BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD

Record No. 1980/26

A REVIEW OF THE GEOLOGY, PETROLEUM EXPLORATION, AND PETROLEUM PROSPECTS OF THE OFFICER BASIN REGION

by

C.S. Robertson, S.J. Mayne, & D.G. Townsend

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CONTENTS

ILLUSTRATIONS

PLATES

FIGURES

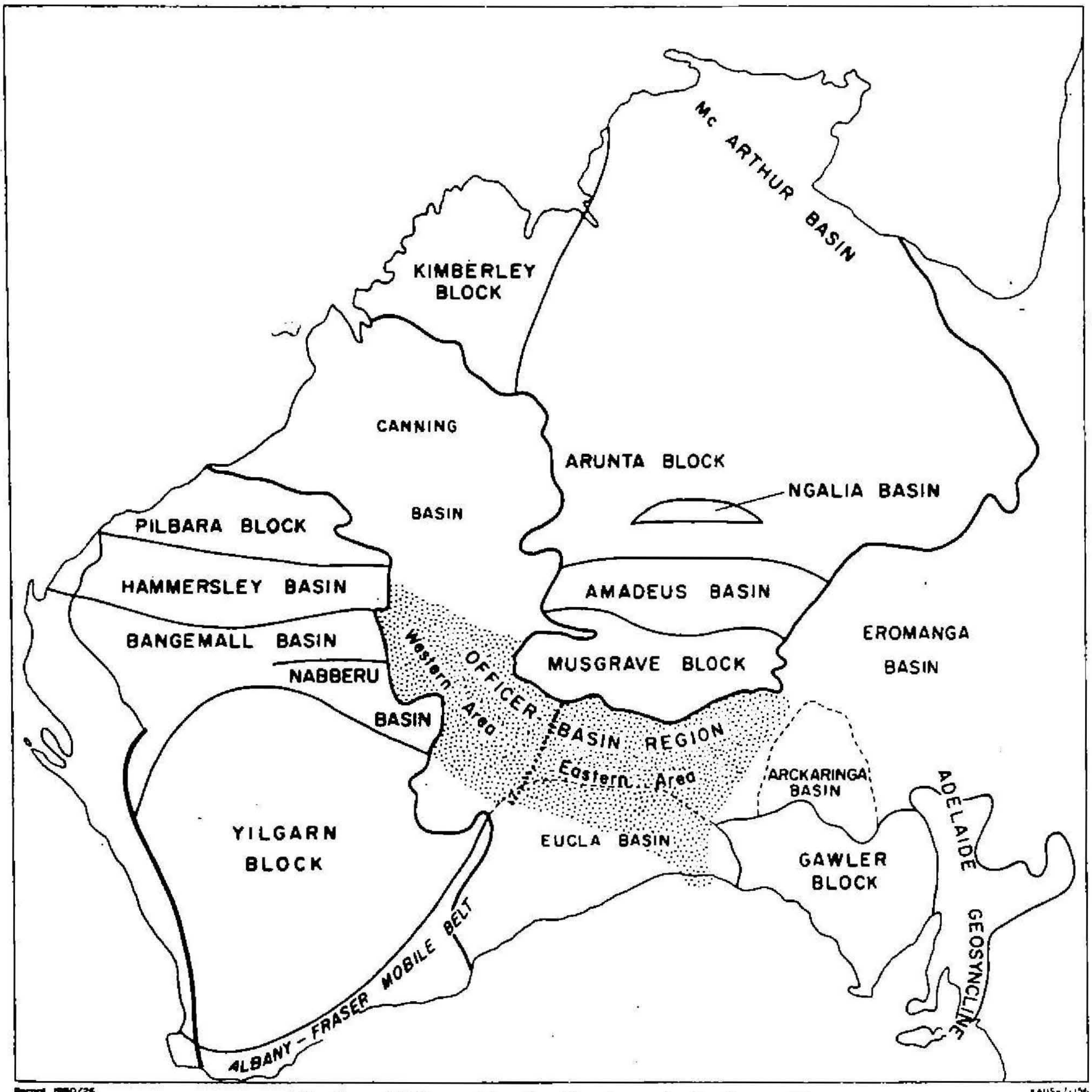
SUMMARY

Petroleum exploration carried out in the Officer Basin region up to December 1977 and geological and geophysical work done by the Bureau of Mineral Resources and State geological surveys have been reviewed to provide an assessment of existing information bearing on the petroleum potential of the region.

The region lies to the south and west of the Musgrave Block in South Australia and Western Australia. Adelaidean sediments are widespread in the region, but older Proterozoic sediments are known only in the west. Early Palaeozoic sediments occur in the Munyarai Trough in the east, but sediments of this age have not been identified in the west, although they are assumed to continue into this area from the Canning Basin. Permian, Cretaceous, and Tertiary platform veneer sediments are widespread in the region.

The region has been covered by regional aeromagnetic and gravity surveys. Seismic coverage is mainly sparse. There have been few detailed seismic surveys, and many of the reconnaissance seismic lines shot have provided poor quality data. Many areas have had no seismic investigation. A limited number of shallow stratigraphic or test holes have been drilled, but only three wells in the whole region have exceeded depths of 900 m.

The western part of the region appears to lack good source rocks, and has a relatively thin sequence of Phanerozoic sediments. Its petroleum prospects are poor, but further exploration seems warranted in some areas which are virtually unexplored. The prospectivity of the Munyarai Trough in the eastern part of the region is better, because seismic surveys and drilling have indicated the presence of at least 4400 m of Palaeozoic sediments. One deep well, on a valid closed structure, failed to detect indications of petroleum or source or reservoir rocks, but the full Palaeozoic sequence has not yet been drilled. Insufficient information is available to allow a reliable assessment of the petroleum potential of the eastern part of the region. More seismic surveying and drilling are warranted.



Record 1980/26

Fig 1   Officer Basin Region, tectonic setting

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INTRODUCTION

This Record is a summary of petroleum exploration and prospects in the large area of central Australia located to the south and west of the Musgrave Block which, in common practice, has been referred to as the Officer Basin (Fig. 1). The term has been applied to a wide age range of sedimentary sequences which cannot or have not been ascribed to other basins, and no precise delineation of basin boundaries is possible based on present data. In order to avoid confusion with previous concepts of the term 'Officer Basin', the term 'Officer Basin region' has been used in this report.

The Bureau of Mineral Resources, Geology and Geophysics (BMR) and the Geological Survey of Western Australia (GSWA) have mapped and published all the 1:250 000 scale geological map sheets in the Western Australian part of the region, and the Geological Survey of the South Australian Department of Mines and Energy (SADME) has mapped and published the BIRKSGATE, LINDSAY, and EVERARD geological map sheets in South Australia (Pl. 1).

Krieg & others (1976) have provided the most recent description of the geology of the Officer Basin region. The geology of the Western Australian part of the region is described by Jackson and van de Graaff (in prep.) and geophysical exploration in the western area has been described by Harrison & Zadoroznyj (1978).

This summary is based mainly on information available to BMR up to December 1977. Much of the petroleum exploration carried out by industry in the region up to 1974 was subsidised by the Australian Government under the terms of the Petroleum Search Subsidy Act (PSSA). Final reports on subsidised wells and subsidised geophysical surveys, containing both basic and interpretative data, are available to the public at BMR and at BMR Open File Centres.

GEOLOGY

The Officer Basin region contains thick Proterozoic to Late Devonian sediments, overlain by a thin veneer of Permian, Mesozoic, and Tertiary sediments. They underlie an area partly bounded by the crystalline igneous and metamorphic rocks of the Musgrave, Yilgarn, and Gawler Blocks. They are contiguous with or extend beneath sediments of the Canning Basin to the north, the Eucla Basin to the south, and the Eromanga Basin to the east.

The surface geology of the region is shown on Plate 1. Postulated sub-surface geological relationships are illustrated in schematic cross-sections in Figures 2, 3, and 4.

For ease of reference in discussion, the regions west and east of about 128°E are designated the western and eastern areas respectively (Fig. 1).

The geology of the western area has been determined almost wholly from a few wells and a few outcrops in the Warburton Mission area, near the western end of the Musgrave Block (Pl. 1); the component units have been extended into the subsurface by Harrison and Zadoroznyj (1978) using geophysical data. Their conclusions are summarised further on.

For convenience the eastern area can be subdivided into three parts informally referred to here as the Munyarai Trough, the Birksgate 'Trough', and the Southern Platform area (Pl. 1). Gravity and aeromagnetic surveys and surface geology first indicated the presence of an east-northeast-trending sediment-filled depression in the easternmost part of the region between the Musgrave Block and the Gawler Block. Seismic surveys and the drilling of Munyarai No. 1 well have confirmed the presence of a depression containing at least 4400 m of probably Palaeozoic sediments, which here has been informally named the Munyarai Trough (Pl. 1). Geophysical data suggest that the igneous and metamorphic rocks of the Musgrave Block have been overthrust a considerable distance over the sediments in the northern part of the Trough.

Interpretation of the gravity map (Pl. 6) and interpretation of depth to magnetic basement suggest the presence of a depression in basement in the Birksgate area near the western border of South Australia. This

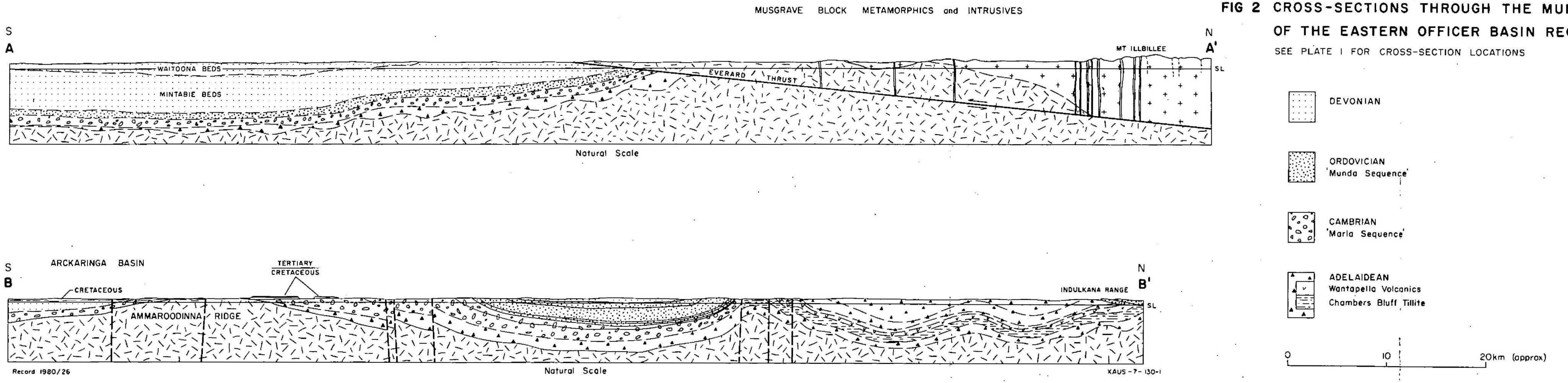
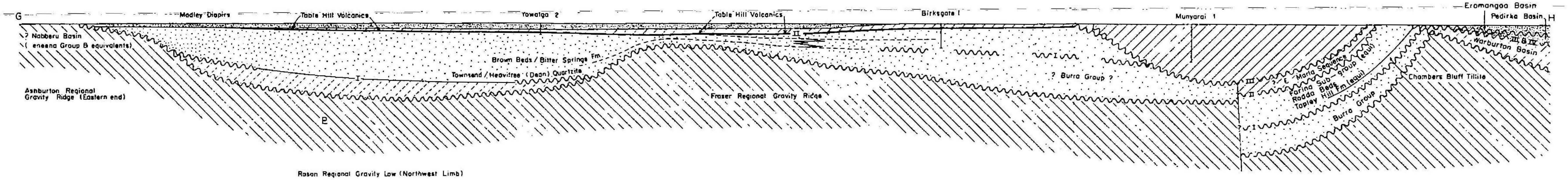


FIG 2 CROSS-SECTIONS THROUGH THE MUNYARAI TROUGH OF THE EASTERN OFFICER BASIN REGION

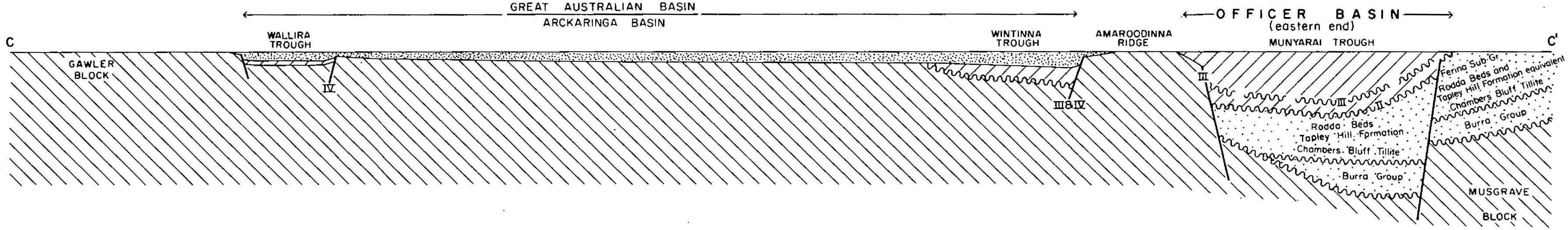
SEE PLATE 1 FOR CROSS-SECTION LOCATIONS

FIG 3 SCHEMATIC LONGITUDINAL CROSS-SECTION THROUGH OFFICER BASIN REGION

SEE PLATE 1 FOR CROSS-SECTION LOCATIONS



SCHEMATIC TRANSVERSE CROSS-SECTION THROUGH OFFICER BASIN REGION



Record 1980/26

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Phanerozoic (Permian & later)

Palaeozoic (Devonian ± Cambro-Ordovician)

Table Hill Volcanics

Proterozoic (Adelaidean)

Proterozoic (Middle P to Early Ad)

Proterozoic (Early to Middle P)

Archaeozoic

IV *Alice Springs Orogeny*

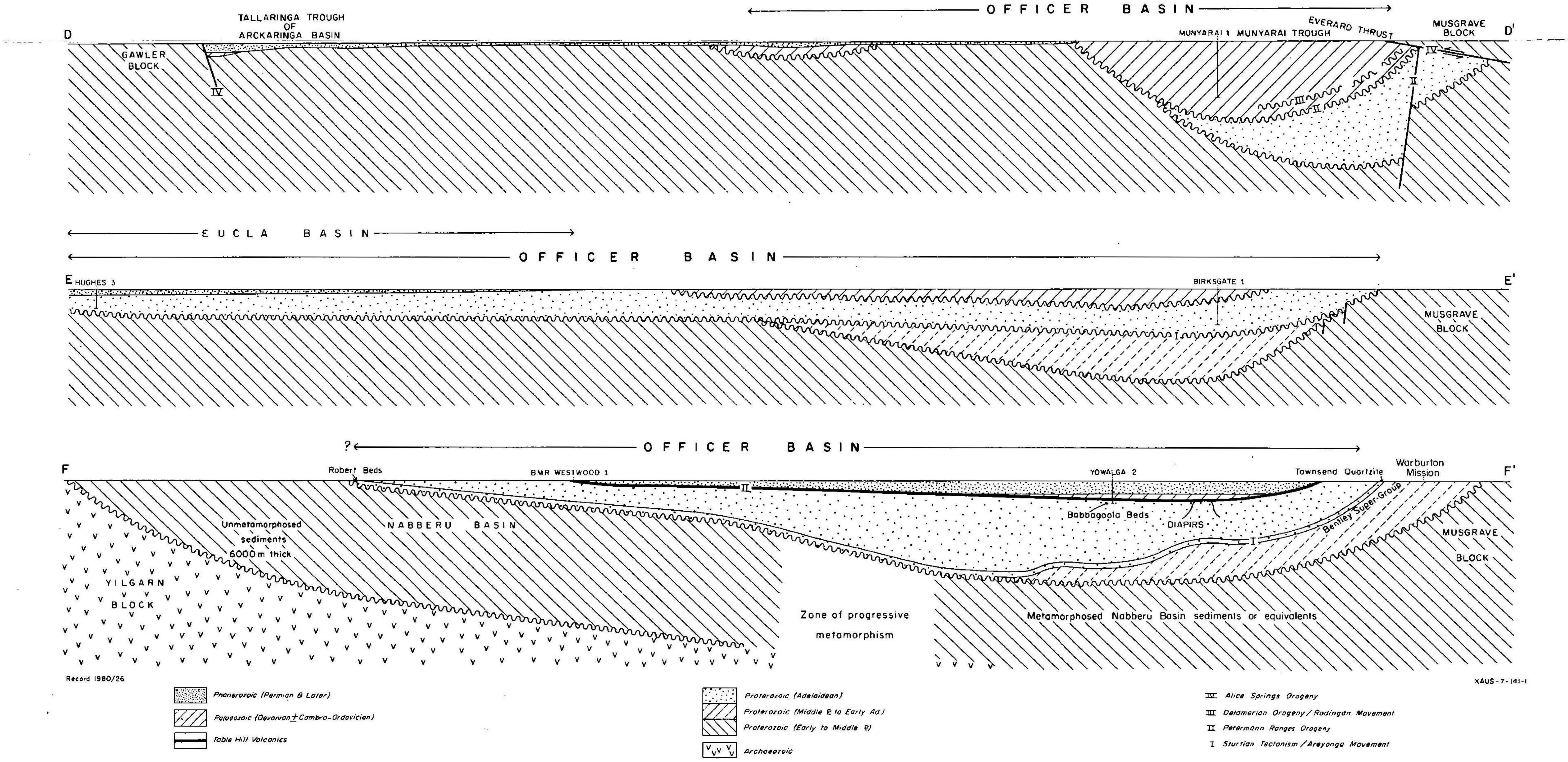
III *Delamerian Orogeny / Rodingan Movement*

II *Petermann Ranges Orogeny*

I *Sturtian Tectonism / Areyonga Movement*

FIG 4 SCHEMATIC TRANSVERSE CROSS-SECTIONS THROUGH OFFICER BASIN REGION

SEE PLATE I FOR CROSS-SECTION LOCATIONS



depression may be an extension of the Munyarai Trough, or it may be a separate depression. Seismic surveys of limited extent tend to confirm the presence of an east-trending synclinal sedimentary depression with a steeper flank to the north than to the south and with an axis plunging gently to the west. However the shape and extent of the Birksgate 'Trough' are not well defined, and the few wells which have been drilled in the eastern part of the Officer Basin region indicate that there is a considerable difference in the stratigraphy of the Birksgate 'Trough' and the Munyarai Trough.

Little is known about the sedimentary rocks south of the Munyarai and Birksgate Troughs, except that they are thinner than those in the depressions to the north. Crystalline basement evidently becomes shallower southwards from the Munyarai and Birksgate Troughs, and this southern part of the eastern Officer Basin region is here referred to as the 'Southern Platform area'.

Large areas of ancient rocks border the Officer Basin region (Pl. 1). These rocks, which are mostly Proterozoic in age, must have served as sediment sources for a large part of the sedimentary sequences in the region. Some of the surrounding rocks may extend under the Officer Basin region to constitute its basement, or may form part of the deeper levels of the basinal sequences.

The surrounding rocks fall into two categories: those which are predominantly crystalline and those comprising relatively unmetamorphosed sediments and volcanics. The crystalline rocks occur in the Yilgarn Block, the Albany-Fraser Province, the Gawler Block and the Musgrave Block (Pl. 1). They consist of migmatites, gneisses, granitoids, schists, and mafics, including greenstone belts. The unmetamorphosed sediments and volcanics occur to the northwest of the region in the Nabberu and eastern Bangemall Basins (Pl. 1). They include carbonates, shale, siltstone, sandstone, and conglomerate, in addition to volcanics.

Proterozoic

Western area

The Late Proterozoic Townsend Quartzite and the Lefroy Beds crop out along the southwestern flanks of the Musgrave Block in Western Australia. As defined by Lowry & others (1972), the Townsend Quartzite is the oldest unit in the Officer Basin. In most places it is unconformable on older rocks, but it is conformable on the Mission Group of the Bentley Super-Group. The formation is known to be at least 370 m thick, and consists of a lower fine to coarse-grained quartzite and an upper coarse-grained to conglomeratic quartzite. Some of the units are cross-bedded. Jackson & van de Graaff (in prep.) correlate the Townsend Quartzite on lithology with the lower sandstone part of the Pindyin Beds of BIRKSGATE*, and consider that probable correlatives occur in ROBERT on the western side of the Officer Basin. They interpret the Townsend Quartzite to have been laid down in a sub-littoral environment. The formation grades upwards into the Lefroy Beds (Lowry & others, 1972), which consist of at least 250 m of laminated lutites, probably deposited in deeper water. The Lefroy Beds are correlated with the upper part of the Pindiyn Beds. Major (1973c) considers it possible that the upper (shale) part of the Pindyin Beds may correlate with the basal part of the Wright Hill Beds in South Australia. Comparison of the thickness of the Wright Hill Beds (estimated to be of the order of 3400 m) with that of the Townsend Quartzite and Lefroy Beds indicates that there is a greatly thicker Adelaidean sequence in the eastern part of the Officer Basin region than in the western part.

The Lupton Beds (Lowry & others, 1972) are a sequence of 'conglomeratic diamictite, and an upper unit of interbedded conglomerate, sandstone, and siltstone', considered to be of glacial origin. The Lupton Beds are known to be at least 250 m thick. They appear to overlie the Lefroy Beds conformably, but as they contain debris from the Townsend Quartzite, some of the older units must have been eroded during their deposition.

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*Names capitalised as such refer to 1:250 000 Geological Sheets.

An unnamed sequence, informally referred to by van de Graaff (1974) as the Woolnough Hills sequence, consisting of dolomitic limestone, stromatolitic dolomite, siltstone, sandstone, and chert, occurs on the flanks of several diapirs in northern MADLEY and WARRI. The diapirs intrude Permian and younger sediments at the surface. The stromatolites indicate an Adelaidean age, suggesting lithological correlation of the Woolnough Hills sequence with the Bitter Springs Formation of the Amadeus Basin to the east. Alternatively, correlation with the evaporite-bearing Carribuddy Formation of the Canning Basin to the north or the Lower Cambrian Browne Beds to the south are possibilities.

The Browne Beds (Lowry & others, 1972) are known only from Browne No. 1 and Browne No. 2 (Pl. 1, Table 1). They consist of at least 251 m of evaporites (dolomitic limestone, calcareous shale, anhydrite, and salt) in a diapir. Some intervals contain abundant organic matter with microfossils of possible Proterozoic age (Kemp, 1976). The Browne Beds may be correlated with either the Woolnough Hills sequence and the Bitter Springs Formation (Amadeus Basin) or the Babbagoola Beds of the western Officer Basin region.

The Clutterbuck Beds (Lowry & others, 1972) are composed of arenites with some thin interbeds of siltstone. They are found in the Clutterbuck Hills in COBB and are thought to be an inlier of late Precambrian sediments from the Amadeus Basin. They are steeply dipping and at least 4260 m thick.

The Babbagoola Beds (Lowry & others, 1972) are known only in Yowalga No. 2 (Pl. 1), and BMR Throssell No. 1 (Jackson & others, 1975). In Yowalga No. 2 they were penetrated from 846 m to total depth at 989 m (Table 1); they are thus over 143 m thick. They lie with angular unconformity below the Table Hill Volcanics and consist of interbedded sandstone and shale, dolomite with gypsum veins and light to dark shale and pale siltstone. They contain Lower Cambrian microfossils (Muir, pers. comm.).

Table 1

Petroleum exploration wells, Western area

Scout holes (modified after Jackson, 1966)

Yowalga No. 1

0 - 92.4	undifferentiated Mesozoic
92.4 - 457.8 m	Paterson Formation
457.8 - 613 m T.D.	Lennis Sandstone

Browne No. 1

0 - 84.4 m	undifferentiated Mesozoic
84.4 - 132.6 m	Paterson Formation
132.6 - 186.8 m T.D.	Browne Beds

Browne No. 2

0 - 140.2 m	undifferentiated Mesozoic
140.2 - 262.1 m	Paterson Formation
262.1 - 292.6 m T.D.	Browne Beds

Lennis No. 1

0 - 137.2 m	undifferentiated Mesozoic
137.2 - 187.2 m	Paterson Formation
187.2 - 612.3 m	Lennis Sandstone
612.2 - 615 m T.D.	Table Hill Volcanics

Table 1 continued

Yowalga No. 2 (Hunt Oil, 1966c)

Age or Rock Unit	Depth (m)	Thickness	Lithology
Recent	K.B. - 7.6	3.7	laterite
Mesozoic	7.6 - 94.5	86.9	sandstone, soft, orange-red to white, very fine to very coarse-grained, angular to sub-rounded, kaolin matrix, some clay
Permian (Sakmarian) Paterson Formation	94.5 - 406.9	312.4	sandstone, soft, fine to very coarse-grained, sub-angular to well-rounded, frosted, high lithic content (igneous and meta-morphic clasts); inter-bedded mudstone; massive zones of igneous rock fragments and coarse quartz grains
Lennis Sandstone	406.9 - 728.5	321.6	sandstone, feldspathic, reddish, very fine to medium-grained, biotite and red clay cement
Table Hill Volcanics	728.5 - 845.8	117.3	basalt (formerly the Officer Volcanics)
Babbagoola Beds			
Unit A	845.8 - 887.0	41.2	sandstone, hard, poorly sorted, interbedded with shale, hard, red-brown; veinlets of anhydrite and gypsum
Unit B	887 - 893.1	6.1	dolomite, dark, silicified, with veinlets of anhydrite and gypsum
Unit C	893.1 - T.D. at 989.4	96+	shale, variegated, inter-bedded with siltstone, light grey to white

EASTERN AREA

The stratigraphy of the Munyarai Trough has been interpreted from outcrops, mainly in northeast EVERARD, and from the petroleum exploration wells Munyarai No. 1 and Officer No. 1 drilled in the central part of the Trough (Pl. 1).

Krieg (1972) and Major (1972), among others, considered that a sequence of folded and 'old looking' sediments occurring in the north-eastern corner of EVERARD are Adelaidean in age, and they correlate them with groups in the Adelaide Geosyncline, some 700 km to the southeast (Pl. 2). They are described in the following stratigraphic table after Krieg (1972).

Table 2

Stratigraphic units, northeast EVERARD

Unit	Lithology
Farina Sub-Group	
unnamed formation:	Siltstone, grey-green, with thin bands of very fine-grained sandstone; calcareous in part; 600 m.
Rodda Beds:	Siltstone, grey-green to khaki, commonly calcareous or dolomitic; grey and vari-coloured limestone and dolomite; sandstone, feldspathic, medium to coarse-grained; conglomerate bands; 1200 m.
Tapley Hill Formation equivalent:	Siltstone, blue-grey, laminated; and siltstone and shale, variegated. 600 m.
unnamed formation:	Sandstone, quartzitic, feldspathic, hard, reddish, medium to coarse-grained; basal conglomerate; 100 m.
Yudnamutana Sub-Group	
Wantapella Volcanics:	Basalt, grey-green, vesicular; 290 m.
Chambers Bluff Tillite:	Siltstones and shales, light brown to pale green, gritty and pebbly, with facetted and striated erratics of igneous, sedimentary, and metamorphic rocks of all sizes; 520 m. Unconformity (Areyonga Movement, Sturtian Tectonism).
unnamed formation:	Siltstone and shale, light brown, also green and purple; quartzite hard, white, in prominent thick bands, feldspathic in part; thin pebble conglomerate at base; 100 m.

The undermentioned Proterozoic beds have been described from the northern margins of the Birksgate 'Trough'.

The Pindyin Beds (Major, 1973b) rest on weathered crystalline basement and are the oldest known unmetamorphosed Precambrian sedimentary rocks cropping out in LINDSAY and BIRKSGATE. They are older than the Chambers Bluff Tillite in the Munyarai Trough (Pl. 2), because this contains chert that is derived from the Wright Hill Beds, which overlie the Pindyin Beds. The lower part of the Pindyin Beds is correlated on lithology with the Townsend Quartzite. The upper, shale part of the Pindyin Beds may be synonymous with the lower part of the Wright Hill Beds.

Most of the Wright Hill Beds (Major, 1973c) including the base and the top, are not exposed, but air-photogrammetry indicates a total thickness of more than 3400 m. The beds generally dip at about 40^{o} south-southeast and consist of the following (youngest uppermost):

665 m	no outcrop
95 m	black oolitic chert (Pebbles assumed to be of this chert are found in the Chambers Bluff Tillite).
95 m	no outcrop
285 m	limestone
95 m	fine to medium-grained pink feldspathic quartzite
330 m	limestone
145 m	no outcrop
65 m	medium-grained feldspathic quartzite; some cross-bedding
145 m	chert
5 m	quartzite
575 m	maroon laminated siltstone; and no outcrop
145 m	coarse to very coarse-grained quartzite Cross-bedding and ripples
710 m	no outcrop
45 m	white medium-grained sandstone

Regional correlations are shown on Plate 2.

The Punkerri Beds (Major, 1974b), formerly Punkerri Sandstone, appear to be conformable on the Wright Hill Beds, but the contact is apparently disconformable, because a thin pebble conglomerate in the Punkerri Beds contains pebbles of black oolitic chert similar to that near the top of the Wright Hill Beds. The Punkerri Beds are correlated with the Adelaidean Pound Quartzite of the Flinders Ranges (Pl. 2) on grounds of lithological similarity and because they contain impressions of Ediacara-type fauna similar to that of the Pound Quartzite.

The Punkerri Beds consist of:

Upper member: 935 + m, white and red sandstone with Ediacara-type trace fossils

Lower member: 265 + m, red, tough, micaceous flaggy sandstone

Overlying the Punkerri Beds are the Wirrildar Beds (Major, 1973a). These are a poorly exposed sequence of about 2700 m of feldspathic and micaceous sandstones of ?late Precambrian to ?early Cambrian age in BIRKSGATE and LINDSAY. The relationship of the Wirrildat Beds to the Punkerri Beds is uncertain. The Wirrildar Beds consist of a fine-grained feldspathic micaceous sandstone overlying a flaggy dolomite, which in turn overlies arkosic and micaceous sandstones. The Wirrildar Beds have been closely folded, probably during the Petermann Ranges Orogeny. They are similar in lithology to the Maurice Formation of the Amadeus Basin and are probably of latest Precambrian age.

The only well in the Birksgate 'Trough' is Birksgate No. 1. The units intersected by this well are summarised in Table 3.

Table 3

Stratigraphy of Birksgate No. 1*

Age unit	Depth (m)	Thickness (m)	Lithology
Tertiary + Quaternary	0-33.5	33.5	sand and loosely cemented sandstone
Palaeozoic			
Wanna Beds	33.5 158.5	125.0	sandstone, pale, chiefly fine-grained, with streaks of white claystone
Lennis Sandstone	158.5	342.5	sandstone, reddish, very fine to medium-grained, with interbedded red-mottled shale, with some dolomitic shale and siltstone
Adelaidean			
Unit A	500.0-662.3	162.3	shale and siltstone, red, green, and grey. Some interbedded sandstone, fine to very coarse-grained. Dolomite with anhydrite and chert near top of unit
?Wirrildar Beds			
or ?Babbagoola Beds			
Unit B	662.3-952.5	290.2	limestone, some oolitic and some arenaceous
Unit C	952.5-1121.7	169.2	interbedded grey shale and siltstone with some very fine to medium-grained sandstone. Rb-Sr isotopic dating on interval 963.2 to 971.7 gave an age of 845 ± 250 m.y.
Unit D	1121.7-T.D. at 1877.6	755.9+	arkose, varicoloured, varisized, feldspar up to 70%; some interbedded varicoloured siltstone and shale

No fossils and little organic matter were found in the sediments in Birksgate No. 2. The absence of the Devonian sequence encountered in Munyarai No. 1 suggests that the Birksgate 'Trough' had a different history to the Munyarai Trough during the earlier half of the Palaeozoic.

*After Continental Oil Co of Australia Ltd (1965). Stratigraphic nomenclature and ages have been altered to conform with more recent interpretation.

The nature of sedimentary rocks in the Southern Platform area south of the Munyarai and Birksgate Troughs is poorly known. It is probably that they include correlatives of the Hughes Beds of Proterozoic or Cambrian age. The 'Hughes Beds' are known from the southwestern corner of South Australia, where several bores have penetrated pre-Permian red beds, carbonate sequences, and evaporites (Table 4), beneath the Eucla Basin. The general aspect of these rocks invites comparison with either the Proterozoic sequences which include the Browne Beds (600 km to the northwest), the Bitter Springs Formation of the Amadeus Basin, and some sediments on Yorke Peninsula, 800 km to the southeast, or the Observatory Hill Beds and the Babbagoola Beds of Early Cambrian age.

It is also likely that the Adelaidean sediments of the Munyarai Trough extend southwards, even if discontinuously, onto the Southern Platform area.

The Ilma Beds (Lowry, 1970) are an isolated inlier of Adelaidean rocks surrounded by the early Miocene sandstone of the Eucla Basin southwest of the Birksgate Trough (Pl. 1). They consist of fine-to medium-grained sandstone, oolitic limestone, dolomite, and chert. The contained stromatolite indicates an Adelaidean age for the beds, which are estimated to be many hundreds of metres thick (Walter, pers. comm.).

Table 4

Stratigraphy of 'Hughes Beds'

(Assumed Officer Basin sediments from the Nullarbor Plain area)

Depth (m)	Thickness (m)	Lithology
≠Cook No. 1		
160 -278.9 (T.D.)	118.9+	Limestone, hard, grey, in places carbonaceous, oolite bands. Pyrite and calcite veinlets. Some chert. Sandy interbeds, fine-grained, silty, micaceous, (calcareous matrix, occasional mottling (overlain by Eucla Basin sediments)
Cook Bore (Commonwealth Railways)		
208.5-368.2 (T.D.	159.7	Shales, purplish red, and siliceous rock
*Hughes No. 1		
359.7-371.9	12.2	Dolomite, oolitic, partly silicified, some galena
371.9-418.2 (T.D.)	46.3	siltstone, green and chocolate, some gypsum. Isotopic age for bottom 3 m is 930 ± m.y.
*Hughes No. 2		
222.5-228	5.5	Sandstone, fine-grained
228 -243.5	15.5+	Dolomite, part oolitic, stylolitic, cherty, with solution cavities
*Hughes No. 3		
163.1-166.7	3.6	Sandstone, yellowish, subrounded quartz grains
166.7-176.8	10.1	Sandstone, feldspathic, red brown, greenish white; chalcedony
176.8-192.0	15.2	Siltstone, sandstone, limestone; pyrite
192.0-216.4	24.4	Dolomite, pyrite, stylolites

≠After Ludbrook (1965)

*After Ludbrook (1966)

Table 4 (cont'd)

Depth (m)	Thickness (m)	Lithology
Hughes No. 3 (cont'd)		
216.4-219.5	3.1	Siltstone, calcareous, sandy
219.5-222.5	3.0	Limestone, dolomitic, reddish
222.5-225.6	3.1	Siltstone, dark grey
225.6-234.7	9.1	Limestone, oolitic, red chert
234.7-250.0	15.3	Dolomite oolitic, pink limestone; vugs
250.0-253.0	3.0	Sandstone, greenish, fine-grained
253.0-271.3	18.3	Sandstone, siltstone, limestone
271.3-274.3	3.0	Limestone, pink, and sandstone
274.3-277.4	3.1	Sandstone, fine-grained
277.4-281.3 (T.D.)	3.9+	Dolomite, stylolitic, chert
Total	118.2+	
***Denman No. 1**		
239.0-243.8	4.8	Sandstone
243.8-268.2	24.4	Siltstone, with dolomite
268.2-278.3	10.1	Siltstone, sandy, red and green
278.3-291.7	13.4	Sandstone
291.7-301.8	10.1	Siltstone, red and green
301.8-310.9	9.1	Sandstone, red
310.9-320	9.1	Siltstone, red, and sandstone
320.0-323.1	3.1	Dolomite, sandstone, siltstone
323.1-361.4	38.3	Siltstone, red
361.4-363.6	2.2	Siltstone, red, green, grey, minor sandstone, part calcareous, some gypsum
363.6-399.3	35.7	Sandstone, red, grading to quartz grit
399.3-451.1	51.8	Dolomite, pink to grey, some gypsum anhydrite, limestone, siltstone, halite moulds
451.1-502.9	51.8	Siltstone, mottled red and green; gypsum
502.9-545.6	42.7	Dolomite, some chert
545.6-548.6 T.D.	3.0+	Dolomite; red and green siltstone
Total	309.6+	

Table 4 (cont'd)

Depth (m)	Thickness (m)	Lithology
Nullarbor No. 8 (Yangoonabie) (after Harris & Ludbrook, 1966)		
422.7-457.2 (T.D.)	34.5+	'Feldspar porphyry'

Table 5

Stratigraphy of Mallabie No. 1 (after Thompson, 1970)

Depth (m)	Thickness (m)	Lithology
436.2-463.7	27.5	Sandstone, yellow, brown, reddish
463.7-541.4	77.7	Sandstone/siltstone interbedded, vari-coloured
541.4-732.0	190.6	Sandstone, orange, gypseous
732.0-916.8	194.8	Sandstone/siltstone interbedded, orange, trace gypsum
916.8-1211.6	294.8	Altered basalt
1211.6-1342	130.4	Sandstone, white, yellow, red, unconsolidated; red clay matrix

? Archaean granite gneiss

Total 915.8

Palaeozoic (pre-Permian)

The oldest known Palaeozoic unit in the region is the Table Hill Volcanics. The Table Hill Volcanics (including the Kulyong Volcanics and Officer Volcanics - Jackson & van de Graaff, in prep.) crop out discontinuously from western BIRKSGATE to northeastern ROBERT, and were intersected in Yowalga No. 2, Lennis No. 1, and BMR Westwood No. 1 (Pl. 1). They may have been penetrated in Mallabie No. 1 (Table 5).

The type section is in Yowalga No. 2 (Table 1) between 728 m and 846 m, and consists of an upper flow, 53 m thick, separated from a lower flow, 63 m thick; this division seems to be a widespread feature of the unit. In BMR Westwood No. 1, two flows are separated by one metre of sandstone.

The volcanics consists of massive to vesicular tholeiitic basalt. They overlie the Babbagoola Beds with angular unconformity and are overlain with an erosional contact by the Lennis Sandstone and Wanna Beds. At Table Hill they unconformably overlie Adelaidean glacials (the Lupton Beds and are unconformably overlain by the Permian glacials.

Isotopic (Rb-Sr) dating of the volcanics gives an age of 575 ± 40 m.y. (Compston, 1974).

The Table Hill Volcanics are an excellent seismic horizon and can be traced over an extensive tract of country (of the order of 60 000 km^2). They are considered to be plateau-basalts.

Early Cambrian to Carboniferous (c.f. Canning Basin) sediments

It is likely that the Lennis Sandstone and Wanna Beds were once coextensive with Palaeozoic sediments of equivalent age in the Canning Basin to the north.

Lennis Sandstone

The Lennis Sandstone (Lowry & others, 1972) is a reddish feldspathic micaceous cross-bedded sandstone, with contorted beds of siltstone up to 3 m thick. The type section is in Yowalga No. 2, from 407 m to 729 m (= 322 m), but it is thick in Lennis No. 1. It crops out in mesas discontinuously from TALBOT into South Australia. The age of the Lennis Sandstone is unknown, but it is thought to lie within the range Cambrian to Carboniferous (Krieg & others, 1976).

Wanna Beds

The Wanna Beds (Lowry & others, 1972) consist of pale, fine-grained quartz arenite, laminated to thick-bedded. Cross-bedding is common, and white claystone clasts are characteristic. Their thickness is estimated to be in the order of tens of metres. Van de Graaff (1972) considers that they were deposited in a shallow sub-tidal marine environment. They are conformable to disconformable on the Lennis Sandstone, and within the same age range.

In the eastern area of the region, the only reliably dated Palaeozoic rocks are those of Devonian age penetrated in Munyarai No. 1 (Table 7). Strata cropping out around the eastern end of the Munyarai Trough and in an outlier in the Indulkana Range on the northeastern border of EVERARD have been interpreted by SADME as Cambrian to Ordovician in age and subdivided into two sequences - a lower 'Marla Sequence' and an upper 'Munda Sequence'.

The units constituting the 'Marla Sequence' are described by Krieg (1972) as follows:

Trainor Hill Sandstone:	Sandstone, red-brown, feldspathic; sandstone thin-bedded, fissile; siltstone and shale, variegated; cross-bedding; 300 m.
Mount Johns Conglomerate:	Polymict conglomerate; sandstone and shale, red and silty; sandstone, reddish, arkosic.
Observatory Hill Beds:	shale, siltstone, maroon, green, grey, micaceous; silty shale; chert; some cherty dolomite; 460 m.

The Observatory Hill Beds (Wopfner, 1969) are overlain disconformably by the Trainor Hill Sandstone (Krieg, 1972), and the two units intertongue with the Mount Johns Conglomerate at the northeastern extremity of the Munyarai Trough. The finding of 'Biconulites' in the Observatory Hill Beds (Gatehouse, 1976) indicates a Cambrian age for the 'Marla Sequence'.

The following sequence has been penetrated in Emu No. 1, south of the Munyarai Trough (Pl. 1):

Table 6

Stratigraphy of Emu No. 1

Depth (m)	Thickness (m)	Lithology
0-60	60	fine-grained sandstone and siltstone interbedded
60-75	15	shale + dolomite; some pyrite at 64 m
75-100	25	siltstone
100-108	8	siltstone and limestone
108-122	14	limestone and shale
122-134	12	calcareous siltstone and calcareous sandstone
134-170	36	limestone, dolomitic limestone with thin cherty lenses
170-216	46	shale, siltstone, and fine-grained sandstone, interbedded
216-277	61	siltstone
277-291	14	siltstone and fine-grained sandstone interbedded
291-332	41	limestone (a major seismic reflector); chalcedony at 298 m
332-350	28	siltstone, dolomitic and gypsiferous
350-418 (total depth)	68 +	sandstone, feldspathic; minor siltstone

The beds are almost horizontal. The sediments above 350 m almost invariably lack porosity and permeability. Below 350 m there is friable, porous, and permeable sandstone to total depth at 418 m. No fossils, and only a little carbonaceous material have been found, but a large part of the sequence probably consists of Observatory Hill Beds.

The 'Munda Sequence" was deposited after a minor regression, possibly during the Ordovician, and contains four conformable units which overlap northwards onto the older units. Krieg (1972) gave the following description of the 'Munda Sequence' (youngest uppermost):

Cartu Beds:	Sandstone, siltstone, and shale; white to green and red; biotitic; thin bedded to laminated; 600+ m.
Blue Hills Sandstone:	Sandstone, fine to medium-grained, reddish, some cross-bedding; gritty and pebbly beds; 1300 m.
Indulkana Shale:	Shale, red/green; rare thin limestone lenses; lateral gradation to siltstone and very fine-grained sandstone; 60 m.
Mount Chandler Sandstone (Upper part):	reddish, slightly feldspathic, abundant organic burrows, and some cross-bedding.
(Lower part):	hard, whitish, quartzitic; 100 m.

The Ordovician and older sediments were gently folded before the Devonian and Early Carboniferous sediments were deposited in the Munyarai Trough (Krieg & others, 1976). The ?Upper Devonian Mintabie Beds and the ?Upper Devonian-Lower Carboniferous Waitoona Beds cropping out in EVERARD are described in Krieg (1972):

Waitoona Beds:	Sandstone, medium to very coarse-grained, white, friable, strongly kaolinised, pebbly. Polymict conglomerate lenses with well-rounded large pebble clasts.
Mintabie Beds:	Sandstone, arkosic, greyish-brown, lithic, micaceous, with interbedded siltstone, yellow and purple-weathering, micaceous, feldspathic. Upper sandstone white, kaolinitic, opal-bearing. Lower sandstone units with large-scale arcuate and planar crossbedding.

The ?Devonian sequence penetrated by Munyarai No. 1 (Table 7) consists of dark grey micaceous dolomitic shales, and the ?Carboniferous sediments intersected in Officer No. 1 (Krieg, 1967) are 'synorogenic conglomeratic feldspathic greywackes composed of fresh, rapidly buried debris from the Musgrave Block' (Krieg & others, 1976).

Table 7

Stratigraphy of Munyarai No. 1 (after Continental Oil Co. of Australia, 1969)

Unit	Surface (m)	Lithology
I Thickness 914 m	914	Undifferentiated red-brown dirty siltstone and mudstone. Gypsiferous in upper 520 m commonly calcareous and dolomitic.
II Thickness 656 m	1570	Quartz sandstone, fine to coarse-grained, generally clean, red-stained, colour varies from white to bright red-orange. Cross-bedding common. Minor mudstone.
III Thickness 1329 m	1570	Laminated grey shale. Poorly bedded, commonly highly calcareous. Dark grey argillaceous limestone at 2155 - 2204 m and 2576 - 2649 m.

T.D. 2899

Note

Fish scales found between 760 m and 950 m were tentatively dated as mid-Silurian to Permian by BMR palaeontologist J. Gilbert-Tomlinson.

Harris, SADME (then SAMD) identified plant material and foram fragments from Unit I as of Devonian or younger age, and woody organic material and rare poorly preserved Chitinozoa from cores from 1189 m to 2743 m as Devonian. The geological and geophysical data suggest that the three units are conformable.

The presence of red beds and poor preservation of organic material suggest that the sequence was rapidly deposited, and, therefore, a Devonian age is tentatively assigned to the whole sequence.

Devine & Youngs (1975) discuss an alternative interpretation of the age of the 'Marla and Munda Sequences', based on tentative correlation of SADME seismic data between Munyarai No. 1 and the outcrops at Cartu Hills. This correlation suggests that the Blue Hills Sandstone of the 'Munda Sequence' is stratigraphically higher, or forms part of the Devonian sequence penetrated by Munyarai No. 1. Doubt as to the age of the underlying 'Marla Sequence' also follows from this interpretation*.

The Palaeozoic rocks of the Munyarai Trough are thought to extend southwards. Thornton (1975), for example, envisages the clastic/carbonate sequences of the Warburton and eastern Officer Basins as having been laid down in one depositional system extending in a great arc from the Boorthanna Trough to the Head of the Bight.

Permian and younger sediments

Almost the whole of the Officer Basin region is blanketed by sediments of Permian and younger age (Pls 1 and 2). Of these, Permian sediments are probably the most extensive and continuous. Cretaceous sediments occur mainly in the northwest of the region. Tertiary strata are mostly outliers of the Eucla Basin, but other Cainozoic sediments such as sand-dunes and silcrete are widespread. The age of some formations can only be inferred.

Permian: The Paterson Formation (Wilkinson Range Series or Beds, Yowalga Sandstone) has been described fully by several authors, especially Wells (1963), who described its occurrence in the Canning Basin. It is 'a unit of highly

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*Work carried out by the SADME in northeast EVERARD since this report was compiled, including additional mapping, shallow stratigraphic drilling, and age dating, strongly supports the earlier interpretation given in this report.

variable lithology, which consists mainly of very poorly sorted conglomerate, pebbly sandstone, sandstone, and claystone with or without dropstones' (Lowry & others, 1972). These are thought to have been deposited in glacial, fluvio-glacial, and glacialacustrine environments, and are of the order of 350 m thick. In BMR Wanna No. 1 there is a facies variant consisting of a silty, carbonaceous, and calcareous wacke, at least 120 m thick, which is thought to extent into BIRKSGATE.

Kemp (1976) has shown that the palynomorphs from the Paterson Formation indicate an Asselian (early Sakmarian) age, and that they are similar to those in the lower Grant Formation (Canning Basin), the upper Nangetty Formation (Perth Basin), and the Merrimelia Formation of the Cooper Basin.

The Paterson Formation is unconformable on older rocks, and is disconformably overlain by Cretaceous and Tertiary rocks. It is flat-lying, except near diapiric centres, for example Woolnough Hills.

Cretaceous: Cretaceous sediments occur as horizontal, commonly deeply weathered beds in the northern part of the Officer Basin region. Two lithological units are recognised, with a combined thickness of 106 m in the reference section in BMR Browne No. 1 (Jackson & others, 1975), which is much thinner than the 300 m estimated elsewhere from seismic surveys and regional mapping. The older unit is the Samuel Formation; the younger is the Bejah Claystone. In South Australia there are local outliers of the Eromanga Basin in the eastern Officer Basin region. They comprise mainly sub-horizontal deposits, which are 5 - 15 m thick in EVERARD.

The Samuel Formation (Lowry & others, 1972) consists of laminated to thin-bedded, fine to medium-grained sandstone, siltstone, and claystone. In the reference section in BMR Browne No. 1 there is an upper section, between 30 m and 70 m thick of 'mottled and variegated, moderately sorted, felspathic quartz wacke, siltstone and claystone' (Jackson & others, 1975). Between 70 m and 109 m grey to black, micaceous, carbonaceous, glauconitic, and feldspathic siltstone and claystone are dominant. This lower part is richly fossiliferous, with Neocomian to Aptian palynomorphs. A shallow-marine environment close to land is indicated.

In the Browne diapir the Samuel Formation is disconformable on the Paterson Formation, and is overlain by the Bejah Claystone, apparently conformably.

The Bejah Claystone (Lowry & others, 1972) consists of indistinctly bedded, often bioturbated, white claystone with minor intercalations of very fine-grained sandstone. It contains mulluscan fossils of Aptian age (Skwarko, 1967) and also radiolaria, and is thought to have been laid down in a quiet shallow-marine environment. There is a gradational contact with the Samuel Formation below, except in ROBERT where it rests disconformably on the Paterson Formation. The top of the unit is eroded and it is overlain by the Lampe Beds.

The type locality is in the Canning Basin (Veevers & Wells, 1961), but Jackson & others (1975) nominated the section between 4 m and 30 m in BMR Browne No. 1 as a reference section.

The Cretaceous beds of the Officer Basin region were laid down during the great mid-Cretaceous marine transgression of Australia, when most of the continent was submerged. It is possible that they originally formed a continuous sheet connecting the Eucla, Eromanga, and Canning Basins.

The Boongar Beds (Major, 1974a) are a sandstone unit found in southern BIRKSGATE and LINDSAY. At the type section in southwest LINDSAY they are 3 m thick. The sandstone is horizontal and laminated, with ripple-marks and characteristic tubes both perpendicular to and parallel to the bedding planes. Major considered it to be either the youngest of the Palaeozoic-?Mesozoic sediments or possibly of early Tertiary age, but Krieg & others (1976) have tentatively correlated it with the Mt Chandler Sandstone of ?Early Ordovician age.

Cainozoic: After the withdrawal of the mid-Cretaceous seas, the whole Officer Basin region was probably topographically low and featureless. A variety of riverine and playa-lake deposits were formed (e.g. the fluviatile Lampe Beds) and during the Tertiary transgressions from the Southern Ocean, nearshore sandstones were deposited around the mouths of streams draining into the Eucla Basin sea (Bunting & others, 1974). Such shallow marine sands are represented by the Plumridge Beds and Colville Sandstone; they are nowhere more than a few tens of metres thick.

The Maralinga Bores, located near the northeastern margin of the Eucla Basin south of the Munyarai Trough (Pl. 1), intersected the following stratigraphic units (Ludbrook, 1961):

Tertiary to Recent non-marine sediments	about 15 - 150 m
Late Eocene calcarenite with bryozoa (Wilson Bluff Limestone)	about 30 m
Eocene paralic siltstone and sandstone with lignite (Pidinga Formation)	about 30 m
?Permian kaolinitic grits and sandstone, with facetted pebbles near base	about 36 m
?Late Proterozoic' chocolate and blue pyritic shales, and brown sandstone. 15 m of dolomite in bore No. 17. Bore No. 7 bottomed in 'Archaean' diorite.	about 340 m

Other Cainozoic deposits occurring at scattered locations throughout the Officer Basin region include calcrete, silcrete, playa evaporites, and sand dunes.

Tectonics and structure of the Officer Basin region

The following tectonic events can be recognised in the Officer Basin region (Pl. 2):

A. 1750 - 1350 m.y., extensive metamorphism with magmatic intrusions and volcanism in the Gawler and Musgrave Blocks and the Albany-Fraser Mobile Belt.

B. 1100 ± 100 m.y., considerable intrusions and extrusions in the Musgrave Block.

C. 750 ± m.y., the Sturtian Tectonism/Areyonga Movement.

D. 600 m.y., the Petermann Ranges Orogeny/Indulkana Folding.

E. 450 m.y., the Delemarian Orogeny/Rodingan Movement and/or Pertnjara Movement.

F. 350 m.y., the Allice Springs Orogeny.

G. 250 m.y., the Permian transgression.

H. 100 m.y., the Cretaceous transgression.

These events, and their influences, are considered in turn below. Unconformities related to the main orogenies are identified in Figures 2, 3, and 4.

A. Most of the sediments of the Officer Basin region were laid down during the Proterozoic. Little is known of the diastrophism that affected this area during the 1800 m.y. of the Proterozoic (Pl. 2), but moderate to high-grade metamorphism occurred over much of the central Australian region (Forman & Shaw, 1973). It is possible that some sedimentary sequences (e.g. the sediments within the Nabberu Basin) grade laterally into coeval metamorphics. The Albany-Fraser Mobile Belt (Fig. 2) possibly extends beneath the Officer Basin region to the Musgrave Block, and the coeval sediments and metamorphics could have a thrust contact.

B. The western area of the region seems to have been the site of considerable sedimentation in the 1100 to 1000 m.y. period: the Bentley Super-Group and correlatives in the southwestern margin of the Amadeus Basin were deposited in an active volcanic province while sediments were deposited in the Bangemall Basin. After major diastrophism, Adelaidean sediments (c. 1400 - 600 m.y.) were deposited in the Officer Basin region, Amadeus Basin, and the Adelaide Geosyncline. This sedimentary cycle began with the deposition of the transgressive Heavitree, Townsend and Dean Quartzites, respectively.

C. The mid-Adelaidean tectonic event known as the Sturtian Tectonism or the Areyonga Movement is recorded in the Officer Basin region by the unconformity between the equivalents of the Burra Group and the Chambers Bluff Tillite in the Munyarai Trough, the unconformity at the top of the Wright Hill Beds, and the partial unconformity between the Lefroy and Lupton Beds. The tectonic event seems to have become milder from east to west. The extrusion of the Wantapella Volcanics may have been related to this movement.

D. The Petermann Ranges Orogeny is evidenced in the Officer Basin region by the Indulkanan Folding, whereby the Lower Cambrian Observatory Hill Beds rest with angular unconformity on the Adelaidean strata in the western area, and possibly by the unconformity in the Warburton Mission area beneath the Table Hill Volcanics, the extrusion of which may be related to the orogeny.

Krieg (1972) states that 'The exposed Adelaidean sediments are moderately to strongly folded (Indulkanan Folding), reflecting the mobility of the nearby basement, but it is not known whether this folding is widespread in the subsurface or confined to the basin margin'. Faulting has considerably modified the general fold pattern, and in places along the margin where the sediments are strongly folded, they occur in narrow elongate synclines with steeply dipping limbs.

The Wirrildar Beds are described (Major, 1972) as being folded similarly to the tightly folded Adelaidean rocks of EVERARD. Seismic surveys show that the sediments in the north have steel southerly dips or are faulted, whereas further south they are almost horizontal.

The Ilma Beds, which occur southwest of the Birksgate 'Trough' (Pl. 1), are described by Lowry (1970) as probably having a northwesterly strike, with irregularities caused by folding or faulting or both. The irregularities suggest that the beds have undergone moderate to severe deformation and they may now have a moderate to strong dip. In this respect, the Ilma Beds are more like sediments of the Nabberu Basin to the northwest than the rather flat-lying Adelaidean sediments of the southern platform.

E,F. It is not possible with the data presently available to determine with any detail how the Palaeozoic tectonic events that are known to have operated in central Australia affected the Officer Basin region. Much depends on the age of the 'Marla and Munda Sequences'. We assume that the main movements on the Everard Thrust occurred during the Alice Springs Orogeny, but that uplift of the Musgrave Block also occurred during the Pertnjara and Rodingan Movements. However, neither of these can be related with certainty to specific unconformities that occur in the pre-Permian infill of the Munyarai Trough.

The Everard Thrust has been described by Moore & others (in prep.). It is thought to have carried Musgrave Block rocks over Officer Basin sediments for a distance of about 20 km, the angle of thrust being about 14°. The over-ridden sediments are thought to be at least 2.5 km thick and of probable Devonian age, although older Palaeozoic or Precambrian sediments may also be included. The most likely time for the thrusting is early Carboniferous (Alice Springs Orogeny).

In southeast EVERARD, the boundary between the Adelaidean Amaroodina Inlier (Amaroodina Ridge, Pl. 1) and the Munyarai Trough is interpreted as a fault, because a steep magnetic gradient overlies this locality and there is extensive minor faulting observable in the vicinity.

Krieg (1972) gives a detailed description of the structural deformation of the Marla and Munda Sequences in EVERARD. Only the major features will be discussed here.

The sediments occur in a gently folded syncline that plunges shallowly westwards, following the deepening magnetic basement. Krieg names the post-early Palaeozoic tectonism which produced this gentle movement, the Chandleran Movement (Pl. 2). In the Mount Johns area, where dips are also very shallow, the sediments are folded into two forking synclines.

In contrast to the gentle folding, faulting has produced strong deformation, which has significantly modified the fold pattern in the area. This is particularly evident on the northern and southern limbs of the syncline. A fault on the southern limb is probably the surface expression of a major west-trending gravity-interpreted fault (Nettleton, 1970). The geophysical data indicate that basement occurs at a depth of about 2000 m and is faulted with a vertical displacement of 1000 m down to the south.

The Devonian Mintabie Beds and Waitoona Beds cropping out on EVERARD are either horizontal or dip very gently to the southwest. These beds are probably a molasse-type deposit laid down in front of the rising Musgrave Block along some 150 km of the northern flank of the basin. Incipient Jura-type folding, and even decollement within the Devonian infill that is visible on seismic sections, probably developed concurrently with the Everard Thrust during the Alice Springs Orogeny.

The Permian, Cretaceous, and Tertiary sediments are generally flat lying, indicating that only gentle epeirogenic movements affected the region after the Alice Springs Orogeny.

Faults

Three major faults are recognised in the Officer Basin region in Western Australia.

The Iragana Fault in COBB (Pl. 1) is a normal fault, downthrown to the east, which affects both steeply dipping Proterozoic and flat-lying Phanerozoic strata and forms the sharp eastern boundary of the Clutterbuck Hills (Jackson & van de Graaff, in preparation). Its throw is reckoned to be large, perhaps as much as 1 km.

The Westwood Fault or fault zone forms the eastern limit of the Proterozoic inlier in NEALE. This inlier is a horst, with a western fault boundary obscured by the Phanerozoic sediments. Throw on the faults is about 300 m.

The Westwood Fault Zone is described by Kennewell (1977) as a series of prominent north-trending faults extending almost across WESTWOOD. Fault traces may curve or bifurcate; parallel traces occur. Downthrow is to the east, with a movement of several tens of metres since the Cretaceous. It appears that the zone is still seismically active.

The Fraser Fault is a major fault that forms the southeastern margin of the Yilgarn Block (Pl. 1). It is considered (Wilson, 1969) that there have been several periods of movement in the Fraser Fault Zone. Minor structures in the pyroxene granulites and the gravity profile suggest a strong reversed movement which has raised the eastern block. Other structures suggest a strong transcurrent component moving the east block northward.

Jackson & van de Graaff (in preparation) consider that the Fraser fault extends northeast to at least the northeastern corner of PLUMRIDGE in the southwestern part of the Officer Basin region. They point out that the Precambrian rocks are the most affected by faulting, that the youngest rocks which are definitely faulted are the Cretaceous to Tertiary Lampe Beds, but that seismic activity is still continuing.

GEOPHYSICAL SURVEYS

The Officer Basin region has been fairly well covered by aeromagnetic and regional gravity surveys, but seismic coverage remains sparse over most of the region, and the quality of much of the existing seismic data is poor. Magnetic, gravity, and seismic surveys are listed in Appendix 2, which includes, for each operation, the survey date, the operator, contractor, size and type of the survey, and reference.

In the western area, Hunt Oil Company carried out a number of geophysical surveys between 1961 and 1966 as operator for a group of companies comprising Hunt Oil Company, Hunt Petroleum Corporation, Placid Oil Company, and Exoil Pty Ltd. The geophysical program of these companies totalled about 10 580 km of aeromagnetic traverses, 350 land magnetic stations, 35 000 gravity stations, and 1030 km of seismic traverses. The results of these surveys and other work bearing on the petroleum potential of the area up to 1966 have been summarised by Jackson (1966).

BMR carried out several geophysical surveys in the western area, and Harrison & Zadoroznyj (1978) reported on the most recent, in 1972, and summarised the results of the previous surveys in the area.

Prior to this review, surveys in the eastern part of the Officer Basin region have been reported on separately by the operators, but there has been no comprehensive summary. Milton & Parker (1973) have given an interpretation of geophysical results on the northern margin of the eastern Officer Basin.

Magnetic surveys

Plate 3 shows the locations of aeromagnetic surveys in the region, with the exception of an aeromagnetic survey of the Western Australian portion of the study region, flown in 1961 for Hunt Oil and Placid Oil. The limited information which is available on this survey (Jackson, 1966) suggests the presence of a sequence of non-magnetic rocks up to 5 km thick, extending over a large area near latitude 27°S. The company interpretation of the results of this survey has been incorporated in a magnetic basement depth of the region shown on Plate 4. A more recent and more detailed survey of the same region by BMR has not yet been interpreted, but the preliminary contours of total magnetic intensity (integrated with previous work) are presented in Plate 5.

An area in the extreme northwest of the region was surveyed for Union Oil in 1965 (Gibson Desert aeromagnetic survey, Pl. 4, Lynch, 1965). This survey straddled the boundary region between the southern part of the Canning Basin and the northwestern part of the Officer Basin. A deep depression in magnetic basement at about latitude 23°45'S was interpreted, with up to 8 km of non-magnetic rocks.

The Eastern Officer Basin aeromagnetic survey, flown for Exoil during 1964-65, investigated the South Australian part of the review area (Steenland, 1965). As indicated on Plate 4, the magnetic results suggested the presence of a deep, east-trending depression in magnetic basement flanked to the north by a steep contour gradient over the southern margin of the Musgrave Block. Magnetic basement in the depression attains a maximum depth of about 5 km in the Birksgate area. Interpreted magnetic basement contours shallow much more gradually to the south, particularly in the western part of South Australia where the depression opens southward to a broad area where magnetic basement is approximately 2 km deep.

Gravity surveys

In 1964 and 1965 Hunt Oil and its associates conducted two large gravity surveys, the Breaden and Lennis gravity surveys, which covered the major part of the Officer Basin region in Western Australia (Bazhaw & Jackson, 1965). A total of about 35 000 gravity stations was established by land vehicle at intervals of about 800 m on a grid about 9.5 km by 3 km.

There have been two major reconnaissance helicopter gravity surveys by BMR in the Officer Basin region, one in Western Australia (Fraser, 1973b) and one in South Australia (Pettifer & Fraser, 1974), at grid spacings of 11 km and 7 km, respectively. Comprehensive catalogues of the locations and results of earlier gravity surveys conducted in the Officer Basin were presented by the same authors. Basic information on these surveys is given in Appendix 2.

Regional Bouguer anomalies, together with names of principal gravity provinces (Fraser, 1976), and smaller gravity units, appear on Plate 6, which is derived from the BMR gravity data bank.

The principal gravity features of the region are an arcuate chain of negative Bouguer anomalies extending westward from the Munyari area in South Australia to about longitude 126°E and thence to the northwest, and several intense, linear positive Bouguer anomalies which flank the negative anomalies.

The most intense negative anomalies are the Munyarai Gravity Low and the Birksgate Gravity Low, in the eastern part of the region (Pl. 6). Fraser (1976) groups these two anomalies together as the Officer Regional Gravity Low, but the anomalies have different orientations and intensities and sediments in the two areas are of different ages, so that a single regional gravity name, implying a common origin, may not be warranted.

The two anomalies show some correlation with sediment-filled depressions, of Palaeozoic age in the case of the Munyarai Gravity Low, and of Proterozoic age in the case of the Birksgate Gravity Low. Fraser (1973(b)), Pettifer & Fraser (1974), and Mathur (1976) have suggested that the anomalies are too intense to be explained by accumulations of light-weight sediments alone, and that parts of the anomalies must be attributed to density variations deeper within the crust. However, Milton & Parker (1973) have published a cross-section model of the most intense part of the Munyarai Gravity Low, which accounts for the anomaly by a consideration of the density contrast between the sediments of the Munyarai Trough and the igneous/metamorphic rocks of the basement and an overthrust granite block postulated to exist on the northern margin of the Munyarai Trough. They consider that no additional gravity effect from postulated intra-basement density variations is required.

The negative Bouguer anomalies in the western and northwestern parts of the Officer Basin region are much less intense than those in the east. Because little is known of the sub-surface geology in those parts of the region, it is difficult to assess the significance of the gravity anomalies in respect to sediment thickness.

The most notable area of elevated Bouguer anomalies within the Officer Basin region is the continuation of the Fraser Regional Gravity Ridge, which extends into the central part of the region from the southwest (Pl. 6). Fraser (1973 (b)) interprets this anomaly as arising from dense basement rocks, similar to gabbro-intruded basic granulites exposed southeast of the Fraser Fault, which are believed to be concealed beneath Officer Basin sediments in PLUMRIDGE and NEALE.

Seismic surveys

The locations of seismic surveys in the Officer Basin are shown in Plate 7. Coverage is limited. Groups of traverses have been recorded in widely scattered areas. Only one regional seismic traverse links the Western Australian and South Australian parts of the Officer Basin region. The data obtained from this traverse, which was shot for Exoil in 1962, are poor, so it is not possible to correlate seismic reflections between the two States. It is therefore convenient to consider seismic results in Western Australia and South Australia separately.

Western Australia. The earliest seismic exploration in the Western Australian portion of the review area was the BMR Giles-Carnegie survey of 1961-62 (Turpie, 1967) made in the northwest of the review area. Both single-fold reflection and refraction techniques were used. Traverses were spaced at about 50 km apart. Three refractors were identified by Turpie. One with a velocity between 3050 m/s and 3350 m/s was interpreted as lying near the base of the Permian at a depth no greater than 600 m; another with a velocity between 4980 m/s and 5180 m/s was interpreted as being near the top of the Proterozoic, and the deepest refractor (6250 m/s) was interpreted as representing igneous basement. Sediment thicknesses between 4400 m and 5700 m and gradually thickening westwards were interpreted over most of the area. In the region near Lake Keene (Pl. 7) about 12 km of sediment was indicated.

Between 1963 and 1966 four seismic surveys were conducted in Western Australia by Hunt Oil and its associates (Kendall & Hartley, 1964; Campbell, 1964; Mickleberry, 1966a and b). Seismic reflection coverage was obtained around the Browne and Yowalga wells, west of Warburton Mission, with selected refraction probes providing aids to interpretation. The Babbagoola survey involved the Vibroseis technique with mainly 5- and 10-fold CDP coverage; the Warburton survey used explosives and 6-fold CDP coverage, and the Yowalga and North Lennis surveys used weight-drop energy sources with 6-fold CDP coverage.

The latter technique proved the most effective with regard to data quality, in this area. Reliable reflections were obtained from a major unconformity, which has subsequently been correlated with the Table Hill Volcanics (Lower Cambrian) by Jackson (1966). Contours on this horizon are shown on Plate 8, for which time-depth conversion has been based on reflection t-delta t analysis and refraction velocities. Some deeper reflections from within the Proterozoic, indicating steeper dips, were recorded from below the mapped horizon.

Based on seismic and gravity data, Jackson (1966) interpreted diapiric intrusion and decollement folding of the sediments below the Table Hill Volcanics.

The 1972 BMR survey (Harrison & Zadoroznyj, 1978) consisted of a series of refraction and reflection probes along the road between Warburton Mission and Lake Throssell in the western portion of the area, between the Yilgarn Block in the southwest and the Musgrave Block in the northeast. Explosive energy sources and 1- to 12-fold CDP coverage resulted in mostly fair quality reflection data, which were interpreted in conjunction with gravity, magnetic, and radiometric readings made along the traverse, and refraction seismic results.

The total thickness of the sedimentary sequence on the survey line was interpreted to be about 7000 m. The sediments are thickest on the north-eastern half of the traverse line and they thin gradually to almost zero on the Yilgarn Block to the southwest. The Phanerozoic sediments above the Table Hill Volcanics have a maximum thickness of about 1300 m, approximately 120 km south-west of Warburton Mission. On the seismic sections, the top of the Table Hill Volcanics is marked by a strong and persistent reflection, which has been identified on the basis of seismic velocity and a tie to Yowalga No. 2. The base of the Proterozoic sediments is marked on the seismic sections by an unconformity. Laterally persistent reflections were recorded from the rocks below this unconformity, but there is evidence that these reflections are derived from a layered complex of metamorphic and/or igneous rocks rather than sediments.

South Australia. The first seismic survey in the South Australian part of the region was probably a small reflection and refraction survey by BMR in 1956 at Maralinga near the southeastern margin of the eastern Officer Basin.

This survey indicated the presence of a high velocity (5700 m/s) refractor, thought to represent igneous or metamorphic basement, at a depth of less than 500 m.

In 1962, a seismic survey was shot by Geosurveys along the Mabel Creek-Emu Track road in the eastern part of the review area. The results of this survey were apparently very poor, and little useful information resulted. In the same year the Mabel Creek seismic survey was carried out for Exoil (Bowman & Harkey, 1962) along two tracks extending northwest and west from near Emu No. 1 well (Pl. 7). The main traverse extended west across the South Australian part of the Officer Basin to about longitude 127°E in Western Australia. This is the only line connecting seismic work in the two States. Reflection quality was poor to fair, and the traverse was not continuous. It consisted of many short segments separated by gaps of more than 6 km. Because of the discontinuous nature of this traverse it is not possible to correlate reflecting horizons in Western Australia with those in the Munyarai Trough in South Australia. In the eastern part of the survey area, reflections indicated dips of up to 7° to the west and northwest. In Western Australia, numerous more or less horizontal reflections were recorded to about 1.6 seconds, indicating the presence of layered rocks to a depth of about 2500 m.

Two seismic surveys conducted by Continental Oil between 1965 and 1967 totalled more than 1000 km of reflection profiling (Shorey, 1966; Bluestone & Raitt, 1967). Vibroseis and weight-drop methods were used with CDP coverage ranging from single-fold to 10-fold. Data quality was mainly fair, except in areas of extensive sand dune cover. The first of these surveys, the Serpentine Lakes survey, was intended to investigate some aeromagnetic anomalies in the Serpentine Lakes region. Two reflectors were mapped, and these confirmed the general structure interpreted from the aeromagnetic work. The two reflecting horizons were penetrated by Birksgate No. 1 and identified as being within the Proterozoic sequence. A shallow reflector was interpreted, by one of the present authors, as an horizon at or near the top of the Proterozoic, and depth estimates to this horizon were incorporated into the contours shown on Plate 8.

In 1967, the Eastern Officer Basin seismic and gravity survey (Bluestone & Raitt, 1967) was done for Continental Oil to confirm closure on the Munyarai structure, which had been indicated by previous aeromagnetic, gravity, and seismic surveys. The survey confirmed the presence of a faulted anticline with an area of about 80 km^2. This anticline was tested by Munyarai No. 1 well, which bottomed in sediments of probable Devonian age at 2899 m. In the Munyarai area coherent reflections were recorded from depths considerably below the bottom of the well. A strong reflection which probably represents igneous or metamorphic basement was recorded at about 2.0 seconds. This suggests that there is probably about 1500 m of untested sedimentary section below the total depth reached by Munyarai No. 1. However, indications are that the untested sediments have rather high seismic velocities (4500+ m/s) and therefore probably poor porosities.

A single reflection and refraction reconnaissance seismic traverse was surveyed for 122 km northwards from Emu No. 1 in 1966 by the South Australian Department of Mines (Moorcroft, 1969). Single-fold reflection recording and an explosive energy source were used, with generally poor results except for the northernmost 25 km. The traverse indicated a sedimentary section of the order of 5 km thick. Refraction probes indicated the presence of a high-speed refractor (5100-5500 m/s) considerably shallower than the base of sediments suggested by the reflection work. This refractor was estimated to lie at a depth of about 2 km in the northern sector.

In 1972 the South Australian Mines Department commenced a seismic reflection and refraction programme near the northeastern margin of the Officer Basin. An interpretation, by Milton & Parker (1973), based on magnetic, gravity, and seismic data strongly suggests overthrusting from the north along this basin boundary.

Shell Development carried out the Everard seismic survey in the Munyarai area in 1974-75. Explosives were used as energy source and 6-fold CDP coverage resulted in good quality seismic sections. The survey confirmed the Munyarai prospect as a valid closed structure.

PETROLEUM POTENTIAL

Western area

Because of the widespread occurrence of horizontally-bedded Cainozoic and Mesozoic sediments, and the shallowness of existing well data, there is little evidence of subsurface structures which might constitute traps for petroleum. The available geophysical data indicate that the Phanerozoic section is generally thin, with the possible exception of the unexplored regions to the northwest of the Gibson Desert Gravity Low and on the eastern side of the Fraser Regional Gravity Ridge.

The stratigraphic sequences penetrated by the petroleum exploration wells have already been given in Table 1. The results of these wells were invariably discouraging.

Yowalga No. 2, the deepest well, was drilled on the crest of a seismically-defined anticline. No shows of oil or gas were detected. Apart from rollover effects adjacent to a likely fault at 262 m, the strata intercepted show only low dips (4^{o} to 6^{o} to the south and southeast in the Babbagoola Beds). There was some evidence of cross-bedding and other depositional features. The Table Hill Volcanics were intercepted between 728.5 and 845.8 m.

The sediments encountered below the Table Hill Volcanics were apparently deposited in an evaporitic, oxidising, marine environment unfavourable for the preservation of abundant organic matter. In Yowalga No. 2, they appear to be tight, although no laboratory measurements are available. They yielded microfossils of Early Cambrian aspect.

Core analysis from the interval 490.7 m to 613.0 m (Lennis Sandstone) in Yowalga No. 1 indicates porosities ranging from 10% to 27% and permeabilities from 0 to 1018 md.

Source rock investigations carried out for BMR (J. Gorter, pers. comm.) on material from Yowalga No. 1, BMR Browne No. 1, and Rason No. 2 failed to reveal the presence of any significant petroleum source rocks.

In summary, the thin Phanerozoic section above the Table Hill Volcanics in the western area has low petroleum potential, but exploration is sparse and the Phanerozoic below the volcanics and in the unexplored areas retains some small potential.

Eastern area

The eastern part of the region is more prospective than the western part because a thickness of at least 4500 m of Palaeozoic sediments has been indicated by seismic surveys and drilling.

Munyarai No. 1 was the most significant test of a potential petroleum trap in the area. Seismic surveys both before and after drilling established the validity of closure on the structure, but no significant hydrocarbon shows were detected.

Dipmeter and other data indicate that the strata penetrated by the well are horizontal or nearly horizontal throughout the well. In general, Lithologic Unit I (Table 1) was primarily tight and impermeable, although some sections had porosity ranging from 7% to 12%, and there were two zones (198 - 204 m, and at about 850 m) with a small yield of salty to brackish water. Lithologic Unit II was more porous, but Lithologic Unit III was non-porous shale.

Unfortunately Munyarai No. 1, which is believed to have bottomed in Devonian sediments, did not test the whole of the Palaeozoic section. The nature of the sediments below the total depth of this well (2899 m) is unknown, but the seismic data indicate that they have relatively high seismic velocity and this tends to downgrade their reservoir potential. The temperature gradient in the well is such that only gas could be expected at deeper levels in the central part of the Munyarai Trough.

Prospects in the Birksgate area have been downgraded by the drilling of Birksgate No. 1, which has shown that most of the sedimentary sequence in that area is of Adelaidean age.

Emu No. 1 was drilled to 479.5 m on the southeastern flank of the Munyarai Trough. Although it was drilled to test a postulated anticlinal nose, there is some doubt whether it was located on a closed structure. No traces of hydrocarbons were observed. The sediments penetrated to 355 m were tight, but below this there was porous, permeable, and friable sandstone which would constitute an excellent reservoir rock. However, source rock investigations carried out for BMR (J. Gorter, pers. comm.) on core samples from Emu No. 1, and also Munyarai No. 1, and Birksgate No. 1, failed to reveal the presence of significant source rocks.

In 1978 SADME drilled a stratigraphic well, Wilkinson No. 1, that intersected a sequence of Early Cambrian evaporites and petroliferous sediments thought to have accumulated within the southeastern Officer Basin. This well is located close to the edge of the Gawler Block, south of Emu No. 1 and Observatory Hill (Pl. 1). McKirdy (Officer Basin Workshop, Adelaide, 7 December 1978) reported that sediments comprising mainly carbonates from the interval 280-660 m contained very high organic carbon values and he considered these rocks to have a high potential for generating oil.

CONCLUSIONS AND RECOMMENDATIONS

Much of the western part of the Officer Basin region is covered by only a thin veneer of Phanerozoic sediments. The relatively small amount of drilling done in the area has produced no evidence of significant source rocks. Some parts of the area are virtually unexplored, and these areas retain some small potential, but exploration to date suggests strongly that the petroleum potential of the part of the region west of 128°E is low.

The potential of the eastern part of the region is higher, because the one deep well drilled has confirmed the presence of a substantical thickness of Palaeozoic sediments, mainly Devonian. This well, in the Munyarai Trough, did not encounter any shows of petroleum and failed to indicate the presence of suitable source or reservoir rocks. However, the well did not penetrate the whole of the Palaeozoic section.

The discovery of good source rocks for oil in Wilkinson No. 1 to the south of the Munyarai Trough has considerably upgraded the potential of the Munyarai Trough. These ?Early Cambrian source rocks require further investigation, together with the reservoir and caprock potential of the adjacent section, probably by further stratigraphic drilling.

The Munyarai Trough warrants further exploration by seismic surveys and drilling. The seismic surveys should be directed at finding and mapping potential petroleum traps where the sediments are likely to be within the 'oil window'. Such traps are most likely on the flanks of the Trough where Early Cambrian sediments, if present, may be expected at shallower depths (and lower temperatures) than in the centre of the Trough. The potential of the Munyarai Trough cannot be adequately assessed on the basis of existing information, but its petroleum potential would seem to be fair.

There is need for modern, high-quality seismic work to tie together the stratigraphy in the Munyarai Trough and the 'Birksgate Trough' to the west.

Regional seismic lines tieing the eastern part of the region to the scattered seismic lines surveyed in the western area, and reconnaissance seismic lines extending into unexplored parts of the western area would be desirable, but because of the large distances involved, the difficult logistics in this remote area, and the fairly low petroleum prospectivity, this work cannot be considered to have high priority.

It is desirable that the aeromagnetic survey by BMR which has been flown over the western part of the region should be interpreted and the results published. This project could provide additional information on the area which would be useful in guiding future research, for a relatively low cost.

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APPENDIX 1

PETROLEUM EXPLORATION WELLS, OFFICER BASIN REGION

Company Well name BMR file no. if subsidised	Latitude South Longitude East o ' "	Elevation (m) GL - Ground Level RT - Rotary Table KB - Kelly Bushing	Date spudded Total depth (TD) reached	TD (m)	Status, remarks (PA - plugged and abandoned)
CONTINENTAL OIL COMPANY OF AUSTRALIA LTD					
Birksgate No. 1 BMR file 67/4242	27 56 20 129 48 10	GL 383.1 KB 388.0	30.1.67 8.3.67	1879.4	PA (dry hole)
Munyarai No. 1 BMR file 68/2012	27 41 53 132 00 03	GL 418.8 KB 420.2	6.7.68 19.8.68	2899	PA (dry hole)
Officer No. 1	27 30 52 132 18 10	GL 384.3 KB 388.6	16.11.66	183.3	Drilled by S.A. Mines Dept. PA (dry hole)
EXOIL PTY LTD					
Emu No. 1 BMR file 63/1030	28 37 45 132 12 05	GL 244 approx. RT 245.8 KB 246.1	23.8.63 25.10.63	479.5	Stuck pipe; PA (dry hole)
HUNT OIL COMPANY					
Browne No. 1	25 51 15 125 48 58	?	9.9.65 15.9.65	387.1	PA (dry hole)
Browne No. 2	25 56 00 125 57 45	GL 484.3 KB 485.9	13.10.65 19.10.65	292.8	PA (dry hole)
Lennis No. 1	27 17 00 126 21 00	GL 415.4 KB 416.9	30.9.65 8.10.65	614.9	PA (dry hole)
Yowalga No. 1	26 10 12 125 58 00	GL 474	21.9.65 29.9.65	613.4	PA (dry hole)
Yowalga No. 2	26 10 12 125 58 00	GL 472.8 KB 476.9	1.3.66 22.3.66	990.0	PA (dry hole)
OUTBACK OIL COMPANY					
Cook No. 1	30 50 130 41	GL 100 RT ?	21.10.64 23.11.64	278.9	Completed as a water bore at 274.3 m
Denman No. 1	30 39 20 129 58 47	GL 140?	6.6.66 13.7.66	549.0	PA (dry hole)
Hughes No. 1	30 42 50 129 30 44	GL 142.1	16.2.66 6.4.66	479.5	PA (dry hole)
Hughes No. 2	30 31 42 129 14 45	GL 142.1	10.4.66 2.5.66	243.1	PA (dry hole)
Hughes No. 3	30 29 45 129 38 07	?	6.5.66 4.6.66	280.0	PA (dry hole)
Mallabie No. 1	31 32 14 130 36 06	GL 56.1 KB 59.8	21.6.69 5.8.69	1496.6	PA (dry hole)

APPENDIX 1A

STRATIGRAPHIC HOLES, OFFICER BASIN REGION

Hole	Position Lat. Long.	Total Depth m	Remarks
BMR Rason 1	28°33'18" S 123°47'36" E	58.5	Paterson Fm 10 to 44 m, then into basement.
BMR Rason 2	28°33'18" S 124°02'42" E	146.7	Paterson Fm 0 to 144 m, then into basement.
BMR Rason 3	28°33'18" S 123°29'48" E	74.7	Paterson Fm 0 to 31 m, then into basement.
BMR Neale 1A & 1B	28°18'18" S 125°56'36" E	86.9 205.7	Paterson Fm; Wanna Beds; Lennis Sandstone.
BMR Neale 2	28°47'48" S 125°46'12" E	74.8	Alluvium and colluvium on Paterson Fm.
BMR Neale 3	28°19'00" S 125°49'12" E	38.1	Paterson Fm throughout.
BMR Wanna 1	28°22'04" S 127°37'44" E	154.5	Paterson Fm throughout.
BMR Yowalga 1 - 4	26°50'04" S 125°37'33" E	43.0	Paterson Fm throughout.
BMR Talbot 1	26°09'12" S 126°32'30"	33.1	Cainozoic deposits on Townsend Quartzite dipping at 25° to 30°.
BMR Talbot 2	26°09'24" S 126°32'20" E	13.7	Cainozoic calcareous conglomerate (alluvium).
BMR Talbot 3	26°09'38" S 126°32'08" E	77.4	Cainozoic alluvium on lutites of Lefroy Beds dipping at 25° to 30°.
BMR Talbot 4	26°09'50" S 126°31'54" E	69.6	Cainozoic alluvium on arenites of Lefroy Beds.
BMR Talbot 5	26°10'00" S 126°31' E	95.1	Cainozoic alluvium; Paterson Formation; Lupton Beds tillites.
BMR Browne 1	25°32'04" S 125°16'30" E	121.9	Bejah Claystone; Paterson Formation.
BMR Westwood 1	27°02'42" S 124°49'06" E	85.3	Table Hill Volcanics; ? Proterozoic sandstone.

APPENDIX 1A (contd)

STRATIGRAPHIC HOLES, OFFICER BASIN REGION

Hole	Position Lat. Long.	Total Depth m	Remarks
BMR Westwood 2	27°07'20" S 124°42'36" E	101.5	Paterson Fm on Wanna Beds or Lennis Sandstone
BMR Throssell 1	27°16'24" S 124°25'30" E	198.1	Cainozoic calcrete and lacustrine deposits on Proterozoic siltstone and claystone (Babbagoola Beds).
SADM Marla 1 (Thornton, 1975)	27°28'00" S 133°44'55" E	106.08	Bulldog Shale; Cadna-Owie Fm; ?Boorthanna Fm; ?Devonian carbonates and clastics.

APPENDIX 2

GEOPHYSICAL SURVEYS, OFFICER BASIN REGION

MAGNETIC SURVEYS

Survey name	Year	Operator	Contractor	Survey altitude (m)	Traverse spacing (km)	Total traverse length (km)	Reference or file number
BMR long line aeromagnetic traverses	1954-60	BMR	-	450	-	3000 km	BMR Recs. 1958/87 & 1961/137
Officer Basin aeromagnetic	1961	Hunt Oil	Adastra Hunting Geophysics	300	112	10 579	Jackson, 1966
Eastern Officer Basin aeromagnetic	1964-65	Exoil	Adastra Hunting Geophysics	600 to 750	16	23 031	PSSA 64/4608
Gibson Desert aeromagnetic	1965	Union Oil	Aero Service	750	10	32 421	" 65/4610
Neale Junction land magnetic	1965	Hunt Oil	-	0	-	560	" 65/4617
Officer Basin aeromagnetic	1975-77	BMR	Austral Air Surveys	150-600	1.5 to 3.0	132 000 (approx)	Not Yet Available

NB. The Officer Basin geophysical survey by BMR in 1972 included magnetic surveying.

SEISMIC SURVEYS

Map key number	Survey name	Year	Operator	Contractor	Seismic energy source	Traverse length (km)	CDP coverage (fold)	Reference of file number
1.	Maralinga seismic*	1956	BMR	-	Explosives	33	-	BMR Rec. 1958/89 " " 1956/48
2.	Giles-Carnegie seismic*	1961-62	BMR	-	"	243	1	" " 1967/123
3.	Mabel Creek-Emu Track seismic	1962	Geosurveys	-	-	-	-	Unsubsidised, not available
4.	Mabel Creek seismic*	1962	Exoil	Namco International	Explosives	233	1	PSSA 62/1588
5.	Babbagoola seismic	1963	Hunt Oil	Seismograph Service	Vibroseis	55	1.5 & 10	" 63/1551
6.	Warburton seismic*	1964	" "	Geophysical Associates	Explosives	272	1 to 6	" 64/4516
7.	North Lennis seismic	1965-66	Hunt Oil/Exoil	Ray/General Geophysical	Weight drop	250	6	" 65/11033
8.	Serpentine Lakes seismic*	1965-66	Continental Oil	Seismograph Service	Vibroseis	890	1 & 10	" 65/11004
9.	Yowalga seismic	1966	Hunt Oil	Ray/General Geophysical	Weight drop	454	6	" 65/4579
10.	Eastern Officer Basin seismic & gravity	1966	S.A.D.M.≠	-	Explosives	122	1	Moorcroft (1969)
11.	Eastern Officer Basin seismic & gravity	1967	Continental Oil	Namco International	Weight drop	122	1 & 2	PSSA 67/11163
12.	Officer Basin seismic,* gravity, magnetic & radiometric	1972	BMR	-	Explosives	85	1 to 12	BMR Rep. No. 191
13.	Officer Basin seismic*	1972	S.A.D.M.	-	"	approx.500	-	Milton & Parker (1973)
14.	Everard seismic	1974-75	Shell Development	Geophysical Engineering	Explosives	250	6	SS 217 (confidential)

* Includes refraction seismic

≠ South Australian Department of Mines

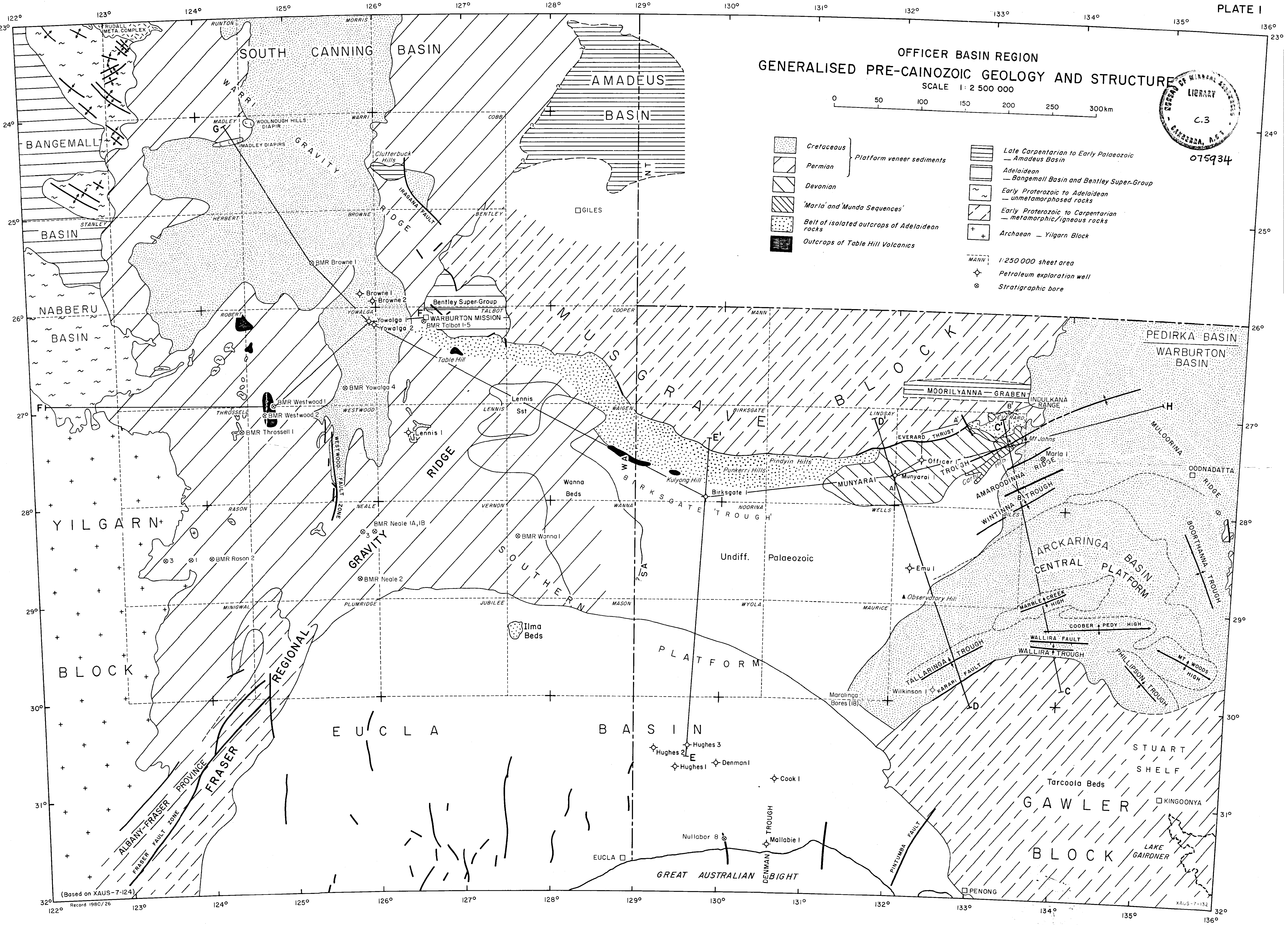
GRAVITY SURVEYS

Survey name	Year	Operator	Contractor	Traverse spacing (km)	Station spacing (km)	Number of stations	Reference or file number
Fisher-Mount Davies gravity	1960	S.A.D.M. ≠	-	-	3	160	Mumme (1963)
Amadeus and South Canning Basins gravity	1962	BMR	-	11	11	300	BMR Rep. 133
Breaden gravity	1963-64	Hunt Oil	(Bell Bros./Hel. Utilities)	3.2x9.6	0.8	20,886	PSSA 6/1900
Lennis gravity	1964-65	Hunt Oil	-	6	0.8	14,100	" 64/4800
Officer Basin gravity	1969	S.A.D.M.	-	15	15	-	-
Eastern Officer Basin helicopter	1970	Murumba Oil	Geophysical Associates	4 & 7.2	7.2 & 8	3 605	PSSA 70/134
Reconnaissance helicopter gravity, South Australia	1970	BMR	Wongela Geophysical	7	7	4 000	BMR Rec. 1974/88
Reconnaissance helicopter gravity, Western Australia	1971-72	BMR	" "	11	11	500	" " 1973/130

≠ South Australian Department of Mines

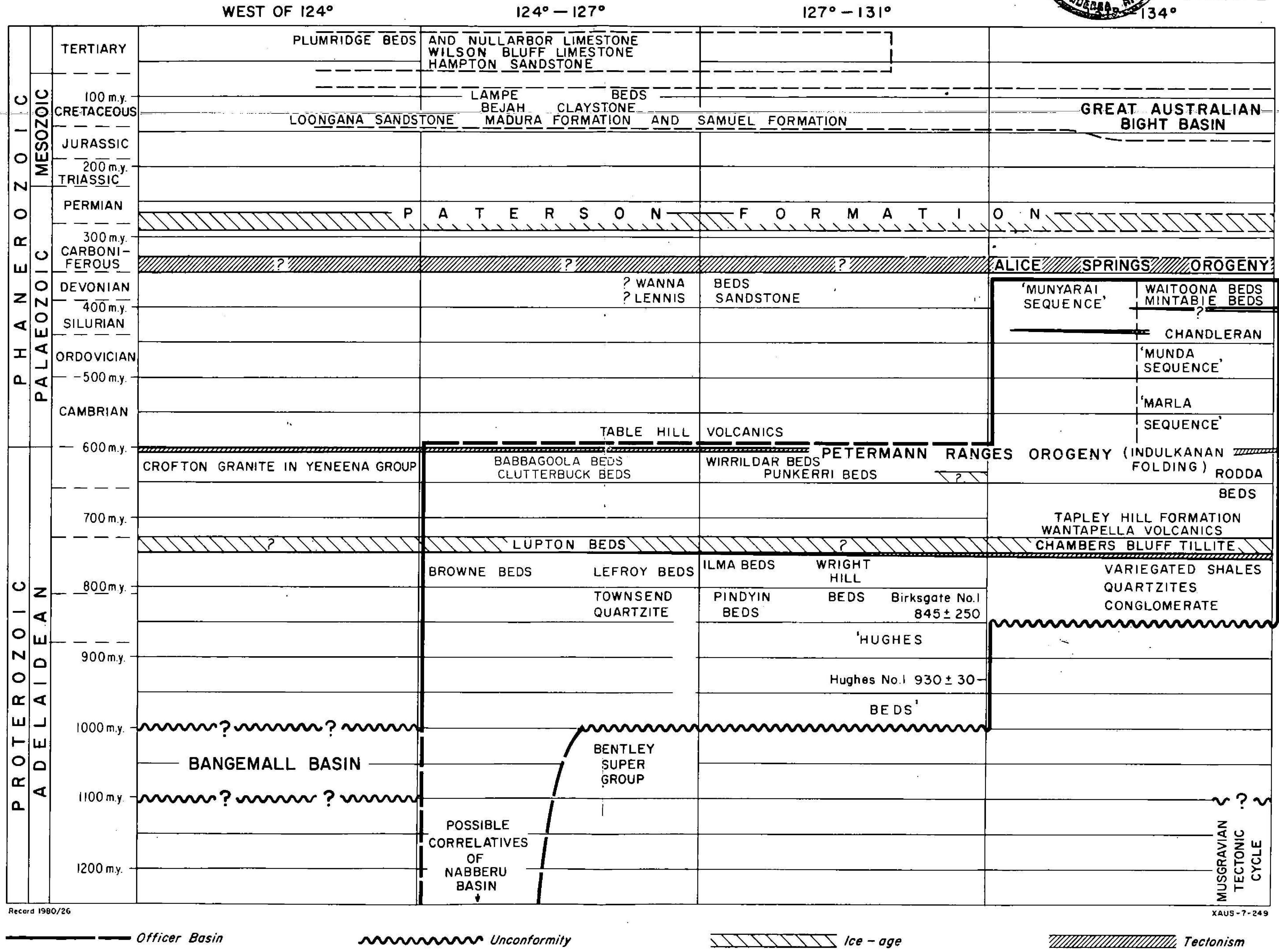
Note: Seismic surveys which included gravity readings are indicated in the list of seismic surveys.

PLATE I


OFFICER BASIN REGION
GENERALISED PRE-CAINOZOIC GEOLOGY AND STRUCTURE
SCALE 1: 2 500 000
0 50 100 150 200 250 300km
Cretaceous
Permian
Platform veneer sediments
Devonian
'Marla' and 'Munda Sequences'
Belt of isolated outcrops of Adelaidean rocks
Outcrops of Table Hill Volcanics
Late Carpentarian to Early Palaeozoic — Amadeus Basin
Adelaidean — Bangemall Basin and Bentley Super-Group
Early Proterozoic to Adelaidean — unmetamorphosed rocks
Early Proterozoic to Carpentarian — metamorphic/igneous rocks
Archaean — Yilgarn Block
1:250 000 sheet area
Petroleum exploration well
Stratigraphic bore
SOUTH CANNING BASIN
AMADEUS BASIN
BANGEMALL BASIN
NABBERU BASIN
YILGARN BLOCK
MUSGRAVE BLOCK
EUCLA BASIN
GAWLER BLOCK
STUART SHELF
PEDIRKA BASIN
WARBURTON BASIN
ARCKARINGA BASIN
CENTRAL PLATFORM
SOUTHERN PLATFORM
WARRI GRAVITY RIDGE
GRAVITY RIDGE
FRASER REGIONAL
ALBANY-FRASER PROVINCE
FRASER FAULT ZONE
WESTWOOD FAULT ZONE
IRAGANA FAULT
RUDALL META. COMPLEX
WOOLNOUGH HILLS DIAPIR
MADLEY DIAPIRS
Clutterbuck Hills
Bentley Super-Group
WARBURTON MISSION
BMR Talbot 1-5
Table Hill
Lennis Sst
Wanna Beds
Ilma Beds
Undiff. Palaeozoic
BIRKSGATE 'TROUGH'
MOORILYANNA GRABEN
INDULKANA RANGE
EVERARD THRUST
OFFICER TROUGH
MUNYARAI
AMAROODINNA RIDGE
WINTINNA TROUGH
MULOORINA RIDGE
BOORTHANNA TROUGH
MARBLE CREEK HIGH
COOBER PEDY HIGH
WALLIRA FAULT
WALLIRA TROUGH
TALLARINGA TROUGH
KARARI FAULT
PHILLIPSON TROUGH
MT WOODS HIGH
PINTUMBA FAULT
DENMAN TROUGH
Tarcoola Beds
Pindyin Hills
Punkerri Hills
Kulyong Hill
Mt Johns
Observatory Hill
Maralinga Bores (18)
GILES
OODNADATTA
KINGOONYA
EUCLA
PENONG
LAKE GAIRDNER
GREAT AUSTRALIAN BIGHT
BMR Browne 1
Browne 1
Browne 2
Yowalga 1
Yowalga 2
BMR Yowalga 4
BMR Westwood 1
BMR Westwood 2
BMR Throssell 1
Lennis 1
BMR Neale 1A, 1B
BMR Neale 2
BMR Wanna 1
BMR Rason 2
Birksgate 1
Officer 1
Munyarai
Marla 1
Emu 1
Wilkinson 1
Hughes 1
Hughes 2
Hughes 3
Denman 1
Cook 1
Nullabor 8
Mallabie 1
RUNTON
MORRIS
MADLEY
WARRI
COBB
HERBERT
BROWNE
BENTLEY
STANLEY
ROBERT
YOWALGA
TALBOT
COOPER
MANN
THROSSELL
WESTWOOD
LENNIS
WAIGEN
BIRKSGATE
LINDSAY
EVERARD
RASON
NEALE
VERNON
WANNA
NOORINA
WELLS
GILES
MINIGWAL
PLUMRIDGE
JUBILEE
MASON
WYOLA
MAURICE
(Based on XAUS-7-124)
Record 1980/26
XAUS-7-132

TIME CORRELATION CHART, OFFICER BASIN REGION

PLATE 2



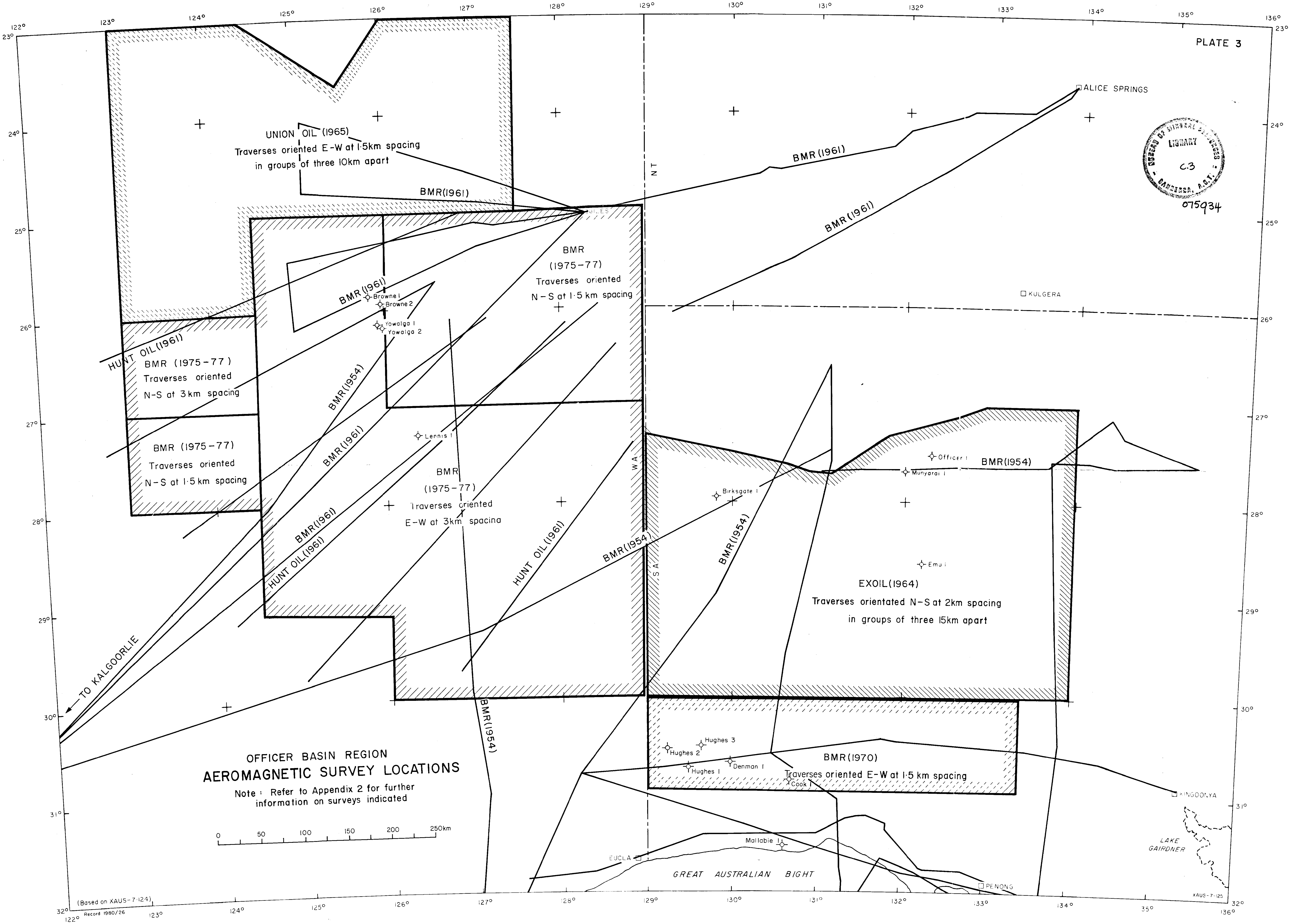


PLATE 3
OFFICER BASIN REGION
AEROMAGNETIC SURVEY LOCATIONS
Note : Refer to Appendix 2 for further information on surveys indicated
0 50 100 150 200 250km
UNION OIL (1965)
Traverses oriented E-W at 1·5km spacing in groups of three 10km apart
BMR(1961)
BMR (1975-77) Traverses oriented N-S at 1·5 km spacing
BMR (1975-77) Traverses oriented N-S at 3km spacing
BMR (1975-77) Traverses oriented N-S at 1·5 km spacing
BMR (1975-77) Traverses oriented E-W at 3km spacing
HUNT OIL(1961)
BMR(1954)
EXOIL(1964)
Traverses orientated N-S at 2km spacing in groups of three 15km apart
BMR(1970)
Traverses oriented E-W at 1·5 km spacing
TO KALGOORLIE
ALICE SPRINGS
KULGERA
GILES
KINGOONYA
PENONG
EUCLA
LAKE GAIRDNER
GREAT AUSTRALIAN BIGHT
NT
WA
SA
Browne 1
Browne 2
Yowalga 1
Yowalga 2
Lennis 1
Birksgate 1
Officer 1
Munyarai 1
Emu 1
Hughes 1
Hughes 2
Hughes 3
Denman 1
Cook 1
Mallabie 1
122° 123° 124° 125° 126° 127° 128° 129° 130° 131° 132° 133° 134° 135° 136°
23° 24° 25° 26° 27° 28° 29° 30° 31° 32°
(Based on XAUS-7-124)
Record 1980/26
XAUS-7-125
BUREAU OF MINERAL RESOURCES LIBRARY CANBERRA, A.C.T.
C.3
075934

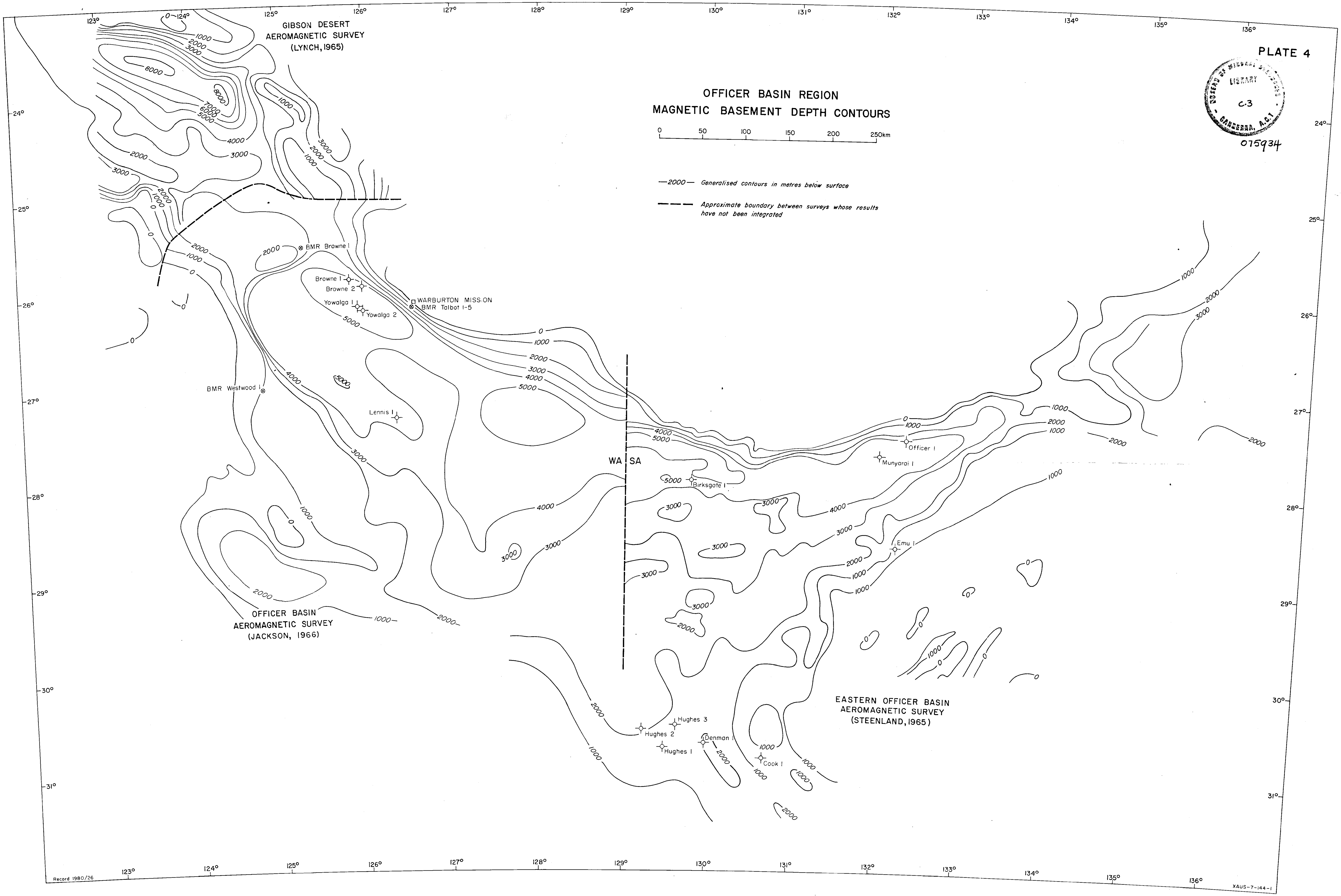
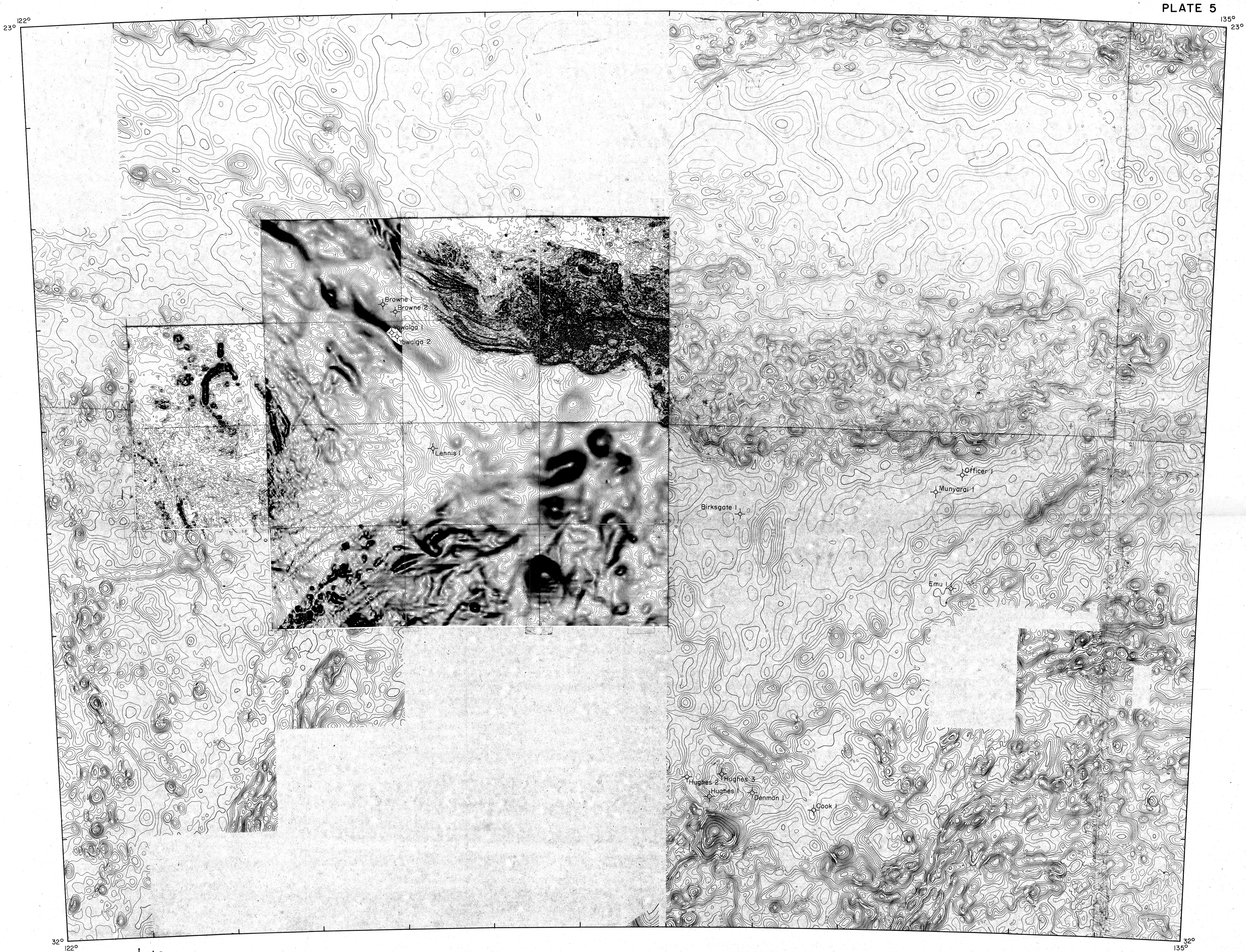


PLATE 4
OFFICER BASIN REGION
MAGNETIC BASEMENT DEPTH CONTOURS
0 50 100 150 200 250km
—2000— Generalised contours in metres below surface
— — Approximate boundary between surveys whose results have not been integrated
GIBSON DESERT AEROMAGNETIC SURVEY (LYNCH, 1965)
OFFICER BASIN AEROMAGNETIC SURVEY (JACKSON, 1966)
EASTERN OFFICER BASIN AEROMAGNETIC SURVEY (STEENLAND, 1965)
BMR Browne I
Browne 1
Browne 2
Yowalga 1
Yowalga 2
WARBURTON MISSION
BMR Talbot 1-5
BMR Westwood I
Lennis I
WA
SA
Birksgate I
Officer I
Munyarai I
Emu I
Hughes 1
Hughes 2
Hughes 3
Denman I
Cook I
Record 1980/26
XAUS-7-144-1

PLATE 5



OFFICER BASIN REGION

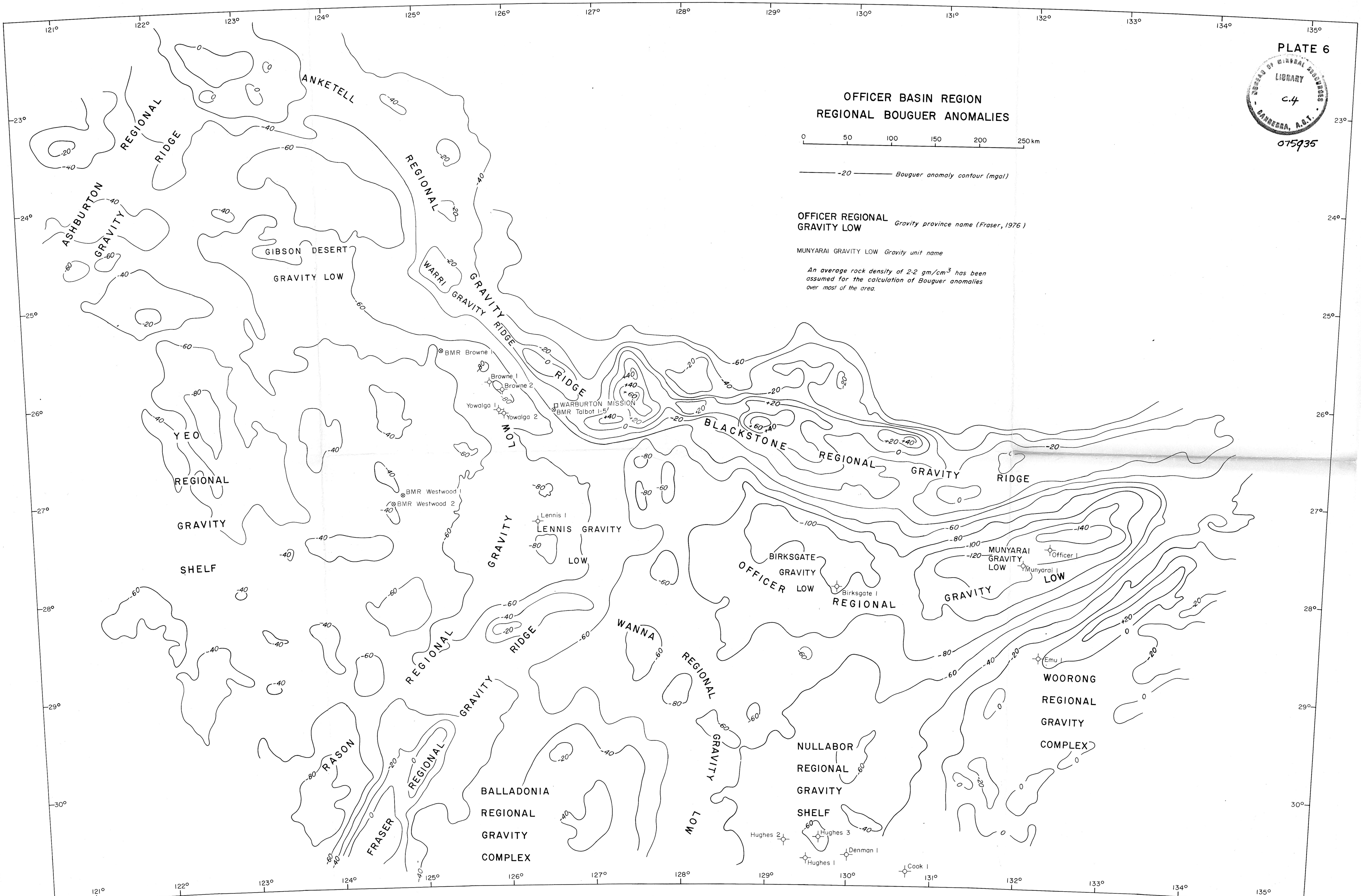
Total Magnetic Intensity Contours

(contour interval varies)

50 0 50 100 150 km

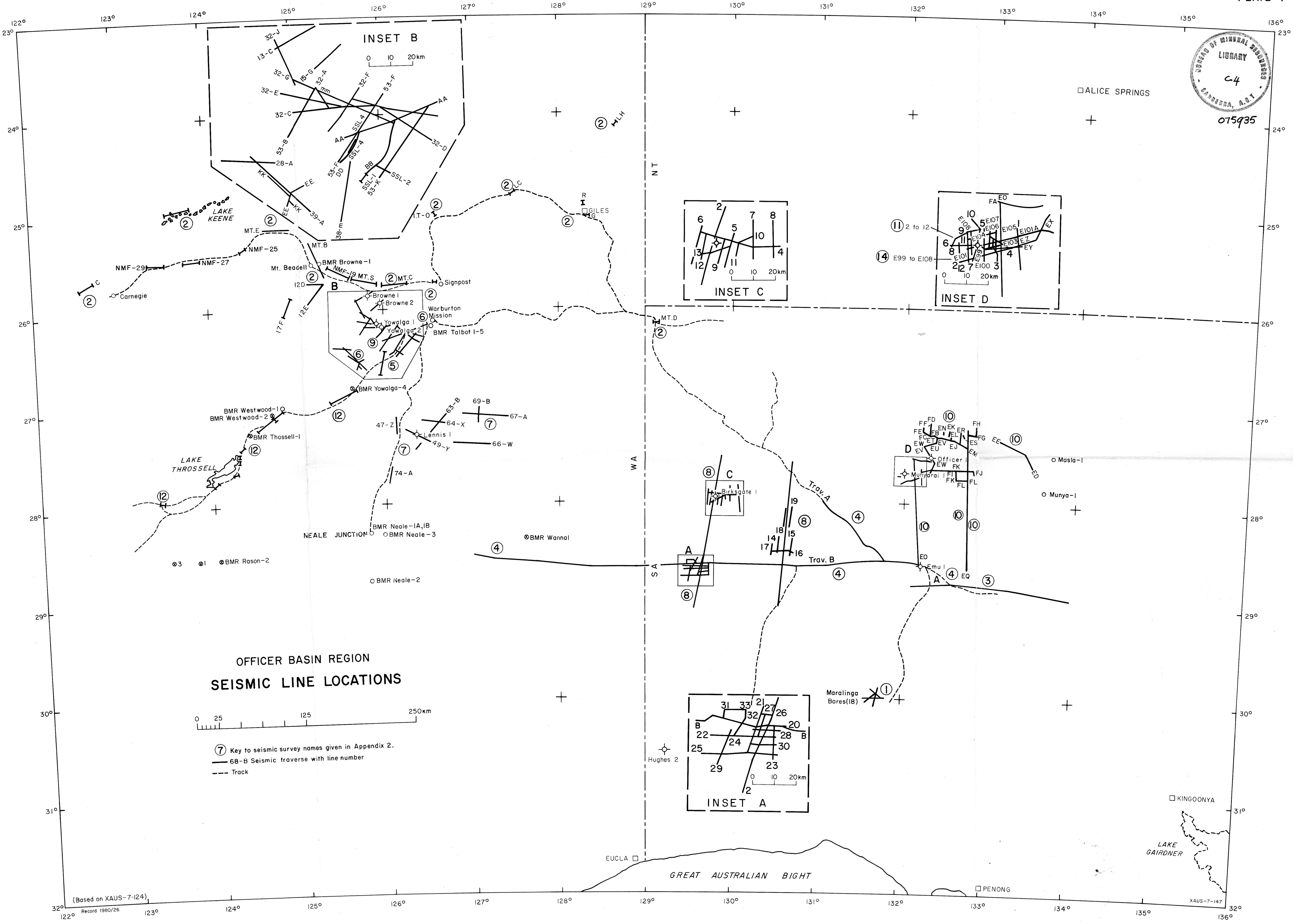
Record 1980/26

A/B1-27



Record 1980/26

XAUS-7-143-1


OFFICER BASIN REGION
SEISMIC LINE LOCATIONS
0 25 125 250km
Key to seismic survey names given in Appendix 2.
68-B Seismic traverse with line number
Track
INSET A
INSET B
INSET C
INSET D
ALICE SPRINGS
GILES
Carnegie
Mt. Beadell
Signpost
Warburton Mission
BMR Browne-1
BMR Talbot 1-5
BMR Yowalga-4
BMR Westwood-1
BMR Westwood-2
BMR Thossell-1
LAKE KEENE
LAKE THOSSELL
NEALE JUNCTION
BMR Neale-1A,1B
BMR Neale-3
BMR Neale-2
BMR Wannal
BMR Rason-2
Lennis 1
Birksgate 1
Officer 1
Munyarai 1
Masla-1
Munya-1
Emu 1
Trav. A
Trav. B
Maralinga Bores(18)
Hughes 2
KINGOONYA
LAKE GAIRDNER
EUCLA
PENONG
GREAT AUSTRALIAN BIGHT
WA
NT
SA
(Based on XAUS-7-124)
Record 1980/26
XAUS-7-147

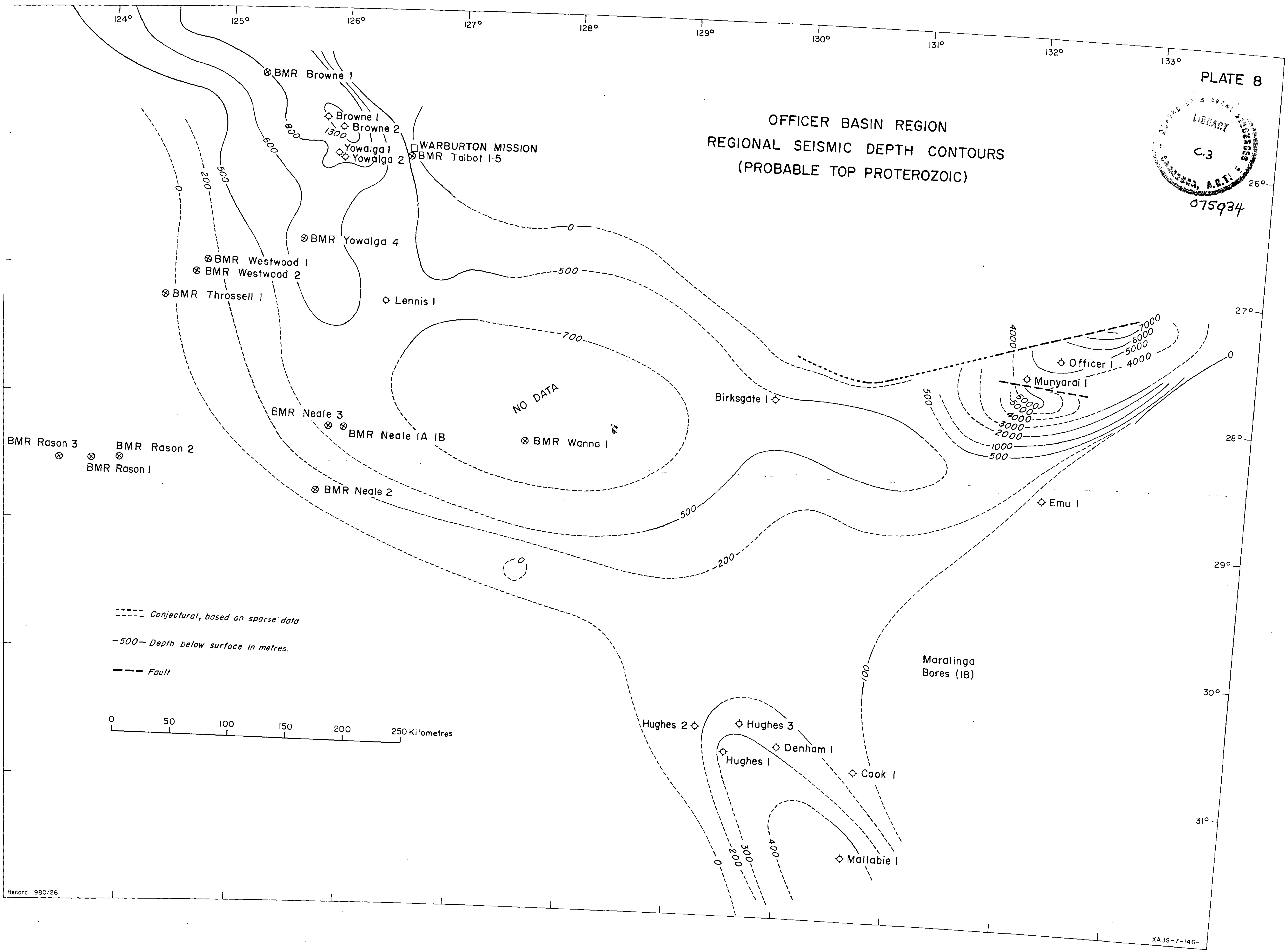


PLATE 8
OFFICER BASIN REGION
REGIONAL SEISMIC DEPTH CONTOURS
(PROBABLE TOP PROTEROZOIC)
124°
125°
126°
127°
128°
129°
130°
131°
132°
133°
26°
27°
28°
29°
30°
31°
BMR Browne 1
Browne 1
Browne 2
Yowalga 1
Yowalga 2
WARBURTON MISSION
BMR Talbot 1·5
BMR Yowalga 4
BMR Westwood 1
BMR Westwood 2
BMR Throssell 1
Lennis 1
NO DATA
BMR Wanna 1
BMR Neale 3
BMR Neale 1A 1B
BMR Neale 2
BMR Rason 3
BMR Rason 2
BMR Rason 1
Birksgate 1
Officer 1
Munyarai 1
Emu 1
Maralinga
Bores (18)
Hughes 2
Hughes 3
Hughes 1
Denham 1
Cook 1
Mallabie 1
Conjectural, based on sparse data
—500— Depth below surface in metres.
Fault
0 50 100 150 200 250 Kilometres
Record 1980/26
XAUS-7-146-1