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**DEPARTMENT OF
MINERALS AND ENERGY**



**BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS**

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MINERAL RESOURCES BRANCH

ANNUAL SUMMARY OF ACTIVITIES

1976

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INTRODUCTION

During 1976 the work of the Branch has been directed towards two main objectives, viz. monitoring and researching the mineral industry, and the assessment of identified and potential mineral resources at a national level.

The first objective involved the Branch in a heavy work load providing information and advice to the Department and other Government agencies for use mainly in policy formulation, and to industry. Branch officers acted as technical advisers to interdepartmental committees such as those reviewing IAC Reports on the Petroleum and Mining Industries, Production of Gold, and Crude Oil Pricing. Background briefing was also provided for international mineral commodity arrangements which now include tin, lead-zinc, copper, iron ore, bauxite, and tungsten. The Assistant Director, Mr J. Ward, prepared technical background material for the Department and the Rutile-Zircon Development Association in connection with the Queensland Government Commission of Enquiry into Land Use of Moreton Island, which commenced in October 1976.

The Branch continued to provide lecturers for Industrial Mobilization Courses and for seminars of economic geoscientific content. Branch representatives attended the 25th International Geological Congress in Sydney during September, as conveners and excursion leaders, and attended meetings of international scientific organizations held in conjunction with IGC.

Contributions to foreign aid continued through participation in the planning for the International Training Course in Mineral Sands Mining, organised by the Australian Development Assistance Agency (ADAA), which in the event was cancelled because of a lack of suitable participants needed to justify such a course. However, planning is now in hand for an International Training Course in Mineral Exploration and Administration to be held in 1977. Mr J.C. Erskine, Mining Engineer, visited Thailand for a fortnight on behalf of ADAA to assess the assistance the Thai authorities would require for the development of lignite mining projects. The Assistant Director represented Australia at the 3rd Session of ESCAP: Committee on Natural Resources held in Bangkok from 21 to 27 September 1976.

Notwithstanding staffing restraints, considerable progress was made in the assessment of Australia's mineral resources. In keeping with restricted manpower and constraints imposed by recruitment cuts, priorities were allotted for the assessment of selected mineral commodities. An inter-Branch committee was established to review the methodology of mineral resource assessment and to recommend how BMR should proceed towards achieving the assessment of mineral resources on a national scale.

During the year considerable thought, discussion, and submission were given to the future role of the Mineral Resources Branch and its contribution to the development of the domestic mining industry, and its relation to other Branches of BMR and Departmental Divisions. It is hoped that the findings and recommendations of the BMR Review Team which is soon to become functional will do much to clarify the position.

Staff ceilings and restrictions on recruitment prevented the filling of key positions in each of the three Sections during 1976. However, action is being taken to fill these positions and it is hoped that they will be manned permanently by late 1976 or early 1977. Since last year's Report, Chiefs of two Branch Sections have retired, viz. Mr G.F. Mead, Chief Mining Engineer, and Mr H.S. Taylor-Rogers, Chief Petroleum Technologist. The vacant positions have been filled by Mr E.G. Timoney and Mr J.A.W. White, respectively.

MINING ENGINEERING SECTION

The Mining Engineering Section is a mining advisory section within the Mineral Resources Branch. The mining engineers provide information and advice to Government on mining matters, for example on mine feasibility and profitability, methods of mining, recommendations for development programs, and requests for mining assistance submitted to the Government. The section also provides assistance to the mineral resource assessment groups of BMR in their compilation of economic and sub-economic mineral resources by calculating data on capital and operating costs of mining projects. In co-operation with the State Mines Departments the section participates in the compilation of a standard mine operating code of practice. A schedule of State mining royalties and Australian Government mining tax provisions is kept up-to-date, together with State mining legislation amendments.

STAFF

Occupied Positions (as at 1 October 1976)

- 1 Engineer Class 5
- 1 Engineer Class 3

Changes in Staff

Mr E.G. Timoney joined the Section as Engineer Class 5 on 24 November 1975, replacing Mr G. Mead who retired on 30 September 1975.

ACTIVITIES

CONFERENCE OF CHIEF INSPECTORS OF MINES

The 1976 Conference was held in Perth during October; Mr E. Timoney attended as Secretary. During the year the basic code for the operation of mines and quarries (except coal mines) was examined in its entirety and the code was reprinted as a 1976 issue and distributed to all conference members. E. Timoney also attended the working group on certification of managers of surface mines, quarries, and tunnels.

GENERAL ASSISTANCE TO GOVERNMENT DEPARTMENTS

The Northern Territory and northwest Queensland mineral potential study was examined and commented on. As was the Industries Assistance Commission report on the effects of taxation and royalty measures on the mining sector. Help was given to the Department of National Resources in estimating mine production in connection with the tin export quotas imposed by the International Tin Council.

GOLD MINING INDUSTRY

The gold mining industry asked for Government help to avoid shutting down four important Australian gold mines (Mt Charlotte, Fimiston, North Kalbarlie, and Hill 50). J. Erskine attended a meeting in Perth with representatives of Federal and Western Australian State Governments and the mining companies concerned, and later inspected three of the four mines.

RESOURCE ASSESSMENT

J. Erskine was a member of the BMR Resource Assessment Committee which prepared a report recommending how BMR should carry out resources assessment.

VISITS TO MINES

E. Timoney visited the King Island Scheelite mine, including the Dolphin mine which has a newly developed 'post pillar' system for ground support; the mine is working below the sea and prevention of subsidence is important. He also visited Groote Eylandt and Bell Bay concerning the disposal of manganese fines.

AUSTRALIAN DEVELOPMENT ASSISTANCE AGENCY

Work was done on two projects for ADAA (Bangladesh beach sands and Thailand lignite mines). J. Erskine spent two weeks in Thailand on the lignite project in company with the senior geologist for the Victorian State Electricity Commission. He also visited two Australian lignite open pit mines during the course of the same project.

GEOSTATISTICS AND ORE RESERVE ESTIMATION

During the year a good deal of effort was put into trying to adapt modern geostatistical theory for use in our ordinary ore reserve estimates; at present these estimates are done using the less appropriate classical statistical theory and traditional geometric methods. The attempt to adapt geostatistics to our needs was unsuccessful, and the position remains unsatisfactory pending the development of shorthand methods to suit our intermittent usage.

THE GOOGONG DAM PROJECT

E. Timoney acted as mining adviser to the project executive committee throughout the year.

MINING LEGISLATION

E. Timoney carried out a survey of state mining legislation. J. Erskine updated our records on state mining royalties. The subject of mining taxation, depreciation, and allowable expenses for taxation purposes generated considerable discussion and correspondence throughout the year.

LIAISON WITH CSIRO

E. Timoney visited the CSIRO laboratory of Applied Geomechanics in Melbourne. CSIRO maintains a large staff of professionals in the rock mechanics and slope stability field.

MINERAL ECONOMICS SECTION

INTRODUCTION

The broad function of the Section is to obtain information on and maintain a continuing review of all aspects of the mineral industry, especially in Australia but also world-wide, and to publish and provide information on the mineral industry. This work follows two main lines: commodity studies, which are continuing reviews of all aspects of individual mineral commodities; and special investigations, which focus in detail on particular aspects of the industry; mineral resource assessment studies are an important part of special studies.

The Section provides advice and information on the mineral industry to Government, particularly to its own Department of National Resources, to government agencies such as the Industries Assistance Commission and the Australian Industries Development Corporation, and to industry and the public generally. The Section prepares the Australian Mineral Industry Annual Review and the Australian Mineral Industry Quarterly Review; details of publications and papers published in Quarterly Reviews are listed separately.

Much of the Section's work depends on statistical data on production and trade and to this end it maintains a close working relationship with the Australian Bureau of Statistics (ABS), through the Statistical Officer (Mining), an ABS Officer outposted to the Section. By arrangement with ABS, the Section carries out some statistical collections. These are issued by EMR as quarterly bulletins on mineral sands, copper, lead and zinc, tin, and sulphur, sulphuric acid and superphosphate.

STAFF

Two of the staff of the Section resigned during the year, Mr P. Roberts (Mineral Economist Class 3) from 23 August and Miss M. Missingham (Clerical Assistant Grade 4) from 17 September. The CA4 position was filled from within EMR, by Mr W. Coulson, from 20 September.

Staffing at 1 November 1976 was:

Mineral Economist Class 5	1
Mineral Economist Class 4	2
Mineral Economist Class 3	1
Mineral Economist Class 2	4
Geologist Class 1	1
Clerk Class 4	2
Clerk Class 2/3	1
Clerical Assistant Grade 4	1

A Clerk Class 8 continues to be outposted to the Section from the Australian Bureau of Statistics, as Statistical Officer (Mining).

Mr J. Ward was appointed to the position of Assistant Director (Mineral Resources), and Mr I.R. McLeod was appointed Chief Mineral Economist (Mineral Economist Class 5) during the year. Both had occupied their respective positions in an acting capacity for some time.

BASIC COMMODITY STUDIES

Commodity studies involve continuing review and assessment of trends in all sections of the mineral industry, from exploration, through mining, processing, and transportation to marketing. This wide coverage is essential, because events in one of these sections of the industry can affect the other sectors, sometimes markedly. Although emphasis is on monitoring the domestic industry, the work is necessarily expanded to cover world-wide developments and requirements because of the international character of the industry and Australia's prominence as a supplier or potential supplier of many minerals - particularly bauxite, mineral sands, coal, iron ore, lead, uranium and zinc - to world markets.

Commodity specialists try to maintain close personal contact with the numerous companies and organisations comprising the industry and the Section gratefully acknowledge the assistance, information and good-will proffered by the industry, through informal discussion and visits by commodity specialists to mines and plants. Various commodity specialists also attend industry symposia and conferences held each year, as well as technical courses, to keep pace with progress and latest developments in the industry. Details of such attendances are listed separately.

The purpose of these continuing studies is to enable the commodity specialists to keep abreast of trends in the industry so that they can provide authoritative information and advice. The most visible product of the work are the reviews published in the Australian Mineral Industry Annual Review and Australian Mineral Industry Quarterly Review. However, the expertise which the Section accumulates from these studies is also provided in the form of briefs, papers and other correspondence in response to the numerous ad hoc enquiries from government, the industry, and the public generally. In 1976, requests for information relating to the copper, gold, uranium, mineral sands and phosphate industries were prominent reflecting, in the case of copper and gold and mineral sands, the difficulties being experienced by those industries because of falling prices, and in the case of uranium and phosphate rock, reflecting the early growth stages of the industry in Australia. Comments and material were also prepared on a range of other topics including the location of mineral deposits in relation to Aboriginal Reserves, the history of mineral discoveries by small corporate explorers,

estimates of land disturbance in present and foreseeable mining projects and estimates of employment opportunities in the mineral industry. The Section also prepared papers, briefs, and other material for several commissions of enquiry, Australian and international mineral commodity groups and other organisations such as United Nations agencies; these included the Conference of Government Geologists, International Lead and Zinc Study Group, International Bauxite Association, UNCTAD Committee on Tungsten, UNCTAD Preparatory Meeting on Copper, ESCAP Committee on Natural Resources and the UN Centre for Natural Resources, Energy and Transport. B. Elliott and K. Patterson attended meetings of producers of copper and lead-zinc respectively in connection with international commodity groups.

SPECIAL INVESTIGATIONS

The Section's capacity to carry out special investigations is limited by its commitment to respond to the numerous ad hoc enquiries from government and industry which, by their nature, take priority over longer-term projects.

Over recent years emphasis has been on resource assessment studies; a new system of classifying reserves and resources, along the lines evolved by the United States Bureau of Mines and United States Geological Survey, has been adopted by BMR. The classification is described in A.M.I. Quarterly Review Vol. 28 No. 1. Briefly, it categorizes mineral resources according to two parameters: the degree of geological certainty of their existence and the degree of economic feasibility of their extraction, which takes into account costs and market prices.

This classification was used for the assessment of Australian antimony resources referred to later. It was also used to prepare estimates of Australian resources of the main mineral commodities on a uniform basis. Although the data used for some of these estimates are not complete, being compiled from data available to BMR through its routine studies, the estimates give an indication of the adequacy of Australia's mineral requirements for the foreseeable future. A more detailed assessment of copper resources was begun during the year. The work to date has identified about 150 copper prospects in New South Wales, which should be taken account of at the planned level of detail; the complete survey is expected to outline some 500 such prospects. The work is being done in conjunction with the Mining Engineering Section, who are carrying out studies of the costs of setting up operations on deposits of particular sizes and types.

A detailed study of Australia's antimony resources was made during the year to ascertain whether reserves were sufficient to justify investigating the feasibility of setting up an antimony oxide smelter in Australia. The study, details of which were published in A.M.I. Quarterly Review Vol. 28 No. 2, indicated that total demonstrated reserves at the time were 66 000 tonnes and total identified resources were 109 000 tonnes of antimony.

Detailed assessment of several mineral commodities has been programmed for the coming year.

While resource assessment studies to date have been concentrated on known (or identified) resources, attention has also been given to estimation of resources in deposits which have yet to be discovered. This is a comparatively new field of study, with a variety of applicable methodologies which are still evolving. The Section reviewed these methodologies during the year, and is monitoring developments in this field.

A committee set up during the year to review the methodology of mineral resource assessment and recommend how BMR should proceed towards fulfilling its objective of assessing Australia's mineral resources - both identified and unidentified - was chaired by a member of the Section. The committee submitted its report in the middle of the year.

Mr McLeod attended a UNESCO-COGEODATA Symposium on Capture, Management and Display of Geological Data, with Special Emphasis on Energy and Mineral Resources, and also an organisational meeting to initiate the IGCP Project "Standards and Guidelines for Application of Computer-Based Information Systems to the Study and Assessment of Global Mineral and Fuel Resources"; both meetings were held in Paris in December 1975. Several geologists from other countries, who are engaged in resource assessment, visited the Section during the year, and gave us useful insights into the possible approaches to, and problems of, this type of study. These international contacts are essential to keeping abreast of developments in a rapidly expanding scientific field.

The Section holds and uses a considerable amount of data pertaining to the mineral industry. Work continued during the year, in conjunction with the ADP Applications Section, on storing metal prices in machine-readable form so that they can be manipulated mathematically to study trends. Some initial work was done on the feasibility of applying ADP techniques to storage and study of mineral resource data, and a watch was kept on related developments in other countries. Possible applications for microfilming material held by the Section were also investigated.

SYMPOSIA, CONFERENCES, COURSES AND LECTURES

Symposia, conferences and courses attended by members of the Section during the year included:

Australian Mineral Foundation Course on Mineral Economics, Adelaide (I. McLeod).
Australasian Institute of Mining and Metallurgy, Illawarra District Conference on Coal (K. Patterson).
International Geological Congress, Sydney (I. McLeod, L. Ranford, A. Driessen).
Mr Ranford was leader of a pre-Congress and a post-Congress field excursion.
Symposium on the Australian Phosphate Industry, Melbourne (A. Driessen).

PUBLICATIONS

Released in 1976

Australian Mineral Industry 1974 Review
Australian Mineral Industry Quarterly Review, Volume 28, Nos. 1,2,3, and 4.
Quarterly Bulletins of Copper, Lead and Zinc Statistics
Quarterly Bulletins of Tin Statistics
Quarterly Bulletins of Mineral Sands Statistics
Bulletin of Sulphur, Sulphuric Acid and Superphosphate Statistics (Annual)
Record 76/13, Mineral Resources of Australia

Papers published were:

Bur. Miner. Resour., 1976 - BMR adopts new system of resource classification.
Bur. Miner. Resour. Aust. Miner. Ind. Quart. Rev., 28(1), 11-13.

GOURLAY, A.J., McCOLL, D.H., & SENIOR, B.R., 1976 - A review of the Australian opal and sapphire industries. Bur. Miner. Resour. Aust. Miner. Ind. Quart. Rev., 28(1), 15-26.

ROBERTS, P.J., & KNIGHT, N.D., 1976 - Assessment of Australian antimony resources. Bur. Miner. Resour. Aust. Miner. Ind. Quart. Rev., 28(2), 51-59.

Bur. Miner. Resour., 1976 - Australian mineral reserves and resources - 1975.
Bur. Miner. Resour. Aust. Miner. Ind. Quart. Rev., 28(3), 79-83.

HILLIER, G., - Growth of the Australian nickel industry. Bur. Miner. Resour. Aust. Miner. Ind. Quart. Rev., 28(4), 99-113.

IN PRESS

PRATT, R., in press - Iron ore in Australia 1965-1975 - a decade of growth.
Bur. Miner. Resour. Aust. Miner. Ind. Quart. Rev., 29(1).

Australian Mineral Industry Quarterly Review Volume 29, Nos. 1 and 2.

IN PREPARATION

Australian Mineral Industry 1975 Annual Review.

HILLIER, G., in prep. - Assessment of Australian tungsten resources.

ELLIOTT, B.G., in prep. - Copper mining in Australia 1953-1975, and the future sufficiency of present ore reserves.

PETROLEUM TECHNOLOGY SECTIONSTAFFOccupied Positions (as at 1 November 1976):

1 Petroleum Technologist	Class 5
2 Petroleum Technologists	Class 4
2 Petroleum Technologists	Class 3
+1 Geophysicist	Class 3
1 Chemist	Class 2
1 Senior Technical Officer (Sci)	Grade 1
2 Technical Officers (Sci)	Grade 1
1 Technical Assistant	Grade 2
1 Rotary Drilling Supervisor	Grade 2
1 Rotary Drilling Supervisor	Grade 1
2 Drillers	Grade 2
5 Drillers	Grade 1
2 Assistant Drillers	-

+1 Clerk	Class 5
+1 Clerical Assistant	Grade 2

+ These positions have been seconded from the Operations Branch.

Unoccupied Positions (as at 1 November 1976):

2 Petroleum Technologists	Class 3
2 Petroleum Technologists	Class 2
1 Chemist	Class 2
2 Assistant Drillers	-
1 Technical Officer (Sci)	Grade 2
2 Senior Technical Officers (Sci)	Grade 1

Staff Changes

Several staff changes occurred during the year; Mr H.S. Taylor-Rogers (Chief Petroleum Technologist) and Mr M.C. Konecki (Supervising Petroleum Technologist) both retired. Mr J.A.W. White assumed duties as Chief Petroleum Technologist in July and Mr B. McKay as Supervising Petroleum Technologist in August. Mr L. Kurylowicz was appointed Petroleum Technologist Class 3 in December. Both Mr J. Henry and Mr S. Ozimic acted on higher duties during the year. Because of these changes and current staff ceilings, several vacant positions now exist in the Section.

GENERAL SUMMARY

During the year under review, the Section carried out its established functions with the exception of the PVT Laboratory which had no filled staff positions and was therefore unable to operate. Other Sections were seriously understaffed and were not able to fulfil all appropriate functions.

Mr J. White, Chief Petroleum Technologist, was involved with the updating and review of the case histories of various oil and gas fields for the study being undertaken by the Special Projects Division. Several meetings were attended with officers of Offshore and International Division and of the Department of the Environment, Housing and Community Development regarding the Environmental Protection (Impact of Proposals) Act as it applies to offshore petroleum operations. Meetings of the Oil Advisory Committee were convened and attended.

Mr K.L. Stillwell, Petroleum Technologist Class 4, continued his duties as officer in charge of the Reservoir Engineering Sub-section. In December 1975 he took the Departmental Induction Course and during August 1976 discussed Gippsland Basin reserves with reference to the price structure of crude oils with Mr A. Garran.

PETROLEUM LEGISLATION

Meetings and discussions were held on petroleum royalties for Australia and its offshore areas. Mr J.M. Henry prepared a paper in regard to this matter on the method of royalty calculation in Western Australia and

Queensland for the Offshore and International Division. Mr M.C. Konecki and Mr J.M. Henry had discussions with representatives of the Japan Petroleum Development Corporation concerning petroleum exploration and development in Australia and PNG. A meeting was held with the Australian Bureau of Statistics about the collection of petroleum exploration and development investment data.

Considerable time was spent on updating and provision for the case histories for all oil and/or gas fields about to be developed or whose development is foreseeable. The technological aspects of several briefing notes prepared by Departmental Officers were considered as to possible difficulties for petroleum exploration and drilling in Antarctic areas.

Comments were prepared for the Oil Advisory Committee on a report by Dr D. McNaughton entitled 'Mount Solitary Prospects and Pacoota Reservoir Rock Quality in the Mount Solitary-Mereenie Area'. Dr McNaughton is geological adviser to Magellan Petroleum Australia Ltd, the holder of the title over the area concerned.

A summary of petroleum exploration and development activity to 30 June 1976 was vetted and updated for the Australian Information Service. A section on Petroleum in Australia was prepared for inclusion in ESCAP documents covering Australia for presentation at the ESCAP meeting on Natural Resources held in Bangkok in September 1976.

Meetings were attended at Dr J. Brook's office (Offshore and International Division) to discuss petroleum royalties with reference to Australian and offshore production. Two papers dealing with various aspects of the question have been written by Messrs Henry, White and Lawrence, and a third paper was compiled and edited by M.C. Konecki.

PETROLEUM ECONOMICS AND STATISTICS

Material prepared in response to Parliamentary questions, correspondence, and other enquiries has continued to be updated and revised. The Department has been kept informed of revisions to the estimated recoverable reserves for the period. In addition, quarterly assessments of recoverable reserves of crude oil, condensate, and plant products, liquified petroleum gas (LPG) and natural gas, together with cumulative production and remaining recoverable reserves were prepared and published in the relevant Petroleum Newsletters Nos. 63, 64, 65 and 66.

The annual collection of petroleum exploration development, and production expenditure and geological and geophysical activities was completed, analysed, and the results published in Petroleum Newsletter No. 66. They have been further analysed and will be published in detail in the Petroleum Chapter of the Australian Mineral Industry 1975 Annual Review.

In summary, the results of this survey show that there was an overall 11.1 percent decrease in exploration drilling expenditure in 1975; this was mainly attributable to a 36.4 percent decrease in offshore exploration drilling. Onshore development drilling increased slightly in 1975 mainly due to drilling in South Australia. Geophysical and geological exploration activity in 1975 in terms of crew months of work together with a comparison with 1974 are given below.

Level of Petroleum Exploration Activity - 1975

Survey	Unit of Work	1975	1974	Difference 1975 over 1974
Land seismic	Crew Months	11.3	32.9	65.6% less
Marine seismic	" "	2.6	14.2	81.7% less
Gravity "	" "	0.25	0.5	50.0% less
Geological "	" "	16.3	23.5	30.6% less
Magnetic Land	Line km	nil	nil	-
Aero	" "	nil	12746	100% less
Shipborne	" "	nil	2715	100% less

Total petroleum exploration expenditure in Australia in 1975 was \$62 962 597; reflecting a decrease on exploration expenditure of 33.9% over 1974.

Discussions were held in April 1976 with members of the Bureau of Mineral Resources ADP group concerning the possible introduction of the AAPG/API system of well data storage and retrieval.

The Section prepared for publication and distribution the following:

- (i) Petroleum Newsletter - quarterly (Nos. 63, 64, 65 and 66)
- (ii) Rig Activity-monthly included in Petroleum Newsletter
- (iii) Wells and metres Drilled - quarterly
- (iv) Breakdown of Petroleum Exploration, Development and Production Activity and Expenditure - annually.
- (v) Statistics and information on petroleum exploration, production, resources, etc. in Australia for various publications, e.g., World Oil, Oil and Gas Journal, Offshore, the petroleum chapter in the Australian Mineral Industry Annual Review, other yearbooks and pamphlets.

A library of index cards containing details on each well drilled is maintained for quick reference, as are reference material on the corporate structure of individual companies engaged in petroleum exploration and development, an information service based on published company activities, lists on contractors, consultants, and service companies and details of petroleum titles held.

PETROLEUM RESERVOIR ENGINEERING

Australia's petroleum reserves on land and offshore were published quarterly in Petroleum Newsletter Nos. 63, 64, 65 and 66. The estimates of petroleum reserves are now classified as crude oil combined with condensate, liquified petroleum gas (LPG) and natural gas. These are all based on company estimates, verified whenever practicable by the Reservoir Engineering Sub-section or on assessments and reservoir studies carried out by the Sub-section.

Included in the statements of reserves are those in the proved and probable categories considered to be recoverable by current methods and known techniques. Australia's petroleum reserves at 30 June 1976 were estimated to be as follows:

	Initial Reserves	Cumulative Production	Remaining Reserves
Crude oil & condensate and plant products	$481.06 \times 10^6 \text{ m}^3$	$135.63 \times 10^6 \text{ m}^3$	$362.98 \times 10^6 \text{ m}^3$
LPG	$173.23 \times 10^6 \text{ m}^3$	$12.19 \times 10^6 \text{ m}^3$	$173.49 \times 10^6 \text{ m}^3$
Natural gas	$844.18 \times 10^9 \text{ m}^3$	$25.46 \times 10^9 \text{ m}^3$	$814.17 \times 10^9 \text{ m}^3$

Not included in these estimates are reserves of oil at Eaglehawk, Egret, and Dockrell, and of gas and liquids at Dockrell and Scott Reef - all on the Northwest Shelf, but the reserves of oil, gas, and liquids at Bream, Mackerel, Flounder, Snapper, and Tuna in the offshore Gippsland Basin as well as those at Barracouta, Turrum-Marlin, Halibut, Cobia, and Kingfish in that Basin are included. Detailed petroleum reserves data are given in Appendix B.

The Reservoir Engineering Group is now firmly established and has programmed the work sequence used in petroleum reserve estimations as well as engineering calculations for gas projections. The approach adopted by the Group in reserve estimates is outlined as follows:

Reserves of hydrocarbons are defined as those expected to be recovered and produced under natural or primary conditions. The recoveries are based on estimates of the original hydrocarbons in place, expected recovery drive mechanisms, and the rate of production at the estimated economic limit.

The original hydrocarbons in place are first estimated from the data obtained from the first wells and extrapolated to the reservoir limits as indicated by seismic data. As more wells are drilled and more data become available, the early estimates of original hydrocarbons in place are regularly revised.

The initial expected recovery mechanism in these studies is assumed to be depletion drive for both the oil and gas reservoirs. Water drive is only considered if production history so indicates.

Expected rates of production for a given field are calculated from well and reservoir data and assumed markets. The projected flow rates are cut off when the estimated economic limit of production is reached. In the absence of economic data an arbitrary cut-off of flow rates is assumed.

The Reservoir Engineering Group activities in the past year have been mainly concentrated on the detailed study and assessment of the petroleum reserves of the Palm Valley and Mereenie fields in Central Australia; West Tryal Rocks, Bonaparte, Scott Reef and Tern fields in Western Australia and the Cabawin field in Queensland; these studies have been completed.

Studies currently being undertaken are electrical and other borehole survey and structural interpretation of the Sunrise and Troubadour fields, Northern Territory and the Pelican field in Bass Basin, Tasmania.

Numerous routine and ad hoc enquiries were answered which covered reservoir information, reserve estimates and reserve classifications.

PETROLEUM TECHNOLOGY LABORATORY

The period under review was noted by a decrease in all exploration drilling activities in Australia; this was demonstrated in the dearth of new material (cores, fluids, etc.) received by the Petroleum Technology Laboratory for analysis. As a result, more emphasis was placed in both fields of the laboratories activities (petrophysical and geochemical) in clearing up a backlog of core analysis and in carrying out more specialised studies, e.g. origin and geochemistry of coastal bitumens in southern and northern Australia (the manuscript which received 'best paper award' at the 1976 APEA conference); recovery characteristics of certain oil and gas productive reservoirs in Gippsland and on the Northwest Shelf. A considerable amount of time was spent in completing work on a petroleum source rock study of the Amadeus Basin by D.M. McKirdy.

1. Petrophysical Subsection

(a) Routine analysis. A total of 695 samples were examined for porosity, permeability (gas and liquid), and fluid saturation characteristics. This included, in the main, samples from a number of wells in the offshore Gippsland Basin of Victoria, porosity and permeability determinations on samples from several stratigraphic wells in Queensland, as well as material from a new (gas) discovery well on the Northwest Shelf. Whole and conventional analysis (porosity and gas and liquid permeability) was carried out on cores from a reservoir in Moomba No. 19, Cooper Basin; this was in relation to a possible gas storage project planned in the field to increase short-term deliverability to the Sydney and Adelaide pipelines.

The balance of routine porosity and permeability analysis involved porosity and permeability tests for the Geological Branch of BMR, the ANU Earth Science Department, and the Northern Territory administration. Of particular interest were some porosity/density values determined for the BMR Marine Geology section on samples from the Great Barrier Reef, in order to get a true perspective of porosity in modern as compared to ancient reef carbonates. Also of interest were porosity/densities carried out on sample material from the Rundle oil shale deposit near Gladstone, Qld, in support of the determination of grades throughout the deposit.

With regard to fluid analysis, during the year two formation water samples from Kanau No. 1 and Karmona No. 1 were analysed. Studies of two drilling mud polymer additives and a 'supergel' bentonite were also carried out; the polymer (viscosifier) additives were submitted by a local chemical supplier as a possible partial replacement for imported bentonite.

(b) Specialized Studies. The balance of the year's work consisted of oil and gas recovery test samples from the offshore Gippsland Basin and gas recovery tests (Tidepole No. 1) in the Dampier Sub-basin of Western Australia. All of the fields studied in these areas have strong water drive; the emphasis was on the laboratory displacement of hydrocarbons by water during depletion. The work has significance in the estimation of Australia's recoverable hydrocarbon reserves.

Some time was spent in studying various techniques of enhanced recovery which might have application to depleted oil reservoirs in Australia; the Moonie oil field in Queensland was selected as a promising candidate for the polymer displacement technique and was included in the 1977 program.

2. Analytical and Geochemical Subsection

(a) Routine analysis. Because of the low level of petroleum exploration activity, only a limited amount of routine analysis was carried out by the subsection; this involved 1 oil sample and 7 condensates from Tidepole No. 1 (Dampier sub-Basin) and an oil from Karmona No. 1 (Cooper Basin). Two oil samples extracted by Fischer retort from oil shale samples in the Rundle oil shale, Gladstone, Queensland, and a reported hydrocarbon surface seepage sample from Western Victoria were also examined.

(b) Special Studies. Completion of the Amadeus Basin project and related studies on the diagenesis of microbial organic matter occupied the major part of this year's work. This study has involved the detailed analysis of 142 core samples from 16 wells to determine their source-rock character (total carbon content, amount and composition of extractable organic matter, composition and structure of kerogen). In addition, oils and condensates from the Mereenie and Palm Valley fields, Lake Amadeus No. 1 and Alice No. 1 were analysed.

Studies on sediments of similar age from other areas (e.g. Georgina Basin, McArthur Basin, Adelaide Geosyncline) were also undertaken as part of the Amadeus Basin project to provide supplementary information. In addition, a perspective on the diagenesis of modern versus ancient marine organic matter was obtained by studying Pliocene - Recent sediments from the Deep Sea Drilling Project, Hole 262, Timor Trough. A Ph.D. thesis on this work will be submitted to the ANU in March 1977. Other source-rock investigations were carried out during the year on cores from two wells in the Canning Basin for the Canning Basin Study (PEB) and a well in the Arrowie Basin (Yalkalpo No. 2) on request from the South Australian Mines Department.

A geochemical study of bituminous material stranded on shorelines in South Australia and the Northern Territory was completed during the year. The composition of this material was compared with organic carbon extracts from sediments (cores) in adjacent offshore wells for determination of possible bitumen source.

As part of the source-rock studies conducted during the year, some basic research was undertaken to try to establish better techniques for the separation (particularly from sulphides) and characterization of kerogens. This involved the use of X-ray diffraction for the semi-quantitative determination of the pyrite in kerogen concentrates; pyrolysis-hydrogenation gas chromatography (Chemistry Department, Duntroon) to provide more definitive information about the complex structure of the kerogen 'molecule'; and coal petrographic methods (at University of Wollongong) to ascertain the appearance and reflectivity of the kerogen in polished sections.

Committees

Laboratory staff members were participants in the following committees during the year:

1. New EMR Centre Planning Committee - B.A. McKay (Member for Mineral Resources Branch).
2. Interdepartmental Committee "Proposal for research program on the effect of oil on the Great Barrier Reef" - D.M. McKirdy and B.A. McKay.

EMR Wednesday Lectures

1. Reservoir and source rock potential of the Larapinta Group, Amadeus Basin, Central Australia - D.M. McKirdy (in part).
2. Geochemistry and significance of coastal bitumen from southern and northern Australia - D.M. McKirdy.
3. An integrated scheme for the laboratory analysis of oil, natural gas, and petroleum source rocks - Z. Horvath.
4. Laboratory techniques in petroleum research and development facilities in Europe and North America - B.A. McKay.

DRILLING

Plant and equipment.

Three additional Mack R685R.S chassis were ferried to Canberra by Drilling Sub-section personnel early in December 1975 for use as replacements for the vehicles carrying the Mayhew 1000 drill units. A further Mack chassis is now in Sydney awaiting registration and delivery to Canberra.

During the period under review the three Fox-Mobile B-40-L drilling units were put up for disposal and tenders for these units are awaiting; one Leyland 'Chieftain' 6 x 4 chassis and AEC 'Militant' 6 x 6 chassis were withdrawn from service as being beyond economic repair; 3 Mayhew 1000 drilling units have been re-mounted on Mark R685RS chassis. The three AEC 'Militant' chassis previously used for the Mayhew rigs have been converted to carry 1000-gallon water tanks removed from other vehicles which have been withdrawn from service.

All the five 1000-gallon water tanks need replacement as do their vehicles, 4 of which have already been used as drill trucks. However, under the present economic restraints it appears unlikely that replacements for the tanks or vehicles will become available during the 1976-77 financial year and as a result failures in the tanks and vehicle breakdowns must be expected and accepted with these units.

The current vehicle and plant strength of the Drilling Sub-section is:

- 4 - Mayhew '1000' rigs mounted on Mark R685R,S chassis
- 1 - Mayhew '1000' rig mounted on a A.E.C. 'Militant' chassis
- 1 - Gemco B210 tracker-mounted auger/diamond drill
- 4 - 1000-gallon water tanks on AEC 'Militant' chassis
- 1 - 1000-gallon water tank on Leyland 'Chieftain' chassis
- 4 - 6-ton 4-wheel drill trailers

Eighty percent of the remounting and modification of the Mayhew 1000 rigs and 1000-gallon water tanks was carried out by EMR mechanics. All modifications were checked and accepted by the Stores and Transport Branch of the Department of Manufacturing Industry.

Repairs, maintenance, and modifications to the drilling equipment were made by Drilling Sub-section personnel.

The Department of Construction, Heavy Plant Workshop, at Fyshwick provided valuable assistance in the repair and manufacture of parts. Sub-section staff also assisted with the repair and overhaul of support vehicles, trailers, water tanks, etc. Minor repairs and reconditioning of heavy vehicle spares were carried out by Truck & Car Sales (Canberra) Ltd.

Drilling Operations

In the year ending October 1976 the Drilling Sub-section provided five drilling parties in support of various EMR field activities. Drilling and diamond coring operations took place in the ACT and New South Wales in support of the geological engineering studies. Diamond coring and drilling for stratigraphic information was carried out in the Alligator River area (N.T.) and in the Georgetown area of Queensland. Other drilling in support of the survey was done in the Galilee Basin area (Qld.)

Five Mayhew 1000 drills and one Gemco drilling unit were used to carry out the drilling operations.

Appendix A summarizes the Section's drilling and coring activities during the period 1 November 1975 to 31 October 1976.

Technical Services

During the year several period contracts for the supply of replacement parts, drilling bits, core heads, and other consumable stores were prepared or revised by the Sub-section and processed by the Contracts Board.

REPORTS PUBLISHED OR IN PRESS

- KURYLOWICZ, L.E., OZIMIC, S., McKIRDY, D.M., KANTSLEER, A.J., & COOK, A.C., 1976 - Reservoir and source-rock potential of the Larapinta Group, Amadeus Basin, Central Australia. APEA J., 16(1), 49-65.
- McKIRDY, D.M., 1975 - Biochemical markers in stromatolites. In M.R. Walter (ed.) - Stromatolites. Elsevier, Amsterdam, 163-191.
- McKIRDY, D.M., & HORVATH, Z. 1976 - Geochemistry and significance of coastal bitumen from Southern and Northern Australia. APEA J., 16(1), 123-35.
- McKIRDY, D.M. & HORVATH, Z. 1976 - An integrated scheme for the laboratory analysis of oil, natural gas, and petroleum source-rocks. Sci. Aust. Technol.
- POWELL, T.G., & McKIRDY, D.M. 1976 - Geochemical character of crude oils from Australia and Papua New Guinea. Economic Geology of Australia and Papua New Guinea, 3 Pet. AIMM, 18-29.
- PETRUSHEVSKI, E. 1976 - Wells and metres drilled for petroleum exploration and development in Australia 1975. Bur. Miner. Resour. Aust. Rec. 1976/75 (unpubl).

B.M.R. DRILLING OPERATIONS 1 NOV. 1975 TO 31 OCT. 1976

APPENDIX "A"

BRANCH AND SECTION	PROJECT (AREA OF OPERATION)	FROM	TO	NO OF HOLES	TOTAL METRES OF HOLE			NO OF CORES	AVERAGE CORE RECOVERY %	TIME SPENT-HOURS* (TOTAL OPERATING TIME)			AVERAGE PENETRATION RATE-METRES/HOUR		AVERAGE DEPTH OF HOLE- METRES	TRAVELLING TIME HOURS @
					DRILLED	CORED	DRILLED AND CORED			DRILLING	CORING	TOTAL	DRILLING	CORING		
<u>GEOLOGICAL</u>																
Metalliferous	Alligator River (NT)	9.8.76	19.10.76	16	1 555.07	11.89	1 566.96	14	85.35	170.50	27.50	198.00	9.12	43	97.93	54.50
	Georgetown (NQ) (Gasco B210 unit)	22.7.76	31.10.76	11	-	473.65	473.65	299	79.72	-	316.00	316.00	-	1.49	43.05	37.00
Engineering Geology & Hydrology	A.C.T.	1.11.75	31.10.76	118	239.09	1302.33	1 541.42	1366	66.91	118.50	831.50	950.00	2.01	1.56	13.06	218.00
<u>GEOPHYSICAL</u>																
Seismic (land)	Galilee Basin (QLD)	1.11.75	12.11.75	1643	26 232.0	-	26 232.0	-	-	1073.25	-		24.44	-	15.96	312.50
		2. 8.76	31.10.76													
	Braidwood (NSW)	3. 6.76	17. 6.76	30	219.50	-	219.50	-	-	49.00	-	49.00	4.47	-	7.31	13.50
TOTALS	-	-	-	1818	28 245.66	1787.87	30 033.53	1679	77.32	1411.25	1175	2586	10.01	1.16	35.46	635.50

Summary: Total metres drilled 28 245.66
 Total metres cored 1 787.87
 Total metres drilled & cored 30 033.53
 Total number holes 1 818
 Total number of Cores cut 1 679
 Average core recovery (overall) 77.32

* "Total Operating Time"

This includes

- (a) Time actually drilling & coring
- (b) Running in & pulling out of hole
- (c) Changing bits & recovering core
- (d) Reaming hole
- (e) Running & cementing casing
- (f) Borehole survey time

It excludes

- (a) Maintenance time
- (b) Time spent on repairs
- (c) Travelling time

@ "Travelling Time" only refers to travel between locations, camps, etc. within an operational area.

It does not include positioning time (travel) between base (Canberra) and the operational area or between operational areas.

PETROLEUM RESERVESAPPENDIX B

A summary of estimates of recoverable primary and secondary reserves of petroleum in Australia as at 30 June 1976 is given in the following tables:

Table 1 gives the reserves and cumulative production from those fields which have been declared commercially viable and indicates that at 30 June 1976 petroleum production and remaining reserves in this category amounted to:

	Cumulative Production	Remaining Reserves
Crude Oil	$134.18 \times 10^6 \text{ m}^3$	$230.95 \times 10^6 \text{ m}^3$
Condensate	$1.45 \times 10^6 \text{ m}^3$	$33.07 \times 10^6 \text{ m}^3$
LPG	$12.19 \times 10^6 \text{ m}^3$	$99.69 \times 10^6 \text{ m}^3$
Natural (Sales) Gas	$25.46 \times 10^9 \text{ m}^3$	$323.95 \times 10^9 \text{ m}^3$

Table 2 details those reserves which have not yet been declared commercially viable and are subject to major revisions. Reserves in this category are estimated to be:

Crude Oil	$26.97 \times 10^6 \text{ m}^3$
Condensate	$71.99 \times 10^6 \text{ m}^3$
LPG	$73.80 \times 10^6 \text{ m}^3$
Natural (Sales) Gas	$490.22 \times 10^9 \text{ m}^3$

SUMMARY OF ESTIMATES OF THE RECOVERABLE
PETROLEUM RESERVES IN AUSTRALIA

BASINS AND FIELDS	INITIAL RESERVES			
	Hydrocarbon Liquids (x 10 ⁶ m ³)			Natural (Sales) Gas (x 10 ⁹ m ³)
	Crude Oil	Natural Gas Liquids (NGL)		
		Well Conden- sate & Plant Products	Liquified Petroleum Gas (LPG)	
<u>TABLE 1</u>				
<u>BOWEN-SURAT</u> (b) Moonie, Alton, Bennett, Roma Area producing gas fields.	3.41	0.04	-	3.90
<u>GIPPSLAND</u> (b) Barracouta, Halibut, Kingfish, Mackerel, Marlin, Tuna, Snapper	313.52	27.66	74.56	221.52
<u>COOPER</u> (c) Big Lake, Daralingie, Moomba, Gidgealpa, Brolga, Brumby, Burke, Della, Dulligari, Epsilon, Fly Lake, Merrimelia, Mudrangie, Moorari, Ropeneath, Strzelecki, Tirrawarra, Toolachee, Dunbar Downs, Wulgalla	7.77	6.39	37.07	99.78
<u>PERTH</u> (c) Dongara, Mondarra, Yardarine, Gingin	0.24	0.11	-	16.04
<u>CARNARVON</u> (c) Barrow Island	40.19	0.32	0.25	8.17
TOTAL TABLE 1	365.13	32.52	111.88	349.41
<u>TABLE 2</u>				
<u>BOWEN-SURAT</u> (b) Rolleston Area, Major, Kincora, Boxleigh, Silver Springs, Noorindoo, Cabawin & Roma Area gas fields not in production	-	0.19	-	2.52
<u>ADAVALE</u> (b) Gilmore	-	-	-	0.58
<u>GIPPSLAND</u> (b) Bream, Flounder, Golden Beach, Turrum, Cobia	11.53	4.53	7.55	36.70
<u>CARNARVON</u> (c) & <u>RONAPARTE GULF</u> (c) Pasco Island, Angel, Dockrell, Eaglehawk, Egrot, Goodwyn, North Rankin, Rankin, Tidepole, West Tryal Rocks, Troubadour and Sunrise	5.16	65.73	62.37	424.88
<u>AMADEUS</u> (a) Mereenie, Palm Valley	10.28	1.54	3.88	25.54
TOTAL TABLE 2	26.97	71.99	73.80	490.22
GRAND TOTAL TABLES 1 and 2	392.10	106.51	185.68	839.63

PROVED PLUS PROBABLE, PRIMARY AND SECONDARY
AS AT 30.6.76

CUMULATIVE PRODUCTION				CURRENT (REMAINING) RESERVES			
Hydrocarbon Liquids (x 10 ⁶ m ³)			Natural (Sales) Gas (x 10 ⁹ m ³)	Hydrocarbon Liquids (x 10 ⁶ m ³)			Natural (Sales) Gas (x 10 ⁹ m ³)
Crude	Natural Gas Liquids (NGL)			Crude	Natural Gas Liquids (NGL)		
	Well Conden- sate & Plant Products	Liquified Petroleum Gas (LPG)			Well Conden- sate & Plant Products	Liquified Petroleum Gas (LPG)	
Oil				Oil			
3.20	0.02	-	1.76	0.21	0.02	-	2.14
111.05	1.27	10.49	11.85	202.47	26.39	64.07	209.67
0.13	0.12	1.69	6.27	7.64	6.27	35.38	93.51
0.01	0.02	-	3.49	0.23	0.09	-	12.55
19.79	0.02	0.01	2.09	20.40	0.30	0.24	6.08
134.18	1.45	12.19	25.46	230.95	33.07	99.69	323.95

NOTES TO ACCOMPANY TABLES 1 AND 2

TABLE 1 indicates the initial and current reserves of those fields or groups of fields which have been declared commercial and combines both the Proved and Probable reserves together with secondary recovery projects were applicable. Table 1 also indicates two additional gas fields, Euthalla and Mooga, in the Roma Area in the Bowen-Surat Basin.

TABLE 2 indicates those theoretically recoverable reserves which are either: geologically proved but considered uneconomic under present conditions, or are awaiting further appraisal and, therefore, subject to major revisions. The estimates given in these tables reflect the updating by the State Department of Mines and Company of the recoverable reserves of West Tryal Rocks and Tidepole fields in the Carnarvon Basin and by IMR of the Mereneie and Palm Valley fields in the Amadeus Basin.

In both tables the Ethane component is reported under sales gas with the exception of the Cooper Basin where it is included with LPG.

Explanatory marks used in the tables include: a) IMR estimate; b) State Mines Department estimate; c) Company estimate; Neg. - negligible.

Conversion to metric units was carried out using the following factors: 1 barrel = 0.1589875 m^3 ;
1 cubic foot = 0.02831685 m^3 .