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RECORD 1967/84

HISTORY OF PETROLEUM EXPLORATION IN AUSTRALIA AND THE TERRITORY OF PAPUA AND NEW GUINEA TO 1967

by

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RESTRICTED

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SUMMARY

Petroleum exploration in Australia gathered momentum after the Second World War. In the pre-war period the footage drilled that can strictly be ascribed to petroleum exploration constitutes only 3.7 percent of the total drilled to the end of 1967. The most notable discoveries made during the pre-war years were by wells drilled for purposes other than petroleum exploration. In 1885, natural gas was discovered near Narrabeen in New South Wales during the search for coal, and in 1900 at Roma in Queensland in a Government water-bore.

After the war, a major factor in the stimulation of exploration activity was the introduction of Commonwealth Subsidy for stratigraphic drilling in 1957 and its extension to include geophysical surveys in 1959. Before the introduction of subsidy the most encouraging event was the discovery of oil, although in non-commercial quantity, in 1953 by West Australian Petroleum Pty Ltd (WAPET) in Rough Range No. 1 in the Exmouth Gulf area of Western Australia. Eight years elapsed before Australia's first commercial oil field was discovered in the Moonie No. 1 well drilled near Tara in Queensland by the Union, Kern, A.O.G. Group. Subsequent important events were the discovery of the Gidgealpa gas field in South Australia in 1963 by Delhi-Santos, followed in 1964 by the Mereenie gas and oil field in the Northern Territory (Exoil Group), the Alton oil field in Queensland (Union, Kern, A.O.G.), and the Yardarino gas and oil field and the Barrow oil field in Western Australia (WAPET). Esso/BHP discovered the Barracouta gas field on the Gippsland Shelf in 1965 with Australia's first offshore well, and followed up this success with the discovery of the Marlin gas and oil field in 1966, and the Halibut and Kingfish oil fields in 1967.

In summary it can be said that the Rough Range discovery in 1953 produced a dramatic increase in the total level of exploration activity during

the following two years. The resultant lack of success produced a decline, which persisted until the late 1950's when the introduction of subsidy, followed by the Cabawin and Moonie discoveries in 1961 produced an upturn that reached its peak about 1965. The subsequent decline is reflected in the amount of drilling and geophysical activity and the area held under title. The continued rise in expenditure reflects the higher cost of offshore work.

INTRODUCTION

One way of critically assessing the progress of oil exploration in Australia is to compare it with the methods and techniques used in the United States. Halbouty (1968) among others has recognized four stages in the exploration of the United States, as follows: seepage, 1859-1900; surface geology, 1901-1932; geophysics and subsurface geology, 1923-early 1930s; and reflection seismograph and wire-line logging, early 1930s onwards.

The third stage merges into the preceding and succeeding stages, but the distinctions are useful enough as a background to the development of oil exploration in the country where oil finding and the oil industry originally developed. In other countries including Australia the stages are less clear cut, but can often be recognized in the history of local exploration.

AUSTRALIAN STAGES

Seepage period

Drilling is mostly random, uncontrolled by any considerations except, when possible, to locate a well near a surface manifestation of oil. Australia, however, is almost devoid of surface indications of oil. The first report of such an occurrence was in 1839 by the crew of HMS Beagle hand-dug well in the tidal reaches of the Victoria River, NT, where they found bitumen; but this seepage has apparently never been rediscovered. Probably the only other authentic shows of oil at the surface are of asphaltite in Lower Cambrian basalt near the junction of the Negri and Ord Rivers, W.A., and of oil impregnations in Cambrian sediments in the Georgina Basin. Rafts of solid hydrocarbons are often washed up on beaches on the southern coasts of Australia, and it has been suggested that they come from submarine seepages offshore (Sprigg & Woolley, 1963), but there is doubt about their origin.

Tasmanite, a reddish brown resinous mineral, which yields oil on distillation, has been known for many years in the valley of the Mersey River, Tasmania; oil shales or torbanite are well known in N.S.W. on the western and northern sides of the Sydney Basin, and have been found at various places in Queensland, and at one place in Western Australia. All these deposits are associated with coal and are probably best regarded as source rocks for petroleum.

Coorongite is known from Lake Coorong, SA, where it probably forms from algal and bacterial growths. Its presence is no indication of crude oil at depth, yet the first well specifically put down for oil in Australia was drilled by the Salt Creek Petroleum Co. near Lake Coorong in 1890-2. However, in 1885 gas was discovered in wells known as Narrabeen Nos 1 and 2 in the Sydney Basin during the search for coal and these wells have been credited to true oil search.

In spite of the lack of natural seepages, hydrocarbon shows in water wells throughout Australia from early days provided much the same sort of incentive for oil explorers. Details of these shows are not given in this report, partly because we can now say that they were mostly insignificant or illusory, but chiefly because they are already recorded elsewhere in publications of State Departments of Mines, previous BMR reports etc (e.g. Geol. Surv. Qld Publ. 299, B.M.R. Report 41A). Perhaps the only significant discovery made in this manner was at Roma, in 1900, when a Government water well (No. 2) struck gas at 3683 feet. The gas blew off for four years, but was finally harnessed in 1906 for an ephemeral town supply lasting ten days. This discovery led to the drilling of several extension wells, one of which (No. 3) blew out, caught fire, and burned for six weeks.

It is a reasonably true, and certainly a practical simplification,

to consider that this seepage period of haphazard exploration and random drilling lasted till the Second World War or about 1940.

The reason for this protracted period of seepage exploration in Australia is fairly obvious. While oil was being found abundantly in North America, Venezuela, Rumania, Russia, the Middle East, and Indonesia, and before various political and economic pressures had appeared, there was almost no incentive for experienced oil explorers to turn to Australia, which geologically was always rated as a poor prospect. It is important also to realize that nearly all other comparable continental land masses had achieved quite early, and quite substantial, discoveries with considerable continuing success. Unfortunately this never happened in Australia.

Petroleum exploration stopped in Australia when the war with Japan started and we can reasonably consider that all exploration up to then was in the seepage period, even if some signs of improved techniques for exploration appeared as early as the middle 1920s. The footage drilled is often taken as the best yardstick of exploration activity, and we can see from this that before 1942 the exploration effort in Australia had been negligible. The cumulative figures up to that date are:

	No.	Footage	Av. depth ft
Exploratory wells	47	147 266(44 887m)	3133 (955m)
Extension wells	8	31 338(9552m)	2917 (889m)
Geological & shallow wells	381	280 000(85 344m)	735 (224m)
Total	436	458 601(13 9782m)	1050 (320m)

This total is only about 6 to 7 percent of the footage drilled to the end of 1967 and though the number of wells seems substantial they were mostly very shallow. The data for those wells, properly regarded as fully exploratory, is more reliable: the number drilled up to the war makes up

6 to 7 percent of the total drilled up to 1967; their average depth was almost 2500 feet (762m) shallower than the total average, and their total footage was about 3.7 percent of the total footage drilled by 31 December 1967.

We are justified in regarding this period of exploration as of minor value in the evaluation of the oil prospects of Australia. Indeed by excluding pre-war exploratory drilling figures from subsequent discussion and analyses, the bases of comparisons are made more straightforward and a more valid assessment of the present position and future possibilities can be made.

Surface geology

Some attempts were made during the 1920s-1930s in the Longreach-Roma areas of Queensland, in the Sydney Basin, and in the Fitzroy Trough of the Canning Basin to use surface geology for locating wells, but the drilling was often too shallow and too poorly executed to contribute seriously to the evaluation of the areas. Generally speaking there is a lack of mappable surface anticlines in sedimentary rocks both in the better populated areas of Australia and in the places where chance finds of hydrocarbons had been reported. Only about 85 (11%) of the petroleum exploration wells drilled can be attributed in some way to surface mapping, and these are mostly in Western Australia, the Amadeus Basin of the Northern Territory, and New South Wales.

Geophysics and subsurface geology

The use of geophysics was heralded before the Second World War by the torsion balance and seismic refraction work carried out by the German company, Elbof, near Roma in Queensland during 1928 and 1929 and by the regional gravity survey of Shell (Queensland) Development Pty Ltd in southern Queensland between 1940 and 1942. But neither of these surveys led directly to drilling.

Reflection seismograph and wire-line logging

The reflection seismograph and wire-line logging techniques were achieved gradually and not fully practised until the later part of the 1950s. Nevertheless the Bureau of Mineral Resources made gravity surveys from 1946 onwards, and began limited seismic work in 1949, and there were operators in the country from 1946 (e.g. Shell (Qld) Dev.) who were prepared to use modern methods of exploration even if they may not have done so extensively.

POST-WAR EVENTS

Before trying to assess the development and progress of exploration during this period, it is as well to outline the main events that may have influenced them. First there was the discovery of oil at Rough Range in the Carnarvon Basin of Western Australia on 23 November 1953. Next was the introduction of Commonwealth Subsidy for so-called stratigraphic drilling; this received Royal assent on 12 December 1957. Two years later it was extended to include other sorts of drilling and geophysical surveys, and that amendment received Royal assent on 11 November 1959. The first discoveries after the start of subsidy were at Cabawin in the Surat Basin on 22 April 1961 and at Moonie on 3 December 1961. Various small discoveries of oil and gas were made in the Roma area from late 1962 onwards, and perhaps the oil discoveries at Sunnybank on 11 December 1962 and at Richmond on 24 August 1963 were the most important initial finds. Subsequent important discoveries were as follows:-

Mereenie (Amadeus Basin) - gas, 5 March 1964; Gidgealpa (Cooper Basin) - gas, 31 December 1963; Yardarino (Perth Basin) - oil and gas, 22 May 1964; Barrow (Carnarvon Basin) - oil 8 July 1964; and Alton (Surat Basin) - oil 7 July 1964.

The discoveries of gas and oil on the Gippsland Shelf in the

Barracouta field on 9 April 1965 and the Marlin field on 14 March 1966 were most important, but they are difficult to fit into the general pattern of exploration progress because marine work is beyond the scope of some exploration companies.

In addition it must be remembered that international events may have affected Australian exploration. The events in Iran, leading to the expulsion of British Petroleum in 1951, were probably too early to have had any effect on the embryonic exploration in Australia at that time; and in any case the data which are used here for assessment of progress are not complete enough to allow any conclusions. The Suez Crisis in the last half of 1956 may have had an effect, but it came so shortly before the introduction of subsidy that its contribution to the increase in activity from about 1957 onwards is difficult to judge. Initially the increased interest in offshore areas from about 1964 was presumably the spreading of an international trend.

The taxation incentives provided for investment and participation in petroleum exploration have been in force since 1939, even though amended at various times since then, and therefore should have had little affect on fluctuations in post-war petroleum exploration activity.

ANALYSIS OF DATA *

Analysis of the post-war period, in order to link the development of exploration to events, is difficult because the data, at any rate for the earlier years, are not always complete or are too complex for full investigation without a very great effort. There are four types of data useful in evaluating the total exploration effort. The total acreage of exploration titles and the number of title holders; the geophysical effort; the total footage drilled, and the annual expenditure in exploration. These four aspects of exploration are discussed separately.

* Data from Papua and New Guinea are included in this section (Figs 1-5 and Fig. 8).

Acreage held in exploration titles and numbers of title holders

Unfortunately data are available only from 1954 onwards. From 1954 to 1967 title holders have been published, every six months, by BMR in the Key to Petroleum Exploration and Development Titles. The number of title holders has been derived simply by counting the names listed each year. A detailed separation of each interest and a classification of such interests according to the seriousness of its exploration, though desirable because it would enable a more illuminating and convincing analysis of the general position and development of exploration in Australia, has not been attempted because it is too immense a task.

The total number of title holders is plotted yearly in Figure 1. Strangely the discovery at Rough Range caused only a modest and short-lived rise in numbers, which remained low despite the advent of subsidy. Numbers rose sharply in 1959 and 1960, but fell a little during 1961. The Cabawin and Moonie discoveries then stimulated another sharp rise until presumably all suitable territory had been taken up by the end of 1962. Since 1962 numbers have fluctuated, but not widely, perhaps tending to decrease more seriously in 1967. These figures probably have little meaning because they include all title holders ranging from individuals to the major international oil companies. They have been divided rather arbitrarily into individuals (Fig. 1D), small companies of all sorts which mostly have never themselves undertaken exploration or evaluation of areas held (Fig. 1A), Australian or largely Australian companies (Fig. 1B) which have persistently undertaken exploration by their own efforts, and overseas companies which similarly have undertaken active evaluation of land areas (Fig. 1C). Figures 1D and 1A show that numbers of individuals and small companies fluctuate the most and indeed cause the fluctuations in the total. Individuals have tended to disappear, probably because they have merged their interests in small companies.

In each year the largest proportion of titles was held by the small companies. The Australian companies (Fig. 1B) show a small but rather steady rise from the time of discovery at Rough Range to the end of 1964, but they were apparently least affected by the introduction of subsidy. The number of overseas companies holding titles (Fig. 1C) was apparently unaffected by Rough Range but increased with subsidy and again in 1961 with the Cabawin and Moonie finds. It is also possible that part or all of the initial stimulation came from the Suez crisis of 1956. Various discoveries in 1964-5 probably helped to maintain the increase in numbers of these larger companies.

The area held under title annually shows a simple and somewhat similar picture (Fig. 2). The acreage decreased immediately after the Rough Range discovery and began to increase in 1957. Subsidy at the end of 1957 encouraged this trend, and accentuated it, but by the end of 1960 interest had evidently come to an end. The Cabawin and Moonie discoveries provided another impetus in 1961 and the total acreage held under title again increased sharply, well beyond the limit of suitable exploration territory. Indeed Figure 2 shows that between 1959 and 1965 a large area of quite unprospective territory must have been held under title provided the limit of 1 667 000 square miles (4 334 200 km^2) is accepted as the total area of sedimentary outcrop in Australia and New Guinea. If this area is reduced to the 1 288 000 square miles (3 348 800 km^2) of the sedimentary basins that have reasonable petroleum prospects, it appears that ever since 1958 a substantial area of very poorly prospective or totally unprospective territory has been held under title - from 100 000 square miles (260 000 km^2) at the end of 1959 to 1 100 000 square miles (2 860 000 km^2) at the end of 1962) - and that only by the end of 1967 was the position returning to reason.

Some marine acreage has been held under title from 1954, chiefly in Western Australia and in Queensland. The areas in Western Australia have

been included with land figures throughout, but the rest have been separated for each year since 1954 (Fig. 2). These fluctuated from about 80 000 square miles (208 000 km^2) to 250 000 square miles (650 000 km^2) until 1962. They then increased steadily each year until 1965, and decreased in 1966 and 1967. The discoveries on the Gippsland Shelf in 1964-5 evidently stimulated the interest in offshore areas that had been growing steadily since about 1958.

In general these figures of total acreage held and number of tenement holders show that the Rough Range discovery had surprisingly little effect on either; in fact both tended to decrease for two years. The introduction of subsidy evidently stimulated the taking out of titles; or probably did so because the Suez Crisis of 1956 may also have been a contributory factor. It is remarkable however that the introduction of subsidy did not encourage any new explorers to enter the field immediately, except perhaps two overseas companies. Once interest was raised it grew rapidly for the two years 1959 and 1960, levelled out in 1961 until stimulated by Cabawin and Moonie, and then rose to its peak in 1962. Because at that time all available territory, on land at least, had been taken up the total acreage held and even perhaps the number of title owners could only decline; but interest in offshore areas continued to increase till the end of 1965, since when decline has also set in there.

Geophysical effort

Geophysical effort has been judged only from the number of crew months of gravity and seismic survey carried out each year by exploration companies. Apart from the difficulty that different compilers may have used different bases for estimating total crew months, the available figures are unsatisfactory. Those for the years 1947 to 1958 (inclusive) are taken from the annual reports in the Bulletin of the American Association of Petroleum Geologists. Unfortunately no figures at all are given there for 1950, 1952, and 1953 and it may be that figures for other years are not

comprehensive or include work by BMR that otherwise is omitted in this study. The figures from 1959 onwards have been supplied to BMR by exploration companies and should be much more reliable. For instance the figures for subsidized surveys have been compiled directly from the final reports of each survey and they faithfully reflect the same trend as the larger total. Nevertheless the figures of gravity crew months for 1958, 1959, and 1960 fluctuate so violently that they appear suspicious and could be misleading.

The gravity data are not very illuminating (Fig. 3). Evidently more than half the total of work was done before the end of 1959, largely in Western Australia by West Australian Petroleum Pty Ltd. The Rough Range discovery may have stimulated it, but the introduction of geophysical subsidy seems to have had little effect. The large peak of the years 1963 to 1965 is entirely due to the effort made by the Hunt Oil Company in the Officer Basin. Exclude that and the peak activity of 1964 is little greater than those of 1955 and 1959. At the same time it must be remembered that BMR has been carrying out regional gravity surveys since 1946 and it is quite likely that this has obviated the need for much gravity work by the exploration companies. In any case gravity surveying is evidently used as a subsidiary exploration tool. Many operators apparently rely more on seismic surveying as a reconnaissance tool - a procedure widely adopted in North America but less common in remote overseas territories where the traditional method is to reserve seismic for detailing gravity leads. Few operators in Australia have used extensive gravity surveys in the reconnaissance stage except West Australian Petroleum Pty Ltd (who did much of their preliminary gravity reconnaissance before subsidy) and Hunt Oil.

The seismic data are more simple (Fig. 4). The first use of the technique (apart from Elbof in 1929, in Queensland) was in 1949 or 1950 though details are now lost, and seismic was used increasingly, perhaps

regularly so, until 1958, and probably mostly in Western Australia. There was a decrease in its use in 1959 but geophysical subsidy probably then provided the stimulus which carried it towards its peak use. The Cabawin and Moonie discoveries must have given it further needed stimulus in 1961 and the first peak was reached in 1963. By then, no doubt, enough surveying had been done to provide plenty of drilling locations and the simple explanation of the drop in 1964 is that at this time operators were putting most of their effort into drilling. A second seismic effort produced an even greater use of the method in 1965, which declined dramatically in the next two years. To some extent this must be expected because, unless improved data can be obtained, surveying of all sorts is bound, in the long run, to decrease because it depends on measuring in some way or another a finite area; yet the peak of geophysics seems to have been reached rather quickly for such a large area as Australia and this no doubt has been partly due to the lack of continued success on land. It probably also indicates generally poor prospects at the seismic stage of exploration, i.e. the general lack of attractive structure.

Marine seismic work in Australian waters apparently started in 1961 with the Frome-Broken Hill Otway Survey in March, the West Australian Petroleum Pty Ltd Exmouth Gulf Survey in August, and the Associated Australian Oilfields Bonaparte Gulf Survey in September. Haematite Petroleum and Arco surveyed Victorian and Tasmanian waters in 1962 and from then on there was a general increase in marine surveys all round Australia till the end of 1966, with subsequent decline in 1967.

Drilling

The annual footage of exploratory drilling (Fig. 5) provides the most complete and exact measure of activity since the war, but unfortunately

it is the least sensitive criterion for judging the controlling factors as it is the last step in exploration. Clearly though, the Rough Range discovery influenced drilling strongly and immediately. The introduction of subsidy had no immediate effect, though it probably had a longer-range effect that reinforced the stimulus provided by the Cabawin and Moonie discoveries. With subsidy, and without those discoveries, the tremendous increases in footage drilled from 1962 to 1965 would probably not have occurred, and the absence of significant discoveries on land since the last half of 1964 must account for the decline in footage in 1966 and 1967.

Expenditure

The figures on expenditure are incomplete and thus difficult to analyse. Total expenditure by private companies is available from 1946, but annually only from 1953 (Fig. 6). This is not a very sensitive criterion of controlling factors. For one thing it is strange that the discovery at Rough Range apparently had so little effect for a year. Then expenditure actually decreased for the year following the introduction of subsidy. The introduction of geophysical subsidy, however, must have stimulated geophysical work greatly, but discoveries at Cabawin and Moonie between 16 and 24 months later were probably more important. Total expenditure has continued to rise dramatically since 1958, but from then on it is necessary to separate the expenditure on different exploration methods, and between land and sea, and to distinguish between exploratory and development drilling in order to get an idea of the possibilities. Development drilling is omitted from the graphs on Figure 6, and expenditure on exploration drilling, geophysical work and geological work is shown separately; unhappily, separate figures for land and marine work are available only for 1967. It is interesting to note the great increase of geophysical expenditure in 1960 and thereafter, and that this

actually equalled the expenditure on exploration drilling in 1960 and 1961, and was a little less in 1962 and 1963; but then geophysical expenditure remained stationary in 1964, no doubt because this effort was being put into drilling after discovery of suitable locations, as suggested above, while expenditure on drilling continued to increase. Thereafter it would be necessary to separate the figures for exploration on land and sea to assess the position. Without separate figures we can only say that geophysical expenditure decreased rather sharply in 1967 and that expenditure on drilling and geophysics on land, during 1967, had evidently returned to its level before the discovery at Cabawin and Moonie and was perhaps even below the peaks achieved in 1955 after Rough Range. This can only have been brought about by the continued poor rate of success on land and the inability to find suitably encouraging areas or structures to explore.

It is also interesting to split the figures for expenditure into their sources, viz Australian or overseas (Fig. 7). If this is done, it is noteworthy that by the end of 1957, after the interest generated by Rough Range had died away, the funds came equally from Australian and overseas sources. The funds from the two sources tend to fluctuate conversely for the next four years, overseas funds rising or falling about one year in advance of the Australian. The total annual investment had risen only moderately by the end of 1960 in spite of the initial introduction of subsidy and the later introduction of geophysical subsidy within the period. Investment increased sharply in 1961 with the doubling of the overseas contribution and continued in 1962 with the tripling of the Australian contribution. The author therefore suspects that the discoveries at Cabawin and Moonie were the really important stimuli and that overseas interests were more sensitive to this sort of encouragement than Australian interests.

Conclusions

The four criteria for assessing the development of exploration and evaluation are arranged in order of decreasing sensitivity to the controlling factors. The acreage held under title reacts first to the influence of events, then geophysical activity, drilling, and finally total expenditure, though this last probably increases for some time after all others begin to fall because the search has moved offshore where expense is so much greater. The Rough Range discovery stimulated all four though perhaps it is surprising that the reaction by geophysics was delayed for so long. Anyway, except perhaps in geophysical activity, this stimulation disappeared by 1956 and 1957. Subsidy, when first introduced, had a very uncertain effect because it apparently caused no immediate increase in any criteria except the acreage, and even there an increase had started in 1957, before subsidy, which leaves the suspicion that the Suez crisis of 1956 may have contributed to a renewed interest in Australia. The introduction of geophysical subsidy seems to have had a more clearly recognizable effect, but before enough time had elapsed to assess its effect fully it was overshadowed by the discoveries of oil at Cabawin and Moonie. These and later finds in 1963 and 1964, together with the prompt dispersal of basic data made possible by the Petroleum Search Subsidy Act, probably provided all the stimulation necessary to ensure that the Australian landmass would be reasonably evaluated. The peak of interest and activity came in 1965 and by the end of 1967 both were waning. The acreage under title had by then fallen below its pre-Moonie level, geophysical activity was little higher than it was in the year of the Cabawin and Moonie discoveries, and drilling had fallen sharply. Only expenditure was still rising but that was caused by the higher cost of marine work, because expenditure for drilling and geophysics on land was substantially less than it had been in the year after Moonie.

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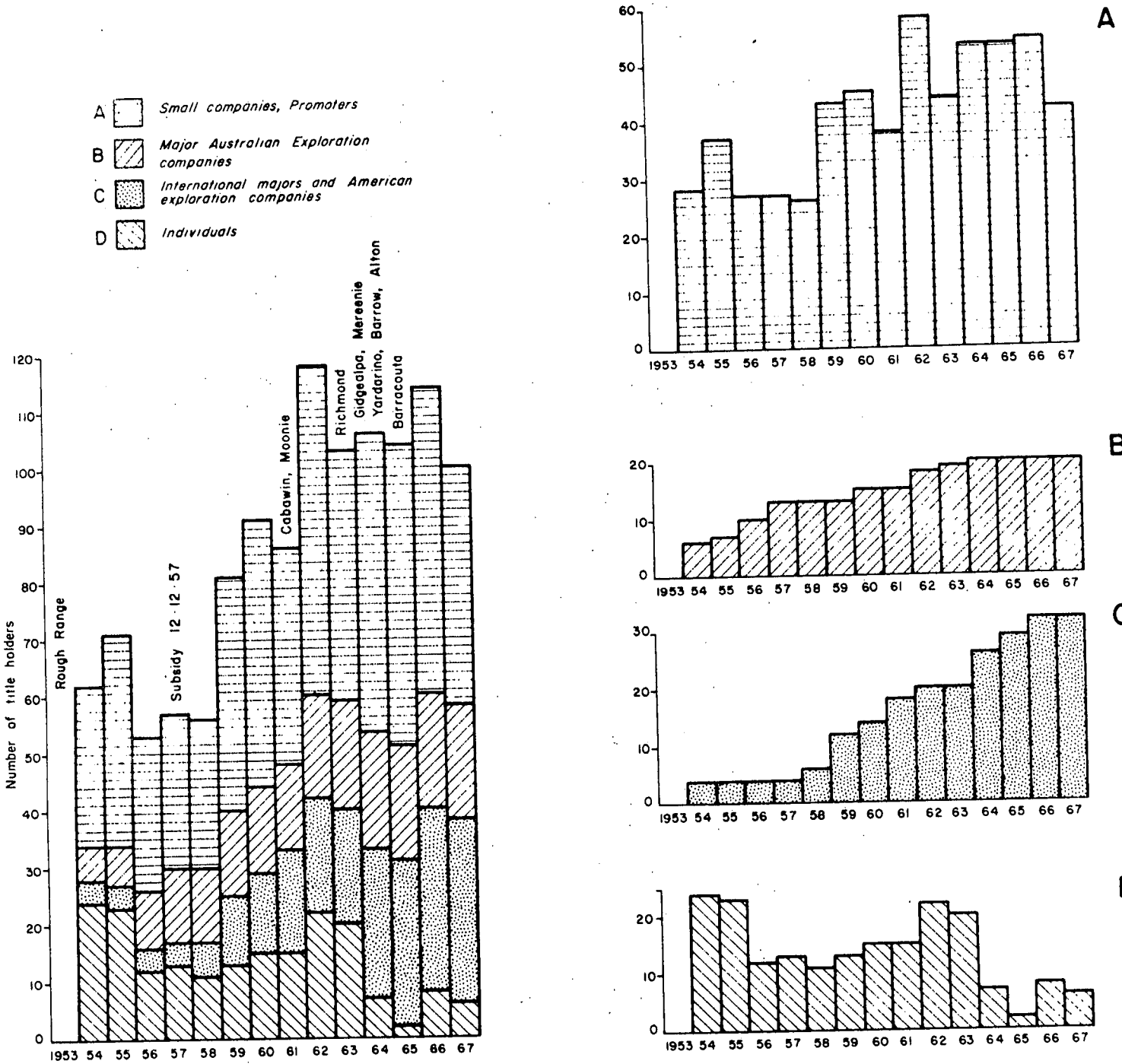
Fig. 1 EXPLORATION TITLE HOLDERS IN AUSTRALIA PAPUA AND NEW GUINEA 1954 - 1967



To accompany Record No. 1967/84

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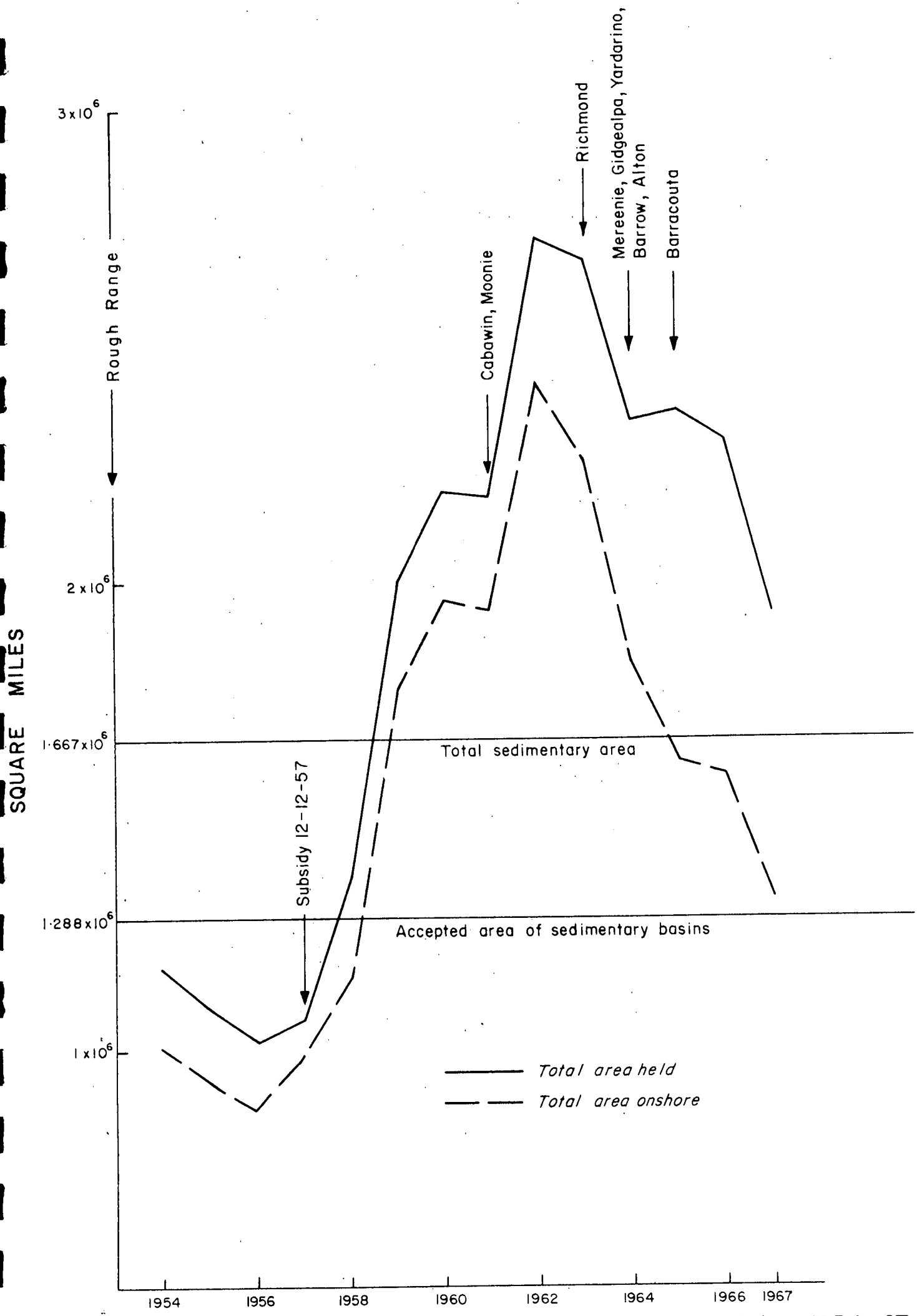

Fig.2 Area held under title in Australia and Papua and New Guinea 1954–67

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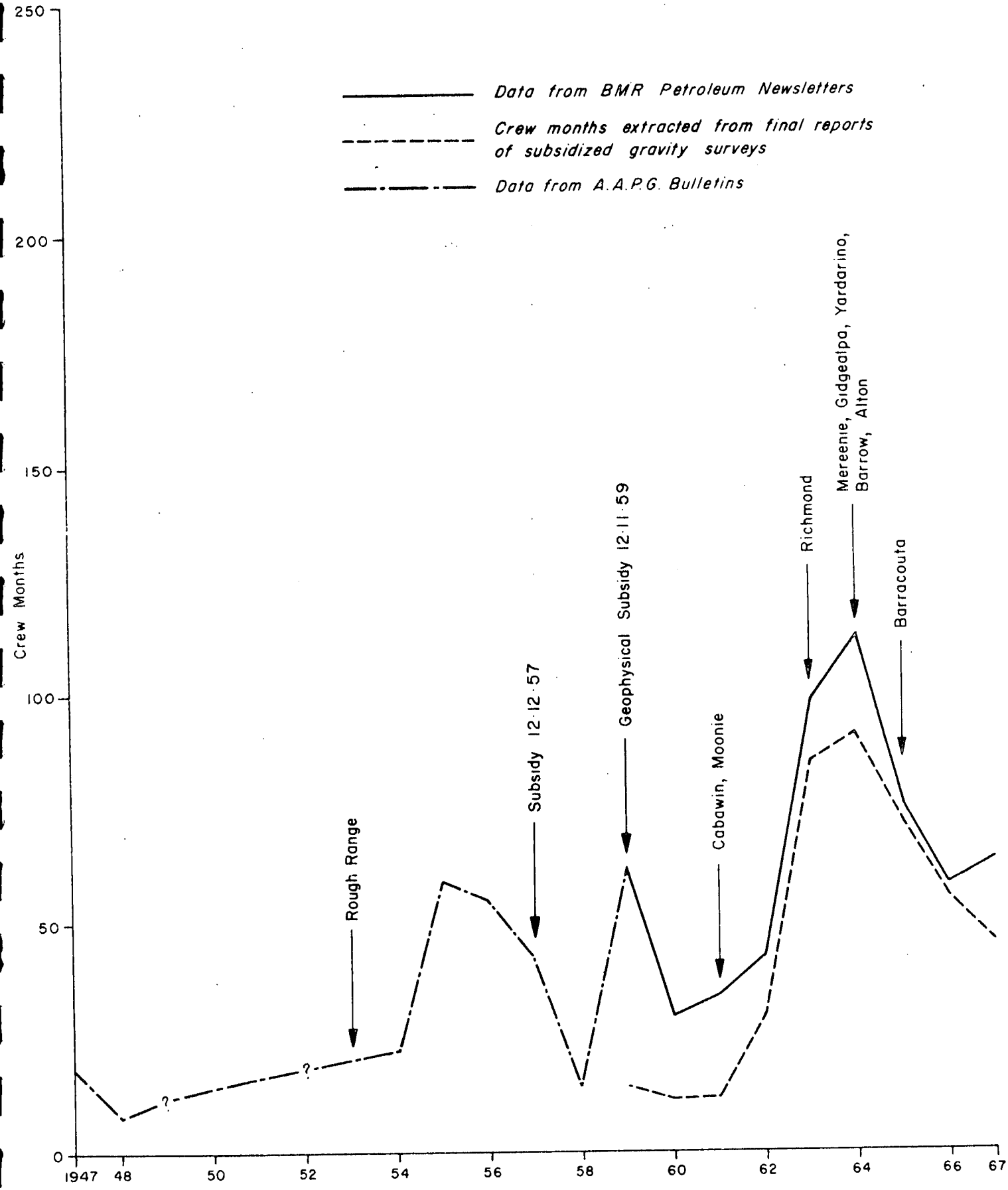

Fig. 3 Gravity surveys in Australia, Papua and New Guinea 1947-1967

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To accompany Record No. 1967/84

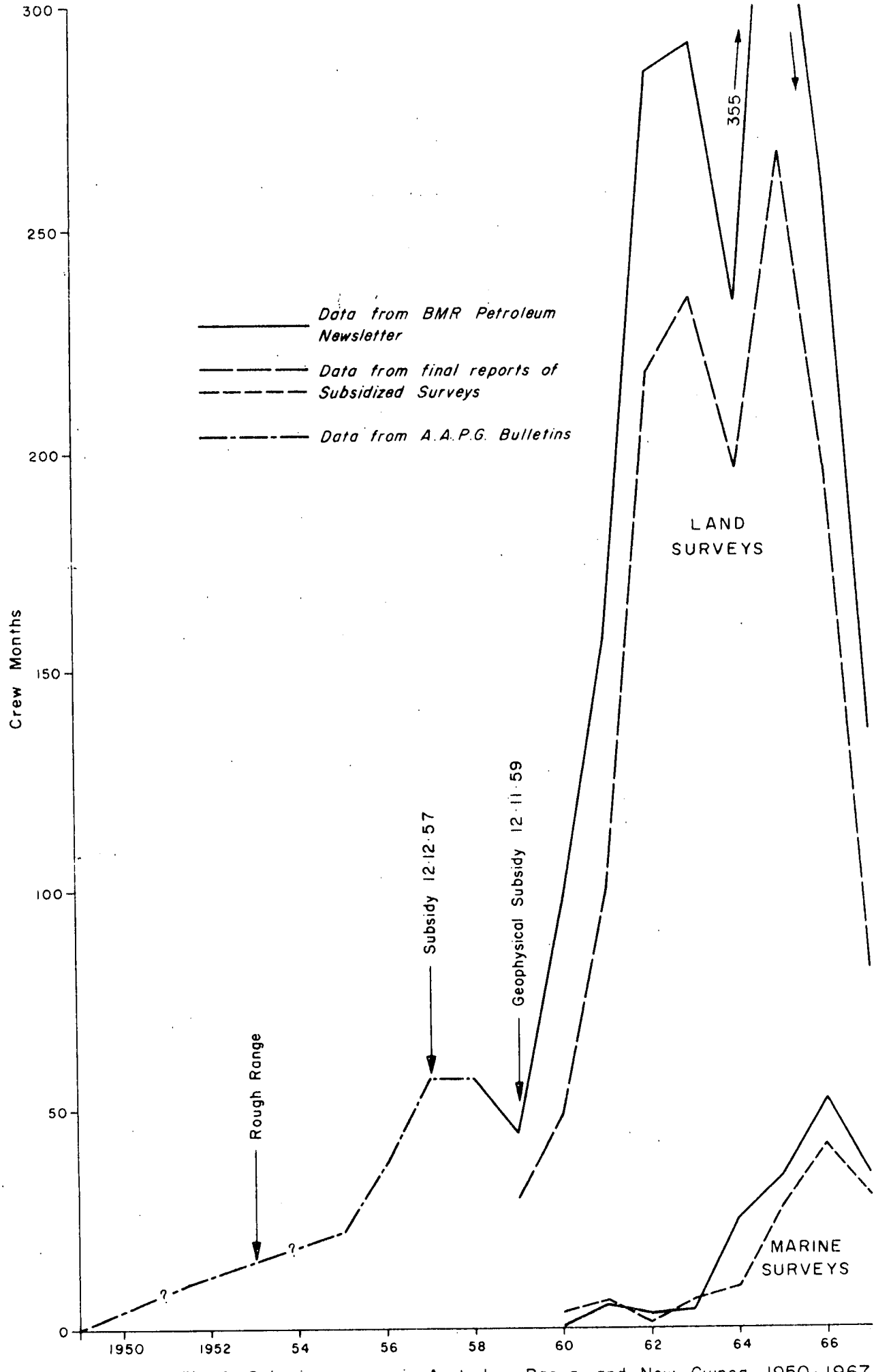

Fig. 4 Seismic surveys in Australia, Papua and New Guinea 1950-1967

To accompany Record No.1967/84

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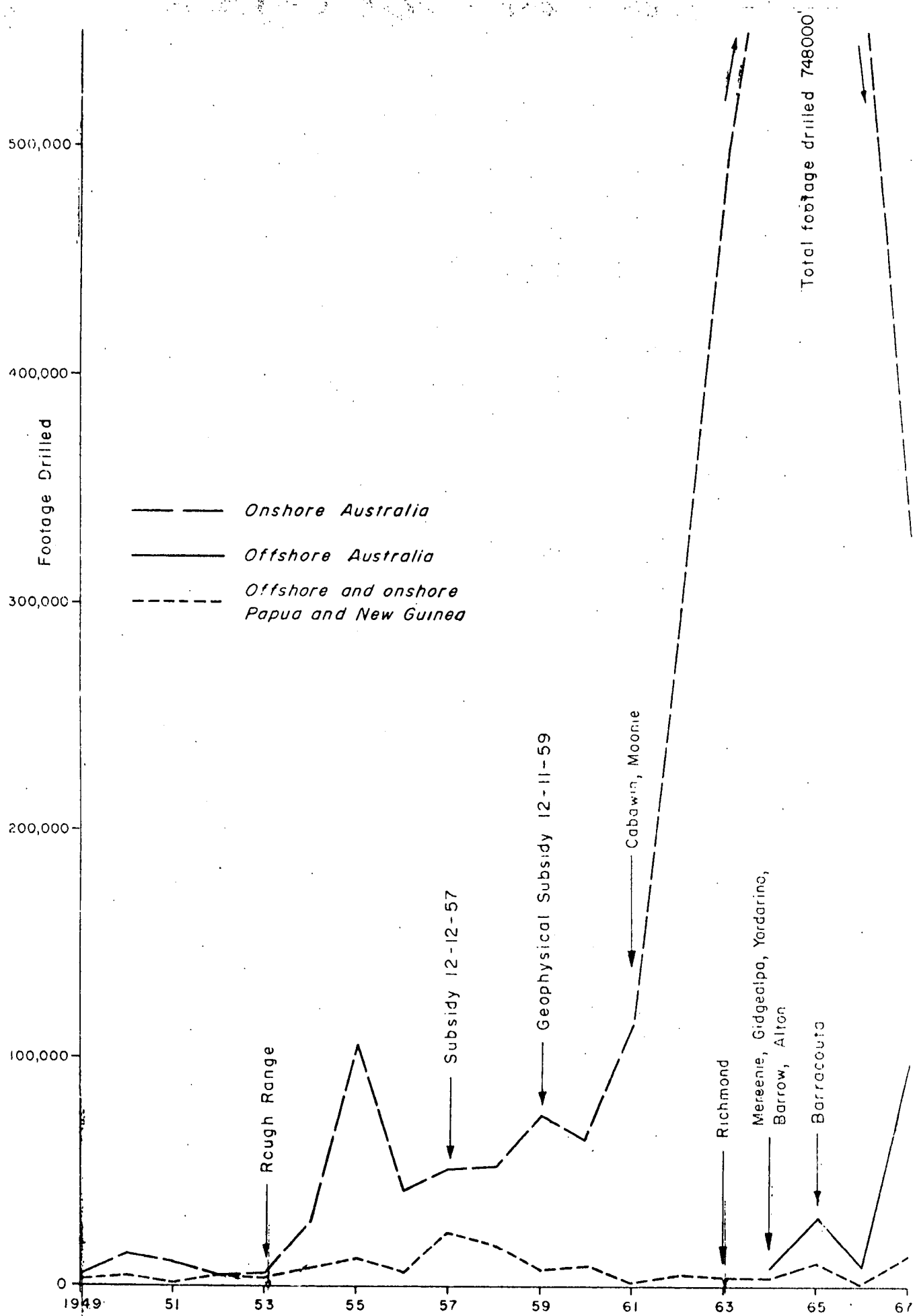

Fig.5 Annual footage for exploration drilling in Australia, Papua and New Guinea

To accompany Record No 1967/84

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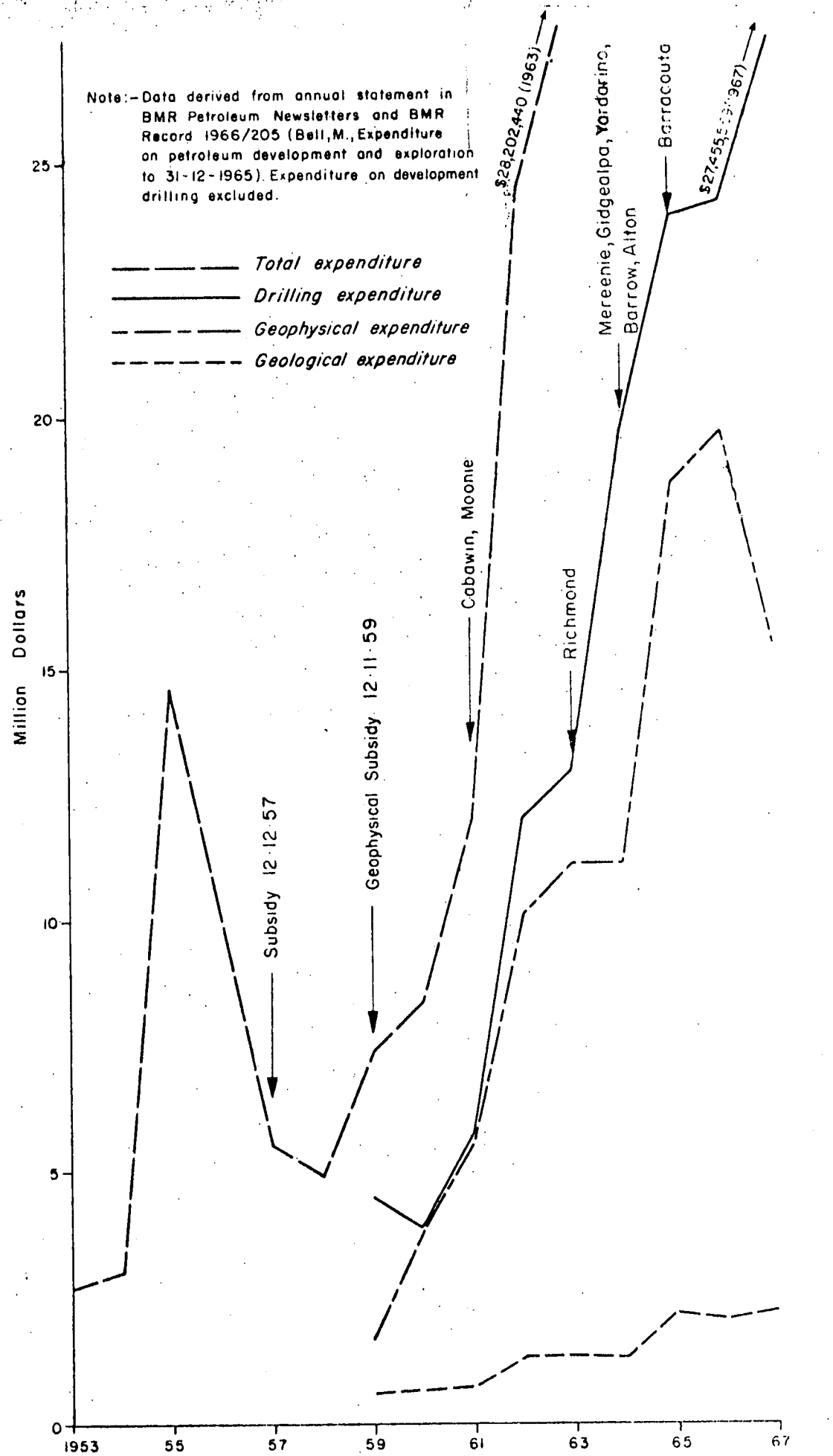

Fig. 6 Total expenditure by private companies on petroleum exploration in Australia 1953 - 1967

To accompany Record No 1967/84

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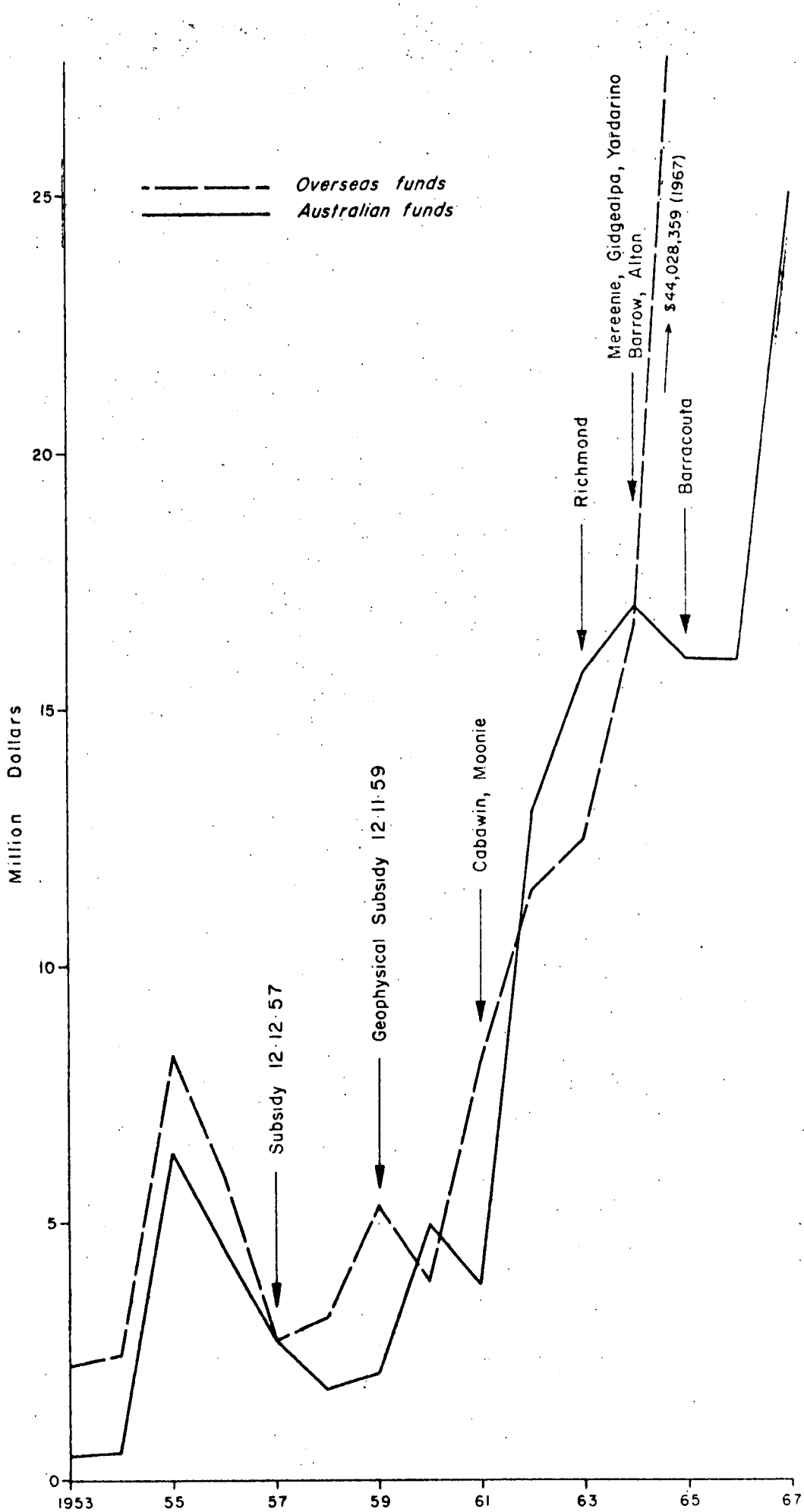

Fig. 7 Expenditure by private companies on petroleum exploration in Australia 1953 – 1967 separated into Australian and overseas sources

To accompany Record No 1967/84

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