GS90/008

NORTHERN TERRITORY GEOLOGICAL SURVEY

PETROLEUM BASIN STUDY

EROMANGA BASIN

Prepared by: Questa Australia Pty Ltd
Adelaide

March, 1990

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PETROLEUM BASIN STUDY - EROMANGA BASIN

FIGURES

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1.0 EXECUTIVE SUMMARY

The Mesozoic Eromanga Basin which occupies a large part of Eastern Australia is underlain in the Northern Territory and northern South Australia by the Late Palaeozoic Pedirka Basin.

The exploration programme that has been conducted in the Pedirka/Eromanga Basin region to date has demonstrated that an abundance of organically rich source rocks, porous and permeable reservoirs with effective vertical seals, and closed anticlinal structures are present throughout the study area. Reservoir objectives and their associated source rocks range in age from earliest Cambrian to Early Cretaceous.

Geochemical evidence has shown that an absence of organic maturity is the primary reason for the lack of exploration success in the basin to date. Geothermal gradients within the study area are low, particularly when compared with those of the nearby gas and oil productive, Cooper/Eromanga Basin region.

Organic maturity is the only ingredient remaining for the establishment of an important hydrocarbon province. This maturity is expected to be found in the Madigan and Eringa Troughs in the western part of the study area. Several closed structures have been identified along the margins of the Madigan Trough. None has been drilled. Several wells have been drilled along the eastern margin of the Eringa Trough on an upthrown fault block without success but the structural configuration is such that hydrocarbon migration from the depression would have been towards the west and northwest and not towards the east. This area has not been explored.

Most of the exploration in the study area has concentrated on the Upper Palaeozoic and Mesozoic succession, particularly since oil was recovered from Early Jurassic and Triassic sands while testing Poolowanna 1 in 1977. Mesozoic and Upper Palaeozoic rocks remain the primary exploration targets in the study area but Early Palaeozoic (Cambrian to Devonian) clastics and carbonates provide exciting secondary objectives. The Eringa Trough would have provided an ideal environment for the development of organically rich source rocks and porous and permeable reservoirs. Stratigraphically equivalent units at Palm Valley and Mereenie fields to the northwest are proven oil and gas producers.

The Pedirka/Eromanga Basin region has all of the prerequisites of an important hydrocarbon province and one must be optimistic about its oil and gas potential. The basin area should be considered both oil and gas prone. There is a ready market for gas both in Darwin and in Adelaide. Pipelines and processing facilities are established at Moomba, 400km to the southeast and at Palm Valley-Mereenie, 300km to the northwest and therefore logistics are favourable.

2.0 INTRODUCTION

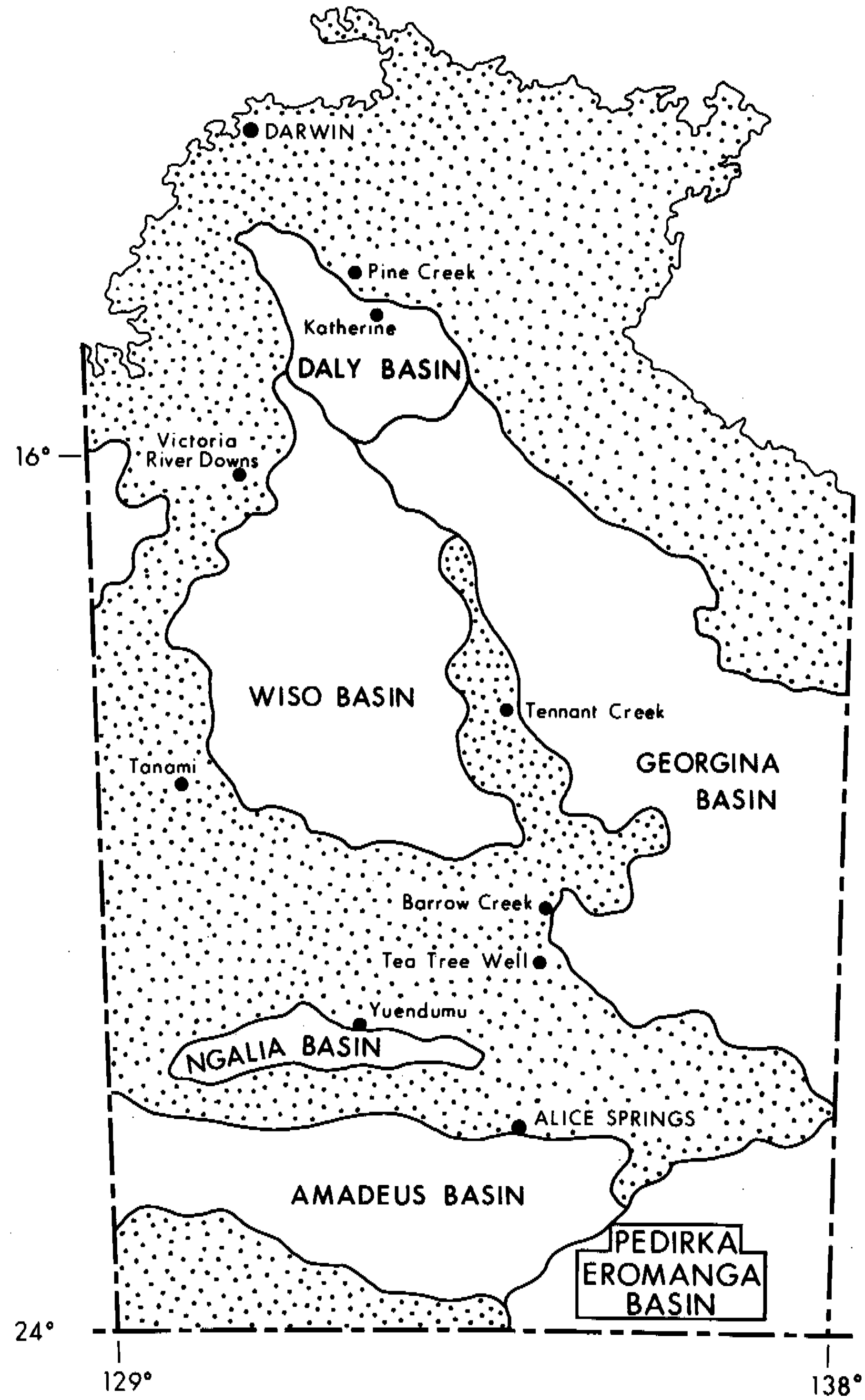
This report is a review of the petroleum potential of the sedimentary basin sequences known as the Pedirka, Simpson and Eromanga Basins in the southeastern corner of the Northern Territory. Although only a paucity of data is available, discussion of the underlying, Early Palaeozoic sediments is also made. The basins under study span state borders into Queensland in the east and South Australia in the south, but this report concentrates on the potential within the Northern Territory. The review was undertaken by Questa Australia Pty Ltd for the Geological Survey of the Department of Mines and Energy of the Northern Territory of Australia.

The purpose of the study is to highlight the potential for petroleum discovery and exploitation within the basin sequence. The objectives were to review those facets of stratigraphy, structure and hydrocarbon source potential which would address this potential, thereby encouraging further involvement in petroleum exploration in the area.

The data used for the study consisted of unpublished open file petroleum notes and reports from the Northern Territory, South Australia and Queensland. Several reports on the area are confidential as exploration permits EP 1 and EP 30 are still current and data remain proprietary and have not been used. All relevant published and unpublished reports are listed in the bibliography of this review.

The study was carried out for the Director of the Geological Survey, Northern Territory Department of Mines and Energy. Considerable assistance in preparing the report which follows was provided by Beach Petroleum N.L., Territory Petroleum N.L. and the South Australian Department of Mines and Energy. The assistance of David Pegum, Senior Petroleum Geologist and other officers of the Northern Territory Geological Survey in obtaining data and reviewing and discussing this report is gratefully acknowledged.

The Northern Territory Government wishes to promote petroleum exploration and development and will do everything in its power to assist those groups who may be interested in pursuing opportunities in the Territory (Appendix 5).



LOCATION MAP
Pedirka/Eromanga Basin

FIGURE 1

3.0 BASIN LOCATION

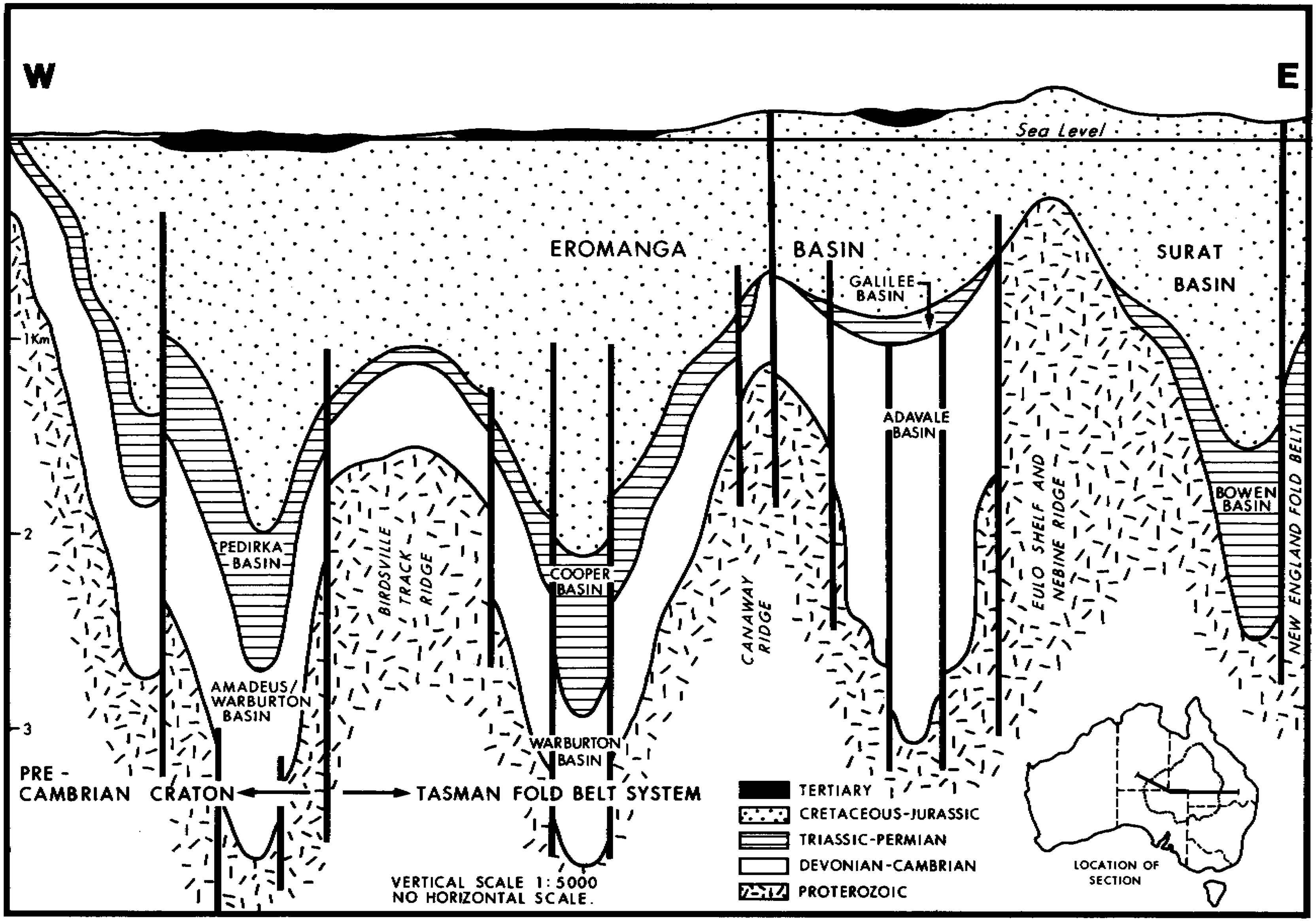
The location of the Pedirka/Eromanga Basin with respect to other Northern Territory basins is shown in Figure 1. The basins underlie the Simpson Desert, which is one of Australia's largest sandy deserts. Within the Northern Territory, these basins occupy an area of some 73,000 sq. km.

The land surface is characterized by north-northwesterly trending sand dunes, often many kilometres long. The major components appear to have been stabilised by spinifex and cane grass but large portions remain mobile. The drainage systems in the area consist of dry watercourses which all flow southwards into the northern extremities of Lake Eyre in South Australia. The Todd, Hay and Hale rivers flow into the northern parts of the desert but do not cross it. Average day time temperatures range from 39°C to 24°C during the summer months and from 21°C to 6°C during the winter months. Temperatures frequently exceed 40°C in the summer and fall below 0°C during winter nights. The Simpson Desert is the most arid area in Australia with no more than 5 or 6cm of rainfall expected annually. There are very few native water wells although some of the petroleum exploration wells have been completed as water producers.

The area is remote from main centres with Alice Springs, 350km to the northwest being the nearest population centre and Port Augusta, 680km to the south, being the closest port. The city of Adelaide is some 1000km from the study area. Land access to the Pedirka Basin region is from the south and north. The Stuart Highway runs just west of the study area, linking Darwin with Port Augusta via Alice Springs. This highway is fully sealed. The Adelaide to Alice Springs railway (The Ghan), also passes just west of the area. Numerous tracks of various quality traverse the basin margins but very few actually penetrate into the desert region. Vehicle access into the basin area itself is via graded road and seismic survey tracks from Finke and Alice Springs. It is possible to also gain access from Clifton Hills in the south via similar means. Access within the western parts of the basin is relatively easy for four wheel drive vehicles although sand dunes are in the order of 25 metres high and 750 metres apart, creating difficulties in travel whilst in the central and eastern areas. Many of the older well sites have graded airstrips which facilitate easier access.

The Pedirka/Eromanga Basin area lies midway between the gas and oil productive Amadeus (300km to the northwest) and Cooper/Eromanga (500km to the southeast) Basins. Gas is delivered by pipeline from the Amadeus Basin to Darwin in the north and from the Cooper Basin to Adelaide and Sydney in the south and east respectively. There is also a liquids pipeline from the Cooper Basin to Port Bonython in the south and from the Amadeus Basin to Alice Springs where the liquids are railed to Adelaide. Proposals have been made for a gas pipeline to connect the Amadeus Basin (Alice Springs) with the Cooper Basin (Moomba) centres and if completed it would pass through the centre of the study area. A discovery in the region would then have ready markets in both Darwin and Adelaide.

FIGURE 2



Diagrammatic Section Showing Relationships of Eromanga and Underlying Basins

4.0 GEOLOGICAL SETTING

4.1 BASIN NOMENCLATURE

Six sedimentary basins have been identified and named within the study area. Together, these accumulated sediments range in age from Early Palaeozoic to Cainozoic and Recent (Figures 2 and 3).

Sediments of Cambrian through Early Carboniferous age are considered to belong transitionally to a southeastern extremity of the Amadeus Basin in the western part of the study area and a portion of the Warburton Basin in the eastern part of the study area. These sediments also exhibit a strong Officer Basin component. Sediments of Late Carboniferous and Early Permian age, present only in the western part of the study area, overlie Amadeus Basin sediments and constitute the Pedirka Basin succession. Regional tilting and subsidence to the east initiated the Simpson Basin in which Early to Late Triassic sediments accumulated. Triassic sediments overlie the Permian sequence across only a small portion of the study area, largely because of uplift of the central part (McDills-Mayhew Trend) of the Permian to pre-Permian depocentre in Late Permian and Early Triassic time.

Permo-Triassic sediments are, in turn, overlain by the Eromanga Basin sequence, a thick succession of Jurassic and Cretaceous sediments which occupy a large part of eastern Australia. These are blanketed by a thin veneer of the Cainozoic and Recent sediments of the Eyre Basin.

As the Amadeus, Warburton, Eromanga and Eyre basins are areally extensive, occupying areas considerably beyond the bounds of the study area, the terms Pedirka Basin and Simpson Basin are more specific to the area under study. The appellation Pedirka Basin is commonly used in reference to that area being reviewed here.

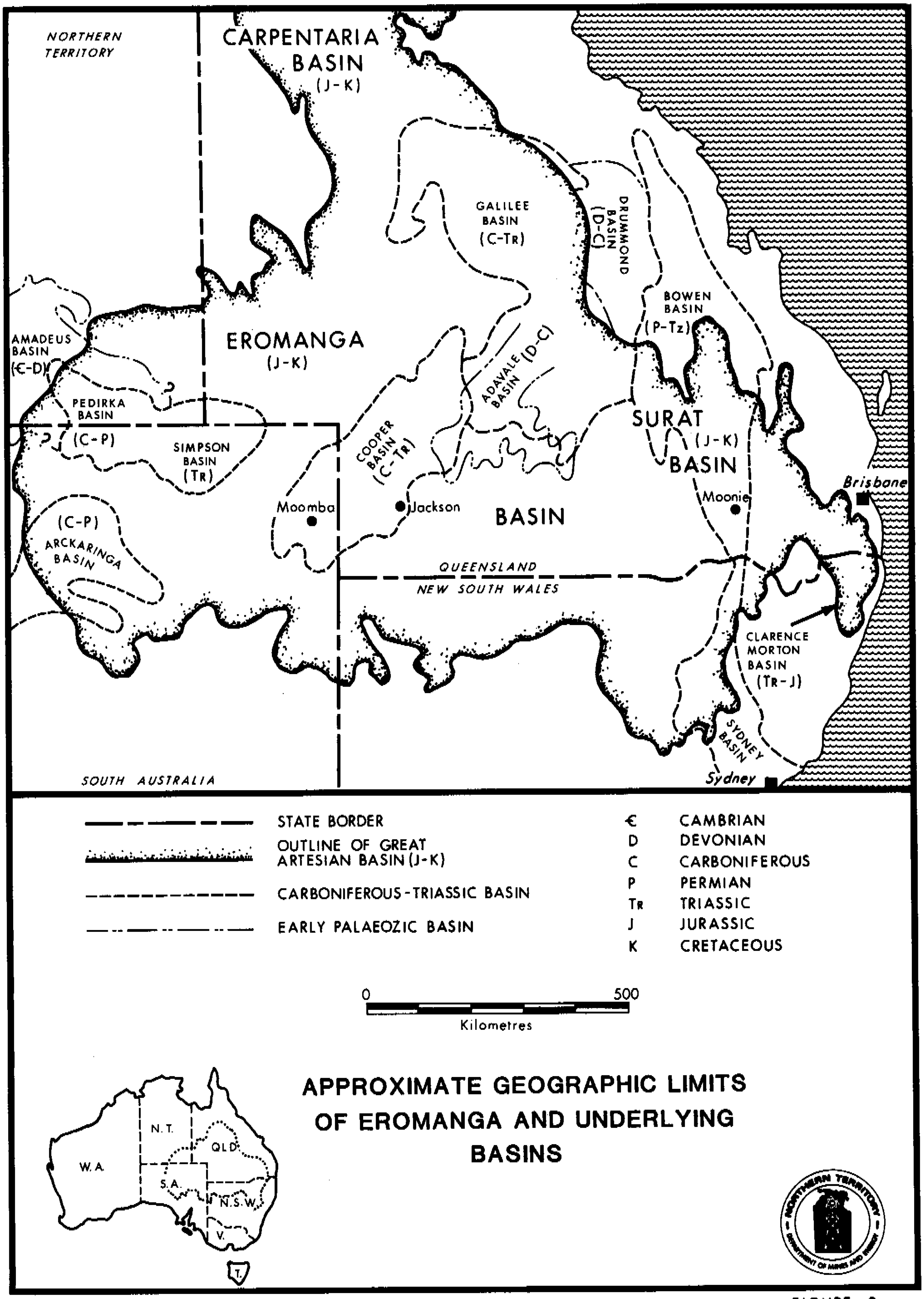
4.2 REGIONAL TECTONIC SETTING AND STRUCTURE

The tectonic setting of the region is reflected in the interpretation of the depth to magnetic basement (Figure 4). The study area is situated on the eastern edge of the original Gondwanaland craton with the northern, western and southern boundaries being controlled by basement blocks and their associated ridges and platforms. From the south these are:

The Denison Block,
the Muloorina Ridge,
the Musgrave Block,
the Andado Ridge,
the Arunta Block, and
the Arunta Platform.

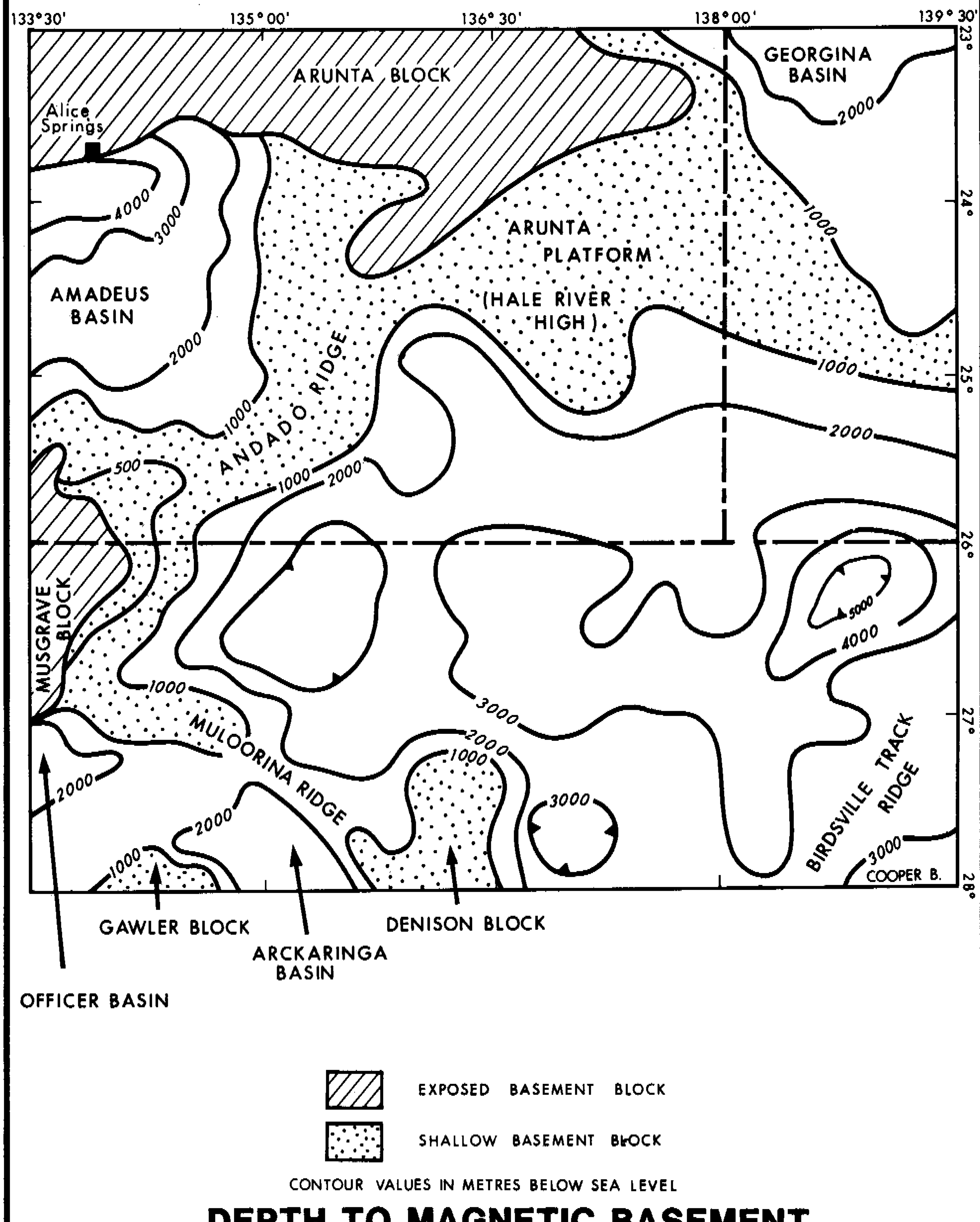
The Permo-Triassic sequence (Pedirka and Simpson Basin sediments) thins to the east and only the uppermost unit may be present over the top of the Birdsville Track Ridge. The sequence wedges out against the Precambrian Arunta Platform to the north and the Black Hill Range to the west. Post Triassic deposition (Eromanga Basin sediments) is continuous across the Birdsville Track Ridge where it overlies the Cooper Basin. To the north and west, Eromanga Basin sediments overlap sediments of Permo-Triassic age.

The Peake and Denison Ranges define the southern limit of the Pedirka/Simpson Basin but the range dies out westward towards Oodnadatta 1. The Permian sequence



APPROXIMATE GEOGRAPHIC LIMITS OF EROMANGA AND UNDERLYING BASINS

FIGURE 3



DEPTH TO MAGNETIC BASEMENT
Simpson Desert Region

(after Thomson (1970), Krieg (1969) & Laherrere & Drayton 1965

FIGURE 4

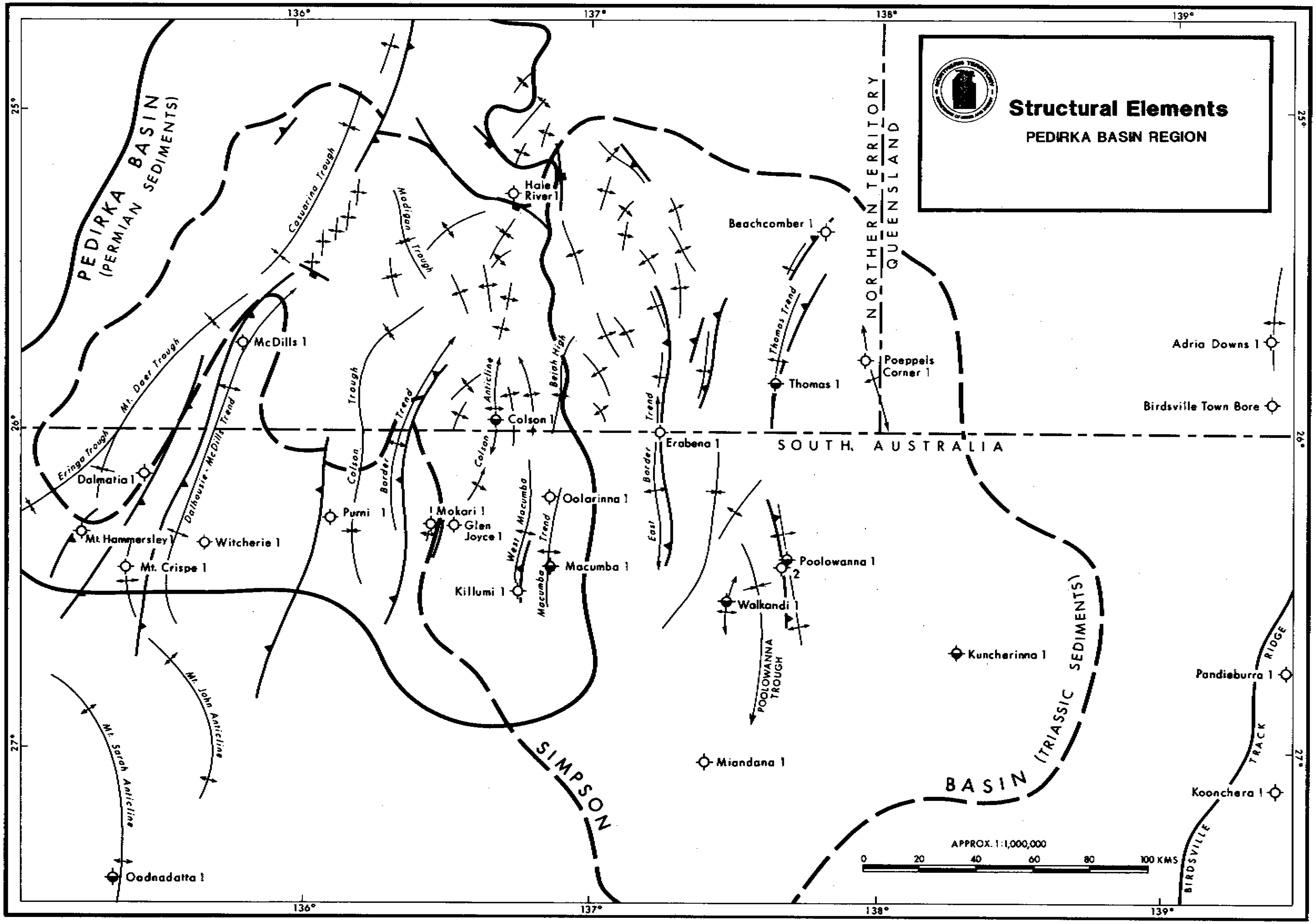

Structural Elements
PEDIRKA BASIN REGION
136°
137°
138°
139°
25°
26°
27°
PEDIRKA BASIN
(PERMIAN SEDIMENTS)
Casuarina Trough
Madigan Trough
Mt. Daer Trough
Eringa Trough
Dalhousie - McDills Trend
Colson Trough
Border Trend
Colson Anticline
Beiaih High
West Macumba Trend
Macumba Trend
East Border Trend
Thomas Trend
POOLOWANNA TROUGH
Mt. John Anticline
Mt. Sarah Anticline
NORTHERN TERRITORY
QUEENSLAND
SOUTH AUSTRALIA
SIMPSON BASIN (TRIASSIC SEDIMENTS)
BIRDSVILLE TRACK RIDGE
Hale River 1
Beachcomber 1
McDills 1
Thomas 1
Poeppels Corner 1
Adria Downs 1
Birdsville Town Bore
Colson 1
Erabena 1
Dalmatia 1
Oolarinna 1
Purni 1
Mokari 1
Glen Joyce 1
Mt. Hammersley 1
Witcherie 1
Mt. Crispe 1
Macumba 1
Killumi 1
Poolowanna 1
2
Walkandi 1
Kuncherinna 1
Pandieburra 1
Miandana 1
Koonchera 1
Oodnadatta 1
APPROX. 1:1,000,000
0
20
40
60
80
100 KMS

FIGURE 5

has been found to be very thin or absent in an area southwest of Oodnadatta 1 although a thin veneer of Permian sediments may connect the Pedirka and Arckaringa basins.

The Pedirka Basin sequence was deposited on a 'basement' of deformed Proterozoic and lower Paleozoic rocks correlated as equivalents to those of the Amadeus Basin to the northwest, the Officer Basin to the southwest and the Warburton Basin to the southeast. These sediments are thin over the Andado Ridge and form the core of the Birdsville Track Ridge. Their distribution is only poorly known in the Pedirka region because very few petroleum exploration wells have penetrated large amounts of them. Seismic data recorded in the area have little energy returned from below the Permo-Triassic coals thus making interpretation of the pre-Permian section difficult. This lack of data makes an accurate knowledge of their actual thickness and distribution difficult.

Enclosures 1, 2 and 3 show the structure of the study area at top Poolowanna Formation, top Cadna-owie Formation and at the top of the pre-Permian unconformity respectively.

D. I. Gravestock (South Australia Department of Mines and Energy - pers comm), through isopach mapping and core examination, has found that the depositional strike of Early Palaeozoic sediments in the Pedirka Basin region is normal (90°) or near normal to the depositional strike of Late Palaeozoic and Mesozoic sediments. As Gravestock points out, seismic lines acquired as dip lines across Mesozoic strata are, in many places, strike lines across the underlying Early Palaeozoic strata, making them difficult to resolve seismically.

This difference in orientation may be explained by rotation of the Australian craton since Proterozoic times as it, as a leading edge of Gondwanaland, continued to collide with a more or less fixed oceanic plate to the east and northeast.

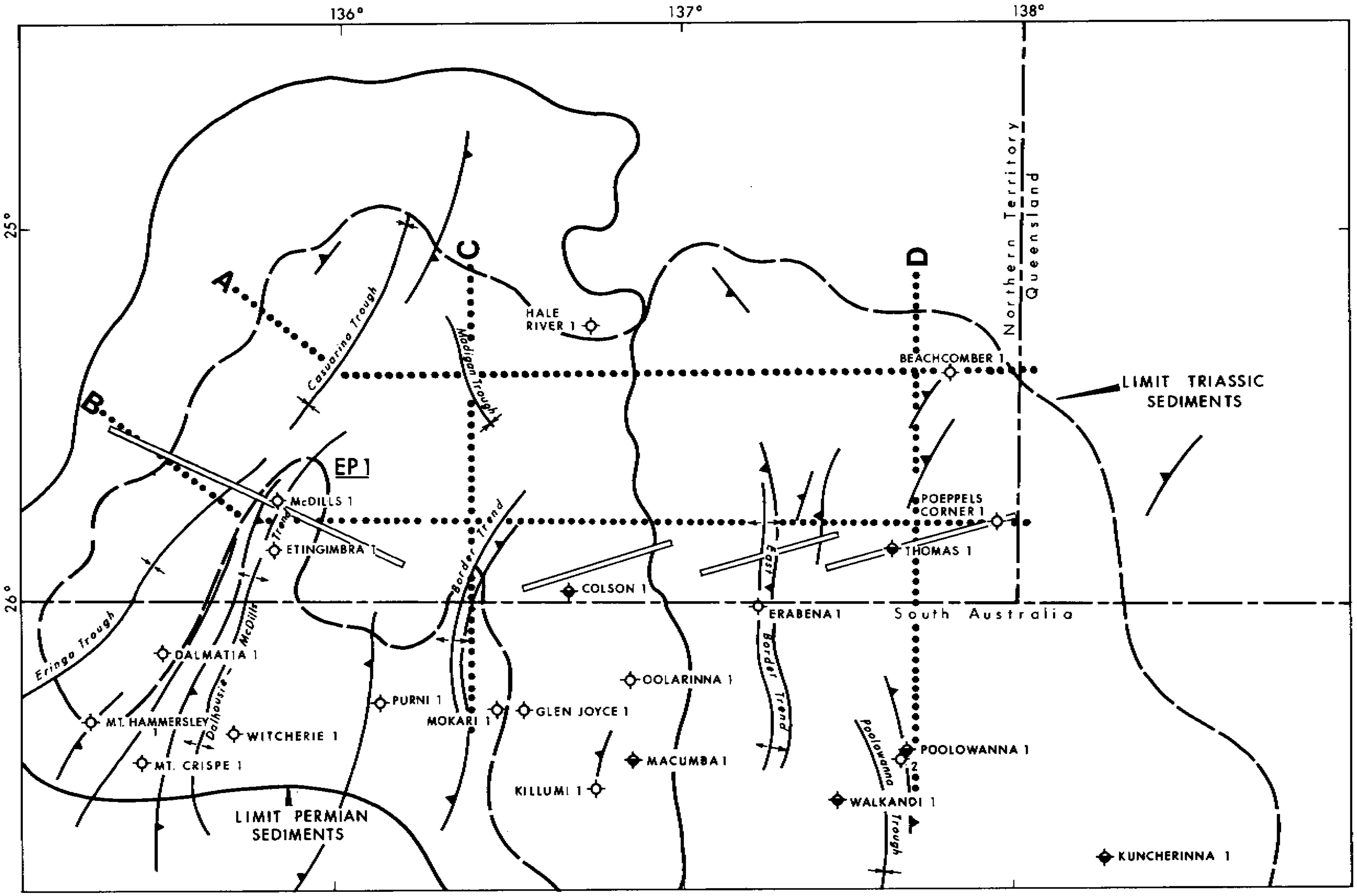
Making structural resolution by the seismic method even more difficult, Early Palaeozoic sediments are steeply dipping (in excess of 25-30°) while being overlain by a thick and relatively flat lying succession of later Palaeozoic and Mesozoic sediments.

Gravity and magnetic interpretation indicates that the major lineaments in the Early Palaeozoics have a northwest trend with 60° to 90° conjugate trends.

Two major depocentres developed within the area under study. The Eringa-Madigan-Casuarina Trough in the west and northwest developed during early Palaeozoic time and continued development into Permian time. After regional tilting, the Poolowanna Trough developed in the southeast during the Triassic. Six anticlinal trends cross the basin, these being from west to east: the McDills-Mayhew Trend, the Border Trend, the Colson Trend, the Macumba-Bejah Trend, the East Border Trend and the Poolowanna-Thomas Trend (Figure 5). The orientation of these anticlinal trends swings from northeasterly in the west through to northerly in the east. Intensity of uplift varies across the area with the McDills-Mayhew and Border anticlines being the most prominent (Enclosure 4). All of the features are reflected by gravity anomalies suggesting involvement of basement rocks in the structuring (Enclosure 5).

Each of the trends plunges to the north and, with the exception of the Thomas Anticline, tend to intersect in the northernmost part of the Pedirka Basin, north of Hale River 1. All are en-echelon, reverse fault controlled anticlines and with the exception of the McDills-Mayhew Trend, all are downthrown to the east. All appear to have developed through post Devonian dextral shear along northwest trending basement lineaments.

FIGURE 6



•••••••••• STRUCTURAL CROSS SECTION (FIGURE 7)

▭ SEISMIC CROSS SECTION (ENCLOSURE 4)

Location Map - Structural & Seismic Cross Sections

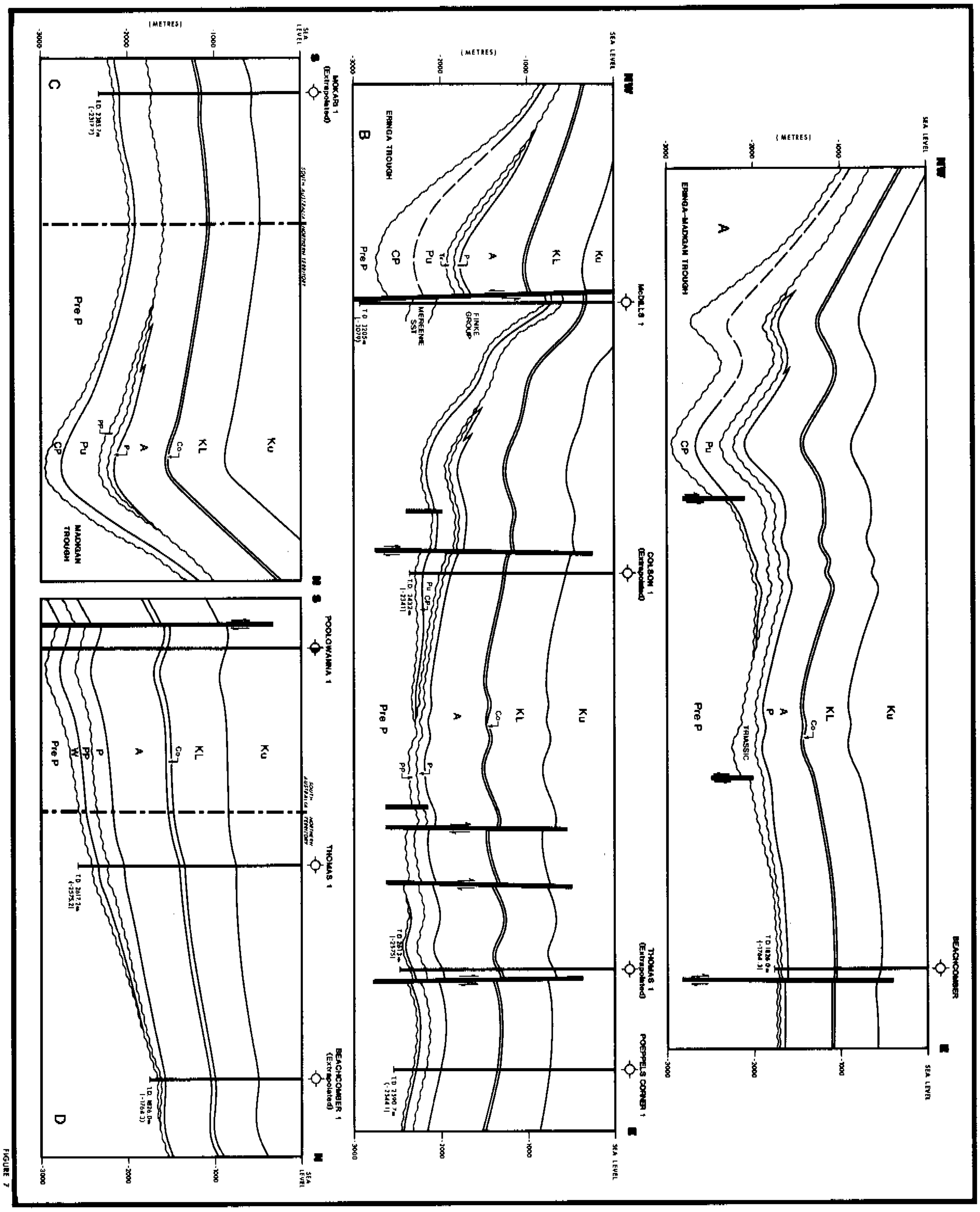


FIGURE 7

KU	WINTON AND YOUNGER SEDIMENTS	JURASSIC / CRETACEOUS MINOR TERTIARY
KL	MACKUNDA Fm, ALLARU MUDSTONE, TOOLEBUC Fm, WALLUMBILLA Fm	
Co	CADNA-OWIE Fm.	
A	ALGEBUCKINA Fm	
P	POOLOWANNA Fm.	
PP	PEERA PEERA Fm.	TRIASSIC
W	WALKANDI Fm	
Pu	PURNI Fm	PERMIAN LATE CARBONIFEROUS
CP	CROWN POINT Fm.	
Pre P	PRE PERMIAN SEDIMENTS	

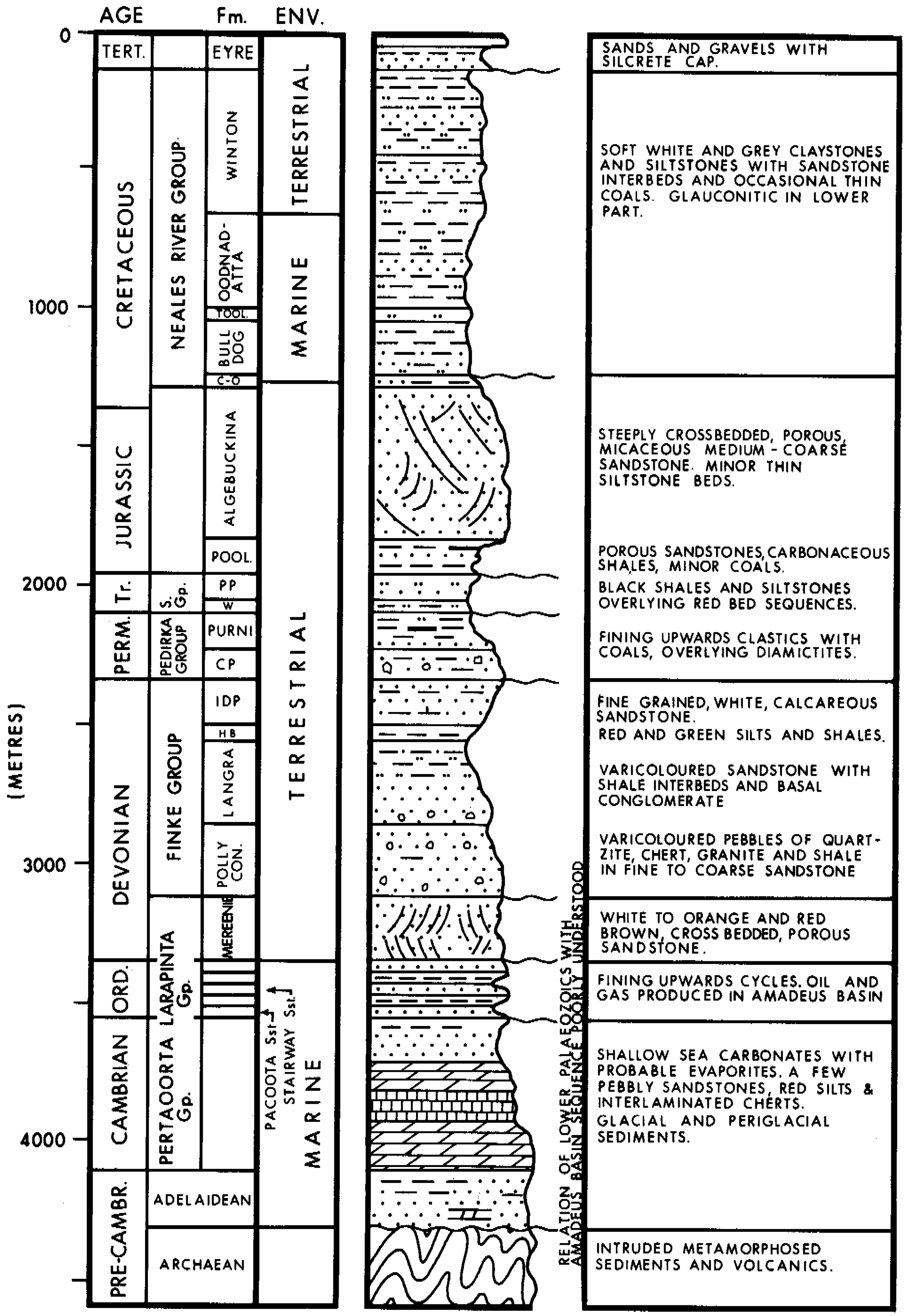
VERTICAL EXAGGERATION = 25

NORTHERN TERRITORY
GEOLOGICAL SURVEY
PETROLEUM BASIN STUDY

STRUCTURAL CROSS SECTIONS IN PART IDEALISED

Northern Pedirka Basin Region

REFER FIG 6 FOR LOCATION



IDEALISED COMPOSITE STRATIGRAPHIC SECTION
Pedirka Basin Region

FIGURE 8

The orientation of Pedirka/Simpson/Eromanga Basin structures and associated faults has been strongly influenced by the tectonic grain imposed by Early Palaeozoic and, in particular, Middle Carboniferous deformation. This deformation consisted predominantly of a compressive strike slip/wrench (transpressional) assemblage which originated from the southeast to east and resulted in horst, graben and half graben fault blocks as the most prominent structural forms. Thrust faults and folds were oriented in a northeast direction. The Colson Trend effectively acted as a basin hingeline during the deposition of Permian sediments.

Syndepositional supratenuous folding by drape and differential compaction is responsible for much of the structure present within the basin sequence today. Onlap of sediments onto pre-Permian highs is also common and may form important stratigraphic plays (Figures 6 and 7).

Many of these older features were continually rejuvenated during subsequent periods of basin deformation. Reactivated thrust faults gave rise to prominent escarpments during deposition of the Permo-Carboniferous sediments.

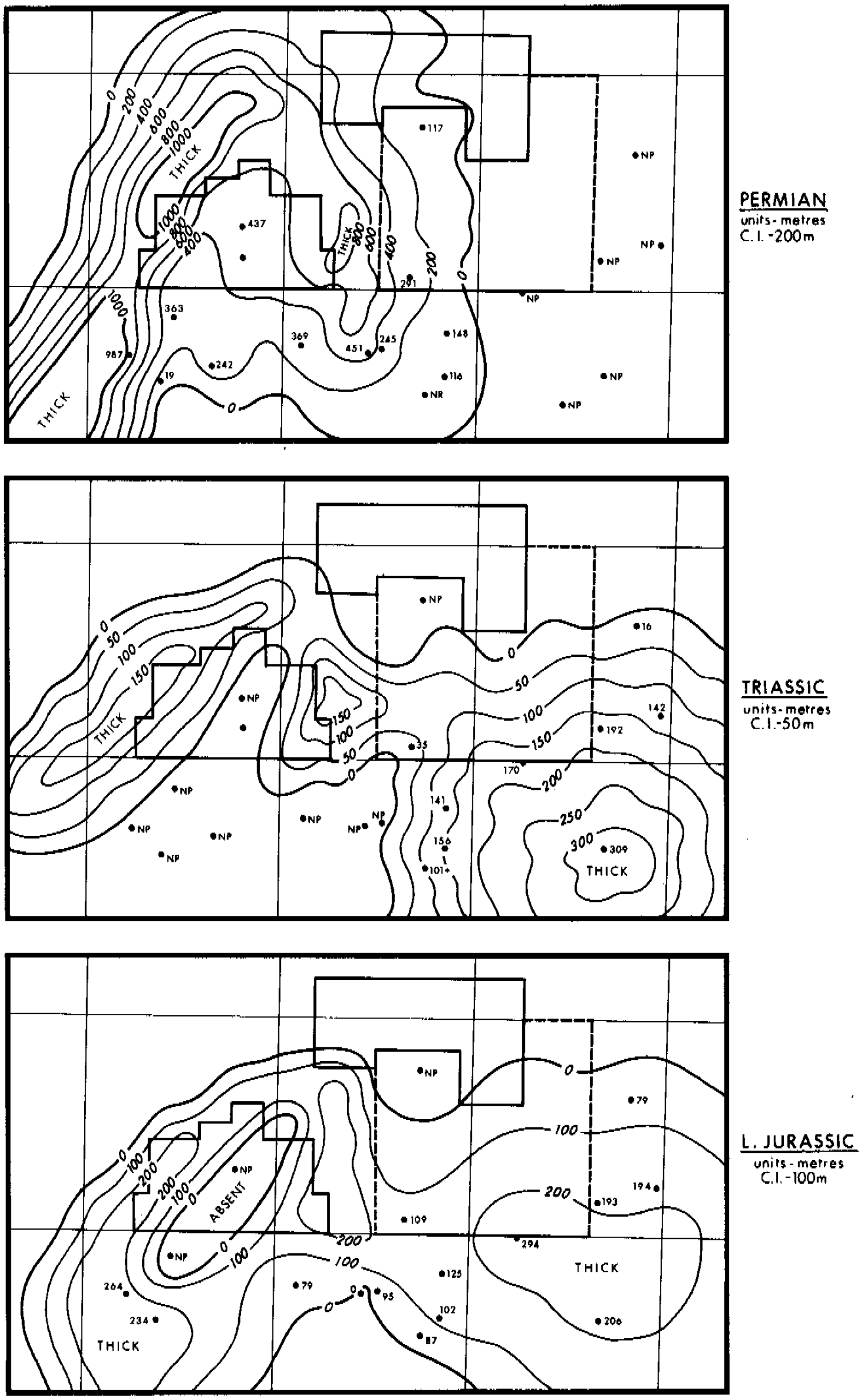
The inception and subsequent growth of structural features present in the Pedirka Basin region have been in response to plate margin behaviour. Since Middle Carboniferous time, the basins were located some 1000km from the eastern margin, some 1200km from the northern margin and some 900km from the southern margin of the Australian continent, and transmitted plate margin stresses were therefore not large. For this reason, post Carboniferous deformation, except for that of the Tertiary, has been relatively small scale.

The Tertiary east-west compressional phase, in response to the rotational stress applied to the Australian Plate by its oblique convergence with the Pacific Plate, was the most severe of the compressional events since the Middle Carboniferous. In addition to rejuvenating older features, some newer features were formed. They are oriented north northwest to north and because of their lack of structural history, do not exhibit structural thinning.

4.3 STRATIGRAPHY

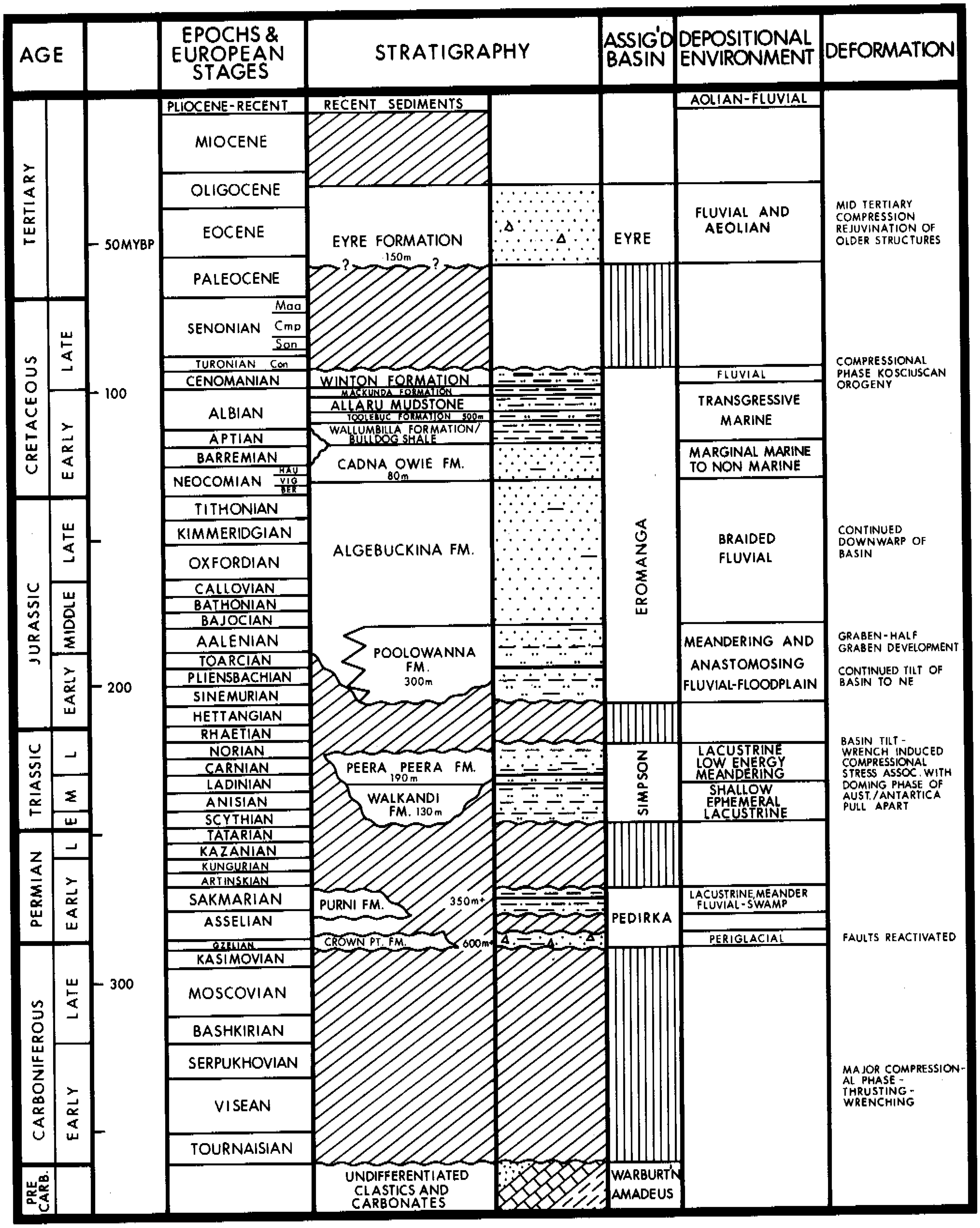
Present day nomenclature suggests that sediment deposition took place within six 'basins' within the study area, the basins being stacked, for the most part, one on top of the other (Figures 2 and 8 and Enclosures 6a and 6b). Pre-Late Carboniferous sediments are variably considered to have been deposited within the southeastern reaches of the Amadeus Basin and within the northwestern limits of the Warburton Basin. It is now accepted that an arm of the Amadeus Basin extended from the northwest into the study area, becoming transitional with the Warburton Basin to the south and east. This 'arm' possibly originated as an aulacogen (Veevers 1981) which penetrated deep into the interior from the Pacific margin, the eastern edge of the Australian craton lying just to the east of the study area during Adelaidean (Late Proterozoic) time. The western part of the study area therefore includes Cambrian to Devonian and Early Carboniferous sediments which can be related to Amadeus Basin deposition while the eastern part of the study area includes sediments which are time equivalent but which have Warburton Basin affinities.

Permian sediments are present only in the western part of the study area while Triassic sediments are present only in the east (although they may also be present in deep depressions in the west - Figure 9 and Enclosures 7 and 8). Permian sediments are said to represent Pedirka Basin deposition while Triassic sediments are said to represent Simpson Basin deposition. As Triassic sediments overlie Permian sediments in parts



FORMLINE ISOPACHS OF PRIMARY TARGET SEDIMENT PACKAGES

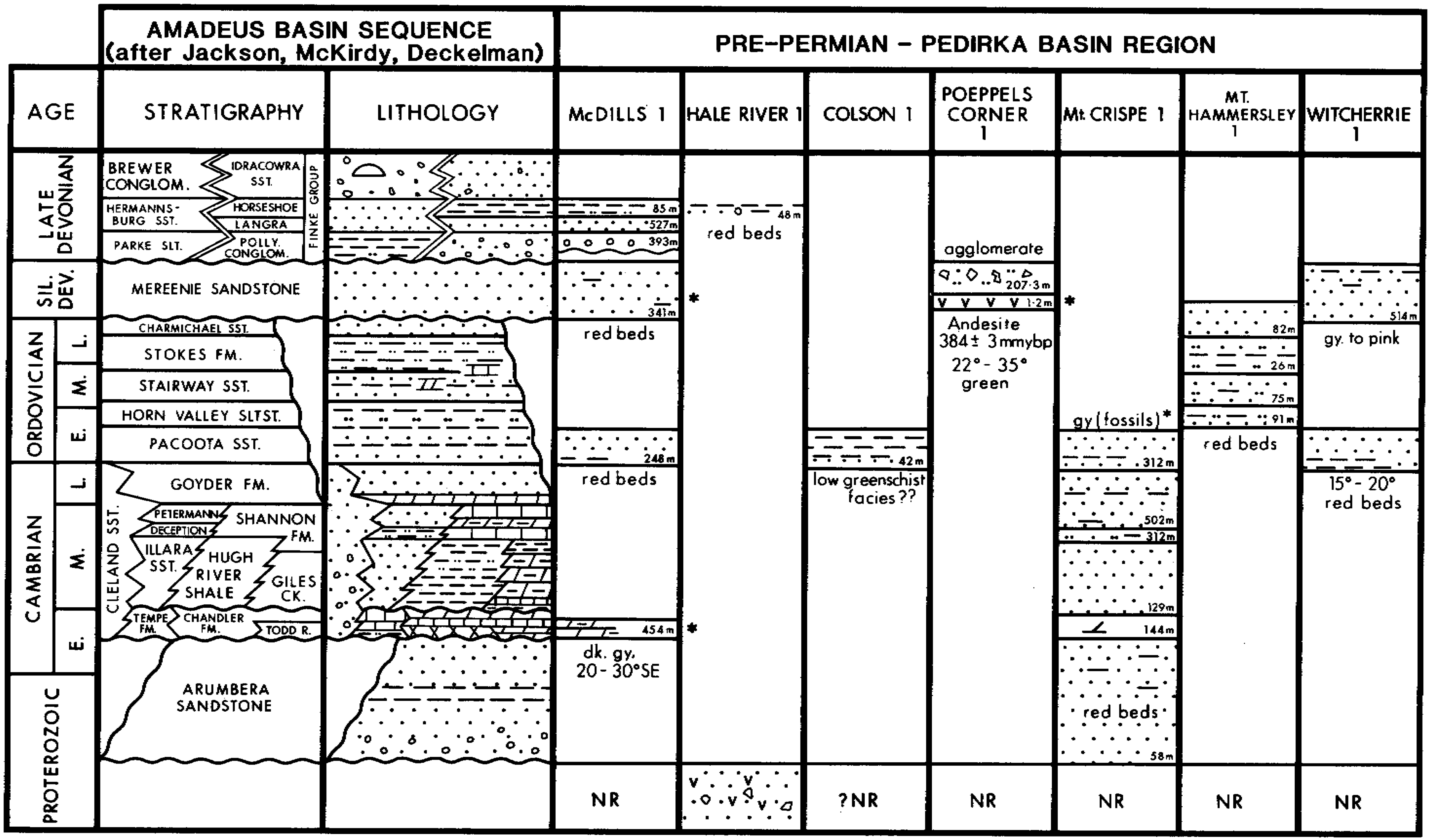
FIGURE 9



STRATIGRAPHY OF NORTHERN TERRITORY SECTOR OF PEDIRKA/EROMANGA BASIN

FIGURE 10

PRE PERMIAN SEDIMENTS - PEDIRKA BASIN REGION



* Reasonable certainty with unit age. Age of unstarred units can only be surmised.
22°-35°-dip of strata. Ordovician clastics may actually be Stairway Sandstone equivalents.

FIGURE 11

of the study area, the term Simpson Basin can be confusing and should perhaps be dropped. It is suggested that sediments of Triassic age should be collectively given group status with reference to its present basin assignment - ie. Simpson Group and sediments of Permo-Triassic age be considered to comprise the Pedirka Basin sequence.

Sediments of Jurassic and Cretaceous age are assigned to the very extensive Eromanga Basin and are, in turn, overlain by sediments of Tertiary age which represent Eyre Basin deposition (Figure 10).

Major unconformities occur at the base and top of the Permian and the Triassic, at the top of the Cretaceous and at several stages throughout the Early Palaeozoic and Precambrian. Dips within Permian and younger strata are small to horizontal whereas dips in pre-Permian sediments are large, increasing with depth.

Adelaidean to Holocene rocks are, with the exception of a lower Cambrian sequence, largely clastic in origin, deposited in non marine to marine environments. The clastic sediments range from conglomerates and diamictities to shales. A surficial silcrete forms a solid, impermeable horizon of quartz. McDills 1 intersected a dolomitic sequence in excess of 450 metres thick which has been dated as being Cambrian in age.

Potential source rocks, reservoirs and cap rocks occur throughout the Adelaidean to Holocene sequence.

Formation tops and basic well data are presented in Appendix 1.

4.3.1 Pre-Devonian Sediments

Figure 5,8 and 11 attempt to illustrate the known pre-Permian sections within the study area. As miospores and other fossil material are often rare to absent, particularly in the coarser clastics, relative stratigraphic position of penetrated sediments must often be assumed.

No proven Proterozoic strata have been encountered in wells in the study area. Volcanics and volcanic conglomerates interstratified with basalt flows and intruded by feldspathic dykes and possible andesitic sills were encountered at Hale River 1. These have been assigned a Proterozoic age on a purely lithological basis. The sediments are believed to be associated with the remnants of an ancient strato-volcanic feature, with stratification due to alternating periods of explosive and quiet eruption.

Basal rocks at Purni 1 have been assigned a Proterozoic age solely on lithological comparison with Proterozoic shales of the Amadeus Basin. Similar shales in Mokari 1 were dated by K-Ar means as being Ordovician but the dating is suspect and may be documenting an Ordovician orogenic event rather than the depositional age of the rock.

McDills 1 intersected 545m of rocks which show lithological similarities to the Todd River Dolomite of the Amadeus Basin and which have been dated on the basis of recovered brachiopods as being Early Cambrian. The formation at McDills 1 is described as a dark grey, microcrystalline, very dense, argillaceous dolomite with thin bands of light to medium grey, microcrystalline limestone and dark shale partings. Fractures are anhydrite filled.

A 1000m sequence of grey to red sandstones, siltstones and occasional dolomites encountered at Mt Crispe 1 is tentatively correlated with the Cambrian Pertaoorrta Group, although lithological similarities are difficult to find. This relatively monotonous sequence exhibits abundant worm burrows and is indicative of a high energy subtidal, shoreface environment (Gravestock - pers comm).

In the Amadeus basin, five alternating sandstone and siltstone sequences comprise the Ordovician Larapinta Group. Hard, pink and white, quartzitic sandstones with red and green clay interbeds were intersected at Mt Crispe 1. Ordovician brachiopods were identified in core and the unit is tentatively correlated with the Pacoota Sandstone (Gravestock - pers comm), the basal unit of the Larapinta Group. They may later prove to be Stairway Sandstone equivalents. Sands of similar appearance encountered in Witcherrie 1, Mt Hammersley 1, Colson 1 and McDills 1 may also be Stairway/Pacoota Sandstone equivalents. The Stairway Sandstone and in particular, the Pacoota Sandstone are important oil and gas producers in the Mereenie and Palm Valley fields in the Amadeus Basin.

Hard, dense, grey shales intersected at the base of Mokari 1 have been dated by radioactive means as being Early Ordovician and may be correlative with the Horn Valley Siltstone of the Amadeus Basin. The relative stratigraphic position of this fine grained clastic interval with respect to the Ordovician sands mentioned above is unknown.

The Mereenie Sandstone is well developed in the southeastern Amadeus Basin and it is very plausible that the formation extends into the subsurface of the Pedirka Basin. At Poeppels Corner 1, a thick section of agglomerate overlies a thin (1.2m) andesite interval. The andesite has been assigned an age of ±384Ma on the basis of Potassium Argon data. Although no age dates can be obtained from the agglomerate, it is assumed on the basis of similar dip angles that deposition of the agglomerate was related to the period of andesitic volcanism and is a time equivalent of the Mereenie Sandstone. A 341m thick red-brown to white sandstone which underlies Finke Group sediments at McDills 1 is also believed to be a lateral equivalent of the Mereenie Sandstone. The sandstone is described as being 'fairly porous', cross bedded, fine to coarse grained and slightly calcareous. A 338m interval of red and white, medium to coarse grain sands with massive cross bedding at Witcherrie 1 also appears to be a Mereenie Sandstone equivalent.

4.3.2 Devonian-Carboniferous Sediments

The Finke Group crops out along the Black Hill Ranges and is also known from a few water bores in the southeastern part of the Amadeus Basin. No fossils have been found in the Finke Group but on the basis of their interfingering relationship with the Pertnjara Group in the Amadeus Basin, they are tentatively assigned a Middle Devonian to Early Carboniferous age (Jones 1972). Although Figures 8 and 11 present the Finke Group as comprising vertically stacked formations, it is likely that they also represent, in part, lateral facies variations.

The Finke Group is considered a time equivalent of the Pertnjara Group of the central and western Amadeus Basin and includes four formations (from base to top): Polly Conglomerate, Langra Formation, Horseshoe

Bend Shale and Idracowra Sandstone. A 1005m thick sequence which underlies Permian sediments at McDills 1 is believed to represent the Finke Group in the Pedirka Basin. The sequence at McDills 1 represents the thickest and most complete section of the Finke Group encountered in the Pedirka Basin to date. Remnants of the group have also been penetrated at Hale River 1.

In McDills 1, 393m of conglomerate with some interbedded sandstone and multicoloured shale is assigned to the Polly Conglomerate. The conglomerate comprises varicoloured pebbles of quartzite, chert, marble, granite and shale in a matrix of white to buff and orange to red, fine to coarse grained, subangular sandstone. Included fragments are up 8cm in size.

In the Amadeus Basin, the Langra Formation comprises a basal, poorly sorted, cross bedded, light coloured sandstone with conglomeratic and silty interbeds, a middle unit of red siltstone and an upper unit of fine grained sandstone. A 527m sequence of porous, cross bedded, orange and red and locally white to grey, fine to coarse grained, subangular to well rounded, crossbedded sandstones encountered in McDills 1 is assigned to the Langra Sandstone. The sandstones are conglomeratic in the lower part and slightly calcareous in the upper part. Interbeds of grey to green shale and silty shale are included in the formation.

A 142m interval of coarse grey, argillaceous sands with red-green silty layers in Witcherrie 1 may be lateral rock extensions of the Langra Formation. The interval is situated above probable Mereenie Sandstone sediments and below strata of Permian age. Youngs (1975b) suggests the unit might represent a transition (interfingering) between the Langra Formation and the overlying Horseshoe Bend Shale.

The Langra Sandstone appears to be the most widespread of Finke Group formations in the Amadeus Basin and it is reasonable to expect the formation's presence in the Pedirka Basin.

In its type section, the Horseshoe Bend Shale comprises a series of red and green shales and siltstones with abundant mudcracks and ripple marks, gypsum and biotite. A very similar, 85m thick section was encountered at McDills 1 and is therefore assigned to the Horseshoe Bend Shale. The formation at McDills 1 is described by Amerada (1965) as comprising red, green, maroon and grey, slightly micaceous shale interbedded with red and green siltstone with minor white, very fine grained, calcareous sandstone present in the lower part of the formation.

In Hale River 1, 48m of red-grey mottled, slightly micaceous shale interbedded with white, fine to medium grained, kaolinitic, pebbly, silty sandstone, probably represents the Horseshoe Bend Shale. The correlation, however, is very tenuous as the interval may be correlative to another Devonian formation or even to the Permian Purni Formation as suggested by Youngs (1975b).

In the Amadeus Basin, fine to medium grained kaolinitic sandstones of the Idracowra Sandstone conformably overlie the Horseshoe Bend Shale. A unit which overlies the Horseshoe Bend Shale at McDills 1 (956.2 to 1155.2m) comprises varicoloured, locally white to grey, very fine to coarse grained sandstones. The unit is calcareous in part, 'fairly' porous and

Comparison of Stratigraphy
Pedirka Basin Region with Southern Cooper Basin Region

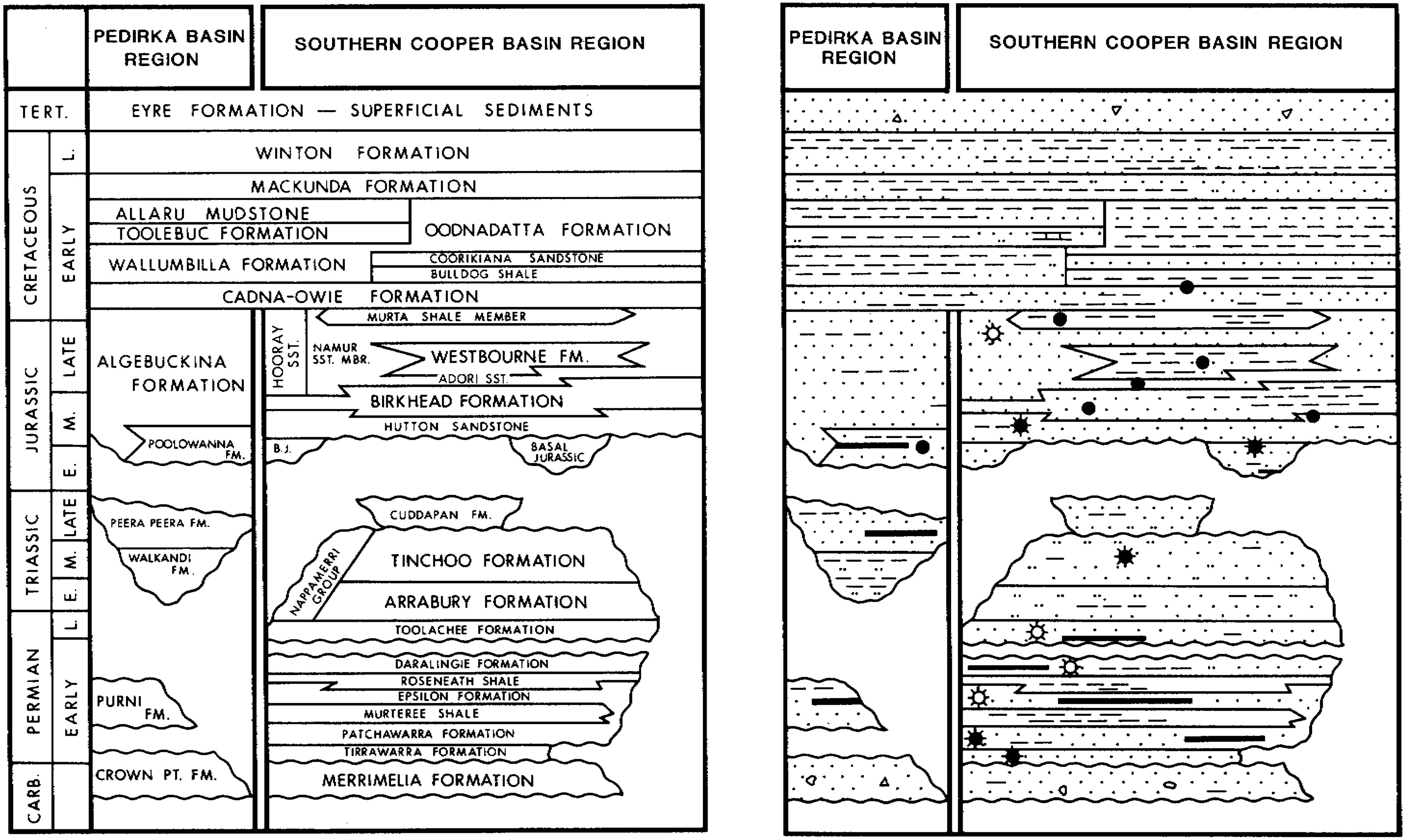


FIGURE 12

interbedded with grey conglomeratic shale and grey siltstone. Palynological dating by Evans (1965-Core 8) indicates a probable Carboniferous (Early or Late) age for the unit.

A lower Carboniferous (C1) age would tend to relate the unit to the underlying units (Polly Conglomerate, Langra Sandstone and Horseshoe Shale). It would thus be appropriate to consider the unit as the uppermost formation (Idracowra Sandstone) of the Finke Group. An upper Carboniferous age, however, would more closely relate the unit to the overlying Crown Point Formation. The correct assignment, at this time, can only be surmised.

In Witcherie 1, a unit of similar lithological character and somewhat comparable electric log definition, has been dated as early Permian and consequently assigned to the Crown Point Formation. Mt. Hammersley 1 has a particularly thick sequence assigned to the Crown Point Formation, being dated as uppermost Carboniferous or Permian.

The interval 956.2 to 1155.2m in McDills 1 is here tentatively assigned, on the basis of lithological and electric log similarities only, to the Crown Point Formation. It may prove, with further study, that the Idracowra Formation and Crown Point Formation are one and the same, or at least time stratigraphic equivalents, or it may prove that the Idracowra Formation and Crown Point Formation are entirely distinct and that the interval 956.2 to 1155.2m in McDills is actually representative of the former. It is very probable, that in the structurally lower parts of the Eringa Trough, the Crown Point Formation is conformable with the Finke Group. It is obviously an area which requires considerably more study and re-evaluation.

4.3.3 Late Carboniferous-Permian Sediments

The Late Devonian-Early Carboniferous Alice Springs Orogeny renewed uplift along the Black Hill Range and initiated the Pedirka Basin. The Late Carboniferous to Early Permian was a period of glaciation with extensive ice sheets occupying the Pedirka region. Thick sequences of the Crown Point Formation were deposited in western basin troughs with the thickest sequences being observed in the Mt Hammersley-Dalmatia area (Eringa Trough) and in the Purni-Mokari area (Madigan Trough). As the ice cap receded, meandering fluvial/backswamp conditions occupied the western Pedirka region resulting in the deposition of Purni Formation sediments. Permian sediments are not present in the eastern part of the study area, possibly due to erosion but most probably due to non-deposition. In the west, Permian strata thin and possibly die out fairly rapidly along the flanks of the deep Eringa Trough.

The Permian has been described in detail by Giuliano (1988) as part of an in-depth evaluation of the Permian sequence in the Pedirka Basin and previously by Youngs (1975b) and Smith (1967).

The Crown Point Formation has been described from outcrop in the northern and western margins of the basin by Crowell and Frakes (1971) and by Wopfner (1964) and has been recognized in 13 of the 20 petroleum exploration wells drilled within the study area.

The formation consists of glaciofluvial, glaciolacustrine, periglacial and interglacial sediments. Extensive diamictites, glaciofluvial outwash, ripple laminated sandstones and siltstones and thick, clay dominant intervals with varvite bands are representative of the formation (Giuliano, 1988). Conglomerates, coarse sandstones and diamictites are more common along palaeo-highs while thick, varved, glaciolacustrine mudstones are present in palaeo-depressions. The upper boundary of the formation is generally defined by a clean sand which marks the termination of the glacial period in the basin. This sand is absent from some structural highs including Colson 1, Purni 1 and Oolarinna 1.

Invariably, the diamictite intervals are interbedded with sands and finer clastics. The sandstones are generally white to light grey, fine to medium grained, well sorted and often kaolinitic.

From its eastern limits, the Crown Point Formation thickens to the west reaching its greatest thickness in the Eringa Trough. At Mt. Hammersley 1, on the eastern flank of the trough, 701m of predominantly clean sandstone and siltstone were encountered. The sandstones are described as having excellent porosity and permeability. Giuliano (1988) interprets the sediments at Mt. Hammersley 1 as being shallow water lacustrine shoreline deposits with glacial influences. The glacial component is often not obvious.

At Mt. Hammersley 1, the formation can be broken into four units of approximately equal thicknesses. Santos Ltd. use a three fold division (Giuliano 1988 - Enclosure 6b). Further study and exploration in the Eringa Trough may result in the Crown Point Formation being formally divided into four (or three) members.

A prominent siltstone (with minor claystone) interval (Unit C) is present in the middle of the formation at Mt. Hammersley. Stratigraphic equivalents do not appear to have been encountered elsewhere in the basin and the unit is probably, therefore, confined to the deeper extremities of the Eringa Trough. The sequence is consistent with relatively deep water, glaciolacustrine sedimentation, although the glacial effect is not readily evident. Giuliano (1988) interprets an abundance of sand in cuttings samples to be representative of varvite or gravity flow bedding and well rounded sand grains in a muddy matrix to be indicative of ice rafting. A fining upwards sandstone sequence, approximately 15 metres in thickness, appears to be of fluvial origin. Claystone is only common near the base of the unit where it is described as being of medium to dark grey in colour, moderately silty and non calcareous.

The Purni Formation is considered to be the lateral equivalent of the oil and gas productive Patchawarra Formation in the Cooper Basin. As with the underlying Crown Point Formation, the depositional edge of the Purni Formation lies to the west of Erabena 1 and to the east of Macumba 1. Within its depositional area, the formation is absent across structural highs at Witcherrie 1 and Mt Crispe 1, either through non-deposition or through erosion. The formation is preserved, however, across the McDills-Mayhew High and as far north as Hale River. The Purni Formation appears to be conformable with the Crown Point Formation over much of its extent being a depositional continuum following the termination of glaciation in Sakmarian time.

Maximum penetrated thicknesses of the Purni Formation are attained at Mokari 1 (350m) and at Mt Hammersley 1 (286m). Evidence suggests that the basin depocentre east of the McDills-Mayhew Trend was slowly moving eastward with regional uplift and tilting, but the Eringa Trough continued to subside and accumulate a large thickness of Purni Formation sediments.

Magnier (1966) and Youngs (1975b) subdivided the Purni Formation at Mokari 1 and Purni 1 into three members. This threefold division is also evident at McDills 1 and Glen Joyce 1. In other wells in the region, the Purni Formation resembles Magnier and Youngs upper member only.

The lower member comprises thinly interbedded sands and silts with shaley and carbonaceous laminae and medium grey shale with carbonaceous and arenaceous streaks and occasional conglomeratic bands. In places, grey, fissile, carbonaceous shales with a few sand and conglomerate layers are more representative of the member. The unit appears to have been deposited in a predominantly low energy, meandering stream environment.

The middle member consists of massive, cross-bedded, fining upwards, medium grained to conglomeratic, kaolinitic sandstone(s) with occasional argillaceous and carbonaceous interbeds. The member exhibits characteristics consistent with braided to meandering fluvial deposition and comprises predominantly point bar facies. Siltstone clasts present in the basal section of the sandstone sequences may represent either lag or cut bank deposits.

The upper member is areally less extensive than the other two members but is greater in thickness than the two other members together. It consists of thin to medium bedded, very fine to fine grained, kaolinitic and carbonaceous sandstone and interbedded siltstone,shale and coal; the latter increasing in prominence upwards. Low angle cross beds, planar bedding and slump structures indicate a paludal/floodplain depositional environment for the upper member.

In most wells in which the Purni Formation has been encountered, characteristics of the upper member only are present. This does not mean that stratigraphic equivalents of the lower two members were not deposited and preserved. Some of the wells (Mt. Hammersley 1 and Colson 1) in which the tripartite division cannot be made have a far greater thickness of Purni Formation sediments than certain wells (Macumba 1, McDills 1) in which the tripartite division is obvious. It is the presence of the middle member that encourages the division of the formation into three members. One would not expect the high energy, meandering stream which defines the middle member in Mokari 1 and McDills 1 to have occupied the entire basin.

4.3.4 Triassic Sediments

Continued eastward tilting of the basin in Early Triassic time initiated the development of the Poolowanna Trough with its depocentre in the vicinity of Walkandi 1 and Poolowanna 1 in South Australia. The tilting was accompanied by widespread deformation. The western part of the Pedirka Basin at this time was subject to continued uplift and erosion which provided an important sediment source for the slowly subsiding Poolowanna Trough. Known Triassic sedimentation is confined to the Poolowanna Trough and for the most part does not overlie sediments of Permian age.

Smyth and Saxby (1981) and Moore (1986) refer to Triassic sediments as constituting the Simpson Desert Basin (Simpson Basin) sequence. The formal use of the term Simpson Desert (Simpson) Basin is one of debate. It is separated from the underlying and, for the most part, laterally offset Pedirka Basin by an unconformity which spans the late Early Permian and Late Permian.

The Walkandi Formation, the lower of the two defined Triassic units, appears to be confined to the central and deepest part of the Poolowanna Trough. The formation's western limit lies between Erabena 1 and Colson 1. To the east, the formation doesn't reach the Birdsville Track Ridge. In the Northern Territory, the Walkandi Formation has been encountered only in Poeppels Corner 1 and Thomas 1.

The overlying Peera Peera Formation overlaps the Walkandi Formation, being present as far west as Colson 1 and extending eastwards across the Birdsville Track. The formation thins to the north and is absent at Hale River 1.

Triassic sediments overlie Permian sediments only over a very small area of the basin. Commonly, the Triassic overlies either steeply dipping black pyritic shales of probable Ordovician age or, less commonly, a thin sequence of silicified redbeds tentatively assigned to the Finke Group.

The Walkandi Formation consists of interbedded shale, siltstone and minor sandstone. The finer grained facies vary in colour from pale grey, grey-green, maroon and brick red. Sandstones are generally pale olive grey, argillaceous and firm to hard, with grain size ranging from very fine to very coarse. Porosity and permeability have proven to be typically low.

A core taken in Poolowanna 1 shows the formation to be strongly variegated and mottled, often poorly sorted and to have been subaerially desiccated.

A shallow, ephemeral, lacustrine environment is envisioned for the Walkandi Formation. In the deeper parts of the Poolowanna Trough, deposition would have occurred slowly and without interruption. The relatively thick (43m) sandstone/siltstone sequence encountered at Poeppels Corner 1 probably represents shoreline deposition. Although the formation at Thomas 1 probably represents a near basin margin accumulation, it is largely lacustrine in character.

Sediments similar to those of the Walkandi Formation are common elsewhere in the Early to Middle Triassic of eastern Australia, suggesting a climate conducive to redbed formation.

The Peera Peera Formation rests conformably on the underlying Walkandi Formation in the central part of the basin and unconformably on the Early Permian Purni Formation towards the basin margins.

In the deepest portion of the Poolowanna Trough (Walkandi 1 and Poolowanna 1) a three fold division of the formation can be recognized (Moore, 1986). The basal unit consists of grey shale and siltstone with occasional thin sandstone and rare coal. The middle unit is sandy and comprises several fining upwards cycles. Black, silty, and highly carbonaceous shale with occasional thin sandstone interbeds constitute the upper member.

Sandstones throughout the formation are typically fine grained and of poor reservoir quality.

The fining upwards sequences of the middle member and the presence of coal and carbonaceous shale are indicative of a meandering fluvial/floodplain environment. Dark shales present in the upper and lower members may represent lacustrine or paludal deposition and provide excellent hydrocarbon source potential.

In the Northern Territory, the Peera Peera Formation has been recognized in four of the seven petroleum exploration wells, being absent only at Hale River 1, McDills 1 and reportedly at Etingimbra 1. At Poeppels Corner 1 and Thomas 1, the formation consists of a predominantly fine grained sequence with thinly bedded sandstones. Pale brown to black, siliceous, carbonaceous shales with coal laminae and inclusions, and brown grey to pale brown, argillaceous and siliceous siltstones are typical of the formation. Sandstones tend to be coarser grained towards the base of the formation but are largely very fine to fine grained in the upper part of the formation. At Thomas 1, the basal 12 metres of the unit is a highly radioactive (150 to 200 API) siltstone and sandstone interval which may represent mineral enrichment from nearby basement exposures. The Peera Peera Formation at Colson 1 is very thin (34.7m) although similar in character to that seen at Poeppels Corner 1 and Thomas 1. The presence of possible sulphate mineralization suggests proximity to the formation's depositional edge. At Beachcomber 1, the Peera Peera Formation is represented by a heavily weathered basement. Palynology suggests the indurated, recrystallized sandstone interval to be a time equivalent of the Peera Peera Formation. The interval includes occasional vein quartz and pyrite and common biotite.

4.3.5 Mesozoic Sediments

A disconformity representing the latest Triassic and earliest Jurassic, separates the Peera Peera Formation from Eromanga Basin units, the oldest of which is the Poolowanna Formation of Early to Middle Jurassic age. During the Late Triassic, epeirogenic uplift reactivated existing structures and resulted in the widespread but relatively brief hiatus.

The Poolowanna Formation rests unconformably on the Peera Peera Formation in the eastern part of the study area and the Purni Formation in the western part of the study area. Towards the west, the formation laterally changes facies, becoming sandier, and is included as part of the Algebuckina Sandstone.

Originally, on questionable palynological information, it was suspected that a major hiatus existed within the Poolowanna Formation. This is no longer considered to be the case.

Typically, the Poolowanna Formation consists of interbedded sandstone, siltstone, shale and coal. The base of the formation is typically sandy while shales comprise at least the uppermost few metres of the formation. The top of the formation is visibly marked by the first occurrence of a black, carbonaceous, coaly shale. In the deeper parts of the Poolowanna Trough, sands and shales are more or less randomly distributed throughout the formation with sands being more abundant than shales.

In Poeppels Corner 1, the basal 144m of the formation (gross formation interval 193m) consists predominantly of thick bedded sand, the upper 25 percent of the formation comprising shale and silt with thin sandstone interbeds. Two massive sand units are present in Thomas 1, each overlain by a thinly interbedded silt-shale-sandstone interval. In Colson 1 and Beachcomber 1, the Poolowanna Formation is thin and comprises mostly medium to thick bedded sandstone. As at other locations in the basin, a prominent silt-shale interval defines the top of the formation. The Gamma Ray log does not appear to define the lithofacies of the Poolowanna Formation accurately and many intervals interpreted from logs as being either sand or shale are actually siltstones.

Sandstones are commonly medium to coarse grained, ranging to fine grained. They are moderately hard and friable to hard and brittle and consist of usually subrounded to subangular quartz with a clay matrix and silica, clay and in places calcite cement. Minor lithic grains and pink garnets have been noted. Porosity and permeability ranges from fair to good, with porosity averaging about 11-13 percent but reaching 16 percent where best developed.

Siltstone within the formation ranges from very light to medium grey and brownish grey in colour, is siliceous, soft to firm, blocky to subfissile and clean to moderately flecked with organic matter. Shales are dark grey to brown grey, moderately hard, carbonaceous and coaly. Coals are black, dull and shaley. Individual coal beds are rarely more than 0.5 metres thick and form only a minor component of the sequence.

The Poolowanna Formation was deposited as point bar and associated flood plain facies. Sediments were supplied probably from the south west and west by a braided stream system. A meandering and anastomosing fluvial system occupied most of the study area during Early Jurassic time.

The Algebuckina Sandstone is a thick, sandy sequence of Early Jurassic to Early Cretaceous age which rests conformably on the Early Jurassic Poolowanna Formation where the latter is present. Towards the basin margins, the Algebuckina Sandstone rests unconformably on progressively older sediments.

The Algebuckina Sandstone is a thick sequence of fine to coarse grained, poorly to moderately sorted sandstone. In the 19 wells drilled within the study area to date, the formation varies in thickness from 210m at Purni 1 to 757m at Poolowanna 1. In the six open file wells drilled in the Northern Territory portion of the basin, the formation ranges in thickness from 255m at McDills 1 to 581m at Colson 1.

The absence of a marine fauna and the presence of a more-or-less unidirectional cross stratification, indicates a fluvial origin for the formation. Shale and siltstone beds are uncommon, thin and areally not extensive, suggesting a braided fluvial origin.

Matrix is generally absent and the sandstone is now cemented by varying degrees of silicification and minor clays. Porosity is fair to excellent throughout.

The Cadna-owie Formation (previously referred to as the Transition Beds) reflects the transition from terrestrial deposition of sediments which persisted through the Permo-Triassic and Jurassic of the Pedirka/Eromanga Basin, to marine deposition, which prevailed throughout much of the Cretaceous. Regionally, the first indications of a marine influence are generally seen in the middle portion of the formation with a gradual increase in dinoflagellates and acritarchs.

The formation was defined by Wopfner et al. (1970) and further described by Senior et al. (1975) and Exon and Senior (1976).

The Cadna-owie Formation is widespread and ranges in thickness from about 15m to over 80m within the study area. The formation thins progressively onto the flanks of the basin and across many prominent structural highs such as the McDills-Mayhew Trend.

The lower part of the formation consists predominantly of fine to medium grained, quartzose, hard to sublabile sandstone with siltstone especially abundant towards the base. Mudstones are an important but usually minor facies in the lowermost part of the formation. A prominent, thin, sandstone is present towards the base of the formation in some wells in the southeastern part of the basin. Over much of the study area, an upper member, equivalent to the Wyandra Sandstone Member of the Central Eromanga Basin (Senior et al., 1975), consists of well sorted quartzite to sublabile sandstone with occasional scattered pebbles and carbonate cement. Shell fragments and glauconite are common in this member and ripple marks have been reported from outcrop. The sandstone member is generally 3-18m thick.

The lower part of the formation appears to have been deposited under paralic conditions. The Wyandra Sandstone Member is interpreted as a transgressive (possibly beach) marine sand. The lower sands of the Cadna-owie Formation have a consistently lower gamma ray response and lower sonic transit time than the sands of the Algebuckina Sandstone.

The development of paralic conditions throughout the Eromanga Basin reflects the transgression of a northern seaway by early Aptian time. This coincides with a global marine transgression. Sediments were derived from uplands around the basin, being transported by streams.

In places, fluvial channels have cut into the uppermost part of the Cadna-owie Formation and these are evident on seismic within the study area.

The formations which comprise the remainder of the Cretaceous of the Eromanga Basin will be reviewed only in brief in this report. A precise knowledge of their stratigraphy is not considered necessary to the efficient hydrocarbon exploration of the Pedirka Basin area. Moore and Pitt (1982), Moore et al. (1986) and Forbes (1982) provide a detailed discussion of the Cretaceous stratigraphy in the Eromanga Basin. Nomenclature of the Cretaceous units is not straightforward and is based on the presence or absence of two lithological units - the Toolebuc Formation and the Coorikiana Sandstone Member (Figure 12). Over most of the basin area, either one or the other of the two units is present but generally not both. Nomenclature becomes difficult when the two units are both present or when both units are absent or poorly defined. Within the study area, the latter is largely the case. Confusion therefore reigns with a host of nomenclature being used.

Over much of the study area, pre Winton-post Cadna-owie sediments are very similar in character and form a thick sequence of massive claystone and siltstone with interbedded sandstones and minor coal seams. The relative homogeneity of the interval within the study area precludes the necessity of its division into formational units. In the past, terms such as Roma Formation (Surat Basin nomenclature) and Rumbalara Shale have been used to define this gross unit.

In the Pedirka Basin region, the lowermost Cretaceous mudstone-siltstone sequence, which rests conformably upon the Cadna-owie Formation, is most commonly referred to as the Bulldog Shale, although Moore (1986) and others suggest the term Wallumbilla Formation is more appropriate. The unit consists of grey mudstone and siltstone with minor interbeds of fine sandstone. The unit is calcareous in part and may contain glauconite. In places, shell fragments are common. Sandstones exhibit poor porosity. Occasional pyrite, *Inoceramus* fragments and dark brown, dense, argillaceous limestone have also been reported. The section is representative of deposition in a very shallow, transgressing sea with, at times, turbid marine conditions predominating. The thickness of the unit varies from 158m at Beachcomber 1 to 237m at Thomas 1.

The Toolebuc Formation is not well developed in the Northern Territory portion of the Pedirka/Simpson Basin area. In the eastern and northern part of the Eromanga Basin, the Toolebuc Formation consists of dark grey to black siltstone, mudstone and marl, with subordinate limestone and coquinite The formation is extremely rich in organic matter, in some cases making it an attractive target for oil shale exploration.

Within the study area, equivalents of the formation can be recognized on the basis of a characteristic gamma ray peak. The unit consists of medium to dark grey, in places organically rich shale with *Inoceramus* prisms and other fossil fragments and in places common grey-brown, dense, limey streaks. Where the limestone unit is absent, the formation is not readily discernable from overlying and underlying formations.

The Toolebuc Formation is interpreted to have been deposited under shallow, low energy marine, essentially reducing conditions.

The sequence which overlies the Toolebuc Formation and underlies the Winton Formation is not easily differentiated into distinct formations as it is elsewhere in the Eromanga Basin, the lithologies of the Oodnadatta Formation, Allaru Mudstone and Mackunda Formation being very similar.

Over much of the study area, the sequence resembles the Bulldog Shale, comprising light to medium grey, soft, slightly fissile, carbonaceous, pyritic, silty shale with traces of fossil fragments and *Inoceramus* prisms and rare, dark grey-brown, argillaceous limestone. Common siltstone beds, minor sandstone and occasional calcareous stringers are also included.

The lithology of the sequence is suggestive of a paralic to shallow marine environment with an apparent lagoonal contribution.

The Winton Formation is a massive claystone and siltstone sequence with interbedded sandstones and minor coal seams. The claystone is medium grey, firm and blocky, silty and sandy, carbonaceous and lignitic, passing with depth into softer, calcareous, sticky, light grey mudstones near the base of the unit.

Sandstones are very fine to medium grained, commonly fine grained, quartzose and well sorted with a silica and calcite cement. Where unweathered, the sandstones are speckled pale green-grey due to the presence of abundant fine lithic material and its subsequent alteration to chloritic clays.

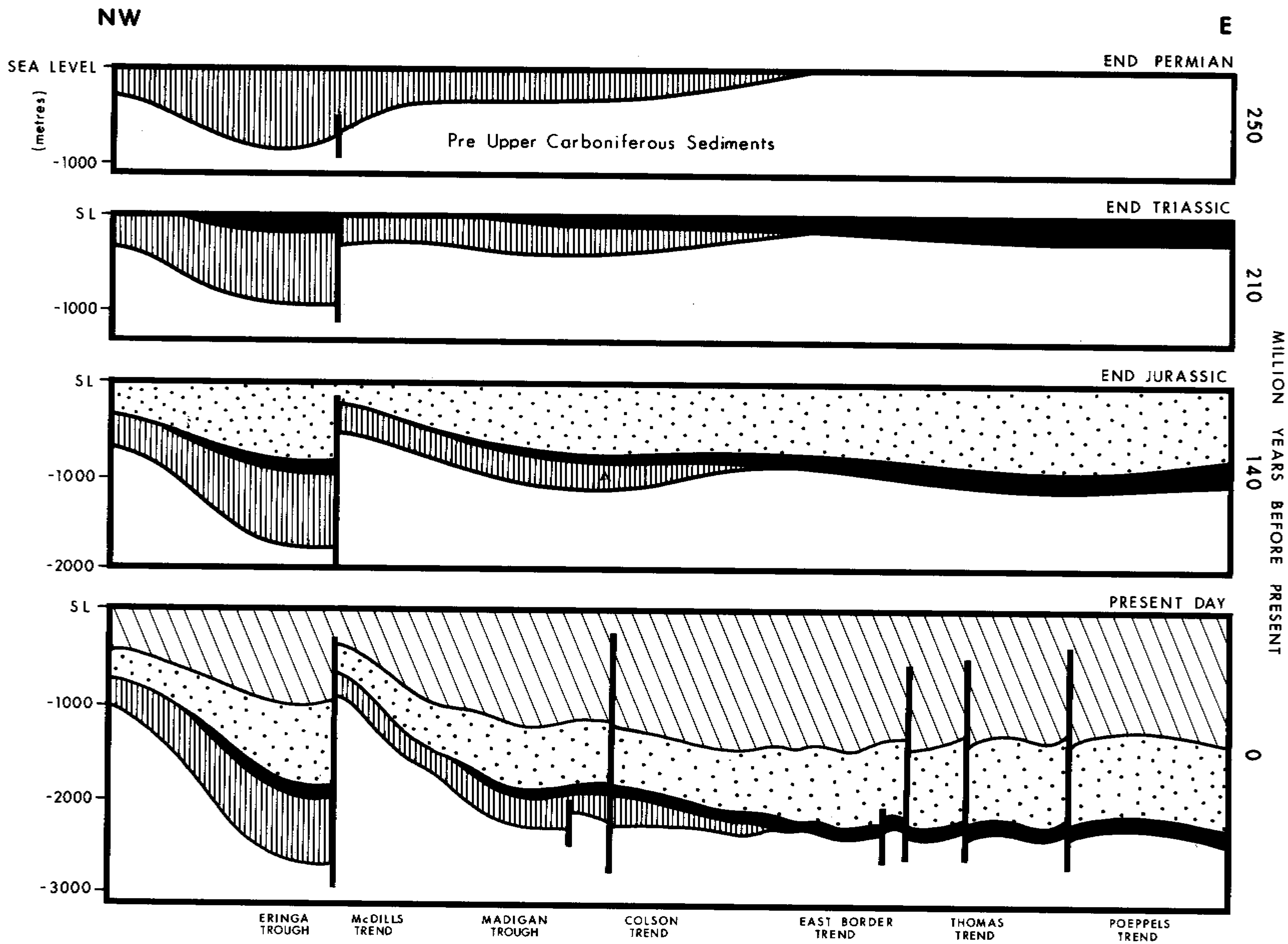
Weathered sandstones are often encountered within the top 25 metres of the formation. Enhanced porosity is exhibited within those sands due to the removal of clays and the reduction of chloritic clay matrix to pyrite.

The depositional environment of the unit is paralic at the top grading to marine at the base of the unit. Fluvial-lacustrine environments are recognized. The environment of deposition was low energy throughout. At Thomas 1, the Winton Formation is 623m thick. The formation exceeds 400m in thickness across most of the study area.

4.3.6 Eyre Formation Sediments

Fluviatile and aeolian sandstones, sands and clays of interpreted Cainozoic age constitute the Eyre Formation and form a surface cover across the entire study area.

The sandstones are generally yellow and yellow brown, soft, friable, fine to medium and coarse to very coarse grained and porous. They comprise subrounded, clear, white and yellow quartz grains which have been coated with limonitic iron oxides. Cement is often clear gypsum and iron oxides. Rare red garnet, pyritic aggregates and limonite nodules are also present. Gypsum is present in the form of bladed crystal aggregates as well as cement in the sandstones. Silcretes are common in the uppermost part of the formation.



Schematic Structural History

PEDIRKA BASIN REGION

FIGURE 13

5.0 BASIN HISTORY

The structural history of the study area is complex and dominated by compressional tectonics. Although deformation of the sediments within the Pedirka/Eromanga Basin has not been severe, there have been at least four periods of post-Devonian and probably six episodes of pre-Devonian and Devonian structural movement and adjustment which directly influenced basin development. Deformation in each case can be related to tectonic events which took place at past and present Australian plate boundaries, the evolution of the basins being controlled to a large extent by Proterozoic and early Phanerozoic tectonics (Figure 13).

The structural model for the region invokes compression and associated wrenching with structural trends that were established in pre Permo-Carboniferous times remaining dominant through to present time. The application of a plate tectonics model to the eastern margin of the Australian craton allows greater understanding of the structural evolution of its sedimentary basins.

During Adelaidean (Late Proterozoic) time the Australian craton occupied only the central and western part of the present day continent (Veevers 1981, Veevers et al. 1975, 1982). Earliest Phanerozoic time saw the inception of the eastern (Pacific) and northwestern (Tethyan) margins of Australia by plate divergence. Failed arms (aulacogens) of triple junctions penetrated deep into the interior from both the Tethyan margin (Bonaparte Basin) and Pacific margin (Officer, Amadeus and Ngalia Basins).

The eastern margin was defined by a complex rift system with a triple junction located geographically nearly coincident with the present day Pedirka Basin region and southern Cooper Basin. Sedimentary rocks underlying the study area are juxtaposed against a resistant, Adelaidean basement complex to the west.

Shallow shelf carbonates, interpreted to be related to the Amadeus Basin Todd River Dolomite, were deposited during Early Cambrian time at least as far east as McDills 1 and Mt. Crispe 1. At Mt. Crispe 1, these carbonates are overlain by 943 metres of sandstones and siltstones of interpolated Middle to Upper Cambrian age. There does not appear to have been any deposition in the Warburton Basin in the eastern part of the study area at this time.

Deformation of the southeastern margin of the craton during the Middle to Late Cambrian was in response to a reversal in plate motion whereby the Pacific Plate converged with the Australian Plate. The eastern half of the Australian continent has developed through Phanerozoic time as a convergent margin dominated by magmatic arcs which, as evidence suggests, migrated progressively eastward in several episodic movements, possibly related to periods of quiescence in the continent's rotation. The eastward migration of these arc complexes resulted in the superposition of foreland and pericratonic basins on former fore-arc basins.

Fore-arc and foreland basin deposition is assumed to have taken place during Late Cambrian/ Ordovician time. In response to rapid subsidence which accompanied a marine transgression in earliest Ordovician time, a relatively thick sequence of sandstones, siltstones and shale was deposited across the study area, apparently as far east as Colson 1. The unit is interpreted as being stratigraphically equivalent to the Pacoota Sandstone of the Amadeus Basin but at some locations may prove to be Stairway Sandstone (Middle Ordovician) equivalents. At Mt. Hammersley 1, an argillaceous siltstone interval is interpreted as being equivalent to the Horn Valley Siltstone of the Amadeus Basin. This interval is overlain by 100 metres of sandstone, siltstone and shale of possible Middle to Upper Ordovician age.

A Late Ordovician to Late Silurian period of deformation, related to the Rodingan Orogeny, affected the entire study area, resulting in uplift and erosion. Structural dips in Ordovician and Cambrian sediments have proven to be considerably greater than those of overlying strata.

Deposition continued during Late Silurian and Devonian times with the development of the Warburton Basin as a pericratonic basin. Sediments in this basin are mainly of clastic origin, although carbonates and evaporites have been encountered to the east, outside of the study area.

A Mereenie Sandstone (Amadeus Basin) equivalent, of Late Silurian-Early Devonian age, was deposited across most of the study area. The formation comprises mainly fine to medium, often porous sandstones but in Poeppels Corner 1 is represented by a thin andesite horizon, overlain by agglomerates. Deposition was terminated by the Pertnjara Orogenic Movement which further uplifted the Proterozoic cored Black Hill Range along the northwest margin of what is now known as the Eringa Trough.

The Black Hill Range provided a renewed sediment source which resulted in the deposition of the Late Devonian Finke Group, a thick sequence of largely red-bed clastics which were deposited as far east as Erabena 1.

A major deformation affected most of eastern Australia in mid Carboniferous time causing remobilization of Archean basement and intense overthrusting in Central Australia (Kanimblan or Alice Springs Orogeny). The Warburton and Amadeus Basins were deformed with high amplitude folding and thrusting. The pattern of folds and faults is consistent with east-west surficial shortening accompanied by a secondary dextral motion along an inferred northeast trend.

Following the Kanimblan Orogeny, the craton remained more or less stable until about 300 Ma when the volcanic arc decayed and later regenerated in a more eastward position. This initiated the Sydney/Bowen foreland basins and the Pedirka/Cooper/Galilee pericratonic basins. The Late Carboniferous and Early Permian was a period of glaciation, with extensive ice sheets occupying much of Australia. A thick sequence of glaciogenic sediments of the Crown Point Formation was deposited in the Eringa Trough, as far east as Colson 1 and Hale River 1. As the continent began to warm in Early Permian time, the ice sheet retreated and Crown Point Formation deposition concluded under predominantly fluvial conditions.

Deposition of the Crown Point Formation was controlled by structural features formed during the earlier orogenies with earliest deposition in particular being synchronous with minor continuous fault adjustment in many parts of the Pedirka Basin.

The basin continued to develop by gentle downwarping through a quiescent tectonic phase although minor tectonic adjustment and readjustment occurred locally. Extensional basin subsidence reflected subduction plate relaxation. The Early Permian Purni Formation was deposited under meandering fluvial, lacustrine, backswamp conditions. In structural depressions, deposition of the Purni Formation would have been continuous with the underlying Crown Point Formation.

By the end of early Permian time, the first pulse of the later and more extensive Hunter-Bowen Orogeny was recorded in the basin, resulting in an accentuation of pre-existing structural features followed by regional truncation of outcropping sediments. During the Early Triassic, regional tilting accompanied by uplift of the McDills-Mayhew Trend and subsidence to the east, initiated the Poolowanna Trough, the depocentre of the Simpson Basin. During the early Middle and Late Triassic, the Walkandi and Peera Peera Formations were deposited in the Simpson Basin and probably also in the Eringa and

Madigan Troughs. Triassic sediments overlie Permian sediments over only a small area of the basin.

The Triassic depositional cycle was terminated by the late Middle Triassic Hunter-Bowen Orogeny, a Gondwana-wide event involving east-west compressional stress which induced wrenching and a rejuvenation of pre-existing structures.

The Eromanga Basin depositional cycle commenced in late Late Triassic - Early Jurassic time during a period of post deformation quiescence which persisted until Late Cretaceous - Early Tertiary time. The depositional cycle in this pericratonic basin was initiated with a system of moderate to high energy meandering and anastomosing streams which deposited predominantly fine grained clastic sediments in a floodplain environment (Poolowanna Formation). This was followed by large volumes of medium to coarse clastic material (Algebuckina Sandstone) being deposited in braided streams that flowed from rejuvenated provenances in the Gawler Craton and Amadeus Basin regions.

Continental deposition in the Eromanga Basin ceased just prior to the southern break-up of the Australian continent from Antarctica. By Aptian time, a broad epeiric sea covered the basin. The Cadna-owie Formation represents the transition between continental conditions and marine conditions. Tilting of the basin to the north in response to doming associated with the final break-up was accompanied by a global rise in sea-level and these together allowed the sea to enter from the north.

A return to non-marine deposition (Winton Formation) in Cenomanian time also appears to be related to plate boundary tectonics, the result of an early compressional pulse of the Kosciuskan Orogeny. The Eromanga Basin and much of the Australian margin underwent a period of rapid subsidence at this time.

The final major phase of structuring of the Eromanga Basin occurred in the Late Cretaceous or Tertiary, following deposition of the Winton Formation. Evidence suggests that uplift, tilting and erosion took place prior to, during and after Eyre Formation deposition, thus representing an essentially continuous period of epeirogeny which extended from at least the earliest Tertiary until the Late Oligocene (Moore and Pitt, 1984). Continued deformation probably continued until Recent time and may in fact be continuing at present. The Tertiary east to west compressional phase was probably the most severe deformation phase since the onset of Permian deposition. It resulted in rejuvenation of older structures and faults as well as the introduction of numerous new structures across the entire basin.

The following is a summary of the depositional and structural history of the study area.

1. Deposition of marine forearc and foreland basin sediments in the Cambrian and Ordovician;

2. Major orogeny in the Late Silurian to Early Devonian, possibly as early as Mid Ordovician;

3. Deposition of marine and non-marine pericratonic basin sediments in the Late Devonian to Early Carboniferous;

4. Major orogeny in Middle Carboniferous time which established the more prominent structural elements seen in the Pedirka/Eromanga Basin today;

5. Epeirogenic downwarping in the Late Carboniferous to Early Permian and deposition of glaciogenic and fluvial-lacustrine Late Carboniferous and Lower Permian sediments;

6. Structural readjustment (isostatic compensation) following Middle Carbonifer ous deformation during deposition of the Crown Point and Purni formations;

7. Mild orogeny at the end of the Early Permian, rejuvenation of pre-existing structures, erosion;

8. Tilting of basin and subsidence to east leading to formation of Simpson Basin and deposition of Middle Triassic continental sediments;

9. Uplift and erosion in the Late Triassic resulting mainly in rejuvenation of pre-existing structures;

10. Epeirogenic downwarping of much of eastern Australia initiating the Eromanga Basin and continued continental sedimentation in the Early Jurassic;

11. Marine transgression in the Late Jurassic to Early Cretaceous;

12. Regression in the Late Cretaceous, increased subsidence allowing deposition of a thick non-marine sequence;

13. Major Tertiary compression resulting in further rejuvenation of pre-existing structures; and finally

14. Deposition of a thin cover of Cainozoic continental sediments.

6.0 PREVIOUS EXPLORATION

Owing to its remoteness, the only access to this area has been for oil exploration purposes. The early explorers avoided the Simpson Desert because of the difficulty in traversing a seemingly infinite series of rather imposing sand dunes.

Petroleum exploration in the Simpson Desert area can be grouped into three phases: 1959 to 1966, 1969 to 1979, 1980 to present day.

Figure 14 summarises the acreage position during the first phase.

The first permits were awarded to the Delhi International and Santos Ltd group in 1959 and included OEL 20/21 (now PEL's 5 and 6) in South Australia and ATP 66P and 67P in Queensland (now part of ATP 259P). Various operators obtained permits in the Northern Territory portion of the basin, the most notable being Beach Petroleum (OP 57) which maintained a continuous exploration presence in the area from 1960 to 1989.

Geophysical exploration in the Northern Territory during the 1960's consisted of four aeromagnetic surveys, eight gravity surveys (approximately 5,000 stations) and fourteen single fold dynamite surveys (approximately 4,000 km) (Appendix 2). Similar levels of activity were seen in South Australia, mainly as a result of a farmout of the eastern part of the Delhi-Santos held permit to the French Petroleum Company (later Total Exploration). The acquisition of geophysical data in the early 1960's led to the drilling of two wells (McDills 1 in 1965 and Hale River 1 in 1966) in the Northern Territory and four wells in the South Australian sector of the basin.

Active exploration ceased in 1966 with the drilling of Hale River 1, the sixth unsuccessful exploration attempt in the basin.

In 1969, Delhi-Santos farmed out the western part of their Pedirka Basin acreage to Vamgas N.L. and Reef Oil became involved in exploration in the Northern Territory portion of the basin (Figure 15). Between 1969 and 1978, two gravity surveys (1321 stations) and two seismic surveys (700 km) were acquired resulting in the drilling of Colson 1 in 1978.

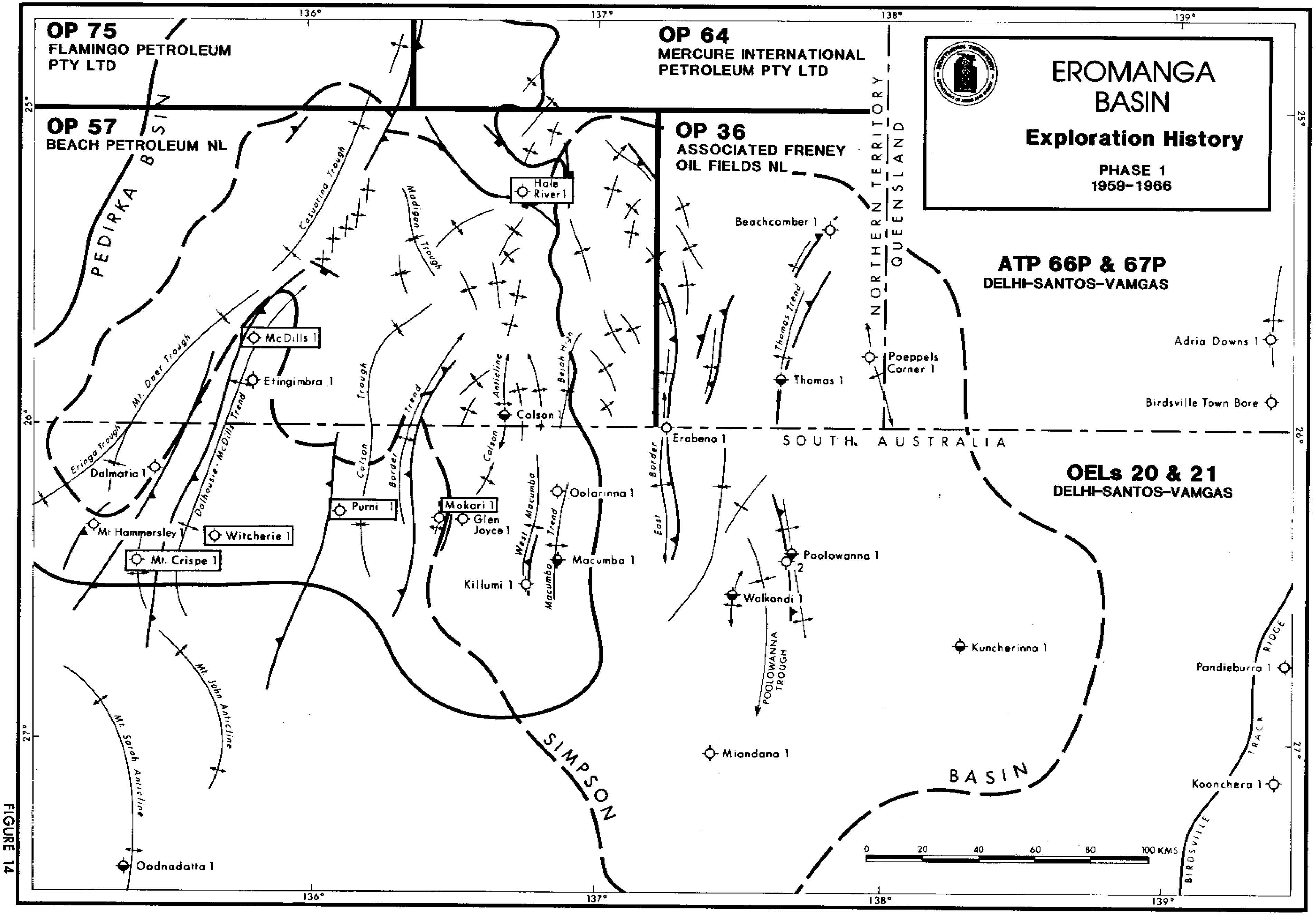
Two wells were drilled in the South Australia sector of the basin in 1977, including Poolowanna 1 from which significant oil recoveries were made.

Exploration activity intensified in the 1980's as a result of the Poolowanna oil discovery. New petroleum exploration permits were awarded in the early 1980's in the Northern Territory sector of the basin and eleven multifold seismic surveys were subsequently acquired. Thomas 1 was drilled in 1981, Poeppels Corner 1 in 1984, Beachcomber 1 in 1988 and Etingimbra 1 in 1990 (Figure 16).

In South Australia, six seismic surveys were recorded and ten wells (including two appraisal wells at Poolowanna were drilled prior to Delhi/Santos relinquishing their acreage at the end of 1989.

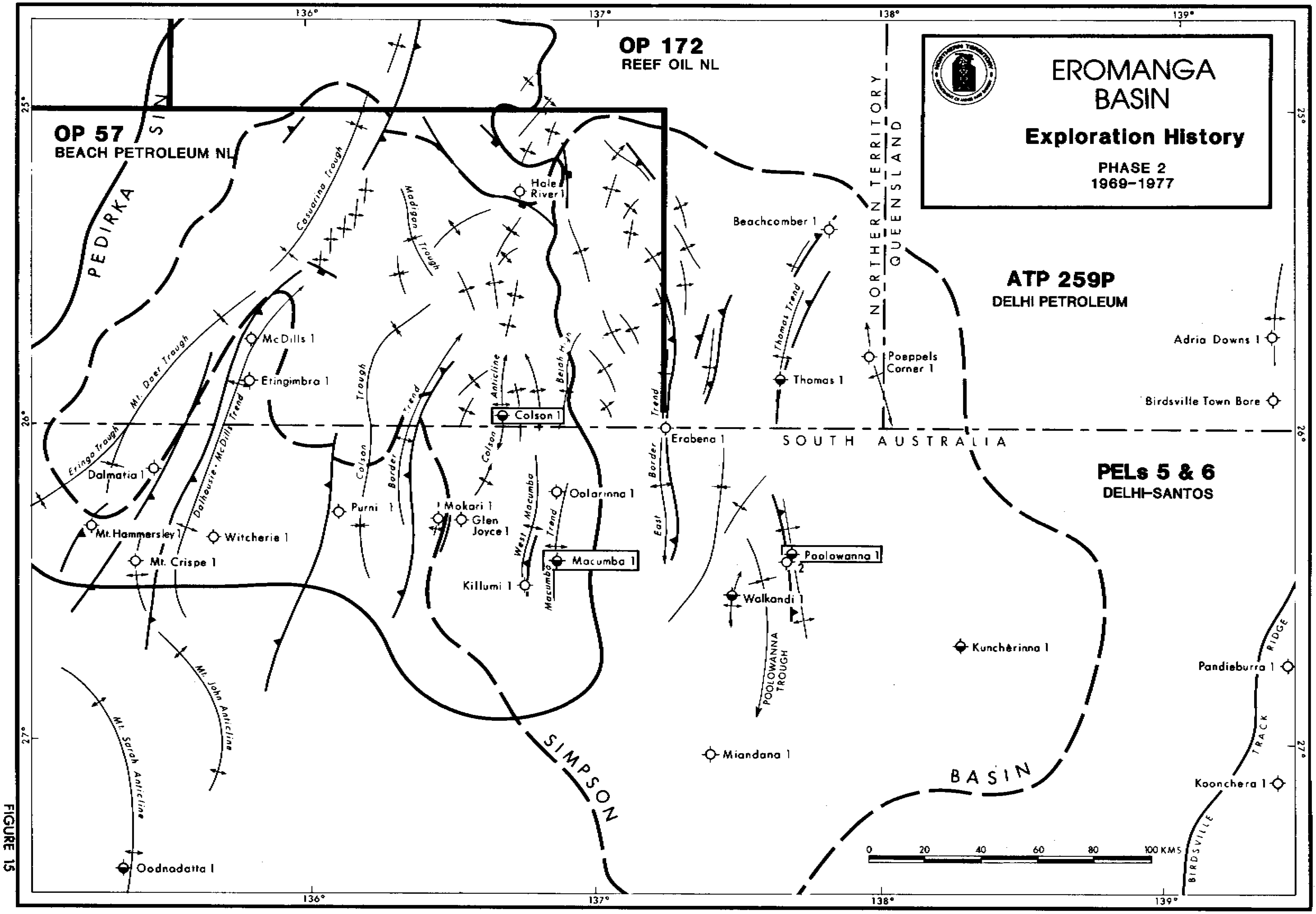
At the time of writing this report, two exploration permits, EP 30 and EP 1, remain current. EP 29 is under application.

The geophysical and geological data acquired over the last three decades is summarized in Appendices 1 to 3. Although the Pedirka Basin region is in only a semi-mature exploration stage, the existing geophysical data base has resolved many of the structural and stratigraphic complexities of the area.



EROMANGA BASIN
Exploration History
PHASE 1
1959-1966
OP 75
FLAMINGO PETROLEUM PTY LTD
OP 64
MERCURE INTERNATIONAL PETROLEUM PTY LTD
OP 57
BEACH PETROLEUM NL
OP 36
ASSOCIATED FRENEY OIL FIELDS NL
ATP 66P & 67P
DELHI-SANTOS-VAMGAS
OELs 20 & 21
DELHI-SANTOS-VAMGAS
PEDIRKA BASIN
SIMPSON
BASIN
NORTHERN TERRITORY
QUEENSLAND
SOUTH AUSTRALIA
Casuarina Trough
Madigan Trough
Mt. Daer Trough
Eringa Trough
Dalhousie - McDills Trend
Colson Trough
Border Trend
Colson Anticline
Beach High
West Macumba Trend
Macumba
East Border
Thomas Trend
POOLOWANNA TROUGH
Mt John Anticline
Mt. Sarah Anticline
BIRDSVILLE TRACK RIDGE
Hale River 1
Beachcomber 1
McDills 1
Etingimbra 1
Colson 1
Thomas 1
Poeppels Corner 1
Adria Downs 1
Birdsville Town Bore
Erabena 1
Dalmatia 1
Oolarinna 1
Purni 1
Mokari 1
Glen Joyce 1
Mt Hammersley 1
Witcherie 1
Mt. Crispe 1
Macumba 1
Killumi 1
Poolowanna 1
2
Walkandi 1
Kuncherinna 1
Pandieburra 1
Miandana 1
Koonchera 1
Oodnadatta 1
136°
137°
138°
139°
25°
26°
27°
0
20
40
60
80
100 KMS

FIGURE 14



EROMANGA
BASIN
Exploration History
PHASE 2
1969-1977
OP 172
REEF OIL NL
OP 57
BEACH PETROLEUM NL
ATP 259P
DELHI PETROLEUM
PELs 5 & 6
DELHI-SANTOS
NORTHERN TERRITORY
QUEENSLAND
SOUTH AUSTRALIA
PEDIRKA
SIMPSON
BASIN
Casuarina Trough
Madigan Trough
Mt. Daer Trough
Eringa Trough
Dalhousie - McDills Trend
Colson Trough
Border Trend
Colson Anticline
Belah High
West Macumba
Macumba Trend
East Border Trend
Thomas Trend
POOLOWANNA TROUGH
Mt. John Anticline
Mt. Sarah Anticline
BIRDSVILLE TRACK RIDGE
Hale River 1
Beachcomber 1
McDills 1
Etingimbra 1
Colson 1
Thomas 1
Poeppels Corner 1
Adria Downs 1
Birdsville Town Bore
Erabena 1
Dalmatia 1
Purni 1
Mokari 1
Glen Joyce 1
Oolarinna 1
Mt. Hammersley 1
Witcherie 1
Mt. Crispe 1
Macumba 1
Killumi 1
Poolowanna 1
Poolowanna 2
Walkandi 1
Kuncherinna 1
Pandieburra 1
Miandana 1
Koonchera 1
Oodnadatta 1
0 20 40 60 80 100 KMS
136° 137° 138° 139°
25° 26° 27°

FIGURE 15

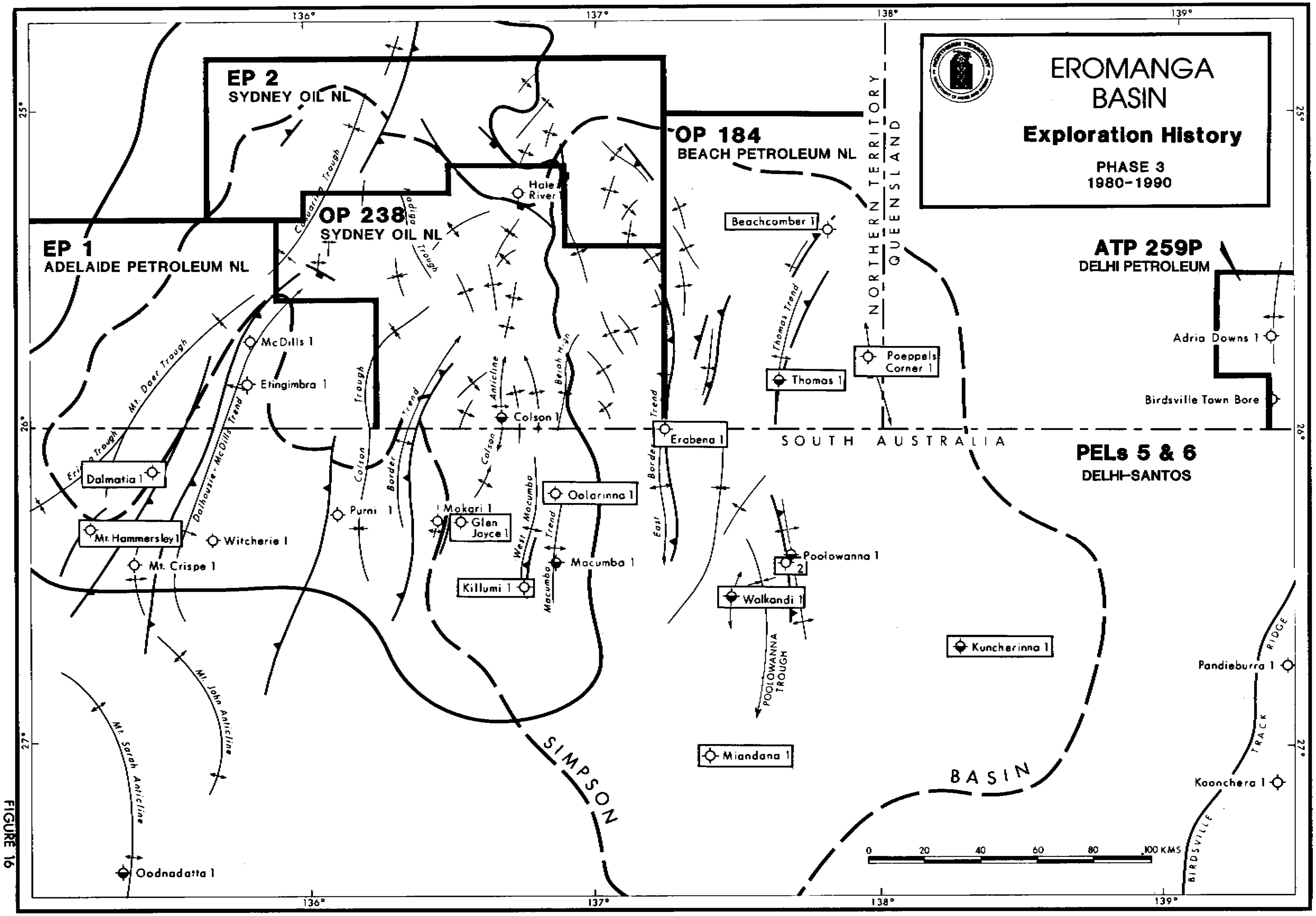

EROMANGA
BASIN
Exploration History
PHASE 3
1980-1990
EP 2
SYDNEY OIL NL
EP 1
ADELAIDE PETROLEUM NL
OP 238
SYDNEY OIL NL
OP 184
BEACH PETROLEUM NL
ATP 259P
DELHI PETROLEUM
PELs 5 & 6
DELHI-SANTOS
NORTHERN TERRITORY
QUEENSLAND
SOUTH AUSTRALIA
SIMPSON
BASIN
Hale River 1
Beachcomber 1
Poeppels Corner 1
Thomas 1
Adria Downs 1
Birdsville Town Bore
McDills 1
Etingimbra 1
Colson 1
Erabena 1
Dalmatia 1
Mt. Hammersley 1
Witcherie 1
Mt. Crispe 1
Purni 1
Mokari 1
Glen Joyce 1
Oolarinna 1
Macumba 1
Killumi 1
Poolowanna 1
2
Walkandi 1
Kuncherinna 1
Pandieburra 1
Koonchera 1
Miandana 1
Oodnadatta 1
Mt. Dare Trough
Eringa Trough
Dalhousie - McDills Trend
Colson Trough
Border Trend
Colson Anticline
Beach High
West Macumba Trend
Macumba Trend
East Border Trend
Thomas Trend
POOLOWANNA TROUGH
Mt. John Anticline
Mt. Sarah Anticline
BIRDSVILLE TRACK RIDGE
0 20 40 60 80 100 KMS
136°
137°
138°
139°
25°
26°
27°

FIGURE 16

Exploration concepts have changed considerably since 1959. Initially, the sequence believed to be the most prospective was the Cambrian. McDills 1, the first petroleum exploration well in the basin, was drilled to test the Early Palaeozoic succession. When gas was discovered in the Permian sediments of the Cooper Basin in 1968, attention was turned to the Permian sequence in the Simpson Desert region.

With the recovery of oil from the basal Jurassic and the Triassic in Poolowanna 1, and the confirmation of a thick Triassic sequence in the Poolowanna Trough, exploration again changed course.

The discovery of the large Jackson Field in the Eromanga Basin sequence showed that Middle and Late Jurassic objectives were also valid and important. Geochemical information obtained over the past few years has shown lack of organic maturity to be the main reason for the lack of petroleum exploration success in the Pedirka Basin region but many of the wells drilled to date have evaluated structurally shallow parts of the basin. The need for a more deeply buried reservoir/source rock couplet is obvious but the Poolowanna Trough has given no encouragement since oil was discovered at Poolowanna 1.

Mt. Hammersley 1, drilled in 1988, showed that the Permian sequence thickens rapidly into the Eringa Trough. Several wells, including McDills 1, drilled along the McDills-Mayhew Trend on the eastern edge of the Trough, demonstrated that a thick Early Palaeozoic sequence should also be present in the Eringa Trough. It looks as if the next phase of petroleum exploration in the basin will include further exploration of the Eringa Trough and its northeastern extension, the Madigan Trough.

6.1 REASONS FOR LACK OF EXPLORATION SUCCESS

McDills 1, the first petroleum exploration well to be drilled in the Simpson Desert area, was drilled in 1965 by Amerada Petroleum on the basis of aeromagnetic, gravity and seismic data gathered and acquired by Beach Petroleum during the three previous years. Geophysical data identified a large northeast trending, closed anticline, possibly faulted along its western flank and McDills 1 was located on the 'highest' part of this structure. One of the primary intents of the well was to obtain stratigraphic information and the well was drilled into Early Cambrian dolomites to a depth of 3205m (10515 ft). No shows of hydrocarbons were found in the well and porosity was limited to the Mereenie Sandstone and younger strata. The well was significant, however, in establishing the presence of a Early Palaeozoic sequence within the area. The well appears to have been a valid structural test although modern seismic indicates that it was not drilled on the structure's absolute crest. Source rocks to the north, south and east are organically too immature for the main phase of oil generation and migration to have been reached although source quality is fair to good. The McDills-Mayhew anticline parallels the eastern margin of the Eringa Trough. Organically rich and mature source rocks are expected to be present in this trough. The fault which defines the western limit of the McDills-Mayhew Trend may be impermeable to the eastward flow of hydrocarbons thereby denying the McDills structure access to Eringa Trough generated hydrocarbons. It may prove that oil and gas generated within the Eringa Trough migrated west and northwest rather than east into the McDills feature. Structure maps of the area strongly suggest this to be the case.

Hale River 1 was drilled by Amerada in 1966 to evaluate a pre-Permian formed structure identified by seismic data. Modern seismic confirms the configuration of the structure and the well's crestal position at Cretaceous levels. Jurassic objectives, however, were encountered downdip of the structural crest. Hale River 1 was drilled in a structurally shallow part of the basin where potential source rock units are immature for significant oil and gas generation.

Colson 1 was drilled by North Broken Hill Pty Ltd in 1978 as part of a farmin commitment to Beach Petroleum. The well tested a closed high on a prominent anticlinal trend and is considered a structurally valid test. Geochemical analysis suggests that Permian source rocks are organically rich and sufficiently mature for significant oil generation and expulsion but comprise predominantly inertinite with only rare exinitic (oil generating) macerals. A large vitrinitic component provides excellent gas sourcing potential but source rocks in the Colson hydrocarbon drainage area are not sufficiently mature for significant gas generation to have been achieved. Residual hydrocarbon shows were noted in Triassic sands.

Thomas 1 was drilled in 1982 by Argonaut International to meet a farmin obligation to Beach Petroleum. The well was drilled on the northern extension of the Poolowanna Trend and consequently the basal Jurassic and Triassic provided the primary reservoir objectives. The well was plugged and abandoned with reported residual oil staining in the lower Poolowanna Formation. The operator suggests that the reason for the well's lack of success may be attributed to a large crestal fault on the Thomas structure breaking the sealing potential at the top of the lower Poolowanna Formation unit. It is also quite possible that geophysically mapped closure on the north of the Thomas 1 culmination is not real. Oil and or gas would as a result continue to migrate to the structurally much higher culmination mapped on trend and immediately to the north of Thomas 1. Geochemical analysis indicates the presence of organically rich source rocks which should have entered the main phase of oil generation window. Many of the analysed samples proved to be exinite rich. The oil (residual oil) recovered from Thomas 1 is chemically different to that recovered from Poolowanna 1.

Poeppels Corner 1 was drilled in 1985 by Arco Australia as a farmin commitment to Beach Petroleum, on a valid structural closure. Residual oil was present in sidewall cores recovered from the Cadna-owie, Poolowanna and Peera Peera formations. The well's lack of success may be attributed to immaturity of organic material in potential source rocks. The maximum value of the vitrinite reflectance (Ro) measured in potential source shales is 0.63% (Peera Peera Formation). Structurally, there is a possibility that a crestally situated fault has breached potential seals.

Beachcomber 1 was drilled in 1988 by Beach Petroleum to test a large, closed, anticlinal structure in the northeast of their permit area. The well was plugged and abandoned with no significant hydrocarbon shows being observed. Geochemical analysis has demonstrated the presence of organically very rich but immature source rocks (mean maximum Ro of 0.60%). The Beachcomber structure is a recently formed structure.

Etingimbra 1 was drilled in 1990 by Adelaide Petroleum to evaluate the pre-Permian succession in a position of closure updip of McDills 1. The well was plugged and abandoned. Although data from this well remain confidential to the operator, the reasons for its lack of success would be similar to those provided above for McDills 1.

In summary, exploration failure in all wells may be attributed to the lack of maturity of source rocks in respective hydrocarbon drainage areas. Thomas 1 should have had access to mature source rocks but it is not certain that the Thomas 'culmination' is closed to the north. McDills and Etingimbra would be expected to be on the migration fairway for hydrocarbons generated in the Eringa Trough but the McDills-Mayhew Thrust may be a barrier to the eastward migration of hydrocarbons from the trough.

Considerable hydrocarbon potential remains in the Northern Territory sector of the Pedirka Basin region. Exploration drilling to date has proven that good source rocks, reservoirs and seals are present throughout most of the study area. Numerous structures remain to be tested and potential stratigraphic traps have yet to be tested. The missing ingredient to date has proven to be organic maturity. This can be expected in the Eringa and Madigan Troughs.

7.0 HYDROCARBON POTENTIAL

Twenty petroleum exploration and two appraisal wells have been drilled in the Pedirka Basin to date without a commercial discovery being made. A relative lack of maturity of hydrocarbon source material has proven to be the main reason for this disappointing lack of success. Adequate oil prone source rocks and porous and permeable reservoirs with effective overlying seals have been found in all of the 22 wells (Figure 17). A large number of structures and structural types remain to be tested, many of them presenting an early structural history.

The drilling of Mt. Hammersley 1 in 1987 in the South Australian portion of the Pedirka Basin has demonstrated that the Eringa Trough contains a much thicker succession of sedimentary rocks than seen elsewhere in the basin. It is very probable that Permian and Triassic sediments in the trough would have reached temperatures sufficient for peak generation and migration of oil and it is postulated here that source rock horizons in the Eringa and Madigan Troughs will prove to be organically very rich with a large portion of exinitic (oil prone) material.

The pre Permo-Carboniferous section along and to the west of the McDills-Mayhew Trend provides additional potential, the Mereenie Sandstone exhibiting particularly good reservoir properties at McDills 1. This play is complex and just beginning to be evaluated. Oil and gas are now being produced from equivalent rocks in the Amadeus Basin. The missing ingredient in the study area is an effective source rock. Horn Valley Siltstone (Amadeus Basin nomenclature) equivalents have been identified at Colson 1 and Mt. Hammersley 1. Source quality of this unit is expected to improve towards the west into the Eringa Trough where it is hoped a reducing rather than an oxidising environment would have prevailed.

An inventory of the geochemical data is presented in Appendix 3.

7.1 HYDROCARBON SHOWS

Numerous hydrocarbon shows have been encountered in the Pedirka Basin region (Table 1 and Enclosures 6a and 6b) although significant shows have been rare. To date, commercial flow rates have not been obtained. Most of the petroleum exploration wells have been drilled in the shallower parts of the basin and a lack of organic maturity has proven to be a problem.

Poolowanna 1, drilled in a structural depression in the central Pedirka Basin region, has provided the most encouragement. It was the results of this well that stimulated a recent wave of exploration in the Pedirka/Simpson Basin area. In Poolowanna 1, DST 2 tested several sandstone units in the middle part of the Jurassic Poolowanna Formation, resulting in the recovery of 1676.3m of fluid of which approximately 610 metres was oil. A subsequent cased hole test (DST 5) resulted in the flow of oil to surface at a rate of 4 barrels per hour (extrapolated 96 barrels per day) although some water was being recovered with the oil after a few hours of production. The oil was a waxy, paraffinitic crude which solidified as it reached the surface. Geochemical analyses of the 37°API gravity (pour point 41°C) oil indicates a mature oil which has been severely water washed, thereby effectively having had the low molecular weight hydrocarbons removed. There was a remarkable absence of gas in association with the oil. The oil was found to be present in fractures but does not appear to have saturated intergranular voids, with the exception of thin sandstones at 2559m.

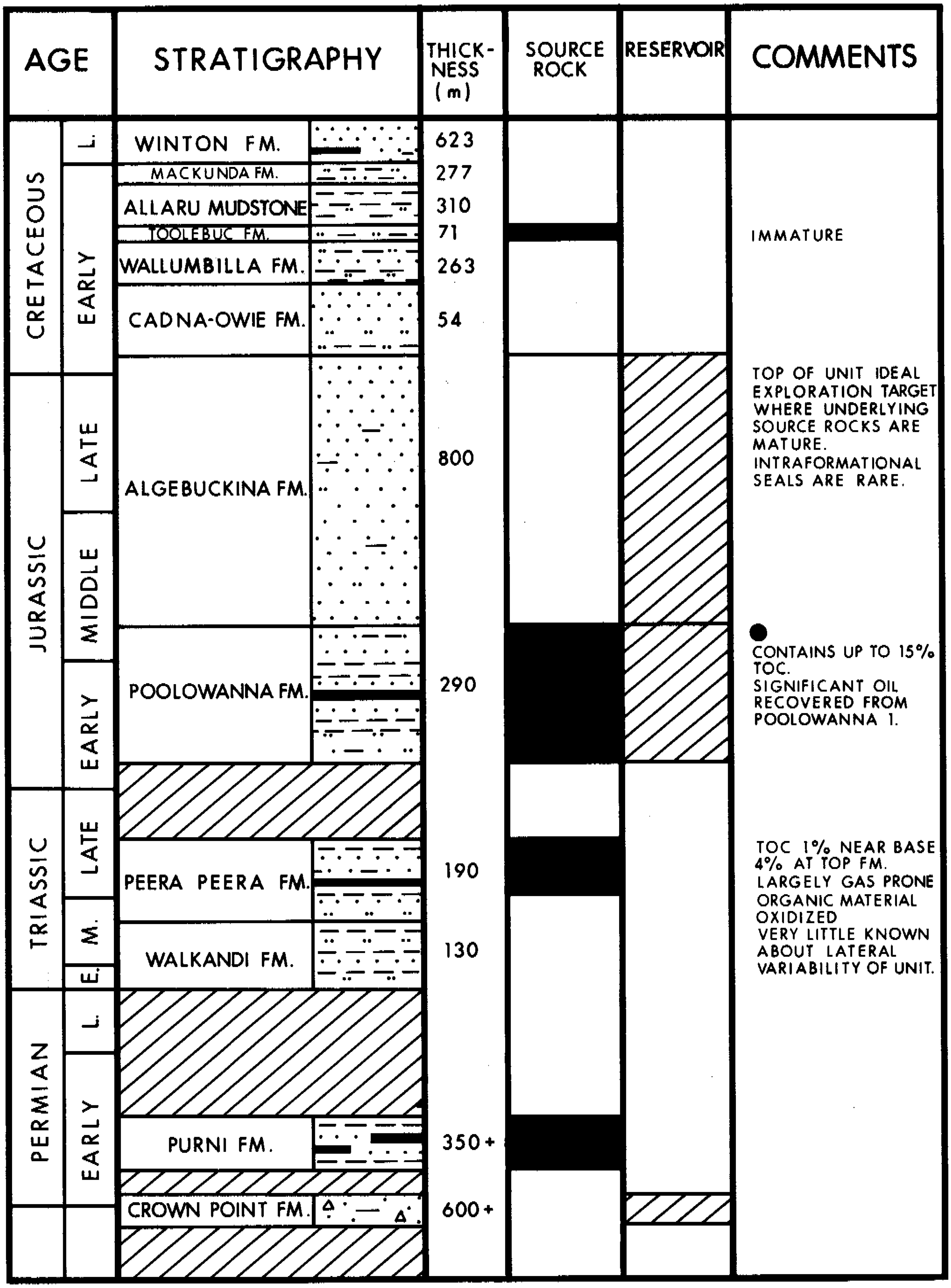


FIGURE 17

Source Rock and Reservoir Intervals

TABLE 1

Inventory Of Hydrocarbon Shows In Pedirka Basin

Northern Territory Wells		
BEACH BEACHCOMBER 1	1988	No significant shows.
NORTH BROKEN HILL COLSON 1	1978	Residual hydrocarbon staining 1994-2003m in upper Poolowanna Formation sands and in pre-Permian section. No associated gas during drilling. Intervals not tested.
AMERADA HALE RIVER 1	1966	No indications of hydrocarbons being present.
AMERADA MCDILLS 1	1965	No hydrocarbon shows other than a minor gas show in lower part of Wallumbilla Formation (416-421m)
ARCO POEPPELS CORNER 1	1985	Residual hydrocarbons reported from sidewall cores taken in Cadna-owie Formation and Algebuckina Sandstone. Good indications of oil throughout the Poolowanna Formation with sidewall cores having up to 27.7% porosity and 16.7% oil saturation by pore space. Spotty dull orange fluorescence noted from cuttings of Peera Peera Formation.
ARGONAUT THOMAS 1	1981	Good residual oil shows (spotty brown stain) in lower Poolowanna Formation between 2183 and 2278 metres. Drillstem tests recovered only water with traces of gas. Similar shows noted in basal Algebuckina Sandstone and minor fluorescence in the Peera Peera Formation
South Australian Wells		
DALMATIA 1	1988	No hydrocarbon shows were noted during the drilling of this well.
ERABENA 1	1981	Very minor fluorescence observed in Poolowanna and Peera Peera Formations.
GLEN JOYCE 1	1985	No significant hydrocarbon shows were observed.
KILLUMI 1	1985	Trace fluorescence in 1m sand in middle Poolowanna Formation. No significant associated gas.
KUNCHERINA 1	1982	Scout information indicated DST of lower Poolowanna Beds recovered 27m of mud with a trace of oil. Zone tested interval of poor shows of residual oil.
MACUMBA 1	1977	No significant hydrocarbon shows were observed.
MIANDARRA 1	1985	No shows of significance reported on scout data.
MOKARI 1	1966	Weak gas shows in basal Jurassic sands and very weak gas shows at top of Permian Crown Point Formation. DST's of key intervals proved to be water saturated.
MOUNT HAMMERSLEY 1	1987-88	No shows of any type were recorded.
OOLARINNA 1	1985	No significant hydrocarbon shows were reported. DST 1 (2437-2445m - Peera Peera Fm.) resulted in recovery of 1618m of gas cut water in drill pipe.
POOLOWANNA	1977	DST 5 resulted in flow of oil from middle Poolowanna Formation at a rate of 4 barrels per hour. Some water was being recovered towards end of test DST 3 resulted in a gas flow from the Peera Peera Formation at a rate too small to measure accompanied by a small amount of oil.
POOLOWANNA 2	1985	Well came in low to prognosis. DST 1 (2413-2438m) in Poolowanna Formation recovered 1530m of slightly gas cut water. It is understood that there were no significant hydrocarbon shows during drilling.
PURNI 1	1964	Minor fluorescence and gas associated with coal seams. No hydrocarbons recovered during testing.
WALKANDI 1	1981	Minor oil shows in Poolowanna and Peera Peera formations. DST 2 (2642-2664m - Poolowanna Fm.) recovered 640m gas cut muddy water; DST 3 (2782-2804m - Peera Peera Fm.) recovered 23m slightly gas cut mud.
WITCHERRIE 1	1963	No hydrocarbon shows were reported during the drilling of this well.

A drillstem test of the Triassic Peera Peera Formation in Poolowanna 1 (DST 3) resulted in a gas flow at a rate too small to measure, accompanied by a small amount of light (42°API gravity) oil. Two broad hydrocarbon peaks, one in the range of nC_7 to nC_{10} and the second in the range of nC_{16} to nC_{19} are prominent on chromatograms of the recovered oil. There is very little nC_{31+} present in the analysed samples.

Poolowanna 2 was drilled low to prediction and appears to have intercepted the Poolowanna reservoir below the pool oil/water contact. Poolowanna 3 encountered an oil saturated Poolowanna Formation section at approximately the same structural level as Poolowanna 1 but recovered oil cut water. The formation proved to be relatively tight.

Hydrocarbon shows encountered in other wells in the South Australian sector or the Pedirka Basin are of lesser significance and for the most part associated with the Poolowanna and Peera Peera formations. Table 1 provides a summary of the hydrocarbon shows reported from Pedirka Basin wells.

The hydrocarbon shows reported from wells drilled in the Northern Territory sector of the Pedirka Basin have been disappointing. This should not be unexpected as wells have been drilled in the structurally shallow parts of the basin where source rocks remain immature for significant hydrocarbon generation and migration. Encouragement is provided, however, in the quality and quantity of shows reported from Colson 1, Thomas 1 and Poeppels Corner 1.

Amerada McDills 1, 1965: No hydrocarbon shows were encountered in the well other than a minor gas show in the lower part of the Wallumbilla Formation (416-421m). Electric logs showed all formations to be water saturated.

Amerada Hale River 1, 1966: There were no valid hydrocarbon shows encountered in Hale River 1. Apparent shows were proven to be due to contamination by diesel fuel in the drilling mud.

North Broken Hill Colson 1, 1978: Residual hydrocarbon staining was noted in porous sands of the upper Poolowanna Formation between 1993.7m and 2002.5m. There was no associated gas or fluorescence with the pale brown staining. Dried cuttings gave a fair, cream-white cut in trichlorethane. Log analysis indicates the presence of hydrocarbons, showing marginal hydrocarbon saturations.

Log analysis also indicates the presence of residual hydrocarbons in pre-Permian sands. No visible shows were noted during the drilling of this section but spotty, brown staining which did not fluoresce under ultra violet light was reported from a single sidewall core.

No significant hydrocarbon shows were reported from Permian strata.

No drillstem tests were carried out owing to excessive hole deviation.

Argonaut Thomas 1, 1981: The well encountered good residual oil shows in the lower unit of the Poolowanna Formation between 2183 and 2278 metres. The shows comprise uniform to spotty, brown fluorescence with a slow crush cut. There were no associated gas shows during drilling and two open hole drillstem tests recovered water with only traces of gas. Similar shows were noted in the basal Algebuckina Sandstone at Thomas 1 and minor fluorescence in the Peera Peera Formation. Small amounts of green fluorescing oil 'wept' from cracks in some of the coals during petrographic examination of polished grain mounts.

Arco Poeppels Corner 1, 1985: No significant hydrocarbon shows were observed in cuttings samples of the sediments penetrated by Poeppels Corner 1 and none of the sediments exhibited any stain or odour. The best shows were from the base of the Peera Peera Formation (2290m) in which a 'trace' percentage of grains exhibited a 'trace' amount of spotty, dull orange fluorescence. In trichlorethane, the grains had a slow, cloudy, greenish-white natural cut fluorescence. The residue fluorescence was a moderately bright yellow ring.

Two sidewall cores taken in the Cadna-owie Formation (1403.2m and 1434.9m), contained residual hydrocarbons. The upper of the two cores yielded a dull, very slow streaming greenish-yellow cut with a thin, yellow, fluorescing film. Laboratory analysis showed the sandstone had 25 percent porosity with 5.1 percent oil saturation (by pore space). Analysis of the lower core showed the sandstone had 25 percent porosity with 6.3 percent oil saturation (by pore space). Dull yellow residue fluorescence was obtained in the laboratory. A formation test of the interval provided no indication of hydrocarbons, suggesting the observed oil was of a residual nature.

Most of the sidewall cores taken in the Algebuckina Sandstone yielded cut fluorescence and residue fluorescence when analysed at the well site but only one of three sidewall cores analysed in the laboratory gave direct indications of hydrocarbons. Laboratory analysis of a sidewall core at 1994.7m showed the sandstone had 23.5 percent porosity and 9 percent oil saturation (by pore space).

Most of the sidewall cores taken in the Poolowanna Formation also showed fluorescence when examined at the wellsite. Three of six Poolowanna Formation sidewall cores (2050.9m, 2141.1m and 2149.3m) analysed in the laboratory provided good indications of oil. The three sidewalls had up to 27.7 percent porosity with up to 16.7 percent oil saturation (by pore space). All three samples yielded a bright yellow residue fluorescence in the laboratory. It is of note, however, that all three of the sidewall cores were taken in sands in close proximity to potential source beds.

Beach Beachcomber 1, 1988: No significant hydrocarbon shows were observed in Beachcomber 1, although a black shale in the Poolowanna Formation (1705m) gave a moderately fast, bright, blue-white crush cut with a bright blue residue fluorescence.

7.2 ORGANIC QUALITY

An abundance of coals and fine grained clastic material obtained from cores, sidewall cores and cuttings samples have been analysed for source rock quality and these provide a good indication of the source potential of Pedirka Basin sediments. Fair to excellent source potential is provided by no less than four stratigraphic formations (the Algebuckina, Poolowanna, Peera Peera and Purni Formations) with lesser source potential being seen in the Wallumbilla, Bulldog Shale, Cadna-owie and the Crown Point Formations. In general, dispersed organic matter and coals from Pedirka Basin wells have been exinite lean, with vitrinite and inertinite predominant (Figures 18 and 19 and Appendix 3).

Wallumbilla (Bulldog Shale) Formation

Notwithstanding the marine influence evident in the Cretaceous sediments, source potential cannot be considered as good. There has been limited sampling of Wallumbilla- Bulldog Shale sediments for geochemical analysis. A single sample from Colson 1 indicated an abundance of inertinite macerals but only rare exinite macerals. The exinite comprises shreds of cutinite and remnants of algal colonies. Vitrinite comprises less than 10 percent of the organics in the sample. Given the depositional history of the Wallumbilla Formation, the one sample analysed does not appear representative of the formation as a whole.

Elsewhere in the Eromanga Basin, the Wallumbilla Formation contains fair to occasionally excellent source intervals with (Kantsler et al., 1986) mixed marine and terrigenous exinitic and vitrinitic organic matter. Bituminite and alginite commonly dominate the exinite content. It is expected that similar source intervals are present within the study region, particularly within structurally depressed areas.

Cadna-owie Formation

As with the Wallumbilla Formation, the Cadna-owie Formation is not considered an important hydrocarbon source and limited geochemical sampling has therefore been undertaken. Nevertheless, the Cadna-owie Formation must be assessed as having some source potential for both oil and gas. For the most part, the Cadna-owie Formation appears to contain predominantly poor quality, gas prone, Type III (Vitrinite) kerogen. Low Hydrogen Indices suggests the presence of inertinite rich and/or oxidised organic matter.

Exinite can locally (Colson 1), however, constitute up to 35 percent of the organic content. At Colson 1, most exinitic material is resinite and bitumen but there are smaller amounts of alginite, sporinite and cutinite present.

Algebuckina Formation

Although predominantly a sandstone interval, the Algebuckina Formation offers significant source potential. The most notable feature about the dispersed organic matter in the Algebuckina Formation is its heterogeneity. It includes fragments of black coal, very fine grained vitrinite and inertinite and in places large masses of exinites. From work done to date, vitrinite is the most abundant maceral, often forming both large, porous aggregates embedded in shale, and finer grained material which is dispersed and tends to be associated with exinite.

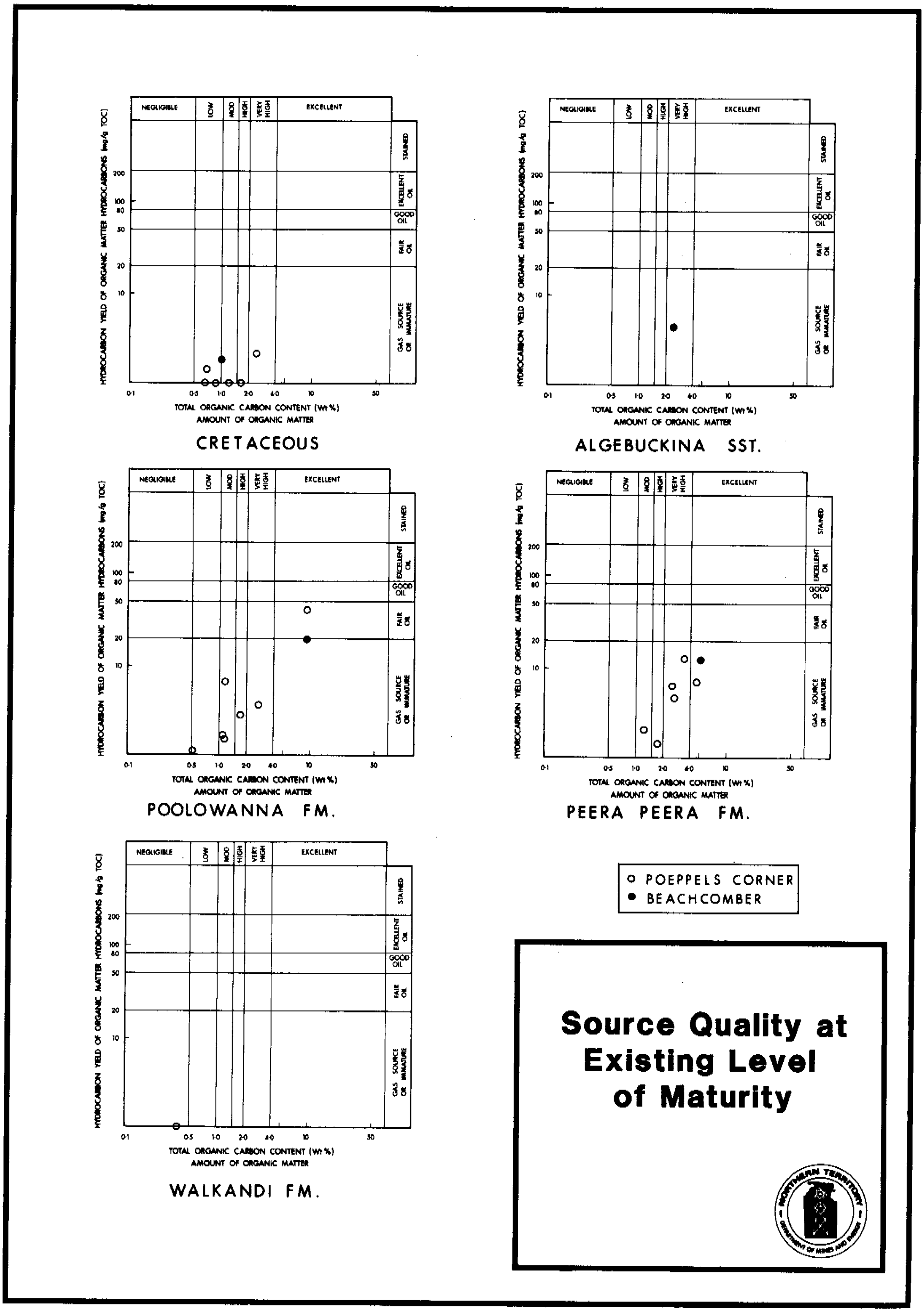
Inertinites do not appear as abundant in the Algebuckina Formation as elsewhere in the stratigraphic sequence. Exinite, locally abundant and often associated with vitrinite laminae, comprises finely intergrown leaf resins and cutinite, while sporinite is typically disseminated throughout fine grained shales and silts.

Total Organic Carbon (TOC) values as high as 10 percent have been reported from samples of the Algebuckina Sandstone, with exinite comprising up to 30 percent of the organic content.

Poolowanna Formation

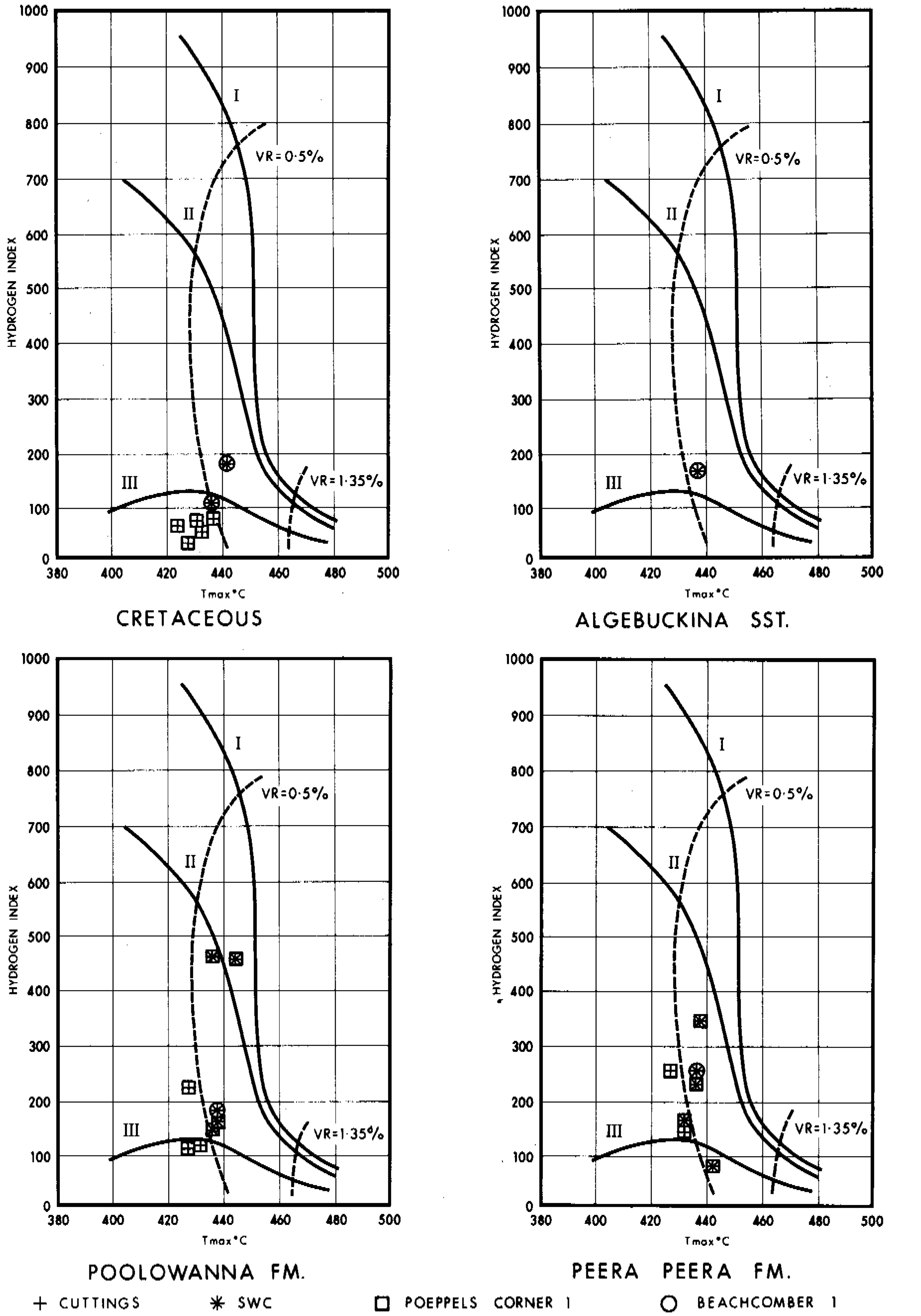
The Poolowanna Formation exhibits the richest source rocks in the study area. The formation reaches thicknesses in excess of 200 metres in the more prominent structural depressions and contains up to 15 percent total organic carbon. Thin coal seams are abundant throughout the formation and complement the often abundant dispersed organic matter present in intraformational silts and shales. Coals and coal related lithologies are an important part, volumetrically, of the Poolowanna Formation sequence. The coals range from vitrinite and vitrinite rich clarite through a range of trimacerites to durite.

Inertinite is the most abundant dispersed organic matter (DOM) but vitrinite is also abundant. Woody herbaceous DOM, rich in exinite consisting mainly of bitumite and



Source Quality at Existing Level of Maturity

FIGURE 18



KEROGEN TYPE AND MATURITY
BASED ON ROCK EVAL Tmax AND HYDROGEN INDEX DATA

FIGURE 19

sporinite (exinite, 20-30 percent of the TOC) is locally abundant at Poeppels Corner 1 and where more mature, would be a fair to excellent source of liquid hydrocarbons (McKirdy, 1984). As with most of the Poolowanna sequence elsewhere in the basin, gas prone Type III kerogen predominates at Poeppels Corner. Nevertheless, the cuttings samples from Poeppels Corner 1 clearly demonstrate that a significant portion of the sequence has very significant oil generative potential. Coals are inertinite rich but contain abundant exinite (Cook, 1986). Exinite contents are typically in the order of 5 to 10 percent of the total organic content but do range up to 50 percent in some layers, with cutinite generally dominant over sporinite and resinite. Some lithologies contain more sporinite than cutinite. Cutinite sheets are relatively extensive and thick and fluorescence intensity is commonly high. Resinite is rarely abundant but usually present. Rare telalginite derived from *Botryococcus* - type algae also occur. A small amount of exsudatinite is present.

As Moore (1986) comments, while many workers believe coals do not provide significant oil generative potential because of their high internal surface area and high sorptive capacity, there is now considerable evidence that coals can be effective oil generators (Cook, 1986). A small number of fractures in clarite wept green fluorescing oil while being examined in core samples obtained from Thomas 1.

Mid Poolowanna Formation sands in Poolowanna 1 were oil saturated, the source most likely being Poolowanna Formation coals and DOM in intraformational fine grained clastics.

Peera Peera Formation

The Peera Peera Formation offers fair to good hydrocarbon potential with total organic carbon content as high as 5 percent. In general, the amount of dispersed organic matter is greater towards the top of the formation. Much of the source potential of the Peera Peera Formation lies in the formation's abundant coals.

Inertinite is the dominant maceral in the abundant dispersed organic matter present in the Peera Peera Formation but exinite macerals cutinite, resinite and sporinite are nevertheless common to abundant.

Vitrinite patches are commonly large and in some cases porous.

Relatively high total organic carbon values measured from the Peera Peera Formation must be considered in the light of the abundance of inertinite but the formation must, nevertheless, be assessed as having good source potential on the basis of DOM alone.

Coals in the Peera Peera Formation are similar to those found in the Poolowanna Formation. A coal sample recovered from Colson 1 consisted mostly of vitrinite with lesser clarite and rare durinite and clarodurite. Sporinite, cutinite and resinite with some bitumen constitute the exinite macerals.

A drillstem test (DST 3) in Poolowanna 1 (Peera Peera Formation) resulted in a gas flow at a rate too small to measure accompanied by a small amount of light (42°API), mature oil. This oil is interpreted by McKirdy (1984) to have been derived from woody-herbaceous DOM. The formation appears to be predominantly gas prone but with the potential for a modest oil yield.

Purni Formation

The upper and lower members of the Purni Formation are characterized by alternating shale, coal and siltstone layers which were deposited in lacustrine, swamp and floodplain environments. These have the potential to constitute good to excellent source rocks.

Coals sampled from Colson 1, Macumba 1, Mokari 1, Oolarinna 1 and Purni 1 are made up predominantly of vitrinite and inertinite but the exinite content (up to 20 percent) is much higher than most other Australian coals. (Smyth and Saxby, 1981).

Most of the coals contain less than 5 percent exinite and exhibit a typical banded structure with semifusinite, micrinite and inertodetrinite intergrown with vitrinite in some bands whereas others consist wholly of vitrinite. Vitrinite rarely exceeds 40 percent of the coal.

Sporinite is the dominant exinite variety but cutinite, megaspores, rare resinite, leaf resins etc are all present in lesser amounts. Rare *Botryococcus* is also present. The exinite material may prove to be largely gas prone as analyses indicates an only average to below average hydrogen content.

Carbonaceous shales in which resinite and bituminite constitute 50 percent of the DOM have been identified (McKirdy, 1981) but shales this rich in exinite appear to be rare. It may prove that similarly rich shales are more abundant in structural depressions such as the Madigan and Eringa troughs.

Gas chromatography analyses of Purni Formation sediments in the eastern Pedirka Basin has identified both hydrogen rich exinite and vitrinite and hydrogen poor vitrinite rich source rocks.

Purni Formation sediments at Mt. Hammersley 1 and Dalmatia 1 appear to be predominantly gas prone but these sediments were deposited across a structurally high block and would not therefore be expected to provide an ideal source situation.

Crown Point Formation

Consistent with its glaciogenic origin, the shales of the Crown Point Formation appear to be organically lean with an average total organic carbon of less than 0.5 percent and rare dispersed organic matter. The kerogen which is present is hydrogen poor.

A sidewall core from Mt. Hammersley 1 (1142m) contained sufficient organic matter to be considered a potential source rock but was, for the most part, hydrogen poor. Evans (1965) identified aff. *Botryococcus* in this core.

7.3 MATURITY OF SOURCE ROCKS

Vitrinite reflectance values and spore colouration (Thermal Alteration Indices) indicate that the Cretaceous and Middle to Upper Jurassic sequences are predominantly immature to marginally mature for effective oil generation and expulsion ($Ro < 0.7\%$). Early Jurassic (Poolowanna Formation) and Permo-Triassic sequences have, however, reached the main oil generative window ($Ro = 0.7\%$ to 0.9%) over large portions of the study area.

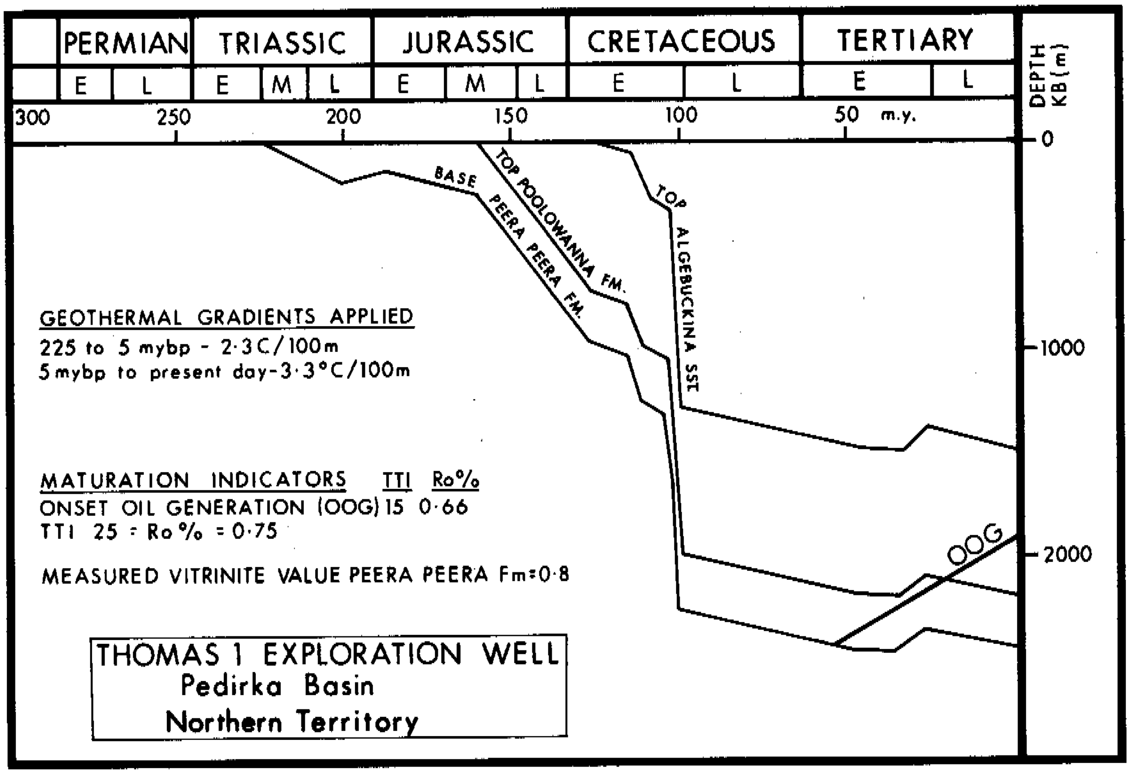


FIG. 20 LOPATIN MATURATION MODEL – THOMAS 1

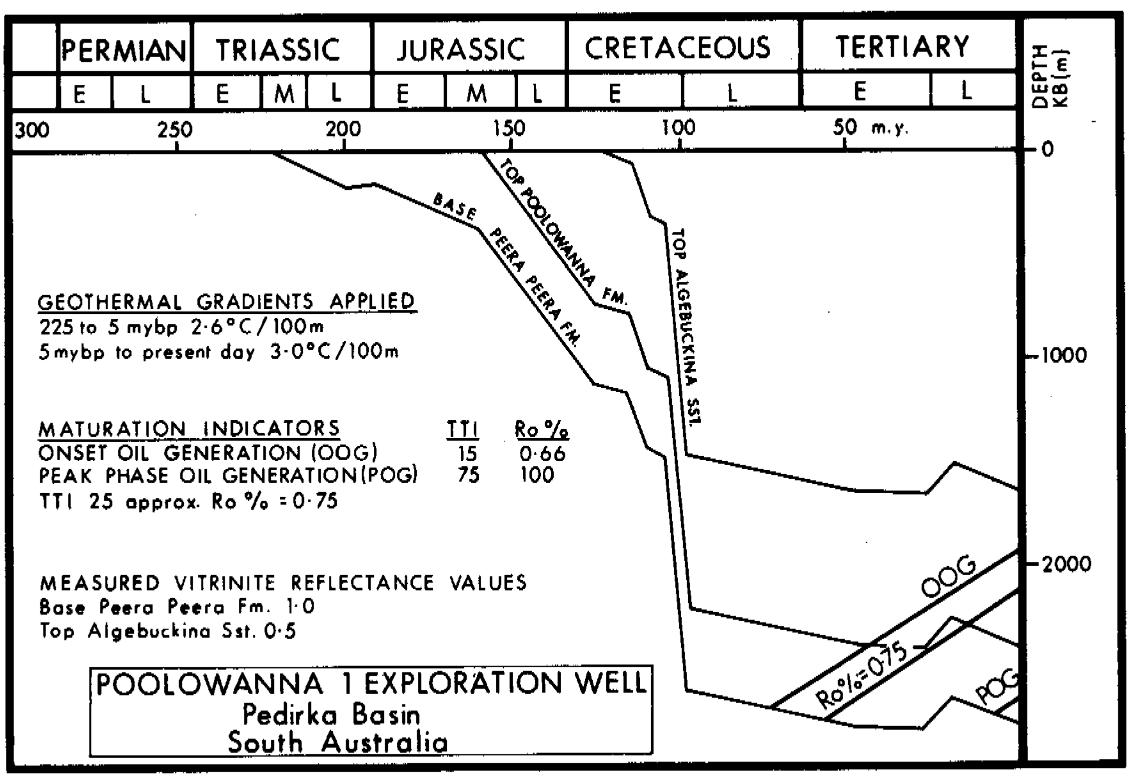


FIG. 21 LOPATIN MATURATION MODEL – POOLOWANNA 1

LOPATIN MATURATION MODELS

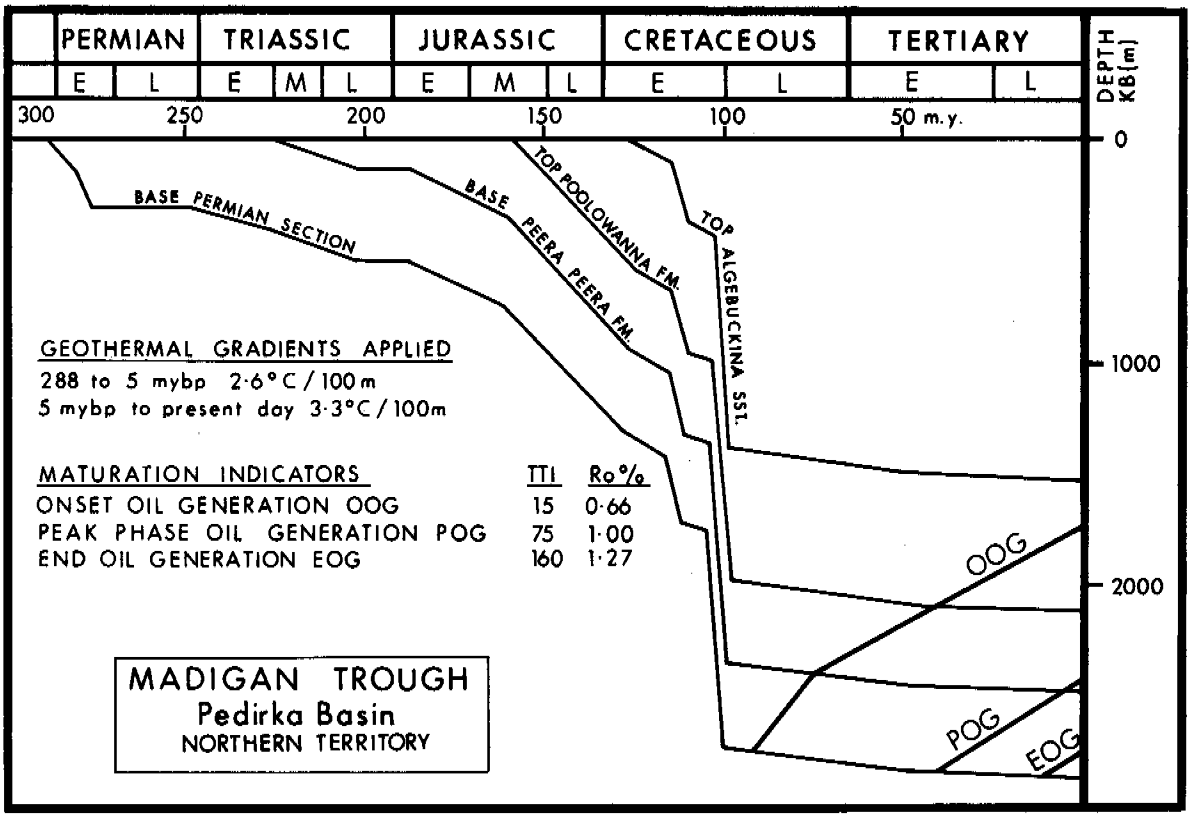


FIG. 22 **LOPATIN MATURATION MODEL**

Maturation modelling (Figures 20, 21 and 22) incorporating the control of quantitative organic geochemistry, suggests that the conditions necessary for peak oil generation would not have been reached until approximately Eocene time (or more recently) and effective oil migration in the basin would therefore not have taken place before the last major period of structural deformation (Kosciuskan Orogeny). Structural and stratigraphic traps present in the basin today would have proven to be effective trapping mechanisms prior to any major hydrocarbon migration.

Oil has been recovered in sub-commercial quantities from Poolowanna 1, the next to structurally deepest well in the basin, suggesting that with sufficient maturation of source rocks, an oil accumulation of commercial proportions should be present in the basin.

Geothermal Gradients

Geothermal gradients in the Pedirka Basin region are significantly lower than those of the adjacent, oil and gas productive, Cooper Basin region (Table 2). In the Pedirka Basin region, geothermal gradients (on the basis of log and limited formation test data) range from about 3°C/100m at Mokari 1, McDills 1 and Mt. Hammersley 1 to almost 5°C/100m at Beachcomber 1. In general, gradients have proven to be higher in the eastern part of the study area than in the west. Gradients of course vary with lithofacies and are controlled to some extent by fault conduits, etc. They vary, therefore, within any given well bore, formation by formation, from surface to total depth.

TABLE 2

Maximum Vitrinite Reflectance Values Reached In Post-Carboniferous Section

Well	Present Day Geothermal Gradient °C/100m	Ro Range (%)	Depth (m)	Formation
Beachcomber 1	4.65	0.46-0.69	1761	Peera Peera
Colson 1	3.80	0.65-1.00	2368	Purni
Hale River 1	3.74			
McDills 1	3.07	0.38-0.54		Purni
Poeppels Corner 1	3.47	0.47-0.75	2305	Peera Peera
Thomas 1	4.30	0.63-0.97	2368	Walkandi
Dalmatia 1	4.00			
Erabena 1	4.04			
Glen Joyce 1	4.05	0.55-0.93	2000	Purni
Killumi 1	3.94			
Macumba 1	3.94	0.99-1.08	2500	Purni
Mokari 1	2.30			
Mt. Crispe 1	3.00			
Mt. Hammersley 1	3.88			
Oolarinna 1	4.00	0.90-1.02	2514	Purni
Poolowanna 1	4.00	0.76-0.86	2500	Peera Peera
Purni 1	3.31	0.35-0.39	1500	Purni
Walkandi 1	3.40	0.77	2950	Walkandi
Witcherrie 1				

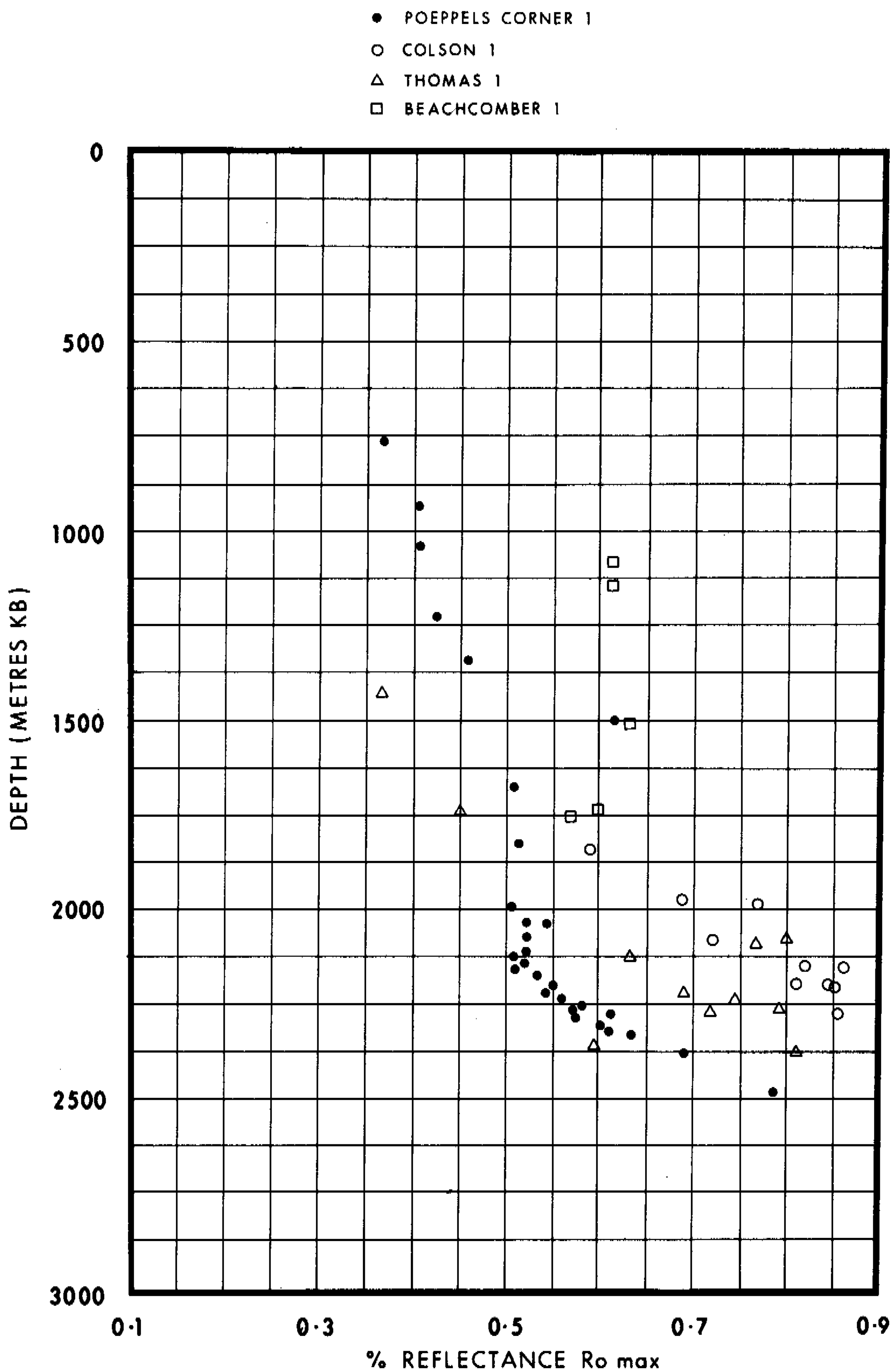
Most of the above geothermal gradients are unextrapolated log determined values.

In comparing measured vitrinite reflectance values with calculated time temperature indices (TTI) of maturation modelling, it becomes readily apparent that present day geothermal gradients are considerably higher than they were in the past. It is not certain whether today's relatively high gradients are a recent (within the last few million years), abrupt phenomenon or whether the gradient has been gradually increasing over a longer period of time. It does not appear that today's geothermal gradients would have been reached much before about 10 million years ago. In the Cooper Basin, geothermal gradients have remained anomalously high since at least earliest Permian time although present day temperatures were not reached until recent time.

Quantitative Organic Maturation Indicators

Vitrinite reflectance measurements, spore colouration (TAI), Rock-Eval Pyrolysis and cuttings gas analyses have been used to provide an indication of the degree of maturity of potential source rocks in the study area. For the most part good agreement is found in the results of the four types of analyses, although thermal alteration indices from spore colouration are in places anomalously high, possibly due to oxidation effects.

Vitrinite reflectance has been the most widely used maturation indicator. Values obtained from Poeppels Corner 1, Colson 1, Thomas 1 and Beachcomber 1 are plotted against depth in Figure 23 and shown structurally in Figure 24. Although there is considerable scatter in plotted values, onset of oil generation (Ro = 0.5%) from source



Vitrinite Reflectance vs Depth Profile
Well Composite

FIGURE 23

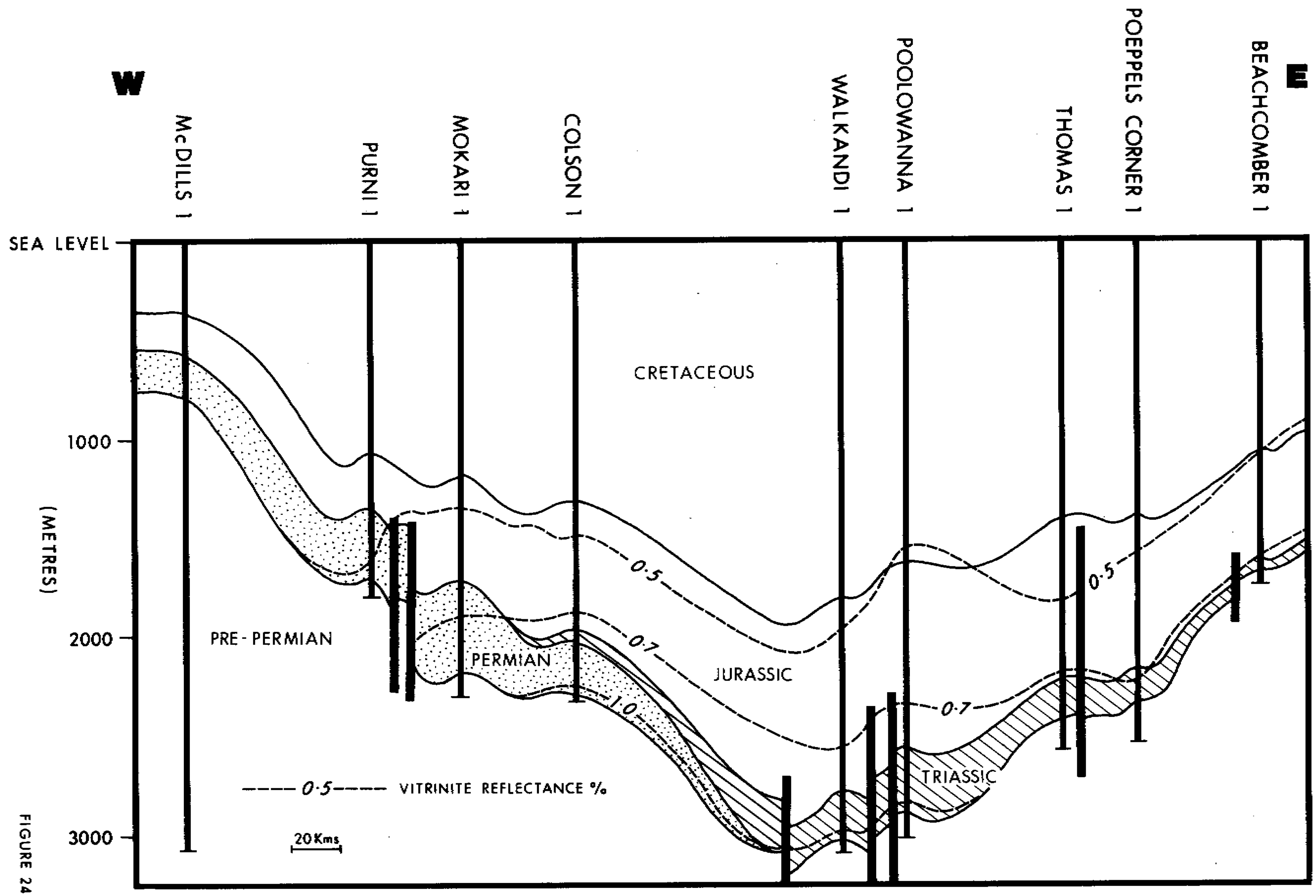


FIGURE 24

Vitrinite Reflectance Profiles Across Pedirka Basin

REFLECTANCE LEVELS INTERPRETIVE BETWEEN WELLS AND AT McDILLS 1 STRUCTURE VERY IDEALISED rocks would be expected with burial to about 1500m and peak oil generation (Ro = 0.7%) with burial to about 2200m.

The actual degree of organic cooking is of course dependent upon the type of organic matter. Powell and Snowdon (1983) and Monnier et al. (1983) suggest the following rank thresholds for hydrocarbon generation from terrigenous organic matter. Approximate depths of burial required to meet these thresholds in the study area are also shown:

	Ro%	Depth of Burial in Study Area
Top of oil window - resinite rich	0.45	1375m
Top of oil window - resinite poor	0.70	2200m
Top of oil window - algal or bacterial matter	0.50	1500m
Top of gas window	0.60	1900m

Resinite is only a minor constituent of the dispersed organic matter (DOM) in the more organically rich source rocks in the study area and consequently an Ro value of 0.7% is more indicative of the top of the oil window in the basin.

Figure 23 clearly shows 'doglegs' in the plotted Ro values for Poeppels Corner 1, Colson 1 and Thomas 1. The vitrinite reflectance gradient increases in each well from about 0.03% per 100m above the Algebuckina Sandstone to 0.1% per 100m below the Algebuckina Sandstone. The rank gradient within the Algebuckina Sandstone itself approximates zero. The movement of artesian waters within the permeable Algebuckina Sandstone appears to be the controlling mechanism for these gradient changes.

The presence of bitumens with dull yellow fluorescence in sediments of the Peera Peera Formation and the existence of 'dead' exsudatinite in the Poolowanna Formation above fluorescing exsudatinite of the Purni Formation suggest that active hydrocarbon generation and migration has occurred in the Colson area. Hydrocarbons comprise approximately 30 percent of the Extractable Organic Material (EOM) of the Peera Peera Formation.

In Poeppels Corner 1, there was an increase of wet gas components to more than 30% of the cuttings gas below 2042m (Poolowanna and Peera Peera formations) and a more poorly defined increase in cuttings gas yield at 2164-2195m (McKirdy, 1984). Corresponding vitrinite reflectance values for these changes are Ro ≈ 0.5% to 0.55%.

The presence of exsudatinite and fluorinite in the Algebuckina and Poolowanna formations in Walkandi 1 indicate that prolific oil generation has taken place. Vitrinite values of 0.69% were obtained from Poolowanna Formation shales.

7.4 THERMAL HISTORY

A comparison of vitrinite reflectance values obtained from numerous wells drilled in the Pedirka Basin area, with calculated maturation modelling indices (time-temperature indices-TTI), indicates that geothermal gradients must have been lower in the past than they are today. It appears the observed 'high' present day geothermal gradients are a recent phenomenon, representing a late thermal event, probably similar in timing and magnitude to that suggested by Pitt (1986) for the Cooper/Eromanga basins. Maturation modelling suggests that present day temperatures are representative of only the past 10 million years or so. It is not known whether the change was gradual or abrupt. Both can be supported by modelling.

There is also evidence of an earlier pulse of high gradients in the Permian to Jurassic. The evidence is based on vitrinite reflectance values and may actually be indicating changes in actual thermal gradient by lithofacies. The geothermal history of the pre-Permian sequence is unknown.

High heat flow may have accompanied the Alice Springs Orogeny in Early to Late Carboniferous time. There is no evidence, however, of high geothermal gradients in the Palaeozoic sequence in the Amadeus Basin.

7.5 STRUCTURAL TIMING AND HYDROCARBON GENERATION

Maturation analysis suggests that Permian and post Permian source rocks would have been incapable of generating liquid hydrocarbons until after deposition of Winton Formation sediments. It seems unlikely that significant oil generation would have taken place much before Eocene time, immediately prior to the Oligocene-Miocene tectonic event that created many of the structures in the basin. In most parts of the basin, the main phase of oil generation and migration would not have occurred until during or after this, the basin's last period of structural deformation.

All structural and stratigraphic traps which now exist in the basin, would have been effective trapping mechanisms prior to any significant oil migration.

In the deeper parts of the Eringa and Madigan troughs, the main phase of oil generation and migration from Permian source rocks may have accompanied the deposition of Winton Formation sediments. This period of intense sedimentation would have significantly assisted the hydrocarbon expulsion and migration process.

Modelling of early Palaeozoic (Ordovician) rocks in the Eringa Trough suggests that source rocks would not have reached maturity for oil generation until Permian time. Higher geothermal gradients than modelled would result in somewhat earlier generation but it is unlikely that significant volumes of hydrocarbon would have migrated from source rocks prior to the Alice Springs Orogeny in Carboniferous time..

7.6 HYDROCARBON MIGRATION

Sandstones of the Algebuckina Sandstone and Poolowanna Formation and to a lesser extent, in the study area, the Purni and Crown Point formations, are laterally well developed and extensive and long distance lateral migration might therefore be expected. An active flow of meteoric waters might impede hydrocarbon migration within the Algebuckina Sandstone. This regional aquifer receives its meteoric water charge from the north and east and would therefore have its biggest effect on the north eastern part of the study area which relies on a southwest source for hydrocarbons.

Vertical migration may be facilitated by faults, many of which appear to extend into Jurassic and in some cases younger formations.

Hydrocarbon staining in pre-Permian sediments at Colson 1 is believed to be the result of Purni Formation sourced hydrocarbons migrating along a fault conduit, in this case into a stratigraphically lower but structurally elevated formation. McKirdy (1981) sees considerable geochemical evidence for this based on n-alkane profiles, pristine/phytane ratios and the presence of exsudatinite and partially micritised exinite in the Purni Formation.

McKirdy (1981) believes the oil recovered in Poolowanna 1 was sourced from intraformational coals and shales. Smyth and Saxby (1981) suggest the oil was sourced from the underlying Peera Peera Formation.

7.7 RESERVOIRS

Sands of good to excellent reservoir quality are found in the Cadna-owie Formation, Algebuckina Sandstone and Poolowanna Formation. Additional reservoir potential is provided by the Peera Peera, Walkandi, Purni and Crown Point formations and in places by pre-Permian (Amadeus Basin equivalent) sands and carbonates. Table 3 summarises the porosities encountered by the six wells which have been drilled in the Northern Territory sector of the Pedirka Basin and placed on open file (non confidential) status.

Although excellent porosities and permeabilities can be expected within the uppermost part of the Cadna-owie Formation throughout the study area, the unit is not considered a primary reservoir objective due to its apparent isolation from mature, organically rich source rocks. The formation has been insufficiently buried, even in the deeper parts of the basin, to be organically mature and fine grained sandstones, siltstones and shales provide an effective barrier to the vertical migration of hydrocarbons. Faults may provide an efficient conduit but stratigraphically lower reservoirs would be expected to fill with hydrocarbons first. The Cadna-owie is, however, the uppermost potential reservoir in the basin, lying immediately beneath the most imposing seal (Wallumbilla, Allaru and Mackunda Formation silts and muds) in the basin and should therefore not be disregarded.

The Algebuckina Sandstone is a laterally extensive aquifer comprising fine to coarse grained, porous and permeable sandstone. The formation overlies the Poolowanna Formation, a proven source of oil in the basin and shales and siltstones of the overlying Cadna-owie Formation provide an effective regional seal. Stratigraphic equivalents of the Algebuckina Sandstone in the central and eastern Eromanga Basin (Hutton Sandstone and Namur Member of the Mooga Formation) contain some 85 percent of all known Eromanga Basin oil and gas. Flow rates of up to 4600 barrels of oil per day have been achieved on testing of the Hutton Sandstone (Muteroo Field) and 2650 barrels per day from the Namur Sandstone Member in the Dullingari Field. Although part of an extensive aquifer it is obvious from the large number of discoveries that the Hutton Sandstone and Namur Sandstone Member have not been flushed, at least to any appreciable degree. It can be concluded therefore that the Algebuckina Sandstone would not have been flushed.

Reservoir properties of the Poolowanna Formation are variable. In the deeper parts of the basin the majority of sandstones within the sequence are fine to very fine grained with low porosity and permeability, the result of extensive silica cementation. In the shallower parts of the basin, the sequence becomes sandier, coarser grained and less siliceous, providing an excellent reservoir objective. Intraformational shales and coals should provide excellent oil (and gas) prone source rocks, and shales and siltstones in the upper part of the formation, an effective seal. Two thick sandstone bodies, each overlain by a thick silt-shale interval, constitute the formation at Poeppels Corner 1 and Thomas 1. Elsewhere in the Northern Territory the formation is seen to comprise a single sand capped by a shale/siltstone interval. The formation was poorly developed at Poolowanna 1, where a flow rate of only 96 BOPD was achieved. Within the Northern Territory sector of the basin, however, reservoir development has been shown to be good to excellent.

TABLE 3

Summary of Porosity Values

Fm./Unit	Beach Comber 1 %	Colson 1 %	Hale River 1 %	McDills 1 %	Poeppels Corner 1 %	Thomas 1 %
Cadna-owie	up to 24	18-20			20-25	11-17
Algebuckina	15-27	9-26	15-25 19(c)	25-35	20-25	13-21
Poolowanna	10-18	13-16			18	7-13
Peera Peera		11-12			8-15	11-12
Walkandi					15 max	9-13
Purni		13-16	15-22 25(c)	15-25		
Crown Point		9-13	15-22 11(c)			
Finke Group			20-25	20-25		
Mereenie Sst				10-15		
Ordov/Camb.		7-16				

The above data have been obtained from well completion reports. All values are derived from log interpretation except where indicated as core (c). Values are expressed as percents and are representative of effective reservoir intervals.

The Peera Peera Formation contains only a few sands and where encountered these have been thin, for the most part of poor reservoir quality and unlikely to be laterally extensive. Abrupt local facies and porosity/permeability changes in the formation are known in South Australia. The formation was deposited in a fluvial-floodplain-lacustrine environment and heterogeneity of facies would therefore be expected. Under such conditions, the presence of a thick, well developed channel sandstone should not be dismissed. Very few wells have penetrated the formation to date and very little is therefore known about its lateral variability.

Only six wells (including four in South Australia) have penetrated the Walkandi Formation to date and very little is therefore known about the formation. The sequence is predominantly fine grained and of low porosity and permeability although reservoir quality sands have been identified through log analysis.

Point bar and other channel derived sands of the Permian Purni Formation offer excellent reservoir potential. Laterally extensive sands, deposited in high energy environments, exhibit excellent porosities and permeabilities in the western part of the study area. East of the McDills-Mayhew Trend, sands reach an average thickness of about 30 metres. West of this high, the sandstones appear to be thinner but with improved porosity and permeability. The formation has had only two valid drillstem tests, resulting in a flow of 1654 BWPD from Mokari 1 (2010-2040m) and a recovery of 1326m of slightly gas cut water at Macumba 1 (2503-2525m).

Reservoir quality within the Crown Point Formation has generally proven to be poor, with the best reservoir development being exhibited by coarser sands across palaeo-structural highs and within glacial outwash sands which commonly cap the formation. Excellent reservoir quality was found, however, in the lower Crown Point Formation at Mt. Hammersley 1. Seventeen core samples were submitted for conventional core analysis. Measured porosities ranged from 13.5 to 24.5% (averaged

21.3%) while permeabilities ranged from 91 to 1998 md (averaged 631 md). The formation proved tight at Mokari 1, but flowed water to surface at a rate of 906 BPD at Witcherrie 1 (interval 778 to 790m). From the limited data available, it is apparent that the Crown Point Formation constitutes a well developed reservoir unit west of the McDills-Mayhew Trend. The recently discovered increase in perceived Permian thickness in the Eringa Trough provides considerable scope for the presence of thick reservoir sands associated with thick, organically rich and mature lacustrine shales and may represent the most exciting play in the Pedirka Basin region. The Permian sequence contains several trillion cubic feet of recoverable gas reserves in the adjacent Cooper Basin. Much of this gas is liquids rich. Several large oil discoveries have also been made and placed on production. Perhaps future drilling will lead to the Eringa-Madigan Trough also becoming an important oil and gas producing province.

Very little is known about the reservoir potential of the pre-Permian section. The Langra Formation, Polly Conglomerate and in particular, the Mereenie Sandstone each contain potential reservoir beds and the middle unit of the Langra Formation and the Horseshoe Bend Shale could act as cap rocks. Ordovician clastics have proven to be good oil and gas producers in the Amadeus Basin. The Pacoota Sandstone, the major oil and gas producer in the Amadeus Basin (Mereenie and Palm Valley fields) exhibits good reservoir quality as does the Stairway Sandstone, also an oil and gas producer in these two fields. There is no reason not to expect similar reservoir development within the study area. In the Amadeus Basin proper, porosity and permeability in the Pacoota and Stairway sandstones can be patchy, being controlled both by their depositional environments, and the degree of post-depositional fracturing.

It has been suggested that the Carmichael Sandstone may extend into at least the northwestern part of the study area and this would provide another potential Ordovician reservoir. Low permeability units such as the Stokes Siltstone would act as cap rocks.

No suitable reservoirs have been identified within Cambrian strata underlying the Pedirka Basin. Tight carbonates have been encountered. Future work may identify porous and permeable reef facies. In the Amadeus Basin, sands are the predominant Cambrian facies and may therefore be expected in the western part of the study area.

8.0 EXPLORATION POTENTIAL

8.1 PLAY CONCEPTS

The exploration programme conducted in the Pedirka Basin to date has demonstrated that an abundance of organically rich source rocks, porous and permeable reservoirs with effective vertical seals, and closed anticlinal structures are present throughout the study area. Reservoir objectives and their associated source rocks range in age from earliest Cambrian to Early Cretaceous.

Geochemical evidence, however, has shown that an insufficiency of organic maturity is the primary reason for the lack of exploration success in the basin to date. Geothermal gradients within the study area are low, particularly when compared with those of the nearby gas and oil productive, Cooper/Eromanga Basin region.

The well to offer most encouragement (Poolowanna 1) was drilled near the centre of the Poolowanna Trough where source rocks have reached the main phase of oil generation. The most prospective areas for future exploration in the basin are considered to be the Eringa, Madigan and Poolowanna Troughs where deeper burial and hence improved thermal maturity of source rocks will be achieved. Long distance migration of hydrocarbons should be expected only within the Algebuckina Sandstone and perhaps Poolowanna Formation.

The McDills-Mayhew Trend defines the eastern limit of the Eringa Trough. Six wells have been drilled along the flanks and on the crest of this feature without any significant hydrocarbon shows being observed.

Organically rich lacustrine shales and coal measure deposits are expected to be well developed within the Permo-Triassic and basal Jurassic sequence in the Eringa and Madigan troughs. Well and seismic information suggests these source rock horizons will be sufficiently buried to place them within the main phase of oil generation and expulsion. The almost total lack of hydrocarbon shows along the McDills-Mayhew Trend needs explanation.

On the assumption that significant quantities of oil and/or gas have been generated within the Eringa Trough sequence, it follows that either the McDills-Mayhew Thrust Fault provides a barrier to the eastward migration of hydrocarbons from the trough or that the structural configuration of the trough does the same. The throw on the McDills-Mayhew Thrust is significant, juxtaposing potential Permian, Triassic and Early Jurassic source rocks in the Eringa Trough against poorly permeable Devonian sediments of the upthrown block. The porous Mereenie Sandstone encountered at McDills 1 is interpreted to be juxtaposed against non-source rocks of the Crown Point Formation (Figure 7).

Figure 7 and Enclosure 1 clearly show that most of the oil and or gas migration out of the Eringa Trough would be in a western and northwestern direction, away from the McDills-Mayhew Trend. It is suggested that structural and stratigraphic traps be sought along these flanks of the trough. This part of the basin has not been tested and existing seismic is extremely limited (Enclosure 9).

The Madigan Trough should also contain suitable source rocks which have been sufficiently buried for effective oil generation and migration and this area should therefore be evaluated.

We believe that the depositional regime that existed in the Eringa and Madigan troughs was considerably different to that of the Poolowanna Trough. We believe the hydrocarbon potential of the former two depositional areas will prove to be much greater than that offered by the Poolowanna Trough.

Thomas 1 found organically mature source rocks in the Poolowanna Trough. A lack of hydrocarbons at Thomas 1 may be attributed to the well being drilled off structural closure. Seismic mapping indicates that Thomas 1 was drilled within closure but proximity to a large thrust fault renders seismic resolution unclear. It is quite possible that the closure mapped at Thomas 1 is open to the north and that generated hydrocarbons would have been trapped instead in the structurally higher closure which is mapped to the north of Thomas 1.

The pre Permo-Carboniferous sequence also deserves further consideration. McDills 1 and Mt Crispe 1 have verified that a thick sequence of Devonian and older rocks is present in the western part of the study area (Figure 11). Where encountered in the subsurface to date, these rocks have exhibited largely redbed characteristics and offer only little source rock potential and with the exception of the Mereenie Sandstone, little reservoir potential.

The McDills-Mayhew Trend is located along a palaeo hinge line of the proto Eringa Basin. Wells which have encountered early Palaeozoic sediments in the subsurface have done so in a shelf or platform position. Sediment facies in the basin proper would have been considerably different to that on the shelf, with organically rich shales, carbonates and clean, porous sandstones expected. Several episodes of pre-Permian orogenic movement would have formed suitable structural traps. These structures would be largely masked by the thick blanket of relatively flat lying, upper Palaeozoic and Mesozoic sediments. As the structural orientation of some of the older structures may be normal to the structural configurations of recently formed structures, seismic 'strikelines' may be necessary to delineate them. Ordovician sandstones in the Amadeus Basin proper are proven oil and gas producers, with the Palm Valley and Mereenie fields currently on production.

The Algebuckina Sandstone exhibits the best reservoir development in the basin. This unit is stratigraphically equivalent to the Hutton Sandstone and Hooray Sandstone of the eastern Eromanga Basin. The Hutton Sandstone has proven to be a significant hydrocarbon producer but a large number of wells were drilled through the formation before its significance was realised. It is unlikely, however, that the Algebuckina Sandstone will have access to a mature, source interval.

8.2 PROSPECTS AND LEADS

8.2.1 Structural

Numerous leads and prospects have been identified from seismic data acquired within the study area (Figure 25 and Enclosures 9 and 10). For the purpose of discussion, these are divided below into groups according to the structural trend on which they occur.

McDills-Mayhew Trend

Several small, discrete culminations exist along the length of this major anticlinal feature. The southern extent has been tested without success by McDills 1 and Etingimbra 1 in the Northern Territory and by four wells in South Australia. Untested culminations along the northern part of the

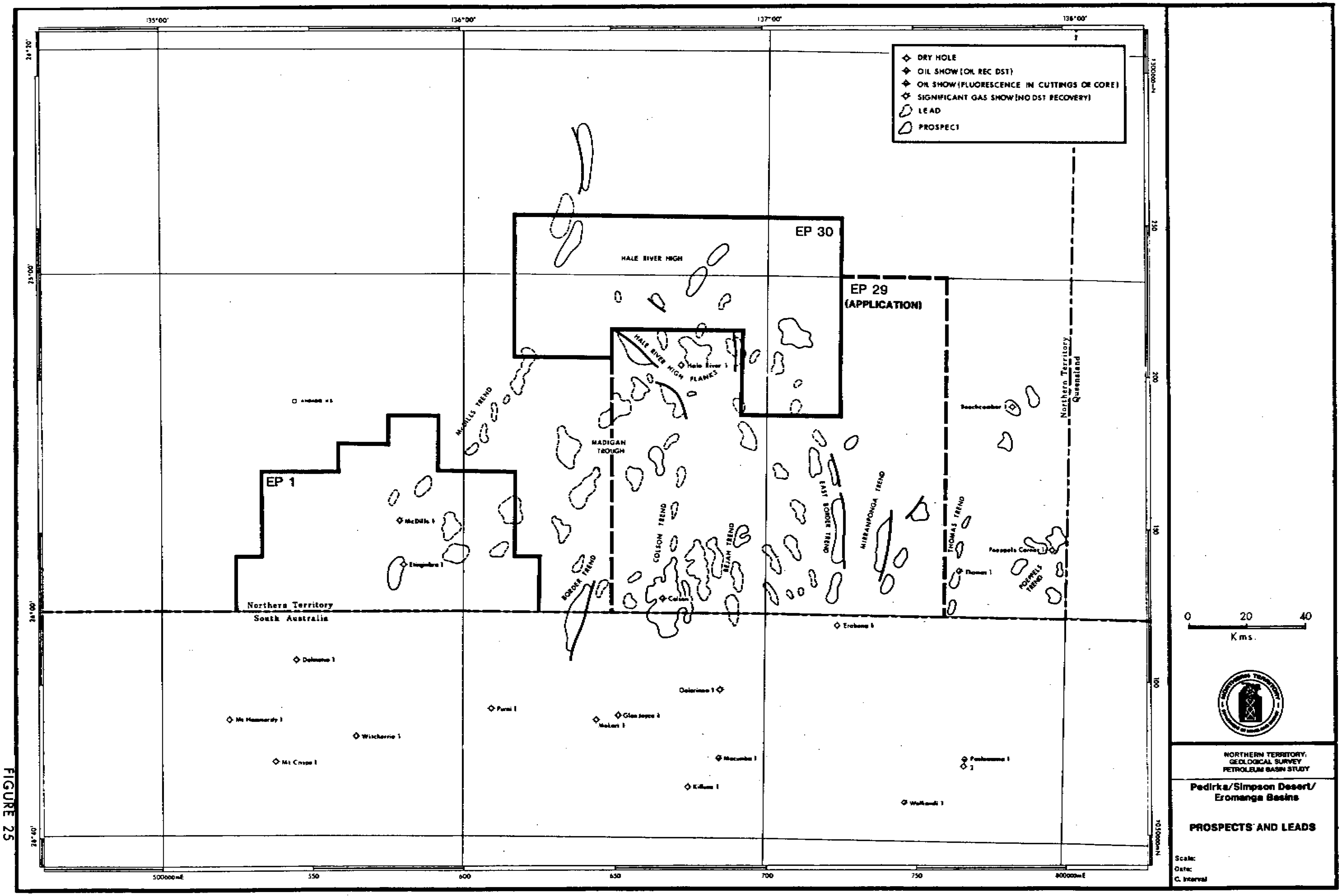

DRY HOLE
OIL SHOW (OIL REC DST)
OIL SHOW (FLUORESCENCE IN CUTTINGS OR CORE)
SIGNIFICANT GAS SHOW (NO DST RECOVERY)
LEAD
PROSPECT
EP 30
HALE RIVER HIGH
EP 29
(APPLICATION)
HALE RIVER HIGH FLANKS
Hale River 1
McDILLS TREND
MADIGAN TROUGH
EP 1
McDills 1
Etingimbra 1
BORDER TREND
COLSON TREND
BEJAH TREND
Colson 1
EAST BORDER TREND
MIRRANPONGA TREND
THOMAS TREND
Beachcomber
Poeppels Corner 1
Thomas 1
POEPPELS TREND
Northern Territory
Queensland
Northern Territory
South Australia
Erabena 1
Dalmatia 1
Purni 1
Glen Joyce 1
Mt Crispe 1
Witcherrie 1
Macumba 1
Walkandi 1
Kms.
0
20
40
NORTHERN TERRITORY GEOLOGICAL SURVEY
PETROLEUM BASIN STUDY
Pedirka/Simpson Desert/
Eromanga Basins
PROSPECTS AND LEADS
Scale:
Date:
C. Interval

FIGURE 25

feature remain attractive targets having good access to hydrocarbons which may have been generated from the Madigan depression to the east. Although McDills 1 and Etingimbra 1 did not receive hydrocarbons from the Eringa Trough, the trough's proximity to the remaining leads and prospects should still be considered positively. Because of the structural configuration of the area, hydrocarbon migration from the Eringa Trough towards the McDills-Mayhew Trend should have been more efficient in the north than in the south.

The depth to the top of the Cadna-owie Formation ranges from 100m in the north to 700m in the south and drilling depths to penetrate the Mesozoic and Upper Palaeozoic sequence are relatively shallow. Lower Palaeozoic (Cambrian through Devonian) clastics and minor carbonates offer additional hydrocarbon potential. On the basis of our present understanding of the basin, however, the lower Palaeozoics will likely prove to be a red bed sequence with limited hydrocarbon source potential. A few of the leads have recent seismic data over them but, in general, further seismic should be acquired to bring them to a drillable prospect status.

Hale River High

Small to medium sized structures are present across the structurally complex Arunta Platform. Hale River 1, the only petroleum exploration well in the area, encountered Jurassic and Permian objectives in an off-structure position. Only a very thin (48m) pre-Permian section was present prior to reaching what is interpreted to be effective basement. Drilling depths to basement do not exceed 1400m and source rocks within close proximity to the area are therefore expected to be immature for the generation of significant hydrocarbons. The Algebuckina provides a valid reservoir objective in the area as long distance hydrocarbon migration from the Madigan, Poolowanna and Eringa Troughs might be effected through the formation's porous and permeable sands.

The leads have been identified with single fold seismic data and additional, modern seismic data will be required to mature them for drilling.

Hale River High Flanks

Sediments rapidly thicken southwards off the Arunta Platform and unlike at Hale River 1, Poolowanna Formation, Triassic and pre Permo-Carboniferous sediments are expected to be developed in the more southern of these structures. Most of the structures are fault dependent, downthrown into the basin, with prospective reservoirs on the downside of faults. Many of the leads do not exhibit fault independent closure at or above Cadna-owie level. The leads are potentially large with the depth to primary targets in the order of 1200m. None of the features in this area has been brought to prospect status and additional seismic is therefore necessary. Long distance hydrocarbon migration may be necessary to charge the traps.

Madigan Trough

Several medium to large size closures are mapped on the flanks of the Madigan Trough, a major depocentre containing a thick Mesozoic succession and interpreted to have in the order of 1000m of Permian sediments. A lack of access of reservoir rocks to mature source rocks has been cited as the primary reason for a lack of success in the Pedirka Basin region to date. Lower Jurassic, Triassic and Permian source rocks should have been sufficiently buried in the Madigan Trough to have reached the main phase of oil generation and expulsion. Valid structural traps in close proximity to the trough should therefore present exciting exploration targets.

On the basis of its configuration (a relatively small, circular depression) and its relative geographic position, it is quite probable that a thick accumulation of organically rich, lacustrine shales and swamp deposits (in particular coals) has accumulated in the northern depocentre of the Madigan trough during Permian to Early Jurassic time.

The character and thickness of the pre Permo-Carboniferous is unknown but this sequence presents an additional exploration objective in the Madigan Trough area.

The proximity of large, closed structures to a potentially large, organically very rich and mature source kitchen makes this untested play area particularly attractive.

Border Trend

The Border Trend separates the Madigan Trough to the northwest from the Poolowanna Trough to the southeast and acted as a hingeline throughout the entire time sediments were being deposited into the Poolowanna Trough. Structures located along the Border Trend are thus ideally positioned to receive hydrocarbons which may have migrated from either depocentre. All potential reservoir objectives are interpreted to be present over the Border highs although the Poolowanna Formation is expected to be thin and its internal seals may therefore be absent.

The Border Trend remains untested in the Northern Territory. A large prospect which straddles the South Australian border and a few smaller leads have been identified by seismic.

Poolowanna Trough Trends

The Colson, Bejah, East Border, Mirranponga, Thomas and Poeppels Trends are northerly trending highs along the northern margin of the Poolowanna Trough. Oil shows were encountered in Colson 1 and Thomas 1 and structural advantage can be gained on both. Poolowanna 1, drilled near the axis of the Poolowanna Trough, has provided the most encouragement to date with respect to the hydrocarbon potential of the basin with recoveries of oil being made from both the Poolowanna Formation and the Peera Peera Formation.

Depths to primary reservoir targets vary from 1700m to 2100m. The Poolowanna Formation is estimated to range from 80 to 100m in thickness, the Triassic from 135 to 150m and the Permian from 0 to 260m. There are very few places in the study area where both Permian and Triassic source rock/reservoir units are present. The Permian pinchout essentially follows the Bejah Trend.

All of the prospects and leads in the area require further seismic to mature them for drilling.

8.2.2 Stratigraphic

Stratigraphic prospects and leads have not been specifically identified in the Pedirka Basin region to date, probably because of the large number of the more conventional structural traps which remain to be drilled. Encouragement was found at Poolowanna 1 and a lack of success to date in drilling closed structures might lead some explorationists towards identifying potential stratigraphic trapping mechanisms.

Stratigraphic traps will occur as onlap and pinchout traps along the basin margins and on the flanks of the major structural highs. Unconformity traps are expected at the base Mesozoic and base Permian unconformities but may have questionable seal integrity.

Most of the more prospective section in the study area was deposited under fluvial or fluvial associated conditions and hence exhibit complex and heterogeneous facies. It is unlikely that present seismic will be able to resolve most of the thin local facies changes which may provide stratigraphic traps.

Perhaps the best stratigraphic traps will be found where the Peera Peera and Poolowanna formations wedge out towards the east and north or where the Purni and Crown Point Formations wedge out to the east. The precise wedgeout edge of each of these formations will not define the actual position of the stratigraphic trap as these wedgeout edges are apt to be overlain by sands of the overlapping formations. It will be intraformational sandstone wedgeouts which will offer the best potential.

9.0 CURRENT EXPLORATION OPPORTUNITIES

Acreage that is currently open for exploration is available in the west on the western flanks of the Eringa Trough, over the northern portions of the McDills-Mayhew Trend and the highly prospective Casuarina/Madigan Trough, and in the east, over the Thomas and Poeppels trends in the northern portion of the Poolowanna Trough. Two current petroleum exploration permits and one Application Block cover the remainder of the region (Figure 26).

EP 1 is held by Territory Petroleum NL, a wholly owned subsidiary of Adelaide Petroleum NL. The permit, having an area of 4640 sq km, covers the southern extent of the McDills-Mayhew Trend and the southeastern portion of the Eringa Trough. The permit has commenced the first year of its second term. The operator recently (January, 1990) drilled Etingimbra 1 as the final work commitment of its first term.

Cluff Resources Pacific Ltd is the holder/operator of the recently awarded permit EP 30 which covers the northern extension of the Hale River High and its flanks on the Arunta Platform in the north of the region. The permit is 5474 sq km in area and is in the first year of its first term.

An application (EP 29A) to explore has been submitted by Nobjade Pty Ltd and Dynoil Inc. This application covers the central portion of the region centred on the Colson, Bejah and East Border trends. The application area also includes the Colson 1 and Hale River 1 wells.

There are two Aboriginal land claims which are current in the area. The Simpson Desert Land Claim was originally made by the Central Land Council in 1980 and amended in 1986. It covers the entire area east of 136° 15'E but no inquiry has been sought and the claim is not ready to proceed.

The Finke Land Claim covers that portion of the area between 135°25'E and 136°15'E. The Central Land Council made this claim in 1983 and amended it in 1984 and 1986. The initial hearing was held in late 1989. The followup is proposed for April 1990 with all submissions due by June 1990. The Commissioner's decision is expected in December 1990 or January 1991.

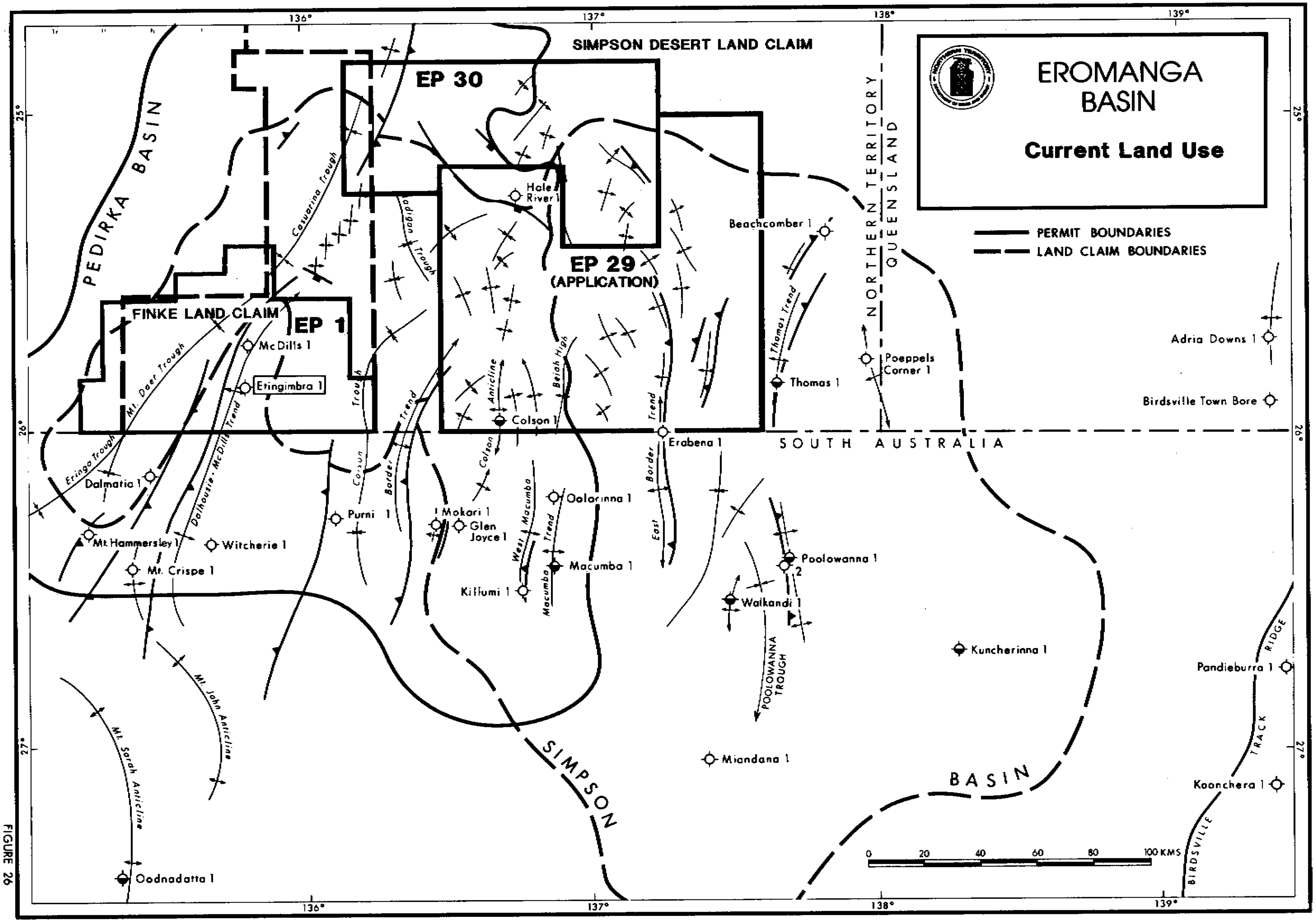

EROMANGA BASIN
Current Land Use
PERMIT BOUNDARIES
LAND CLAIM BOUNDARIES
SIMPSON DESERT LAND CLAIM
EP 30
EP 29 (APPLICATION)
EP 1
FINKE LAND CLAIM
PEDIRKA BASIN
SIMPSON BASIN
NORTHERN TERRITORY
QUEENSLAND
SOUTH AUSTRALIA
BIRDSVILLE TRACK RIDGE
POOLOWANNA TROUGH
Casuarina Trough
Madigan Trough
Mt. Daer Trough
Eringa Trough
Dalhousie - McDills Trend
Border Trend
East Border Trend
Colson Anticline
Beach High
West Macumba Trend
Macumba
Thomas Trend
Mt. John Anticline
Mt. Sarah Anticline
Hale River 1
Beachcomber 1
McDills 1
Etingimbra 1
Colson 1
Thomas 1
Poeppels Corner 1
Adria Downs 1
Birdsville Town Bore
Erabena 1
Dalmatia 1
Oolarinna 1
Purni 1
Mokari 1
Glen Joyce 1
Mt. Hammersley 1
Witcherie 1
Mt. Crispe 1
Macumba 1
Poolowanna 1
2
Kilfumi 1
Walkandi 1
Kuncherinna 1
Pandieburra 1
Miandana 1
Koonchera 1
Oodnadatta 1
136°
137°
138°
139°
25°
26°
27°
0 20 40 60 80 100 KMS

FIGURE 26

10.0 CONCLUSIONS

The drilling of twenty exploration wells in a basin without a commercial success is not unusual. Disappointing as it might be, the lack of exploration success in the Pedirka Basin region should not be considered unduly significant. Many of the wells drilled to date evaluated similar play concepts in shallow parts of the basin where reservoir objectives did and do not have access to mature source rocks. The biggest problem in the basin has proven to be an apparent lack of organic maturity. Source rocks are organically rich with a high percentage of vitrinitic (gas prone) and often exinitic (oil prone) material and reservoir objectives are abundant and well developed with porosities ranging from 10 to 20 percent and accompanied by reasonable permeabilities.

Organic maturity is the only ingredient remaining for the establishment of an important hydrocarbon province. This maturity is interpreted to be found in the Madigan and Eringa Troughs in the western part of the study area where thick sequences of organically rich source rocks should be present.

Most of the exploration in the Pedirka Basin region to date has concentrated on the Upper Palaeozoic and Mesozoic succession. Early Palaeozoic strata have proven to be oil and gas productive in the Amadeus Basin (commercial production at Mereenie and Palm Valley fields) and good hydrocarbon indications have been found in these rocks in the poorly explored Officer Basin. These two basins and the virtually unexplored Warburton Basin (also a Lower Palaeozoic Basin) become transitional with each other in the Eringa Trough. Lower Palaeozoic clastics and carbonates are considered to offer excellent hydrocarbon potential within the Eringa Trough although they have yet to be explored. Wells which have penetrated these older sediments east of the Eringa Trough have found a predominantly red bed sequence, void of potential source rocks. The Eringa Trough appears to have been a pronounced depression during Early Palaeozoic time and a totally different suite of sedimentary rocks to that seen on the eastern shelves would have accumulated in it.

The Pedirka Basin region needs at least three additional exploratory tests: one in the Eringa Trough to evaluate Permian and pre-Permian objectives, one adjacent to the Madigan Trough in the northwest to evaluate Permian to Lower Jurassic objectives and one north of Thomas 1 in the northern Poolowanna Trough to evaluate the Triassic and Lower Jurassic succession there. Each of these plays provides an ideal, relatively inexpensive, exploration opportunity for a small joint venture team and all are considered moderate risk, moderate potential projects.

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APPENDIX ONE

FORMATION TOPS AND BASIC WELL DATA

Formation Tops — Northern Territory Wells

FORMATION	BEACHCOMBER 1 (KB 61.7m) KB	SS	Thickness	COLSON 1 (KB 90.8m) KB	SS	Thickness	HALE RIVER 1 (KB 125.3m) KB	SS	Thickness
Winton/Eyre	5.0	56.7	605.0	7.0	83.8	660.5	5.0	120.3	834.7
mid Cretaceous	610.0	-548.3	490.2	667.5	-576.7	665.5			
Cadna-owie	1100.2	-1038.3	33.3	1333.0	-1242.2	39.2	839.7	-714.4	35.1
Algebuckina	1133.5	-1071.8	558.0	1372.2	-1281.4	581.3	874.8	-749.5	393.8
Poolowanna	1691.5	-1629.8	79.0	1953.5	-1062.7	109.4	NP	NP	NP
Peera Peera	?1770.5	?-1708.8	?16	2062.9	-1972.1	34.7	NP	NP	NP
Walkandi	NP	NP	NP	NP	NP	NP	NP	NP	NP
Purni	NP	NP	NP	2097.6	-2006.8	187.5	1268.6	-1143.3	81.4
Crown Point	NP	NP	NP	2285.1	-2194.3	103.3	1350.0	-1224.7	35.3
Finke Group	NP	NP	NP	NP	NP	NP	?1385.3	?-1260.0	?48.5
Pre Devonian	NP	NP	NP	?2388.4	?-2297.6	?42.1+	NP	NP	NP
Proterozoic	?1786.5	?-1724.8	?39.5+	NR	NR	NR	1433.8	-1308.5	298.4+
TD (Logger)	1826.0	-1764.3		2430.5	2339.7		1732.2	-1606.9	

FORMATION	McDILLS 1 (KB 125.6m) KB	SS	Thickness	POEPPELS CORNER 1 (KB 46.6m) KB	SS	Thickness	THOMAS 1 (KB 37.4m) KB	SS	Thickness
Winton/Eyre	4.9	120.7	432.8	Surface	41.0	810.3	7.0	30.4	797.0
mid Cretaceous				815.9	-769.3	551.7	804.0	-766.6	591.5
Cadna-owie	437.7	-312.1	25.0	1367.6	-1320.9	81.0	1395.5	-1358.1	42.6
Algebuckina	462.7	-337.1	255.1	1448.6	-1402.0	598.3	1438.0	-1400.7	636.9
Poolowanna	NP	NP	NP	2046.9	-2000.3	193.6	2075.0	-2037.6	193.0
Peera Peera	NP	NP	NP	2240.5	-2193.8	98.7	2268.0	-2230.6	152.0
Walkandi	NP	NP	NP	2339.2	-2292.6	43.0	2420.0	-2382.6	40.0
Purni	717.8	-592.2	238.4	NP	NP	NP	NP	NP	NP
Crown Point	956.2	-830.6	199.0	NP	NP	NP	NP	NP	NP
Finke Group	?~1155.2	-1029.6	1595.3	?2382.2	?-2335.6	?208.5+	NP	NP	NP
Pre Devonian	2750.5	-2624.9	454.5+	NR	NR	NR	?2460.0	?-2422.6	?157.2+
Proterozoic	NR	NR	NR	NR	NR	NR	NR	NR	NR
TD (Logger)	3205.0	3079.4		2590.7	-2544.1		2617.2	-2579.8	

Formation Tops — South Australian Wells

FORMATION	DALMATIA 1 (KB 169.8m)			ERABENA 1 (KB 73.1m)			GLEN JOYCE 1 (KB 76.6m)		
	KB	SS	Thickness	KB	SS	Thickness	KB	SS	Thickness
Winton/Eyre	4.3	165.5	299.6	5.4	67.7	674.9	6.1	70.5	737.0
mid Cretaceous				680.3	-607.2	666.6	743.1	-666.5	495.6
Cadna-owie	303.9	-134.1	14.9	1346.9	-1273.8	46.4	1238.7	-1162.1	46.7
Algebuckina	318.8	-149.0	272.5	1393.3	-1320.2	576.3	1285.4	-1208.8	582.4
Poolowanna	NP	NP		1969.6	-1896.5	293.8	1867.8	-1791.2	94.8
Peera Peera	NP	NP	NP	2263.4	-2190.3	116.8	NP	NP	NP
Walkandi	NP	NP	NP	?2380.2	?-2307.1	?53.4	NP	NP	NP
Purni	591.3	-421.5	237.2	NP	NP	NP	1962.6	-1886.0	196.3
Crown Point	828.5	-658.7	118.8	NP	NP	NP	2158.9	-2082.3	48.5
Finke Group	?947.3	?-777.5	?595.9+	2433.6	-2360.5	106.0	?2207.4	?-2130.8	?82.3+
Pre Devonian	NR	NR	NR	2539.6	-2466.5	45.1+	NR	NR	NR
Proterozoic	NR	NR	NR	NR	NR	NR	NR	NR	NR
TD Logger	1543.2	-1373.4		2584.7	-2511.6		2289.7	-2213.1	

FORMATION	MT. HAMMERSLEY 1 (KB 178.9m)			OOLARINNA 1 (KB 63.6m)			POOLOWANNA 1 (KB 30.5m)		
	KB	SS	Thickness	KB	SS	Thickness	KB	SS	Thickness
Winton/Eyre	4.3	174.6	313.9	6.1	57.5	726.6	6.0	24.5	876.7
mid Cretaceous				732.7	-669.1	724.3	882.7	-852.2	698.0
Cadna-owie	318.2	-139.3	22.3	1457.0	-1393.4	49.3	1580.7	-1550.2	50.0
Algebuckina	340.5	-161.6	264.2	1506.3	-1442.7	720.0	1630.7	-1600.2	756.5
Poolowanna	NP	NP	NP	2226.3	-2162.7	125.0	2387.2	-2356.7	205.5
Peera Peera	NP	NP	NP	2351.3	-2287.7	140.5	2592.7	-2562.2	175.8
Walkandi	NP	NP	NP	NP	NP	NP	2768.5	-2378.0	133.2
Purni	604.7	-425.8	285.9	2491.8	-2428.2	113.4	NP	NP	NP
Crown Point	890.6	-711.7	701.1	2605.2	-2541.6	34.4	NP	NP	NP
Finke Group	?1591.7	?-1412.8	?182.9	NP	NP	NP	NP	NP	NP
Pre Devonian	?1774.6	?-1595.7	?89.9+	?2639.6	?2576.0	?38.7+	?2901.7	?-2871.2	172.2+
Proterozoic	NR	NR	NR	NR	NR	NR	NR	NR	NR
TD Logger	1864.5	-1685.6		2678.3	-2614.7		3073.9	-3043.4	

KILLUMI 1 (KB 60.4m)			MACUMBA 1 (KB 45.7m)			MOKARI 1 (KB 68.0m)			MT. CRISPE 1 (KB 131.4m)		
KB	SS	Thickness	KB	SS	Thickness	KB	SS	Thickness	KB	SS	Thickness
6.1	54.3	667.2	6.0	39.7	689.9	4.0	64.0	615.0	4.0	127.4	5.1
673.3	-612.9	691.9	695.9	- 650.2	727.5	619.0	-551.0	574.0	9.1	122.3	175.6
1365.2	-1304.8	49.7	1423.4	-1377.7	54.3	1193.0	-1125.0	48.0	184.7	-53.3	28.0
1414.9	-1354.5	709.6	1477.7	-1432.0	710.8	1241.0	-1173.0	562.2	212.7	-81.3	233.8
2124.5	-2064.1	86.5	2188.5	-2142.8	102.4	NP	NP	NP	NP	NP	NP
2211.0	-2150.6	101.2+	2290.9	-2245.2	115.8	NP	NP	NP	NP	NP	NP
NR	NR	NR	?2406.0	?-2361.0	?40.6	NP	NP	NP	NP	NP	NP
NR	NR	NR	2447.3	-2401.6	75.3	1803.2	-1735.2	349.6	NP		
NR	NR	NR	2522.6	-2476.9	40.8	2152.8	-2084.8	101.2	446.5	315.1	19.2
NR	NR	NR	?2563.4	?-2517.7	?53.6+	NP	NP	?131.7+	? NP	? NP	NP
NR	NR	NR	NR	NR	NR	?2254.0	?-2186.0	NR	465.7	334.3	?1255.5+
NR	NR	NR	NR	NR	NR	NR	NR	NR	? NR	? NR	NR
2312.2	-2251.8		2617.0	-2571.3		2385.7	-2317.7		1721.2	-1589.8	

PURNI (KB 77.7m)			WALKANDI 1 (KB 30.8m)			WITCHERRIE 1 (KB 100.9m)		
KB	SS	Thickness	KB	SS	Thickness	KB	SS	Thickness
4.9	72.8	412.7	5.5	25.3	1683.1	?4.9	?96.0	?10.3
417.6	-339.9	630.9	-	-		15.2	85.7	264.8
1048.5	970.8	79.3	1688.6	-1657.8	48.5	280.0	-179.1	36.1
1127.8	-1050.1	210.3	1736.8	-1706.3	801.9	316.1	-215.2	238.3
eq1338.1	-1260.4	78.9	2538.7	-2508.2	196	NP	NP	NP
NP	NP	NP	2734.7	-2704.2	190.2	NP	NP	NP
NP	NP	NP	2924.9	-2894.4	102.4	NP	NP	NP
1417.0	-1339.3	281.0	NP	NP	NP	NP	NP	NP
1698.0	-1620.3	88.1	NP	NP	NP	554.4	-453.5	242.4
NP	NP	NP	NP	NP	NP	796.8	-695.9	373.0
NP	NP	NP	3027.3	-2996.8	104.3+	?1169.8	?-1068.9	?294.2+
?1786.1	?-1708.4	?93.9+	NR	NR	NR	NR	NR	NR
1880.0	-1802.3		3131.6	-3103.1		1464.0	-1363.1	

BEACHCOMBER 1

BASIC DATA

OPERATOR:	Beach Petroleum N.L.	
PETROLEUM TITLE:	OP-184, Northern Territory	
PARTICIPANTS:	Beach Petroleum N.L.	82.5 percent
	Peko Oil Ltd.	17.5 percent
LOCATION: Lat.:	25° 22' 43.89"S	
Long:	137° 48' 8.50" E	
Seismic:	SP 440, Line SD 84-40	
ELEVATION: GL:	56.7m above sea level	
RKB:	61.7m above sea level	
DRILLING COMMENCED:	1130 hrs - 29th October, 1988	
RIG RELEASED:	1400 hrs - 14th November, 1988	
DRILLING TIME TO TD:	17 days	
RIG:	ATCO - APM Drilling Pty Ltd Rig No. 47	
TOTAL DEPTH:	Driller - 1829.0m Logger - 1826.0m	
BOTTOM HOLE TEMP.:	110°C at 1829m	
STATUS:	Plugged and Abandoned	
N.T.D.M.E. REF.:	PR88/086	

COMPLETION DETAILS: Casing 9 5/8" set at 327.0m

Five cement plugs as follows:

1: 1770-1800m
2: 1660-1690m
3: 1140-1170m
4: 311-341m
5: 0-45m

STRATIGRAPHY:

AGE	FORMATION	DEPTH(m)	ELEV.(m)	THICKNESS(m)
Tertiary-Recent	Surficial & Eyre Fm.	5.0	+56.7	107.0
Late Cretaceous	Winton Fm.	112.0	-50.3	498.0
Early Cretaceous	Oodnadatta Fm.	610.0	-548.3	261.0
Early Cretaceous	Toolebuc Fm. Equiv.	871.0	-809.3	71.0
Early Cretaceous	Bulldog Shale	942.0	-880.3	158.2
Early Cretaceous	Cadna-owie Fm.	1100.2	-1038.5	33.3
Late-Mid Jurassic	Algebuckina Sandstone	1133.5	-1071.8	558.0
Early Jurassic	Poolowanna Fm.	1691.5	-1629.8	79.0
Late Jurassic	Peera Peera Fm. (?)	1770.5	-1708.8	16.0
? Proterozoic	Metamorphic Basement	1786.5	-1724.8	39.5+
TOTAL DEPTH	1826.0	-1764.3		

All formations were encountered consistantly high to prognosis with the Cadna-owie Formation 27.8m high and the Poolowanna Formation 38.5m high.

STRUCTURE: A broad, WNW-ESE trending structure, fault bounded along south eastern flank. There appears to be little, if any, fault independent closure on this flank. Permian and Triassic strata thin and pinch out onto the flanks of the high, although Jurassic-Cretaceous sediments do not exhibit notable thinning.

WIRELINE LOGS: The following wireline logs were run by Gearhart Australia:

LOG TYPE	RUN	INTERVAL (LOGGER)
DLL -	1	1825.4-327.0m
- MSFL		1825.4-327.0m
- GR		1825.4-327.0m
- SP		1825.4-327.0m
- CAL		1825.4-327.0m
BCS -	1	1822.0-14.7m
- CAL		1822.0-14.7m
- GR		1822.0-14.7m
SLD-CNT-GR	1	1815.0-1565.0m
1200.0-1080.0m		
CIS	1	
SWC	1	Shot 22, rec. 13
	2	Shot 24, rec. 17

DEVIATION SURVEYS: Maximum measured hole deviation was 3.75° at 1674m.

CORES: No full hole cores were cut. Sidewall cores were obtained between 1005.0 and 1784.0m KB:

DEPTH	LITHOLOGY	DEPTH	LITHOLOGY	DEPTH	LITHOLOGY
1136.0m	Sandstone	1685.0m	Sandstone	1136.0m	Sandstone
1102.0m	Sandstone	1653.0m	Sandstone	1132.0m	Claystone
1097.0m	Claystone	1646.0m	Sandstone	1104.0m	Sandstone
1784.0m	Sandstone	1631.5m	Claystone	1088.0m	Claystone
1780.0m	Sandstone	1569.0m	Sandstone	1005.0m	Claystone
1715.0m	Claystone	1225.0m	Sandstone		

FORMATION TESTS: No formation tests were conducted.

VELOCITY SURVEY: A velocity survey was conducted by Velocity Data Pty Ltd on reaching total depth.

HYDROCARBON SHOWS: A total gas detector and FID chromatograph were in operation from 900m to T.D. (1829m). No significant hydrocarbon shows were noted. Minor shows were noted in coals and in a black shale of the Poolowanna Formation.

RESERVOIRS: Beachcomber 1 demonstrated the presence of excellent reservoir sands within the Cadna-owie, Algebuckina and Poolowanna formations with log derived porosities ranging up to 24% in the Cadna-owie Formation and 27% in the Algebuckina Sandstone. Adequate seals were present for all three units. Log interpretation indicates all reservoirs to be water saturated.

SOURCE ROCKS: Source rocks with some oil source potential were present in the basal Algebuckina and Poolowanna formations, however, they have only reached the very onset of marginal maturity.

SPECIAL ANALYSES:

- Palynology (for ages)
- Source Rock Analysis (VR, TOC, Rock-Eval pyrolysis)

COLSON 1

BASIC DATA

OPERATOR:	North Broken Hill Ltd
PETROLEUM TITLE:	OP-177, Northern Territory
PARTICIPANTS:	Beach Petroleum N.L. North Broken Hill Ltd North Broken Hill Ltd were earning an interest in OP-177.
LOCATION: Lat:	25° 57' 45" S
Long:	136° 40' 00" E
Seismic:	Just south of line B4 between VP's 111 and 112
ELEVATION: GL:	83.8m above sea level
RKB:	90.8m above sea level
DRILLING COMMENCED:	20th November, 1978
RIG RELEASED:	13th December, 1978
DRILLING TIME TO T.D.	20 days
RIG:	Richter National 100
TOTAL DEPTH:	Driller - 2432.3m, Logger - 2430.5m
BOTTOM HOLE TEMP:	111°C @ T.D. Not corrected
STATUS:	Plugged and Abandoned
N.T.D.M.E. REF.:	PR79/001

COMPLETION DETAILS: 9 1/2" casing set at 1350.3m (driller). Abandonment plugs were set as follows:

1. Open end at 1934m - 50 sacks
2. Open end at 1362m - 50 sacks
   Neither plug was felt for.
3. Surface plug of 10 sacks.

STRATIGRAPHY:

AGE	FORMATION	DEPTH(m)	ELEV.(m)	THICKNESS(m)
Cainozoic	Eyre Fm.	Surface	+83.8	168.6
U. to L. Cretaceous	Winton Fm.	175.6	-84.8	491.9
Lower Cretaceous	Tambo Fm.	667.5	-576.7	414.5
Toolebuc Fm.	1082.0	-991.2	29.0	
Roma Fm.	1111.0	-1020.2	219.2	
L. Cret. to U. Jur.	Cadna-owie Fm.	1333.0	-1242.2	39.2
U. to Middle Jurassic	Algebuckina Sst.	1372.2	-1281.4	581.3
M. to Lower Jurassic	Poolowanna Fm.	1953.5	-1862.7	109.4
M. to Upper Triassic	Peera Peera Fm.	2062.9	-1972.1	34.7
Lower Permian	Purni Fm.	2097.6	-2006.8	187.5
Basal Permian	Crown Point Fm.	2285.1	-2194.3	103.3
Pre-Permian	Unnamed-Pre Devon?	2388.4	-2297.6	42.1+
	TOTAL DEPTH	2430.5	-2339.7	

The well came in very close to prognosis down to basal Purni Formation coal, the deepest reliable reflector.

STRUCTURE: Colson 1 is crestally located on an elongate north-south structure, 19.2kms by 6.4kms in extent on the lowest closing contour (areal closure 10608 hectares). The structure is unfaulted at post basement levels and is related to a smaller, faulted anticline some 8 kms to the east.

WIRELINE LOGS: Two open-hole, wireline logging runs were made by Schlumberger. One prior to setting 9 1/2" casing at 1353.3m and the second at T.D. of 2432.3m. Logs were field recorded in analog and digital form.

LOG TYPE	INTERVAL
Run #1 - 1353.3m driller - 12 1/4" hole - 26th November 1978.	
BHC Sonic - GR	1347.8m - 196m - surface
DLL (Sim)-Cal-SP	1346m - 195.7m
Loggers T.D. on this run was 1351.2m.	
Run #2 - 2432.3m driller - 8 1/2" hole - 10th December 1978.	
BHC Sonic-GR	2426.2m - 1348.4m
DLL-MSFL-SP-Cal	2428.0m - 1348.4m
FDC-CNL-Cal	2428.6m - 1349.0m

DEVIATION SURVEYS: Maximum measured hole deviation was 4.25° at 1743m. All other measurements were less than 2°.

CORES: No conventional cores were cut due to a 'dogleg' in the hole at 1743m. One gun of sidewall cores was taken, from 1824 to 2423m. 4 samples were from shale sequences, 1 from a coal and the remaining 24 from sandstones and siltstones (One attempt resulted in no recovery).

Sidewall samples were forwarded to Mines Administration Ltd, Brisbane, for palynological and EOM determination.

FORMATION TESTS: No open hole drillstem tests were carried out.

VELOCITY SURVEY: A velocity survey was run by Velocity Data Pty Ltd. A shallow refraction line was shot to check weathering effects as part of the survey.

HYDROCARBON SHOWS: One interval of residual hydrocarbon staining was noted while drilling between 1993.7m and 2002.5m in the upper sands of the Poolowanna Formation. The show consisted of pale brown staining with no associated gas or fluorescence. Dried cuttings gave fair cream-white cut in trichloroethane.

RESERVOIRS: Excellent reservoir is seen in the Poolowanna Formation and Algebuckina Sandstone. A 70m sand in the Poolowanna Formation exhibits porosities (log derived) of between 13 and 16 percent. Porosities in the Algebuckina Sandstone range from 12 to 26 percent. Suitable cap rocks are present.

SOURCE ROCKS: Limited material was submitted for geochemical analysis. Sediments submitted appear to have good potential for gas and poor to good potential for sourcing oil and are marginally mature for hydrocarbon generation.

SPECIAL ANALYSIS: Palynology, Kerogen Analysis, Thermal Alteration examination.

HALE RIVER 1

BASIC DATA

OPERATOR:	Amerada Petroleum Corporation of Australia Ltd
PETROLEUM TITLE:	OP-57 Northern Territory
PARTICIPANTS:	Beach Petroleum N.L. Amerada Petroleum Corporation of Australia Ltd
LOCATION: Lat:	25° 15' 48" S
Long:	136° 43' 36" E
Seismic:	
ELEVATION: GL:	120.4m
RKB:	125.3m
DRILLING COMMENCED:	14th October, 1966
RIG RELEASED:	11th November, 1966
DRILLING TIME TO T.D.	27 days
RIG:	Reading and Bates National N-55
TOTAL DEPTH:	Driller - 1732.2m, Logger - 1694.0m
BOTTOM HOLE TEMP:	83.3°C (uncorrected) at 1694.0m
STATUS:	Plugged and Abandoned
N.T.D.M.E. REF.:	PR66/026

COMPLETION DETAILS: 13 $^3/_8$" casing set to 409m. Three abandonment plugs were set at:

1. 1250-1295m
2. 396-427m
3. 0-15m

A total of 220 sacks of cement were used.

STRATIGRAPHY:

AGE	FORMATION	DEPTH(m)	ELEV.(m)	THICKNESS(m)
Quaternary	Surficial & Eyre Fm.	5.0	+120.3	56.0
E. to L. Cret.	Winton/Tambo Fm.	61.0	+64.3	581.0
Early Cretaceous	Toolebuc Fm.	642.0	-516.7	36.0
Early Cretaceous	Undifferentiated	678.0	-552.7	161.7
Early Cretaceous	Cadna-owie Fm.	839.7	-714.4	35.1
M. to L. Jurassic	Algebuckina Sst.	874.8	-749.5	393.8
Early Permian	Purni Fm.	1268.6	-1143.3	81.4
E. Perm.-Carbonif.	Crown Point Fm.	1350.0	-1224.7	35.3
Late Dev.-Carbonif.	Finke Group	1385.3	-1260.0	48.5
Proterozoic ?	Undifferentiated	1433.8	-1308.5	298.4+
	TOTAL DEPTH	1732.2	-1606.9	

STRUCTURE: Hale River 1 was drilled on a NW trending subsurface anticline located on the southwest flank of a broad, prominent, platform. Dip on the SW flank extends uninterrupted for several kilometres. Dip to the NE is apparently disrupted by faulting. There is a pronounced truncation of seismic reflectors below the Permian.

WIRELINE LOGS: The following wireline logs were run by Welex:

LOG TYPE	RUN	INTERVAL (LOGGER) m
Induction-Electric	1	1692.6-402.0
Acoustic Velocity-GR	1	1692.3-396.2
FoRxo-Caliper		1692.9-402.3

DEVIATION SURVEYS: Maximum measured hole deviation was 4° at 1303m. For the most part, hole deviation was kept under 1.5°.

CORES: Eight cores were taken from below 1171.7m. A total of 39.3m of core was cut with a recovery of 33m.

CORE NO.	DEPTH (m)	CUT (m)	RECOVERED (m)
1	1171.7-1177.8	6.1	4.0
2	1271.0-1275.6	4.6	1.4
3	1376.8-1381.4	4.6	4.6
4	1449.6-1451.8	2.1	2.1
5	1504.8-1514.3	9.4	9.1
6	1606.6-1611.8	5.2	4.6
7	1694.1-1697.8	3.7	3.7
8	1728.5-1732.2	3.7	3.7

FORMATION TESTS: No formation tests were conducted.

VELOCITY SURVEY: Austral Geo Prospectors Pty Ltd conducted velocity survey.

HYDROCARBON SHOWS: Minor hydrocarbon shows were detected by core analysis in cores 1 and 2 but these shows are believed to be representative of 48 barrels of diesel fuel added to the drilling mud 36 hours prior to cutting core 1. There were no other hydrocrabon shows reported.

RESERVOIRS: Good porosity and permeability was found in the Jurassic, Permian and Devonian-Carboniferous sandstones. Average porosity for clean sandstones calculated by the Operator from the electric logs are as follows:

	Average Porosity	Net interval Porosity >10% (m)
Jurassic	15-25%	165
Permian	15-22%	44
Upper Devonian	20-25%	5

SOURCE ROCKS: Due to the age of the well, (1966), there is limited quantitative information on source rock potential at the Hale River 1 location.

SPECIAL ANALYSIS: Core Analysis, Petrography.

McDILLS 1

BASIC DATA

OPERATOR:	Amerada Petroleum Corporation of Australia Ltd
PETROLEUM TITLE:	OP-57 Northern Territory
PARTICIPANTS:	Beach Petroleum N.L. Amerada Petroleum Corporation of Australia Ltd
LOCATION: Lat::	25° 43' 50" S
Long:	135° 47' 25" E
Seismic:	
ELEVATION: GR:	120.7m
RKB:	125.6m
DRILLING COMMENCED:	27th May, 1965
RIG RELEASED:	5th September, 1965
DRILLING TIME TO T.D.	99 days
RIG:	Australian Drilling Co. Pty Ltd National N-55
TOTAL DEPTH:	Driller - 3205.0m, Logger - 3201.4m
BOTTOM HOLE TEMP.	118.3°C uncorrected at 3201.4m
STATUS:	Plugged and Abandoned - Water well
N.T.D.M.E. REF.:	PR65/012

COMPLETION DETAILS: 9 5/8" intermediate casing set at 919.0m. Three abandonment plugs were set at:

1. 2148.9 - 2179.3m
2. 1005.9 - 1188.7m
3. 903.7 - 934.2m

Forty sacks of cement were pumped down the annulus between 13 3/8" and 9 5/8" casing.

STRATIGRAPHY:

AGE	FORMATION	DEPTH(m)	ELEV.(m)	THICKNESS(m)
Quaternary	Surficial & Eyre Fm.	4.9	+120.7	26.1
E. to L. Cret.	"Rumbalara Shale"	31.0	+94.6	406.7
Early Cretaceous	Cadna-owie Fm.	437.7	-312.1	25.0
Mid to L. Jurassic	Algebuckina Sst.	462.7	-337.1	255.1
Early Permian	Purni Fm.	717.8	-592.2	238.4
L. Carb. E. Perm.	Crown Point Fm.	956.2	-830.6	199.0
L. Dev., Carbonif.	Horseshoe Bend Sh.	1155.2	-1029.6	85.4
L. Dev., Carbonif.	Langra Sandstone	1240.6	-1115.0	527.3
L. Dev., Carbonif.	Polly Conglomerate	1767.9	-1642.3	393.2
Early Devonian	Mereenie Sandstone	2161.1	-2035.5	341.3
Ordovician/Camb.?	Unnamed unit	2502.4	-2376.8	248.1
Lower Cambrian	Todd River Dolomite	2750.5	-2624.9	454.5+
	TOTAL DEPTH	3205.0	-3079.4	

STRUCTURE: The McDills structure is a NE-SW trending anticline some 72 km by 8 km. The west flank is fault controlled, the western side of the fault defining the eastern limit of a prominent depression which formed in pre- Permian time and continued to subside at a rate far in excess of that seen at McDills. The McDills feature has recently been evaluated by Etingimbra 1 which was also plugged and abandoned.

WIRELINE LOGS: The following wireline logs were run by Welex:

LOG TYPE	RUN	INTERVAL (m)
Induction-Electric	1	15.2-364.2
	2	364.9-436.7
	3	426.7-1692.0
	4	1676.4-2321.1
	5	2286.0-3199.8
Accoustic Velocity-GR	1	363.3-1691.4
	2	1676.4-2319.9
	3	2286.0-3199.8
FoRxo-Caliper	1	363.3-1692.9
	2	1676.4-2321.1
	3	2286.0-3200.7
Dipmeter	1	919.0-3199.8

DEVIATION SURVEYS: Measured hole deviation ranged from 0.5° to 0.875° in the Permian and post-Permian sequence. Deviation increased to 4.5° in the Devonian to Carboniferous sequence and ranged between 4° and 16.25° in the Todd River Dolomite. Deviation rapidly increased from a depth of about 2812m reaching 10° at 2987m.

CORES: Thirty two conventional cores were cut in McDills 1, the first being cut at 724m. Routine coring was done at convenient bit change depths. Samples of 10cm length from the top, 20cm and 10cm from every succeeding 60cm interval of each core were sent to the BMR in Canberra. The remaining core was deposited with the NTDME in Alice Springs. The following cores were taken:

CORE	CORE DEPTH (m)	CUT (m)	RECOVERED (m)
1	723.9-728.5	4.6	4.0
2	819.9-822.1	2.1	1.4
3	833.1-835.2	13.1	2.7
4	901.9-906.2	4.3	4.1
5	906.2-909.2	3.0	0.3
6	952.8-956.5	3.7	3.7
7	1024.4-1029.0	4.6	4.3
8	1111.0-1115.6	4.6	4.6
9	1165.0-1169.5	4.6	0.6
10	1169.5-1173.5	4.0	2.4
11	1265.5-1270.1	4.6	4.6
12	1362.2-1366.7	4.6	2.6
13	1458.2-1461.8	3.6	3.6
14	1555.1-1559.7	4.6	4.6
15	1600.8-1605.4	4.6	3.2
16	1689.8-1693.5	3.7	3.4
17	1772.4-1775.5	3.1	1.5
18	1927.9-1930.9	3.0	1.8
19	2009.3-2010.8	1.5	1.5
20	2148.9-2151.9	3.0	2.4
21	2157.7-2160.8	3.1	2.7
22	2318.9-2323.2	4.3	4.3
23	2471.3-2473.2	1.8	1.8

24	2473.2-2474.7	1.5	1.5
25	2534.1-2536.0	1.9	1.4
26	2664.0-2664.3	0.3	0.0
27	2717.3-2720.4	3.0	3.0
28	2756.3-2759.4	3.0	2.1
29	2851.1-2854.2	3.0	2.7
30	2935.9-2938.9	3.0	3.0
31	3065.7-3068.7	3.0	2.7
32	3202.0-3205.0	3.0	3.0

Total interval cored: 115.8m
Total interval recovered: 85.8m

Note: above depths converted from imperial units. Interval cored may not agree with core depth values due to rounding off.

FORMATION TESTS: No drillstem tests were attempted. The well was completed as a water well flowing an estimated 50 barrels per hour from the Algebuckina Sandstone (594 to 595.9m)

VELOCITY SURVEY: Austral Geo Prospectors Pty Ltd in conjunction with Welex conducted the velocity survey.

HYDROCARBON SHOWS: The well was almost totally devoid of shows. A gas show was logged from 416 to 421m but resistivity logs did not verify the show.

RESERVOIRS: Good porosity and permeability was found in sandstones of the Algebuckina Sandstone, Permian, Finke Group and the Mereenie Sandstone due to a "lack of hydrocarbons".

No cores were analysed but average porosities for clean sands were taken from the Gamma Ray - Acoustic Velocity log:

Algebuckina Sandstone	25-35%
Permian	15-25%
Finke Group	20-25%
Mereenie Sandstone	10-15%

SOURCE ROCKS: Likely source material is present in the "Rumbalara Shale" but this is expected to be immature. The Finke Group does not have any significant source potential although the Todd River Dolomite is very argillaceous and appears to be a possible source rock.

SPECIAL ANALYSIS: Petrology, Palaeontology, Water Analysis

POEPPELS CORNER 1

BASIC DATA

OPERATOR:	Arco Australia Ltd
PETROLEUM TITLE:	OP-184, Northern Territory
PARTICIPANTS:	Arco Australia Ltd Beach Petroleum N.L. North Broken Hill Ltd Phillips Australian Oil Company
LOCATION: Lat:	25° 47' 36" S
Long:	137° 57' 06" E
Seismic:	
ELEVATION: GL:	39.9m
RKB:	46.6m
DRILLING COMMENCED:	August 21, 1984
RIG RELEASED:	September 22, 1984
DRILLING TIME TO TD:	32 days
RIG:	Richter Rig No. 8
TOTAL DEPTH:	Driller - 2590.7m, Logger - 2593.3m
BOTTOM HOLE TEMP.:	104.4°C at 2593.3m uncorrected
STATUS:	Plugged and Abandoned
N.T.D.M.E. REF.:	PR85/029

COMPLETION DETAILS:

9 5/8" intermediate casing to 1382.0m
Five cement plugs as follows:

1. 2222.6-2283.6m
2. 2098.0-2158.9m
3. 1357.6-1479.5m

Cement retainer at 1322.8m

4. 1322.8m
5. 3 metres to surface

STRATIGRAPHY:

AGE	FORMATION	DEPTH(m)	ELEV.(m)	THICKNESS(m)
Tertiary-Recent	Surficial & Eyre Fm.	Surface	+39.9	186.8
Late Cretaceous	Winton Fm.	193.5	-146.9	622.4
Early Cretaceous	Oodnadatta Fm.	815.9	-769.3	303.3
Early Cretaceous	Toolebuc Fm.	1119.2	-1072.6	65.8
Early Cretaceous	Bulldog Shale	1185.0	-1138.4	182.6
Early Cretaceous	Cadna-owie Fm.	1367.6	-1321.0	81.0
Late-Mid Jurassic	Algebuckina Sst.	1448.6	-1402.0	598.3
Early Jurassic	Poolowanna Fm.	2046.9	-2000.3	193.6
Late Triassic	Peera Peera Fm.	2240.5	-2193.9	98.7
Middle Triassic	Walkandi Fm.	2339.2	-2292.6	43.0
? Ordovic./Devon.	Unnamed	2382.2	-2335.6	207.3
Unnamed igneous	2589.5	-2542.9	3.8+	
	TOTAL DEPTH	2593.3	-2546.7	

STRUCTURE:

A NNW-SSE trending fault independent but fault controlled closure with approx. 35m TWT apparent closure at Top of Poolowanna Formation time horizon.

WIRELINE LOGS: The following wireline logs were run by Schlumberger:

LOG TYPE	RUN	INTERVAL (LOGGER) m
DLL -	1	1369.8-221.9
- MSFL		1369.8-221.9
- GR		1369.8-221.9
- SP		1369.8-221.9
- Cal		1369.8-221.9
DLL -	2	2590.8-1381.7
- MSFL		2590.8-1381.7
- GR		2590.8-1381.7
- SP		2590.8-1381.7
- Cal		2590.8-1381.7
SLS -	1	1369.8-221.9
- GR		1369.8-221.9
- Cal		1369.8-221.9
SLS -	2	2590.8-1381.7
- GR		2590.8-1381.7
- Cal		2590.8-1381.7
HDT -	1	1369.8-221.9
HDT -	2	2590.8-1381.7
CST -	1	1369.8-243.8
CST -	2	2561.6-1381.7
LDL/CNL/EPT	1	2592.4-221.9
RFT	1	2149.5-1435.0
WST	1	2587.8-335.3
HRT	1	1005.9-731.5

Synergetic logs: EPT - Quick Look, Pass One (Cyberlook Pass One) and Dual Water Quick Look - EPT - Pass Two (Cyberlook pass two) were also run.

DEVIATION SURVEYS: Maximum measured hole deviation was 2.75° at 2261.6m until depth 2569.2m where deviation angle was 14°.

CORES: A 3 metre core 2587.6 - 2590.6m (unnamed Ordovician - Devonian section) was recovered. The core was forwarded to Core Laboratories - Adelaide.

106 of a total attempted 122 sidewall cores were recovered from between 243.8m and 2561.4m. Eighteen were sent to Core Laboratories, Adelaide for routine porosity and fluid analyses. Ten sidewall cores were sent to AMDEL, Adelaide for hydrocarbon potential study and remainder to ECL, Perth for palynological study and/or for storage.

FORMATION TESTS: Five Schlumberger Repeat Formation Tester (RFT) wireline tests were taken to evaluate the resistivity of the formation waters. The test tool used had a 22,712 cc (6 gallon) lower chamber and a 3,785 cc (1 gallon) upper chamber.

RFT	1	1434.9m	both chambers
	2	2050.9m	22712cc chamber
	3	2063.4m	3785cc chamber
	4	2146.0m	22712cc chamber
	5	2149.3m	3785cc chamber

No other tests were conducted.

VELOCITY SURVEY: A vertical-seismic-profile survey was made over the interval 2587.6m to 697.9m. A check shot survey was made over the interval 630.9-335.3m

HYDROCARBON SHOWS: Only trace to poor oil shows were seen in cuttings samples, the best being from the interval 2289.9-2295.2m of the Peera Peera Formation. Cuttings from the sandstone had a trace percentage of grains with a trace amount of spotty, dull orange fluorescence which produced a slow, cloudy, greenish white, natural cut fluorescence in trichlorethane.

Cut fluorescence and residue fluorescence were noted in cores of the Cadna-owie, Algebuckina and Poolowanna formations. Samples produced a dull yellow residue fluorescence and laboratory analyses indicated up to 16.7% oil saturation by pore space. Formation tests gave no indication of hydrocarbons and most of the oil is likely residual oil. Log analysis indicates all potential reservoirs to be water saturated.

RESERVOIRS: Good reservoir sandstones are present in the Cadna-owie Formation, Algebuckina Sandstone and in the Poolowanna Formation with porosities in the order of 18-25% and good permeability. Fair reservoir quality is present in sands of the Peera Peera Formation. Sands of the Walkandi Formation exhibit fair porosity (15% maximum) but poor permeability.

SOURCE ROCKS: Geochemical studies indicate that oil and gas prone source beds were penetrated by Poeppels Corner 1 but all source material is below the threshhold of maturity for oil generation. Richness parameters examined indicated the Poolowanna Formation is a poor to fair source interval (although one atypically rich - ie. excellent oil source - sample was present). The Peera Peera Formation is regarded as a poor to good oil source. Both Type II and Type III kerogen are present in both formations.

SPECIAL ANALYSIS: Source Rock Maturation and richness, Palynology - biostratigraphy, Routine Core Analysis.

THOMAS 1

BASIC DATA

OPERATOR:	Argonaut International Corporation
PETROLEUM TITLE:	OP-184, Northern Territory
PARTICIPANTS:	Argonaut International Corporation *50%
	Beach Petroleum N.L 37.5%
	North Broken Hill Ltd 12.5%
	* earning
LOCATION: Lat:	25° 51' 28.50" S
Long:	137° 38' 24.53" E
Seismic:	
ELEVATION: GL:	30.41m above sea level
RKB:	37.41m above sea level
DRILLING COMMENCED:	September 5th, 1981
RIG RELEASED:	November 9th, 1981
DRILLING TIME TO T.D.	59 days
RIG:	Houston Systems HD 5000 INTMA HELIRIG
TOTAL DEPTH:	Driller - 2612.7m, Logger - 2617.2m
BOTTOM HOLE TEMP:	120°C Non extrapolated
	132.5°C extrapolated
STATUS:	Plugged and Abandoned
N.T.D.M.E. REF.:	PR83/010

COMPLETION DETAILS: 9 5/8" intermediate casing set at 1414.5m KB. Abandonment plugs were set as follows:

1. 2350-2390m
2. 2060-2100m
3. 1405-1460m
4. 800-840m
5. Surface plug

STRATIGRAPHY:

AGE	FORMATION	DEPTH(m)	ELEV.(m)	THICKNESS(m)
Tertiary	Eyre Fm.	7.0	+30.4	173.5
U. to L. Cretaceous	Winton Fm.	180.5	-143.1	623.5
	Oodnadatta Fm.	804.0	-766.6	303.0
L. Cretaceous	Toolebuc Fm.	1107.0	-1069.6	52.0
	Bulldog Shale	1159.0	-1121.6	236.5
	Cadna-owie Fm.	1395.5	-1358.1	42.5
Upper Jurassic	Algebuckina Sst.	1438.0	-1400.6	637.0
Middle Jurassic	Poolowanna (Upper)	2075.0	-2037.6	89.0
Lower Jurassic	Poolowanna (Lower)	2164.0	-2126.6	104.0
Middle Triassic	Peera Peera Fm.	2268.0	-2230.6	95.5
? Lower Triassic	Unnamed Redbeds	2363.5	-2326.1	56.5
? Permo-Triassic	Unnamed	2420.0	-2382.6	40.0
Unknown-Ordovician?	Basement Metased.	2460.0	-2422.6	157.2+
	TOTAL DEPTH	2617.2	-2579.8	

Thomas 1 encountered all formation tops slightly higher than prognosed due to use of slightly higher velocity function than observed velocities.

STRUCTURE: A crestally faulted culmination on a major north-south anticlinal trend. Thomas was drilled very close to the mapped but not necessarily actual structural high point. There is some thinning onto the structure indicating some growth of structure during deposition.

WIRELINE LOGS:

Run 1

On 22nd September, in 12 1/4" hole, prior to running 9 5/8" casing, at TD of 1428 metres the following logs were run:

DLL (Sim) - SP from 1417.5m to 170.5m
BHC Son - GR - Cal from 1419.2m to 170.5m

Run 2

On 4th, 5th and 6th November, at driller's TD of 2612.6m, in 8 1/2" hole, the following logs were run:

DLL (Sim)-MSFL-SP-Cal from 2616.5m to 1415m
BHC Son - GR from 2613.5m to 1414.5m
FDC-CNL-GR-Cal from 2617.0m to 1414.7m
HDT No interval available, but all of open hole
Velocity Survey (14 levels shot)
CST - one sample run with 30-shot gun

DEVIATION SURVEYS: Maximum measured hole deviation was 4° at 2090m. TVD estimated to be 3 metres less than logged depth.

CORES: Two conventional cores were cut:

1. 2208-2216m — recovered 8.0m (97.5%)
2. 2614.2-2617.2 — recovered 2.3m (77%)

The cores were shipped to Core Laboratories in Brisbane for porosity and permeability analysis. One gun of 30 shots of sidewall samples were attempted with a recovery of 29 cores. These cores primarily intended for age dating and source rock studies and were therefore shot mainly in shales.

FORMATION TESTS: One open hole drill stem test was run by Halliburton Ltd, as a bottom hole test.

Test interval:

Drillers depth	2177.5-2211m
Log corrected depth	2182.5-2216m

No water cushion was used. Bottom choke size was 3/4" and top choke size 1/2". Recovered 1399m (67 BBLS) of fluid of which 6 barrels was mud and the remainder was fresh water. No hydrocarbons of any type were detected. Pressures were: Top recorder: IHP 3616.4 psi, IFP 303.7 to 2105.9 psi, ICIP 2550.8 psi (doubtful). Bottom recorder: IHP 3700.4 psi, IFP 536.5 to 2199.2 psi. Effective first flow period was 68 minutes.
A test was then run by Lynes Inc to evaluate an interval of higher hydrocarbon saturation, in a selective straddle test (interval 2185-2204m). The tool became stuck during the first flow period and was not shut-in. After 220 mins it was pulled loose. Total recovery was 305m of drill mud, 258m of muddy water and 177m of slightly gas cut water.

No other tests were attempted.

VELOCITY SURVEY: No velocity survey was run in this well.

HYDROCARBON SHOWS: The only shows seen in the well were of residual oil staining in the lower unit of the Poolowanna Formation. Staining was present as brown stain with dull orange fluorescence. There was no light fluorescence and no significant associated gas. One sample of Core 1 yielded a small amount of oil on extractive analysis.

No hydrocarbons were produced on test and wireline logs indicate potential reservoirs to be water saturated.

RESERVOIRS: The basal Cadna-owie sandstones are porous and permeable with log derived porosities of up to 20%. Porosities of up to 23% are calculated for the Algebuckina Sandstone. These high porosities appear to be associated with high permeabilities. Porosities in the Poolowanna Formation range from 7% to 15%. Porosity is very low and permeability virtually nil in the encountered 'basement' section.

SOURCE ROCKS: Oil source potential ranges from poor to excellent. Shales in the Algebuckina appear to be immature for oil generation but the Poolowanna and Peera Peera formations both appear to be oil mature and some oil is present indicating some generation. The chromatograms of extracted oils suggest an oil different to those at Poolowanna 1.

SPECIAL ANALYSIS: Palynology, Source Rock, Core Analysis.

APPENDIX TWO

GEOPHYSICAL SURVEYS

Seismic Survey

Name	Year	Company	Contractor	Length (km)	Fold (%)	G.I. (m)	Source	Reference	Open/Closed File
Anacoora	1988	Adelaide Petroleum						PR88/064	C
Simpson	1988	Sydney Oil	Norpac	225.9	1200%	30	Vibroseis	PR88/070	O
88 Simpson Desert	1987	Beach Petroleum						PR88/005	O
Dune	1987	Sydney Oil	Norpac	136.0	1200%	30	Vibroseis	PR88/054	O
Bejah	1986	Sydney Oil	Norpac	270.2	1200%/2400%	30	Vibroseis	PR86/016	O
Etingimbra	1986	Adelaide Petroleum						PR86/035	C
Mooney	1986	Sydney Oil	Norpac	96.0	1200%	30	Vibroseis	PR86/017	O
Colson	1985	Sydney Oil	Petty Ray	259.0	2000%	30	Thumper	PR85/041	O
84 Simpson Desert	1984	Beach Petroleum						PR85/061	O
80 Simpson Desert	1980	Beach Petroleum	GES	70.7	1200%	75	Geoflex	PR80/007	O
79 Simpson Desert	1979	Beach Petroleum	Austral	501.5	600%	70	Geoflex	PR80/007	O
Poeppels Corner	1972	Reef	GSI	421.6	600%/1200%	100	Vibroseis	PR73/008	O
Three Corners	1971	Beach Petroleum	Geosurveys	257.5	100%	45	Dynamite	PR71/002	O
Simpson Desert C	1966	Amerada	Geo Prospectors	544.8	100%	40	Dynamite	PR66/005	O
Simpson Desert A	1966	Amerada	Geo Prospectors	1606.0	100%	40	Dynamite	PR66/004	O
Perlanna	1966	Aquitaine	CGG	332.8	600%	60	Dynamite	PR66/008	O
Simpson Desert B	1966	Amerada	Austral	333.1	100%	40	Dynamite	PR64/023	O
Simpson Desert North	1966	Amerada	Austral	118.7	100%	40	Dynamite	PR64/023	O
Hale River	1964	Beach Petroleum	Geoseismic	136.8	100%	35	Dynamite	PR64/020	O
Hale Area	1964	Flamingo	Geophysical Assoc.	138.0	100%	35	Dynamite	PR63/036	O
North Simpson Desert	1964	Mercure	CGG	142.7	100%	35	Dynamite	PR64/024	O
Kilpatha	1964	Aquitaine	CGG	212.4	100%	50	Dynamite	PR64/012	O
Dakota Bore	1964	Beach Petroleum	Geoseismic	195.5	100%	35	Dynamite	PR65/030	O
Todd River	1963	Flamingo	Namco	161.9	100%	35	Dynamite	PR63/035	O
Anacoora/Andado	1963	Beach Petroleum	Geoseismic	241.4	100%	35	Dynamite	PR64/018	O
Simpson Desert	1961	Geoseismic	Geoseismic		100%	35	Dynamite	PR61/009	O
Steele's Gap	1961	Flamingo	Geoseismic	23.3	100%	35	Dynamite	PR61/005	O

Gravity Surveys

Name	Year	Company	Contractor	Length (St.)	Grid (m)	Reference	Open/Closed File
Three Corners	1971	Beach Petroleum	Geosurveys	552	500	PR71/002	O
Mount Daer	1970	Beach Petroleum	Geosurveys	769	800	PR70/012	O
Simpson Desert	1967	Beach Petroleum	Geosurveys	1646		PR68/009	O
Perlanna	1966	Aquitaine	CGG	552	6500	PR66/008	O
Dakota Bore	1964	Beach Petroleum	Geosurveys	1001	2800	PR65/027	O
Anacoora Bore	1963	Beach Petroleum	Geosurveys	675	800	PR64/019	O
Simpson Desert	1962	Beach Petroleum	Geosurveys		1600	PR62/006	O
OP 36	1961	Associated Freney	Mine Administration	225	6500	PR61/002	O
OP 34/42	1960	Flamingo	Mine Administration	501		PR60/004	O
Andado	1960	Geosurveys	Geosurveys	336	1600	PR60/006	O

Magnetic Surveys

Name	Year	Company	Contractor	Spacing (km)	Orientation	Height (m AMSL)	Reference
N0275\027H							
Hay River	1967	Exoil	Adastra	2.41	East/West	610	PR67/013
OP 75	1964	Flamingo	Aeroservices	9.66	East/West	610	PR63/010
OP 54	1963	Flamingo	Aeroservices		East/West	610	PR63/037
Oodnadatta	1962	BMR/Delhi	Aeroservices	8.05	East/West	610	SADME 202

APPENDIX THREE

HYDROCARBON SHOWS AND GEOCHEMISTRY INVENTORY

Inventory of Source Rock and Geochemical Analyses.

WELL	TOC	ORGANIC PETROGRAPHY	EOM	EXIN/VITRIN REFLECTANCE	ROCK EVAL PYROLYSIS	TAI	HEAD SPACE GAS	DATA SOURCE
Beachcomber 1	5 SWC	-	-	5 SWC	5 SWC	-	-	1
Colson 1	1 SWC 19 Cuttings	19 Cuttings	1 SWC 13 Cuttings	19 Cuttings	-	-	-	2 3
Hale River 1	NO GEOCHEMICAL ANALYSIS SIGHTED							
McDills 1	NO GEOCHEMICAL ANALYSIS SIGHTED							
Poeppels Cnr. 1	10 SWC 20 Cuttings	10 SWC 2 Cuttings	-	9 SWC 22 Cuttings	8 SWC 11 Cuttings	5 Cuttings	22 Samples	4
Thomas 1	11 SWC	11 SWC 1 Core 4 Cuttings	2 SWC	11 SWC 1 Core 4 Cuttings	-	-	-	5

1) Source Rock Analysis AMDEL Report F7459
2) Vitrinite Reflectance Analyses and Petrographic Descriptions of Coal Cuttings - Kantsler 1979
3) Source Rock Studies, S.A. Sedimentary Basins Progress Report 17, DME S.A. 1979 (AMDEL)
4) Maturity and Source Rock Evaluations - AMDEL Report F6042/85
5) Source Potential and Maturity of Sequence - Thomas 1 - Keiraville Konsultants 1982

BEACHCOMBER 1 — Geochemistry Summary

DEPTH m	ft	FORMATION	SAMPLE LITHOLOGY	TOC %	TOC COMPOSITION (%) Exinite	Vitrinite	Inertinite	HI	PYROLYSIS S1	S2	S1/(S1+S2)	POT. YIELD Kg hc/tonne	Ro % mean	TAI	T max	SAMPLE
1088.0	3569.6	Cadna-owie	Claystone	1.00				109	0.10	1.09	0.0840	1.19	0.62		437	SWC
1132.0	3713.9	Cadna-owie	SS & Clay	0.77				185	0.10	1.43	0.0654	1.53	0.62		442	SWC
1631.5	5352.7	Algebuckina	Claystone	2.36				179	0.41	4.24	0.0882	4.65	0.63		437	SWC
1715.0	5626.6	Poolowanna	SS & Clay	9.70				181	1.92	17.57	0.0985	19.42	0.60		439	SWC
1761.0	5777.6	Poolowanna	Claystone	5.20				234	0.94	12.19	0.0716	13.13	0.57		439	SWC

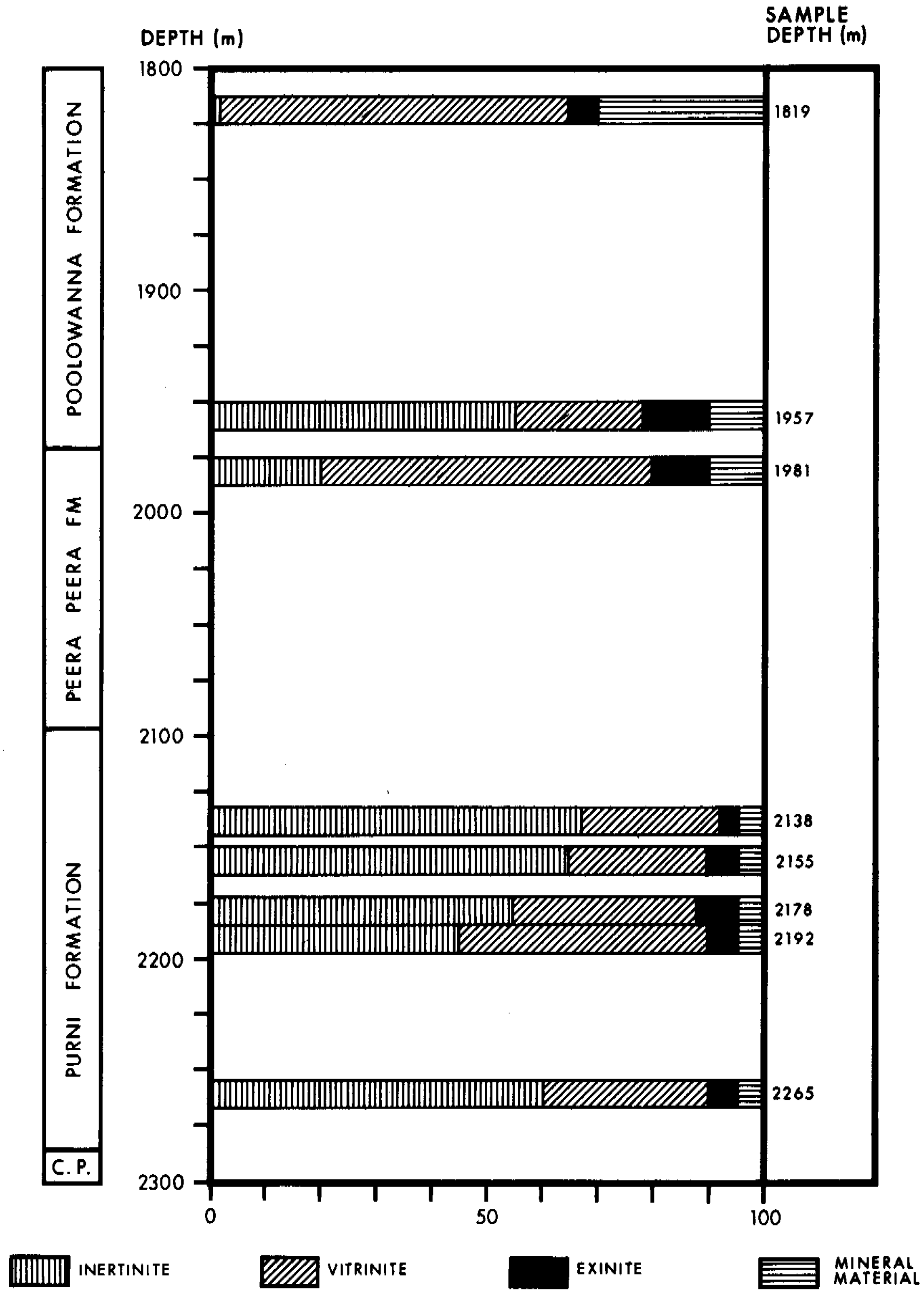
COLSON 1 — Geochemistry Summary

DEPTH m	ft	FORMATION	SAMPLE LITHOLOGY	TOC %	TOC COMPOSITION (%) Exinite	Vitrinite	Inertinite	HI	PYROLYSIS S1	S2	S1/(S1+S2)	POT. YIELD Kg hc/tonne	Ro % (max)	TAI	T max	SAMPLE
1818.6	5966.5	Algebuckina	Coal	70	6	92	2						0.59			cuttings
1957.3	6421.6	Poolowanna	Coal	90	9	30	61						0.69			cuttings
1981.7	6501.6	Poolowanna	Coal	90	11	67	22						0.77			cuttings
2073.2	6801.8	Peera Peera	Coal	-	-	-	-						0.72			cuttings
2138.7	7016.7	Purni	Coal	95	3	25	72						0.82			cuttings
2157.0	7076.8	Purni	Coal	95	5	30	65						0.86			cuttings
2178.3	7146.7	Purni	Coal	95	5	37	58						0.84			cuttings
2184.4	7166.7	Purni	Coal	95	3	39	58						0.81			cuttings
2193.6	7196.9	Purni	Coal	95	6	47	47						0.85			cuttings
2266.8	7437.0	Purni	Coal	95	5	32	63						0.85			cuttings
1310.7-1325.9	4300-4350	Wallumbilla	Shale	1.20												cuttings
1325.9-1341.1	4350-4400	Cadna-owie	Shale	0.93												cuttings
1804.4-1807.5	5920-5930	Algebuckina	Sandstone	0.02												cuttings
1810.5-1813.6	5940-5950	Algebuckina	Sandstone	0.05												cuttings
1906.5	6255	Algebuckina	SS & Sh	1.47												cuttings
1920.2	6300	Algebuckina	SS & Sh	0.30												cuttings
1935.5	6350	Algebuckina	SS & Coal	0.10												cuttings
1956.8	6420	Poolowanna	Coal	31.60												cuttings
2072.6	6800	Peera Peera	Shale	0.57												cuttings
2137.3-2139.1	7012-7018	Purni	Coal	74.00												cuttings
2155.0-2158.0	7070-7080	Purni	Coal	75.50												cuttings
2173.3-2176.3	7130-7140	Purni	Coal	13.90												cuttings
2182.4-2185.4	7160-7170	Purni	Coal	74.10												cuttings
2164.1	7100	Purni	Sh & Coal	2.85												cuttings
2423.2	7950	Basement		0.21												SWC

COLSON 1 — Extract Organic Matter

DEPTH (m)	FORMATION	TOC (%)	EOM (ppm)	(mg/g)	ASPH	ANALYSIS EOM (% wt) SATS	ARom	Res	Loss	LITHOLOGY
1311-1326	Low Cret	1.20	465	38.8	42.7	7.5	14.7	21.5	13.6	Shale
1326-1341	Low Cret	0.93	357	38.4	43.2	10.9	8.9	21.9	15.1	Shale
1804-1807	Algebuckina	0.02	63	315.0	78.4					Sandstone
1811-1814	Algebuckina	0.05	166	322.0	63.6	4.7	6.5	12.0	13.2	SS/Tr C
1907	Algebuckina	1.47	770	52.4	48.7	6.0	9.1	18.3	17.9	SS/Sh
1920	Algebuckina	0.30	502	167.0	54.3	3.9	8.4	10.7	22.6	SS/Sh/C
1936	Algebuckina	0.10	89	89.0	68.1	6.3	2.5	6.9	16.3	SS/Tr C
1957	Poolowanna	31.6	22560	71.4	46.5	4.5	13.9	10.8	24.3	Coal
2073	Peera Peera	0.57	243	42.6	50.7	15.7	13.2	12.2	8.1	Shale
2137-2139	Purni	74.0	35065	47.4	44.3	4.8	19.8	22.1	9.0	Coal
2155-2158	Purni	75.5	48175	63.8	46.2	5.2	16.2	25.8	6.5	Coal
2173-2176	Purni	13.9	8000	57.6	45.4	6.3	16.8	21.1	10.3	Coal
2182-2185	Purni	74.1	46755	63.1	40.4	6.6	16.2	24.1	12.6	Coal
2164	Purni	2.85	1480	51.9	40.1	7.5	17.5	23.3	11.6	Sh/Tr C
2423	Pre Permian	0.21	620	295.2	24.8	47.1	7.4	7.4	13.2	Sandstone

All samples except 2423 - SWC are canned cuttings samples.
Analyses by A.J. Kantsler. May, 1979.



Approximate Maceral Composition Coal Cuttings
COLSON 1

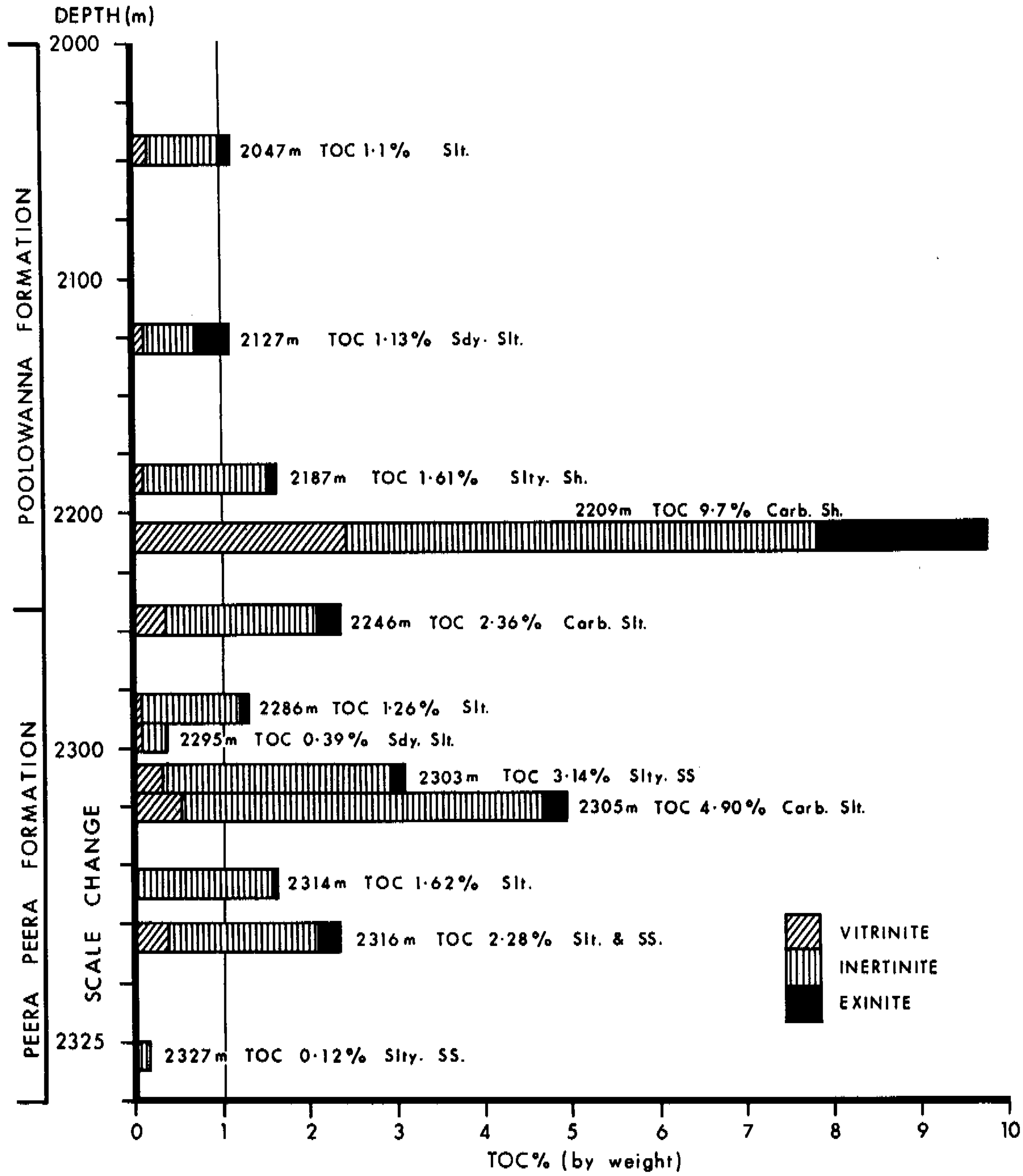
FIGURE A3.1

POEPPELS CORNER 1 — Geochemistry Summary

DEPTH m	ft	FORMATION	SAMPLE LITHOLOGY	TOC %	TOC COMPOSITION (%) Exinite	Vitrinite	Inertinite	HI	PYROLYSIS S1	S2	S1/(S1+S2)	POT. YIELD Kg hc/tonne	Ro %	TAI	T max	SAMPLE
762.0	2500.0	Winton	Slt & Coal	2.34				82	0.00	1.94	0.0000	1.94	0.37	2+	438	cuttings
914.4	3000.0	Oodnadatta	Mudstone	0.98				33	0.00	0.33	0.0000	0.33	0.41	2+	428	cuttings
1066.8	3500.0	Oodnadatta	Mudstone	1.01				58	0.00	0.59	0.0000	0.59	0.41	2+	433	cuttings
1219.2	4000.0	Bulldog	Mudstone	0.78				61	0.01	0.48	0.0204	0.49	0.43	2+-3	425	cuttings
1341.1	4399.9	Bulldog	Slt & Mud	1.10				60	0.02	0.67	0.0290	0.69	0.46	2+-3	431	cuttings
1493.5	4899.9	Algebuckina	SS	0.12									0.62			cuttings
1676.4	5500.0	Algebuckina	SS	0.16									0.51			cuttings
1828.4	5998.7	Algebuckina	SS	0.23									0.52			cuttings
1981.2	6500.0	Algebuckina	SS & Coal	0.26									0.51			cuttings
2011.7	6600.1	Algebuckina	SS	0.06												cuttings
2042.2	6700.1	Algebuckina	SS & Shale	0.26									0.52			cuttings
2047.4	6717.2	Poolowanna	Shale	1.10	5.0	5.0	75.0	144	0.10	1.59	0.0592	1.69	0.54		436	Swc
2072.7	6800.2	Poolowanna	Shale	2.42				111	0.08	2.70	0.0288	2.78	0.52		433	cuttinngs
2013.1	6604.7	Poolowanna	Slt & SS	0.50				214	0.07	1.07	0.0614	1.14	0.52		427	cuttings
2126.6	6977.0	Poolowanna	SS & Shale	1.13	30.0	10.0	60.0	459	0.28	5.19	0.0512	5.50	0.51		435	Swc
2133.6	7000.0	Poolowanna	Shale	1.27				108	0.03	1.38	0.0213	1.41	0.52		431	cuttings
2164.1	7100.1	Poolowanna	Slt & Sh	0.23									0.51			cuttings
2187.3	7176.2	Poolowanna	Slt & Sh	1.16	5.0	5.0	90.0	153	0.26	2.47	0.0952	2.73	0.53		438	Swc
2194.6	7200.1	Poolowanna	Slt & Sh	0.29									0.55			cuttings
2209.2	7248.0	Poolowanna	Shale	9.70	20.0	25.0	55.0	452	2.16	43.85	0.0469	46.01	0.54		443	Swc
2225.1	7300.2	Poolowanna	SS	0.18									0.56			cuttings
2245.6	7367.5	Peera Peera'	Siltstone	2.36	10.0	15.0	75.0	223	0.31	5.28	0.0555	5.59	0.58		436	Swc
2255.5	7399.9	Peera Peera'	SS	0.36									0.57			cuttings
2286.0	7500.0	Peera Peera'	Siltstone	1.26	5.0	5-10	90.0	148	0.16	1.87	0.0788	2.03	0.62		433	cuttings
2294.6	7528.2	Peera Peera'	SS & Shale	0.39	5.0	5.0	90.0						0.60			Swc
2303.1	7556.1	Peera Peera'	Slt & Ss	3.14	10.0	75.0	15.0	334	0.58	10.51	0.0523	11.09	0.60		437	Swc
2305.2	7563.0	Peera Peera'	Siltstone	4.90	5.0	10.0	85.0	168	0.66	8.24	0.0731	8.89	0.61		432	Swc
2312.9	7588.3	Peera Peera'	Siltstone	1.62	5.0	0.0	95.0	83	0.19	1.35	0.1234	1.54			441	Swc
2316.5	7600.1	Peera Peera'	Slt & SS	2.28	10.0	15.0	75.0	262	0.54	5.98	0.0828	6.52	0.61		428	cuttings
2326.6	7633.2	Peera Peera'	Slt & SS	0.12	5.0	5.0	90.0						0.63			Swc
2347.0	7700.1	Walkandi	SS & Slt	0.45				68	0.03	0.31	0.0882	0.34			440	cuttings
2377.5	7800.2	Walkandi	Shale & SS	0.17									0.69			cuttings
2438.4	8000.0	Basement	Calc Slt	20.02												cuttings
2468.9	8100.1	Basement	Calc Slt	0.02									0.78			cuttings
2499.4	8200.1	Basement	Calc Slt	0.02												cuttings
2529.9	8300.2	Basement	Calc Slt	0.02												cuttings
2560.4	8400.3	Basement	Calc Slt	0.02												cuttings

THOMAS 1 — Geochemistry Summary

DEPTH m	ft	FORMATION	SAMPLE LITHOLOGY	TOC %	TOC COMPOSITION (%) Exinite	Vitrinite	Inertinite	HI	PYROLYSIS S1	S2	S1/(S1+S2)	POT. YIELD Kg hc/tonne	Ro % mean	TAI	T max	SAMPLE
1436.5	4712.9	Cadna-owie	Shale	1.10	33	33	33						0.37			SWC
1745.3	5726.0	Algebuckina	Shale	1.31	50	30	20						0.45			SWC
2087.5	6848.8	Poolowanna	Shale	1.90	trace	50	50						0.80			SWC
2089.0	6853.7	Poolowanna	Coal		41	52	7						0.77			cuttings
2091.0	6860.2	Poolowanna	Shale	5.30	-	trace	100						0.80			SWC
2118.0	6948.8	Poolowanna	Shale	1.23	90	trace	10						0.63			SWC
2121.0	6958.7	Poolowanna	Siltstone	0.41	trace	-	100						-			SWC
2209.5	7249.0	Poolowanna	Clay & Slt		trace	50	50						0.68			core
2215.0	7267.1	Poolowanna	Coal & Sh		6	63	31						0.74			cuttings
2224.0	7296.6	Poolowanna	Shale	1.89	4	-	96						-			SWC
2263.0	7424.5	Poolowanna	Coal & Slt		28	40	32						0.79			cuttings
2268.2	7441.6	Peera Peera	Shale	1.74	trace	trace	100						0.73			SWC
2287.0	7503.3	Peera Peera	Shale	2.51	26	13	61						0.57			SWC
2356.4	7731.0	Peera Peera	Shale	0.98	33	trace	66						0.59			SWC
2368.0	7769.0	Peera Peera	Coal		10	68	22						0.81			cuttings
2392.3	7848.8	Peera Peera	Shale & Slt	0.17	-	trace	trace						-			SWC

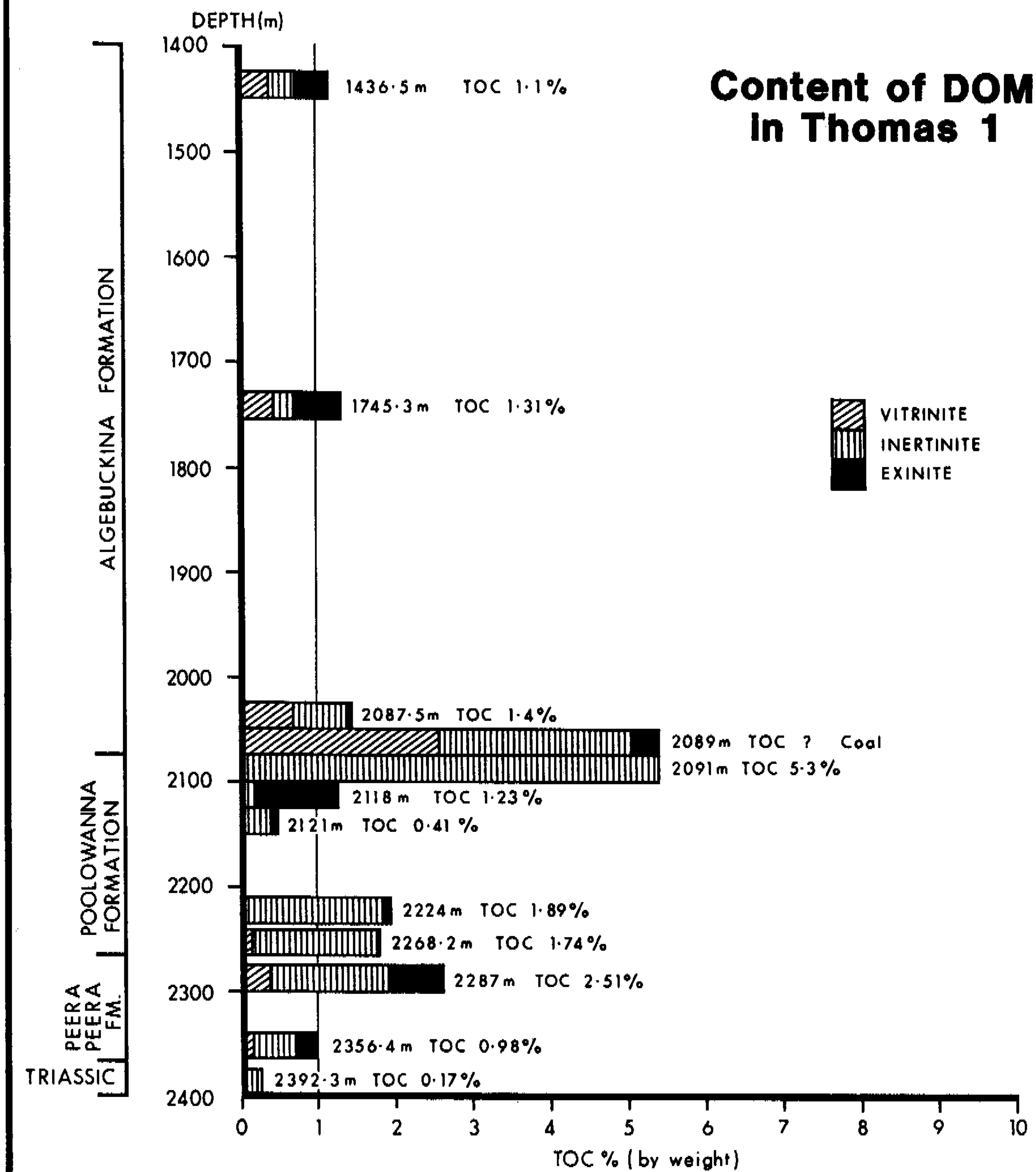


* CUTTINGS — REMAINDER OF SAMPLES SWC

	DEPTH Feet	DEPTH Metres	TOC %	% DOM Vitrinite	% DOM Inert	% DOM Exinite	LITHOFACIES
	6717.0	2047.4	1.10	15	75	10	Siltstone
	6977.0	2126.6	1.13	10	60	30	Sandy Siltstone
	7176.0	2187.3	1.61	5	90	5	Silty Shale
	7248.0	2209.2	9.70	25	55	20	Carb. Shale
	7367.5	2245.6	2.36	15	75	10	Carb. Siltstone
*	7500.0	2286.0	1.26	<5	90	5-10	Siltstone
	7528.0	2294.6	0.39	5	90	5	Sandy Siltstone
	7556.0	2303.1	3.14	75	15	10	Silty Sandstone
	7563.0	2305.2	4.90	10	85	5	Carb. Siltstone
	7588.0	2313.9	1.62	-	95	5	Siltstone
*	7600.0	2316.5	2.28	15	75	10	Siltstone & Sandstone
	7633.0	2326.6	0.12	5	90	5	Silty Sandstone

Content of DOM in Poeppels Corner 1

FIGURE A3.2



DEPTH		TOC	% DOM			LITHOFACIES
Feet	Metres	%	Vitrinite	Inert	Exinite	
4713	1436.5	1.10	33	33	33	Siltstone
5726	1745.3	1.31	30	20	50	Siltstone
6849	2087.5	1.40	50	50	Tr	Mudstone
6854	2089.0	-	52	41	7	Coal
6860	2091.0	5.30	Tr	99	0	Carb. Claystone
6949	2118.0	1.23	Tr	10	90	Claystone
6959	2121.0	0.41	0	99	Tr	Sandstone/Claystone
7233	2209.5	-	50	50	Tr	Shaley Siltstone
7267	2215.0	-	63	31	6	Coal/Shaley
7296	2224.0	1.89	0	96	4	Siltstone
7424	2263.0	-	40	32	28	Coal, Siltstone
7442	2268.2	1.74	Tr	100	Tr	Siltstone
7503	2287.0	2.51	13	61	26	Siltstone
7731	2356.4	0.98	Tr	66	33	Siltstone
7769	2368.0	-	68	22	10	Coal
7849	2392.3	0.17	0	Tr	Tr	Siltstone

FIGURE A3.3

APPENDIX FOUR

PLAY CONCEPTS

NORTHWEST FLANK ERINGA TROUGH PLAY

RESERVOIR OBJECTIVES:
Permian and Triassic Sands
Cambrian, Ordovician and
Devonian Clastics and
Carbonates

DEPTHS TO RESERVOIRS:
Base Permian:
?1000 to 3000m
3300 to 9800ft

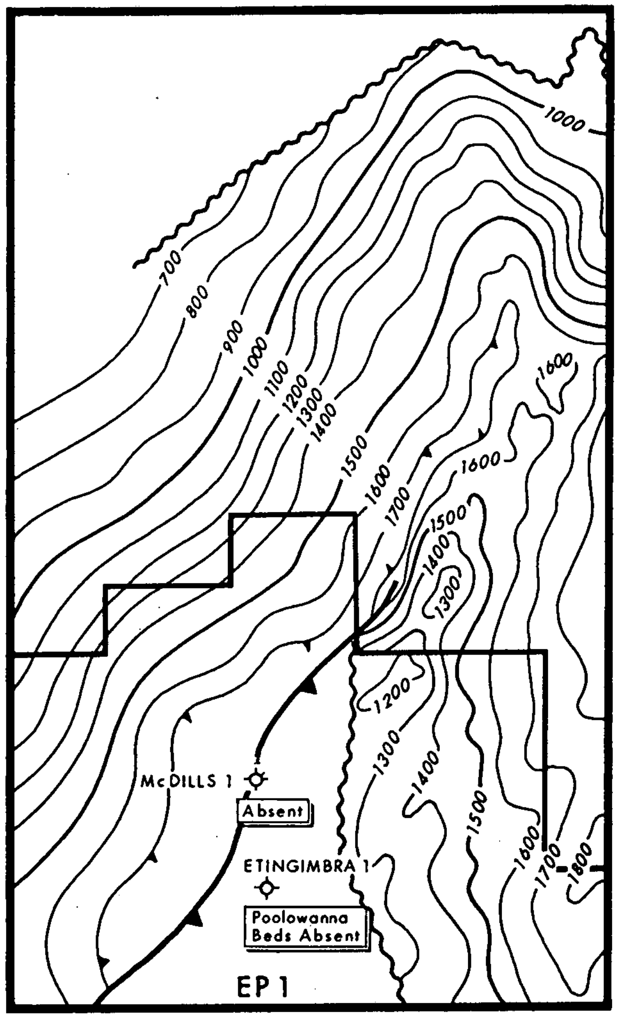
Base Cambrian:
?up to 5000m
up to 16,400ft

STRUCTURE SIZE:
Unknown

HYDROCARBONS EXPECTED:
Oil and Gas

ACREAGE AVAILABLE:
60% Open
40% part of EP 1

WORK REQUIRED:
There has been extremely
little seismic acquired
in this part of basin.



STRUCTURE TOP POOLOWANNA FM.

CONCEPT:
The Eringa Trough would have provided an ideal environment for the deposition of organically rich source shales, carbonates and evaporites from Cambrian through Early Jurassic time. The depositional history of the trough would have been very different to that of the more explored Poolowanna Trough and would have been more favourable for the formation and preservation of oil and gas prone source rocks and porous and permeable reservoirs.

A rapid and continuous subsidence resulted in potential source rock intervals being buried sufficiently deep to be placed within the main phase of oil generation and expulsion.

Almost all of the hydrocarbons generated within the trough would have migrated to the northwest and west, and not to the east as anticipated by previous explorers.

MADIGAN TROUGH ANTICLINAL CLOSURES

RESERVOIR OBJECTIVES:
Poolowanna Formation Sands
Permian and Triassic Sands
Pre Permo Carboniferous
Clastics and Carbonates

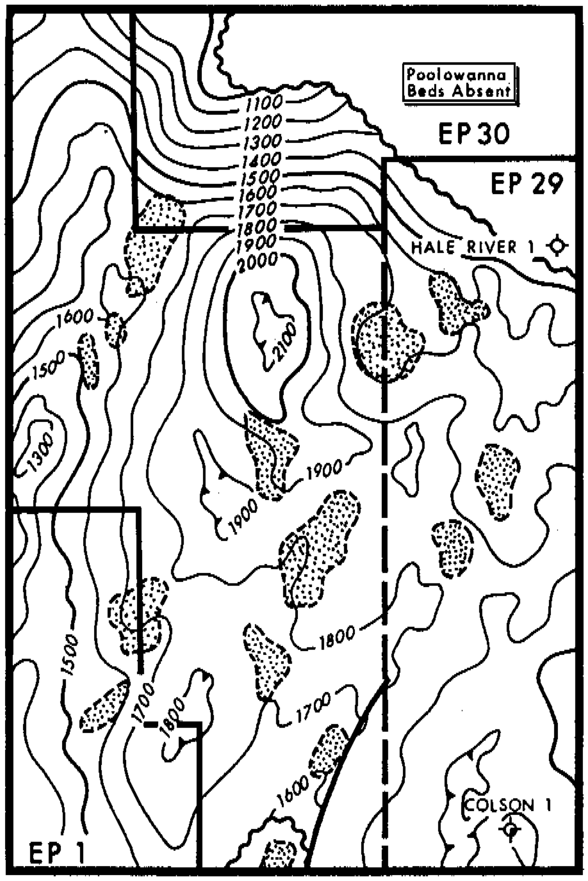
DEPTHS TO RESERVOIRS:
Base Permian ?2500m
Base Cambrian ?

STRUCTURE SIZE:
Medium to large

HYDROCARBONS EXPECTED:
Oil and Gas

ACREAGE AVAILABLE:
Acreage largely open
Some closures in EP 29

WORK REQUIRED:
Detailed seismic across leads
Only one prospect defined



STRUCTURE TOP POOLOWANNA FM.

CONCEPT:
The configuration and position of the Madigan Trough suggests that during Permian through Early Jurassic time, the trough would have been the site of lacustrine and coal swamp deposition. The most organically rich, oil prone source rocks in the Pedirka Basin are interpreted to be contained in this trough, in particular, within its northern depocentre. Seismic information indicates that these source rocks would have entered the main phase of oil and gas generation and expulsion making this unexplored part of the Pedirka Basin region very prospective.

UPDIP THOMAS 1 PLAY

RESERVOIR OBJECTIVES:
Early Jurassic and Triassic Sands

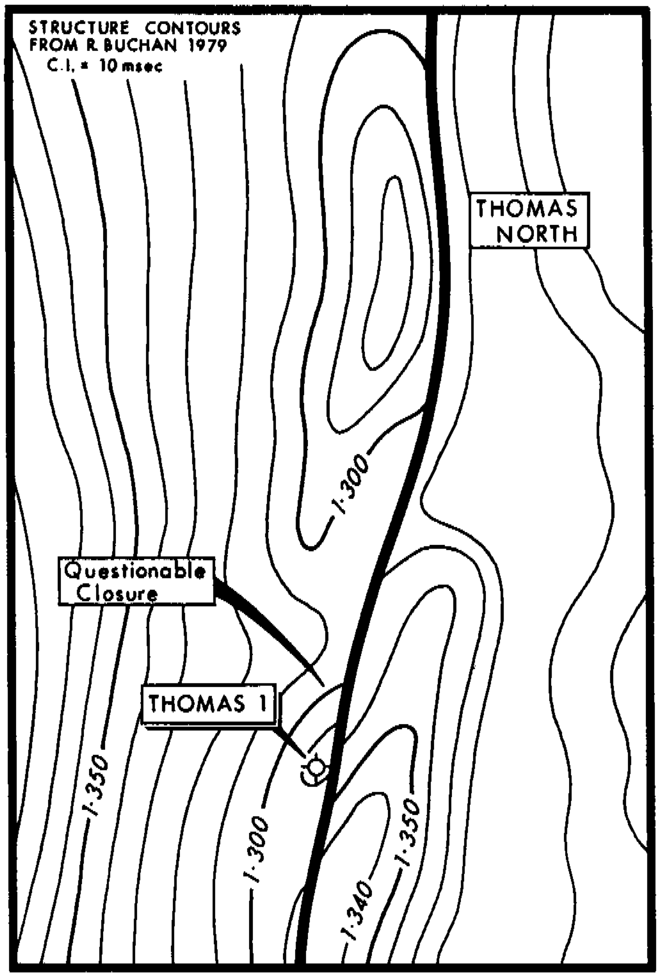
DEPTHS TO RESERVOIRS:
2000 to 2400m
6560 to 7875ft

STRUCTURE SIZE:
Approx 7.5 x 2.5km
20ms vertical

HYDROCARBONS EXPECTED:
Oil

ACREAGE AVAILABLE:
Contained within EP 29 Application Block

WORK REQUIRED:
Seismic Reprocessing to verify integrity of model



STRUCTURE APPROX. TOP ALGEBUCKINA SST.

CONCEPT:
Operator's structure mapping indicates Thomas 1 to have evaluated a valid structural closure. Definition of northern closure is, however, obscured by proximity to a major north-south trending fault. A review of seismic data suggests north closure is invalid. Hydrocarbon entrapment would therefore be within fault independent closure on trend and to north of Thomas 1 where some 20ms (TWT) of structural advantage can be gained.

Vitrinite Reflectance values at Thomas 1 indicate source rocks to be mature for oil generation. Brown stain with dull orange fluorescence was present in basal Poolowanna Formation in Thomas 1. The updip Thomas 1 closure has a large hydrocarbon drainage area and makes an attractive drilling objective.

APPENDIX 5

INFORMATION ON ONSHORE PETROLEUM TENEMENTS

Exploration for and production of petroleum in the onshore area of the Northern Territory is controlled by the Petroleum Act which came into force on 15 October 1984.

Prior to that the relevant legislation was the Petroleum (Prospecting and Mining) Act which by virtue of the savings provisions of the Petroleum Act continues to apply to permits and leases that had been issued or granted prior to that date.

The Petroleum Act was the first Australian petroleum legislation to introduce the concept of a retention tenement to provide a permittee with security of tenure over a currently non-commercial discovery. This initiative was later adopted by the Commonwealth in amendments to the Petroleum (Submerged Lands) Act 1967.

Under the terms of the Petroleum Act, an application for a permit may be made over any land not currently the subject of a petroleum tenement. The maximum area that can be applied for is 200 blocks. Each block comprises an area of five minutes of longitude by five minutes of latitude and a permit of 200 blocks covers an area of about 16,000 km^2.

The initial term of a permit is five years and it may be renewed for two further periods of five years with 50% relinquishment of the area held at the end of each term.

Permits are granted subject to specific work commitments which must be met year by year (or earlier).

Where a commercial discovery is made the successful explorer may apply for a production licence. The maximum area of a production licence is 12 blocks, however, a permittee may apply for more than one licence. The initial term of a production licence is 21 years and it may be renewed for further periods not exceeding 21 years as determined by the Minister for Mines and Energy.

If the original discovery proves to be currently non-commercial but is potentially of a commercial quality and quantity, the permittee may apply for a retention licence or licences of not more than 12 blocks for each licence. The initial term of a licence is five years and it may be renewed for further periods of five years.

Onshore Permit Application Procedures

An application for a permit may be made over any land that is not already the subject of a petroleum tenement.

An applicant should provide the following information:

- the name and address of the applicant and an address for service within the Territory.
- the designated number of each block the subject of the application.
- a map clearly delineating the application area and the boundaries of existing permit or licence areas in the immediate vicinity of the application area;
- a proposed technical works programme for exploration of the blocks during each year of the term of the proposed permit;
- evidence of the technical and financial capacity of the applicant to carry out the proposed technical works programme and to comply with the Act;
- where the application is made by two or more persons, the proposed sharing arrangement between the applicants;
- the name of the designated operator and evidence of his technical capacity to carry out the proposed technical works programme;
- a statutory declaration stating the applicant's interest, if any, in or in relation to a permit or licence applied for a granted under, or in force by virtue of, the Act or the repealed Act;
- the application fee of $3,000; and
- such other information in support of the application as the applicant thinks fit.

Summary Of Onshore Petroleum Legislation

Exploration Permits

Application fee	$3,000
Refund if application refused	Nil
Maximum blocks	200
Annual fee per block	$15
Initial term of permit	5 years
Relinquishment at end of term	50 per cent
Security to be lodged	Determined by Minister
Normally $10,000	

Retention Licences

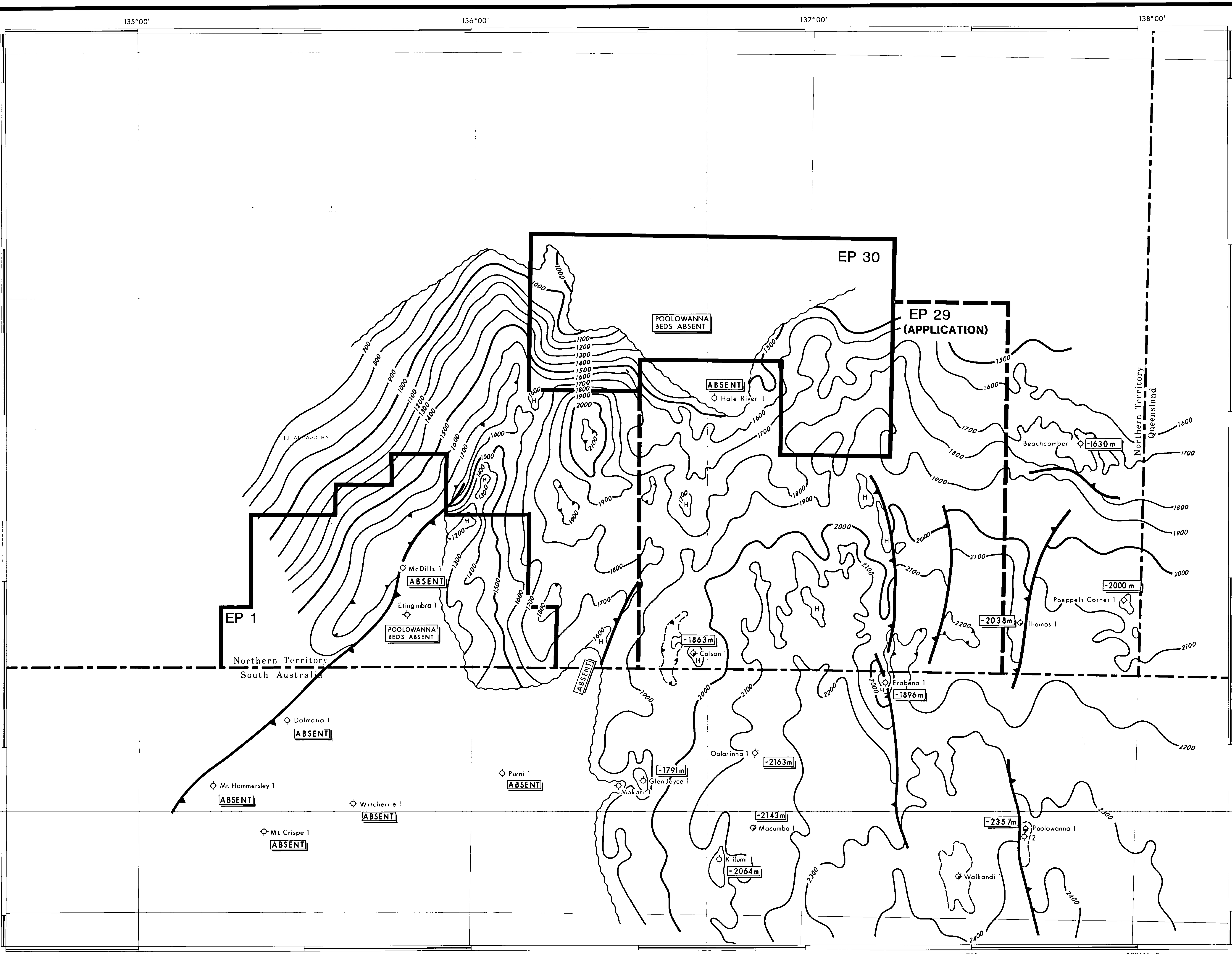
Application fee	$3,000
Annual fee per block	$2,000
Term	5 years
Renewal	Subsequent periods of 5
years depending upon the	discovery remaining subcommercial
Security	Determined by Minister

Production Licences

Application fee	$600
Annual fee per block	$9,000
Security	Determined by Minister

Pipeline Licences

Application fee	$1,000
Annual fee	Calculated in accordance with the formula: A = B x C x D where A is the fee payable, B is the unit amount prescribed by the Regulation (currently 60 cents), C is the diameter of the pipeline expressed in metres, D is the length of the pipeline expressed in metres.
Term	Up to 21 years
Renewal fee	$100
Variation fee	$100
Security	Determined by Minister



LEGEND

- DRY HOLE
- OIL SHOW (OIL REC DST)
- OIL SHOW (FLUORESCENCE IN CUTTINGS OR CORE)
- SIGNIFICANT GAS SHOW (NO DST RECOVERY)

0 10 20 30 40 KMS

NORTHERN TERRITORY
GEOLOGICAL SURVEY
PETROLEUM BASIN STUDY

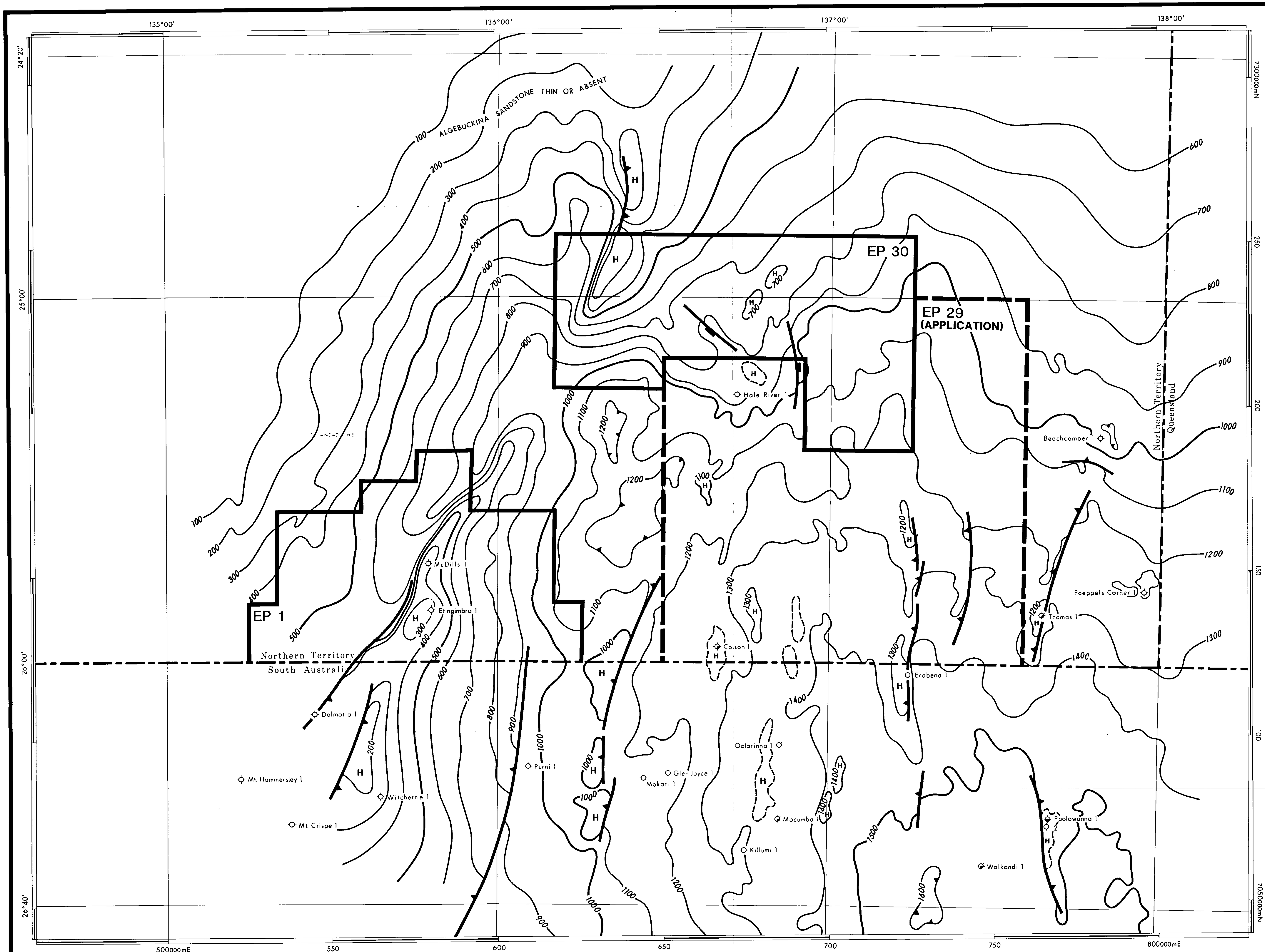
Eromanga Basin

DEPTH STRUCTURE

TOP POOLOWANNA BEDS

Scale: 1:500,000
Date: JAN. 1990
C. Interval: 100m (≈ 80 msec.)

Enc. No
1



LEGEND

- DRY HOLE
- OIL SHOW (OIL REC. DST)
- OIL SHOW (FLUORESCENCE IN CUTTINGS OR CORE)
- SIGNIFICANT GAS SHOW (NO DST RECOVERY)

0 10 20 30 40 KMS

NORTHERN TERRITORY
GEOLOGICAL SURVEY
PETROLEUM BASIN STUDY

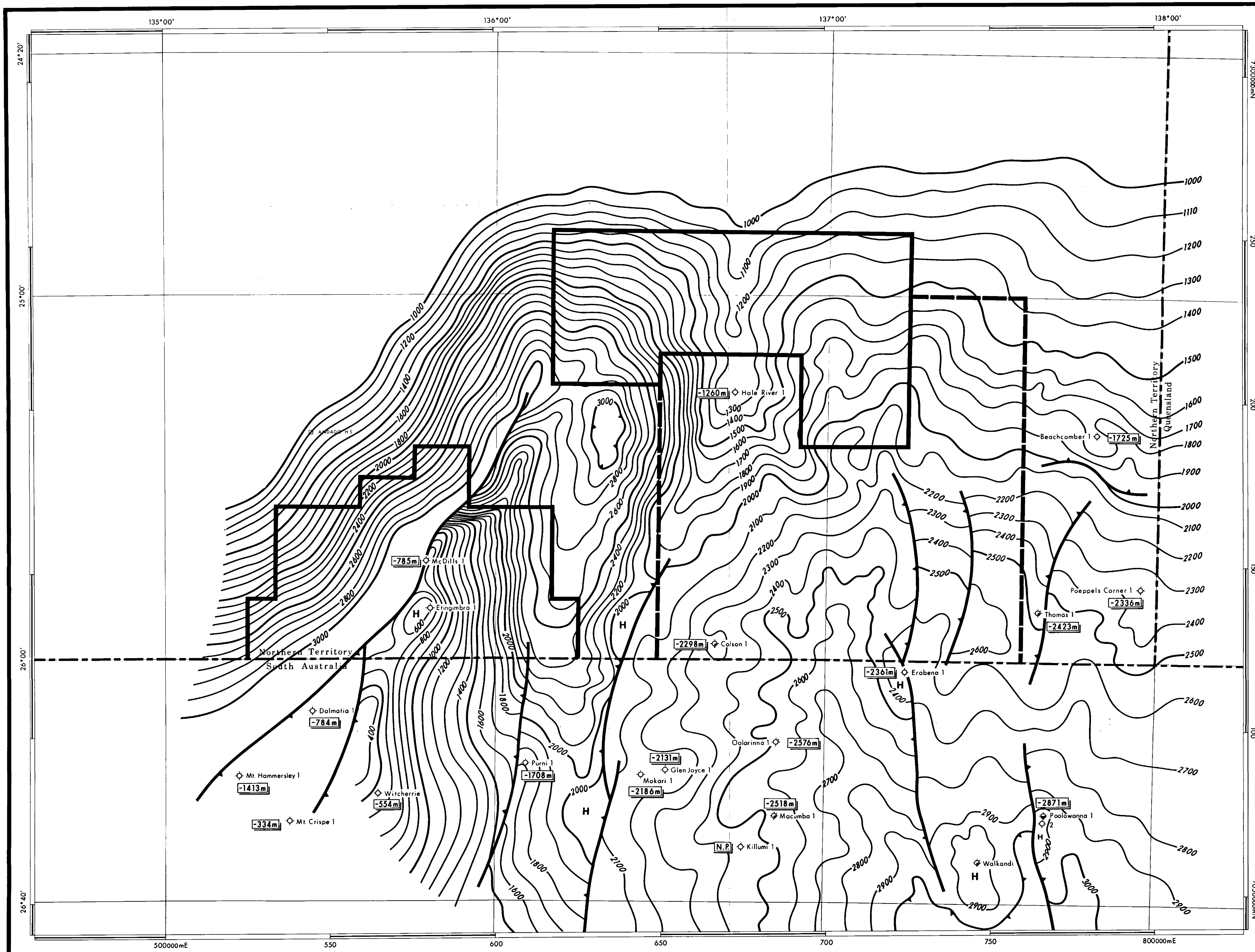
Eromanga Basin

TWO WAY TIME STRUCTURE

TOP CADNA-OWIE FORMATION

Scale: 1:500,000
Date: JAN. 1990
C. Interval: 100msec. ---50msec.

Enc. No
2



LEGEND

- DRY HOLE
- OIL SHOW (OIL REC. DST)
- OIL SHOW (FLUORESCENCE IN CUTTINGS OR CORE)
- SIGNIFICANT GAS SHOW (NO DST RECOVERY)

0 10 20 30 40 KMS

NORTHERN TERRITORY
GEOLOGICAL SURVEY
PETROLEUM BASIN STUDY

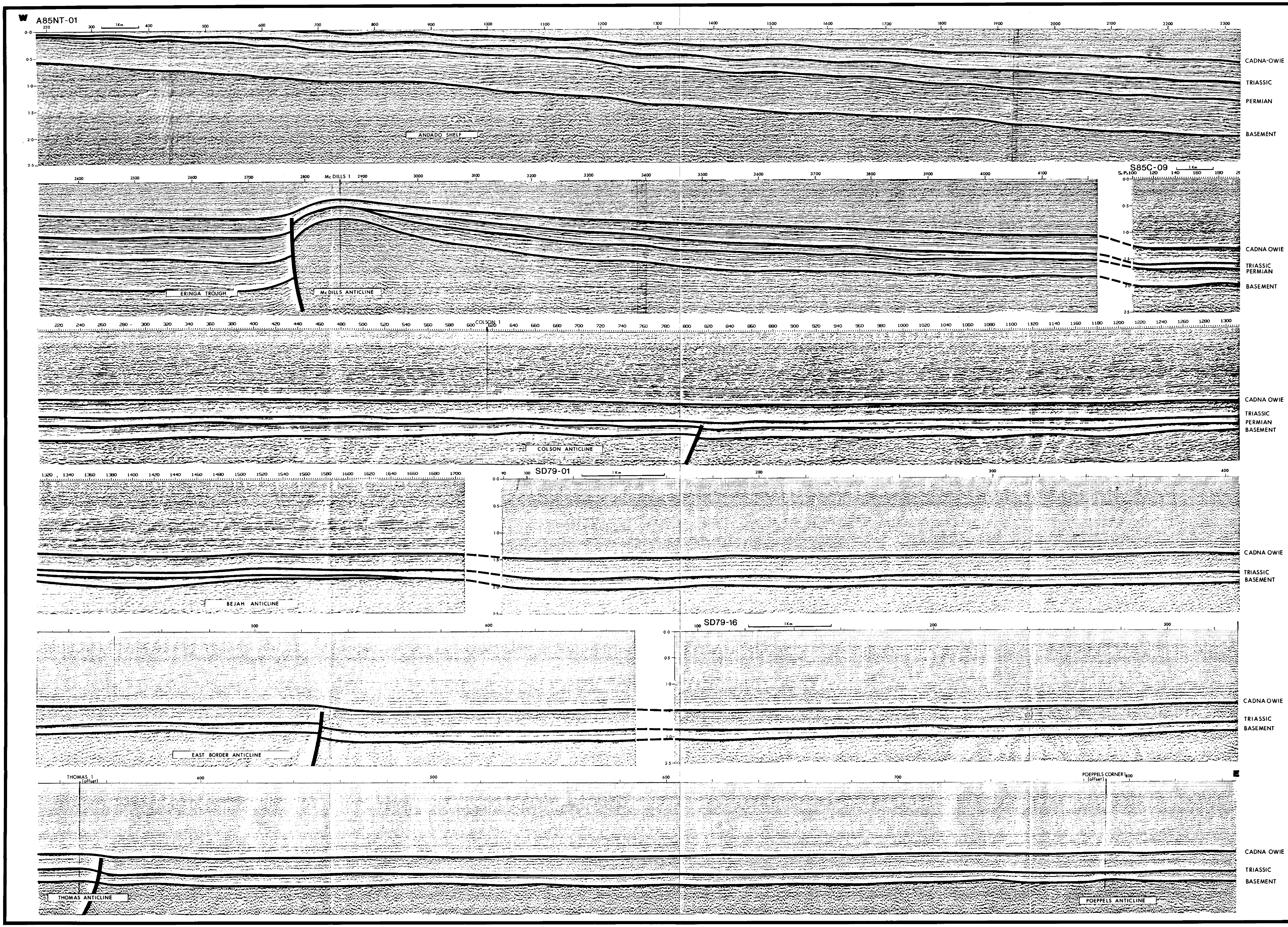
Eromanga Basin

FORMLINE DEPTH STRUCTURE

TOP OF PRE-PERMIAN UNCONFORMITY

Scale: 1:500,000
Date: JAN. 1990
C. Interval 100m

Enc. No
3



NORTHERN TERRITORY PEDIRKA/EROMANGA BASIN

COMPOSITE SEISMIC CROSS SECTION REFER TO FIGURE 6

ENCL. No. 4

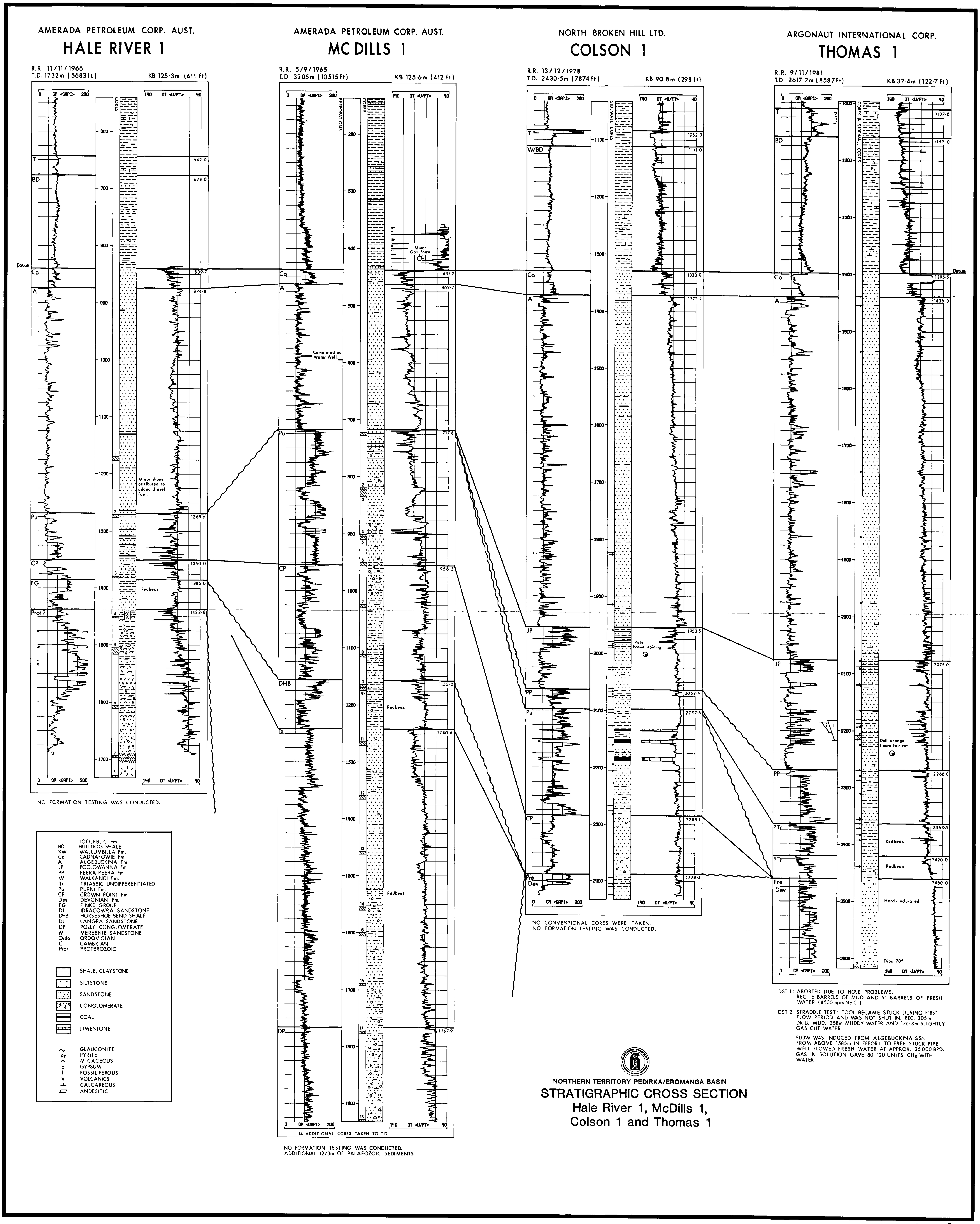
NORTHERN TERRITORY
GEOLOGICAL SURVEY

Eromanga Basin

BOUGUER GRAVITY

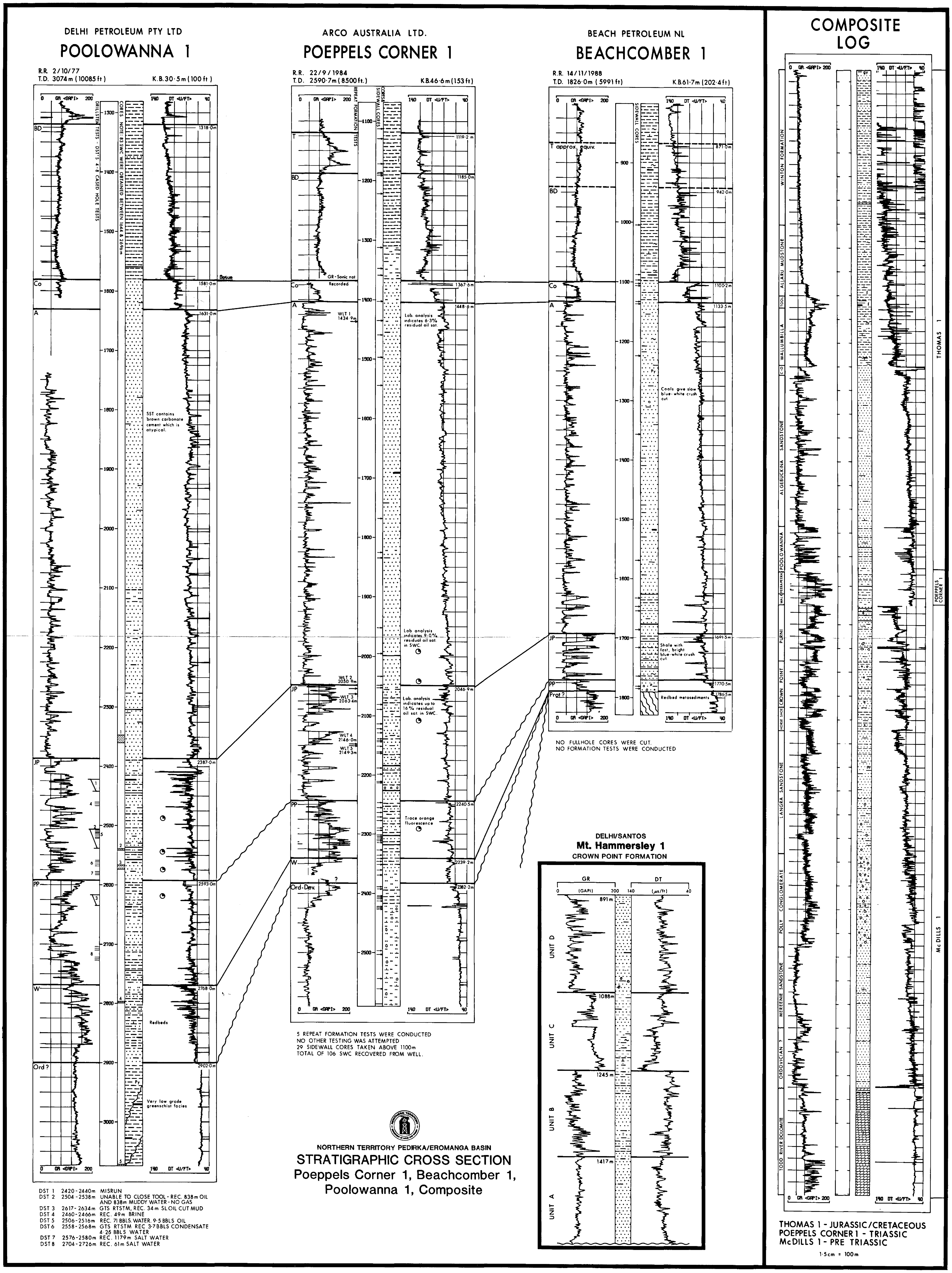
Scale: 1:500,000
Date: JAN. 1990
C. Interval: -5mgal

Enc. No
5

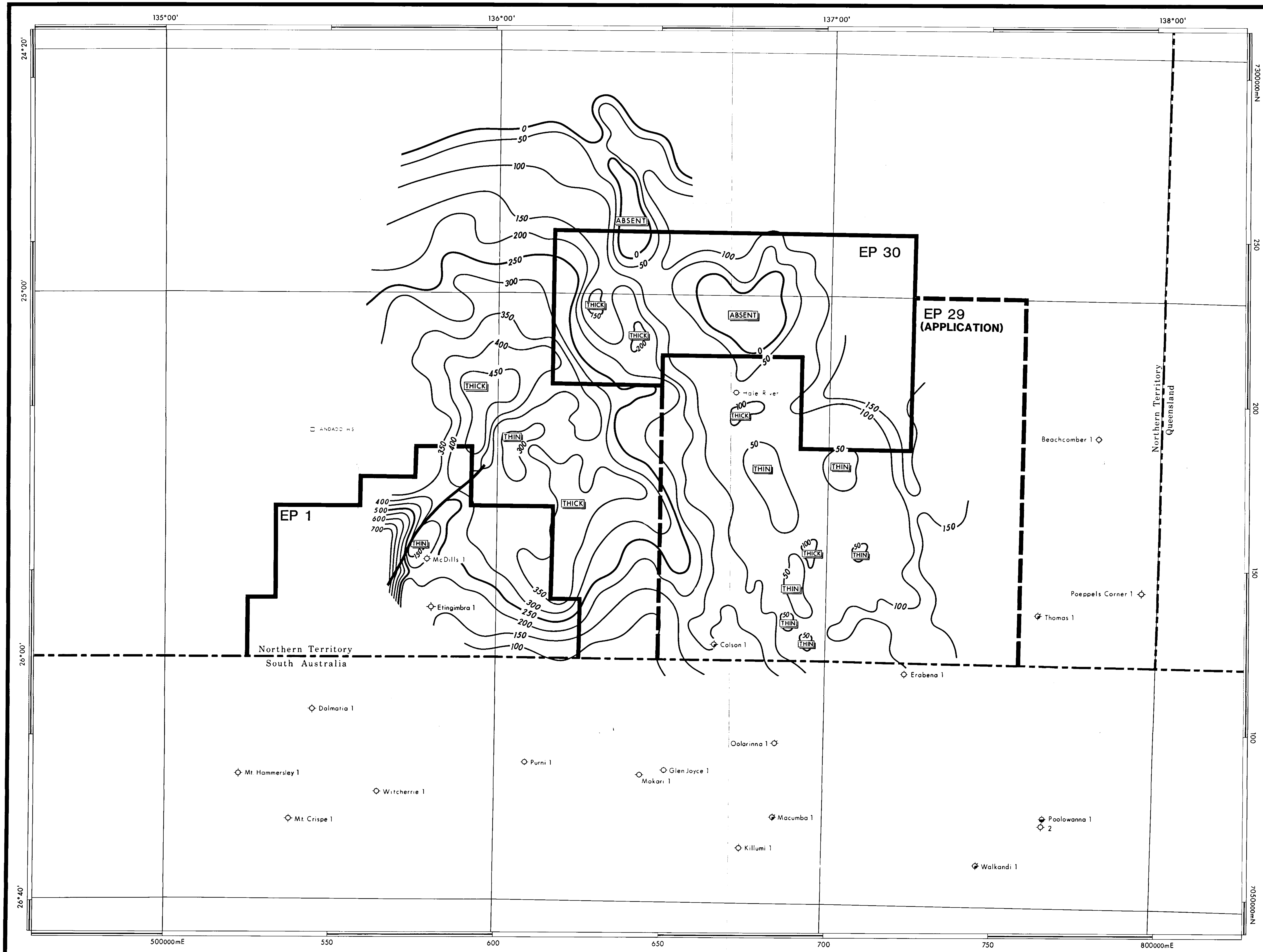


NORTHERN TERRITORY PEDIRKA/EROMANGA BASIN
STRATIGRAPHIC CROSS SECTION
Hale River 1, McDills 1, Colson 1 and Thomas 1

ENCL. No. 6a


DELHI PETROLEUM PTY LTD
POOLOWANNA 1
R.R. 2/10/77
T.D. 3074m (10085 ft)
K.B. 30·5m (100 ft)
ARCO AUSTRALIA LTD.
POEPPELS CORNER 1
R.R. 22/9/1984
T.D. 2590·7m (8500 ft.)
K.B. 46·6m (153 ft)
BEACH PETROLEUM NL
BEACHCOMBER 1
R.R. 14/11/1988
T.D. 1826·0m (5991 ft)
K.B. 61·7m (202·4 ft)
COMPOSITE LOG
SST contains brown carbonate cement which is atypical.
Redbeds
Very low grade greenschist facies
DST 1 2420-2440m MISRUN
DST 2 2504-2538m UNABLE TO CLOSE TOOL - REC. 838m OIL AND 838m MUDDY WATER - NO GAS
DST 3 2617-2634m GTS RTSTM, REC. 34m SL OIL CUT MUD
DST 4 2460-2466m REC. 49m BRINE
DST 5 2506-2516m REC. 71 BBLS WATER, 9·5 BBLS OIL
DST 6 2558-2568m GTS RTSTM REC 3·7 BBLS CONDENSATE 4·25 BBLS WATER
DST 7 2576-2580m REC. 1179m SALT WATER
DST 8 2704-2726m REC. 61m SALT WATER
GR - Sonic not Recorded
Lab. analysis indicates 6·3% residual oil sat.
Lab. analysis indicates 9·0% residual oil sat. in SWC
Lab. analysis indicates up to 16% residual oil sat. in SWC
Trace orange fluorescence
5 REPEAT FORMATION TESTS WERE CONDUCTED
NO OTHER TESTING WAS ATTEMPTED
29 SIDEWALL CORES TAKEN ABOVE 1100m
TOTAL OF 106 SWC RECOVERED FROM WELL.
Coals give slow blue-white crush cut
Shale with fast, bright blue-white crush cut
Redbed metasediments
NO FULLHOLE CORES WERE CUT.
NO FORMATION TESTS WERE CONDUCTED
DELHI/SANTOS
Mt. Hammersley 1
CROWN POINT FORMATION
UNIT D
UNIT C
UNIT B
UNIT A
NORTHERN TERRITORY PEDIRKA/EROMANGA BASIN
STRATIGRAPHIC CROSS SECTION
Poeppels Corner 1, Beachcomber 1, Poolowanna 1, Composite
WINTON FORMATION
ALLARU MUDSTONE
WALLUMBILLA
ALGEBUCKINA SANDSTONE
POOLOWANNA
PURNI
CROWN POINT
LANGRA SANDSTONE
POLLY CONGLOMERATE
MEREENIE SANDSTONE
ORDOVICIAN ?
TODD RIVER DOLOMITE
THOMAS 1
POEPPELS CORNER 1
McDILLS 1
THOMAS 1 - JURASSIC/CRETACEOUS
POEPPELS CORNER 1 - TRIASSIC
McDILLS 1 - PRE TRIASSIC
1·5cm = 100m

ENCL. No. 6b



LEGEND

- DRY HOLE
- OIL SHOW (OIL REC. DST)
- OIL SHOW (FLUORESCENCE IN CUTTINGS OR CORE)
- SIGNIFICANT GAS SHOW (NO DST RECOVERY)

0 10 20 30 40 KMS

NORTHERN TERRITORY
GEOLOGICAL SURVEY
PETROLEUM BASIN STUDY

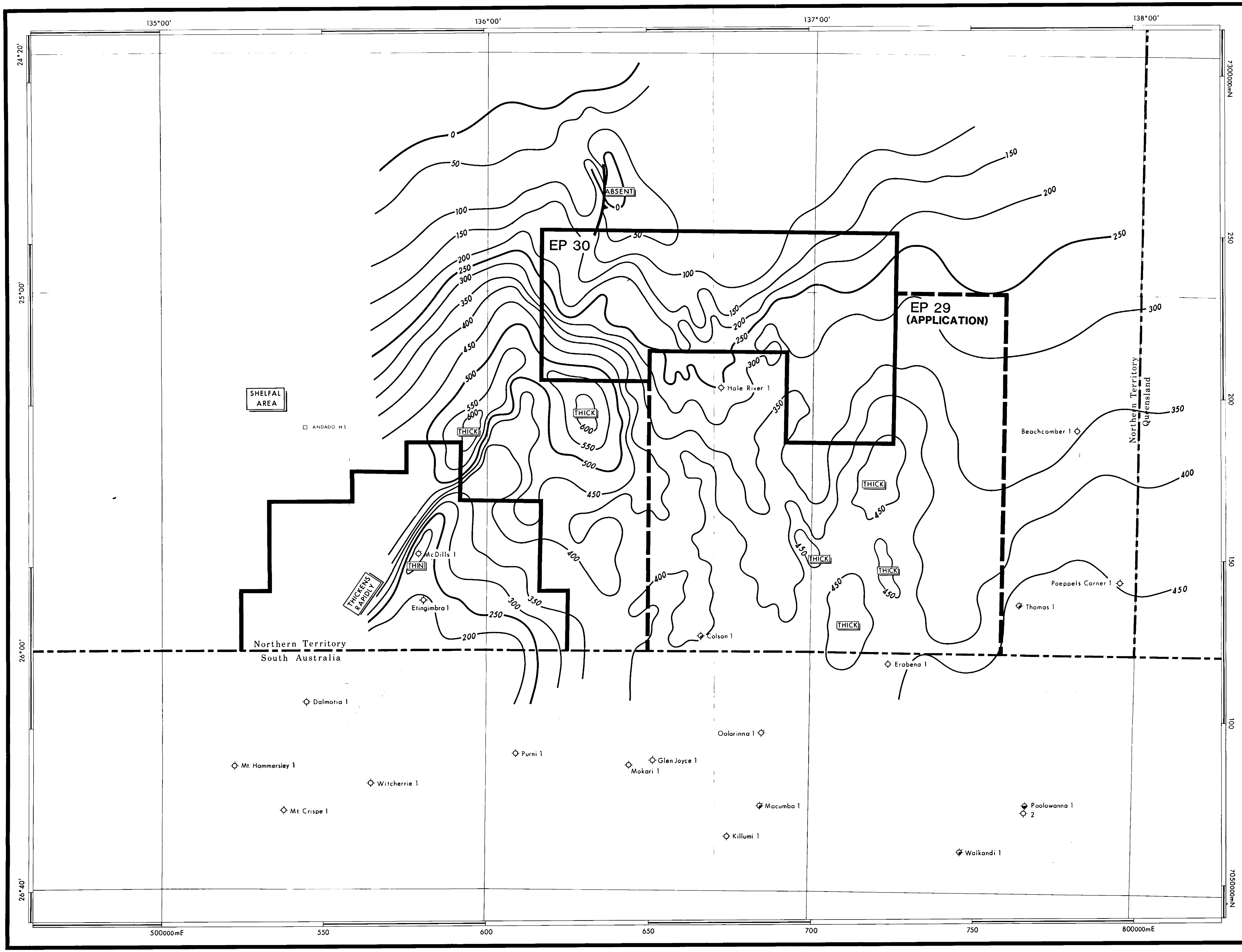
Eromanga Basin

ISOCHRON

PERMO-TRIASSIC

Scale: 1: 500,000
Date: JAN. 1990
C. Interval: -50msec.

Enc. No
7



LEGEND

- DRY HOLE
- OIL SHOW (OIL REC. DST)
- OIL SHOW (FLUORESCENCE IN CUTTINGS OR CORE)
- SIGNIFICANT GAS SHOW (NO DST RECOVERY)

NORTHERN TERRITORY
GEOLOGICAL SURVEY
PETROLEUM BASIN STUDY

Eromanga Basin

ISOCHRON

TOP CADNA-OWIE FM. TO BASE JURASSIC

Scale: 1:500,000
Date: JAN. 1990
C. Interval: 50msec.

Enc. No
8

LEGEND

- DRY HOLE
- OIL SHOW (OIL REC DST)
- OIL SHOW (FLUORESCENCE IN CUTTINGS OR CORE)
- SIGNIFICANT GAS SHOW (NO DST RECOVERY)

0 10 20 30 40 KMS

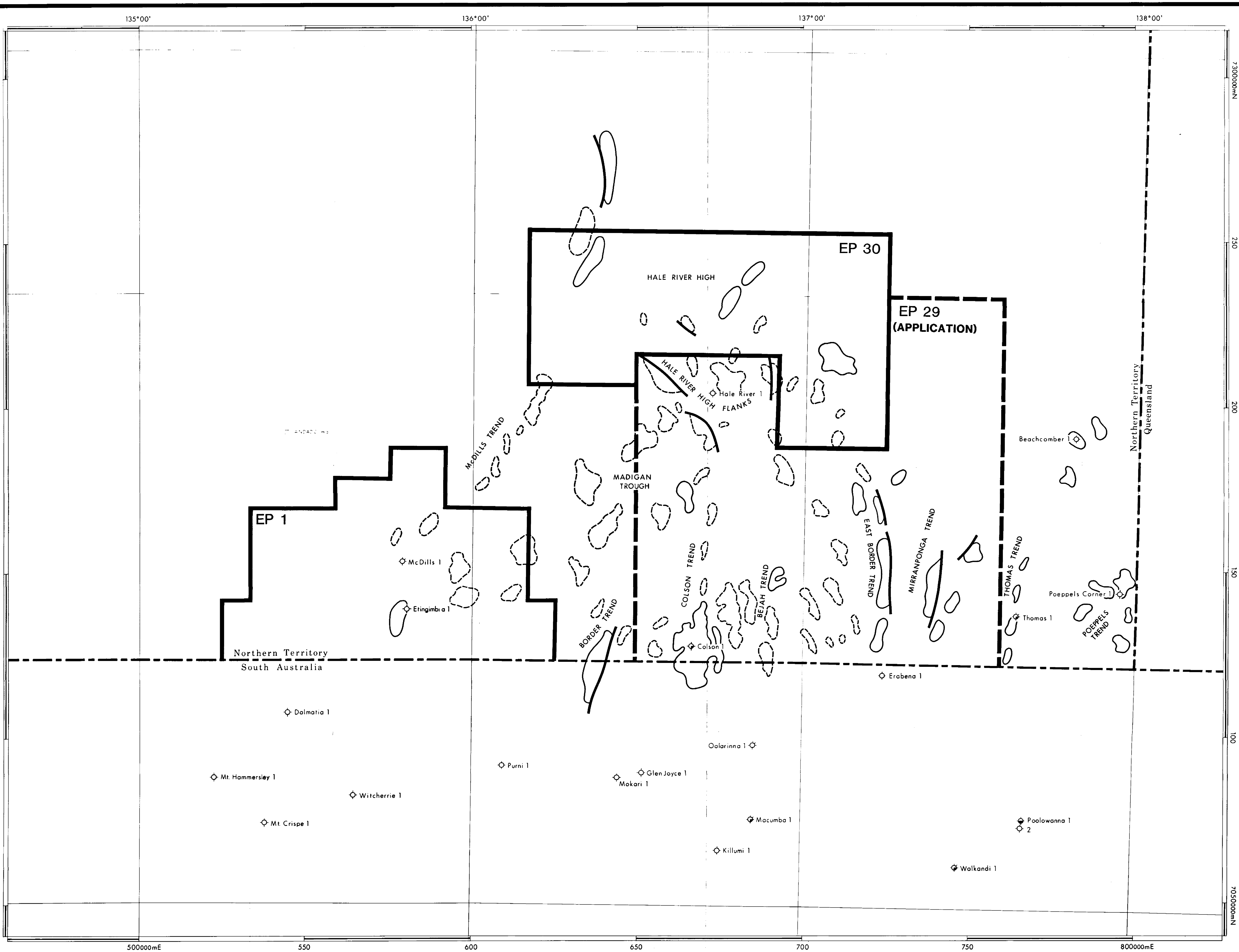
NORTHERN TERRITORY
GEOLOGICAL SURVEY
PETROLEUM BASIN STUDY

Eromanga Basin

SEISMIC LINE LOCATION

Scale: 1:500,000
Date: JAN. 1990
C. Interval

Enc. No
9



LEGEND

- DRY HOLE
- OIL SHOW (OIL REC DST)
- OIL SHOW (FLUORESCENCE IN CUTTINGS OR CORE)
- SIGNIFICANT GAS SHOW (NO DST RECOVERY)
- LEAD
- PROSPECT

0 10 20 30 40 KMS

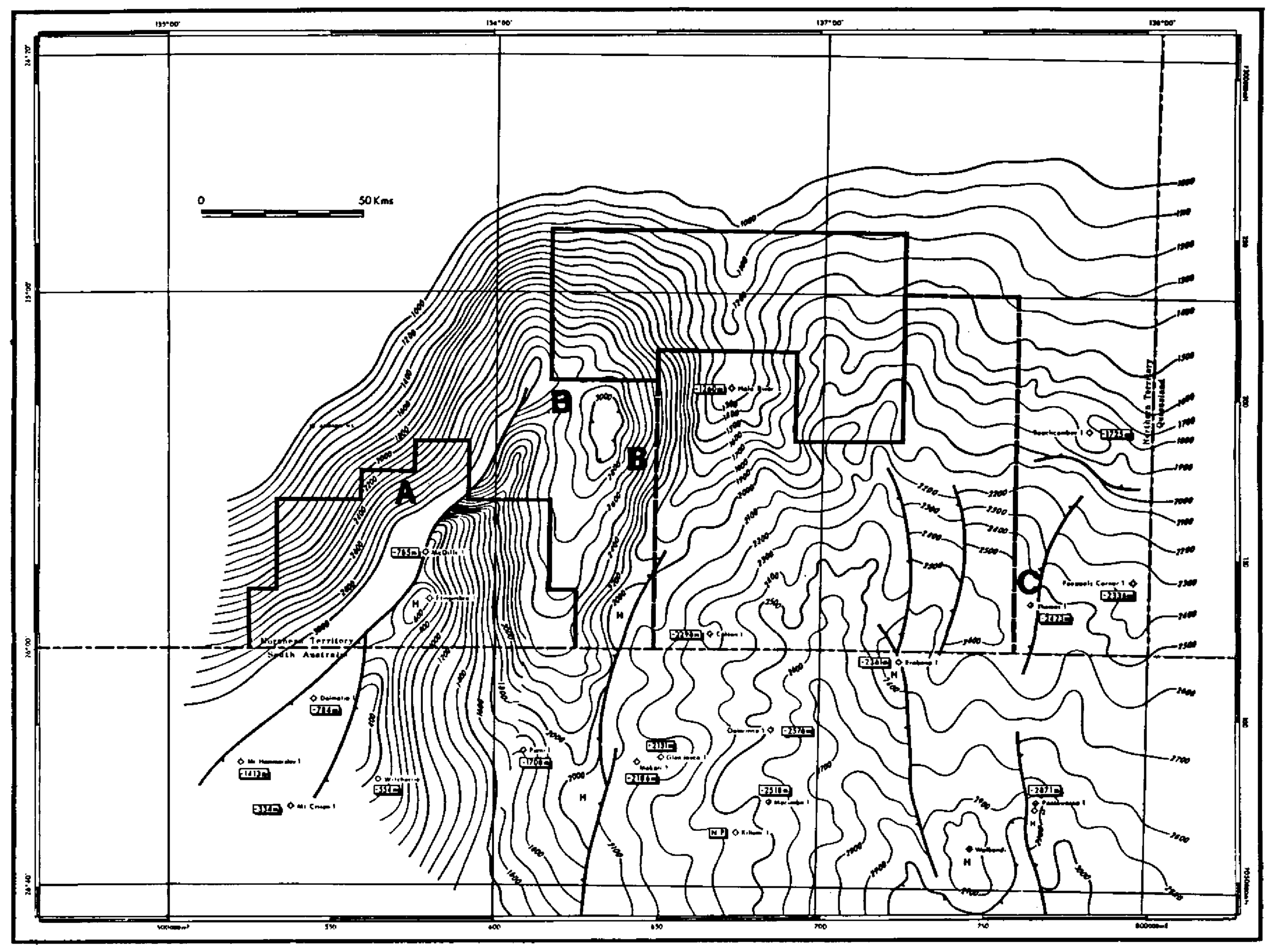
NORTHERN TERRITORY
GEOLOGICAL SURVEY
PETROLEUM BASIN STUDY

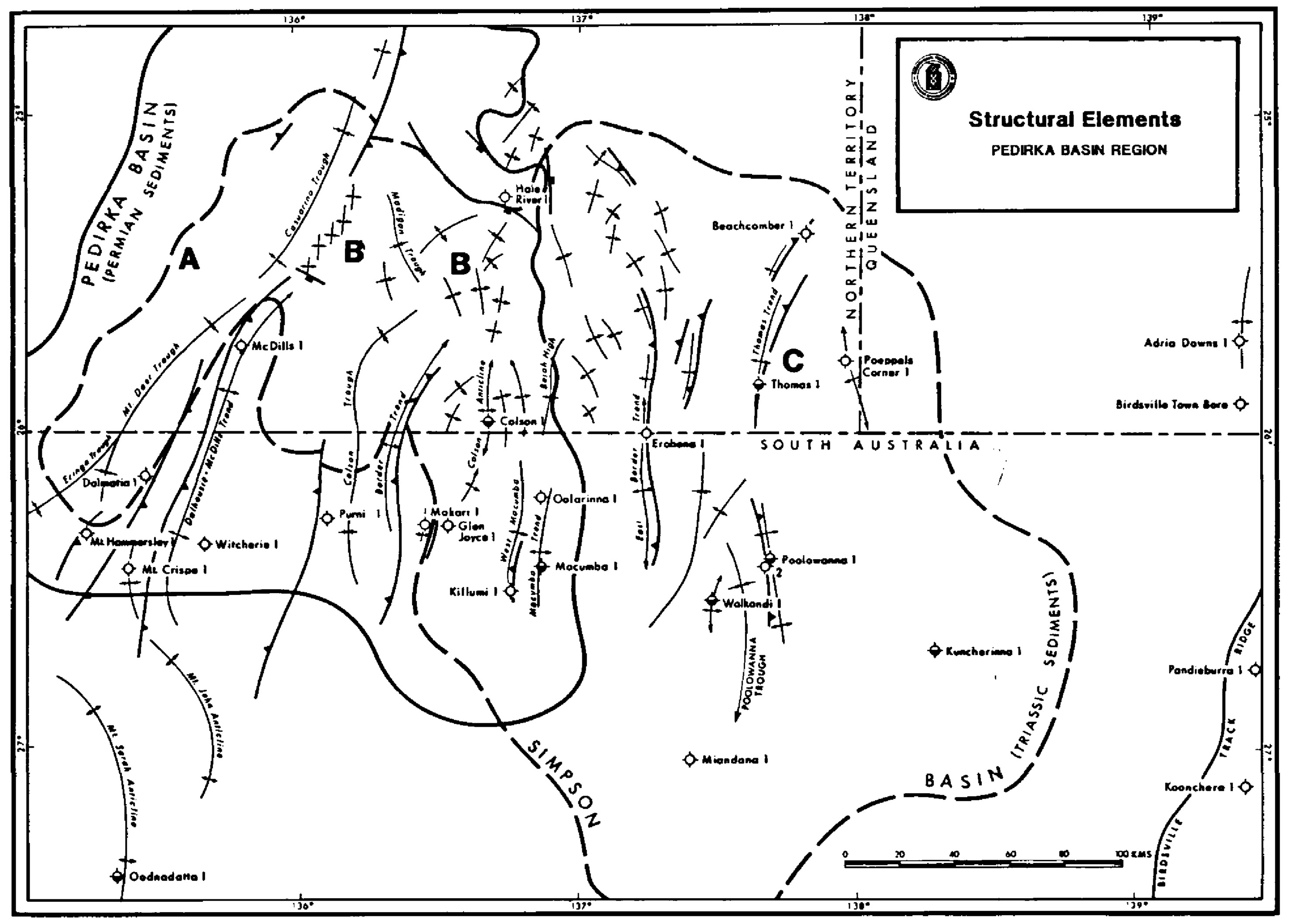
Eromanga Basin

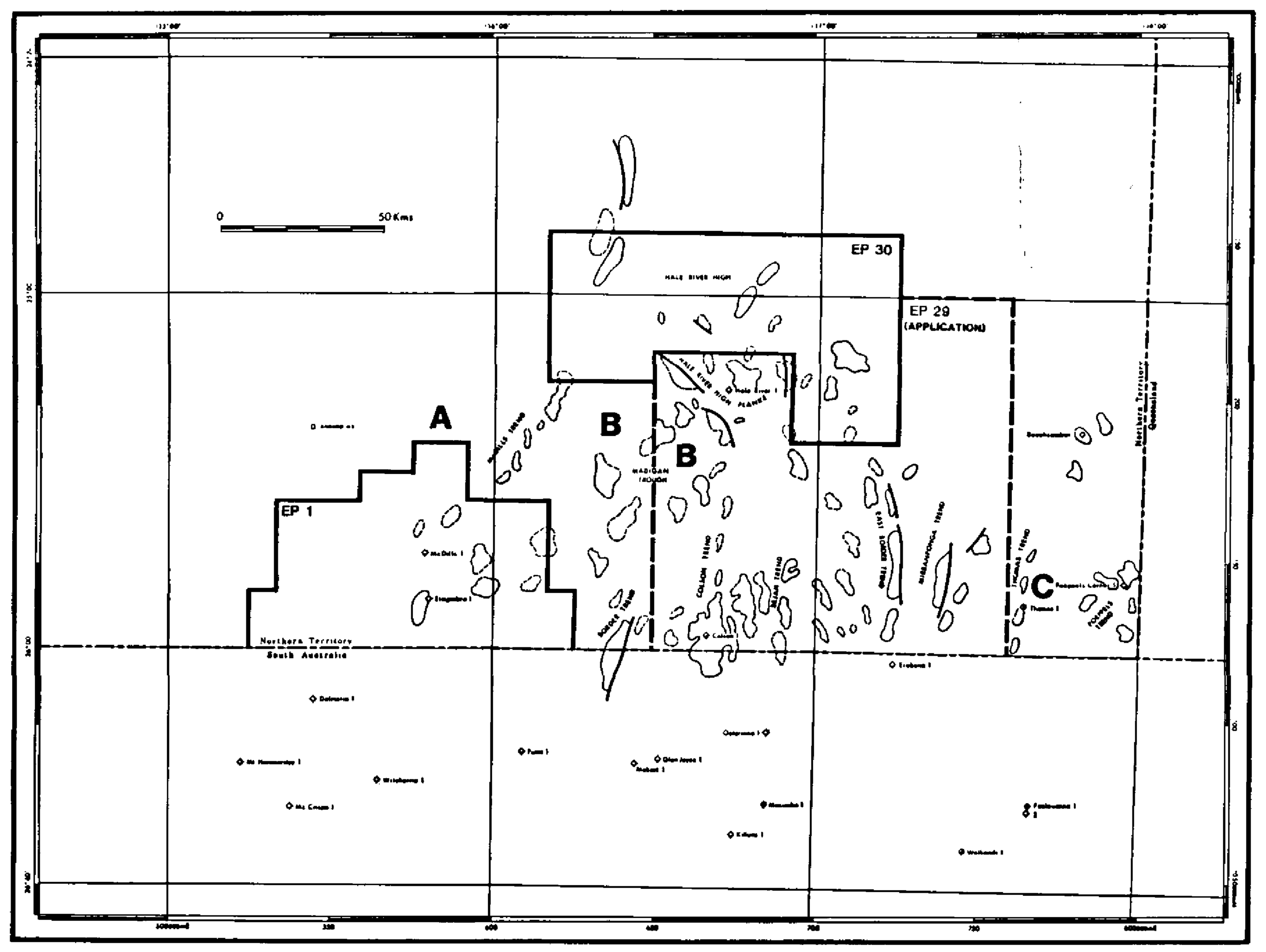
PROSPECTS AND LEADS

Scale: 1:500,000
Date: JAN. 1990
C. Interval

Enc. No
10







NORTHWEST FLANK ERINGA TROUGH PLAY

RESERVOIR OBJECTIVES:
Permian and Triassic Sands
Cambrian, Ordovician and Devonian Clastics and Carbonates

DEPTHS TO RESERVOIRS:
Base Permian:
?1000 to 3000m
3300 to 9800ft

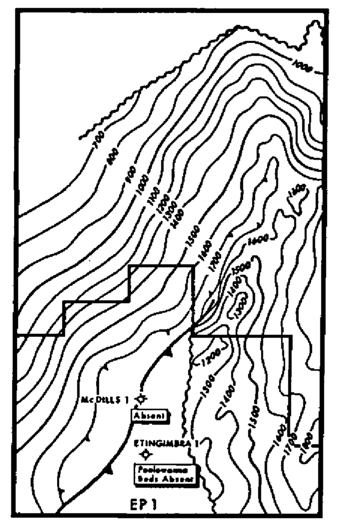
Base Cambrian:
?up to 5000m
up to 16,400ft

STRUCTURE SIZE:
Unknown

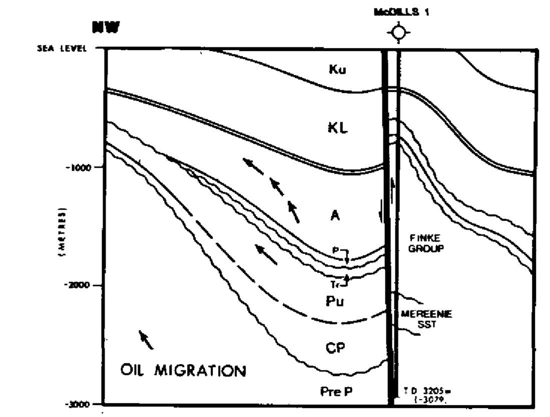
HYDROCARBONS EXPECTED:
Oil and Gas

ACREAGE AVAILABLE:
60% Open
40% part of EP 1

WORK REQUIRED:
There has been extremely little seismic acquired in this part of basin.



STRUCTURE TOP POOLOWANNA FM.



CONCEPT:
The Eringa Trough would have provided an ideal environment for the deposition of organically rich source shales, carbonates and evaporites from Cambrian through Early Jurassic time. The depositional history of the trough would have been very different to that of the more explored Poolowanna Trough and would have been more favourable for the formation and preservation of oil and gas prone source rocks and porous and permeable reservoirs.

A rapid and continuous subsidence resulted in potential source rock intervals being buried sufficiently deep to be placed within the main phase of oil generation and expulsion.

Almost all of the hydrocarbons generated within the trough would have migrated to the northwest and west, and not to the east as anticipated by previous explorers.

A

MADIGAN TROUGH ANTICLINAL CLOSURES

RESERVOIR OBJECTIVES:
Poolowanna Formation Sands
Permian and Triassic Sands
Pre Permo Carboniferous Clastics and Carbonates

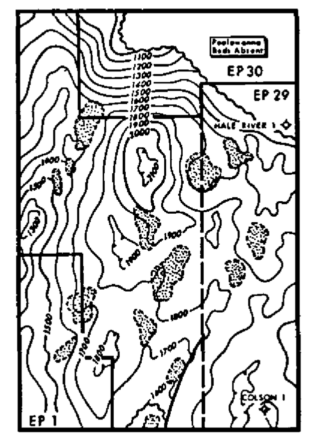
DEPTHS TO RESERVOIRS:
Base Permian ?2500m
Base Cambrian ?

STRUCTURE SIZE:
Medium to large

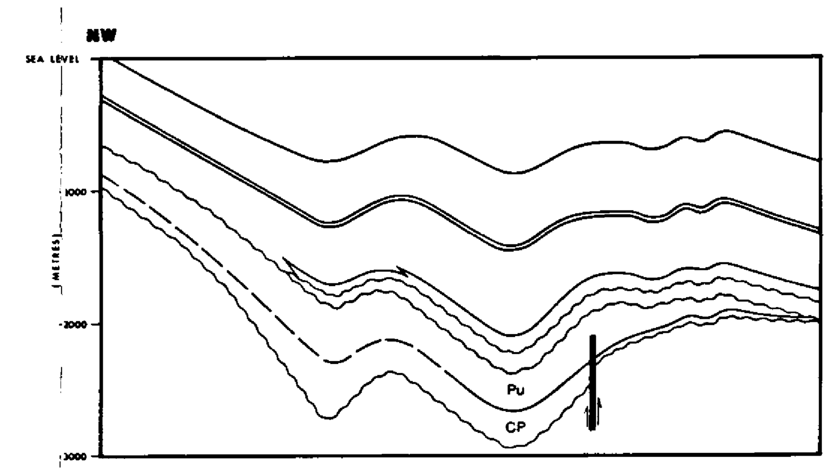
HYDROCARBONS EXPECTED:
Oil and Gas

ACREAGE AVAILABLE:
Acreage largely open
Some closures in EP 29

WORK REQUIRED:
Detailed seismic across leads
Only one prospect defined



STRUCTURE TOP POOLOWANNA FM.



CONCEPT:
The configuration and position of the Madigan Trough suggests that during Permian through Early Jurassic time, the trough would have been the site of lacustrine and coal swamp deposition. The most organically rich, oil prone source rocks in the Pedirka Basin are interpreted to be contained in this trough, in particular, within its northern depocentre. Seismic information indicates that these source rocks would have entered the main phase of oil and gas generation and expulsion making this unexplored part of the Pedirka Basin region very prospective.

B

UPDIP THOMAS 1 PLAY

RESERVOIR OBJECTIVES:
Early Jurassic and Triassic Sands

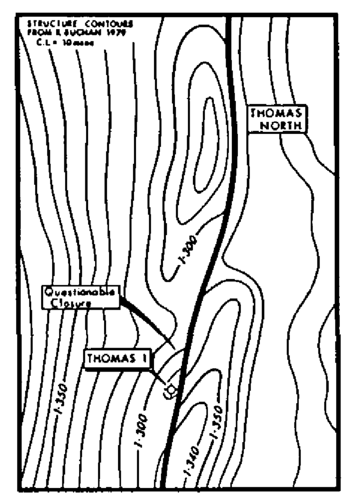
DEPTHS TO RESERVOIRS:
2000 to 2400m
6560 to 7875ft

STRUCTURE SIZE:
Approx 7.5 x 2.5km
20ms vertical

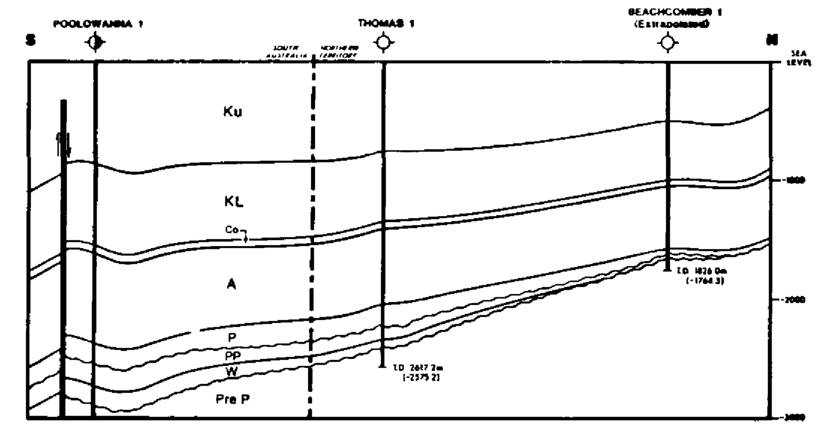
HYDROCARBONS EXPECTED:
Oil

ACREAGE AVAILABLE:
Contained within EP 29 Application Block

WORK REQUIRED:
Seismic Reprocessing to verify integrity of model



STRUCTURE APPROX. TOP ALGEBUCKINA SST.

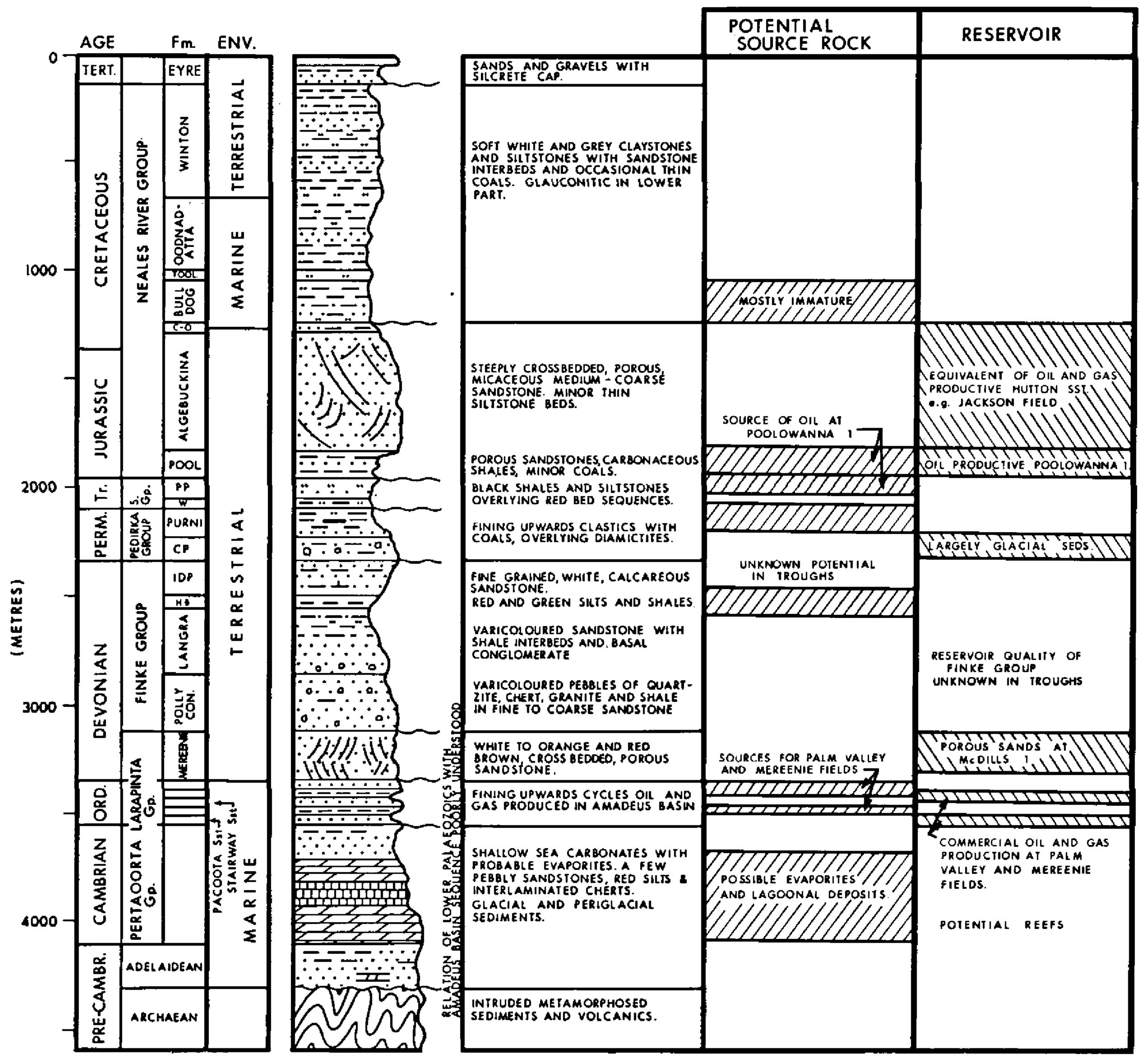


CONCEPT:
Operator's structure mapping indicates Thomas 1 to have evaluated a valid structural closure. Definition of northern closure is, however, obscured by proximity to a major north-south trending fault. A review of seismic data suggests north closure is invalid. Hydrocarbon entrapment would therefore be within fault independent closure on trend and to north of Thomas 1 where some 20ms (TWT) of structural advantage can be gained.

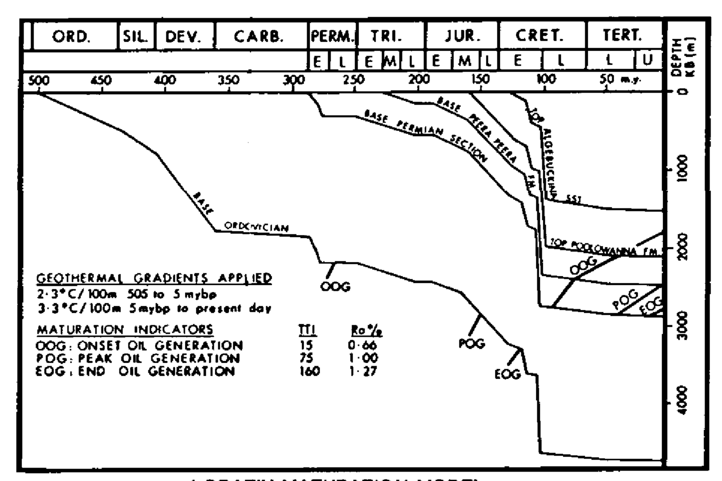
Vitrinite Reflectance values at Thomas 1 indicate source rocks to be mature for oil generation. Brown stain with dull orange fluorescence was present in basal Poolowanna Formation in Thomas 1. The updip Thomas 1 closure has a large hydrocarbon drainage area and makes an attractive drilling objective.

C

- **EARLY CAMBRIAN THROUGH LATE JURASSIC OBJECTIVES**
- **ERINGA AND MADIGAN TROUGHS IN NORTHERN TERRITORY PRESENT BEST HYDROCARBON POTENTIAL IN PEDIRKA-SIMPSON BASIN REGION YET THESE AREAS HAVE NOT BEEN EXPLORED**
- **READY MARKETS FOR BOTH GAS AND OIL: NEARBY INFRASTRUCTURE (ALICE SPRINGS AND MOOMBA)**



IDEALISED COMPOSITE STRATIGRAPHIC SECTION
Pedirka Basin Region



LOPATIN MATURATION MODEL
Depocentre of Eringa Trough

The Mesozoic Eromanga Basin which occupies a large part of Eastern Australia is underlain in the Northern Territory and northern South Australia by the Late Palaeozoic Pedirka Basin.

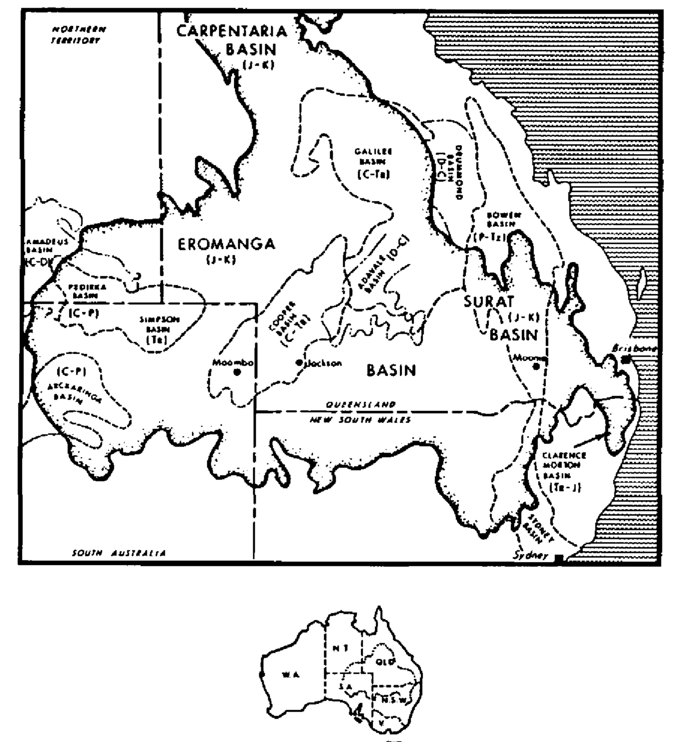
The exploration programme that has been conducted in the Pedirka/Eromanga Basin Region to date has demonstrated that an abundance of organically rich source rocks, porous and permeable reservoirs with effective vertical seals, and closed anticlinal structures are present throughout the study area. Reservoir objectives and their associated source rocks range in age from earliest Cambrian to Early Cretaceous.

Geochemical evidence has shown that an absence of organic maturity is the primary reason for the lack of exploration success in the basin to date. Geothermal gradients within the study area are low, particularly when compared with those of the nearby gas and oil productive, Cooper/Eromanga Basin region.

Organic maturity is the only ingredient remaining for the establishment of an important hydrocarbon province. This maturity is expected to be found in the Madigan and Eringa Troughs in the western part of the study area. Several closed structures have been identified along the margins of the Madigan Trough. None has been drilled. Several wells have been drilled along the eastern margin of the Eringa Trough on an upthrown fault block without success but the structural configuration is such that hydrocarbon migration from the depression would have been towards the west and northwest and not towards the east.

Most of the exploration in the study area has concentrated on the Upper Palaeozoic and Mesozoic succession, particularly since oil was recovered from Early Jurassic and Triassic sands while testing Poolowanna 1 in 1977. Mesozoic and Upper Palaeozoic rocks remain the primary exploration targets in the study area but Early Palaeozoic (Cambrian to Devonian) clastics and carbonates provide exciting secondary objectives. The Eringa Trough would have provided an ideal environment for the development of organically rich source rocks and porous and permeable reservoirs. Stratigraphically equivalent units at Palm Valley and Mereenie fields to the northwest are proven oil and gas producers.

The Pedirka/Eromanga Basin region has all of the prerequisites of an important hydrocarbon province and one can only be optimistic about its oil and gas potential. The basin area should be considered both oil and gas prone. There is a ready market for gas both in Darwin and in Adelaide. Pipelines and processing facilities are established at Moomba, 400km to the southeast and at Palm Valley-Mereenie, 300kms to the northwest and therefore logistics are favourable.



NORTHERN TERRITORY GEOLOGICAL SURVEY
PETROLEUM BASIN STUDY

EROMANGA BASIN

Summary of Hydrocarbon Potential