DEPARTMENT OF
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IN CONFIDENCE

Record 1978/39

An Appraisal of Petroleum Exploration Title Areas WA-15-P, WA-16-P, WA-17-P, WA-18-P, WA-19-P. March 1975.

by

W.J. McAvoy and P.R. Temple

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SUMMARY

This Record is the result of a brief examination at date relevant to the title areas. All available data have been used in its preparation including confidential company reports, but no original interpretation has been made.

Summaries are given of the regional geology and depositional history of the Bonapartes Gulf Basin, hydrocarbon potential, geophysical activity, and drilling results. Assessments have been made of the prospectivity of the title areas, and recommendations are made for further exploration.

The area has been covered by an extensive seismic grid and ten offshore wells have been drilled. Results have been disappointing to date, and as only one well, Tern No. 1, has had significant hydrocarbon shows, chances for future discoveries are not rated highly.

INTRODUCTION

This record is the result of a brief examination of data relevant to the title areas under consideration.

All available data were used in its preparation including reports received under the Petroleum Search Subsidy Act (PSSA) and the Petroleum (Submerged Lands) Act (P(SL)A), review reports from private companies, and BMR data. No original interpretations were made.

Because a large proportion of the data used is confidential and not available to the general public this Record must be classified as confidential.

REGIONAL SETTING

The title areas under consideration are located in the Western Australian portion of the Bonaparte Gulf and off the northern coast of Western Australia southeast of the island of Timor. Offshore acreage immediately east of the title areas is within the Northern Territory. The adjoining onshore area is geographically remote and Darwin is the only centre capable of providing a logistical base. Darwin is situated 170 miles (272km) from the eastern limit and 380 miles (608km) from the western limit of the title areas.

Water depths in the area vary from very shallow at the coastline to 600 ft (200 m) at the seaward margins of the title areas. Only a small part of the northern portion of WA-15-P lies in water depths in excess of 600 ft (200 m).

GEOPHYSICS

Aeromagnetic

In 1958 BMR carried out an aeromagnetic survey over the subject permits. The results showed a depression plunging to the north to a maximum depth estimated as 20,000 ft (6000 m).

A more extensive survey was flown for Arco Limited and Australian Aquitaine Petroleum Pty Ltd, in the 1965 'Timor Sea Aeromagnetic Survey'. This survey outlined the offshore configuration of the Bonaparte Gulf and indicated possible faults and structures along the flanks of the basin.

Gravity

Regional and detailed gravity surveys were carried out on the Australian mainland in the Bonaparte Gulf and Timor Sea areas by BMR and various leaseholders. BMR also recorded gravity in their marine surveys of the offshore Bonaparte Gulf in 1965 and 1967. The major gravity feature revealed was a large north-south maximum showing approximately 100 milligals relief located in the centre of the Bonaparte Gulf. This maximum is flanked by two minima, one to the east trending north and one on the west trending northwesterly. Because the large gravity maximum coincides with aeromagnetic and seismic depressions, it is possible that it originates from an intra-basement density contrast.

Seismic

Several seismic surveys have been carried out over the onshore parts of the Bonaparte Gulf Basin by BMR and the various tenement holders.

The offshore areas have been covered by a number of reconnaissance and detail surveys since 1965 when the first BMR gravity and seismic spark array survey was carried out. The BMR survey in 1965 was followed by further reconnaissance, using the same techniques, carried out for Arco and Australian Aquitaine.

This early work confirmed the existence of a large Permian and Mesozoic sedimentary basin in the Bonaparte Gulf but the sparker unit used had insufficient power to penetrate the full sedimentary section in the deeper parts of the basin.

Explosive energy source and 3-fold CDP techniques were used in 1965 by Anacapa Corporation in the West Bonaparte Gulf seismic survey which provided a rconnaissance cover of WA-19-P. The results showed that the sediments thickened to the northeast with a possibility of 25,000 ft (7620m) of Palaeozoic to Mesozoic sediments. Record quality ranged from good to poor, being affected by multiples at depth. Three structural leads were uncovered and possible intrusive features suggested. The structural leads were detailed in the Medusa Bank seismic survey using a combination of three-fold and six-fold coverage.

In 1966, Arco Ltd and Australian Aquitaine carried out the Sahul Shelf survey. This was a wide-ranging reconnaissance survey using a 130 000 joules sparker. Results were good in the southern part of the Bonaparte Gulf, but in the norhtern deeper part of the basin penetrating power was inadequate. Overall configuration of the basin was outlined and the aeromagnetic interpretation of a triangular basin confirmed. The northwesterly limit of the basin appears to be a high trend along the edge of the continental shelf. Several significant structures were found mainly in the southern area of good data.

These features were further detailed in 1967 in the Lesueur Marine Seismic Survey and two additional structures located.

In 1966 Arco Ltd and Australian Aquitaine Petroleum compared 'Flexotir' three-fold coverage and conventional dynamite six-fold shooting with sparker results on line TS 14. Dynamite source gave the best penetration and record character, and digital processing and multiple coverage resulted in significant upgrading of record quality.

A major reconnaissance of the Sahul Rise was carried out in the Sahul Rise survy in 1967. Dynamite energy source with six-fold digital recording and processing were used in the deep areas where data were poor. Basement was recorded in the southwestern part of the survey area and reliable events down to the Permian were recorded in

the north. Two principal structural trends were revealed - an older northwest Palaeozoic trend with a superimposed northeast younger trend probably Tertiary in age. Two structural closures (A3 and A6) were confirmed and numerous structural leads uncovered. The main structural elements as interpreted from magnetic and gravity results were confirmed.

Reconnaissance of the Bonaparte Basin and margins was completed in the Londonderry Rise Survey in 1968. Six-fold explosive and 12-fold 'Flexotir' techniques were employed. Record quality was good in the south, poor in the central depression (Malita Graben) because of deepening markers, complex tectonics, and rough sea bottom, and fair to poor in the northeast. Known structural leads were evaluated. Detailed velocity analysis was introduced in this project.

Further detailing of structures was carried out in the Van Diemen's Rise Survey in 1969. Structures in four scattered areas were detailed and average velocity and depth maps prepared. Most surveys up to 1969 were subsidised under the Petroleum Search Subsidy Act 1959-1969.

Since 1970 the tenement holders have further evaluated the tenements with unsubsidised surveys not available to the Public. These more recent data are of significantly improved quality due to improvements in the streamer used, better deconvolution and velocity analysis, and increased multiplicity of coverage.

The Holothuria survey carried out in 1970 provided further regional and some detail coverage. Aquapulse energy source and digital recording and processing produced data of satisfactory quality down to 5 two-way time. Structures P9, A23, A19, and A20, A32, A33, A34 were confirmed although further detailing is required on the last three. In the Cape Scott survey a single tie-line was recorded between Lacrosse-1 and Bougainville structures in 1970. Lacrosse 1 and Pelican Is-1 were detailed in the Pelican Is Survey carried out in September 1971.

In September and October 1971 the Gale Bank survey added detail coverage in NT/P3, WA-17-P, WA-18-P, and semi-detail coverage in WA-15-P, WA-16-P, and NT/P2. Record quality ranged from questionable to good. Regional control was strengthened and previous shooting tied in WA-15-P. A-20 (Eider-1) was further detailed and A-1, A-2, A-4 (Penguin-1), A-7, and A-15 were shown to be the result of salt flowage.

Regional coverage in WA 15, 16, 17P was extended in the Baldwin Bank survey carried out in 1972. Several low-relief anomalies were mapped on the Sahul Rise but require further work. Detailing of A19 and A20 was advanced, the latter being matured as a site for Eider-1.

The Pago survey recorded in May-July 1972 was concentrated in WA-18-P and in the south of WA-17-P and WA-16-P where detailing and semi-detailing were carried out. Control in the Tern, Penguin, and Petrel areas was improved. A15, A2, and A7 anomalies were further delineated. The Plover feature appears to be a promising faulted stratigraphic trap. Further work is required to evaluate stratigraphic entrapment possibilities in the Osprey (A47) vicinity.

Detail and semi-detail work was carried out in WA-15, 16, 17, 18P, NT/P2, and NT/P4 to detail structures and to extend regional coverage in Hat Point survey in 1973. Airgun energy source with 4800% digital recording and processing techniques produced data comparable in quality to Pago results and better than that of previous surveys. Detailing was carried out near the southeast-trending basin margin fault and its associated structures A7 and A15. The Plover feature (A-46) was more accurately delineated and shown to be dependent on truncation and faulting for entrapment. No additional information resulted in the Flamingo area because of a multiple problem.

Structures located near the boundary between WA-19-P and NT/P1 were detailed in the Knob Peak survey recorded for Arco in 1973 with airgun energy source. Only insignificant closures were mapped.

Detailing in the Puffin and Plover localities was carried out in the Cartier Survey in 1973. Regional coverage was extended into areas of sparse coverage, but no new anomalies were revealed. The Plover feature was matured as a stratigraphic trap. Anomalies A-8, A-52, A-11 in the Puffin/Swan area were more accurately delineated. Anomalies A-53, A-56, A-57, A-58, and A-59 need further investigation. Also in 1973 Arco participated in a joint venture with BOC over titles WA-15-P, NT/P2, and NT/P15 in the Dillon Shoals Survey. Only 7% of the total mileage was recorded in WA-15-P.

Most recent work has been carried out in August/September 1974. The Cape Talbot seismic survey recorded approximately 1500 miles of 2400% airgun data in six separate areas: Penguin-Tern-Petrel, northeast

of Gulf-1, Plover-2, Eider-1, midway between Plover and Eider, and Puffin-Swan-Osprey, localities scattered over permit areas NT/P2, NT/P3, NT/P4, Wa-15-P, WA-16-P, WA-17-P, and WA-18-P.

Further detailing of sturctural leads in the southern part of the Bonaparte Gulf in permit areas WA-17-P, WA-19-P, and NT/P3 was carried out in the Tree Point survey. Results of WA-19-P and NT/P3 have not yet been supplied.

REGIONAL GEOLOGY

The structural and depositional history of the general Bonaparte Gulf Timor Sea area has been relatively simple. The only tectonic forces evident are tensional block-faulting, vertical epeirogenesis, salt diapirism, and salt flow. There is no evidence of compressional forces during the sedimentary history of the basin.

The regional structural configuration is basically the result of the intersection of two major structural trends. The Palaeozoic to mid-Jurassic structural grain is northwest but late Jurassic to Holocene trends are predominantly northeast. However, there still remains a northwest component to post-mid-Jurassic trends in areas where the original Palaeozoic grain has remained dominant.

The title areas under consideration in this record all lie within the Bonaparte Gulf Basin. This basin is bounded to south and east respectively by the Precambrian Kimberley and Sturt Blocks and to the north by the Timor Trough, a Plio-Pleistocene downwarp in which water depths exceed 10000 ft (3000m). To the west, the Bonaparte Gulf Basin is separated from the northern extension of the Browse Basin by the Northeast Londonderry Rise.

The Bonaparte Gulf Timor Sea area has been divided into a number of distinct structural provinces: Kimberley, Sturt, and Darwin blocks, Petrel Sub-basin, Malita Graben, Sahul Platform and Sahul Syncline, Northeast Londonderry Rise, Vulcan Sub-basin, Ashmore Block, and Timor Trough. The last three tectonic elements lie outside the area under consideration.

Kimberley, Sturt, and Darwin Blocks

The Kimberley and Sturt Blocks are stable areas of Precambrian rocks flanking the Bonaparte Gulf Basin to the south and east respectively. They consist mainly of gently dipping Upper Proterozoic sediments and volcanic sills and have been the source of the bulk of sediments deposited in the Bonaparte Gulf Basin. A postulated Mesozoic landmass near the Timor Trough is believed to have periodically contributed sediments from the northwest.

The Darwin Block is a traingular-shaped westward extension of the Sturt Block, consisting of Precambrian rocks overlain by a relatively thin sequence of Phanerozoic sediments. It is separated from the Sturt Block by the Halls Creek Mobile Zone, a major crustal lineament consisting of older Precambrian metamorphic and plutonic rocks. It has been suggested that formation of the Bonaparte Gulf Basin possibly originated from northward movement of the Darwin Block along the Halls Creek Mibile Zone.

Petrel Sub-basin. The Petrel Sub-basin is a U-shaped northwest-pitching syncline of Phanerozoic sediments in the southeastern portion of the Bonaparte Gulf Basin. The geology of the area is fairly well known from well data and seismic control. Northwest (pre-mid-Jurassic) structural trends have persisted throughout and the sub-basin depocentre has virtually remained in the same position since at least early Permian time. Fault systems flanking the sub-basin were active throughout the Palaeozoic but have acted as hinges throughout the Mesozoic.

Some 18000 ft (5500 m) of Palaeozoic sediments is known to occur onshore and at least a portion of it is present at the head of the Bonaparte Gulf Basin. Lacrosse - 1 penetrated some 8000 ft (2500 m) of Upper Permian to Lower Carboniferous rocks below a thin veneer of Tertiary and Lower Triassic sediments. The extent to which the Palaeozoic rocks continue seawards is unknown, with the exception of the Upper Permian (Hyland Bay Formation). To date no Pre-Permian sediments have been penetrated by drilling north of Tern-1 well (13^{o} 13').

Structures within the Petrel Sub-basin are believed to be the result of salt diapirism. Both Pelican Island-1 and Sandpiper-1 have reached salt of probable Devonian age. Some movement is believed to have commenced during the Permo-Carboniferous although structures such as

those below Petrel, Tern, and Lacrosse were actively growing during the Mesozoic. Oil and gas shows are confined to the Upper Permian (Hyland Bay Formation) offshore (Penguin-1, Petrel-1, Tern-1) but shows occur in the Carboniferous and Devonian on land.

Although growth diapiric structures are evident in the Petrel Sub-basin in the Mesozoic, there have been no indications of hydrocarbons in the Mesozoic.

Malita Graben

The Malita Graben, also known as the Heron Graben and Calder Graben, shares some common characteristics with the Sahul Syncline and Gartier Trough (Vulcan Sub-basin). Well evidence and seismic control demonstrate that subsidence of the these areas took place in the Callovian-Oxfordian (Upper Jurassic). It is possible that the Malita Graben may have had some expression during the Palaeozoic.

These negative trough areas accumulated 4500-10000 ft (1400-3000m) of ?Oxfordian to Campanian or Maestrichtian marine shales.

The Malita Graben is a major northeast-trending faulted trough terminating at its southern end in the Petrel Sub-basin. A major fault zone defines its northern junction with the Sahul Ridge with an estimated throw in excess of 5000 ft (1500 m). About 7000 ft (2000 m) of Cretaceous and 8000 ft (2500 m) of Tertiary sediments are present in the deeper part of the graben. Only one well, Heron-1, has been drilled to date within the area. Seismic records are generally poor apparently owing to a great thickness of homogeneous fine clastic fill.

Although movement along major bounding faults may have been initiated somewhat earlier, well data and seismic correlations suggest that the graben had its major development in mid and Upper Jurassic time. It has continued to subside into the Holocene and is coincident with a bathymetric depression in which water depths reach 500 ft (150 m).

Sahul Platform and Sahul Syncline

The Sahul Platform (also referred to as the Sahul Ridge) lies to the north of and parallel to the Malita Craben. It is limited to the north by the Timor Trough where Plio-Pleistocene faulting marks the

boundary, and to the west by the Sahul Syncline. The eastern extent of the Sahul Platform is unclear, but results from Lynedoch-1 suggests that it is not continuous with the Darwin Shelf. It is well-defined on gravity and aeromagnetics and has a bathymetric expression.

Interpretation of seismic sections is complicated by velocity anomalies caused by profilic surface and near-surface limestone reefs. It is however interpreted as a large basement high that may have been formed at the time of the initial rifting of the craton.

Only one well, Flamingo-1, has been drilled on the platform within the title areas under consideration and this, together,with seismic work, indicates that Triassic to Palaeocene sediments thin northwestward across the platform owing partly to starved basin conditions and partly to thinning onto a high considered to have been present in the Timor Trough area during most of Mesozoic time. Conversely, the Eocene to Holocene sequence thickens northwestward across the Sahul Platform in the direction of regional thinning of the older sediments.

The Platform is characterised by a series of northwest-trending folds crossing the platform, limited to the west by the structurally simple Sahul Syncline. These broad anticlines and synclines are considered to reflect a Permo-Triassic basement fault pattern which was partly rejuvenated in the Jurassic and Cretaceous. Before mid-Jurassic time, the Sahul Platform, Sahul syncline, and Petrel Sub-basin probably formed a single structural entity which was subsequently interrupted by the formation of the Malita Graben.

Reservoir rocks are considered to be present in the Middle-Upper Triassic and Middle Jurassic with ?Lower Permian reservoirs on the Flanks of the Platform. Adequate cap-rock, principally Upper Cretaceous shale, is envisaged.

Northeast Londonderry Rise

The Northeast Londonderry Rise separates the Browse and Bonaparte Gulf Basins. It is expressed on seismic maps as an intensely faulted shelf extending northeastward from the Londonderry Arch. To the northeast it is bordered by the Sahul Syncline, to the east by the Bonaparte Shelf and Kimberly Block margin, and on the northwest by the Cartier Trough (Vulcan Sub-basin).

There is some evidence for post-Permian faulting in a northwest direction but the major fault trend is northeast. This may have been initiated at the close of the ?Triassic, if so, it was strongly rejuvenated in the Callovian-Oxfordian when the Northeast Londonderry Rise was uplifted. The Rise was subsequently eroded and then thinly onlapped by Upper Jurassic and younger sediments. A subsequent period of faulting occurred in the Upper Tertiary with the rejuvenation of old faults and the development of new faults at a shallow angle to the original fault direction. This has resulted in a complicated structural pattern of jumbled fault-blocks and fault wedges.

Four wells have been drilled on the Northeast Londonderry Rise: Dillon Shoals-1, Eider-1, Osprey-1 and Whimbrel-1. Only Eider-1 and Whimbrel-1 are located in the title areas under consideration. Eider-1 penetrated a Tertiary/Cretaceous section to 5910 ft (180 m), Jurassic to 8730 ft (2660 m), and Upper Triassic to TD 9300 ft (2835 m). The Lower Cretaceous Petrel 'A' formation was absent. No shows were encountered and the well was plugged and abondoned.

Whimbrel-1 penetrated a Tertiary/Cretaceous section to 3610 ft (1100 m), Jurassic/Lower Cretaceous Petrel Fn to 3710 ft (1128 m) Triassic to 6171 ft (1881 m), and Permian Hyland Bay Fm to TD 6754 ft (2059 m). Now shows were encountered and the well was plugged and abandoned.

Londonderry-1 was drilled in WA-35-P on the eastern flank of the Londonderry Arch/Kimberley Block margin within the Browse Basin. Plover Nos 1 and 2 were drilled as stratigraphic trap wells on the Londonderry Rise/Kimberley Block margin where the sedimentary section thins and pinches out.

DEPOSITIONAL HISTORY

Lower to Middle Palaeozoic

It has been suggested that the origin of the Bonaparte Gulf Basin may be tied to rift development following northward movement of the Darwin Block along the Hall Creek Mobile Zone.

Within the Bonaparte Gulf Basin Lower to Middle Palaeozoic sediments have been encountered only in the offshore portion of the Petrel Sub-basin and offshore in wells drilled on diapiric structures (Sandpiper-1). The depositional history within the Petrel Sub-basin followed the typical 'Rift Valley' and early 'Red Sea' stages (Schneider 1972, Geol. Soc. Am. Mem. 132) with initial outpourings of basalt (early Cambrian) followed by clastics (Cambro-Ordovician), evaporites, (Silurian to ?Devonian) and fringing reef carbonates (Devonian).

Within the Petrel Sub-basin, evaporites occur over a broad area as evidenced by the wide distribution of slat piercement structures. Two wells, Sandpiper-1 and Pelican Island-1, have intersected massive salt. Outside the Sub-basin the distribution of salt is unknown. In the onshore portion of the basin, a reef complex developed on the shelf fringing the Kimberley and Sturt Blocks in the late Devonian. Thick shales and siltstones are postulated to have been deposited basinward in deeper water, but to date this sequence has not been reached in offshore wells.

In outcrop and a number of wells drilled onshore a thick monotonous sequence of Carboniferous shales, mudstones, and limestones overlie Upper Devonian. In Lacrosse-1, sandstones and fractured limestones were encountered in the Upper Carboniferous.

Late Carboniferous to Permian

Following faulting and major uplift of the basin flanks in the late Carboniferous, widespread stripping of marginal areas occurred. A deltaic complex occupies the Petrel Sub-basin from the ?late Carboniferous to late Permian and more than 20,000 ft (6000 m) of sediments was deposited during this interval.

The bulk of the sediments laid down in the Petrel Sub-basin during the late Carboniferous to late Permian were sands deposited during major regressive and transgressive cycles. At the base of the sequence the sands are of a regressive nature and include offshore bar, strand line and associated environments, grading up to channel and natural levee deposits. Sands deposited near the basin margins are generally clean with good reservoir characteristics; towards the depocentre these characteristics decrease with increasing depth of burial and argillaceous content.

Outside the Petrel Sub-basin, the only well to penetrate early Permian was Rob-Roy -1 in the Browse Basin.

Sedimentation continued to the Upper Permian, and sediments are predominantly marine to marginal marine deltaic clastics with thin limestone bands which can be traced over the Petrel Sub-basin.

Only five wells outside the Petrel Sub-basin have penetrated the Upper Permian, Whimbrel-1, Osprey-1, Sahul Shoals-1 and Plover 1 and 2. All penetrated a shale and limestone section.

Triassic to Middle Jurassic

Deposition continued without a break from the Permian into the Triassic with the onset of renewed marine transgression. The transgression reached its maximum phase in the early Triassic and subsequent regression continued at least into the Early Jurassic and probably into the Middle Jurassic.

In the Petrel Sub-Basin, Lower to Middle Triassic marine sands and shales overlie the massive basal shale unit and grade upwards to massive sands of fluvial origin. The sands are succeeded by an Upper Triassic to Lower Jurassic non-marine redbed facies of multi-coloured shales with interbedded sandstones which are generally restricted to the basin margins.

West of the Northeast Londonderry Rise, Lower to Upper Triassic sediments overlying the massive basal shale unit are characterised by marine to marginal marine carbonates, shales, and sandstones. There is a definite increase in sand concentration to the northwest, probably indicating a sediment source in that direction ('Western Landmass' - APEA 1973 Waris). Deposition continued into the Jurassic conformably with the persistence of a regressive cycle.

After Middle Jurassic deposition and before the recommencement of deposition in the Late Jurassic a major period of epeirogeny occurred ('Callovian'). The dominant northwest structural grain was supplanted by northeast trends and the Malita Graben, Sahul Platform, Londonderry High, Vulcan Sub-basin, and Ashmore Block were all formed. Upper Triassic to Middle Jurassic sediments were stripped from the positive areas on the Northeast Londonderry Rise and Ashmore Block.

Both the Vulcan Sub-basin and Malita Graben possibly owe their origin to tensional forces of the same type which initiated the Petrel Sub-basin in the Lower Cambrian. Basalts of Late Jurassic age are present in Ashmore Reef-1.

Late Jurassic to Neocomian

After the Middle Jurassic ('Callovian') epeitogeny, deposition recommenced in the late Jurassic and continued into the Neocomian. The sediments thicken uniformly from their lineated edge along the basin margin into the Malita Graben where they exceed 4000 ft (1200 m) in thickness. From this major depocentre the sediments thin northwards across the Sahul Platform and westwards over the Northeast Londonderry Rise, suggesting the presence of highs in these directions. They thicken erratically into the Vulcan Sub-basin and are largely missing on the Ashmore-Sahul Block owing to non-deposition or subsequent erosion.

Three units are recognised in these sediments; the lower and upper units (Petrel 'C' and 'A' respectively) are largely sandstone, separated by a middle unit (Petrel 'B') which is predominantly shale.

Cretaceous

Cretaceous sediments thicken northward from their erosional edge near the present Australian coast into the Malita Graben where they exceed 7000 ft (2000 m). Apart from minor thickening in the Vulcan Sub-basin, the Cretaceous thins uniformly north and west from the graben, becoming more marine and generally more calcareous.

Shales and argillaceous micrites are the dominant rock types of the Cretaceous, with sands known only in the upper part of the cycle. Two major depositional cycles are involved, the first ranging from Albo-Aptian to Turonian, and the second from Turonian to Maestrichtian.

Tertiary

In the Bonaparte Gulf Basin a distinct lithological change is evident across the Cretaceous/Tertiary boundary, with Maestrichtian shales generally being succeeded by Palaeocene carbonates. However, in the

Vulcan Sub-basin and Ashmore-Sahul block areas, the facies above and below the boundary are generally quite similar although there is a tendency of the Tertiary carbonates to be more argillaceous than those in the Cretaceous.

The Tertiary sequence thickens northwestward from less than 1000 ft (300 m) in the southeastern portion of the Petrel Sub-basin to more than 8000 ft (2500 m) in the Malita Graben and on the Sahul Platform. The equivalent interval thickens westward from about 2000 ft (600 m) on the Northeast Londonderry Rise to more than 6000 ft (1800 m) in the Vulcan Sub-basin and on the Ashmore-Sahul Block.

HYDROCARBON POTENTIAL

The hydrocarbon potential of the offshore Bonaparte Gulf Basin is known from the scattered well control throughout the area. A number of wells have had significant hydrocarbon shows and have given sufficient encouragement to warrant further exploration. Within the title areas under consideration the significant hydrocarbon shows are noted in Table 1.

Apart from the southeastern margins of the basin the section beneath the Upper Permian Hyland Bay Formation is considered too deep to be of economic significance. Within this part of the sub-basin (WA-19-P) the Lower Permian Kulshill Formation and the Carboniferous Medusa Beds must be regarded as having some prospect, however they cannot be rated very highly.

The hydrocarbon potential of the section from the Upper Permian to Tertiary is now discussed in further detail with some indication of the prime areas of interest for each section.

HYDROCARBON POTENTIAL

Upper Permian - Hyland Bay Formation

This formation has been penetrated by a number of wells in the offshore Bonaparte Gulf Basin. The thickest drilled section of Hyland Bay Formation measured 2343 ft (714 m) and was penetrated in Osprey-1 on the Northeast Londonderry Rise. In the Petrel Sub-basin the sequence thickens along a northwest-trending linear depression flanked by salt domes which were believed to be moderately active during that period.

OFFSHORE WELLS - GENERAL DATA

Well	Title	Rig release	RT/wd	T.D.	Tectonic division	Deepest horizon reached
Whimbrel -1	WA-15-P	8.5.74	25m/77m 83'/252'	2059m 6754'	SE flank Londonderry R.	U. Permian
Eider -1	WA-15-P	30.9.72	34m/100m 113'/328'	2835 m 9300'	Londonderry R.	U. Triassic
Flamingo -1	WA-16-P	8.12.71	34m/96m 113'/315'	3700m 12139'	Sahul Rise	U. Jurassic
Plover -1	WA-16-P	17.12.72	34m/58m 112'/190'	2438m 8000'	Londonderry Rise	U. Permian
Plover -2	WA-16-P	23.5.71	25m/59m 83'/194'	1524m 5000'	Londonderry Rise	U. Permian
Gull -1 $2.3mm	WA-17-P	11.9.71	13m/134m 43'/441'	3421m 11225'	Petrel Sub-basin	Triassic
Penguin -1	WA-17-P	29.7.72	34m/69m 113'/225'	2757m 9045'	Petrel Sub-basin	L. Permian
Sandpiper -1	WA-18-P	11.9.71	12m/87m 39'/284'	1892m 6206'	Petrel Sub-basin	U. Devonian
Tern -1	WA-18-P	5.8.71	12m/92m 39'/302'	4352m 14278'	Petrel Sub-basin	L. Permian
Lacrosse -1 $2.00mm 68/2053	WA-19-P	7.5.69	25m/31m 83'/103'	3054m 10020'	Petrel Sub-basin	L. Carb.
Pelican Is -1 72/B68	EP - 54	29.7.72	12m/8m +41/GL+25'	1981m 6500'	Bonaparte	Devonian

Table 2

OFFSHORE WELLS - STRATIGRAPHY

Seismic horizons				Whitebrol=1	Elder=1	Flamingo=1	Plover=1	Plover=2	Gull=1	Penguin=1	Sandpiper=1	Tern=1	Lacrosse=1	Pelican Is=1
MT/wd				• 83°/252° (25m/77m)	•113°/328° (34m/100m)	• 113°/315° (34m/96m)	•112°/190° (34m/ 58m)	•83°/194° (25m/ 59m)	•43°/441° (13m/ 134m)	•113°/225° (34m/ 69m)	•39°/284° (12m / 87m)	•39°/302° (12m/92m)	•83°/103° (25m/31m) 188° (57m)	•41°/•25° (12m/8m) GL
Quaternary													Tertiary Cost. undiff.	
Tertiary	1C	Upper	P.											
			M.	778° (237m) NP	925° (282m)	910° (282m) 2576° (785m)	776° (237m)	1020° (311m)	1020° (311m) NP	840° (256m)		341° (104m)		
			O.											
		Lower	E.	) 1310° (399m)	) 1716° (523m)	3630° (1105m)			NP					
			P.	)	)	5053° (1540m)			1250° (381m)					
	2A													
Cretaceous		Upper		Upper Bathurst Island Fm.) 1950° (594m)	3862° (117. m)	6584° (2007m)	1272° (388m)		) 1958° (595m)	) 1240° (378m)		1377° (401m)		
		Lower		Lower Bathurst Island Fm.	5560° (?)	8170° (2490m)	3180° (969m)	1177° (359m)			800° (244m)	7609° ? (795m)		
	2			Petrel 'A' 3610° (1100m)	N.P.	9595? (2925m)	N.P.	2020° (616m)	6984° (2129m)	NP	1654° (504m)	3738° (1139m)		
	J	Upper		Petrel 'B'	5910° (1801m)	10,000° (3046m)	3450° (1051m)			2634° (803m)	1937° (590m)	4070° (1241m)		
Jurassic				Petrel 'C'	6063° (1848m)	10,716° (3266m)	3638° (1109m)	N.P.		2824° (861m)	2298° (700m)	4368° (1331m)		
	3A													
		Lower		"Red beds" NP	7650° (2332m)		4286° (1306m)		10206° (3111m)	3711° (1131m)		NP		
	3						(1492m)		(3345m)					
		Upper		Undiff. 3701° (1128m)	6730° (2661m)		4896°		10974°	4195° (1279m)	3000 (914m)	5494° (1675m)		
Triassic	MT													
		Lower		Mt. Goodwin Fm 5038° (1535m)			5534° (1687m)	2343° (714m)		5287° (1611m)		6673° (2034m)	505° (154m)	
	4													
		Upper		Hyland Bay Fm 6171° (1881m)			7049° (2148m)	3728° (1136m)		6883° (2098m)		8272° (2521m)	760° (232m)	
	5													
Permian		Lower		Undiff. Kulshill Fm		(Note: Petrel 'A' may be absent?)				8348° (2544m)		9818° (2993m) 11708° (3569m)	1990° (607m)	
	MB	Upper											7823° (2384m)	25° (8m)
Carboniferous														
		Lower									3097° (944m)		8866° (2702m)	1282° (391m)
Devonian		Upper									5751° (1753m)			5877° (1791m)
		Lower												
Precambrian														
				6754° (2059m)	9300° (2835m)	12,139° (3700m)	8000° (2438m)	5000° (1524m)	11225° (3421m)	9045° (2757m)	6206° (1837m)	14278° (4352m)	10020° (3054m)	6500° (1981m)

Four wells, Petrel 1 and 2, Tern-1, and Penguin-1, located within the Petrel Sub-basin all tested gas from the Hyland Bay Formation. Petrel-1 blew out after drilling a limestone section and Penguin-1 recovered 129 cu. ft of gas from an F.I.T. in the same interval. Petrel-2 and Tern-1 recovered gas at the rates of 9.2 MMcf/d and 7.89 MMcf/d respectively.

The Hyland Bay Formation is overlain by the Mount Goodwin Formation which is not only an excellent caprock but also has source potential.

Areas of interest Structures flanking the Petrel Sub-basin margins being nearer the palaeo-shoreline should possess better reservoir characteristics than both the Petrel and Tern structures. Areas flanking the salt piercement structures are expected to have a somewhat thicker sand section. In the west, good trap possibilities exist along the downfaulted margins of the Browse Basin and the margins of the Londonderry Arch. Elsewhere in the basin the Upper Permian is considered to be too deep to be of any significant economic interest.

Triassic To date, although the Triassic has been completely drilled in a number of wells, no significant hydrocarbon shows have been detected.

The Mount Goodwin Formation conformably overlies the Hyland Bay Formation. Horizon MT near the top of the Mount Goodwin Formation is a good seismic reflector and is present throughout most of the Bonaparte Shelf south of the Malita Graben and east of the Londonderry Arch. The overlying Lower to Middle undifferentiated Triassic sequence in the south-east is composed of non-marine to marginal marine sandstone and shales. In the western portion of the basin the Upper Triassic is characterised by marginal marine and marine carbonates and clastics.

Areas of interest The block faulted margins of the Browse-Cartier province west of the Londonderry Arch seem most attractive. This area is, however, outside the area of interest in this Record.

Although the Triassic was not reached at Flamingo-1 on the Sahul Platform a number of prospects have been revealed in this area which could be of interest. Success in the Triassic will depend on whether good clean sands have been deposited from a northern source.

Stratigraphic pinchout plays along the basin margins where the Upper Triassic is wedged between the Mount Goodwin Formation and the Bathurst Island Formation are also distinct possibilities although the drilling of Plover-1 and Plover-2 has not given too much encouragement.

Lower Jurassic - 'Red Beds'

These clastics are thought to represent an alluvial facies deposited by mature river systems. Although the unit has good reservoir properties in the southeastern part of the basin it is not presently considered prospective. This is primarily due to its continental origin, and its apparent limited thickness and areal extent. To date no hydrocarbon shows have been encountered in these sands.

Upper Jurassic to Lower Cretaceous - Petrel Formation

Generally the Petrel Formation is present over most of the basin and unconformably overlies the 'Red Beds'.

The Petrel Formation ranges from marine to non-marine and is composed of three distinct members which are, within limits, essentially diachronous. Members 'A' and 'C' are primarily sand units separated by the 'B' member which is a shale unit (with sands present in the Gull and Plover areas).

Sidewall cores shot from 6020 ft (1835 m) to 6160 ft (1878 m) in the 'C' sand in Eider-1 exhibited oil staining, fluorescence, and cut, but FIT and DST data subsequently proved this zone to be water-bearing.

In Flamingo-1 a minor residual oil show at 11920 ft (3633 m) in a tight 'C' sand interval was noted in a core. Log analysis and an FIT established the presence of gas from 10716 ft (3266 m) to approximately 11068 ft (3374 m) in the 'C' sand. The sand, however, is silicified and has a very low effective porosity in this well.

The Petrel 'B' member forms the effective seal in the Flamingo area and should be considered as potential caprock and source rock elsewhere in the basin. The Bathurst Island Shale blankets the basin and provides a moderately good source rock and an excellent caprock for the underlying Petrel Formation.

Areas of interest Of particular interest is the erosional edge of the 'C' member sand in the south-central portion of the basin where it has onlapped the Mount Goodwin Formation and is overlain by the Lower Cretaceous Bathurst Island Shale.

Other stratigraphic and structural/stratigraphic plays have been located around the flanks of the Northeast Londonderry Rise, the eastern faulted margin of the Browse Basin, and the Cartier Trough.

The salt dome province in the Petrel Sub-basin should also prove to be prospective, especially piercement and pillow structures which have had early growth and late migration histories.

Lower to Upper Cretaceous - Bathurst Island Formation

The Bathurst Island Formation has been penetrated by all wells drilled in the offshore Bonaparte Gulf Basin except the nearshore wells in the Petrel Sub-basin. The thickest section was penetrated by Heron-1 (6976 ft (2126 m)) in the Malita Graben. The contact with the underlying Petrel Formation is an excellent seismic reflector (Horizon 2). From its erosional edge south of Plover the Bathurst Island Formation thickens northwards into the Malita Graben.

Within the title areas under consideration no significant shows have been encountered, but the Puffin wells and Swan-1 in the Browse/Cartier depression had good shows. Puffin-1 proved 5 ft (1.5 m) of net pay in the Upper Cretaceous and Puffin-2 considerably more - both wells flowed oil on test. A test at Swan-1 recovered gas and condersate from the same interval.

Although the formation is predominantly shale, sands as in the Puffin and Swan areas are common around the basin flanks.

Areas of interest The Browse-Cartier area probably offers the best hydrocarbon prospects, the only real doubt is in the caprock capacity. This area is in NT/P2 outside the area under consideration.

Within the eastern part of the basin moderate reservoir rocks are known, but the overlying Tertiary does not really afford suitable caprock capacities.

Tertiary

The Tertiary within the Bonaparte Gulf Basin thickens from 1000 ft (300 m) in the southeastern portion of the Petrel Sub-basin to more than 8000 ft (2500 m) in the Malita Graben and Sahul Platform. The section is predominantly carbonates and marls, and sandstones and shales form only a minor proportion of the sediments deposited. The shales which are present grade to marls and the sandstones are commonly cemented with a calcareous matrix.

The only hydrocarbon shows in Tertiary sediments in the Bonaparte Gulf basin recorded to date are in Puffin-1 well. Electric log and core analysis indicate the presence of heavy sour crude oil in vuggy calcarenites and argillaceous calcilutities of Eocene age from 3350 ft (1021 m) to 3376 ft (1029 m) in this well.

To date no hydrocarbon shows have been encountered within Tertiary sediments in the title areas under consideration.

Title Assessment WA-15-P

Title Holder	Arco Australia Ltd Australian Aquitaine Petroleum Pty Ltd Esso Exploration and Production Aust. Inc.
No. of Blocks	352
Expiry Date	20.3.1975

Farmout Agreements Agreement 4SL/1970 - by which Esso Exploration and Production Australia Inc. receives a 12½% undivided interest in WA-15-P - approved and registered 29.1.71.

Previous six-year conditions ($A)

First	247, 000	701.70 block/year
Second	75,000	213.06 block/year
Third	100,000	284.09 block/year
Fourth	3,100,000	8,806.81 block/year
Fifth	25,000	71.02 block/year
Sixth	25,000	71.02 block/year
	3,572,000	1,691.28 block/year average

Regional Setting

WA-15-P is located entirely offshore from the north coast of Western Australia. It is a north-south elongate title area bounded to the west by WA-37-P, NT/P2 and NT/P8; to the north by WA-36-P, to the east by WA-36-P, NT/P4 and WA-16-P; and to the south by WA-35-P. Water depths throughout are less than 600 ft (200 m) except in the northern portion of the title area.

Wells Drilled

Two wells, Eider -1 and Whimbrel -1 have been drilled within WA-15-P. Eider -1 was drilled on a large extensively faulted structural high on the Londonderry Rise. The well drilled Tertiary to 3862 ft (1177 m), Cretaceous Bathurst Island Formation to 5910 ft (1801 m), Jurassic Petrel Formation Members 'B' and 'C' to 7650 ft (2332 m), Lower Jurassic to Upper Triassic 'Red Beds' to 8730 ft (2661 m) and Upper Triassic undifferentiated sediments to TD. 9300 ft (2835 m). Several gas flows were recorded while drilling the Cretaceous section but all zones of interest when tested by FIT's and DST's proved to be water-bearing.

Whimbrel -1 was located on the eastern side of the Londonderry Rise in an area of pinchouts and truncations. Whimbrel -1 drilled Tertiary to 1950 ft (594 m), Cretaceous Bathurst Island Formation to

3610 ft (1100 m), Lower Cretaceous to Upper Jurassic Petrel Formation to 3701 ft (1128 m), Middle to Lower Triassic to 6171 ft (1881 m) and Upper Permian Hyland Bay Formation to TD 6754 ft (2059 m). The Lower Jurassic and Upper Triassic sections were absent. Several minor gas flows were recorded in the Lower Cretaceous and Upper Permian section. Subsequent FIT's produced only formation water.

Both wells were plugged and abandoned.

Geophysical coverage

Refer to basin notes, details of seismic surveys (Appendix), and line density maps.

Prospectivity The area can be conveniently divided into five separate areas:- Browse Basin margins, Londonderry Arch - Kimberley Block margins, North east Londonderry Rise, Sahul Syncline, and the Sahul Platform.

Browse Basin Margins This area has only been covered by scattered reconnaissance seismic lines. Indications from seismic and the drilling of Londonderry -1 (WA-37-P) show that the Browse Basin sediments thin and wedge out against the Londonderry Arch. The section thickens rapidly westwards towards Heywood -1 which bottomed in Lower to Middle Jurassic sediments at TD 15000 ft (4572 metres). Minor hydrocarbon indications in this well show that the area must be regarded as prospective.

Recommendations Further seismic work is recommended to locate any large stratigraphic or structural plays followed by the drilling of a well.

Londonderry Arch - Kimberley Block Margins Reconnaissance seismic confirms this as an area of shallow basement with sediments onlapping the Kimberley Block. Indications are that the Tertiary and Cretaceous sediments onlap economic basement. The most prospective section is the Cretaceous Bathurst Is. Formation with the possibility of targets in the Permian (Hyland Bay Fm). Around the margin, possibilities exist for stratigraphic/structural entrapment of up-dip migrating hydrocarbons.

Recommendations No further work is recommended in the inshore margins of the Londonderry Arch where the thin sedimentary section and shallow basement make the area unattractive. Further consideration should be given to work on the outer margins of the Arch especially in the vicinity of Whimbrel -1 where stratigraphic traps are known. Recent detailing has been carried out in the Cape Talbot Marine Seismic Survey completed in August 1974 but the results are not yet to hand. A structural lead (A-55) straddling the NT/P2-WA-15-P boundary may now be sufficiently upgraded to recommend a well location (approx. 2500 m).

Northeast Londonderry Rise This area is an intensely faulted shelf extending northeastwards from the Londonderry Arch. It has been systematically explored by reconnaissance seismic with detailing of structural leads. The area was uplifted in the Callovian and Upper Triassic to Middle Jurassic sediments were stripped from the most positive areas. Target horizons in the area are sands within the Petrel Formation and possibly the Bathurst Island formation. On the flanks of the Rise, the Upper Permian Hyland Bay Formation may also have potential.

Recommendations The area is complicated structurally being dissected by northeast-trending faults. The principle target, the Petrel Formation, thickens uniformly in a northeasterly direction along the axis of the ridge.

One well-location, Dotterel No. 1, has been proposed on a faulted anticline but as yet has not been drilled. Priority should be given to the drilling of this well (ETD 8370 ft 2550 m) or shallower if Permian encountered).

Sahul Syncline No wells have been drilled within the Sahul Syncline; however well extrapolation and seismic evidence indicate that subsidence of the syncline took place at the same time as the Malita Graben (Callovian-Oxfordian).

Heron-1 well drilled in the Malita Graben (NT/P4) encountered a monotonous sequence of Cretaceous and Upper Jurassic shales which, although not possessing reservoir characteristics, possess good source qualities. Thus the Sahul Syncline can also be regarded as a good source area. Sands on the flank of the Sahul Syncline must be regarded as good prospects.

Recommendation No further work is recommended within the syncline but more detail seismic coverage is necessary to delineate structural/ stratigraphic leads on its updip margins.

Sahul Platform This is a large basement high which may have been formed very early in the history of the Bonaparte Gulf basin. Seismic coverage is reconnaissance with detailing in the Flamingo vicinity. Record quality is affected by multiples and interpretation is complicated by velocity anomalies carried by near-surface limestone reefs.

Prospective section is considered to be Middle to Upper Triassic and Jurassic sands and Permian reservoirs on the flanks of the platform. There are no recognised structural leads within the area of WA-15-P and at this stage further seismic work is required to define leads.

Recommendation Seismic reconnaissance and detailing of any structural leads uncovered, with improved velocity control is required. Drilling of a deep well to test the full section is recommended (14750 ft to 4500 m) or shallower if Permian encountered).

Title Assessment WA-16-P

Title holder Arco Australia Ltd
Australian Aquitaine Petroleum Pty Ltd
Esso Exploration and Production Aust. Inc.

No. of Blocks 354 blocks

Expiry Date 16.4.1975

Farmount Agreements Agreement 4SL-1970 - by which Esso Exploration and Production Australia Inc. receives a 12½% undivided interest in WA-16-P - approved and registered 29.1.71.

Previous six-year conditions Expenditure commitment for life of permit A$3,618,000, average A$1,703.38 block/year.

Regional Setting

WA-16-P is located offshore from the northern coast of Western Australia. It is an elongate north-south title area bounded by the coast to the south and the Northern Territory border to the north. Water depths increase from very shallow at the coast but are less than 200 m throughout the title area.

Wells Drilled

Three wells, Flamingo -1, Plover -1, and Plover -2 have been drilled within WA-16-P.

Flamingo -1 was drilled on a large faulted anticlinal structure on the Sahul Rise. The well drilled Tertiary to 6584 ft (2007 m), Cretaceous Bathurst Island Formation to 9595 ft (2925 m), and Lower Cretaceous to Upper Jurassic Petrel Formation (Members 'A', 'B', 'C') to TD 12139 ft (3700 m). No significant hydrocarbon shows were noted above 9375 ft (2858 m). From 9375 ft (2858 m) to T.D. several poor to good gas shows were recorded whilst drilling. F.I.T.s indicate only methane and ethane accumulations in the zones tested. A small amount of crude oil was recovered from a thin interval (6 inches) in a core from the Upper Jurassic. The occurrence of liquid hydrocarbons and gas shows in the Upper Jurassic lends encouragement for the exploration prospects of this stratigraphic section.

Plover -1 was drilled on the east flank of the Northeast Londonderry Rise in an area of extensive pinchouts and truncations and was drilled as a test of a stratigraphic trap. The well drilled Tertiary to 1272 ft (388 m), Cretaceous Bathurst Island Formation to 3450 ft (1052 m), Upper Jurassic Petrel Formation (Members 'B' and 'C') to 4286 ft (1306 m), Lower Jurassic Red Beds to 4896 ft (1492 m), Triassic to 7049 ft (2149 m) and Upper Permian Hyland Bay Formation to TD 8000 ft (2438 m). Numerous gas shows were noted in the Bathurst Island Formation and minor shows in the section below 3400 ft (1036 m), but these were not regarded as significant.

Plover -2 was located on the flank of the Bonaparte Basin against the Londonderry Rise some 19 miles southwest and updip of Plover -1.

The well drilled Tertiary to 1177 ft (359 m), Cretaceous Bathurst Island Formation to 2020 ft (616 m) and Lower Cretaceous/Upper Jurassic Petrel Formation to 2343 ft (714 m), Lower Triassic Mount Goodwin Formation to 3728 ft (1136 m), and Upper Permian Hyland Bay Formation to TD 5000 ft (1524 m). Only minor traces of hydrocarbons were noted in the Upper Jurassic and Upper Permian section.

All wells were plugged and abandoned.

Geophysical Coverage

Refer to basin notes, data sheets of seismic surveys, and line density maps.

Prospectivity The area can be conveniently divided into five distinct areas:- Kimberley Block margins, East Londonderry Rise, Bonaparte Shelf, Sahul Syncline, and the Sahul Platform.

Kimberley Block Margins The thinness of the sedimentary section and the shallowness of economic basement make this area unattractive for petroleum exploration. Very little seismic coverage exists in this area and no wells have been drilled.

Recommendations No work is recommended.

Northeast Londonderry Rise Only the southeastern flank of the Northeast Londonderry Rise falls within WA-16-P. The sedimentary section thins from the Bonaparte Gulf basin onto the Kimberley Block and the North East Londonderry Rise. Plover Nos. 1 and 2 have been drilled without success to test the updip stratigraphic pinch-out prospects of this area. Arco have proposed Plover No. 3 to test another stratigraphic pinch-out play. Other pinch-out possibilities have been derived. Prospective horizons are sands within the Petrel formation pinching out between the Mount Goodwin Fm. and the Bathurst Island Formation.

Recommendation In the light of the results of Plover No. 2, perhaps the proposal for Plover No. 3 should be examined in greater detail. Other

pinch-out possibilities along the depositional edge of the Petrel Formation are known. Further seismic would be required to mature these or drill-sites.

Bonaparte Shelf This area is situated between the Kimberley Block - East Londonderry Rise margins and the Sahul Syncline to the north. The only wells drilled in this area are the two Plover wells and these give the only stratigraphic control. The sedimentary section thickness to the north and prospective horizons are expected to be sands within the Petrel Formation and possibly Triassic sands. The area has been covered by a reconnaissance seismic grid including modern high-effort recording in the recent Cape Talbot seismic survey.

Recommendations Evaluation of the results of the latest work carried out in the Cape Talbot survey may upgrade the structural leads investigated into a drillable prospect. If so a well located in a position updip from the Sahul Syncline should test the hydrocarbon potential of this untested area (11500 ft, 3500 metres)). Further seismic semi-reconnaissance and detailing will be dependant on the results of this well.

Sahul Syncline No wells have been drilled within the Sahul Syncline. Evidence from the existing regional seismic reconnaissance coverage and well data indicates that the section will be similar to that encountered in Heron No. 1.

Recommendation No further work is recommended within the Syncline, but more detail seismic coverage is necessary to delineate structural/stratigraphic leads in its updip margins.

Sahul Platform One well, Flamingo No. 1, has been drilled on the Sahul Platform. The well terminated at T.D. 12129 ft (3700 m) in the Jurassic Petrel Formation without penetrating into the Triassic. Although good to poor gas shows were encountered in the Jurassic sands the permeability and porosity were found to be very low. Elsewhere on the Platform the Jurassic could have better reservoir characteristics and together with Triassic sands are regarded as the prospective target horizons. Seismic density is adequate in the Flamingo vicinity but is limited to reconnaissance over the northeastern portion of WA-16-P.

Recommendation Because of hydrocarbon indications in Flamingo No. 1 additional semi-reconnaissance control seems justified over the Sahul Platform in WA-16-P. Drilling of any promising leads would then be recommended (well depth about 15000 ft (4500 m)).

Title Assessment WA-17-P

Title Holder — Arco Australia Ltd,
Australian Aquitaine Petroleum Pty Ltd
Esso Exploration and Production Aust Inc.

No. of blocks — 378 blocks

Expiry Date — 22.4.75

Farmout Agreements Agreement 4SL/1970 by which Esso Exploration and Production Australia Inc receives a 12½% undivided interest in WA-17-P - Approved and registered 29.1.71.

Previous six year conditions ($A)

First	262,000	693.12	block/year
Second	100,000	264.55	"
Third	2,500,000	6,613.75	"
Fourth	1,000,000	2,645.50	"
Fifth	25,000	66.13	"
Sixth	25,000	66.13	"
	$ 3,912,000	1,724.86	" average

Regional Setting

WA-17-P is located offshore from the northern coast of Western Australia. It is bounded to the east by the Northern Territory/ Western Australia boundary and to the west by WA-16-P. The title area

encompasses WA-18-P on three sides. Water depths increase from high tide mark at the coastline but are less than 200 m throughout the entire title area.

Wells Drilled

Two wells, Gull -1 and Penguin -1 have been drilled within WA-17-P.

Gull -1 was drilled on a large anticlinal structure in the central offshore part of the Bonaparte Gulf Basin. The well drilled Tertiary to 1958 ft (597 m), Cretaceous Bathurst Island Formation to 6984 ft (2129 m), Jurassic Petrel Formation to 10206 ft (3111 m), Lower Jurassic Red Beds to 10974 ft (3345 m) and Triassic to TD 11225 ft 3421 m. No significant shows of hydrocarbons were recorded and the well was plugged and abandoned.

Penguin -1 was drilled on an anticlinal feature within the Petrel Sub-basin. The well drilled Tertiary to 1240 ft (378 m), Cretaceous Bathurst Island Formation to 2634 ft (803 m), Jurassic Petrel Formation (Members 'B' and 'C') and Red Beds to 4195 ft (1279 m), Triassic to 6883 ft 2098 m and Permian to TD 9045 ft (2757 m). One gas show was recorded in the Upper Permian Hyland Bay Formation in a sandstone interval 8314-8446 ft (2534-2574 m). FIT's taken at 8316 ft (2535 m) and 8333 ft (2540 m), recovered 127 and 129 cu. ft of methane respectively. These results certainly enhance the Upper Permian as a geologic prospect for dry gas in this general area.

Geophysical Coverage Refer to basin notes, data sheets of seismic surveys, and line density maps.

Prospectivity For the sake of simplicity the area is divided into three parts - western, northern and eastern.

Western area This is a narrow tract extending from the coast to the northern boundary of WA-18-P. The area can be divided into two distinct regions - Kimberley Block, southern margin of the Bonaparte Gulf Basin.

Kimberley Block The thinness of the sedimentary section and the shallowness of economic basement make the area unattractive for petroleum exploration. Very little seismic coverage exists in the area and no wells have been drilled.

Recommendations No work is recommended.

Southern margin of the Bonaparte Gulf Basin This area includes the faulted northwestern portion of the Petrel Sub-basin. No wells have been drilled in this part of WA-17-P. Fair-quality seismic reconnaissance provides reasonable control. The sedimentary section thickens northwards towards the Malita Graben. No structural leads have been delineated, although structural/stratigraphic trapping as in the nearby Plover area can be expected. Prospective horizons are expected to be sands within the Petrel Formation and possibly the Upper Permian Hyland Bay formation.

Recommendations Reconnaissance seismic coverage indicates a number of structural noses which warrant further investigation. Structural/stratigraphic traps against faults are also likely. Consequently semi-detail seismic coverage and detailing of any significant leads is recommended.

Northern area The major part of this area is taken up by the Malita Graben and its faulted northern and southern margins. One well, Gull No. 1, has been drilled within the title area on a deep-seated diapiric structure, on the southern margin of the Malita Graben. Although a thick section of Jurassic Petrel Formation was encountered, the sediments were found to be indurated and thus non-prospective. This has considerably downgraded prospects in the area. Deep seismic data have proven difficult to record in the Malita Graben area because of the increased depth of the seismic horizons. Even in the most recent work difficulty has been experienced in obtaining reliable information below Horizon 2 (near base of Cretaceous). Existing seismic coverage is reconnaissance only except near structural lead A 11 on the boundary of WA-16-P, where some detailing has been completed. The most prospective areas are expected to be around the faulted flanks of the Malita Graben, providing sediments have not been indurated. The Malita Graben has been considerably

down-graded by the drilling of Heron No. 1 and should not be given priority in exploration, although it must be stressed that it is an excellent source area for hydrocarbons.

Recommendations Further reconnaissance and detail seismic on the flanks of the Malita Graben could mature further drill locations. Detailing of one structure, A 11, is advanced, but may require further detailing.

Eastern area This area includes the central portion of the Petrel Sub-basin. One well, Penguin No. 1 has been drilled within the title area and the Petrel wells are adjacent in NT/P3. Prospective horizons are sands within the Jurassic and the Upper Permian Hyland Bay formation which had shows in the Penguin and Petrel wells. Diapiric features A1 and P3 are known. However, these are not regarded highly as exploratory prospects because of lack of closure and limited areal extent. Prospective horizons on these features would be restricted to the Petrel Formation.

Recommendations Both of these structures A1 and P3 should be drilled. 3000 ft (914 m) or prior salt should provide an adequate test of P3 but further seismic evaluation is necessary for A1.

Title Assessment WA-18-P

Title holder	Arco Australia Ltd Australian Aquitaine Petroleum Pty Ltd Esso Exploration and Production Aust. Inc.
No. of blocks	322 blocks
Expiry date	16.4.1975

Farmout negotiations Agreement 4SL/1970 by which Esso Exploration and Production Aust. Inc. recieves a 12½% undivided interest in WA-18-P - Approved and registered 29.1.71.

Previous six year conditions $A

First	189,000	block/year	-	586.95
Second	50,000	" "	-	155.27
Third	2,500,000	" "	-	7,763.97
Fourth	500,000	" "	-	1,552.79
Fifth	25,000	" "	-	77.63
Sixth	25,000	" "	-	77.63
	$ 3,289,000		average	1,702.37

Regional setting

WA-18-P is located offshore from the northern coastline of Western Australia. It is bounded to the north, east, and west by WA-17-P and WA-19-P and the coastline on its southern boundary. Water depths increase from high tide mark but are never greater than 600 ft (200 m) throughout the title area.

Wells drilled

Two wells, Tern -1 and Sandpiper -1, have been drilled within WA-18-P. Tern -1 was drilled in a large faulted anticlinal structure within the Petrel Sub-basin. The well drilled Tertiary to 1317 ft (401 m), Cretaceous Bathurst Island Formation to 3738 ft (1139 m) Cretaceous/ Jurassic Petrel Formation (Members 'A', 'B' and 'C') to 5494 ft (1675 m), Triassic to 8272 ft (2521 m) and Permian to TD 14278 ft (4352 m), the well bottoming in Lower Permian Kulshill Formation. Several gas shows were recorded while drilling the Upper and Lower Permian sections and several zones of interest in these sections were recorded. Numerous hydrocarbon zones were tested, both by FIT and DST, but all of these zones proved to be tight except for one interval in the Upper Permian which flowed gas at rates varying from 5.5 to 7.6 MMcf/d.

Sandpiper -1 was drilled on a domal structure within the Petrel Sub-basin. The well drilled Quaternary-Tertiary to 470 ft (143 m),

Cretaceous Bathurst Island Formation to 1654 ft (504 m), Cretaceous/ Jurassic Petrel Formation (Members 'A', 'B', and 'C') to 3000 ft (914 m), Triassic to 3097 ft (944 m), Lower Carboniferous/Upper Permian diapiric caprock to 5751 ft (1753 m) and Devonian Salt intrusives to TD 6206 ft (1892 m). No significant shows of hydrocarbons were noted and the well was plugged and abandoned.

Geophysical Coverage Refer to basin notes, data sheets of seismic surveys, and line density maps.

Prospectivity WA-18-P can be divided into three distinct regions - Kimberley Block, Petrel Sub-basin and Bonaparte Shelf.

Kimberley Block The boundary between the Kimberley Block and the Petrel Sub-basin is a large down-to-the-basin fault. The sedimentary section thins over the Precambrian basement and is mainly confined to Tertiary sediments. The thinness of the sedimentary section and shallow basement make this area unattractive for petroleum exploration. No wells have been drilled in this area and it has only been covered by sparse reconnaissance seismic.

Recommendations No further work is recommended.

Petrel Sub-basins Two wells Tern -1 and Sandpiper -1 have been drilled within WA-18-P. Gas was flowed from the Upper Permian Hyland Bay Formation in Tern -1 and Sandpiper proved to be a diapiric salt structure.

This is the main area of salt structures within the Bonaparte Gulf Basin and a number of anomalies due to salt have been delineated by seismic coverage (P 1, 2, 3 (part) 4, 5, 6, 7, A2, 5, 6, 7, 15A, B, C, D).

The 'P' structures are shallow diapiric structures - the salt occurring at depths no deeper than 4500 ft (1372 m). Of these P-6 is the best seismically controlled at this stage. The main hydrocarbon objective in these prospect is the Petrel Formation.

The 'A' structures are deep seated diapirs and these have the additional objectives in the Permian section.

Recommendations Although results of drilling have not proven encouraging on the shallow-seated diapiric structures, at least one other well should be drilled to test the hydrocarbon potential of the Petrel Formation in such an environment. P6, being the best seismically controlled, is recommended, (5000 ft, 1500 m or prior salt).

Additional seismic work to further define the Tern-Penguin trend was completed in the recent Cape Talbot seismic survey. Indications before the survey were that this could be one continuous northwesterly-trending structure with several separate culminations. Should results of the Cape Talbot survey prove encouraging, a further test of the favourable Hyland Bay formation is warranted (11500 ft, 3500 m).

A structural trend along the fault controlled southwestern margin of the Petrel Sub-basin is most significant. This trend may be due to deep-seated salt intrusions and turnover is apparent on all mapped horizons. The largest culmination A15A is recommended as a well-location. The top of the salt is predicted at 13000 ft (4000 m) although the prospective Hyland Bay formation should be penetrated with a well-depth of 1500 m.

Bonaparte Shelf This is the general area north of the marginal fault which forms the northern limit of the Petrel Sub-basin. No wells have been drilled in this area although the area has been gridded by reconnaissance seismic. The prospective section is the Petrel Formation and the Permian Hyland Bay Formation, although the latter is too deep (16500-23000 ft, 5000-7000 m) to be of economic significance in the northern part of WA-18-P.

Recommendations At this stage there are no obvious drill targets in this area and further semi-reconnaissance seismic work is recommended. Any structural leads revealed then be detailed with a view to drilling.

Title Assessment WA-19-P

Title holder	Alliance Oil Development Australia NL
No. of blocks	142
Expiry date	20.3.1975

Farmout negotiations Agreement 2SL/1968 Application for approval of agreement as between Alliance Oil Development Australia NL and Newmont Pty Ltd. Agreement provides that Alliance will assign 20% interest to Newmont Pty Ltd after that Company has spent $2250,000 on exploration - Approved 2.10.69 and registered 17.12.1969.

Previous six year conditions

First	1,400,000	$9859.15	block/year		
Second	100,000	704.22	"	"	
Third	10,000	70.42	"	"	
Fourth	10,000	70.42	"	"	
Fifth	10,000	70.42	"	"	
Sixth	10,000	70.42	"	"	
	$ 1,540,000	$1807.50	"	"	average

Regional Setting

WA-19-P is located in the Western Australian portion of the Joseph Bonaparte Gulf. It is bounded to the south and west by the coastline - to the north by WA-17-P and WA-18-P and the east by the Northern Territory/Western Australian border. Water depths are very shallow throughout, the southern boundary being the high water mark.

Wells Drilled

Only one offshore well, Lacrosse -1, was drilled within WA-19-P. One island well, Pelican Island -1, was drilled within the confines of the title area.

Lacrosse -1 was located on a faulted anticlinal structure within the Petrel Sub-basin. The well drilled Triassic to 760 ft (232 m), Permian to 7823 ft, (2384 m), and Carboniferous to T.D. 10020 ft (3054 m). The only significant shows of hydrocarbons were in Lower Permian sandstones.

Good shows of viscous low-gravity oil were seen in cores in the interval 5717-5770 ft (1743-1759 m). A DST of the interval 5634-5770 ft (1717-1759 m) failed to recover any hydrocarbons, probably because of poor lateral permeability. The well was plugged and abandoned as a dry hole.

Pelican Island -1 was located on a large faulted anticlinal structure. The well drilled Upper Carboniferous to 1282 ft (391 m), Lower Carboniferous to 5877 ft (1791 m) and ?Devonian Salt to 6500 ft (1981 m). Several dead oil shows in tight sandstones were recorded while drilling the upper Carboniferous section, and several zones with fair gas shows were penetrated in the Lower Carboniferous section. On examination of electric logs and sidewall cores all these zones were found to be either too tight or too thin to warrant testing. The well was plugged and abandoned.

Prospectivity

This area may be conveniently divided into three distinct regions:- Kimberley Block, the southeastern margins of the Petrel sub-basin and the Palaeozoic Bonaparte Gulf basin.

Kimberley Block Seismic coverage in this area consists of early reconnaissance work recorded in 1965 and the recently completed Tree Point marine survey which detailed structural leads uncovered by the 1965 survey. No wells have been drilled. The sedimentary section thins onto the Kimberley Block and is probably, except on the basin margins fault, too shallow to be of interest.

Recommendations This area is largely regarded as non-prospective although the recent Tree Point survey may have confirmed structural leads of interest near Medusa Banks. Results are not yet to hand.

Southeastern margins of the Petrel Sub-basin Cretaceous, Jurassic, and Triassic sediments pinch out in this area. Just south of Lacrosse No. 1 well no Mesozoic sediments are present. Seismic coverage consists of early reconnaissance and detailing around Lacrosse. The recent Tree Point coverage was tied to Lacrosse No. 1. Structural leads of interest are probably of diapiric origin and have been recently detailed in the

Tree Point survey. Prospective horizons are within the Permian and Carboniferous particularly the Lower Carboniferous Kulshill Formation which had minor shows in Lacrosse No. 1.

Recommendations Depending on the results of the Tree Point survey, further detailing or the drilling of a well may be in order.

Palaeozoic Bonaparte Gulf Basin The Permian section pinches out between Lacrosse and Pelican Island. Prospective section in this area lies mainly in the Carboniferous. Seismic coverage consists of reconnaissance work recorded in 1965 with later reconnaissance in 1971. One well, Pelican Island No. 1, has been drilled on a diapiric structure within the confines of the title area. It drilled a Carboniferous/Devonian (salt) section and was plugged and abandoned without significant shows. There are seismic indications in this area of other diapiric structures.

Recommendations This cannot be regarded as a high priority area but neither can it be classed as totally non-prospective. A number of onshore wells have given a little encouragement with minor hydrocarbon shows. Further seismic detailing will be required before any drilling can be carried out.

Appendix

Details of Geophysical Surveys

Rig	Trap	(Subsea) Base K u/c	Status	Remarks
Margie	Structural/Strat.	(1075 m) 3527'	Ø	No significant K, J, Tr. shows. Minor amounts of CH_4 only. Minor C_2H_6 M.Tr. or U. Perm.
Sedco 135G	faulted anticline	(1767 m) 5797'	Ø	Minor gas shows only. Mainly CH_4, traces C_2H_6, C_3H_8. No signif. shows. Minor residual oil staining in SWC 6020'-6160' (1835m-1878m).
Sedco 135G	faulted anticline	(2890 m) 9482'	Ø	from 9375' to T.D. poor-good gas shows 55 poor k Ø (Jurassic)
Sedco 135G	Stratigraphic	(1017 m) 3338'	Ø	minor gas shows from U. Cret. to T.D. (Bathurst Is. shales especially).
Margie	Stratigraphic	(590 m) 1937'	Ø	No shows
Navigator	faulted anticline	(2116 m) 6941'	Ø	below 7000' (2134m) advanced diagenesis, seds. indurated.
Sedco 135G	Anticline	(768 m) 2521'	☼	Gas bearing zone (2534m-2544m) 8314'-8346' at base Hyland Bay Fm. (equiv. to Petrel below out zone).
Navigator	Dome	(492 m) 1615'	Ø	Petrel 'C' Methane cut water on FIT
Navigator	faulted anticline	(1127 m) 3699'	☼	(Sand 8270'-8350') (2521m-2545m) DST#2 8285'-8367' Dry Gas c. 7.89 MMcf/d (Hyland Bay Fm). Kulshill Fm. tight.
Sedco 135G	faulted anticline	N.P.	Ø	oil traces in cores and samples in L. Permian (5720'-5750') (1743m-1753m).
ODE	faulted anticline	N.P.	Ø	dead oil shows in U. Carb. Gas shows in L. Carb. too tight or thin.

SURVEY:CAPE TALBOT NO: 74/6 MAP CODE:

DATES:5-8-74 to 24-8-74 COMPANY:ARCO LTD CONTRACTOR:GSI

TENEMENTS: WA-15P, WA-16-P, WA-17-P, WA-18-P

SEISMIC SOURCE:AIRGUN PROCESSING:GSI

CABLE:2400 m RECORDER:DFS 111

MULTIPLE COVERAGE:2400%

MILEAGE: 1500

REFRACTION: -

GRAVITY: -

MAGNETIC: -

DATA QUALITY:)
RESULTS:) Report not supplied as yet
)

SURVEY: TREE POINT NO: 74/7 MAP CODE:

DATES:15-9-74 to 20-9-74 COMPANY:ARCO LTD CONTRACTOR: GSI

TENEMENTS: WA-19-P

SEISMIC SOURCE: AIRGUN PROCESSING:GSI

CABLE: 2400-3200 m RECORDER: DFS 111

MULTIPLE COVERAGE: 2400%

MILEAGE: 304

REFRACTION: -

GRAVITY: -

MAGNETIC: -

DATA QUALITY:)
RESULTS:) Report not supplied as yet
)

SURVEY: CARTIER M/S NO: 73/11 MAP CODE: (19-37)(19-14)

DATES: 21-6-73 to 5-7-73 COMPANY: ARCO AUST. LTD CONTRACTOR: G.S.I.

TENEMENTS: WA-15,16,17,18-P NT/p2/p3/p4

SEISMIC SOURCE: AIRGUNS PROCESSING: G.S.I.

CABLE: 2400 m 48 live groups RECORDER: 2.4 trace DFS 111

MULTIPLE COVERAGE: 24 fold

MILEAGE: 2043.8 km

REFRACTION: -

GRAVITY: -

MAGNETIC: -

DATA QUALITY: F - G

RESULTS: The survey confirmed existing structural leads. Puffin and Plover more accurately delineated. In the latter faulting and truncation created conditions for stratigraphic entrapment. No new structural information was obtained in the Flamingo area although correlations were improved. A-8,A52,A11 in Puffin/Swans area were more accurately delineated. A53,A56,A57,A58 A59 require further interpretation.

SURVEY: HAT POINT M/S NO: 73/5 MAP CODE: (19-10)

DATES: 16-1-73 to 19-2-73 COMPANY: ARCO AUST LTD CONTRACTOR: G.S.I.

TENEMENTS: WA-15,16,17,18-p NT/p2,p4

SEISMIC SOURCE: AIRGUN PROCESSING: G.S.I.

CABLE: 2400 m 48 trace 3200 m 48 trace RECORDER: 24 trace DFS 111

MULTIPLE COVERAGE: 24 and 48 fold COP

MILEAGE: 2345.5 km

REFRACTION: -

GRAVITY: -

MAGNETIC: 2345.5 km Magnetometer towed but no results presented

DATA QUALITY: G

RESULTS: The survey completed detail and semi-detail coverage A7,A15,A19, A54,A8,A11 were more accurately delineated.

SURVEY:KNOB PEAK SEISMIC NO: 73/4 MAP CODE:(19-37) (19-6)

DATES:27-1-73 to 29-1-73 COMPANY:ARCO AUST. LTD CONTRACTOR: GSI

TENEMENTS:NT/p1 and WA-19-p

SEISMIC SOURCE: AIRGUN PROCESSING: GSI

CABLE:2400 m 48 trace RECORDER:DIGITAL 2 sets of DFS 111's

MULTIPLE COVERAGE: 24 fold

MILEAGE: 244 km

REFRACTION: -

GRAVITY: -

MAGNETIC: parts of two lines (Kp7, kp4) and one complete line left out (Kp8)

DATA QUALITY:G except for shallow data

RESULTS:Structure D small

SURVEY:PAGO M/S NO: 72/13 MAP CODE:(19-47)

DATES:25-5-72 to 25-7-72 COMPANY:ARCO AUST. LTD CONTRACTOR:WESTERN GEOPHYSICAL

TENEMENTS:WA-15,16,17,18-p and NT/p3,4

SEISMIC SOURCE:'AQUAPULSE' PROCESSING:G.S.I. and W.G.C.

CABLE:7590 ft 24 group RECORDER:DIGITAL SDS 1010 Series DFR 300

MULTIPLE COVERAGE:2400% stack

MILEAGE: 4359 kms

REFRACTION: -

GRAVITY: -

MAGNETIC: -

DATA QUALITY:G in WA-18-P, F in WA-17-19 and WA-16-P. Multiple interference in Eider and Flamingo areas.

RESULTS:Recording in the Tern,Penguin,and Petrel areas of WA-18-P,WA-17-P and NT/P3 improved regional and local control. A15,A2, and A7 anomalies were further delineated. The Plover structure (A46) is shown to be a faulted stratigraphic trap. Further work is required to evaluate stratigraphic entrapment possibilities in the Osprey (A47) vicinity.

SURVEY:BALDWIN BANK NO: 72/1 MAP CODE: (19-35)

DATES:13-1-72 to 20-3-72 COMPANY:ARCO AUST LTDCONTRACTOR:WESTERN GEOPHYSICAL

TENEMENTS:WA-15,16,17-P and NT/p2,3,4

SEISMIC SOURCE:'AQUAPULSE' PROCESSING:W.G.C.

CABLE:7590 ft. 24 group RECORDER:DIGITAL SDS 1010 SERIES DFR 300

MULTIPLE COVERAGE:24 fold

MILEAGE: 3060 km

REFRACTION:1 refraction on BB16 (outside of our area)

GRAVITY: -

MAGNETIC: -

DATA QUALITY: P - G

RESULTS: Survey provided detail and semi detail coverage in NT/p2 and NT/p4 and extended regional coverage in WA 15,16,17 p. Several low-relief anomalies were mapped on Sahul Rise but require further work. Detailing of A19 and A20 (Eider) and Brown Garnet was completed.

SURVEY:GALE BANK M/S NO:71/3 MAP CODE: (19-6)

DATES:21-9-71 to 5-10-71 COMPANY:ARCO AUST. LTD CONTRACTOR:W.G.C. of America

TENEMENTS:WA-15,16,17,18 - p and NT/p2,3

SEISMIC SOURCE:'AQUAPULSE' PROCESSING: "

CABLE:7773 ft 48 group RECORDER:DIGITAL DATA SYSTEMS MODEL 777

MULTIPLE COVERAGE: 2400%

MILEAGE:1345 km

REFRACTION: -

GRAVITY: -

MAGNETIC: -

DATA QUALITY: ? - G

RESULTS:Regional control was strengthened and previous shooting tied in WA-15-P. A20 (Eider 1) was further detailed. A-1,A-2,A-4 (Penguin-1), A-7 and A-15 shown to be result of salt flowage.

SURVEY:PELICAN ISLAND M/S NO:71/1 MAP CODE: (19-14) (19-45)

DATES:14-9-71 to 20-9-71 COMPANY: CONTRACTOR:W.G.C. of America

TENEMENTS: NT/p1 and WA-19-p

SEISMIC SOURCE:'AQUAPULSE' PROCESSING: "

CABLE:7773 ft 48 group RECORDER:DIGITAL DATA SYSTEMS MODEL 777

MULTIPLE COVERAGE:24 fold stack

MILEAGE: 235 miles (STATUTE)

REFRACTION: -

GRAVITY: -

MAGNETIC: ? magnetometer towed but no results presented

DATA QUALITY: F

RESULTS:Three horizons were reliably mapped. Structure B has been downgraded.

SURVEY:HOLOTHURIA SEISMIC SURVEY NO: 70/8 MAP CODE: (19-39)

DATES:7-11-70 to 9-12-70 COMPANY:ARCO AUST. LTD CONTRACTOR:W.G.C. of America

TENEMENTS:NT/P2,3 and WA-15,16,17,18-p

SEISMIC SOURCE:'AQUAPULSE' PROCESSING: "

CABLE:2400 m 48 trace RECORDER: DDS Mod. 777

MULTIPLE COVERAGE:24 fold

MILEAGE: 1068.2 miles

REFRACTION: -

GRAVITY: -

MAGNETIC: -

DATA QUALITY: Satisfactory down to 5 sec 2WT

RESULTS: The survey provided semi-detailed coverage in WA 16P, WA 17P & WA18P and confirmed closures on structures *23, A19 and A20. A32, A33 and A34 were confirmed but require further detailing.

SURVEY: CAPE SCOTT S/S NO: 70/11 MAP CODE: (19-6) (19-22)

DATES: 17-10-70 to 21-10-70 COMPANY: A.A.P. PTY LTD CONTRACTOR: WESTERN GEOPHYSICAL

TENEMENTS: NT/P17, p3, p1 and WA-19-p

SEISMIC SOURCE: 'AQUAPULSE' PROCESSING:

CABLE: 2400 m 48 trace RECORDER: DDS - 777

MULTIPLE COVERAGE: 2400%

MILEAGE: 79.4 km

REFRACTION: -

GRAVITY: -

MAGNETIC: -

DATA QUALITY: Good

RESULTS: Survey effected a tie between Lacrosse No. 1 and Bougainville

SURVEY: DILLON SHOALS NO: 73/9 MAP CODE: (19-45)

DATES: 15-6-73 to 15-7-73 COMPANY: ARCO AUST LTD and B.O.C. of Aust. Ltd CONTRACTOR: W.G.C.

TENEMENTS: WA-15-p and NT/p2,15

SEISMIC SOURCE: Maxi-pulse PROCESSING: "

CABLE: 3200 m 48 trace RECORDER: DDS model 777

MULTIPLE COVERAGE: 2400% stack

MILEAGE: 519.4 km

REFRACTION: -

GRAVITY: -

MAGNETIC: -

DATA QUALITY: F - G

RESULTS: 7% of mileage only in WA-15-P. Provided detail coverage of A49 with a tie to Osprey.

SURVEY: TIMOR SEA M,G & S '67 NO: BMR Rec. 1969/40 MAP CODE: (19-22)

DATES: '67 COMPANY: BMR CONTRACTOR:

TENEMENTS:

SEISMIC SOURCE: 21000 joule "spark-array" PROCESSING:

CABLE: RECORDER:

MULTIPLE COVERAGE:

MILEAGE: 13000 nautical miles

REFRACTION:

GRAVITY:

MAGNETIC:

DATA QUALITY: P - F

RESULTS: Survey results on continental shelf were poor. Seven Gravity Provinces were defined. Faulting is principal tectonic phenomenon on the continental slope. A number of anticlinal and diapiric features were observed.

SURVEY: TIMOR SEA G & S '65 NO: BMR Rec. 1966/72 MAP CODE: (Staedtler)

DATES: '65 COMPANY: BMR CONTRACTOR: G.A.I.

TENEMENTS:

SEISMIC SOURCE: SPARKER PROCESSING:

CABLE: RECORDER:

MULTIPLE COVERAGE: 100%

MILEAGE: 3600

REFRACTION: -

GRAVITY:

MAGNETIC: -

DATA QUALITY: Fair

RESULTS: Seismic results indicate presence of a large Permian and Mesozoic sedimentary basin in the Joseph Bonaparte Gulf extending north and north-west into the Timor Sea. Gravity results show general agreement with the seismic results.

SURVEY: GULFREX RECONNAISSANCE M/S, G,M NO: PSLA 72/9 MAP CODE: (19-6) (19-14)

DATES: May-July 1972 COMPANY: Australian Gulf Oil Co. CONTRACTOR: Aust. Gulf Oil Co.

TENEMENTS:

SEISMIC SOURCE: AQUAPULSE PROCESSING: Gulf R & D Co

CABLE: 5280 ft 24-trace RECORDER: DDS 777

MULTIPLE COVERAGE: 24-fold

MILEAGE: 3318 nautical

REFRACTION:

GRAVITY:

MAGNETIC:

DATA QUALITY: F

RESULTS: Reconnaissance

SURVEY: N.W. Continental shelf M/S G.M. NO: MAP CODE: (19-45)

DATES: Sept-Dec '68 COMPANY: BMR CONTRACTOR: RAY

TENEMENTS:

SEISMIC SOURCE: Sparker (21 kj) PROCESSING:

CABLE: single channel RECORDER: Analogue

MULTIPLE COVERAGE:

MILEAGE: 15000 miles (Total survey)

REFRACTION:

GRAVITY:

MAGNETIC:

DATA QUALITY: F

RESULTS: Reconnaissance

SURVEY: TRYAL-EVANS M/S NO: 70/245 MAP CODE: (19-35) (19-39)

DATES: 6-3-70 to 18-7-70 COMPANY: B.O.C. of Aust. CONTRACTOR: WESTERN GEOPHYSICAL

TENEMENTS: WA-1,28,29,30,31,32,33, 35,36-P NTP/6,11,12

SEISMIC SOURCE: AQUAPULSE PROCESSING: "

CABLE: 5290 ft 24 group and 7520 ft RECORDER: DIGITAL SDS1010

MULTIPLE COVERAGE: SUM 2 STACK 2400% (7520 ft cable) 2400% STACK 3 (5920 ft cable)

MILEAGE: 4604.3 miles

REFRACTION: SONOBUOY REFRACTION carried out but not successful.

GRAVITY: -

MAGNETIC: -

DATA QUALITY: F

RESULTS: Detail and reconnaissance coverage. Some anomalies upgraded, others downgraded. Several significant new leads detected.

SURVEY: LEGENDRE-MARIE M/S NO: 69/3005 MAP CODE: (19-51)

DATES: 23/1 - 12/6/69 COMPANY: BOC CONTRACTOR: WESTERN GEOPHYSICAL

TENEMENTS: PE 213H, 232H, 238H and OPS 108, 158, & 159 NT.

SEISMIC SOURCE: AQUAPULSE PROCESSING:

CABLE: RECORDER:

MULTIPLE COVERAGE: 3600%

MILEAGE: 4348.5

REFRACTION: -

GRAVITY: -

MAGNETIC: -

DATA QUALITY: F

RESULTS: Reconnaissance and detailing of known structures

SURVEY:VAN DIEMEN RISE M/S NO: 69/3044 MAP CODE:(Staedtler)

DATES:7-7-69 to 21-8-69 COMPANY:ARCO AUST LTD CONTRACTOR:COMPAGNIE GENERALE DE GEOPHYSIQUE

TENEMENTS:WA-15,16,17-p and NT/p2,3,4

SEISMIC SOURCE:conventional 66.6 lb charges of Mitromon WWEL PROCESSING: "

CABLE:2400 M CGG 24 trace RECORDER:LEACH 21 format SERCEL AS-626-x amplifier

MULTIPLE COVERAGE:6-fold stacked

MILEAGE:1414-8 km

REFRACTION: -

GRAVITY: -

MAGNETIC: -

DATA QUALITY: F

RESULTS:Closure confirmed at P10 and A25. A16 was further detailed and new feature A26 discovered. Evaluation of PB and A27 indicate they are related to intrusives. Average velocity and depth maps prepared.

SURVEY:LONDONDERRY RISE NO: 68/3024 MAP CODE: (19-17)

DATES: 12-6-68 to 17-12-68 COMPANY: ARCO LTD CONTRACTOR:COMPAGNIE GENERALE DE GEOPHYSIQUE

TENEMENTS: WA-15,16,17,18-P

SEISMIC SOURCE:conventional and Flexotir PROCESSING:CGG

CABLE: 2400 m CGG 24 traces RECORDER: DIGITAL

MULTIPLE COVERAGE:12 fold (flexotir) 6 fold (conventional)

MILEAGE: 8270.7 km

REFRACTION: -

GRAVITY: -

MAGNETIC: -

DATA QUALITY: G in south. Poor in central depression (Malita Valley) F-P in NE

RESULTS:A3,4,6,15 confirmed, P2,4,6 accurately delineated, A23,22,20,18 more accurately mapped on Horizon 2, A25 confirmed, A13 requires further work, P9 and P10 (intrusives discovered). Detail velocity studies initiated.

SURVEY: SAHUL RISE M/S NO: 67/11166 MAP CODE: (19-65)

DATES: 15-6-67 to 4-11-67 COMPANY: ARCO LTD CONTRACTOR: C.G.G. W.G.C. of America and NAMCO GEOPHYSICAL CO.

TENEMENTS: pe 221H and op 151

SEISMIC SOURCE: - BOLT 1500 AIRGUNS (NAMCO)
- CONVENTIONAL(NAMCO W.G.C.) PROCESSING:

CABLE: 2400 m W.G.C. RECORDER: DIGITAL DFR-200 (W.G.C.)
8040 ft NAMCO 24 trace SDS MODEL 1010 (NAMCO)

MULTIPLE COVERAGE: 600% (WGC) 600% and 1200% (NAMCO)

MILEAGE: 6988 km

REFRACTION: Reversed refractions

GRAVITY: -

MAGNETIC: -

DATA QUALITY: G in SW. P - F in North

RESULTS: The Survey confirmed the regional interpretation involving the Sahul Rise, the Londonderry Rise, the Van Dieman Rise, and the Bonaparte Depression. Two structural trends are evident, an older NW trend (Palaeozoic) and a younger NE trend.

SURVEY: LESUEUR M/S NO: 67/11165 MAP CODE: (19-14)

DATES: 10-6-67 to 24-6-67 COMPANY: ARCO LTD CONTRACTOR: C.G.G.

TENEMENTS: op 151, pe 221H

SEISMIC SOURCE: SPARKER (120 000 joules) PROCESSING: C.G.G.

CABLE: GEOTECH HYDROSTREAMER RECORDER: GEOTECH SSP

MULTIPLE COVERAGE:

MILEAGE: 888 km

REFRACTION: -

GRAVITY: -

MAGNETIC: -

DATA QUALITY: F - G

RESULTS: Survey detailed several structural leads from the Sahul Shelf Survey and discovered two new closed structures.

SURVEY:SAHUL BANK EXTENSION NO:66/11126 MAP CODE: (19-65)

DATES:9-12-66 to 18-12-66 COMPANY:ARCO LTD CONTRACTOR:GSI

TENEMENTS: 221H

SEISMIC SOURCE:Conventional explosives PROCESSING: GSI

CABLE:1600 m Type C RECORDER:TEXAS INSTRUMENTAL 9000 SERIES

MULTIPLE COVERAGE: 600%

MILEAGE: 190 miles

REFRACTION: -

GRAVITY: -

MAGNETIC: -

DATA QUALITY: P - G

RESULTS: See Sahul Bank Survey

SURVEY: SAHUL BANK S/S NO: 66/11126 MAP CODE: (19-65)

DATES: 14-10-66 to 20-10-66 COMPANY: ARCO LTD CONTRACTOR: CGG

TENEMENTS: op151 and pe 221H

SEISMIC SOURCE:FLEXOTIR PROCESSING: "

CABLE: 12 trace RECORDER:

MULTIPLE COVERAGE: 300%

MILEAGE: 284.5 km

REFRACTION: -

GRAVITY: -

MAGNETIC: -

DATA QUALITY: P - G

RESULTS: The survey compared results from the sparker,"Flexotir" and conventional dynamite shooting along line TS14. Dynamite source gave the best penetration and record character, and digital processing and multiple coverage resulted in significant upgrading of record quality.

SURVEY: SAHUL SHELF M/S - NO: 66/11088 MAP CODE: (19-27)

DATES: 2-5-66 to 25-11-66 COMPANY: ARCO LTD CONTRACTOR: COMPAGNIE-GENERALE DE GEOPHYSIQUE

TENEMENTS: op 151 (parts 1 and 2) PE 221H

SEISMIC SOURCE: SPARKER 130 KJoule PROCESSING:

CABLE: GEOTECH HYDROSTREAMER RECORDER:

MULTIPLE COVERAGE: 600%

MILEAGE: 12050 KM

REFRACTION: -

GRAVITY: -

MAGNETIC: -

DATA QUALITY: Good in S half of Bonaparte G. Deteriorates to N where reverberations and rough bottom topography exist. Inadequate penetration in deeper parts of the basin.

RESULTS: Outlined overall configuration of the basin and confirmed a-mag interpretation of a triangular basin. Several large structures were located

SURVEY: MEDUSA BANKS NO: 66/11080 MAP CODE: (19-22)

DATES: 30-3-66 to 13-5-66 COMPANY: ANACAPA CORP CONTRACTOR: WESTERN GEOPHYSICAL

TENEMENTS: pe 127H

SEISMIC SOURCE: conventional PROCESSING: "

CABLE: 600-600: 1200-1200 metre 36 group RECORDER: ANALOG AND DIGITAL Redcor model 600 D/A system

MULTIPLE COVERAGE: 300% or 600%

MILEAGE: 300 miles of 300% ANALOG plus 350 miles of 300% and 25 miles of 600% analog and digital

REFRACTION: 3 profiles

GRAVITY: -

MAGNETIC: -

DATA QUALITY: VP - VG

RESULTS: Regional dip NE. 5 structural leads. Indications of intrusives.

SURVEY: WEST BONAPARTE BAY NO: 65/4596 MAP CODE: (19-37)

DATES: 21-5-65 to 3-9-65 COMPANY: ANACAPA CORP CONTRACTOR: GSI

TENEMENTS: pe 127H (WA-19-p)

SEISMIC SOURCE: conventional PROCESSING: "

CABLE: 1600 m(deep water) marine 20SC RECORDER: TEXAS INSTRUMENTS SERIES 8000
2976 ft 'Vector' (shallow water)

MULTIPLE COVERAGE: 3 fold

MILEAGE: 20.2 miles shot for 6 fold stacking 1018.6 miles for 3 fold

REFRACTION: 33 miles reversed refraction profile on lines G, 14, 16 and 7A

GRAVITY: -

MAGNETIC: -

DATA QUALITY: P - G - deteriorates with depth. Multiple problem

RESULTS: Regional dip northeast. Three structures A,B,C revealed.
Possibility of intrusives

SURVEY: TIMOR SEA SEISMIC NO: 65/11042 MAP CODE: (19-14)

DATES: 12-10-65 to 31-10-65 COMPANY: ARCO LTD CONTRACTOR: GSI

TENEMENTS: pe 221H and o.p. 1, 2, 83.

SEISMIC SOURCE: SPARKER (E.G.G. 14 K.W.S.) PROCESSING: GSI

CABLE: 180 ft. RECORDER: E.G.G. MODEL 254 (on loan from BMR)

MULTIPLE COVERAGE: 100%

MILEAGE: 1437 miles

REFRACTION: -

GRAVITY: -

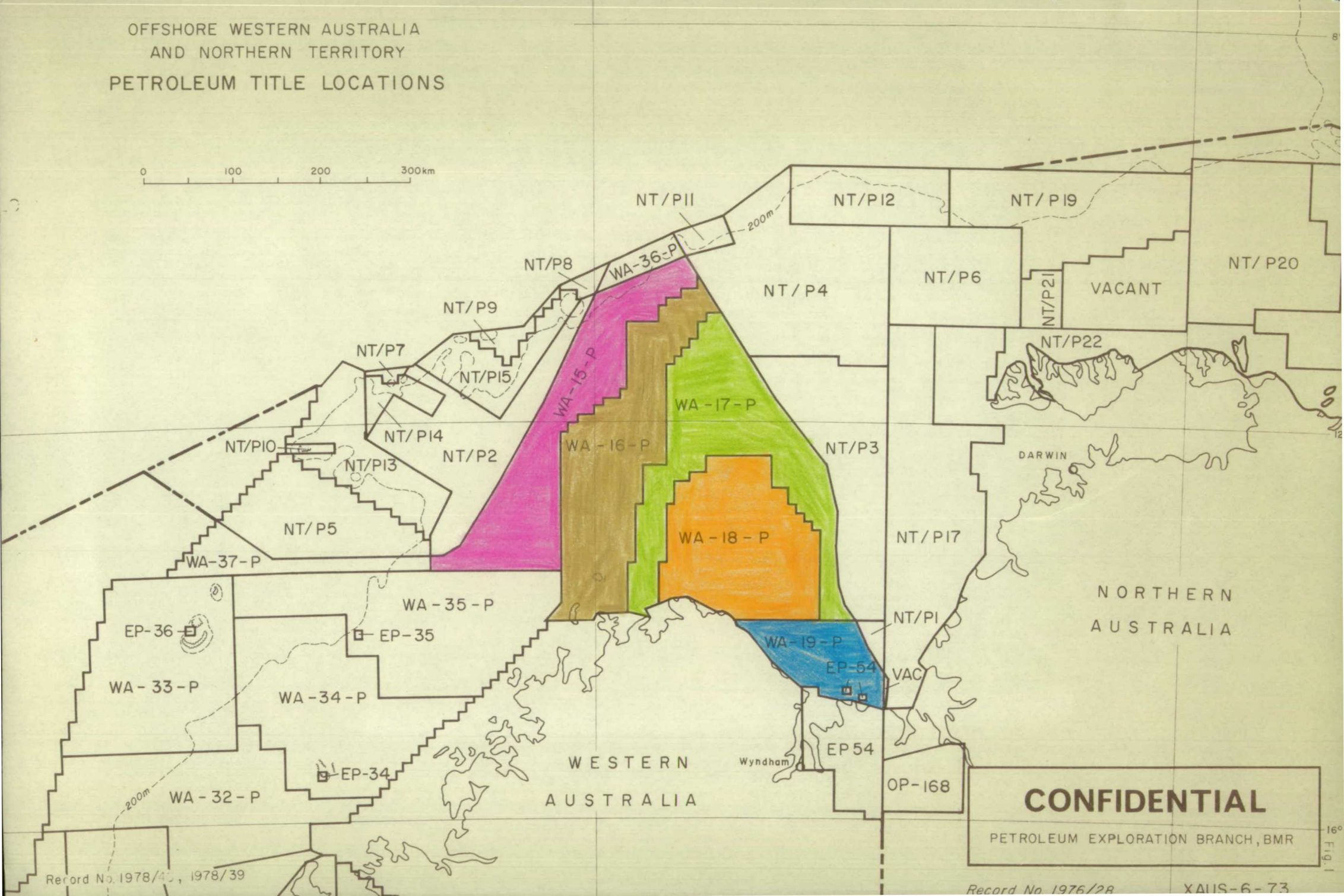
MAGNETIC:

DATA QUALITY: Good to questionable

RESULTS: Lack of penetration. Reconnaissance lines only. NE dip indicated

OFFSHORE WESTERN AUSTRALIA
AND NORTHERN TERRITORY

PETROLEUM TITLE LOCATIONS



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PETROLEUM EXPLORATION BRANCH, BMR

Record No. 1978/4[illegible], 1978/39

Record No. 1976/28

XAUS-6-73

Fig. 1

OFFSHORE BONAPARTE GULF BASIN (W.A.)

1 : 1 000 000

PROSPECTIVITY

Water depth	< 200m	> 200m
	Good	Good
	Fair	Fair
	Poor	Poor

Diapiric structure

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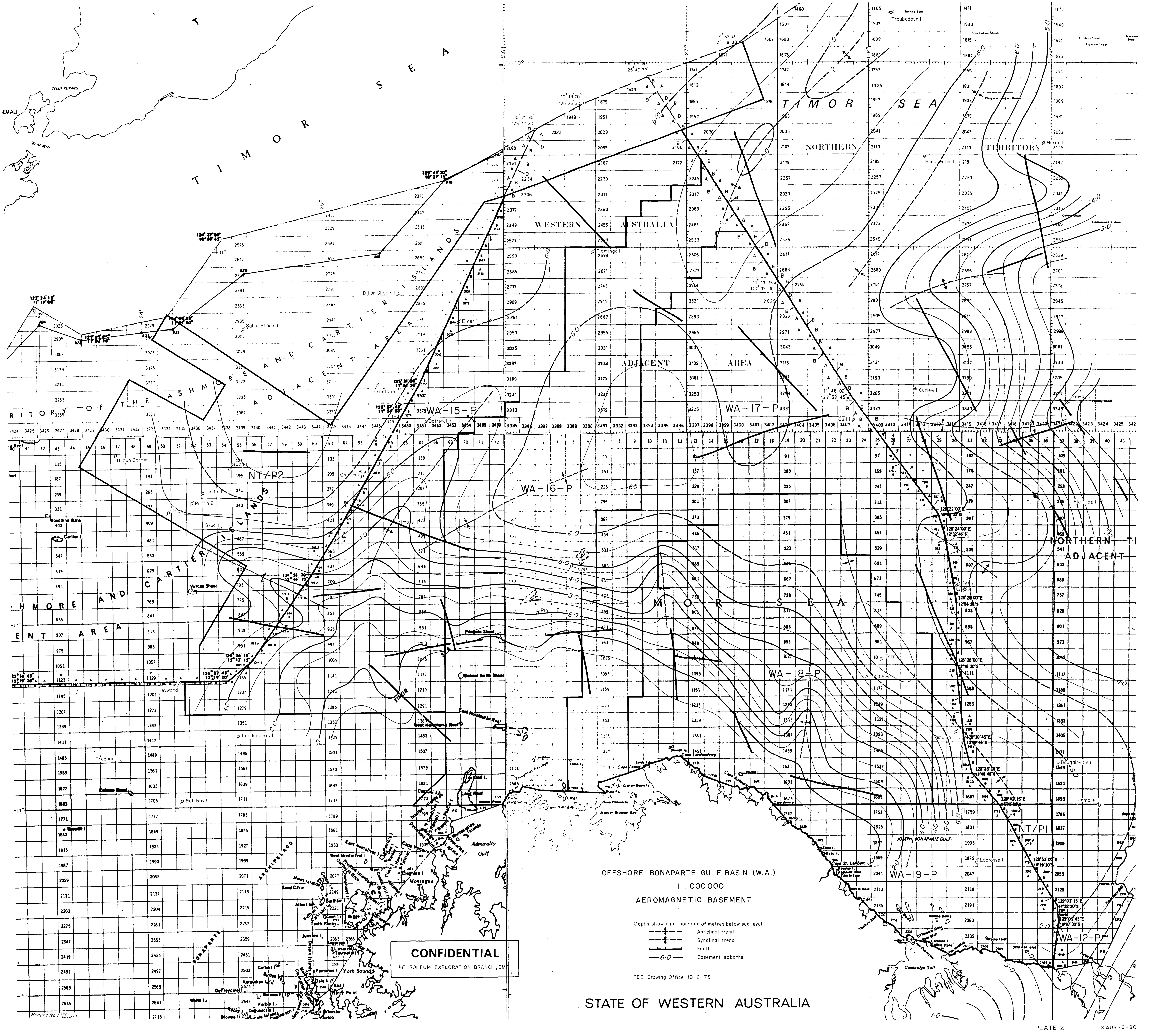
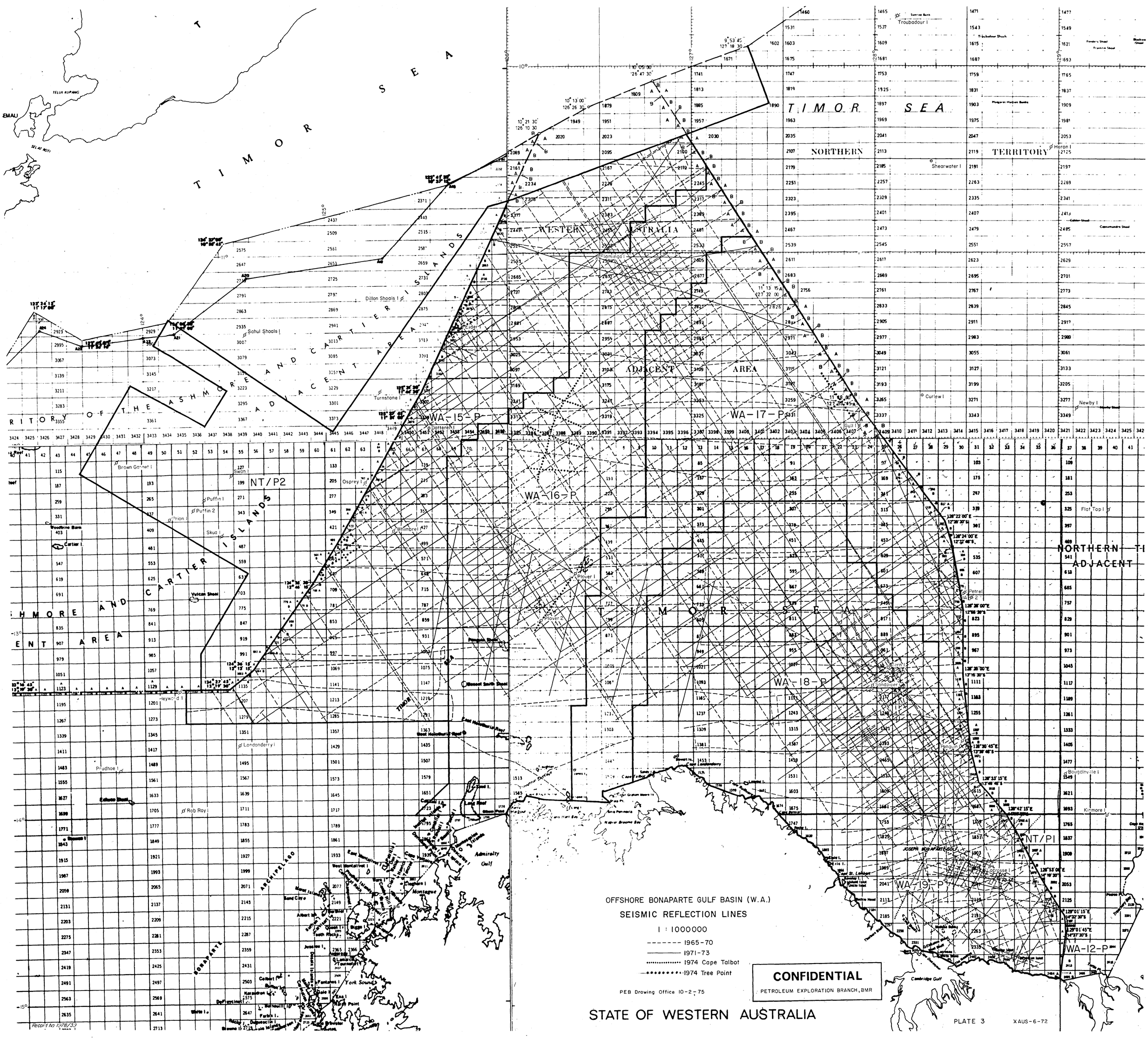
Record No 1978/39

STATE OF WESTERN AUSTRALIA

PLATE I XAUS-6-81



TIMOR SEA
NORTHERN TERRITORY
WESTERN AUSTRALIA ADJACENT AREA
TERRITORY OF THE ASHMORE AND CARTIER ISLANDS
ASHMORE AND CARTIER ISLANDS ADJACENT AREA
NORTHERN TERRITORY ADJACENT
NT/P2
WA-15-P
WA-16-P
WA-17-P
WA-18-P
WA-19-P
NT/P1
WA-12-P
JOSEPH BONAPARTE GULF
Cambridge Gulf
Admiralty Gulf
BONAPARTE ARCHIPELAGO
York Sound
OFFSHORE BONAPARTE GULF BASIN (W.A.)
1:1 000 000
AEROMAGNETIC BASEMENT
Depth shown in thousand of metres below sea level
Anticlinal trend
Synclinal trend
Fault
6·0 Basement isobaths
PEB Drawing Office 10-2-75
STATE OF WESTERN AUSTRALIA
CONFIDENTIAL
PETROLEUM EXPLORATION BRANCH, BMR
PLATE 2
X AUS-6-80



OFFSHORE BONAPARTE GULF BASIN (W.A.)

SEISMIC REFLECTION LINES

1 : 1000000

------- 1965-70

——— 1971-73

..... 1974 Cape Talbot

—•—•—•— 1974 Tree Point

PEB Drawing Office 10-2-75

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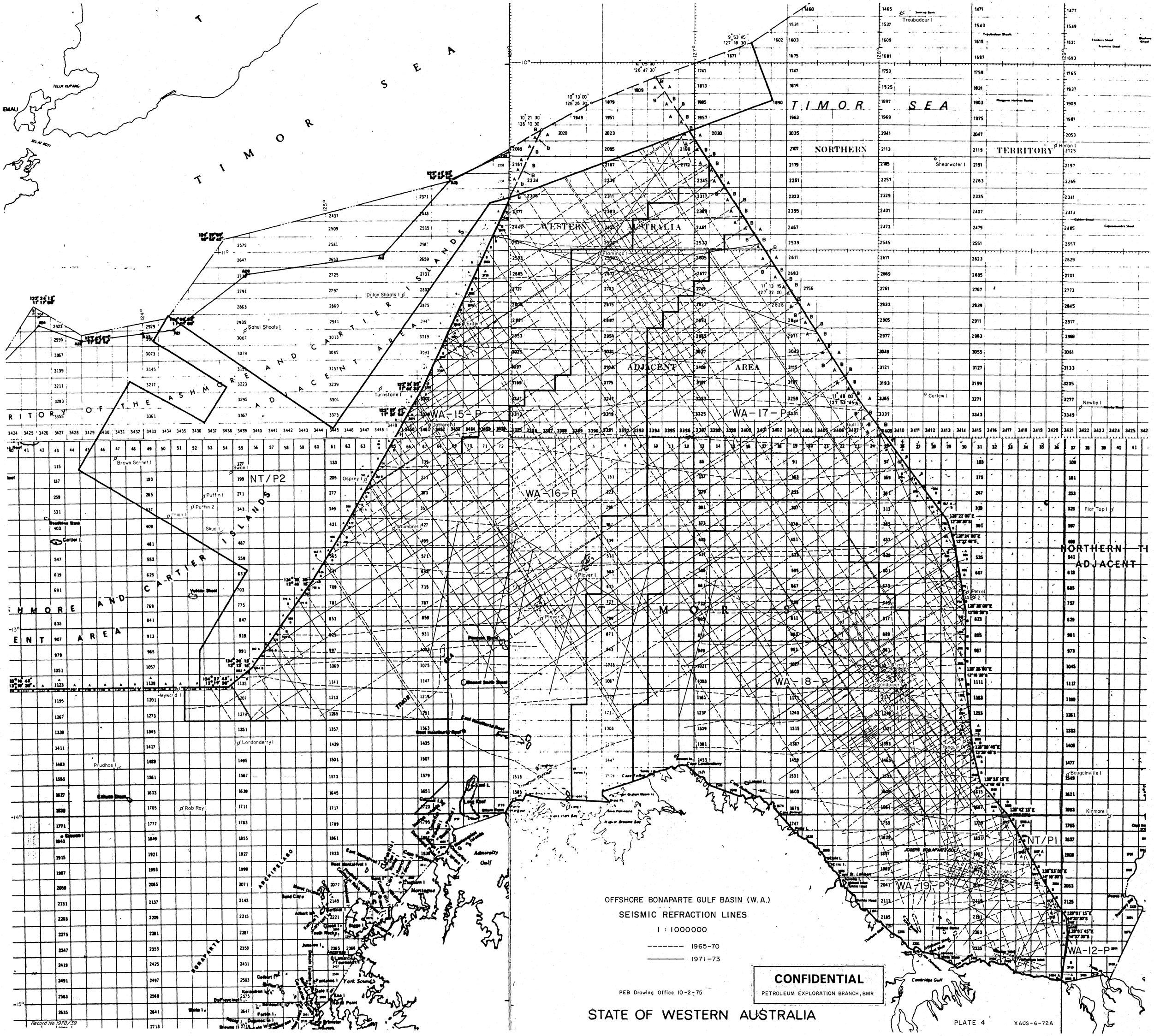
PETROLEUM EXPLORATION BRANCH, BMR

STATE OF WESTERN AUSTRALIA

PLATE 3 XAUS-6-72



OFFSHORE BONAPARTE GULF BASIN (W.A.)

SEISMIC REFRACTION LINES

1 : 1000000

------- 1965-70

——— 1971-73

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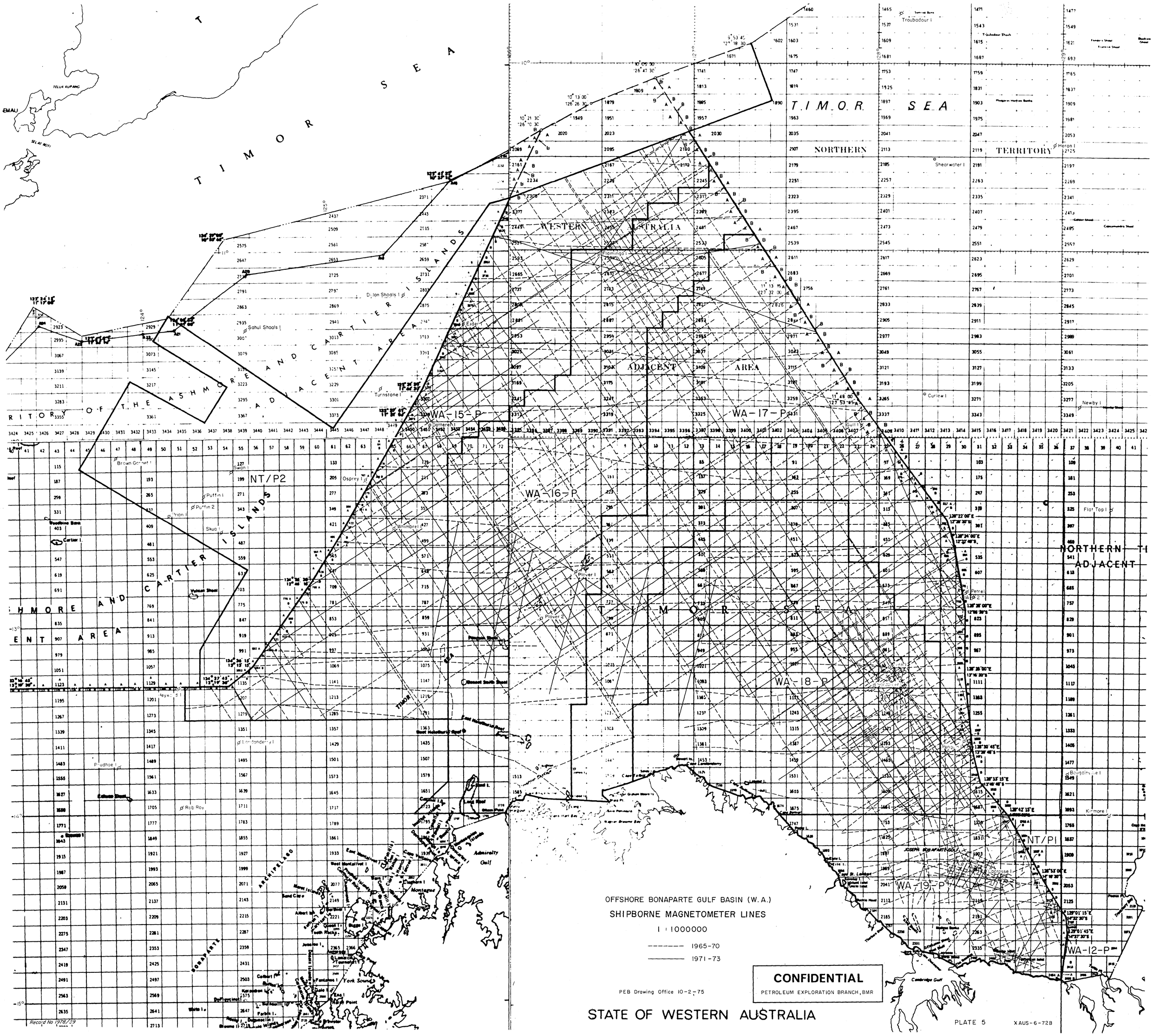
PETROLEUM EXPLORATION BRANCH, BMR

PEB Drawing Office 10-2-75

STATE OF WESTERN AUSTRALIA

PLATE 4 XAUS-6-72A



OFFSHORE BONAPARTE GULF BASIN (W.A.)

SHIPBORNE MAGNETOMETER LINES

1 : 1000000

------- 1965-70

——— 1971-73

PEB Drawing Office 10-2-75

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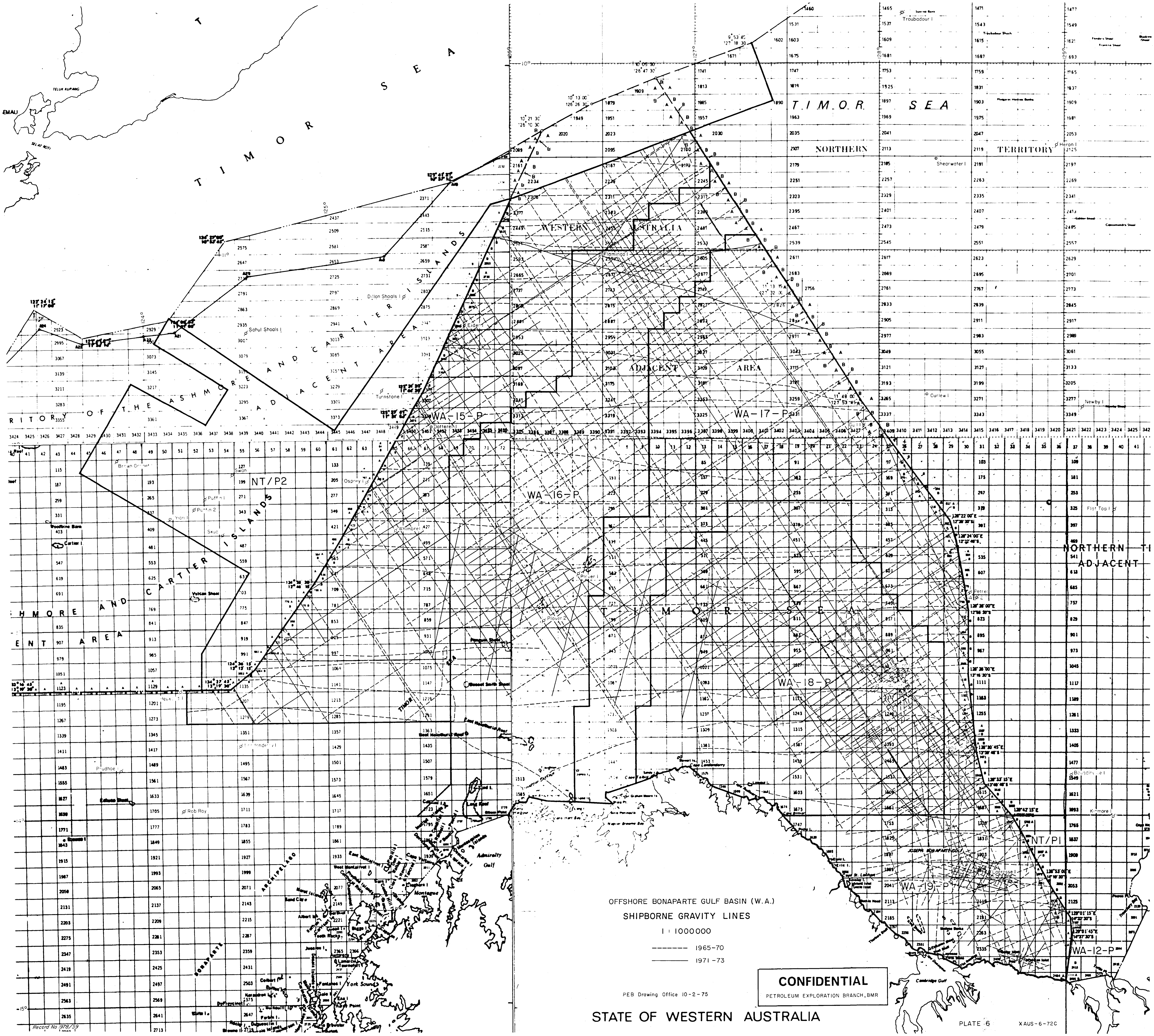
PETROLEUM EXPLORATION BRANCH, BMR

STATE OF WESTERN AUSTRALIA

PLATE 5 XAUS-6-728

Record No 1978/39


OFFSHORE BONAPARTE GULF BASIN (W.A.)
SHIPBORNE GRAVITY LINES
1 : 1000000
1965-70
1971-73
PEB Drawing Office 10-2-75
CONFIDENTIAL
PETROLEUM EXPLORATION BRANCH, BMR
STATE OF WESTERN AUSTRALIA
PLATE 6
XAUS-6-72C
Record No 1978/39
TIMOR SEA
T.I.M.O.R. SEA
NORTHERN TERRITORY
WESTERN AUSTRALIA ADJACENT AREA
TERRITORY OF THE ASHMORE AND CARTIER ISLANDS
ASHMORE AND CARTIER ISLANDS ADJACENT AREA
NORTHERN TERRITORY ADJACENT
WA-15-P
WA-16-P
WA-17-P
WA-18-P
WA-19-P
WA-12-P
NT/P2
NT/P1
JOSEPH BONAPARTE GULF
Cambridge Gulf
Admiralty Gulf
York Sound
BONAPARTE ARCHIPELAGO

OFFSHORE BONAPARTE GULF BASIN (W.A.)

1:1000000

BOUGUER ANOMALIES

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PETROLEUM EXPLORATION BRANCH, BMR

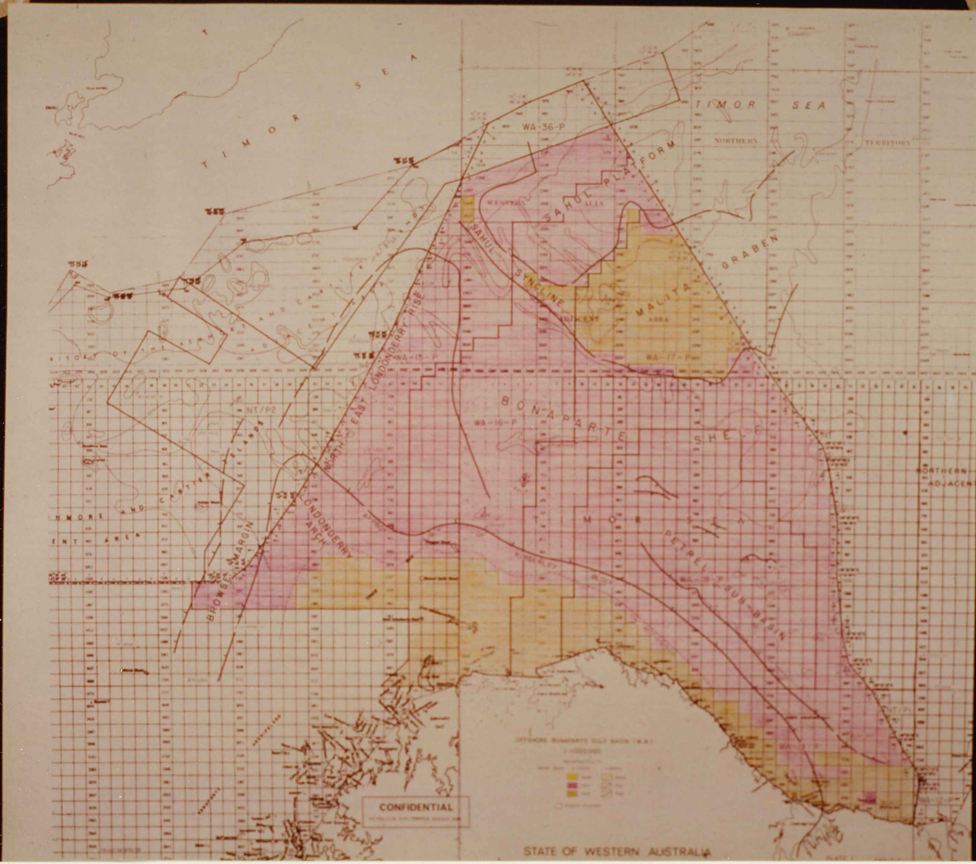
PEB Drawing Office 10-2-75

STATE OF WESTERN AUSTRALIA

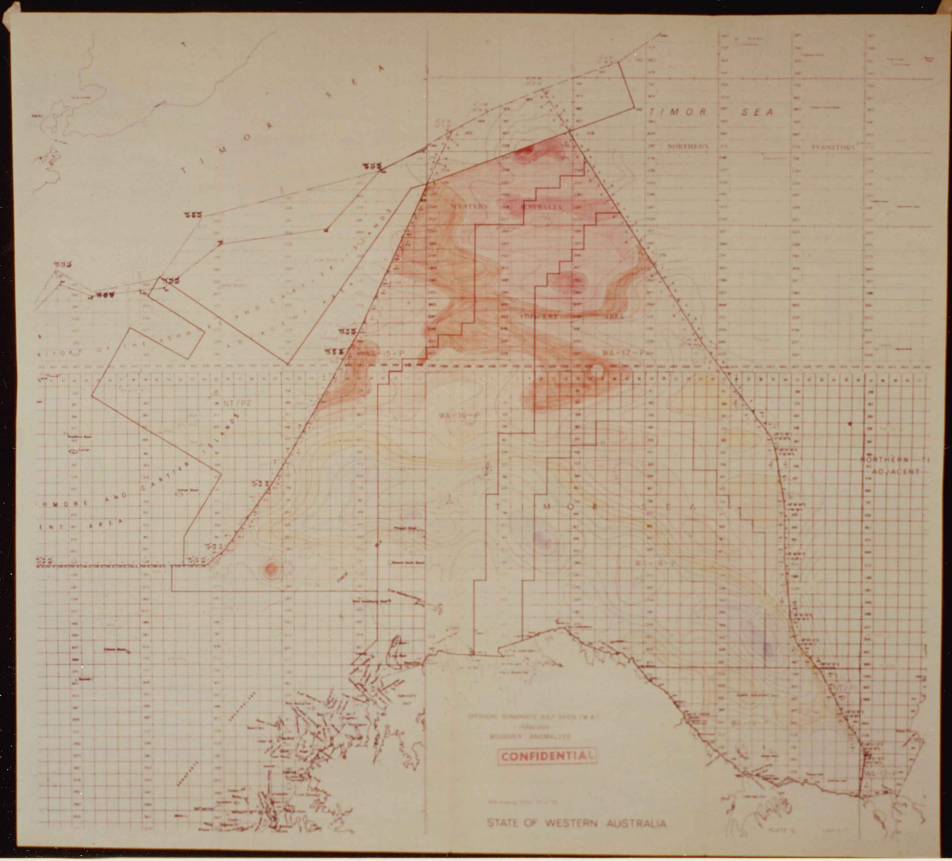
PLATE 7

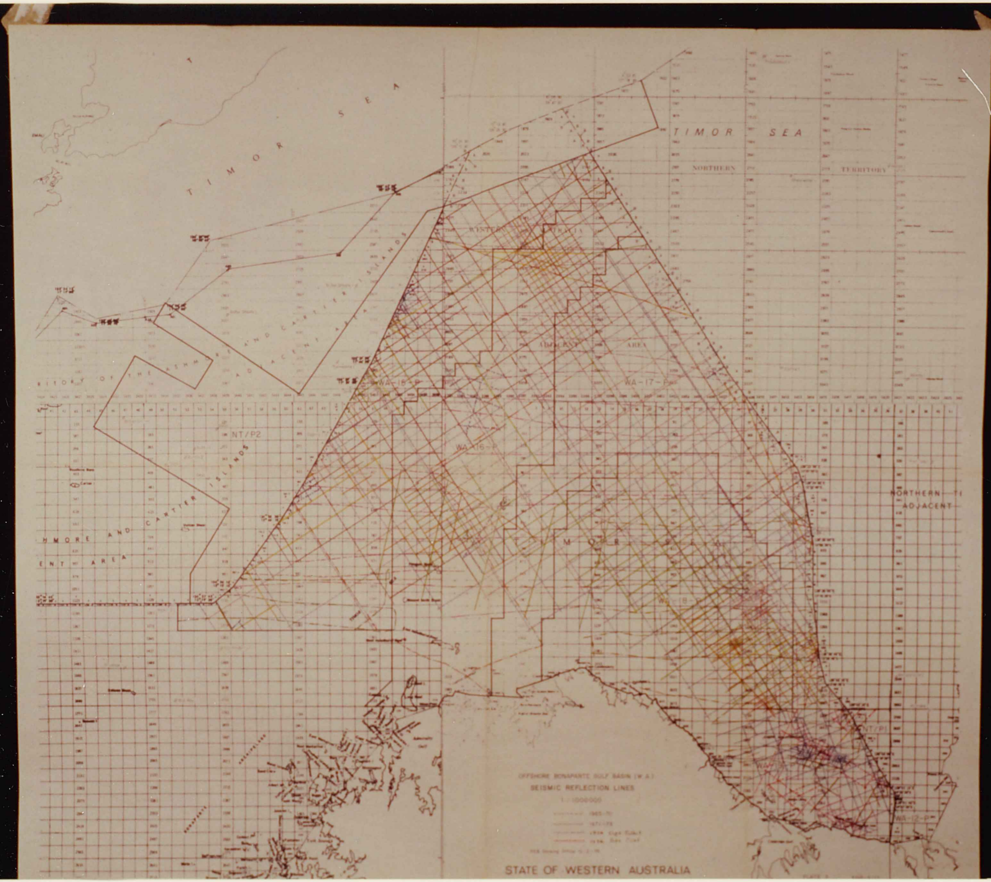
XAUS-6-77

Record No 1978/39

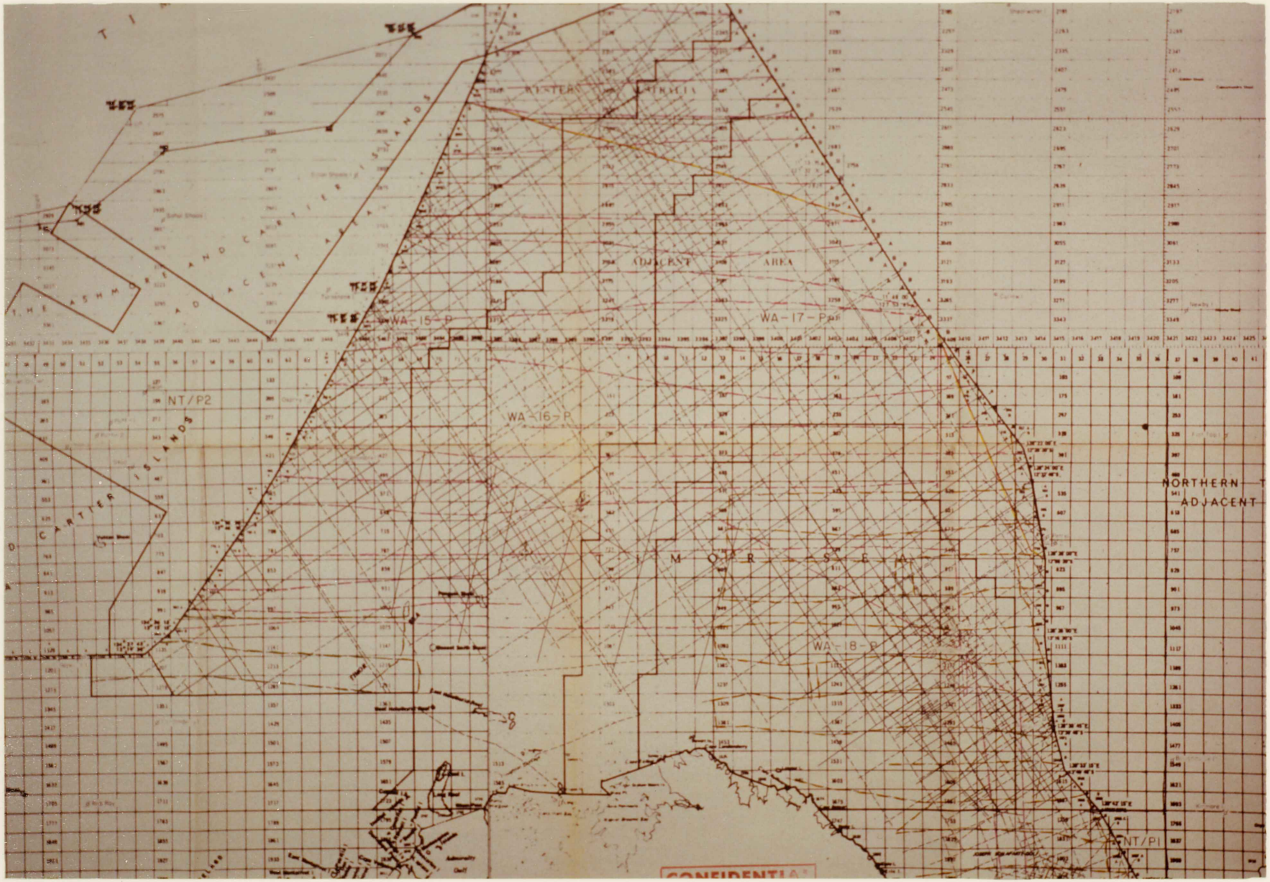


TIMOR SEA
TIMOR SEA
NORTHERN
TERRITORY
WA-36-P
SAHUL PLATFORM
SAHUL SYNCLINE
MALITA GRABEN
WA-17-P
WA-15-P
WA-16-P
BONAPARTE SHELF
NORTH EAST LONDONDERRY RISE
LONDONDERRY ARCH
BROWSE MARGIN
NT/P2
NT/P1
PETREL SUB-BASIN
NORTHERN ADJACENT
CONFIDENTIAL
STATE OF WESTERN AUSTRALIA


TIMOR SEA
TIMOR SEA
NORTHERN TERRITORY
WESTERN AUSTRALIA
JOINT AUTHORITY AREA
BOUGUER ANOMALIES
CONFIDENTIAL
STATE OF WESTERN AUSTRALIA


TIMOR SEA
TIMOR SEA
NORTHERN
TERRITORY
NT/P2
WA-16-P
WA-17-P
WA-18-P
NT/P1
NORTHERN
ADJACENT
OFFSHORE BONAPARTE GULF BASIN (W.A.)
SEISMIC REFLECTION LINES
STATE OF WESTERN AUSTRALIA


TIMOR SEA
TIMOR SEA
NORTHERN TERRITORY
WESTERN AUSTRALIA
ADJACENT AREA
WA-17-P
WA-15-P
WA-2-P
NORTHERN TI
ADJACENT
OFFSHORE BONAPARTE GULF BASIN (W.A.)
1:1000000
AEROMAGNETIC BASEMENT
CONFIDENTIAL
STATE OF WESTERN AUSTRALIA


WESTERN AUSTRALIA
ADJACENT AREA
WA-15-P
WA-17-P
WA-16-P
WA-18-P
NT/P2
NT/P1
NORTHERN
ADJACENT
TIMOR SEA
CARTIER ISLANDS
CONFIDENTIAL