DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD 1975/159

MINERAL RESOURCES BRANCH

ANNUAL SUMMARY OF ACTIVITIES

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INTRODUCTION

As in past years, a considerable part of the Branch's workload stemmed from the provision of information and advice to the rest of the Department and to other government agencies and industry. In particular, the Branch provided information for enquiries conducted by the Industries Assistance Commission into aspects of the mineral industry, and several other government enquiries and departmental and interdepartmental committees, and the Petroleum and Minerals Authority. The Acting Assistant Director, Mr J. Ward, gave evidence before the Fraser Island Environmental Inquiry in October. Assistance was also given to several visiting technical groups from other countries. The Chief Petroleum Technologist, Mr H. Taylor-Rogers, spent two months in Bangkok as technical adviser to the Economic Commission for Asia and the South Pacific.

The Branch helped the Australian Development Assistance Agency to organize an International Training Course in Minerals Exploration, and several staff members delivered lectures to the trainees.

In its work the Branch is increasing the emphasis on assessment of mineral resources. Some time was spent investigating what might be the most appropriate methods of doing this and, also, because of the Branch's limited manpower, methods of allocating priorities for assessment of the various mineral commodities. Estimation of petroleum reserves on a periodic basis continued, using company information and data obtained by studies in the Petroleum Technology Laboratory. This laboratory continued to co-operate with other groups in BMR in investigations involving the geological role of algae.

The Drilling Sub-section continued to provide support for field investigations in engineering geology and stratigraphic and metalliferous studies.

Consideration was given during the year to the future role of the Branch and its relation with other groups of BMR and the Department, particularly in the context of study and assessment of national mineral resources.

The staffing position was generally satisfactory during the year. The two vacant Mineral Economist positions and the Petroleum Technologist position in the Reservoir Engineering Sub-section, which had been vacant for some time, were all filled, and expansion of the Reservoir Engineering Sub-section was approved. The Chief Mining Engineer, Mr G. Mead, retired on 30 September; an appointment has been made to this position. An additional Mining Engineer Class 3 position has been created and is expected to be filled by the end of the year. The Chief Petroleum Technologist, Mr H. Taylor-Rogers, retires early in December, and this position is being advertised. The former Assistant Director (Mineral Resources) was appointed Director of BMR - a position he had occupied in an acting capacity for some time - on 30 October 1975. He continued as Special Adviser on detrital heavy minerals to CCOP/EA during the year.

MINING ENGINEERING SECTION

STAFF

Occupied Positions (as at 1 October 1975)

1 Engineer, Class 3

Change in Staff

G.F. Mead, Engineer Class 5, retired from the Public Service on 30 September 1975.

GOLD MINING

G.F. Mead made a visit of inspection to Mount Magnet, Norseman, and Kalgoorlie, and wrote various minutes and comments concerning gold mining. He attended two meetings of the Standing Interdepartmental Committee on Assistance to Industry in connection with the I.A.C. report on gold mining. He visited Perth and Kalgoorlie with officers of the Department of Labour and Immigration in connection with a proposed miners' training scheme, and gave assistance in the preparation of a report on the proposal.

CODE OF RADIATION PROTECTION IN MINING AND MILLING RADIOACTIVE ORES

G.F. Mead attended six meetings of the working group and one of the Interdepartmental Committee. The code was completed after consultation with the mining industry and labour unions, and is ready for printing when Cabinet approval is given. The working group and the I.D.C. were disbanded.

CONFERENCE OF CHIEF INSPECTORS OF MINES

G.F. Mead was secretary to this conference throughout the year. Following the 1974 Conference the basic code of safety rules was revised and issued to conference members. The 1975 conference was held in Brisbane between 15 and 19 September, after which the basic code of safety was further revised, and issued to all members.

URANIUM MINING

G.F. Mead made a detailed examination of the feasibility studies for the proposed uranium mining operations at Yeelirrie, W.A., and Jabiluka, N.T.

PETROLEUM AND MINERALS AUTHORITY

Reports and other advice concerning more than twenty mines and projects have been prepared in the Section and furnished to the PMA.

TIN QUOTA

At the request of the Department a number of tin-mining operations were inspected, to provide advice on production capacity in connection with the administration of the export quotas on tin.

ASSISTANCE TO MINERS

J.C. Erskine drafted a program of work for North Coast Copper Mines Pty Ltd after inspecting their operations at the Cangai and Dundurrabin mines.

COMPUTER METHODS FOR FINANCIAL ANALYSIS OF PROJECTS (with A.D.P. Section)

J.C. Erskine has spent some time preparing a computer program for financial analysis of mining projects. When complete, this program will run on the BMR computer HP 2100. Preparations are also being made to prepare a more elaborate program, with the help of consultants, to be run on the computer of another Department in Canberra.

BMR SYMPOSIUM

J.C. Erskine delivered a paper on Mining Costs.

ASSESSMENT OF COPPER RESOURCES

This assessment is being prepared in conjunction with the Mineral Economics Section of the Mineral Resources Branch, and the Geological Branch, and the role of the Mining Engineering Section is to make inspections of the operating mines and prepare reports on costs, ore reserves, and cut-off grades. J.C. Erskine inspected and reported on the Hillgrove mine of New England Antimony Mines Ltd, near Armidale, and the adjoining small project of Silver Valley Minerals N.L.

STANDARDS ASSOCIATION OF AUSTRALIA, IRON ORE SAMPLING SUB-COMMITTEE

G.F. Mead attended two meetings of the sub-committee, at which the principal business was discussion of I.S.O. documents on mechanical sampling.

GUIDE TO MINING LEGISLATION

G.F. Mead completed stage 1 of this project, i.e. the preparation of an up-to-date list of legislation, which was sent to the administering departments in the States and Northern Territory for comment.

OTHER WORK

J.C. Erskine accompanied BMR geologists at an inspection by the Minister for the Capital Territory of a mineral prospect in the catchment of the Cotter River. He also attended a three-day senior management conference arranged by the Public Service Board, and several minor courses in computer applications to financial analysis of mining projects.

MINERAL ECONOMICS SECTION

INTRODUCTION

The broad function of the Mineral Economics Section is to obtain information on and maintain a continuing review of all aspects of Australian mineral resources and the mineral industry, 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 such as assessment of Australian resources of particular commodities.

The Section provides advice and information on the mineral industry to the Government in connection with policy relating to the development and utilization in the national interest of Australia's mineral resources; to government agencies such as the Industries Assistance Commission and the Australian Industries Development Corporation; and to industry and the public generally.

STAFF

Two new professional positions of Mineral Economist, Class 4 and Class 3, created in 1974 were occupied in 1975.

Occupied positions at 1 November 1975 were:-

Mineral Economist Class 5	1
Mineral Economist Class 4	2
Mineral Economist Class 3	2
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 BMR from the Australian Bureau of Statistics, as Statistical Officer (Mining).

Mr J. Ward acted as Assistant Director (Mineral Resources) throughout the year, and Mr I.R. McLeod as Chief Mineral Economist (Min. Econ. Class 5). Mr L.C. Noakes, formerly Assistant Director (Mineral Resources), was appointed Director of BMR on 30 October.

COMMODITY STUDIES

Commodity studies involve continuing review and assessment of trends in the exploration for and mining, processing, transportation, utilization, and marketing of mineral commodities. Because of the international structure of the industry, these studies cannot be confined to domestic aspects, but must be done in the context of world developments and requirements.

Officers of the Section maintain close contact with the mineral industry and keep abreast of new technology and new uses for minerals by attending industry conventions and visiting the offices, mining operations, and treatment plants of various companies, and the Mines Departments of the States. Many organizations have assisted the

work of the Section through informal discussions and provision of information. This assistance, which is essential to the commodity reviews, is gratefully acknowledged.

Reviews arising from these studies are published in the Australian Mineral Industry Annual Review and the Australian Mineral Industry Quarterly Review.

During the year, a short questionnaire was sent out with one issue of the AMI Quarterly Review in an attempt to ascertain the value of this publication to its users. Most respondents were satisfied with the type of material in the publication, and found it useful. The main comment was on the time taken to publish each issue. Unfortunately, it takes time to collect the statistics from the many individual sources and then compile them to produce the various totals. The mechanics of printing the Quarterly Review in its present form also mean that considerable time elapses between the preparation and issue of each number. We are at present seeking ways of reducing these delays.

The expertise of the staff of the Section resulting from the continuing commodity studies is also applied to the provision of information in response to ad hoc enquiries from both government and industry, and preparation of briefs, papers, etc., on specific topics for other parts of the Department and other government agencies. In particular, material was prepared for several commissions of enquiry which were examining various aspects of the mineral industry and for meetings of international commodity study groups such as the International Lead and Zinc Study Group, the International Bauxite Association and the UNCTAD Committee on Tungsten, and for the Organization for Economic Co-operation and Development.

SPECIAL INVESTIGATIONS

Australia is a major producer of several mineral commodities, and much of the production of these is exported in one form or another. It is therefore important to have an estimate - as accurate as possible - of the total currently known resources in Australia of the various minerals and the likely demand for them, so that their resources can be utilized in the best interests of the nation. Accordingly, BMR is assessing resources of several mineral commodities as part of a long-term program for the investigation of Australia's mineral resources. This work is done by the Mineral Economics and Mining Engineering Sections of the Mineral Resources Branch, using data supplied by companies, with contributions as appropriate from other groups within BMR.

Results of resources surveys of coal, iron ore, tin, mineral sands, and clays have been published.

A survey of Australian antimony resources was completed during the year. This had the main objective of assessing identified reserves and paramarginal resources of antimony. A second objective was to demonstrate that Australian reserves were sufficient to justify a proposed feasibility study by CSIRO on an antimony oxide plant to treat domestic reserves.

For its resources surveys, BMR has adopted a new and more useful classification of mineral reserves and resources which closely follows that adopted by the United States Geological Survey and United

States Bureau of Mines. The classification uses two parameters: the degree of certainty with which mineral reserves can be identified and quantified, and the degree of economic feasibility which takes into account aspects such as mining, metallurgical, transport and market costs, and the market price of the commodity. The classification is described in AMI Quarterly Review Vol. 28 No. 1.

During the year the Section gave some attention to the sort of criteria which could be used to establish priorities for assessing mineral resources. These range from objective criteria such as reserve:production ratios to more subjective aspects involving projections of world supply and demand and can be extended beyond 'life of resources' considerations to encompass economic and social factors.

In addition to these resource assessments, which investigate in some detail national resources of selected mineral commodities, the Section uses more readily available information to maintain a continuing but less detailed estimate of reserves and resources of the various mineral commodities. These estimates, although they are merely first approximations, are useful in that they give a qualitative indication of the sufficiency for foreseeable requirements of Australia's resources of the various mineral commodities.

Although increasing emphasis is being given to resource assessment, the section continues to conduct other special studies of various kinds. These include reviews of a particular commodity, or of an aspect of a commodity, in more detail than the continuing reviews, or studies of some aspect of the industry as a whole. Such studies completed or in progress during the year include reviews of the domestic nickel and iron ore industries, an historical survey of the Australian copper industry, surveys of the secondary aluminium and secondary copper industries, and a summary survey of world and Australian energy reserves and resources.

CONFERENCES, COURSES, AND LECTURES

Conferences and courses attended by members of the Section during the year included:

Australasian Institute of Mining and Metallurgy (AIMM) Annual Conference, Adelaide (Mr McLeod).

AIMM symposium on black coal, Wollongong (Mr Pratt).

Australian Mineral Foundation (AMF) Course on 'Mineral Economics', Adelaide (Messrs Roberts and Hillier).

Symposium on phosphate minerals, Melbourne (Mr Driessen).

AMF Geoscience Information Seminar, Adelaide (Mr Hughes).

Members of the Section helped organize and delivered lectures at an International Training Course on Mineral Exploration organized by the Australian Development Assistance Agency and held in Canberra in September. Several members of the Section also delivered lectures to various scientific and technical meetings and to university groups.

GENERAL

The Section's workload remained high during the year. Many of the ad hoc enquiries received from government and industry required some research for preparation of a reply. By their nature, these enquiries take priority over the longer-term projects, with consequent interruption of work on the projects.

Visitors to the Section during the year numbered about 150. They included representatives of local and overseas companies, government authorities, research organizations, universities, etc. In particular, visitors from overseas included representatives of:

Bethlehem Steel, U.S.A.

UNESCO

DSIR, New Zealand

Metal Mining Agency of Japan

Newmont Mining Corporation

University of Arizona

Stanford Research Institute

Swiss Aluminium Company

Scandinavian Export Income Company

Much of the Section's work depends on statistical data on mineral production and trade. The Section maintained close working liaison with ABS, especially concerning the collection of data, and continued to collect some data on behalf of ABS. It also continued the compilation and issue of regular statistical bulletins on mineral sands; copper, lead and zinc; and tin; and began investigating the feasibility of issuing similar bulletins for additional mineral commodities.

PETROLEUM TECHNOLOGY SECTION

STAFF

Occupied Positions (as at 1 November 1975)

	1 Petroleum Technologist	Class 5
	2 Petroleum Technologists	Class 4
	2 Petroleum Technologists	Class 3
	1 Petroleum Technologist	Class 2
	1 Chemist	Class 2
+	1 Geophysicist	Class 3
	1 Senior Technical Officer (Sc)	Grade 1
	2 Technical Officers (Sc)	Grade 1
	1 Trainee Technical Officer	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
	4 Assistant Drillers	

+	1 Clerk	Class 5
+	1 Clerical Assistant	Grade 2

+ These positions seconded from Operations Branch

Unoccupied Positions (as at 1 November 1975)

1 Petroleum Technologist	Class 3
1 Chemist	Class 2

Staff Changes

K. Blair, Petroleum Technologist, Class 3, retired under Section 67 Public Service Act, on 10 July 1975.

K.L. Stillwell, Petroleum Technologist, Class 4, commenced duty on 10 October 1975.

D.M. McKirdy, Chemist Class 2, rejoined the Section on 28 February 1975 on completion of his studies towards a PhD at A.N.U.

Technical and Scientific Visits, Conferences, etc.

Mr H.S. Taylor-Rogers was Acting Assistant Director, Mineral Resources Branch from 1-24 January 1975; he attended a meeting with officers from the Department to discuss the recommendations contained in the Report of the Royal Commissions on Great Barrier Reef Petroleum Drilling. He attended the 1975 APEA Conference at Surfer's Paradise on 16-19 March 1975 and was on leave without pay from 4 June till 11 August 1975 during which time he acted as a Consultant to CCOP in Bangkok.

Mr M.C. Konecki, Petroleum Technologist, Class 4 acted as Chief Petroleum Technologist, Class 5, vice Mr H.S. Taylor-Rogers during the periods 1-22 November 1974, 1-24 January 1975, and 4 June - 11 August 1975. He was on Recreation Leave and Furlough from 26 September 1975 - 31 October 1975.

Mr J.M. Henry, Petroleum Technologist, Class 3 acted on higher duties vice Mr M.C. Konecki during the periods shown above. On 14 November, 1974 he attended a meeting with officers of the Australian Bureau of Statistics to finalize the forms and instructions covering the new ABS quarterly petroleum exploration expenditure collection; he also attended meetings on behalf of the Section at the regular meetings of the Publications Review Committee. From 23-29 May, 1975 he visited the SRO project at Narrogin, Western Australia, to witness the completion of the drilling operation and to ensure that the hole deviation was within the specified limits; he also visited the Department of Mines and the Regional Office of the Department of Minerals and Energy concerning the SRO Project.

Mr L.E. Kurylowicz, Petroleum Technologist Class 2, acted on higher duties as Petroleum Technologist, Class 3 vice K. Blair throughout the year. From 1-6 June 1975 he attended the 4th Indonesian Petroleum Association Conference in Djakarta and visited the offices and operations of Pertamina, Lemigas, and Migas for discussions concerning petroleum reservoir engineering studies.

Mr B.A. McKay, Petroleum Technologist, Class 3 made visits to a number of petroleum research laboratories and institutions in the United Kingdom, France, Canada and the United States between 2 June and 11 July 1975.

Mr A. Ozimic, Senior Technical Officer, Grade 1, visited Alice Springs between 17-22 February 1975 to select material from cores from unsubsidized wells in the Mereenie Field for petrophysical and thin section examination in connection with the study of the petroleum resources of that field. Between 6-11 April 1975, he attended a formation evaluation course by the Australian Mineral Foundation at Adelaide.

Dr D.M. McKirdy, Chemist, Class 2 attended the First Australian Geological Convention on Proterozoic Geology in Adelaide from 12-16 May 1975.

Messrs B.A. McKay, Z. Horvath and R.M. Bresnehan visited the offshore drill ship "Regional Endeavour" and other Esso-Hematite installations in Bass Strait on 13-15 February 1975.

Mr Z. Horvath, Technical Officer, Grade 1, between 16-27 July 1975 attended an introductory course in ADP presented by the Department of Minerals and Energy. Between 18-20 August 1975, he presented a paper entitled 'An integrated scheme for the Laboratory Analysis of Oil, Natural Gas and Petroleum Source Rocks'.

Mr E. Petrushevski, Clerk, Class 5 attended an introductory course in ADP presented by the Department between 17-28 February, 1975 and visited the Bureau seismic party in Queensland between 9-18 July 1975, for familiarization with drilling operations undertaken by Petroleum Technology Section.

PETROLEUM LEGISLATION

Mr H.S. Taylor-Rogers continued as Secretary-Convenor of the Oil Advisory Committee throughout the period under review. Four meetings of the Committee were held and relevant correspondence prepared and dispatched. Mr M.C. Konecki, as alternate member, undertook the duties of Secretary/Convenor during the absence of Mr Taylor-Rogers. Brief notes and comments were prepared on applications for pipeline licenses relating to the development of the Tuna and Mackerel fields in Bass Strait and on primary and secondary production licences over the Flounder field.

Background information was prepared for the Petroleum and Minerals Authority on the hydrocarbon prospects of the Amadeus Basin, Northern Territory and the Northwest Shelf, Western Australia.

PETROLEUM ECONOMICS AND STATISTICS

Material prepared in response to Parliamentary Questions, correspondence and other enquiries has covered a large range of subjects. The Department of Minerals and Energy has been kept informed of revisions to the estimated recoverable reserves of petroleum which have been made as additional information has been received. In addition, quarterly assessments of the recoverable reserves of crude oil, condensate and plant products, liquified petroleum gas (LPG) and natural gas, together with the

cumulative production and remaining recoverable reserves are prepared and published in the relevant Petroleum Newsletter, Nos 60,61,62, and 63.

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 62 and have been further analysed and will be published in detail in the Petroleum Chapter of the 1974 Australian Mineral Industry Review.

In summary, the results of this survey show that there was an overall 15 percent decrease in exploration drilling activity in 1974: this was directly attributable to a 31 percent decrease in onshore exploration drilling. Onshore development drilling increased slightly while there was no drilling in this category offshore in 1974 or in the first half of 1975. Changes in geophysical and geological exploration activity between 1973 and 1974 in terms of crew months of work were as follows:- land and marine seismic operations both fell by some 27 percent, gravity work fell by just under 98%, and geological activity fell by some 52 percent.

Total petroleum exploration expenditure in Australia in 1974 was down by some 6 percent over 1973, again reflecting a 30 percent drop on exploration expenditure onshore.

A study of the Australian and overseas equity in production from individual fields and groups of fields as at 1 October 1975 was prepared for the Minister's Office.

Mr M.C. Konecki delivered a paper entitled 'Australian Petroleum Resources' at the 46th ANZAAS Congress in Canberra in January 1975.

The section prepared for publication and distribution the

(i) Petroleum Newsletter - quarterly, (Nos 60,61,62 and 63)

(ii) Rig Activity - monthly

(iii) Wells and Footage 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, the Petroleum chapter in Australian Mineral Industry Review, other various 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 of 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 the Petroleum Newsletter Nos 60,61,62, and 63. The estimates of petroleum reserves are now classified as Crude Oil, Condensate and Plant Products, Liquified Petroleum Gas (LPG) and Natural Gas and are based on company estimates, verified whenever practicable,

by the Reservoir Engineering Sub-section, and/or on assessments and reservoir studies carried out by the Sub-section. Included in the statements of reserves are those of the proved and probable categories considered to be recoverable by current methods and techniques. Australia's petroleum reserves at 30 June 1975 were estimated to be as follows:

	Initial Reserves	Cumulative Production	Remaining Reserves
Crude Oil & condensate and plant products	$481.06 \times 10^6 m^3$	$111.82 \times 10^6 m^3$	$369.24 \times 10^6 m^3$
LPG	$173.23 \times 10^6 m^3$	$9.37 \times 10^6 m^3$	$163.86 \times 10^6 m^3$
Natural Gas	$844.18 \times 10^9 m^3$	$19.63 \times 10^9 m^3$	$824.55 \times 10^9 m^3$

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.

The Reservoir Engineering Group is now firmly established and has formulated the work sequence used in petroleum reserves estimations and resource assessments.

The work of the Reservoir Engineering Group was mainly concentrated on the detailed study and assessment of the petroleum resources of the Palm Valley and Mereenie Fields in the Amadeus Basin, NT; studies are nearing completion.

Other studies by the Group covered the petroleum reserves of the West Tryal Rocks field in Western Australia; the revision of the figures for cumulative production of crude oil, natural gas liquids and natural gas from the Gippsland Basin fields, revision of reserves in the Turrum-Marlin field on the basis of the information gained by the drilling of the Turrum No 2 well, and an assessment of the natural gas reserves in that part of the Bonaparte Basin adjacent to the Bonaparte No 2 well. Numerous routine and ad hoc enquiries covered reservoir information, reserves, definitions of reserve classification.

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, mechanism, and the rate of production as it declines to the 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 data become available, the first estimates of original hydrocarbons in place are regularly revised.

The initial expected recovery mechanism is assumed to be depletion drive (ie the fluids are driven through the reservoir by the expansion of gas) for both oil and gas reservoirs. Water drive is only considered if production history so indicates.

Rates of production are calculated from well data and the amount of hydrocarbons estimated to be remaining in place. The projected flow rates are cut off when the economic limit of production is reached. These economic limits assumed are based on data supplied by the operating companies and in the absence of economic data an arbitrary cut-off of flow rates is assumed.

PETROLEUM TECHNOLOGY LABORATORY

During the period under review, activity was concentrated in two of the three sections of the laboratory, namely petrophysics and drilling fluids, and petroleum and source rocks geochemistry. Operations in both spheres were somewhat curtailed by staff shortages while the reduced activity in the private petroleum exploration sector had a bearing on the availability of material with which to work. This in turn controlled the scope of work, with increased concentration being placed on 'in-house' co-operative studies.

The third section of the laboratory still under development planning (hydrocarbon reservoir fluid analysis or PVT) did not operate during the year. Although equipment is on hand for this work, the two positions proposed for this work (one professional, one technical) have only recently been approved by the Public Service Board. Until these positions are filled, operations cannot proceed.

The studies carried out during the year included:

I. Petrophysics

(a) Routine core analysis: During the year 652 core and outcrop samples were analysed for porosity, permeability, fluid saturation, and density. The samples were derived from sources such as operations under the Petroleum (Submerged Lands) Act, State Mines Departments, BMR field parties, and private sources. Of special interest were studies commenced for the Basin Studies Group (Petroleum Exploration Branch) as part of the project on the Canning and Browse Basins in Western Australia.

A start was also made during the year on the compilation of a record of all core analyses carried out to date in the laboratory. This information is often called for by other sections of the Bureau; its completion will facilitate access to the data.

(b) Special core analysis. Core samples from the Tirrawarra field (Cooper Basin), the Mereenie field (Amadeus Basin) and the Tryal Rocks field (Dampier Sub-basin) were examined. Studies on these samples involved capillary pressure, electrical resistivity, relative permeability, and waterflood displacement efficiency of both oil and gas. Two of the fields (Mereenie and Tryal Rocks) were studied in co-operation with the Reservoir Engineering Group of the Petroleum Technology Section to determine reserves and productivity of various domestic hydrocarbon deposits. The Tirrawarra work was carried out as a co-operative study with industry.

(c) Drilling and reservoir fluids. Formation water samples from 3 wells drilled under the Petroleum (Submerged Lands) Act were examined. Two other samples, a native clay and a drilling mud additive were tested for possible application to oil well drilling. The object of these latter tests was to fully investigate any possible discovery of materials suited to use as drilling clays or mud additives which might displace imported products.

II. Petroleum and Source Rock Geochemistry

Staff:- D.M. McKirdy
Chemist Class II (vacant since Feb 1974)
Z. Horvath

The lack of a second chemist has impaired the group's research capability and explains the shortfall in achievement of its stated program objectives. Two projects set down for the latter part of the year, viz.

1) Canning Basin, WA source-rock study
2) Toolebuc Formation, Qld, oil shale study have yet to be commenced.

D.M. McKirdy resumed duty on March 24 after two years at ANU on an Australian Public Service Scholarship studying the diagenesis of algal organic matter in relation to the generation of oil and gas in the Amadeus Basin, Central Australia.

a) CLASSIFICATION AND DIAGENESIS OF ALGAL ORGANIC MATTER

This work represents a continuation of the research carried out at ANU during 1973 and 1974. Construction of a geochemical model describing the diagenesis and incipient metamorphism of algal organic matter is now almost complete. The model is based on data obtained from a wide variety of marine or paralic sediments which, by virtue of their age (pre-Devonian) or facies, are known or may be expected to contain organic matter of predominantly algal origin.

These sediments include:-

- pelagic calcareous muds (upper Pliocene - Recent) from DSDP Leg 27 Site 262, Timor Trough (22 samples)
- marine shales and carbonates (Triassic - Recent) from Ashmore Reef No 1, Sahul Shelf (12 samples)
- algal mat ('Coorongite') Coorong Lagoon, South Australia (3 samples)
- torbanites from New South Wales (3 samples)
- phosphorites (Late Precambrian - Recent) from U.S.A., U.S.S.R., Algeria, Morocco, and Australia (20 samples)
- stromatolitic carbonates (Middle Precambrian - Devonian) from Western Australia, South Australia, Northern Territory, and New South Wales (13 samples)
- carbonaceous cherts (Precambrian) from the Onverwacht Group, South Africa, and the Skillogalee Dolomite, South Australia (24 samples)

- bituminous carbonates (Cambrian) from the Arrowie Basin, South Australia, and Georgina Basin, Queensland (11 samples)
- carbonaceous shale from the Tindelpina Shale Member, Tapley Hill Formation (700 m.y.) Adelaide Geosyncline (24 samples)
- fossiliferous black shale from the McMinn Formation (1400 m.y.), McArthur Basin, Northern Territory (17 samples)

The model shows that algal sedimentary organic matter is less uniform in composition than had been previously thought. At least four categories can be recognized, and their respective maturation pathways defined, on the basis of the following geochemical parameters:-

1. kerogen H/C and O/C atomic ratios;
2. yield of extractable organic matter, expressed as milligrams of extract per gram of organic carbon;
3. percent total hydrocarbons (saturates & aromatics) in the extract;
4. normal alkane distribution;
5. pristane /n-C_{17} ratio;
6. phytane /n-C_{18} ratio;
7. kerogen stable carbon isotopic composition (δC^{13});
8. kerogen structure (as determined by XRD analysis) and
9. kerogen functional groups (as determined by infra-red spectroscopy)

Work is in progress to characterize further the four types of algal kerogen by pyrolysis - gas chromatography - mass spectrometry (in co-operation with Dr D.J. McHugh and Mr J. Tardiff, Chemistry Dept., Faculty of Military Studies, University of New South Wales). The model will then be used to interpret source-rock data currently being obtained on sediments from the Amadeus Basin.

b) PETROLEUM SOURCE ROCK STUDY, AMADEUS BASIN, N.T.

Work continued throughout the year on a detailed geochemical evaluation of potential source rocks in the Proterozoic, Cambrian (Pertaoorta Group) and Cambro - Ordovician (Larapinta Group) sequences in Australia's oldest prospective sedimentary basin. Cores from another 12 wells were sampled and prepared for analysis, concluding a sampling program which has provided a total of 141 rock specimens from 16 different exploration and/or stratigraphic holes.

Soxhlet extraction and organic carbon analysis of all samples, plus the isolation of kerogens from selected samples, are expected to be completed during December 1975. Further analysis of the extracts (viz. liquid and gas chromatography) and the kerogens (viz. elemental and infra-red analysis, pyrolysis GC-MS, and petrographic examination) is planned for completion by March 1976.

Several findings of particular interest emerged from this year's research:

1. Shales of the Horn Valley Siltstone and the Pacoota Sandstone are the source-beds for highly paraffinic oil at Mereenie and the ultra-paraffinic condensate at Palm Valley.

2. Oil saturating a reservoir sand of the Lower Stairway Sandstone in BMR AP I is extensively biodegraded, probably as a result of invasion of the formation by meteoric waters.

3. Kerogen of the same rank from the Stairway Sandstone and Horn Valley Siltstones in BMR AP I are distinctly different in composition, the latter being richer in hydrogen. This difference is reflected in the saturated hydrocarbon distributions of the two sediments.

4. Phosphorites from the Stairway Sandstone commonly exhibit alkane patterns characterized by a predominance of the n-C_{22} alkane, in marked contrast to non-phosphatic lutites in the same formation. This alkane is thought to be derived from dinoflagellates and other algae rich in an unusual C_{22} polyunsaturated fatty acid.

5. An apparent northwesterly increase in the level of organic maturation of Larapinta Group sediments, from the southern part of the Amadeus Basin into the central folded belt, changes direction abruptly to an increase eastwards across the northern prospective area of the basin.

6. An investigation of the rank of the Pacoota Sandstone and Horn Valley Siltstone (by Mr A.J. Kanstler and Prof A.C. Cook Geology Department, Wollongong University) using reflectance measurements on graptolite fragments, has confirmed the difference in level of organic maturation between the Mereenie and Palm Valley Fields, and permitted estimates to be made of the maximum pre-orogenic temperatures for the Larapinta Group in each area.

These and other preliminary results of the Amadeus Basin source rock study are being prepared for presentation at the 1976 APEA Conference.

c) COASTAL BITUMEN PROJECT

Over the past five years, the laboratory has assembled a collection of 12 coastal bitumens collected from nine separate localities around the Australian coast, mainly in the Otway (South Australia/ Victoria) and Money Shoal (Northern Territory) Basins. These bitumens have generally been found stranded on beaches, frequently after storm activity, suggesting a probable offshore source.

The composition of these bitumens, and the various diagenetic and weathering processes through which they evolved, have been determined in order to establish their origin. It is concluded that they represent genuine submarine seepages of immature, highly paraffinic to naththenic oils. The results of this study, and their implications for the prospectivity of the two basins in question, will be presented in a paper to the 1976 APEA conference.

d) OIL SHALE PROJECT, QUEENSLAND

The laboratory staff and Mr M.C. Konecki have been engaged in discussions with other Branches of plans for an economic appraisal of the extensive Toolebuc oil shale deposit of Queensland. Laboratory involvement in the project will include evaluation of the oil content of the shales, followed by geochemical studies of both the shales and the retorted oil. Fischer Assay retorts for carrying out this work have been ordered.

e) ROUTINE OIL AND GAS ANALYSIS

The low level of exploration activity during 1974 and the first half of 1975 was reflected in the fact that only 6 hydrocarbon liquids and 1 gas sample were received from exploration companies. Five other samples from the Mereenie/Palm Valley fields were analysed as part of the Amadeus Basin project.

f) CO-OPERATION WITH THE BASIN STUDIES GROUP, PETROLEUM EXPLORATION BRANCH

Following discussions with this group during the year, plans have been developed to conduct source rock studies on selected samples from some wells in the Canning and Browse Basins during 1976. Samples from two wells in the former basin have already been prepared for analysis which will commence on completion of the Amadeus Basin project.

g) MOUNT ECLIPSE SANDSTONE, NGALIA BASIN

A joint geochemical and petrographic investigation (with A.J. Kautsler, Geology Dept., Wollongong University) of carbonaceous shale and sandstone from this uranium-bearing formation revealed alkane patterns and coal macerals with unusual features which in part may be due to irradiation of the organic matter.

External publications - in preparation

McKIRDY, D.M. & HORVATH, Z.

Geochemistry and significance of coastal bitumen from southern and northern Australia. APEA J.

KURYLOWICZ, L.E., OZIMIC, S., McKIRDY, D.M., KAUTSLER, A.J. & COOK, A.C.

Reservoir and source-rock potential of the Larapinta Group, Amadeus Basin, Central Australia. APEA J.

BMR Journal of Australian Geology and Geophysics - in preparation

MUIR, M.D., PLUMB, K.A., PEAT, C.J., NORVICK, M.S. & McKIRDY, D.M.

Micro-organisms from shales of the mid-Proterozoic McMuir Formation, Roper Group, Northern Territory.

McKIRDY, D.M. & POWELL, T.G.

Diagenesis and incipient metamorphism of organic matter in Cambrian and Precambrian sediments from Australia.

BMR Records

B.A. McKAY & R. BRESNEHAN	A petrophysical study of the Stairway and Pacoota sandstones in four wells from the Mereenie Field, Amadeus Basin, Northern Territory.
B.A. McKAY (in preparation)	Overseas visit to petroleum research and development facilities in Europe and North America, 2 June - 11 July, 1975.

DRILLING PLANT & EQUIPMENT

The new Mayhew 1000 drilling unit was mounted on a Mack 8 x 6 chassis by Gardner Denver Australia Ltd, Sydney; it was tested and checked at the Gardner Denver works by the Drilling Sub-section personnel. It was accepted on behalf of BMR on 1 June 1975 and arrived in Canberra 2 June 1975; the drilling unit and crew left Canberra 11 June to carry out a drilling program in the Naracoorte area of South Australia where operations commenced on 17 June.

Three additional Mack 8 x 6 chasses were inspected and passed for service by the Contracts Board in Sydney during late September 1975. These units are presently being held by the Stores and Transport Branch, Sydney, awaiting ferrying to Canberra and commencement of hire when the drilling units arrive back in Canberra from field duties, probably in late November 1975.

During the period under review, the following changes in plant and equipment have taken place as part of the equipment and vehicle retirement and replacement program, planned to be implemented over the next 1 to 2 years: One (1) Fox-Mobile B-40-L drilling unit has been removed from its A.E.C. 'Militant' chassis; all three (3) Fox-Mobile B-40-L's have been made ready for disposal. Two (2) of the Leyland 'Comet' 6 x 4 vehicles have been disposed of as being beyond economic repair, bringing the total disposed of to three (3).

One (1) AEC 6 x 6 'Militant' chassis has been re-equipped as a 1000-gallon water tanker thus providing a current vehicle strength of:

4 Mayhew rigs mounted on A.E.C. 'Militant' 6 x 6 chassis.
1 Mayhew rig mounted on MACK 8 x 6 chassis.
3 x 1000-gallon water tanks mounted on AEC 'Militant' - 6 x 6 chasses.
2 x 1000-gallon water tanks mounted on Leyland 'Chieftain' 6 x 4 chasses.

Eighty percent of the demounting of the B-40-L rigs and installation of the 1000-gallon water tanks was carried out by BMR mechanics. These modifications have been 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 Housing and Construction machine shop 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, water tanks, springs, braking systems, servicing, etc. Major heavy vehicle repairs, etc. were carried out by Truck & Car Sales (Canberra) Pty Ltd.

Drilling Operations

In the year ending October, 1975 the Drilling Sub-section has fielded seven (7) parties in support of various BMR field activities. Drilling operations took place in the A.C.T. and Braidwood, N.S.W., in support of geological engineering studies; diamond coring and drilling for stratigraphic information was carried out in the Burnside and Alligator River (N.T.); in the Wiso Basin (N.T.) and in the Naracoorte/ Bordertown areas of South Australia; drilling in support of a seismic survey was done in the Galilee Basin area of Queensland.

Appendix A summarizes the results of drilling and coring activities during the period 1 November 1974 to 31 October 1975.

Technical Services

Specifications and draft tender schedules were prepared, examined and recommendations made for a program of 'over-coring' in a series of six holes for the stress measurement project in the Meekering-Narragin area of Western Australia. Similar work was undertaken in respect of the SRO project at Narrogin; W.A. Both these projects were on behalf of the Geophysical Branch.

For the Geological Branch, tenders for a diamond-coring operation in the Cloncurry area were examined and a recommendation prepared.

During the year several period contracts for the supply of replacement parts, drilling bits, core heads and other consumables were prepared or revised.

With respect to the supply of the new Mack Model R685RS vehicles for use with the Mayhew 1000 drilling rigs, several discussions were held with representatives from Mack Trucks, Australia Pty Ltd, and the Stores and Transport Branch of the Department of Manufacturing Industry - to finalize details of the vehicles and delivery. In addition visits were made to the Mack Assembly plant in Brisbane to inspect progress and two of the Section's mechanics spent a week at the factory on a servicing and familiarisation course offered by the Mack organisation as a customer service. The Mack trucks being supplied are unique in that they feature a Tri-Drive EWW57C (three driven axles) rear bogie. Initial field operations with the first Mack-mounted drilling unit have proved most successful.

Senior representatives from the Department of Defence, Army, held numerous discussions with the Drilling Sub-Section concerning the selection and procurement of a drilling unit to meet their specific requirements and visited BMR drilling operations in the A.C.T. Advice and assistance was also given to the Army in the preparation of tender specifications and cost estimates.

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POWELL, T.G., COOK, P.J., & McKIRDY, D.M., 1975 - Organic geochemistry of phosphorites: relevance to petroleum genesis. Bull. Am. Assoc. Petrol. Geol., 59, 618-32.

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APPENDIX 'A'

BMR DRILLING OPERATIONS 1 NOV. 1974 TO 31 OCT. 1975

BRANCH AND SECTION	PROJECT (area of operation)	FROM	TO	NO. OF HOLES	TOTAL METRES OF HOLE DRILLED	CORED	DRILLED & CORED	NO OF CORES	AVERAGE CORE RECOVERY %	TIME SPENT - HOURS (Total operating time) DRILLING	CORING	TOTAL	AVERAGE PENETRATION RATE-METRES/HOUR DRILLING	CORING	AVERAGE DEPTH OF HOLES-METRES	TRAVELLING TIME - HOURS (if any)
GEOLOGICAL																
Sedimentary	Naracoorte/Penola S.A.	1.11.74 7.4.75	6.12.74) 28.8.75)	47	245.53	1,048.75	1,294.28	853	62.17	131.25	411.00	542.25	1.87	2.55	27.54	-
	Wiso Basin, N.T. (Green Swamp)	21.4.75	26.5.75	1	301.34	35.76	337.10	13	98.00	271.00	30.00	301.00	1.11	1.19	337.10 (one hole)	-
	Burnside/Hayes Creek, N.T.	10.6.75	16.7.75	32	721.74	49.89	771.63	46	96.82	93.50	65.00	158.50	7.72	0.77	24.11	-
Metalliferous	Alligator River, N.T.	6.8.75	13.10.75	13	1,419.18	17.00	1,436.18	14	87.50	227.00	12.00	239.00	6.25	1.42	110.48	-
Engineering Geology and Hydrology	A.C.T. Queanbeyan & Braidwood, N.S.W.	6.12.74 13.1.75	17.12.74) 31.10.75)	75	472.10	1,347.32	1,819.42	805	84.16	223.25	900.50	1,123.75	2.11	1.50	24.26	-
GEOPHYSICAL																
Seismic (land)	Galilee Basin,	30.6.75	31.10.75	965	30,337.11	nil	30,337.11	nil	-	1,080.75	nil	1,080.75	28.07	-	31.44	380.25
TOTALS	-	-	-	1,133	33,497.00	2,498.72	35,995.72	1,731	85.75	2,026.75	1,418.50	3,445.25	7.86	1.49	98.49	380.25

Summary:

Total metres drilled	33,497.00
Total metres cored	2,498.72
Total metres drilled & cored	35,995.72
Total number of holes	1,133
Total number of cores cut	1,731
Average core recovery (overall)	85.75%

PETROLEUM RESERVES

A summary of estimates of recoverable primary and secondary reserves of petroleum in Australia as at 30.6.75 is given in the following two tables:

Table I gives the reserves and cumulative production from those fields which have been declared commercially viable and indicates that at 30.6.75 petroleum production and Remaining reserves in this category amounted to:

	Cumulative Production	Remaining Reserves
Crude Oil & condensate and plant products	$111.82 \times 10^6 m^3$	$270.49 \times 10^6 m^3$
LPG	$9.37 \times 10^6 m^3$	$90.37 \times 10^6 m^3$
Natural Gas	$19.63 \times 10^9 m^3$	$299.14 \times 10^9 m^3$

Of the remaining natural gas reserves, $21.78 \times 10^9 m^3$ are shown in the table as raw natural gas in the Bowen-Surat, Perth and Carnarvon basins. The balance represents dry natural gas.

Table II 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 & condensate and plant products	$98.75 \times 10^6 m^3$
LPG	$73.49 \times 10^6 m^3$
Natural Gas	$525.41 \times 10^9 m^3$

NOTE: In Tables I and II on pages 4 and 5 the figures previously shown separately as "Crude Oil" and "Well Condensate and Plant Products" have been combined under the heading of "Hydrocarbon Liquids" as a temporary measure because the break up is not presently available for all areas. For this reason also the "percentage depletion" figures previously shown in parenthesis have been omitted. Figures quoted for natural gas reserves represent raw gas except in the Cooper and Gippsland basins where the figures are for dry natural gas, i.e. the volume of gas remaining after the removal of natural gas liquids and non hydrocarbons.

The LPG fraction of the Cooper Basin production is sold with sales gas, since the LPG and sales gas are not physically separated anywhere in the entire flow system. Their allocation is based on compositional analyses.

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

Explanatory marks used in the table include: a) BMR 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.

SUMMARY OF ESTIMATES OF THE RECOVERABLE

PETROLEUM RESERVES IN AUSTRALIA

BASINS AND FIELDS	INITIAL RESERVES		
	Hydrocarbon Liquids ($\times 10^6 m^3$)		
	Crude Oil & Well Condensate and Plant Products	Liquified Petroleum Gas (LPG)	Natural Gas ($\times 10^9 m^3$)
TABLE 1			
BOWEN-SURAT (b) Moonie, Alton, Bennett, Roma Area producing gas fields.	3.44	-	3.69
GIPPSLAND (a) & (c) Barracouta, Halibut, Cobia, Kingfish, Mackerel, Marlin, Tuna, Snapper	323.85	62.42	191.02
COOPER (b) & (c) Big Lake, Daralingie, Moomba, Gidgealpa, Brolga, Brumby, Burke, Della, Dullingari, Epsilon, Fly Lake, Merrimelia, Mudrangie, Moorari, Roseneath, Strzelecki, Tirrawarra, Toolachee, Durham Downs, Wolgalla	14.16	37.07	99.78
PERTH (c) Dongara, Mondarra, Yardarino, Gingin	0.35	-	16.11
CARNARVON (c) Barrow Island	40.51	0.25	8.17
TOTAL TABLE 1	382.31	99.74	318.77
TABLE 11			
BOWEN-SURAT (b) Rolleston Area, Major, Kincora, Boxleigh, Silver Springs, Cabawin, Leichhardt & Roma Area gas fields not in production.	0.19	-	2.92
ADAVALE (b) Gilmore	-	-	0.58
GIPPSLAND (a & c) Bream, Flounder, Golden Beach, Turrum-Marlin (Palaeocene)	27.45	12.14	46.50
CARNARVON (a & c) Pasco Island, West Tryal Rocks, Angel, Goodwyn, N. Rankin	59.19	53.83	433.47
AMADEUS (a) Mereenie, Palm Valley	11.92	7.52	41.94
TOTAL TABLE 11	98.75	73.49	525.41
GRAND TOTAL TABLES 1 and 11	481.06	173.23	844.18

PROVED PLUS PROBABLE, PRIMARY AND SECONDARY

AS AT 30.6.75

Appendix B.

CUMULATIVE PRODUCTION			CURRENT (REMAINING) RESERVES		
Hydrocarbon Liquids ($\times 10^6 m^3$)			Hydrocarbon Liquids ($\times 10^6 \times m^3$)		
Crude Oil & Well Condensate and Plant Products	Liquified Petroleum Gas (LPG)	Natural Gas ($\times 10^9 m^3$)	Crude Oil & Well Condensate and Plant Products	Liquified Petroleum Gas (LPG)	Natural Gas ($\times 10^9 m^3$)
3.15	-	1.51	0.29	-	2.18
90.51	8.03	8.14	233.34	54.39	182.88
0.21	1.33	5.30	13.95	35.74	94.43
0.02	-	2.72	0.33	-	13.39
17.93	0.01	1.96	22.58	0.24	6.21
111.82	9.37	19.63	270.49	90.37	299.14

NOTES TO ACCOMPANY TABLES 1 and 11

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 where applicable.

TABLE 11 indicates those theoretically recoverable reserves which are either
(a) Geologically proved but considered uneconomic under present conditions, or
(b) are awaiting further appraisal and, therefore, subject to major revisions.

The estimates given in the two tables reflect adjustments and revisions made during the previous quarter to the recoverable petroleum reserves of the Palm Valley field in the Amadeus Basin; the Alton and Richmond Boxleigh fields in the Bowen-Surat Basin, the Barrow Island and Angel fields in the Carnarvon Basin; and the Halibut-Cobia, Flounder and Turrum-Marlin (Palaeocene) fields in the Gippsland Basin. In addition, BMR reserves estimate of the West Tryal Rocks field (raw gas of low calorific value) is included for the first time in Table 11.