

EXPLORATION OPPORTUNITY

LAKE EYRE-BIRDSVILLE TRACK RIDGE

AREAS 90 B-E

DATA PACKAGE BROCHURE

DEPARTMENT OF MINES AND ENERGY  
SOUTH AUSTRALIA

JUNE 1990

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SOUTH AUSTRALIA

**Exploration Opportunity  
Lake Eyre - Birdsville Track Ridge**

REPORT BOOK NUMBER 90/35

DATA PACKAGE BROCHURE  
AREAS 90 B-E

by

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&

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OIL, GAS & COAL DIVISION

JUNE 1990

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<b>CONTENTS</b>	<b>PAGE</b>
STATEMENT OF INTENT	1
GEOLOGICAL SUMMARY	3
Introduction	
Stratigraphy	
Hydrocarbon Potential	
Structure	
Sample prospects	
EXPLORATION ACCESS	29
Regional Reserves	
Conservation Parks	
National Parks	
BIBLIOGRAPHY	33
APPENDICES	35
Formation tops	
Available drillcore	
DATA PACKAGE CONTENTS	38
Geological data	
Geophysical data	
LICENCE APPLICATION PROCEDURES	42
ORDER FORMS	45
<b>FIGURES</b>	<b>PLAN NO.</b>
1. Areas available for application	S21523
2. Geological setting	S21524
3. Geological summary	S21525
4. Cross section A-A'	S21526
5. Cross section B-B'	90-274
6. Major structural elements	S21528
7. Prospects and leads summary map	S21529
8. Total seismic coverage	S21530
9. C Time structure map of Lake Promise Prospect	S21531
10. Seismic section A-A' through Lake Promise Prospect	S21532
11. Seismic section B-B' through Lake Promise structure	S21533
12. C Time structure map of Lake Howitt strong lead	S21534
13. Seismic section A-A' through Lake Howitt structure	S21535
14. C Time structure map of Warrawarrinna strong lead	S21536
15. Seismic section A-A' through Warrawarrinna structure	S21537
P.41 Selected seismic lines locality map	S21527
<b>TABLES</b>	
1. Petroleum exploration wells relevant to area	3
2. Seismic surveys	4
3. Formation tops	35
4. Available drillcore	36
5. Onshore petroleum exploration guidelines	43

## STATEMENT OF INTENT

Applications are invited by 5 October 1990 for Petroleum Exploration Licences (PELs) in the Lake Eyre-Birdsville Track Ridge area, over Blocks 90 B, C, D and E or parts thereof, shown on Figure 1.

The areas cover the Cambrian to Devonian Warburton Basin, and Mesozoic Simpson and Eromanga Basins (Fig 2) and have come available following the relinquishment of a portion of PELs 5 and 6 in early 1990. A total of 34 630km<sup>2</sup> is now available for applications. Ten petroleum wells have been drilled and 6 034 kms of seismic have been recorded in the area to date. A number of leads and prospects have been identified (Fig. 7) and remain to be fully evaluated.

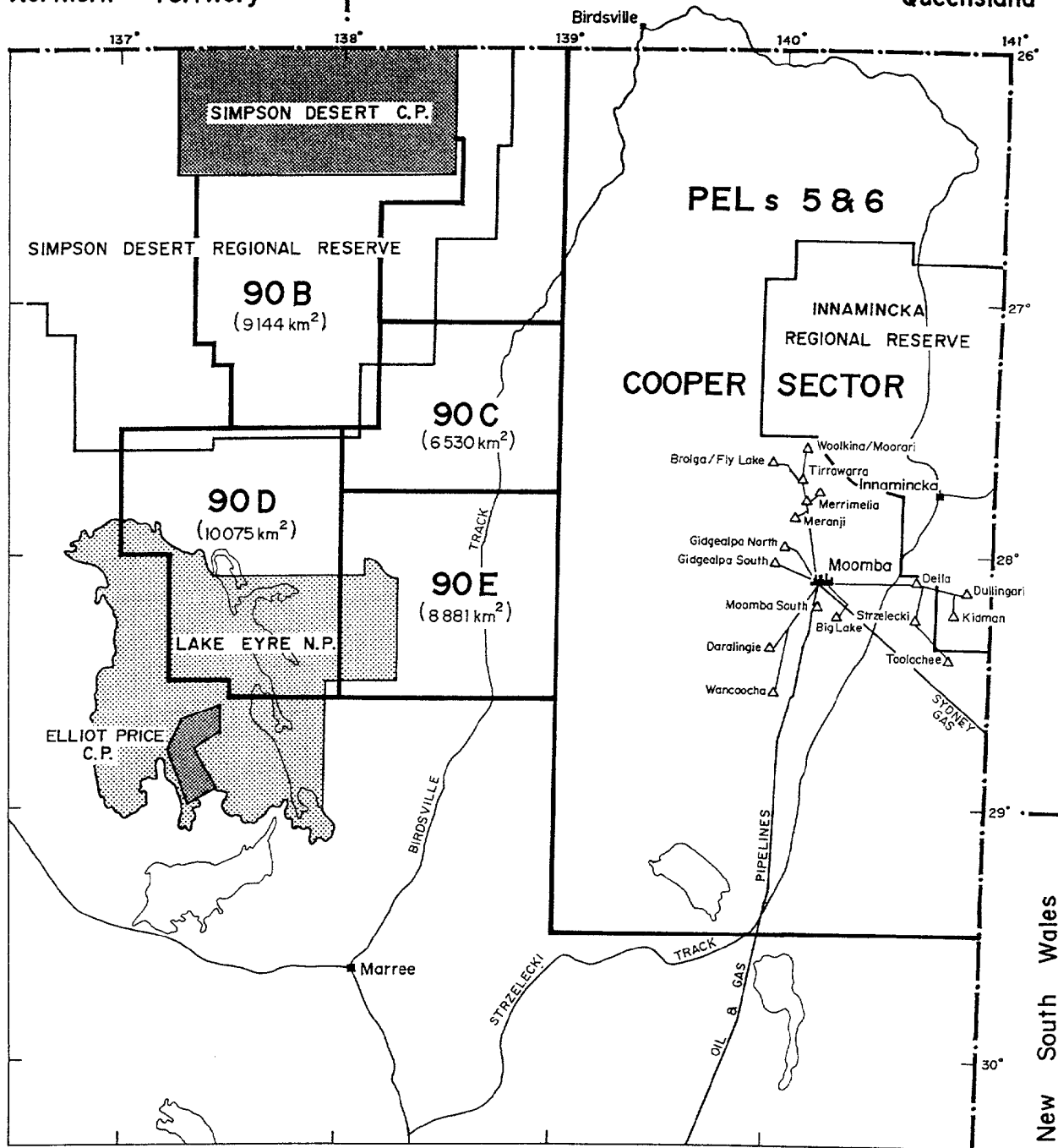
A brief review of the geology and hydrocarbon potential of the area is set out below, together with a detailed breakdown of data package contents and licence application procedures.

An order form for the data package is provided at the back of this brochure. Data packages will be supplied promptly after 22 June 1990.

Please contact *Mr R Frears* - Chief Geologist, Oil, Gas and Coal Division, telephone (08) 274 7623, fax (08) 373 3269, with any queries.

Northern Territory

Queensland



50 0 100  
Kilometres

Gas processing plant .....

Oil or gas satellite .....

Oil or gas pipeline .....

Fig. 1

# AREAS AVAILABLE

## GEOLOGICAL SUMMARY

### Introduction

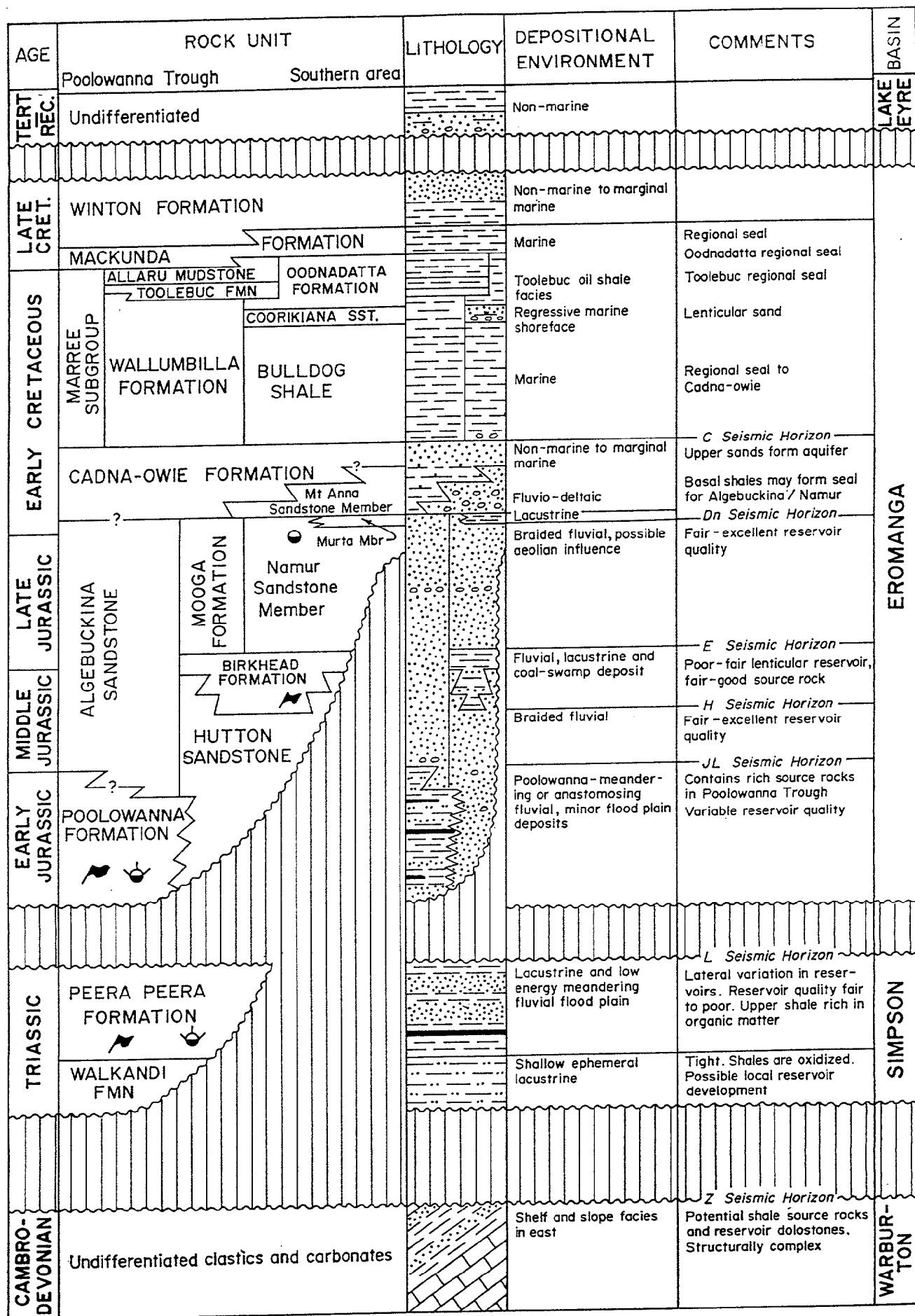
Blocks 90 B-E contain sediments from four superimposed basins, ranging from Cambrian to Recent in age (Fig 3). The Permian Pedirka Basin lies immediately to the west of Block 90B (Fig 2). Exploration activity in the area has concentrated on the Pedirka, Simpson and Eromanga Basin sequences. Ten petroleum exploration wells have been drilled in the area (Table 1), and fifteen seismic surveys conducted (Table 2) since 1964.

**Table 1:** Petroleum exploration wells relevant to the Area

WELL	YEAR DRILLED	OPERATOR	LATITUDE	LONGITUDE	TD (m)
Poonarunna-1	1964	FPCA	27.5420000	137.5430000	1 697
Poolowanna-1	1977	DELHI	26.2534560	137.4020410	3 074
Walkandi-1	1981	DELHI	26.3341340	137.2803750	3 125
Kuncherinna-1	1981	DELHI	26.4241000	138.1612000	2 866
Poolowanna-2	1985	DELHI	26.2652520	137.4009080	2 916
Miandana-1	1985	DELHI	27.0313240	137.2341430	2 672
Mulapula-1	1986	DELHI	28.2018390	139.4324140	1 415
Lake View-1	1988	SANTOS	27.5143000	137.5121000	1 427
Mulkarra West-1	1989	SANTOS	27.5141000	138.4002000	1 287
Tirari West-1	1989	SANTOS	27.5314568	137.3358287	1 785
Poolowanna-3	1989	SANTOS	26.2502349	137.4012589	2 692

**Table 2: Seismic Surveys**

SURVEY NAME	OPERATOR	CONTRACTOR	YEAR	FOLD	ENV
COOPERS CREEK SEISMIC SURVEY	DELHI PET	UNITED	1964	100/400%	477
LAKE GREGORY SEISMIC & GRAVITY SURVEY	ASHBURTON OIL	UNITED	1969	100/300/ 600%	1319
KALLAKOOPAH	FRENCH PET	UNITED	1964	100%	405
POOLAWANNA SEISMIC SURVEY	FRENCH PET	CGG	1964/65	100%	845
BEAL HILL SEISMIC SURVEY	DELHI PET	SSL	1974	1200%	2400
LAKE THOMAS SEISMIC SURVEY	DELHI PET	SSL	1974	1200%	2415
PILLAN HILL SEISMIC SURVEY	DELHI PET	SSL	1976	1200%	2771
PEERA PEERA SEISMIC SURVEY	DELHI PET	GES	1979	600/1200%	4311
KOOMARINNA SEISMIC SURVEY	DELHI PET	GES	1980	1200%	3707/3807
CHRISTMAS CREEK SEISMIC SURVEY	DELHI PET	GES	1982	600% 1200% 2400%	5064
HOGARTH SEISMIC SURVEY	DELHI PET	GES/SSL	1984	1200%	5561
MORPHETT SEISMIC SURVEY	DELHI PET	SEISCOM	1985	2400% 4800%	5995
FLETCHER SEISMIC SURVEY	SANTOS	GSI	1986		
MITCHELL SEISMIC SURVEY	SANTOS	SSL	1987	3000% 4800% 6000%	6826
FORREST SEISMIC SURVEY	SANTOS	SSL	1988	3000% 4800% 6000%	6936



Oil show.....● Gas show.....☉ Source rock.....▲

Fig. 3

# GEOLOGICAL SUMMARY



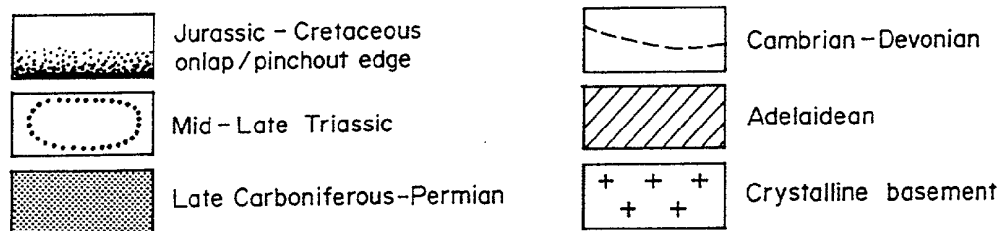
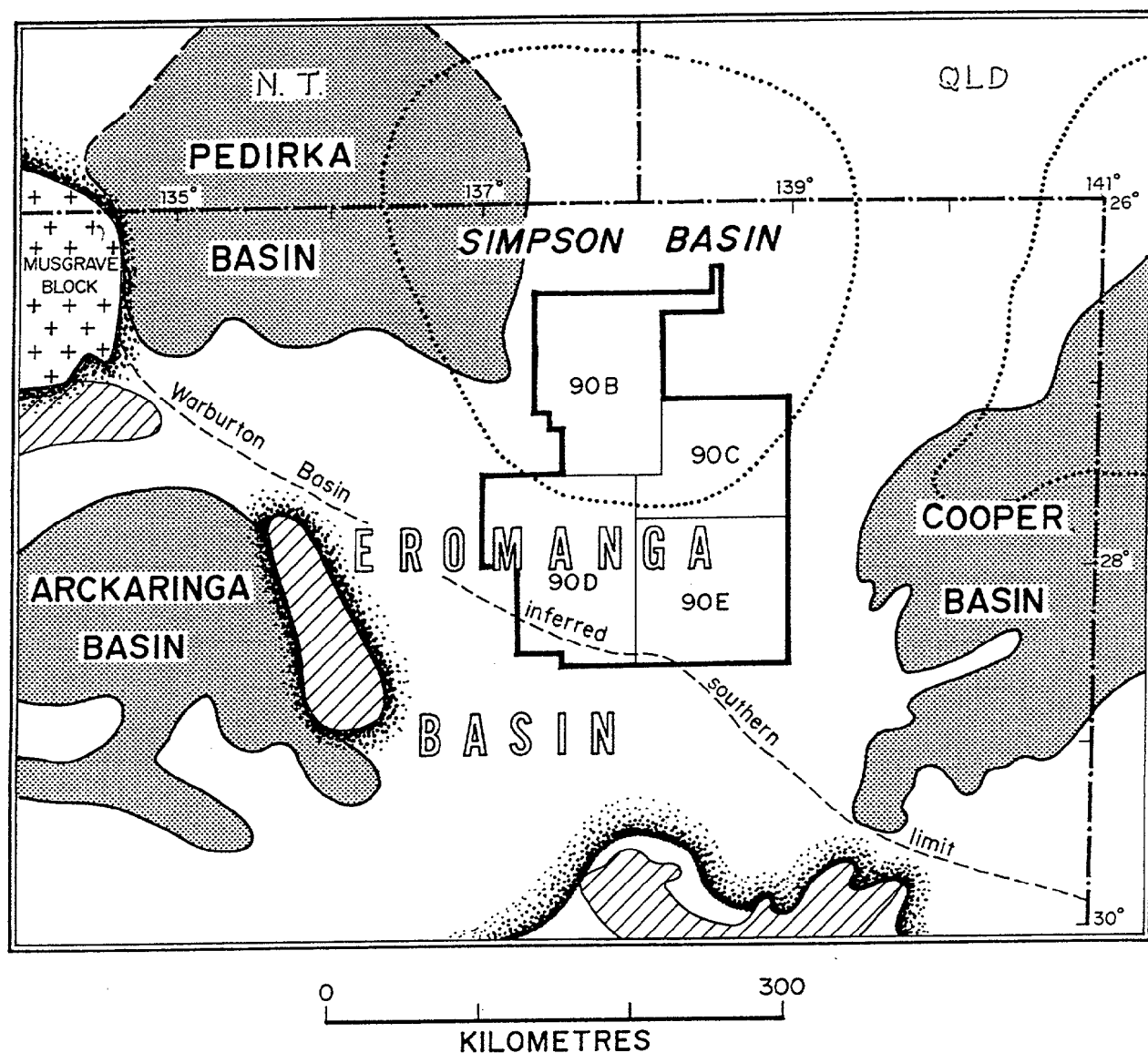


Fig. 2

## GEOLOGICAL SETTING

## Stratigraphy

Economic basement is inferred to be metasediments of Adelaidean age. Sheared and metamorphosed basement was intersected in Miandana-1 (core 1) and in Walkandi-1 (phyllite was intersected in core 3). Economic basement is overlain unconformably by the following basins.

### Warburton Basin (Cambrian to Devonian)

Sediments of the Warburton Basin are only known from drillhole intersections in northern South Australia (Gatehouse, 1986). Connections with the Cambrian Arrowie Basin to the south, the Precambrian to Devonian Officer Basin to the west and to the Precambrian to Devonian Amadeus Basin to the north have been inferred.

Equivalents of Early-Late Cambrian clastics, red beds, volcanics and shelf and slope carbonates have not been penetrated in the Blocks. Available core (Table 4) is lithologically similar to the Ordovician Dullingari Group described in the Cooper Sector of PELs 5 & 6, and typically consists of dark grey finely interbedded, occasionally slumped, pyritic siltstone and fine sandstone. In one core (Mulapula-1, core 2), the unit is moderately bioturbated. Interpreted environments of deposition range from subtidal (in Mulapula-1) to slope (in Lake View-1, Kuncherinna-1, Poonarunna-1 and Walkandi-1). In Walkandi-1, possible Dullingari Group equivalent is in fault contact with Adelaidean phyllite (core 3).

### Simpson Basin (Triassic)

The Simpson Basin contains ?Early to Middle Triassic Walkandi Formation, overlain by Late Triassic Peera Peera Formation (Wiltshire, 1978; Moore, 1986) (Fig 3). In Blocks 90 B-E, sediments of the Simpson Basin lie unconformably on the Warburton Basin, or on Adelaidean metasediments. To the west, Triassic sediments lie unconformably on the Permian Pedirka Basin.

The Walkandi Formation consists of green to brick red, interbedded shale, siltstone and minor sandstone red beds deposited in a shallow, ephemeral lacustrine environment. Powis (1989) correlates the Walkandi Formation with the Arrabury Formation of the Cooper Basin - Early to Middle Triassic red bed sequences also occur in the Sydney and Bowen Basins and are thought to reflect a world-wide lowering of sea level.

The Peera Peera Formation lies conformably on the Walkandi Formation in the central part of the basin, and consists of a sequence of grey shale and siltstone at the base, with minor thin sandstones and coal, a fining upwards sandy middle unit and a black, silty highly carbonaceous shale at the top (Moore, 1986). Deposition of the Peera Peera Formation occurred on a floodplain crossed by meandering fluvial streams with lacustrine development. Powis (1989) correlates the Peera Peera Formation with the Late Triassic Cuddapan Formation and the Leigh Creek Coal measures, which may represent isolated, eroded remnants of more extensive Late Triassic deposits (Wiltshire, 1982 and Powis, 1989). Figures 4 & 5 are regional cross sections through the Poolowanna Trough, showing the relationship between the Simpson and Eromanga Basins.

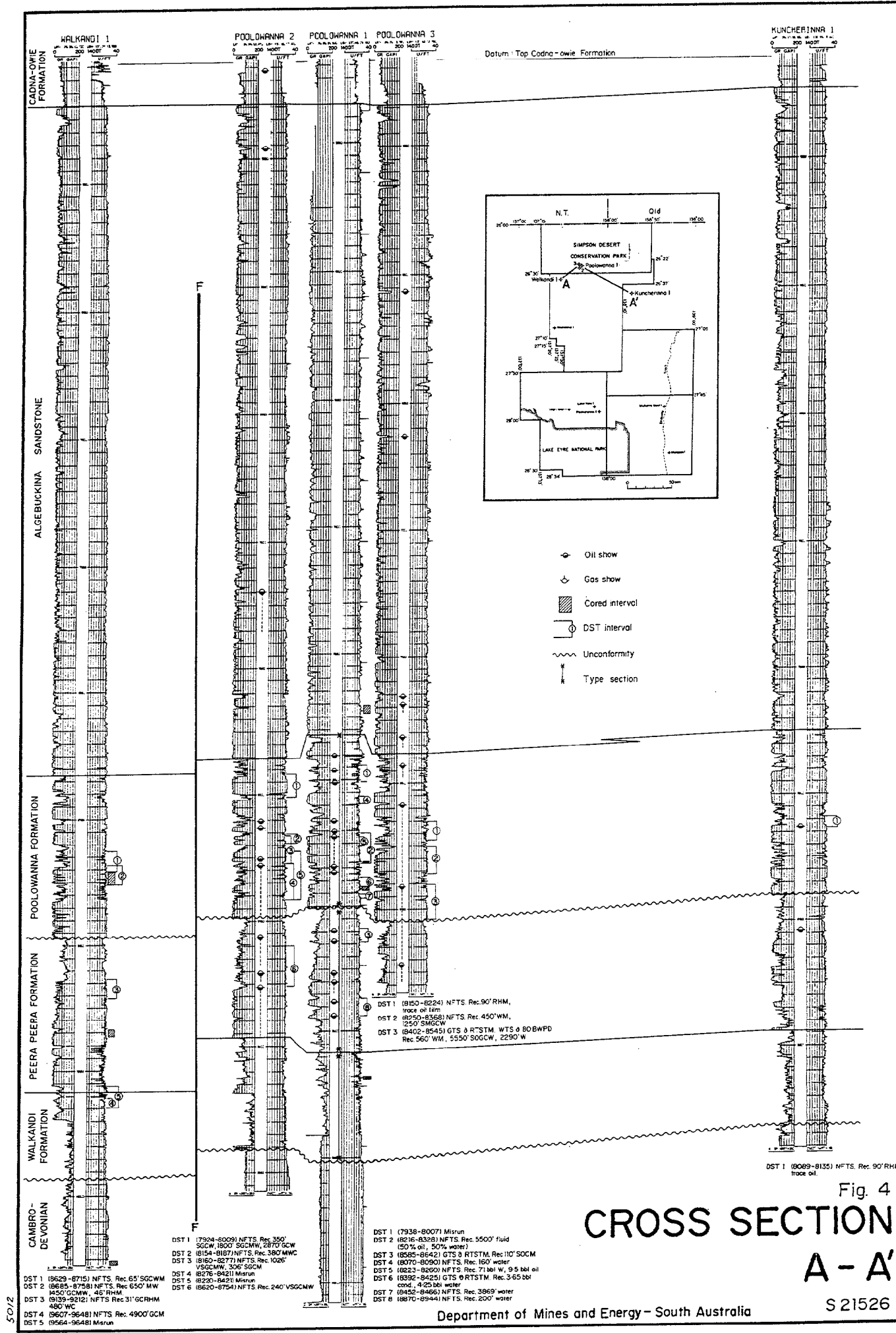
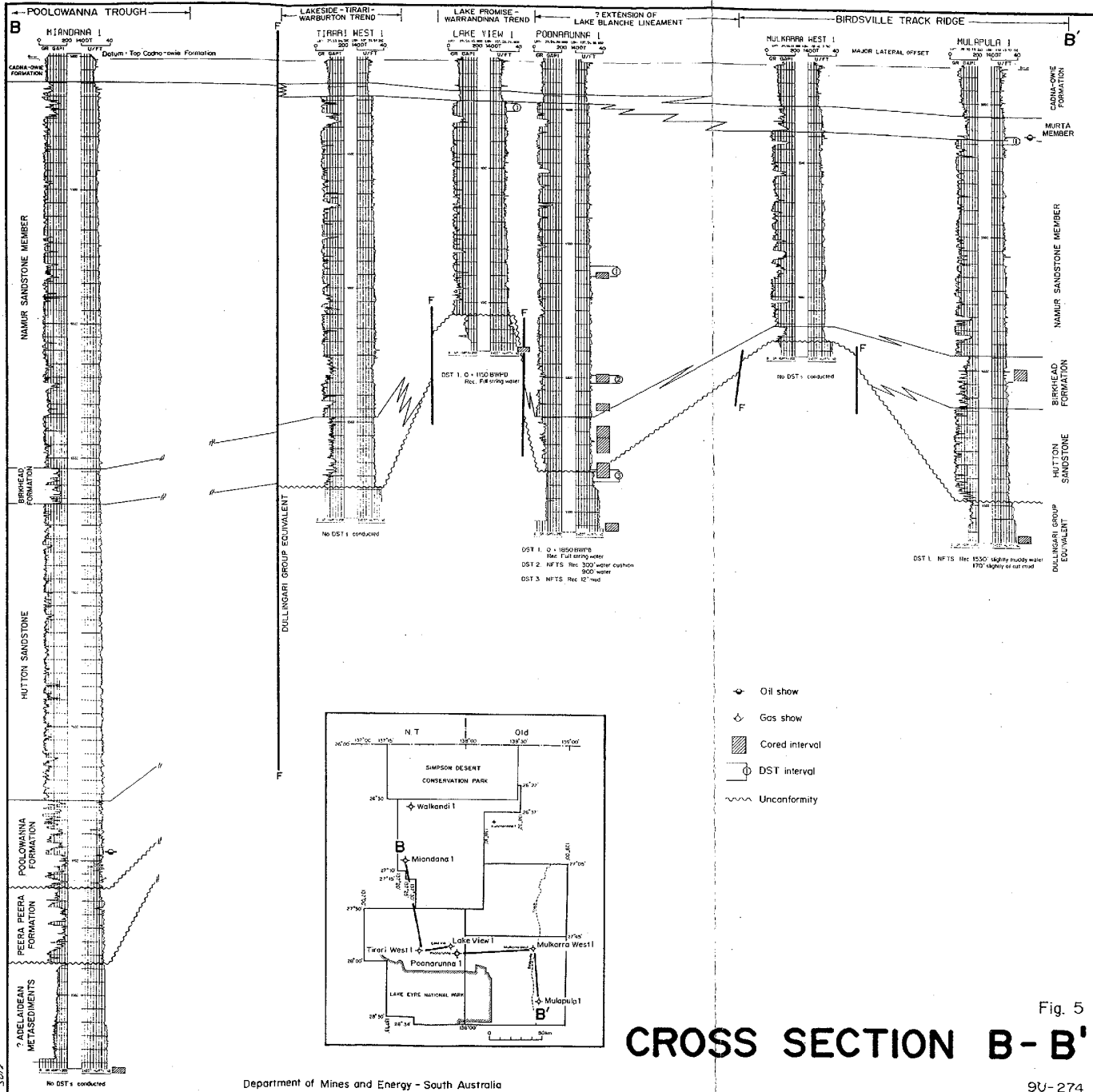


Fig. 4  
**CROSS SECTION**  
**A - A'**

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## Eromanga Basin (Jurassic to Cretaceous)

The Eromanga Basin lies unconformably on the Simpson Basin in the Poolowanna Trough area and unconformably on the Warburton Basin or Adelaidean metasediments in the south (Blocks 90 D and 90 E) - see Figures 4 and 5.

In the Poolowanna Trough, Early Jurassic Poolowanna Formation forms the basal unit of the Eromanga Basin. It consists of interbedded siltstone, shale, sandstone and thin discontinuous coals, deposited in a meandering or anastomosing fluvial environment with minor floodplain sediments (Moore, 1986). The Poolowanna Formation intertongues with, and is overlain by, a thick sandy sequence - the Algebuckina Sandstone - in the Poolowanna Trough. Figure 6 shows the inferred Poolowanna Formation zero edge.

The Early Jurassic to Early Cretaceous Algebuckina Sandstone contains only minor thin and discontinuous siltstones. Moore (1986) inferred braided fluvial deposition, however, Wiltshire (1989) regards aeolian transport of sand across the Eromanga Basin as the main process of bulk sediment transport. The Algebuckina Sandstone is interpreted to be a product of aeolian and fluvial processes in the hinterland to a sand dominated shallow lake (Wiltshire, 1989).

South of the Poolowanna Trough, laterally equivalent shale and siltstone units intertongue with the Algebuckina Sandstone, enabling division of the sequence into the Hutton Sandstone - Birkhead Formation - Namur Sandstone Member - Murta Member (Fig. 5). Here, the Hutton Sandstone (Mulapula-1, Miandana-1) or Birkhead Formation (Tirari West-1, Poonarunna-1, Mulkarra West-1) rest unconformably on Warburton Basin sediments.

The Hutton Sandstone consists of a sequence of stacked braided fluvial channel sands (with possible aeolian influences) and minor discontinuous siltstones. The Hutton Sandstone intertongues with, and is overlain by interbedded shale, siltstone, coal and sandstone of the Birkhead Formation. The Birkhead Formation was deposited in a fluvio-lacustrine floodplain setting. Figure 6 shows the interpreted Birkhead Formation zero edge. Braided fluvial deposition recommenced in the overlying Namur Sandstone Member (of the Mooga Formation), which intertongues with lacustrine siltstones and shale and minor fine shoreface sandstones of the Murta Member (seen in Mulkarra West-1 and Mulapula-1 in Blocks 90 B-E).

The Algebuckina Sandstone/Murta Member/Namur Sandstone Member are all overlain by Early Cretaceous Cadna-owie Formation (Figs. 4 and 5). The Early Cretaceous is marked by marine transgression over the entire Eromanga Basin (Moore and Pitt, 1986). The Cadna-owie Formation coarsens upwards from interbedded mudstone and siltstone at the base, to fine grained, calcareous sandstone at the top. To the west of Block 90 B-E, Cadna-owie Formation marginal marine facies intertongue with pebbly fan-delta sandstone of the Mount Anna Sandstone (Wopfner *et al*, 1963).

The Bulldog Shale, and laterally equivalent Wallumbilla Formation, lie conformably on the Cadna-owie Formation. The contact is close to the 'C' seismic horizon - readily identifiable over most of the Eromanga Basin. Succeeding units consist of transgressive marine shales and siltstones, shoreface sandstones, dysaerobic marine organic rich mudstone (Toolebuc) and calcareous siltstone covered by extensive and thick continental

deposits of the Winton Formation (Fig 3). Moore and Pitt (1982 and 1986) discuss the Early Cretaceous sequence in detail. Rapid deposition of the Winton Formation (up to 1 100m thick) contributed to the onset of significant hydrocarbon generation in the Nappamerri Trough (Cooper Basin) and in the Poolowanna Trough (Kantsler *et al*, 1986). The Mount Howie Sandstone (Wopfner, 1985), deposited by large meandering streams, was the last unit within the Eromanga Basin to be deposited.

### **Lake Eyre Basin (Tertiary to Recent)**

Deposition of continental, fluvio-lacustrine sediments of the Lake Eyre Basin followed a period of erosion in the Late Cretaceous, caused by a switch in drainage from the Innamincka Depocentre to the Ceduna Depocentre on the rifted southern margin of the Australian continent (Veevers *et al*, 1984).

### **Hydrocarbon Potential**

A brief summary of the hydrocarbon potential of each basin follows. Figures 4 & 5 summarise oil shows and DST results from wells in the area.

### **Warburton Basin**

Oil shows have been recorded from Cambrian sediments in the Warburton Basin (Gidgealpa-1 and -2), Arrowie Basin (Wilkatana bores) and Officer Basin (Byilkaoora-1 etc). Study of the hydrocarbon potential of the Warburton Basin has concentrated on the Cooper Sector of PELs 5 and 6 - little is known in Blocks 90 B-E.

#### *Source*

Roberts *et al* (1990) made a detailed study of the Early Cambrian to Early Ordovician Kalladeina Formation in the Cooper Basin area. This formation may underlie the Dullingari Group in Blocks 90 B-E; source potential is generally poor to moderate. Type II kerogen, of possible marine algal/bacterial origin, was identified. Results from Tmax, PI and MPR methods indicate that the Kalladeina Formation is mature to over mature in the Cooper Sector of PELs 5 and 6. There are no data for the Dullingari Group, but steep dips and occasional quartz veins locally downgrade the unit. In areas of less severe deformation, source potential is worth investigating.

#### *Reservoir*

Roberts *et al* (1990) recognised three main types of Kalladeina Formation reservoirs: vuggy fractured dolomites, dolomitised oolitic limestones and karsted limestones (the "Mulkarra West impact structure" of Flynn (1989) may be a karst complex). The overlying Dullingari Group in Blocks 90 B-E does not display any reservoir facies and the westward extent of Kalladeina Formation is unknown.

### *Seal*

Siltstones and shales of the Dulligari Group may form a regional seal in Blocks 90 B-E for any older reservoir units. The Walkandi Formation and Poolowanna Formation in the Poolowanna Trough would have some sealing capacity for Warburton Basin reservoir. Elsewhere, there is a lack of regional seal for the Warburton Basin beneath the Mesozoic unconformity.

### **Simpson Basin**

Oil shows have been recorded from the Peera Peera Formation in Poolowanna-1, (GTS at RTSTM and a recovery of 9.5 bbl of oil on DST), Poolowanna-2, and -3, Walkandi-1 and Miandana-1 (Figs. 4 and 5).

### *Source*

The oxidised nature of Walkandi Formation red beds downgrades any source potential. However, the overlying Peera Peera Formation is rich in organic matter (TOC up to 5%), and should be oil mature in the Poolowanna Trough (Cook, 1986). The Peera Peera Formation is considered to be gas-prone, with modest oil yields.

### *Reservoir*

Sandstone interbeds in the Walkandi Formation are fine-grained, with low porosity and permeability. The Peera Peera Formation also suffers from laterally variable poor quality reservoirs (the highest porosity and permeability measured on Walkandi-1, core 2, were 7.8% and 0.3 md). Reservoir quality is thought to improve towards the edge of the basin (Teakle, 1990).

### *Seal*

Intraformational shale and siltstone seals exist in both the Walkandi and Peera Peera Formations.

### **Eromanga Basin**

Poolowanna-1 recorded the first flow of oil from the Eromanga Basin in 1977 - a year before the first commercial oil flow, from Strzelecki-3, in the Cooper Sector of PELs 5 and 6. Modern theories about the origin of Eromanga Basin oil fall into two groups:

- a) most Eromanga Basin oil is sourced from underlying coaly Permian rocks of the Cooper Basin (Heath *et al* 1989) or,
- b) that a proportion of Eromanga Basin oil is sourced *in situ* (eg Murta Member - Michaelsen and McKirdy, 1989).

Resolution of this problem is critical in evaluating hydrocarbon potential of the Eromanga Basin outside Cooper Basin source kitchen limits.

Long distance migration of oil from Cooper/Eromanga Basin source rock kitchens (Patchawarra, Nappamerri and Tenapera Troughs) was investigated by McKirdy and Willink, 1988 and Habermehl, 1988, for the southwestern Eromanga Basin.

### *Source*

The Poolowanna Formation contains the richest source rocks in the Poolowanna Trough (TOC up to 15%). Significant oil shows in the formation were recorded in Poolowanna-1 and -2, Walkandi-1 and Kuncherinna-1. Maturity may not be sufficient for significant oil generation (Teakle, 1990).

The Birkhead Formation (best developed in Blocks 90 C and E) has TOC values up to 15% (in Poonarunna-1) and contains good to very good source rocks in Mulapula-1 (Keraville Konsultants, 1987), where oil droplets were described. The unit is early mature for oil generation in the area.

Thin and poorly developed Murta Member, deposited near the margin of Lake Murta (Ambrose *et al*, 1986), is present. Fair oil source material, marginally mature for oil generation, was described in Mulkarra West-1 (Nugent, 1987).

The overlying Cadna-owie Formation has good source potential, and is early mature for oil generation (Keiraville Konsultants, 1987). The younger Eromanga Basin sequence has poor to good source potential, but is immature.

### *Seal*

The Poolowanna Formation contains good to excellent intraformational seals. Where developed, shaly facies of the Birkhead Formation seal the Hutton Sandstone, and Murta Member shale seals the Namur Sandstone Member. A regional seal to the Algebuckina Sandstone or Namur Sandstone Member is provided by Cadna-owie Formation shale.

### *Reservoir*

Reservoir sandstones are developed throughout the Poolowanna Formation, however diagenetic silicification in the deeper parts of the Poolowanna Trough has adversely effected reservoir quality. Fracture porosity was noted by Wiltshire (1978) in Poolowanna-1. The overlying Algebuckina Sandstone has excellent reservoir properties (porosity greater than 22%), and is a major artesian aquifer.

Elsewhere, the Hutton Sandstone and Namur Sandstone Member exhibit fair to excellent reservoir properties. Reservoir sandstones of limited lateral extent occur in the Birkhead Formation. Reservoir quality is poor to excellent (Mulapula-1, core 1 recorded a maximum porosity of 25.5% and a maximum permeability of 318 md).



## Lake Eyre Basin

Sediments of the Lake Eyre Basin are immature for hydrocarbon generation and are regarded as having low hydrocarbon potential.

## Structure

### Structural History

The following structural phases have been postulated for the area:

*Ordovician (Delamerian Orogeny):* NW compression. Contrary to previous ideas (eg Williams, 1975), there is no evidence of basin-wide metamorphism of Warburton Basin sediments. Thermal/metamorphic effects of the Delamerian Orogeny may only be minor to the north of the Muloorina Ridge and Peake and Denison Inlier. Williams (1975) proposed that Ordovician isotopic ages recorded in Poonarunna-1 Dullingari Group equivalent reflected a Delamerian tectonic overprint, however Gravestock (in prep) regards the age as depositional, with folding and faulting being Devonian or younger.

*Late Ordovician to Carboniferous (Alice Springs Orogeny):* NE-SW compression followed by late stage NW-SE compression. Gravestock (in prep) regards overthrusting during the Alice Springs Orogeny as an important contributor to the Palaeozoic structural framework of northern South Australia, resulting in gentle to steep dips evident in the Cambro-Ordovician record. Bradshaw and Evans (1988) provide the most recent definition and description of this orogeny. Moore's (1986) suggestion that gentle folding of Devonian strata in the Simpson Desert region is a result of the Alice Springs Orogeny is supported.

*Late Carboniferous to ?Early Permian:* NW-SE compression. Downwarping to west, producing Pedirka Basin depocentre in Eringa Trough.

*Mid-Late Permian:* uplift and erosion or non-deposition, essentially separating the Cooper, Arckaringa and Pedirka Basins.

*Early Triassic:* regional tilting to east and renewed subsidence in Simpson Basin depocentre (Teakle, 1990a).

*Late Triassic:* NW-SE compression and associated wrenching (Kuang, 1985). Uplift and erosion producing separate outliers of what were once more extensive Triassic sediments (Wiltshire, 1982).

*Jurassic:* regional downwarping, initiating Eromanga Basin deposition. Simpson Basin depocentre reactivated as Poolowanna Trough.

erosion and onlap of basement highs. Persistent subsidence in central part of area permitting the accumulation of fine-grained Birkhead Formation.

*Early Cretaceous:* onlap of basement highs, during marine transgressive-regressive depositional sequence.

*Late Cretaceous:* widespread erosion, due to shift in depocentre to southern margin of Australian continent (Veevers *et al.*, 1984).

*Tertiary:* WE compression, reactivation of older structures, propagation of faults upwards into Cretaceous, and occasionally to surface, with dominant N-S strike.

### **Major structural elements**

Figure 2 illustrates the geological setting of Blocks 90 B-E. The structural framework of the area is dominated by the following large scale structures (Fig 6).

#### *SW-NE trending highs*

The largest feature is the Birdsville Track Ridge (BTR), which is subparallel to the Gidgealpa-Merrimelia-Innaminka (GMI) Trend of the Cooper Basin. Both structural trends consist of a series of elongate, offset domes. The GMI trend has been interpreted as a SW-NE oriented thrust (Kuang, 1985) and the BTR may be of similar origin. Gravestock (in prep) regards these features as originating during NW-SE compression during the Alice Springs Orogeny. Roberts *et al* (1990) however, consider the Ordovician Delamerian Orogeny responsible for this structuring. The southernmost extension of the BTR is known as the Cooryanna Dome.

The Warrandinna-Lake Promise Trend and Lakeside-Tirari-Lake Peera Trend are smaller scale features which are subparallel to the BTR. These trends consist of a series of discontinuous basement highs.

All of these structures were reactivated during mid-Permian, Triassic and Tertiary compressional events.

#### *NW-SE trending lineaments/faults*

The most significant of these is the Lake Blanche Lineament, which may offset the BTR in the Mulapula-1 area. The lineament was interpreted by Veevers and Powell (1984) to have been a dextral continent-ocean transform fault during plate divergence in the latest Precambrian-Early Cambrian. The Lake Blanche lineament is subparallel to the Muloorina Ridge (a gravity high consisting of Adelaidean metasediments) and to the system of wrench faults parallel to the Pepita-Wackett-Nockatunga trend in the Cooper Basin (Kuang, 1985) to the east. Preiss (1987) regards the Muloorina Ridge as the northern shoulder of the early Adelaidean (Willouran) rift.

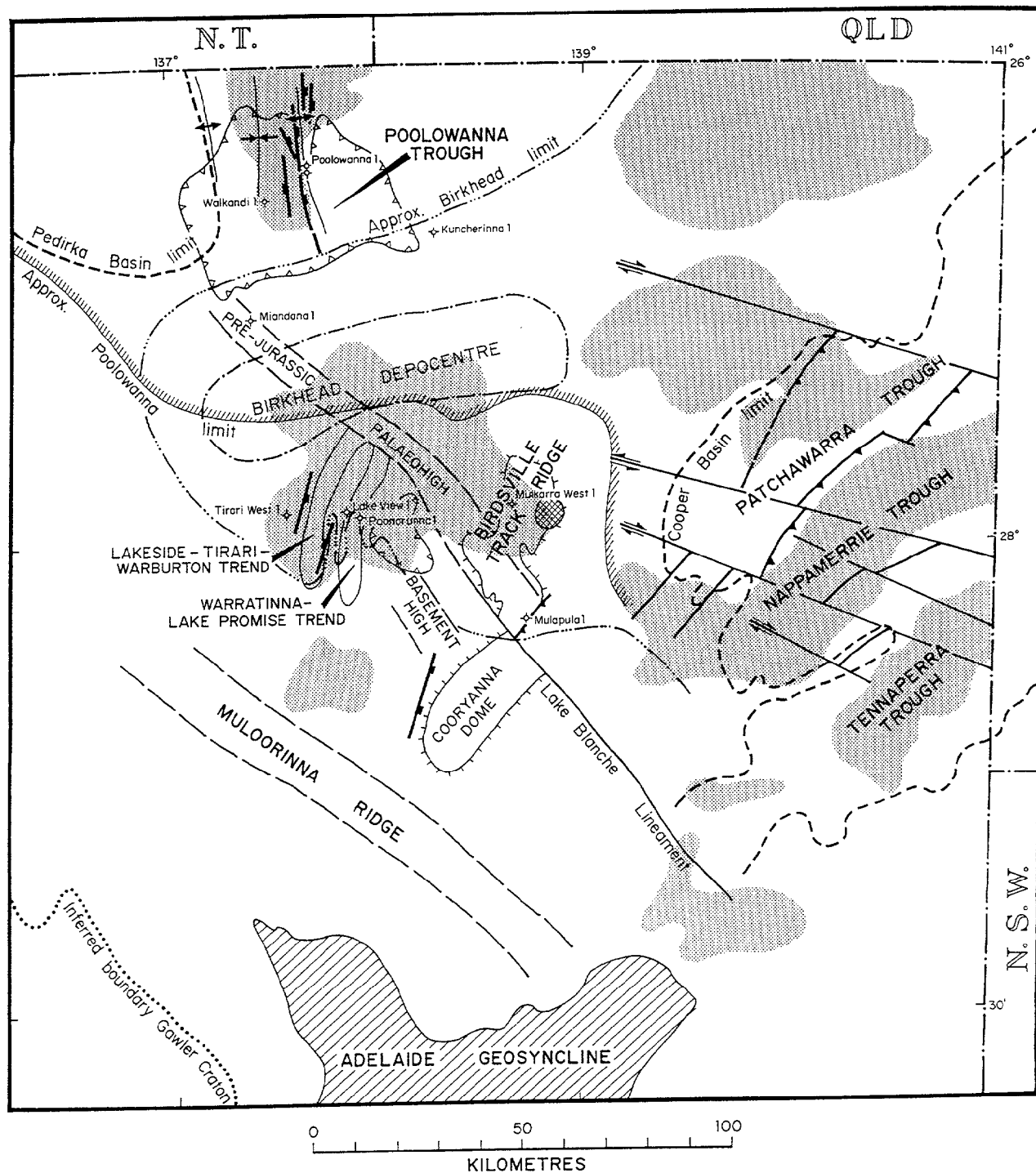


Fig. 6

# STRUCTURAL ELEMENTS

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### *N-S trending faults*

The northern part of the area is dominated by N-S trending faults and lineaments. Kuang (1985) regards the severe east-west Tertiary compressional event reactivating earlier structures, as the origin for such features.

### *Other features*

An unusual feature in Block 90 C is a roughly circular, 18 km diameter bad seismic zone, ascribed by Flynn (1989) to a meteorite impact. It is an isolated feature in the area. An alternative model for the feature is a network of karst/solution collapse structures developed in Cambrian shelf carbonates (Gravestock pers. comm). More work is required in the area to resolve its origin, and links, if any, with structural trends and possible petroleum plays.

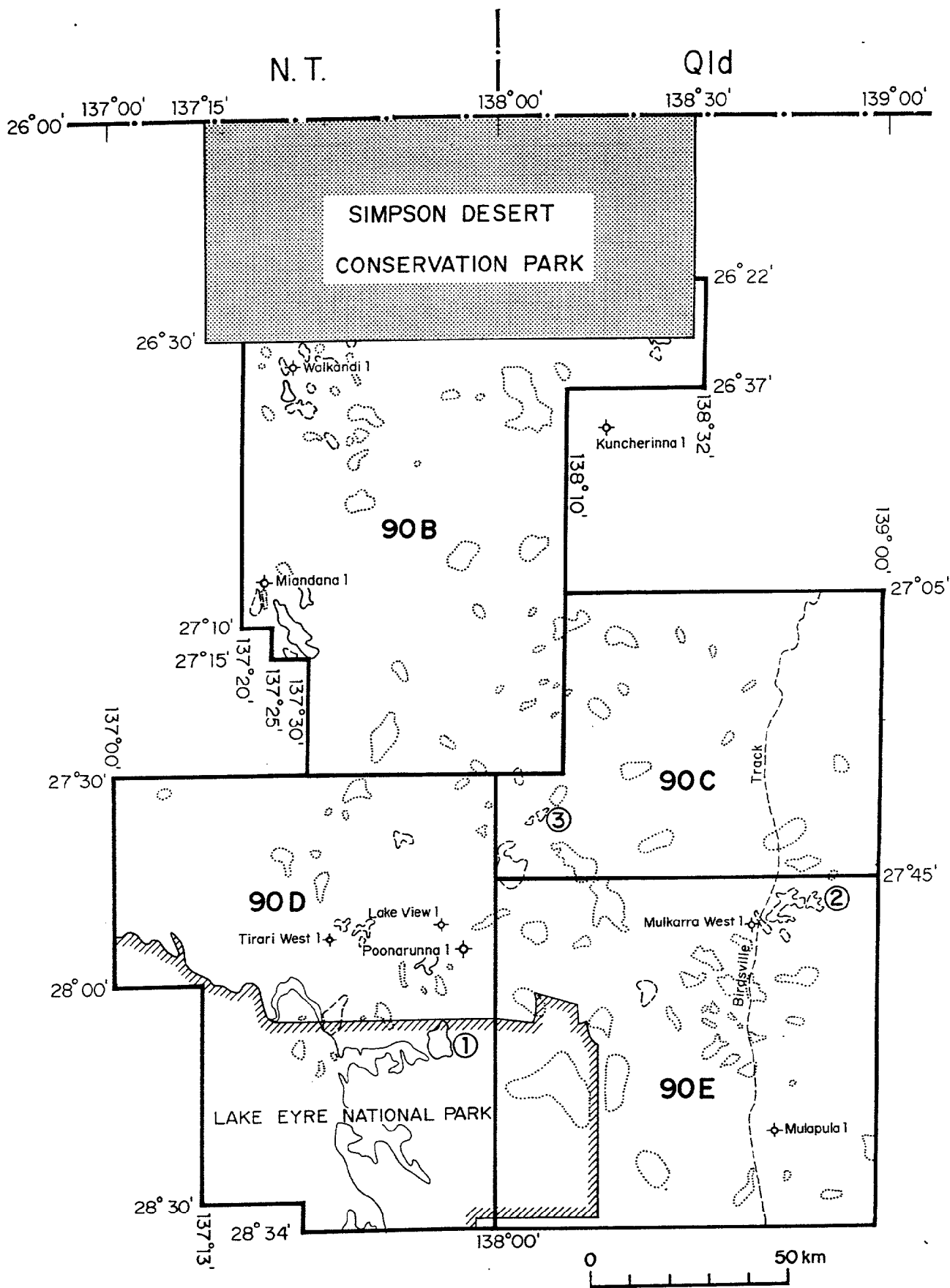
### **Sample Prospects**

Santos geologists and geophysicists were able to delineate 10 prospects (2 ready to drill), 32 strong leads and 64 weak leads in the area (including the Simpson Desert Conservation Park now excluded from exploration).

Santos (1988a and b), Teakle (1990a and b) and Delhi (1987) list prospect and lead evaluation details and potential oil-in-place for each structure in the old Lake Eyre and Mulka Blocks. These reports have been included in the Data Package for purchase (Section A).

Three examples of prospects and leads delineated by Santos (1988a and b) are included here to show the kind of data available in the Package. A separate compilation of prospects and leads prepared for SADME for the former Pedirka North and South Blocks, is also available in the Data Package.

Figure 7 shows the location of all major leads and prospects in Blocks 90 B-E, and Figure 8 shows total seismic coverage of the area.



Prospect..... Strong lead..... Weak lead.....

① Lake Promise ② Lake Howitt ③ Warrandinna

Fig. 7

# PROSPECTS & LEADS

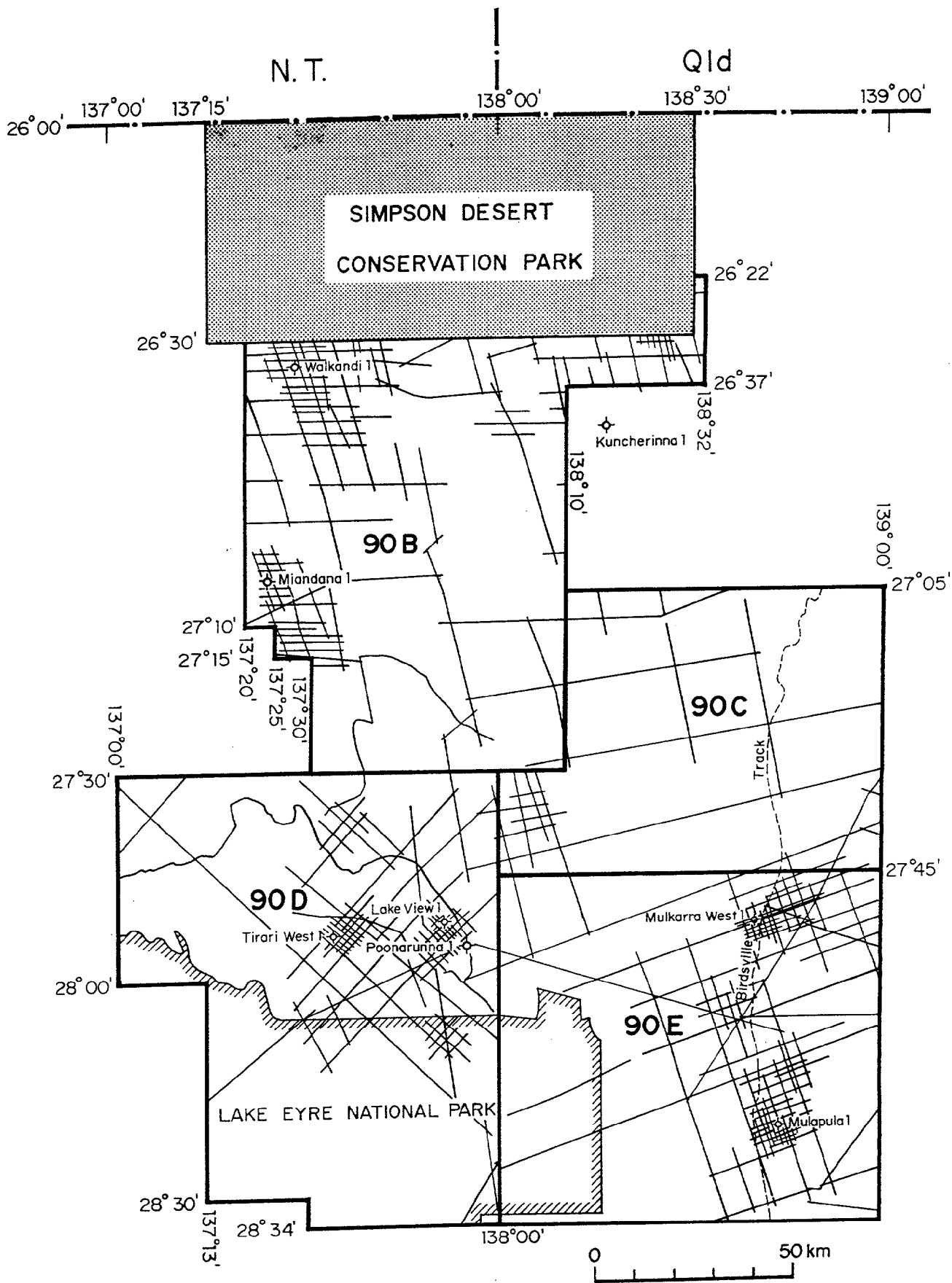


Fig. 8

# SEISMIC LINES

*Lake Promise Prospect*

Located in Block 90D, this prospect was ready for drilling when the area was relinquished. Santos has calculated 16 MMSTB of potential oil-in-place in the Namur Sandstone Member reservoir.





# LAKE PROMISE PROSPECT

LINE 85-YRY

NW

A



A'

SE

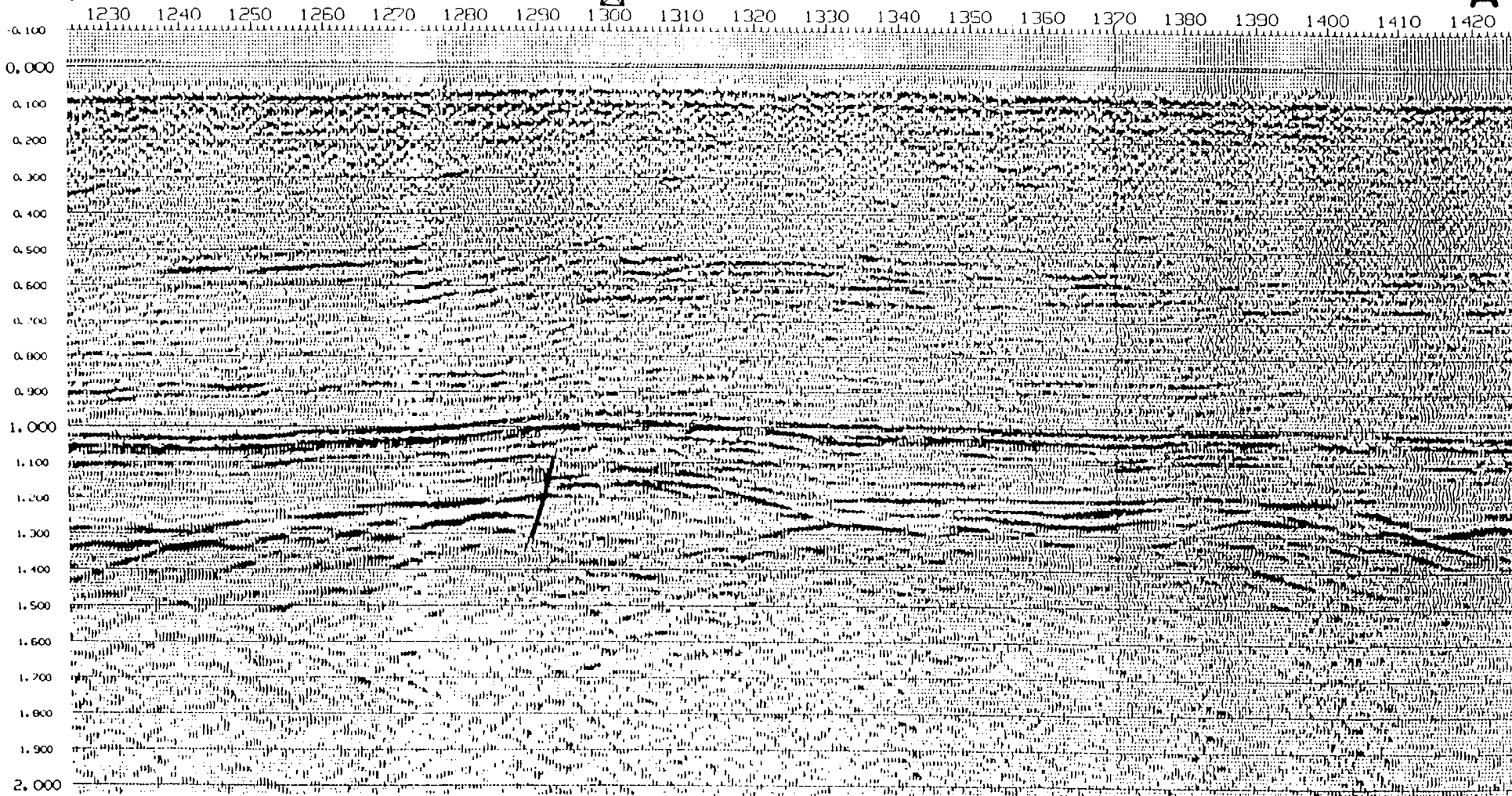


Fig. 10

## LAKE PROMISE STRUCTURE SEISMIC SECTION A - A'

NNW

B

B' SSE

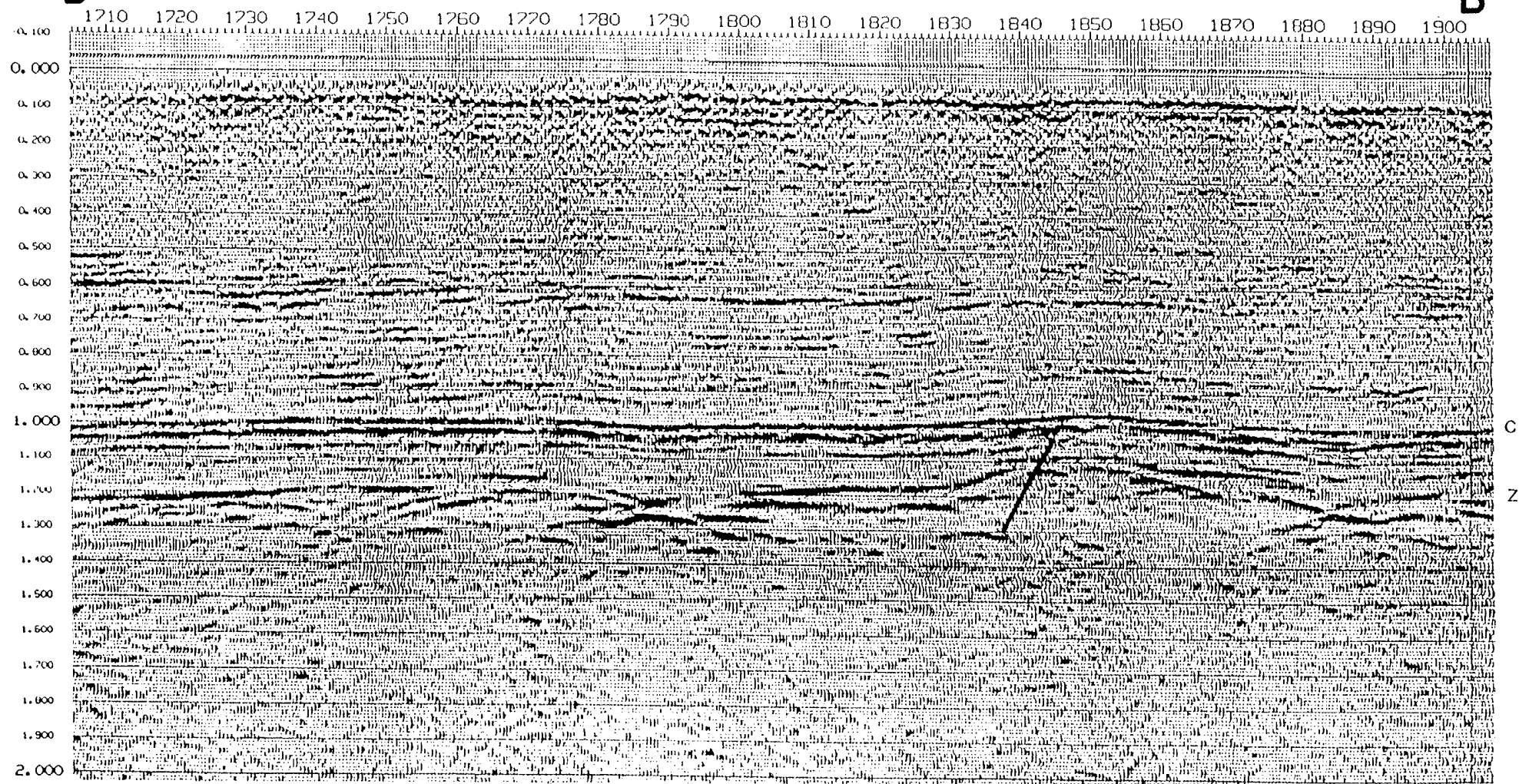


Fig. 11

# LAKE PROMISE STRUCTURE SEISMIC SECTION B-B'

*Lake Howitt Strong Lead*

Located in Block 90 C, this strong lead is forecast to contain a potential oil-in-place volume of 25.28 MMSTB in the Namur Sandstone Member by Santos.

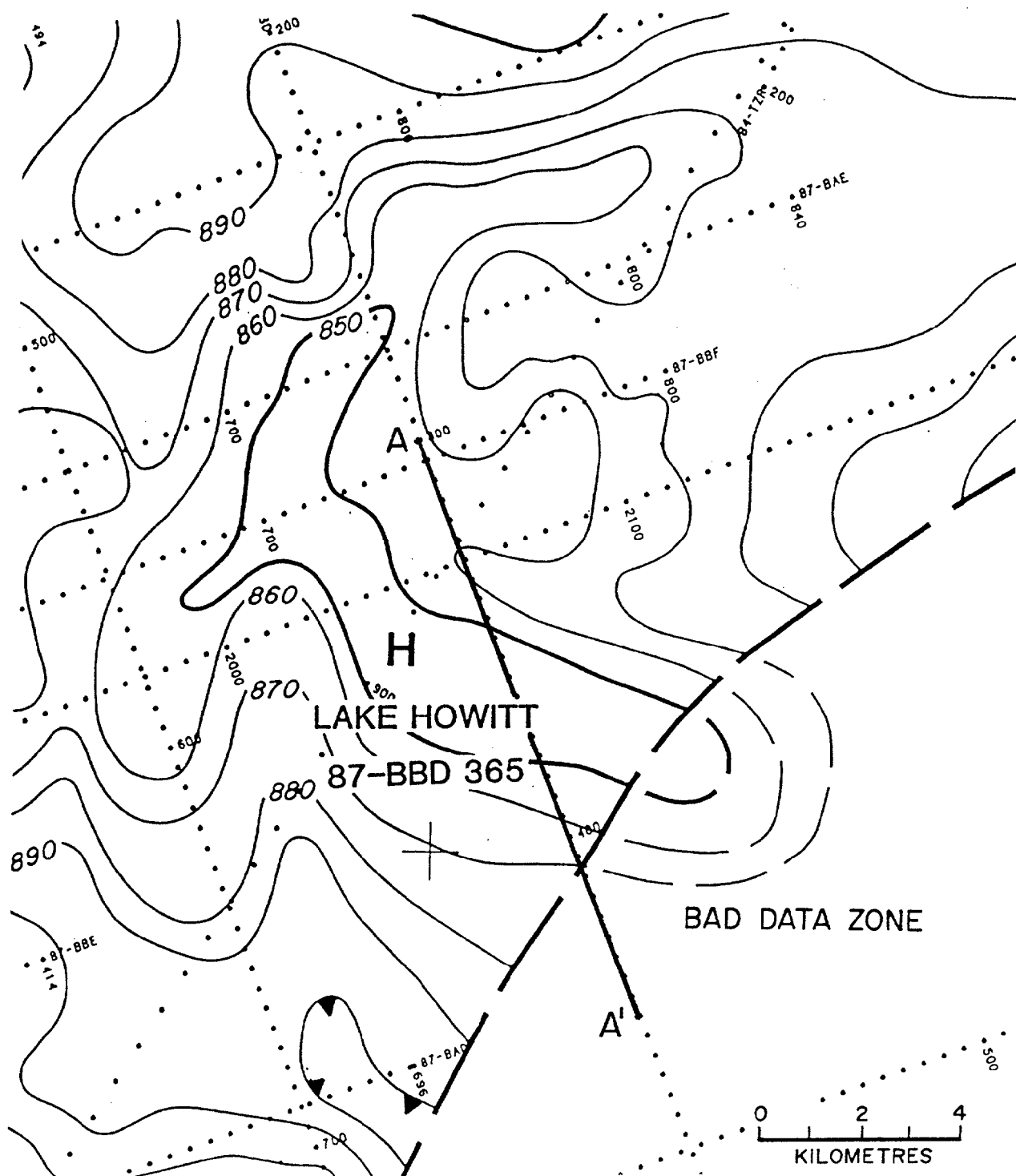


Fig. 12

# LAKE HOWITT STRONG LEAD C TIME STRUCTURE MAP

# LAKE HOWITT

87-BBD 365

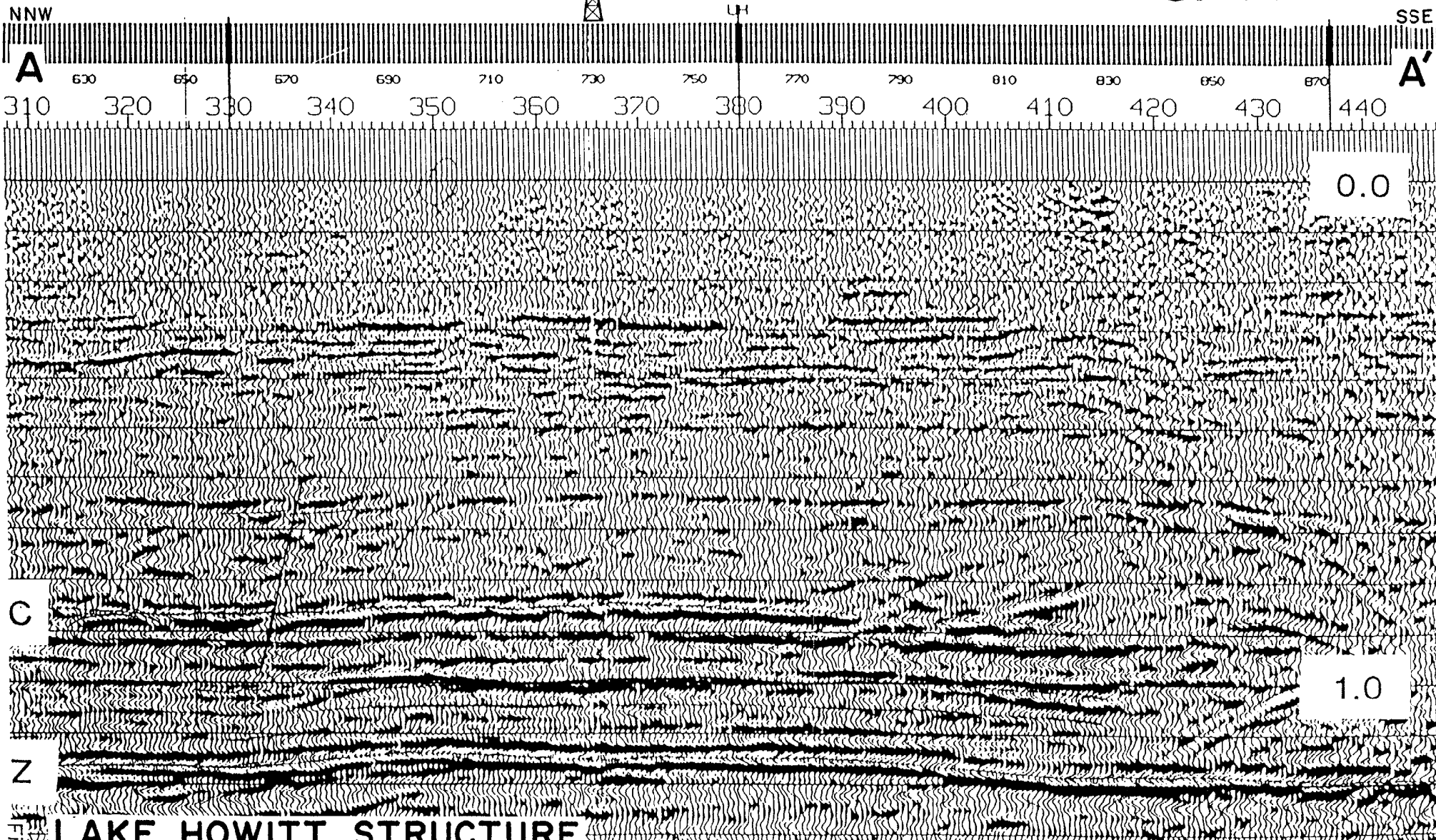


Fig. 13  
**LAKE HOWITT STRUCTURE  
SEISMIC SECTION A-A'**

***Warrawarrinna Strong Lead***

Located in Block 90 E, east of Mulapula-1, this strong lead is forecast to contain 12 MMSTB of oil-in-place by Santos.

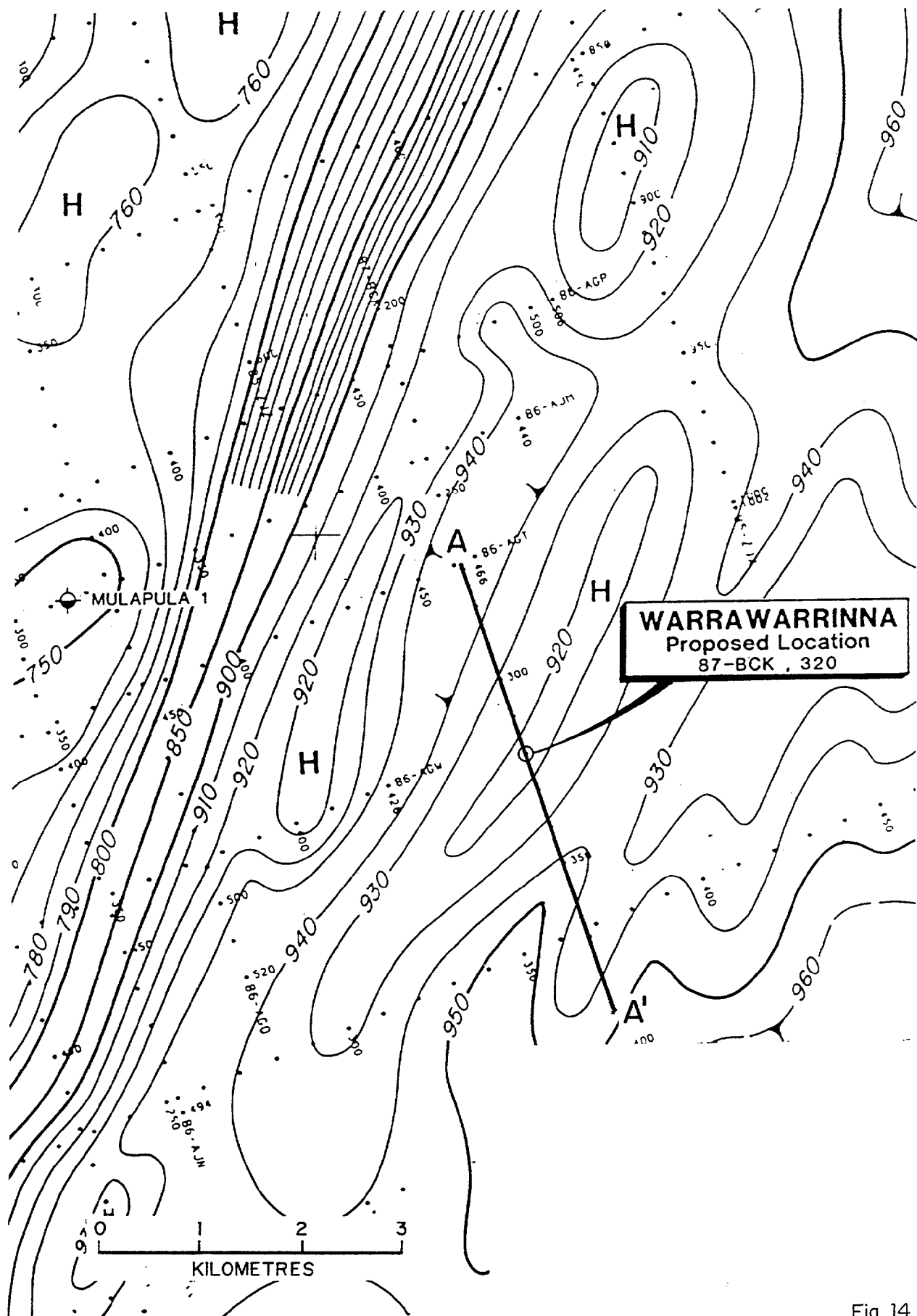


Fig. 14

# **WARRAWARRINNA STRONG LEAD C TIME STRUCTURE MAP**



SANTOS LIMITED  
S.A. EXPLORATION

MULKA BLOCK

WARRAWARRINNA

LINE 87-BCK 320 (143.1B)

NW A

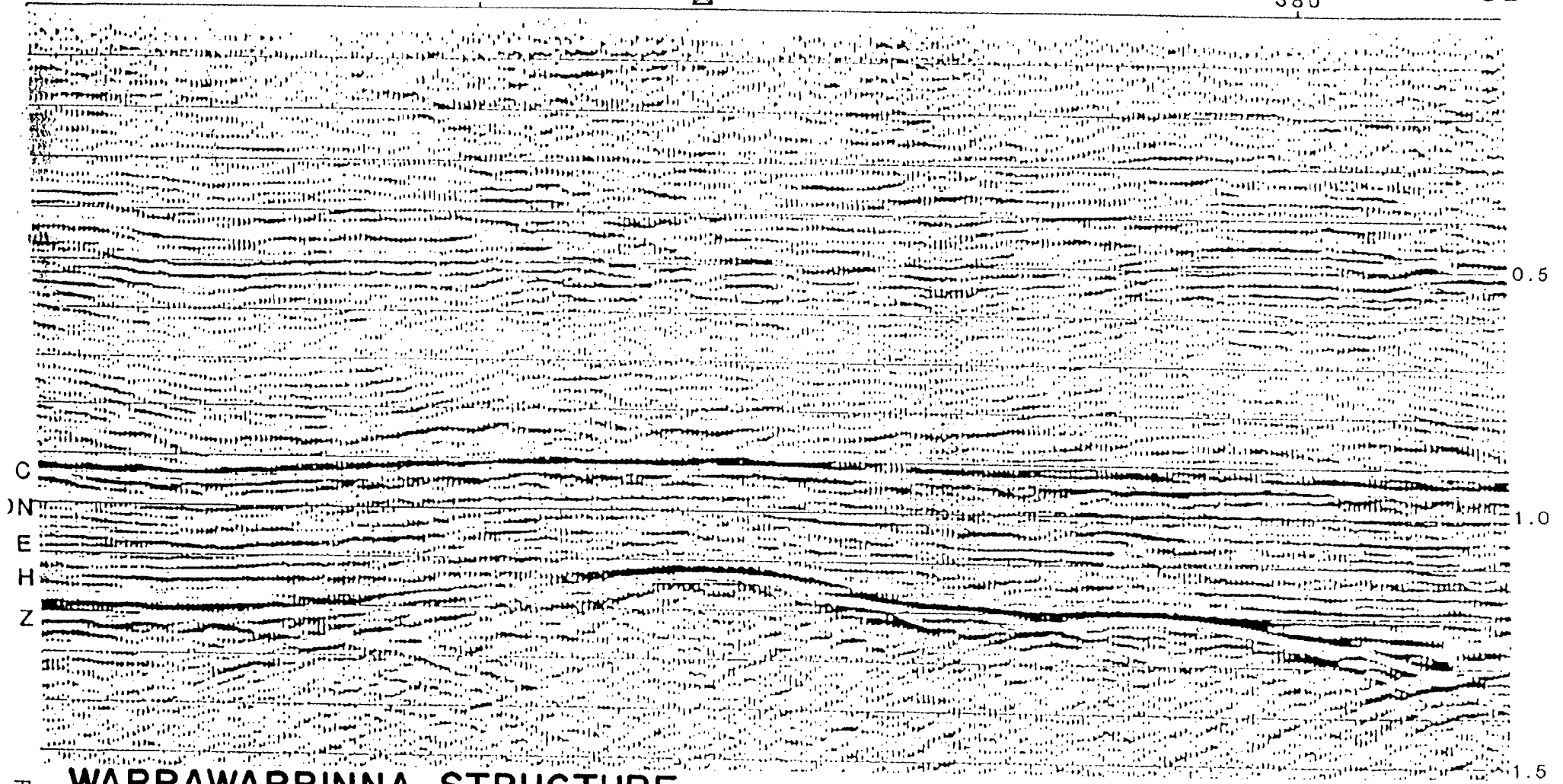


Proposed Location

A' SE

300

380



C  
N  
E  
H  
Z

Fig. 15

WARRAWARRINNA STRUCTURE  
SEISMIC SECTION A-A'

S21537

Department of Mines and Energy - South Australia



## EXPLORATION ACCESS

Figure 1 shows four major Parks and Reserves in the area. Conditions of entry are different for each and are described below.

### Entry Conditions for Regional Reserves

The Simpson Desert Regional Reserve is partially covered by blocks 90B and 90C. Regional Reserve is a reserve category under the National Parks and Wildlife Act (NPWA) 1972 which provides for multiple land use. Section 34a defines a regional reserve as being "for the purpose of conserving any wildlife or the natural or historic features of that land while, at the same time, permitting the utilization of the natural resources of that land." Exploration and production is provided for elsewhere in the act (section 43a). A summary of some of the relevant provisions are:

- The Minister of Mines and Energy must not grant an application for an exploration tenement in a Regional Reserve without first submitting the application to the Minister for Environment and Planning, and considering his/her views in relation to the application.
- In the case of an application for a production tenement, the Minister of Mines and Energy must not grant the application without approval of the Minister for Environment and Planning. If approval is refused, the matter may be determined by the Governor and with his approval the Minister of Mines and Energy may grant the application.
- Under section 40a of the NPWA, the Minister for Environment and Planning and the Minister of Mines and Energy may enter into an agreement with the holder of a PEL granted in relation to land that is, or has become, a regional reserve imposing conditions limiting or restricting the exercise of rights under the tenement by the holder of the tenement and by his or her successors in title.
- If a person contravenes, or fails to comply with, a condition imposed by agreement in relation to a PEL, the Minister of Mines and Energy must, at the request of the Minister for Environment and Planning, serve notice on the holder of the tenement requiring the holder to rectify the contravention or failure in the manner and within the period (which must not exceed three months) set out in the notice. If the holder of a PEL on whom a notice has been served fails to comply with the notice, the Minister of Mines and Energy may cancel the tenement.

In all other respects exploration and production in a Regional Reserve is carried out under the provisions of the Petroleum Act 1940 and its Regulations.

### Entry into the Simpson Desert Conservation Park

Entry is not currently permitted into the Simpson Desert Conservation Park following the lapse of the previous exploration licences in this area. The NPWA provides that the Governor may by proclamation provide for rights of entry, exploration and production in the park if the proclamation is made as a result of a resolution passed by both Houses in Parliament. Notice of a motion for resolution of such a proclamation must be given at least 14 days before the resolution is passed.

No Government has yet seen fit to resolve through Parliament that there should be any change to the status of a reserve. Nor has such a change has been proposed and argued for by industry.

### Entry Conditions for Lake Eyre National Park

The Lake Eyre National Park is covered by parts of blocks 90 D and E. Rights of access for exploration and production are enabled by a joint proclamation. Section 43(2) of the NPWA enables the Governor, by proclamation, to declare that subject to any conditions specified in the proclamation rights of entry for exploration and production may be acquired. Such a proclamation must be made simultaneously with the proclamation constituting the park.

Approval is required to be sought by the Department of Mines and Energy from the Minister for Environment and Planning before exploration and production licences can be granted.

The conditions under which exploration can be undertaken are given in the proclamation, and are as set out below.

#### NATIONAL PARKS AND WILDLIFE ACT, 1972; SECTIONS 28 AND 43: CONSTITUTION OF LAKE EYRE NATIONAL PARK

PURSUANT to the National Parks and Wildlife Act, 1972, I, the Governor, with the advice and consent of the Executive Council, make the following proclamation:

1. The following Crown lands are constituted as a national park to be known as the "Lake Eyre National Park":

Section 1466, Out of Hundreds (Curdimurka, Lake Eyre, Marree and Noolyeana) and Section 1468, Out of Hundreds (Curdimurka, Kopperamanna and Lake Eyre).

2. Subject to clause 4, existing rights of entry, prospecting, exploration or mining under the Mining Act, 1971, or the Petroleum Act, 1940, may continue to be exercised in respect of the lands constituting Lake Eyre National Park.

3. (1) Subject to subclause (2), rights of entry, prospecting, exploration or mining may, with the approval of the Minister for Environment and Planning, be acquired pursuant to the Mining Act, 1971, or the Petroleum Act, 1940, in respect of the lands constituting Lake Eyre National Park.
- (2) The approval of the Minister for Environment and Planning is not required for the acquisition of mining rights under the Petroleum Act, 1940, by the holder of an exploration licence in force under the Act in relation to the lands immediately before the making of this proclamation.
4. A person in whom rights of entry, prospecting, exploration or mining are vested pursuant to the Mining Act, 1971, or the Petroleum Act, 1940, (whether those rights were acquired before or after the making of this proclamation) shall not exercise those rights in respect of the lands constituting Lake Eyre National Park unless he complies with the following conditions:
  - (a) at least 3 months before commencing any drilling or excavation, any vegetation clearance, the making of any road, track or airstrip or the construction of any building or other structure, the person shall notify the Minister for Environment and Planning and the Minister of Mines and Energy of the proposed work and shall supply each Minister with such information relating to the proposed work as that Minister may require;
  - (b) the person, in carrying out any work referred to in paragraph (a) -
    - (i) shall comply with such directions as the Minister for Environment and Planning may give in writing in relation -
      - (A) to carrying out the work in a manner that minimizes damage to the land or the environment or to vegetation or wildlife on the land;
      - (B) to preserving objects, structures or sites of historic, scientific or cultural interests; or
      - (C) to rehabilitating the land upon the completion of the work;

and
    - (ii) if the work is being carried out in pursuance of a right of entry, prospecting, exploration or mining acquired after the making of this proclamation (other than a mining right acquired under the Petroleum Act, 1940, by the holder of an exploration licence in force under the Act immediately before the making of this proclamation), shall comply with such directions as the Minister for Environment and Planning or the Minister of Mines and Energy may give in writing in relation to the prohibiting

or restricting access to any specified area of the lands that the Minister believes would suffer significant detriment as a result of carrying out the work;

- (c) if a plan of management is in operation under section 38 of the National Parks and Wildlife Act, 1972, in respect of Lake Eyre National Park, the person shall have regard to the provisions of the plan of management;
- (d) the person, in addition to complying with any directions given under the paragraph (b) -
  - (i) shall take such steps as are reasonably necessary to ensure that objects, structures and sites of historic, scientific or cultural interest, features of scientific or scenic interest and any wildlife on the lands are not unduly affected by the exercise of those rights;
  - (ii) shall take reasonable steps to minimize damage to vegetation;
  - (iii) shall maintain all work areas in a clean and tidy condition;and
  - (iv) shall, upon the completion of any work, obliterate or remove all roads, tracks, airstrips, buildings or other structures (other than a road, track, airstrip, building or structure designated by the Minister for Environment and Planning and the Minister of Mines and Energy as suitable for retention) used exclusively for the purposes of that work.

Given under my hand and the public seal of South Australia, at Adelaide: 31 October 1985.

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## APPENDICES

TABLE 3: FORMATION TOPS, AS PICKED BY DELHI/SANTOS, AND SADME

WELL FORMATION	POOLOWANNA 1	POOLOWANNA 2	POOLOWANNA 3	WALKANDI 1	KUNCHERINNA 1	MIANDANA 1	TIRARI WEST 1	LAKE VIEW 1	POONARUNNA 1	MULKARRA WEST 1	MULAPULA 1
CADNA-OWIE	5186	5130	5170	5545	5112	5010	4150	3600	3823	3132	2866
MURTA	A	A	A	A	A	A	4236	3714	3942	3286	3046
ALGEBUCKINA	5350	5287	5340	5698	5233	NA	NA	3752	NA	NA	NA
NAMUR	NA	NA	NA	NA	NA	5226	4285	NA	3974	3378	3132
BIRKHEAD	NA	NA	NA	NA	NA	6538	5482	A	5170	4114	3945
HUTTON	NA	NA	NA	NA	NA	6669	A	A	A	A	4135
POOLOWANNA	7832	7858	7888	8329	7767	7777	A	A	A	A	A
PEERA PEERA	8506	8487	8544	8972	8402	8102	A	A	A	A	A
WALKANDI	9083	8967	NP	9596	8944	A	A	A	A	A	A
UNNAMED (CAMBRO- DEV)	9520	9407	NP	9932	9306	A	5738	4550	5349	4167	4486
ADELAIDEAN	NP	NP	NP	10242	NP	8380	NP	NP	NP	NP	NP
TD	10085	9574	8831	10274	9405	8772	5856	4681	5575	4222	4640

NA = Not applicable  
A = Absent  
NP = Not penetrated

## AVAILABLE DRILLCORE

Cores listed below, and cuttings (from all wells in the area) can be examined and sampled (subject to approval) at the SADME Core Library, located at:

29 Conyngham Street  
GLENSIDE SA 5065

A core inspection form is included here, for use.

Please note that **48 hours notice** is required to the time of inspection, and all inspections of petroleum core must be approved by an officer of the Oil, Gas and Coal Division (contact person *Mr R Frears*, (08) 274 7623).

**Table 4: Available Drillcore**

WELL	FORMATION	CORE NO.	CORED INTERVAL (FEET)	PETROPHYSICAL DATA MAX. POROSITY, PERM
MULAPULA-1	BIRKHEAD	#1	3 997-4 034'	25.5%, 318 md
	UNNAMED CAMBRO-DEV	#2	4 635-4 643'	-
LAKE VIEW-1	UNNAMED CAMBRO-DEV	#1	4 670-4 681'	-
POONARUNNA-1	NAMUR	#1	4 603-4 629'	-
	NAMUR	#2	4 985-5 201'	-
	NAMUR	#3	5 096-5 126'	-
	BIRKHEAD	#4	5 185-5 223'	-
	BIRKHEAD	#5	5 223-5 283'	-
	BIRKHEAD	#6	5 317-5 377'	-
	UNNAMED CAMBRO-DEV	#7	5 546-5 566'9"	-
MIANDANA-1	?ADELAIDEAN	#1	8 763-8 768'	-
POOLOWANNA-1	ALGEBUCKINA	#1	7 704-7 744'	
	POOLOWANNA	#2	8 327-8 328'	11.1%, k<0.5 md
	POOLOWANNA	#3	8 425-8 443'	12.2%, 1065 (fractured)
	WALKANDI	#4	9 178-9 185'	-
	UNNAMED CAMBRO-DEV	#5	10 080-10 086'	-
WALKANDI-1	POOLOWANNA	#1	8 711-8 758'	12.4%, 102 md
	PEERA PEERA	#2	9 340-9 367'	7.8%, 0.3 md
	UNNAMED CAMBRO- DEV/?ADELAIDEAN	#3	10 262-10 274'	-
KUNCHERINNA-1	UNNAMED CAMBRO-DEV	#1	9 394-9 405	-



REQUISITION TO INSPECT CORE LIBRARY SAMPLES

NAME .....

COMPANY/SECTION ..... PHONE .....



TO TECHNICAL INFORMATION SERVICES:

Inspection of the following samples is required at the Glenside Core Library on...../...../.....at.....A.M./P.M.  
for approximately .....hours/days.

Type of sample (drillhole, geochem, rock etc.) .....

If sample will be taken, please list approximate size and interval .....

48 HOURS NOTICE IS REQUIRED PRIOR TO THE TIME OF INSPECTION.

SAMPLE NAME AND NUMBER	SAMPLES COLLECTED BY	DEPTH INTERVAL REQUIRED (METRES)	FOR OFFICE USE: UNIQUE No./ STORAGE LOCATION

FOR OFFICE USE ONLY:  
Security status of samples—Confidential/Type section/Open file

DATE ...../...../.....

Name of appropriate approving officer..... Signature.....

Name of appropriate T.I.S. officer.....

Checked by.....

## DATA PACKAGE CONTENTS

### Geological Data

#### Geological reports

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#### Well Completion Reports

WELL	YEAR DRILLED	SADME ENVELOPE
Poonarunna-1	1964	451
Poolowanna-1	1977	3170
Walkandi-1	1981	4744
Kuncherinna-1	1981	4936
Poolowanna-2	1985	6334
Miandana-1	1985	6491
Mulapula-1	1986	7025
Lake View-1	1988	7124

Mulkarra West-1	1989	7211
Tirari West-1	1989	7213
Poolowanna-3	1989	7205

### **Optional magnetic tapes**

The following well log tapes are available for purchase as separate items from the data package. A charge of \$65 per well is applied. Ten wells nominally fit on one tape.

#### ***KUNCHERINNA 1***

CALI, DRHO, DT, GR, LLD, LLS, MSFL, NPHI, PEF, RHOB, SP.

#### ***LAKE VIEW 1***

CALI, DRHO, DT, DTL, GR, LLD, LLS, MSFL, NPHI, PEF, RHOB, SP.

#### ***MIANDANA 1***

CALI, DT, DTL, GR, LLD, LLS, MSFL, SP.

#### ***MULAPULA 1***

CALI, CGR, DRHO, DT, GR, DTL, LLD, LLS, MINV, MNOR, MSFL, NPHI, PEF, POTA, RHOB, SGR, SP, THOR, URAN.

#### ***MULKARRA WEST 1***

CALI, DRHO, DT, DTL, GR, LLD, LLS, MSFL, NPHI, PEF, RHOB, SP.

#### ***POOLOWANNA 1***

CALI, DRHO, DT, GR, LLD, LLS, NPHI, PROX, RHOB, SP.

#### ***POOLOWANNA 2***

CALI, DT, DTL, GR, LLD, LLS, MSFL, SP.

#### ***POOLOWANNA 3***

CALI, DT, DTL, GR, LLD, LLS, MSFL, NPHI, SP.

#### ***POONARUNNA 1***

CALI, DT, GR, R16, R64, RL18.

#### ***TIRARI WEST 1***

CALI, DT, DTL, GR, LLD, LLS, MSFL, SP.

#### ***WALKANDI 1***

CALI, DRHO, DT, GR, LLD, LLS, MSFL, NPHI, PEF, RHOB, SP.

**NOTE THAT THIS COST IS ADDITIONAL TO THAT OF THE DATA PACKAGE. A SEPARATE ORDER FORM IS INCLUDED ON PAGE 50.**

Tapes supplied by SADME will conform to the following specification:

**SCHLUMBERGER 1974 LIS FORMAT, 1600 BPI**

## Geophysical Data

### Selected Seismic Sections

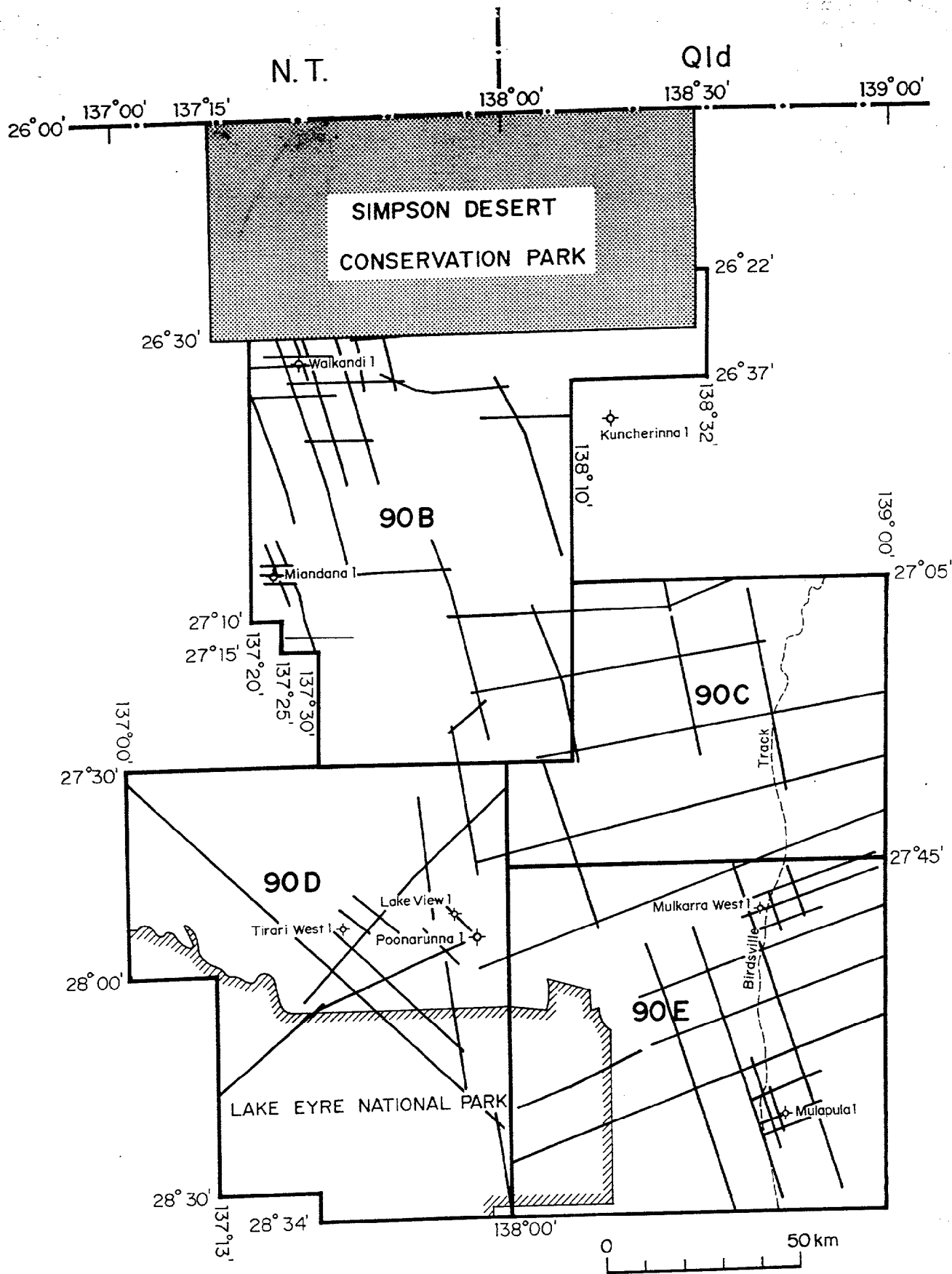
The following sections will be supplied as sepia copies with the data package. Figure 8 illustrates the total seismic coverage within the area. Shot point maps showing selected lines will be provided with the data package. A seismic shot point magnetic data tape is also available on request, at \$250 per tape + postage and handling. An order form is included on page 47.

1974	WAC	BEAL HILL SS	1985	WPE	MORPHETT SS
				WPF	
1976	WBJ	PILLAN HILL SS		WPX	
	WBT			WPY	
	WBW			YRS	
	WBY			YRY	
				YSA	
1979	WEA	PEERA-PEERA SS		ZDR	
	WDF			ZDS	
	WDL			ZDW	
	WDN			ZKB	
	WDQ			ZKD	
	WDS			ZKH	
				ZKM	
1980	WFM	KOOMARINA SS		ZKN	
	WFN			ZKK	
	WFQ		1986	AFX	FLETCHER SS
	WFT			AES	
	WFW			AET	
	WGE			AEZ	
	WHJ			AFB	
	WHK			AFC	
	WHN			AGW	
1982	RBC	CHRISTMAS CK SS		AJM	
	RBD				
1984	TZL	HOGARTH SS	1987	WQT	MITCHELL SS
	TZM			BAM	
	TZN			BAH	
	TZP			BBF	
	TZR			BAD	
	TZS		1988	WRJ	FOREST SS
	XFG			WRH	
	ZEZ			WRK	
				WRG	
				WRF	
				BQY	

### Selected seismic lines - location maps.

An A4 summary map showing the above selected seismic lines is included here.

A 1:250 000 scale seismic line location map will be included in the data package.



## SELECTED SEISMIC LINES LOCALITY MAP

## LICENCE APPLICATION PROCEDURES

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.

There is no set form for making an application other than by a written request addressed to the Director-General, Department of Mines and Energy. Application guidelines, licence conditions, obligations, etc. for onshore petroleum exploration are summarised in Table 4. In summary, all applications should be signed under seal and include a \$400 application fee (cheques should be made out to SADME), a proposed program cost for each year of the initial 5 year licence term, evidence of the applicant's financial ability to undertake such a program and the technical qualifications and expertise of personnel available to the applicant to undertake the program. For any enquiries relating to licence applications contact:

*Mr. Bob Frears*

*Chief Geologist, Oil, Gas and Coal Division*

*Phone (08) 274 7623*

**Table 5: Onshore petroleum exploration guidelines****PETROLEUM ACT, 1940**

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 (PEL).	
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). Where application is made on behalf of a company, the application must be made under the company seal.	6(1) 41(b)&(c)
When Application Can be Made	Initial Licence - At any time over any area not already under licence. Renewal of Licence - not less than 3 months before existing licence is due to expire.	6(1a) 18(5b)
Maximum Area	26 000 km <sup>2</sup> .	15(1)
Application Fee	For initial application - \$400 For each renewal - \$400	7(2) 7(2)
Bond (to ensure compliance with licence conditions)	\$4 000 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. Each Renewal (to a maximum of 3) - 5 years.	15(2) 15(2)
Annual Rental Payable	Initial 5 Year licence term - 16 c/sq. km. First Renewal (2nd 5 Year licence term) - 24 c/km <sup>2</sup> . Second Renewal (3rd 5 Year licence term) - 32 c/km <sup>2</sup> . Third & Final Renewal (4th 5 Year licence term) - 40 c/km <sup>2</sup> .	18c(a) 18c(b) 18c(c) 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 km <sup>2</sup> per year - last three years - \$24 per km <sup>2</sup> per year. First Renewal (2nd 5 Year licence term) - \$62 per km <sup>2</sup> per year. Second Renewal (3rd 5 Year licence term) - \$80 per km <sup>2</sup> per year. Third & Final Renewal (4th 5 Year licence term) - \$94 per km <sup>2</sup> per year.	17(1)(a) 17(1)(b) 18a(1)(a) 18a(1)(b) 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	\$400 per transaction (document).	42(3)

Fee for Inspection of Register	\$2.	Reg.7(1)
Fee for Copy or Extract from Register	50c per page.	Reg.7(2)
Method of Application	<p>Letter of application addressed to the Director-General, Department of Mines and Energy (there is no prescribed form). Attached to the application should be:</p> <p>(1) full names and addresses of the party/parties making the application, including (where applicable) the percentage interests of the various parties</p> <p>(2) two copies of a map and description of the area being applied for</p> <p>(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. (Expenditure estimates should satisfy the minimum expenditure commitments set out in Sections 17 and 18).</p> <p>(4) particulars of the technical qualifications and expertise available to the applicant party/parties (e.g. qualifications and experience of employees, consultants retained etc.).</p> <p>(5) particulars of the financial resources available to the applicant party/parties to carry out the proposed terms and conditions of the licence. (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).</p> <p>(6) the \$400 application fee. Where the application is made on behalf of a company, the application must be made under the company seal.</p>	<p>7(1)</p> <p>7(3)</p> <p>7(3a)</p> <p>7(4)</p> <p>7(4)</p> <p>7(2)</p> <p>41(b)&amp;(c)</p>
Penalty for Non-Payment of Annual Rental Fees	<p>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.</p>	83(1)&(2)
Licence Variations	<p>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.</p>	17(3)



## DATA PACKAGE AND MAGNETIC TAPE ORDER FORMS

Order forms for both the data package and geological and geophysical magnetic tapes are included here.

The Director-General  
SA Department of Mines and Energy  
PO Box 151  
EASTWOOD SA 5063

Telephone: (08) 274 7612  
Facsimile: (08) 373 3269

ATTENTION: MR R LAWS, DIRECTOR, OIL, GAS & COAL DIVISION  
MR O POLATAYKO, GEOTECHNICAL COMPUTING

Dear Sir

AREAS 90 B-E - MAGNETIC TAPES

Please provide the following Schlumberger 1974 LIS format 1600 BPI magnetic tapes as indicated below, at a cost of \$65 per well.

Kuncherinna 1 .....	Lake View 1 .....
Miandana 1 .....	Mulapula 1 .....
Mulkara West 1 .....	Poolowanna 1 .....
Poolowanna 2 .....	Poolowanna 3 .....
Walkandi 1 .....	Tirari West 1 .....

(Tick required wells).

Please provide a magnetic tape of selected seismic shot point data at a cost of \$250 plus handling and freight ..... (Yes or No).

Company .....

Address .....

..... Postcode .....

Contact Person .....

Telephone ..... Telex .....

Facsimile .....

A cheque for \$..... made out to SA Dept of Mines and Energy is included.

Signed ..... Date .....

The Director-General  
SA Department of Mines and Energy  
PO Box 151  
EASTWOOD SA 5063

Telephone: (08) 274 7612  
Facsimile: (08) 373 3269

**ATTENTION: MR R LAWS, DIRECTOR, OIL, GAS & COAL DIVISION**

Dear Sir

**AREAS 90 B-E DATA PACKAGE**

Please provide the Areas 90 B-E Data Package as specified in Section 5 (Data Package Contents) at a cost of:

\$7,250 (including handling and freight).

Company .....  
Address .....  
..... Postcode .....  
Contact Person .....  
Telephone ..... Telex .....  
Facsimile .....

A cheque for \$7,250 made out to SA Dept of Mines and Energy is included.

Signed ..... Date .....