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# ANNUAL REPORT

## 1986-87

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**DEPARTMENT OF MINES  
WESTERN AUSTRALIA**

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DEPARTMENT OF MINES  
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The Honourable David Parker BA, MLA  
Minister for Minerals and Energy  
Parliament House  
PERTH WA 6000



Dear Minister

In accordance with Section 62 of the Financial Administration and Audit Act 1985, I submit for your information and presentation to Parliament the Annual Report of the Department of Mines of the State of Western Australia for the year ending 30 June, 1987.

The Annual Report has been prepared in accordance with the provisions of the Financial Administration and Audit Act 1985.

This document departs from the format of past reports and follows the theme of the Department's Corporate Plan. It outlines the Department's activities in relation to Corporate Objectives against a background of the mining industry in Western Australia during 1986/1987.

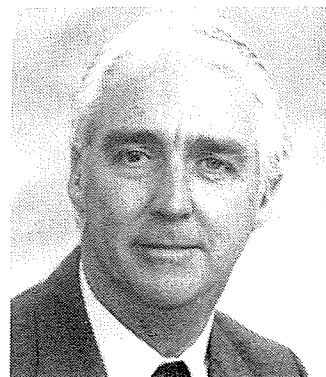
Previous annual reports contained further information of value to industry and clients of the Department which it is no longer appropriate to include in this document. It will now be published later in the year as an Annual Review.

I wish to acknowledge the loyal and responsible contribution of Departmental officers to the range of activities undertaken and to express my appreciation for the support given by you and the Government throughout the past year.

Yours sincerely

A handwritten signature in cursive script that reads "D.R. Kelly".

D.R. KELLY  
DIRECTOR GENERAL  
August 1987



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# DIRECTOR GENERAL'S REPORT

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The importance of servicing and administering the mining and petroleum industries properly to maximise their benefit to the State was emphasised again during the year under review when these industries took an even more dominant role in the State's economic development.

Only 12 months after passing the \$5 billion mark for the first time, the annual value of mineral production in Western Australia reached \$5,950 million this year.

The year also saw the announcement of a number of important new processing operations which derive from the mining and petroleum industries. These include the LPG and ammonia-urea plants at Kwinana, both based on North West Shelf gas; the zirconia plant for Rockingham; and Pinjarra's rare earths and gallium plants based on the mineral sands and alumina industries respectively.

In the first section of this report I have taken the opportunity to review the position of the mineral and petroleum industries as they affect Western Australia, in order to provide a background to the work of the Department of Mines. Subsequent sections of the report describe how the Department has undertaken the task of administering and assisting these industries.

The high level of mining activity, particularly in gold, has placed a heavy burden on the Department, but I am pleased to report that the Department has successfully met the challenge. Organisational reforms and new information systems on which we have been working for some time assisted in meeting the demands and also provided new and valuable services to industry.

An increase over the previous year of some 30 per cent in applications for mining tenements indicates the growth in workload, and the revenue generated by new computerised information systems confirms the value industry places on the new services offered.

The Department's understanding of the requirements of industry was further enhanced during the year by the establishment of the Mining Industry Liaison Committee, the Petroleum Industry Liaison Committee, and the Geological Survey Liaison Committee. These top-level bodies will ensure that the Department's administration, services and research are all directly related to the changing needs of industries which are vital to the State's present and future well-being.

Simultaneous with the development of new services to industry, the Department has moved some way towards meeting Government's requirements for improved efficiency, greater accountability, and new management systems. It began to develop a Corporate Plan, accommodated with difficulty the Government's freeze on new appointments, and met the requirement for an overall staff reduction of three per cent.

The transfer of the State Batteries from the Department to the West Australian Development Corporation was accomplished smoothly as part of the Government's reorganisation of its involvement in gold processing through the State Batteries and the Perth Mint.

The year has been a significant one for the Department and the industry. I believe that this annual report will reveal the teamwork and dedication which made its successes possible.

# THE MINING AND PETROLEUM INDUSTRIES IN 1986/87

## REVIEW

Although the value of mineral production in 1986/87 of \$5,950 million was some \$630 million up on 1985/86 results, the improvement was almost entirely due to the gold industry. Overall the low level of profitability of last year continued through to this, and the prospects for the producers of most commodities are not bright, considering the international backdrop of falling or stagnant metal prices, sluggish market demand, high stock levels and excess production capacity.

Over the last few years the industry has geared itself to this situation and has achieved significant reductions in production costs by rationalisation and increased efficiency. Our competitive position internationally has been further helped by the low level of the Australian dollar against the \$US, the currency in which many of the major commodities are traded.

There has been a slight improvement in returns to shareholders in the industry, averaging between 5 and 6%, although such levels are well below rates in other areas of finance and business. Despite this the Australian share market has performed reasonably well, with the metals and minerals index rising by 110% during the 1986/87 year. Gold was responsible for the major part of this with a massive 206% increase in the index during this period.

Outside of gold, the industry has a high capital intensity, and because of the small Australian capital market it relies heavily on overseas funds and participation. There have been moves to deregulate foreign involvement and to relax the requirements of the Foreign Investment Review Board.

The performance and importance of the major industries is shown in Figure 1 and Table 1.

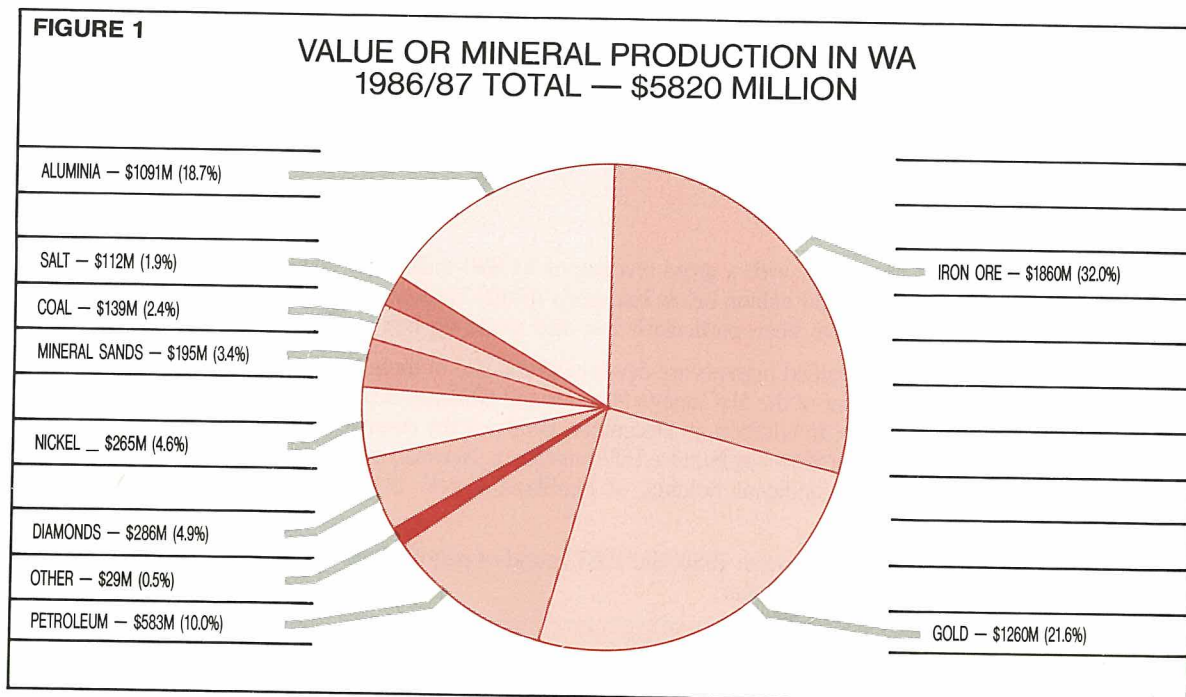


TABLE 1: MINERAL PRODUCTION  
(Major Industries)

VALUE RANKING	MINERAL	UNITS	1985-86	1986-87	INCREASE/DECREASE
1	Iron Ore	Mt	85.5	78.0	- 9%
2	Gold	t	46.1	64.9	+40%
3	Alumina	Mt	5.4	5.7	+ 5%
4	Petroleum				
	Crude Oil	Ml	1 430	1 575	+10%
	Condensate	Ml	381	512	+34%
	Natural Gas	Mm <sup>3</sup>	2 756	3 199	+16%
5	Diamonds	M cts	17.5	32.2	+84%
6	Nickel				
	Nickel (Conc)	Kt	466	417	-11%
	Cobalt	t	515	463	
	Copper	t	3 484	3 519	
	Platinum	Kg	94	105	
	Palladium	Kg	421	490	
	Silver	Kg	716	1 088	
7	Mineral Sands				
	Ilmenite	Kt	1 050	1 038	- 1%
	Rutile	Kt	72	84	+15%
	Zircon	Kt	349	310	-11%
	Monazite	Kt	18	12	-31%
8	Coal	Mt	3.8	3.8	+ 1%
9	Salt	Mt	4.8	5.1	+ 5%

## Iron Ore

Iron ore remains the most important, with a gross revenue of \$1,890 million, or some 32% of the total value of mineral production. This is about \$80 million below last year's results because of a combination of lower shipments and price. Japanese shipments have been particularly low and made up just over 50% of exports.

On the positive side, new and diversified markets are developing and two of these, Romania and China, have resulted in commitments to the development of the McCamey's Monster and Channar deposits. These are the first substantial new iron ore projects for 15 years. In addition, in December, Goldsworthy committed itself to a further 15-20 years operation on its northern deposits at Shay Gap/Sunrise Hill/Nimingarra. Newman continued with its major improvements programme, while BHP's other significant holding, at Marillana Creek, is gradually moving to a decision on development.

Following a 4% decline in iron ore prices in 1986, the 1987 round of negotiations with Japanese steel mills resulted in a further 5% reduction for the next year.

## Gold

Gold output in the State was 40% up on last year (Table 1) and, at an average price for the year of \$620/oz. value was up nearly 80% to \$1,260 million. There were 23 significant new producers in 1986/87 spread through the Eastern Goldfields, Yilgarn and Murchison. A further 15 are committed for the next six months, including Boddington, in the South West, which alone will add a further 5 tonnes of fine gold per annum. The Telfer project also made a \$30 million commitment to ensure its significance in the long term.

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## Mineral Sands

After gold, the heavy mineral sands industry showed the most dramatic improvement. Although sales showed only small changes from last year, the strong upward move in prices for almost all commodities helped to improve profitability and provide a base for major processing projects. Ilmenite, rutile and monazite exceeded all-time high prices quite significantly, while zircon approached the 1975 peak of nearly \$200 per tonne by year end. Overall the industry achieved a gross revenue of about \$195 million, up 25% from that of 1985/86.

Two new synthetic rutile plants were brought on-stream in February and April this year.

Other downstream processing developments for zirconia and rare earths, together with plans to relocate the titanium pigment plant to Kemerton and convert it to the chloride process, represent a significant level of reinvestment and advancement of the industry in this State.

## Diamonds

Diamond production on the Argyle pipe exceeded 31 million carats and with a slight improvement in prices revenue doubled in the 12 months. The successful operation of the joint venture partners' marketing office in Antwerp was a pleasing result in an industry dominated by the Central Selling Organisation (the De Beers Group).

The development of the alluvial diamond prospect in Lower Limestone Creek/Bow River, downstream from the Argyle AKI pipe, was announced recently by Freeport-Gemex.

## Alumina

Western Australia is the world's largest free market supplier of alumina. The industry is worth nearly \$1,100 million a year. The last few years have been extremely difficult, with cut-backs in operating levels of some plants and reduced profitability. In recent months the industry has indicated fuller order books and while prices are still relatively depressed there are signs that things could be improving. During the year, the French chemical giant Rhone-Poulenc announced plans to extract gallium from the Bayer Liquor used in Alcoa's alumina refinery at Pinjarra, a new development for the industry.

## Nickel

Similar improvement is not yet visible for nickel. With prices in the range \$US1.60-1.80/lb. through most of the year, the industry has remained in a desperate situation. Following the closure of a number of the Kambalda mines last year, the whole of the Agnew operation was shut down in October 1986 and the depletion of reserves at Nepean resulted in its closure in May of this year. State output was down 22% on last year and although prices improved in the last two months of the year, to \$US2.00/lb., they were still well below acceptable levels.

## Petroleum

Through the expansion of the North West Shelf Project and progress on the Harriet Project, production of crude oil, gas and condensate all increased, but the dramatic February 1986 fall in world oil prices meant a reduced return overall to less than \$600 million. Prices are still 35% below price levels at the beginning of 1986.

The major phase of the North West Shelf project, the LNG plant, with a further investment of \$9.8 billion, is on schedule for production of LNG from 1989. To assist in immediate cash flow a gas recycling project which strips condensate from the gas and re-injects the dry gas into the reservoir has been commissioned. This will double condensate sales for the next six-year period.

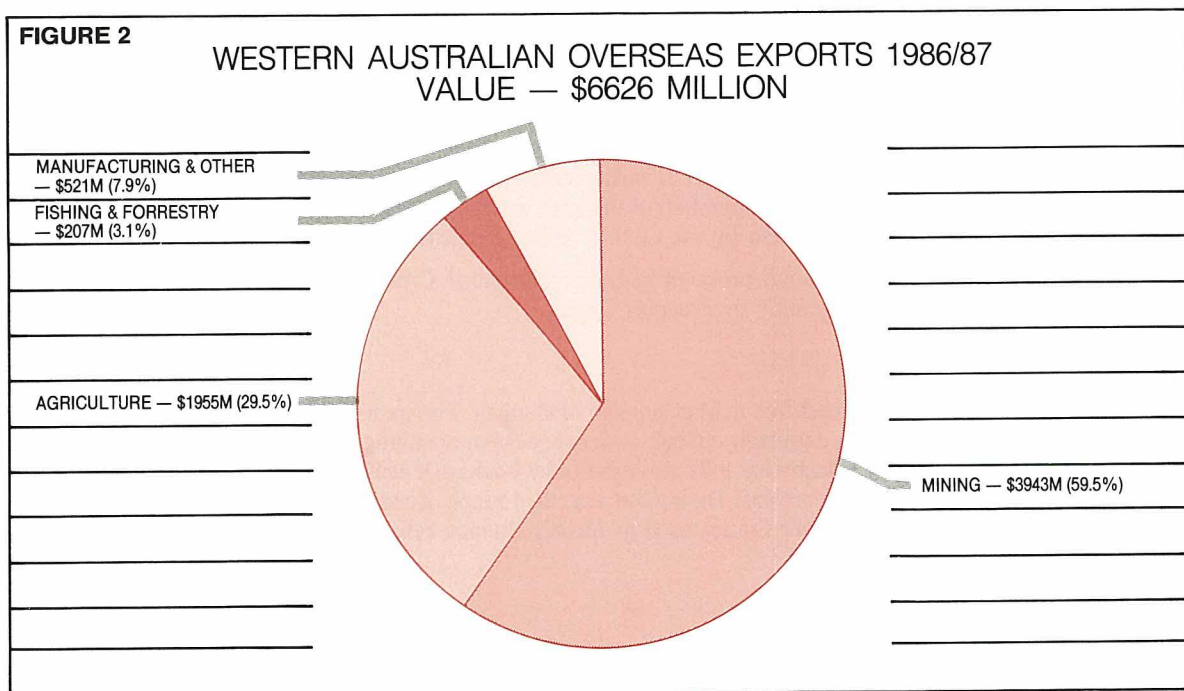
Exploration in the petroleum industry in 1986 was the lowest since 1980 and half that of 1985. However progress has been made towards the development of the small South Pepper and North Herald Fields off the Pilbara coast by Westminco. Record flows have been recorded from Wapet's Saladin Field, south of Barrow Island.



## MINING AND THE ECONOMY

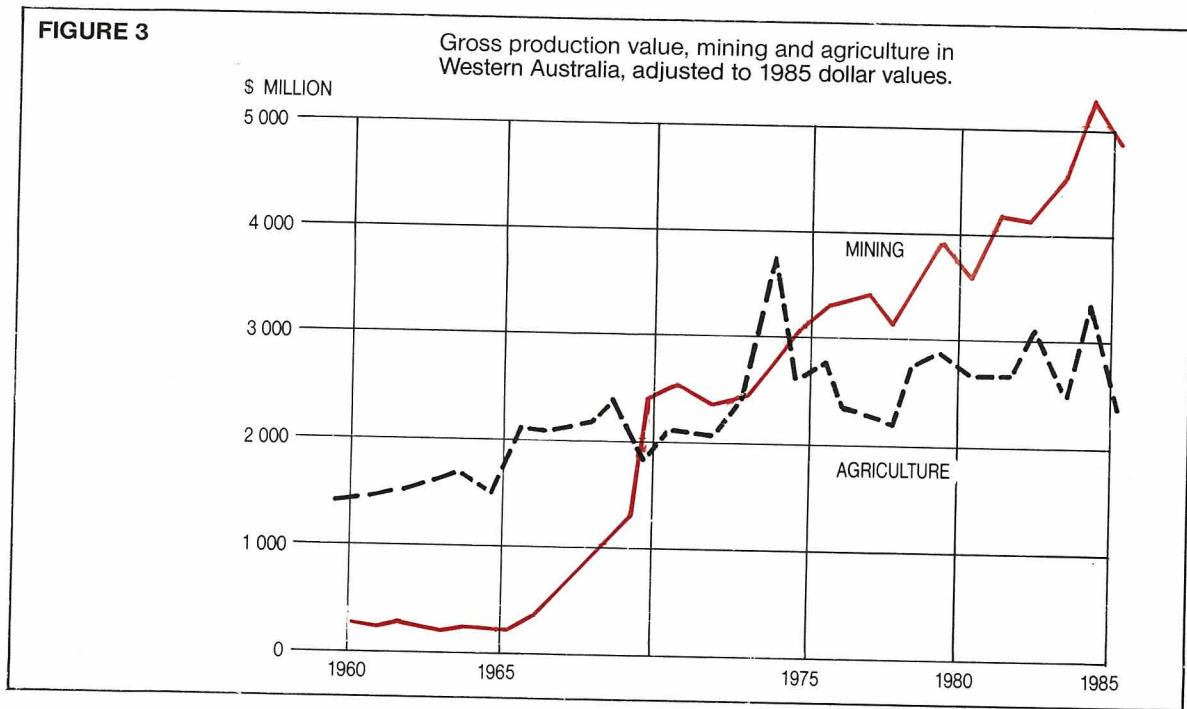
Mining continues to make a major contribution to the economy of the State and the nation. From a largely rural based economy in 1960 the State has emerged as a major force on the world mineral scene.

In 1986/87 exports from mining represented approximately 41.4% of Australia's total overseas export trade. Western Australia contributed 26.6% of these exports, which is approximately 11% of the value of Australia's total exports. In 1986/87 mining made up 59.51% of overseas exports from Western Australia.



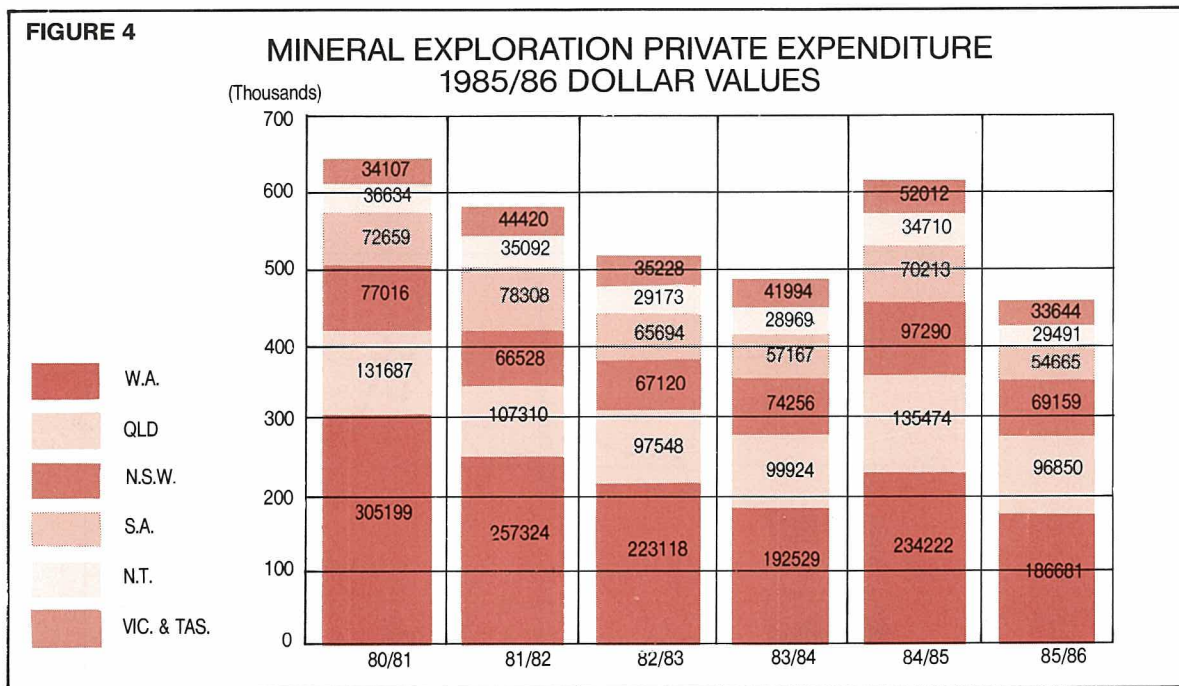
Within Western Australia the gross value of mining has grown from being 1/6th the value of agriculture in 1960 to now exceeding it in value.

As mining has increased in importance over the years, manufacturing industry within the State has become mining-oriented rather than being predominantly in support of agriculture. The mining industry has become so important to the economy that high priority must be given to ensuring that it has appropriate industrial, transport and legislative support.



Exploration is important to the future of the mining industry and Western Australia attracts the bulk of the exploration investment in Australia. A similar situation exists with respect to petroleum.

Despite the fluctuation in world demand and prices for minerals and petroleum, major exploration companies are pushing ahead with investment in Western Australia at a level not equalled elsewhere in Australia. The Department administers the State Government's responsibilities in this area.



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# THE DEPARTMENT OF MINES

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## BACKGROUND

Government policy is designed to encourage investment in exploration, extraction and utilisation of mineral and petroleum resources. Because of their major contribution to the State's economy for almost 100 years, mining activities have ramifications that reach directly or indirectly into the whole economic and social fabric of Western Australia. This is reflected in the wide range of activities administered today by the Department of Mines.

The Department was established on January 1, 1894 as a regulatory body to ensure the orderly development of the State's mineral resources, and to allow the State and the community in general to participate in these activities. This is still the Department's major role.

The creation of the Geological Survey in 1896, closely followed by the establishment of a system of State gold batteries, and the transfer to the Department in 1902 of the Government Analyst's Laboratory, saw the emergence of another important role — the provision of services to the mining industry.

These service facilities have evolved with the growth of the mining industry. As the industry became prominent, and complex regulatory functions demanded greater range and depth of internal services and expertise, many of the sections of the Department traditionally involved in regulation were able to provide further services in the form of technical advice, tenement maps and safety recommendations. Progressively this role has been extended and now the Department is called upon to provide services to many sectors of the community not directly related to the mining and petroleum industries.

The Department has recently re-examined its role and activities against the background of contemporary industry. This has been part of the corporate planning process and the relevant Corporate Philosophy, Role and Objectives of the Department can now be set out.

## CORPORATE PHILOSOPHY

In establishing its Corporate Philosophy, the Department of Mines has given particular attention to the relationships that exist between the Department, the Government, the community, the natural environment, and the mining and petroleum industries. These relationships are central to the way the State's resources are developed and the industries are administered. They are summarised below:

- The mineral and petroleum resources of the State are owned by the Crown, but are explored and developed almost entirely by private enterprise.
- Exploration and development are therefore undertaken in an organisational framework controlled and directed by Government.
- The mining and petroleum industries play a major role in the economy of the State and mineral, petroleum and groundwater resources will be required to sustain our future economic viability and living standards.
- Mineral and petroleum deposits are almost always difficult and expensive to find, small in size relative to the total land mass, finite, and non-renewable.
- They are assets only after they have been discovered and delineated and the incentive to engage in high-risk exploration to find them is directly related to the potential for an appropriate financial return.
- Changes in the economy, technology and exploration science may lead to the re-appraisal of previously tested ground; thus the potential of any area can never be totally written off and information about it should always remain available.
- Resources allocated to the Department are to be administered efficiently according to the prevailing principles and standards expected of the Public Service. The Department must respond quickly and effectively to changes required by the community through Government.

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## ROLE

*The primary role of the Department is to promote and facilitate the orderly exploration and development of minerals and petroleum in Western Australia for the benefit of the community, now and in the future.*

*In addition to and emanating from its primary role, the Department is:*

- to provide scientific and technical advice to Government agencies and the public on geotechnical and mining-related matters;*
- to provide chemical consultancy services; and*
- to regulate for public safety in matters concerning explosives and dangerous goods.*

## BROAD OBJECTIVES

*1. To ensure that exploration and development of the State's mineral and petroleum resources are carried out in an orderly and responsible manner that is fair and equitable to all concerned.*

Specifically:

- 1.1 To provide an adequate and efficient system of title giving legal right to explore and develop the minerals and petroleum resources of the State under appropriate conditions.
- 1.2 To provide an adequate, efficient and equitable system for the registration of title and the survey and recording of tenement positions on plans.
- 1.3 To provide a system which minimises potential for legal disputes, but facilitates their prompt settlement when they arise.
- 1.4 To ensure prompt and efficient assessment and collection of royalties.
- 1.5 To collect and compile relevant statistics for timely release.

*2. To provide a scientific and technical information base which fosters mineral and petroleum exploration and development, protects community standards and safety, and aids long-range planning and decision-making by Government.*

Specifically:

- 2.1 To investigate, interpret and record the geology of the State and to make this information available to industry.
  - 2.2 To foster the development of scientific knowledge relating to mineral and petroleum occurrences.
  - 2.3 To provide a chemical consultancy service to Government, industry, and the public, and to undertake research and development in ore processing.
  - 2.4 To evaluate the mineral, petroleum and groundwater resources of the State.
  - 2.5 To gather from industry the results of exploration, record such information, and where appropriate, allow public access.
  - 2.6 To provide geotechnical advice on land-use, environmental management, urban development, and engineering projects.
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3. *To ensure that all operations in the mining and petroleum industries and activities involving explosives and dangerous goods are conducted in a manner that is safe for workers and the public in general; and to ensure that proper attention is given to rehabilitation and protection of the environment.*

Specifically:

- 3.1 To provide advice and administer legislation relating to working practices and the safety and health of workers in the mining and petroleum industries.
- 3.2 To review, formulate and administer laws, regulations and policies aimed at the safe manufacture, storage, handling and transport of explosives and dangerous goods; and provide safety advice on these matters.
- 3.3 To monitor operations to ensure compliance with prescribed guidelines and conditions for rehabilitation and protection of the environment.

4. *To create and maintain a favourable climate for mineral and petroleum exploration and development.*

Specifically:

- 4.1 To promote the mining and petroleum industries.
- 4.2 To develop and sustain an awareness of industry needs by maintaining close liaison with representative bodies.
- 4.3 To inform the community and other Government departments on the role of the mineral and petroleum industries and the substantial benefits they bring to the State and national economies.
- 4.4 To point out, when land-use conflicts arise, the value of the mineral and petroleum industries in competition with other possible users, and support the concept of multiple land-use based upon the best information.
- 4.5 To promote industry access to areas of mineral and petroleum potential.

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# THE ORGANISATION

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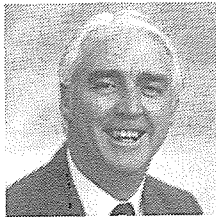
## MINISTER

The Department is responsible to the Minister for Minerals and Energy, the Honourable David Parker, B.A., M.L.A.

## ENABLING LEGISLATION

The Department is established by the Governor pursuant to Section 21 of the Public Service Act 1978 and satisfies Section 11 of the Mining Act 1978.

## PRINCIPAL OFFICERS



Dr D.R. Kelly, BE(Hons), PhD(Lond), MIE Aust.  
DIRECTOR GENERAL OF MINES AND ACCOUNTABLE OFFICER  
(Appointed by the Governor pursuant to Section 29 of the Public Service Act for a term not exceeding 7 years)



Mr E.J. Blake, Dip Pub Admin.  
ASSISTANT DIRECTOR GENERAL OF MINES

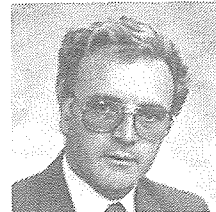
(vacant)  
ASSISTANT DIRECTOR GENERAL OF MINES



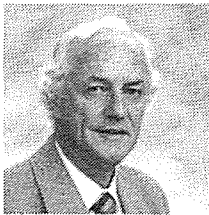
Dr P.E. Playford, BSc(Hons), PhD.  
DIRECTOR, GEOLOGICAL SURVEY DIVISION



Mr J.M. Torlach, BE(Min), MAIMM  
DIRECTOR, MINING ENGINEERING DIVISION



Mr I. Fraser, BSc(Hons), Geophysics/Geology  
DIRECTOR, PETROLEUM DIVISION



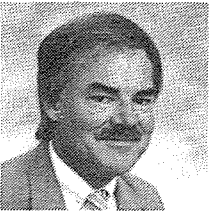
Mr H.C. Hughes, BSc, FRACI.  
DIRECTOR, GOVERNMENT CHEMICAL LABORATORIES (ACTING)



Mr K.O. O'Neil, MBA, AASA, Dip Pub Admin.  
DIRECTOR, CORPORATE SERVICES DIVISION



Mr H. Douglas, APTC(Chem), C CHEM, ARACI, AM Aust IMM.  
DIRECTOR, EXPLOSIVES AND DANGEROUS GOODS DIVISION



Mr W. Phillips, Dip Pub Admin.  
DIRECTOR, MINING REGISTRATION DIVISION



Mr W.R. Moore, Dip Cart, MIS, MAIC, MIEMS.  
DIRECTOR, SURVEYS AND MAPPING DIVISION

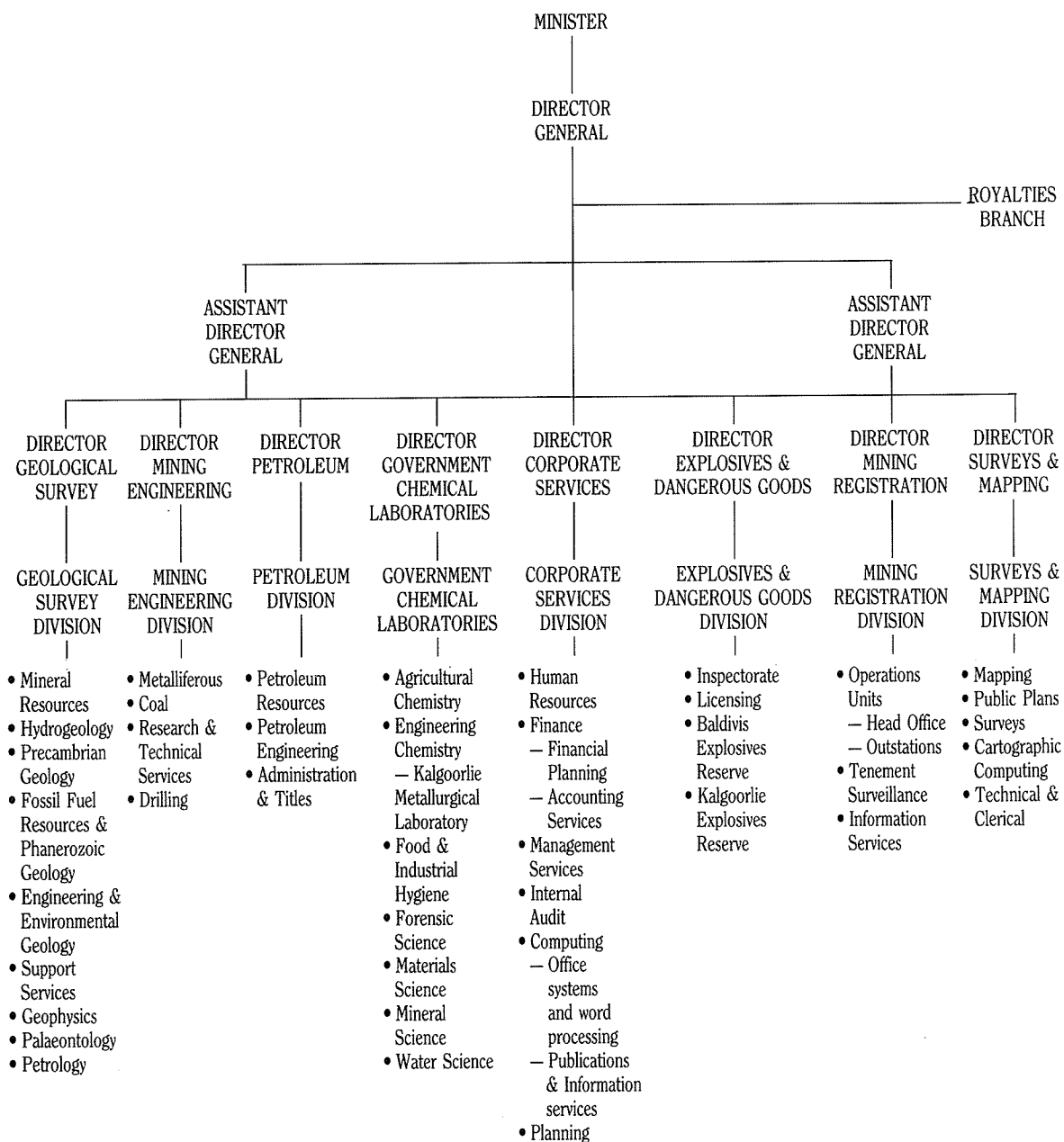


Mr M.L. Meaton, BSc(Agric)(Hons), BEc.  
MANAGER, ROYALTIES BRANCH

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## ORGANIZATION CHART



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## DIVISIONS OF THE DEPARTMENT

*The Geological Survey* systematically records and interprets the geology of Western Australia and provides this information to Government, industry and the general public in order to assist the exploration, development and conservation of the State's mineral, petroleum and groundwater resources.

It evaluates mineral and petroleum resources as a basis for decision making by Government and assists and advises in a variety of community needs, including urban planning, land-use matters, and engineering developments.

*Mining Engineering* administers mine safety legislation to safeguard and promote the health and safety of those working in the industry. It provides advice to the Government and to industry on mining engineering matters, including deep mining, open-cut mining, quarrying, drilling, the environment, and rehabilitation.

It carries out exploratory drilling and associated services for the Department and other Government organisations.

*Petroleum* facilitates the undertaking by industry of geophysical and drilling programs for the identification and development of oil and gas accumulations.

It ensures that sound engineering principles and standards are applied to system design and plant assembly in production and exploration.

It also maintains an effective title registration system, monitors and advises on State and Commonwealth legislative amendments, and advises on matters requiring interpretation and application of legislation.

*The Government Chemical Laboratories* provide chemical, metallurgical and mineralogical consultancy and analytical services to Government instrumentalities, private industry and the general public. They assist in mineral exploration and processing, soil and fertiliser analysis, agricultural trials, water quality assessment, food nutritional and quality evaluation, forensic science, chemical aspects of occupational and physical environments, and materials testing, and undertake research and development in all these areas.

*Explosives and Dangerous Goods* reviews, formulates and administers laws, regulations and policies aimed at the safe manufacture, storage, handling and transport of explosives and dangerous goods; and provides safety advice on these matters.

*Mining Registration* receives applications and allocates titles that give legal rights to explore for and mine minerals in Western Australia pursuant to the Mining Act.

It maintains a mining tenement registry which records tenement holders, conditions and term of their grant, and expenditure details from which the Division monitors compliance with the provisions of the Act.

*Surveys and Mapping* determines and documents the boundaries of mining tenements and produces and updates all maps and plans necessary for the operations of the Department of Mines.

All functions from primary field survey to final map production are embraced. The range of activities includes plotting, drafting, cartography, field surveying, computations, reprographics and advice to the public as an integral part of the tenement management process.

*Corporate Services* provides and coordinates administrative services for the Corporate Executive and the operational Divisions of the Department. These services include the management of the Department's human resource, finance, computing, corporate planning, auditing, typing and records activities.

## AREA OF OPERATIONS

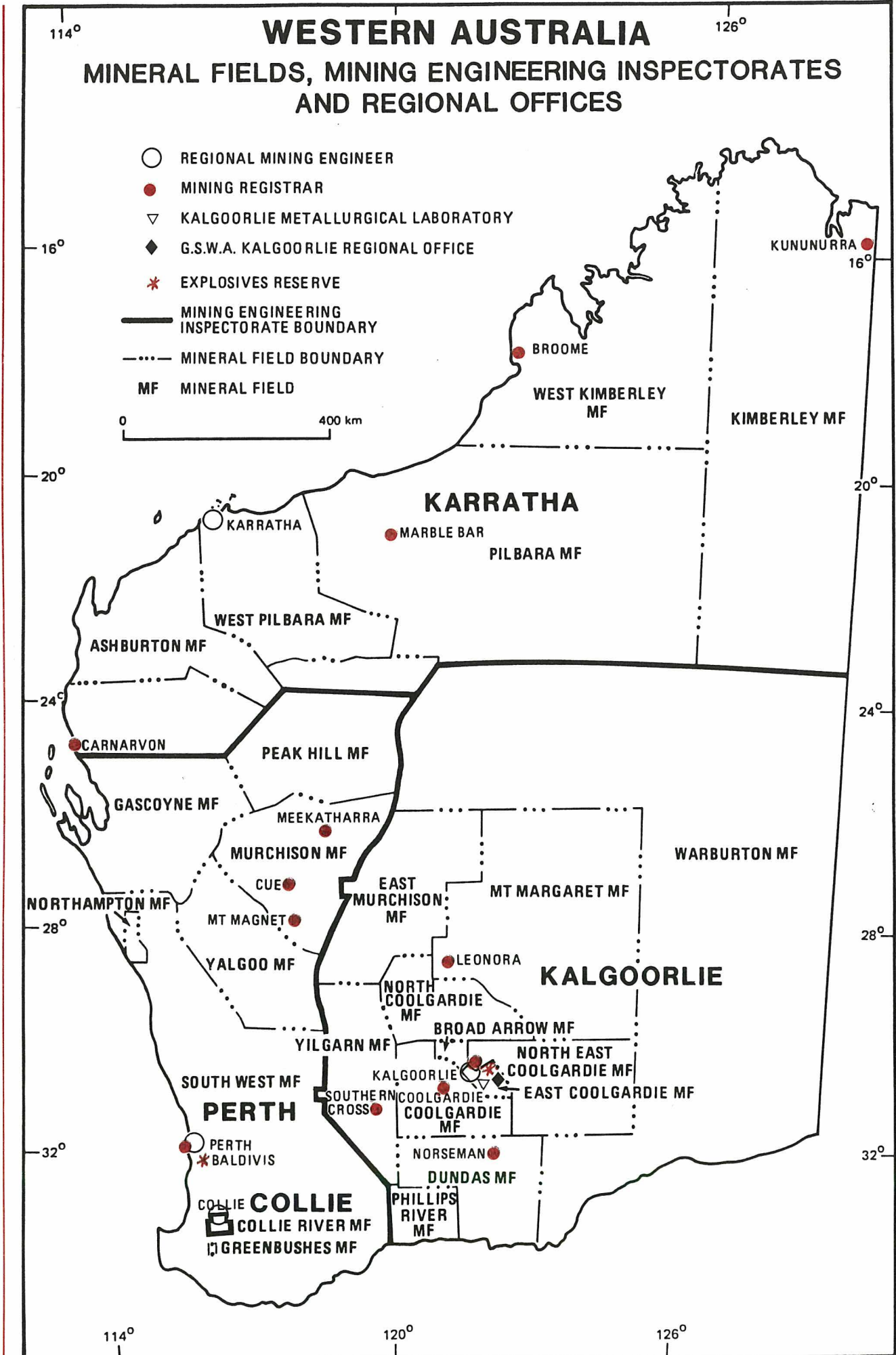
Mining activity is spread throughout the State of Western Australia and extends from Albany in the South to the Mitchell Plateau in the northern Kimberley and eastwards as far as the border. The area of the State is approximately 2,500,000 sq kms, about 1/3 of the Australian land mass.

The officers of the Department are mostly located in Perth. However, members of the Geological Survey, Mining Engineering, Government Chemical Laboratories, Explosives & Dangerous Goods and Mining Registration are situated in regional centres. A number of these people work in areas that are large and remote by world standards (Fig. 5).

In addition to providing services for land based operations, the Department is required to administer State and Commonwealth legislation regarding offshore oil and gas exploration and exploitation.

A departmental directory is included in the appendices to this report.

Figure 5.



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# REPORT ON ACTIVITIES

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The Broad Objectives of the Department provide a framework for a report on activities.

## EXPLORATION AND DEVELOPMENT

*OBJECTIVE To ensure that exploration and development of the State's mineral and petroleum resources are carried out in an orderly and responsible manner which is fair and equitable to all.*

### Mining and Petroleum Tenements

Fundamental to the mineral and petroleum industries are access to land for exploration and security of tenure for the development of economic discoveries. These are provided in Western Australia in a legislative framework which protects the rights of landowners and requires that those who take up land for exploration must meet certain commitments or forfeit their rights.

In the currently booming gold mining industry, competition for prospective mining areas is so intense that applications to the Mining Registration Division are 30 per cent greater than last year. Despite this, the Department has maintained its goal of a five-month turnaround in processing the majority of applications.

The main causes of delays are disputes among competing applicants, overloading in the Warden's Courts, disputed land use including private property, and inter-departmental assessments of the relative merits of mining and such things as conservation, recreation, forestry, water supplies, agriculture and urban development.

Access to information about existing tenements and pending applications was greatly improved during the year by the introduction of a computerised tenement index system (TENDEX) which makes the latest information immediately available to the public at the Department's head office and the Kalgoorlie Regional Office. The system came into operation in December 1986 and has been so well received it generated income of \$35,000 in its first six months. Access to this system will be extended to other regional offices.

Apart from its use in the Department, TENDEX is a big help to Shires because it gives them immediate access to the names of tenement holders for rating purposes. Industry's use of the system is growing and is expected to accelerate rapidly when the next stage of the system is operational. This will reveal whether tenement holders are complying with the requirements for exploration, and will therefore open the way for competing claims if compliance is inadequate.

### Mapping

The high level of mining activity has added to the pressure on the Department's Surveys and Mapping Division which is responsible for the positioning of all tenements.

The Division has 1,422 maps covering the whole of the State and these are revised continuously to record applications and any changes in the status of a tenement. The Department is investigating the latest technology in computer-assisted mapping for a number of reasons, including the need to be able to make these changes in a timely manner. At the moment, due to the high level of activity, delays of 6 weeks in changing the plans have had to be accepted.

The healthy competition in the gold mining industry has also increased the pressure on the 30 contract surveyors who work for the Department on mining tenement surveys. Boundary disputes have become more frequent and a bigger aspect of surveying activity. In addition, the large number of prospecting licences which have reached the end of their term and require conversion to mining leases is continuing to place a heavy demand on surveyors as the licences (which do not require surveys) are converted to mining leases (which do).

The intensity of the competition was also reflected in court decisions during the year. Warden's Court decisions underlined the need for applicants to comply strictly with the marking out requirements.

Applications for tenements in the South-West land division, while not numerically significant, have brought the industry into more frequent contact with private landholders, and therefore increased the Department's work in handling objections and advising people about their rights.

One application for an exploration licence in suburban Gosnells saw the Department receive 80 objections in one day and a steady stream of letters and objections for weeks after. Many of them were based on a misunderstanding that unless an objection was lodged exploration could be permitted on private property. The fact is that the Mining Act forbids exploration or mining on private property without the written permission of the owner.

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## Petroleum

Although economic conditions, and particularly the drop in oil prices, adversely affected petroleum exploration there were encouraging signs by the end of the year that exploration was picking up again. There were 13 wells completed and three still in progress — most of them in the offshore Carnarvon and Bonaparte Basins — compared with 29 in 1985/86.

The number of permits increased from 89 in 1985/86 to 91 in 1986/87. No permits were surrendered onshore and only two offshore during the year. Other encouraging signs included the entry of Japan into Western Australian exploration for the first time; the large number of companies asking the Department to make new areas available; and the interest shown in new areas advertised during the year. Eighty per cent of all gazetted areas have been taken up by exploration companies.

Wells drilled to date in Western Australia have resulted in the discovery of a number of oil and gas fields, but large areas of the State's sedimentary basins are still relatively unexplored and there is good potential for further discoveries.

A Production Licence has been awarded for the Tubridgi gas accumulation — Australia's second largest onshore gas field — and several offshore oil fields, including Saladin, South Pepper, North Herald and Talisman, are expected to begin production in the near future.

## Industry Liaison

An important feature of the administration of the mining and petroleum industries in this State has been the close contact between the Department and all sections of the industries. This consultative process was enhanced during 1986/87 by the establishment of the Mining Industry Liaison Committee and the Petroleum Industry Liaison Committee.

An initiative of the Minister for Minerals and Energy, the Hon David Parker, MLA, the Committees are chaired by the Director General of Mines and include representatives from the Chamber of Mines, the Association of Mining and Exploration Companies, the Australian Mining and Petroleum Law Association, the Amalgamated Prospectors and Leaseholders Association and the Australian Petroleum Exploration Association.

Their prime function is to monitor and review the Petroleum and Mining Acts and to make recommendations to the Minister whenever they consider it appropriate to do so. There are numerous organisations through which the Department and the mining and petroleum industries interact in the administration of the many facets of resource development, but these new Committees will ensure top-level consultation with direct access to the Minister.

They express the Government's policy that the administration and services provided by the Department are to be directly related to the needs of industry in a rapidly changing economic and scientific environment.

One of the key items currently being discussed by the Mining Industry Liaison Committee is a proposal to use graticular sections for exploration licences. In such a scheme the State would be divided into units according to measurements of latitude and longitude and licence boundaries would conform to these.

Currently, the petroleum industry operates on a graticular system in which blocks measure 5 minutes by 5 minutes. The proposal for the mining industry is for blocks measuring 1 minute by 1 minute. All blocks would be numbered and individuals or companies could apply for exploration licences according to block numbers.

## Royalties

The industries administered by the Department of Mines bring in more than \$160 million a year in royalties to the State Government.

The royalties are paid by more than 100 companies operating under 25 pieces of legislation, including 21 Agreement Acts written for specific projects.

The Department's Royalties Branch has been extensively upgraded this year to meet the challenges of the increasingly complex nature of royalty payments. The basic principle of royalty payments at the moment is either 7.5% or 5% or 2.5% of the value of the minerals produced, depending on the degree of processing. Under petroleum legislation a rate of either 12.5% or 10% of the value of production at the wellhead is levied.

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To ensure equity for all parties, including public revenue, the Royalties Branch has become involved in more complex assessment and verification procedures, such as the profit-related royalties for Argyle diamonds and a resource rent royalty for Barrow Island.

Separately from this, the Government is currently studying the report of the Mineral Revenues Inquiry conducted by Professor Paul Bradley, of the University of British Columbia. Professor Bradley's inquiry into mineral revenues has been from the viewpoint of equity, economic efficiency, stability of Government revenue, and administrative efficiency.

As well as collecting royalties, the Branch maintains statistics for the Department on all aspects of production. More than 700 companies in the gold mining industry (which does not pay royalties) report statistics to the Branch monthly. The Department of Mines' gold statistics from 1894, giving production levels and grades, when plotted on tenement maps have been the starting point for a number of successful gold ventures in recent times.

The computerisation of mining statistics was studied during the year and it is hoped that resources will be available to introduce a computer system in the near future. It would facilitate the Department's responses to the many requests it receives for current and historic information.

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## SCIENCE IN SUPPORT

*OBJECTIVE To provide a scientific and technical information base which fosters mineral and petroleum exploration and aids long-range planning and decision-making by Government.*

As well as being Australia's bicentenary, 1988 will mark the centenary of the appointment of the first permanent Government Geologist in Western Australia. The appointment of H.P. Woodward came after several years of less-than-enlightening debates in the Legislative Council about the relative merits of scientific geologists and practical pick-and-shovel men.

Since then, the Department of Mines has become the scientific backbone of many WA Government operations. At the heart of this wide-ranging scientific endeavour is the Geological Survey which continues the delineation, definition, analysis and mapping of the geological resources of the State. The Survey works with information provided by mining companies, research undertaken by tertiary institutions, and the results of the field work and analysis of its own geoscientists and those from the Government Chemical Laboratories.

The year under review (1986-87) was a significant one for the Geological Survey. Its new Director, Dr Phillip Playford, chaired the first meeting of the Geological Survey Liaison Committee which was established by the Minister in October 1986 to bring together the interests of the industry and research institutions to ensure that the Survey's efforts were meeting the most appropriate needs. The committee includes representatives of the Chamber of Mines, Australasian Institute of Mining and Metallurgy, Australian Petroleum Exploration Association, Association of Mining and Exploration Companies, CSIRO, Bureau of Mineral Resources, University of WA, Curtin University, and WA School of Mines. A Yilgarn Block sub-committee has also been established to meet the special needs of the extremely active Goldfields region.

### Five Year Plan

With substantial input from the Liaison Committee, the Survey produced its first ever five-year plan to spell out its scientific and administrative priorities till 1991. The plan will be a continuous five-year program subject to review each year according to the results of work done and emerging priorities within the industry and the geoscientific community.

High priority was given in the plan to increasing the field work done by the Survey's geologists. In 1976, the Survey staff spent an average of 67 days a year in the field, but in 1986 this was down to 17 days. The target is to double the average time spent in the field within five years.

Among the research projects to be undertaken by the Geological Survey in its five-year plan is the geological mapping and assessment of mineral resources in the State's national parks. The three studies to begin in 1987 cover the Ruddall River, D'Entrecasteaux, and Hamersley Range national parks.

Work in the Rudall River National Park is part of a major research project on the geology of the Paterson Orogen, including the known mineralised belts in the Rudall, Throssell Range, and Telfer areas. This region is believed to be one of the most prospective "frontier" exploration areas in the State.

In terms of the area covered and the mining and exploration administered, the Geological Survey of WA faces a greater challenge than any of its Australian counterparts.

### Rich Finds

The value of the Department's basic geological research was illustrated during the year by the start of construction of the Boddington gold mine and the announcement by BHP that it would open a zinc-lead mine at Cadjebut near Fitzroy Crossing late in 1987. The gold potential at Boddington was first identified by the Department's geologists. Acting on this advice the Worsley Alumina joint venturers subsequently proved the deposit and are now constructing a mine with the capacity to produce 5,000 kg of gold a year.

Cadjebut will be the first major mine in the West Kimberley and BHP reports that the region has the potential to be a major zinc-lead province. The company's exploration in the area utilised the Geological Survey's detailed studies of the Devonian limestones which pointed to their zinc-lead potential.

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The large backlog of company reports due for release but not made available because they had not been microfilmed was causing concern to exploration companies and the Survey. A program was launched to clear the backlog in 12 months, using contract geologists and private microfilm services where necessary.

The introduction of the five-year plan also saw a return to the high priority previously given to the production of geological maps. This was a preference strongly supported by industry and research representatives on the Liaison Committee.

Apart from its extensive work in mining and petroleum tenement mapping, the Department's Surveys and Mapping Division produces more than one third of the geological maps published in Australia. During 1986/87 it produced 12 coloured geological maps.

### Environmental Maps

Of particular interest to the general public is the series of environmental geological maps of the Perth area. This series covers the metropolitan region from Yanchep to Rockingham and similar maps cover regional centres such as Collie, Albany, Geraldton, Harvey-Lake Clifton, and Burekup. They give precise information about the location of various types of soil, sand, clay, stone, gravel and other industrial minerals.

As well as locating valuable basic resources, these maps classify the suitability of land for various urban uses and will be a big help to Local Government, town planners, developers, Government departments, and schools for educational purposes. They fill a knowledge gap which has concerned metropolitan region planners for some time.

### Water Studies

The Department continued its studies of the State's underground water resources through the Geological Survey's Hydrogeology Section, the Mining Engineering Division's Drilling Branch, and the Water Science Laboratory of the Government Chemical Laboratories. For the last 15 years the Drilling Branch's work has been almost totally devoted to water studies, compiling information which is laying the foundation for the future development of the State, and which has already had a considerable practical impact in the metropolitan region.

Most of the work done this year was concentrated on the ongoing study of the Perth Basin deep aquifers. The program included the drilling of the State's deepest water bore — a 1,671 metre hole about 25kms north west of Nannup. It was one of seven holes drilled in the area, including two to 1,500m and one to 1,450m.

The deep aquifer investigation has been in progress since 1961, is three quarters finished and is expected to be completed by 1991. The Perth Basin shallow aquifers have been under study since 1966 and coverage is more than half-complete. The study provided the information which enabled the WA Water Authority to tap the underground water resources which have so effectively augmented Perth's surface supplies.

The Perth Basin studies are part of a total assessment of the State's water resources, an assessment which is advanced by all available means but which still has many gaps.

As well as its basic research into water supplies, the Department drilled three holes for the Main Roads Department in the Carnarvon-Minilya area, and drilled 45 holes in the ongoing survey of the effects of bauxite mining on water supplies.

The Drilling Branch works on contract to other departments and to private companies. Among its many services is a borehole television scanning service which is unique in Australia. The service puts a television camera into a borehole to give drillers a clear picture on the surface of what is happening hundreds of metres underground.

The service is used by the Water Authority, the SEC, mining companies, and even the US Navy. The Branch has also developed its own Borehole Electronic Recording Gear (BERG) of which there are very few in the world of equal quality.

The Branch's latest technological breakthrough is to develop a system to combine satellite receiving dishes and the services of GWN television to send written instructions by facsimile to drill crews in remote areas.

This enables head office to solve problems and issue detailed instructions without the long and costly delays that used to occur previously. The system also enables the crews to pick up television, a morale booster for people spending many months in remote areas.



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## Laboratories

Hydrogeology and drilling are not the limit of the Department of Mines' involvement in the State's water supplies. The Water Science Laboratory does the chemical analysis associated with all water studies.

It also tests country water supplies and advises the WA Water Authority on the appropriate treatment plants for new or existing supplies.

The laboratory also did chemical research to enable WAWA to eliminate unwanted smells and tastes from some water supplies. It is a national leader in this field and during the year a poster paper was presented in Adelaide to help other States to overcome these sorts of problems.

The Water Science Laboratory provides advice to the public for a nominal charge on domestic bore water, farm water supplies and the treatment of pool water.

It is one of seven laboratories operated by the Department of Mines under the title Government Chemical Laboratories. They give the Department a range of scientific skill rarely matched in one organisation, and enable it to provide a wide range of services to the Government and people of Western Australia.

In the years since 1922 when various departmental laboratories were joined as the Government Chemical Laboratories, the Department of Mines has provided chemical consultancy for mining, agriculture, water supplies, police, food, consumer affairs and industrial health.

The Mineral Science Laboratory, which is now the second biggest of the seven, carries out the chemical and mineralogical components of the research undertaken by the Geological Survey, researches the processing of minerals and by-products, and undertakes various projects in combination with universities, mining companies, and research groups.

An important project undertaken by the laboratory this year was research into the quantitative analysis of the platinum group of metals. The research will make it possible to build up a profile of this rare but valuable group of metals as they occur in Western Australia.

The laboratory also completed detailed identification of various types of soil in the coastal plain, research which is proving significant in police forensic work.

In addition, it analysed and established the qualities of a range of road-building materials used by the Main Roads Department.

The biggest of the laboratories is the Agricultural Chemistry Laboratory. This is the organisation which conducts most of the chemical analysis for the Department of Agriculture's field trials.

Its particular projects this year included research into the State's 3 million ha of molybdenum deficient soils, and the continuation of its five-year research program into the qualities of sweet lupins.

The development of sweet lupins as a major export crop has been the biggest new success story in agriculture in recent years. This success has been largely dependent on the Department of Agriculture's success in breeding out of lupins the bitter qualities that can make them unpalatable to humans and stock, and that success in turn has been influenced by the precise chemical analyses undertaken in the Mines Department's Agricultural Chemistry Laboratory.

The laboratory is now believed to be the world leader in the chemistry of lupins.

## Forensic Science

The Forensic Science Laboratory achieved national recognition during the year when it became the first in Australia to detect the drug etorphine (commonly known as elephant juice) in racehorses. While etorphine made the headlines, it was only one of a series of narcotic drugs the WA laboratory was first to detect, although it is known that they were being used in other States.

The WA success was due to a more aggressive approach to the detection of problem drugs and to skilful research into methods of detection of drugs. The Forensic Laboratory acquires information from the racetracks about new drugs being tried and then embarks on an aggressive program to detect the drugs it knows are being used.

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Apart from its work for the racing industry, the Forensic Science Laboratory undertakes all chemical work for the WA Police, including blood alcohol analysis, tests for drugs in drivers, and the examination of all physical evidence.

It undertook research into the identification of a variety of paints, polymers, tyre rubbers, and glass and its staff are now recognised as the foremost experts in Australia on the identification of glass. This research is the basis for identification in many accident cases and crimes.

Another of the laboratory's achievements was a sharp reduction in maritime pollution in WA harbours after it developed techniques for linking oil and other pollutants to particular ships.

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## SAFETY AT WORK

*OBJECTIVE To ensure that all operations in the mining and petroleum industries and activities involving explosives and dangerous goods are conducted in a manner that is safe for workers and the public; and to ensure that proper attention is given to protection and rehabilitation of the environment.*

The two seemingly different goals of human safety and environmental protection are linked in the Department's objectives and operations because as well as being responsible for industrial safety in the mining and petroleum industries, the Department is responsible for the public safety aspects of all explosives and most dangerous goods. The effect of these materials on people and the natural environment must be considered simultaneously.

Properly managed, the mining industry can have minimal adverse effect on the environment — certainly not as much effect as urban development or agriculture. However, because of its nature and because it is frequently conducted in remote areas it has the potential to be a hazardous industry.

The fact that it has a good safety record is a result of diligence and genuine concern for people shared by management, employees and Department of Mines inspectors.

In 1986, there were four fatal accidents in the mining industry, the lowest figure since 1963. Expressed as fatalities per 1,000 workers, the figure of 0.15 is the lowest on record.

In the metalliferous mining industry serious injuries (involving absence from work of 14 days or more) were below 20 per 1,000 workers for the fourth consecutive year and for only the fifth time in the last 20 years.

Minor injuries at 47 per 1,000 workers were less than half the figure of 10 years ago.

These figures were achieved at a time when new gold mines were being opened at the rate of nearly one a fortnight, often with relatively inexperienced management and certainly with inexperienced workers. A sudden influx of new workers to any industry always creates problems from an industrial safety point of view, but the mining industry is working through its current gold boom very effectively.

### Mining Engineering

The Department's Mining Engineering Division — which is responsible for industrial health and safety in all mines, pits, private railways, treatment plants, and ports to the point of shiploading — maintained close contact with the Chamber of Mines, the TLC, unions, and management directly and through industry bodies such as the Ventilation Board and the interim Mines Radiation Safety Committee to ensure that standards were maintained.

The Division's Research and Technical Services section combined with the Department's Food and Industrial Hygiene Laboratory to conduct seminars in mining areas on the safe use of cyanide. The seminars attracted more than 300 workers and achieved a much higher level of awareness of the need for safe procedures in handling this potentially lethal chemical.

Protection of mineworkers against industrial noise is another of the Division's roles. Industry compliance with requirements to submit noise surveys was better than 90%.

The Department achieves its industrial health and safety goals almost entirely through cooperation from management and workers. Prosecutions are launched only for grossly negligent breaches of safety or for chronic breaches in defiance of warnings.

At the beginning of 1987, the Department introduced a new system of reporting industrial safety data. The information contained in the standardised forms will be fed into a computer later in the year and once the system is proved it will operate continuously.

The system will alert the Department to any adverse trends in a branch of the industry or in particular mines so that remedial action can be taken.

Another computerised system is already recording atmospheric health hazards such as dust and gas and will give the Department and the industry early warning of any unsatisfactory trends.

During the year, the Department began an ongoing review of regulations to ensure consistency with the standards and procedures being established by the new Department of Occupational Health, Safety and Welfare of WA (DOSHOWA).

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Apart from this high level of direct involvement in health and safety, the Mining Engineering Division has had substantial input to the Standards Association of Australia on matters concerning the industry, and into the establishment of radiation standards.

The Petroleum Division carries the responsibility for the safety of personnel and environment in oil and gas exploration and production. Its Engineering Branch ensures the application of sound engineering principles and standards for system design and plant assembly in production and exploration.

### **International Standing**

The Department's Explosives and Dangerous Goods Division was involved in a number of major issues relating to proposed new industries and the expansion of existing ones.

The Director made a visit to the UK and the Netherlands in April to study the safety requirements for the transport of liquid sodium cyanide and the road transport of liquefied natural gas — both of which are related to important new industries for the State.

The Division was closely involved in a report by a technical committee reviewing the overall operating safety procedures at the North West Shelf gas project; in assessment of proposals to dispose of polychlorinated biphenyls by incineration; and the assessment of major resource development projects at Kwinana.

The Division participated in reports for both the Bunbury and Geraldton Port Authorities on the safe increase of port limits for the shipment of ammonium nitrate.

Despite what at times appears to be a public perception to the contrary, Western Australia has some of the most effective transport regulations in the world.

The quality of the work done here was recognised by the Canadian Government when it asked the Department to provide a senior officer to participate in a review and assessment of Transport Canada's Dangerous Goods Regulations. The Deputy Director of the Division was assigned to the task and his two months' work in Canada in January and February was highly acclaimed by the Canadian Director General of Transport.

The trust placed in the Department's staff by the national Government of Canada — which has easier access to all the expertise of the US and Europe — is a tribute to the quality of protection provided to workers and the public in the transport of explosives and dangerous goods in this State.

### **Public Health**

The Department of Mines was further involved in industrial and public health through the operations of the Food and Industrial Hygiene Laboratory and the Materials Science Laboratory. The former is involved in inspections of mines, factories, and other premises to check airborne chemicals, dust and other health hazards. It also tests a wide range of consumer goods, including the dyes and colourings used in food, the lead content of toys, paints, food samples, and levels of pesticides in food, water and soils.

The Materials Science Laboratory analyses a wide range of goods, particularly paints, building materials and carpets which are frequently the subject of complaints to the Small Claims Tribunal. It also checks the quality of detergents and other goods bought in large quantities by the State Tender Board for use by Government departments.

It is involved in the restoration of historic buildings (including Parliament House), the study of the release of toxic substances from insulating materials in a variety of situations, and analysis of the effect, if any, of various pipes and coatings used to convey potable water.

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## The Environment

The Department is directly involved in environmental planning through its Mining Registration, Mining Engineering, Geological Survey and Petroleum Divisions and the GCL, all of which have direct responsibilities for establishing or maintaining environmental standards in relation to exploration and development of mineral and petroleum resources.

The feature of the year's activities has been the increased level of cooperation that has been achieved among the wide range of official, semi-official and volunteer bodies associated with environmental protection.

The higher level of realistic cooperation among Government departments appears to have resulted in increased confidence among industry and conservation groups.

For instance, the Report on Conservation and Rehabilitation in the Mineral Sands Industry by a committee chaired by Dr Playford of the Geological Survey with representatives from the Chamber of Mines, AMEC and the Conservation Council produced a consensus which was then issued for public review.

The Mining Engineering Division was able to initiate a resolution of the Wonnerup tailings problem, and throughout the State the various Divisions of the Department reported a more realistic and effective approach to environmental management.

The Amendment to the Mining Act which strengthens its authority against illegal mining was applied from January 1987. In addition to the protection it gives legitimate leaseholders and pastoralists against illegal miners, the amendment allows the courts to order rehabilitation of illegally mined areas.

This will enhance the Department's ability to enforce its environmental protection measures.

The Government Chemical Laboratories assess Environmental Review and Management Programs and Public Environmental Reports for the EPA, and each of the seven laboratories is involved in environmental matters, from preparing slow-release fertilisers and testing chemical residues and dusts to the safe disposal of waste products by landfill or incineration.

The Water Science Laboratory in particular has been involved in the Swan River, Peel-Harvey and Leschenault studies since their inception. It is also involved in monitoring mercury levels in the Princess Royal Harbour at Albany.

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## MINING IN PERSPECTIVE

*OBJECTIVE To promote and maintain a favourable climate for mineral and petroleum exploration and development.*

This objective is embraced in the programs associated with the Department's three other main objectives, but it is considered so important that it is given special treatment in all departmental planning.

The mining industry is of crucial importance to the State, and Governments and the public have traditionally accorded it a positive and supporting attitude. However, with so much of the mining industry located in remote areas, and so much of its production exported, the true significance of the industry can easily be lost on the majority of the population who are mainly urban-oriented. It is easy for city dwellers to forget that even such basics as road-making materials and building supplies are the products of the mining industry.

Although the Department of Mines does not undertake a major public relations program on behalf of the industry, it does ensure that its information about minerals, oil and gas is readily available to the public.

Every six months the Department updates an Overview of Mining in Western Australia which is used as the basis of a series of presentations which senior Departmental officers make to school teachers who attend seminars organised by the Chamber of Mines.

It is a clearly written document which gives basic information about the various minerals produced in the State, the importance of Western Australia in world mineral trade, and the impact of mining on the State's economy and workforce.

To coincide with the centenary of the Geological Survey next year, a new edition of The Geology of Western Australia, Memoir 3 will be produced. This is a substantial volume which is not matched by any other report on the State's geology.

New editions of The Geological Map of WA and of The Mineral Deposits of WA will also be produced. The first edition of a Hydrogeological map of the State showing the extent and quality of its underground water resources will also be issued.

The Department's annual map entitled Mineral Production continues to be a colourful and informative guide to the minerals produced in the State, their uses, their value, their location, the producing companies, and their contribution to employment.

Numerous other maps together with periodic reports, statistical digests, and historical records are all available from the Department.

The Department also prepares displays of photographs, posters and printed material which are set up for a few weeks at a time in the foyer of Mineral House, the State Public Library and in other suburban and country libraries. The Department also maintains a geological museum which caters for school groups and the public.

Within Government the Department vigorously maintains its role as the representative of the industry in discussions about competing land uses.

The Department is convinced that neither Government nor the community at large can make the most appropriate decisions about land use unless all appropriate information is available and understood.

Accordingly, it will continue to advance research into the State's geology and its mineral, petroleum, and water resources, and will endeavour to ensure that the significance of these resources is properly understood.

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# MANAGEMENT AND HUMAN RESOURCES

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In response to Government initiatives to improve the Public Sector's efficiency, accountability, and relevance to industry and the community, the Department of Mines has made progress towards restructuring its management systems.

The Department has faced the challenges of change in the Public Sector at a time when a thriving gold mining industry has placed unprecedented demands on its services. This boom co-incided with a Government freeze on filling vacant positions in the public service, and a requirement that overall staff be reduced by three per cent in 1986- 87.

The freeze came at a particularly awkward time for the Department because many positions had been allowed to fall vacant so as to facilitate a re-allocation of resources into Corporate Affairs, Human Resource Management, and Information Technology.

Departments were required to maintain the freeze until they had produced an overall staff plan with a three percent reduction in personnel — a reduction of 23 staff for the Department of Mines. This was achieved early in 1987 and the Department was then able to begin to fill the new positions it had created in place of old ones to give it a management team which is better equipped to meet the new requirements of the Financial Administration and Audit Act and the delegation of duties by the Public Service Board, and Government's demands for greater efficiency and accountability as set out in its White paper "Managing Change in the Public Sector".

The changes now being implemented demand acceptance of a much broader concept of the role of managers and supervisors at all levels. The transition is difficult and the objective of servicing industry within the broad context of efficiency and effectiveness demands a high level of planning skills. In this regard, the Department has made initial steps towards corporate planning and strategic management.

## THE MOMENTUM OF CHANGE

As part of this corporate planning process, the following primary objectives have been included in the Department's strategic program.

- to implement strategic planning as quickly as possible by developing Divisional plans and linking them with the budgetary process;
- to improve support systems, particularly in the area of human resource planning, finance and budgeting; and
- to enable the Corporate Executive to more effectively discharge its responsibilities in planning and policy by gaining a better understanding of the strategic issues affecting the organisation.

The planning process will involve the effective linking at corporate and divisional level of departmental activities in a number of key areas — financial management, workforce planning, capital works planning, operations planning, information support and performance measurement.

Over the next 12 months the Department is committed to further development of corporate objectives; development of divisional objectives and plans; review of strategies in key areas; better identification and response to strategic changes affecting the organisation; and performance management.

The strategic planning approach reflects the Department's attitude that industry should play a bigger role in determining the services provided by the Department and the standard of these services. This will ensure that the Department's activities and programs are compatible with industry needs and that they provide Government with the information it requires for decisions on the allocation of resources to the Department.

Industry liaison was greatly enhanced during the year by the establishment of top-level committees to deal with mining, petroleum and geological activities. The structure and work of these committees is dealt with in the report on the Department's activities.

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## HUMAN RESOURCE MANAGEMENT

The Department, through its Human Resources Branch, aims to ensure that staff have the necessary skill, knowledge and expertise to effectively contribute to the achievement of the Department's goals and objectives. Its approach to developing human resource management strategies is consistent with the Government's objective to maximise its human resources to their full potential.

Late in the year, a Human Resource Manager was appointed to the Department in order to accelerate the implementation of a number of programs which will give staff better training, more job satisfaction, the opportunity for greater productivity, and the requirement that they meet performance standards.

Some of the initiatives the Department has instituted or is planning for, are set out hereunder.

### Human Resource Budgeting

During the year the Department adopted the Full Time Equivalent (FTE) system of monitoring its human resource allocation. While this system required an overall reduction of 23 positions for the Department it nevertheless has afforded the opportunity to change priorities in staff allocations. This requirement together with the transfer of the State Batteries Division, has resulted in an overall reduction of 100 positions. The Department's allocation at June 30, 1987 is 736 Full Time Equivalents.

A summary of the number of employees by category in comparison with last year is as follows.

	1985/86	1986/87
Public Service Act	640	656
Contract	2	1
Ministerial	48	16
Wages	<u>146</u>	<u>63</u>
TOTALS	<u>836</u>	<u>736</u>

The monitoring of human resource allocations will be enhanced by access to the Personnel Information Management Systems (P.I.M.S.). This initiative is presently in progress.

### Equal Employment Opportunity

In accordance with Government policy an Equal Employment Opportunity (EEO) Management Plan is in its early stages of development. The Plan will ensure that employment and promotion are based on merit and that discrimination does not occur on the grounds of sex, marital status, physical disability, race, or religious or political conviction. Accordingly, staff awareness is being raised, the Department's personnel policies and practices are being reviewed, and strategies will be developed as necessary.

### Development and Training

The Department continues to provide development training courses and seminars to staff. This has been achieved largely through the services provided by external consultants, particularly the Australian Institute of Management. Under the restructure of the Human Resources Branch a Staff Development officer will be responsible for co-ordinating the training and development needs of the Department.

### Performance Management

To influence job performance and employee development consistent with the achievement of the Departmental objectives, performance management (appraisal) systems have been developed in the Geological Survey and Mining Registration Divisions as well as the Records Branch of the Corporate Services Division. Systems will continue to be implemented throughout the Department.

These performance management systems are designed not only to give an effective method of staff appraisal, but also to ensure that the Human Resource Management team can plan appropriate training courses and ensure that all staff are given the opportunity to develop their skills and plan their career objectives.



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## Retirement Planning

The Branch's co-ordination of seminars for staff concerning the services available when planning for their retirement, and particularly the Superannuation options, is proving most worthwhile.

## Occupational Health and Safety

The Department has a close involvement in occupational health and safety because of its responsibilities in these fields in mines, pits, ports, and railways in various parts of the State. This responsibility for the welfare of others will not be allowed to cloud the need for all staff to be fully aware of the internal requirements for industrial health and safety which are being established by the Human Resources Branch.

## INFORMATION TECHNOLOGY

In the last 12 months the Department of Mines has made good progress in the practical application of computer technology to its primary functions as the administrator of the State's involvement in the mining and petroleum industries.

The maintenance of up-to-date records about exploration and mining tenements and the dissemination of geological information have been among the Department's most important responsibilities since its formation and for most of this century the work has been clerically intensive.

Although computers were used earlier for scientific purposes it was not until late 1982 that the first steps were taken to computerise the administration of the Mining and Petroleum Acts. The next 18 months were largely devoted to planning and it was not until the second half of 1984 that the Department began to build key starter systems that could be used by the Department and the industry.

The key point of computing philosophy then and now is to build starter systems that can be used as quickly as possible, in their earliest stages of development, and with minimum resources, rather than trying to establish comprehensive systems that would take years to implement.

Among the key areas were better storage and retrieval of information obtained from exploration; better control of internal documents and records; better control of tenement information; and more effective administration of regulations.

WAMEX (the WA mineral exploration database index) was the first system developed and it came into operation in 1985 to give the Department and the industry better access to information gleaned either by Geological Survey staff or companies which are required by law to report their findings to the Department. There are various legal restraints on the release of the information while companies are still operating.

The Department then picked up the Public Service Board's records management system (RMS), adjusted its application and became leaders throughout the Service on RMS. After the equivalent of 14 man-years of data take-up and validation effort, the Department brought its RMS into operation in 1986 and completed it early in 1987. The system has 150,000 files in the data bank, more than 90,000 of them tenement files. All are bar coded and can be traced with ease in any of the Department's five city locations.

The RMS has substantially reduced the demands on clerical staff, the amount of overtime worked in the Department, and the delay in handling the 2,000 plus requests for files received each week.

The third of the key starter systems, the tenement information system (TENDEX), was made available to the public in December 1986. It has proved of great benefit to industry and to various divisions within the Department, including Mining Registration, Surveys and Mapping, the Geological Survey, and the Royalties Branch. TENDEX will be expanded during 1987-88.

The complexities of the administration of the Explosives and Dangerous Goods Act led to the introduction this year of DANEX, a licensing system currently storing data on some 12,000 licences and permits which have been issued in accordance with various regulations prescribed under the Act. The information in the system is available from the Department's Explosives and Dangerous Goods Division.

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CONTAM, a system for measuring and recording dust and other atmospheric contaminants is in operation and a State-wide accident reporting system, AXTAT, will be in operation before the end of 1987. This system was developed in close consultation with industry and is becoming recognised, even before it is fully operational, as the pacesetter for Australia.

The expansion of TENDEX, completion of the safety reporting system and the introduction of a petroleum equivalent to WAMEX (WAPLEX) are the priorities for the coming year, but the Department has already targetted 34 man-years of work for the next 3 to 5 years to introduce further systems which will service the various Divisions of the Department in their efforts to serve the mining and petroleum industries.

The systems introduced to date have resulted in significant savings in overtime and other costs within the Department and in additional revenue generated by serving industry better. WAMEX, for instance, earned about \$100,000 in 1986-87 and TENDEX earned \$35,000 in its first six months. It is expected that the systems will fully pay for themselves in four years.

The Computing Services function will expand from 8 to 11 people in 1987-88 as the re-allocation of resources allows the Department to accelerate its implementation of essential industry-related systems.

Internally, the Department has developed a strict justification system for the introduction of personal computers in some Divisions. The Government Chemical Laboratories and the Geological Survey have demonstrated that personal computers can help field staff get research information out to the public much more efficiently.

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# FINANCE

## YEAR ENDED JUNE 30, 1987

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# DEPARTMENT OF MINES

## FINANCIAL RESPONSIBILITIES

The financial responsibilities of the Department of Mines include the collection and recording of revenue, and the payment of salaries, wages and other expenses.

The Department's funds are provided from the Consolidated Revenue Fund and General Loan and Capital Works Fund with certain activities being financed from Treasurer's Advances and Trust Funds. In addition, funds are received from the Commonwealth for specific programs.

### Consolidated Revenue Fund

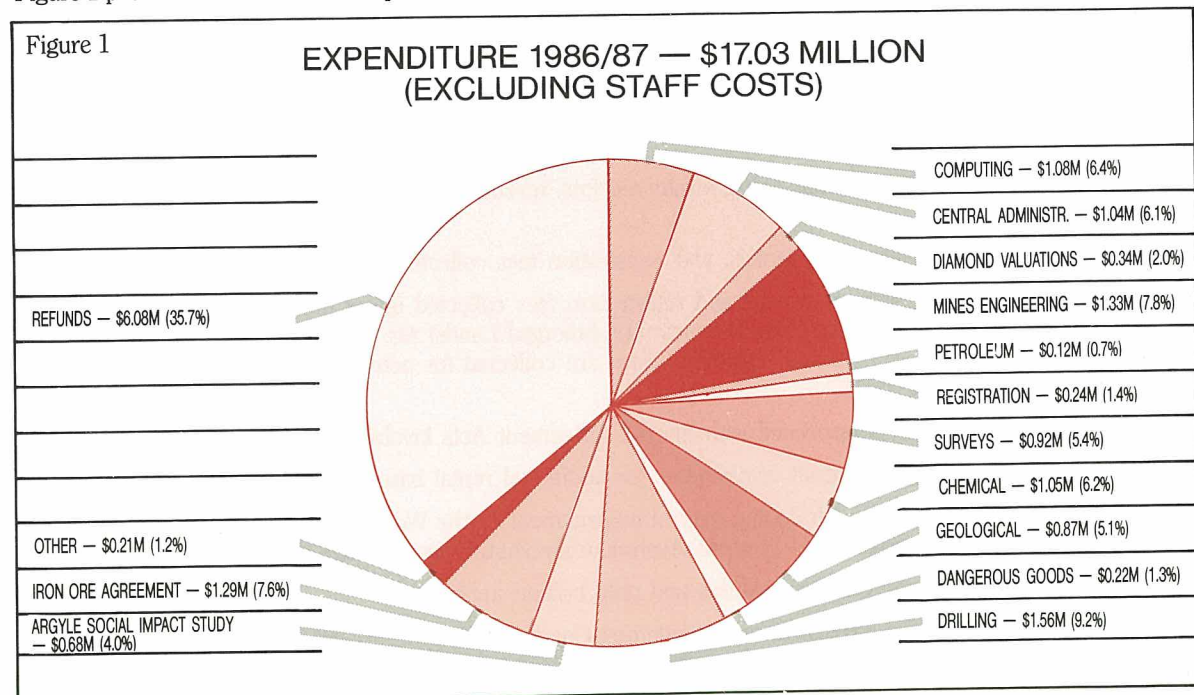
#### Expenditure

This fund provides finances:—

- (i) the Department's recurrent costs;
- (ii) certain projects of a capital works nature; and
- (iii) items of expenditure that are related to the mining and petroleum industries but which are not an operating cost of the Department.

In addition any refunds of revenue collected in previous financial years appear as an expenditure commitment against the Department. For example, statutory obligations require rents to be refunded when mining tenements are refused, withdrawn or surrendered. More recently, a revised royalty agreement between the Commonwealth and the State Governments has resulted in excess royalties being refunded. (N.B. In 1986/87 refunds of revenue totalled \$6.085 million — 35.7% of total non- labour expenditure).

Figure 1 provides a breakdown of expenditure (excluding staff costs) financed from the Consolidated Revenue Fund.

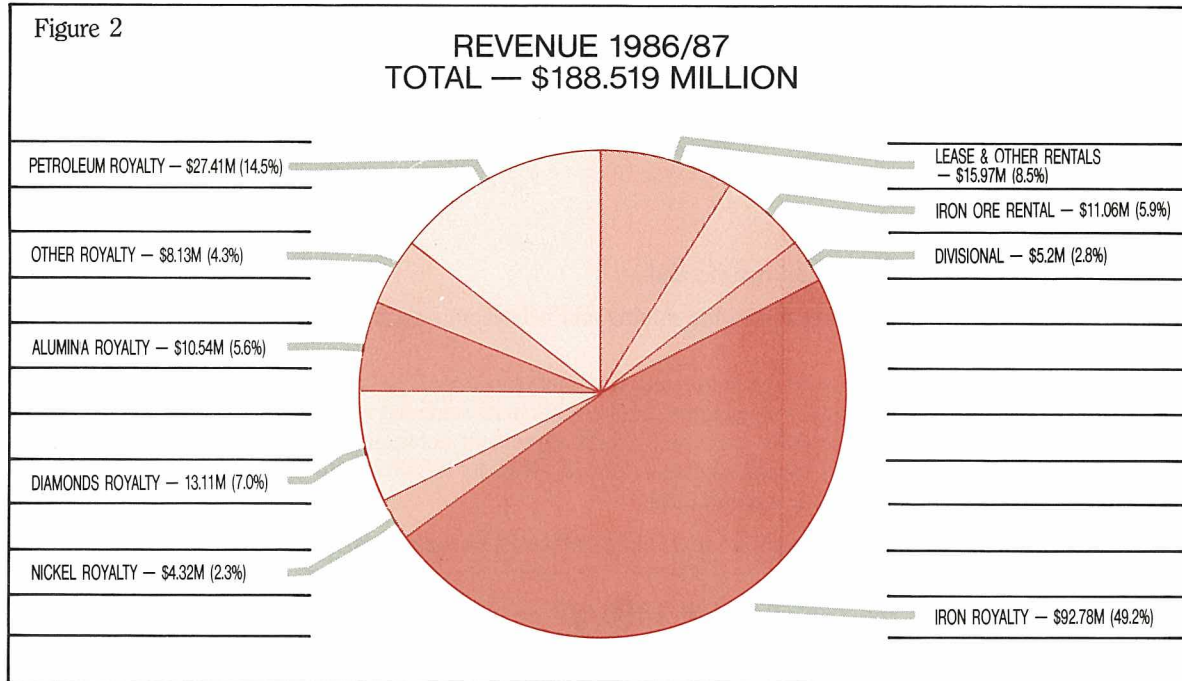


Included, at times, in the funding allocation from this source are funds for projects of a capital nature. The decision regarding the source of funds for capital projects rests with Treasury.

Certain items of expenditure that are related to activities of the mining and petroleum industries but which are not operational costs of the Department are also financed from this source. An example is the contribution to the Argyle Social Impact Group. This group is a joint Government and Argyle Diamond Mines Ltd exercise established in 1984 to fund the development of aboriginal social infrastructure in the East Kimberley region for a period of five years.

## Revenue

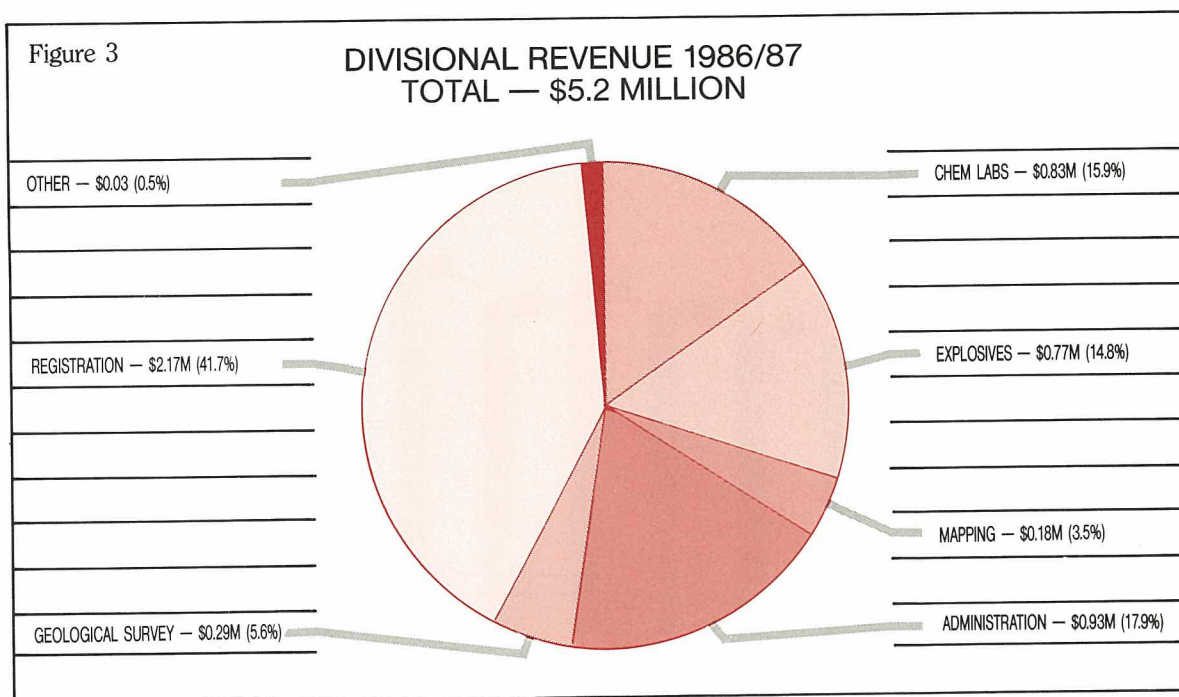
The majority of revenue collected by the Department is from mining and petroleum royalties. Figure 2 provides an analysis of the total revenue collected during 1986/87.



Whilst overshadowed by the magnitude of the royalty receipts, revenue is also generated from other sources. Some of these are:

- Mining tenement application fees, rentals, and registration fees collected under the Mining Act 1978.
- Petroleum tenement application, annual and registration fees collected under the Commonwealth Petroleum (Submerged Lands) Act 1967, the State Petroleum (Submerged Lands) Act 1982 and the Petroleum Act 1967. In addition, application, annual and registration fees are collected for petroleum pipeline licences under the Petroleum Pipelines Act 1969.
- Lease payments and rentals associated with Special Agreement Acts involving Government and operators.
- Quasi royalties collected as a result of payments for additional rental based on iron ore shipments.
- Analytical services associated with doping control management or the Western Australian Turf Club, Western Australian Trotting Association and Western Australian Greyhound Dog Racing Club.
- Evaluation of mineral processing procedures and gold bullion analysis.
- Fees prescribed under the Explosives and Dangerous Goods Act 1961-1986 and regulations thereunder.
- Sale of tenement maps, geological maps, plans and other Departmental publications.
- Sale of information regarding the status of mining tenements applied for and held under the Mining Act 1978. This information is available via a computerised Tenement Information System (TENDEX).

Figure 3 provides a breakdown of the Divisional Revenue category shown in figure 2.



### General Loan and Capital Works Fund

Major capital works projects are financed under the State's Capital Works Program from the General Loan and Capital Works Fund.

In 1986/87 \$14,060,816 was expended on capital works funded from this source (eg. relocation of explosives depot, laboratory equipment, computer equipment, buildings and associated works).

### FINANCIAL MANAGEMENT

In accordance with Government's accountability concept, the Department has initiated a number of reporting mechanisms which inform the Accountable Officer of the Department, the Director General of Mines, of the financial position of the Department on a periodic basis.

These reporting procedures are based on a flexible budgeting approach and enable the Executive of the Department to make the most effective use of available funds.

It is intended that these processes will be further developed to strengthen the links between the budgeting processes and strategic planning.

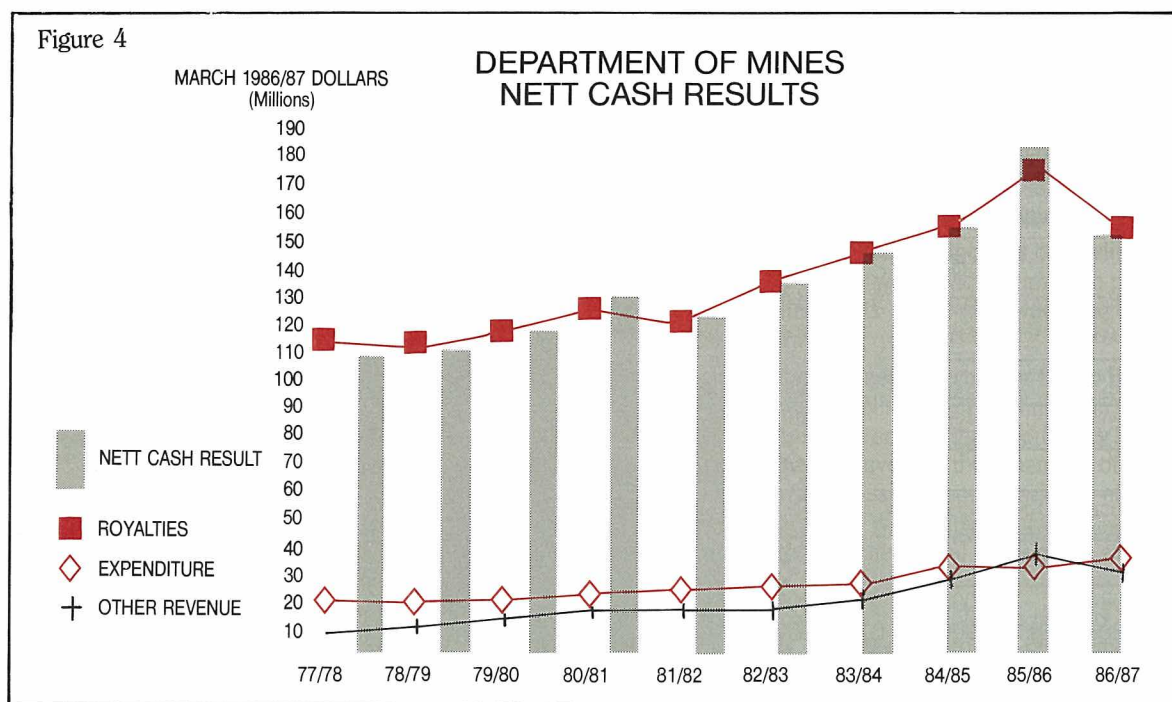
### Pricing Policy

Departmental fees and charges are reviewed annually and determined in accordance with Government directives, having regard to such factors as the cost of providing services, impact on industry and the public and price movements for the year.

### Royalty Policy

The Government's policy on the raising of revenue through mineral and petroleum royalties is to ensure that royalty levels are such that all Western Australians benefit from the use of these resources. The Department aims to administer a comprehensive royalties management system which ensures that all royalties due are collected in the most cost effective manner.

## CASH RESULT: A TEN YEAR COMPARISON



## PERFORMANCE REVIEW 1986/87

### CRF Expenditure

During the financial year the Department's Consolidated Revenue Fund (CRF) expenditure budget of \$37.313 million was overspent by \$0.257 million (0.7%). However, in evaluating the performance of the Department, an adjustment should be made for the overspending associated with a payment to the State Development Fund in accordance with the Iron Ore (Goldsworthy — Nimingarra) Agreement Act (\$1.073 million).

Allowing for this adjustment, the Department underspent its CRF budget by \$0.816 million (2.2%). This result was expected as the underspending associated with the level of refunds (\$0.573 million) for mining tenements reflected the activity in the industry during 1986/87. In addition, a significant underspending in salaries and wage costs (\$0.643 million) was a consequence of the Government's "freeze" on the advertising of vacant positions and the subsequent 3% reduction in the Full Time Equivalent (FTE) staff of the Department (23 FTE's) by June 30, 1987.

The significant overspending during the year was by the Government Chemical Laboratories. This variation of \$0.224 million was a result of increased cost and demand for chemical analysis during 1986/87.

Comparing the expenditure result in 1986/87 to the previous financial year, there is an increase in expenditure of \$5.908 million (18.7%) in unadjusted terms.

Significant contributing factors were:

- a single refund in 1986/87 of excess royalties collected in previous years due to a revised royalty agreement between the Commonwealth and State Governments caused a \$3.341 million variation between the two years;
- a contribution under the Iron Ore (Goldsworthy — Nimingarra) Agreement Act of \$1.296 million in 1986/87 when no contribution was made in 1985/86;
- a change in procedures which has resulted in new and replacement motor vehicle purchases being appropriated to the Department in 1986/87 (\$0.525 million). These expenditures were previously accounted for by the Treasury;

- the exemption from payroll tax charges in 1986/87 whereas previously this commitment was met by the Department (\$0.887 million in 1985/86);
- one calendar year (1987) indexed contribution to the Argyle Social Impact Group in 1986/87 (\$0.677 million) compared to two calendar year payments (1985, 1986) in 1985/86 (\$1.129 million).

Adjusting for these extraordinary factors, there is an increase in expenditure of \$2.087 million (6.9%) between 1985/86 and 1986/87.

### CRF Revenue

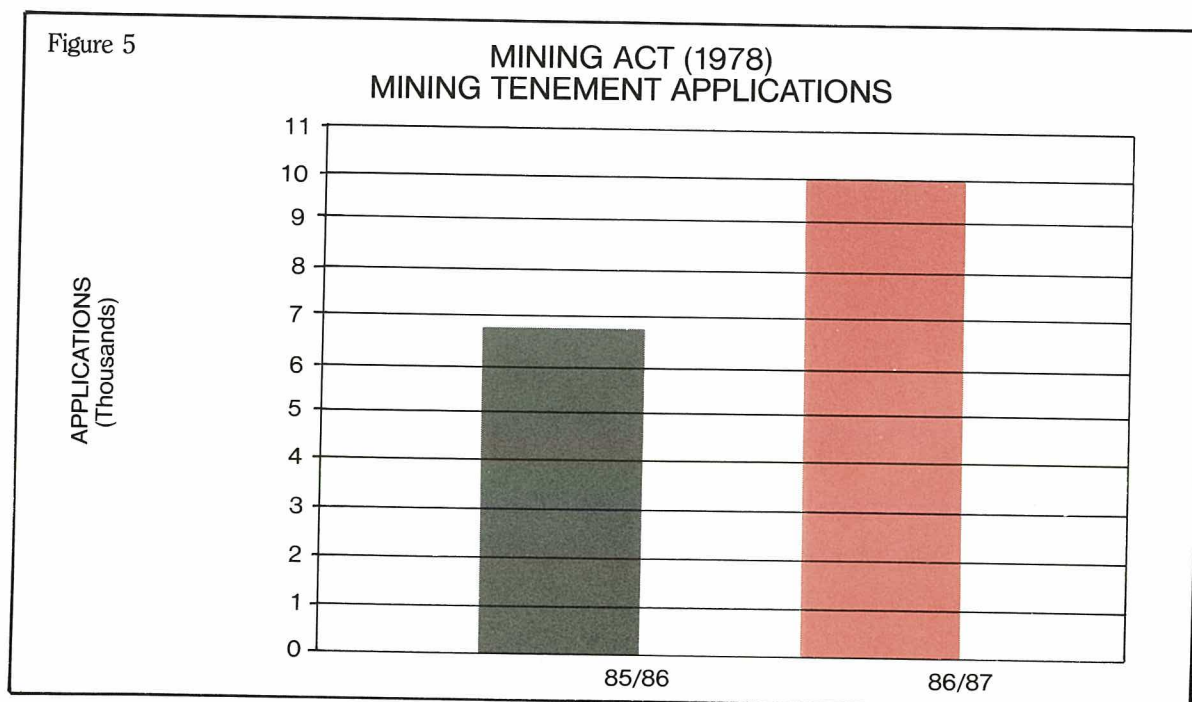
Additional revenue of \$6.349 million (3.5%) was received during 1986/87 when compared to budget.

The variation is categorised as follows:

Total Royalties	\$ million
Lease & Other Rentals	+ 1.982
Divisional Revenue	+ 3.524
Commonwealth Revenue	+ 0.832
	<u>+ 0.011</u>
	+ 6.349

Reductions in iron ore royalties (\$8.720 million) due to reduced shipments of ore to Japan, and in nickel royalties (\$1.585 million) due to depressed world nickel prices were offset by additional diamond royalties (\$4.609 million) as a result of increased sales, and a variation in the world price of crude oil which increased the level of petroleum royalties (\$1.778 million). For further information on the petroleum royalty variation see note 15 of the Notes to and Forming Part of the Financial Statement.

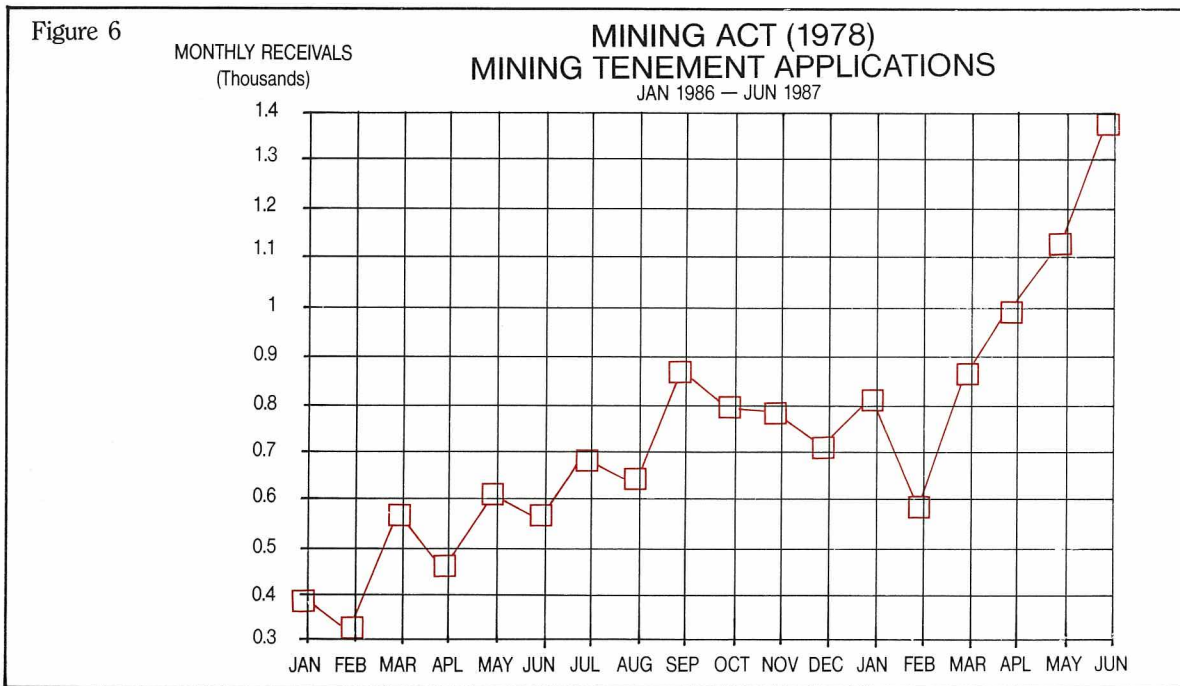
The increase in revenue collected against Lease and Other Rentals represented a 15% variation on budget. This variation and most of the increased divisional revenue were due to the high level of mining tenement applications during the year.





Figures 5 and 6 indicate:—

- i) the increase in the number of mining tenement applications received when comparing 1986/87 and 1985/86; and
- ii) the trend associated with these applications in the latter half of 1986/87.



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## MAJOR CAPITAL PROJECTS UNDERTAKEN DURING 1986/87

### DEPARTMENT OF MINES

#### Projects uncompleted at June 30, 1987

##### Baldivis — Relocation of Explosives Reserve

In 1983 Government agreed to relocate the Explosives Reserve from Woodman Point to Baldivis. The funding arrangements were for the Department to repay Cockburn Cement Ltd for costs incurred by the company in the construction of the Baldivis Explosives Depot. The repayments were to be in three equal annual instalments from 1985/86 to 1987/88.

The estimated cost to complete the project is \$718,000 and the estimated total cost of the project is \$2,141,500. This is \$14,500 more than the total cost estimated in the previous financial year. The increase is a result of interest rate variations to which the annual instalments are subject.

##### Geological Survey — Laboratory Relocation

Several Geological Survey laboratories were located on the fourth floor of Mineral House. Because of increasing attention to occupational health and the rising standards for laboratory safety, it became necessary to relocate the laboratories.

Government provided \$500,000 in 1986/87 for this purpose. However, completion of the laboratory was delayed to July 1987. \$375,347 was expended in 1986/87, resulting in an underspending of \$124,653. The expected year of completion for the project is now 1987/88. The estimated total cost of the project has risen to \$570,000, a variation of \$70,000 over the original estimate. The estimated cost to complete the project is now \$194,653.

##### Government Chemical Laboratories — Equipment Replacement

The Government Chemical Laboratories developed a program for the first time in 1986/87 to replace obsolete capital equipment on an ongoing basis.

Government provided funding of \$800,000 in the first year of the program, but, due to payment delays associated with overseas equipment purchases only \$731,331 was expended. the balance of \$68,669 is expected to be paid in 1987/88.

#### Projects completed during the course of the financial year

##### Mainframe Computer

An amount of \$760,000 was provided for upgrading the Department's computer facilities. Upgrading disk storage capacities cost \$163,648 and replacement of the mainframe computer cost \$616,380, a total of \$780,028.

##### Mainframe Printer

Upgrading of the Department's mainframe computer printing facilities was proposed for October 1987, but private sector demands resulted in the need for an additional printer in 1986/87. After discussions with Treasury on the justification and need for the printer, approval was granted to include the printer in the Capital Works Program for 1986/87 (\$43,380).

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## **BUILDING MANAGEMENT AUTHORITY**

### **Projects uncompleted at June 30, 1987**

#### **Mineral House Stage II**

In order to provide adequate Departmental accommodation, Mineral House Stage II, an extension to the existing Mineral House, was commenced in 1984/85. The project is due for completion in 1987/88.

The estimated cost to complete the project is \$7,367,000 and the estimated total cost of the project is \$22,371,375. This is \$3,360,425 more than the total cost estimated in the previous financial year.

#### **Government Chemical Laboratories — Fume Cupboard Scrubbing**

In 1985/86 a project was undertaken to install fume scrubbers to provide for the efficient treatment of hazardous materials exhausted by the Government Chemical Laboratories. The project is expected to be completed in 1987/88.

The estimated cost to complete the project is \$69,000 and the estimated total cost of the project is now \$564,193. This is \$807 below the total cost estimated in the previous financial year.

#### **Mining Engineering Division — Kalgoorlie Accommodation Additions**

Additions to the Mining Engineering Division's Kalgoorlie office commenced in 1985/86 and are due for completion in 1987/88.

The estimated total cost to complete the project is \$7,000 and the total estimated cost of the project is now \$296,093. This is \$5,093 more than the total cost estimated in the previous financial year.

### **Projects completed during the course of the financial year.**

#### **Government Chemical Laboratories — Alterations and Additions**

To ensure that the Government Chemical Laboratories remain functional funds are provided in certain instances for upgrading the existing premises. The total cost of projects completed in 1986/87 was \$239,513.

#### **Government Chemical Laboratories — Forensic Science Laboratory**

Government provided funding to give the Forensic Science Laboratory clean, secure, quiet work areas for the examination of forensic exhibits.

The project was completed in 1986/87 at a cost of \$139,464.

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# STATE BATTERIES

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## OVERVIEW

On March 1, 1987, the administration and operations of the State Batteries were transferred from the Department of Mines to the Western Australian Mint.

Funds necessary for the State Batteries to carry out their functions were provided from the Consolidated Revenue Fund and General Loan and Capital Works Fund with the purchase of tailings financed from a Trust Funds-Government account.

In the budget, State Batteries had only been allocated sufficient funding to 31 October 1986 because the operations were to be the responsibility of the W.A. Mint from November 1, 1986.

However, for various reasons, the W.A. Mint was not in a position to meet the changeover date and asked the Department to continue administering the Batteries' operations until 28 February 1987.

For the Department to continue to meet the day to day running costs past 31 October 1986 it was necessary for additional funding to be injected and this is reflected in the State Batteries Expenditure Table.

In addition, an amount of \$525,000 was approved as a subsidy to allow State Batteries to operate under the auspices of the W.A. Mint for a three month settling period. This necessitated the creation of a new item (Item 9) under the State Batteries expenditure budget.

## MAJOR CAPITAL PROJECTS UNDERTAKEN DURING 1986/87

### Noise Abatement Modifications

\$47,000 was provided for noise abatement modifications of all State Batteries in accordance with the requirements of the Noise Abatement Act, 1972 (Hearing Conservation in Work Places Regulations 1983). \$41,757 was spent. As the administration and operations of the State Batteries were transferred to the Western Australian Mint during 1986/87, any further modifications are the responsibility of that organisation.

### Mobile Carbon-in-Pulp Plant

An amount of \$87,000 was provided for the purchase of a Mobile Carbon in Pulp Plant to service State Batteries where vat leaching is not viable. The project was completed with \$86,859 being expended.

# FINANCIAL STATEMENTS

## DEPARTMENT OF MINES EXPENDITURE STATEMENT CONSOLIDATED REVENUE FUND

	Note	1985/86		1986/87	Variance \$
		Actual \$	Estimate \$	Actual \$	
Special Acts					
Petroleum (Submerged Lands) Act 1982		773 606	2 240 000	2 225 241	(14 759)
Governmental					
Salaries, Wages & Allowances	2	19 062 972	20 874 000	20 230 984	(643 016)
Other Staffing Costs	3	1 405 016	530 000	628 797	98 797
Communications	—	138 160	149 000	191 919	42 919
Services & Contracts	—	1 597 402	1 563 000	1 613 327	50 327
Consumable Supplies	—	127 473	136 000	135 977	(23)
Maintenance Plant, Equipment etc.	—	29 919	30 000	19 991	(10 009)
Purchase Plant, Equipment etc.	—	19 996	35 000	44 131	9 131
Grants, Subsidies etc.	4	11 019	118 000	115 863	(2 137)
Mining Engineering	5	909 479	1 326 000	1 325 806	(194)
Petroleum	6	103 000	101 000	117 948	16 948
Registration of Mining Titles	7	2 772 189	6 896 000	6 323 261	(572 739)
Surveys & Mapping	8	883 986	950 000	924 829	(25 171)
Chemical Laboratories	9	863 607	829 000	1 053 281	224 281
Geological Surveys	10	632 758	853 000	872 054	19 054
Control of Dangerous Goods	—	227 179	227 000	224 843	(2 157)
Exploratory Drilling	—	1 512 987	1 624 000	1 563 964	(60 036)
Special Projects	11	185 630	160 000	160 000	—
Iron Ore (Goldsworthy — Nimingarra) Agreement Act — Contribution	12		223 000	1 296 000	1 073 000
Argyle Social Impact Study Group	13	1 129 634	639 000	677 305	38 305
East Kimberley Impact Assessment Project	—	50 000	50 000	50 000	
		31 662 406	37 313 000	37 570 280	257 280
<b>GRAND TOTAL</b>		32 436 012	39 553 000	39 795 521	242 521

**DEPARTMENT OF MINES  
REVENUE STATEMENT  
CONSOLIDATED REVENUE FUND**

	Note	1985/86	Estimate \$	1986/87	Variance \$
		Actual \$		Actual \$	
Territorial					
Royalties —	15				
Iron Ore		101 950 692	101 500 000	92 780 315	(8 719 685)
Petroleum		34 023 504	20 400 000	27 409 627	7 009 627
Nickel		5 948 772	5 900 000	4 315 281	(1 584 719)
Alumina		9 923 606	10 000 000	10 540 226	540 226
Diamonds		2 864 655	8 500 000	13 109 395	4 609 395
Other		8 270 430	8 000 000	8 127 024	127 024
Lease & Other Rentals	16	28 406 440	23 500 000	27 024 288	3 524 288
Departmental					
Chemical Laboratories		758 495	830 000	829 362	(638)
Explosives		706 260	763 000	772 038	9 038
Mines	17	3 278 869	2 777 000	3 600 246	823 246
Commonwealth					
Community Employ. Program		154 030	—	11 266	11 266
Water Resources Program	18	590 000	—		
Special Employment			—		
— Related Program		2 461			
		196 878 214	182 170 000	188 519 068	6 349 068

**DEPARTMENT OF MINES  
EXPENDITURE STATEMENT  
GENERAL LOAN AND CAPITAL WORKS FUND**

Note	1985/86		1986/87	
	Actual \$	Estimate \$	Actual \$	Variance \$
<b>Department of Mines</b>				
18 Baldivis — Relocation of Depot	708 586	709 000	714 952	5 952
19 Chemical Laboratories — Equip.	—	800 000	731 331	(68 669)
20 Geological Survey — Laboratory Relocation	—	500 000	375 347	(124 653)
21 Mainframe Computer	—	760 000	780 028	20 028
22 Mainframe Printer			43 380	43 380
<b>Total Mines</b>	<b>708 586</b>	<b>2 769 000</b>	<b>2 645 038</b>	<b>(123 962)</b>
<b>Building Management Authority</b>	23			
Kalgoorlie — Office Additions	25 093	266 000	264 200	(1 800)
Mineral House — Stage II Add.	3 361 823	12 500 000	10 588 092	(1 911 908)
Chemical Laboratories — Alterations & Additions	28 052	44 000	43 056	(944)
Forensic Science	59 444	74 000	80 020	6 020
Fume Scrubbers	55 193	510 000	440 410	(69 590)
<b>Total Building Management Authority</b>	<b>3 799 605</b>	<b>13 394 000</b>	<b>11 415 778</b>	<b>(1 978 222)</b>
<b>GRAND TOTAL</b>	<b>4 508 191</b>	<b>16 163 000</b>	<b>14 060 816</b>	<b>(2 102 184)</b>

Building Management Authority Administration charges not included in the above as follows:

	1985/86	1986/87
Mines	—	30,220
Building Management Authority	307 126	875 188
	307 126	905 408

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## TRUST STATEMENTS

### Kalgoorlie Metallurgical Laboratory Account

NAME	An account called the Kalgoorlie Metallurgical Laboratory Account shall be maintained as a Governmental Operating and Trust Account at the Treasury.
PURPOSE	To hold funds to meet the operating costs of the Kalgoorlie Metallurgical Laboratory.
RECEIPTS	Such moneys as are received by the Department of Mines as are appropriated by Parliament shall be paid into and placed to the credit of the Account.
PAYMENTS	The funds in the Account shall be applied to the operating costs of the Laboratory.
ADMINISTRATION OF ACCOUNT	The Account shall be administered by the Director General of Mines, Department of Mines in accordance with the Financial Administration and Audit Act, Financial Administration Regulations and the Treasurer's Instructions.
ACCOUNTING	There shall be maintained by the Director General of Mines a detailed record of transactions with such other accounting records and procedures as are prescribed in the accounting manual.
FINANCIAL STATEMENT	The Director General of Mines shall cause to be prepared a statement of cash receipts and payments and such other supplementary information in accordance with the requirements of Treasurer's Instructions.
INVESTMENT OF FUNDS	Moneys standing to the credit of the Account may be invested in accordance with section 38 of the Financial Administration and Audit Act.

I have examined and agree  
to the provisions of this Trust Statement.

Approved

D R Kelly

P J Farrell

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DIRECTOR GENERAL OF MINES

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ASSISTANT UNDER TREASURER

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DATE 27.6.87

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DATE 30.6.87



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## Surveys of Leases under Mining Act Account

NAME	An account called Surveys of Leases under Mining Act Account shall be maintained as a Private Trust Account at the Treasury.
PURPOSE	To hold survey fees paid by applicants on mining tenements pending determination of title.
RECEIPTS	Such moneys as are received by the Department of Mines being survey fees in respect to mining tenement applications pursuant to the Mining Act shall be paid into and placed to the credit of the Account.
PAYMENTS	The funds in the Account shall be paid to the: (i) Applicant when the application for a mining lease is refused, or is not proceeded with, or the lease is surrendered or forfeited or expires before the survey is carried out; or (ii) Consolidated Revenue Fund when the land subject to a mining lease has been surveyed.
ADMINISTRATION OF ACCOUNT	The Account shall be administered by the Director General of Mines, Department of Mines in accordance with: (i) the Mining Act; and (ii) the Financial Administration and Audit Act, Financial Administration Regulations and the Treasurer's Instructions.
ACCOUNTING RECORDS	There shall be maintained by the Director General of Mines a detailed record of transactions processed through the Account, together with such other accounting records and procedures as are prescribed in the accounting manual.
FINANCIAL STATEMENT	The Director General of Mines shall cause to be prepared a statement of cash receipts and payments and such other supplementary information in accordance with the requirements of Treasurer's Instructions.
INVESTMENT OF FUNDS	Moneys standing to the credit of the Account may be invested in accordance with sections 38 and 40(a) of the Financial Administration and Audit Act.

I have examined and agree  
to the provisions of this Trust Statement.

Approved

D R Kelly

P J Farrell

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DIRECTOR GENERAL OF MINES

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ASSISTANT UNDER TREASURER

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DATE 5.8.87

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DATE 22.8.87

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## Barrow Island Royalty Trust Account

NAME	An account called the Barrow Island Royalty Trust Account shall be maintained as a Governmental Operating and Trust Account at Treasury.
PURPOSE	To hold such moneys as are received by the Department of Mines in accordance with section 5 of the Barrow Island Royalty Trust Account Act.
RECEIPTS	Such moneys as are received by the Department of Mines in accordance with section 5 of the Barrow Island Royalty Trust Account Act, being: (i) every royalty payment, as defined by the Act, received by the State; and (ii) an amount (a) paid to the State by the Commonwealth to meet the Commonwealth share of a refundable amount; or (b) paid from the Consolidated Revenue Fund to meet the State share of the refundable amount  shall be paid into and placed to the credit of the Account.
PAYMENTS	The funds in the Account shall be applied in accordance with section 6 of the Barrow Island Royalty Trust Account Act.
ADMINISTRATION OF ACCOUNT	The Account shall be administered by the Director General of Mines, Department of Mines in accordance with: (i) the Barrow Island Royalty Trust Account Act; and (ii) the Financial Administration and Audit Act, Financial Administration Regulations and the Treasurer's Instructions.
ACCOUNTING RECORDS	There shall be maintained by the Director General of Mines a detailed record of transactions processed through the Account, together with such other accounting records and procedures as are prescribed in the accounting manual.
FINANCIAL STATEMENT	The Director General of Mines shall cause to be prepared a statement of cash receipts and payments and such other supplementary information in accordance with the requirements of Treasurer's Instructions.
INVESTMENT OF FUNDS	Moneys standing to the credit of the Account may be invested in accordance with section 38 of the Financial Administration and Audit Act.

I have examined and agree to the provisions of this Trust Statement.

Approved

D R Kelly

P J Farrell

\_\_\_\_\_  
DIRECTOR GENERAL OF MINES

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ASSISTANT UNDER TREASURER

DATE 26.6.87

DATE 30.6.87

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## Deposits — Mines Department Account

NAME	An account called Deposits — Mines Department Account shall be maintained as a Private Trust Account at the Treasury.
PURPOSE	To hold moneys received in respect to a permit, licence or security pursuant to the: (i) Petroleum (Submerged Lands) Act; (ii) Petroleum Act; (iii) Petroleum Pipelines Act; and (iv) Petroleum Pipelines Regulations pending determination by the Minister.
RECEIPTS	Such moneys as are received by the Department of Mines being moneys received as a: (i) fee for a permit or licence in accordance with the: (a) Petroleum (Submerged Lands) Act; (b) Petroleum Act; (c) Petroleum Pipelines Act; (d) Petroleum Pipelines Regulations; and (ii) deposit for security pursuant to the: (a) Petroleum (Submerged Lands) Act; (b) Petroleum Act; (c) Petroleum Pipelines Act; (d) Petroleum Pipelines Regulations; and shall be paid into and placed to the credit of the Account.
PAYMENTS	The funds in the Account shall be applied to the Applicant or the Consolidated Revenue Fund in accordance with the: (i) Petroleum (Submerged Lands) Act; (ii) Petroleum Act; (iii) Petroleum Pipelines Act; and (iv) Petroleum Pipelines Regulations; and (v) Financial Administration and Audit Act, Financial Administration Regulations and the Treasurer's Instructions.
ACCOUNTING RECORDS	There shall be maintained by the Director General of Mines a detailed record of transactions processed through the Account, together with such other accounting records and procedures as are prescribed in the accounting manual.
FINANCIAL STATEMENT	The Director General of Mines shall cause to be prepared a statement of cash receipts and payments and such other supplementary information in accordance with the requirements of Treasurer's Instructions.
INVESTMENT OF FUNDS	Moneys standing to the credit of the Account may be invested in accordance with sections 38 and 40(a) of the Financial Administration and Audit Act.

I have examined and agree  
to the provisions of this Trust Statement.

D R Kelly

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DIRECTOR GENERAL OF MINES

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DATE 26.8.87

Approved

P J Farrell

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ASSISTANT UNDER TREASURER

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DATE 30.6.87

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### Departmental Receipts in Suspense — Mines

NAME	An account called Departmental Receipts in Suspense — Mines shall be maintained as a Suspense Account at the Treasury.
PURPOSE	To hold funds pending identification of the purpose for which those moneys were received pursuant to section 9(2)(c)(iv) of the Financial Administration and Audit Act.
RECEIPTS	Such moneys as are received by the Mines Department being amounts held pending identification of the purposes for which those moneys were received shall be paid into and placed to the credit of the Account.
PAYMENTS	The funds in the Account shall be cleared by: (i) refunding the remittance to the payer; (ii) transferring the funds to the correct account; (iii) payment to another department or statutory authority; or (iv) transferring the funds to the Sundry Creditors Account at Treasury.
ADMINISTRATION OF ACCOUNT	The Account shall be administered by the Director General of Mines in accordance with the Financial Administration and Audit Act, Financial Administration Regulations and the Treasurer's Instructions.
ACCOUNTING RECORDS	There shall be maintained by the Director General of Mines a detailed record of transactions processed through the Account, together with such other accounting records and procedures as are prescribed in the accounting manual.
FINANCIAL STATEMENT	The Director General of Mines shall cause to be prepared such financial statements, together with supplementary information, as are required to be prepared in respect of prescribed suspense accounts in accordance with the provisions of the Financial Administration and Audit Act and Treasurer's Instructions.
INVESTMENT OF FUNDS	Account may be invested in accordance with sections 38 and 40(a) of the Financial Administration and Audit Act.

I have examined and agree  
to the provisions of this Trust Statement.

Approved

D R Kelly

P J Farrell

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DIRECTOR GENERAL OF MINES

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ASSISTANT UNDER TREASURER

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DATE 26.6.87

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DATE 30.6.87

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**Suspended Postings**

**NAME** An account called Suspended Postings shall be maintained as a Suspense Account at the Treasury.

**PURPOSE** To hold the Department of Mines' rejected credit postings pending identification and subsequent posting to the correct account or the creation of the required account.

**RECEIPTS** Such credit amounts as are rejected by the Government Accounting System due to incorrect posting account details shall be credited to the Account.

**PAYMENTS** The funds standing to the credit of the Account shall be cleared by journal transfer to the appropriate account prior to the end of each month.

**ADMINISTRATION OF ACCOUNT** The Account shall be administered by the Director General of Mines, Department of Mines in accordance with the Financial Administration and Audit Act, Financial Administration Regulations and the Treasurer's Instructions.

**ACCOUNTING RECORDS** There shall be maintained by the Director General of Mines a detailed record of transactions processed through the Account, together with such other accounting records and procedures as are prescribed in the accounting manual.

**INVESTMENT OF FUNDS** Moneys standing to the credit of the Account may be invested in accordance with sections 38 and 40(a) of the Financial Administration and Audit Act.

I have examined and agree  
to the provisions of this Trust Statement.

Approved

D R Kelly

P J Farrell

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DIRECTOR GENERAL OF MINES

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ASSISTANT UNDER TREASURER

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DATE 26.6.87

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DATE 30.6.87

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## ACCOUNTS OF THE TRUST FUND

### Kalgoorlie Metallurgical Laboratory Account

The account was created to hold the equivalent amount of revenue collected by the Laboratory to offset operational costs. This practice ceased some years ago, the account has a zero balance and the operations are funded by consolidated revenue as part of the Government Chemical Laboratories vote.

### Mining Development Account

The account is maintained to hold moneys received from saleable items initially purchased from the General Loan Fund and Capital Works Fund. The balance of this account is transferred to Loan Repayments. There was no money received during 1986/87.

### Survey of Leases under Mining Act account

Survey fees collected under the Mining Act are paid into this account. The cost of surveys is charged to the Consolidated Revenue Fund. Fees applicable to completed surveys are transferred from the suspense account to Departmental revenue, and where appropriate refunds are made to depositors.

	1985/86 \$	1986/87 \$
Balance July 1	2 036 570 CR	2 031 464 CR
Receipts	562 170	930 597
Payments	567 276	538 503
Balance June 30	<u>2 031 464 CR</u>	<u>2 423 558 CR</u>

### Barrow Island Royalty Trust Account

The account was created in 1985/86 under the Barrow Island Royalty Trust Account Act 1985 which provides that royalty payments received by the State under the Barrow Island lease shall be credited to the account and subsequently apportioned between the Commonwealth and the State.

	1985/86 \$	1986/87 \$
Balance July 1	—	—
Receipts	90 800 000	79 344 166
Payments/Transfers	<u>90 800 000</u>	<u>79 344 166</u>
Balance June 30	<u>—</u>	<u>—</u>

### Deposits — Mines Department Account

Funds held in this account comprise amounts received for the issue of temporary reserves and exploratory permits pending finalisation of certain legal requirements.

Refunds of deposits and transfers to the Consolidated Revenue Fund following finalisation of outstanding requirements during the year reduced the amounts held to \$289,420 at June 30, 1987.

	1985/86 \$	1986/87 \$
Balance July 1	593 142 CR	337 647 CR
Receipts	4 511 591	263 382
Payments	<u>4 767 086</u>	<u>311 609</u>
Balance June 30	<u>337 647 CR</u>	<u>289 420 CR</u>

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### Loans for Development of Mining

Interest and principal repayments during the year on loans provided from the Consolidated Revenue Fund amounted to \$1,967 and \$26,613 respectively compared to \$2,442 and \$14,547 for the previous year. Interest charges raised during the year totalled \$1,016 (\$1,874) and the outstanding liability at June 30, 1987 was \$4,738 (\$31,351) for principal and \$244 (\$1,195) for interest.

Prospecting Assistance — The scheme provided for assistance to prospectors and for the recovery of advances from the proceeds of gold won from mining activities. There were no transactions during the year. The outstanding balances at June 30, 1987 remained at \$30,034 and \$3,043 from the General Loan Fund and the Consolidated Revenue Fund respectively.

### Departmental Receipts in Suspense — Mines

The account is maintained to hold moneys temporarily pending identification of the purpose for which the funds were received.

	1985/86	1986/87
	\$	\$
Balance July 1	916 CR	2 249 CR
Receipts	1 440 119	1 807 999
Payments/Transfers	<u>1 438 786</u>	<u>1 803 924</u>
Balance June 30	<u>2 249 CR</u>	<u>6 324 CR</u>

### Suspended Postings

This account is maintained to hold rejected credit postings pending identification of and subsequent posting to the correct account or the creation of the required account.

### TREASURER'S ADVANCE

#### Drilling

Recoverable drilling expenditure is charged, in the first instance, to an account Drilling under the appropriation Advance to Treasurer. The cost of work performed, together with overhead charges in certain instances where Departmental equipment is used, are recovered and credited to this account.

	1985/86	1986/87
	\$	\$
Balance July 1	114 310 CR	115 727 CR
Credits	4 498 557	5 204 161
Debits	<u>4 497 140</u>	<u>5 461 256</u>
Balance June 30	<u>115 727 CR</u>	<u>141 368 DR</u>

**STATE BATTERIES  
REVENUE AND EXPENDITURE STATEMENT  
CONSOLIDATED REVENUE FUND**

	Note	1985/86	July 1, 1986 — February 28, 1987		
		Actual \$	Estimate \$	Actual \$	Variance \$
<b>REVENUE</b>					
	24				
Milling		337 192	52 000	208 896	156 896
Cyaniding		1 314 806	297 000	829 345	532 345
		1 651 998	349 000	1 038 241	689 241
<b>EXPENDITURE</b>					
	24				
Salaries		111 332	40 000	59 882	19 882
Other Staffing Costs		168 153	120 000	174 533	54 533
Communications		23 883	9 000	19 928	10 928
Services & Contracts		42 859	16 000	31 468	15 468
Consumable Supplies		4 025	2 000	3 820	1 820
Maintenance Plant, Equipment etc.		1 141	1 000	1 165	165
Purchase Plant, Equipment etc.		4 431	2 000	429	(1 571)
Milling & Tailings Treatment		3 386 812	1 267 000	2 559 143	1 292 143
Grants, Subsidies, Transfers, etc.				525 000	525 000
		3 742 636	1 457 000	3 375 368	1 918 368

**STATE BATTERIES  
EXPENDITURE STATEMENT  
GENERAL LOAN AND CAPITAL WORKS FUND**

	Note	1985/86	1986/87		
		Actual \$	Estimate \$	Actual \$	Variance \$
Noise Abatement Modifications		91 633	47 000	41 757	(5 243)
Mobile Carbon-in-Pulp Plant		162 030	87 000	86 859	(141)
		253 663	134 000	128 616	(5 384)



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## TRUST STATEMENTS

### Purchase of Tailings Account

NAME	An account called Purchase of Tailings Account shall be maintained as a Governmental Operating and Trust Account at the Treasury.
PURPOSE	To hold moneys to meet payments to prospectors for their tailings assaying over the rate per tonne prescribed by the State Battery Regulations.
RECEIPTS	Such moneys as are received by the Department of Mines being proceeds from the sale of gold tailings on behalf of prospectors shall be paid into and placed to the credit of the Account.
PAYMENTS	The funds in the Account shall be applied to prospectors whose tailings qualify for purchasing.
ADMINISTRATION OF ACCOUNT	The Account shall be administered by the Director General of Mines, Department of Mines in accordance with: (i) the State Batteries Regulations; and (ii) the Financial Administration and Audit Act, Financial Administration Regulations and the Treasurer's Instructions.
ACCOUNTING	There shall be maintained by the Director General of Mines a detailed record of transactions processed through the Account, together with such other accounting records and procedures as are prescribed in the accounting manual.
FINANCIAL STATEMENT	The Director General of Mines shall cause to be prepared a statement of cash receipts and payments and such other supplementary information in accordance with the requirements of Treasurer's Instructions.
INVESTMENT OF FUNDS	Moneys standing to the credit of the Account may be invested in accordance with sections 38 and 40(a) of the Financial Administration and Audit Act.

I have examined and agree to the provisions of this Trust Statement.

Approved

D R Kelly

P J Farrell

\_\_\_\_\_  
DIRECTOR GENERAL OF MINES

\_\_\_\_\_  
ASSISTANT UNDER TREASURER

DATE 26.6.87

DATE 30.6.87

## ACCOUNTS OF THE TRUST FUND

### Purchase of Tailings Account

Funds totalling \$96,000 have been transferred in previous years from the General Loan Fund to this account to finance transactions associated with the purchase of tailings at State Batteries.

With the transfer of State Batteries operations to the Western Australian Development Corporation/Perth Mint, the account is no longer required and consequently the advance has been repaid.

	1985/86	1986/87
	\$	\$
Balance July 1	49 205 CR	53 670 CR
Receipts	17 248	19 051
Payments	12 782	72 721
	<u>53 670 CR</u>	<u>—</u>

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## SUPPLEMENTARY FINANCIAL INFORMATION

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The following information is supplied in addition to the Financial Statements.

(i) Write offs

Public and other property and revenues and debts due to the State written off during the financial year by:—

(a) Accountable Officer	\$ 1 262	
(b) Minister	<u>803</u>	\$ 2 065

(ii) Losses through thefts, defaults etc.

(a) Recoveries of losses	\$11 468	
(b) Losses unrecouped	<u>\$ 2 179</u>	\$13 647

(iii) Expenditure claims unpaid

(Accounts on hand as at 30.6.87)		\$251 402
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# NOTES TO AND FORMING PART OF THE FINANCIAL STATEMENTS FOR THE YEAR ENDED JUNE 30, 1987

## 1. Accounting Policy

- (a) The Department prepares accounting and reporting requirements on a cash basis in accordance with Treasury requirements.
- (b) The financial statements included in this report have been prepared in accordance with the requirements of the Financial Administration and Audit Act, 1985.
- (c) All expenditures incurred by the Department of Mines and the State Batteries in the provision of services are not appropriated to these organisations. The employer's share of superannuation pensions is met by Treasury. Rental of office accommodation is met by the Office of Government Accommodation. Maintenance of government buildings is met by the Building Management Authority. The servicing of the Department's General Loan and Capital Works Fund debt is met by Treasury.
- (d) Property disposals are effected through the State Tender Board and proceeds credited to Revenue Government Property Sales. Exceptions are:—
  - (i) when the original acquisition was met from General Loan and Capital Works Fund the proceeds are credited to Loan Repayments;
  - (ii) proceeds received from the disposal of Departmental vehicles are credited to general departmental revenue.

## 2. Salaries Wages and Allowances

The underspending in 1986/87 of \$643,016 is a consequence of Government's freeze on the advertising of vacant staff positions and a 3% reduction in the F.T.E. base (23).

## 3. Other Staffing Costs

State Government Departments are not liable for payroll tax after 1985/86. Payroll tax expenditure in 1985/86 amounted to \$887,169.

## 4. Grants, Subsidies and Transfer Payments

Expenditure in 1986/87 includes a contribution of \$95,000 to the CSIRO towards the cost of an electron microprobe.

## 5. Mines Engineering

Prior to 1986/87, expenditures associated with motor vehicle purchases were met by Treasury. In 1986/87 these expenditures were met by the Department. The cost associated with this Division of the Department was \$260,983.

## 6. Petroleum — Administration and Engineering

\$14,750 was expended on a statutory royalty audit of the North West Shelf Gas Project in 1986/87.

## 7. Registration of Mining Titles

	1985/86	1986/87
	\$	\$
Refunds of Revenue		
• Mining Tenements	733 576	912 133
• Alteration in Petroleum Royalty Methodology *	1 831 754	5 173 128
Divisional Operating Expenses	206 859	238 000
	2 772 189	6 323 261

\*Under a revised royalty agreement between the Commonwealth and State Governments, excess royalties collected in previous years were refunded.

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## 8. Surveys and Mapping

	1985/86	1986/87
	\$	\$
Contract Survey Payments	686 000	674 730
Divisional Operating Expenses	197 986	216 099
Microfilm Camera		34 000
	<u>883 986</u>	<u>924 829</u>

## 9. Chemical Laboratories

Additional expenditure in 1986/87 due to increased cost and demand for chemical analysis.

## 10. Geological Surveys

Prior to 1986/87, expenditure associated with motor vehicle purchases were met by Treasury. In 1986/87 these expenditures were met by the Department. The cost associated with this Division of the Department was \$193,656.

## 11. Special Projects

Expenditure associated with land resource projects:

- (i) Bauxite Related Research
- (ii) Land Salinisation Research

## 12. Iron Ore (Goldsworthy-Nimingara) Agreement Act — Contribution to State Development Fund

Costs associated with the construction of a water pipeline extension and associated works from South Hedland to Finucane Island payable to the State Development Fund to help finance the infrastructure. The variance is a result of a Cabinet decision to apply additional royalty to the De Grey Water Scheme.

## 13. Argyle Social Impact Group

One Calendar year's (1987) indexed contributions to the Group was made in 1986/87 compared to two calendar year payments (1985,1986) in 1985/86.

This Group is a joint Government and Argyle Diamond Mine Ltd exercise established in 1984 to fund the development of Aboriginal social infrastructure in the East Kimberley region for a period of five years.

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#### 14. Royalties Revenue

Increased royalty collections of \$1,981,868 in 1986/87 compared to budget were due to reduced demand for iron ore, fluctuation in world prices for petroleum and nickel and increased sales of diamonds. In addition the petroleum royalties estimate was a net figure after allowing for a refund of royalties to WAPET. The actual accounting arrangements for this transaction realised an appropriation of the royalty refund to the expenditure vote.

The reduction of \$6,699,799 in royalty receipts between 1985/86 and 1986/87 is also due to fluctuations in world demand and prices.

#### 15. Lease and Other Rentals

	1985/86	1986/87
	\$	\$
Iron Ore Additional	12 364 626	11 059 968
Lease & Other Rentals	10 460 154	15 457 526
Petroleum Permits	5 581 660	506 794
	<u>28 406 440</u>	<u>27 024 288</u>

1985/86 Petroleum Permits collections includes \$4.03 million registration fee for the sale of the interest of production licence on the North West Shelf project.

#### 16. Mines

	1985/86	1986/87
	\$	\$
Administration	1 522 659	929 175
Registration	1 461 317	2 170 706
Surveys & Mapping	98 403	184 235
Geological Survey	187 924	291 130
Mines Engineering	8 474	7 046
Petroleum Engineering	92	17 954
	<u>3 278 869</u>	<u>3 600 246</u>

N.B.

- Registration includes mining tenement application fees.
- Surveys & Mapping and Geological Survey include sale of maps and publications.

#### 17. Water Resources Program

The last contribution by the Commonwealth towards an underground water assessment program was in 1985/86 (\$590,000).

#### 18. Baldvis — Relocation of Explosives Reserve

The overspending of \$5,952 is a result of interest rate variations.

#### 19. Chemical Laboratories Equipment

The underspending of \$68,669 is a result of delays associated with the purchase of overseas equipment. The estimated total cost of the project remains the same.

#### 20. Geological Survey — Laboratory Relocation

The underspending of \$124,653 is due to a delay in the completion of the Laboratory to July 1987; the cashflows have been correspondingly delayed.

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## **21. Mainframe Computer**

The overspending of \$20,028 is due to fluctuations in the valuation of the Australian dollar against the United States dollar, the supplier's currency.

## **22. Mainframe Printer**

Approval was granted by Treasury to include this project in the 1986/87 Capital Works Program. The variation of \$43,380 is a result of there being no initial budget allocation.

## **23. Building Management Authority**

The underspending on General Loan and Capital Works Funded projects of \$1,978,222 administered by the Building Management Authority can mainly be attributed to Mineral House Stage II where \$1,911,908 was underspent due to weather delays and industrial problems.

## **24. State Batteries — Consolidated Revenue Fund**

Estimates were based on operations being transferred to the Western Australian Development Corporation/Perth Mint from 1 October 1986. Transfer did not occur until 1 March 1987 and accordingly actual revenue and expenditure reflect this delay. In addition a subsidy of \$525,000 was paid to Westmill (formerly State Batteries) to assist them in meeting costs for a three month transitional period from the date of transfer.

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# CERTIFICATION OF FINANCIAL STATEMENTS

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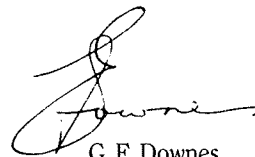
"We hereby certify that the accompanying financial statements of: (i) the Department of Mines and (ii) State Batteries, are based on proper accounts and records and have been prepared in accordance with the Financial Administration and Audit Act 1985.

In our opinion the financial statements present fairly the financial transactions for the year ended June 30, 1987 and the state of affairs of the Department of Mines and State Batteries as at June 30, 1987.

At the date of signing we are aware of no circumstances which would render any particulars included in the financial statements misleading or inaccurate."



D R Kelly  
ACCOUNTABLE OFFICER



G F Downes  
PRINCIPAL ACCOUNTING OFFICER

August 14, 1987

# PERFORMANCE INDICATORS

The use of performance measurement has come into prominence in public sector management because of the need to operate in an environment of budgetary restraint and staff ceilings.

A major challenge facing the Department is to continue to provide high service standards and maintain professional capacity and skills while financial resources are constrained.

Performance indicators are part of a package of new management techniques being implemented to supplement traditional management styles.

The Department is at an early stage in its application and development of performance measurement and, as a part of its corporate planning process, will continue to refine and identify relevant performance indicators.

The following information provides an indication of the Department's performance in 1986/87 in relation to its corporate objectives.

## BROAD OBJECTIVE 1

*To ensure that exploration and development of the State's mineral and petroleum resources are carried out in an orderly and responsible manner, that is fair and equitable to all concerned.*

### Mining Tenements

- Tenement Applications Received

Application type	1984/85	1985/86	1986/87
Prospecting Licences	2 968	4 636	7 045
Exploration Licences	462	1 075	1 927
Mining Leases	505	676	1 089
Miscellaneous Licences	137	117	158
General Purpose Leases	31	30	97
	4 103	6 534	10 316

- Tenements Applied For Area of Tenements Applied For

1982	2 968	10 874 612
1983	13 434	23 432 921
1984	5 859	12 998 200
1984/5	8 034 (18 mths)	16 423 582
1985/6	6 534	15 896 497
1986/7	10 316	24 050 069

- Tenement Applications Finalized

(Percentage of applications under Mining Act 1978 received since 1.1.82)

1984/85	82.75%
1985/86	87.05%
1986/87	89.00%

- Mining Tenements in Force

	1978 Mining Act			1904 Mining Act
	Prospecting Licences	Exploration Licences	Mining Leases & Others	Mineral Claims & Others
As at 30.06.86	10 286	1 259	4 503	1 364
As at 30.06.87	12 976	1 750	4 691	887



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- Total Area of Mining Tenements in Force

As at	Area (hectares)
31.12.82	12 756 046
31.12.83	10 505 270
31.12.84	17 308 525
30.06.85	18 414 443
30.06.86	17 496 124
30.06.87	22 232 171

- Tenements Added to Public Plans

1985/86	6 285
1986/87	9 848

- Surveys of Tenements

	1985/86	1986/87
Surveys completed	461	583
Average size of surveyed tenements (hectares)	194	134
Survey diagrams processed for acceptance	2 036	1 327

- Applications for Prospecting Licence Extensions

1984/85	1 133
1985/86	3 483
1986/87	2 039

- No of Dealings Received

1985/86	16 086
1986/87	17 392

- Tenement Surveillance — Reporting & Forfeitures

	1985/86	1986/87
Reports on Operations Received	13 120	13 790
Applications for exemption from labour and expenditure commitments	1 936	1 737
Notices of Intention to Forfeit issued	4 216	2 004
Tenements forfeited	571	467

## Petroleum Tenements

- Exploration Permit Dealings

	1985/86		1986/87	
	No	Area (km <sup>2</sup> )	No	Area (km <sup>2</sup> )
<b>AREA ADVERTISED</b>				
Onshore	2	6 685	4	26 210
Offshore	6	15 577	7	5 913
Totals	8	22 262	11	32 113
<b>PERMITS GRANTED</b>				
Onshore	6	37 202	3	13 790
Offshore	3	33 153	5	8 804
Totals	9	70 355	8	22 594
<b>PERMITS HELD</b>				
Onshore	56	471 218	48	332 638
Offshore	32	284 893	28	108 919
Totals	88	756 111	76	441 557

## Royalty Receipts

1984/85	\$130 994 275
1985/86	\$162 981 659
1986/87	\$156 281 868

## BROAD OBJECTIVE 2

*To provide a scientific and technical information base which fosters mineral and petroleum exploration and aids long-range planning and decision-making by Government.*

- Petrological Examinations

	1985/86	1986/87
Reports completed	53	39
Samples determined	1 728	937

- Palaeontological Reports

Compiled and issued	19	36
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- Library

Members of public using library	3 426	4 068
No. who used microfilm reader/ printer facilities	858	1 114

- Mineral & Petroleum Exploration Reports

Petroleum exploration reports received	N/A	320
Mineral exploration reports received	2 059	2 888

• Exploration Information Made Available to Public	1985/86	1985/86
Petroleum exploration (reports)	N/A	86
Minerals exploration (volumes)	927	1 908
• Groundwater and Stratigraphic Evaluation		
Metres drilled	8 024	9 161
• Geological Maps		
Major colour maps produced	15	12
• Petroleum Exploration		
Exploration wells drilled	29	16
Metres drilled	79 286	28 357
Line Kilometres of Seismic Surveys	40 623	17 506
• Chemical Consultancy Service provided by Government Chemical Laboratories		
Client	Number of Samples	
	1985/86	1986/87
Government Departments and Agencies	82 313	81 581
Public	8 161	9 200
Total	90 474	90 781
	Number of Samples	
Laboratory	1985/86	1986/87
Agricultural Chemistry	51 386	49 349
Engineering Chemistry	186	475
Food & Industrial Hygiene	5 692	5 203
Forensic Science	9 669	9 674
Kalgoorlie Metallurgical	3 527	5 043
Materials Science	490	450
Mineral Science	4 160	5 801
Water Science	15 364	14 786
Total	90 474	90 781

### BROAD OBJECTIVE 3

*To ensure that all operations in the mining and petroleum industries and activities involving explosives and dangerous goods are conducted in a manner that is safe for workers and the public in general; and to ensure that proper attention is given to rehabilitation and protection of the environment.*

• Field Inspections — Petroleum	1985/86	1986/87
Offshore drilling inspections	3	4
Onshore drilling inspections	7	8
Offshore production inspections	16	20
Onshore production inspections	16	8
Overseas inspections of offshore drilling units	4	4
Total	46	44

• Accidents — Petroleum, Exploration, Production and Pipeline Industries

	1985/86			1986/87		
	Onshore	Offshore	Total	Onshore	Offshore	Total
<b>MAGNITUDE OF INJURY</b>						
Minor	26	27	53	20	59	79
Serious	22	17	39	5	12	17
Fatal	—	—	—	—	—	—
<b>TIME FACTOR</b>						
Man hours lost	11 424	18 998	30 422	3 848	4 765	8 613
<b>FREQUENCY RATE</b>	67.43	58.32	60.47	47.17	20.38	23.92

• Explosives and Dangerous Goods

	1985/86	1986/87
Explosives Licences and Permits	3 022	3 438
Premises licensed to store flammable liquids	4 453	4 248
Vehicles licensed to convey dangerous goods in bulk	1 130	1 155
Dangerous goods driver licences	1 480	953

**BROAD OBJECTIVE 4**

*To create and maintain a favourable climate for mineral and petroleum exploration and development.*

The Department continued to promote the mining and petroleum industries and during the year three industry liaison committees were established:

**Mining Industry Liaison Committee**

- Representatives — Department of Mines
- Chamber of Mines
- Association of Mining and Exploration Companies
- Australian Mining and Petroleum Law Association Limited
- Amalgamated Prospectors and Leaseholders Association

**Petroleum Industry Liaison Committee**

- Representatives — Department of Mines
- Australian Petroleum Exploration Association
- Australian Mining and Petroleum Law Association Limited

**Geological Survey Liaison Committee**

- Representatives — Geological Survey of Western Australia
- Chamber of Mines
- Association of Mining and Exploration Companies
- Australasian Institute of Mining and Metallurgy
- Australian Petroleum Exploration Association
- CSIRO
- Bureau of Mineral Resources
- University of Western Australia
- Curtin University
- WA School of Mines

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**CERTIFICATION OF PERFORMANCE INDICATORS**

"I hereby certify that these performance indicators are based on proper records and fairly represent the performance of the Department of Mines for the year ending June 30, 1987.



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D R Kelly  
Accountable Officer

August 14, 1987

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# AUDITOR GENERAL'S OPINION

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office of the  
AUDITOR GENERAL

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REPORT OF THE AUDITOR GENERAL FOR WESTERN AUSTRALIA

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## MINES DEPARTMENT

The accounts of the Mines Department have been audited for the period July 1, 1986 to June 30, 1987 and the State Batteries for the period July 1, 1986 to February 28, 1987 under the provisions of the Financial Administration and Audit Act 1985 and found to be in order.

Statistics advanced as performance indicators provide details of aspects of the operations of the mining industry and the Department. Records are not yet maintained in a manner which permits verification of those statistics.

In my opinion

- (i) the financial statements are based on proper accounts and records and have been properly drawn up so as to present fairly the transactions for the period ; and
- (ii) the controls exercised by the Director General of Mines were sufficiently adequate to provide reasonable assurance that the receipt and expenditure of moneys and the acquisition and disposal of property and the incurring of liabilities have been in accordance with legislative provisions.

A handwritten signature in black ink, appearing to read 'N.E. Smith'.

ACTING AUDITOR GENERAL

October 9, 1987

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# APPENDICES

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## LEGISLATION

The Department is responsible to the Minister for Minerals and Energy for the administration of eighteen Acts of Parliament.

### Principal Acts

Mining Act  
Petroleum Act

### Other Acts

Mining Development Act  
Mining on Private Property Act  
Mines Regulation Act  
Coal Mines Regulation Act  
Petroleum Pipelines Act  
Petroleum (Registration Fees) Act  
Petroleum (Submerged Lands) Act  
Petroleum (Submerged Lands) Registration Fees Act  
Explosives and Dangerous Goods Act  
Coal Mine Workers (Pensions) Act  
Coal Mining Industry Long Service Leave Act  
Coal Miners' Welfare Act  
Western Australian Coal Industry Tribunal Act  
Miners' Pthisis Act  
Mine Workers' Relief Act  
Mining and Petroleum Research Act

The following Commonwealth legislation is administered in the Western Australian adjacent area by the State and through the Commonwealth/Western Australian Offshore Petroleum Joint Authorities:

Commonwealth Petroleum (Submerged Lands) Act  
Commonwealth Petroleum (Submerged Lands) Registration Fees Act  
Commonwealth Petroleum (Submerged Lands)(Royalty) Act  
Commonwealth Petroleum (Submerged Lands)(Retention Lease Fees) Act  
Commonwealth Petroleum (Submerged Lands)(Exploration Permit Fees) Act  
Commonwealth Petroleum (Submerged Lands)(Production Licence Fees) Act  
Commonwealth Petroleum (Submerged Lands)(Pipeline Licence Fees) Act

In addition to its responsibilities under the abovementioned acts, the Department performs functions in relation to a number of special agreement acts.

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## Changes to Legislation

### (a) Mining Amendment Act 1986 (No 105 of 1986) effective from 9 January 1987

#### 1. Section 24

Previously Ministerial consent was needed to mark out Class "A" Reserves and National Parks in the South West Land Division and Esperance and Ravensthorpe municipal districts.

The amendment to this section extends the requirement for consent to mark out to include all National Parks and Class "A" Nature and Flora and Fauna Reserves throughout the State.

#### 2. New Division added —

Division 8 (Part IV) — Registration of documents affecting tenements

This addition to the Act was necessary to clarify the apparent anomaly between time of lodgement of a dealing and when that dealing was considered registered.

- (i) Section 103A(1) provides that time and date of registration of a dealing is the time and date of lodgement.
- (ii) Section 103A(2) validates pending applications affected by surrenders and any granted tenements that may have been similarly affected.

#### 3. Section 96

Application for forfeiture (expenditure conditions) of Prospecting Licences must be made within eight months of the expenditure year — this brings it into line with Section 98(2) as it relates to mining leases, exploration licences and general purpose leases.

#### 4. Section 8

The definition of "Crown Land" has been extended to include any Crown land leased for the use and benefit of Aboriginal inhabitants. The Department of Land Administration will be issuing this type of lease. Therefore this amendment was necessary to exclude this type of lease from the private property provisions. These leases will be treated in the same way as existing pastoral leases.

#### 5. Sections 133, 155 and 158

Sections 155 and 158 have been amended to strengthen the Act in respect to "unlawful mining". Specific powers have been given for police and authorised personnel to enforce the cessation of suspected illegal mining.

Penalties have been provided for any breach, and the court may order rehabilitation of the land with the cost being borne by the offender. The new Section 133 clarifies the jurisdiction of the Warden in dealing with these offences.

### (b) Mining (Transitional Provisions)(Anomalies Prevention) Order 1987

Clause 2A deleted and Clause 13A added

The intent of Clause 2A was to allow consents given by private land owners to the grant of 1904 Mining Act mining tenements to carry over to substitute new Act tenements.

However, a subsequent Supreme Court ruling cast doubt on its validity, so Clause 13 was introduced on May 15, 1987 by way of Anomaly Prevention Order, to re- enforce the original intent of the Transitional Provisions.

### (c) Mining Amendment Act 1987 (No 12 of 1987) effective from 26 June 1987

#### 1. Amendment to Section 65

Previously holders of Exploration Licences authorised to explore for iron could obtain exemption from the necessity to relinquish half of the licence area at the expiry of the 3rd and 4th years of the term of the licence.

This provision has now been extended to all exploration licence holders, in certain circumstances.



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**(d) Mining Amendment Act 1985 (No 100 of 1985)**

The majority of Amendment Act 100/85 was proclaimed on January 3, 1986, but some sections of the Amending Act were not proclaimed at that time.

Once certain amendments to the Mining Act Regulations become effective, the majority of the balance of 100/85 will be proclaimed. These include:

- (i) Any person will be able to apply for a general purpose lease or a miscellaneous licence — this is presently restricted to holders of certain tenements.
- (ii) The term of a miscellaneous licence will be 5 years, renewable.
- (iii) The holder of an exploration licence will be able to apply to the Minister to include within the licence boundaries a surrendered, expired or forfeited tenement (provided the tenement is wholly within the licence).

**(e) Explosives and Dangerous Goods Amendment Act 1986 (No 32 of 1986) effective from 28 August 1986**

The amending legislation provided an additional averment clause to Section 61 of the Act to enable proof given by an Inspector that a container was labelled as containing dangerous goods to be accepted by the Court as evidence that the contents of that container were in fact dangerous goods. This amendment thereby obviated the need for sampling the contents of a container (frequently under hazardous conditions) and the costly analysis and identification of these contents.

**Significant Judicial Decisions**

Navan Mining Pty Ltd v Aztec Exploration Ltd and Australian Ores and Minerals Ltd (Meekatharra Warden's Court, 23 July 1986).

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## RESEARCH AND DEVELOPMENT PROJECTS

### 1. Geological Survey of Western Australia

Most of the work of the Geological Survey is involved in research and development projects including investigation, interpretation and recording the geology of Western Australia, relating mineral, petroleum and groundwater occurrences and potential to that geology, and evaluation of the mineral, fossil fuel and groundwater resources in the State. For a full listing of current and proposed projects see "Record 1987/1, Summary of Progress of the Geological Survey of Western Australia during 1986 and Plans for 1987-1991" available from the Geological Survey.

### 2. Mining Engineering Division

Continuing

- CONTAM: Contaminant Sampling in the Mining Workplace (computerised)
- AXTAT: Accident Recording System (computerised)
- "Mixtures" TLV for Underground Nickel Mines
- Mica-Muscovite: To determine an overall standard in the iron ore industry.

### 3. Government Chemical Laboratories

Completed

- Lupins
- Doping control in horse racing
- Analysis of platinum group metals
- Gold processing
- New methods in cannabis analysis
- Estimation of firing distance from gunshot residue distribution patterns
- Discrimination of typewriter carbon film for use in forensic cases
- New methods for identification of accelerants in arson cases
- Methods for the determination of rare-earth elements in mineral ores
- Identification of taste/odour problems in WA drinking water
- Evaluation of coatings, sealants and related items suitable for use in potable water storage and transportation

Continuing

- Lupins
- Doping control in horse racing
- Analysis of platinum group metals and gold processing
- Molybdenum absorption characteristics of the acidic yellow earth soil of the eastern/north eastern wheatbelt
- Restoration of stonework on historical buildings
- Urea formaldehyde foam insulation study
- Rust converter testing
- Environmental investigation of lead and mercury levels in aquatic life and sediments in Princess Royal Harbour, Albany
- New methods of extracting acid drugs
- Comparison of heroin seizures using fluorescent impurities
- Pigment identification by infrared methods for forensic analysis
- Identification of different vehicle type rubber to assist in hit-run police investigations
- Mineral analysis of limestone for use in road construction
- Extensive development of new analytical chemical methods for ores mined in WA
- Phosphorus enrichment of Peel-Harvey estuary
- Trace metal analysis of WA water bodies
- Metal pollution studies of estuarine and harbour waters

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#### 4. Explosives and Dangerous Goods Division

The Explosives and Dangerous Goods Division participated in the following research and development projects.

##### Completed

- Report of the Technical Committee reviewing overall operating safety procedures of the North West Shelf Gas Project
- Proposal for the disposal by incineration of polychlorinated biphenyls (PCBs) in WA
- Proposed sodium cyanide plant, risk assessment report
- Kwinana regional strategy, cumulative risk assessment report
- Geraldton Port Authority, increase in port limits for the shipment of ammonium nitrate
- Bunbury Port Authority, increase in port limits for the shipment of ammonium nitrate
- Proposed sodium cyanide plant supporting document on the use of rail transport

##### Continuing

- Risk assessment for the handling of ammonium nitrate at Port of Bunbury
- Production plant for the manufacture of explosives at the Baldivis Explosives Reserve by Du Pont Australia Ltd
- Production plant for the manufacture of explosives at Kalgoorlie Explosives Reserve by CBS Ltd
- Production plant for the manufacture of explosives at Kalgoorlie Explosives Reserve by Nitro Nobel

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## PUBLICATIONS

### Geological Survey Division

- **Informative — technical**

Bulletins, Mineral Resources Bulletins, Reports, Records, Memoirs — are geoscientific publications describing the geology, mineral resources, groundwater occurrence of particular parts of the State.

Microfilm/fiche of released company reports on mineral and petroleum exploration are available for inspection or purchase.

- **Promotional**

Information pamphlets designed to assist the understanding by lay persons of rock and mineral occurrences.

- **Maps — technical**

1:250,000 geological series 163 for whole state coverage

1:50,000 urban geology/environmental series

1:2,500,000 state geological map

1:2,500,000 mineral occurrences map

### Mining Engineering Division

- **Informative**

List of Operating Mines in W.A.

List of Gold Producers in W.A.

Guidelines for Evaluation of Atmospheric Contaminants in the Mining Industry

- **Promotional**

Cyanide Seminars — 1986

Ventilation Officers Course — 1986

### Petroleum Division

- **Informative and Promotional**

Petroleum in Western Australia

Directions as to Drilling Operations

Directions as to Geological and Geophysical Surveys

### Government Chemical Laboratories

- **Informative**

#### Agricultural Chemistry

Eight publications about superphosphate and rock phosphate use on very sandy soils, lateritic soils and acid clay loams; testing of Darling Range damsite soils; the dispersive nature of WA wheatbelt soils; phosphorus application to soil relating to herbage yields; molybdenum retention in acidic soils; and study of soils from Fitzroy River.

Eight reports on plant analysis and research on antinutritional factors in sweet lupinseed.

#### Forensic Science

Five publications concerning petrol sniffing and deaths caused by drug abuse.

Three papers about toxicological aspects of cannabis; developments in automotive paint microanalysis; and experiences in relation to drugs/driving offences.

#### Mineral/Engineering Science

Four publications concerning a new copper mineral moolooite; gold processing; and rotary kiln simulation tests.

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### Water Science

One paper about taste and odour problems in drinking water the cause of which was iodoform (iodine equivalent of chloroform) produced by chloramination.

### Explosives and Dangerous Goods Division

- **Informative**

Notes for the Shotfirer

Guide to Flammable Liquids Regulations

Understanding the Dangerous Goods (Road Transport) Regulations

Summary of Accident Reports, (yearly)

80-90 Guideline Documents on various aspects of the Explosives, Flammable Liquids and Dangerous Goods (Road Transport Regulations

### Mining Registration Division

- **Informative**

#### Information Pamphlets

Basic Provisions

Miner's Rights

Marking Out and Applying for Mining Tenements

Private Land Provisions

Transitional Provisions

Guidelines on Reporting Requirements

Prospecting Licences — A Guide to Holders

Exploration Licences — Compulsory Partial Surrender

- **Promotional**

"TENDEX" — Computerised Mining Tenement Index System

### Surveys and Mapping Division

- **Informative and Maps**

#### Minerals Tenement Maps and Lists

Index to Public Plans

Departmental Public Plans

Maps showing Exploration Licences

Mining Act — Section 57(4) Areas

#### Petroleum Tenement Maps and List

Petroleum Tenement Map of the State

List of Petroleum Tenements

Petroleum Act Graticular Section Maps

Petroleum Tenement Maps

#### Thematic Maps

Map of Western Australia with Gazetteer

Areas which have been held under Gold Mining Lease

Historical Map — Wiluna to Kimberley Stock Route

Administrative Divisions

Mineral Productions

Gold in Western Australia

Map Sheet Index

Oil and Gas Exploration

Index to Special Agreement Acts

#### Plans of Mines

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## Royalties Branch

- Informative

Statistical Digest of Mineral Production (published twice yearly to cover calendar and financial years).

In addition two informal information sheets are produced:

Principal Gold Producers Reported for the year ended ..... (produced twice yearly for calendar and financial years).

Mineral Royalties (a summary of royalty arrangements in W.A.)

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## PROMOTIONAL, PUBLIC RELATIONS AND MARKETING ACTIVITIES

- The Department participated in a joint Resources and Energy in Western Australia display with the State Energy Commission, Department of Resources Development, Chamber of Mines and Woodside Petroleum at the Perth America's Cup International Exposition (PACIEXPO) held at Fremantle from 21 — 30 November 1986.
- The Department conducted a display at the Royal Agricultural Society Show, 27 September — 4 October 1986, relating to the support provided by the Department to the mining industry.
- Other displays included presentations as part of Library Week 1986, Map Week 1986 and participation in the Great Gold Exhibition at the Carousel Shopping Centre.
- The Geological Survey Museum was extensively used by the public and 20 schools made visits to the museum.

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## BOARDS AND COMMITTEES OF THE DEPARTMENT OF MINES

Coal Mines Accident Relief Fund Trust  
Coal Mines Accident Relief Fund Committee  
Ventilation Board  
WA Coal Industry Tribunal  
Board of Directors WA Mining and Petroleum Research Institute  
Coal Mine Workers' Pension Tribunal  
Mine Workers Relief Fund Board  
Coal Miners Welfare Board  
Coal Industry Board of Reference  
Advisory Committee Western Australian Mining and Petroleum Research Institute  
Board of Examiners for Mine Managers and Underground Supervisors  
Survey Board  
Board of Examiners for Quarry Managers  
Selection Committee for Inspectors of Mines

### Boards, Committees and Councils on which the Department has Representation

#### Executive

Board of Directors and Advisory Committee — WA Mining and Petroleum Research Institute  
Iron Ore Officers Committee  
Advisory Council to the Faculty of Engineering of the University of WA  
Energy Advisory Council  
Australian Minerals and Energy Council Advisory Committee  
Royalties Committee  
Planning and Co-Ordinating Authority  
Conservation and Environment Council

#### Corporate Services Division

Coal Mine Workers Pension Tribunal  
Mine Workers Relief Board  
Board of Examiners (Mine Workers Relief Act)  
Coal Industry Board of References  
Coal Mines Accident Relief Fund Trust  
Coal Mines Accident Relief Fund Committee  
WA Coal Industry Tribunal



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### Mining Registration Division

Mines Department Computer Co-Ordinating Committee  
Mining Act Steering Committee  
Mining Tenement Information Steering Committee  
Exemptions Committee  
Committee of Inquiry Into the Mining Act  
Mining Industry Liaison Committee  
Australian Mining and Petroleum Law Association Advisory Service Committee

### Surveys and Mapping Division

State Survey and Mapping Committee  
Nomenclature Advisory Committee  
Conference of Chief Geological Draftsmen  
Drafting Materials Supply Committee  
Western Australian Land Information System Council  
Mines Department Computer Co-Ordinating Committee  
Mining Act Steering Committee

### Petroleum Division

Petroleum Industry Liaison Committee  
AMEC Standing Committee on Offshore Petroleum Legislation  
Australian Standard Association ME/38  
North West Shelf Project Commonwealth/State Security Group Oil Spillage Committee  
Engineering Heritage Committee  
Industrial Tropical Cyclone Liaison Committee  
North West Shelf Project Energy Resource Committee

### Geological Survey

Abrilhos Islands Consultative Committee  
Abrilhos Islands Interdepartmental Management Committee  
Accredited Technical Expert for National Disasters (ATEND)  
Ad Hoc Committee on Environmental Management of Groundwater Abstraction Area  
Advisory Committee on MSc in Environmental Management of UWA  
Advisory Committee on Geology and Geophysics at Curtin University  
Australian Geoscience Information Association Standards Sub-Committee  
Agricultural Catchments Sub-committee of Research Steering Committee  
ALCOA Mining and Management Planning Group  
    Mining Operations Group  
    Reserves Review Committee  
    Working groups for MMPG and RRC  
Basic Raw Materials Committee  
Bauxite Sub-committee of RSC  
Board of Directors, Mining and Petroleum Research Institute, Mining and Petroleum Research Act 1981  
Central East Regional Development Strategy Committee  
Central South Regional Development Strategy Committee  
Chamber of Mines, Mines Department Liaison Committee  
Cockburn Cement Dredging Management Committee  
Collie Land Use Working Group Committee for Conservation and Rehabilitation in the Mining Industry  
Committee on Exploration and Mining in National Parks and Nature Reserves  
Country Planning Council  
Curtin University Advisory Committee for Geophysics  
Department Publications Coordinating Committee  
Eastern Goldfields Esperance Regional Development Committee  
EPA, S 24 Working Group  
Executive Committee of Research Steering Committee  
Exemptions Committee

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Extractive Industries Committee Working Group  
Geological Advisory Committee, Technical Education Division, Education Department  
Geological Liaison Committee  
Geological Sites Sub-committee  
Geological Survey Computer Policy Committee  
GSWA Isotope Geochronology Advisory Committee  
Goldfields Planning Council  
GCL Liaison Committee  
Government Geologists Conference  
Groundwater Liaison Committee  
Kimberley Land Use Appraisal Committee  
Kwinana Red Mud Disposal Committee  
Land Salinisation Sub-committee of RSC  
Leeuwin-Naturaliste Regional Study Group  
Microfilm Steering Committee  
Mines Department Computer Co-ordinating Committee  
Natural Infiltration Research Steering Committee  
Northern Arthur River Wetland Rehabilitation Committee  
Proposed Coastal Planning and Development Committee and/or Marine and Estuarine Management Committee of the Coastal Management Advisory Council  
Radioactive Waste Disposal Committee  
Reserves Review Committee  
Seismic Task Force of State Advisory Committee for ATEND  
Soil Conservation Advisory Group  
State Liaison Committee for Remote Sensing  
State Survey and Mapping Committee  
State Water Resources Information System Working Group  
Steering Committee for Research into Land Use and Water Supply (RSC)  
Tender Board Advisory Sub-committee for the procurement of motor vehicles  
Venture Task Force Committee  
WA Conservation Consultative Committee  
WAPEX Steering Committee  
WA Water Resources Council Groundwater Resources Management Committee  
WORSLEY Alumina Conservation Working Group  
WMC Industrial Effluent Committee

#### Government Chemical Laboratories

Floor and Wall Maintenance Products Committee (State Tender Board)  
Paints Advisory Committee  
State Paint Technical Working Group  
Government Paint Committee  
Detergents Committee (State Tender Board)  
Ad Hoc Committee of Occupational Health on Anaesthetic Gases in Operating Theatres  
Bandages and Dressings Committee of the Tender Board  
Forensic Sciences Co-Ordinating Group  
Food Analysis Sub Committee  
Oils Committee of the Tender Board  
Pesticide Committee of the Tender Board  
Incinerator Sub Committee  
Veterinary Preparations and Annual Feeding Stuffs Advisory Committee  
Mines Department Computer Co-Ordinating Committee  
Lupinseed Technology Committee  
Environmentally Hazardous Chemicals  
Laboratory Safety Committee of the Industrial Foundation for Accident Prevention  
Swan River Management Authority Industrial Committee

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Swan River Management Authority Biological Committee  
Pesticides Advisory Committee  
Poisons Advisory Committee  
Combined Metropolitan and Country Water Purity Advisory Committee  
Fluoridation of Public Water Supplies Advisory Committee  
Food Advisory Committee  
Drug Advisory Committee  
Meeting of Government Chemists  
Community Consultation Committee on Chemicals  
Hazardous Substances Sub Committee  
Fire Brigade Professional Advisory Group  
GCL Liaison Committee  
Cleaning and Gardening Equipment Safety Sub Committee  
NHMRC Pesticides and Agricultural Chemicals Committee  
Harding Dam Water Quality Committee  
Hospital Laundry Linen Service Standing Committee on Linen Quality  
Laporte (SCM) Effluent Disposal Steering Committee  
National Health and Medical Research Council — Food Analysis (Reference) Sub Committee  
Princess Royal Harbour — Pollution (by Mercury) Working Group  
SCM Effluent Management Committee  
State Tender Board Medical Requisites Advisory Sub Committee  
State Tender Board Polishing and Cleaning Products Advisory Sub Committee  
Water Purity Committee  
WA Advisory Committee on Chemicals  
Groundwater Management Committee  
Standards Association of Australia-Committee/Sub Committee  
    MN/3/2 — Chemical Analysis of Aluminium Ores  
    MN/2/2 — Chemical Analysis of Iron Ores  
    MN/4/2 — Chemical Analysis of Heavy Mineral Sands  
    MN/1/1/7 — Coal and Coke — Trace Elements  
    MN/4 — Heavy Mineral Sands  
Association of Official Racing Chemists

#### Mining Engineering Division

Board of Examiners for Mine Managers and Underground Supervisors  
Board of Examiners for Quarry Managers  
Ventilation Board  
Selection Committee for Inspector of Mines  
Australian Drilling Industry Training Committee  
Australian Institute for Non Destructive Testing  
Collie Federated School of Mines Education Committee  
South West Inter-Departmental Regional Advisory Council Group  
Goldfields Dust Abatement Committee (Kalgoorlie)  
Goldfields Dust Abatement Committee Technical Sub Committee (Perth)  
Standards Association of Australia WA Safety Reviewing Committee  
Collie Coal Mines Rehabilitation Committee  
Conference of Chief Inspectors of Mines  
Central Rescue, Training Co-Ordinating Facility Steering Committee  
Mineral Sands Rehabilitation Co-Ordinating Committee  
Coal Miners Welfare Board  
Mine Survey Board  
Coal Mines Accident Relief Fund Trust  
Board of Examiners for Mining Manager, Undermanagers, and Deputies

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### Explosives and Dangerous Goods Division

ATAC Advisory Committee on the Transport of Dangerous Goods (ACTDG)  
ACTDG Competent Authorities Sub-Committee  
ACTDG Drafting Sub-Committee  
Association of Australian Port and Marine Authorities  
Community Consultative Committee on Chemicals  
Road Transport Emergency Assistance Scheme Co-ordinating Committee  
WA Advisory Committee on Chemicals  
Hazardous Substances Sub-Committee  
GCL Liaison Committee  
Mines Department Computer Co-ordinating Committee  
Microfilm Steering Committee  
Conference of Chief Inspectors of Explosives  
State Co-ordinating Committee for the North West Shelf Gas Project  
State Counter Disaster Advisory Committee  
Transport Code Competent Authorities Working Group on the Safe Transport of Radioactive Substances  
Chemicals Labelling Sub-Committee  
Professional Advisory Group on Hazardous Goods and Chemicals Information System  
Inter-departmental Committee on Fire Prevention and Public Safety Kwinana Industries Co-ordinating Committee  
Stored Chemicals Sub-Committee  
National Occupational Health and Safety Commission Chemicals Standing Committee  
State Tender Board Polishing and Cleaning Products Advisory Sub-Committee  
Standards Association of Australia Committees;  
    ME/15 — Storage and Handling of Liquefied Petroleum Gases  
    ME/17 — Storage and Handling of Flammable and Combustible Liquids  
    ME/59 — Road Tankers for Hazardous Liquids and Gases

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## DEPARTMENTAL DIRECTORY

### Mineral House

DEPARTMENT OF MINES MINERAL HOUSE  
66 ADELAIDE TERRACE  
PERTH WESTERN AUSTRALIA 6000  
TELEPHONE (09) 222 3333  
TELEX AA95791 MINEWA  
FAX (09) 222 3510

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA  
5TH FLOOR MINERAL HOUSE  
66 ADELAIDE TERRACE  
PERTH WA 6000  
TELEPHONE (09) 222 3333  
TELEX AA95791 MINEWA  
FAX (09) 222 3510

SURVEYS AND MAPPING DIVISION  
2ND FLOOR MINERAL HOUSE  
66 ADELAIDE TERRACE  
PERTH WA 6000  
TELEPHONE (09) 222 3333  
TELEX AA95791 MINEWA  
FAX (09) 222 3510

CORPORATE SERVICES DIVISION  
8TH FLOOR MINERAL HOUSE  
66 ADELAIDE TERRACE  
PERTH WA 6000  
TELEPHONE (09) 222 3333  
TELEX AA95791 MINEWA  
FAX (09) 222 3510

### Other Perth Offices

MINING REGISTRATION DIVISION  
LEVEL 1 MERLIN CENTRE  
PLAIN STREET  
EAST PERTH WA 6001  
TELEPHONE (09) 222 3118  
TELEX AA95791 MINEWA  
FAX (09) 222 3452

MINING ENGINEERING DIVISION  
LEVEL 3 MERLIN CENTRE  
PLAIN STREET  
EAST PERTH WA 6001  
TELEPHONE (09) 222 3333  
TELEX AA93780  
FAX (09) 325 2280

MINING ENGINEERING DIVISION  
DRILLING BRANCH  
HARRIS STREET  
CARLISLE WA 6101  
TELEPHONE (09) 362 3211  
FAX (09) 362 5694

PETROLEUM DIVISION  
LEVEL 3 MERLIN CENTRE  
PLAIN STREET  
EAST PERTH WA 6001  
TELEPHONE (09) 222 3333  
TELEX AA95791 MINEWA  
FAX (09) 222 3515

GOVERNMENT CHEMICAL LABORATORIES  
125 HAY STREET  
PERTH WA 6000  
TELEPHONE (09) 325 5544  
TELEX AA95791 MINEWA  
FAX (09) 222 3510

GOVERNMENT CHEMICAL LABORATORIES  
ENGINEERING CHEMISTRY LABORATORY  
19 CATHERINE STREET  
BENTLEY WA 6102  
TELEPHONE (09) 458 9088  
TELEX AA95791 MINEWA  
FAX (09) 222 3510

EXPLOSIVES AND DANGEROUS GOODS  
DIVISION ALBERT HOUSE  
10 VICTORIA AVENUE  
PERTH WA 6000  
TELEPHONE (09) 222 3390  
TELEX AA95791 MINEWA  
FAX (09) 325 4896

### Kalgoorlie

MINING REGISTRATION DIVISION  
MINING REGISTRAR KALGOORLIE  
BROOKMAN STREET  
BOX 34  
KALGOORLIE WA 6430  
TELEPHONE (099) 213 066  
FAX (090) 213 612

GEOLOGICAL SURVEY  
OF WESTERN AUSTRALIA  
KALGOORLIE REGIONAL OFFICE  
BROOKMAN STREET  
KALGOORLIE WA 6430  
TELEPHONE (090) 213 066

MINING ENGINEERING DIVISION  
BROOKMAN STREET  
BOX 671  
KALGOORLIE WA 6430  
TELEPHONE (090) 213 066  
FAX (090) 213 612

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GOVERNMENT CHEMICAL LABORATORIES  
KALGOORLIE METALLURGICAL LABORATORY  
95 EGAN STREET  
BOX 881  
KALGOORLIE WA 6430  
TELEPHONE (090) 220 120  
FAX (090) 213 612

EXPLOSIVES AND DANGEROUS GOODS DIVISION  
KALGOORLIE EXPLOSIVES RESERVE  
PICCADILLY STREET WEST  
KALGOORLIE WA 6430  
TELEPHONE (090) 218 246

#### Other Country Offices

##### MINING REGISTRATION DIVISION

MINING REGISTRAR  
ROCHESTER STREET  
BOX 4  
LEONORA WA 6438  
TELEPHONE (090) 376 106  
FAX (090) 376 248

MINING REGISTRAR  
40 BAYLEY STREET  
BOX 41  
COOLGARDIE WA 6429  
TELEPHONE (090) 266 066

MINING REGISTRAR  
GREAT EASTERN HIGHWAY  
SOUTHERN CROSS WA 6426  
TELEPHONE (090) 491 107

MINING REGISTRAR  
PRINCEP STREET  
NORSEMAN WA 6443  
TELEPHONE (090) 391 082

MINING REGISTRAR  
MAIN STREET  
BOX 7  
MEEKATHARRA WA 6642  
TELEPHONE (099) 811 008  
FAX (099) 811 482

MINING REGISTRAR  
COURT HOUSE  
BOX 35  
CARNARVON WA 6701  
TELEPHONE (099) 411 082

MINING REGISTRAR  
COURT HOUSE  
BOX 43  
CUE WA 6640  
TELEPHONE (099) 631 052

MINING REGISTRAR  
RICHARDSON STREET  
BOX 13  
MT MAGNET WA 6638  
TELEPHONE (099) 634 040

MINING REGISTRAR  
BOHEMIA ROAD  
BOX 7  
MARBLE BAR WA 6760  
TELEPHONE (091) 761 044

MINING REGISTRAR  
COURT HOUSE  
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# ANNUAL REVIEW

1986-87

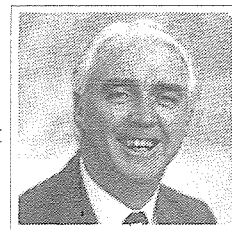


DEPARTMENT OF MINES  
WESTERN AUSTRALIA

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## FOREWORD

Dr D.R. Kelly, BE(Hons), PhD(Lond), MIE Aust  
Director General Of Mines



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This Annual Review is produced in association with the Annual Report of the Department of Mines, but is not a part of that report.

The Review contains information which the Department believes is of importance to the mining and petroleum industries and to members of the public with a general or particular interest in mining.

The information concerns the research being undertaken by various Divisions of the Department of Mines and the services provided by the Divisions to those who need guidance or help.

Additional information gives a picture of the interaction between the Department and the mining and petroleum industries, with particular reference to how the industries are performing in such areas as health and safety, the handling of dangerous goods, and environmental protection.

Statistical details about the industry are contained in the Statistical Summary associated with this publication.



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# GOLD - THE THIRD RUSH

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## Halls Creek

Western Australia has witnessed three "gold rushes". The first, between 1885 and 1914, followed this State's first discovery of payable gold at Halls Creek in 1885. The discovery, although small, fired people's imagination and led to subsequent rich gold discoveries in the Pilbara, around Southern Cross, and through the Murchison. News of the huge gold discoveries at Coolgardie and Kalgoorlie in 1892-93 soon spread around the world, causing a rush of diggers from overseas and the eastern colonies of Australia. A shortage of manpower, equipment and stores during the First World War effectively stifled this first main period of gold mining which was typified by the exploitation of numerous shallow high-grade deposits by small companies and syndicates.

The second gold rush, between 1930 and 1940, was partly a response to the Great Depression. Many of the unemployed, encouraged by a doubling of the gold price, the introduction of the State Prospecting Scheme (1933) and the much publicized discovery of the Golden Eagle nugget at Larkinville in 1931, moved to the goldfields to try their luck. More efficient mining methods and the injection of fresh capital also helped promote increased production from mines which generally penetrated well into the deeper primary ores. Again, it was a major war which marked the end of this period of activity. From 1939 to 1945 gold production fell from 37t to 14.6t and, despite some improvement during the 1950's, deteriorated further through the 1960's and early 1970's, when production fell as low as 6.5t, the lowest since 1894.

## Gold Price

The third gold rush was started by the dramatic rise in the price of gold during late 1979 and early 1980, the value of the precious metal changing from A\$267 to A\$752 per ounce over a period of 5 months. Although during subsequent years the price stabilized at about A\$400 per ounce, the prevailing long-term price increase maintained profitability and encouraged large-scale investment in exploration and mining ventures. During the last two years the depreciation of the Australian dollar has caused gold prices to again rise above A\$600 per ounce, further consolidating the present boom.

Production increases have been achieved by technological advances in mining, grade control, and processing. The great majority of new gold mines have been open cuts, made possible by improvements in ore-reserve determination, orebody delineation, selective mining techniques, sampling and grade control, and extraction technology. These, and other factors, have enabled relatively large volumes of low-grade material to be aggregated and mined at moderate to high stripping ratios, and treated with generally high rates of recovery. Most of the present generation of mines are on shallow mineralized haloes in weathered rock around old workings.

## Carbon-in-Pulp

The principal individual factor in promoting the open-cut mining approach (higher volume, lower grade) has been the refinement of extraction technology. It was the development of the carbon-in-pulp process in the 1970's that revolutionized the treatment of gold ores. This technique has removed the need for filtration, permitted the treatment of very fine ores, improved gold recovery rates from low-grade ores, avoided treatment problems associated with impurities, and enabled small producers to treat their own ore.

About 600 companies and prospectors currently produce gold in Western Australia, and many new companies, with gold as the prime exploration target, are being floated. In 1986-87, 21 significant new gold mines were opened and another 10 were expected to commence production before the end of 1987. Many of the new mines will have a life of about 4 to 10 years, and new and replacement production should continue at least to the end of the decade. If the gold price continues to improve many of the shallow open-cut mines could probably extend development to greater depths.

The major projects to come onstream include Brunswick Oil's Galtee More, Reynolds/Forsyth's Mt Gibson, Newmont/ Hampton's New Celebration, Aberfoyle's Bardoc Joint Venture, Chevron's Mt Wilkinson, Barrack Mines' Wiluna Open Cut and Eastmet's Youanmi. All were developed with capital expenditure in the range of \$8-15 million raised primarily through equity either directly from companies' internal cashflow or through share issues.

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### Concealed Deposits

Modern methods of exploration have opened up the possibility of locating concealed gold deposits. In regions such as the Eastern Goldfields where rock exposures are, on average, less than 5% of the total land surface, many major deposits probably await discovery under sand plains, salt lakes and areas of laterite. In addition, some of these superficial deposits may themselves host large, low-grade secondary concentrations of gold, like those at Boddington and Mount Gibson.

Gold production in Western Australia increased from 11.2t in 1980 to 53.6t in 1986, and production in 1987 is expected to be 79t. Production in the financial year 1986-87 was 64.9t and exceeded the previous record annual production of 61t in 1903. In terms of total production in the non-communist world, these figures represent an increase in Western Australia's contribution from 1.2% to about 6%, and will raise total Australian production to over 100t, giving us equal status with Canada and U.S.A. as gold producers, exceeded only by South Africa in the Western world.

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## IN MINING, SAFETY MATTERS

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For many years, it has been a requirement of the Mines Regulation Act that Mine Managers report all lost time injuries to the District Inspector of Mines. This information has enabled the Mining Engineering Division to record basic trends in the numbers of fatal, serious\* and minor\* injuries in the mining industry. Collation and more detailed analysis of accident data was extremely time consuming and could not be done on a regular basis and in the detail required with the resources available.

Computerisation was seen as the best way of overcoming this problem and early in 1985 a working group was set up to investigate the development of a system for the recording, storage and easy retrieval of accident and injury data. The concept was discussed with the mining industry through the Chamber of Mines of Western Australia and was generally supported. At that time, the only computerised accident reporting systems operating at State level in the mining industry were those developed by the New South Wales Joint Coal Board and the Queensland Coal Association. No such system existed at State level for metalliferous mines.

Valuable assistance was received from the New South Wales Joint Coal Board, the Queensland Coal Association and Australian Bureau of Statistics at an early stage in the development of the system, which by this time had acquired the name AXTAT.

In November 1986, Injury Report Forms were distributed to all operating mining companies and since 1 January 1987, all lost time injuries have been reported on them. In addition to injury details, mining companies report on the number of persons employed and the hours worked, enabling injury frequency rates to be calculated. The frequency rate is the number of lost time injuries per million hours worked and is a commonly used indicator of industrial safety.

Coding systems were developed by the Mining Engineering Division with the assistance of a consultant. Data is entered into the Department's IBM Model 4381-P13 mainframe computer directly from the centrally coded forms.

### Information

The computer program, which took three people more than six months to write, allows easy retrieval of injury related information in many different forms. The data base is updated from monthly reports submitted by mining companies and in addition to injury frequency and duration rates, breakdowns are available of injuries by occupation, part of body injured, nature of injury, place of accident, type of accident and activity at time of accident.

AXTAT is considered by a leading risk management company to have the potential for widespread use in the Australian mining industry and for other major industry groups outside the mining sphere.

The system, which became operational on 1 July 1987, serves the following purposes -

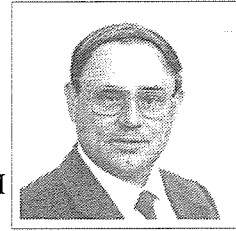
- To determine trends and produce analyses of injury and exposure-related data at different levels of the industry (individual mines to total State);
- To identify areas and occupations which are subject to elevated risk;
- To provide information for dissemination of up-to-date accident information to all concerned parties making them aware of the risks and motivating action where necessary;
- To provide organised data for the use of mines inspectors enabling them to focus their attention on the areas which are cause for most concern;
- To assist in measuring effectiveness of the State's mining safety legislation.

Safety in the mining industry has improved significantly in the last twenty years with the incidence of lost time injuries per thousand employees now one quarter the rate in 1965 and fatal injuries falling to one tenth the 1965 rate. Introduction of the AXTAT system will assist in efforts to improve the State mining industry's safety record still further.

\*Serious injury is defined in the Mines Regulations Act 1946-74 as one where a person is disabled from following his ordinary occupation and earning his usual rate of remuneration for a period of two weeks or more and minor injury, for less than two weeks.

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# MINING ENGINEERING DIVISION



Mr. J.M. Torlach, BE(Min), MAIMM  
Director

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The first phase of the restructure of the Mining Engineering Division was commenced in 1986-87 and most of the additional staff approved early in 1986 were recruited during the year.

Without the engagement of these additional staff, the Division would have been poorly placed to offer effective services and advice to the industry and government on occupational health, safety and environmental matters.

Assistant Directors were appointed to head the Coal Mining Inspectorate and the Research and Technical Services Branch in August 1986 and March 1987 respectively, completing the senior appointments to the Division.

The Technical Services Branch was further strengthened by recruitment of an Executive Officer-Radiation, a Manager, Environment and Rehabilitation and by filling a vacancy for a Senior Mining Engineer - Occupational Health and Safety.

Regional Inspectorates were reinforced with the appointment of a District Coal Mining Engineer for Collie, a Mining Engineer (Ventilation), Environmental Officer and Machinery Inspector based in Kalgoorlie, a Senior Ventilation Officer based in Karratha and a Machinery Inspector for the Perth Inspectorate.

Five additional staff are to be appointed in the second stage of the restructure during 1987-88.

With this progressive build-up of essential staff in key areas, the Division has been able to cope generally with the immediate demands made on its services, and to undertake a number of initiatives in occupational health and safety throughout the year. Some of these are described in the body of the report. Implementation of further programs will be accelerated throughout the coming year as the capacity afforded by the expanded resources is developed.

## MINING ACTIVITIES

Some of the more significant events in 1986-87 are listed below:

### Coal Mining

- The construction of Western Collieries Ltd No 3 open cut mine was nearing completion by June 1987. A large modern maintenance workshop and administration complex has been completed and the first coal seams intersected by box cut ramps. The new 3.8km haul road to the crushing, screening and load-out plant at WD2 was 90% complete at the end of the year.
- At Western Collieries Ltd (WCL) No 6 underground mine coal extraction began in November 1986 from the experimental Wongawilli panel. The project, carried out jointly by ACIRL and WCL, commenced five years earlier with the identification of the various aquifers in the overlying strata. The upper aquifers were intersected by boreholes from the surface while the two immediately above the coal seam and in the floor were dewatered with pumps in the workings.

Dewatering and depressurisation reached a suitable stage by June 1986. The start of extraction was deferred until November 1986 when a Voest Alpine AM65 roadheader unit carrying a bridge conveyor commenced full extraction. There were no indications of uncontrollable problems associated with the water, and strata caving characteristics were good.

In-flow of water and pumping levels peaked at 7,000 kilolitres per day from an average of 4,000 kilolitres per day. A total of 42,000 tonnes of coal was extracted, averaging 275 tonnes per shift.

Increases in coal extraction ratio of 300 per cent are expected when employing this mining method. Evaluation of the application of this system in the Collie coalfield is continuing.

- In December 1986, a major new welding workshop was opened at Griffin Coal's Muja Open Cut by the Minister for Minerals and Energy, the Hon David Parker. Equipped with the latest technology, the workshop is designed to meet the highest safety and health requirements for the maintenance tradesmen. In addition to large acoustic screens, each bay is connected to a fume extraction system and is supplied by compressed gas reticulation.

- Placement of cable bolts (30m in length) in the West wall of Muja open cut continued through the year, enabling an average slope of 40 degrees to be maintained. Some spalling of the weathered face took place and repairs to the 160m wide by 60m high face, including meshing, were effected with the assistance of climbing ropes.
- The WA Coal Industry Council was formed early in 1987, chaired by the Minister and made up of representatives from the employer companies, unions and government. Its purpose is to address the problems arising from the energy surplus and consequent stockpiling of coal by acknowledging the need for change in the WA Coal Industry to achieve increased efficiency, lower production costs and increased productivity.

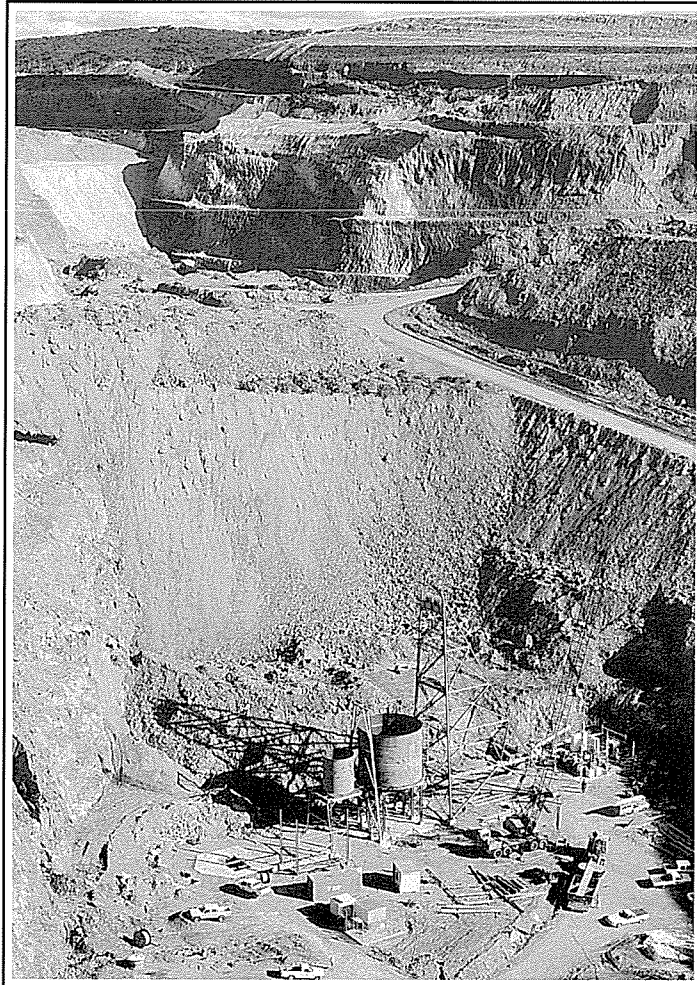
#### Metalliferous Mining

- During its first full year of production from the AKI Pipe, Argyle Diamond Mines achieved its scheduled production rate. It is notable that this fly in/fly out operation has one of the lowest injury rates in the State.
- Freeport of Australia Incorporated and Gem Exploration and Minerals Ltd completed exploration, bulk sampling and pilot-plant processing of diamonds in the Limestone Creek/Bow River area and announced plans for development.
- Construction and commissioning of a new gold treatment plant at the Telfer operations of Newmont Holdings was completed during the year. Available plant capacity was expanded from 0.5 to 2.0 M tonnes per annum.

Exploration drilling has delineated a supergene sulphide orebody at depth and mine design is currently being modified to allow for economic extraction. The possibility of underground exploitation of deep reserves at some future date has also been considered. Construction of a flotation plant and associated facilities for processing the supergene ore commenced in April 1987.

- Western Mining Corporation announced that it intends to construct a two million tpa carbon gold plant at St Ives to treat gold ore from its open pits on the south side of Lake Lefroy.
- Exploration drilling at the Lancefield mine has shown that the Lancefield Deeps orebody contains significant reserves. To gain access, a decline was commenced in the West open pit and consideration is being given to sinking another shaft for haulage purposes.
- Sinking of a 4.5m diameter concrete lined shaft to a depth of 430m was completed at the Bellevue gold mine north of Agnew. Subsequent development on the 8, 11 and 12 levels has exposed the orebody and predicted grades have been confirmed.
- Kalgoorlie Mining Associates successfully detonated an 880,000 tonne mass pillar blast at the Mount Charlotte mine. The ground vibrations from the blast were monitored by seismic instruments placed at strategic positions both underground and on the surface. Results were in accordance with SAA Codes.
- The installation and commissioning of the underground crusher on the 36 level off the Cassidy shaft signalled the completion of the \$55 million Cassidy shaft project which was commenced some four years ago. The Cassidy shaft is recognised as the most modern ore haulage complex in Australia and boasts the only ground mounted Kope winders in the southern hemisphere. With the completion of this project, the phasing out of the Reward shaft for ore haulage and the decommissioning of the Man & Supply shaft below the 9 level have commenced.
- At KMA's Fimiston operations a more efficient higher capacity rail haulage drive from the Chaffers shaft 20 level to the Lake View shaft has been completed. This haulage way will bring all ore from below the 14 level of the Lake View workings to the Chaffers shaft where the ore will be crushed on the 28 level before being hoisted to the surface via the Chaffers shaft.
- The historic Sons of Gwalia headframe was moved to an area close to the Gwalia museum, allowing the company to mine ore from the block of ground over which the headframe was situated. The winding engine, believed to be the largest surviving first motion steam engine in the Southern Hemisphere, is also to be relocated.

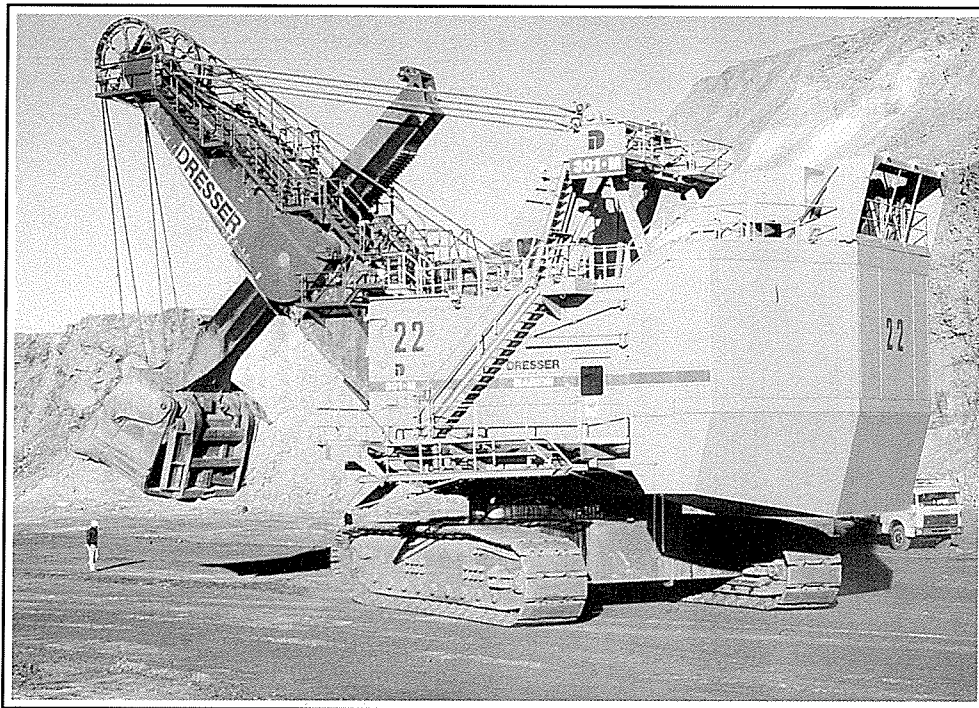
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- Central Norseman Gold Corporation rehabilitated the North Royal inclined shaft down to the 10 level and plans are well advanced to re-install the original headframe and winder in the bottom of the North Royal open pit to reach ore reserves between the 5 and 9 levels.



The newly constructed Headframe at Royal Number 3 pit.

- A memorandum of agreement between Mt Newman Mining Co and Hancock Mining Ltd on the development of the McCamey's Monster deposit (35km south-east of Newman) was signed towards the end of the year. Under the terms of the agreement, supplies of iron-ore will be shipped to Romania, initially from Mt Newman, while Hancock Mining start up a mining operation at McCamey's Monster. Mt Newman has the option to enter into a joint agreement with Hancock Mining if it is decided to develop the deposit further.
- Hamersley Iron Pty Ltd commenced an exploration winze- sinking programme at the Manuldi prospect some 80km west of Tom Price. The development of a new operation at Channar near Paraburdoo remained under consideration throughout the year.
- Goldsworthy Mining Ltd commenced upgrading port facilities at Finucane Island to accommodate larger ships, and earthworks for the installation of crushing facilities for the exploitation of the Nimingarra ore deposit. Future plans include the construction of a beneficiation plant at Finucane Island.

- At the Mt Whaleback iron mining operation, a new in-pit crusher and waste conveyor installation and a Dresser 301-M mining shovel were commissioned during the year. The shovel is the largest machine of its type in the southern hemisphere, with a weight of over 900 tonnes and a capacity of up to 65 cubic yards per load. Much test-work was completed on blasting in the pyritic Mt McRae Shale formation at Mt Whaleback. Deflagration in blast-holes has been inhibited by the use of zinc oxide in the ANFO mix.

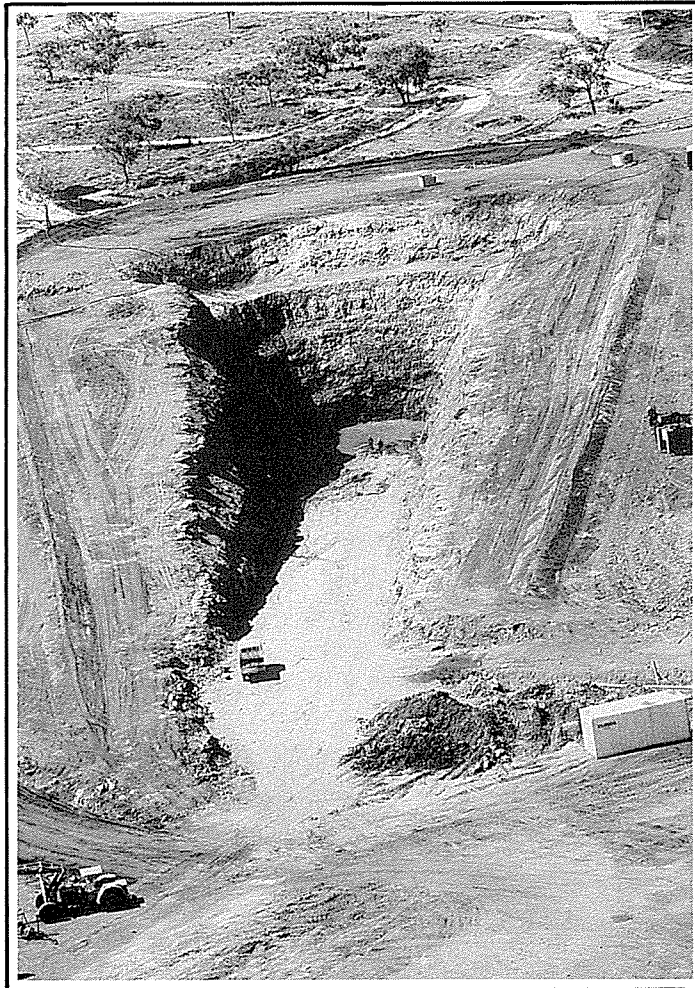


The Dresser 301-M mining shovel commissioned by the Mt Whaleback iron mining operation, is the largest machine of its type in the southern hemisphere.

- BHP Minerals continued operations at Koolan Island where the pit has been deepened to below sea level. Although there are still significant mineable reserves available, extraction of the remaining ore will require strict control on slope stability, and ground water and sea water pressures. The final pit design places the pit bottom at 82m below sea level.
- BHP Minerals Ltd let a contract for the excavation of a 200,000 tonne bulk sample from the Marillana Creek (formerly Yandicoogina) deposit located approximately 140km north-west of Newman. Mining commenced in February and was completed in May 1987. The ore sample was crushed on site and transported 44km by road to the Mt Newman railroad before being railed to Port Hedland and shipped to Port Kembla for metallurgical trials. A decision on future development has yet to be made.
- Two new synthetic rutile plants were commissioned during the year, one at Capel by Westralian Sands Ltd, the other at Narngulu by Associated Mineral Consolidated Ltd.
- The Agnew Nickel Mine operated by Agnew Mining Co Pty Ltd was a major casualty in the decline of the nickel industry and the mine was placed on a care and maintenance basis during August 1986. Prior to its closure, the mine produced about 700,000 tonnes of ore per year.
- Depleted ore reserves and high extraction costs, together with low metal prices, resulted in the closure of the Nepean Nickel Mine which was operated by Metals Exploration NL.
- Western Mining Corporation Ltd rationalised its nickel operations at Kambalda by closing several of its less productive shafts. The company found it necessary to curtail production and reduce its labour force at Kwinana Nickel Refinery.



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- The Golden Grove zinc-lead-copper project near Yalgoo has remained on care and maintenance. No further work has been carried out at the site since the initial shaft sink and sample extraction program was completed in 1985.
  - A major zinc-lead mining and processing operation at Cadjebut near Fitzroy Crossing is described elsewhere in this report.



The boxcut for the portal at Cadjebut nearing completion, May 1987.

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## SAFETY, OCCUPATIONAL HEALTH AND INDUSTRIAL HYGIENE

### MINE VENTILATION

#### Karratha Inspectorate

A Special Inspector of Mines (Ventilation) was appointed to the Karratha Inspectorate in February 1987 and took up his duties in the region in March, following a period of induction in Perth. The Noise and Vibration Officer for the Inspectorate was also trained in ventilation sampling in order to increase the Division's efficiency in this field.

Inspections with Government Chemical Laboratories staff were carried out at a number of mine sites during the year, including several of the large iron ore operations, ports and shipping facilities and many of the small gold mines in the Marble Bar/Nullagine area. Defects observed during these inspections included unlabelled baths and storage vessels containing industrial solvents, and the use of inappropriate or no protective equipment when handling chemicals. The use of incorrect types of respiratory protection and gloves when handling chlorinated solvents and the lack of knowledge among supervisors and workers about the safe handling and use of these materials is of continuing concern and has been regularly drawn to the attention of managers by several inspectors during the year.

Respirable and total dust samples were taken during routine inspections of mine-sites during the year. Of 89 samples taken, 11 exceeded the Standard of Purity prescribed in the Regulations. Follow-up corrective action was requested in all cases. Of particular concern were crushing plants being operated without effective dust suppression equipment and the high silica content of respirable dust in a gold mine assay laboratory.

Atmospheric contaminant sampling results were generally submitted on a regular and satisfactory basis by companies in the Inspectorate.

#### Kalgoorlie Inspectorate

The work of the Ventilation section in Kalgoorlie was adversely affected by the resignation on 20 February 1987 of two Ventilation Officers to pursue full time studies at the Kalgoorlie School of Mines. These two positions were filled on 29 June 1987.

Inspections of underground workings, milling operations and underground diesel equipment were carried out on a regular basis.

Of the 341 respirable dust samples taken by inspectors and ventilation officers, 19 were found to be greater than the standard of purity required, as were two of the 47 total dust samples.

553 short term gas samples were taken by inspectors in gold treatment operations, 542 for hydrogen cyanide and 11 for ammonia. Of the 542 hydrogen cyanide samples, 85 exceeded the standard of purity, and of the 11 ammonia samples, one exceeded the standard of purity.

In addition to dust and gas sampling, routine underground inspections were carried out to determine workplace temperatures and adequacy of ventilation. Of the 620 workplaces inspected, 55 were found to be unsatisfactory.

In general it was found that unsatisfactory conditions were caused by recirculation of air flows, ventilation not extended up to the workplace, or ventilation not installed. Follow-up corrective action was directed in all cases.

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Gas emission tests were conducted on 59 underground diesel units. Of these 14 were found to be unsatisfactory and corrective action was directed.

Two seminars on the safe handling of cyanide were conducted in Kalgoorlie at the end of June 1987.

#### Perth Inspectorate

Ventilation activities in the Perth Inspectorate were adversely affected by staff shortages during the year, brought about by the death of Mr R.A.C Williams in September 1986 after a short illness, and transfer of another officer.

Of 61 total dust samples, 15 exceeded the standard of purity as did eight of the 127 respirable dust samples. 21 of the 91 respirable quartz samples exceeded the standard of purity. Of sixteen fibre samples, none exceeded the standard of purity.

In addition, 43 samples were taken in the Perth Inspectorate for heavy metals and four exceeded the standard of purity.

Follow-up corrective action was directed in all cases where the standard of purity was exceeded.

#### Collie Inspectorate

An increasing awareness of occupational health and safety issues by the coalfields workforce kept the Collie inspectorate, with the support of Special Inspectors of Mines and the Government Chemical Laboratories, busy during the year.

Directives controlling gravimetric dust sampling frequency and standards of purity were issued to mine managers in March under Section 12.1(f) of the Coal Mines Regulation Act. A permitted maximum of 3 mg/m<sup>3</sup> of coal dust and 0.1 mg/m<sup>3</sup> respirable quartz brings Western Australia into line with the eastern states. A respiratory health survey of the total coal mining labour force of 1200 people was carried out by doctors from the Department of Occupational Health, Safety and Welfare as well as the Department of Health in May 1987. Simultaneously, officers of the Mining Engineering Division carried out a comprehensive gravimetric dust sampling programme in the underground mines.

There were ten fires of varying seriousness at underground mines during the year. Self rescuers were worn on two occasions and closed circuit breathing apparatus was employed by Mines Rescue personnel on two occasions while extinguishing fires.

Progress continued to be made on the various elements of the program adopted to eliminate naked lights in the underground coal mines.

Electrical switchgear is being progressively replaced by flame proofed enclosures.

The larger LHD type diesel machines are fully flame proofed, and during the year the Bobcat loaders were made naked light proof.

A regulatory system of permissions from the Inspector of Mines was initiated during this year to control welding and burning.

New rules brought in under the Act restricted smoking to crib cabins.

A new fire-fighting reticulation system was installed at the main surface facilities at Western No 2.

Stonedusting trials are continuing and a survey of various sources of limestone of adequate purity was carried out during the year.

#### Ventilation Board

The Board met on six occasions in 1986-87 to exercise its functions under the provisions of the Mines Regulation Act.

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## Electrical Inspections

Special Inspectors of Mines (Electricity) carried out 772 inspections of mining operations during the year. As a result of these inspections, 187 letters detailing defects were issued to mine managers.

A total of 92 submissions by mining companies, mainly relating to approval of electrical installations, were processed and 25 electrical supervisors' appointments were approved.

There were no fatal accidents involving electricity. However, 28 electrical incidents were reported and follow-up corrective action was directed where necessary.

Eight prosecutions were initiated for offences on mining leases against Electricity Act Regulations and three fires were investigated.

## Machinery on Mines

Six nickel mine shafts and associated winding equipment were placed on care and maintenance during the year.

The increase in underground gold mining activity has led to the introduction of transportable shaft haulage systems which consist of headframes and associated hoists mounted on road vehicles. Five such systems have been approved for use in the State.

In addition to the transportable systems, a further nine shaft haulage systems have been approved for underground gold mining operations.

Greater emphasis has been placed on the inspection of mobile earth-moving equipment because of the ever increasing number of items of contractors' equipment involved in gold mining. This has been made possible by the appointment of two additional machinery inspectors in the Perth and Kalgoorlie Regional Offices.

Inspection of classified machinery on surface mines (other than winders) now falls directly under the control of the Department of Occupational Health, Safety and Welfare, following the end of secondment of Machinery Inspectors from that Department.

1986-87 saw a marked reduction in reported winder mishaps. Only four were reported and all were investigated.

Four fatalities occurred as a result of mining accidents in the twelve months ended 30 June 1987. One of the fatalities occurred underground when a miner fell down an orepass in a gold mine. Two fatalities were associated with gold treatment plants on the surface. The last of the four, in June 1987, involved a prospector working with explosives on the surface of a gold mining lease.

Accident statistics for 1986-87 are given in the Statistical Summary.

## Prosecutions

Six people were prosecuted during the year for offences against the Mines Regulation Act and Regulations.

Charges against four other people were withdrawn.

Details of the offences are available in the Statistical Summary.

## Noise and Vibration

The Noise and Vibration Section made 298 inspections of mining operations for compliance with hearing conservation regulations. In addition, 43 noise survey reports were submitted by mining companies to the section for assessment.

The likely changes to the regulations, which were foreshadowed in September 1986, are expected to include removal of the requirement for mandatory audiometric testing, and streamlining of the requirements for noise surveys and noise survey reports.

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The proposed changes have been well received by the mining industry.

A total of 71 blasts were monitored – 27 in the Perth metropolitan area and 44 in the Goldfields. As a result of blast monitoring, some changes in blasting practice have been made by mining companies to reduce the nuisance to residents and to reduce the risk of property damage.

A training program to multi-skill noise and ventilation officers was initiated in September 1986 to improve efficiency of inspections. Good progress has been made in this regard and the training program will continue in 1987-88.

A total of 210 Mines Department employees who work in noise hazard areas underwent hearing tests before 30 June 1987.

#### Radiation Health

Mineral sands operations were inspected regularly to determine compliance with the Code of Practice on Radiation Protection in the Mining and Processing of Mineral Sands. The 24 radiation inspections were usually carried out in conjunction with ventilation inspections to use resources most effectively.

Other radiation-related inspections were carried out at the Western Mining Corporation Ltd pilot uranium treatment plant in Kalgoorlie, at CRA's uranium exploration activities at the Kintyre prospect, and at Wonnerup.

Regular contact was maintained with senior officers of the Radiation Health Branch of the Health Department through the Radiation Inspection Liaison Committee. This committee monitors radiation inspection activity at mining and processing sites and is used as a forum for the exchange of information.

The standard for inhaled radioactive dust is a function of the particle size distribution of the airborne dust. The parameter of the size distribution which provides a good measure of radioactive dust deposition in the lung is the activity median aerodynamic diameter (AMAD). The AMAD is the diameter which splits the particle size distribution in two (ie 50% of the radioactivity is associated with particle sizes greater than the AMAD and the remaining 50% of the radioactivity is associated with particle sizes less than AMAD). Because of the importance of AMAD, considerable monitoring effort has been directed at establishing the characteristic particle size of dust in the industry.

Effort has also been directed at quality control auditing to ensure that the measurement methods and analytical techniques used by the industry are providing valid results.

#### Information Initiatives

Several guidelines in radiation protection have been developed to help operators to meet the requirements of the Code of Practice.

These guidelines include notification requirements, implementation of dust control strategies, the determination of AMAD by inertial separation, and calculations of dose from the inhalation of airborne radioactivity.

In addition, advice has been issued on dose assessment procedures and reporting requirements.

The Department, in conjunction with the Radiation Health Branch and the industry, conducted a successful one-day training seminar on particle size determinations for occupational health professionals in the industry.

The Executive Officer (Radiation) maintained close liaison with appropriate industry representatives through regular meetings with the Monazite Sub-Committee of the Chamber of Mines.

#### Mines Radiation Safety Board

The preparation of the Draft Bill to establish this Board has progressed slowly but the Bill is now close to its final form and the Board is likely to be established before the end of 1987. The Interim Mines Radiation Committee has continued to function effectively throughout the year.

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### New Code of Practice

A revised Commonwealth Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores is expected to be given effect late in 1987. The Department has been active in the review and formulation stages and it is expected that this Code will replace the present Mineral Sands Code of Practice. The revised Code establishes a radiation protection framework that requires significantly greater administration than the existing Mineral Sands Code.

### Environment and Rehabilitation

A Working Party on Conservation and Rehabilitation in the Mining Industry was set up by the Hon Minister for Minerals and Energy in April 1985. After it completed its examination of the gold mining industry in November 1985, the membership was reorganised in February 1986 to undertake an examination of the mineral sands mining industry.

The Working Party presented its report to the Minister in April 1987 and concluded that the rehabilitation standards and practices associated with current mineral sands operations are generally satisfactory, although improvements are needed in certain areas. However, rehabilitation after mining was inadequate for many previous mining operations, including earlier mined parts of several current operations. Some of these areas have been left completely unrehabilitated or with inadequate restoration, and remedial measures are urgently needed. Sites requiring such attention are located in the Yoganup, Capel, Jurien and Eneabba areas.

The Working Party deemed the existing provisions of the Mining Act to be satisfactory for environmental control of the mineral-sands industry, except that private land alienated from the Crown prior to 1899 (where the mineral rights are held by the landowner) should be brought under the environmental provisions of the Act. It also stated there is a need for more consideration to be given by Government and companies to the proposed land use after mining, so that appropriate rehabilitation methods are planned before mining operations begin.

With the mining industry coming under increasing pressure to achieve higher standards of environmental management and rehabilitation, the Division's Environment and Rehabilitation section has an important role in establishing environmental conditions for mining tenements. The environmental conditions are developed after assessing proposal outlines (notices of intent) submitted by the mining companies. During the year, 53 proposals were received. Other government departments, particularly the Environmental Protection Authority, are closely involved in the assessment procedure and the Division's Environmental Section acts as the co-ordinator of government input to the mining tenement conditions.

The Section represents the Department on a number of important environmental committees including the Mineral Sands (Eneabba) Agreement Rehabilitation Co-ordinating Committee, Meekatharra Soil Conservation District Committee, the Licence Advisory Panel - Rights in Water and Irrigation Act and the Work Party on Conservation and Rehabilitation in the Mining Industry.

The Collie Coal Mines Rehabilitation Committee (CCMRC) met twice during the year as well as conducting field trips to the open cut mines in November and June to inspect progress under the requirements of the respective Coal Agreement Acts. Good progress has been maintained at Western No 5 mine where the spoils are being progressively planted with native forest species. At Muja, very significant areas of spoil dumps have been profiled and contoured during the past year while trials with various mulches and trees planted in re-established grasslands continue to provide valuable data.

Advice has been provided to Government on a wide range of environmental issues that directly and indirectly affect the industry, including the question of mining in national parks and reviewing draft regional management plans prepared by other government departments.

### Wonnerup Project

A project to mine mineral sands and tailings with elevated radiation levels from rural/residential blocks of land at Wonnerup is progressing well. Cable Sands (WA) Pty Ltd will carry out the mining as agents for the State. The division has been heavily involved in discussion with the owners of the affected land, with Cable Sands, and with other State Government Departments.

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An agreement has been drawn up by Crown Law Department between the State, Cable Sands and the affected land owners, and is currently being distributed to all parties for signature.

The mining operation will start within a few months of the agreement being signed.

The operation will be only marginally profitable for the company. The bulk of the mining is required to remove radioactive tailings, the residue of previous mining in the area. The balance of the material to be removed is a natural mineral strand. This project exemplifies the heightened standards of environmental awareness of the Mines Department, the mining industry and the public.

#### Aboriginal Matters

An Aboriginal Liaison Officer has been appointed to facilitate interaction between mining companies and Aboriginal groups so that potential conflict can be minimised. Prior to his appointment as Manager, Environment and Rehabilitation in 1986, Mr John Clarke had been Aboriginal Liaison Officer since 1984 and he has continued to carry these duties pending the arrival of his successor.

Most contacts between the industry and Aboriginal groups have been low key, with a satisfactory outcome for both parties, but a small number of controversial mining exploration proposals have placed considerable demand on the Section's resources.

#### Drilling Branch

In the 1986-87 fiscal year, the Drilling Branch drilled 115 bores, totalling 14,692.5 metres, developed aquifers in most of the bores, and controlled the construction of two multi-ports by contractors.

This is the highest meterage drilled by the Branch – the previous record was 12,983 metres in 1975.

Television camera scanning was carried out on 16 bores, 262 sidewall cores were taken, and 817 perforations made in bore casings using shaped charge explosives. Minor repair work was done on existing and abandoned bores, mainly for redevelopment and controlling artesian flows.

The work was all for groundwater purposes, mainly for assessment of the State's groundwater resources or for specific mining and land use projects such as bauxite mining and land salinisation.

Use of well pressure control equipment and techniques is now standard practice on the deep drilling operations, and has been introduced for medium depth operations primarily for control of water pressure.

One-way satellite communication has been introduced to improve communication with drilling units. The system provides fast, all-weather, all-location transmission of detailed instructions in printed form.

Computerising the Branch accounting and stores system is being reconsidered due to unexpected cost escalation.

A summary of drilling and associated work is available in the Statistical Summary.

#### Obituary

R.A.C WILLIAMS (Senior Mining Engineer) died in hospital on 18 September 1986 after a short illness.

The Department wishes to acknowledge the valuable contribution Oscar Williams made to occupational health, particularly in the field of mine ventilation. His passing has been a major loss to the Division.

Expressions of regret and acknowledgement of the magnitude of his contribution to occupational health and safety in the mining industry were received from a wide spectrum of mining and professional associations and from the Trades and Labor Council.

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## CADJEBUT - W.A.'s NEW ZINC-LEAD MINE

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The Pinnacles Joint Venture, with BHP Minerals Ltd as manager, commenced mining the Cadjebut zinc-lead deposit in June 1987. Situated 80km southeast of Fitzroy Crossing in the Kimberley area, Cadjebut will become the State's biggest zinc mine to date. Indicated geological reserves are 3.25 million tonnes of 14% zinc and 4.8% lead of which about 2.5 million tonnes are presently thought to be mineable. The deposit is owned 58% by BHP Minerals Ltd and 42% by Billiton Australia Ltd.

The Cadjebut deposit is a Mississippi Valley-type deposit in carbonates of the Lennard Shelf associated with Devonian reefs. The mineralization is in the form of sphalerite and galena with minor marcasite. It is exposed at the surface as low-grade ferruginous gossan and dips gently to the east-southeast for 3 kilometres where it is 270 metres below the surface. The mineralization is about 100 metres wide and occurs in two lenses each 4 to 5 metres thick and separated by 6 to 8 metres of low-grade dolomitic shale.

The ore is being mined by a shallow decline which passes through the ore resulting in little or no waste rock. The mine will produce 320,000 tonnes of ore per year which will be fed to a concentrator on site. 80,000 tonnes of concentrate containing 58% zinc and 15,000 tonnes of concentrate containing 75% lead will be produced each year and trucked to Wyndham for shipping to Australian or overseas smelters. The concentrates are free of many of the impurities commonly found in lead and zinc concentrates and have proved attractive to smelter operators. The mine could double the State's zinc production within three years.

### First Find

Lead and zinc were first discovered in the Devonian reefs of the Lennard Shelf at Narlarla in 1906. The small Narlarla deposit was worked out between 1948 and 1966. In 1937, Finucane and Jones had suggested that this occurrence of lead and zinc had similarities to the Mississippi Valley lead deposits, but although the reefal nature of the Devonian sediments was known, it was not until the publication of Geological Survey of Western Australia Bulletin 118 "Devonian reef complexes of the Canning Basin, Western Australia" by P.E. Playford and D.C. Lowry in 1966 that it became generally apparent that the geological environment of the Lennard Shelf had similarities to geology in the region of the major Mississippi Valley lead-zinc deposits of North America. This bulletin and subsequent detailed studies of the reef complexes by the Geological Survey have played an important role in guiding exploration in this area.

### Long Search

In 1971-72 several companies pegged large areas of the Devonian reefs and commenced reconnaissance exploration. After several years of geological, geochemical and geophysical exploration backed up by shallow drilling to about 100 metres, several promising prospects had been identified but no orebodies. In 1974 Shell Minerals (later Billiton Australia) farmed-in on many of these prospects as well as pegging more ground of their own, but the following two years saw little success. In 1976 Dampier Mining Co Ltd (now BHP Minerals Ltd) joined Shell in a joint venture and, after appraisal of previous work, commenced deep pattern drilling in the Pillara Spring area. In 1978 high-grade mineralization was intersected in what was subsequently named the Blendevalle deposit. Exploration was concentrated in the Blendevalle area and when it became apparent that the Lennard Shelf area did contain an orebody of economic proportions, work on other parts of the shelf intensified.

The Blendevalle deposit has indicated geological reserves of 20 million tonnes containing 8.3% zinc and 2.5% lead. Subsequently, deposits have been found at Wagon Pass (500,000 tonnes of 14% combined lead and zinc) and Twelve-mile Bore (+2 M tonnes of 10% zinc and 1% lead) as well as at Cadjebut. The Cadjebut deposit, although small, is the highest grade and most easily mined of the discoveries so far and is therefore to be mined first.

Exploring for zinc-lead deposits on the Lennard Shelf has been long and expensive - 136 holes had been drilled in the Pillara area before Blendevalle was discovered - but sixteen years on and many hundreds of thousands of metres of core drilling later, a major zinc-lead province has been proved and the first mine has commenced production.



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# GEOLOGICAL SURVEY DIVISION

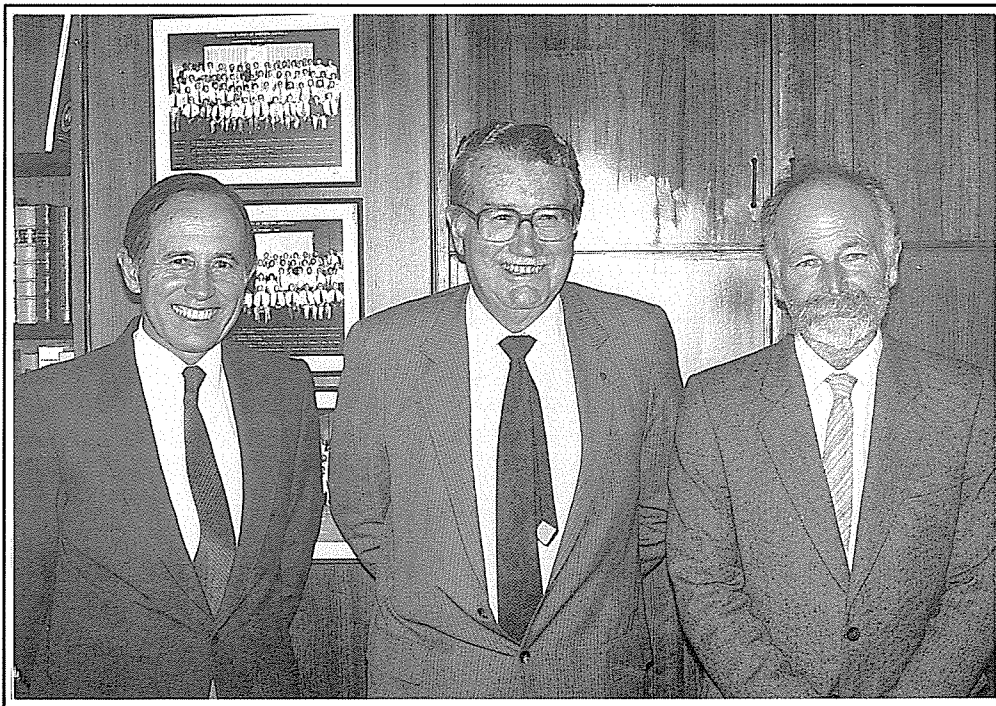


Dr P.E. Playford, BSc(Hons), PhD.  
Director

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Dr A.F. Trendall voluntarily stepped down from the position of Director of the Geological Survey on 31 August 1986 to become Senior Principal Geologist in the Precambrian Geology Section, and was succeeded by Dr P.E. Playford, who had been Assistant Director General of Mines, and before that, Deputy Director of the Survey.

In his 6 years as Director, Dr Alec Trendall reoriented the Survey's endeavour following some 20 years in which systematic regional mapping at 1:250,000 scale had been the principal function. Dr Trendall recognized the gaps in our knowledge of the geological history of many parts of Western Australia that had been highlighted by mapping over the previous two decades. Many of these geological problems relate to areas of economic importance, and projects designed to solve them could have significant effects on the State's mineral industry.



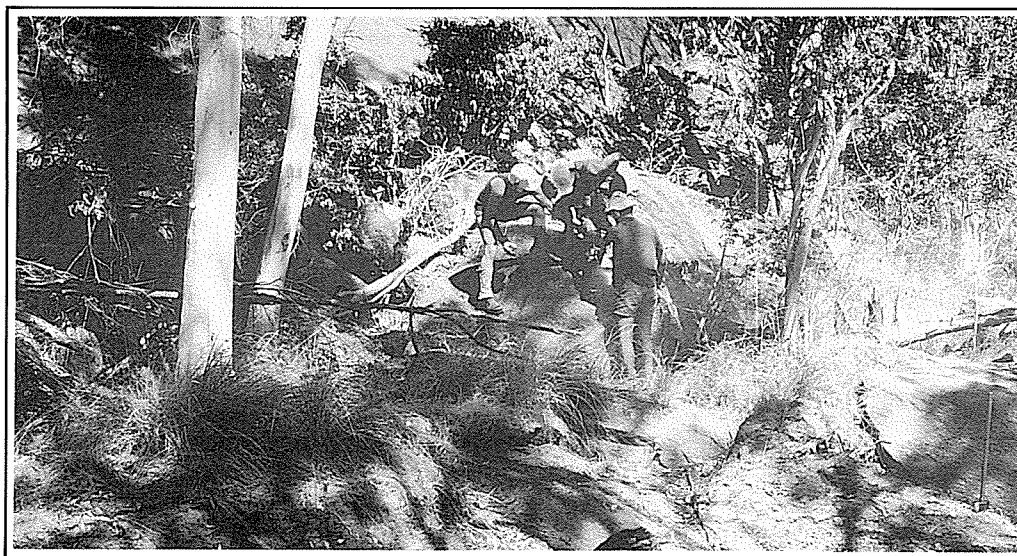
Dr Phillip Playford appointed Director of the Geological Survey in August 1986 with his immediate predecessor Dr Alec Trendall (right) and the previous Director, Mr Joe Lord.

In September 1986, the incoming Director, Dr Phillip Playford, released a discussion document entitled "Future direction of the Geological Survey", outlining his ideas on the strategy for development of the Survey. This was discussed with staff of the Survey, the Director General of Mines, the Minister for Minerals and Energy, and representatives of the mining industry. With minor modifications, the strategy was adopted as Survey policy, and implementation began in October 1986.

The principal features of the new policy can be summarized as follows:

- A Geological Survey Liaison Committee has been set up comprising representatives of the Geological Survey, Chamber of Mines, Association of Mining and Exploration Companies, Australasian Institute of Mining and Metallurgy, BMR, CSIRO, University of WA, Curtin University, and WA School of Mines, and chaired by the Director of the Survey. The objectives of the committee are to examine and advise on the Survey's operations, and to co-ordinate geoscientific research by Government and academia in Western Australia. The Geological Survey needs to ensure that it is carrying out work that is relevant to the needs of industry, and the liaison committee will be an appropriate forum through which to gauge industry views and seek broad support for the Survey's program.

- Five-year planning, linked to the Corporate Plan, has been introduced in place of the previous annual planning. Project proposals are now mission oriented and are assessed on the basis of their economic and geoscientific importance to the State. Deadlines are specified for each project and are expected to be met.
- Scientific priority is to be placed on field-based, economically oriented, applied research, with the production of geological maps being given the highest priority. There has been a steady decline in the time spent on field work by Survey staff in recent years; in 1976 each staff member spent an average of 67 days per year in the field, but in 1986 this had fallen to only 17 days. The target is to achieve a 30% increase in field work over the next two years, and a 100% increase over five years.
- The large backlog of mining company reports that are due for release, but cannot be made available because they have not been microfilmed, has been of major concern to both exploration companies and the Survey directorate. A program to clear this backlog within 12 months has been given special funding. It involves employment of contract geologists and support staff, and the use of private microfilm services.
- A comprehensive performance-appraisal system for all professional staff has been introduced in the Survey, after examining the systems in use by various exploration companies in WA and fully consulting staff members.
- A high priority has been given to the acquisition of personal computers, to be used by geoscientists for both word processing and scientific computing. It is intended that over the next several years every staff member having a continuing need for such computing will be provided with a PC or other work station.



Drilling into a large boulder of Kongorow Granodiorite to obtain an unweathered specimen for geochronological determination.

### Geochronology

The increasing use of isotope geochronology to determine the age of geological events prompted the Director to establish a small committee to report on the future of geochronological research by the Survey with special reference to cooperation with other organizations. The Committee, chaired by Assistant Director Mr P.R. Dunn, comprised representatives of the local organizations most active in isotope geochronology in Western Australia viz. Curtin University of Technology, University of Western Australia, and Geological Survey of Western Australia.

The committee submitted its report in May 1987 and recommended the retention of a geochronologist on the staff of the Survey and the broadening of the range of methods in which he is directly involved to include rubidium-strontium and zircon-lead techniques as well as the samarium-neodymium technique being used at present. These additional methods would be applied in close cooperation with geoscientists at Curtin University and the University of WA, and using the facilities of those organizations.

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## Visiting Scientists

A number of noted overseas geoscientists visited the Geological Survey in the period. Many came during the Fourth International Kimberlite Conference held in Perth on 11-15 August 1986. This Conference was convened by Dr Trendall and Prof P. Harris of the University of W.A. Mr J. Lewis, petrologist, Geological Survey of Western Australia, and co-author of GSWA Bulletin 132 "The kimberlites and lamproites of Western Australia" was Conference Secretary. Nearly 300 local, interstate and overseas geoscientists attended the conference.

Eminent Soviet scientist Dr M.A. Semikhatov (from the Institute of Geological Sciences, USSR) visited from 26 May to 15 June 1987 to compare Western Australian Precambrian stromatolites with those previously described from USSR, Canada and elsewhere. In company with GSWA palaeontologist Ms K. Grey, Dr Semikhatov inspected Precambrian fossil stromatolites in the Pilbara (Bangemall and Wyloo Groups) and living forms at Shark Bay and Lake Clifton.

A number of projects staffed by personnel from overseas universities, and in some cases supervised by Geological Survey staff, were undertaken during the period.

Ms C. Brown returned to Western Australia from Imperial College, University of London, and completed the field phase of her project in the Stirling Range-Mt Barren area.

Matthias Cornelius, from the Mining University, Leoben, Austria, revisited Western Australia to sample tholeiitic and komatiitic rocks in the Kambalda area.

Dr Bruce Simonson of Oberlin College in Ohio, USA continued his study of the regional stratigraphy and sedimentology of the Wittenoom Dolomite. He aims to establish the palaeoenvironment of the Wittenoom Dolomite and relate this to depositional conditions of the banded iron formations.

A project commenced late in the year by Australian National University post-graduate student Michael Wiedenbeck is expected to considerably enhance the relatively sparse uranium-lead studies made in the northern sector of the Western Gneiss Terrain and the adjoining Murchison Province.

Ms V. Pedone and Mr B. Ward, post-graduate students from the State University of New York, completed field work on their projects on dolomitization and diagenesis of Devonian reef complexes in the Kimberley region. Results of these studies will be incorporated in the proposed Geological Survey Bulletin on the geology and petroleum potential of these reefs being compiled under the principal authorship of Dr Playford for release late in 1988.

A number of staff travelled interstate or overseas to attend conferences during the year. Dr Playford delivered a paper by invitation to the annual meeting of the American Association of Petroleum Geologists in Los Angeles in June 1987. He also presented a paper at the Canberra Bureau of Mineral Resources Petroleum and Minerals Review in March, and attended the Government Geologists' Conference in Adelaide in April 1987.

Assistant Director Mr P. Dunn attended the fifth thematic conference on Remote Sensing for Exploration Geology in Reno, Nevada, and was one of several Western Australian Government and industry representatives at the American Mining Congress immediately afterwards in Las Vegas in October 1986. In May 1987 Mr Dunn in company with Mr J. Blockley, Supervising Geologist, Mineral Resources Section, spent three weeks in China responding to an invitation from the Chinese Ministry of Geology and Mineral Resources to evaluate mineral prospects in China for possible future cooperative development.

Dr A. Thorne, Ms K. Grey and Mr R. Hocking, presented papers at the 12th International Sedimentological Congress in Canberra in August 1986. Drs A.Hickman and D.Gee attended "Geocongress '86" in Johannesburg South Africa in July 1986. Assistant Director Mr T.T.Bestow, presented a paper to a groundwater conference at Harare in Zimbabwe in June 1987 and Mr M.Fetherston, geologist, Mineral Resources, presented a paper at the 10th Biennial Conference of Australian Clay Minerals Society in Sydney in December 1986.

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## Research Priorities

The thrust of the Survey's five-year program for 1987-1991 is to concentrate on those aspects of geoscience that the Geological Survey does best, are of most value to industry and the general community, and are not being undertaken by others. It is intended to increase the level of field-based research, on the basis that geological mapping is the primary scientific role of the Survey.

The following are some features of new or expanded projects encompassed in the five-year plan.

**Geological mapping.** Following completion of the first-edition 1:250,000 regional mapping of the State, priority is now being given to 1:100,000 scale mapping of areas having high economic potential. The five-year program includes the mapping of twenty five 1:100,000 sheets, most of which cover prospective greenstone belts in the Eastern Goldfields. In addition, second-edition 1:250,000 mapping will proceed over important sheet areas where revision of the geology is desirable.

**Eastern Goldfields study.** The mapping program in the Eastern Goldfields is to form part of an integrated study of the gold-bearing greenstone belts between Norseman and Menzies, relating gold and other mineralization to structure and stratigraphy, and studying the geology of individual deposits. This research will include a detailed structural study of the Golden Mile.

**North West Shelf study.** A geological and geophysical study of the Mesozoic sequence on the North West Shelf, beginning with the Cretaceous, will be undertaken in conjunction with the Curtin University of Technology and with funding from the Western Australian Mineral and Petroleum Research Institute. This work will aim to integrate the results of the many seismic surveys and exploratory wells in this area.

**Geology and mineral resources of National Parks.** A program of geological mapping and mineral-resources assessment of the State's national parks is to begin, and will in due course be extended to cover other major nature reserves. The first three parks to be studied, commencing in 1987, will be the Rudall River, D'Entrecasteaux, and Hamersley Range National Parks.

**Paterson Orogen.** A major research project on the geology of the Paterson Orogen will include known mineralized belts in the Rudall, Throssell Range, and Telfer areas. This region is believed to be one of the most prospective "frontier" exploration areas in the State. The work on the Rudall River National Park will form part of this research.

**Goldfields palaeodrainage groundwater study.** A program of drilling, geophysical logging, sampling, and test pumping will be undertaken in a palaeodrainage system in the Eastern Goldfields in order to obtain information relevant to the development and management of saline water supplies for the mining industry. This will be the first such program undertaken by the Survey directed towards non-potable water supplies.

**Hydrogeological mapping.** A program of hydrogeological mapping, at 1:250,000 scale, will be extended over key areas of the State, with associated 1:100,000 maps where appropriate. A hydrogeological map of the State at 1:2,500,000 scale will also be produced in 1987.

**The geology of Western Australia, Memoir 3.** A new memoir on the geology of Western Australia, replacing Memoir 2, is to be produced in 1988, together with a new edition of the State geological map (1:2,500,000).

### Computerization

The use of EDP systems in the Survey will be expanded as rapidly as possible. PC equipment will be acquired progressively over the next 5 years, with the objective of providing access to a workstation for each geoscientist having ongoing needs for scientific, computing, data-processing, or word-processing facilities.

### Environmental geology mapping.

Environmental geology mapping has been completed over most of the coastal zone from Perth south to Busselton and around other urban centres in Western Australia. Environmental mapping will be concentrated, in future, on National Parks and areas of intense gold-mining activity such as Kalgoorlie.

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## OPERATIONS

Some of the more important projects undertaken are described in the following sections.

### Basement, Minerals, and Geotechnics Branch Precambrian Geology Section

The principal emphasis was on finalizing reports on mapping projects the field work for which was completed earlier.

Second-edition coloured 1:250,000 geological maps of Balfour Downs, Boorabbin, Newman, Robertson, Widgiemooltha, and Wyloo were substantially completed and the accompanying explanatory notes were in advanced stages of preparation.

Mapping at 1:100,000 scale, aimed at solving geological problems in complex areas of economic importance, proceeded satisfactorily, with Kalgoorlie, Yilmia, Cowan and Lake Lefroy map sheets being completed and the accompanying reports nearly completed. These maps, incorporating new field observations, geophysical data, and available subsurface information from exploration activities, will be invaluable for mineral exploration in those areas.

An interesting spin-off from the detailed study of the Kalgoorlie map sheet is the project initiated by the Open University (London) in which multi-spectral scanning data from a variety of sources will be experimentally processed in an attempt to produce signatures characteristic of particular rock and residual soil types in this area. In this project detailed and accurate knowledge of surface and subsurface lithologies, as shown on the 1:100,000 map, is essential if correlation of reflected or emitted wavelength combinations with residual soil types is to be valid.

As a logical follow-up to the completed 1:250,000 first edition geological mapping, systematic studies of individual tectonic and stratigraphic units are now being undertaken.

Such a study of the Ashburton Fold Belt, commenced in 1981, is nearing completion, and will result in the issue of a bulletin devoted to a comprehensive description of the rocks of this belt, their geological history and economic potential.

Similar studies are in progress on the Fortescue Group (in the Pilbara Region), and the King Leopold Orogen (Kimberley Region).

The Fortescue Group is the basal (oldest) unit of the sedimentary and volcanic rock succession in the Hamersley Basin. The Fortescue Group resembles the Ventersdorp Supergroup of South Africa which is separated from its basement (the Kaapvaal Craton) by the Witwatersrand Supergroup, the world's largest single source of gold. With the recognized equivalence of the Kaapvaal Craton and the Pilbara Block, upon which the Fortescue Group was deposited, the apparent absence of a Western Australian correlative to the Witwatersrand Supergroup is anomalous and puzzling and certainly warrants close examination.

Field work continued on the study of the King Leopold Orogen, part of the Halls Creek Province flanking the Kimberley Basin on its southwestern and southeastern sides. The Halls Creek Province has significant copper, lead, zinc, tin, tungsten, gold, and diamond deposits in its eastern (Halls Creek) area where the geology is complicated by major transcurrent faults. The western (King Leopold) area is not significantly mineralized, but with less disruptive faulting in this area it should be possible to obtain a better understanding of the geological history there. This could then be applied to the Halls Creek zone and might lead to the development of exploration targets in the King Leopold zone itself.

Recognition of a younger rock sequence (the Savory Group) in the eastern part of the Bangemall Basin has led to closer study of the group to determine its extent and economic significance. Work in progress has indicated that a major stratigraphical, structural and palaeogeographical revision of the eastern part of the Bangemall Basin is necessary and suggests that the area should now be designated as the Savory Basin.

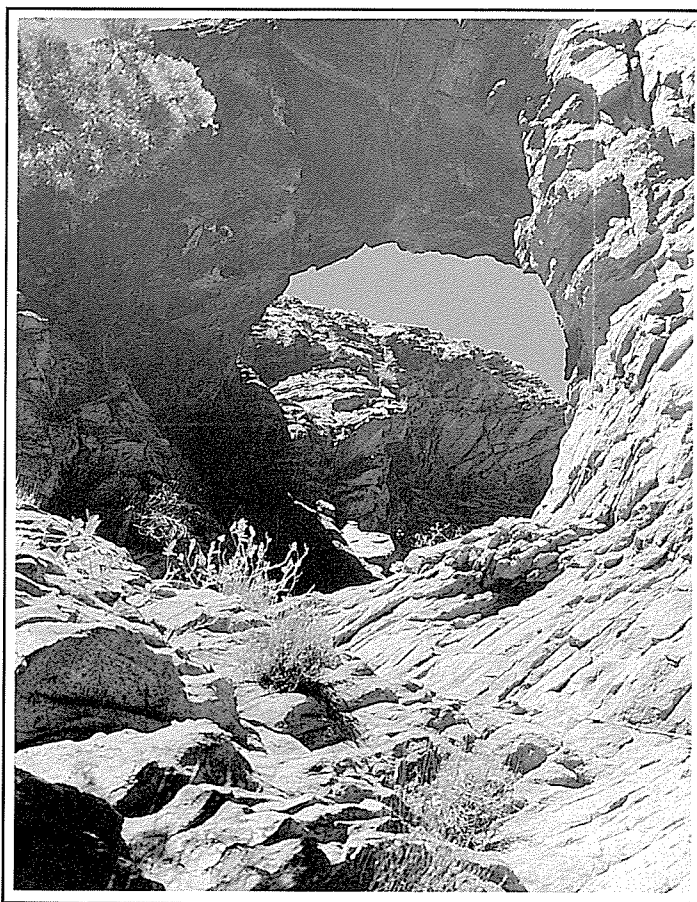
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## Mineral Resources Section

The Exploration Data Sub-section received 2,888 new exploration reports in the 1986–87 year (cf 2,059 in 1985–86) bringing the total number of volumes to 20,809 relating to 5,292 projects. Of these, 1,946 projects and 8,273 related volumes concern (wholly or in part) exploration for gold. Twenty rolls of microfilm containing 338 volumes on 160 projects were filmed in the year and this included material previously prepared by a Community Employment Programme team.

Late in 1986 Cabinet granted special funds to eliminate the microfilm backlog and by June 1987 a further 4,985 microfiche (16mm and 35mm) covering 1,570 volumes on 585 projects had been filmed. The library open-file M Series now contains 7,487 volumes on 2,723 projects. The Survey's WAMEX database has been revised accordingly and entries forwarded for inclusion in the national AESIS database.

There were 75 industry requests for information from reports not yet microfilmed, resulting in the release of an additional 96 volumes on 46 projects.



A natural rock arch in the Carnarvon Range near Good Camp Rockhole, visited during mapping of the eastern part of the Bangemall Basin.

In the Economic Geology Sub-Section a study of gold mineralization in the Westonia and Bullfinch-Forrestania greenstone belts in the Southern Cross Province was completed. Field mapping of the greenstones and immediately adjoining rocks was undertaken at 1:50,000 scale for presentation at 1:100,000 and a broader interpretation at 1:500,000.

Investigation of the nature and geological setting of skarn-hosted tungsten mineralization in the north-eastern Gascoyne Province was completed. Synthesis of the data indicates that the Gascoyne skarns are of a type similar to that group which contains most of the important tungsten skarn deposits in the world.

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A project to review and re-examine the gypsum resources of Western Australia was begun and although other commitments precluded field work, data collated from other sources proved useful in resource development strategy planning.

In the study of the potential for platinum-group elements (PGE) in Western Australia by the Evaluation Sub-section all laboratory analyses are now complete, a microcomputer program has been written for plotting chondrite-normalized PGE data, and compilation of a comprehensive report will be undertaken.

The assessment of reserves, resources, and potential for heavy-mineral sands in Western Australia, which was commenced last year for the Working Party on Conservation and Rehabilitation in the Mining Industry, was completed.

The recent acquisition of the MINMET INFOPAC system operated on a personal computer promises to fulfil the need for information on listed companies.

Future efforts will concentrate on obtaining basic data from unlisted companies and upgrading data from major producers.

The senior geologist of the Mineral Economics Sub-section remained seconded to the Royalties and Statistics Branch during the year. His temporary replacement, Mr A Heath extended the coverage of MININFORM to include heavy- mineral sands, iron ore, base metals, tin, tantalite and manganese. Other minor commodities have been compiled but require further check before input to the computerized database.

MININFORM was designed to retain information on mineral exploration and development projects in Western Australia but has been extended to cover an inventory of commodity reserves and resources. Between MININFORM and MINMET INFOPAC, answers to more questions on exploration or mining related company activities can now be provided quickly.

#### Engineering and Environmental Geology Section

The Environmental Geology Sub-section continued with its program of 1:50,000 environmental mapping. During the period the Armadale, Perth, Serpentine, Collie, and Muja sheets were published; field work and map compilation were completed on Burekup, Busselton, Capel, Yallingup, Albany and Broome sheets; maps are being compiled for Jumperkine and Gleneagle sheets; and field work is in progress on the Karragullen sheet. Work on the last three sheets has been postponed in favour of a bulletin on the bauxite deposits in the southwest of the State. Compilation of this bulletin is continuing.

Investigations on the availability of industrial minerals were published in Record format for Collie, Lancelin to Bunbury, and Broome. Reports such as these, and the industrial minerals database established last year, are particularly valuable to urban and regional planning groups as well as to those requiring to use or develop the resources. As usual, the Sub-section prepared numerous reports and provided input in other forms for a variety of government planning and management groups.

The Engineering Geology Sub-section, as in previous years, continued to provide geological advice on a wide range of projects. Typical of the short-term projects were: searches for quarry sites for road base or surfacing materials for the Main Roads Department at such scattered localities as Eyre Highway, Duncan Highway and the Gibb River road; examining drill core from the bed of Hillarys boat harbour to determine the depth to which piles should be driven; a study of slope stability at Buckland Hill reservoir site; the search for rock for a protective breakwater at the proposed Dawesville Channel mouth; inspection and report on a cavity associated with a collapsed well beneath a private residence at Hamilton Hill; investigation of a proposed bridge site over the Hill River near Jurien; and the supply of cut-and-polished specimens and advice on rock facing for the entrance lobby at Mineral House.

Following Cabinet approval of the Harris River Dam site and Environmental Protection Authority approval of the Environmental Report and Management Programme, the data relating to geological investigations on the Harris River dam site has been collated in a form that can be accessed and distributed more easily.

#### Petrology Section

Routine petrological examinations during 1986-87 resulted in the completion of 39 reports covering 937 samples.

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Bulletin 132, "The kimberlites and lamproites of Western Australia," was distributed at the Fourth International Kimberlite Conference which began in Perth on 11 August 1986. Other projects were brought to completion with publication of Report 20 "Geochronology of the Gascoyne Province" and Report 19 paper 1 "Metamorphic patterns in the greenstone belts of the Southern Cross Province". Petrological studies of rocks from the Murchison Province are nearing completion.

All officers of the Section have been involved in isotope geochronology projects of which 30 are in progress. As mentioned elsewhere, geochronology in the Survey has been examined by a small committee which recommended that the number of such projects be cut down and that resources be concentrated on larger projects to solve major problems of age and correlation in the Precambrian.

Meanwhile at the end of June 1987 there are 14 rubidium-strontium and 14 samarium-neodymium isotopic geochronology projects in progress, most at the Curtin University of Technology, many of which involve Petrology Section personnel.

An interesting application of isotope geochronology is in the long-term study of the post-Archaeon tectonic history of the western part of the Yilgarn Block. Samples containing fresh biotite have been collected along lines extending eastward from Perth and Harvey. If the biotite dates are interpreted as the time of uplift of the containing rock then dating along the Perth line shows a rather narrow uplifted zone, 20km wide, immediately east of the Darling Fault, the uplift decreasing gradually over the next 50km. Along the Harvey line the uplifted zone is some 50km wide but falls off rapidly over the next 15km. The general indication is that the effect of uplift is confined to a zone about 75km wide with its eastern margin parallel to the Darling Fault.

One petrologist (Dr A.Ahmat) is also participating in the mapping project of the Eastern Goldfields. His contribution will be geological mapping of the Kanowna, Gindalbi and Kanowna 1:100,000 sheets with a special petrological study of layered basic sills including the Bulong Complex.

#### Geochemistry Section

Results of an investigation into geochemical patterns in the laterite profile at the Boddington gold deposit were published in the Journal of Geochemical Exploration late in 1986.

A paper describing trace elements, geochemistry, and petrogenesis of Archaean felsic igneous rocks from the Pilbara Block is the latest product from a long-term study of the volcanic rocks of the Pilbara. It had earlier been decided that the results of this study were best presented as numerous short papers; several have already been published.

The geochemistry of Collie coals has been studied to complement the re-examination of the geology of the Collie Basin. Although results of analyses by neutron activation have not yet been received from CSIRO, the report on the geochemistry has been compiled using results of analyses completed earlier by the Government Chemical Laboratories.

Other projects in progress include a geochemical contribution to the bulletin on the Murchison Region, a study of the laterite profiles at the Mount Gibson gold deposit (in cooperation with Reynolds Australia Ltd and the Government Chemical Laboratories) and a study of the Mount Clement precious metals project (with R.Clarke, Government Chemical Laboratories and D.Seymour, Geological Survey of Tasmania).

#### Basins, Fuel, and Groundwater Branch Hydrogeology Section

The aggregate depth drilled in the National Water Resources Assessment Program was 8873m for the 12-month period to the end of June 1987.

Deep drilling in the Perth Basin accounted for 7538m of this exploratory work. The Gillingarra line drilling was completed and drilling along the Cowaramup line commenced. The deepest borehole drilled in the year was Cowaramup 7A at 1671m.

The Cataby shallow drilling program was completed with 1335m drilled in the review period.



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In August 1986 it was announced that no further Commonwealth funds would be available for exploratory drilling under the National Water Resources Assessment Program and it was feared that this important work might be severely curtailed. However, the State Government, realizing the importance of groundwater to Western Australia's future development, allocated the necessary funds and the program is able to continue.

The withdrawal of Commonwealth financial support and the consequential removal of constraints on objectives means that drilling need no longer be limited to investigation of groundwater resources. In the past the information collected by drilling has always made an important contribution to stratigraphic and other studies but it is now feasible to broaden the objectives of drilling by including the resolution of a range of other problems relating to mineral resources, geological structure and geophysics.

Hydrogeological mapping has been advanced by completion of a 1:2.5 million state map which is now being prepared for printing. The publication of 1:250,000 hydrogeological maps had been delayed through lack of national agreement on the manner of presentation of the collected data. It has now been decided that the Western Australian maps will be published in a manner that will best serve users in this State as there is little point in withholding the information any longer simply for the sake of Australia-wide uniformity.

The section provides advice and acts as a consultant for numerous other Government departments, including the Department of Conservation and Environment, Main Roads Department, and Commonwealth Department of Aboriginal Affairs. Miscellaneous groundwater information has been provided to consultants, mining companies, the rural community, and the general public.

Fifteen inspections were made of private properties to determine the most favourable prospects of groundwater occurrence, mainly on wheat belt farms and a few on outer metropolitan hobby farms. Personal, mail and telephone inquiries totalled 1730 for the year and, to promote awareness of the manner of occurrence and proper use of groundwater, a number of lectures were given at rural seminars and to public-interest groups and professional societies.

A large part of the section's activities (a full-time equivalent of nearly 6 geoscientists) is concerned with Water Authority of Western Australia projects. This work is channelled through a GSWA Liaison officer (Mr W.A. Davidson). The Section's involvement and cooperation with the Water Authority over the 12-month period included the following projects.

Groundwater investigations were conducted at the following locations: Kununurra, Halls Creek, Yiyili, Muludju, Pinnacles, Frog Hollow, Violet Valley, Kapungarra, Imintji, Derby, Dongara, Leonora, Menzies, Gingin, Lake Toolibin, Waroona, Bunbury, Hopetoun, Wyndham, Tjirrkah, Terralintji, Ngalingadi, Wunga, Kartang Ratjarr, Ngiling, Anjaru, Broome, Carnarvon, Sandstone, Jurien, Dathagnoorara, Busselton/Capel, Dunsborough, Collie, Augusta, the Ord River irrigation area, Perth Basin generally and the Perth Metropolitan area.

Groundwater pollution studies were conducted at the Rockingham rubbish tip, Albany proposed tannery, Leonora treatment plant, Mundaring Caravan Park effluent disposal, Talloman-Fertal Bushmead, Coogee water levels and salinity monitoring, Excelsior gold treatment, Eaton wastewater plant, the Nu-farm site at Kwinana, and waste disposal at Queens Park.

The long-term study of hydrogeological effects of bauxite mining continued. Pumping tests were completed at Del Park and North Yarrigil and monitoring bores were established. Tritium and Carbon-14 analyses are being made to determine recharge within various catchments.

The comparable long-term study of the effects of clear felling for woodchip production continued, mainly by collection of monitoring data.

Hydrogeological advice was given to the Authority on many projects in which consultants were engaged.

Perhaps the most significant contribution in the year was finalization of the Section's input to the Perth Urban Water Balance Study, release of the multi-volume report on which is imminent.

Of 41 Hydrogeological Reports prepared by the Section for all purposes, 20 were for the Water Authority.

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## Fossil Fuel and Phanerozoic Geology Section

The Petroleum Resources Sub-section continued to review and microform the data submitted by petroleum exploration companies. A new service was established during the year: shot-point base maps, seismic sections and well logs can now be obtained at full scale through PI Energy Services. This has involved recataloguing much of the earlier data. A total of 659 microfiche were produced during the period.

Further work on WAPEX, the petroleum exploration database, was postponed due to budget constraints. As an interim measure it is intended to take up the most frequently required data on a personal computer, using commercially available software, in such a way that the database can be readily transferred to the mainframe system when WAPEX is fully developed.

The geophysical synthesis of the southern Perth Basin is proceeding satisfactorily. In conjunction with Professor K. Lambeck of the Australian National University, two seismometer traverses have been made across the Darling Fault and these will aid in determining crust thickness in the basin and the nature of the fault.

The Coal Resources Sub-section monitors coal-related activities in the State and works in close association with the State Coal Mining Engineer. A geological study of the Collie Coalfield has recommenced following the appointment of a Senior Coal Geologist. Efforts are being made to obtain data from the companies on magnetic tape which will enable the more rapid manipulation of the large database which exists for the coalfield.

The Basin Studies Sub-section started a major study of Cretaceous units in the southern North West Shelf to determine the geological setting of the known petroleum-productive beds. This is a cooperative project with the School of Geology & Geophysics at Curtin University of Technology and is a WA Minerals and Petroleum Research Institute (WAMPRI) project.

A related project is being undertaken jointly with Dr G. Buntebarth of the University of Clausthal (Germany), to develop a regional framework for the structural and thermal evolution of the southern North West Shelf.

In the Bonaparte Basin, offshore drilling data have been reviewed and some revisions of the stratigraphy are proposed. This will be integrated with geophysical information and a geological history will be produced in the form of palaeogeographic maps. This project will assist in the regional evaluation of the petroleum potential of the area.

## Geophysics Section

In the regional gravity mapping project, work was resumed and a further 246 stations were occupied and positioned. This, together with supplementary data released by the Griffin Coal Mining Company, enabled the compilation of a Bouguer Anomaly map covering the Bridgetown 1:100,000 sheet – the first such systematic gravity map produced by the Geological Survey of Western Australia.

Results from the investigation into the apparent reversal of magnetic polarity on the Binneringie Dyke showed that there was in fact no reversal. The linear 'high' associated with the dyke over most of its length is replaced by a linear 'low' that is shown to be due to one of a number of near-parallel magnetic features not related to the dyke which ends at the western extremity of the positive anomaly.

The level of geophysical logging of boreholes was maintained; although only 87 bores were logged, the aggregate depth logged (28,702 m) was much the same as in the previous 12-month period.

A final report on at Harris River Dam site No.5 and a seismic refraction survey at Bedfordale were completed for the Water Authority of WA.

Seismic refraction surveys were conducted for the Main Roads Department at Noble Falls and Arthur River.

The Department of Agriculture was supplied with field work and reports relating to seismic refraction surveys at Mallee Road sump, Bedford Harbour, and Wallatin Catchment, and magnetic and electromagnetic surveys at Wongan Hills, Crossman, and Frankland River Catchment.

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In support of 1:100,000 mapping of economically important Eastern Goldfields areas, composite aeromagnetic maps have been compiled using all available source data for Dunnsville, Davyhurst, Woolgangie, and Kanowna. Similar compilations have been made for the Southern Cross greenstone belt and the Ravensthorpe area.

#### Palaeontology Section

During the period 36 Palaeontological Reports were compiled. Most concern palynology, palynostratigraphy, or biostratigraphy based on palynology, of boreholes put down for water exploration or development in Western Australia. Others deal with Cambrian fossils and Precambrian stromatolites in Western Australia.

Studies on the Permian and Cretaceous palynology of the Collie Basin (which will supplement the revision of geology of the Collie Basin) are nearing completion. Accordingly, a start has been made on a project to establish a wider palynostratigraphy applicable to the sedimentary basins across the southern part of the State.

Although pressure of other work has delayed progress on the study of stromatolites from the Glengarry and Earahedy Sub-basins, work on stromatolites from the nearby Savory Basin supports the application of stromatolites to Precambrian stratigraphic correlation.

A project to establish and maintain a comprehensive collection of fossils relating to the biostratigraphy of Western Australia was commenced, and by end of March 1987 a collection representing the Cambrian had been assembled and described.

#### Support Service Branch

##### Publication and Information Section

The section dealt with numerous inquiries about geology, economic minerals and related topics. The interest in gold continued at a high level and there was an increase in the number of inquiries about platinum and related metals.

Thirty-eight publications, 17 of which were maps only, were released during the year. Another 19 publications were in process of preparation for the printer on 30 June.

The database MINIFORM became operational during the year, and was used, among other things, to produce a listing of reported reserves and grades of Western Australian gold deposits; this list has since been published as Record 1987/7. A companion database that deals with industrial minerals (INDUSTRIAL MINIFORM) has been developed and is operational in the Engineering and Environmental Geology section.

The booklet "An overview of Mining in Western Australia" was updated and reprinted several times during the year to meet demand.

#### Library

In 1986-87, 4068 members of the public visited the library, of whom 1114 used the microform reading and printing facilities. Staff loans totalled 736, and 431 inter-library loans were arranged. The library sent 362 inter-library loans to other libraries.

## ORGANIZATION

### Staff

The public-service staff cut of 3% imposed during the year meant that the division lost 4 items (1 Geologist level 6, 1 Geophysical Assistant level 2, 1 library assistant level 2/4, and 1 Survey hand). All of these items were vacant or became vacant by the time the reductions had to be completed. The approved staff strength then became 67 permanent professional officers, 33 clerical and general officers and 7 wages staff. Three professional and three other staff items remained vacant at 30 June 1987.

On 31 August 1986, as planned, Dr A.F. Trendall stepped down from Directorship of the Division (after some 6 years in that office) to become a Senior Principal Geologist in the Precambrian Geology Section. Dr P.E. Playford was appointed as Director and took office on 1 September 1987.

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The Deputy Director Dr R.D. Gee, resigned on 15 June 1987. Dr Gee, first appointed to the Survey in 1972 as Supervising Geologist, Precambrian Geology Section, left to lead the exploration division of a major international mining group in Australia.

Ms S. Belford, Dr W.Keats, and Mr G. Beere resigned from the professional staff during the year; Dr G. Le Blanc-Smith was appointed Senior Geologist, Fossil Fuels and Phanerozoic Geology Section, and Mr M. Fetherston was appointed Geologist, Mineral Resources Section.

There has been virtually no progress with the previously approved (1983) plans to expand the Division; the number of permanent officers (100) is now only one more than in 1983. With growing demand for services, particularly from the precious metals exploration sector, it is difficult to keep abreast of current developments with a static staff, let alone try to keep the necessary step ahead.

#### Accommodation

Considerable time has been spent during the year planning the new accommodation being provided in the extended Mineral House Complex. Changing circumstances have demanded frequent changes to subdivisional plans, and because floor space has been restricted, these changes have taken considerable time to achieve.

A pressing need to remove the Geological Survey Division's laboratories from the complex was met by constructing a new laboratory building at Carlisle alongside the Mines Department's Drilling Branch.

#### Publications

##### Issued during 1986-87

Bulletin 132. The kimberlites and lamproites of Western Australia; by A.L. Jaques, J.D. Lewis & C.B. Smith.

Report 15, Geology of the Gascoyne Province; by S.J. Williams.

Report 16, Stratigraphy, structure, and economic geology of the Mount Monger area, Eastern Goldfields Province; by A.H. Hickman.

##### Report 19, Professional Papers for 1984

1. Metamorphic patterns in the greenstone belts of the Southern Cross Province, Western Australia; by A.L. Ahmat.
2. Problematic microstructures in the Proterozoic Discovery Chert, Bangemall Group, Western Australia. Ambient grains or microfossils? by Kathleen Grey.
3. Stromatolite evidence supporting a correlation of the Proterozoic Uaroo and Bangemall Groups, Western Australia; by Kathleen Grey.
4. The mineral potential of layered igneous complexes within the Western Gneiss Terrain; by P.H. Harrison.
5. Liquid-waste disposal in Perth. A hydro geological assessment; by K-J.B. Hirschberg.
6. Occurrence, distribution, and origin of smithsonite in the No.2 lead-zinc deposit at Narlarla, Western Australia; by C.R. Ringrose.
7. The sedimentology of a tide-influenced fan-delta system in the Early Proterozoic Wyloo Group on the southern margin of the Pilbara Craton, Western Australia; by A.M. Thorne and D.B. Seymour.
8. Age and stratigraphy of a sequence of metavolcanic and metasedimentary rocks in the Prairie Downs-Deadman Hill area, southwestern margin of the Sylvania Dome; by I.M. Tyler.

Report 20, Geochronology of the Gascoyne Province; by W.G. Libby, J.R. de Laeter & J.S. Myers.

Record 1986/2, Surveys conducted and wells drilled in 1985, and wells drilled to the end of 1985, for petroleum exploration in Western Australia; by R.M.L. Elliott & R.P. Iasky.

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- Record 1986/3, Two-dimensional gravity modelling on Tektronix 4054 graphic system; by L. Kevi.
- Record 1986/5, Revised stratigraphic nomenclature for the onshore Bonaparte and Ord Basins, Western Australia; by A.J. Mory & G.M. Beere.
- Record 1986/7, Explanatory Notes on the Corrigin 1:250 000 Geological Sheet, W.A.; by R.J. Chin.
- Record 1986/8, Hydrogeology of the Western Fortescue Valley, Pilbara Region, W.A.; by J.C. Barnett & D.P. Commander.
- Record 1986/9, Economic significance of geochemical data from granitoids in the Poona - Dalgara area, Murchison Province; by R. Davy, A.H. Hickman, K.P. Watkins & P.C. Muhling.
- Record 1986/10, Vertical electrical sounding interpretation using Tektronix graphic system; by L. Kevi.
- Record 1986/11, Explanatory notes on the Peak Hill 1:250 000 geological sheet, Western Australia (Second Edition); by R.D. Gee.
- Record 1986/12, Explanatory notes on the Cue 1:250 000 geological sheet, Western Australia (Second Edition); by K.P. Watkins, I.M. Tyler and A.H. Hickman.
- Record 1986/13, Hydrogeology of Lake Toolibin; by M.W. Martin.
- Record 1986/14, Silica sand and gypsum in Western Australia; by I.M. Brown.
- Record 1987/1, Summary of progress of the Geological Survey of Western Australia during 1986 and plans for 1987; by P.E. Playford.
- Record 1987/2, Petroleum exploration activity in Western Australia — 1986; by R.P. Iasky.
- Record 1987/4, Geology and mineral potential of southwestern Australia; by P.H. Harrison, A.H. Hickman, J.G. Blockley, I.M. Brown, W.A. Preston, W. Keats, S.L. Lipple, A.C. Wilson & R.M.L. Elliott.
- Record 1987/6, Review of the effect of logging on groundwater in the southern forest of Western Australia — Project 2, paired catchment study; by M.W. Martin.
- Record 1987/7, Reported reserves and grades of Western Australian gold deposits; by A. Nash & A. Heath.
- Explanatory Notes, Corrigin, Western Australia; by R.J. Chin.
- Explanatory Notes, Kellerberrin, Western Australia; by R.J. Chin.
- 1:250,000 Geological Map Series (colour): Corrigin; Kellerberrin; Wyloo (Second Edition); Cue (Second Edition).
- 1:250,000 Geological Map Series (black and white): Widgiemooltha; Boorabbin.
- 1:50,000 Environmental Geology Series: Armadale; Perth; Serpentine; Collie; Muja.
- Special Geology: Kalgoorlie-Boulder (3 maps); Carnarvon Basin (3 maps).
- In press at June 1987
- Bulletin 133, The geology of the Carnarvon Basin, Western Australia; by R.M. Hocking, H.T. Moors & W.J.E. van de Graaff.
- Bulletin 134, Geology of the onshore Bonaparte and Ord Basins; by G.M. Beere & A.J. Mory.
- Bulletin 135. Palynological studies of Late Jurassic and Early Cretaceous sediments, Perth Basin, Western Australia; by John Backhouse.
- Report 21, Regional geology of the Kalgoorlie-Boulder gold-mining district; by W. Keats.
- Report 22, Archaean geology of the Mount Narryer region; by I.R. Williams & J.S. Myers.

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Report 23, Professional Papers.

- A - Brachiopods and bivalves of the Kungurian (late Early Permian) Age from the top of the Coolkilya Sandstone; by N.W. Archbold & S.K. Skwarko.
- B - Geology and exploration history of uraniferous and auriferous pyritic conglomerates in Western Australia; by J.D. Carter & R.D. Gee.
- C - Geology and hydrogeology of the superficial formations and coastal lakes between Harvey and Leschenault Inlets (Lake Clifton Project); by D.P. Commander.
- D - Geochemical patterns in granitoids of the Corunna Downs Batholith, Western Australia; by Richard Davy.
- E - The transition between the Hamersley and Fortescue Groups as evidenced in a drill core; by Richard Davy & A.H. Hickman.

Record 1987/3, Explanatory notes on the Wyloo 1:250 000 geological sheet, Western Australia (Second Edition); by D.B. Seymour, A.M. Thorne, & D.F. Blight.

Record 1987/8, Information on Industrial Minerals, Collie area; by J.R. Gozzard. Record 1987/9, Information on industrial minerals, coastal plain between Fremantle and Bunbury; by J.R. Gozzard.

Record 1987/10, Information on industrial minerals, Broome; by J.R. Gozzard.

Explanatory Notes, Cue, Western Australia (Second Edition); by K.P. Watkins, I.M. Tyler & A.H. Hickman.

Explanatory Notes, Peak Hill, Western Australia (Second Edition); by R.D. Gee.

Explanatory Notes, Wyloo, Western Australia (Second Edition); by D.B. Seymour, A.M. Thorne & D.F. Blight.

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1:250,000 Geological Series (colour reprint) Kalgoorlie, Leonora, Sir Samuel.

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Gee, R.D., Myers, J.S. and Trendall, A.F., 1986, Relation between Archaean high-grade gneiss and granite-greenstone terrain in Western Australia: *Precambrian Research* 33, p.87-102.

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NB: Names underlined represent Geological Survey staff.

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## CHEMICALS IN THE COMMUNITY

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Frequent media coverage of fires, industrial accidents and transport spills plus better dissemination of safety information has led to a growing community awareness of the potential hazards associated with chemicals. This has been reinforced by new Government legislation in the areas of environmental protection, and occupational health and safety.

Requests for assistance are increasing and the involvement of the Government Chemical Laboratories (GCL) now embraces workplace monitoring, poisoning, accident investigation, community problems and environmental pollution.

The increasingly sophisticated nature of the requests requires the GCL to constantly improve their knowledge, understanding and technology.

While the Food and Industrial Hygiene Laboratory is directly involved in workplace assessments of chemicals, other sections of the GCL are developing specialist techniques in the areas of health, environment and the community.

The GCL undertakes occupational health assessments of industrial and mining locations. Field trips to the more remote mining locations can last up to two weeks. Scientific officers use rapid on-site determination of chemicals (e.g. portable infrared analyser and Drager tubes where different concentrations give different colours in the tube), as well as collecting samples for more sophisticated analyses back at the laboratory. Chemical exposure can include gases, mists, vapours, dusts and aerosols. The choice of analytical technique depends on the particular chemicals encountered.

Volatile organic chemicals such as solvents, paint thinners and petroleum hydrocarbons are often encountered in workshops, factories and laboratories. Occupational exposure can be determined using Gas Chromatography (GC). The more sophisticated technique of Gas Chromatography-Mass Spectrometry (GC-MS) may be required where the contaminant is unknown or mixed with other chemicals.

Occupational exposure to nuisance dusts as well as quartz and asbestos fibres is routinely determined by Scanning Electron Microscopy, optical microscopy and X-ray Diffraction spectroscopy.

The expanding industrial range of plastic and other synthetic materials means information is often sought concerning chemical structure, the nature of any additives, and identification of decomposition products in fires. While pyrolysis GC provides information on toxic decomposition products, the purchase of a Fourier Transform Infra Red Spectrometer has proved invaluable for identification of synthetic materials. Spectral analysis can be obtained on as little as a single fibre.

Water supplies are continually monitored to ensure they comply with the relevant standards. Instances of pollution such as the mercury contamination of Princess Royal Harbour at Albany require a long term study of marine biota, sea grasses and sediments.

Samples obtained from an oil spillage can be matched with those from the suspected source using specific identification techniques, coupled with a comprehensive library of analysed chemicals.

Baseline studies of water resources and community access areas, and measurement of contamination by pesticides, nutrients and industrial pollution are carried out by GCL staff and incorporate field investigation and analysis in the laboratory.

Health studies into the long term effects of chemicals require the determination of normal clinical levels of chemicals and their metabolites in biological samples. Analytical techniques have had to improve to measure the trace levels known to be biologically significant.

The recent acquisition of a Zeeman corrected Atomic Absorption Spectrometer helps provide this information on patient specimens forwarded through the State Health Laboratory Services.

A rapid service is also provided in case of accidental or industrial poisoning, where a series of samples may be forwarded for analysis to assess the effectiveness of medical treatment.

The need for chemical assessments in the workplace, environment and community in general will continue to increase the demands on the analytical service and consulting role provided by the GCL. Applied research into the hazards associated with chemical use will similarly expand as these Laboratories further improve their technology.



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# GOVERNMENT CHEMICAL LABORATORIES

Mr H.C. Hughes, BSc, FRACI  
Acting Director



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The years of uncertainty surrounding the future of the Government Chemical Laboratories (GCL) were brought to an end on 26 June when the Minister announced that the GCL are to remain a single consolidated unit as a part of the Department of Mines. The Government recognised the advantages in maintaining centralised facilities which would avoid overlapping and duplication of buildings and equipment, and would provide a central independent source of expertise available to all departments.

The GCL will now face the future with confidence and aim to provide an even more effective and efficient chemical consultancy service.

Following the Government's decision, more intensive plans will be made about the GCL's new site on land adjacent to Curtin University of Technology. The vision for the near future is the construction of new laboratories at Bentley in association with in the first instance a Mineral Research Centre.

Discussions are well advanced with scientific bodies involved in minerals which would see a conglomerate of laboratories and other facilities for joint use with the Curtin University of Technology. The participants would work together towards the common goal of aiding the exploration for minerals and developing the processing of minerals in this State.

Another exciting prospect for the future of the GCL is that it is poised to become more involved in the field of materials technology. Discussions have taken place which may lead to considerable development in this field and the GCL would be involved with organisations having expertise in materials technology. This is a 'high tech' area where the State is looking to a potential source of valuable exports and the industrial application of bright ideas.

Yet another area for sharing expertise mooted for the Bentley site is a Forensic Science Centre with the Police Forensic Branch working side by side with the Forensic Science Laboratory of GCL. If this is brought about it will be of considerable benefit to the field of forensic science and lead to a more effective and efficient service to the investigating police and to the courts.

The desirability of combining the Mineral Science Laboratory, the Engineering Chemistry Laboratory and Kalgoorlie Metallurgical Laboratory to provide more efficient use of resources has been considered over a number of years. The retirement of the Chief of the Engineering Chemistry Laboratory, Mr L. Brennan, late in the year, provided the opportunity to proceed with the amalgamation. From 1 May 1987 the three Laboratories became one, the Mineral Science Laboratory, under the Chief, Dr J. Hosking. This amalgamation is the first visible step in implementing the restructure of the GCL.

The functions of the three laboratories are being integrated with project team members having, where necessary, mineralogical, analytical, mineral-chemical and metallurgical expertise. The mineral processing project teams are also increasing their collaboration with staff from Murdoch and Curtin Universities and CSIRO, thus sowing the seeds for the future Mineral Research Centre.

The wealth of knowledge and expertise in the GCL is also used in a range of expert committees on which, in some facet of chemistry, each of the laboratories is represented. Advice to Government plays a role in forming Government policy.

In this role, the Laboratories have been most active in the last few years particularly in matters relating to the environment. All seven present Laboratories contribute in some way to environmental studies. With the recognition of the important role which the GCL has to play in the environmental field and to provide the Environmental Protection Authority with a focus for their needs, it is proposed to form an Environmental Section in its own right in the restructure of the Laboratories.

## Funding

After many difficult years in relation to the acquisition of equipment, access to loan funds for the purchase of major equipment occurred for the first time in 1986-87. This was a major breakthrough and although the equipment needs of the Laboratories were by no means fully satisfied a number of desperately needed major items of equipment were ordered.

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These were :

- Gas Chromatograph-Mass Spectrometer (\$467,000)
- Capillary Gas Chromatograph (\$95,000)
- Automated Gas Chromatograph (\$73,000)
- Auto Analysis Systems for Water (\$41,000) and Soil (\$37,000)
- Electrothermal Atomic Absorption Spectrometer (\$40,000)
- Autosampling and Data Handling Equipment for ICP Spectrometer (\$29,000)

All of these are now in operation except the Gas Chromatograph-Mass Spectrometer which is due to be installed early in the new financial year.

The desire of the GCL to co-operate with other organisations not only for the benefit of science but also for economic reasons again was evident when CSIRO took delivery of an Electron Microprobe at a cost of \$750,000. The State Government contributed \$150,000 to the purchase of the instrument which has already proved its worth and which will continue to be of considerable benefit to mineralogical and mineral processing investigations of the Mineral Science Laboratory. The Forensic Science Laboratory have also found it to be a very valuable tool in the investigation of physical evidence, particularly when the micro nature of the exhibits precludes analysis by other procedures.

#### Staff

Restrictions on advertising staff vacancies because of the uncertainty of the future of the Laboratories resulted in an unusually high number of temporary staff whose tenure was generally renewable at one to three monthly intervals.

There continues to be loss of senior staff, a trend which has peaked in the last few years. Two long serving senior officers to retire during the year were Les Brennan and Roy Wood.

Les Brennan had joined the Fuel Technology Laboratory in 1948 and spent his first years working at Collie on coal. His expertise as a Fuel Technologist resulted in many years service on the Clean Air Act Scientific Advisory Committee. In 1969 he joined the Engineering Chemistry Laboratory becoming Chief in 1985.

Roy Wood joined the Food and Drugs Laboratory in 1951 taking a particular interest in micro-analysis. He had the unique experience of being the chemist who confirmed that the discovery at Rough Range No. 1 was indeed petroleum. Roy served as Assistant Chief of the reorganised Food & Industrial Hygiene Laboratory for 26 years.

Jack Staniforth, for a long time the reliable and unflappable technician in charge of water analyses, retired after 23 years service.

Another similarly reliable officer in Bryan Skeet retired from Mineral Science after 13 years service and June Nankivell retired as Assistant Librarian after 8 years service.

#### Publications and Lectures

The broad spectrum of chemical investigation, research and analysis carried out by the various laboratories results in a reservoir of expertise which is tapped by a wide range of Government departments and authorities and private industry.

The results of the research and investigation are published in a range of scientific journals as well as being transmitted by way of conferences and symposia. The following list of publications confirms the GCL as a leader in Australia and in some instances in the world in many aspects of applied chemistry:

Allen, D.G., Greirson, B.N. and Wilson, N.L., Chemical Analysis of Antinutritional Factors in Sweet Lupinseed; Proc. IV Int. Lupin Conf., Geraldton, 1986, p. 291.

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Bolland, M.B.A. and Allen, D.G., 1987, Comparison of 3 Soil Tests for Phosphate on Laterite Soil Fertilised with Superphosphate, Crandallite, Rock Phosphates and Apatite Rock Phosphates; Aust. J. Soil Res. (in press).

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Clarke, R.M. and Williams, I.R., 1986, Moolooite, a Naturally Occurring Hydrated Copper Oxalate from Western Australia; Mineralogical Magazine, 50, p. 295.

Coates, P., 1987, Plant Analysis Quality Assurance Programme; GCL Report.

Codling, B., Development of a Laboratory Information Management System; Proc. IX Aust. Symp. on Analytical Chemistry, Sydney, 1987, vol I, p. 180.

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Greirson, B.N. and Allen D.G., 1987, Immunoassay for Lupin Alkaloids; progress report on project for Grain Research Committee of WA, GCL Report.

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Hansson, R.C., 1986, Fifteen Deaths Associated with Dextromoramide; The Int. Assoc. of Forensic Toxicol. Newsletter, 19, November.

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Hansson, R.C., Henderson, M., Jack, P. and Taylor, R., 1987, Production of Iodoform in Drinking Water by Chloramination; Water Research (in press).

Harris, D.J., Silylation : An Improved and More Accurate Method for Analysis of Lupin Alkaloids by Capillary Gas Chromatography; Proc. IV Int. Lupin Conf., Geraldton, 1986, p. 329.

Harris, D.J. and Jago, J., Chemical Composition of WA Sweet Lupinseed over Seasons 1982/83 to 1985/86; Proc. IV Int. Lupin Conf., Geraldton, 1986, p. 290.

Harris, D.J. and Spadek, Z.E., Isolation of Standard Alkaloids and Profile of Bitter Lupinus angustifolius Cultivar Fest; Proc. IV Int. Lupin Conf., Geraldton, 1986, p. 328.

Jack, P., Nutrient Status of the Swan/Canning Estuary; Proc. Swan River Symposium, WAIT, 1986 (in press).

Jeffery, R.C., 1986, Chemical Data of Soil from the Fitzroy River Valley Djada and Gogo Land Systems; GCL Report.

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LaBrooy, S.R., Bax, A.R., Muir, D.M., Hosking, J.W., Hughes, H.C. and Parentich, A, Fouling of Activated Carbon by Organics; Proceedings of the International Conference on Gold, vol 2, Extractive Metallurgy of Gold, Johannesburg, SAIMM, October 1986, p. 123.

McLinden, V.J., 1987, Experiences in Relations to Drugs/Driving; J. Forensic Science Society, 27, p. 73.

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Yeates, J.S. and Allen, D.G., 1987, Low Effectiveness of Three Rock Phosphates as Phosphorus Fertilisers and Liming Materials on Acid Clay Loam from SW Australia; Australian J. Agric. Res. (in press).

Yeates, J.S., Deeley, D. and Allen, D.G., 1987, The Agronomic Effectiveness of Phosphorus Fertilisers for Subteranean Clover Growth on Sandy Soils, 2. Influence of Liming; submitted to Aust. J. Agric. Res.

#### AGRICULTURAL CHEMISTRY LABORATORY

The efficiency of the laboratory was maintained at a high level and for the second successive year more samples were reported out (52,783) than were received (49,349) resulting in a significant reduction in the backlog.

Contributions to scientific conferences (8 poster papers), research journals (7 papers) and scientific reports (6) were indicative of the laboratory's very active research programme.

Three research grants were awarded to the laboratory by the Grain Research Committee for further work on lupins.

#### Lupin Research

Work has commenced on the development of an enzyme-linked immunosorbent assay (ELISA) for lupin alkaloids in a joint project with staff from the Department of Medical Technology, Curtin University of Technology.

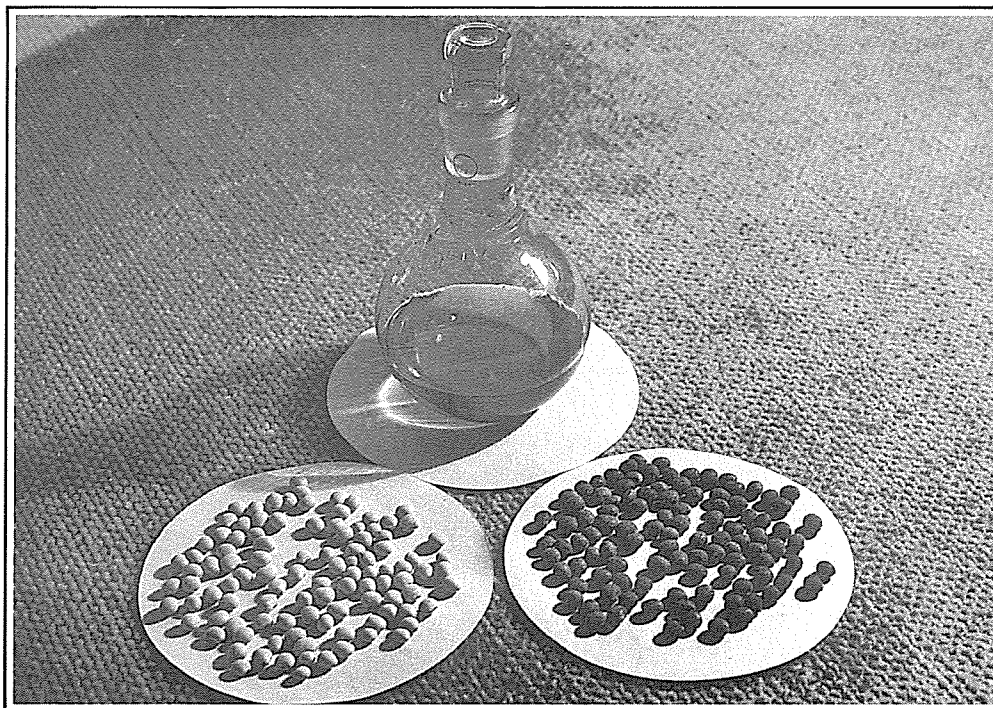
Two lupin alkaloid-protein conjugates have been synthesised one of which is being used for antibody production from rabbits.

The advantages of the ELISA test when developed will be its sensitivity, low cost and rapid throughput. This State has the world's largest and most comprehensive lupin breeding programme and its success depends on careful control of the alkaloid content in the large number of selections involved in the production of new commercial varieties.

Work was completed this year on the extraction and purification of 1.5 kg of lupin alkaloid to be used by the British Industrial and Biological Research Association for toxicity and mutagenicity trials.

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A research project on antinutritional factors in lupinseed, funded by the Rural Credits Development Fund, was also concluded this year.



Alkaloid extracted from bitter sweet lupins (dark seeds).  
Sweet lupins (white seeds) bred for low alkaloid content

#### Analysis Systems

A Technicon Autoanalyser system, the only major equipment acquired by the Agricultural Chemistry Laboratory this year, has been fully commissioned by the Soil Chemistry Section for extractable forms of phosphorus and nitrogen. The equipment will enable the laboratory to continue support for the Peel-Harvey Estuary research on phosphorus pollution and the extension of this work to similar problems developing in the Albany area.

The Inductively Coupled Plasma (ICP) Atomic Emission Spectrometer in the Mineral Science Laboratory is now being used for routine determination of nutrient elements in plant tissue, fertilizers and gypsum. Problems in the system are essentially software ones. When these are fully resolved it would be feasible for this laboratory to support the Department of Agriculture with a rapid diagnostic service for plant tissue analysis. The current capacity, allowing for other users of the equipment, is about 500 samples/week. An investigation was commenced on the application of a bar code label system to increase the reliability of sample identification. Further work was undertaken on a laboratory information management system to improve the efficiency of operations.

#### Quality Assurance

The laboratory maintains a constant watch on the quality of its analytical data by incorporating control samples in all batch runs, frequent replicate analyses, checks against standard reference materials and most importantly participation in international and interstate quality assurance programs.

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In a program operated by the Netherlands Wageningen Agricultural University, in which six plant samples are sent bi-monthly to nearly 200 participating laboratories world wide, this laboratory ranked highly in the accuracy of its analysis of all the major and trace plant nutrients.

Our analytical results on Magruder fertilizer reference materials received monthly from the Association of American Plant Food Control Officials were in excellent agreement with the mean of 50 participating laboratories.

Other inter-laboratory comparisons on the analysis of soil and plant materials were conducted with the Department of Agriculture and the Department of Services and Supply in South Australia and with private laboratories.

In general, State Laboratories appear to be well ahead of their private sector counterparts in terms of data reliability.

#### Molybdenum Deficiency

There are over three million hectares of WA soils in which the productivity of wheat and pasture legumes is affected by molybdenum deficiency.

An investigation is being conducted into the effectiveness of different molybdenum fertilizers, the migration rate of molybdenum from fertilizer granules and soil adsorption characteristics. Leaching experiments have shown that the water soluble molybdenum content and rate of movement from fertilizer granules vary according to the source of the fertilizer. These factors will inevitably influence the long term residual effectiveness of applied molybdenum and are under further investigation.

#### Marron Farming

Soils were analysed to assist in the selection of material with suitable dam floor characteristics and with ability to supply nutrients.

Dispersion tests together with flocculation experiments using local water were carried out to assess whether turbidity could be maintained to provide protection against predators.

In a separate investigation, the amino acid profile and other components were determined in marron flesh and carapace, and in prawn and crayfish waste with the object of finding a feeding material to improve the growth rate of juvenile marron.

#### ENGINEERING CHEMISTRY LABORATOR

The Laboratory continues to support a wide range of projects related to the processing of Western Australian minerals. These range from gold, mineral sands, alumina, vanadium, iron ore, zircon, nickel and other processing projects to the evaluation of building materials and to the utilisation of mining wastes. Seventy percent of projects assisted the gold industry.

#### Collaborative Projects

Many of the Laboratory's projects which are helping to improve and increase the processing of minerals in Western Australia are carried out in conjunction with CSIRO and tertiary institutions.

Collaborative research is being carried out with Murdoch and Curtin Universities in an ongoing AMIRA sponsored project which is investigating carbon-in-pulp (CIP) gold processing. A second project involving WAMPRI, Curtin University of Technology and CSIRO commenced in December 1986. This project is investigating the problems of roasting and leaching refractory gold concentrates. The two year project is sponsored by WAMPRI and the gold producers North Kalgurli Mines Ltd, BHP, Newmont and Pancontinental. The project will utilize the new electron microprobe which was partly funded by the WA Government and recently installed at CSIRO in Floreat Park.

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Additional projects relating to flotation are being undertaken with the Bentley group of the Minerals and Geochemistry Division of CSIRO.

Local consultants are also making more use of the facilities and staff knowledge.

#### Gold Metallurgy

Considerable expertise and data have been generated on various aspects of the CIP process for extracting and recovering gold. The CIP process uses granular activated carbon to recover gold from cyanide solutions. The gold is desorbed from the carbon with a hot caustic cyanide solution. The solution is then electrolysed to deposit metallic gold on a steel wool cathode. Before the barren carbon is recycled it is usually reactivated at temperatures above 600C. The important factors influencing the efficiency of the CIP process have been established through in-house experiments, visits to operating gold mines, assistance from suppliers and equipment manufacturers, and collaborative research with Murdoch and Curtin Universities.

Research carried out in the last 2 years has given a better understanding of the fouling and reactivation behaviour of carbon. This has led to an increase in the volume of sponsored testwork from the gold industry, particularly in the monitoring of carbon reactivation kiln efficiencies and adsorption circuit behaviour. Other aspects of the CIP process which have been examined include the effect of water quality on gold desorption from carbon, electrolytic recovery of gold, the loss of fine carbon in tailings, the evaluation of the hardness of commercial carbons, and the development of new analytical methods for gold and other elements adsorbed on carbon. Improved plant performance has resulted from these investigations.

During the CIP process the carbon particles slowly wear and as a consequence some is screened out after each cycle. This carbon usually contains around 100g per tonne of gold and is often stored for later recovery of gold. Attempts were made to recover the gold after burning the carbon in a fluid bed, but recoveries were low. Alternative procedures are being examined.

Although the majority of clients have been from the WA gold industry there has been an encouraging number of requests for test work from large and small gold miners in Queensland, Northern Territory, Tasmania and South Australia indicating the recognition of the expertise within the Laboratory which is readily available to industry.

#### FOOD AND INDUSTRIAL HYGIENE LABORATORY

The Laboratory's activities in the area of occupational health, safety and chemical management have continued to increase. This is due to growing public perception of chemicals in the workplace and environment.

#### Hospital safety

Technical support and applied research for the State's hospitals were extended this year. Hospital extensions were visited and new reticulated gas lines inspected to ensure the correct gas was supplied to each outlet free of contaminants.

Growing concern over the use of ethylene oxide has led all hospitals to review their equipment sterilisation procedures. The Laboratory assisted Royal Perth Hospital in designing a humidity control system for calibrating gas equipment, and in commissioning tests on installation of the automatic monitors and alarms used to detect ethylene oxide leaks in the sterilisation equipment.

A survey of pathology and neuropathology laboratories was undertaken to measure staff exposure to formaldehyde and other chemicals routinely used in laboratory work. Exposure was often reduced by improvements to ventilation. Measurement of exposure to iodoform in a pharmaceutical laboratory required the development of new analytical techniques.

#### Coating technology

The commercial use of a polyamine cured epoxy resin system has resulted in a wide ranging project with the company and other Departments. The specialised coating technique was monitored during spraying to

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determine the extent and nature of spray drift. As the resin required a relatively slow cure, laboratory trials studied the kinetics of the curing reaction, along with leaching rates of components into aqueous and organic solvents.

#### Treatment of fruit

Concern over ineffective post-harvest treatment of fruit resulted in an investigation in conjunction with the Department of Agriculture. Unless fruit is adequately treated prior to storage, life is limited, causing considerable losses to growers. A series of trials using a commercial product recommended a change in the composition of the treatment solution. This should overcome storage problems and the reduced shelf life of the produce.

#### Pesticides

An increased emphasis on pesticides in food and the environment was evident this year.

The pesticides survey undertaken on fresh foods for the Health Department was repeated in expanded form this year. The range of pesticide residues for which analysis was done included organochlorines, organophosphates, carbamates, pyrethroids and organotin compounds necessitating further developmental work on multi residue methods of determination. The range of crops examined was extended to fruits such as apples, apricots, grapes, mandarins, nectarines, peaches, pears, plums and oranges as well as vegetables.

Of the 117 samples received, less than 2 percent had pesticide residue levels exceeding the maximum residue limit (MRL). Forty percent of samples had no detectable residues. Of note was the presence of DDT and fenthion in over 20 percent of fruit samples at levels well below the respective MRLs.

An increased number of fruit and vegetable samples were also received from the Department of Agriculture as part of their research effort into replacing the few remaining uses of organochlorine pesticides in horticulture. The principal crops concerned are potatoes and fruit including apples and pears. Candidate compounds under trial included organophosphates, carbamates and pyrethroids. As a result of this work new recommendations on plant protection will be forthcoming.

#### Herdsmen Lake Argentine Ant Control

With the construction of a moat around part of Herdsmen Lake the Department of Agriculture commenced a major argentine ant eradication program around the north eastern sector of the lake with heptachlor and chlorpyrifos. Because of concern about the ecological effects of this spraying, the Herdsmen Lake Subcommittee on Argentine Ants initiated a research program to evaluate the short and long term effects of spraying. The research group consisted of staff from the GCL, Murdoch University and Department of Conservation and Land Management.

Work has been carried out to assess the pesticide burden of the lake and its biota, establish the contribution to this burden from drains and compare the lake with other metropolitan lakes with varying histories of pesticide treatment.

Results to date have been encouraging with respect to the ecological effects of spraying on the lake. The combined research effort is expected to be completed in the following year enabling a decision to be made on future spraying for argentine ant control around Herdsmen Lake.

#### FORENSIC SCIENCE LABORATORY

Publicity given to the detection of etorphine, the stimulant narcotic drug better known as 'Elephant Juice', in a number of horse race winners highlighted the role the laboratory plays in providing a forensic service to the West Australian community in general. This role has increased in recent years particularly with respect to the control of drug abuse in prisons and doping control programs in horse racing. The service provided to the Department of Corrective Services and the Western Australian Trotting Association and Western Australian Turf Club is as important for the proper control of horse racing and prison administration as is the analytical, advisory and support service provided to the Police for law and order in general.



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### Alcohol Drugs and Driving

A total of 1,127 exhibits were received from the Police Traffic Branch, 65 percent in connection with sobriety offences and the remaining 35 percent from traffic accident victims.

Although the role played by alcohol in traffic accidents and offences is well understood, that of drugs is much less clearly defined. It is nevertheless disturbing that the frequency of drug detections in sobriety cases increased by 12 percent in the period under review. In particular the number of cases in which cannabis was implicated rose by 125 percent from 20 to 45.

### Toxicology and Drugs

A major function of the laboratory is the examination of cases submitted by the Police Coronial Inquiry Section for drugs and poisons, to assist in determining the cause of sudden deaths.

In the course of examination of 421 such cases a total of 87 different drugs or poisons were detected. Carbon monoxide continued as the most frequent cause of death and although the number of cases in which morphine was detected remained static the number of deaths which were attributable to heroin abuse fell by 60 percent from 17 to 7.

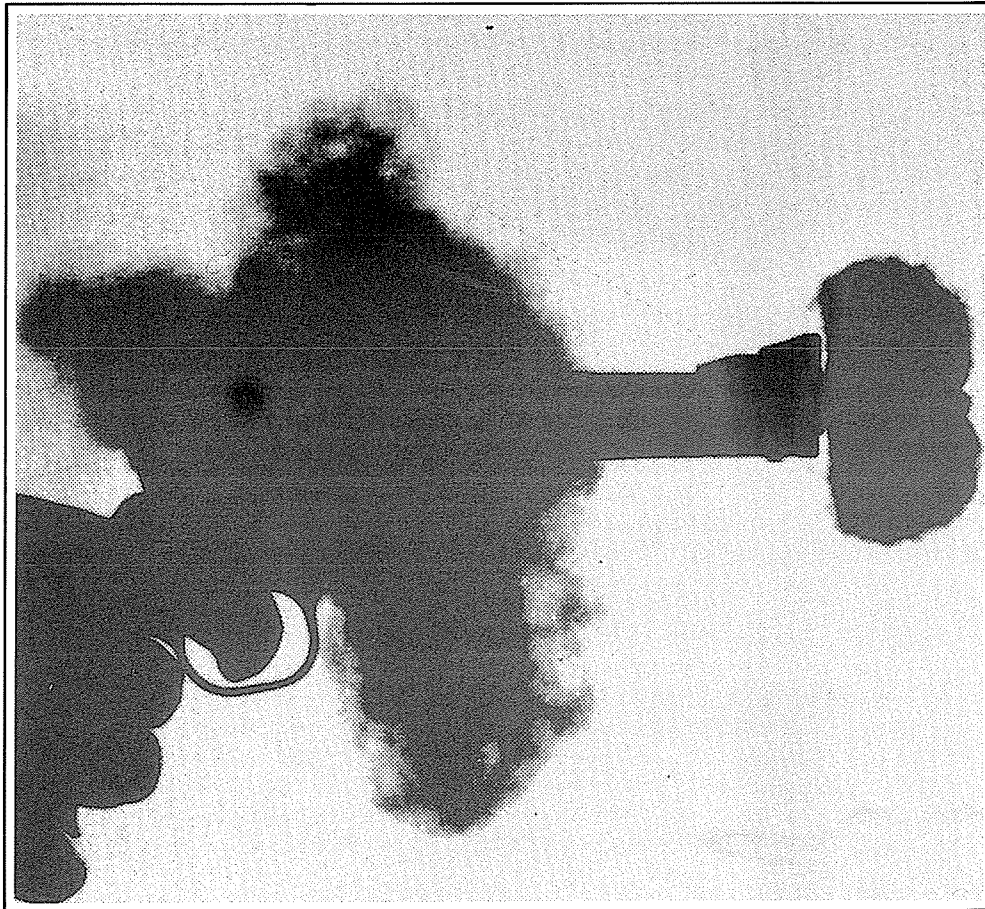
This decrease in heroin deaths was mirrored by a similar decline in illicit drug seizures involving heroin submitted for examination by the CIB Drug Squad, from 182 to 93.

### Doping Control in Sport

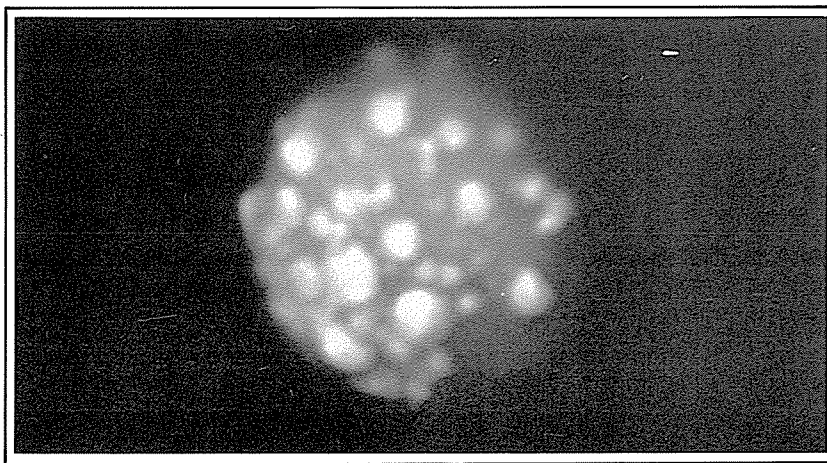
To enable the laboratory to keep one step ahead of would be dopers, the WA Equine Drug Disposition Research Group was established last year to study the effects of, the detection of, and the excretion kinetics of drugs in race horses. The detection of etorphine or 'Elephant Juice' was directly attributable to research carried out by the group and as such the result was gratifying. Etorphine and many of the other drugs investigated by the group require specific target analysis for their detection and it is of some concern that while the techniques have been perfected, the laboratory does not yet possess sufficient resources to mount the number of target analyses required to completely eliminate the scourge of horse doping.

### Criminal Investigations

In common with previous years the wide variety of materials from scenes of crime included fire debris, blood and urine, paint, glass, fibres, explosives and gunshot residues. There was a considerable increase in the gunshot residue samples in 1986/87. The majority of cases involved swabs taken from the hands of suicide victims where the firearm was usually a longarm (rifle) rather than a pistol. The purpose of the examination of the swab was to determine if a person discharged a firearm. Ammunition primer residues are emitted when the firearm is discharged.



Clouds of gunshot residue from a magnum 0.357 hand gun.

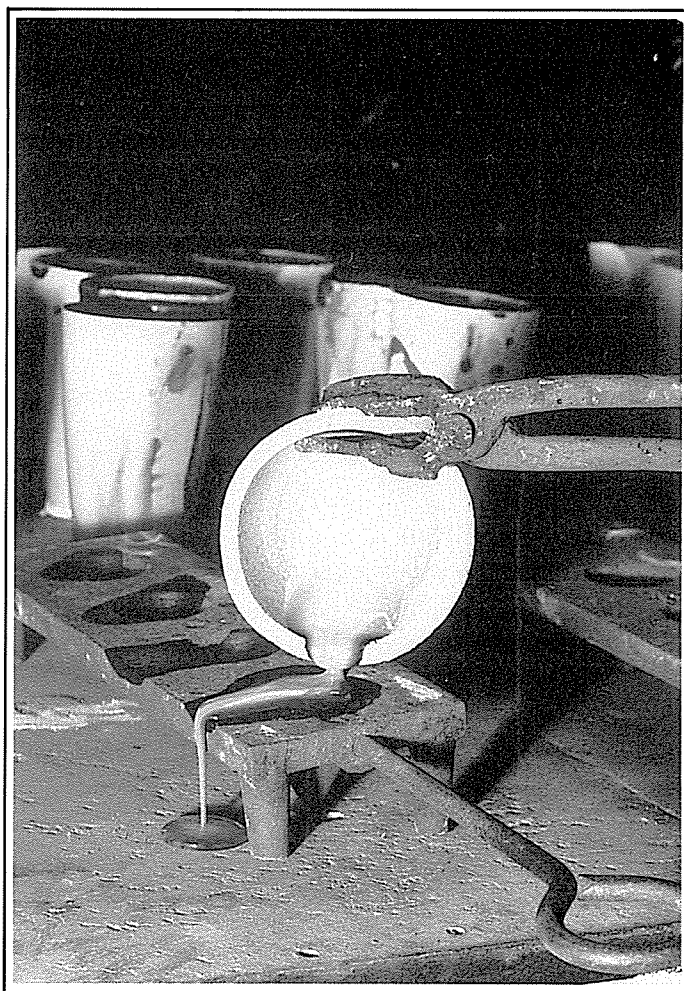


Electron micrograph of a single gunshot residue particle.

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## KALGOORLIE METALLURGICAL LABORATORY

The continuing boom in the gold industry has seen further growth in the Laboratory's throughput. Sample numbers rose by another 43% in the past year resulting in more than a four fold increase over three years. The number of bullion samples assayed has also risen again with the opening of new mines and the continuing reliance on this Laboratory for accurate gold fineness results. The Laboratory is currently looking to link the balance used for this work to a small computer to eliminate any possible transcription or calculation errors and to automate certificate typing.



Fire assaying for gold.

Metallurgical testwork has centred almost exclusively on gold recovery. The industry trend toward heap leaching of lower grade ores of coarse sizes has been reflected in the number of samples submitted for column leach cyanidation.

An influx of new staff and post-graduate students has seen a dramatic upsurge in the research effort of the School of Mines Metallurgy Department. An excellent working relationship exists with the School and, where staff numbers allow, the Laboratory is taking a small part in joint research and development work. There is great potential for co-operative projects both with the WASM and with the other Laboratories involved in gold investigations but this is unlikely to be realised under the current routine workload. Successful co-operation has been achieved in fire assaying, with the Laboratory providing the necessary lecturing expertise for the WASM to run Certificate level fire assay courses for the personnel from local industry.

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## MATERIALS SCIENCE LABORATORY

During the year 18 State departments, several local and Commonwealth government bodies and over 30 clients from private industry used the services of this section. Independent product quality assessments and failure analysis continue to be important. Staff expertise in a wide range of topics, particularly in building materials and industrial chemicals, is utilised by small business and consumers generally.

### Investigation and Industry Support

Staff were involved in a wide range of consultative matters including a Water Authority collaborative project with a local fibreglass manufacturer to design and produce a glass reinforced plastic bore casing.

An investigation into the efficacy of rust conversion chemical treatments (as an alternative to sand blasting) prior to painting is continuing. Departments with major structural steel maintenance responsibilities (Westrail, Building Management Authority, SEC) could save millions of dollars if some of the claims made by manufacturers of rust conversion products can be substantiated.

Premature failure of coating systems is a problem for large paint users such as Main Roads Department. In one case severe chalking (after a few months exposure) of an epoxy paint system used on guard rails in the North West of the State resulted in accelerated laboratory testing and recommendation of an alternative high performance polyurethane coating system.

At the request of the Police Department in one instance and the SEC in another, industrial clothing (overalls, boots, jackets) from a number of suppliers was tested for flammability and chemical resistance to enable suitable outer garments to be provided for staff required to attend emergency scenes.

### Fourier Transform Infrared Spectroscopy

The FTIR facility commissioned in 1986 is proving a powerful analytical and investigational tool. Two examples of current FTIR usage are

- Investigation into fouling mechanisms on carbon particles during carbon-in-pulp gold recovery.
- Dating of historical artifacts by chemical characterisation of gums and other deposits on the artifacts.

### Environment

Technical appraisals were conducted on proposed new chemical industries such as a sodium cyanide plant, tannery, pigment manufacturing plant and several incineration plants for disposal of hazardous chemical wastes. This work is carried out at the request of government bodies such as the Environmental Protection Authority or as an independent consultant to private clients.

## MINERAL SCIENCE LABORATORY

The Laboratory's chemical and mineralogical expertise were used by some 20 government departments and authorities to analyse and characterise rocks, minerals, building products, dusts and related materials.

The associated consulting and advisory service has assisted many projects and investigations and helped solve problems related to mineral exploration, mining, mineral processing, occupational health, forensic investigations, environmental programs, consumer protection, and the building and construction industry.

### Geological Samples

The Laboratory provides a comprehensive service to the Geological Survey of WA. A vast variety of geological specimens are submitted to the Laboratory for chemical and mineralogical examination. The range of elements determined in these samples has recently been increased from 53 to 65 with the inclusion of twelve rare earth elements.

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Rare earth elements, the 14 elements after lanthanum in the periodic table, are generally present at low levels in silicate rocks. The relative abundance of the rare earth elements in geological samples compared with the levels in chondrites, material which may represent primitive solar material and thus can be expected in the Earth's mantle, is used to give valuable geological information. Relative enrichment data for groups of the rare earths or even individual elements provide information about petrogenetic processes.

Analytical procedures have been developed to enable the low levels of these elements to be determined in silicate rocks. After dissolution the rare earth elements are separated from other elements by ion exchange chromatography. The solution containing the rare earth elements is then analysed by inductively coupled plasma atomic emission spectroscopy. This technique allowed the determination of twelve of the rare earth elements. This is considerably better than many published procedures which only report results for six or eight elements.

The procedures are also available for the determination of the rare earth elements in mineral sands. Western Australia has a significant proportion of the world's ore reserves of these elements.

#### NATA Assessment

The Laboratory is registered by NATA (National Association of Testing Authorities) for a large number of chemical tests relating to the analysis and testing of geological samples, minerals, metals and building materials. This registration is granted after a thorough assessment (by experts in the area) of staff expertise, and test methods and procedures.

Over a period of many years the Laboratory has also developed considerable expertise in areas related to occupational hygiene such as the identification of asbestos minerals and other mineral fibres and particles in air. This technical proficiency has also been used to assist and train staff from commercial laboratories so they could provide a service to industry.

The Laboratory was recently reassessed for the estimation of the fibre concentration in air. At the same time a NATA assessment was carried out on the Laboratory's ability to identify asbestos mineral fibres.

Officers of the Laboratory regularly use these skills to provide on-the-spot identification of insulation materials brought to the Laboratories by staff from the Department of Occupational Health, Safety and Welfare and from other Departments.

Mineral ore and gangue samples from mine sites are also evaluated for fibrous minerals. If the air breathed by workers contains fibres which are small enough to be deposited in the lungs they may constitute a health hazard. Recent operations monitored by Mining Engineering Division officers include vermiculite mining and processing. Vermiculite deposits have been shown to contain small amounts of fibrous minerals including anthophyllite. As a result of the monitoring, dust suppression procedures have been implemented to ensure the work force are not exposed to potentially hazardous materials.

#### Limestone

Limestone, an industrial mineral used in the production of cement and lime, is also used as a building material and a base for road construction. Its quality is usually determined by the percentage of calcium and magnesium and the acid insoluble content. However, road base performance is also dependent on other factors.

The Laboratory has been involved in a project aimed at finding additional tests which can assess the performance of limestone for road bases.

Attrition tests were carried out on behalf of the Main Roads Department on limestone from quarries in the Perth-Bunbury region. The method involved tumbling small representative samples of stone and weighing the attrition products obtained after three hours tumbling. 'Hard' limestones recorded a weight loss of less than 20 percent and 'soft' limestones a weight loss of between 30 and 50 percent. Limestones that performed well in road construction were found to be mainly in the softer range.

The production of sand sized particles of limestone rises steeply and linearly as the attrition percentage rises, showing that this figure in effect measures the relative 'crumbliness' of a limestone. This in turn relates to its degree of cementation. The capacity of a limestone to reset is considered to depend largely upon an optimum proportion of disaggregated sand sized particles in the road bed.

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## WATER SCIENCE LABORATORY

The diverse uses of water are reflected in the range of departments and authorities who utilise the Laboratory's expertise and experience. The Laboratory is required to assess water quality and determine its suitability for reticulated supplies, farm and stock use, and specific uses like fish culture. If it is not suitable, treatment recommendations are made.

### Iodoform taste

As indicated a year ago the medicinal taste in the Kalgoorlie and agricultural area water from the Mundaring Weir was thought to be due to iodoform. This problem was rectified after suggested modifications to the treatment procedures were implemented.

A similar problem exists in Brisbane where iodoform levels around the taste threshold levels of 5 micrograms per litre have been observed. The treatment procedures used for the past 50 years were the same as in the Mundaring treatment plant prior to the successful modifications.

### Geraldton's dirty water problem

Geraldton has had for many years a problem due to iron contamination of its water supply. It had been previously shown that this was not due to rusting of the distribution pipes. The mean level of 0.3 mg/L iron in the water is sufficiently low not to be a problem.

Further concerted work this year confirmed levels of iron from less than 0.05 to 5 mg/L in the approximately 30 bores. However the level of iron varied significantly with pumping time. The initial levels of iron were high. After a few days the iron values were generally quite low ( 0.1 mg/L). As a consequence of this finding a bore management programme was implemented in November 1986 which uses maximum operating times for each bore. The indications are that this programme has significantly reduced the problem.

It is believed that the iron is coming from unweathered pyrite (iron sulphide) nodules.

### Cyanide leakage

Cyanide is widely used in Western Australia in gold recovery process plants. After the dissolved gold is removed the remaining solution and insoluble materials are pumped to holding ponds to allow the waste material to settle before recycling the solution. Recent monitoring of bores around the ponds has shown measurable levels of cyanide. However the analysis of these solutions containing a mixture of free and complexed cyanides is difficult. The Laboratory has organised an inter-laboratory study and is assisting commercial laboratories to improve their procedures so that reliable and consistent results can be obtained.

### Bromide

The chloride to bromide ratio is used by hydrogeologists as a means of tracing the movement of underground water. The Laboratory has successfully introduced the technique of ion chromatography to determine this ratio.

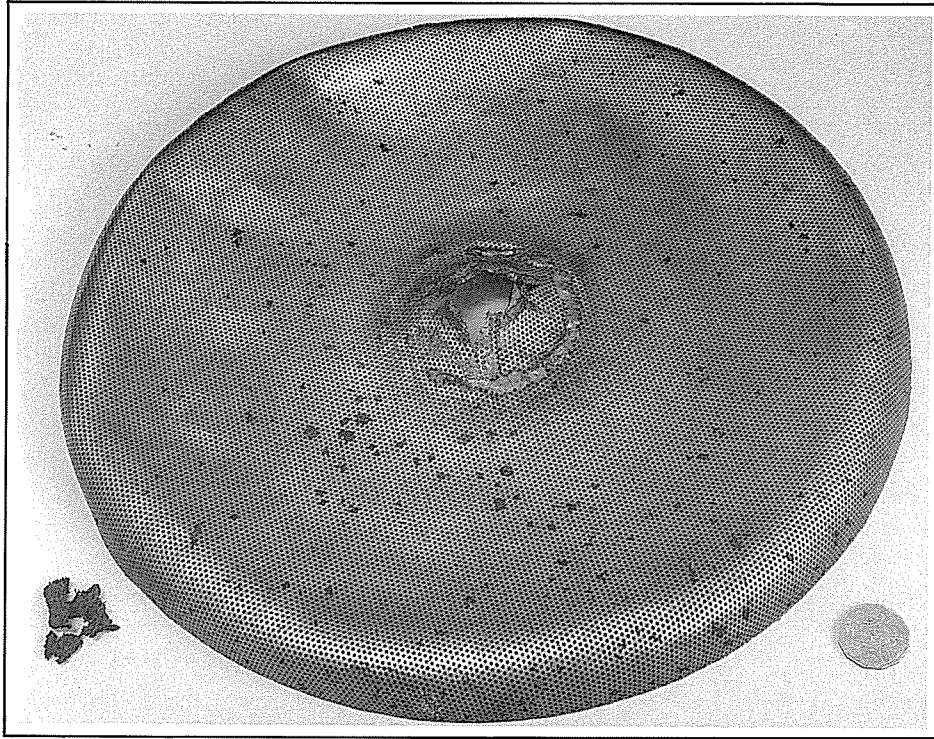
### Pipe moss

Two instances of problems due to the bryozoa *Plumatella repens* were identified for the first time in WA though these were well known in Victorian town waters in the seventies. Commonly called pipe moss because of their moss-like appearance, these plant-like animal growths can greatly reduce water flow.

The first occurrence was in Kalgoorlie where large diameter meter screens were ruptured by the pressure increase due to the plumatella. Accumulated growths were dislodged from pipe walls by the first effective chlorine residuals in the Kalgoorlie reticulation (resulting from the chloramination program).

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The second was in a fish culture venture on a farm out of Geraldton where the water which was diverted through pipes to trout tanks was blocked by plumatella growth. Some trout died from lack of oxygen.



Meter screen ruptured by bryozoa.

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# GAS RECYCLING: SCIENCE AND ECONOMICS

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The gas recycling project on the North Rankin A Platform is expected to more than double condensate production from the North Rankin field to over 3000 cubic metres (18,000 barrels) a day for the next seven years, producing an additional 4 million kl (25 million barrels) of condensate in the early life of the platform.

Gas recycling is the term used for producing gas from a natural gas reservoir, removing the liquids associated with the gas, and returning the gas to the reservoir for recovery at a later date.

The benefits of gas recycling are three-fold. In the first place, higher condensate volumes are produced for sale than originally planned in the early years of gas production. Secondly, because it is being done when the reservoir pressure is still high, the actual recoverable reserves of condensate are increased. Thirdly, the gas recycling will help maintain reservoir pressures.

Condensate, a light oil, is gaseous at the high pressure (31 MPa) and temperature (105C) existing in the natural gas reservoir and only condenses to a liquid as the pressure and/or temperature is lowered. The phenomenon of liquid condensation as pressure is reduced is known as retrograde condensation and commonly occurs in the reservoir as the pressure is lowered by depletion. Without gas recycling, production from the reservoir would cause liquids to condense out as the pressure falls and remain deposited in the reservoir rock, reducing the overall condensate recovery.

On the North Rankin A Platform recovered natural gas is depressured to 11.3 MPa and cooled to 38 - 42C causing much of the condensate to condense out. The liquid is separated from the gas and is treated to remove formation water and then put with the dehydrated gas into the subsea pipeline to the onshore treatment plant.

## Spare Capacity

The gas/liquid separation and treatment facilities on the platform currently have sufficient production capacity above that required for domestic gas and early LNG demands. Some of this spare production capacity is being utilised for gas recycling in the interim period before full LNG production is required.

The excess dehydrated gas at 11.3 MPa and 40C is fed to the gas recycling facility which consists of a gas turbine-driven two-section centrifugal compressor. Compressed gas discharges from the first section at about 20 MPa and 90C and is cooled in the compressor intercooler to enter the second section of the compressor at about 20 MPa and 40C.

Gas is discharged from the second section of the compressor at 30 MPa and 70C and piped to the wellhead area into the reservoir via five dedicated gas injection wells.

The multistage compressor, operating at a speed of 10,000rpm, has a forged barrel of 720mm diameter, 220mm wall thickness and is two metres long. A total of six stages is used in two sections of three stages, each of which is arranged back-to-back to assist in balancing out the axial thrust imposed on the rotor and its thrust bearings. A speed increasing gearbox is included to raise the power turbine speed of 5400rpm to the required compressor speed.

The gas turbine driver selected for the compressor set was a Rolls Royce RB211 industrial gas turbine, a derivative of the compact aircraft gas turbine used on the Boeing 747 Jumbos. The RB211 gas generator is constructed from five modules - all fully interchangeable with standard replacements.

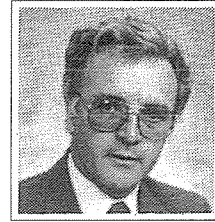
The North Rankin Field is located 130km north-north west from Karratha off the coast of Western Australia. The first exploration well, North Rankin-1, was drilled in 1971 and since then 5 field appraisal wells and 13 development wells have been completed of which five wells are used for gas reinjection. Production started in July 1984 and, for the year ending 30 June 1987,  $2700 \times 10^6 \text{ m}^3$  of gas and  $411 \times 10^3 \text{ kL}$  of condensate were produced.

The main reservoir is in the Upper Triassic Mungaroo Formation. Gas is currently being produced at a rate of about  $8700 \times 10^3 \text{ m}^3$  per day and condensate at 1500 kL per day. Total recoverable reserves of gas and condensate at North Rankin are estimated to be  $225 \times 10^9 \text{ m}^3$  and  $24 \times 10^6 \text{ m}^3$  respectively.

In late 1985 an agreement was reached to sell LNG to Japan. The 20-year agreement, with the first shipment scheduled for October 1989, requires exports reaching a plateau of 6 million tonnes per annum.



# PETROLEUM DIVISION



Mr I. Fraser, BSc(Hons), Geophysics/Geology  
Director

## Exploration and Development

Sixteen exploration wells were drilled in 1986-87 compared to 29 in 1985-86. Metres drilled also dropped dramatically from 79,286m to 28,357m, a reflection of the general economic downturn and particularly the falling oil price, which also affected the 1985-86 statistics. Seismic surveys were also down from 40,623 kilometres in 1985-86 to 17,462 kilometres in 1986-87. There were signs however towards the end of the period that the level of activity was starting to pick up again.

A list of wells drilled and geophysical surveys conducted in 1986-87 is shown in the tables in the Statistical Summary.

Most drilling was concentrated in the offshore Carnarvon and Bonaparte Basins and very little took place onshore, which contrasts sharply with last year.

The most significant developments in this period were the discovery of oil columns in Saladin-2 and -3 where record single-test oil flows were recorded, 11,287 barrels of oil per day (1800 kL/d). Development plans for the Saladin field are well underway. Encouragement was also gained from the drilling of Goodwyn-9 which confirmed the presence of a section in the Goodwyn Field with a very high condensate-to-gas ratio. These results could significantly improve the economics of the North West Shelf Project. Also of significance was the discovery of a new oil zone in the small Mt Horner Field in the northern part of the Perth Basin by Barrack Energy, which is drilling a second well in the area, Horner West-1 on a separate structure.

Early in 1987 the Japan National Oil Corporation was given permission to carry out a 5400 kilometre seismic survey in the offshore Canning Basin, the first entry into Western Australian exploration by a Japanese company. This "Special Prospecting Authority" has brought to the attention of the industry a method by which acreage can be temporarily reserved for exploration.

Other developments during this period include the submission of a Notice of Intent by WAPET to develop the Saladin Oil Field with facilities on Thevenard Island. A location, the first step in preparing for production, has been declared over the North Herald and South Pepper Fields by Western Mining Corporation. Onshore, a Production Licence has been granted over the Tubridgi Gas Field – the gas is to be used in producing chemicals for the mining industry.

In 1986-87 seven development wells were completed including six from the North Rankin Platform and one onshore at Mt Horner.

## Tenements

On 30 June 1987 there were 86 permits to explore for petroleum in Western Australia including 32 offshore and 54 onshore. The permit area comprises 655,962 square kilometres made up of 256,975 square kilometres offshore and 398,987 square kilometres onshore. An accompanying map shows, in simplified form, the petroleum tenements at the end of the year.

A summary comparison of permit dealings for the years 1985-86 and 1986-87 is tabulated in the Statistical Summary. At the end of the year vacant areas totalled about 850,000 km<sup>2</sup>.

The number of permits held has dropped by two although the area held decreased by 100,149 km<sup>2</sup>. Permit surrenders, expiries and cancellations have decreased from 14 in 1985-86 to 10 in 1986-87, but new permits granted decreased from 9 to 8. At the end of the year 6 permit applications were under consideration and during the second half of 1987 it is expected that several areas of high exploration potential will be advertised for application.

## Development and Production

In Western Australia, production of crude oil totalled 1,659,958 kilolitres (kL) and production of gas 3629 x 10<sup>6</sup>m<sup>3</sup> for the year ending 30 June 1987. Oil was produced from Barrow Island, Blina, Sundown, West Terrace, Harriet, Dongara and Mt Horner fields, while gas and condensate were produced from North Rankin, Dongara, Mondarra, Yardarino and Woodada. No new fields were added during the year and one field, Woodada, was shut-in due to lack of local markets.

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#### Barrow Island Oil Field (West Australian Petroleum Pty Ltd)

Barrow Island Field is located on a 233 km<sup>2</sup> island, 88km north from Onslow and 145km west from Dampier. The first well was spudded in 1964, and since then 727 wells have been drilled. Production started in April 1967, and at the end of June 1987 a cumulative total of 35,187 x 10<sup>3</sup> kL of oil have been produced.

At least 27 different accumulations are producing or holding oil and/or natural gas in the field, but the four main producing pools are the Lower Gearle Siltstone, representing about 0.3 percent of oil production, the Windalia Sandstone (97 percent), Muderong Shale (1.3 percent) and Cretaceous/Jurassic sandstones (1.2 percent).

No wells were drilled on Barrow Island in 1986–87.

The total production for 1986–87 was 1,066,113 kL.

#### Blina, Sundown and West Terrace Oil Fields (Home Energy Company Ltd)

Blina Field is located 105km southeast from Derby in the Canning Basin. Six wells have been drilled in the field and all are producing.

The oil was discovered in the Blina-1 well in 1981 and production started on 30 September 1983. Production, which comes from two main reservoirs, the Upper Devonian Nullara Limestone and the Lower Carboniferous Yellow Drum Formation, totalled 36,467 kL for 1986-87. Blina-5 was drilled in mid-1985 and was placed on production in August of the same year, and Blina-6 which was drilled in August 1985 commenced production in mid-September 1985.

Oil was discovered 26km northwest from Blina, where the Sundown-1 well encountered oil in several separate zones within Permo-Carboniferous sandstones of the Grant and Anderson Formations. Subsequently the well was completed in the "1100 sand" horizon. Three other wells have been drilled and two of these are now producing. One was a dry hole. Production commenced in July 1984 and the total produced during the year ending 30 June 1987 was 6704 kL.

In late June 1985 oil was discovered at West Terrace-1, which was completed as a producer after a drillstem test conducted over a 3m interval flowed oil at a rate of 122 kL/d through a 9.5mm choke. Production started on 21 June 1985 and in the year ending 30 June 1987, 7108 kL was produced.

Production from Blina, Sundown and West Terrace Fields totalled 52 x 10<sup>3</sup> kL to 30 June 1987.

#### Dongara, Mondarra and Yardarino Gas Fields (West Australian Petroleum Pty Ltd)

These fields are located about 320km north from Perth and 65km south from Geraldton in the northern part of the Perth Basin. Production from the Dongara Field began in 1971 and was followed by Mondarra in 1972 and Yardarino in 1978.

The four reservoirs in these fields are the Arranoo Member (Early Triassic), the Dongara Sandstone (Early Triassic), the Wagina Formation (Upper Permian), and the Irwin River Coal Measures (Lower Permian).

A total of 25 wells have been drilled in the Dongara Field and at present there are 9 gas producers, 1 oil producer, 3 oil and gas producers, 7 shut-in wells, 1 water well and 4 abandoned wells. Gas produced at a rate of about 1036 x 10<sup>3</sup> m<sup>3</sup> per day was transported in a 36cm diameter pipeline from Dongara to Pinjarra via Perth and Kwinana. The Mondarra Field, two gas wells and two abandoned wells, produced gas at a rate of about 50 x 10<sup>3</sup> m<sup>3</sup> per day. Yardarino Field produces a small amount of gas from one well only. Oil production from Dongara averaged about 22 kL per day for the year.

Production of gas from the Dongara, Mondarra and Yardarino Fields totalled 399 x 10<sup>6</sup> m<sup>3</sup> for the year ending 30 June 1987. During the same period 7952 kL of Dongara oil was produced.

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#### Mt Horner Field (Barrack Energy Ltd)

The Mt Horner Field is about 380km north-northwest from Perth in the Perth Basin. The first well was drilled by WAPET in 1965 and since then five extension tests and one development well have been completed. Of these wells, four are classed as suspended producers and two (Nos. 2 and 6) are plugged and abandoned. The No. 7 well has found oil in a new zone but has not been placed on production yet. Production commenced in May 1984 and, in the year ended 30 June 1987, 890 kL of oil was produced.

At least three potentially productive units occur at Mt Horner: the Cockleshell Gully Formation, the Kockatea Shale, and basal Triassic sands.

During 1986 a workover program was undertaken and completed late in the year.

#### Woodada Gas Field (Strata Oil N.L.)

Woodada Field is 13km northwest from the township of Eneabba in the Perth Basin. The discovery well was drilled in 1980 and since then 10 wells have been completed. Gas production commenced on 24 May 1982 and, for the year ending 30 June 1987,  $47 \times 10^6 \text{ m}^3$  of gas was produced. The field has now been shut-in due to lack of local markets.

The main reservoir is in the Early Permian Carynginia Formation. Of the 11 wells drilled in the field 5 were gas producers, 4 were shut-in wells, and 2 were plugged and abandoned.

Gas was originally produced from Woodada -1 and -2 but in mid-April 1983 the rate at the No. 2 well fell to a sub-economic level and it had to be shut-in. The number of wells producing gas peaked at six, but by the end of June 1986 only three were on production and the field was shut-down on April 6, 1987 due to the cessation of sales to the State Energy Commission.

#### Harriet Oil Field (Bond Corporation Pty Ltd)

Harriet Field is located 20km northeast from Barrow Island and 120km west from Dampier, near the Lowendal Islands.

Since the discovery well was drilled in 1983, 10 appraisal wells have been drilled, all of which have been successful except Harriet-2 which was plugged and abandoned. Production commenced on 18 January 1986 and for the year ending 30 June 1987 a cumulative total of  $534 \times 10^3 \text{ kL}$  of oil was produced.

The reservoir is in Lower Cretaceous sandstones of the upper part of the Barrow Group. Oil is currently being produced at a rate of about 1600 kL per day.

#### Reserves

Estimated recoverable reserves at 30 June 1987 (see Statistical Summary) using a 75% probability were  $14.30 \times 10^6 \text{ kL}$  of crude oil,  $1060 \times 10^9 \text{ m}^3$  of natural gas,  $107 \times 10^6 \text{ kL}$  of condensate and  $24.52 \times 10^6 \text{ m}^3$  of LPG.

90% of the State's developed oil reserves are in two fields in the Carnarvon Basin (Barrow Island and Harriet). The Carnarvon Basin also holds proven plus probable gas reserves of more than 500 billion cubic metres. There are also very large gas reserves in the Bonaparte and Browse Basins and in the Exmouth Plateau, which are not economically viable at present because of water depth and lack of markets. These could be developed later in this century.

Very high condensate reserves appear to be present in the Goodwyn Field which could be developed in the next few years.

The main changes since the last report involve adjustments to Woodside's reserves, particularly an increase in gas and condensate for Goodwyn and a decrease for Wilcox. Other adjustments are minor.

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### Royalties

During 1986-87 total royalties paid on petroleum in Western Australia were \$27,409,626. This was derived from \$21,917,124 paid on crude oil sales, \$4,797,338 on natural gas sales and \$695,164 on condensate (see Royalty Receipts in Statistical Summary). Annual royalties paid in 1985-86 totalled \$34,023,504 including \$29,538,137 for oil, \$3,843,821 for natural gas and \$641,546 for condensate.

### Engineering

Wesminco Oil commenced the development of the South Pepper and North Herald Oil Fields, in the WA-149-P permit area. The company proposes to use the jackup rig, "Vicksburg", as a drilling/production/accommodation platform on the South Pepper location and construct submarine pipelines to storage facilities on Airlie Island. From the island crude oil will be pumped to an offshore loading facility.

A Notice of Intent for the development of Saladin Oil Field has been received from WAPET. Single-well protector jackets, with individual flow-lines to onshore facilities are proposed. Production and storage would be on Thevenard Island and a subsea pipeline would be constructed to a multi-point tanker mooring, 7km to the northwest of the island. More appraisal drilling is expected late in 1987.

During the year it was announced that production is to start up from the Tubridgi Gas Field near the town of Onslow in 1989. The gas is to be used in a proposed chemical plant to provide sodium cyanide, ammonium nitrate and lime alkalis to the mining industry. Main markets will be the iron ore industry in the Pilbara, the gold mining industry and the Kimberley diamond mines.

### Accidents

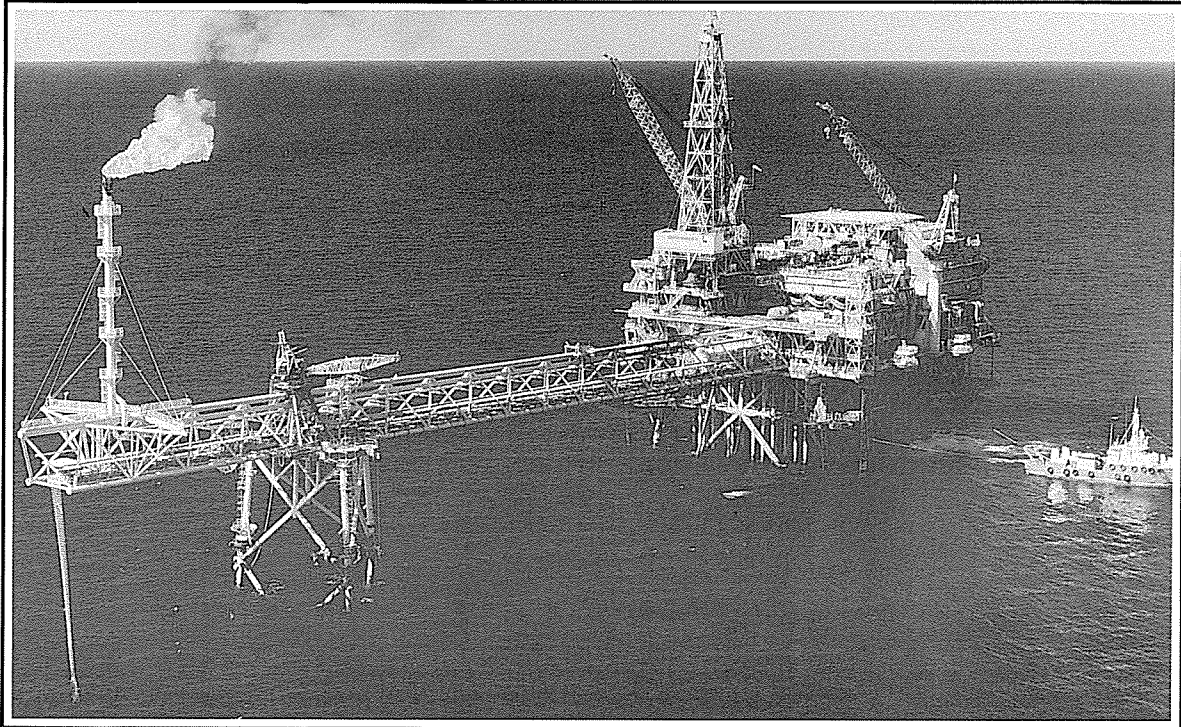
Figures relating to accident statistics in the petroleum exploration and production industry are shown in the Statistical Summary.

### Pipelines

A total of 238 work proposals relating to the Dongara to Pinjarra Natural Gas Pipeline from Government Departments, instrumentalities and other parties were processed during the year. There were 14 encroachments on the pipeline by the State Energy Commission during the year.

### Organisation

During 1986-87 the Deputy Director of the Petroleum Division (Mr A. H. Pippet) retired and there was one professional appointment, Mr E. Delfos, a geologist who was assigned to the Petroleum Resources Branch.



The North Rankin platform pictured above is the seabed production centre for the giant North West Shelf Project which is the biggest engineering undertaking in Australia's history.

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## EXPLOSIVES ALSO BOOM

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The tremendous surge in gold production in Western Australia has made the Kalgoorlie Explosives Reserve one of the busiest supply points in Australia.

Storage facilities have been expanded greatly and the Reserve is now home to three manufacturing plants with two more being developed.

The Reserve officially began in June 1904 and Western Australian agencies marketed explosive imported from Nobel. For most of the past 80 years only one company has had main use of the Reserve for storage and manufacture of explosives. However, in recent years other multinationals have shown interest and in 1985 a Magazine Keeper was appointed by the State Government to oversee the expanding operations and general increase in demand.

### Small Start

The first magazine in 1904 had a 10 tonne capacity and other similar sized units were added over the years. It was not until 1975 that the first 50 tonne magazine was constructed. By 1984 there were two magazines of that size and by December 1986 there were two explosives manufacturing plants and five more 50 tonne magazines. By 30 June 1987 an extra factory had been constructed and two more are being developed.

Not only was storage increased but transport levels and consumption at mines was increasing as more and more mines began operations. On top of this some explosives formulae of low sensitivity, known as blasting agents, are made on mine sites and loaded for immediate daily blasting.

Traditional methods of blasting are still being maintained in some deep mines with cartridge explosives, but new products and methods are also being used. Explosives can now be gravity fed, air loaded or pumped into drill holes depending on the problems of the gold location.

### Big Changes

Most explosives now have little resemblance to the plug or fracture used world wide for over a hundred years. In large mines the paper wrapped cartridge has changed to the plastic tube with a wire clip at each end. Nitroglycerine is seldom used and explosives now have large amounts of ammonium nitrate and include significant quantities of water so that they look like gravel more than solid explosive.

With further development in the mines, more action will occur at Kalgoorlie Reserve. In the past year, the area of the Reserve has been increased by 30% to meet the demands of future years. The consumption of explosives is increasing rapidly and the Reserve is one of the most active supply points in Australia.

In the last two years the quantity of explosives transported from the Reserve has increased by 18 per cent to be close to 10,000 tonnes and there is no sign that the rate of supply is going to diminish. Vehicle movements for the explosives companies and private customers have increased by 24 per cent this year with more than 4,000 registered movements for the twelve months to destinations in an area of 220,000 square kilometres.

With more gold mines to operate in the near future it is inevitable that there will be even more explosives activity at Kalgoorlie Explosives Reserve which will be a focal point for the mining industry for many years.

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# EXPLOSIVES AND DANGEROUS GOODS DIVISION



Mr H. Douglas, APTC(Chem), C CHEM,  
ARACI, AM Aust IMM.  
Director

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The past year has seen extensive development work by the Division which should culminate in a wider application of the public safety provisions of the Explosives and Dangerous Goods Act during the next few years.

Persistent staff shortages, caused by the retirement of older members of the staff and compounded by limitations on staff levels and administrative changes in the procedures for appointing new staff, made it necessary for the Division to defer some activities.

## Explosives

The Division has continued to supervise tests for explosives.

Western Australia is at the forefront of developing technology in the explosives industry, particularly in the areas of hard rock mining and large diameter bulk explosives. This has been very demanding on the technical expertise of the Inspectoral staff.

## Explosives Manufacture

Construction work commenced, and in some cases was completed, on three major new explosives manufacturing plants at the Baldivis and Kalgoolie Explosives Reserves. Approval was also given for two major support facilities for explosives manufacturing operations at mine sites.

The State now has representatives of five major explosives companies (CBS; Du Pont; ICI; Johnsons; and Nitro Nobel) all actively manufacturing and importing explosives.

## Transport Emergencies

The Division continued its role as a member of the State Transport Emergency Assistance Scheme Co-ordinating Committee. Since the transfer of Chairmanship of the Committee from the Commissioner of Transport to the Director, State Emergency Service, the Committee met infrequently and it was not until January 1987 that consideration of a complete update of the TEAS document was commenced.

After a full meeting in March, the Committee had completed its review and the amended scheme was presented to the State Counter Disaster Advisory Committee. It was returned to the Co-ordinating Committee for inclusion of additional amendments proposed by the Fire Brigade.

To date, agreement has not yet been achieved on the interaction of the roles of the Police and Fire Brigade.

## Dangerous Goods

In 1985 the Division began enforcing the packaging requirements of the Dangerous Goods Regulations. We moved through the phases of advice and instruction with the various parties involved and the program culminated with the detention or turning back of goods from transport yards when they were found to not comply. This is one area which suffered because of staff shortages and the final stages of the program were only completed in late June some six months behind schedule. A preliminary review of the program shows that it has been fruitful with very positive and prompt responses by industry without the need for punitive action.

## LP Gas

Early in the year the Division commenced preliminary work on LP Gas Regulations and prepared a Cabinet Minute recommending that such Regulations should be promulgated. The early retirement of two officers and other factors involving other Government Departments resulted in this program being severely cut back. However, the Division has been active in drafting work for the Australian Standard on the subject so the preparation of Regulations should not be unduly complicated when approval is given to proceed.

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### Rotterdam Conference

In April, the Director attended a Dangerous Goods Symposium on the handling of dangerous goods in ports. At that time the opportunity was taken to discuss with Dutch, Canadian and UK regulatory authorities matters of current interest to Western Australia.

The DSM Chemicals manufacturing plant at Geleen, Holland was visited and the production facilities for liquid sodium cyanide were inspected. The design and construction specifications of containers for the road/sea transport of liquid sodium cyanide were discussed with senior personnel of DSM.

The loading of ammonium nitrate at ports was discussed in depth with risk analysis specialists both in Holland and the UK. Discussions were also held with British Gas (Scotland) Ltd personnel in Edinburgh on the design specifications for tanker vehicles currently used in the road transport of LNG to Western parts of Scotland and the use of satellite storages of LNG for the domestic supply of Natural Gas to towns of up to 10,000 inhabitants isolated from the UK pipeline distribution system.

### Canadian Visit

As a result of a request from Transport Canada, the Deputy Director was released from duties for two months to participate in a review of the Dangerous Goods Transport Program in Canada. Participation in this review was of benefit to the Division as several aspects of the Canadian program could be applied fruitfully in Western Australia.

### North West Shelf

As a result of the deliberations and recommendations of a Technical Safety Review Committee, which considered the on-shore aspects of safety at the North West Shelf Project, Cabinet approved the creation of a new position of Safety Co-ordinator within the Explosives Division.

The Co-ordinator will review a Total Hazard Control Plan prepared by the joint venture partners. The Hazard Control Plan should cover all aspects of the design, construction, commissioning, operation and ongoing maintenance of the on-shore facilities.

The recommended approach to hazard control at the North West Shelf Project was essentially the current self-regulation approach but this is to be extended to a number of areas not presently covered by Government Regulations or agreements and to be audited by the Safety Co-ordinator.

Ultimately, the Co-ordinator will also monitor major public safety aspects of other chemical and petrochemical plants throughout the State.

### Ammonium Nitrate

The Division devoted much time in the year to reviewing the capacity of several Western Australian Ports to handle ammonium nitrate (AN). Impetus for the review came from industry pressures as large markets for Australian AN had developed in South East Asia and the limit of 150 tonnes for an ordinary berth, set by the Association of Australian Port and Marine Authorities, was stifling the development of this market. As an interim measure, Western Australia unilaterally raised the limit to 300 tonnes after applying some compensatory safety precautions. The Division's confidence to act in this way was enhanced by the knowledge that several countries in Europe and North America allow shipments of the order of 1000-2500 tonnes to move through ordinary berths on a regular basis.

Several comprehensive risk analyses were performed on two Western Australian ports; two by external organisations and one by Divisional Inspectors.

The analysis by Divisional Inspectors identified such major areas of risk as the likelihood of a fire, the risk of it involving the ammonium nitrate, then becoming severe enough to detonate the load, and the effect of such a detonation.



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The more discursive analysis by the external consultant was then used as a source of actions to mitigate the hazards at those areas. These included containerisation of the cargo, relocation of flammable liquids, improvements to the fire protection at the port, specific berthing procedures to facilitate the easy removal of the vessel in the event of an emergency, and comprehensive emergency plans for the area around the harbour.

In April, the earlier interim approval was extended for an indefinite trial period to allow up to 2000 tonnes to pass through the Port of Bunbury. The April consignment was the first occasion that an export of this magnitude had occurred at an ordinary berth in Australia. All the additional safety precautions were implemented, the operation was supervised by an Explosives Inspector, and it proceeded extremely well.

The Division is continuing to review port limits and is investigating overseas policies. The limits set will ensure that a balance is maintained between the sometimes conflicting requirements of trade and public safety.

#### Risk Analysis

The analysis of the risks associated with ammonium nitrate movements through ports was only one problem the Division faced in the area of risk analysis. Several Inspectors attended training courses on risk analysis and can now confidently review the risk analysis section of Public Environmental Reports.

Legally, the Division usually only becomes involved with projects when they become operational and dangerous goods are actually in storage. However, it is important to review projects at the planning and design stage so that problems can be resolved before construction commences. This is achieved by commenting on quantitative risk analyses submitted to the Environmental Protection Authority.

#### Work with Police

The Division continued to benefit from good co-operation with the Police Department in metropolitan and country regions.

The normal areas of co-operation included collection of deteriorated explosives and those found in illegal possession, and assistance at dangerous goods accidents.

The Water Police helped in the inspection and supervision of the Australia Day fireworks display on the Swan River.

A trial was conducted in the Goldfields region in which a Divisional Inspector accompanied a traffic patrolman on normal duties. This enabled any vehicles stopped by the patrolman for traffic offences to be examined for possible illegal conveyance of dangerous goods. The trial proved successful and will aid in the development of proposed future joint operations statewide.

Additional assistance was given by Police in remote areas in monitoring illegal transport of dangerous goods. This avenue was employed when persons were suspected of using unlicensed or unsatisfactory vehicles and an Inspector was not immediately available.

#### Explosives Magazines

There were 332 explosives magazines licensed under the Explosives Regulations at 30 June 1987, varying in capacity from 50kg to 100,000kg.

Most of the magazines are portable, having been constructed from steel. All new magazines are constructed to Australian Standard 2188 which prescribes minimum wall and door thickness, lining, ventilation and locking arrangements.

In recent years a trend has developed towards large transportable magazines up to 15 tonne capacity.

The continued application of Divisional inspectoral resources to ensuring the security of explosives is considered of paramount importance. With the widespread use of these high quality magazines, break-ins have measurably declined (there has never been evidence of a forced-entry theft from one of these magazines in WA) and deterioration is almost non-existent so the time between inspections of magazines can be extended with a high level of confidence.

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### Prosecutions

	Initiated 1986-1987	Won	Lost	Pending	Withdrawn
EXPLOSIVES FLAMMABLE LIQUIDS DANGEROUS GOODS	1	-	-	1	-
	Nil	-	-	-	-
	17	3	1	11	2

An amendment to the Explosives and Dangerous Goods Act made during the year provided that proof that a container was at a particular time labelled, branded or marked as containing particular dangerous goods will be deemed as proof that the container contained those goods.

Prior to the introduction of this amendment, inspectors encountered many difficulties in proving that goods contained within a package were in fact dangerous goods even though the package was already marked as such. There were also logistical problems in taking samples from containers that might have been involved in transport accidents.



Inspector H. Zuidersma sifts through the burnt out receptacle containing detonators after a fire at a factory in Pinjarra. The owner of the explosives has been prosecuted for the illegal storage of explosives at the site.

### Bulk Dangerous Goods Transport

The current boom in mining operations throughout the State has meant that the supply of chemical reagents in drum form cannot keep up with consumption. This has necessitated a swing to the transport of chemicals in bulk containers, a practice which until recently was restricted mainly to the petroleum industry. The introduction of the Dangerous Goods (Road Transport) Regulations 1983 ensures that the transport of dangerous goods within the State is controlled to maximise public safety.

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Transport of dangerous goods in bulk requires the manufacture of specially designed tanks, with capacities ranging from 250 litres to 42,000 litres. All new designs for bulk tanks are assessed for compliance with the relevant Australian Standard, with approvals being granted only to those submissions which meet all of the Standard's requirements.

In the past 12 months bulk tanks have been constructed of fibre reinforced plastics for the conveyance of corrosives that are not compatible with conventional materials such as steel and aluminium.

Once a design is approved it is assigned a unique design approval number with every subsequent unit of that design receiving a unit approval number.

Before a tanker is commissioned for use, it must undergo a hydrostatic pressure test to ensure the integrity of the welds and fittings. Tanks that have had repairs involving cutting into the tank shell must also be pressure tested. This follow through of testing results in tanks being frequently under the eye of Inspectors so that defects may be detected and repaired before they present a major hazard.

Once the Inspector is sure that the tank fully complies with the Australian Standard and the Regulations an approval plate is issued. This plate enables Inspectors and personnel at loading depots to readily identify approved tanks which are the only ones that can be legally loaded with dangerous goods.

Under the requirements of the Regulations each bulk tank must be examined every 2 years. Over the past 12 months a total of 465 bulk tanks have been examined and 48 pressure tests supervised.



Transport of Dangerous Goods in non-complying vehicles has resulted in legal action being instigated against the operators.

#### Licensing

All vehicles used for bulk transport must be licensed under the Regulations, and before a vehicle is licensed it must be examined by an Inspector to ensure safety requirements are met. These safety requirements include protective clothing, breathing apparatus for poisonous gases, shielding of hot vehicle parts from flammable liquids and the position of fire fighting apparatus.

Complementary to the dangerous goods inspection, vehicles must undergo a Police examination for roadworthiness every 12 months and failure to pass these tests results in cancellation of the licence.

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## THE MINING ACT SIX YEARS LATER

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At the end of 1987 the Mining Act 1978 will have been in force for six years. The Act greatly simplified our mining legislation but at the same time demanded from industry closer attention to title maintenance.

The most noticeable impact of the Mining Act 1978 on title administration concerned the failure by some to comply with expenditure conditions, or to apply for licence extension prior to expiry which meant the loss of ground which was actively sought by others.

The passing of the 1904 Act was also not without similar incident as, despite widespread publicity, a percentage of tenement holders failed to convert their titles within the prescribed time.

Some of the features of the Mining Act 1978 that changed the rules, but escaped controversy, are:

- the requirement for annual reports of operations for all tenements;
- the review of performance prior to extension of licence term;
- appeal rights by way of Ministerial review;
- granting of prospecting licences by Wardens;
- rental no longer payable during the application stage; and
- the right to the grant of a lease following compliance with licence conditions.

Some amendments to the Act have been needed in the light of operating experience. Initially, amendments were made in response to the Hunt Inquiry recommendations, and subsequently as a result of submissions from the mining industry representative bodies - the Chamber of Mines, the Association of Mining and Exploration Companies, the Amalgamated Prospectors and Leaseholders Association, and the Australian Mining and Petroleum Law Association.

It is expected that further amendments will be required from time to time to keep pace with developments in a dynamic industry.

To ensure this ongoing review of our mining legislation, the Mining Industry Liaison Committee was formed with representation from the same mining industry bodies which were part of the Hunt Inquiry. This committee had its inaugural meeting on 28 January 1987.

The opportunity presented by this Committee for regular discussion of issues affecting either the whole or particular sections of the industry is contributing to an earlier and more satisfactory resolution of problems.

In retrospect, the first six years of the new Act have been an exciting learning curve for all participants. They have had their dramatic moments such as the midnight peggers and legal arguments about atomic clocks, reports and expenditure statements, affidavits and appeals.

Both industry and the Department have had to come to grips with new legislation without the loopholes and administrative expedients of the repealed statute.

The result has been a simpler yet more certain set of rules that retain the basic principles of sound title administration, but with a limited degree of flexibility to accommodate the commercial realities of the mining industry.

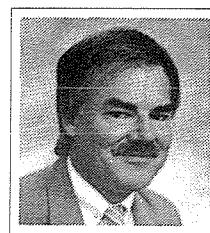
The upsurge in gold activity in recent years and the operating experience of the 1978 Act have been the major reasons for an industry demand for people with specialized title administration skills.

An unprecedented number of experienced officers from the Mining Registration Division have left the Department recently to take up positions involving tenement management for industry. While this loss of experienced personnel (9 officers during the past year with a combined service of 110 years) has given the Mining Registration Division short term resource problems, there has been a balancing effect in the mutual appreciation from both sides of the public counter of the need for an efficient tenement registration system.

Looking ahead, initiatives are being taken to improve the availability of up to date tenement information, and to utilise available technology to overcome the delays of traditional forms of communication. The introduction of the TENDEX information system in December 1986, and the placement of facsimile facilities in several outstation offices are seen as first steps.

Future enhancement of the TENDEX system to embrace more dynamic functions, and the establishment of an effective network of speedy communication with the outstations will provide an improved tenement registration system.

# MINING REGISTRATION DIVISION



Mr W. Phillips, Dip Pub Admin.  
Director

1986-87 was a particularly busy year for the Mining Registration Division as the upsurge in the gold price and other favourable factors ensured that activity in the mining industry continued at a high level.

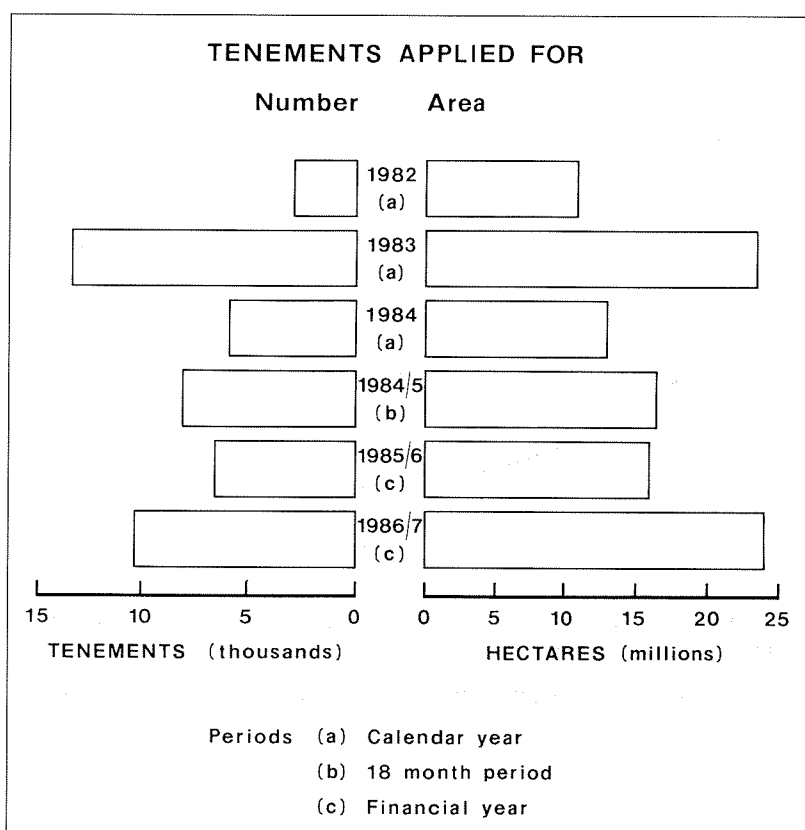
The area of the state covered by in-force mining tenements on June 30, 1987 increased by 27% to 22,232,171 hectares compared with 17,496,124 hectares on June 30, 1986. This is the largest area of the state covered by in-force mining tenements since the height of the nickel boom in 1970 when the area was 22,878,205 hectares.

During the year the Division continued to lose experienced personnel to the mining industry, and the high work volume placed a considerable strain on existing human resources.

Tenement applications received for the year ending June 30, 1987 totalled 10,316, being:-

Prospecting Licences	7045
Exploration Licences	1927
Mining Leases	1089
Miscellaneous Licences	158
General Purpose Leases	97

This is an increase of approximately 58% on applications received for the previous twelve months. Tenement receipts over the last five years together with areas of tenements applied for during the corresponding period appear in the figure below.



# DEFINING TENEMENTS BY GRATICULAR SECTIONS

Mining tenements form part of the fabric of land ownership. Commencing from the original discoveries of gold in Western Australia they have followed the principles unique to mining practices; that is, the establishment of priority by physically taking possession of ground and marking out the boundaries. Approximate descriptions of the boundaries can be given initially, but these are subsequently clarified by survey.

Modern techniques for mineral exploration require large areas of ground which can be held for comparatively short terms and turned over on a rapid basis. The Mining Act in force since 1982 has provided this type of tenure in the form of an exploration licence which continues to be described using the older principles of relativity. The decision has now been made to move to the alternative and absolute system of defining the exploration licence by what are known as graticular sections.

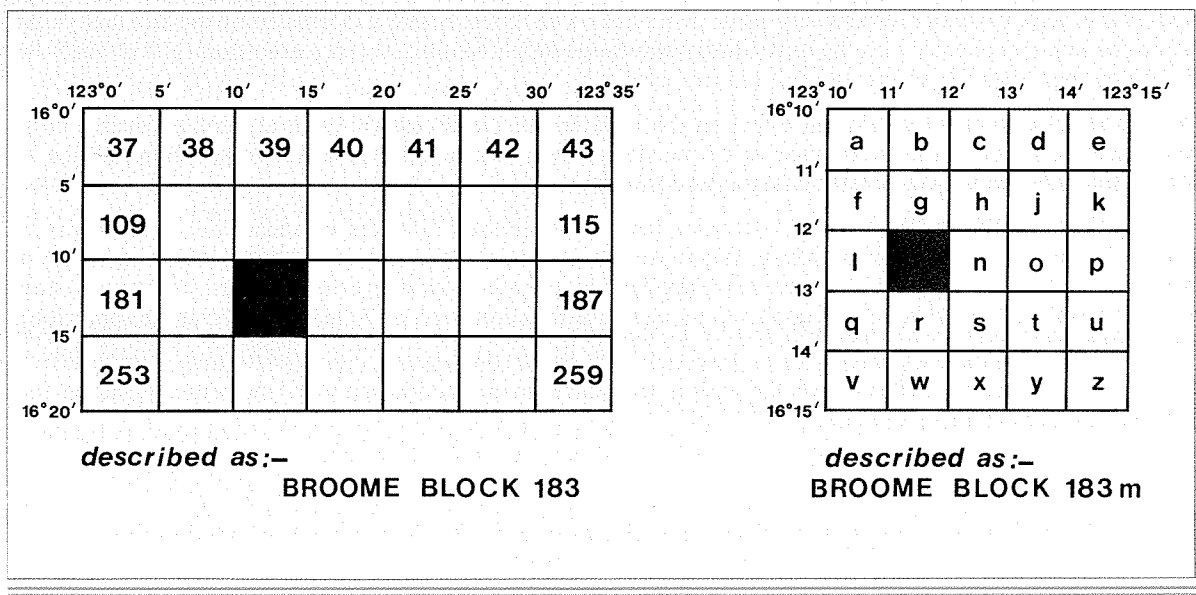
This system uses the lines of latitude and longitude to create regular units of land. The lines are known as graticules and the units created are called graticular sections. The interval selected must be regular and of a size that will allow for closely spaced boundary intervals but at the same time not be so small as to be too hard to administer. The system has an inherent inefficiency in that it automatically includes more ground than might otherwise be wanted. However, it is uniquely suitable for defining large parcels of ground in which the boundaries will not normally require to be marked on the ground, but must be represented on a map. Should the need arise correlation on the ground to acceptable accuracy is achievable.

By comparison with the alternative system of physically marking the boundaries, the system suffers from inflexibility. On the other hand it has the advantage of certainty. The following principles for implementation of the system are proposed so as to maximise the advantages while minimising its limitations.

The basic graticular section will be known as a block and will be 1 minute of latitude by 1 minute of longitude. Blocks in the north of the State have approximate dimensions of 1.79km by 1.84km and contain 3.3km<sup>2</sup>. Blocks in the south of the State have approximate dimensions of 1.52km by 1.85km and contain 2.8km<sup>2</sup>. The average area of a block at the central latitudes of the State is 3.1km<sup>2</sup>. Due to this variability, it will not be possible to equate blocks to an area.

For facility of reference each block will be identified by a map sheet name and a unique number obtained by taking the number of the primary 5' x 5' graticular section from the petroleum legislation and then subdividing it into 25 units each of 1' x 1' and identified alphabetically by the letters "a" to "z" omitting "i". This system is illustrated in the diagram.

The new system will require significant changes to the Mining Act and the preparation of a special set of maps showing the graticules to overlay exactly the existing public plans. The transition phase will be widely publicised in the industry.



## SURVEYS AND MAPPING DIVISION

Mr W.R. Moore, Dip Cart, MIS, MAIC, MIEMS.  
Director



The year has been one of high activity combined with a complete review of goals and practices in all areas of the Division's operations. The Department's corporate goals and objectives were set during the year and this necessitated a review of the Division's provisional functions and objectives in order to re-state them in terms of the newly defined corporate goals.

Mandatory 3% staff reductions caused the loss of 4 positions by natural attrition. With a loss of 3 for the previous year and 1 before that, the Division has lost a total of 8 positions since 1985 - reducing from 132 to 124.

A major review of the Surveys and Mapping Division was commenced by a systems consultant, Mr G. Glover. The purpose of the review was to examine functions and work procedures with a view to extending the application of computer-based systems. This is the first such review of the surveying and drafting activities of the Department and some significant initiatives are expected.

### Tenement services

A total of 9848 new tenements were added to the public plans. This is 57% above the figure for last year. A similar increased level also applied to other dealings which necessitated adjustments to these plans.

Public plans are now maintained with a currency of data which has not been possible in the past. The computerised tenement system, TENDEX, now furnishes accurate data within a much shorter time of the event taking place. In addition a suite of reporting functions are now possible, providing combinations of data which were hitherto not thought possible.

### Petroleum titles and maps

The level of activity in petroleum tenement processing on the plans remained high. The major map "Petroleum Exploration and Development Tenements" together with its supplementary brochure of title information continued to be produced and distributed within two weeks of the end of each quarter.

All the existing maps in the 1:1,000,000 graticular section series need to be re-constructed and redrawn. Commencement of the project is delayed awaiting information from the Commonwealth concerning the position and limits of the territorial sea and availability of staff to undertake the task.

Work started on gathering data about petroleum titles and wells to provide a range of computer derived map products at various scales for use by many areas of the Department. The main thrust is to support and complement the two existing products - Petroleum Titles Map and the Wells Drilled for Petroleum Map. In addition, the project will provide data in a simplified and flexible form. The project is proceeding and has required substantial cleansing of the existing data sources.

### Surveying Services

Surveys of 583 tenements were completed during the year which is an increase of 122 over the previous year. The average size of tenements surveyed decreased from 194 hectares to 134. There are 1483 tenements awaiting survey, 573 tenements under the old Act and 910 under the new. This compares with the previous year of 1647 outstanding, 742 old and 904 new.

It is becoming necessary to spend an increasing amount of time determining priority of ground to be included in an increasing number of tenements. Partly this is due to the intensity of the pegging pattern and partly to the potential for overlapping tenements, but mainly it is due to the difficulties of tracing a chain of ownership and tenure of ground which is included in tenements transferred from the old Act to the new. The intermediate connecting record has been neglected.

A statement of policy giving guidelines to be followed when issuing contract surveying work to consulting surveyors was approved by the Minister. This policy statement together with a newly prepared booklet setting out the legislative provisions and a set of Directions to Surveyors was formally presented to a gathering convened with the Association of Consulting Surveyors and the Institution of Surveyors (Aust). The exchange of views on policy, professional indemnity and the future of the profession was of benefit to all parties.

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The program for conversion of standard plan series maps from imperial to metric and to conform with the AMG was continued. Sixty four plans were completed while 111 are in the process of completion and a further 525 await attention.

All disputes or potential disputes concerning pegged ground which required a survey or an assessment from plans and other information were attended to expeditiously.

#### Technical information services.

Enquiry by the public for information concerning tenement maps, plans of mines, searches of ground covered by old tenements and other technical matters relating to surveys and documents continued at a high level. Sales of tenement maps themselves increased by 1.9 times over the previous year. The high level of enquiry about current ground status was matched by increased searching of old ground and production records. This facility fulfills an important role in providing industry access to a vast body of historic mining information. Although the value of this service (and the actual data itself) may be recognised by only a minority within the mining industry, this interest is increasing in line with general exploration activity, particularly within the gold sector.

The increased number of new gold mining operations which have recently commenced is resulting in problems with handling and storage of the increased numbers of plans of the operations. Plans were received from 55 Companies covering 121 mining operations.

#### Geological maps and other publications.

The preparation and production of the maps, the map base material and illustrative diagrams and small maps required as part of the geological mapping program were maintained to meet the demand. Twelve major coloured maps were printed, made up of 2 Regional 1:250,000 scale maps, 3 Environmental 1:50,000 scale maps, and 7 Bulletin and Report maps, while a further 2 maps were reprinted from original reformat.

While this fulfilled the set program it does not realistically reflect the high level of activity which is proposed in the next few years.

All drafting requirements for monochromatic diagrams and illustrative figures were met as were those for slides and visual presentations.

With the completion of the initial regional geological map coverage at 1:250,000 a program of selected second series or revision mapping is proceeding in areas where revision of the geology is necessary and five map sheets are currently on the program.

A new series of detailed geological maps at a scale of 1:100,000 has been commenced, initially over selected areas of high priority in the Eastern Goldfields. The first year of a five year program is well advanced with 2 maps currently in production of a total of 4 maps planned to be printed in the coming year. Commencement of this series necessitated careful development of an efficient system of preparation and drawing together with a distinctive format and design.

An internal review of the methods and procedures used to prepare the 1:250,000 geological maps was carried out with significant results. It has been variously stated that it takes more than 2 years to produce and print a geological map and that this time is a disincentive to industry which seeks earlier access to vital information. The review first noted that the process is divided loosely into three phases – compilation, fair drawing or drafting, and printing.

The compilation phase, which involves both geologist and draftsman, takes about 22 months. Until completion of this phase the basic geology has not been established and accordingly this period should not be classified as being part of the time taken to draw a geological map. It was further established that actual fair-drawing time took about 3-4 months on average with a further 2 months for printing. These figures apply to regional 1:250,000 maps. Maps in other series take less time.

With this information it was apparent that most benefit would accrue by reviewing the compilation process. New procedures have been developed whereby data types are compiled on separate overlays, less attention is given to the topographic layer and the traditional "approval copy" eliminated and a new product, a hand coloured preliminary copy (the compiled geology overlay) is produced as an "approval copy" at an earlier stage in the process. The result is an anticipated saving of 2 months.



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The Division has also responded to pleas from the geological fraternity for earlier release of preliminary material by producing a suitable compilation product much earlier and at minimal cost to this Division in time and effort.



Michael Prause preparing geological maps for "early release" of information at compilation stage.

The acquisition by the State Printing Services Division of a 4 colour ROLAND 800 printing press has enabled good quality printing of maps within a short time. To supplement this, continued use was made of our regular arrangement with Mercury Walch, Hobart, for printing by contract of 4 maps.

#### Promotional activity

The annual map entitled Mineral Production continues to be a colourful and informative guide to the minerals produced in the State, and shows their uses, their value, their location, the producing companies and their contribution to employment all on the one map. Due to the growing numbers of gold mines starting up in the Eastern Goldfields an enlarged map of this portion showing gold production has been printed on the reverse side of the main map.

A Displays Committee was set up to monitor the preparation and disposition of the Department's displays and to co-ordinate the many themes used. Thirteen displays and posters were prepared. These included displays on "Health and Safety in Mines" at Karratha, the "Records Management System" at Perth, the "Activities of the Mines Department" at the PACIEXPO exhibition at Fremantle and "Geological Mapping" displayed in Mineral House and subsequently on circuit at venues provided by several suburban libraries. An award was won for the PACIEXPO presentation.

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Mr W.R. Moore, Director, attended the Association of Consulting Surveyors 1986 Conference at Margaret River and the 29th Survey Congress in Perth. The Conference of Chief Geological Cartographers in Melbourne was attended by Mr. D.S. Manuel, Acting Chief Cartographer while the ICA conference Auto Carto - London was attended in a private capacity by Messrs. P.A. Shaw and P.J. Walby with Mr. Walby subsequently attending the 6th Australian Cartographic Conference in Melbourne.

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## COMPUTERS COME INTO THEIR OWN

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The Department has continued to introduce new information handling technologies to increase performance and reduce the cost of its operating and administrative activities.

The use of up-to-date computing and information handling systems is enabling quicker response to enquiries from the public and mining/exploration companies.

The Department's information technology philosophy is to implement practical and innovative systems primarily aimed at streamlining internal procedures and providing a better service to industry.

For instance, the introduction of one of the first automated file and document tracking systems in Australia has revolutionised the Department's records handling procedures. This Records Management System uses a combination of bar code technology and microcomputers networked to a mainframe data base holding in excess of 160,000 files, the majority of which are mining tenement related.

The application of this philosophy was seen again in the successful introduction of phase 1 of a mining tenement information system. This on-line system – known as TENDEX – was introduced in Perth and Kalgoorlie as a public information service in December 1986. The TENDEX data base currently holds up-to-date information on 47,000 mining tenements – 25,000 of which are active or in a pending state.

Expenditure on Phase 1 of the Mining Tenement Information System has been more than justified – with the system currently being used extensively by the public and the mining and exploration industries.

Significant progress has also been made by the Department during 1986-87 on the introduction of new systems to provide services to the State's mining operations and to sections of the explosives and dangerous goods industries.

The development of an accident recording and reporting system for the mining industry was completed by the Department in June 1987. This comprehensive but flexible system (AXTAT) will be implemented in the Perth, Kalgoorlie, Pilbara and the Collie regions during the first half of 1987-88.

During the review period the Department also developed and commissioned a comprehensive licensing and information service for the storage and transport of dangerous goods and explosives. This on-line system – known as DANEX – currently holds in excess of 12,000 licences in addition to 17,000 supplementary records concerning these commodities – thus providing a more streamlined service to the relevant industries.

The Department expects to recoup a significant part of its capital outlay on these new systems through direct revenue from service fees and through improved operational efficiency.

While good progress has been achieved in the introduction of new technology, much still remains to be done to ensure that the information needs of the Department and industry are more adequately met. The penetration of computing technology into the mining and petroleum industries and hence by implication to the Department of Mines will be significantly greater during the next 10 years than it has been during the previous decade. One of the most significant challenges confronting Departmental management over the next 3 years will be coordinating and exploiting information handling strategies. This will require considerable effort in the determination of appropriate strategies and the implementation of key policies. The primary objectives of the overall Departmental information handling strategy are -

- to make information in the public domain relating to the mining and petroleum industries more easily accessible through data links; and
- to achieve a uniform data policy over a common network – using multi-function workstations. System components will operate either on traditional data processing facilities, personal computers or text preparation/word processing equipment.

It is of critical importance therefore that basic standards are established to ensure that all forms of information – be they data, text or 'image data' – can move from one Departmental system component to another.

Such standards are now evolving and will be further developed by the Department during the coming challenging year.

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# STATISTICAL SUMMARY

## 1986-87

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**DEPARTMENT OF MINES  
WESTERN AUSTRALIA**

Supplement to the Annual Review

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STATISTICAL SUMMARY 1986-87

SUPPLEMENT TO THE DEPARTMENT OF MINES

ANNUAL REVIEW

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Number of persons employed in the Western Australian Mining Industry as at June 30, 1987	32



SERIOUS ACCIDENTS FOR 1986/87

	Inspectorate				Totals	
	Perth	Karratha	Kalgoorlie	Collie	1986/87	1986
<b>MAJOR INJURIES</b> (exclusive of fatal) -						
<b>Fractures:</b>						
Head	1	1			2	2
Shoulder		1			1	1
Arm	1		6		7	2
Hand	1		6	1	8	11
Spine	1	1	2		4	1
Rib	2	3	1		6	4
Pelvis		1			1	1
Thigh	2			1	3	
Leg			10		10	6
Ankle	1	1	3	1	6	4
Foot		1	11		12	7
<b>Amputations:</b>						
Arm						1
Hand						
Finger	3	4	4		11	7
Leg						
Foot						2
Toe	1				1	1
Loss of eye						
Serious internal						
Hernia	2		3	4	9	5
Dislocations						
Other major	8	8	21	1	38	15
<b>Total major injuries</b>	<b>23</b>	<b>21</b>	<b>67</b>	<b>8</b>	<b>119</b>	<b>70</b>
<b>MINOR INJURIES</b>						
<b>Fractures</b>						
Finger	5	10	2	1	18	33
Toe			1		1	4
Head		10	1	5	16	8
Eyes	3		3	1	7	8
Shoulder	4	10	2	2	18	21
Arm	4	11	5	3	23	30
Hand	30	49	20	6	105	48
Back	21	69	32	18	140	134
Rib	1	4	1	1	7	8
Leg	13	21	15	7	56	58
Foot	10	20	14	4	48	31
Other minor	9	3	11	1	24	40
<b>Total minor injuries</b>	<b>100</b>	<b>207</b>	<b>107</b>	<b>49</b>	<b>463</b>	<b>423</b>
<b>GRAND TOTAL</b>	<b>123</b>	<b>228</b>	<b>174</b>	<b>57</b>	<b>582</b>	<b>493</b>

SUMMARY OF FATAL AND SERIOUS ACCIDENTS IN 1986/87

Mineral	Number of persons employed	Accidents		
		Fatal	Serious	Minor
Bauxite (Alumina)	4 484		51	110
Coal	1 160		56	350
Diamond	674		6	19
Gold	6 455	4	155	352
Gold - Nickel	2 034		39	53
Mineral sands	1 097		18	62
Iron	10 713		207	620
Nickel	789		25	54
Salt, gypsum	493		13	31
Tin, tantalite	150		2	12
Other minerals	260		5	15
Rock quarries	214		5	19
<b>TOTALS</b>	<b>28 523</b>	<b>4</b>	<b>582</b>	<b>1 697</b>

SUMMARY DESCRIPTION OF FATAL ACCIDENTS

Reported during the 12 month period ending 30 June 1987

Name Occupation Date of Accident	Mine/Details and Remarks
Leslie Hunt Miner 13.12.86	The deceased fell down an ore pass at the Golden Spec mine near Nullagine.
Paul Christian Rogers Millworker 7.1.87	The deceased died following a heart attack while working in the screen box of a leach tank at BHP Minerals gold mine near Ora Banda.
Rueben Michael Robinson Treatment Plant Operator 13.2.87	The deceased was struck by rocks tipped from a loader bucket while working to clear a blockage in the crusher at the Whim Creek Consolidated gold mine near Meekatharra.
James Vincent Young Prospector 21.6.87	The deceased died following the detonation of an unknown quantity of explosives on ML 51/99 at Garden Gully near Meekatharra.

## PROSECUTIONS

Six persons were prosecuted for offences against the Mines Regulation Act and Regulations.

A miner was fined \$50 for interfering with electrical apparatus in contravention of Regulation 5.8.

A mining engineer was fined \$100 for negligence and endangering the safety of persons, contravening Section 54 of the Mines Regulation Act and Regulation 6.5.

A platman was fined \$50 for travelling in a cage containing drill steel in contravention of Regulation 15.52 (3).

Two miners were each found guilty of contravening Regulation 7.24 (1) on two occasions. They were fined \$75 for each offence of boring in a face without washing out butts.

A workman was found guilty of negligence and endangering the safety of a person in contravention of Section 54 of the Act and not operating a machine in a safe manner in contravention of Regulation 6.2. He was fined \$50 on each charge.

SUMMARY OF DRILLING AND ASSOCIATED WORK 1986/87  
(Drilling Branch)

JOB NAME	PURPOSE	TYPE OF WORK	NO OF BORES	METRES DRILLED
Gillingarra	Groundwater Investigation	Rotary drilling	2	1313.5
Carnarvon	Groundwater Investigation (road construction)	Rotary drilling	4	1921.5
Cowaramup	Groundwater Investigation	Rotary drilling	12	6755.5
Cataby Shallow	Groundwater Investigation	Wireline coring	27	1092
Derby	Groundwater Investigation	Rotary drilling	4	1166
Biotech Pt. Gregory	Groundwater Investigation (Private Company)	Wireline coring and Rotary drilling	8	635.96
North Stirlings	Salinity Studies	Rotary drilling	10	224.5
Yarragil	Effects of bauxite mining	Wireline coring and Rotary drilling	47	1482
Carlisle	Geophysical equipment calibration	Rotary drilling	1	101.6
Local Government	Pollution Monitoring	Contract supervision	2	
Various	Groundwater Investigation	Bore pumping tests	2	
Various	Various	Bore Repairs	8	
Various	Various	T.V. Borehold Scans	16	
TOTAL				14692.5

METALLIFEROUS MINING CERTIFICATES  
OF COMPETENCY ISSUED 1986/87

First Class Mine Managers

	Certificate Number		Certificate Number
Hine, M.A.	202	Shaw, J.H.	217
Powell, S.J.	203	Pilgrim, J.S.	218
Carpenter, R.E.	204	Corn, A.	219
Frazer, W.P.	205	Procter, T.H.	220
Snowden, C.T.	206	McGregor, R.J.	221
Ford, R.K.	207	Campbell, A.B.	222
Carlton, R.A.	208	Hulmes, M.R.	223
Young, R.J.	209	Ashby, I.R.	224
Mulroney, D.P.J.	210	Beven, G.M.	225
Lambert, B.T.	211	Daly, M.J.	226
Calnan, R.T.	212	Pitt, M.W.	227
Rossetti, L.O.	213	Dunlop, J.S.F.	228
Wilkie, D.K.	214	Smith, T.R.	229
Robertson, A.C.	215	Haymes, D.K.	230
Williams, C.J.	216		

Underground Supervisors

	Certificate Number		Certificate Number
Green, C.J.	A435	Briggs, T.A.	A463
Martinkus, P.L.	A436	Parks, J.P.	A464
Loerch, P.M.	A437	Marston, M.W.	A465
Harvey, S.M.	A438	Dixon, R.G.	A466
Valent, M.	A439	Ryan, E.	A467
Andrewartha, G.	A440	Oxley, D.R.	A468
Parker, C.R.	A441	Armstrong, C.T.	A469
Hebbard, G.J. *	A442	Toth, T.M.	A470
Mc Lardy, W.J.	A443	Colwell, R.	A471
Drew, S.S.	A444	Thomson, R.J.	A472
Jacob, R.P.	A445	Campbell, N.P.	A473
Beilby, P.A.	A446	Warua, S.V.	A474
Daly, P.A.	A447	Mc Guirck, N.D.	A475
Gillman, M.P.	A448	Manning, R.J.	A476
Cernotta, N.L.	A449	McCracken, M.G.	A477
Bartlett, R.W.	A450	Whalley, G.	A478
Rabski, D.J.	A451	Sandford, D.L.	A479
Laffan B.F.	A452	Thomas, K.J.	A480
Skinner, N.R.	A453	Dennis, S.L.	A482
Davis, J.L.	A454	Yaxley, A.S.	A483
Thomas, B.	A455	Firth, R.D. *	A484
Willcox, L.K.	A456	Poole, F.L.	A485
Hill, D.I.	A457	Botting, M.D.	A486
Rodan, M.F.	A458	O'Callaghan, M.J.	A487
Grljusich, I.F.	A459	Fuerweger, J.H.	A488
Brachieri, M.J.	A460		
Hall, D.H.	A461		
Willis, E.J.	A462		

\*Restricted ticket

## Quarry Managers

	Certificate Number		Certificate Number
Mac Issaac, J.A.	110	Secker, P.A.	123
Muriale, O.	111	Vitali, R.G.	124
Wade, B.J.	112	Doherty, P.K.	125
Price, B.F.	113	Little, A.P.D.	126
Cransberg, A.J.	114	Lynch, T.C.	127
McManus, F.K.	115	Stafford, G.	128
Reat, A.B.	116	Varcoe, D.J.	129
Valenzuela, E.J.A.	117	Yates, W.R.	130
Weir, A.	118	Vergone, R.J.	131
King, M.S.	119	Zuvich, G.J.J.	132
Francis, D.A.	120	Rowe, F.J.	133
Bath, L.J.	121	Medway, C.	134
Spicer, N.A.	122	Michael, H.N.	135

## Restricted Quarry Managers

	Certificate Number		Certificate Number
Watts, H.R.	177	Tooher, P.G.	203
Billing, G.C.	190	Walters, G.	204
Aspland, K.G.	191	Wooding, F *	205
Horne, A.J. *	192	Hannaford, B.J.	206
Clements, L.J.	193	Parrick, R.F.	207
Clayton, G.A.	194	Stewart, P.J.	208
Fielder, G.J.	195	Paine, M.L.	209
Baker, A.R.	196	Luhrs, W.L.	210
Barnes, T.E.	197	Paddon, L.J.	211
Biggs, C.J.	198	Burkett, S.J.	212
Kennedy, W.R.	199	Kaine, R.J.	213
McDowell, D.G. *	200	Willcox, D.W.	214
Smith, K.	201	Paynter, I.L.	215
Tedder, J.	202	Lemon, G.J.	216

\* Restricted ticket

COAL MINING CERTIFICATES OF COMPETENCY

	Certificate Number		Certificate Number
<b>First Class Mine Manager</b>		<b>Third Class (Deputy)</b>	
Hopkins, R.S.	55 *	McCrystal, T.	117
Cameron, D.P.	56 *	Pesci, P.J.	118
		Dyer, K.F.	119
<b>Second Class Mine Manager</b>		<b>Open Cut Mine Manager</b>	
Kaurin, P.K.	22	Turnbull, D.J.	17 **
O'Donnell, A.M.	23 *		
Addis, K.	24	<b>Deputy (Open Cut)</b>	
Weighell, S.J.	25	Daniels P.J.	25
		Gianola, S.R.	26
		Westphal I.G.	27
		Jones I.G.	28

\* Reciprocal

\*\* Mining Law and Oral Examination

AUTHORISED MINE SURVEYORS CERTIFICATE ISSUED 1986/87

	Certificate Number
Mitchell, B.J.	083
Smith, P.L.T.	084
Carlton, J.	085
Kenneally, J.C.	086
O'Dwyer, D.	087
Harrison, P.	088
O'Loughlin, C.R.	089
Burke, G.K.	090
Cusack, C.J.	091
McGay, D.J.	092
Stapleton, P.G.	093



SOURCE AND ALLOCATION OF WORK 1986/87

SOURCE	Laboratory								Total Samples
	Agricultural Chemistry	Engineering Chemistry	Food and Industrial Hygiene	Forensic Science	Kalgoorlie Metallurgical	Materials Science	Mineral Science	Water Science	
DEPARTMENT OR AUTHORITY									
Agriculture Department	48 491		805	6		2	25	207	49 536
Building Management Authority			3			30	116	61	210
Conservation & Land Management Department			237					24	261
Consumer Affairs Department			1					1	80
Education Department	42		18			65	13	4	105
Environmental Protection Authority	171		241			23	1 065	3 251	4 751
Fisheries Department	3		860					14	877
Geological Survey of WA	36						2 392	340	2 768
Government Chemical Laboratories	242	78	23	163	1 617	7	337	87	2 554
Health Department	7		1 661	6		22	73	249	2 018
Main Roads Department	1		3	4		11	61	2	82
Mines Department		2	208		8		488	15	721
Occupational Health, Safety & Welfare Department			284	1		1	389	1	676
Police Department			33	5 798	68	2	72		5 973
Prisons Department				382					382
Resources Development Department							100	218	318
Services, Department of			1	65		5			71
State Planning Commission								143	143
Swan River Management Authority			5					228	233
Water Authority of WA	10		575		40	39	66	8 221	8 951
Waterways Commission			8					504	512
Other Departments (15)		1	100	18	16	46	83	95	359
PUBLIC									
Pay	346	394	137	61	3 294	189	488	1 121	6 030
Equestrian Federation				8					8
Royal Agricultural Socoety				3					3
Western Australian Greyhound Association				383					383
Western Australian Trotting Association				787					787
Western Australian Turf Club				1 989					1 989
TOTAL	49 349	475	5 203	9 674	5 043	450	5 801	14 786	90 781

WELLS DRILLED FOR PETROLEUM 1986/87

WELL	COMPANY	TENEMENT	TYPE	LAT.(S)			LONG.(E)			ELEVATION (M)		COMMENCED	RIG RELEASED	TD (M)	BOTTOMED IN	STATUS ON 30 JUNE
				D	M	S	D	M	S	GL	WD					
<b>BONAPARTE BASIN</b>																
Avocet-1A	Bond	WA-199-P	NFW	11	22	22	125	45	18	106	12	29.07.86	01.09.86	2,217	L-M Jur	P & A
Cygnets-1	Bond	WA-199-P	NFW	11	53	46	125	56	21	80	12	02.09.86	27.09.86	2,050	L-M Jur	P & A
Barita-1	Bond	WA-199-P	NFW	11	26	36	125	43	41	95	12	28.09.86	20.10.86	2,500	L. Jur	P & A
<b>CANNING BASIN</b>																
Lloyd-1	Home	EP 129	NFW	17	28	03	124	14	57	39	47	05.06.87		1,581		Drilling
Dodonea-2	WMC	EP 143	NFW	19	22	18	125	10	41	206	212	10.06.87		1,285		Drilling
Runthrough-1*	Home	EP 129	NFW	17	29	23	124	11	56	50	57	06.06.87		355		Temp. Susp
Mellany-1*	Home	EP 129	NFW	17	24	06	124	17	17	31	38	18.06.87		402		Temp. Susp
Twin Buttes-1	Santos	EP 142	NFW	-	-	-	-	-	-	-	-	26.06.87		277		Drilling
<b>CARNARVON BASIN</b>																
Goodwyn-9	Woodside	WA-5-L	EXT	19	36	13	115	58	24	133	25	12.06.86	11.08.86	3,395	U. Trias	G.C. Susp
Forestier-1	Woodside	WA-1-P	NFW	19	35	41	116	49	15	43	25	13.08.86	20.09.86	2,514	M. Jur	P & A
Saladin-2	WAPET	TP/3	EXT	21	26	49	115	02	22	15	38	15.11.86	11.12.86	1,275	U. Jur	O, Susp.
Glennie-1	WAPET	TP/3	NFW	21	24	04	115	04	12	18	37	31.12.86	17.01.87	1,275	U. Jur	P & A
Somerville-1	BHP	WA-155-P	NFW	21	29	55	114	40	00	57	33	20.01.87	10.02.87	1,749	U. Jur	P & A
Saladin-3	WAPET	TP/3	EXT	21	28	16	115	01	24	8	33	12.02.87	12.03.87	1,250	U. Jur	O, Susp
Talisman-3	Marathon	WA-191-P	EXT	19	30	24	116	56	33	80	25	07.05.87	11.06.87	2,285	U. Jur	P & A
Sharon-1	Avon	EP 137	NFW	21	21	00	115	42	04	6	13	13.05.87	28.05.87	259	Dev?	O, Susp.
Talisman-4	Marathon	WA-191-P	EXT	19	30	35	116	55	49	81	25	13.06.87		2,120	U. Jur	P & A
<b>PERTH BASIN</b>																
Mt Horner-7	Barrack	PL-7	DEV	29	27	29	115	05	27	-	-	17.04.87	01.06.87	1,845	Perm.	O, Susp.
Horner West-1	Barrack	PL-7	NFW	29	08	11	115	02	34	-	-	02.06.87		1,386		Drilling

\* Tophole only drilled - not counted in well statistics.

SUMMARY COMPARISON OF EXPLORATION PERMIT DEALINGS

	1986/87		1985/86	
	No.	Area (km <sup>2</sup> )	No.	Area (km <sup>2</sup> )
<b>AREA ADVERTISED</b>				
Onshore	4	26 210	2	6 685
Offshore	7	5 913	6	15 577
Totals	11	32 113	8	22 262
<b>PERMITS GRANTED</b>				
Onshore	3	13 790	6	37 202
Offshore	5	8 804	3	33 153
Totals	8	22 594	9	70 355
<b>PERMIT APPLICATIONS (Pending at year end)</b>				
Onshore	4	-	-	-
Offshore	2	-	6	-
Totals	6	-	6	-
<b>PERMITS HELD</b>				
Onshore	54	398 987	56	471 218
Offshore	32	256 975	32	284 893
Totals	86	655 962	88	756 111
<b>PERMITS SURRENDERED</b>				
Onshore	4	46 738	5	16 931
Offshore	4	35 827	1	7 192
Totals	8	82 565	6	24 123
<b>PERMIT RENEWALS</b>				
Onshore	5	15 143	6	44 838
Offshore	5	23 673	5	9 057
Totals	10	38 816	11	53 895
<b>PERMITS CANCELLED</b>				
Onshore	1	2 412	2	8 176
Offshore	-	-	-	-
Totals	1	2 412	2	8 176
<b>PERMITS EXPIRED</b>				
Onshore	-	-	6	60 208
Offshore	1	4 955	-	-
Totals	1	4 955	-	60 208

SUMMARY OF IDENTIFIED RECOVERABLE RESERVES AT 30 JUNE 1987

	OIL		GAS		L.P.G.		CONDENSATE	
	(10 <sup>6</sup> kL)		(10 <sup>9</sup> m <sup>3</sup> )		(10 <sup>6</sup> m <sup>3</sup> )		(10 <sup>6</sup> kL)	
	P1	P2	P1	P2	P1	P2	P1	P2
PRODUCING FIELDS								
Barrow Island	6.79	9.60	-	11.04	0.02	0.02	-	0.39
Blina	0.18	0.51	-	-	-	-	-	-
Dongara	0.03	0.04	-	1.58	-	-	-	-
Mt Horner	0.50	0.50	-	-	-	-	-	-
North Rankin	-	-	204.45	239.40	15.80	18.20	24.05	28.52
Sundown	0.04	0.08	-	-	-	-	-	-
Woodada	-	-	1.33	2.69	-	-	-	-
West Terrace	0.03	0.06	-	-	-	-	-	-
Harriet	2.48	2.94	-	-	-	-	-	-
<b>TOTAL</b>	<b>10.05</b>	<b>13.73</b>	<b>205.78</b>	<b>254.71</b>	<b>15.82</b>	<b>18.22</b>	<b>24.05</b>	<b>28.91</b>
UNDEVELOPED FIELDS								
Angel	-	-	24.50	59.20	-	-	7.16	18.00
Brecknock	-	-	111.00	175.00	-	-	6.33	9.65
Brewster	-	-	-	27.50	-	-	-	-
Goodwyn	3.30	6.13	121.00	141.00	8.70	11.10	37.00	44.10
Gorgon	-	-	-	57.19	-	-	-	0.16
Central Gorgon	-	-	-	45.57	-	-	-	0.40
North Gorgon	-	-	-	130.34	-	-	-	1.66
Rankin	-	-	5.56	5.56	-	-	0.69	0.69
* North Herald	-	0.40	-	-	-	-	-	-
Saladin	-	3.14	-	0.25	-	-	-	-
Scarborough	-	-	170.00	555.00	-	-	-	-
Scott Reef	-	-	384.00	695.00	-	-	27.20	46.90
* South Pepper	-	0.80	-	-	-	-	-	-
Spar	-	-	-	7.04	-	-	-	0.79
* Tern	-	-	15.08	17.81	-	-	-	-
Tidepole	0.97	1.18	12.80	16.90	-	-	1.61	2.13
Tubridgi	-	-	2.14	2.16	-	-	-	-
West Tryal Rocks	-	-	-	80.73	-	-	-	3.93
Wilcox	-	-	8.05	11.00	-	-	2.82	3.86
<b>TOTAL</b>	<b>4.27</b>	<b>11.65</b>	<b>854.13</b>	<b>2027.25</b>	<b>8.70</b>	<b>11.10</b>	<b>82.81</b>	<b>132.27</b>
<b>TOTAL RESERVES</b>	<b>14.32</b>	<b>25.38</b>	<b>1059.91</b>	<b>2281.96</b>	<b>24.52</b>	<b>29.32</b>	<b>106.86</b>	<b>161.18</b>
P1 probability 75 per cent; P2 probability 25 per cent * These figures have been prepared by the Mines Department								

ACCIDENT STATISTICS RELATING TO THE PETROLEUM,  
EXPLORATION, PRODUCTION, AND PIPELINE INDUSTRY

	Year Ending 30 June 1987			Year Ending 30 June 1986		
	Onshore	Offshore	Total	Onshore	Offshore	Total
<b>PART OF BODY</b>						
Eye	1	5	6	2	3	5
Ear	1	-	1	-	-	-
Face	-	1	1	1	-	1
Head, neck	5	1	6	4	5	9
Trunk	6	4	10	14	9	23
Spine	3	2	5	-	-	-
Internal organs	-	-	-	1	-	1
Shoulder, upper arm	5	1	6	1	3	4
Elbow, lower arm	1	2	3	2	-	2
Wrist, hand, finger	3	7	10	10	13	23
Hip, thigh, groin	2	1	3	1	1	2
Leg, foot, toes	7	12	19	12	11	23
Skin	-	1	1	-	1	1
Multiple	-	-	-	-	-	-
Other	-	-	-	-	-	-
<b>NATURE OF INJURY</b>						
Fractures	2	3	5	9	1	10
Dislocations	1	-	1	1	1	2
Strains/sprains	13	12	25	17	19	36
Concussion	-	3	3	1	-	1
Internal	-	-	-	-	-	-
Amputation	2	2	4	1	-	1
Lacerations, cuts	2	10	12	6	9	15
Superficial (bruising)	4	3	7	9	5	14
Contusions, crushing	6	5	11	2	6	8
Burns	-	2	2	1	-	1
Multiple	-	-	-	-	-	-
unconsciousness	-	-	-	-	-	-
Fumed	-	-	-	-	-	-
Other	2	2	4	2	3	5
<b>AGENCY OF INJURY</b>						
Harmful contact	-	1	1	3	1	4
Chemicals	-	2	2	-	2	2
Slipping, falling	10	5	15	11	9	20
Falling objects	7	5	12	6	4	10
Machinery in operation	-	7	7	3	2	5
Stationary machinery	-	2	2	2	-	2
Hoisting	-	2	2	1	-	1

	Year Ending 30 June 1987			Year Ending 30 June 1986		
	Onshore	Offshore	Total	Onshore	Offshore	Total
AGENCY OF INJURY (CONT)						
Manual Labour	3	6	9	15	7	22
Vehicles	1	1	2	-	-	-
Explosions	-	-	-	-	-	-
Fires	-	-	-	-	-	-
Entrapment	1	-	1	3	8	11
Electricity	-	-	-	-	-	-
Noxious gases	1	1	2	-	-	-
Other	-	1	1	4	11	15
JOB DESCRIPTION						
Rig labour	16	54	70	36	36	72
Supervisor	3	5	8	3	2	5
Tradesman	4	10	14	7	3	10
Auxillary services	2	2	4	2	3	5
MAGNITUDE OF INJURY						
Minor	20	59	79	26	27	53
Serious	5	12	17	22	17	39
Fatal	-	-	-	-	-	-
TIME FACTOR						
Man-hours exposure	530 047	3 483445	4013 492	711 813	2 314 714	3026527
Man hours lost	3848	4765	8613	11 424	18 998	30422
FREQUENCY RATE						
	47.17	20.38	23.92	67.43	58.32	60.47

SEISMIC SURVEYS COMMENCED DURING 1986/87

SURVEY NAME	COMPANY	TENEMENT	COMMENCED	COMPLETED	KILOMETRES RECORDED
<b>BONAPARTE BASIN</b>					
Whimbrell Detail MSS	Ampol	WA-201-P	01.11.86	09.11.86	852
B-1/86 MSS	Bond	WA-199-P	09.11.86	14.11.86	402
SPA 1SL/87	GSI	Vacant			637
<b>CANNING BASIN</b>					
Nibil SS	WMC	EP 143/225	29.05.86	19.07.86	163
1986 Ryan High SS	Shell	EP 308	06.06.86	29.08.86	490
Honorine MSS	Lasmo	WA-58-P	07.07.86	16.07.86	272
William Hill SS	PSEC	EP 306	08.09.86	08.10.86	147
1986 Fitzroy Basin (Phase I) SS	Kufpec	EP 314?	27.09.86	31.10.86	250
Dampier Shelf SS	Bridge	EP 114	03.11.86	03.12.86	197
Karrobridill SS	OCA	EP 231	17.11.86	24.12.86	240
B86A MSS	BHP	WA-204-P	20.11.86	03.12.86	1,909
Meda 1986 SS	Home	EP 129	07.12.86	11.12.86	40
Laurice MSS	Ampol	WA-203-P	11.12.86	17.12.86	520
SPA 4SL/86	JNOC	Vacant	15.01.87	28.02.87	5,421
1987 Ryan High SS	Shell	EP 308	26.04.87	21.06.87	473
1987 Fitzroy Basin (Phase I) SS	Kufpec	EP 314	15.05.87	10.06.87	209
1987 Fitzroy Basin (Phase II) SS	Kufpec	EP 102	11.06.87		20
1987 Fitzroy Basin (Phase III) SS	Kufpec	EP 97	23.06.87		75
Benfro MSS	Lasmo	WA-58-P	26.06.87		320
<b>CARNARVON BASIN</b>					
Echidna MSS	Marathon	WA-191-P	05.07.86	07.07.86	250
B86 Test SS	Bond	WA-192-P	28.08.86	28.08.86	30
West Barrow (25) MSS	WAPET	WA-25-P	31.08.86	15.09.86	1,645
West Barrow (149) MSS	WMC	WA-149-P	31.08.86	15.09.86	91
SI 3SL/86 MSS	GSI	Vacant	31.08.86	15.09.86	141
Rough Range Field Detail SS	Ampol	EP 41	10.09.86	13.09.86	14
Bullara 2 SS	Golden West	EP 166	15.09.86	08.10.86	202
B86 MSS	Bond	WA-192-P	16.09.86	02.10.86	723
C86A MSS	BHP	WA-155-P	03.10.86	05.10.86	156
Rough Range Detail SS	Ampol	EP 41	20.11.86	20.12.86	169
86/202P MSS	Arco	WA-202-P	05.12.86	10.12.86	680
Barrow (451) SS	WAPET	PL 1H	07.04.87		460
<b>PERTH BASIN</b>					
Koojan West SS	Agnew Clough	EP 231	08.07.86	11.07.86	13
Mooriary (Phase I) SS	WMC	EP 23	09.03.87	22.03.87	67
Beharra Springs SS	Barrack	EP 320	23.03.87	15.04.87	177
Wye Springs SS	Barrack	EP 96	16.04.87	23.04.87	20
Mooriary (Phase II) SS	WMC	EP 23	23.04.87	29.04.87	42
Wakeford SS	Balmoral	EP 201	30.04.87	15.05.87	77
Condor S87 SS	Strata	EP 111	15.05.87	18.05.87	11

PETROLEUM PRODUCTION IN WESTERN AUSTRALIA 1986/87

	Crude Oil (m <sup>3</sup> )	Condensate (m <sup>3</sup> )	LPG (m <sup>3</sup> )	Natural Gas (million m <sup>3</sup> )
Barrow Island	1,066,113	-	5,633	102
Blina	36,467	-	-	-
Dongara	7,952	1,672	-	378
Harriet	534,724	-	-	134
Mondarra	-	201	-	18
Mt Horner	890	-	-	-
North Rankin	-	498,263	-	2,948
Sundown	6,704	-	-	-
West Terrace	7,108	-	-	-
Woodada	-	289	-	47.6
Yardarino	-	2.3	-	0.3
TOTAL	1,659,067	501,317	5,633	3,629



MINING TENEMENTS IN FORCE AS AT 30 JUNE, 1987

Mineral Field/ District	1978 Mining Act			1904 Mining Act
	Prospecting Licences	Exploration Licences	Mining Leases & Others	Mineral Claims & Others
01 Greenbushes			14	
04 West Kimberley	29	134	124	228
08 Ashburton	97	62	42	
09 Gascoyne	57	36	43	
12 Collie			158	
15 Coolgardie	884	44	821	
16 Kunanalling	449	20	68	
20 Cue	527	31	76	4
21 Day Dawn	143	7	21	9
24 Broad Arrow	791	14	221	2
25 Bulong	236	12	86	2
26 East Coolgardie	489	19	264	49
27 Kanowna	316	18	84	
28 Kurnalpi	173	57	35	
29 Menzies	465	35	56	
30 Ularring	302	13	58	
31 Yerilla	399	15	77	
36 Lawlers	312	22	51	24
37 Mt Malcolm	1053	37	167	
38 Mt Margaret	544	51	79	5
39 Mt Morgans	705	35	107	1
40 Niagara	375	7	46	
45 Pilbara	675	204	237	21
46 Nullagine	307	24	75	
47 West Pilbara	261	93	163	7
51 Meekatharra	613	58	186	
52 Peak Hill	156	65	111	
53 Wiluna	204	64	103	109
57 Black Range	247	53	65	
58 Mt Magnet	314	26	99	
59 Yalgoo	336	72	107	
63 Dundas	177	44	145	
66 Northampton	6		2	
69 Warburton		45		
70 South West	215	101	283	368
74 Phillips River	48	18	35	4
77 Yilgarn	753	83	205	
80 Kimberley	318	131	177	27
Special Agreement Act areas				27
<b>TOTAL</b>	<b>12 976</b>	<b>1750</b>	<b>4691</b>	<b>887</b>

TOTAL AREA OF MINING TENEMENTS IN-FORCE

As at	Area (hectares)
31-12-82	12 756 046
31-12-83	10 505 270
31-12-84	17 308 525
30-06-85	18 414 443
30-06-86	17 496 124
30-06-87	22 232 171

## ABBREVIATIONS

cons.	concentrates	f.o.t.	free on truck
f.o.b.	free on board	n.a.	not available
f.o.r.	free on rail	Inf.	infinity

## REFERENCES

- (a) Value based on the average Australian value of alumina as published by the Bureau of Mineral Resources in the Australian Mineral Industry Review.
- (b) Value at works.
- (c) Estimated f.o.b. value.
- (d) Estimated f.o.r. value.
- (e) Estimated f.o.b. value based on the current price of nickel containing products.
- (f) Nett well head value.
- (g) Value based on the price per barrel as assessed by the Commonwealth for crude oil at Kwinana.
- (h) Value at pithead.
- (i) Nominal Price at Wellhead

## UNITS AND CONVERSION FACTORS

				Conversion factors	
Metric unit		Symbol	Imperial unit	Multiply imperial unit by	Multiply metric unit by
Mass	gram	g	troy (fine) ounce (oz)	31.1035	0.0321507
	kilogram	kg	pound (lb)	0.453592	2.20462
	tonne	t	long tonne (2240 lbs)	1.01605	0.984207
	tonne	t	short tonne (2000 lbs)	0.907185	1.10231
Volume	kilolitre	kL	barrel (bbl)	6.29	0.159

QUANTITY AND VALUE OF MINERALS REPORTED 1985/86, 1986/87

Mineral	Unit	1985/86		1986/87	
		Quantity	Value (\$A)	Quantity	Value (\$A)
Alumina	tonne	5 430 555	1 029 283 528	5 727 327	1 090 879 157
Building Stone					
black granite	t	145	45 000	585	50 000
quartz	t	2 233	100 481	1 861	83 755
Clay					
attapulgite	t	41 885	n.a.	10 458	n.a.
cement clay	t	23 131	57 828	23 991	59 969
fire clay	t	242 489	292 015	208 895	252 326
kaolin	t	4 600	188 422	7 460	241 564
white clay	t	126 899	372 318	72 176	209 528
Coal	t	3 765 045	n.a.	3 795 055	n.a.
Cobalt	t	515	9 230 525	463	4 012 332
Construction Material					
aggregate	t	117 255	744 055	100 816	581 430
gravel	t	6 379	16 098	22 365	28 965
rock	t	46 524	92 686	116 222	787 560
sand	t	886 091	1 660 770	1 271 826	3 786 995
sandstone	t	-	-	20	40
Copper	t	3 484	4 162 432	3 519	4 106 685
Copper Concentrate	t	44 468	9 700 345	-	-
Diamond	carat	17 472 460	147 567 905	32 164 524	284 094 805
Diatomite	t	1 638	8 450	401	2 006
Dolomite	t	330	2 310	243	3 162
Emerald	gram	225	1 685	200	1 784
Felspar	t	10 104	118 452	4 405	68 814
Garnet Sand	t	8 166	285 810	12 122	427 334
Gold	kilogram	46 287	710 655 104	64 911	1 300 079 190
Gypsum	t	348 639	3 908 872	233 404	2 673 698
Iron Ore	t	85 513 414	1 965 666 843	78 026 315	1 888 998 210
Kyanite	t	249	29 817	955	153 220
Limestone	t	206 289	1 088 735	194 895	1 251 642
Mineral Beach Sand					
ilmenite	t	1 050 131		1 038 922	
reduced ilmenite	t	-	59 817 919	53	78 836 361
upgraded ilmenite	t	57 818		61 178	
leucoxene	t	19 002	6 219 583	12 606	5 140 988
monazite	t	17 962	10 384 934	12 407	8 417 755
rutile	t	71 794	30 751 960	82 462	46 089 968
xenotime	t	25	345 693	43	328 846
zircon	t	349 030	48 356 864	310 576	56 297 397
Nickel Concentrate	t	455 155	313 472 129	406 321	264 726 489
Nickel Ore	t	45 937	8 490 324	59 257	10 065 723
Palladium	kilogram	421	2 050 352	490	3 218 062
Peat	t	10 238	441 894	1 641	51 669
Petroleum Products					
condensate	kilolitre	381 287	n.a.	512 434	n.a.
crude oil	kilolitre	1 430 180	311 924 009	1 574 655	262 843 620
natural gas	'000m <sup>3</sup>	2 756 065	291 608 694	3 199 165	277 989 304
Platinum	kilogram	94	1 498 493	105	2 645 121
Salt	t	4 814 138	95 326 825	5 051 148	107 382 344
Semi-precious Stone					
amethyst	kilogram	8 988	50 716	51 000	195 500
moss opal	kilogram	21	14	-	-
tiger eye	t	54	50 214	-	-
Silica Sand	t	377 009	n.a.	371 165	n.a.
Silver	kilogram	41 135	10 705 718	11 160	1 971 953
Spodumene	t	12 690	2 967 402	8 221	1 955 601
Talc	t	132 262	n.a.	179 241	n.a.
Tantalite	t	143	4 853 625	108	4 224 365
Tin Concentrate	t	679	6 371 195	731	4 882 698
Vermiculite	t	552	9 034	819	16 388
Zinc Concentrate	t	75 946	20 044 441	-	-
Total Value			5 317 196 704		5 949 989 563

QUANTITY AND VALUE OF MINERALS REPORTED  
SHOWING MINERAL FIELD AND METALLIC CONTENT.

Mineral	Mineral Field	Quantity tonnes	Metallic Content	Value (\$)	Ref.
Alumina	South West	5 727 327		1 090 879 157	(a)
Building stone					
black granite	West Kimberley	585		50 000	
quartz	South West	1 861		83 755	
		2 446		133 755	(b)
Clay					
attapulgite	South West	10 458		NA	
cement clay	South West	23 991		59 969	
fire clay	South West	208 895		252 326	
kaolin	Greenbushes	7 460		241 564	
white clay	South West	72 176		209 528	
		322 980		N.A.	(b)
Coal	Collie	3 795 055		N.A.	
			Cobalt tonnes		
Cobalt (metallic by- product of nickel mining)					
	Coolgardie		308.639	1 815 734	
	East Murchison		153.904	2 196 598	
			462.543	4 012 332	(c)
Construction Materials					
aggregate	East Coolgardie	73 557		371 927	
	Kimberley	9 860		39 440	
	Pilbara	11 849		137 824	
	West Kimberley	1 876		17 203	
	West Pilbara	3 674		15 036	
		100 816		581 430	
gravel	Pilbara	17 685		17 685	
	West Pilbara	4 680		11 280	
		22 365		28 965	
rock	West Pilbara	116 222		787 560	
sand	Coolgardie	6 893		28 679	
	North East				
	Coolgardie	850		1 700	
	Pilbara	15 407		94 758	
	South West	690 162		1 116 296	
	West Kimberley	30		60	
	West Pilbara	558 484		2 545 502	
		1 271 826		3 786 995	

QUANTITY AND VALUE OF MINERALS REPORTED  
SHOWING MINERAL FIELD AND METALLIC CONTENT - continued

Mineral	Mineral Field	Quantity tonnes	Metallic Content	Value (\$)	Ref.
Construction Materials (Cont)					
sandstone	West Pilbara	20		40	
Total Construction Materials		1 511 249		5 184 990	(b)
Copper tonnes					
Copper (metallic by- product of nickel mining)	Coolgardie		2 408.223	3 023 914	
	East Murchison		1 110.834	1 082 771	
			3 519.057	4 106 685	(c)
Carats					
Diamond	Kimberley		32 164 524	284 094 805	(c)
Diatomite	South West	401		2 006	(d)
Dolomite	South West	243		3 162	(d)
Grams					
Emerald	North Coolgardie		200	1 784	(d)
Felspar	South West	4 405		68 814	(d)
Garnet Sand	South West	12 122		427 334	(d)
Ore treated Estimated Au Kg*					
Gold	State generally	17 726 307	64 911.313	1 300 079 190	
*Includes alluvial, dollied + specimens, gold obtained from tailings retreatment and gold contained in exported gold bearing material.					

QUANTITY AND VALUE OF MINERALS REPORTED  
SHOWING MINERAL FIELD AND METALLIC CONTENT - continued

Mineral	Mineral Field	Quantity tonnes	Metallic Content	Value (\$)	Ref.
Gypsum	Dundas	42 084		629 000	(d)
	Gascoyne	41 721		722 063	(c)
	South West	85 281		892 759	(b), (d)
	Yilgarn	64 318		429 876	(d)
		233 404		2 673 698	

Plaster of Paris reported as manufactured during the year - 45 495 tonnes from 66 989 tonnes of gypsum by two companies.

		Av. Assay Fe %			
Iron Ore					
Ore shipped interstate	Peak Hill	4 341 031	64.00	90 426 332	
	Pilbara	205 890	63.39	5 831 039	
	West Kimberley	1 355 712	66.60	14 879 832	
		5 902 633		111 137 203	

Ore exported overseas	Peak Hill	24 647 515	63.00	617 371 486	
	Pilbara	4 863 979	61.79	115 553 933	
	West Pilbara	40 214 550	61.49	990 494 975	
	West Kimberley	2 268 979	66.71	51 465 045	
		71 995 023		1 774 885 439	

Pellets (exported overseas)	West Pilbara	128 659	63.00	2 975 568	
Total Iron Ore		78 026 315		1 888 998 210	(c)

Kyanite	South West	955		153 220	(c)
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Limestone	South West	177 844		1 069 510	
	West Pilbara	17 051		182 132	
		194 895		1 251 642	(b)

QUANTITY AND VALUE OF MINERALS REPORTED  
SHOWING MINERAL FIELD AND METALLIC CONTENT - continued

Mineral	Mineral Field	Quantity tonnes	Metallic Content	Value (\$)	Ref.
Mineral Beach Sands			Av. Assay TiO <sub>2</sub> %		
ilmenite upgraded	South West	1 038 922	50.53)	78 836 361	
ilmenite reduced	South West	61 178	92.00)		
ilmenite	South West	53	65.00)		
			TiO <sub>2</sub> tonnes		
leucoxene	South West	12 606	11 351	5 140 988	
			Th O <sub>2</sub> units		
monazite	South West	12 407	80 231	8 417 755	
			TiO <sub>2</sub> tonnes		
rutile	South West	82 462	78 566	46 089 968	
			Y <sub>2</sub> O <sub>3</sub> kg		
xenotime	South West	43	12 985	328 846	
			ZrO <sub>2</sub> tonnes		
zircon	South West	310 576	205 849	56 297 397	
Total Mineral Beach Sands		1 518 247		195 111 315	(c)
			Assay Ni%		
Nickel Concentrates	Coolgardie	311 673	11.53	203 001 576	
	East Coolgardie	28 402	11.66	18 760 455	
	East Murchison	8 702	13.23	7 133 300	
	Mt Margaret	57 544	11.14	35 831 158	
		406 321		264 726 489	(e)
			Assay Ni%		
Nickel Ore	Coolgardie	59 257	3.53	10 065 723	(b)

QUANTITY AND VALUE OF MINERALS REPORTED  
SHOWING MINERAL FIELD AND METALLIC CONTENT - continued

Mineral	Mineral Field	Quantity tonnes	Metallic Content	Value (\$)	Ref.
Palladium (metallic by-product of nickel mining)	Coolgardie		kg 489.728	3 218 062	(c)
Peat	South West	1 641		51 669	(b)
Petroleum condensate	Basin	Kilolitres			
	Carnarvon	509 910		NA	
	Perth	2 524		NA	
		512 434		NA	
crude oil	Canning	51 360		7 852 546	
	Carnarvon	1 514 566		253 650 041	
	Perth	8 729		1 341 033	
		1 574 655		262 843 620	(g)
natural gas		m <sup>3</sup> 10 <sup>3</sup>			
	Carnarvon	2 774 237		244 521 000	
	Perth	424 928		33 468 304	
		3 199 165		277 989 304	(i)
Platinum (metallic by-product of nickel mining)	Coolgardie		kg 105.218	2 645 121	(c)
Salt	Gascoyne	1 755 186		37 928 780	
	Pilbara	1 840 393		38 010 349	
	South West	600		11 850	
	West Pilbara	1 454 969		31 431 365	
		5 051 148		107 382 344	(c)



QUANTITY AND VALUE OF MINERALS REPORTED  
 SHOWING MINERAL FIELD AND METALLIC CONTENT - continued

Mineral	Mineral Field	Quantity tonnes	Metallic Content	Value (\$)	Ref.
Semi-precious stones amethyst	Gascoyne		kg 51 000	195 500	(d)
Silica Sand	Coolgardie South West	75 966 295 199		N.A. N.A.	
		371 165		N.A.	(c)
Silver	By-product of gold mining By-product of nickel mining		kg 10 072.070 1 087.543 11 159.613	1 614 738 357 215 1 971 953	(c)
Spodumene	Greenbushes	8 221.46	Li <sub>2</sub> O tonnes 476.56	1 905 601	(c)
Talc	South West	179 241		NA	
Tantalite	Greenbushes	107.78	Ta <sub>2</sub> O <sub>5</sub> kg 73 054	4 224 365	(c)
Tin	Greenbushes Pilbara	677.55 53.09 730.64	Sn tonnes 474.29 38.56 512.85	4 231 227 651 471 4 882 698	(c)
Vermiculite	Phillips River	819		16 388	(d)
	Value of Minerals			4 649 910 373	
	Value of Gold			1 300 079 190	
				5 949 989 563	

QUANTITY OF GOLD AND ORE TREATED AS REPORTED 1986/87  
SHOWING MINERAL FIELD AND DISTRICT

	ALLUVIAL KILOGRAMS	DOLLIED AND SPECIMENS KILOGRAMS	MILLED OR SMELTERED		TOTAL GOLD KILOGRAMS	SILVER KILOGRAMS
			ORE TREATED (TONNES)	GOLD THEREFROM KILOGRAMS		
KIMBERLEY	27.990	1.640	450	4.131	33.761	2.092
WEST KIMBERLEY	-	-	-	-	-	-
MARBLE BAR	34.246	5.806	1 516 159	6 321.294	6 361.346	521.378
NULLAGINE	24.367	4.080	23 810	164.848	193.295	2.199
PILBARA	58.613	9.886	1 539 969	6 486.142	6 554.641	523.577
WEST PILBARA	9.720	3.007	-	-	12.727	1.003
ASHBURTON	4.253	0.207	8	0.335	4.795	0.122
GASCOYNE	3.472	-	15	0.423	3.895	0.144
PEAK HILL	37.735	0.071	408 213	2 113.938	2 151.744	270.643
LAWLERS	11.173	-	950 814	2 931.339	2 942.512	186.617
WILUNA	1.419	0.534	254 707	1 256.241	1 258.194	68.179
BLACK RANGE	10.040	1.464	280 868	817.059	828.563	10.296
EAST MURCHISON	22.632	1.998	1 486 389	5 004.639	5 029.269	265.092
CUE	34.166	4.707	219 554	902.910	941.783	45.115
MEEKATHARRA	38.105	5.792	929 389	2 500.102	2 543.999	9.776
DAY DAWN	11.429	0.013	65 745	1 517.919	1 529.361	210.294
MT MAGNET	12.462	1.443	724 331	2 704.877	2 718.782	173.712
MURCHISON	96.162	11.955	1 939 019	7 625.808	7 733.925	438.897
YALGOO	1.308	0.158	387 177	1 458.761	1 460.227	29.250
MT MORGANS	14.712	0.284	1 467	19.973	34.969	1.449
MT MALCOLM	28.033	2.584	1 475 699	5 102.286	5 132.903	310.595
MT MARGARET	31.592	2.565	653 201	2 369.716	2 403.873	329.226
MT MARGARET	74.337	5.433	2 130 367	7 491.975	7 571.745	641.270
MENZIES	0.064	0.160	588	53.533	53.757	14.191
ULARRING	1.302	-	11 058	115.150	116.452	1.882
NIAGARA	1.909	0.365	50	8.135	10.409	0.095
YERILLA	0.321	0.016	279 803	813.236	813.573	137.648
NORTH COOLGARDIE	3.596	0.541	291 499	990.054	994.191	153.816
BROAD ARROW	6.318	-	1 968 692	5 044.364	5 050.682	292.914
KANOWNA	6.902	0.579	54 321	109.440	116.921	4.082
KURNALPI	0.605	1.144	194	0.398	2.147	0.105
NE COOLGARDIE	7.507	1.723	54 515	109.838	119.068	4.187
EAST COOLGARDIE	4.818	1.817	3 716 178	14 832.511	14 839.146	3 140.466
BULONG	2.487	0.447	-	-	2.934	0.202
EAST COOLGARDIE	7.305	2.264	3 716 178	14 832.511	14 842.080	3 140.668
COOLGARDIE	7.312	1.898	1 385 055	4 834.328	4 843.538	1 348.692
KUNANALLING	1.613	0.097	13 950	86.556	88.266	2.481
COOLGARDIE	8.925	1.995	1 399 005	4 920.884	4 931.804	1 351.173
YILGARN	3.070	0.395	1 888 557	5 149.903	5 153.368	272.846
DUNDAS	1.969	0.039	425 269	2 916.057	2 918.065	1 821.303
PHILLIPS RIVER	0.095	-	1 428	32.040	32.135	2.961
SOUTH WEST	-	-	89 557	309.854	309.854	-
STATE GENERALLY	2.077	1.260	-	-	3.337	0.406
TOTAL	377.084	42.572	17 726 307	64 491.657	64 911.313	9 212.364

## ROYALTY RECEIPTS 1985/86 AND 1986/87

Mineral	Value (\$A)		Value (\$A) variance	% up (% down)
	1985/86 (\$A)	1986/87 (\$A)		
Alumina	9 923 606	10 540 225	616 619	6
Building stone	792	823	31	4
Clay	88 672	153 343	64 671	73
Coal	1 400 429	1 353 229	(47 200)	(3)
Cobalt	131 844	56 373	(75 471)	(57)
Construction materials				
aggregate	28 996	19 797	(9 199)	(32)
gravel	6 907	10 088	3 181	46
rock	21 779	22 519	740	3
sand	134 051	250 568	116 517	87
Copper	276 349	143 183	(133 166)	(48)
Diamond	2 864 655	13 109 395	10 244 740	358
Diatomite	281	173	(108)	(38)
Dolomite	369	18	(351)	(95)
Emerald	126	134	8	6
Feldspar	2 906	3 195	289	10
Garnet sand	11 327	19 230	7 903	70
Gold	103 663	111 974	8 311	8
Gypsum	118 963	83 998	(34 965)	(29)
Iron ore	101 950 692	92 780 315	(9 170 377)	(9)
Kyanite	1 285	5 841	4 556	355
Limestone	86 091	90 641	4 550	5
Mineral beach sands				
ilmenite	1 150 156	1 462 769	312 613	27
leucoxene	133 303	137 980	4 677	4
monazite	282 594	252 178	(30 416)	(11)
rutile	1 173 396	1 038 150	(135 246)	(12)
xenotime	2 742	8 457	5 715	208
zircon	1 486 272	1 347 903	(138 369)	(9)
Nickel	5 926 069	4 315 281	(1 610 788)	(27)
Ochre	1 460	2 255	795	55
Palladium	15 247	24 567	9 320	61
Peat	11 719	2 740	(8 979)	(77)
Petroleum Products				
condensate	641 546	695 164	53 618	8
crude oil	29 538 137	21 917 124	(7 621 013)	(26)
natural gas	3 843 821	4 797 338	953 517	25
Platinum	15 247	24 567	9 320	61
Salt	555 276	747 615	192 339	35
Semi-precious stones				
amethyst	10 581	6 375	(4 206)	(40)
moss opal	1	-	(1)	(100)
tiger eye	3 766	-	(3 766)	(100)
Silica sand	180 720	165 339	(15 381)	(9)
Silver	163 756	87 238	(76 518)	(47)
Spodumene	48 803	72 632	23 829	49
Talc	80 442	88 874	8 432	10
Tantalite	86 284	109 428	23 144	27
Tin	125 563	143 601	18 038	14
Vermiculite	377	804	427	113
Zinc Concentrate	350 598	78 427	(272 171)	(78)
Total value	162 981 659	156 281 868	(6 699 791)	(4)

NUMBER OF PERSONS EMPLOYED IN THE WESTERN AUSTRALIAN MINING INDUSTRY  
AS AT JUNE 30, 1987

MINERAL Company	Location	Total
<b>ALUMINA</b>		
Alcoa of Australia Ltd	Jarrahdale/Kwinana	1 449
	Del Park/Huntley/Pinjarra	1 646
	Wagerup	498
	Administration	260
Worsley Alumina Pty Ltd	Worsley	842
		4 695
<b>COAL</b>		
Griffin Coal Mining Co Ltd	Collie	474
Western Collieries Ltd	Collie	691
		1 165
<b>DIAMOND</b>		
Argyle Diamond Mines Joint Venture	Lake Argyle	661
<b>GOLD</b>		
AUR NL	Mt. Martin	62
Australian Consolidated Minerals Ltd	Golden Crown	88
	Westonia	133
Australis Mining NL	Norseman	49
Austwhim Resources NL	Cork Tree Well/Mt Morgans	75
BHP Minerals Ltd.	Gimlet South/Orban J.V.	121
Bamboo Creek J.V.	Bamboo Creek	64
Bardoc Gold Pty Ltd	Bardoc	73
Barrack Mine Management	Peak Hill	29
	Horseshoe	84
	Wiluna	80
Boddington Gold Project	Boddington	94
Broad Arrow J.V.	Talbot/Victory	42
Brunswick NL	Galtee More	54
Central Norseman Gold Corp. NL	Norseman	456
Chevron Exploration Corp.	Mt. Wilkinson	78
Cypress Minerals Aust. Co.	Gidgee	74
Eastmet Ltd.	Youanmi	68
Edjudina Gold Mines Pty Ltd.	Neda/Gawler	94
Endeavour Resources Ltd	Bluebird	128
Forrest Gold Pty Ltd.	Hannans South	29
	Tower Hill	39
Forsayth NL	Lawlers	71
Golden Spec J.V.	Golden Spec	41
Great Victoria Gold Ltd.	Gt. Victoria	106
Harbour Lights Mining Pty Ltd.	Leonora	101
Hill 50 Gold Mine NL	Mt. Magnet	276
KLV-Kalgoorlie	Mt. Charlotte	386
KLV-Fimiston	Perseverance	611
Kia Ora Gold Corp. Ltd.	Marvel Loch	188
Kurara J.V.	Kurara	56
Metana Minerals	Black Cat	34
	Reedy	68
	Mt. Magnet	7
Mincoa NL	Edwards Find	42
Mt Percy Project	Mt Percy	75
Nevoria J.V.	Nevoria	40
Newmont Holdings Pty Ltd.	New Celebration	91
North Kalgurli Mines Ltd.	Norkal/Fimiston	477
Pancontinental Gold Mining Areas Pty Ltd	Paddington	141
Queen Margaret Gold Mines	Bellevue	57
Sons of Gwalia NL	Gwalia	81
Telfer Project	Telfer	425
WMC-Gt. Boulder Holdings	Davyhurst	23
	Emu	92
	Kambalda	123
	Lancefield	84
	Sand King	35
WMC Ltd & Consolidated Exploration Ltd	Lady Bountiful	71
Whim Creek Consolidated NL	Meekatharra	140
All Other Operators		737
		6 757
<b>IRON ORE</b>		
BHP Minerals Pty Ltd.	Yampi	499
Goldsworthy Mining Ltd	Pilbara/Port Hedland	1 003
Hammersley Iron Pty Ltd	Tom Price-Paraburdoo/Dampier	3 830
Mt Newman Mining Co Ltd	Newman/Port Hedland	4 192
Robe River Mining Co Pty Ltd	Pannawonica/Cape Lambert	1 365
		10 889
<b>MINERAL BEACH SAND</b>		
Allied Eneabba Pty Ltd	Eneabba	119
Associated Minerals Cons. Ltd	Capel	185
	Eneabba	364
Cable Sands Pty Ltd	Capel	109
Westralian Sands Ltd	Capel	343
		1 120
<b>NICKEL</b>		
Agnew Mining Co Pty Ltd	Leinster	29
Metals Exploration Ltd	Nepean	18
Western Mining Corporation	Kalgoorlie	317
	Kambalda	1 375
	Kwinana Refinery	360
	Mt Windarra	360
		2 428
<b>PETROLEUM PRODUCTS</b>		
Bond Corporation Pty Ltd.	Harriet	61
Home Energy Pty Ltd	Blina/Sundown	6
Barrack Energy Ltd	Mt Horner	2
Strata Oil NL	Woodada	1
West Australian Petroleum Pty Ltd	Barrow Island	171
	Dongara	13
Woodside Offshore Petroleum Pty Ltd	North Rankin A/ Burrup Peninsula	1 351
		1 605
<b>SALT</b>		
Dampier Salt Ltd	Dampier	202
	Lake McLeod	96
Leslie Salt Co.	Port Hedland	122
Shark Bay Salt JV	Shark Bay	82
		502
All Other Materials (including Rock Quarries)		759
	<b>TOTAL</b>	<b>30 581</b>

Source: Axtat Reporting System, Mining Engineering Division