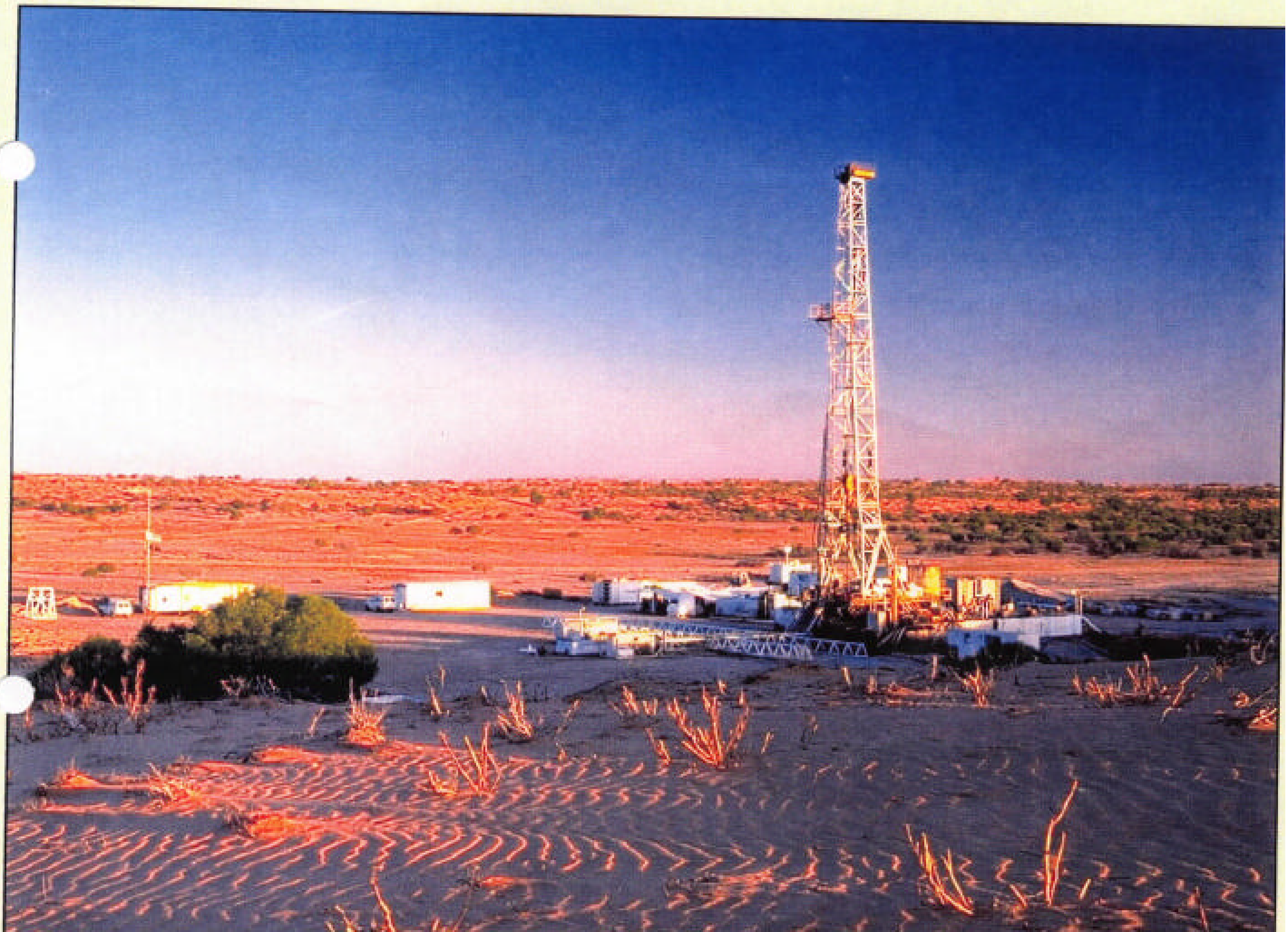
Eromanga Basin Exploration Opportunity



May 1996

MINES and ENERGY
SOUTH AUSTRALIA

NUMBER 8083 R 21

EXPLORATION OPPORTUNITY
EROMANGA BASIN ACREAGE RELEASE

EVALUATION REPORT

Submitted by

MESA
1996

ENVELOPE 8083 R 21

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(Part of Volume Two, Envelope 8083)

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MINES and ENERGY
SOUTH AUSTRALIA

EROMANGA BASIN
EXPLORATION OPPORTUNITY
BLOCKS ER96-A to D

by

ELINOR M ALEXANDER

Petroleum Division

MAY 1996

Cover photo: Drilling in the Moomba area (courtesy of Santos Ltd)

EXECUTIVE SUMMARY

Areas, ER96-A, B, C and D located in the Eromanga Basin of South Australia, are available for application for Petroleum Exploration Licences. The approximate area of each block and seismic coverage is as follows:

Block	Area (km^2)	Area (million acres)	Seismic (line km)	Seismic (line miles)
ER96-A	7756	1.9	1502	933
ER96-B	4573	1.1	996	619
ER96-C	4112	1.0	783	486
ER96-D	6813	1.7	2613	1624

The blocks on offer lie adjacent to PELs 5 and 6, operated by Santos Ltd, which covers the Cooper Basin – Australia's largest onshore oil and gas province. Blocks lie on a large structural complex, the Birdsville Track Ridge which separates the Mesozoic Poolowanna Trough depocentre from the Permian to Mesozoic Cooper Basin depocentre. The geology of the region is known from relatively limited seismic and petroleum drillholes. Blocks ER96A-D contain sediments from four superimposed intracratonic basins separated by unconformities – the Cambro-Ordovician Warburton Basin and the intracratonic Triassic Simpson Basin, Jurassic-Cretaceous Eromanga Basin and Cainozoic Lake Eyre Basin.

Fair to excellent quality sandstone reservoirs are sealed by siltstone and shale units - these reservoir/seal units are proven producers in the nearby Cooper Basin region. In addition, many prospects and leads have been identified by former explorers in the region and by MESA. The perceived problem with Eromanga Basin hydrocarbon prospectivity is lack of adequate source rocks. Conventional wisdom is that oil reservoired in the Eromanga Basin is sourced from the Cooper Basin and that little potential exists outside the Cooper region. However, new geochemical data from the Poolowanna Trough and Birdsville Track Ridge area indicate that organic-rich shales in the Eromanga Basin are oil-prone and are at the peak maturity for oil-generation in the Poolowanna Trough. This has significantly upgraded the hydrocarbon potential of this region.

KEY DATA

Depth to target zones:	1 200–3 000 m (3940–9840 ft)
Thickness:	Up to 3 050 m or 10 000 ft (in Poolowanna Trough)
Hydrocarbon shows:	Cooper Basin region – commercial discoveries of oil from almost every unit from the Cambrian to the base Cretaceous. Elsewhere – shows in Poolowanna Formation, Namur Sandstone, Peera Peera Formation.
First discovery:	1976 (Namur 1 gas), 1978 (Poolowanna 1, non-commercial oil), 1978 (Strzelecki 3, commercial oil).
Basin type:	Intracratonic.
Depositional setting:	Non-marine, fluvio-lacustrine.
Reservoirs:	Good-excellent quality braided and meandering fluvial and shoreface sandstone reservoirs. Fair-excellent lacustrine turbidite sandstone reservoirs.
Regional structure:	Broad, four way dip closed anticlinal trends in regional sag basin.
Seals:	Lacustrine and floodplain siltstones and shales.
Source rocks:	Cooper Basin coal, shale and siltstone (?long distance lateral migration). Simpson Basin – Peera Peera Formation coal, shale and siltstone. Eromanga Basin – Poolowanna and Birkhead Formation coal, siltstone and shale, Murta Formation shale.
Migration	Vertical migration from Triassic and Jurassic source rocks, possible long distance lateral migration via groundwater movement from Cooper Basin, approximately 180 km away.
Traps	anticlines with four-way dip closure, possible stratigraphic traps against basement highs, possible hydrodynamic component.

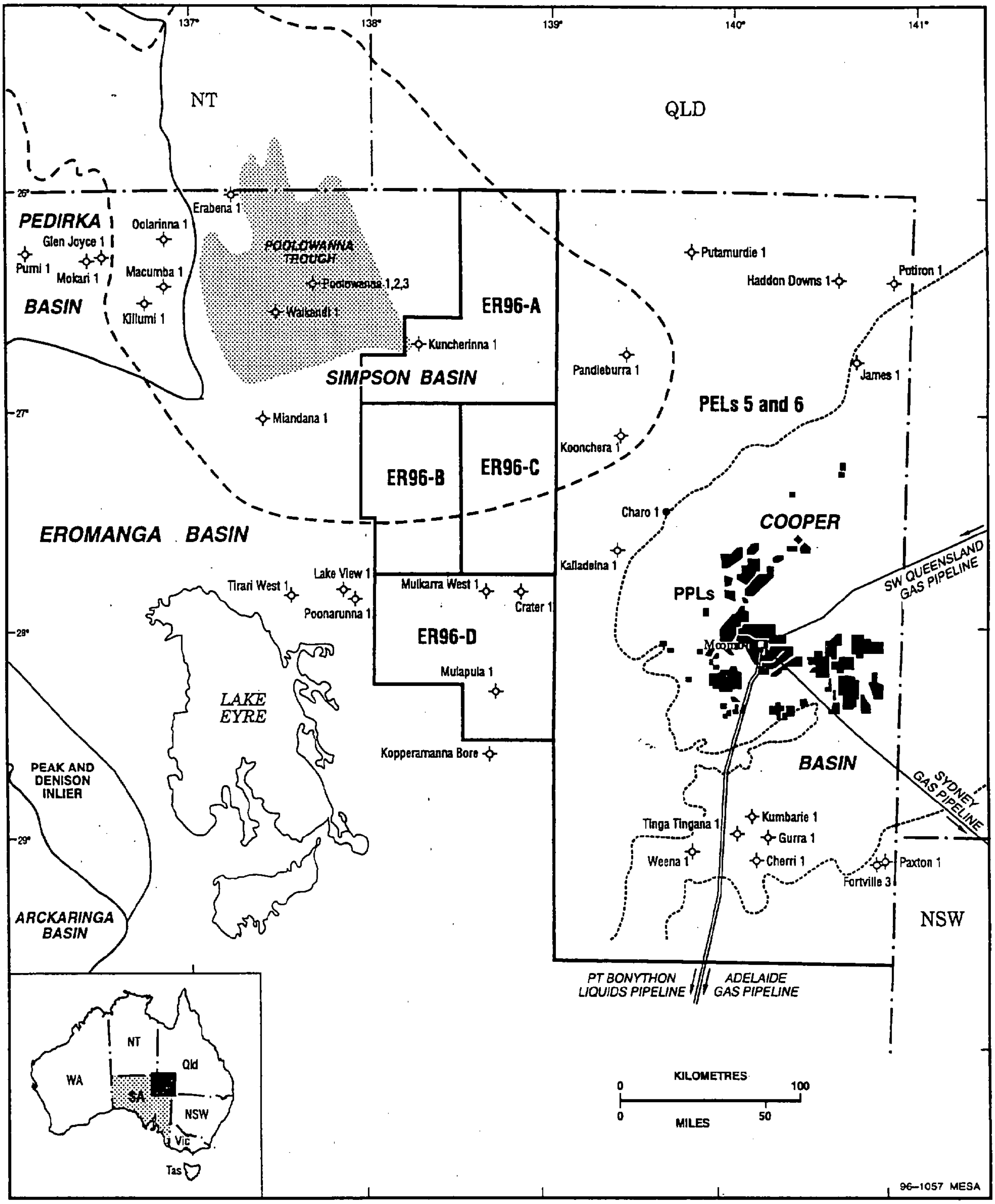

Fig. 1 *Locality map showing blocks ER96-A to ER96-D*

APPLICATIONS FOR EXPLORATION LICENCES

Applications may be made for any or all of the areas ER96-A to D. Applicants are encouraged to apply for all areas of interest. Licences are offered on the basis of the most competitive work program. In the event that more than one area is offered to an applicant for licence, there is no obligation for the applicant to accept any or all of the offers.

Enquiries and applications for Petroleum Exploration Licences should be addressed to:

Mr R A Laws
Director, Petroleum Division
MESA
191 Greenhill Road
PARKSIDE SA 5063

PO Box 151
EASTWOOD SA 5063

Before August 1996

Telephone:	National	(08)	274 7680
	International	*61 8	274 7680
Facsimile:	National	(08)	373 3269
	International	*61 8	373 3269

From August 1996

Telephone:	National	(08)	8274 7680
	International	*61 8	8274 7680
Facsimile:	National	(08)	8373 3269
	International	*61 8	8373 3269

* *Dial appropriate International Access Code*

Application forms should be accompanied by a proposed five year work program, a map of the area applied for, a $2,000 application fee and details of the technical and financial resources of the applicant.

Guidelines for onshore petroleum exploration are included in Appendix 2, an application form is included in Appendix 3.

The closing date for applications is 27 September 1996 at 4.00pm.

EXPLORATION HISTORY

Blocks ER96A-D were formerly part of PELs 5 and 6, operated by Delhi Petroleum Pty Ltd and Santos Ltd. The first flow of oil from the Eromanga Basin was recorded in Poolowanna 1 in 1977. Oil shows have since been recorded in Walkandi 1, Kuncherinna 1, Poolowanna 2 and 3, Miandana 1 and Mulpula 1

In 1990 the operators relinquished the area and a number of smaller companies have held PELs in the region. However little additional exploration has occurred in the region over the last six years. . The most recent review of the petroleum potential of the region was prepared by Durrant (1994) for Stirling Resources, operator of PEL 55. Eleven petroleum exploration wells have been drilled in the region – all were plugged and abandoned (Table 1, Fig. 1).

TABLE 1: Petroleum exploration wells drilled in the region.

WELL	YEAR DRILLED	OPERATOR	TD (feet)	TD (metres)
Poonarunna 1	1964	French Petroleum	5567	1697
Poolowanna 1	1977	Delhi	10085	3074
Walkandi 1	1981	Delhi	10252	3125
Kuncherinna 1	1981	Delhi	9403	2866
Poolowanna 2	1985	Delhi	9567	2916
Miandana 1	1985	Delhi	8766	2672
Mulapula 1	1986	Delhi	4642	1415
Lake View 1	1988	Santos	4682	1427
Mulkarra West 1	1989	Santos	4222	1287
Tirari West 1	1989	Santos	5856	1785
Poolowanna 3	1989	Santos	8832	2692
Crater 1	1992	Stirling Resources	4809	1466

A number of seismic surveys have been conducted in the region and many prospects and leads delineated (Fig. 2). The most recent seismic was acquired in 1992 by Stirling Resources NL (Table 2).

TABLE 2: Seismic lines within blocks, by decade (line km).

BLOCK	SEISMIC BY DECADE (LINE KM)			
	1960-69	1970-79	1980-89	1990-96
ER96-A	213	863	426	
ER96-B	39	256	701	
ER96-C	37	61	361	
ER96-D	36		2046	60

STRATIGRAPHY

The stratigraphy of northern South Australian basins is summarised in a recent publication produced by MESA entitled *The Geology of South Australia. Volume 2, the Phanerozoic* and edited by Drexel and Priess (1995). Figure 3 summarises the stratigraphy of the area.

Warburton Basin (Cambro-Ordovician)

During the Cambro-Ordovician, more or less continuous sedimentation took place in the Warburton, Amadeus and Georgina Basins (Gravestock, 1995). The intracratonic Officer Basin lay to the west with deeper marine conditions to the east. Early-Late Cambrian clastics, carbonates and volcanics of the **Kalladeina Formation** have yet to be drilled in the Blocks, but occur in the subsurface in the western Cooper Basin region.

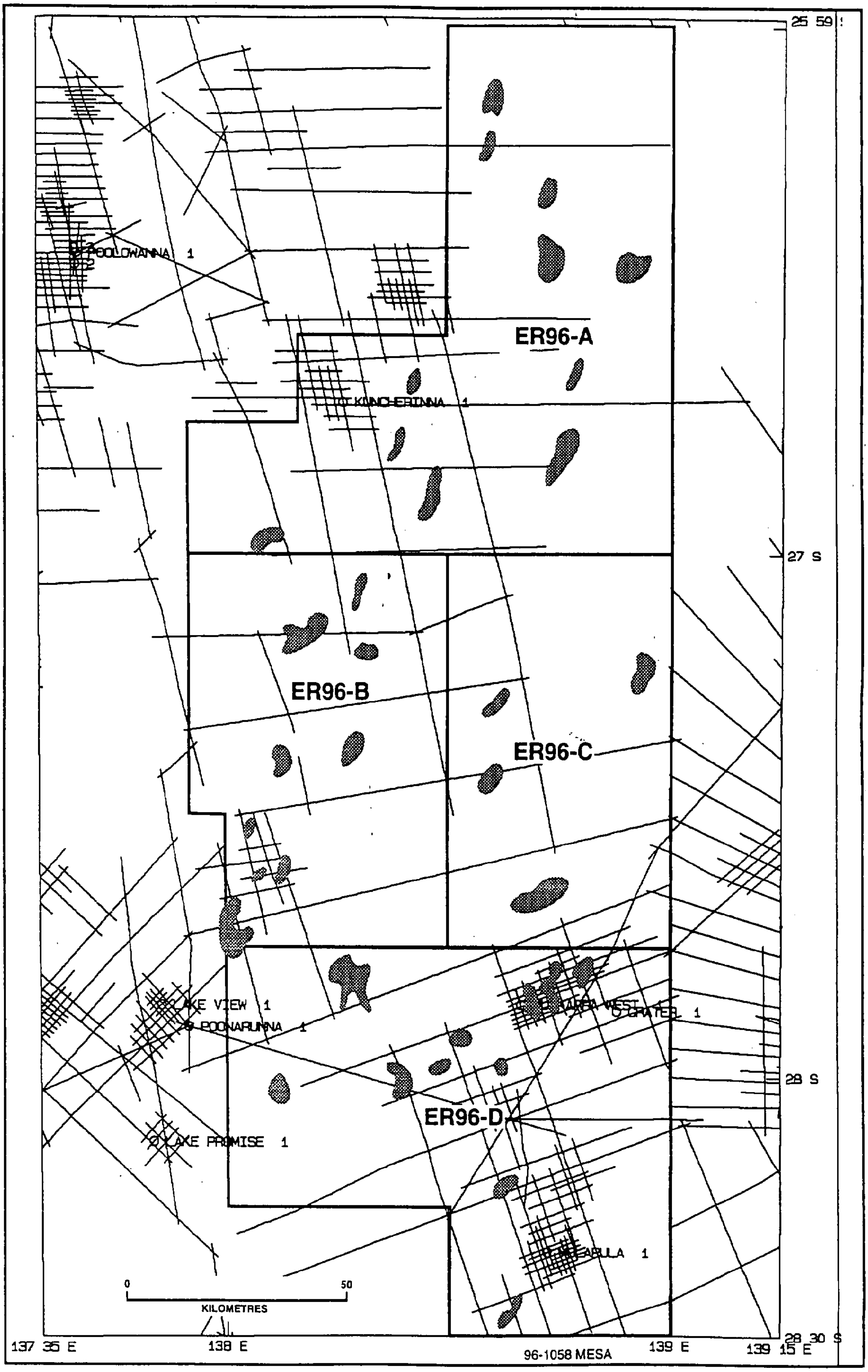

Fig. 2 *Location of seismic lines, prospects and leads*

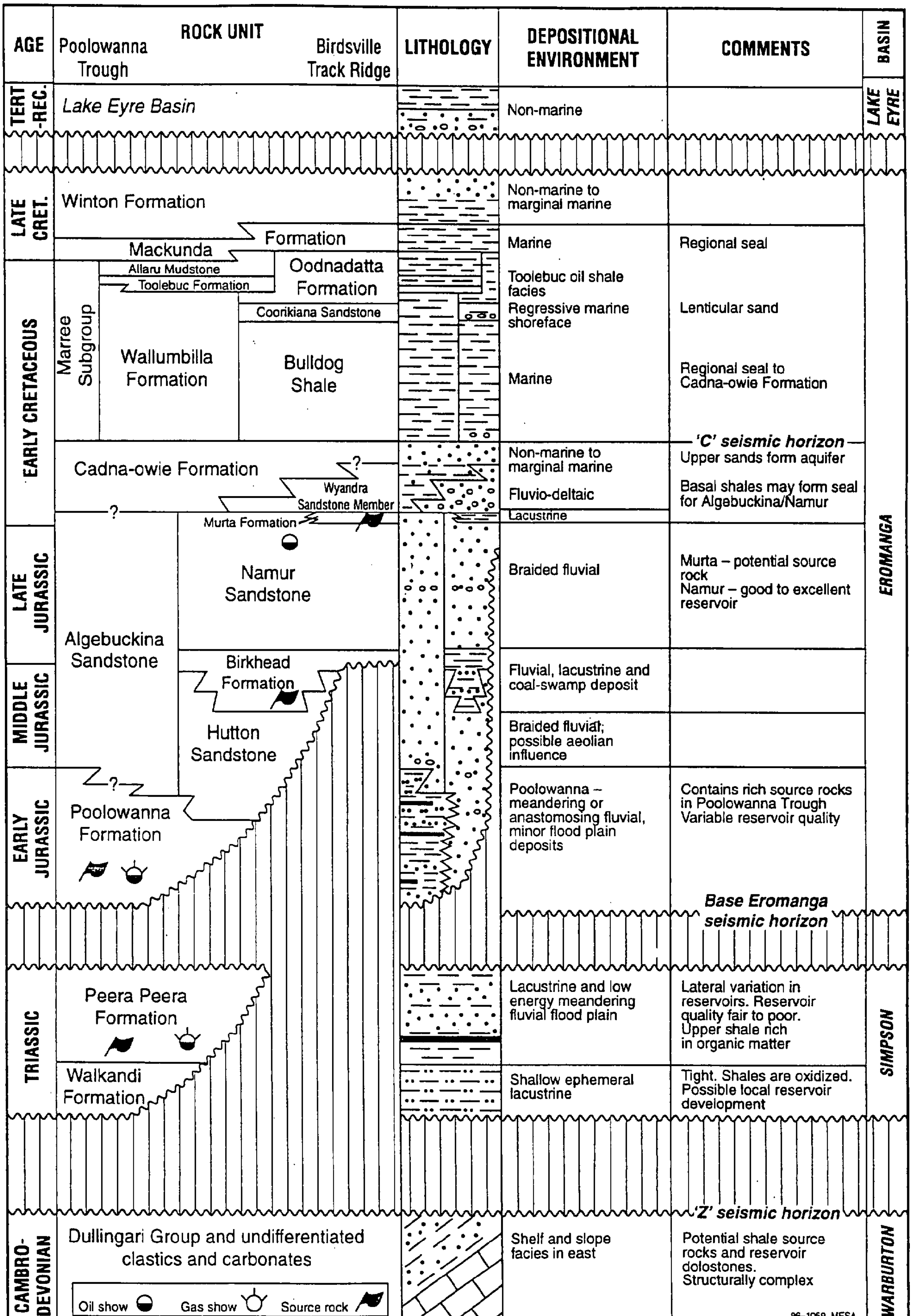

Fig. 3 *Geological summary of Blocks ER96-A to D, Eromanga Basin SA*

During the Ordovician the Larapintine Sea developed across the continent (Webby, 1978), and **Dullingari Group** was deposited in subtidal to slope environments. Dark grey pyritic siltstones and fine sandstones of the Dullingari Group in the region. The top of Early Palaeozoic sediments corresponds to the Z seismic horizon.

Simpson Basin (Triassic)

During the Triassic, the climate was warmer and widespread subaerial weathering and pedogenesis occurred. Triassic deposits of the Simpson and Cooper Basins consist of non-marine, fluvial sandstones and shallow lacustrine, floodplain and swamp siltstones and minor coals.

Two formations have been defined in the Simpson Basin (Moore, 1986). **Walkandi Formation** is the oldest Triassic unit and consists of oxidised, pale-grey, grey-green, brick red, brown and maroon interbedded shale siltstone and minor sandstone (Moore, 1986). Desiccation cracks and pedogenic structures indicate a shallow ephemeral lacustrine and flood plain environment of deposition. Walkandi Formation is conformably overlain by Late Triassic **Peera Peera Formation** in the Poolowanna Trough. Peera Peera Formation consists of grey and black carbonaceous shale, coal and thin sandstone interbeds deposited in a high sinuosity fluvial environment (Moore, 1986). Deposition in the region was terminated at the end of the Triassic with slight but widespread compressional deformation, regional uplift and erosion.

Eromanga Basin (Jurassic-Cretaceous)

The lowermost unit of the Eromanga Basin in the Poolowanna Trough is **Poolowanna Formation** of Early to Middle Jurassic age (Krieg *et al.*, 1995). The unit consists of interbedded siltstone, sandstone and coal, deposited in meandering fluvial and overbank environments. Poolowanna Formation intertongues with and is overlain by braided fluvial deposits of the Algebuckina and Hutton Sandstones (Fig. 4).

Algebuckina Sandstone is a fine to coarse-grained cross bedded quartzose sandstone deposited in a braided fluvial environment (Moore, 1986), with aeolian input and possible development of shallow sandy lakes (Wiltshire, 1989). It reaches a maximum thickness of 750 m (2460 ft) in the Poolowanna Trough depocentre (Moore, 1986). Lateral equivalents in the area are (in stratigraphic order) Hutton Sandstone, Birkhead Formation, Adori Sandstone, Westbourne Formation, Namur Sandstone and Murta Formation (Nugent, 1969) (Fig. 3). The **Hutton, Adori** and **Namur Sandstones** are identical in lithology and facies to the Algebuckina.

Birkhead Formation consists of interbedded siltstone, coal and sandstone of Middle to Late Jurassic age, **Westbourne Formation** consists of interbedded siltstone and sandstone of Late Jurassic age. Previous interpretations restricted Birkhead and Westbourne Formation to the east of the Birdsville Track Ridge, however drilling and seismic have extended the limit of both units west into the Simpson Basin region (e.g. Williams, 1984; Teakle, 1990). Birkhead Formation onlaps and blankets Warburton Basin highs on the Birdsville Track Ridge.

Murta Formation overlies the Namur Sandstone, and consists of thinly interbedded dark grey siltstone, shale, pale grey fine to very fine grained sandstone and minor medium and coarse grained sandstone. Murta Formation was deposited in a large lake which extended throughout the Cooper Basin region and as far west as Mulapula 1 and Mulkarra West 1. The McKinlay Member of the Murta Formation is a lacustrine shoreface facies developed at the interface between the Namur and Murta. **Cadna-owie Formation** records the transition into marine conditions during the Early Cretaceous and conformably overlies the Murta Formation. It consists of interbedded sandstone, siltstone and claystone with minor limestone. The lower part of the Cadna-owie Formation is non-marine (lacustrine) the upper part paralic (Moore and Pitt, 1985). In Queensland and the Cooper Basin region of South Australia, the fluvio-deltaic **Wyandra Sandstone Member** is developed at the top of the Cadna-owie Formation.

The contact between sandstones of the upper Cadna-owie Formation and overlying marine shales of the Bulldog Shale or Wallumbilla Formation approximates a prominent seismic reflector - the C horizon – which is mappable across the entire Eromanga Basin (Fig. 5). Formations of the Early Cretaceous (Aptian to Albian) are of secondary interest to petroleum exploration in the area and are not discussed here. Readers are referred to Moore and Pitt (1985) and Krieg and Rogers (1995) for more detail. The

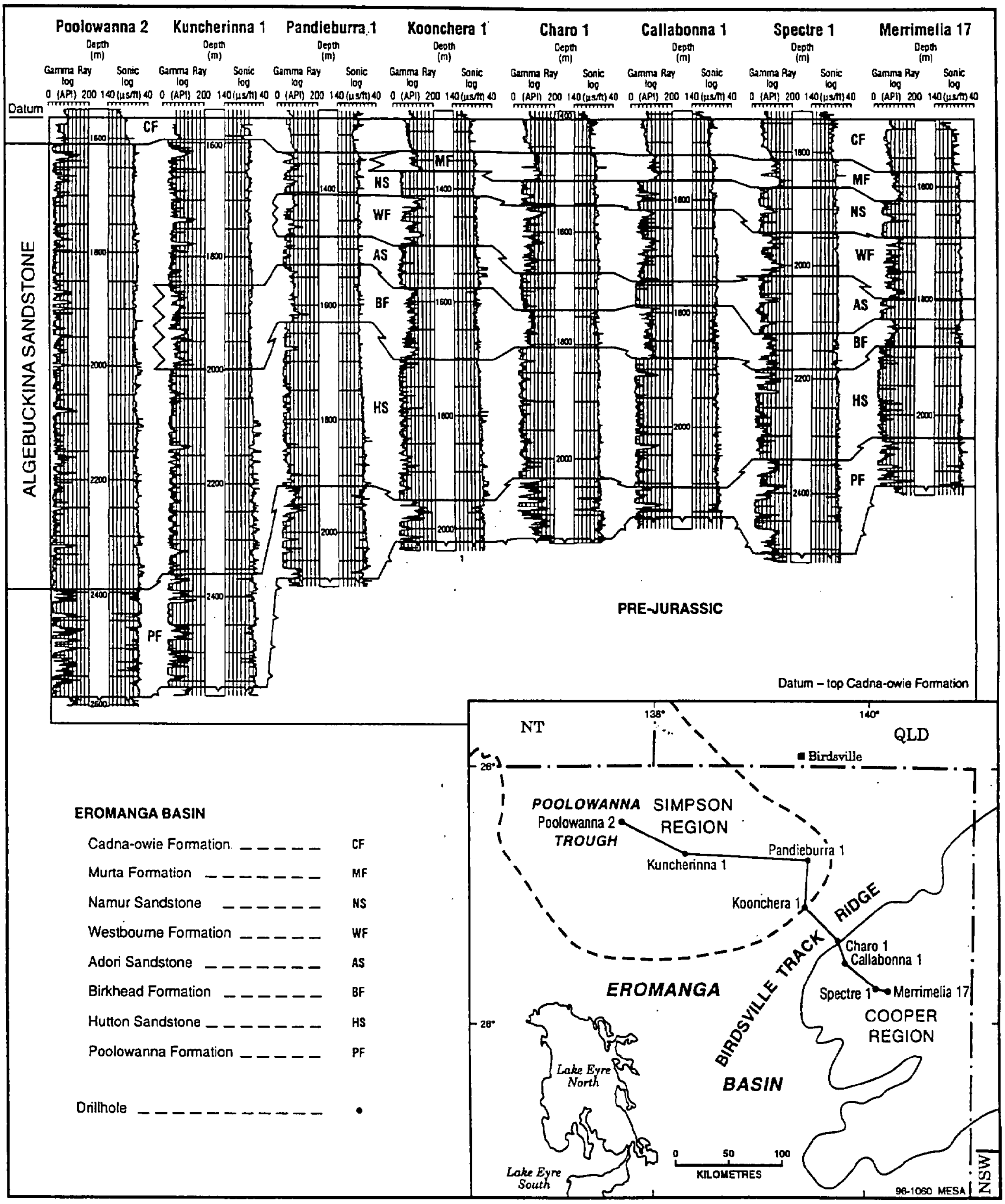

Fig. 4 *Wireline log correlation, Simpson to Cooper region*

marine succession is overlain by non-marine **Winton Formation** (Rogers, 1995). A period of erosion and deep weathering followed Winton deposition and non-marine sediments of the **Lake Eyre Basin** unconformably overlie the Eromanga Basin. Krieg *et al.* (1990) recognised three phases of deposition in the Lake Eyre Basin, interrupted by two phases of structural movement.

STRUCTURE

Tectonic history

The structural grain of the region is a product of a series of deformations and epierogenic movements since the Cambrian. The Delamerian Orogeny was a series of major tectonic events which affected the Adelaide Geosyncline and the Palaeozoic mobile belt to the east in the Late Cambrian. However, the Warburton Basin was not severely deformed by these events (Gravestock and Flint, 1995).

The structural grain of the Cooper and Pedirka regions has been profoundly influenced by northwest-southeast oriented compression and uplift associated with the Devonian to Carboniferous Alice Springs Orogeny (360-330 Ma). Roberts *et al.* (1990) described overthrusts in Cambrian rocks beneath the Cooper Basin from seismic sections and drillholes. Overthrusts form northeast-southwest arcuate domal trends (e.g. Gidgealpa-Merrimelia-Innamincka Ridge and the Birdsville Track Ridge) in the region.

Permian structuring in the Cooper Basin region is evidenced by a regional disconformity which separates the Late Carboniferous to Early Permian Gidgealpa Group and Late Permian to Middle Triassic Nappamerri Group. To the west, the Poolowanna Trough was initiated by tilting and by uplift and erosion of the western Pedirka Basin during the Early to Late Permian (Hibburt and Gravestock, 1995). Sediment was shed into the Poolowanna Trough where 300 m of Triassic are preserved (Moore, 1986). Regional uplift, tilting and erosion terminated deposition in the Cooper and Simpson Basins at the end of the Early to Middle Triassic.

Deposition in the Eromanga Basin was initially controlled by the topography of the Triassic unconformity surface, especially for the Poolowanna Formation and lower Hutton Sandstone. No major depositional breaks occur in the Eromanga Basin, indicating a period of tectonic quiescence.

During the Cainozoic, the continental compressive stress field evolved from east-west to north-south as Australia drifted in a northeasterly direction from Antarctica towards collision with the Southeast Asian and Pacific Plates (Smith, 1990). Events on the margins of the Australian Plate strongly influenced Cainozoic deposition and structuring in the interior of the continent. Continent-wide Miocene structural movements formed traps and influenced hydrocarbon migration in a number of Australian basins including the Gippsland and Bass Basins (Baillie and Jacobsen, 1995).

The significance of Cainozoic structuring in the Eromanga Basin region has been recognised by Moore and Pitt (1984), Wopfner (1985) and Sprigg (1986) amongst others. During the Early Oligocene, major surface anticlines formed, such as the Innamincka Dome and Birdsville Track Ridge (Wopfner *et al.*, 1974; Moore and Pitt, 1984). A second phase of compression occurred during the Miocene, reactivating pre-existing faults and produced localised uplift and erosion with folding and faulting (Santos, 1988). Uplifts of the order of 350m to 500m occurred near the margin of the basin (Foster *et al.*, 1994; Krieg, 1986; Alexander and Jensen-Schmidt, 1995). Cainozoic uplifts strongly influenced groundwater flow in aquifers within the Great Artesian Basin (i.e. Hutton, Namur, Adori and Algebuckina Sandstones and Cadna-owie Formation) and may have influenced hydrocarbon migration and re-migration in the region. Tingate and Duddy (in prep) noted widespread evidence for a recent increase (< 5 Ma) in geothermal gradient in the Eromanga Basin linked to the flow of hot groundwater. This recent heating has not had sufficient time to increase the thermal maturity of Eromanga Basin source rocks over structural highs, but has probably caused recent petroleum generation in troughs within the Cooper Basin and within the Poolowanna Trough (Tingate and Duddy, in prep).

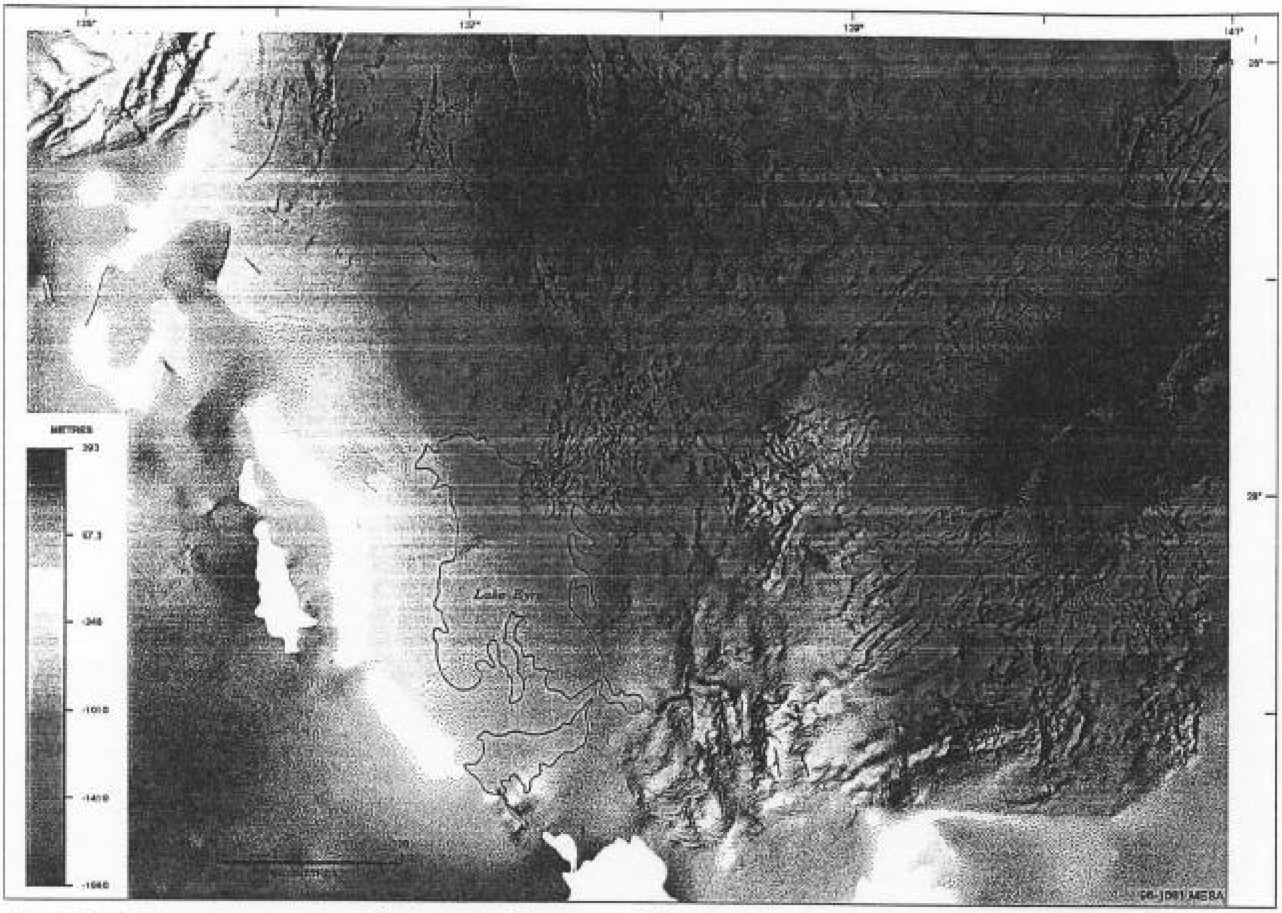

Fig. 5 *Depth structure map, top of Cadna-owie Formation ('C'-horizon), Eromanga Basin SA*

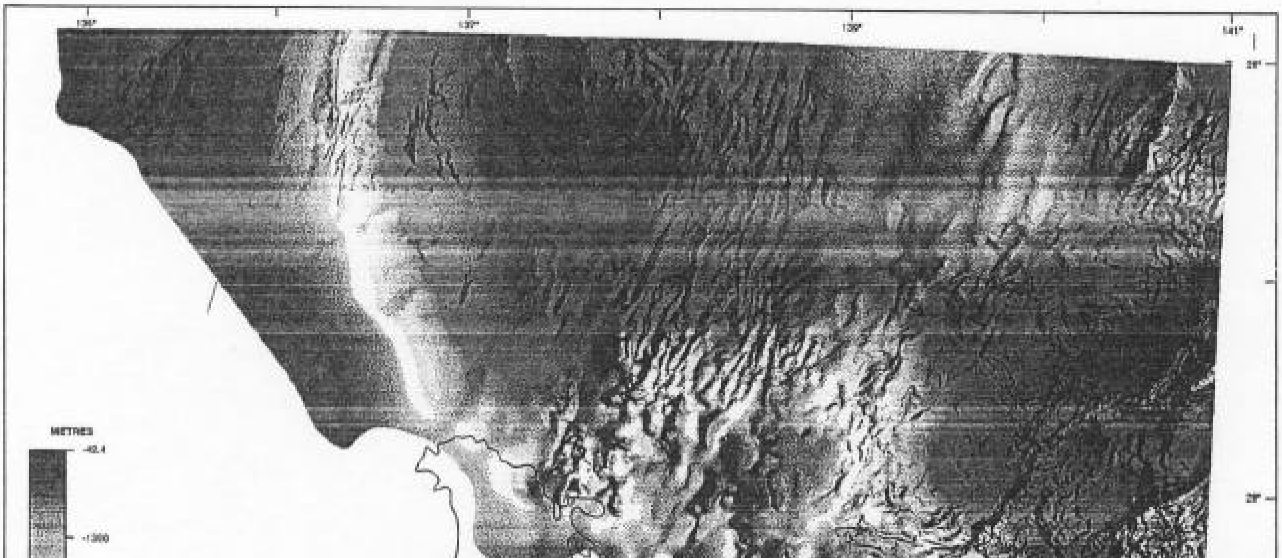

Fig. 6 *Depth structure map, base of Eromanga Basin*

Structural elements

The Eromanga Basin was deposited during a period of tectonic quiescence with subsidence being the major mechanism creating space for deposition. All structuring within the Eromanga Basin is controlled by deposition over, and reactivation of, older tectonic trends. Blocks ER96A to D are located on the Birdsville Track Ridge, defined by surface exposures of the Winton Formation and older units, is a complex of related domes and ridges. The ridge trends northeast-southwest and is easily distinguished on the C-Horizon depth map (Fig. 5). Major features on the ridge include the Cooryanna, Gason and Cordillo Domes. These highs influenced Permo-Triassic deposition in the region. Evidence of Oligocene reactivation and uplift of these structures was described by Wopfner (1974, 1985) and Moore and Pitt (1984).

The Poolowanna Trough is the main depocentre in the region and has been active since the Triassic. Figure 6, showing depth structure on the base of the Eromanga Basin illustrates its areal extent and sediment thickness.

Traps

Trapping mechanisms for Eromanga Basin oilfields are dominantly structural (anticlines with four-way dip closure over pre-existing highs) with a stratigraphic component (at the Hutton-Birkhead and Murta-McKinlay-Namur contacts, and within the Poolowanna and Murta Formations). Individual traps with fault-bounded closures are rare in the Eromanga Basin. Onlap and pinchout traps against Warburton Basin highs and sealed by Birkhead Formation are possible on the Birdsville Track Ridge. Eromanga Basin structures in SA and Queensland are typically not filled with oil to spill – net oil columns are relatively thin compared to the area under closure.

Using the regional seismic grid, company geologists and geophysicists delineated a number of prospects and leads in the region (Fig. 2). Santos (1988a and b), Teakle (1990a and b), Delhi (1987) and Hayball (1990) list prospect and lead evaluation details and potential oil-in-place for each structure in the region.

PETROLEUM POTENTIAL

Source rocks

Potential source rocks in the Eromanga Basin occur within the Poolowanna, Birkhead and Murta Formations (Michaelsen and McKirdy, in prep). The Simpson Basin contains potential source rocks in the Peera Peera Formation.

Peera Peera Formation

The Peera Peera Formation is rich in organic matter (TOC up to 5%) and should be oil mature in the Poolowanna Trough (Cook, 1986). It is considered to be gas-prone, with modest oil generative potential.

Poolowanna Formation

The Poolowanna Formation has good to excellent source richness and has good oil generative potential (Fig. 7). Poolowanna Formation has reached a peak maturity of 0.9% R_o in the Poolowanna Trough. Elsewhere in the region, Poolowanna Formation is marginally mature (Michaelsen and McKirdy, in prep).

Birkhead Formation

Birkhead Formation ranges from fair to excellent source richness, with good-excellent source quality (Fig. 8) and maturity levels from 0.8-0.85% – near the peak of hydrocarbon generation for Type II organic matter (Michaelsen and McKirdy in prep).

Murta Formation

The Murta Formation is the youngest effective source rock in the region and has been studied in detail by Michaelsen and McKirdy (1989) in the Cooper Basin region – source potential in Blocks ER96-A-D is poorly known. Source richness is typically fair in the Cooper Basin region, with localised development of good source richness (Michaelsen and McKirdy, 1989). Murta Formation has the potential to generate oil at maturities of 0.5-0.55% R_o.

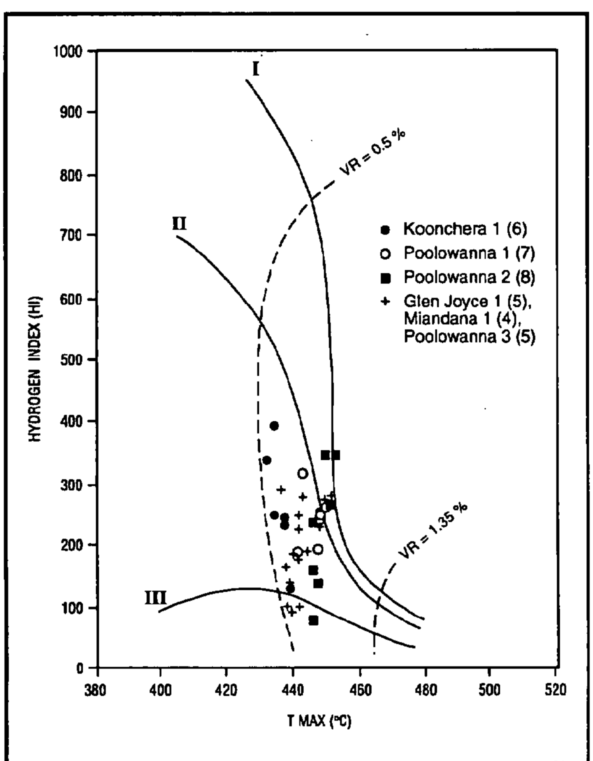

Fig. 7 *HI versus T_{max} plot, Poolowanna Formation, Eromanga Basin, SA (western sector).*

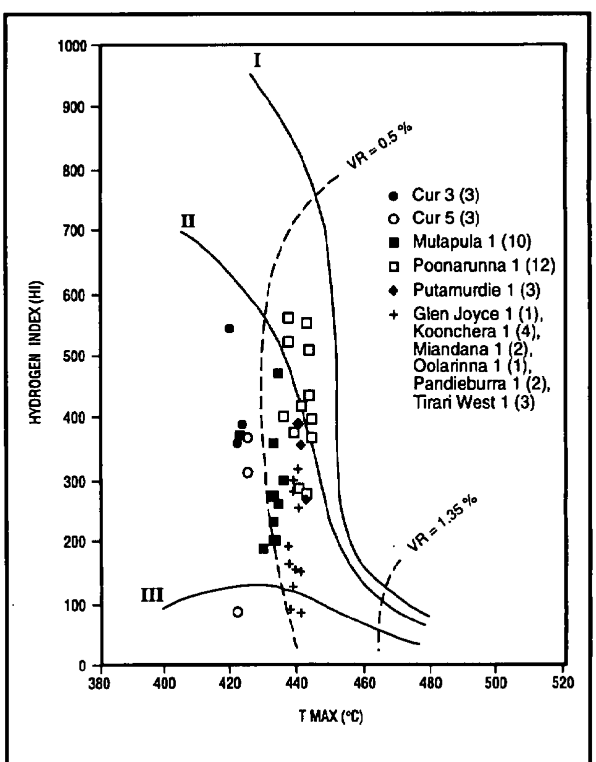

Fig. 8 *HI versus T_{max} plot, Birkhead Formation, Eromanga Basin, SA (western sector).*

Reservoirs and seals

The key potential reservoir units in the region fall into three categories:

- meandering fluvial channel sandstone in the Poolowanna and Birkhead Formations,
- stacked braided fluvial sandstone in the Algebuckina, Hutton and Namur Sandstones, and
- lacustrine turbidite and shoreface sandstones of the Murta Formation.

The petrophysical properties of these Eromanga Basin reservoirs in the Cooper Basin region were studied in detail by Gravestock and Alexander (1986, 1988 and 1989). Porosity and permeability data (measured at ambient pressure) quoted below originates from this work.

Poolowanna Formation

Seal

Siltstones within the Poolowanna Formation are intraformational seals, but the occurrence of stacked oil pools in fields in the Cooper Basin region indicate they are not wholly effective. Seal effectiveness is reduced by their limited areal extent, thickness and siltstone mineralogy.

Reservoir characteristics

The Poolowanna Formation contains the deepest reservoir in the Eromanga Basin, occurring at depths up to 2226 m in the Poolowanna Trough. Deeper samples show the lowest average porosities due to the formation of quartz overgrowths. Porosity averages 13%, permeability ranges from 0.001-3674 md.

Algebuckina Sandstone

Seal

Thick marine shales of the Wallumbilla Formation and Bulldog Shale form a regional seal to the Algebuckina Sandstone. Siltstones at the base of the Cadna-owie Formation may also act as seals.

Reservoir characteristics

The Algebuckina Sandstone has good-excellent porosity and permeability and forms a major artesian aquifer. Few laboratory measurements are available, but log-derived porosities average more than 20% (e.g. New, 1989). Reservoir properties can also be gauged from aquifer flow rates which are of the order of 500-1000 kL/day (Krieg, 1985).

Hutton Sandstone

The Hutton Sandstone has proved to be the most productive unit within the Jurassic-Cretaceous in the Cooper Basin region. Nearly half the total oil produced from the Eromanga Basin in South Australia originates from the Hutton Sandstone sealed by Birkhead Formation.

Seal

The Hutton Sandstone is sealed by a capillary type seal created by diagenetic alteration of volcanogenic lithics and feldspar within the Birkhead Formation (Boult, 1993). Shale interbeds in the lower Birkhead Formation act as seals locally but are not effective regionally (Boult, 1993).

Reservoir characteristics

Hutton Sandstone reservoirs consist of mineralogically mature quartz arenites with minor amounts of feldspar (Gravestock *et al.*, 1983). Excellent reservoir properties are indicated by an average porosity of 21% with permeability ranging from 0.321-9780 md.

Birkhead Formation

Seal

Birkhead Formation sandstone reservoirs are sealed by intraformational shales and diagenetic seals as described above.

Reservoir characteristics

In contrast to the Hutton Sandstone, Birkhead Formation reservoirs show considerable variation in quality. The average porosity is 14% and permeability ranges from 0.008-7620 md. Birkhead Formation sandstones are lithic arenites with a significant proportion of labile volcanogenic grains and feldspar.

Namur Sandstone

Seal

The Namur Sandstone is either sealed by siltstones of the McKinlay Member or by interbedded low permeability sandstones and siltstones of the lower Murta Formation. In the Cooper Basin region, seals are not effective and oil trapped in the Namur has migrated upwards along vertically connected sandstone beds into the Murta Formation (Williams *et al.*, 1994).

Reservoir characteristics

The Namur Sandstone has similar porosity and permeability distribution to the Hutton Sandstone, with an average porosity of 20% and permeability range from 0.011-10000 md.

Murta Formation and McKinlay Member

Seal

Interbedded low permeability sandstones and siltstones of the lower Murta Formation form capillary seals to the McKinlay Member and Namur Sandstone (Boult *et al.*, in press). The shaly M1 unit at the top of the Murta Formation forms a regional seal for thin sandstones within the Murta Formation (Williams *et al.*, 1994) and hence the entire lower non-marine succession of the Eromanga Basin. In South Australia this upper seal appears to be effective – economic accumulations of oil have not yet been discovered above the Murta Formation.

Reservoir characteristics

Murta Formation sandstones are quartz arenites and form two types of reservoirs (Williams *et al.*, 1994): a high permeability sandstone (up to 30 mm thick), and thin low permeability fine to very fine grained sandstones interbedded with siltstone (less than 5 mm thick). The average porosity is 22% and permeability ranges from 0.007-999 md.

Cadna-owie Formation and Wyandra Sandstone Member

Seal

Thick marine shales of the Wallumbilla Formation and Bulldog Shale form a regional seal to the Cadna-owie Formation and Wyandra Sandstone Member.

Reservoir characteristics

Sandstones are quartzose, with lithics and potassium feldspar (Green *et al.*, 1989). In Queensland, Tintaburra 1 recorded flows of 534 kL oil per day (85 bpd) and 2138 kL water per day (340 bpd) from the Wyandra Sandstone Member (Newton, 1986). In South Australia, drillstem tests in the Cadna-owie Formation have recovered only small amounts of oil, and oil and gas-cut mud. No core analyses are available for this formation from South Australia, however it forms an important aquifer within the Great Artesian Basin.

Migration

Prior to the discovery of Eromanga Basin oil in the late 1970s at Poolowanna 1 and at Strzelecki oil and gas field, it was widely believed that any Jurassic oil and gas had been flushed out by movement of artesian water (the Eromanga Basin is part of the Great Artesian Basin). The hydrodynamic gradient in the region flows from the northeast to the southwest (Habermehl, 1980, Fig. 12). Bowering (1982) postulated that the hydraulic gradient during the Plio-Pleistocene may have been stronger and partially flushed some hydrocarbons from accumulations, however he concluded that the modern hydraulic gradient is insufficient to flush hydrocarbons.

Exploration activity has concentrated in the Eromanga Basin where it overlies the Cooper Basin, as the origin of oil in Eromanga reservoirs is regarded by many as the result of vertical migration from Permian source rocks (Heath *et al.*, 1989). This conventional wisdom is however challenged by the work of Michaelsen and McKirdy (1989, in prep) who conclude that migration from Permian source rocks into Eromanga Basin reservoirs has not appreciably occurred in the southern Cooper Basin region and that many of the oils reservoired in the Eromanga Basin were generated *in situ.* In addition, Tupper and Burkhart (1990) concluded that mixing of Cooper and Eromanga Basin oils has occurred in some Murta Formation oil fields. Long-distance lateral migration towards the basin margin has also been proposed (McKirdy and Willink, 1988) and mature oil-prone potential source rocks occur within the Eromanga Basin (Michaelsen and McKirdy, in prep). Blocks ER96-C and D lie down the hydrodynamic gradient and updip from oil and gas kitchens in the Patchawarra and Nappamerri Troughs within the Cooper Basin region (Habermehl, 1980; Durrant, 1994). The possibility of long distance lateral migration of hydrocarbons out of Cooper Basin kitchens into traps in the Birdsville Track region has not been adequately tested.

In the Cooper Basin region, the main phase of hydrocarbon generation occurred during the Late Triassic to Late Cretaceous with peak expulsion occurring during the Cretaceous (Tupper and Burkhart, 1990). These authors concluded that structures which formed during the Cainozoic are less favourable prospects.

INFRASTRUCTURE

Pipelines

A total of 3 740 km of pipeline, nearly 900 km of trunklines and roughly 1 500 km of flowlines have been laid from the Cooper Basin to gas markets and to Port Bonython (Fig. 9). Key pipelines in the region are the Moomba-Port Bonython Liquids Line and the Moomba-Adelaide Pipeline, operated by Tenneco Australia. The Moomba-Adelaide Pipeline is 781 km long, has an outside diameter of 560 mm and the maximum allowable operating pressure is 7300 kPa. In 1994, the pipeline supplied 86 PJ of gas to Adelaide markets and has a current maximum capacity of 353 TJ/day (130 PJ/year). The Moomba-Port Bonython Liquids Line is 659 km long, has an outside diameter of 355.6 mm and a maximum allowable operating pressure of 10380 kPa. In 1994 the liquids pipeline carried 5.0 million barrels of oil, 3.6 million barrels of condensate and 0.4 million tonnes of LPG to Port Bonython, a throughput of 36 600 bbl/day. The maximum flow rate in the liquids pipeline is 50 000 bbl/day under current operating conditions, however this can be increased to 66 000 bbl/day with the injection of drag reducing agents in the product stream.

Pipelines supply Cooper Basin gas to Sydney (90 PJ in 1994) while Southwest Queensland gas is piped from Ballera to Moomba for processing. A pipeline from Moomba to Sydney to supply 16 PJ of ethane per annum to ICI Australia is nearing completion.

Processing Plants

At the Moomba plant, operated by Santos Ltd, produces sales gas for Adelaide and Sydney and processes 25.4 million m^3 (902 MMcf) of raw gas and 6 000 kL (42 000 bbl) of condensate and crude oil per day. Condensate, LPG, crude and some ethane are transported as a "cocktail" via a pipeline to Port Bonython where they are separated and marketed within Australia and overseas. Port Bonython is also operated by Santos and produces the following products – crude, naphtha, butane and propane.

A local destination for Cooper and Eromanga liquids is the refinery at Port Stanvac, which produces petroleum products mainly for the SA market and is operated by Mobil. The refinery, 10 km south of Adelaide, commenced operations in 1963 and the adjacent lubricating oil refinery began operations in 1976. The main refinery products from Port Stanvac are LPG, solvents, motor gasoline, jet fuel, kerosene, diesel (both automotive and industrial), lube oil basestocks for Australian and overseas markets, fuel oil and bitumen.

Oil and Gas Liquids

The Cooper Basin Liquids Project was initiated in 1980 and completed in stages from 1982 to 1984 at a cost of $1.4 billion. The project involved the construction of a high vapour pressure liquids pipeline from Moomba to a processing plant and storage and loading facilities at Port Bonython, as well as field development, oil collection and crude stabilisation facilities at Moomba.

Shipments of crude oil and condensate commenced in 1983 and LPG handling facilities were commissioned in July 1984. Ships of up to 1100 000 tonnes can be handled at the port. The establishment of these facilities enabled the Producers to bring the 'wet' gas reservoirs (those containing significant quantities of propane, butane and condensate) into production, which further enhanced production flexibility. In 1991 condensate production from Port Bonython was replaced by a full range naphtha.

Mini-refineries

Mini-refinery technology has proven itself viable in the Eromanga Basin at Eromanga in southwest Queensland, where the company, Inland Oil Refiners has been operating since 1985 (Petroleum Gazette, 1994). The Eromanga mini refinery has a throughput capacity of 1500 barrels of crude per day and receives feedstock from a number of Eromanga Basin oil fields, including the Inland oilfield, discovered by the company in 1994. The principal product is diesel, which is trucked across western Queensland to regional centres for marketing. Other products include automotive distillate, jet fuel, high quality kerosenes and specialised products for Mount Isa Mines. Heavy residues are processed in Brisbane.

Transport

The area is remote from Australia's main population centres – Adelaide (population 1.4 million) is over 800 km south. The nearest port is Port Augusta, approximately 600 km south. The distance to the Port Bonython liquids processing plant is approximately 700 km. The Birdsville and Strzelecki Tracks are unsealed but provide important routes for heavy transports into the region. Most towns in the region as well as the Moomba facility have air strips.

Groundwater

The location, yield and quality of water supplies are critical for operations in the harsh climate of northern South Australia. The Eromanga Basin encloses the multi-aquifer system of the Great Artesian Basin (GAB), one of the world's largest groundwater basins (Habermehl, 1980). Groundwater of the Great Artesian Basin is used by the petroleum and mineral exploration industries, pastoralists and the tourism industry.

There are two major confined aquifers: a lower aquifer of Algebuckina Sandstone and Cadna-owie Formation and an upper aquifer which comprises the Winton and Mackunda Formations. The lower aquifer is a source of hot (up to 100 C°), good quality artesian water with total dissolved solids ~ 1000 mg/L. Water is predominantly of the sodium bicarbonate type. The upper aquifer produces poorer quality water.

ENVIRONMENT

Natural environment

Climate

Seasonal and diurnal temperature variations can be extreme. In summer, average temperatures range from 23 to 38 °C (74 to 100 °F) and often exceed 40 °C in the shade. Winters are short and cool to mild with average temperatures ranging from 6 to 19 °C (42 to 67 °F), occasional sub-zero conditions occur. Rainfall is extremely low and unreliable averaging approximately 150 mm (6 inches) per annum, mean annual evaporation is 4000 mm (157 inches). Although it is often infrequent and highly variable, there is a seasonal tendency for rains to occur in late summer.

The windiest months occur in September through to December when winds prevail from the south-south east. Winds are more variable in winter with more calm days, whilst in summer, winds tend to prevail from the north.

Landforms

The Eromanga Basin region covers almost 360 000 km^2 of South Australia which, although broadly designated as being within the arid zone, is by no means environmentally homogeneous. There is a wide variety of major landforms within which many minor landform patterns or environmental units occur. The major landforms include:

- Dunefields – which vary in height, spacing, alignment and shape.
- Gibber plains – sometimes described as gently undulating stony plains which occasionally fringe the various uplands and silcrete capped plateaux and ridges.
- Undulating plains – which tend to join the dissected tablelands, hills and ranges and sand dune areas.

- Floodplains – which are generally only inundated following high rainfall events in the upper catchment area rather than due to local rains. They can be diverse in their features ranging from fields of parallel dunes and extensive systems of interconnected claypans that are periodically flooded, to broad floodplains which may contain sinuous channels, low levees and braided channels partly overlain by dunes.
- River channels and alluvial fans.
- Salt lakes and clay pans.
- Dissected tablelands, hills and ranges.
- Mound springs produced by vertical leakage from the Great Artesian Basin. These are small but important sources of permanent water providing foci for plant, animal and human life in the desert environment. The largest of these springs is located at Dalhousie which discharges 90% of the total spring flow in South Australia.

The occurrence of minor landforms can vary depending upon the detailed morphological characteristics of a major landform based upon the local geology, soil type, topography, drainage patterns and biota. The degree of landform diversity in the Eromanga Basin, together with a highly variable rainfall and flooding regime has resulted in a diverse array of vegetation and animal habitats which are themselves in a continuous state of change

Native Vegetation
Due to the climatic extremes experienced throughout the Eromanga Basin vegetation is sparse over relatively large areas, which during drought periods, may often appear quite barren and lifeless. Throughout these areas, small differences in habitat such as depressions or drainage lines may produce more growth and a greater variety of species.

Perennial plants have adapted to endure long dry spells and extreme temperatures whilst the appearance of herbaceous plants can be episodic and infrequent depending upon suitable climatic combinations. Differences in landforms and soil type account for some of the major differences that appear throughout the vegetation within the region.

The vegetation associated with water courses, floodways or mound springs generally consists of permanent shrubs and trees or herbage which are independent of rainfall. Vegetation associated with floodplains relies more on the incursion of floodwaters and rainfall events in the upper catchment area rather than on local rains, whereas in sand dune country local rainfall is often sufficient to stimulate plant growth. Plant responses to rainfall in the interdunes may differ.

Human environment

Land use
The main forms of land use within the Eromanga Basin are, pastoralism, conservation, tourism, petroleum exploration, production and transport of oil, gas and gas liquids. The major primary industry is cattle. Access to such land requires giving notice to the landowner. The most common issues are repair of damage to fences, gates and tracks and avoiding excessive disturbance of cattle. There are standard techniques for managing such issues and the landholders are generally accepting of exploration and associated activities.

National Parks and Reserves
A number of National Parks and Reserves have been created to conserve the best examples of vegetation and landforms in the region (Fig. 9). The parks are comprised of three types of reserve classifications including Conservation Parks, National Parks and Regional Reserves. Access for petroleum exploration and production is allowed in all parks other than the Simpson Desert and Elliot Price Conservation Parks. The conditions of access vary from park to park, based upon the type of reserve classification, the activity proposed and the impact it is likely to have on the environment.

Simpson Desert Regional Reserve
Blocks ER96-A and B lie within the Simpson Desert Regional Reserve (Fig. 9). The Regional Reserve provides for the conservation of wildlife and the natural or historic features of the land while, at the same time, permitting use of its natural resources. Petroleum and mineral exploration activity may take place provided that they are subject to controls consistent with the management plan for the reserve (as occurs

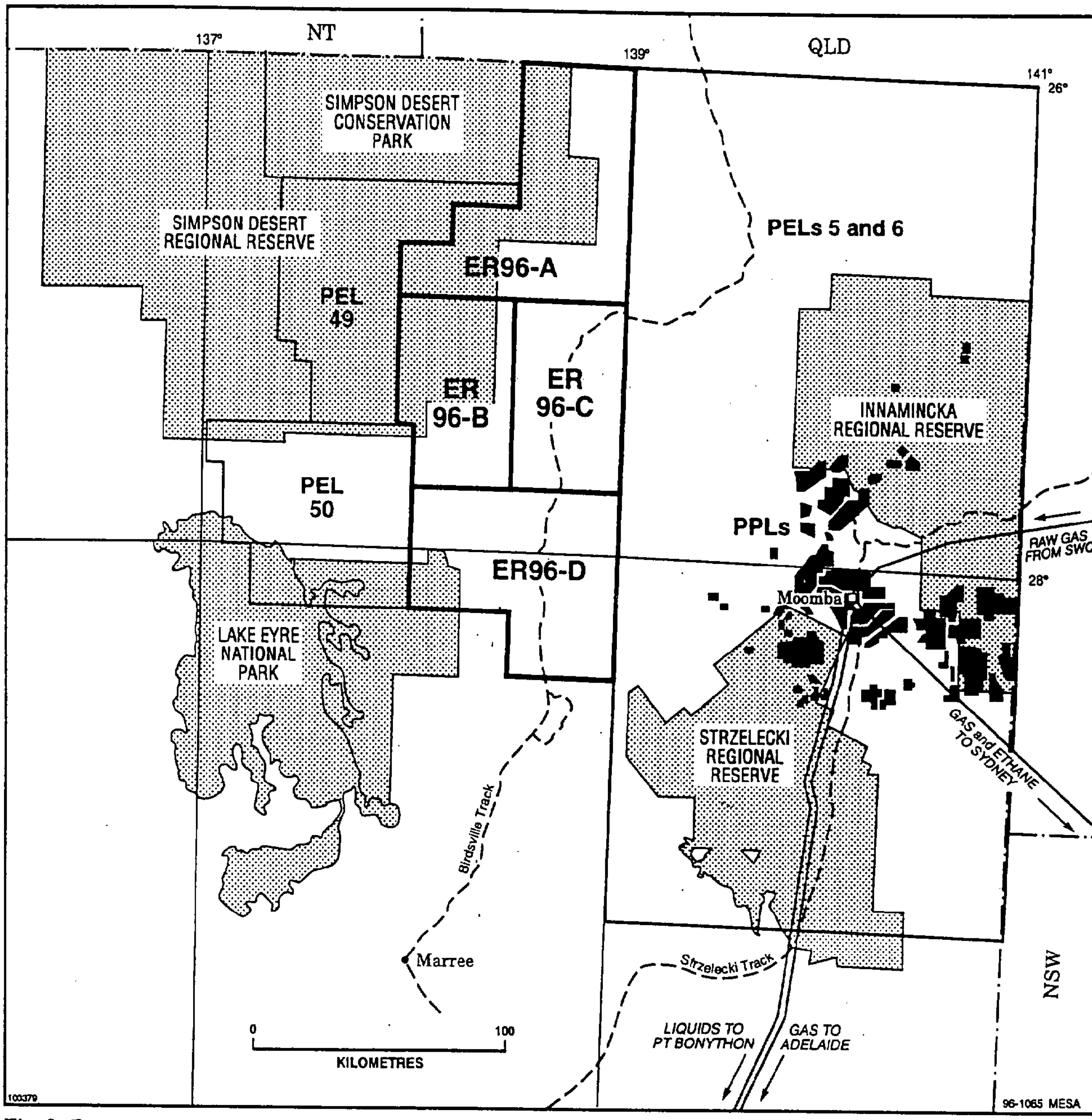

Fig. 9 *Eromanga Basin acreage release, parks and reserves*

in the Cooper Basin where much of the production is sourced from the Innamincka Regional Reserve). Mineral and petroleum exploration licence applications for areas within Regional Reserves are processed by MESA but are referred to the MENR (Minister for Environment and Natural Resources) for comment. Exploration work programmes are discussed with DENR (Department of Environment and Natural Resources) as a matter of policy. In the case of production tenements, approval must be given by the MENR. Failing Ministerial agreement, the issue is referred to the Governor for decision.

Lake Eyre National Park
Block ER96-D lies within the Lake Eyre National Park (Fig. 9). The proclamation for the Lake Eyre National Park provides for the acquisition of rights of entry, prospecting, exploration and mining. Mineral exploration and mining activity are possible only with approval of the MENR and in accordance with the management plan for the park. This is also the case for petroleum exploration and production licences.

Simpson Desert Conservation Park
Access for exploration and production is not permitted in the Simpson Desert Conservation Park.

In all other respects exploration and production is carried out under the provisions of the Petroleum Act and Regulations.

Aboriginal Heritage
In South Australia it is an offence to disturb or destroy Aboriginal sites, objects or remains. Standard procedures for determining the presence of Aboriginal heritage prior to the commencement of activities have been determined. These procedures involve consulting with the relevant Aboriginal organisation and maintaining a watch for sites, objects or remains during activities. Generally the sites are no larger than a few hundred square metres and are easily avoided. Since the inception of the Aboriginal Heritage Act in 1988, there have been no conflicts between Aboriginal heritage sites and exploration or production activities in South Australia.

Commonwealth Native Title Act 1993
The *Native Title Act 1993* was passed by Federal Parliament on 22 December 1993. The lengthy and complex Act provides statutory recognition and protection for the concept of native title as recognised by the High Court in the case of Mabo v Queensland in 1992. Native title means rights held by indigenous inhabitants of Australia at and since the time of European settlement - it differs from conventional titles. The nature of native title rights vary from group to group according to laws and customs, however there must be a sufficient and relevant connection to the land in question, continuous since 1836 in South Australia. Native title may include the right to camp or travel across land, rights to hunt, fish, gather food and take materials (timber, bark, ochre etc.) from the land. Applications by Aboriginal claimants are recorded in the Register of Native Title Claims. The National Native Title Tribunal (NNTT) makes determinations on applications under the Act. A National Native Title Register comprising a record of all approved determinations made by the NNTT, Federal Court, High Court, other Courts or Tribunals and recognised State/Territory arbitral bodies.

The Premier of South Australia declared in April 1994 that SA would enact State legislation to ensure that State laws were consistent with the Commonwealth's Racial Discrimination Act and as far as appropriate, the Native Title Act, while retaining the option to challenge the Native Title Act in whole or in part to make it more workable and less complex. Late in 1994, a package of four Native Title Bills was introduced into the House of Assembly and were all passed.

Following passage of the Commonwealth Native Title Act, petroleum exploration and production licences continue to be issued over South Australian land over which Native Title Rights have been extinguished on the advice of the Crown Solicitor (leasehold and freehold land which comprises the vast majority of the State). In 1995 a 'safety net' clause was introduced into the Petroleum Act which gives a licensee first right to any licence which may be terminated due to no fault of the licensee.

Licence holders are encouraged to develop a dialogue with regard to Aboriginal Heritage and related matters, with Aboriginal people having associations with their licence area.

The Commonwealth Government is currently considering ammendments to the Native Title Act most of which are designed to simplify administrative procedures.

European Heritage
A number of sites of European heritage significance such as historic buildings and structures and geological monuments occur in the region. These are indicated on the Environmental Sensitivity Maps available from MESA. The majority of the sites are small and easily avoided by exploration activities.

Environmental regulation

A number of environmental issues are pertinent to petroleum exploration in South Australia, all of which can be resolved by proper operational planning in the initial stages. In order to ensure that activities are undertaken in a manner which minimises environmental impacts, a number of documents are required before approval to commence operations is given. First a Declaration of Environmental Factors (DEF) is required form the licensee. This is the licensee's assessment of the environmental impact of the proposed activity. In addition to the DEF, a Code of Environmental Practice is also required by regulation. The code describes procedures that the proponent will adopt during the planning, assessment, field management, auditing and monitoring phases of the operation.

Santos Ltd. and Partners, who are the major oil and gas producers within the Eromanga and Cooper Basin, have developed Codes of Environmental Practice for exploration and production. The codes provide guidance to licensees on environmental issues that need to be taken into consideration in planning and undertaking exploration activities. These codes are currently being revised in a move towards an outcomes based approach. However in the interim they provide an acceptable standard. A company may either adopt these Codes or use its own Codes of Environmental Practice subject to approval by MESA.

MESA is able to assist licensees by providing examples of the documentation and advising on their scope. To date there have been no significant concerns raised by licensees with regard to requirements to minimise the environmental impacts of their operations.

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APPENDIX 1

DATA AVAILABILITY

Definition of basic data from onshore South Australia tenements

Under the terms of the Petroleum Regulations, 1989, basic exploration data relating to petroleum search activities in onshore tenements becomes open file and available for public purchase upon:

- The surrender or expiry of those tenements.
- Where an exploration licence (PEL) is in force, basic well data may be made available to the public after the expiration of two years from the rig release date and, for geophysical surveys, two years after the completion of field acquisition.
- Where a production licence (PPL) is in force, basic well data may be made available to the public after the expiration of five years from the rig release date and for geophysical surveys, five years after the completion of field acquisition.
- While a production licence is in force, production data from each completion may be made available to the public after the expiration of three months from the end of the relevant six month period (ie. ending 30 June and 31 December each year).

Basic data include:

Gravity/Magnetic Surveys–all data other than potential field qualitative and quantitative interpretation maps and reports.

Seismic Surveys–all data other than:

- seismic picks, correlations and stratigraphic units on sections,
- time/depth contour maps,
- interpretation reports.

Vertical Seismic Profiling and Well Check Shot Data–all data other than qualitative or quantitative maps and reports using proprietary techniques.

Lithological Data and Formation Tops–all data other than core analysis studies carried out by oil company research units utilising proprietary techniques.

Palaeontological Data–all data other than conclusions drawn from the species lists and range charts.

Source Rock Data–all laboratory and contractor data.

Special Core Analyses–all data other than relative permeability data, capillary pressure test data and water flood test results derived by oil company research units utilising proprietary techniques. All contractor derived data and results are defined as basic data.

Regional Geological Data–all data other than:

- regional basin-wide geological and palaeoenvironment maps,
- regional formation structure and isopach maps.

Reservoir Engineering Data–all contractor derived data and results are defined as basic data.

Reserve Data–company derived estimates are not considered basic data.

Basic Well Drilling Data–all data from this source are defined as basic data.

Wireline Log Data–all data other than oil company log interpretations utilising proprietary techniques.

Fluid Analyses–all laboratory and contractor data.

Samples–core and cuttings are defined as basic data.

Well Completion Reports–regardless of the above, all data supplied in well completion reports is regarded as basic data.

Note: These provisions are currently under review.

Data available from MESA

PEPS-SA

MESA have developed PEPS-SA (Petroleum Exploration and Production System-South Australia), a comprehensive database of SA petroleum exploration and production data. PEPS-SA is being continually developed and is now available for purchase. PEPS-SA is available in a variety of formats including PC-based data packages or hardcopy.

PEPS-SA comprises eight key data sets — wells, geophysics, geology, engineering, production, statistics, tenements and addresses — each of which is subdivided into modules:

Wells: Well and petrophysical log data. Basic well data for all wells is included.

Geology: Cores and cuttings, core photographs, formation tops, palynology and source rock analyses. Results from analyses post-dating the well completion report and recent revisions to stratigraphy are included.
Geophysics: Seismic survey and seismic line data.
Engineering: Abandonment, casing and perforation details and drill stem, liquid evaluation and well tests.
Production is separated into gas, oil and CO_2 recorded on a monthly basis for each completion.
Statistics provides a quick reference to annual statistics on petroleum exploration and production (expenditure, sales, annual LPG/condensate production per field etc).
Tenements: exploration, production and pipeline licence summaries.

Customers may purchase the entire data set or only modules of interest. Data may be selected for specific areas or for all of SA. Purchase includes quarterly updates for a full year. A Windows Help File on PEPS-SA is available free of charge.
Contact Alan Sansome fax (08) 373 3269 or Email: asansome@msgate.mesa.sa.gov.au

Seismic Database
A comprehensive index of all seismic lines recorded in the State has been prepared on a survey by survey basis. This index is stored in PEPS-SA and a manual system. It includes survey summary data, shotpoint ranges and line lengths.
Contact Rob Langley, fax (08) 373 3269

A digital seismic shotpoint database covering SA and adjacent waters to 40 S latitude has been compiled and data is available in various formats on 9-track tape or diskette. Hardcopy maps can be prepared for any area at any scale.
Contact Peter Dunne, fax (08) 379 8133.

Aeromagnetic Database
A digital database of aeromagnetic survey boundaries has been compiled and gives the location of all airborne surveys over SA and adjacent waters.
Contact Nick Dunstan, fax (08) 373 3269.

Petroleum Tenements
An A4 size petroleum tenement map, including a listing of tenement, holder(s) and interests, expiry date and area, is prepared quarterly and is free on request. A 1:2 000 000 scale tenement map is available quarterly.
Contact Mario Collela, fax (08) 373 3269.

All tenements granted, surrendered or cancelled are published in the SA Government Gazette issued weekly from the State Information Centre, 25 Grenfell St, Adelaide. These notices are also widely publicised in the business, investment and resources sectors of the local and international press, as well as by circulation to listed exploration companies, stockbrokers, etc.

Consolidated Data Sets
A program has now commenced to consolidate open file basic and interpreted data into coherent data sets. A range of attribute databases have been prepared (e.g. wireline log data, basic well information, seismic survey data, formation tops etc.). Geographical databases have been created such as the seismic shotpoint and seismic horizon interpretation databases. Image processing has also been used to enhance seismic horizon databases. Datasets are available for the Eromanga Basin (1992) and in progress for the Cooper, Warburton, Simpson and Pedirka Basins.
Contact Dave Cockshell, fax (08) 373 3269.

Digital Geological Maps of SA
SA_Geology provides an accurate, detailed and up-to-date overview of the State's geology. Covering the entire State, the dataset portrays outcrop geology, derived from 1:250,000 mapping, but generalised into over 80 individual units.
Contact Dr Tony Belperio, fax (08) 274 1239.

Accessing Data
MESA holds the largest collection of SA geoscientific literature, mining and exploration data, dating from the 1850s. The data comprises open file company exploration reports (including well completion and seismic survey reports), MESA open file report books, Government publications, geoscientific maps, plans, publications and more.

Most publications may be borrowed by means of inter-library loan. Unpublished data which has been microfilmed are also available on inter-library loan (in microfiche only). Unpublished data are held on microfiche, however viewing of hardcopy at MESA can be organised by prior arrangement.
Contact Greg Drew (08) 272 7597.

Purchasing Data
The MESA Document Storage Centre is responsible for storing and copying all unpublished material. Copies may be ordered in paper, microfiche, transparency or digital media. The centre strives to complete standard orders within two days.
Contact Peter Dunne, fax (08) 272 7597.

Core Library
Confidential and open file drillhole samples obtained from Departmental and company petroleum, stratigraphic and mineral exploration are stored at the MESA Core Library. The Core Library is located 2 km from head office at 23 Conyngham St, Glenside. Viewing facilities are fully enclosed. All open file samples are available for inspection and sampling is permitted. Forty-eight hours notice is required to reserve sample space and allow time for layout of sample trays. There is **no charge** levied to inspect or sample core and cuttings at this facility.
Contact Brian Logan, fax (08) 338 1925.

APPENDIX 2

ONSHORE PETROLEUM ACT GUIDELINES

Introduction

Petroleum exploration and development in South Australia are administered under the Petroleum Act, 1940 (onshore) and the Petroleum (Submerged Lands)Acts, 1967 of the Commonwealth and 1982 of the State (offshore). Vacant onshore areas are continuously available for licence applications, whereas offshore permits are open to application only after gazettal of areas by the Commonwealth and State Governments.

PETROLEUM ACT, 1940 GUIDELINES

Note: The area to which this Act applies covers all of onshore South Australia exclusive of Commonwealth Lands; it extends south to the State Territorial Sea Baseline and includes the waters of Spencer and St Vincent Gulfs.

	ONSHORE PETROLEUM EXPLORATION	Petroleum Act Reference
Title of Tenement	Petroleum Exploration Licence (P.E.L.).	
Who Can Apply	An individual, a body corporate (i.e. a company) or an unincorporated association of persons and bodies corporate (i.e. a joint venture involving several persons and/or companies).	6(1)
	Where application is made on behalf of a company, the application must be made under the company seal.	41(b)&(c)
When Application Can be Made	Initial Licence - At any time over any area not already under licence.	6(1a)
	Renewal of Licence - not less than 3 months before existing licence is due to expire.	18(5b)
Maximum Area	26 000 sq. km.	15(1)
Application Fee	For initial application - $2000	7(2)
	For each renewal - $1000	7(2)
Bond (to ensure compliance with licence conditions)	$15 000 minimum. Amount required is specified in letter of offer. Bond may be in the form of cash, cheque or bank guarantee.	13(1)
Term of Licence	Initial Term - 5 years.	15(2)
	Each Renewal (to a maximum of 3) - 5 years.	15(2)
Annual Rental Payable	Initial 5 Year licence term - 24 c/sq.km.	18c(a)
	First Renewal (2nd 5 Year licence term) -	

	36 c/sq. km.	18c(b)
	Second Renewal (3rd 5 Year licence term) - 48 c/sq. km.	18c(c)
	Third & Final Renewal (4th 5 Year licence term) - 60 c/sq. km.	18c(d)
Minimum Work Commitments	As negotiated with applicant after application (which must contain a proposed 5 year work program) has been received.	
Minimum Expenditure Commitments	Initial 5 Year licence term - first two years - $16 per sq. km. per year - last three years - $24 per sq. km. per year.	 17(1)(a) 17(1)(b)
	First Renewal (2nd 5 Year licence term) - $100 per sq. km. per year.	18a(1)(a)
	Second Renewal (3rd 5 Year licence term) - $125 per sq. km. per year.	18a(1)(b)
	Third & Final Renewal (4th 5 Year licence term) - $150 per sq. km. per year.	18a(1)(c)
Area to be Relinquished on each Renewal	25% of original licence area. This is in addition to any areas voluntarily surrendered during each 5 Year licence term.	18(2)
Fee for Minister's Consent to Dealings in Licence	$1000 per transaction (document).	42(3)
Fee for Inspection of Register	$100	Reg.13(2)
Fee for Copy or Extract from Register	$1 per page	Reg.13(4)
Method of Application	Letter of application addressed to the Director-General, Department of Mines and Energy (there is no prescribed form).	7(1)
	Attached to the application should be:	
	(1) full names and addresses of the party/ parties making the application, including (where applicable) the percentage interests of the various parties	
	(2) two copies of a map and description of the area being applied for	7(3)
	(3) a table showing the work intended to be carried out, and the estimated cost of	

	that work, during each year of the five year licence term.	7(3a)
	(Expenditure estimates should satisfy the minimum expenditure commitments set out in Sections 17 and 18).	
	(4) particulars of the technical qualifications and expertise available to the applicant party/parties (e.g. qualifications and experience of employees, consultants retained etc.).	7(4)
	(5) particulars of the financial resources available to the applicant party/parties to carry out the proposed terms and conditions of the licence.	7(4)
	(In the case of a company application, this is generally supplied in the form of a copy of the company's most recent Annual Report).	
	(6) the $1000 application fee.	7(2)
	Where the application is made on behalf of a company, the application must be made under the company seal.	41(b)&(c)
Penalty for Non-Payment of Annual Rental Fees	All fees are payable in advance. If fees are not paid by the due date, a fine of 10% is imposed and in addition, interest accrues at the rate of 6% per annum. If any fee is in arrears for 3 months or more, the licence may be cancelled.	83(1)&(2)
Licence Variations	Only on application by the licensee, the Minister may at any time during the term of the licence, vary or revoke a condition of the licence or attach new conditions to the licence.	17(3)
Environmental Conditions	These will be outlined in the letter of offer attached to the licence.	
Surrenders (Partial or Whole of Licence)	The Act requires the licensee to:	
	(1) apply to the Minister for permission to surrender	38(1)
	(2) give three months notice in writing	38(1)(a)
	(3) pay all outstanding fees	38(1)(b)
	(4) pay all outstanding monies and wages to workmen and employees.	38(1)(c)
	Surrenders are only permitted if the licensee has fulfilled all the terms and conditions of the licence up to and	

	including the year in which the application to surrender is lodged.	38(2a)
	Licensees are required to lodge all outstanding data on their licences and carry out the cleanup and rehabilitation of their licence areas (where necessary) as a condition of surrender.	
	Surrenders are effective from the end of the appropriate year of the term of the licence (unless specified otherwise).	38(2b)
Required Notice for Approval to Undertake Work in Licence Area	Three months notice is required to arrange necessary clearances with other Government Agencies. This is carried out by DME on the licensee's behalf.	
Required Notice of Entry to Landholders	No risk of damage to land or improvements thereon - 14 days.	51(1)
	Risk of damage to land or improvements thereon - 28 days.	51(1)
Gazettals	Gazettals occur on:	
	(1) Grant of Licence	6(2)
	(2) Surrender of Licence	
	(3) Cancellation of Licence	71(1)
Suspension and Cancellation	The Act provides for suspension and/or cancellation for failure to comply with licence conditions.	87a(1)

APPENDIX 3

LICENCE APPLICATION FORM AND PROCEDURES

Application

Although there is no form set by regulation, an application for a Petroleum Exploration Licence (PEL) may be lodged in accordance with the attached PRO FORMA, and should be accompanied by two copies of a plan of the application area and accompanied by the prescribed fee (which is currently A$2,000 for each licence applied for).

An application for a PEL can be lodged at any time over any area of the State not currently under a PEL or a Petroleum Production Licence (PPL) unless applications for the area have been specifically invited and a closing date nominated for receipt of applications.

An application can be made by an individual(s) or a company(s) or a combination of an individual(s) or a company(s). When a foreign company makes an application, the foreign company must be registered as a foreign company under the provisions of the Australian Corporations Law. Information on registration requirements can be supplied on request.

Technical Qualifications/Experience

The applicant must submit with the application a summary of the technical qualifications of the applicant (or consultants/agents of the applicant) to satisfy requirements that the applicant is capable of satisfying compliance with the Petroleum Act and the terms and conditions of the licence.

Financial Position

Evidence of the financial position of the applicant is to be supplied to demonstrate ability to fulfil the proposed work program. Such evidence can be in the form of the latest annual report or a verifiable statement from an independent accountant/auditor/ financial institution. If financial resources are not available for the full five year program, the applicant will have to provide evidence that there are financial resources available for at least the first licence year program prior to the grant of the licence.

Work Program

The applicant must submit with the application a statement of exploratory operations the applicant proposes to carry out in each year of the five year term of the licence, including an estimate of exploration expenditure to be incurred in each year of the licence.

A minimum exploratory expenditure for each of the first two years of the licence is sixteen dollars per km^2 per year, and twenty four dollars per km^2 for each of the remaining three years.

Competing Applications

Where there are competing applications and where the financial and technical criteria are satisfied, the successful applicant would normally be the applicant who has offered the most effective work program. The number and timing of wells would be the most critical element in determining the most effective work program, with seismic and other work generally being a secondary issue.

Where competing bids are within reasonable proximity in total scope, preference would generally be given to the applicant who has the most effective work program in the early years of the licence.

Once a licence has been granted, a licensee is obliged to carry out the work program stipulated in the year the licence is in. Any failure to fulfil the work program for that year may, if a genuine 'force majeure' case is not proved, may result in cancellation of the licence. Variation of licence conditions are possible, however this would only generally be done where extraordinary cause exists, especially for a licence issued for which there were competing bids.

MINES and ENERGY
SOUTH AUSTRALIA

PRO FORMA

EROMANGA BASIN ACREAGE RELEASE

APPLICATION FOR PETROLEUM EXPLORATION LICENCE

PETROLEUM ACT, 1940 (SECTION 7)

To the Chief Executive Office, Department of Mines and Energy

I/We, ...

....

....

hereby make application for the grant of a petroleum exploration licence in respect of the area described hereunder:

DESCRIPTION OF AREA

Block		Approximate area	
		km^2	Acres (million)
ER 96-A	☐	7756	1.9
ER 96-B	☐	4573	1.1
ER 96-C	☐	4112	1.0
ER 96-D	☐	6813	1.7

Please indicate Block(s) under application. Note each Block is offered as a separate licence and the application fee is currently A$2,000 per licence.

Details in support of the application (see guideline) and the application fee of

$...................... are attached.

Dated this .... day of .... 19...........

....

....

Signature of applicants(s)*

** Note: Where application is made by a consortium including a company(s), the application must be made under the company(s) seal*