



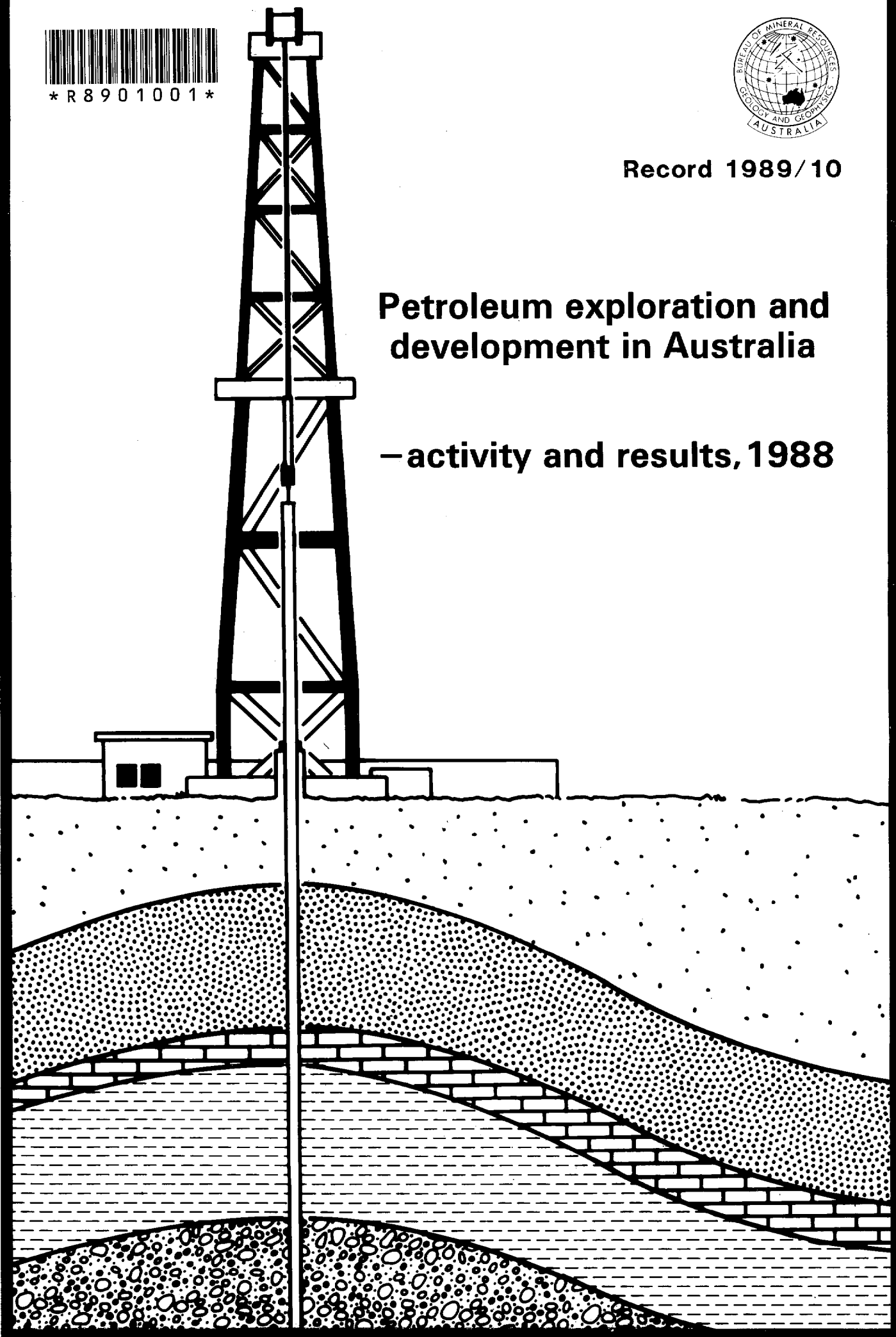
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Record 1989/10

Petroleum exploration and development in Australia

— activity and results, 1988



BMR Record 1989/10

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**Compiled by the Petroleum Branch, Resource Assessment Division,
Bureau of Mineral Resources, Geology and Geophysics, Canberra**

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INTRODUCTION

This report has been prepared by the staff of the Petroleum Branch of the Resource Assessment Division of BMR. The functions of the Petroleum Branch include the monitoring of petroleum exploration and development activity, the preparation of estimates of petroleum reserves and resources and their availability through time, and the provision of technical advice in relation to Commonwealth legislation and policies concerning petroleum exploration, development and production.

The report provides a preliminary summary of petroleum exploration and development activity in Australia during 1988. It also summarises BMR's assessment of Australia's identified petroleum resources (reserves) and undiscovered petroleum resource potential.

In addition to a summary of activity in 1988 in each of the major onshore and offshore sedimentary basins, the report includes a summary of the number of wells and metres drilled to the end of 1988, a table of discoveries of petroleum in 1988, and a list of the major events in the history of the Australian petroleum industry.

1988 IN RETROSPECT

Expenditure on petroleum exploration in Australia increased in 1988, however expenditure on development decreased, resulting in an overall reduction in exploration and development expenditure in 1988 compared with 1987. Although the number of offshore exploration wells more than doubled, the number of offshore development wells decreased substantially compared with 1987, and the number of onshore exploration and development wells were slightly less than in 1987. In contrast, seismic survey activity rose substantially compared with 1987 mainly as a result of the increased offshore exploration activity.

The highest proportion of exploration wells were drilled in the Eromanga Basin and its infrabasins - the Adavale, Cooper, Galilee and Pedirka Basins. Other onshore basins which were actively explored were the Amadeus, Bonaparte, Bowen/Surat, Canning, Carnarvon, Carpentaria, Eucla, Georgina, Laura, McArthur, Otway, and Perth Basins. Most offshore exploration wells were in the Bonaparte and Carnarvon Basins: exploration wells were also drilled in the offshore Gippsland Basin. Onshore seismic surveys were mainly in the Cooper/Eromanga and Bowen/Surat Basins, and offshore surveys were mainly in the Gippsland, Bonaparte and Carnarvon Basins.

Fifty-four oil, gas and condensate discoveries were made during 1988; 20 oil, 18 gas, one oil and gas, five gas/condensate and one oil/gas/condensate discoveries were made onshore, and three oil, one gas, four oil and gas and one gas/condensate discoveries were made offshore. Additions to demonstrated resources resulting from discoveries were insignificant compared to upward revisions of resources in known fields, and to changes resulting from production. Extension/appraisal wells in the Challis and Petrel fields further upgraded the reserves of the Bonaparte Basin, and drilling in the Bamba and Saladin fields further upgraded the reserves of the offshore Carnarvon Basin.

Development wells completed onshore were mainly in the Cooper/Eromanga Basins, but development wells were also drilled in the Bowen/Surat and Perth Basins. Most offshore development wells were drilled in the Bream field in the Gippsland Basin, but development wells were also drilled in the North Rankin and South Pepper fields in the Carnarvon Basin, and in the Jabiru and Challis fields in the Bonaparte Basin.

Other major offshore development projects continued during 1988: these

included construction of the second phase of the North West Shelf gas project to supply liquefied natural gas to Japan, construction of a natural gas liquids plant on Varanus Island to process gas from the Rosette and Harriet oil fields in the Carnarvon Basin, and construction of production facilities for the Saladin and Talisman oil fields also in the Carnarvon Basin. Proposals were made to develop the Challis oil field in the Bonaparte Basin and increase production from the nearby Jabiru oil field. Plans were also announced to include the small Perch and Dolphin fields with the proposed development of the small Whiting, Tarwhine and Seahorse fields in the Gippsland Basin.

Onshore development projects that commenced in 1988 included construction of a second oil refinery at Port Bonython, S.A., reticulation of natural gas in Alice Springs, and facilities in Alice Springs for the manufacture of LNG for use in power generation at Yulara and electricity supply to the Cosmo Howley gold mine. The announcement of plans to use coal-derived gas from the Bowen Basin as feedstock in an ammonia plant near Moranbah follows successful completion of a pilot project to investigate the commercial viability of producing methane gas from coal beds in the Bowen Basin. The Queensland Government has endorsed a proposal to sell natural gas from the Queensland part of the Cooper/Eromanga Basin to S.A. If the proposal is implemented it is expected to encourage more exploration in the area.

PETROLEUM GEOLOGY, RESOURCES AND PRODUCTION

Geology

Sedimentary rocks ranging in age from Proterozoic to Cainozoic underlie about 4.3 million km² or about one half of the land area of Australia, and about another 2 million km² of the continental shelf (Fig. 1). Forty-eight sedimentary basins are presently recognised, 20 of which lie wholly or partly offshore.

Proterozoic and early-mid Palaeozoic basins occur mainly in the central and western parts of the continent and in some places extend offshore. Basins that have developed during the late Palaeozoic and Mesozoic underlie large areas of eastern Australia, and extend onshore and offshore around the continental margins. Tertiary strata overlie many of the older basins. The Tertiary basins, and basins that continued to develop into the Tertiary, are mostly distributed along the southern coastline.

Australia's petroleum reservoirs range in age from Precambrian to early Tertiary. Most of the oil resources discovered so far are in offshore early Tertiary reservoirs in the Gippsland Basin. The petroleum reservoirs in the Carnarvon and Browse Basins are Mesozoic, and both Mesozoic and Permian reservoirs exist in the Bonaparte Basin. Onshore, petroleum occurs in Jurassic and Cretaceous reservoirs in the Eromanga Basin, and Jurassic reservoirs in the Surat Basin. The reservoirs are of Permian and Triassic age in the Perth, Bowen, and Cooper Basins, and in the Canning and Adavale Basins which are of Permian and Devonian, and Devonian age respectively. Late Precambrian to late Ordovician reservoirs occur in the Amadeus Basin.

The early-mid Palaeozoic reservoirs in the Amadeus and Adavale Basins are in shallow-marine sedimentary sequences. However, most of Australia's petroleum resources have been discovered in Tertiary, Mesozoic, and late Palaeozoic sequences that were deposited in marginal marine or non-marine environments and which commonly contain extensive coal measures.

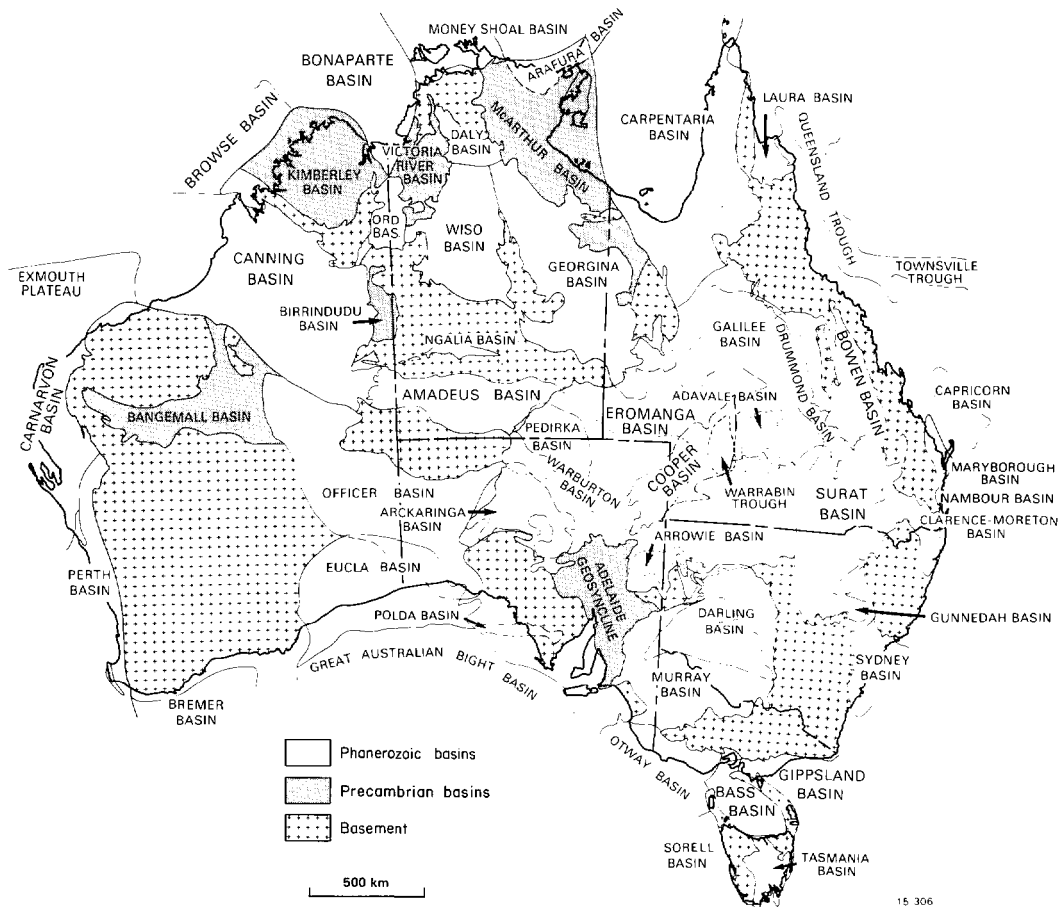
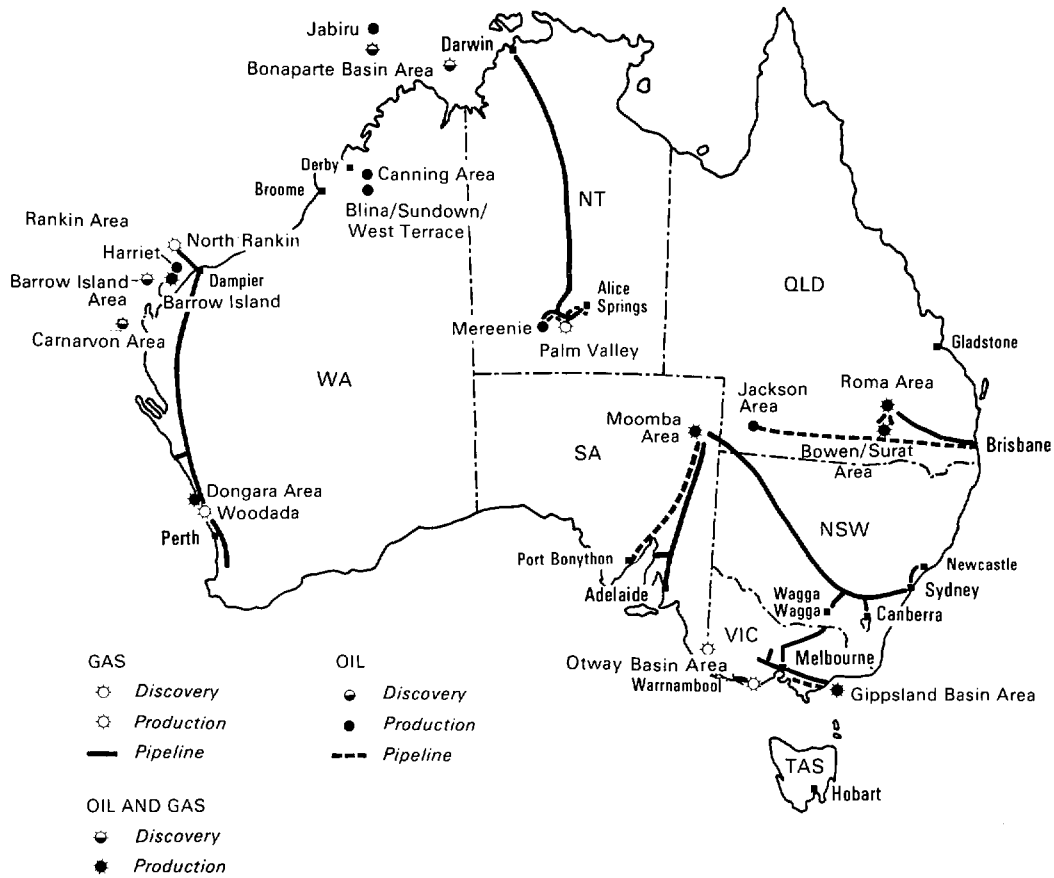


Fig. 1. Australia's sedimentary basins. Basement denotes regions generally unprospective for petroleum - mainly areas underlain by crystalline rocks or by tightly folded or metamorphosed strata. The dashed lines are boundaries of concealed basins; locally relationships are complex, e.g. the Galilee Basin overlies the Adavale Basin and underlies the Eromanga Basin.



DISCOVERIES IN 1988

Bonaparte Basin Area

- Bilyara 1
- Cassini 1
- Evans Shoal 1
- Garimala 1
- Montara 1
- Oliver 1
- Skua 5
- Weaber 2A

Bowen/Surat Area

- Beaufort 6
- Beechwood 2
- Carbean 5
- Parknook 2
- Pine Ridge 15
- Tinker 1
- Walpanara 1

Canning Area

- Crimson Lake 1
- Leo 1

Jackson Area

- Epsilon 4
- Epsilon 5
- Gumla 1
- Karmona 2
- Karri South 1
- Milkryna 1
- Munro 1
- Natan 1
- Pitchery 1
- Tarbat 1
- Thoar 1
- Wackett 3

Moomba Area

- Arrakis 1
- Bobs Well 1
- James 1
- Jena 2
- Kirrallee 1
- Kudrieke 2
- Kujani 1
- Massy 1
- Moomba 58
- Narie 1
- Spencer 7
- Sturt 1
- Sturt 2
- Sturt 3
- Sturt East 1

Moomba Area(cont'd)

- Taloola 1
- Taloola 2
- Tantanna 1
- Tantanna 3
- Varanus 1
- Varanus 2

Carnarvon Area

- Echo 1
- Yammaderry 1

Gippsland Basin Area

- Torsk 1

Otway Basin Area

- Iona 1

Fig. 2. Location of oil and gas production, pipelines and discoveries in 1988.

Resources

Most of Australia's identified resources of crude oil occur in the Gippsland Basin (Fig. 2, Table 1); smaller amounts exist in the Amadeus, Bonaparte, Bowen, Canning, Carnarvon, Cooper, Eromanga and Perth Basins. Most identified resources of natural gas occur in the Bonaparte, Carnarvon (inc. Exmouth Plateau), Cooper and Gippsland Basins. Gas has been discovered in all basins known to contain resources of crude oil and additionally in the Adavale, Bass, Browse and Otway Basins.

Australia's demonstrated recoverable resources of crude oil, condensate, liquefied petroleum gas (LPG), and sales gas are shown in Table 1 (see also Figure 3). Table 1 is based on the McKelvey classification, which subdivides resources in terms of their economic feasibility of extraction and geological certainty of occurrence. **Economic demonstrated resources** of petroleum are judged to be economically recoverable, their quantity and quality being assessed partly from specific measurements and partly by extrapolation for a reasonable distance on geological evidence; **subeconomic demonstrated resources** are similar in terms of certainty of occurrence but, although physically recoverable, are judged at present to be subeconomic.

TABLE 1. LOCATION AND MAGNITUDE OF AUSTRALIA'S DEMONSTRATED RECOVERABLE PETROLEUM RESOURCES, 30 JUNE 1988(a)

Basin	Crude Oil ($\times 10^6 \text{ m}^3$)	Condensate ($\times 10^6 \text{ m}^3$)	LPG ($\times 10^6 \text{ m}^3$)	Sales Gas ($\times 10^9 \text{ m}^3$)
Economic Demonstrated Resources				
Amadeus & Bonaparte	9	4	11	73
Bowen/Surat	*	*	*	3
Carnarvon & Canning	29	86	27	708
Cooper/Eromanga	14	8	12	80
Gippsland	179	22	46	196
Otway	-	*	-	*
Perth	1	*	-	5
Total	232	120	96	1065

Basin	Crude Oil ($\times 10^6 \text{ m}^3$)	Condensate ($\times 10^6 \text{ m}^3$)	LPG ($\times 10^6 \text{ m}^3$)	Sales Gas ($\times 10^9 \text{ m}^3$)
Subeconomic Demonstrated Resources				
Adavale	-	-	-	1
Amadeus	*	*	*	10
Bowen/Surat	-	*	*	5
Cooper/Eromanga	1	1	2	18
Gippsland, Bass	18	10	5	49
Perth, Carnarvon, Browse, Bonaparte	9	47	6	1088
Total	28	58	13	1171

(a) preliminary - subject to revision * refers to volumes less than 1

Exploration Potential

BMR assessed Australia's undiscovered crude oil and sales gas resources in 1986. An assessment of undiscovered condensate was made in 1987 and revised in 1988.

The assessment of petroleum resources indicates an 80 percent chance of finding at least another $190 \times 10^6 \text{ m}^3$ (1200×10^6 barrels) of crude oil and a 20 percent chance of finding more than another $460 \times 10^6 \text{ m}^3$ (2900×10^6 barrels). The average of the estimate is $380 \times 10^6 \text{ m}^3$ (2400×10^6 barrels) of crude oil. The gas assessment indicates an 80 percent chance of finding at least another $400 \times 10^9 \text{ m}^3$ (14 TCF) of sales gas and a 20 percent chance of finding more than another $820 \times 10^9 \text{ m}^3$ (29 TCF). The average of the assessment is $650 \times 10^9 \text{ m}^3$ (23 TCF).

The latest condensate assessment indicates an 80 percent chance of finding at least another $50 \times 10^6 \text{ m}^3$ (320×10^6 barrels) of condensate and a 20 percent chance of finding more than another $100 \times 10^6 \text{ m}^3$ (630×10^6 barrels). The average of the assessment is $80 \times 10^6 \text{ m}^3$ (500×10^6 barrels).

The assessments refer to the oil and gas resources, remaining to be discovered in Australia's Phanerozoic sedimentary rocks, that could be

brought into production within the next 20 to 25 years. They exclude new pool discoveries that may be made in Australia's identified fields and accumulations that may occur in deep-water or remote areas along parts of Australia's southern margin and in the offshore territories.

Production

Commercial production of oil began in Australia in 1964, from the Moonie field in the Surat Basin (Fig. 1, Tables 2 and 3; see also Fig. 3). Production from Barrow Island (Carnarvon Basin) began in 1967, and from Bass Strait (Gippsland Basin) in 1969. The Gippsland Basin is the major source of petroleum liquids in Australia and with the completion of a liquids pipeline from Moomba to Stony Point in 1982 and the Jackson to Moonie pipeline in 1983, the Cooper/Eromanga Basins are presently the nation's second largest producer of liquids.

Natural gas was first delivered to Brisbane, Melbourne, and Adelaide in 1969 from the Surat, Gippsland, and Cooper Basins respectively. In 1983 the Palm Valley field in the Amadeus Basin began supplying gas to the Alice Springs power station, and in 1984 North West Shelf gas reached the Perth market to supplement the gas from the Dongara field (Perth Basin) which first supplied gas to Perth in 1971. Since 1976 Sydney has received gas from the Moomba and adjoining fields (Cooper Basin). Other major centres, particularly in Victoria and New South Wales, have also been connected to gas supplies. A 1600 km gas pipeline from Palm Valley supplies gas to the Channel Island power station at Darwin, to Tennant Creek, and to Katherine.

In 1987-88, Australia's crude oil and condensate production was $31.3 \times 10^6 \text{ m}^3$ (197×10^6 barrels), corresponding to an average rate of about $85\,750 \text{ m}^3/\text{d}$ ($540\,000 \text{ bbls/d}$); this was 0.8 percent less than production for the previous year. Production from the Bass Strait fields decreased from 78 percent in the previous year to 73 percent of Australia's total production. This is mainly a reflection of the continuing depletion of the Kingfish and Halibut fields, and the producers' inability to secure satisfactory export sales because of depressed oil prices.

Australia's production of sales gas increased by nearly 4 percent compared to the preceding year while the production of LPG decreased marginally. Imports of crude oil and other refinery feedstock in 1987-88 were valued at \$1 428 million, 42 percent more than the value of imports in 1986-87.

TABLE 2. COMMERCIAL PRODUCTION OF PETROLEUM IN AUSTRALIA, 1987-88(a)

Basin	Crude Oil	Condensate	LPG	Natural Gas (b)
	($\times 10^6 \text{ m}^3$)(c)	($\times 10^6 \text{ m}^3$)(c)	($\times 10^6 \text{ m}^3$)(c)	($\times 10^9 \text{ m}^3$)(c)
Amadeus	0.14	-	-	0.28
Bonaparte	1.34	-	-	-
Bowen/Surat	0.08	0.07	0.10	0.60
Canning	0.04	-	-	-
Carnarvon	1.88	1.17	-	3.63
Cooper/Eromanga	2.84	0.72	0.98	5.26
Gippsland	22.22	0.74	2.84	5.21
Otway	-	-	-	0.01
Perth	<u>0.01</u>	<u>-</u>	<u>-</u>	<u>0.26</u>
Total	28.55	2.71	3.92	15.25(d)

Source: Department of Primary Industries and Energy

(a) Fiscal year ending 30 June 1988.

(b) Commercial sales plus field and plant usage.

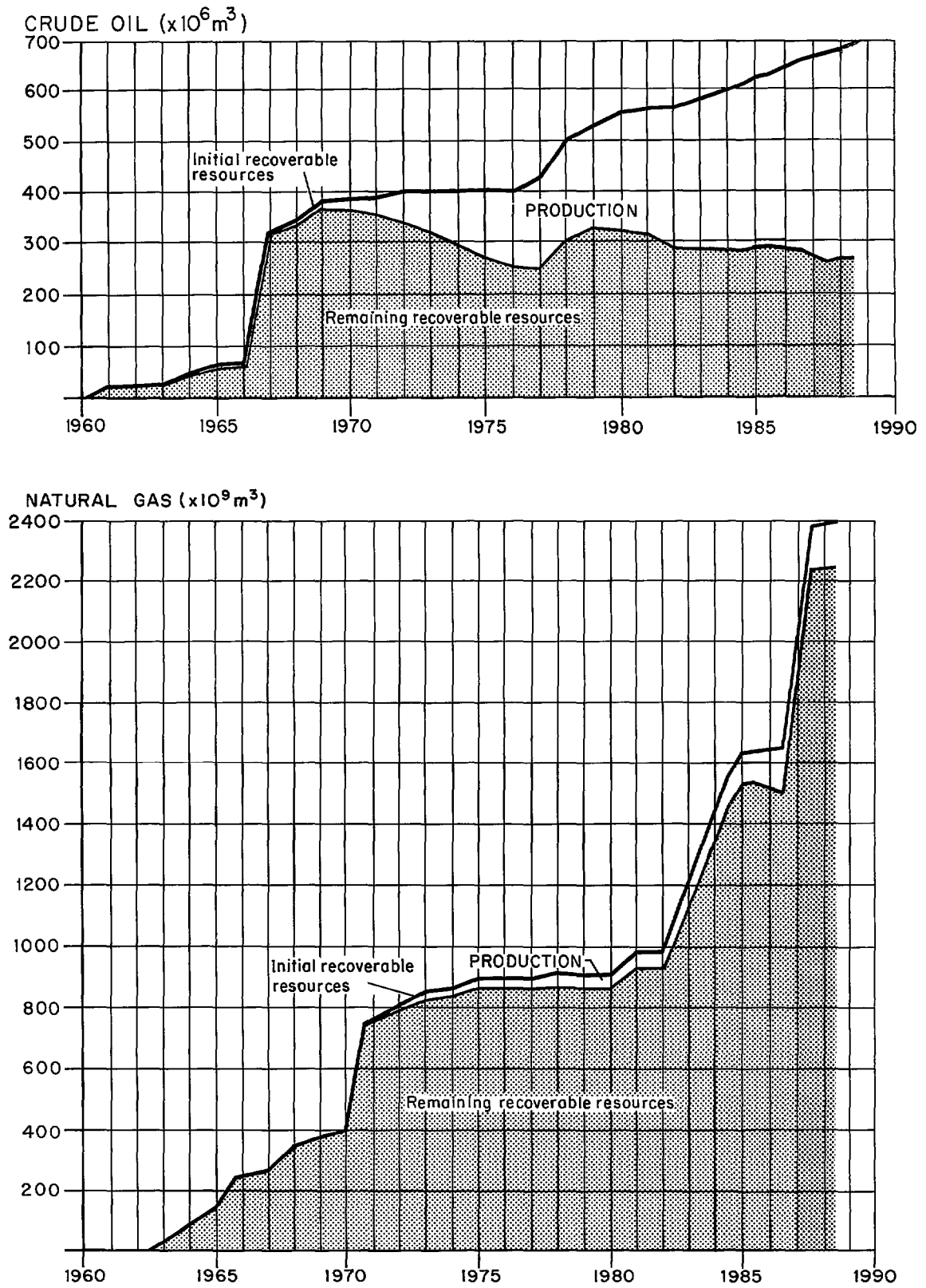
(c) $1 \text{ m}^3 = 6.29 \text{ barrels (liquids), } 35.315 \text{ ft}^3 \text{ (gas).}$

(d) Production of sales gas was $13.90 \times 10^9 \text{ m}^3$.

TABLE 3. CUMULATIVE COMMERCIAL PRODUCTION OF PETROLEUM IN AUSTRALIA TO 30 JUNE 1988

Basin	Crude Oil	Condensate	LPG	Natural Gas (a)
	($\times 10^6 \text{ m}^3$)	($\times 10^6 \text{ m}^3$)	($\times 10^6 \text{ m}^3$)	($\times 10^9 \text{ m}^3$)
Amadeus	0.57	-	-	0.45
Bonaparte	2.08	-	-	-
Bowen/Surat	4.06	0.39	0.38	6.59
Canning	0.23	-	-	-
Carnarvon	37.47	2.33	0.06	13.68
Cooper/Eromanga	12.82	4.05	6.10	53.68
Gippsland-Otway	379.01	10.77	46.03	73.97
Perth	<u>0.16</u>	<u>0.06</u>	<u>-</u>	<u>12.44</u>
Total	436.40	17.60	52.57	160.81

(a) Commercial sales plus field and plant usage.



14-1/34

Fig. 3. Australia's demonstrated recoverable resources of crude oil and natural gas. Remaining recoverable resources at 30 June 1987 were: crude oil 260 million m^3 ; (natural gas) sales gas 2236 billion m^3 .

SUMMARY OF PETROLEUM EXPLORATION IN 1988

Statistics relating to petroleum exploration and development activity in recent years are given in Table 4 and Figure 4. Discoveries of petroleum in 1988 are listed in Table 5.

Preliminary data indicate that about \$430 million were spent on exploration in 1988, compared with \$353 million in 1987 and \$429 million in 1986. A total of 291 wells were drilled in 1988 of which 243 were exploration wells. 211 wells were drilled onshore and 32 were drilled offshore.

Onshore exploration drilling was concentrated in the Eromanga Basin and its infrabasins - Adavale, Cooper, Galilee, and Pedirka Basins - in which 124 (59 percent) of the onshore exploration wells were drilled. Other onshore exploration wells were drilled in the Amadeus (1 well), Bonaparte (3 wells), Bowen/Surat (28 wells), Canning (11 wells), Carnarvon (10 wells), Carpentaria (8 wells), Eucla (1 well), Georgina (4 wells), Gippsland (2 wells), Laura (1 well), McArthur (7 wells), Otway (4 wells), and Perth (7 wells) Basins. Onshore exploration drilling resulted in 20 oil discoveries, 18 gas discoveries, 5 gas/condensate discoveries, 1 oil/gas discovery and 1 oil/gas/condensate discovery. Extensions to known fields in the Bowen/Surat, Canning, Carnarvon and Cooper/Eromanga Basins were proved by the appraisal drilling.

The Cooper/Eromanga Basins region continued to be the most active onshore exploration area in 1988. 33 of the 45 onshore petroleum discoveries were in this region. Other onshore petroleum discoveries were in the Bonaparte (2), Bowen/Surat (7), Canning (2) and Otway (1) Basins.

Offshore exploration drilling was undertaken in the Bonaparte (19 wells), Carnarvon (11 wells) and Gippsland (2 wells) Basins. Offshore exploration drilling resulted in three oil, one gas, four oil/gas and one gas/condensate discoveries. Appraisal drilling was carried out in the Bonaparte and Carnarvon Basins at the Cassini, Challis, Petrel, Puffin, Skua, Bambra and Saladin fields. The appraisal drilling at Cassini failed to encounter the oil accumulation discovered by Cassini No. 1. Appraisal drilling at the Challis and Petrel fields in the Bonaparte Basin and at the Bambra and Saladin fields in the Carnarvon Basin further upgraded the reserves in these fields. Further drilling at Puffin and Skua fields recovered only small amounts of hydrocarbons. A new field wildcat, Oliver No. 1, drilled 35 km north of the Jabiru oil field, was not tested, but

showed log indications of a 165 m gas column overlying a 6-18 m oil column.

Preliminary estimates of seismic survey activity in 1988 (Table 4) indicate that a total of 50 323 line km was surveyed - 36 918 line km offshore and 13 405 line km onshore. These figures are 48 percent higher and 24 percent lower respectively than in 1987.

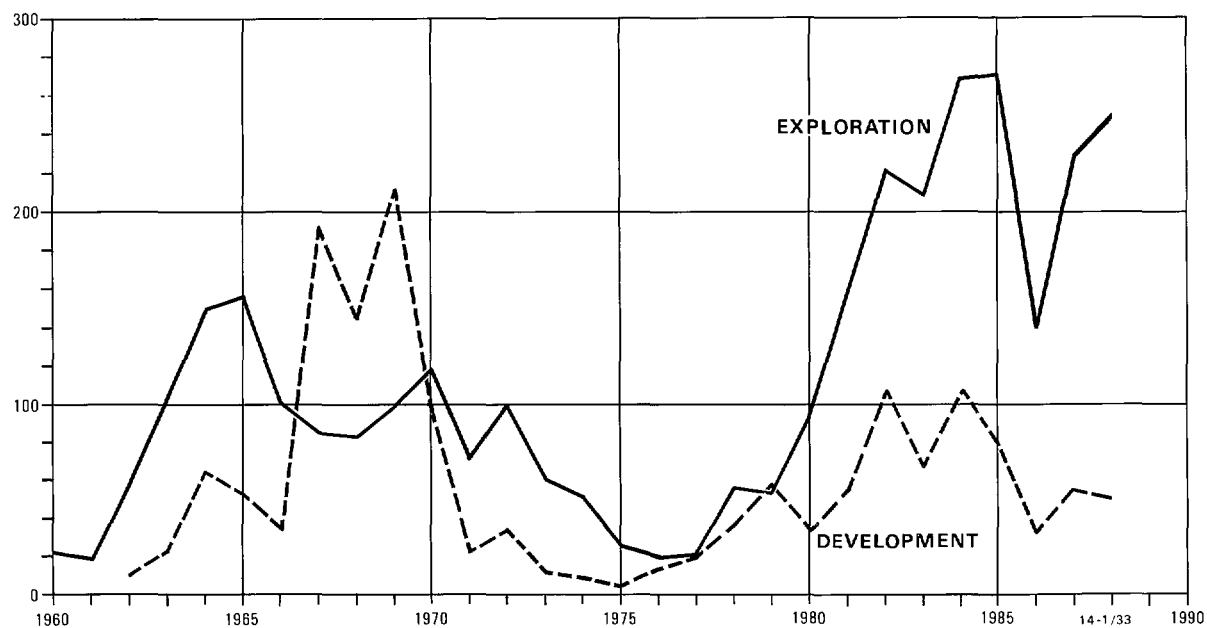
The total number of drilling rigs in Australia at the end of 1988 was 52, one more than at the end of 1987. The number of land rigs, including those used on offshore production platforms, numbered 43, i.e two rigs less than in the previous year. The number of offshore drilling vessels increased to nine at the end of 1988. Rig availability both onshore and offshore is not expected to be a factor limiting exploration drilling in 1989.

TABLE 4. PETROLEUM EXPLORATION AND DEVELOPMENT EXPENDITURE
AND ACTIVITY, 1976-88

Exploration expenditure (\$ million)	Development (including production) expenditure (\$ million)	Seismic surveys (line-km)	Exploration wells drilled	Development wells drilled
1976 49	94	94200	19	13
1977 82	114	11600	21	20
1978 112	216	44421	55	37
1979 222	236	41539	52	57
1980 290	358	55445	94	33
1981 458	944	74438	158	55
1982 957	1263	95253	221	108
1983 731	1022	38761	209	66
1984 748	734	61941	264	109
1985 784	1065	90169	270	94
1986 429	936	47353	139	37
1987 353	2068	42527	229	53
1988(a)430	1800	50323	243	48

(a) Preliminary

Number of wells



Number of wells

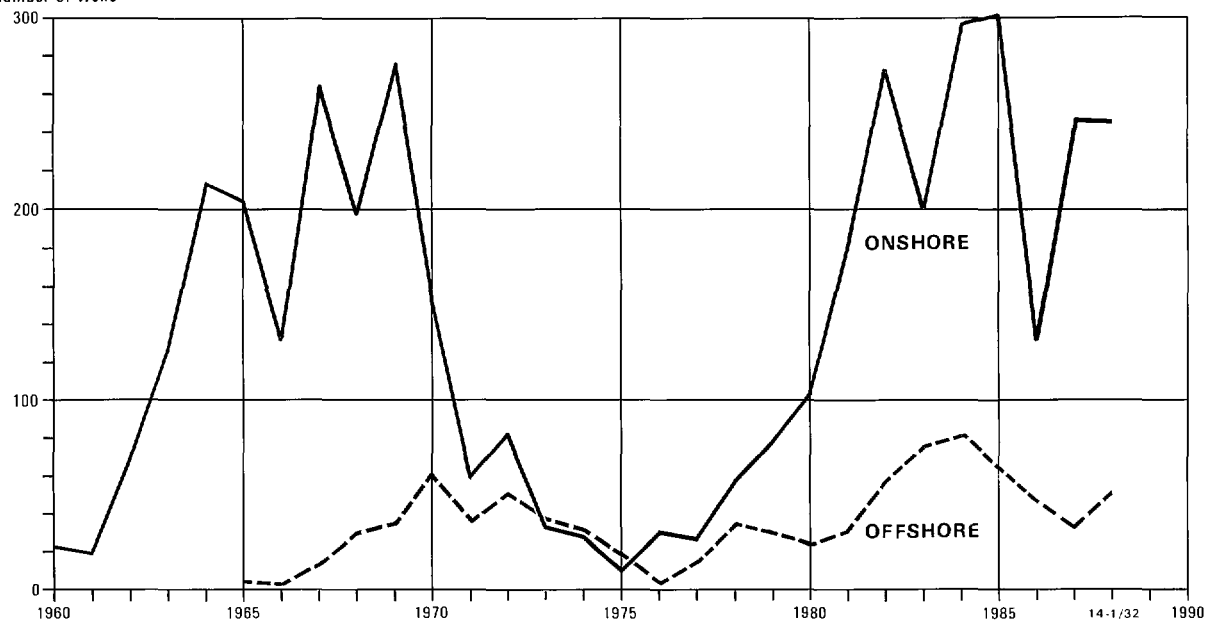


Fig. 4. Petroleum exploration and development, onshore and offshore wells drilled in Australia 1960-1988.

SUMMARY OF PETROLEUM DEVELOPMENT IN 1988

The level of development drilling activity in 1988 was about 10 percent lower than in 1987. A total of 48 development wells were drilled - 32 onshore and 16 offshore. Development and production expenditure is estimated to be about \$1800 million.

Of the 32 onshore development wells completed, 24 were in the Cooper/Eromanga Basins, five were in the Bowen/Surat Basins and three were in the Perth Basin. Of the 16 offshore wells completed, nine were in the Bream field in the Gippsland Basin, two were in each of the North Rankin and South Pepper fields in the Carnarvon Basin and the Challis field in the Bonaparte Basin, and one well was drilled in the Jabiru field in the Bonaparte Basin.

Queensland

Contracts have been let for the supply of steel pipe for the gas pipeline to connect Queensland Alumina Limited's refinery at Gladstone with the Denison Trough and the Wallumbilla field in the Surat Basin. It is expected that construction of the pipeline will start in March 1989 and gas will be supplied to Gladstone in October 1989.

The first stage of duplicating parts of the Roma-Brisbane natural gas pipeline has been completed. New sections of pipeline, totalling 71 km, parallel the existing pipeline and increase the capacity of the pipeline to supply natural gas to Brisbane by ten percent.

A spur pipeline linking the Cooroo, Watson and Tickalara fields in the Cooper/Eromanga Basins was due to be completed in January 1989. Operators expect that the pipeline will reduce production costs and encourage more exploration in the area.

A pilot project, which involved the drilling of ten wells, to investigate the commercial viability of production of methane gas from coal beds near Moranbah was considered to be successful by the operators. Plans were announced for coal-derived methane gas from the Bowen Basin to be used in an ammonia chemical plant to be built near Moranbah. It is anticipated that 30-50 wells will be required to provide the $5 \times 10^6 \text{ m}^3/\text{d}$ ($176 \times 10^6 \text{ ft}^3/\text{d}$) of gas required in the long term.

The Queensland Government has endorsed the proposal to sell natural gas, from the Queensland part of the Cooper/Eromanga Basins, to South Australia. If the proposal is implemented it will encourage further exploration in the area. However the Queensland Government considers that additional reserves will need to be proved up to ensure supplies are available for Queensland's needs. Condensate associated with the natural gas would be transported to Brisbane via the Jackson-Moonie-Brisbane pipeline, for processing in Queensland.

Victoria

Development drilling from the Bream Platform is continuing. The field is producing more than $2100 \text{ m}^3/\text{d}$ (13 000 bbls/d) from six of the eight wells already drilled.

The small Perch and Dolphin fields will be included in the program to develop several small oil fields in the Gippsland Basin. Unmanned, single well 'Monotowers', which have been developed recently, will be used to bring these fields into production. The oil from these fields will flow through a 47 km pipeline for processing at the Longford plant. The Perch and Dolphin fields, and the other small fields to be developed - Whiting, Tarwhine and Seahorse - have the capacity to produce oil at a peak rate of $4000 \text{ m}^3/\text{d}$ (25 000 bbls/d).

The upgrading of the Marlin, Halibut, and Kingfish A and B production platforms is continuing. Massive tubular steel struts are being attached to the western side of each platform, and fixed to the seabed with driven piles.

South Australia

Construction commenced on South Australia's second oil refinery at Port Bonython. The refinery will have a capacity of $1600 \text{ m}^3/\text{d}$ (10 000 bbls/d) and is expected to produce its first petroleum products in 1989.

Western Australia

Commissioning work is underway on some sections of the North West Shelf LNG project. The first of three LNG trains is expected to start up in October 1989, and the second before the end of 1989. By 1993 all three trains should be on stream, allowing exports to Japan to rise to 6 mt/yr. Contracts have been awarded for the design of the Goodwyn 'A' gas

production facility. However development work on this stage of the project is to be reviewed in early 1989.

Wells have been drilled from Thevenard Island, using directional drilling techniques, to produce oil from the Saladin field. The oil field is scheduled to come on stream in June 1989 with a production rate of about 9500 m³/d (60 000 bbls/d).

A natural gas liquid plant, which is under construction on Varanus Island is due to start operating in March 1989. The plant is planned to use gas, associated with production from the Rosette and Harriet oil fields, to produce propane at a rate of 40 t/d for Western Australian markets. Butane and condensate will be spiked back into oil storage tanks on Varanus Island.

Production facilities are being constructed for the Talisman oil field. It is planned to produce the oil, through a sub-sea tree linked to a floating production storage and off-loading vessel, at a rate of 1600 m³/d (10 000 bbls/d), commencing during the first quarter of 1989.

An LPG plant began production at Kwinana in October. The plant was designed to strip propane and butane only from North West Shelf gas. It is now planned to add an ethane extraction unit to supply ethylene to a new petrochemical plant planned to start operation in 1991, and produce caustic soda, ethylene, ethylene dichloride and vinyl chloride monomer for other markets.

Northern Territory

Production from the Jabiru oil field was increased from the rate of about 2500 m³/d (16 000 bbls/d) to a rate of about 7200 m³/d (45 000 bbls/d) at the end of 1988. Proposals have also been made to develop the Challis oil field, south of the Jabiru field in the Timor Sea, to commence production in late 1989. A floating production facility will be used to produce oil at a rate of about 4600 m³/d (29 000 bbls/d).

Additional drilling on the Petrel gas field provided a better understanding of the reserves in the field and their possible deliverability. Development of the Petrel field and an associated LNG project depends on the emergence of a market for the LNG.

Further developments underway include reticulation of natural gas in Alice

Springs, and manufacture of LNG in Alice Springs, mainly for delivery to Yulara for power generation, and supply of electricity to the Cosmo Howley gold mine. The Northern Territory and Federal Governments are reported to be examining a proposal for a gas-to-petrol conversion plant to be built in Darwin. A feasibility study on the project is being carried out to provide additional information to the two governments. Gas for the plant would be supplied from the Mereenie and Palm Valley gas fields which are already providing gas to Darwin power stations.

MAJOR ACTIVITIES IN 1988

Onshore Basins

Amadeus Basin (NT)

Undandita No. 2, the first exploration well in the basin since 1985, was plugged and abandoned after encountering minor non-commercial gas shows. Gosses Bluff No. 2 was being drilled in the crater of the Gosses Bluff impact structure at the end of the year. Gosses Bluff No. 1, the only other well on the structure, was drilled in 1965.

No development or appraisal drilling was undertaken, but the effect that horizontal drilling may have on oil flow rates in the Mereenie field was examined.

Bonaparte Basin (NT)

Three wells, Garimala No. 1, Weaber No. 2 and Weaber No. 2A, were drilled. Garimala No. 1, which was drilled 5.2 km southeast of Ningbing No. 1, produced gas at a rate of 21 240 m³/d (750 x 10³ ft³/d) from a test of the Devonian Cockatoo Formation.

Weaber No. 2A was drilled after Weaber No. 2 was plugged and abandoned due to mechanical difficulties. Weaber No. 2A, which was drilled 2.4 km west-northwest of the Weaber No. 1 gas discovery, produced gas on test at a rate of 3790 m³/d (134 x 10³ ft³/d) from a sand in the Carboniferous Milligan Beds. This sand was not developed in Weaber No. 1. The gas was considered non-commercial and the well was plugged and abandoned.

Bowen/Surat Basins (Qld, NSW)

The level of exploration drilling in these basins was significantly lower than in 1987, and only 11 exploration wells were drilled. Three new fields, the Beechwood, Tinker and Walpanara gas fields, were found. Two wells drilled in the Arbroath Trough west of the Roma Shelf, were the first wells drilled in the trough for several years.

A total of 17 appraisal and five development wells were drilled. Three new pool discoveries were made in the Bowen Basin sequence, and one new pool discovery was made in the Surat Basin. The appraisal activity mainly

centred on the Taylor field, where five wells successfully intersected the oil leg that was first encountered in Taylor No. 4, located south of Taylor No. 1. Gas and condensate flowed in Taylor No. 7.

The first ten wells, planned to test the feasibility of recovering methane from coal beds in the northern Bowen Basin, have been successfully completed.

Canning Basin (WA)

Ten new field wildcat wells were drilled, and minor amounts of oil were recovered on test from two of the wells, Crimson Lake No. 1 and Leo No. 1. Crimson Lake No. 1, drilled on the Lennard Shelf, 3.5 km northwest of Ellendale No. 1, produced 80 l (0.5 bbl) of 37.9° API oil from a DST in the Permian Grant Formation. Leo No. 1, drilled in the Willara sub-Basin, 3.2 km southeast of Cudalgarra No. 1, produced small amounts of oil on test from the Ordovician Nita and Willara Formations at rates too small to measure.

An appraisal well, Mirbelia No. 2, drilled 130 m north-northeast of Mirbelia No. 1, did not find any hydrocarbons.

The new field wildcat wells and the appraisal well were all plugged and abandoned.

Carnarvon Basin (WA)

One new field wildcat well was drilled. Ward Reef No. 1, drilled on Thevenard Island was plugged and abandoned without encountering any hydrocarbons.

A new drilling program commenced on Barrow Island. Nine wells were drilled to test objectives in the Muderong Shale. Two of these wells were drilled deeper to test objectives in the Jurassic sequence.

Carpentaria Basin (Qld)

A program of 944 km of seismic surveys was carried out to detail possible drilling prospects. One new field wildcat well was drilled near Weipa in Cape York Peninsula, and three wells were drilled in the southern part of the basin. The four wells tested structural traps but failed to find hydrocarbons.

The Queensland Department of Mines completed four stratigraphic wells as part of a stratigraphic drilling and coring program in widely separated areas of Cape York Peninsula and the southern part of the basin.

Cooper/Eromanga Basins (Qld, SA)

Exploration activity remained at a high level in the Cooper and overlying Eromanga Basins, where a total number of 110 wells were drilled. The number of exploration wells in South Australia was about the same as in Queensland, but the number of appraisal wells in South Australia was almost double that in Queensland.

A total of 20 new field discoveries were made in the 50 exploration wells drilled. This is a discovery rate of 1 : 2.5 for 1988. The discoveries were mainly oil discoveries in the Eromanga Basin sequence. However oil was also discovered in the Triassic Lamdina Beds in the Cooper Basin sequence in James No. 1, and oil, gas and condensate flowed from the Permian Tirrawarra Sandstone in Narie No. 1. Gas and gas/condensate discoveries were all in the Cooper Basin sequence. Hydrocarbons were found in tests of more than one formation in several fields.

The most interesting discoveries in the Cooper Basin region during 1988 were made in the Lake Hope area near the western margin of the basin. Oil was discovered in the Eromanga Basin sequence in four new fields in that sparsely drilled part of the basin. They are the westernmost fields discovered in each of the Cooper/Eromanga Basins area to date. Oil flowed from three or more pools in each of the Sturt, Taloola and Tantanna fields. The discovery of the multiple pools, which have high flow rates, and the relative proximity of the fields to established pipeline facilities have greatly enhanced the prospectivity of the area. The James No. 1 discovery well is also near the western margin of the Cooper Basin, in a sparsely drilled area northeast of the Lake Hope wells. Appraisal drilling was largely successful and new pools were found in 11 fields. New gas pools were found below the main producing pools in the Moomba field. Gas flowed in Moomba No. 57 from a reservoir below the recognized field-wide gas/water contact in the Permian Toolachee Formation. Oil flowed from the Toolachee Formation in Naccowlah South No. 11. This was the first oil to flow to the surface from the Permian sequence in the Queensland part of the Cooper Basin. Oil was recovered from the same formation in Naccowlah South No. 10 but no flow was recorded. A new pool discovery was made in the Toolachee Formation in Wackett No. 3 on the

flank of the Jackson- Naccowlah-Pepita (J-N-P) Trend. The well, a 7 km stepout from the discovery well, was the first deliberate test of the downflank Toolachee Formation onlapping anticlines along the J-N-P Trend.

Eromanga Basin (Qld)

An extensive drilling program commenced in the Eromanga Basin west of the northern part of the Galilee Basin, where five wells were drilled. The wells all intersected basement at shallow depths and were plugged and abandoned without shows of hydrocarbons. Results were also disappointing in wells in the southern Eromanga Basin area, south of the Adavale and Cooper Basins. Spring Creek No. 1 on the Cheepie Shelf and Titheroo No. 1 on the Thargomindah Shelf failed to find hydrocarbons and were plugged and abandoned.

Eucla Basin (SA)

Denman North No. 1 was terminated because of mechanical problems before the Tertiary target was reached.

Galilee/Eromanga Basins (Qld)

Denbigh Downs No. 1 and Waiora No. 1 near the western margin of the northern part of the Galilee Basin, Cairnhope No. 1 in the central northern part of the Galilee Basin, and Barwinock No. 1 in the southern part of the Galilee Basin overlying the Adavale Basin were plugged and abandoned after failing to find hydrocarbons.

Georgina Basin (Qld, NT)

Four stratigraphic wells were drilled in the southern end of the basin. Phillip No. 2, the deepest hole, was abandoned at 1493 m because of mechanical difficulties. The drilling results have not been released.

Gippsland Basin (Vic)

Wonga Binda No. 1 and Macalister No. 1 were plugged and abandoned after failing to find hydrocarbons.

Laura Basin (Qld)

The Queensland Department of Mines drilled a stratigraphic well, GSQ

Ebagoola No. 1, in the onshore depocentre of the basin. The well was plugged and abandoned without finding hydrocarbons after bottoming in indurated sediments of possible Permian age.

McArthur Basin (NT)

Seven stratigraphic wells were drilled to test the sedimentary sequence in the central part of the McArthur Basin. Atree No. 2, the deepest hole, was drilled to a depth of 1700 m. The drilling results have not been released.

Otway Basin (Vic, SA)

Four exploration wells were drilled. Iona No. 1, drilled in the Port Campbell Embayment 6 km south-southeast of the North Paaratte gas field, discovered an 18 m thick gas column in the Waarre Sandstone. A gas flow of 230 000 m³/d (8.1×10^6 ft³) was obtained on a DST. The well has been completed as a gas producer. Calista No. 1, also in the Port Campbell Embayment, was plugged and abandoned after failing to find hydrocarbons in the Waarre Sandstone. Compton No. 1 was drilled in the Gambier Embayment to test the hydrocarbon potential of the Pebble Point Formation and the Waarre Sandstone, and Lake Hawdon No. 1 was drilled to test the Pretty Hill Sandstone. Both wells were plugged and abandoned after failing to find hydrocarbons.

Katnook No. 2 was being drilled in the Penola Trough in South Australia at the end of the year as an appraisal well in the Katnook gas field, which was discovered in 1987.

Pedirka Basin (SA, NT)

Three new field wildcat wells were drilled. Dalmatia No. 1 was drilled in the centre of the basin, Lake View No. 1 was drilled in the southern part of the basin, and Beachcomber No. 1 was drilled in the northern part. The wells were plugged and abandoned without encountering any hydrocarbons.

Perth Basin (WA)

Seven new field wildcat wells were drilled in the northwestern part of the basin. Conder No. 1 and Connolly No. 1, drilled approximately 15 km north of the Mount Horner oil field, encountered oil shows at shallow depth. Oil was found in basal Triassic sandstone over an 11 m interval from a depth

of 201 m in Conder No. 1, and in the Jurassic Cadda Formation over a 9 m interval from a depth of 206 m in Connolly No. 1. Wakeford No. 1, drilled 30 km northwest of the Mount Horner oil field, encountered basement at a depth of 27 m. The wells were all plugged and abandoned.

Development drilling continued in the Mount Horner oil field. Mount Horner Nos. 5A, 8 & 9 were drilled and Mount Horner No. 6 was re-entered and completed for production.

TABLE 5. DISCOVERIES OF PETROLEUM - 1988 (a)

BASIN	WELL NAME	OPERATOR	STATE	NATURE OF DISCOVERY	PRODUCING FORMATION	CLASSI- FICATION	REMARKS
ONSHORE							
Bonaparte							
	Garamila 1	Santos	NT	Gas	Cockatoo Fm	NFD	DST flowed 21 240m ³ /d. P&A.
	Weaber 2A	Santos	NT	Gas	Milligan Beds	NPD	DST flowed 3 790m ³ /d. P&A.
Bowen/Surat							
	Beaufort 6*	CSR	Qld	Gas	Showgrounds Ss	NPD	Flowed gas at 50 971m ³ /d. Completed in Precipice Ss and Showgrounds Ss.
	Beechwood 2	Bridge	Qld	Gas/cond	Showgrounds Ss	NFD(b)	Flowed gas at 127 400 m ³ /d and condensate at 22.9m ³ /d.
	Carbean 5	Hartogen	Qld	Gas	Boxvale Ss Mbr	NPD	Boxvale Ss Mbr flowed gas at 2407m ³ /d. Completed in basal Evergreen Fm only.
	Parknook 2	Hartogen	Qld	Gas	Blackwater Gp	NPD(b)	Blackwater Gp flowed gas at 326m ³ /d. Completed in Rewan Fm only.
	Pine Ridge 15	CSR	Qld	Gas	Showgrounds Ss	NPD	Flowed gas at 104 800m ³ /d.
	Tinker 1	Bridge	Qld	Gas	Showgrounds Ss	NFD	Flowed gas at 2 580m ³ /d.
				Gas	Rewan Fm	NFD	
	Walpanara 1	Hartogen	Qld	Gas	Blackwater Gp	NFD	Flowed gas at 185 800m ³ /d.
Canning							
	Crimson Lake 1	Kufpec	WA	Oil	Grant Fm	NFD	DST recovered 80 l. P&A

TABLE 5. DISCOVERIES OF PETROLEUM - 1988 (a) (cont'd)

BASIN	WELL NAME	OPERATOR	STATE	NATURE OF DISCOVERY	PRODUCING FORMATION	CLASSI- FICATION	REMARKS
Canning (cont'd)							
	Leo 1	Command	WA	Oil	Nita Fm Willara Fm	NFD	DST recovered oil at rate too small to measure. P&A.
Cooper/Eromanga							
	Arrakis 1	Santos	SA	Gas Oil	Epsilon Fm Birkhead Fm	NFD NFD(b)	Epsilon Fm flowed gas at 218 000m ³ /d. Birkhead Fm recovered 8.7m ³ oil. Completed for gas production only.
	Bobs Well 1	Santos	SA	Gas	Patchawarra Fm	NFD	Flowed gas at 39 600m ³ /d.
	Epsilon 4	Delhi	Qld	Gas	Toolachee Fm	NPD(b)	Flowed gas at 7362m ³ /d. Completed for gas production in Patchawarra Fm only.
	Epsilon 5	Delhi	Qld	Oil	Namur Ss Mbr	NPD	Recovered 385.9m ³ oil.
	Gumla 1	Lasmo	Qld	Oil Oil	Birkhead Fm Hutton Ss	NFD(b) NFD(b)	Birkhead Fm recovered 2.8m ³ oil and Hutton Ss recovered 0.8m ³ oil. P&A.
	James 1	Santos	SA	Oil	Lamdina Beds	NFD	First discovery in this formation. Flowed oil at 288m ³ /d.
	Jena 2	Santos	SA	Oil	McKinlay Mbr	NPD(b)	Recovered 540m oil in DST. Completed for oil in Murta Mbr.
	Karmona 2	Delhi	Qld	Gas	Toolachee Fm	NPD(a,b)	P&A.
	Karri South 1	Delhi	Qld	Gas/cond	Patchawarra Fm	NFD	Flowed gas at 98 000m ³ /d and condensate at 2.4m ³ /d. Completed for gas production only.

TABLE 5. DISCOVERIES OF PETROLEUM - 1988 (a) (cont'd)

BASIN	WELL NAME	OPERATOR	STATE	NATURE OF DISCOVERY	PRODUCING FORMATION	CLASSI- FICATION	REMARKS
Cooper/Eromanga (cont'd)							
	Kirrilee 1	Santos	SA	Gas	Epsilon Fm	NFD	Epsilon Fm flowed gas at 82 100m ³ /d.
				Gas	Patchawarra Fm	NFD(b)	Patchawarra Fm flowed gas at 53 800m ³ /d. Completed in Epsilon Fm only.
	Kudrieke 2	Santos	SA	Gas/cond	Toolachee Fm	NPD	Flowed gas at 147 000m ³ /d and condensate at an indeterminate rate. Completion to be determined.
	Kujani 1	Santos	SA	Gas/cond	Patchawarra Fm	NFD	Flowed gas at 109 000m ³ /d and condensate at 15.6m ³ /d. Completed for gas production only.
	Massy 1	Santos	SA	Gas	Toolachee Fm	NFD	Flowed gas at 90 000m ³ /d.
	Milkryna 1	Delhi	Qld	Oil	Murta Mbr	NFD(b)	Recovered 28m oil from Murta Mbr and
				Oil	Namur Ss Mbr	NFD(b)	18m oil from Namur Ss Mbr. P&A.
	Moomba 58	Santos	SA	Gas	Patchawarra Fm	NPD(b)	Flowed gas at 31 100m ³ /d. Completed in Toolachee Fm only for gas production.
	Munro 1	Delhi	Qld	Oil	Hutton Ss	NFD	Flowed oil at 8.3m ³ /d.
	Narie 1	Santos	SA	Oil/Gas/cond	Tirrawarra Ss	NFD	Completed for oil and gas in Tirrawarra Ss
				Gas	Patchawarra Fm	NFD	and gas in Patchawarra Fm. Tirrawarra Ss
				Gas	Toolachee Fm	NFD(b)	flowed gas at 134 000m ³ /d and condensate at 196m ³ /d, and gas at 40 200m ³ /d and condensate at 45m ³ /d from two separate reservoirs.
	Natan 1	Delhi	Qld	Oil	Hutton Ss	NFD	Flowed oil at 38.2m ³ /d from Hutton Ss and
				Oil	basal Jurassic	NFD	7.3m ³ /d from basal Jurassic.
	Pitchery 1	Delhi	Qld	Oil	Murta Mbr	NFD	Flowed oil at 79.2 m ³ /d.
	Spencer 7*	Santos	SA	Oil	Birkhead Fm	NPD	Recovered 40m ³ from Birkhead Fm and
				Oil	Hutton Ss	NPD	160.3m ³ /d from Hutton Ss.

TABLE 5. DISCOVERIES OF PETROLEUM - 1988 (a) (cont'd)

BASIN	WELL NAME	OPERATOR	STATE	NATURE OF DISCOVERY	PRODUCING FORMATION	CLASSI- FICATION	REMARKS
Cooper/Eromanga (cont'd)							
	Sturt 1	Santos	SA	Oil	Birkhead Fm	NFD	Flowed oil at 216.2m ³ /d.
	Sturt 2	Santos	SA	Oil	Poolowanna Fm	NPD	Flowed oil at 373.6m ³ /d.
	Sturt 3	Santos	SA	Oil	Poolowanna Fm	NPD	Recovered 792m oil. Completed in Birkhead Fm and Poolowanna Fm.
	Sturt East 1	Santos	SA	Oil	Poolowanna Fm	NFD	Flowed oil at 381.6m ³ /d.
	Taloola 1	Santos	SA	Oil	Namur Ss Mbr	NFD	Flowed oil at 254.4m ³ /d.
	Taloola 2	Santos	SA	Oil	Poolowanna Fm	NPD	Flowed oil at 180m ³ /d from Poolowanna Fm
				Oil	Hutton Ss	NPD(b)	and 97.4m ³ /d from Hutton Ss. Completed for oil in Namur Ss Mbr and Poolowanna Fm.
	Tantanna 1	Santos	SA	Oil	Namur Ss Mbr	NFD	Flowed oil at 360m ³ /d from Namur Ss Mbr,
				Oil	Hutton Ss	NFD	505m ³ /d from Hutton Ss and 303m ³ /d from
				Oil	Poolowanna Fm	NFD	Poolowanna Fm.
	Tantanna 3	Santos	SA	Oil	Birkhead Fm	NPD(b)	Flowed oil at 407m ³ /d. Completed in Namur Ss Mbr and Hutton Ss.
	Tarbat 1	Hartogen	Qld	Oil	Wyandra Ss Mbr	NFD	Flowed oil at 218.6m ³ /d
	Thoar 1	Delhi	Qld	Gas	Toolachee Fm	NFD	Flowed gas at 209 500m ³ /d.
	Varanus 1	Santos	SA	Gas	Patchawarra Fm	NFD	Flowed gas at 90 600m ³ /d.
	Varanus 2	Santos	SA	Gas	Patchawarra Fm	NPD	Flowed gas at 55 200m ³ /d.
	Wackett 3	Delhi	Qld	Gas/cond	Toolachee Fm	NPD	Flowed gas at 249 200m ³ /d and condensate at 3.2m ³ /d. Completed only for gas production.

TABLE 5. DISCOVERIES OF PETROLEUM - 1988 (a) (cont'd)

BASIN	WELL NAME	OPERATOR	STATE	NATURE OF DISCOVERY	PRODUCING FORMATION	CLASSI- FICATION	REMARKS
Otway	Iona 1	Beach	Vic	Gas	Waarre Ss	NFD	Flowed gas at 230 000m ³ /d. Completed as a gas producer

TABLE 5. DISCOVERIES OF PETROLEUM - 1988 (a) (cont'd)

BASIN	WELL NAME	OPERATOR	STATE	NATURE OF DISCOVERY	PRODUCING FORMATION	CLASSI- FICATION	REMARKS
OFFSHORE							
Bonaparte							
	Bilyara 1	BHP	NT	Oil	Jurassic	NFD	Recovered 3.1 l on RFT. P&A.
				Gas	Jurassic	NFD	Recovered 0.5m ³ on RFT.
	Cassini 1	BHP	NT	Oil	Jurassic/Triassic	NFD	Flowed oil at 1210m ³ /d. Suspended.
	Evans Shoal 1	BHP	NT	Gas		NFD	Recovered 12.9m ³ on RFT.
	Montara 1	BHP	NT	Oil	Jurassic	NFD	Flowed oil at 910m ³ /d. Well suspended.
				Gas	Jurassic	NFD	
	Oliver 1	BHP	NT	Oil	Jurassic	NFD	RFT recovered oil and gas.
				Gas	Jurassic	NFD	Well suspended.
	Skua 5	BHP	NT	Oil	Jurassic	NPD	Recovered 4.5 l on RFT. P&A
Carnarvon							
	Echo 1	Woodside	WA	Gas/cond	Triassic	NPD	Production test flowed gas at 439 000m ³ /d
					Triassic	NPD	and condensate at 610m ³ /d.
	Yammaderry 1	WAPET	WA	Oil	Barrow Gp	NFD	Suspended.

TABLE 5. DISCOVERIES OF PETROLEUM - 1988 (a) (cont'd)

BASIN	WELL NAME	OPERATOR	STATE	NATURE OF DISCOVERY	PRODUCING FORMATION	CLASSI- FICATION	REMARKS
Gippsland	Torsk 1	Esso	Vic	Oil	Latrobe Gp	NFD	Recoveries of oil and gas were made on RFTs. P&A.
				Gas	Latrobe Gp	NFD	

(a) Preliminary subject to revision.

(b) Not completed for production formation.

* Development well which made a New Pool Discovery.

NOTE: A discovery is defined here as a well from which any measureable amount of oil or gas has been recovered; no consideration of commerciality is implied. In previous years some discoveries which recovered only small amounts of hydrocarbons were not included in this table.

Offshore Basins

Arafura/Money Shoal Basins (NT)

A 30 705 km aeromagnetic survey was flown over two permits on the western side of the Money Shoal Basin. A seismic survey was in progress at the end of the year.

Bonaparte-Browse Basins (NT, WA)

Fourteen new field wildcat wells were drilled, and significant discoveries were made in three wells. Cassini No. 1, drilled 3.4 km southwest of Challis No. 4, produced oil at a rate of $1210 \text{ m}^3/\text{d}$ (7596 bbls/d) from a test of Jurassic/Triassic reservoir sands. Montara No. 1, drilled in the Vulcan Sub-basin, 23 km southeast of Skua No. 3, produced oil at a rate of $910 \text{ m}^3/\text{d}$ (5736 bbls/d) from a production test over a 5 m interval. Logs from Oliver No. 1, drilled 35 km north of the Jabiru oil field, indicated a 165 m gas column overlying a 6-18 m oil column. However no testing was carried out. The three wells were suspended for further evaluation.

Successful appraisal drilling continued with the drilling of Petrel No. 4 and Skua No. 3. However Cassini No. 2, Puffin No. 4 and Skua Nos. 4 and 5 gave disappointing results, and were plugged and abandoned without finding significant hydrocarbons.

Production drilling continued in the Jabiru and Challis fields.

Carnarvon Basin (WA)

Eight new field wildcat wells were drilled. Three of the wells, Dillson No. 1, Trap Reef No. 1 and Yammaderry No. 1 were drilled offshore, but within Western Australian State waters.

There were two significant discoveries. Echo No. 1, drilled 9.5 km north of Rankin No. 1, produced $439 \times 10^3 \text{ m}^3/\text{d}$ ($15.5 \times 10^6 \text{ ft}^3/\text{d}$) of gas and $610 \text{ m}^3/\text{d}$ (3858 bbls/d) of condensate on testing Triassic reservoirs, similar to those found in the North Rankin and Goodwyn gas/condensate fields. The condensate-to-gas ratio of $1 \text{ m}^3/700 \text{ m}^3$ (254 bbls/ 10^6 ft^3) in Echo No. 1 was the highest of any discovery in Australia.

Yammaderry No. 1, drilled south of the Saladin oil field, was suspended as a future oil producer, after logs indicated hydrocarbon-bearing sands similar to those encountered in the Saladin field.

Bambra No. 3 and Saladin Nos 5 and 7 were successful appraisal wells. The North Rankin-A14 and A15 production wells were drilled in the North Rankin gas/condensate field and South Pepper Nos 6 & 7 production wells were drilled in the South Pepper oil field. The Bambra, Saladin and South Pepper wells were drilled in Western Australian State waters.

Carpentaria Basin (Qld)

Activity in the only active permit in the offshore area at present, in the eastern part of the basin, was confined to reprocessing and evaluating old seismic data from the area.

Gippsland Basin (Vic)

Two new field wildcat wells, were drilled. Oil and gas were recovered from wireline tests of two intervals in Torsk No. 1, and Roundhead No. 1 was plugged and abandoned without finding any hydrocarbons.

Nine development wells were drilled from the Bream platform.

APPENDIX 1

WELLS AND METRES DRILLED - AUSTRALIA 1971 - 88

WELLS DRILLED

Year	EXPLORATION			DEVELOPMENT			TOTALS	
	Onshore	Offshore	Sub-total	Onshore	Offshore	Sub-total	For Year	Cumulative
To 1971	1450	105	1555	772	77	849	-	2404
1972	62	38	100	21	12	33	133	2537
1973	29	31	60	5	6	11	71	2608
1974	20	31	51	8	-	8	59	2667
1975	6	19	25	4	-	4	29	2696
1976	16	3	19	13	-	13	32	2728
1977	8	13	21	18	2	20	41	2769
1978	33	22	55	24	13	37	92	2861
1979	31	21	52	48	9	57	109	2970
1980	77	17	94	26	7	33	127	3097
1981	142	16	158	41	14	55	213	3310
1982	177	44	221	95	13	108	329	3639
1983	160	49	209	40	26	66	275	3914
1984	221	43	264	71	38	109	373	4287
1985	227	43	270	76	18	94	364	4651
1986	111	28	139	17	20	37	176	4827
1987	214	15	229	33	20	53	282	5109
1988*	211	32	243	32	16	48	291	5400

METRES DRILLED

Year	EXPLORATION		DEVELOPMENT		TOTALS	
	Onshore	Offshore	Onshore	Offshore	Yearly	Cumulative
To 1971	1 903 594	332 854	786 015	195 107	-	3 217 570
1972	107 002	117 429	47 365	23 643	295 439	3 513 009
1973	50 301	80 616	11 347	9 644	151 908	3 664 917
1974	37 206	84 078	15 531	-	136 815	3 801 732
1975	12 579	35 658	10 351	-	58 588	3 860 320
1976	32 393	15 119	24 863	-	72 375	3 932 695
1977	23 675	36 827	44 508	6 419	111 429	4 044 124
1978	52 709	56 900	56 332	42 493	208 434	4 252 558
1979	59 635	76 424	44 110	36 612	216 781	4 469 339
1980	137 296	62 012	41 337	27 142	267 787	4 737 126
1981	277 258	45 126	77 602	34 473	434 459	5 171 585
1982	324 288	128 213	154 030	28 379	634 910	5 806 495
1983	273 571	137 472	82 019	86 425	579 487	6 385 982
1984	403 329	113 486	147 294	137 645	801 754	7 187 736
1985	406 967	105 145	125 190	59 816	697 118	7 884 854
1986	204 107	62 093	27 926	65 211	359 337	8 244 191
1987	400 146	37 606	66 412	55 518	559 682	8 803 873
1988*	392 543	91 661	62 419	46 320	592 943	9 396 816

* Preliminary figures subject to revision.

APPENDIX 2

EVENTS IN PETROLEUM EXPLORATION, DEVELOPMENT AND PRODUCTION IN AUSTRALIA

- 1839 Commander Stokes discovers "bitumen", Victoria River NT.
- 1885 Gas discovered in Narrabeen Nos 1 and 2 during search for coal in Sydney Basin, NSW.
- 1892 First exploration drilling for petroleum: Alfred Flat, Coorong area, SA.
- 1900 Roma (Qld) No. 2 town water bore encounters natural gas.
- 1907 First gas appraisal well in Roma, Qld, caught fire in 1908 and extinguished with difficulty.
- 1908 Roma streets lit by gas for 10 days.
- 1920 Rewards offered by the Commonwealth and New South Wales Governments for the discovery of petroleum in commercial quantities.
- 1924 Lakes Entrance oil field discovered (Vic).
- 1926 Petroleum exploration subsidised by the Commonwealth Government for the first time, under the Petroleum Prospecting Act of 1926.
- 1928 Condensate produced commercially in small quantities at Roma.
- 1930 Shafts sunk at Lakes Entrance (Vic) to mine heavy oil
- 1936 Petroleum exploration subsidised by the Commonwealth Government under the Petroleum Oil Search Act of 1936.
- 1953 Rough Range No. 1 (WA) flows oil 550 barrels per day.
- 1954 AAO finds gas in the Hospital Hill field, Roma, Qld.

- 1956 BMR aeromagnetic program in Bass Strait indicates existence of sedimentary basin offshore Gippsland (Vic).
- 1957 Commonwealth Government introduces Petroleum Search Subsidy scheme.
- 1958 BMR seismic survey indicates possible drilling targets at Cabawin and Moonie, Qld.
- 1959 Frome-Broken-Hill's Port Campbell No. 1 (Vic) produces strong gas flow on test.
- 1960 Associated Group discovers Timbury Hills and Pickanjinie gas fields near Roma, Qld.
- 1961 Cabawin No. 1 (Qld), drilled by Union-AOG, discovers significant gas and condensate. Moonie No. 1 (Qld) discovers oil. First sustained commercial use of natural gas in Australia at Roma from Hospital Hill and Timbury Hills gas fields.
- 1963 Associated Group discovers the Richmond oil and gas field near Roma.
- 1964 First offshore well in Australia, Esso Gippsland Shelf No. 1 (later renamed Barracouta No. 1) discovers gas drilling in 46 m of water offshore Victoria (Bass Strait). Santos's Gidgealpa No. 2 discovers gas in the Cooper Basin, SA. Wapet's Barrow Island No. 1 (WA) and Yardarino No. 1 (Perth Basin, WA) discover oil. Mereenie No. 1 (NT) discovers oil and gas. Moonie oil field starts commercial production.
- 1965 Palm Valley No. 1 (NT) discovers gas. Gingin No. 1 (WA) discovers gas.
- 1966 Delhi-Santos discovers the Moomba gas field in Cooper Basin (SA) and Esso/BHP discovers the Marlin gas field offshore Victoria. Dongara No. 1 (WA) discovers gas in the Perth Basin.

- 1967 Esso/BHP discovers major oil fields at Halibut and Kingfish in Bass Strait.
- 1968 Esso/BHP discover the Tuna oil and gas field in Bass Strait. Mondarra No. 1 (WA) discovers gas. Petroleum (Submerged Lands) Act 1967 come into force on 1 April.
- 1969 Roma-Brisbane gas pipeline operational in March. Melbourne supplied with natural gas from Bass Strait fields in April. Adelaide supplied with natural gas from Gidgealpa/Moomba in November. Crude oil production commenced in Bass Strait fields. Esso/BHP discovers Mackerel oil field in Bass Strait.
- 1970 Bridge Oil discovers Tirrawarra oil and gas field in the Cooper Basin SA, and the Boxleigh gas field in the Bowen Basin, Qld.
- 1971 The North Rankin and Scott Reef gas fields and the Rankin and Goodwyn gas and condensate fields on the North West Shelf discovered. Natural gas production from the Dongara field for Perth, Kwinana, and Pinjarra commenced in October. Walyering No. 1 (WA) discovers gas.
- 1972 Delhi/Santos discovers the Dullingari and Della gas fields in the Cooper Basin. Mondarra, Gingin, and Walyering fields began supplying gas into Perth-Kwinana-Pinjarra pipeline.
- 1974 Operations under the terms of the Petroleum Search Subsidy Act terminated with effect from 30 June.
- 1975 Commonwealth Government's "new" oil pricing policy announced on 14 September.
- 1977 Esso/BHP drills Cobia No. 2 in Bass Strait and prepares the well for completion as Australia's first sub-sea completion.
- 1978 Wapet announces further Barrow Island drilling spurred on by "new" oil policy. Delhi/Santos discovers oil in Strzelecki No. 3 in the Eromanga Basin (SA). In Bass Strait Esso Fortescue Nos 2 and 3 confirms Fortescue oil discovery and Seahorse No. 1 discovers oil.

- 1979 Beach Petroleum discovers gas at North Paaratte No. 1 onshore in the Otway Basin. Exploration in the deep water on the Exmouth Plateau starts and Esso makes a major gas discovery in Scarborough No. 1 in 912 m of water. Oil production begins from Cobia No. 2 subsea completion.
- 1980 Beach Petroleum finds gas in Grumby No. 1 and Wallaby Creek No. 1 in the Otway Basin (Vic). Gas discovered at Woodada No. 1 in the Perth Basin (WA).
- 1981 Hudbay Oil discovers oil in West Seahorse No. 1 in Bass Strait. Esso discovers oil in Yellowtail No. 1 and Tarwhine No. 1 in Bass Strait. Delhi finds oil in Jackson No. 1 in Eromanga Basin, Qld. Home discovers oil in Blina No. 1, Canning Basin (WA), and Wapet makes a major offshore gas discovery at Gorgon No. 1 in the offshore Carnarvon Basin (WA). In all there are 8 oil and 20 gas discoveries.
- 1982 North West Shelf gas project construction phase commences. Major gas discovery in deep water at North Scott Reef. Production commenced from Woodada gas field in Perth Basin. Home discovers oil in Sundown No. 1 in Canning Basin.
- 1983 BHP discovers Jabiru oil field in the Bonaparte Basin. Palm Valley (NT) gas supply to Alice Springs commences. First commercial oil production from Blina field (WA). Significant oil discoveries in Harriet No. 1 and South Pepper No. 1, North Herald No. 1, Chervil No. 1 and South Chervil No. 1 near Barrow Island (WA). First shipment of liquids from Cooper/Eromanga Basins to Port Bonython facility in SA. First production of Fortescue oil (Vic). Further oil discoveries in Jackson area (Qld).
- 1984 Record year for total wells drilled - 373. Significant offshore discoveries in Challis, Talisman and Lenita wells. Numerous small oil and gas discoveries in Cooper/Eromanga Basins and) - record flows from Wancoocha No. 2. Oil and gas discoveries in Gippsland Basin at Tuna, Grunter, Manta, Chimaera, West Fortescue and Veilfin. First phase North West Shelf gas completed - Perth market supplied. Oil production commenced

from Jackson to Moonie and Mereenie to Alice Springs. Cooper Basin Liquids Scheme completed (oil, LPG, condensate).

- 1985 Record year for exploration drilling - 270 wells. Cooper/Eromanga Basins record 29 discoveries of oil and gas or both. Significant offshore gas discoveries at Saladin and Montague in the Carnarvon Basin. Oil and gas at Angelfish, Snapper, Whiptail and Whiting in the Gippsland Basin and at Yolla in the Bass Basin. Construction of LNG phase on North West Shelf commenced. New development plans for Bass Strait fields announced - construction of Bream platform underway.

- 1986 Major fall in price of crude oil early in year to half 1985 level results in reduction in exploration and development activities and expenditure. Construction of Palm Valley to Darwin natural gas pipeline completed. Warrnambool supplied by natural gas from nearby North Paaratte gas field in onshore Otway Basin, Vic. Work commenced on Australia's first enhanced oil recovery project at Tirrawarra, SA.

- 1987 Extension/appraisal drilling at Challis and Skua enhanced the prospectivity of the Bonaparte Basin. Record Australian exploration well flow produced from Saladin oil field. Bream production platform installed - thirteenth in Bass Strait. Enhanced oil recovery project established in the Tirrawarra and Moorari fields.

- 1988 Significant discoveries of petroleum made offshore in the Bonaparte Basin at Montara, Cassini and Oliver fields and in the Carnarvon Basin at Yammaderry and Echo fields. Further extension/appraisal drilling at Bamba and Saladin fields and at Petrel and Challis fields enhanced the prospectivity of the Carnarvon and Bonaparte Basins. Potential of northwest section of Cooper Basin enhanced following oil discovery at James No. 1 well. Crude oil production commenced from Bream field in the Gippsland Basin.