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DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

RECORDS:

1967/18

PETROLEUM EXPLORATION PREVIEW FOR 1967

C21076

by

M. A. CONDON

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PETROLEUM EXPLORATION PREVIEW FOR 1967.+

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M. A. CONDON

RECORD 1967/18

ABSTRACT

Exploration for petroleum in Australia paused in 1966 and this pause is likely to continue in 1967.

The number of wells drilled and seismic activity will both be slightly less in 1967 than in 1966 but the work will generally be directed to more specific targets. The cost of exploration will be somewhat higher than in 1966.

During the year off-shore drilling should increase and it is expected that five mobile rigs will be drilling in the off-shore areas by the end of the year. The immediate structural targets available for these rigs are in the Gippsland, Bass and Otway Basins (Victoria - Tasmania), the North-West Shelf and Timor Sea - Bonaparte Gulf, and in the Gulf of Papua.

Onshore exploration will be concentrated in the Western Australian basins, the Surat Basin, the central Great Artesian Basin, and the Gidgealpa region of the south western Great Artesian Basin.

The success or otherwise of the off-shore drilling will determine the rate of exploration over the next few years. If important discoveries are made off-shore, these may and probably would result in more intensive exploration of the same stratigraphic intervals onshore.

The exploration patterns of Australia and several other countries before and after first commercial discovery are compared. This indicates that Australian discovery came early, as compared with other countries, where production has developed since the war, but that post-discovery effort in Australia has been very much less. The main obvious differences appear to be that in Australia the average size of the exploration concession is very much larger and the number of operators (having regard to the areas concerned) is much smaller, than in the other successful countries.

There has been a gradual movement towards reducing the size of operating areas in Australia either by obligatory relinquishment or by farmouts but if discoveries are to be made at a satisfactory rate more operators are needed in every basin.

The economic environment of Australia vis-a-vis Middle East oil and oil markets is probably the main basic reason for the peculiar exploratory pattern, which has impelled the Government to provide financial incentives to encourage exploration and development.

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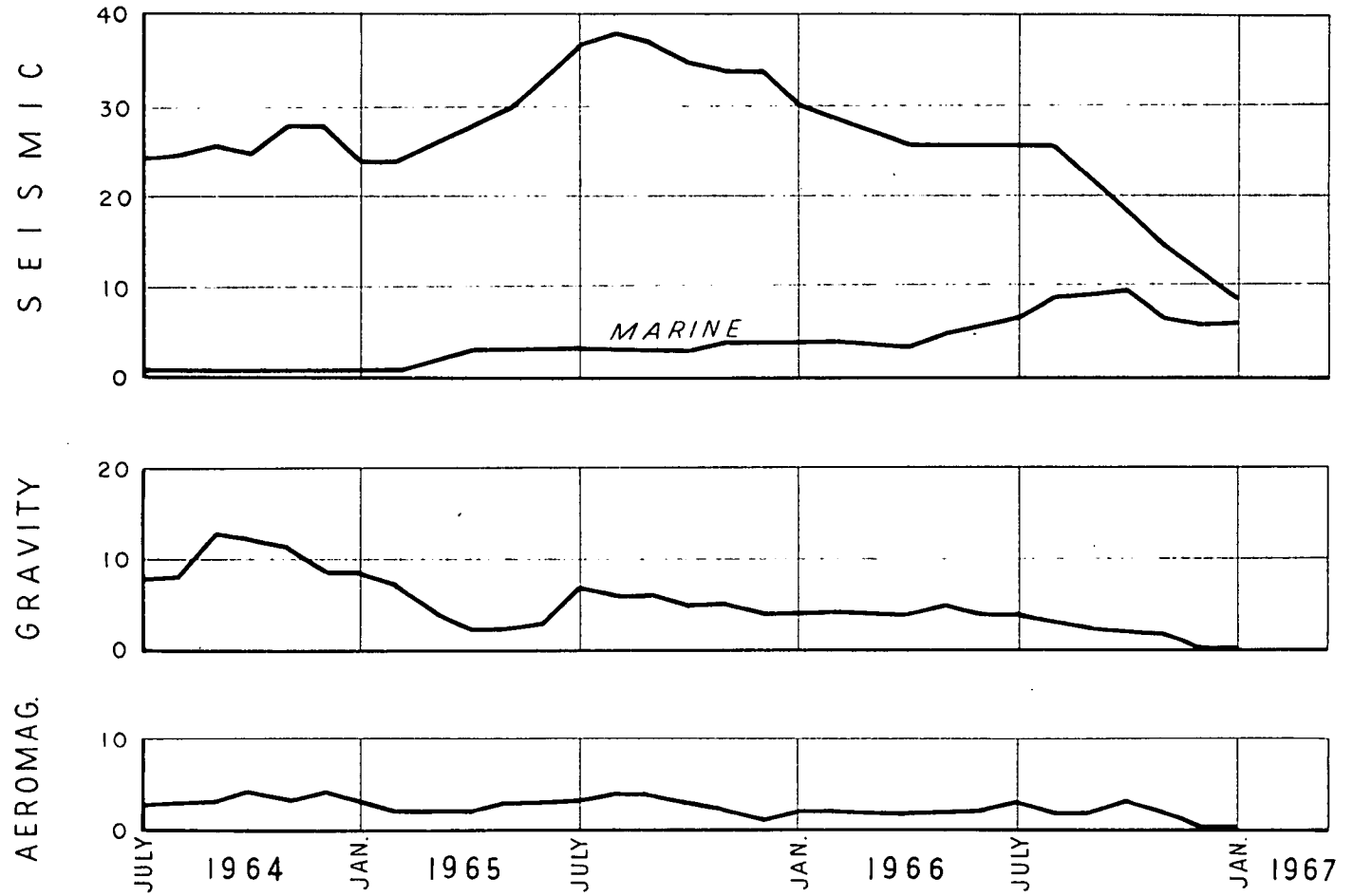
x Assistant Director, Petroleum Exploration, Bureau of Mineral Resources, Canberra.

Figure 1

GEOPHYSICAL CREWS

ON PETROLEUM EXPLORATION IN AUSTRALIA & P-N.G.



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INTRODUCTION

There has been a noticeable pause in petroleum exploration activity in Australia over the past year that is still continuing.

This has been related to the absence of significant discoveries in new areas on-shore and to the necessarily slow organization of off-shore drilling.

In making a forecast of the likely activity in 1967 I am indebted to the operating companies who have discussed their programmes with me (for the purposes of Subsidy budgetting) and for providing the detailed estimates of work on which this summary is based.

This preview takes no account of possible discoveries and their effect on exploration because first, there has been no recent discovery that might change established programmes and secondly, any discovery later in the year is unlikely greatly to increase this year's programme.

Since the discovery of Moonie late in 1961 the rate of discovery has been disappointingly slow. In an attempt to discover some possible reasons for this I shall examine the exploration statistics of Australia and several African producing countries which, until the initial commercial discoveries were made, shared with Australia a reputation of not being prospective for petroleum.

GEOLOGICAL ACTIVITY

Regional geological mapping by the Bureau of Mineral Resources will continue in the Great Artesian Basin, in the south-western corner of Queensland and in the Surat Basin. This mapping has been successful (perhaps more than might have been expected) in mapping the surface expression of the main formations and thus to indicate the broad structural pattern of the surface of the Basin and to suggest some regional patterns of facies change.

A joint geological-geophysical reconnaissance of the Ngalia Basin (Northern Territory) will be started.

Surface mapping will be undertaken by Company geologists in the Eyre Peninsula, S.A. (to examine the projection of aeromagnetic trends of possible sediments from off-shore). Geological mapping will also be carried out in Papua and New Guinea.

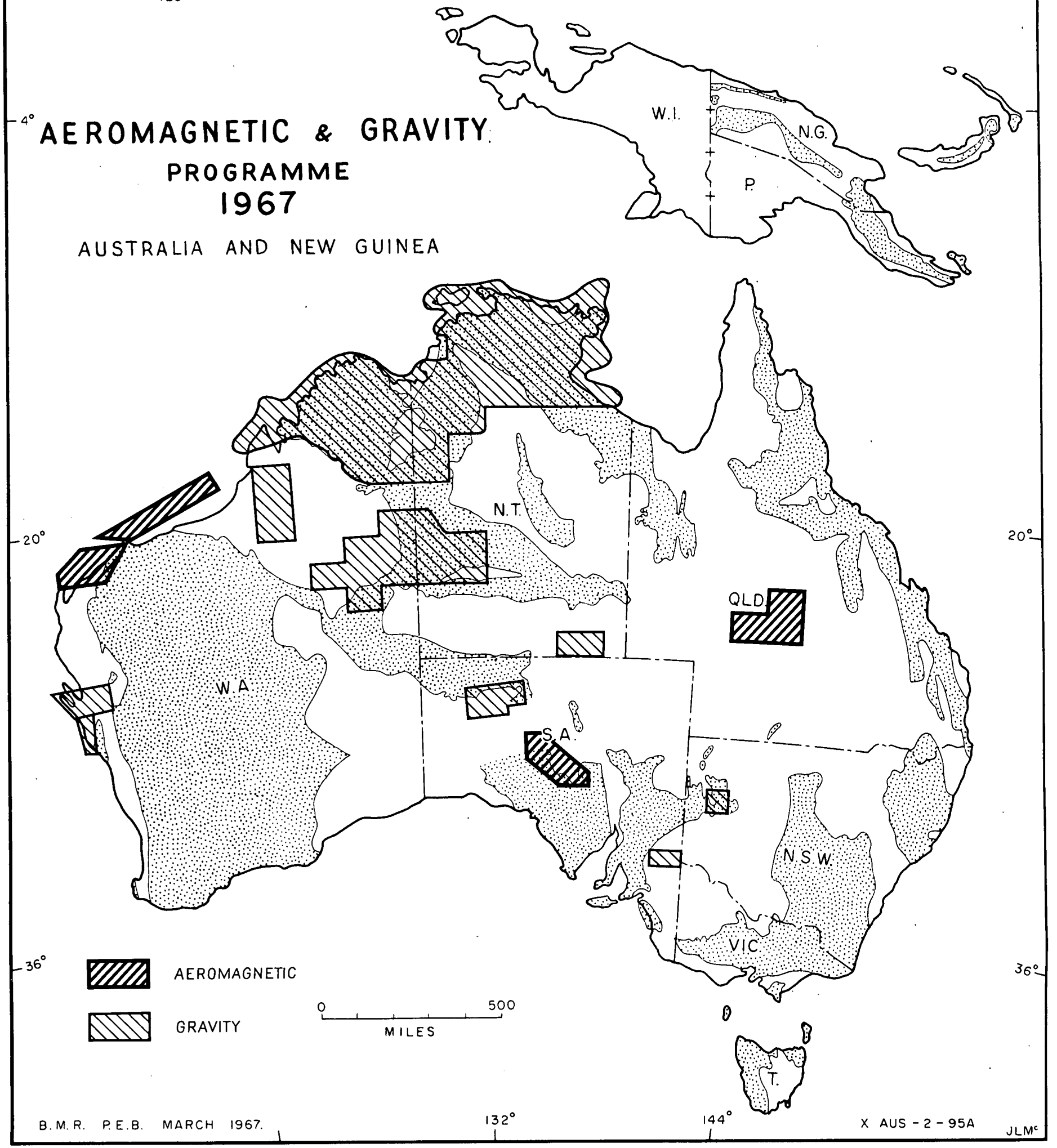
Photogeology, particularly to look for geomorphic indications of structure will be undertaken in the northern Carnarvon Basin, west-central Canning Basin, Officer Basin, Murray Basin and the central part of the Great Artesian Basin.

Subsurface studies continue in many areas currently held but particular efforts will be directed to the Sydney Basin by the Bureau and to the Surat Basin, Adavale-Drummond Basins, southern Perth Basin, Onslow Basin (on-shore and off-shore) and Gippsland Basin by Company groups. The total effort being put into these studies is increasing as information improves.

Figure 2.

AEROMAGNETIC & GRAVITY PROGRAMME 1967

AUSTRALIA AND NEW GUINEA



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GEOPHYSICAL ACTIVITY

Figure 1 is an extension of the illustration presented by Mr. Williams last year showing the number of seismic, gravity, and aeromagnetic crews employed on petroleum exploration in Australia each month since 1964. Because of their greater output the marine seismic crews are shown separately.

Aeromagnetic

The amount of aeromagnetic work done has declined over the past year and shows no sign of increasing.

Aeromagnetic surveys have been regarded as a reconnaissance method to suggest the main form of a sedimentary basin and, in combination with gravity, to give some indication of large structural trends and basement lineaments. The newer high-resolution magnetometer has only been little usedin Australia and not at all in a suitably stable aircraft. Overseas surveys using a high-resolution magnetometer in a stable aircraft indicate that very small magnetic anomalies such as might be associated with average sized structural targets can be detected.

Suitable aircraft fitted with equipment for high-resolution aeromagnetic surveys may now be approved for import into Australia. It is to be hoped that this tool will be used, particularly in some of the central basin areas of low magnetic intensity, to indicate areas of small anomaly that may be worth investigation by seismic surveys.

The very small amount of aeromagnetic survey work programmed for 1967 is shown in Figure 2.

Gravity

Gravity has not generally been well regarded as an exploration tool except at the early reconnaissance stage. The amount of gravity work carried out in Australia has declined since about 1963, but there has been an increase over the last year or two in the amount of gravity work carried out in combination with seismic surveys. These combined surveys help to establish correlations between sedimentary profiles and gravity anomalies.

Some detailed gravity surveys have been carried out and especially when used with computer programmes can, by means of gravity residuals, point to areas of density anomaly that may be related to structural anomalies.

In 1967, the main gravimetric surveys (shown in Figure 2) will be the reconnaissance (one station to 50 square miles) helicopter gravity survey stretching from Arnhem Land to the Kimberleys and including the Daly Basin, part of the Bonaparte Basin and the eastern Canning Basin. This survey will be carried out by contractors for the Bureau.

Companies will undertake semi-detailed surveys in the Murray Basin, Surat Basin, Great Artesian Basin (in South Australia and Northern Territory), northern Perth Basin, Carnarvon Basin and Officer Basin.

Seismic

Last year saw a continuing fall in the number of seismic crews operating on-shore as previous surveys failed to lead to discoveries. The proportion of surface-input crews continued to rise and in the conventional

Figure 4

DRILLING RIG ACTIVITY

ON PETROLEUM EXPLORATION IN AUSTRALIA & P-N.G.

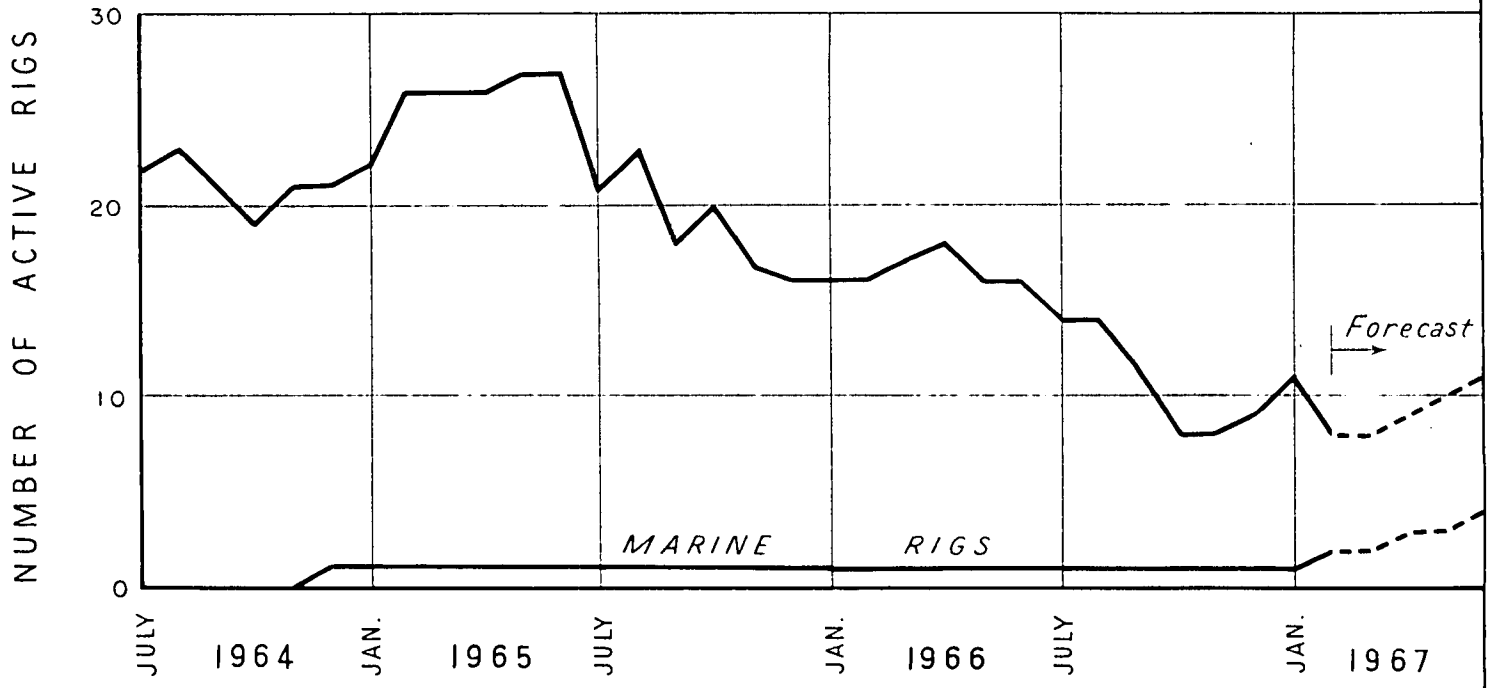

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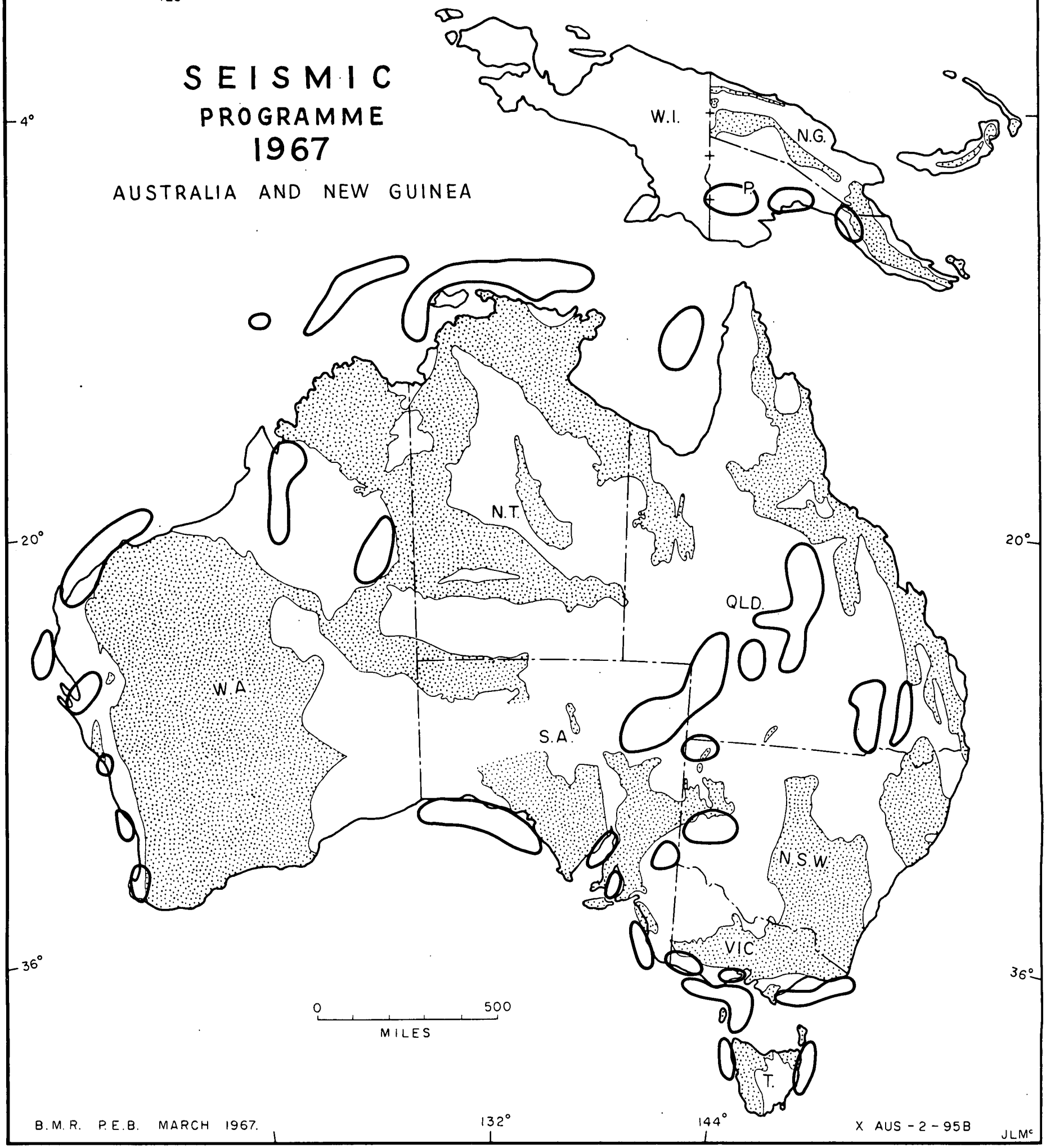
Figure 3

SEISMIC PROGRAMME 1967

AUSTRALIA AND NEW GUINEA



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crews almost all surveys used multiple-coverage methods and sophisticated processing. Current surveys are producing far better records than earlier surveys even in areas where previously only poor records were obtainable. Much more reliable information on sedimentational and structural histories can now be obtained and this is encouraging some Companies to undertake surveys aimed mainly at finding stratigraphic traps.

Marine seismic surveys have continued at a useful level and here the move has been towards digital recording and processing. Many very good structural targets have been located but there is likely to be some marking time until a good sampling of the sedimentary sections has been effected by drilling.

In 1967, seismic work on-shore should increase a little over the level of the end of 1966 but the total amount of work programmed for the year will be well below the total for 1966. Marine seismic work will be only slightly below the total for 1966.

The main areas where seismic surveys will be carried out are shown in Figure 3. The Bureau's two seismic parties will undertake experimental and reconnaissance surveys in the Bellarine Peninsula, Colac and Hamilton areas of the Otway Basin and experimental work aimed at locating stratigraphic traps in the Roma Shelf area. Companies will do reconnaissance seismic work in the eastern Canning Basin and in the western Papuan Basin and off-shore in the Arafura Sea and the Great Australian Bight. Semi-detailed and detailed surveys will be done in the Papuan Basin, Surat Basin, Drummond-Adavale Basins, Eromanga Basin, Murray Basin, Perth Basin, Carnarvon Basin and Canning Basin, and off-shore on the Sahul Shelf, Gulf of Carpentaria, Barrow Island shelf, the Rottnest Shelf, in and near Bass Strait and on the east and west shelves of Tasmania.

In general the seismic work is becoming more specific in its objectives and more sophisticated in its methods. This perhaps gives the exploration company in Australia some hope of locating stratigraphic traps which elsewhere have been found only by accident or after a large amount of drilling has provided detailed information about the subsurface geology. It should give more precision to the delineation of unconformities. It may also indicate the need to drill more than one structural-stratigraphic situation on an established anticline.

DRILLING ACTIVITIES

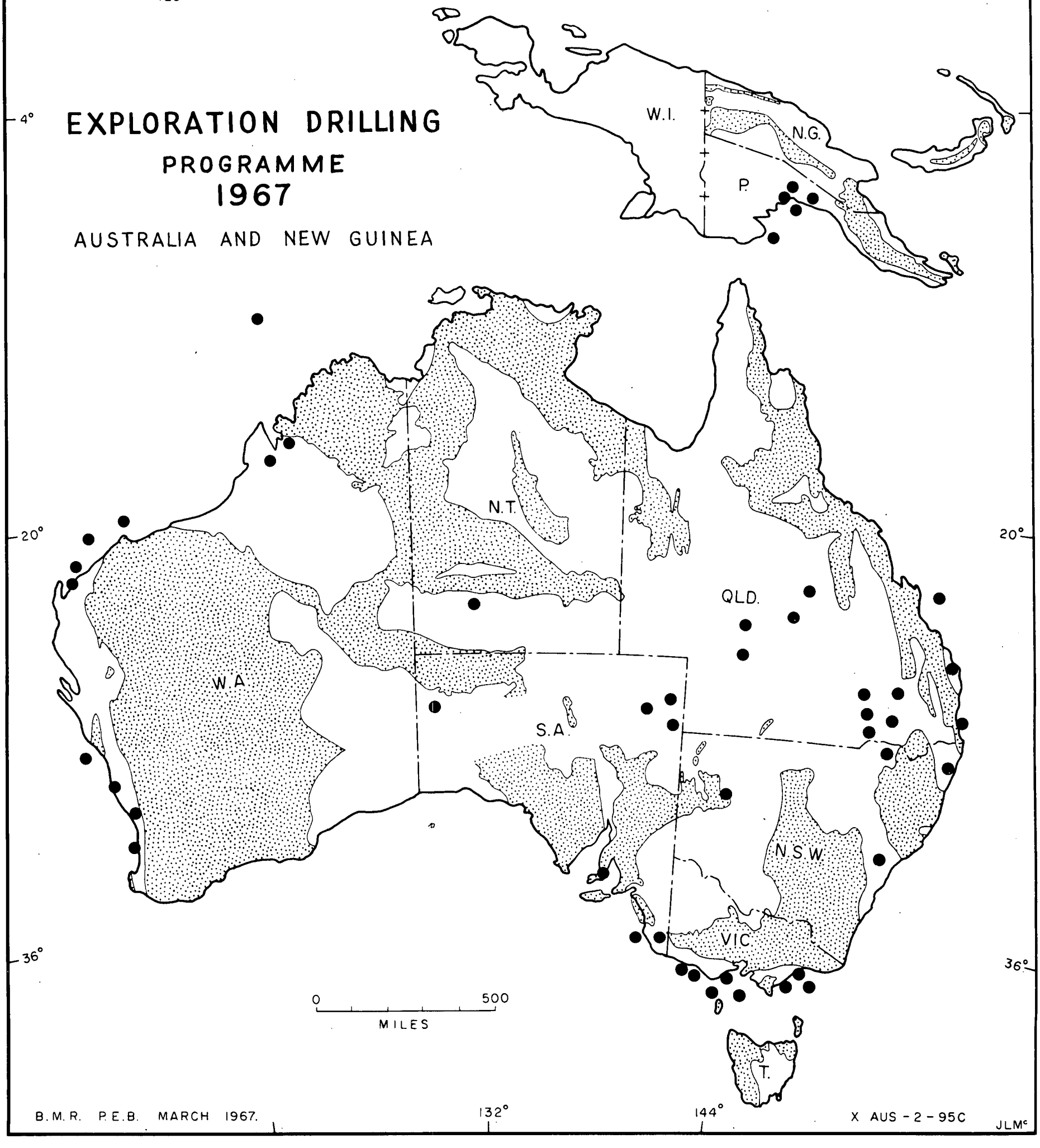
The number of active drilling rigs engaged on exploration drilling in Australia and Papua-New Guinea since 1964 is shown in Figure 4. Marine rigs are shown separately. An estimate of the number of rigs to be used in the first half of 1967 is included; forecast beyond that point is not easy as so much depends on progress results from that drilling and the definition of targets by seismic surveys.

The number of active rigs has dropped over the past eighteen months from the peak of 28 to the current level which is fluctuating from 8 to 12. It seems likely that by mid-year there should be 15 rigs working including three or possibly four marine rigs.

Because of deeper drilling and the increase in the number of marine rigs the expenditure on exploration drilling will be appreciably higher in 1967 than in 1966.

Figure 5

EXPLORATION DRILLING
PROGRAMME
1967
AUSTRALIA AND NEW GUINEA



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The areas where drilling is programmed in Australia and Papua during 1967 are shown in Figure 5. This illustration does not intend to show actual locations but only the general area in which drilling is likely.

Almost all of the programmed drilling is of great interest and the results will have a marked bearing on the future of petroleum exploration in Australia. Perhaps the most significant wells will be those in Papua (both on-shore and off-shore), those off-shore in the Otway Basin, and any that may be drilled in the north-western shelf region.

Practically all the wells to be drilled in 1967 will be 'rank wild-cats' because of their distance from other wells. In many cases the stratigraphy is completely unknown or only inferred by seismic correlation with distant data. Only when discoveries are made and the stratigraphic position of the pay-zone established can exploration be directed to specific targets. This is essential before any detailed seismic search for stratigraphic traps can be undertaken with confidence.

COMPARISON OF AUSTRALIAN AND AFRICAN EXPLORATION PATTERNS

No very large oilfield has been discovered in Australia to date although several commercial oilfields and gas fields have been found. It may be worth while to compare the exploration effort in Australia with that in countries where conditions, both geological and environmental, are somewhat similar and to attempt to find some reasons for differences in the rate of discovery.

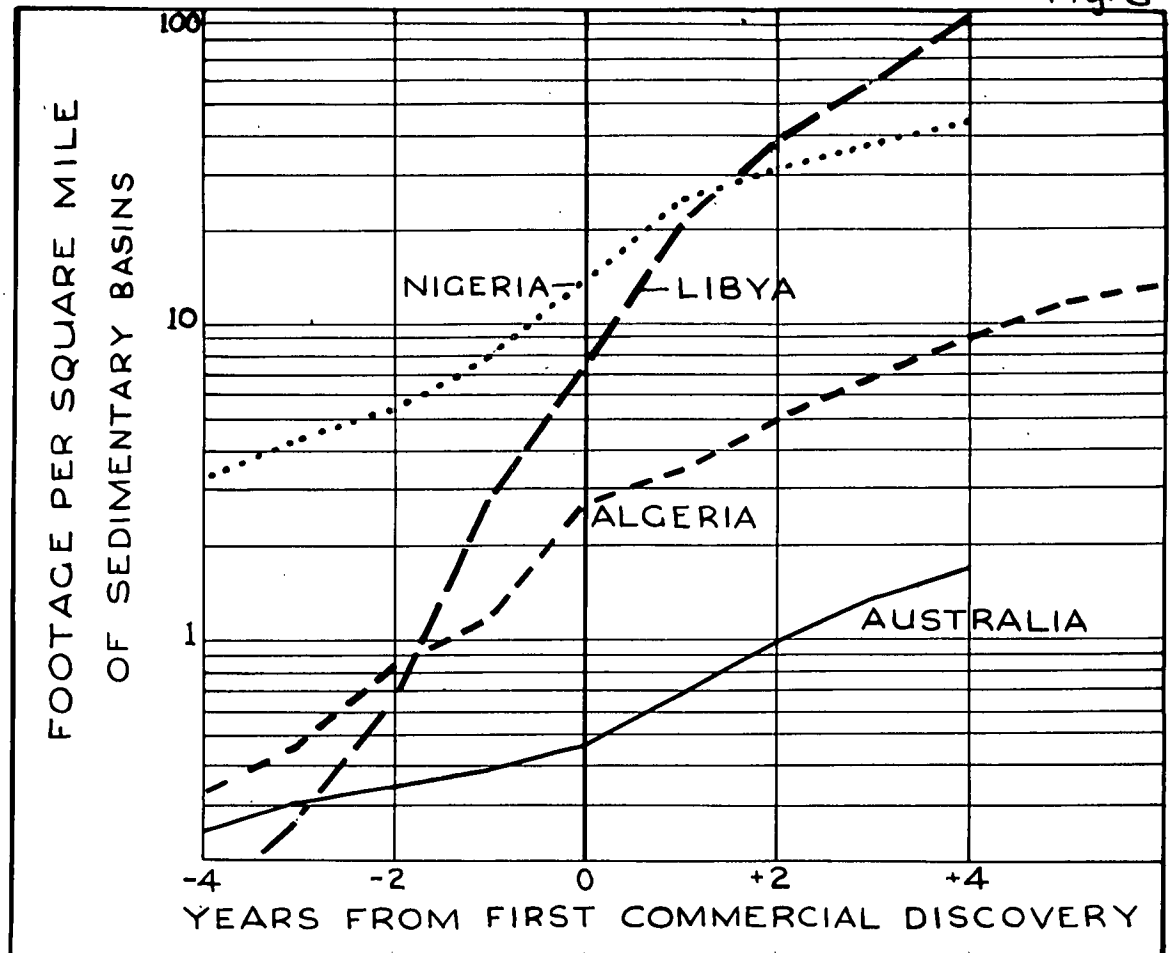
I consider that the most appropriate group of countries to be compared with Australia are the African countries that have discovered commercial oil since World War II. Like Australia these countries were commonly considered (before the initial discoveries were made) to have very little chance of producing significant amounts of oil; they began their main exploration effort after the war; they were able to use modern geological, geophysical and drilling techniques; they were able to avail themselves of the experience of international oil finders; their land systems were generally similar in that the rights to explore for oil were controlled by the Governments concerned; also, very little risk capital was available locally.

In order to compare such countries with Australia it is necessary to compare ratios rather than totals although totals need also to be kept in mind in some fields.

I shall look at Nigeria, Algeria and Libya. In making comparisons related to time, the significant reference point is the year of discovery of the first commercial oilfield. It will be of interest to compare the exploration situations at the time of the initial discovery and before and after that time.

The most obvious comparison is the areas of sedimentary basins: Australia has about 2,150,000 square miles including continental shelf, Nigeria about 50,000 square miles, Algeria about 560,000 square miles and Libya about 685,000 square miles. Thus only Nigeria has a different order of area of basins.

Fig. 6


100
10
1
FOOTAGE PER SQUARE MILE OF SEDIMENTARY BASINS
NIGERIA
LIBYA
ALGERIA
AUSTRALIA
-4
-2
0
+2
+4
YEARS FROM FIRST COMMERCIAL DISCOVERY

The most relevant exploration statistic is footage drilled - the annual figure indicates the size of the exploration effort and the aggregate figure indicates the density of information particularly if this is related to the area of the basins.

Figure 6 compares the aggregate footage per square mile. In the discovery year it was 14.7 feet/square mile in Nigeria, 2.8 in Algeria, 8.0 in Libya, and 0.5 in Australia. Thus it may be claimed that the first discovery was made in Australia earlier in the exploration than in the African countries. Even at the end of 1966 (five years after discovery) Australia had only drilled 2.1 feet/square mile. By contrast Nigeria four years after discovery had drilled 45.2 feet/square mile, Algeria five years after discovery had drilled 11.8 and Libya four years after had drilled 98 feet.

The area held by an operator to some extent determines the intensity of the exploration effort because larger areas tend to be explored mainly by reconnaissance methods and only small parts of the area in more detail, and because the individual operator's budget, both of funds and personnel, tends to have an upward limit that is not related to the total size of the concession.

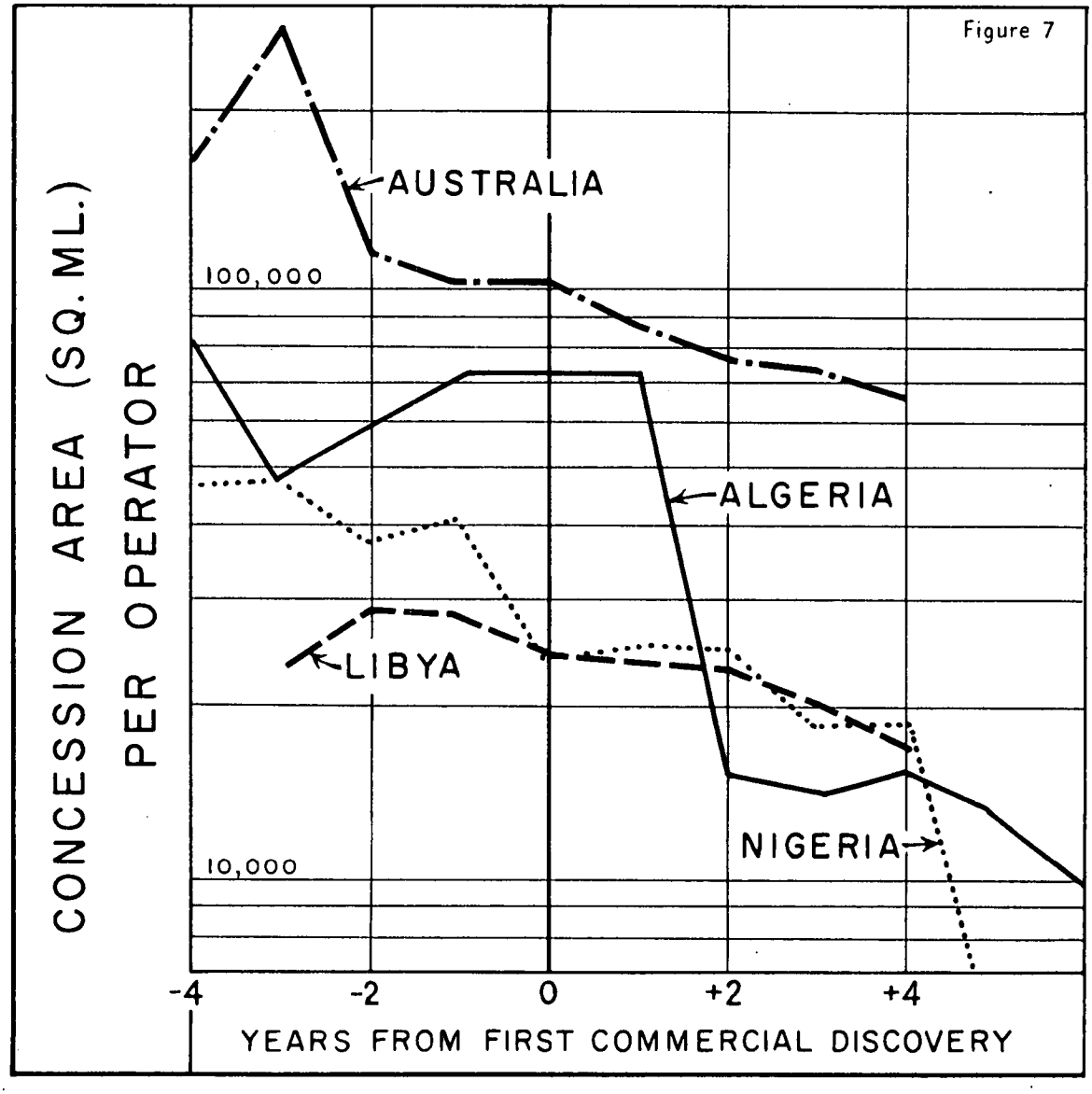
The concession area held (in square miles per operator) is shown in Figure 7. In the respective discovery year in Australia operators averaged just over 100,000 square miles; in Algeria about 73,000, and in Libya and Nigeria about 24,000. In Australia after four years the average area had decreased to 66,000, Nigeria to 19,000, Libya to 17,000, and Algeria to 16,000. One year later the Nigerian average area was 6,000 square miles and three years later the Algerian average was 8,500.

These figures reflect two related trends - an increase in the number of operators and a decrease in the total area held (resulting from the vacating of areas of low prospect) - that together result in a concentration of exploration effort in manageable areas. In Australia, even in the area where the greatest concentration of effort has occurred (the Surat Basin) the 75,000 square miles of the basin has been held by only three or four operators.

Discoveries of oil have now been made in the Cretaceous (Barrow Island and Gippsland Basin), Jurassic (Surat Basin, Onslow Basin) and Permian (Perth Basin) and of natural gas in the Tertiary (Papuan and Gippsland Basins) Cretaceous (Gippsland and Onslow Basins), Jurassic (Surat and Perth Basins), Triassic (Surat Basin), Permian (Cooper and Perth Basins) Carboniferous (Bonaparte Basin), Devonian (Adavale Basin) and Ordovician (Amadeus Basin). These widespread discoveries have not led to the establishment of large reserves perhaps mainly because the exploration effort has remained too diffuse.

Perhaps the main difference between Australia and the African countries lies not in their geology but in their geography - they are well placed relative to the very large European market to compete with cheap and abundant Middle East oil whereas Australia can look only to its own restricted market in an area of cheap crude and cheap transport. There seems little doubt that this geographic-economic environment forced Australian governments to provide the incentives of large exploration concessions and financial and technical assistance in order to have the early exploration work carried out. Now that discoveries have been made, different incentives may have to be found if adequate reserves are to be established.

Figure 7


CONCESSION AREA (SQ. ML.) PER OPERATOR
100,000
10,000
AUSTRALIA
ALGERIA
LIBYA
NIGERIA
-4
-2
0
+2
+4
YEARS FROM FIRST COMMERCIAL DISCOVERY