

1977/48

copy 4.

BMR PUBLICATIONS COMPACTUS
(LENDING SECTION)



DEPARTMENT OF
NATIONAL RESOURCES

BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS

RECORD 1977/48

055861

PETROLEUM EXPLORATION BRANCH

SUMMARY OF ACTIVITIES

1977



The information contained in this report has been obtained by the Department of National Resources
as part of the policy of the Australian Government to assist in the exploration and development of
national resources. It may not be published in any form or used in a company prospectus or statement
without the permission in writing of the Director, Bureau of Mineral Resources, Geology and Geophysics.

BMR
Record
1977/48
c.4

RECORD 1977/48

PETROLEUM EXPLORATION BRANCH

SUMMARY OF ACTIVITIES

1977

CONTENTS

	Page
<u>Petroleum Assessment Section</u>	
Basin Assessment Group 1	1
Basin Assessment Group 2	3
Basin Assessment Group 3	6
Offshore Sub-section	7

<u>Petroleum Technology Section</u>	
Industry and Economics Group	10
Petroleum Technology Laboratory	12
Reservoir Engineering Sub-section	13
Drilling Engineering Sub-section	14

Illustrations

Table 1	Offshore Drilling Operations, Australia, completed 1.11.76 - 31.10.77
Table 2	Level of Geophysical Activity, 1976
Table 3	Petroleum Reserves
Table 4	BMR Drilling Operations, 1.11.76 - 31.10.77
Plate 1	Offshore Drilling Operations, Australia, completed 1.11.76 - 31.10.77

INTRODUCTION

Two significant changes have been made to the structure of the Petroleum Exploration Branch. The Petroleum Technology Section was transferred from the Mineral Resources Branch to the Petroleum Exploration Branch in August 1976. In August 1977 the Public Service Board approved a new organisational structure for the former Subsidy Section and Basin Studies Sub-Section which acknowledged the fact that the Petroleum Search Subsidy Scheme had terminated and that these sections were now involved with basin studies and petroleum resource assessments and with the technical administration of the Petroleum (Submerged Lands) Act.

The Petroleum Exploration Branch now consists of the following sections and sub-sections:

Petroleum Assessment Section

- Basin Assessment Group 1
- Basin Assessment Group 2
- Basin Assessment Group 3
- Offshore Sub-section

Petroleum Technology Section

- Industry and Economics Group
- Petroleum Technology Laboratory
- Reservoir Engineering Sub-section
- Drilling Engineering Sub-section

PETROLEUM ASSESSMENT SECTION

A considerable amount of time was spent preparing material for the National Energy Advisory Committee (NEAC). This included an assessment of Australia's resources of petroleum and shale oil for NEAC Standing Committee No. 2.

Basin Assessment Group 1

The group was engaged in preparation of preliminary assessments of undiscovered hydrocarbon resources of a number of offshore basins in Western Australia. Basins covered in 1977 included the northern Carnarvon Basin and the Browse Basin. Quantitative estimates of undiscovered resources will be presented in restricted BMR records in preparation.

Methodology for undiscovered petroleum resource assessment continued to be developed. Progress was achieved in handling areas suited to analysis by the prospect-by-prospect method. A workable system incorporating a computer program for expressing results in the form of resource probability distributions was developed. An assessment method based on field size distribution plots was investigated, but the lack of world-wide data on oil and gas occurrence prevented any firm conclusions being reached on the applicability of the method to the assessment of Australian basins.

A cooperative program was initiated in which the group provided resource assessment methodology and advice to the South Australian Mines Department. The group's prospect-by-prospect method was applied under Dr Forman's guidance to estimating the undiscovered resources of certain prospects in the Cooper Basin.

A program of source rock and temperature studies was undertaken in cooperation with CSIRO. Some 233 samples from selected onshore wells have been submitted for determination of the following parameters:-

Total organic carbon
Extractable organic matter
Hydrocarbon content
Gas chromatography
Vitrinite reflectance

Results are currently being assessed and an interpretative report is being prepared.

Three offshore sub-basins in the Carnarvon Basin have been assessed in detail. These were the Barrow, Dampier, and Beagle sub-basins. In the Barrow sub-basin undiscovered hypothetical resources were assessed in four prospects. Inferred resources have been calculated on the southern extension of the Rankin Platform in the West Tryal Rocks structure, and hypothetical resources in three prospects have been estimated. These prospects involve one or more of three possible plays in the Barrow sub-basin:-

- (1) Fold, fault, and stratigraphic traps containing Lower Cretaceous Barrow Group sands,
- (2) Structural and stratigraphic traps in the Jurassic Dupuy Sandstone Member of the Dingo Claystone, and
- (3) Structural and stratigraphic traps in the Upper Triassic Mungaroo Beds.

In the Dampier sub-basin, prospects for future discoveries lie in fold, fault, and stratigraphic traps containing Tithonian (Upper Jurassic) reservoir sandstones. Hypothetical resources have been assessed for four prospects.

In the Beagle sub-basin, hypothetical resources were assessed for five prospects. Prospects for future discoveries are believed to be restricted to fold and fault traps containing Triassic or Lower to Middle Jurassic sandstones.

In the Browse Basin eight large structures have been assessed on Lower Jurassic/Triassic plays. Any one of these structures could contain substantial gas resources.

Records and publications (in preparation)

Riesz, E.J. - SIMULAT, a computer program for the 'prospect-by-prospect' method of estimating petroleum resources using Monte Carlo simulation. Bureau of Mineral Resources, Australia, Record.

Forman, D.J. & McAvoy, W.J. - A preliminary assessment of the Tithonian play in the Dampier Sub-basin and Rankin Trend. Bureau of Mineral Resources, Australia, Record (restricted).

Forman, D.J., & McAvoy, W.J. - A preliminary assessment of the recoverable hydrocarbon potential of five prospects and leads in the Beagle Sub-basin, Western Australia. Bureau of Mineral Resources, Australia, Record (restricted).

- Forman, D.J. & McAvoy, W.J. - A preliminary assessment of the recoverable hydrocarbon potential of the Sahul Platform, Bonaparte Gulf Basin, Northern Territory and Western Australia. Bureau of Mineral Resources, Australia, Record (restricted).
- Forman, D.J., & McAvoy, W.J. - A preliminary assessment of the recoverable hydrocarbon potential of the Vulcan Sub-basin, Bonaparte Gulf Basin, Northern Territory. Bureau of Mineral Resources, Australia, Record (restricted).
- Gorter, J.D., McAvoy, W.J., & Riesz, E.J. - A preliminary assessment of the recoverable hydrocarbon potential of the Barrow Sub-basin, Western Australia. Bureau of Mineral Resources, Australia, Record (restricted).
- Gorter, J.D., & Riesz, E.J. - A preliminary assessment of the recoverable hydrocarbon potential of the Browse Basin, Western Australia. Bureau of Mineral Resources, Australia, Record (restricted).
- Gorter, J.D., & Nicoll, R.S. - Conodonts from the Lower Permian Noonkanbah Formation and Lower Triassic Blina Shale, Canning Basin, Western Australia. BMR Journal of Australian Geology and Geophysics.
- Gorter, J.D. - Triassic environments in the Canning Basin, Western Australia. BMR Journal of Australian Geology and Geophysics.
- Gorter, J.D. - Maturation of petroleum source rocks in Australia (tentative title). BMR Journal of Australian Geology and Geophysics or APEA Journal.

Basin Assessment Group 2

The group was engaged in the assessment of the petroleum potential of a number of basins in southern Australia. Regional reviews of petroleum exploration and prospects in the basins were prepared both as restricted BMR Records and as Reports for publication. The group continued to study methods for the assessment of undiscovered petroleum resources. Attempts were made to assess the undiscovered resources of some of the basins reviewed. Considerable progress was achieved on the Australian contribution to ESCAP Stratigraphic Atlas project.

A review of the Arafura Sea/Gulf of Carpentaria region previously issued as a BMR Record was updated and prepared for publication as a Report. Regional reviews of the Perth and Carnarvon Basins were updated and editorial queries within the Branch were resolved. A review of the Gippsland Basin was completed and a start was made on the assessment of petroleum resources in that basin.

A regional review of petroleum exploration and prospects in the Bass Basin was completed and an estimate was made of the undiscovered resources of the basin using the prospect-by-prospect method and the SIMULAT computer program for Monte Carlo simulation.

The Bass Basin contains sediments of Early Cretaceous to Late Tertiary age. It has been fairly well covered by seismic surveys, and 17 wells have been drilled to date, six of which encountered hydrocarbon shows in the Late Cretaceous to late Eocene Eastern View Coal Measures. The most promising of these was in the Pelican Structure in the southeast of the

basin, where significant quantities of gas were indicated. The interbedded sandstone, siltstone, shale, and coal of the Eastern View Coal Measures provide source, reservoir, and cap rocks for petroleum accumulations in the basin.

Good structural control is lacking at the prospective Palaeocene and early Eocene levels because of the difficulty of obtaining good-quality seismic data from below the coals which overlie them. Further evaluation of the hydrocarbon potential of the Bass Basin depends on the use of advanced seismic reflection surveying techniques to improve the resolution of the prospective horizons below the coals. Because of this mapping problem, the ultimate potential of the basin is difficult to estimate at this stage. The chance of the discovery of significant additional petroleum resources in the near future seems poor.

A regional review of petroleum exploration and prospects in the Otway Basin region was also completed to the first draft stage and the assessment of the undiscovered resources of the region was begun. The Otway Basin region has been moderately well explored for petroleum but no commercial discoveries have been made, despite the occurrence of good gas shows in wells drilled near Port Campbell in 1959 and the early 1960s. There is still some potential for discoveries to be made, but these are unlikely to be prolific.

It appears that the Early Cretaceous Otway Group has the best source rock potential in the area, although the Late Cretaceous Belfast Mudstone could be a source in some areas. The most important reservoirs are sands in the lower part of the Otway Group, capped by overlying shales, and the Waarre Sandstone at the base of the Late Cretaceous Sherbrook Group, capped by the Flaxmans Formation and the Belfast Mudstone.

Onshore the Port Campbell Embayment appears to be the most promising area. However, in the two most recent wells drilled in the area the Tertiary and Upper Cretaceous sediments were flushed by fresh water, a situation which is prevalent in much of the onshore Otway Basin. Where the Lower Cretaceous sands occur at drillable depths they are often hard and tight owing to secondary silicification. There do not appear to be any large, promising undrilled structures in the Port Campbell area. Prospects elsewhere in the onshore part of the region are poor.

Because of the known occurrences of petroleum onshore in the Port Campbell area, the area immediately offshore from the Port Campbell Embayment, which is in a more basinward situation to the structures drilled onshore, seems reasonably prospective. Several possible hydrocarbon traps have been indicated by seismic surveys, but the only well drilled in the near-shore area to date encountered gas shows in the Sherbrook Group. Results of the drilling of a total of 15 wells offshore have been disappointing. The offshore areas are not without some prospects, but overall the prospectivity of the region is only poor to fair.

A draft review of petroleum exploration and prospects in the Officer Basin region of Western Australia and South Australia was completed. This region has not been extensively explored and its petroleum potential is not well known. It seems probable that the western portion of the region lacks adequate thicknesses of suitable sediments for petroleum generation and entrapment. A considerable thickness of Palaeozoic sediments occurs in the eastern part of the region but the results of the two wells drilled so far have

been discouraging. The organic content of the sediments encountered is low and there are indications of high palaeotemperatures approaching the destructive level for petroleum. Further exploration is required before the region can be reliably assessed, but present indications are that prospectivity is low.

Work on the ESCAP Stratigraphic Atlas project was done by V. Passmore under the supervision of E. Nicholas during part of the year. Plates for the Carnarvon Basin were completed and forwarded to ESCAP after amendments, and additions to previously prepared plates were made. Plates for the Sydney Basin, Carpentaria and Karumba Basins, and Laura Basin were all completed in draft form.

The following Bulletin was issued (plates in microform) during 1977.

Mayne, S.J., 1976 - Australian platform-cover correlation charts - Adelaidean to Recent. Bureau of Mineral Resources, Australia, Bulletin 183.

Records and publications (in preparation)

Douch, H.F., & Nicholas, E. - The Phanerozoic sedimentary basins of Australia and their tectonic implications. Symposium: The structure of Australia and variations in tectonic style. Special issue of Tectonophysics.

Robertson, C.S., Cronk, D.K., Nicholas, E., & Townsend, D.G. - A review of petroleum exploration and prospects in the Arafura Sea/Gulf of Carpentaria region. Bureau of Mineral Resources, Australia, Report.

Robertson, C.S., Nicholas, E., & Townsend, D.G. - A review of petroleum exploration and prospects in the Perth Basin. Bureau of Mineral Resources, Australia, Record (and Report).

Robertson, C.S., Cronk, D.K., Lockwood, K.L., & Mayne, S.J. - A review of petroleum exploration and prospects in the Carnarvon Basin. Bureau of Mineral Resources, Australia, Record (and Report).

Robertson, C.S., Lockwood, K.L., Nicholas, E., & Soebarkah, H. - A review of petroleum exploration and prospects in the Gippsland Basin. Bureau of Mineral Resources, Australia, Record (and Report).

Robertson, C.S., Cronk, D.K., Mayne, S.J., & Townsend, D.G. - A review of petroleum exploration and prospects in the Great Australian Bight region. Bureau of Mineral Resources, Australia, Record.

Robertson, C.S., Lockwood, K.L., & Nicholas, E. - A review of petroleum exploration and prospects in the Bass Basin. Bureau of Mineral Resources, Australia, Record (and Report).

Robertson, C.S., Cronk, D.K., Mayne, S.J., & Townsend, D.G. - A review of petroleum exploration and prospects in the Otway Basin region. Bureau of Mineral Resources, Australia, Record (and Report).

Robertson, C.S., Mayne, S.J., & Townsend, D.G. - A review of petroleum exploration and prospects in the Officer Basin region. Bureau of Mineral Resources, Australia, Report.

Note: All BMR Records listed above are restricted.

Basin Assessment Group 3

The Canning Basin detailed study was completed to first draft stage. J. Rasidi prepared a paper on the Laserscan enhancement of seismic data for the detection of buried reefs in the Lennard Shelf. Several possible pinnacle reefs were outlined on the seismic sections. CSIRO analysed samples from a number of key wells in the Canning Basin to determine organic content and thermal history.

The group studied the petroleum potential of a number of areas on the northeastern margin of Australia.

The main conclusions of a study of the eastern region of Cape York Peninsula and the adjoining offshore area are that the 'Peninsula Trough' (Mott, 1958) does not exist, and that the Olive River Basin west of Cape Grenville contains about 1200 m of Permian, ?Triassic, and Jurassic sedimentary rocks. The petroleum potential of the Laura Basin, the remainder of the northeast Cape York Peninsula, and the Torres Strait area is considered to be low because of the immaturity of the sediments, flushing by fresh water, and lack of suitable structures for entrapment of petroleum.

The Australian section of the offshore Papuan Basin contains a mature Mesozoic sequence and suitable reservoir rocks but lacks structural traps. Maturation studies indicate that the source section is probably in the gas-generative phase. Stratigraphic traps may be present, but if so these would be difficult and expensive to locate. The Cainozoic in the Papuan-Laura Basin area is mostly considered to be low in prospectivity. Although Miocene reef limestones occur in the area, only one situation is known where a Miocene reef is likely to be sealed by surrounding clastic sediments. There is a good chance that this reef is gas-bearing. Elsewhere Miocene reefs appear to lack suitable cap-rocks.

The Halifax Basin which lies offshore northeast of Townsville has not been drilled and therefore its sedimentary section can only be inferred from seismic data. A Tertiary and Mesozoic section of unknown lithology with an estimated maximum thickness of 2.5 km was evident in the Halifax Basin, and there are possibly closed anticlines present on the western side. It has been determined that onshore prospects in the Hillsborough Basin are poor owing to the lack of reservoir rocks and traps, whilst offshore prospects depend on the presence of suitable reservoir rocks and adequate trapping, neither of which has been established.

Of some interest in the Capricorn Basin is a possible Tertiary delta suggested by seismic data in a part of the basin where sedimentary rocks are thickest. This is located in an area of deep water between 200 and 1000 m and coincides with a strong regional gravity minimum. However, the seismically-depicted deltaic section appears to be structurally featureless and therefore offers little prospect for the location of anticlinal drilling targets.

Both the Maryborough and Clarence-Moreton Basins are considered to have low potential, owing in large part to the absence of reservoir beds.

Publications (in preparation)

Rasidi, J.S. - Buried reef structures in the Lennard Shelf. BMR Journal of Australian Geology and Geophysics. (also as appendix in Canning Basin Atlas).

Rasidi, J.S., & Smart, J. - The geology of the eastern region of Cape York Peninsula and the adjoining offshore area. BMR Journal of Australian Geology and Geophysics.

Wales, D.W., & others - Canning Basin Atlas. Bureau of Mineral Resources, Australia, Special publication.

Wales, D.W., Lockwood, K.L., Rasidi, J.S., & Smart, J. - The geology of the eastern region of Cape York Peninsula and the adjoining offshore area. Bureau of Mineral Resources, Australia, Report.

Offshore Sub-section

Petroleum (Submerged Lands) Act: The receipt, examination, indexing, and storage of data and reports received under the Act continued during the year. Applications to carry out operations under the Act, and final reports on operations performed in offshore titles were examined and comments prepared. A register of relinquished and vacant offshore areas, and the availability of basic data with respect to these areas, was maintained.

During the twelve months ended 31 October 1977, nine exploratory wells were drilled in offshore Australia; of these, three were new-field wildcats, five were stepouts or appraisal wells, and one was abandoned and re-drilled for mechanical reasons (see Table 1 and Plate 1). Five of the wells were in waters adjacent to Victoria and four in waters off Western Australia. The average depth of the wells off Victoria was 2268 m and off Western Australia 3074 m. The overall average depth was 2626 m.

In the Haycock No. 1 well, drilled by Woodside-Burmah in the Dampier Sub-basin, five formation interval tests run in water-bearing sections within the interval 3250-3330 m provided valuable pressure data, and two formation interval tests run in thin hydrocarbon-bearing sections within the same interval recovered gas and condensate. The objectives of the well were encountered shallower than expected and the well was plugged and abandoned at a total depth of 3668 m.

The two wildcat wells, Swordfish No. 1 and Opah No. 1 drilled by Esso Exploration and Production Australia Inc. in the Gippsland Basin off Victoria, were both plugged and abandoned without finding any significant hydrocarbon indications.

In the North Rankin No. 5 appraisal well, drilled by Woodside Petroleum Development in the Dampier Sub-basin, the maximum flow rate attained in multi-rate testing was 1.566 million m³/day of gas (55.3 million cu ft/day) on a one-inch choke. North Rankin No. 5 was plugged and abandoned as a gas extension well.

Scott Reef No. 2A well drilled by Woodside in permit WA-33-P off Western Australia is currently the deepest offshore well drilled in Australian waters. Its total depth was 4820 m. Hydrocarbon indications were reported in the interval 4609-4660 m. Six formation interval tests were run and three of these recovered small quantities of gas. The results of the formation interval tests and log interpretation confirmed the presence of some gas-bearing sands in the interval 4611-4660 m and their significance in relation to the Scott Reef accumulation is under study by the operators. The well was plugged and abandoned.

TABLE 1.

Offshore Drilling Operations, Australia, Completed
1 November 1976 to 31 October 1977

Operator	Well	Total depth (m)	Status
Esso Exploration and Production Aust. Inc.	Swordfish 1	2469	Plugged and abandoned, dry
	Opah 1	2501	Plugged and abandoned, dry
	Barracouta 4	1458	Plugged and abandoned
	Cobia 2	2498	Plugged and secured oil extension well
	Kingfish 7	2415	Plugged and abandoned oil confirmation well but volume insufficient to justify completion
Woodside Petroleum Development Pty Ltd (formerly BOCAL Pty Ltd)	North Rankin 5	3500	Plugged and abandoned gas and condensate extension well
	Haycock 1	3668	Plugged and abandoned, dry
	Scott Reef 2	310	Plugged and abandoned for mechanical reasons
	Scott Reef 2A	4820	Plugged and abandoned gas shows. Scott Reef 2A is deepest offshore well drilled in Aust to 31.10.77

During the year eleven marine seismic surveys were carried out in waters adjacent to Western Australia and the Northern Territory. The total coverage of the surveys was 6242 line-kilometres.

Offshore Index: The initial steps have been taken to transfer the computer-based file of drilling and geophysical operations from the INFOL system to the Hewlett-Packard IMAGE system. However, owing to restrictions on funds, staff shortages, and work loads the transfer has not progressed beyond adding to the index in the form of punched cards. Additional work to include archival data and other relevant matters, including onshore data is planned or in-hand.

Assessments: The group reviewed and revised assessments made of offshore areas as new data became available and as comments were required on applications for new petroleum title areas and for the renewal of existing title areas. The preparation of assessment reports in restricted Record form continued. In the case of the Northern Territory offshore permits, technical advice on work programs was given to the Department of the Northern Territory.

The assessment and detailed interpretation of data from the Tuna structure in the Gippsland Basin and the Scott Reef structure on the Northwest Shelf were completed. These studies enabled volumetric estimates of the possible petroleum reserves of the structures to be calculated by the Reservoir Engineering Sub-section, with assistance from the group.

In February 1977, a request was received from the Government of Papua New Guinea for the supply of technical advice on drilling operations. In late February an officer of the Sub-section visited Port Moresby and the Kusa No. 1 offshore well in the Gulf of Papua as part of the request for assistance and for discussions with PNG Government officials. Additional assistance has also been provided in the matter of preparing offshore drilling Regulations for Papua New Guinea.

Petroleum Search Subsidy Act: The Group met requests by visitors to BMR and BMR officers for information on and access to PSSA reports and other material. Assistance was given to the Australian Government Publishing Service with respect to customers' requests for copies of PSSA material.

Work continued on the preparation of a comprehensive report on the operation of the subsidy scheme.

Core and Cuttings Laboratory: During the year, BMR personnel made 264 visits to the laboratory. Representatives from 6 consulting organisations, and representatives from petroleum and mining companies made 64 visits. The facilities provided at the laboratory for visitors were used for a total of 136 man-days.

Documentation, packing and transportation materials for field samples were provided for two BMR field parties and for operations within the Canberra area. 1188 collapsible core boxes, 8000 core bags, and 5500 cuttings bags were supplied.

During the year 250 m of core were slabbed, 51 thin sections were prepared, and 44 slabbed polished sections were made. The core slabbing machinery was used for 60 man-days.

1085 m of core, 9204 cuttings samples, 4 water, 8 gas, and 1 condensate samples were received. 3417 m of core and 16638 cuttings samples were added to the register during the year. The Core and Cuttings Laboratory now holds a total of 1 115 604 fully registered items.

Offshore Sub-section Records

McAvoy, W.J., & Temple, P.R., 1976 - An appraisal of Petroleum Exploration and Development Title Area WA-1-P, Dampier Sub-basin, Western Australia. Bureau of Mineral Resources, Australia, Record 1976/79 (restricted).

McAvoy, W.J., & Temple, P.R., 1976 - An appraisal of Petroleum Exploration and Development Title Areas WA-23-P, WA-24-P and WA-25-P, Carnarvon Basin, Western Australia. Bureau of Mineral Resources, Australia, Record 1976/80 (restricted).

Records (in preparation)

McAvoy, W.J., & Temple, P.R. - An appraisal of Petroleum Exploration and Development Title Areas Q/1P, Q/2P, Q/3P, Q/4P, Q/5P, Q/6P, Q/7P, Q/8P, Q/9P, Q/10P, Q/11P and Q/12P, offshore Queensland. Bureau of Mineral Resources, Australia, Record (restricted).

McAvoy, W.J., & Temple, P.R. - An appraisal of Petroleum Exploration and Development Title Areas SA-2-P and SA-8-P, offshore Otway Basin, S. Aust. Bureau of Mineral Resources, Australia, Record (restricted).

McAvoy, W.J. & Temple, P.R. - An appraisal of Petroleum Exploration and Development Title Areas SA-4P, SA-5P, SA-6P, SA-7P, SA-10P and SA-11P, Great Australian Bight, South Australia. Bureau of Mineral Resources, Australia, Record (restricted).

McAvoy, W.J., & Temple, P.R. - An appraisal of Petroleum Exploration and Development Title Areas WA-15-P, WA-16-P, WA-17-P, WA-18-P and WA-19-P, offshore Bonaparte Gulf Basin, Western Australia. Bureau of Mineral Resources, Australia, Record (restricted).

McAvoy, W.J., & Temple, P.R. - An appraisal of Petroleum Exploration and Development Title Area Vic/P8, offshore Gippsland Basin, Victoria. Bureau of Mineral Resources, Australia Record (restricted).

McAvoy, W.J., & Temple, P.R. - An appraisal of Petroleum Exploration and Development Title Areas WA-29-P, WA-30-P, WA-31-P and WA-32-P, offshore Canning Basin Western Australia. Bureau of Mineral Resources, Australia, Record (restricted).

McAvoy, W.J., & Temple, P.R. - An appraisal of Petroleum Exploration and Development Title Areas NT/P2, NT/P7, NT/P8, NT/P9, NT/P10, NT/P13, NT/P14, NT/P15, offshore Bonaparte Gulf Basin, Northern Territory. Bureau of Mineral Resources, Australia, Record (restricted).

McAvoy, W.J., & Temple, P.R. - An appraisal of Petroleum Exploration and Development Title Areas Vic/P6, Vic/P7, and Vic/P10, offshore Otway Basin, Victoria. Bureau of Mineral Resources, Australia, Record (restricted).

Riesz, E.J., & Temple, P.R. - An appraisal of Petroleum Exploration and Development Title Areas NT/P11, NT/P12, NT/P4, NT/P6, NT/P19 and WA-36-P, offshore Bonaparte Gulf Basin, Northern Territory and Western Australia. Bureau of Mineral Resources, Australia, Record (restricted).

PETROLEUM TECHNOLOGY SECTION

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 fulfill all appropriate functions.

Mr J. White, Chief Petroleum Technologist, prepared a paper for the National Energy Advisory Committee on Exploration for Oil and Gas in Australia. The Oil Shale Committee was re-formed during the year and several meetings of this Committee were attended. A revised set of Directions under the Petroleum (Submerged Lands) Act was drafted and passed to the Northern Territory Designated Authority for issuing to Permittees.

Considerable time was spent on the evaluation of new prospects on Barrow Island to determine whether 'new' oil or 'old' oil prices would be appropriate.

Several meetings of the Oil Advisory Committee were convened and attended by J.A.W. White. The Oil Advisory Committee is a statutory body set up under the Petroleum (Prospecting and Mining) Ordinance 1954-1966 and has the function of advising the Administrator or the Minister for the Northern Territory on any scientific or technical matter arising in connection with the exploration for and production of petroleum in the Northern Territory.

Industry and Economics Group

Petroleum Legislation: A review of the onshore petroleum legislation of each State and the Northern Territory was made to determine the provisions covering the release to the public of information and data provided by exploration and production companies. The results of this review have been incorporated in a summary forwarded to the Department to indicate the difficulties in obtaining detailed onshore data.

Comments were prepared on the level of petroleum exploration in the Northern Territory with particular reference to the effects of recently introduced legislation covering Aboriginal land rights and conservation.

J.A.W. White as Secretary/Convenor of the Oil Advisory Committee dealt with matters associated with the work of the Committee. Various officers of the group provided technical advice on specific subjects.

During the year considerable time was spent in the preparation of comments on the corporate structure and financial and technological capacity of applicants for offshore permits under the terms of the Petroleum (Submerged Lands) Act.

Petroleum Economics and Statistics: Material prepared in response to questions from industry, the public, and Parliamentary enquiries has continued to be updated and revised. In addition, quarterly assessments of the recoverable reserves of crude oil, condensate, 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 67, 68, 70, and 71 (currently in preparation).

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. 70. They have been further analysed and will be published in detail in the Petroleum chapter of the Australian Mineral Industry 1976 Annual Review.

In summary, the results of this survey show that there was an overall 26 percent decrease in exploration drilling expenditure in 1976; this was mainly due to a 44 percent decline in offshore exploration drilling with only 3 wells completed in the year compared to 19 in 1975. Geological and geophysical exploration activity in 1976 in terms of crew months of work together with a comparison with 1975 are given below.

Table 2. Level of Geophysical Activity, 1976

Survey	Unit of Work	1976	1975
Land Seismic	Crew months	19.5	11.3
Marine Seismic	" "	8.26	2.6
Gravity Surveys	" "	2.5	0.25
Geological Surveys	" "	23.5	16.3
Magnetic Land	Line km	nil	nil
Aero	"	nil	nil
Shipborne	"	8651	nil

Total petroleum exploration expenditure in Australia in 1976 was \$54 233 158; reflecting a decrease on exploration expenditure of 8.65 percent over 1975 when the expenditure was \$62 962 597.

The Section prepared for publication and distribution the following documents:-

- (i) The Petroleum Newsletter (Quarterly) Nos 67, 68, 69, and 70, including monthly drilling rig activity and quarterly statistics.
- (ii) A breakdown of petroleum exploration, development, and production activity and expenditure for 1976 presented in Petroleum Newsletter No. 70 and in the Petroleum Chapter of the A.M.I. Annual Review.
- (iii) Statistics, and information on petroleum exploration, production, and resources, etc. in Australia for various publications such as World Oil, Oil and Gas Journal, year books, and pamphlets.
- (iv) The Petroleum Exploration and Development Titles Map and Key showing the position as at 1 January 1977. A similar map to show the position as at 1 July 1977 is in preparation.

A library of index cards containing details on each well drilled is maintained for quick reference, as is reference material on the corporate structure of individual companies engaged in petroleum activities. An index to articles of interest in the various trade and professional journals is maintained on a subject and author basis.

Petroleum Technology Laboratory

Petrophysios Group: The principal projects undertaken during the year were the enhanced oil recovery project on samples from the Moonie Field, Queensland, and the analysis of hydrocarbon samples from near the Center Cinema Theatre, Canberra.

The Moonie enhanced recovery project entailed capillary pressure tests by the centrifugal technique, viscosity tests over an extended temperature range of a synthetic crude oil, water flooding tests, and routine porosity and permeability analyses. A literature search on the use of polymers for enhanced recovery was also undertaken. However, progress on the study was severely hampered by the lack of professional staff.

An explosion in the basement of the Center Cinema Canberra (Feb. 10, 1977) and resultant Coroner's inquest resulted in about four months work. The Department of Capital Territory requested analyses of petrol from surrounding service stations, from bores specifically drilled for petrol samples, and from the seepage in the theatre itself. Water-petrol emulsion stability tests were carried out using a surfactant which may be used for dispersing the petrol around the theatre. Staff from the laboratory gave evidence at the inquest to determine the cause of the explosion and the source of petrol leaking into the theatre. The Commonwealth was obliged to be involved in this instance because of the leasehold conditions governing tenancy of land in Canberra.

Other special projects undertaken were on drilling fluid foaming agents, and water filtrate characteristics on samples of a polymer mud additive used in drilling and workover operations in the Cooper Basin.

Routine porosity and permeability analyses were carried out on 330 samples up to the end of October, 1977.

Formation fluid analyses were carried out on four samples from Spar No. 1 and five samples from North Rankin No. 5.

Petroleum and Source Rocks Geochemistry Group: Investigations with respect to the explosion at the Center Cinema occupied a considerable proportion of the section's time. The work involved density, distillation, refractive index, and gas-liquid chromatography of fluid samples from various locations in and around the theatre building. In addition, distillation analysis of petrol samples from various service stations was carried out.

Work continued on writing up a thesis on the Amadeus Basin project up until the time of the geochemist's resignation at the end of September.

Source rock studies were carried out on samples from the Georgina Basin, the Pedirka Basin, and the Bonaparte Gulf Basin. The studies entailed extraction of soluble organic matter, determination of total organic carbon, asphaltene precipitation, and liquid and gas chromatography.

During the year two Hewlett-Packard Flame Ionization Gas Chromatographs were installed. The two units have aided significantly the analytical work of the group.

Routine condensate analysis was carried out on samples from Spar-No. 1.

Analysis of heating oils used in various government departments in Canberra showed that they all had high sulphur content (1.7-2.4%) and of particular consequence was the fact that oil used in BMR boilers had a pour point of 16°C making it unsuitable at Canberra's winter temperatures.

Reservoir Engineering Sub-section:

Australia's petroleum reserves on land and offshore were published quarterly in Petroleum Newsletter Nos 67, 68, 69, and 70. The estimates of petroleum reserves are now classified as crude oil, condensate, liquified petroleum gas (LPG), and natural gas. For the most part they are 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 1977 were estimated to be as follows:

Table 3. Petroleum Reserves

	Initial Reserves	Cumulative Production	Remaining Reserves
Crude oil	384.66 x 10 ⁶ m ³	158.12 x 10 ⁶ m ³	226.54 x 10 ⁶ m ³
Condensate	112.24 x 10 ⁶ m ³	1.99 x 10 ⁶ m ³	110.25 x 10 ⁶ m ³
LPG	183.92 x 10 ⁶ m ³	15.23 x 10 ⁶ m ³	168.69 x 10 ⁶ m ³
Natural gas	887.29 x 10 ⁹ m ³	32.36 x 10 ⁹ m ³	854.93 x 10 ⁹ m ³

The Reservoir Engineering Sub-section has now established 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.

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 Sub-section's activities in the past year have been mainly concentrated on the detailed study and assessment of the petroleum reserves of the Troubadour and Sunrise fields, Northern Territory, Puffin field, Western Australia and Pelican field, Tasmania, all being offshore; these studies have been completed and reported.

Preliminary studies of Haycock No. 1 and North Rankin No. 5 wells, Western Australia and Kingfish-7, Victoria have been made as well as a re-appraisal of the Tuna field in Victoria.

Several computer programs have been designed and completed to aid in gas well performance predictions and well-log interpretation.

Numerous routine and ad hoc enquiries including support for the NEAC studies covered reservoir information, reserve estimates, and reserve classifications.

L. Kurylowicz gained experience in well testing and completion procedures in the Cooper Basin over a two-week period through the courtesy of Delhi International Oil Company and partners.

Drilling Engineering Sub-Section:

Plant and Equipment: Drilling Sub-section personnel ferried one additional MACK R685RS chassis prime-mover to Canberra from Brisbane in January. A MAYHEW 1000 drill unit (the fifth so far obtained) was mounted on the MACK chassis from an AEC MILITANT truck at the Department of Construction Plant Workshops at Fyshwick. A 1000-gallon water tank was mounted on the AEC chassis.

On the completion of the 1976 field party, MACK TRUCKS AUST., Brisbane, modified a rear suspension by replacing the 'walking beam' with conventional springs. By carrying out this modification vibrations previously experienced were rectified as witnessed by a road test from Brisbane to Canberra. A further 3 units were modified in June, 1977, and the fifth unit will be modified in Darwin by the Mack Trucks agency at the completion of the Alligator River field party operations.

A transfer box for the rig drive was installed (the second drill unit to be so altered). The third transfer box will be installed later in the year.

The following were withdrawn from service as being beyond economic repair: one LEYLAND 400 'on-deck' rig motor, one 'Chieftain' 6 x 4 chassis, and two AEC 6 x 6 chassis. A replacement motor for the LEYLAND 400 was mounted on a MAYHEW 1000 chassis; and two AEC chassis were converted to carry 1000-gallon water tanks which were removed from the vehicles withdrawn from service.

All five 1000-gallon water tanks and their vehicles are in need of urgent replacement because they are liable to breakdown at any time. Either

failures in the tank or breakdowns in the vehicles are expected. The tight 1976-77 and 1977-78 economic restraints are hindering the timely replacement of obsolescent plant and equipment.

The Drilling Sub-section mechanics carried out 90 percent of the installation of the transfer box and LEYLAND 400 motor and about 80 percent of the work of remounting and modifying the MAYHEW rig and water tank.

Repairs, maintenance and modification of the drilling equipment, support vehicles, trailers, etc., were made by Drilling Sub-section personnel.

Truck and Car Sales (Canberra) Ltd carried out repairs and reconditioning of LEYLAND heavy vehicle spares.

The current vehicle and plant strength is:

- 5 - MAYHEW 1000 rigs mounted on Mack R685RS chassis
- 1 - GEMCO 210B 'Tandem-Trailer' mounted auger diamond
- 5 - 1000-gallon water tanks on AEC MILITANT chassis
- 1 - 600-gallon water tank on INTERNATIONAL 1600 chassis
- 4 - 6-ton 4-wheel drill trailers.

Drilling Operations: In the year ending October 1977, the Sub-section provided eight drilling parties in support of various BMR field activities. Drilling and diamond coring operations took place in the ACT (including the Center Cinema explosion enquiry), NSW, SA, and Vic. in support of geological engineering studies. Diamond coring and drilling for stratigraphic information was carried out in the Alligator River area (NT) and in the Georgina Basin (Qld). Drilling support of the Georgina Basin seismic survey was also undertaken.

The five MAYHEW 1000 drills and one GEMCO drilling unit were used to carry out the operations.

Table 4 summarises the drilling and coring activities during the period 1 November 1976 to 31 October 1977.

Technical Services: During the year a number of 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 forwarded to the Contracts Board.

Symposia, conferences, courses and lectures attended

Symposia, conferences, courses and lectures attended by members of the Section during the year in question were:

Basic wire line log interpretation by Schlumberger and held in Canberra (I. Donald and K. Stillwell).

Reservoir monitoring by Schlumberger, Sydney (S. Ozimic).

Enhanced and secondary recovery, University of Sydney (L. Kurylowicz).

Reservoir simulation, University of Sydney (L. Kurylowicz).

Advanced wire line log interpretation by Schlumberger, Melbourne (S. Ozimic).

Australian Petroleum exploration Association Annual Conference, Sydney (J.A.W. White, B.A. MacKay).

Australian National University, Conference on Energy - the eighties and beyond, Canberra (J.A.W. White).

Varian leak detection course, Canberra (Z. Horvath).

Publications (in preparation)

Kurylowicz, L.E., & Stillwell, K.L., 1977 - GAS 1 - A computer program to predict gas deliverability. Bureau of Mineral Resources, Australia, Record.

Kurylowicz, L.E., 1977 - LOG 1 - A computer program to estimate porosity and water saturation. Bureau of Mineral Resources, Australia, Record.

TABLE 4

PHE DRILLING OPERATIONS 1st NOVEMBER 1976 TO 31st OCTOBER 1977

BRANCH AND SECTION	PROJECT AREA OF OPERATION	TOTAL METRES OF HOLE		NO. OF HOLES	TOTAL METRES OF HOLE			NO. OF CORES	AVERAGE CORE RECOVERY (%)	TIME SPENT-HRS (TOTAL OPERATING TIME)		AVERAGE PENETRATION RATE METRES/HR DRILLING	AVERAGE PENETRATION RATE METRES/HR CORING	AVERAGE DEPTH OF HOLE (METRES)	TRAVELLING TIME (HOURS)	
		FROM	TO		DRILLED	CORED	DRILLED & CORED			DRILLING	CORING					TOTAL
<u>GEOLOGICAL</u>	Georgetown (Qld)	1-11-76	9-11-76	1	-	51.00	51.00	23	83.11	-	36.00	36.00	-	1.41	51.00	9.00
Metalliferous	Alligator River (N.T.)	14-7-77	24-10-77	53	1388.22	59.07	1447.29	52	90.00	200	149.00	349.00	6.94	2.52	27.30	-
"	Jugiong (N.S.W.)	2-3-77	28-4-77	2	151.70	106.10	257.80	67	97.59	96	150.00	246.00	1.58	.70	128.90	35.50
Sedimentary	Georgina Basin (Qld)	18-7-77	21-10-77	2	155.25	166.35	321.60	103	98.08	157	152.50	309.50	.98	1.09	160.80	-
"	"Gasco" drill	25-7-77	30-9-77	7	18.00	420.85	438.85	113	97.14	13	159.00	172.00	1.38	2.64	62.69	33.00
"	Penola (SA)															
"	Horsham (Vic)	10-2-77	18-5-77	11	426.42	584.99	1011.41	292	60.16	109	228.5	337.50	3.91	2.56	91.94	26.00
Engineering Geology & Hydrology	A.C.T./N.S.W.	1-11-76	8-12-76	2	4.00	84.60	88.60	69	88.66	2.00	103.5	105.50	2.00	1.22	44.30	31.00
"	"	9-6-77	16-6-77	1	2.20	28.26	30.48	14	95.00	.50	28.5	29.00	4.40	1.00	30.48	7.50
"	Cinema Centre (A.C.T.)	20-2-77	23-3-77	14	-	119.46	119.46	119	60.00	-	44.00	44.00	-	2.71	8.56	9.50
Observatories & Regional	Adelaide & Leigh Crk (S.A.)	21-4-77	21-5-77	5	2.55	37.65	40.20	43	100.00	21.5	36.00	57.50	.12	1.04	8.04	17.00
<u>GEOPHYSICAL</u>																
Seismic (Land)	Clermont (Qld)	1-11-76	1-12-76	484	9212.00	-	9212.00	-	-	280.50	-	280.50	32.84	-	19.03	73.50
"	Georgina Basin (Qld)	20-6-77	19-10-77	1202	36450.74	-	36450.74	-	-	1735.50	-	1735.50	21.00	-	30.32	327.50
TOTALS		1-11-76	31-10-77	1784	47811.03	1658.35	49469.43	895	86.97	2615.00	1087.00	3702.00	18.28	1.52	67.94	569.50

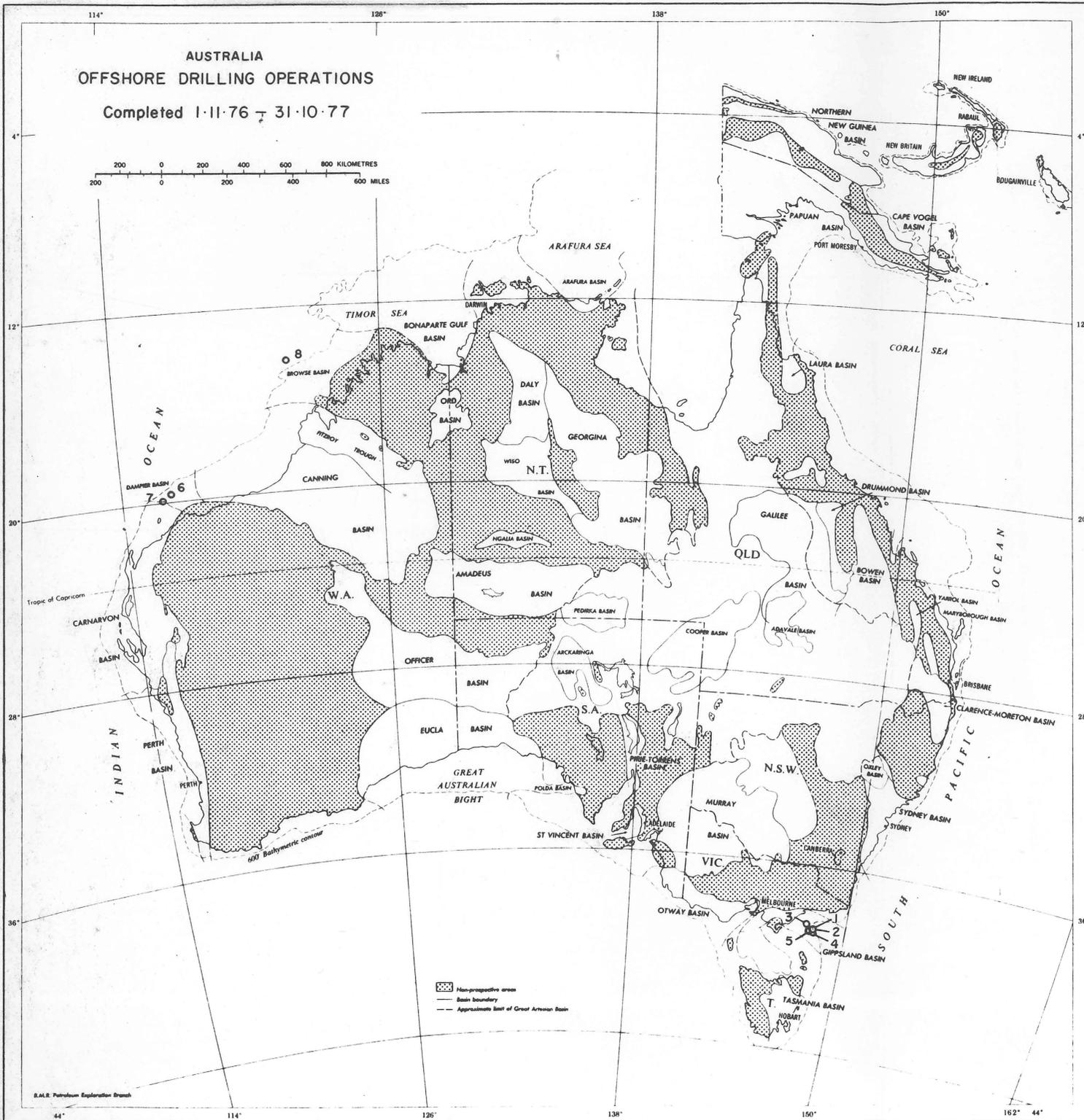
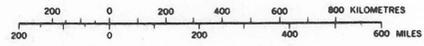
SUMMARY:- Total metres drilled 47 811.08
 " " cored 1 658.35
 " " drilled & cored 49 469.43
 " number of holes 1 784
 " " " cores out 895
 Average core recovery 86.97 %

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

AUSTRALIA
OFFSHORE DRILLING OPERATIONS
Completed 1-11-76 to 31-10-77



Note: Unless otherwise stated, well location refers to No.1 well.

1. Swordfish, Vic.
2. Opah, Vic.
3. Barracouta No.4, Vic.
4. Cobia No.2, Vic.
5. Kingfish No.7, Vic.
6. North Rankin No.5, W.A.
7. Haycock, W.A.
8. Scott Reef No.2 & 2A, W.A.