolin						
MC 70/247, 605	Universal Milling Co. Pty Ltd	Mt Kokeby	South West	235		1 412
				242 971		337 440 (a) (c)
Coal						
CML 12/448	Griffin Coal Mining Co. Ltd	Muja	Collie	2 021 203		43 860 102
CML 12/437	Western Collieries Ltd	Western	Collie	1 680 994		43 600 543
				3 702 197		87 460 645 (e)
Cobalt						
(Metallic By-Product of Nickel Mining)					Cobalt Tonnes	
ML 15/152 etc	Western Mining Corporation	Kambalda	Coolgardie		434.308	4 195 151
ML 38/255 SA	Agnew Mining Co. Pty Ltd	Leinster	East Murchison		99.443	1 119 028
					533.751	5 314 179
Copper Concentrates (g)					Copper Tonnes	
ML 37/3758-62	Seltrust Mining Corporation Pty Ltd	Teutonic Bore	Mt Margaret	61 373	14 214	12 491 102 (b)

Copper						
(Metallic By-Product of Nickel Mining)					Copper Tonnes	
(g)						
ML 15/152 etc	Western Mining Corporation	Kambalda	Coolgardie		2 606.146	2 192 616
ML 38/255 S.A.	Agnew Mining Co. Pty Ltd	Leinster	East Murchison		783.615	706 490
					3 389.761	2 899 106
Feldspar						
MC 70/2110	Snowstone Pty Ltd	Mukinbudin	South West	1 677		74 861
ML 15/96,100,108 etc	Universal Milling Co. Pty Ltd	Londonderry	Coolgardie	237		4 752
				1 914		79 613 (a)
Garnet Sands						
MC 70/11563	Target Minerals NL	Port Gregory	South West	3 126		214 186
MC 70/746 etc	Cable Sands Pty Ltd	Capel	South West	140		8 540
				3 266		222 726 (b)
Glass Sands						
MC 70/417-8	Australian Glass Manufacturers	Lake Gnangara	South West	29 189		115 768
MC 70/1076	Ready Mix Group (WA)	Jandakot	South West	93 716		N.A.
				122 905		115 768 (c)
Gold				Ore Treated Tonne	Kg.	
GML 45/1430	Newmont Pty Ltd	Telfer	Pilbara	460 090	5 040.747	60 085 146
GML 26/6563 etc	Kalgoorlie Lake View Pty Ltd (Mt Charlotte)	Kalgoorlie	East Coolgardie	929 134	4 240.249	50 543 299
GML 63/1936 etc	Central Norseman Gold Corp.	Norseman	Dundas	205 662	2 586.367	30 829 208
GML 26/6663, 6837, 7124	Kalgoorlie Lake View Pty Ltd	Boulder	East Coolgardie	337 380	1 939.142	23 114 358
ML 15/163 etc	Western Mining Corp.	Kambalda	Coolgardie	427 936	1 294.504	15 430 344
GML 26/6910 etc	North Kalgurli Mines Ltd	Boulder	East Coolgardie	251 733	986.113	11 754 358
GML 38/2914 etc	Lancefield Joint Venture (WMC & Shell Co.)	Windarra	Mt Margaret	173 787	793.621	9 459 874
GML 45/1457, 1447, 1869	Hill 50 Gold Mines NL	Mt Magnet	Murchison	145 898	778.549	9 280 218
GML 51/2008, 2105	Whim Creek Consolidated NL	Meekatharra	Murchison	225 318	449.706	5 360 446
GML 26/6903 etc	Great Boulder Mines—WMC	Boulder	East Coolgardie	77 109	372.576	4 441 065
GML 77/4629, 4631, 4814	Kia Ora Gold Corp.	Marvel Loch	Yilgarn	30 648	233.840	2 787 347
GML 24/2351	Western Mining Corp—Sand King	Ora Banda	Broad Arrow	61 469	229.823	2 739 465
ML 15/152 etc	Western Mining Corp. (ex Nickel Mining)	Kambalda	Coolgardie		187.675	2 237 065
	Minor Producers		State Generally	126 340	1 623.842	19 356 017
				3 452 504	*20 756.754	247 418 210

*Includes Alluvial, Dollied and Specimens

Number of Lease Claim or Area	Producer	Centre	Goldfield or Mineral Field	Quantity (Tonnes unless otherwise stated)	Metallic Content	Value $	
Gypsum							
MC 77/9 etc	West Australian Plaster Mills	Yellowdine	Yilgarn	36 282		121 908	(a)
MC 77/50 etc	H B Brady Pty Ltd	Lake Brown	Yilgarn	26 330		65 826	(a)
MC 70/15466 etc	Swan Portland Cement Ltd	Lake Hillman	South West	11 886		262 705	(c)
MC 70/1115-6	McAndrew R W	Yelbini	South West	12 204		36 612	(a)
MC 70/611 etc	Amalgamated Industries Ltd	Lake Cowcowing	South West	1 500		4 000	(a)
MC 9/43,49,50	Agnew Clough Ltd	Shark Bay	Gascoyne	338 341		3 597 864	(b)
				526 543		4 070 915	
(Plaster of paris reported as manufactured during the year 42 666 tonnes from 61 175 tonnes of gypsum by 2 companies.)							
Iron Ore							
Ore Railed to Kwinana					Av. Assay Fe%		
ML 77/2 S.A.	BHP Minerals Ltd	Koolyanobbing	Yilgarn	*734 378	63.00	8 025 011	(n)
Ore Shipped Interstate							
ML 52/244 S.A.	Mt Newman Mining Co. Pty Ltd	Mt Whaleback	Peak Hill	6 143 446	64.00	95 277 003	(b)
ML 4/10 etc	BHP Minerals Ltd	Cockatoo Island	West Kimberley	447 938	68.550	4 405 318	(b)
Ore Exported Overseas							
ML 4/50 etc	BHP Minerals Ltd	Koolan Island	West Kimberley	2 527 195	67.03	48 314 540	(b)
ML 4/10 etc	BHP Minerals Ltd	Cockatoo Island	West Kimberley	231 044	69.09	3 947 462	(b)
ML 52/244 S.A.	Mt Newman Mining Co. Pty Ltd	Mt Whaleback	Peak Hill	22 563 165	63.00	473 991 572	(b)
ML 47/4 S.A.	Hamersley Iron Pty Ltd	Mt Tom Price	West Pilbara	27 332 823	63.24	561 098 132	(b)
TR 2401H	Cliffs WA Mining Co. Pty Ltd	Pannawonica	West Pilbara	13 307 638	56.71	195 257 198	(b)
ML 45/235 S.A.	Goldsworthy Mining Ltd	Mt Goldsworthy	Pilbara	4 894 768	62.29	104 748 778	(b)
				78 182 395		1 495 065 014	
*Includes 564 028 tonnes shipped interstate							
Limestone (for Building, Burning and Agricultural Purposes)							
MC 70/684,728	Bell Bros Pty Ltd	Wanneroo	South West	73 426		73 426	
MC 70/1290	Bellombra V	North Wanneroo	South West	4 187		41 870	
MC 70/1755	Cockburn Cement Ltd	Kwinana	South West	123 000		123 000	
MC 70/2734-5	Swan Portland Cement	Wanneroo	South West	65 490		284 356	
MC 70/1660	Swan Portland Cement	Jandakot	South West	237 589		1 115 340	
MC 70/17025	Wolfe S H	Bornholm	South West	378		2 310	
ML 47/513	Specified Services Pty Ltd	Cleaverville	West Pilbara	9 212		9 212	
MC 63/3086	WA Salt Supply Pty Ltd	Esperance	Dundas	970		9 700	
				514 252		1 659 214	(c)

Manganese (Metallurgical Grade)					Av. Assay Mn%	
ML 52/14	Universal Milling Co. Pty Ltd	Mt Padbury	Peak Hill	74	47.5	1 852 (b)
Mica						
MC 45/7145,8416	Pilbara Mica Corporation Pty Ltd	Pippingarra	Pilbara	300		84 241 (b)
Mineral Beach Sands						
Ilmenite (g)					Av. Assay TiO_2%	
MC 70/516	Associated Minerals Consolidated Ltd	Capel	South West	173 234	55.00	
MC 70/746 etc	Cable Sands Pty Ltd	Capel	South West	137 729	54.65	
MC 70/389	Western Mineral Sands Pty Ltd	Capel	South West	172 480	54.00	
MC 70/619 etc	Westralian Sands Ltd	Yoganup	South West	233 041	57.51	
MC 70/7062	Allied Eneabba Pty Ltd	Eneabba	South West	322 523	60.60	
MC 70/7002	Associated Minerals Consolidated Ltd	Eneabba	South West	1 099	59.50	
				1 040 106		34 285 775 (b)
Upgraded Ilmenite (g)						
MC 70/516	Associated Minerals Consolidated Ltd	Capel	South West	35 704	92.00	
Reduced Ilmenite (g)						
MC 70/516	Associated Minerals Consolidated Ltd	Capel	South West	51	65.00	
Rutile (g) (h)					TiO_2 Tonnes	
MC 70/7002	Associated Minerals Conolidated Ltd	Eneabba	South West	23 210	22 050	6 368 323
MC 70/7062	Allied Eneabba Pty Ltd	Eneabba	South West	56 989	54 744	15 455 287
				80 199	76 794	21 823 610 (b)
Leucoxene (g) (h)					TiO_2 Tonnes	
MC 70/516	Associated Minerals Consolidated Ltd	Capel	South West	2 180	1 961	326 072
MC 70/619 etc	Westralian Sands Ltd	Yoganup	South West	10 147	9 147	2 026 598
MC 70/746 etc	Cable Sands Pty Ltd	Capel	South West	2 991	2 751	694 894
				15 318	13 859	3 047 564 (b)
Monazite (g) (h)					ThO_2 Units	
MC 70/516	Associated Minerals Consolidated Ltd.	Capel	South West	1 740	10 545	721 804
MC 70/746 etc	Cable Sands Pty Ltd	Capel	South West	1 242	8 072	484 973
MC 70/619 etc	Westralian Sands Ltd	Yoganup	South West	2 416	15 423	932 576
MC 70/7062	Allied Eneabba Pty Ltd	Eneabba	South West	10 838	67 180	4 683 711
				16 236	101 220	6 823 064 (b)

Number of Lease Claim or Area	Producer	Centre	Goldfield or Mineral Field	Quantity (Tonnes unless otherwise stated)	Metallic Content	Value $	
Zircon (g) (h)					ZrO_2 Tonnes		
MC 70/516	Associated Minerals Consolidated Ltd	Capel	South West	15 978	10 385	1 602 552	
MC 70/746 etc	Cable Sands Pty Ltd	Capel	South West	11 111	7 286	1 153 756	
MC 70/619 etc	Westralian Sands Ltd	Yoganup	South West	39 170	29 349	3 579 969	
MC 70/7002	Associated Minerals Consolidated Ltd	Eneabba	South West	61 681	40 707	6 541 013	
MC 70/7062	Allied Eneabba Pty Ltd	Eneabba	South West	169 165	113 708	16 446 906	
				297 105	201 435	29 324 196	(b)
Nickel Concentrates					Av. Assay Ni%		
ML 15/152 etc	Western Mining Corporation	Kambalda	Coolgardie	302 130	12.02	213 023 217	
ML 15/336	Selcast Exploration Ltd	Emu Rock	Coolgardie	2 292	16.50	2 458 709	
ML 26/130-1	Western Mining Corporation	Carnilya Hill	East Coolgardie	25 308	12.03	17 681 612	
ML 36/255 S.A.	Agnew Mining Co. Pty Ltd	Leinster	East Murchison	77 155	14.28	64 256 894	
ML 38/31,34	Western Mining Corporation & Shell Co. of Australia	Windarra	Mt Margaret	50 900	12.04	34 718 525	
				457 785		332 138 957	(o)
Nickel Ore					Av. Assay Ni%		
MC 15/1288, 15/248	Metals Exploration Ltd	Nepean	Coolgardie	98 187	3.15	19 411 692	(c)
Palladium(g) (Metallic by-product of Nickel Mining)					Kg		
ML 15/152 etc	Western Mining Corporation	Kambalda	Coolgardie		416.141	1 112 023	
Platinum(g) (Metallic by-product of Nickel Mining)					Kg		
ML 15/152 etc	Western Mining Corporation	Kambalda	Coolgardie		74.280	933 357	
Petroleum							
Crude Oil				Kilolitres			
1H	West Australian Petroleum P/L	Barrow Island	Ashburton	1 256 586		254 243 236	(m)
LIC 1	West Australian Petroleum P/L	North Perth Basin	South West	17 943		3 735 451	(q)
EP 129	Home Energy Company Ltd	Blina	West Kimberley	3 242		586 204	(q)
EP 96	Pacific Basin Exploration P/L	Mt Horner	South West	229		37 745	(q)
				1 278 000		258 602 636	

Natural Gas				$M^3 10^3$	
LIC 1	West Australian Petroleum P/L	North Perth Basin	South West	801 612	30 954 038
EP 100	Hudbay Oil (Australia) Ltd	Woodada	South West	79 542	5 064 656
				881 154	36 018 694 (p)
Condensate				Tonnes	
LIC 1	West Australian Petroleum P/L	North Perth Basin	South West	2 143	N.A.
EP 100	Hudbay Oil (Australia) Ltd	Woodada	South West	513	N.A.
				2 656	
Salt		State Total Reported to Mines Department		3 422 159	47 673 788 (b)
Semi Precious Stones					
Amethyst				Kg	
MC 9/256,444	Soklich F	Gascoyne	Gascoyne	5 456	38 963
Moss Opal					
MC 63/60	Soklich F	Norseman	Dundas	1 200	922
Chalcedony					
MC 9/498,884	Soklich F	Carnarvon	Gascoyne	20	22
					39 907
Silver				Kg	
ML 37/3758-62	Seltrust Mining Corporation P/L	Teutonic Bore	Mt Margaret	46 926.740	10 137 519
	By-Product of Gold Mining			3 109.817	637 172
	By-Product of Nickel Mining			270.243	57 491
				50 306.800	10 832 182
Talc					
ML 70/433	Three Springs Talc Pty Ltd	Three Springs	South West	72 519	N.A.
ML 52/190	Westside Mines N L	Mt Seabrook	Peak Hill	19 663	N.A.
				92 182	

Number of Lease Claim or Area	Producer	Centre	Goldfield or Mineral Field	Quantity (Tonnes unless otherwise stated)	Metallic Content	Value $
Tanto-Columbite Ores and Concentrates(g) (h)					Ta_2O_5 kg	
MC 45/107 etc, DC 45/553	Goldrim Mining Australia Ltd	Wodgina	Pilbara	6.37	3 475	231 386
MC 45/6684-5, DC 45/254	Kincora Pty Ltd	Western Shaw	Pilbara	14.06	3 629	233 368
				20.430	7 104	464 754 (b)
Tin Concentrates					Sn Tonnes	
ML 1/657 etc	Greenbushes Tin N L	Greenbushes	Greenbushes	550.51	383.83	4 628 222
MC 45/672,700	D N & L E Hart	Abydos	Pilbara	3.67	2.69	29 953
MC 45/10093, 10095	Metana Minerals N L	West Wodgina	Pilbara	10.04	7.22	68 000
MC 45/107 etc	Goldrim Mining Australia Ltd	Wodgina	Pilbara	7.79	5.66	64 255
MC 45/668 etc	Endeavour Resources Ltd	Moolyella	Pilbara	84.77	61.13	966 209
MC 45/6684-5, DC 45/254	Kincora Pty Ltd	Western Shaw	Pilbara	63.33	44.87	518 629
				720.11	505.40	6 275 268 (b)
Vanadium						
ML 70/257SA	Agnew Clough Ltd	Wundowie	South West	166.601		971 300 (b)
Vermiculite						
MC 74/1567	Vermiculite Industries Pty Ltd	Young River	Phillips River	429		7 040 (a)
Zinc Concentrates					Zn Tonnes	
ML 37/3758-67	Seltrust Mining Corporation P/L	Teutonic Bore	Mt Margaret	101 787	48 018	18 709 900 (b)
			VALUE OF MINERALS			$3 086 835 234
			VALUE OF GOLD			$247 418 210
			TOTAL			$3 334 253 444

REFERENCES:

N.A. Not available for publication.
(a) Estimated F.O.R. value.
(b) Estimated F.O.B. value.
(c) Value at works.
(d) Value of Mineral recovered.
(e) Value at Pithead.
(f) Estimated value based on current prices published.
(g) Only results of sales realised during the period under review.
(h) Metallic content calculated on assay basis.
(i) Concentrates.
(j) By-Products of gold mining.
(k) By-Products of tin mining.
(l) Value based on the Average Australian value of Alumina as published by the Bureau of Mineral Resources in the Australian Mineral Industry Review.
(m) Value based on the price per barrel as assessed by the Commonwealth Government for Barrow Island Crude Oil at Kwinana.
(n) Nominal Price.
(o) Estimated F.O.B. value based on the current price of nickel containing products.
(p) Nominal price at well head.
(q) Nett well head value.

The Department of Mines logo was approved by the Hon. Minister for Mines on 18 August 1982. It was designed jointly by Trevor Dods and David Smart, both drafting assistants in the Surveys and Mapping Division of the Department. Their design was selected by an expert adjudication panel as the winner of an open competition that attracted 167 entries.

First prize was two half-ounce gold ingots, and one-ounce silver ingots were awarded as second and third prizes to David Scott-Miller and Sherrie Brown.

The winners originally sought only to combine the initial letters of Mines Western Australia, in an attractive design, but to the judges this also evoked impressions of mine headframes and folded rock strata most appropriate to the theme.

It is hoped that widespread use of the logo will bring wider recognition of the many activities carried out by the Department of Mines.

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WILLIAM C. BROWN, Government Printer, Western Australia