South Australia South Australia South Australia South Australia

Open File Envelope

NUMBER 4341

PEL 5 AND PEL 6

EROMANGA AND COOPER BASINS

1980 KARAWINNIE SEISMIC SURVEY

FINAL REPORT

Submitted by

Delhi Petroleum Pty Ltd
1986

MINES AND ENERGY
SOUTH AUSTRALIA

Enquiries: Records Management
Mines and Energy South Australia
191 Greenhill Road, Parkside 5063
Telephone: (08) 274 7687
Facsimile: (08) 272 7597

ENVELOPE 4341

TENEMENT: PEL 5 and PEL 6; Eromanga and Cooper Basins

TENEMENT HOLDER: Delhi Petroleum Pty Ltd (operator), Santos Ltd, Vamgas NL and South Australian Oil and Gas Corp. Pty Ltd

CONTENTS

END OF CONTENTS

DELHI PETROLEUM PTY. LTD.

Incorporated in the State of South Australia

4341 R1 0003

1980 KARAWINNIE SEISMIC SURVEY

PEL 5 AND 6

SOUTH AUSTRALIA

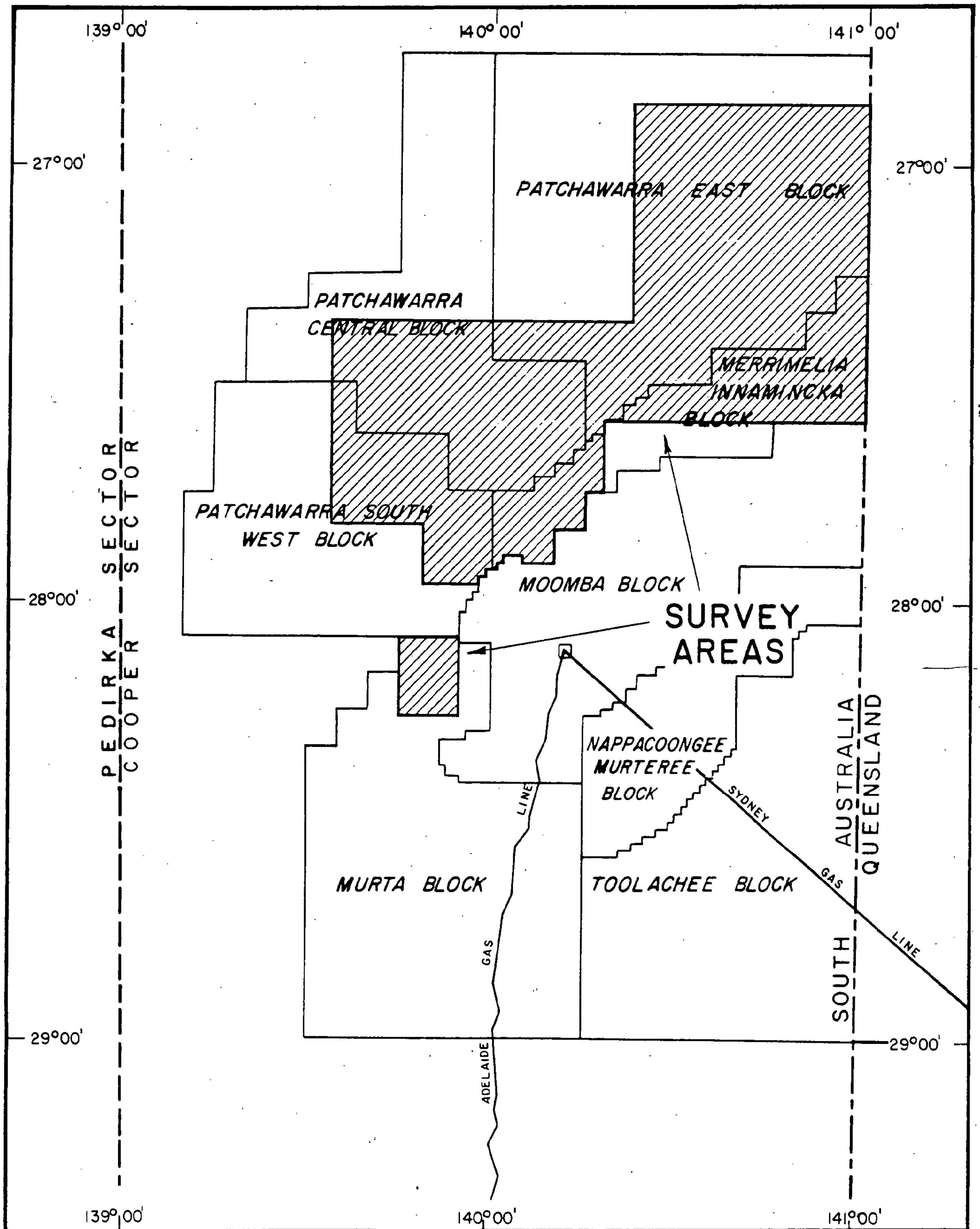
FINAL REPORT

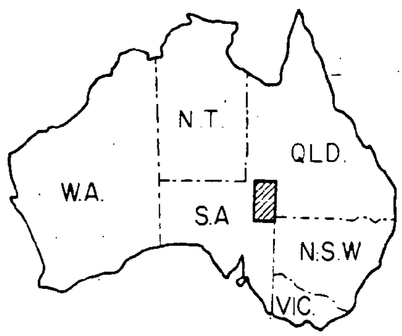
B. Finlayson

May 1985

DELHI PETROLEUM PTY LTD
Incorporated in the State of South Australia

(received 2/1/86)





DELHI PETROLEUM PTY. LTD.

1980 KARAWINNIE SEISMIC SURVEY

LOCATION MAP

P.E.L. 5 & 6 SOUTH AUSTRALIA

KILOMETRES 0 20 40 60 80 100 KILOMETRES

DELHI

Author. B. FINLAYSON	Dwg. No. 85XP-4240
Drafted. W. ASPINALL	PLATE I
Date. MAY 1985	

File: RX-29

ABSTRACT

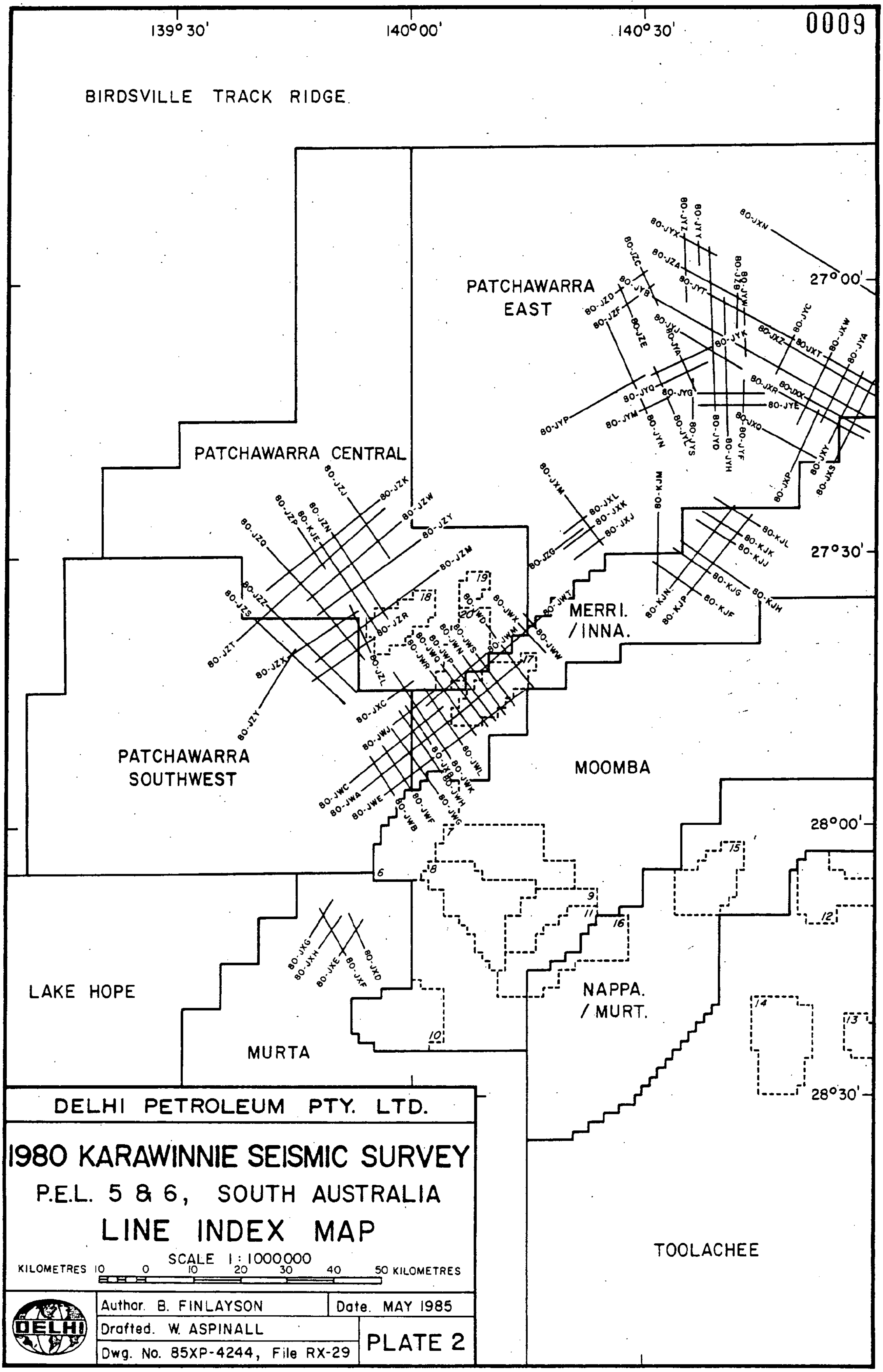
The 1980 Karawinnie Seismic Survey was designed to provide a semi-regional grid of data over the flanks of the Patchawarra Trough. The survey has led to the recognition of a number of new leads and the upgrading of previously recognized leads. In particular the survey has highlighted the potential for structural/stratigraphic traps at the margins of the trough.

CONTENTS

APPENDICES

FIGURES

ENCLOSURES



DELHI PETROLEUM PTY. LTD.

1980 KARAWINNIE SEISMIC SURVEY

P.E.L. 5 & 6, SOUTH AUSTRALIA

LINE INDEX MAP

SCALE 1 : 1000000

KILOMETRES 10 0 10 20 30 40 50 KILOMETRES

DELHI	Author. B. FINLAYSON	Date. MAY 1985
	Drafted. W. ASPINALL	PLATE 2
	Dwg. No. 85XP-4244, File RX-29	

INTRODUCTION

The 1980 Karowinnie Seismic Survey was conducted over a wide area in PEL's 5 and 6 in South Australia (Fig. 1).

Delhi, operator for the Cooper Basin Partners, contracted Geophysical Service Incorporated (G.S.I.) of Adelaide, South Australia, to undertake a Vibroseis* Seismic Reflection Survey in the Cooper Basin in South Australia. A total of ~~1398~~ ?1518 km of 12-fold coverage was recorded in five blocks: Patchawarra East, Patchawarra Central, Patchawarra Southwest, Merrimelia-Innamincka, and Murta. Recording commenced on May 7 and was completed on December 15 1980.

Line clearing was contracted to F.T. and B.I. Thomson of Adelaide. Drilling was contracted to Thorpe Bros of Adelaide and Australian Consolidated Exploration of Brisbane. Processing was carried out by G.S.I. at their Elizabeth centre.

Terrain varied from elongate sand dunes with wide interdunal corridors and dry shifting sands in the west to rough, rocky country in the Yalchirrie area.

Field acquisition details are given in Appendix I, Data Processing in Appendix II, survey information in Appendix III and representative half-scale sections in Appendix IV.

* Vibroseis is a trademark of Continental Oil Company.

REGIONAL GEOLOGY

The Karawinnie Seismic Survey was conducted in PEL's 5 and 6 where Late Carboniferous, Permian and Triassic sediments of the Cooper Basin are overlain by Jurassic and Cretaceous sediments of the Eromanga Basin.

The Cooper Basin is a northeast trending intracratonic basin approximately 600 kilometres long and 300 kilometres wide containing up to 2000 metres of Permo-Triassic sediments unconformably overlying sediments, metamorphics and igneous intrusives of the Warburton Basin or a redbed sequence representing remnants of the Adavale Basin.

The Cooper Basin is bounded by the Birdsville Track Ridge in the west, the Canaway Ridge to the northeast and by the Thargomindah Shelf to the east and south.

The Eromanga Basin comprises a thick sequence of up to 3000 metres of Mesozoic sediments which effectively blanket the older sediments of the underlying Cooper, Pedirka and Galilee Basins.

Sedimentation began in the Cooper Basin in Late Carboniferous to Early Permian times with deposition of poorly sorted glacio-fluvial and lacustrine-fluvial sediments in restricted palaeotopographical lows. The source and reservoir potential of these sediments, which comprise the Merrimelia Formation, are considered low.

Following the retreat of glaciation, eustatic rebound resulted in extensive reworking of Merrimelia Formation into braided fluvial clastics of the Tirrawarra Formation. The latter is an important oil reservoir, the potential of which is, however, limited by extensive diagenetic porosity-permeability reduction.

REGIONAL GEOLOGY (Cont.)

Active deposition resumed with the Patchawarra Formation, a thick and extensive rhythmic succession of sandstones, shales and coals culminating with the deposition of the Murteree Shale, a relatively homogeneous body of siltstone and shale. The Murteree Shale provides both source and cap rock for important accumulations of gas/condensate within the Patchawarra Formation. Gas/condensate discoveries have also been made in the overlying Epsilon Formation sequence of shales, siltstones, thin sandstone and coals, where reservoir quality is highly facies dependant. Providing both source and seal to the Epsilon Formation is the Roseneath Shale, which is very similar in lithology to the Murteree Shale.

In the late Early Permian, erosion occurred along the basin margins with contemporaneous restricted deposition of the Daralingie Beds elsewhere in the basin. This was followed by extensive basin wide peneplaining.

Following this essentially minor hiatus, the depositional cycle resumed with the fluvial-floodplain sediments of the Upper Permian Toolachee Formation. These pass upward into the Lower to Middle Triassic Nappamerri Formation of low energy fluvial and lacustrine sediments. Towards the end of this cycle, deposition of the Nappamerri Formation was again restricted to depositional centres, contemporaneous with erosion of the basin margins and positive features within the basin. An extended period of erosion and weathering followed in the Late Triassic.

Deposition of the overlying Eromanga Basin sequence began with regional and differential subsidence along the axis of the present day Cooper Syncline and was initially characterized by a low energy environment with sandstones, carbonaceous siltstones and shales of Early Jurassic age. With

REGIONAL GEOLOGY (Cont.)

increased depositional gradients the overlying Hutton Sandstone was deposited as a series of coalescing braided stream deposits migrating out from the basin centre as the basin subsided. The Birkhead Formation marks the end of this cycle and provides both a source and seal for the extensive reservoirs of the Hutton Sandstone.

Continued subsidence resulted in the deposition of the moderate energy Adori Sandstone and low energy fluvial-lacustrine Westbourne Formation. Sandstones in the Westbourne Formation are important oil bearing reservoir in the Jackson area. Overlying this is the Mooga Formation represented by the braided stream sandstones of the Namur Sandstone Member and the deltaic-lacustrine sediments of the Murta Member. The formation is an important reservoir and source unit.

Above is the Cadna-owie Formation representing paralic conditions which existed prior to the Early Cretaceous marine incursion. The acoustic impedance contrast between the Wyandra Sandstone Member of the Cadna-owie Formation and the basal Wallumbilla Formation results in the prominent C horizon seismic event.

The Toolebuc Formation above the shales and siltstones of the Wallumbilla Formation is an organic rich restricted marine sequence. This in turn is overlain by the Allaru Mudstone and the Mackunda Formation, the latter representing a regressive return to nonmarine conditions. This was followed by deposition of the Winton Formation in a fluvial-paludal-lacustrine environment. In the Late Cretaceous, sedimentation effectively ceased and sediments were exposed to erosion and intense weathering.

REGIONAL GEOLOGY (Cont.)

In the Early Tertiary, a period of deposition occurred associated with uplift of the Great Dividing Range. The Glendower Formation was deposited in an east west drainage system imposed by regional tilting.

Compressional tectonics associated with this uplift resulted in structural folding, transcurrent faulting and reverse fault movement. Continued weathering and erosion resulted in breached anticlinal cores and accumulation of sediments in newly folded synclines.

Since late Pliestocene time, semi arid to arid conditions have prevailed.

Hydrocarbon Potential

Up to mid 1976, important hydrocarbon discoveries had been made only in the Permian Gidgealpa Group, although minor discoveries had been recorded in the basal Triassic sands. Traps in the Gidgealpa Group are typically associated with structural highs, over which thinning of the Permian section (and to a lesser extent, the C-P section) occurs. The thinning probably indicates contemporaneous growth during these periods, as well as onlap onto pre-Permian basement highs, and subsequent differential compaction. Some fields have demonstrated a stratigraphic trapping mechanism on the flanks of the structures and a significant thrust of the Karawinnie Survey has been to outline such targets around the flanks of the Patchawarra Trough.

In 1976, the Namur 1 well discovered an accumulation of gas in the Late Jurassic - Early Cretaceous Namur Sandstone Member of the Eromanga Basin. Several important discoveries of oil and gas in this previously neglected artesian sequence have followed. They include the discoveries of oil in the Namur and Hutton Sandstones at Strzelecki and Merrimelia, gas and condensate in the Namur Sandstone Member in Marabooka, oil in the

REGIONAL GEOLOGY (Cont.)

Poolowanna Beds of Poolowanna 1, oil in the 'basal Jurassic' at Cutapirrie 1, oil in the Murta Member in Dullingari, and gas in the Birkhead Formation at Wackett 1. These developments have significantly upgraded the potential of the Mesozoic sediments overlying the Cooper Basin and have caused a shift in the emphasis of exploration. A further significant thrust of the Karawinnie Survey has been the delineation of Mesozoic crestal targets.

PREVIOUS EXPLORATION

1. Aeromagnetic Surveys

The area of operations has been covered by aeromagnetic surveys during earlier stages of exploration, but there are no obvious correlations between the major post-Permian structural trends and the magnetic data. Magnetic basement depth estimates range from 1000 - 6500m.

Drilling has generally shown the shallower depth estimates to be unreliable in that these depths are often less than the actual drilled depth to the P horizon.

2. Gravity Surveys

The area has been covered by reconnaissance helicopter gravity surveys on a 6400m grid, and gravity surveys were carried out in conjunction with a number of early seismic surveys. There is broad coincidence between major geological trends and the gravity data. In particular, the Gidgealpa-Merrimelia-Packsaddle-Innamincka trend is associated with strong positive Bouger anomalies, and a prominent low is observed over the Patchawarra Trough. However, a number of gravimetric anomalies which do not correlate with Permian and younger structures therefore appear to relate to deeper density contrasts. No evidence of diapirism has been observed.

3. Seismic Surveys

Seismic reflection surveys have been conducted since 1959 in the southern Cooper Basin. Seismic data have delineated a number of significant anticlinal structures, the drilling of which have established several fields containing commercially recoverable hydrocarbons.

PREVIOUS EXPLORATION (Cont.)

3. Seismic Surveys (Cont.)

Prior to the late 1960s, conventional dynamite techniques were primarily used, with single-fold coverage and analogue recording. Processing was also analogue. The late 1960s and early 1970s saw the introduction of multi-fold coverage and digital processing. By 1972 recording and processing was generally digital.

In 1973, vibroseis** recording became the dominant source used for exploration in the southern Cooper Basin, usually recorded at a subsurface multiplicity of twelve.

The following surveys may be pertinent to the areas covered by the Karawinnie Survey.

1963 Diamantina-McGregor
1964 Cooper Creek
1965 Strzelecki Cooper
1966 Eromanga Frome
1967 Cooper Basin
1968 Western Cooper Basin
1969 Southern Cooper Basin
1969 Carraweena-Murta
1969 Lake Gregory
1970 Patchawarra Southwest
1970 Patchawarra Central and Jimpawirrie
1970 Nappacoongee-Murteree
1970 Merrimelia
1970 Accalona

PREVIOUS EXPLORATION (Cont.)

3. Seismic Surveys (Cont.)

1970 Innamincka

1970 Boxwood

1970 Lake Hope

1971 Coopers Creek Central

1971 Cadrapowie

1972 Embarka, Andree and Swan Lake

1972 Tickerna

1973 Mudlankie

1975 Tooroopie

1976 Callamurra

1977 Perigundi

1978 Oonabrinta

1979 Pulcara

1979 Moonlight Flat

1980 Woolkanie

MAPPING TECHNIQUE

In addition to the data obtained during the Woolkanie Survey, data from previous surveys have been incorporated into each interpretation presented as part of this Report. The maps presented are listed in the Enclosures section at the beginning of the text.

Picking Mechanics

Final sections from the Survey were displayed in SEG polarity where a reflection from a positive acoustic impedance contrast is represented by a (white) trough. The mechanics involved in picking the various mapped horizons are as follow:

Horizon C: This reflection is correlated with the Top of Cadna-owie (Lower Cretaceous age). It is a prominent event correlatable over the Eromanga Basin. The pick is made in the centre of a strong trough which is followed by a prominent peak.

Horizon P: This event is usually correlated with the first coal which occurs at or very close to the top of the Toolachee Formation. It maintains good character throughout much of the Cooper Basin. The pick is centred in the first strong peak of the Permian reflectors. In areas where the Permian section is thin or absent, the P horizon is defined as the surface representing the "base of Mesozoic", and the seismic pick may vary accordingly.

Horizon Z: This event is highly variable on a Basin-wide scale, although it can be distinctive over localised areas. The Z horizon represents the pre-Permian topography

MAPPING TECHNIQUE (Cont.)

Picking Mechanics (Cont.)

Horizon Z: (Cont.) which is usually associated with a strong positive impedence change. Accordingly, the pick is usually in the centre of the trough below the last Permian reflector (peak).

Time-Depth Conversion

Depths in the Spencer region were calculated using simple average velocities to the specified horizons.

RESULTS AND CONCLUSIONS

PATCHAWARRA EAST BLOCK - Yalchirrie Area

The Patchawarra Trough is a major structural element of the Permo-Carboniferous Cooper Basin. A thick sequence of Permian and Triassic sediments are contained within the trough and thin onto the Merrimelia-Innamincka high to the south and onto the Birdsville Track Ridge to the north. Permian sedimentation is largely constrained by fault systems along these margins. Structures beyond the margins retain potential for hydrocarbon accumulations in Mesozoic sediments.

Candra Area

At the Base of the Mesozoic, the Candra structure is a northwest trending anticlinal feature on a northwest plunging nose. The feature has no closure independent of a possible east bounding fault and further mapping to the southeast into Queensland is required for maturation of a drilling target. At the C horizon a small closure is mapped centred on Line 80-JYB VP 750 which is 4 km north of potential closure at the Base of Mesozoic, indicating significant late structural tilting. Significant C-P thinning indicates that significant growth of the structure has occurred during the Mesozoic although onlap onto a pre-existing high in the area may also have occurred together with later compaction. Control in the area is provided by tie lines to Yanpurra 1.

Tooroo

Tooroo is a large domal structure located north of a major fault system which marks the northern edge of the Patchawarra Trough. Permian sediments are expected in the area.

At the Base of Mesozoic up to 30 ms of relief has been mapped centred at Line 70-FTB SP 104 with approximately 6000 acres of areal extent. A

RESULTS AND CONCLUSIONS (Cont.)

PATCHAWARRA EAST BLOCK - Yalchirrie Area (Cont.)

Tooroo (Cont.)

smaller closure has been indicated at the C horizon and C-P thinning is insubstantial.

The structure requires further detailed coverage.

West Flank Complex

To the north of the major fault system which marks the edge of the Patchawarra Trough, a number of leads have been outlined as rollovers on the 1980 data. With the incorporation of older data, closure independent of faulting has been indicated only at Deramooka, a large low relief structure centred at the intersection of Lines 80-JYK and 78-JPP. Here less than 20 ms relief is indicated at the Base of the Mesozoic with over 7000 acres of areal closure. The other rollovers are indicated centred at Lines 80-JYJ VP 140, 80-JYH VP 350 and VP 400, and 80-JYD VP 350.

In this area only very thin Toolachee Formation is expected with other Permian absent.

To the south of the fault system, three small-moderate sized features have been indicated. The first is centred at Line 80-JYG VP 200, where approximately 10 ms relief is indicated at the Base of Mesozoic over 560 acres. A second small domal feature is centred at Line 80-JYD VP 130 with up to 20 ms relief over 600 acres.

To the south west an elongate anticlinal feature has been indicated as a rollover on Line 80-JYS at VP 130. This feature appears to have up to 15 ms of relief over 3500 acres.

RESULTS AND CONCLUSIONS (Cont.)

PATCHAWARRA EAST BLOCK - Yalchirrie Area (Cont.)

West Flank Complex (Cont.)

Each of these structures is reflected in the shallower C horizon. These three features lie towards the deeper portion of the Patchawarra Trough and to the east of the successful Cuttapirrie 1 well.

Beyond the expected limit of Permian sediments, the 1980 survey has indicated a number of leads which retain Mesozoic potential. On Line 80-JYD a rollover has been indicated at VP 460. A rollover on Line 80-JZE at VP 125 has also been indicated. A closed feature has been indicated at the intersection of Lines 80-JZC and 80-JYB. These features indicated at the Base of Mesozoic are reflected in the C horizon.

The West Flank survey is tied to the Cuttapirrie 1 well.

Coonatie Area

The 1980 Karawinnie Survey was designed to investigate extension of the Coonatie structure.

At the Base of Mesozoic the Coonatie feature is currently mapped as a moderate sized equidimensional dome. The feature lies on a NNE trending ridge. No further culminations have been indicated on this ridge although potential remains within the current grid of data for small closed culminations. Above Coonatie 1, at the Base of Mesozoic nearly 950 acres of updip potential has been indicated with up to 15 ms relief.

Yalchirrie

The Yalchirrie lead lies adjacent and to the north of the Packsaddle high. The lead is a structural, stratigraphic trap with potential Permian sealed against the fault system which marks the southern edge of the Patchawarra

PATCHAWARRA EAST BLOCK - Yalchirrie Area (Cont.)

Yalchirrie (Cont.)

Trough. In addition, the Nappamerri Formation is expected to provide an adequate seal to onlapping Permian sediments. Permian sediments are absent from the crest of the Packsaddle high. The potential area closed against the fault system is large and extends to the southwest. A potential fourway dip closure is indicated within this prospect at the intersection of Lines 76-JFE and 73-EAZ to the southwest of the 1980 grid.

West Flank - Merrimelia Area

Along the west flank of the Patchawarra Trough a number of closed domal structures have been indicated, generally as reversals of plunge along anticlinal noses which plunge down into the trough.

At the Base of Mesozoic, a rollover on Line 80-JZT at VP 510 when incorporated with older data indicates a small dome at 77-JLV VP 195 with 10 ms relief over 200 acres of closure. Similarly a small dome is indicated centred adjacent to Line 80-KJE VP 160 with a similar relief and 350 acres of closure. From the contours a moderate-large sized domal feature is indicated to the southwest and adjacent to the ends of Lines 80-JZW and 80-JZK. These structures are reflected in the C horizon. They lie in an area where Permian sediments thin and the possibility of pinchout traps exists.

To the south, a closed feature is indicated with approximately 10 ms relief at the intersection of Lines 80-JZR and 80-JZD. This feature has up to 850 acres of areal closure and is again reflected in the C horizon.

On the southern margin of the Patchawarra Trough the 1980 Karawinnie Survey

PATCHAWARRA EAST BLOCK - Yalchirrie Area (Cont.)

West Flank - Merrimelia Area (Cont.)

has confirmed anticlinal features at Line 72-BDX VP 375 and at Line 72-PAX VP 50. Only the former has confirmed closure at the C horizon.

A rollover with potential for closure has been indicated on Line 80-JWB at VP 130, demonstrating updip potential from Tindilpie 1 well which requires further detailing.

A further small closed feature is indicated on Line 80-JWC at VP 190.

In the Merrimelia Area the Karawinnie Survey was designed in part to investigate flank structural stratigraphic plays where reservoirs might be closed against faulting on the Merrimelia High. Such potential is indicated southwest of Mudrangie 2 where a complex set of faults may have closed off reservoirs against the basement high.

At the top of the Merrimelia high, a separate culmination has been indicated at Line 80-JWX VP 209 with a small areal closure at the Base of Mesozoic. The feature is reflected in the C horizon.

On the southern side of the Merrimelia high a similar trapping mechanism may exist as on the northern Mudrangie side with potential to trap hydrocarbons migrating from the Nappamerri Trough. Small rollovers have been indicated on Line 80-JWE at VPs 490 and 520 in this setting. Updip fault traps may occur from these potentially small features.

This survey has highlighted updip potential on the Merrimelia high for Mesozoic crestal accumulations and further detailing is recommended.

RESULTS AND CONCLUSIONS (Cont.)

MURTA BLOCK

Spencer Area

The Spencer feature is a doubly culminating anticlinal dome on the north-east trending Warra anticline which in turn is a southwestern continuation of the Gidgealpa-Merrimelia-Innamincka (GMI) trend.

Spencer 1 well was drilled in 1966 as an unsuccessful flank test of the structure.

Early Triassic Nappamerri Formation and Late Permian Toolachee Formation are absent from the area with top Permian over the structure interpreted as Patchawarra Formation. Permian is interpreted to be very thin or absent over the western of the two culminations and Basal Jurassic to unconformably drape over the structure.

Relief on the structure is greatest on the western culmination which is also the highest at all levels.

The 1980 Karawinnie Seismic Survey was designed to detail the structure and site a crestal well test with 43.5 km of seismic data collection. A proposed well site was chosen on the western culmination adjacent to VP 140 on Line 80 JYG at SP 184 on Line 76-JDC. At this point approximately 150 ft of relief is expected at the C horizon with areal closure of 4800 acres.

APPENDIX I

Field Operations Report

1980 Karawinnie Seismic Survey

TABLE OF CONTENTS

KARRAWINNIE SURVEY 1980

Overview

Geophysical Service Inc began the Karrawinnie Seismic Survey for Delhi International on 17th March with an advance party consisting of 2 surveyors, 3 chainmen and a small 3 man refraction crew.

The main vibrator recording crew was moved into the field in April and began noise tests on the third of May. The crew shot continuously moving to various areas in the Cooper Basin (see map) and completed shooting on the 16th December, 1980.

Refraction Crew

This crew began by shooting multiple upholes and short refraction spreads every kilometer and intersection. Weathering depths were computed from this information and intermediate datum statics were computed by interpolation.

Dynamite shots were taken into the main spread for the majority of the Merrimelia program. This was done to upgrade the quality of the weathering information by using a reciprocal refraction method to establish the weathering depth at each surface location.

The method worked well but slowed the crew down, due to the time taken to shoot the dynamite. So a separate crew was set up on the 23rd of July using a new 2 x 13 trace cable with a 75 metre group interval. Initially shots were taken every 900 metres (12 stations) but this was decreased in some areas due to poor first breaks on the outside traces. The method works well and means that the main crew is not contrained by the drillers production. Final static computations were made by SAOGC in their Adelaide office.

Main Crew

Noise analyses were run at the start of each new prospect as a check on the recording parameters. These analyses were evaluated by the Client Representative on the crew at the time and any adjustments to geophone or vibrator patterns are noted on the observor logs and Appendix 5.

Generally the parameters were:

VIBRATORS: 3 vibs, in line, 12 - 18 m spacing, 4 - 8 m moveup, 10 sweeps. Sample rate 2 ms, sweep frequency 10 - 84 Hz. 16 second sweep, 4 second listen 0.7 sec taper, 12 fold.

GEOPHONES: 24 phones, symmetrical weighting 7 - 9 m spacing (1, 1, 2, 2, 3, 3, 3, 3, 2, 2, 1, 1) Split spread, 2 or 6 group gap between 24 - 25.

RECORDER: DFS V, filter setting 10 - 90 Hz.

Instrument tests were run each day before crew start-up and hard wire similarities were run from special velocity phones attached to the base plate. Base plate similarities took up to an hour each day because the vibrators needed moving to the recorder and back to their line position plus some time was needed for warm up to get good similarities.

Recommendations

1. Preferentially use a D8 for line clearing and ensure that the larger dunes are cut down far enough and cut wide enough to allow access even after some blow in. (See monthly summary)

2. Ideally perform only radio similarities daily with a hard wire test once a week. Radio similarities are accepted throughout the industry as a check to see if all vibrators are in phase.

3. Production can often be greatly increased if the crew completes a line change in the day that shooting is completed. While this would mean an additional charge for hours in excess of 10 per day, Delhi would gain more production due to the decrease in travel time.

Respectfully Submitted,
GEOPHYSICAL SERVICE INC

Bill Pailthorpe
SUPERVISOR

PRODUCTION SUMMARY

1980	Total Km	Merrimelia 100 metres gps	Merrimelia 75 metres gps	Spencer (75)	Coonatie (75)	Patchawarra East (75)	96 trace & 3D Experimental	Patchawarra Central/Flylake	Yalchirrie
Jan	Mobilization								
Feb	Mobilization								
Mar	Mobilization								
Apr	Advance Party								
May	154.70	64.40	90.30						
Jun	223.50		179.95	43.55					
Jul	233.77		19.35	-	41.99	172.43			
Aug	187.75					187.75			
Sep	201.29					201.29			
Oct	182.825					8.85	9.625	164.35	
Nov	202.05							202.05	
Dec	130.65								130.65
	1,516.535	64.40	289.6	43.55	41.99	570.32	9.625	365.40	130.65

MONTHLY SUMMARY APPENDIX 1

March

The advance party left Adelaide on the 17th and proceeded to Moomba. The area around the Merrimelia No: 1 Well was scouted and chosen on the initial camp site.

A Thompson's D6 Bulldozer was set off on line JWA heading south west from the well. Some initial trouble with bogging and break downs kept the dozer production low for this month.

Ace's drill rig drilled two upholes on the 27th and the refraction crew shot its first uphole that afternoon.

April

Dozers, drills and refraction crew continued working until the 22nd when heavy rain and high velocity winds destroyed the camp and made all roads unserviceable.

Mobilization of the main crew was halted due to rain and road conditions. However most of the equipment had arrived by the end of the month.

May

On the third the vibrators passed their similarity tests and a series of noise anaylsis were begun on JWA.

Production shooting began on the 7th using, 100 metre group intervals, 24 phones per group with a weighted array, 10 vibrator sweeps per pattern with 16 seconds/sweep, 200 metre moveups. Hard wired similarities were run daily before production could begin.

In addition dynamite shots were taken into the main spread to test the feasibility of collecting reciprocal refraction information so that a more vigorous evaluation of datum statics could be done.

Dingos were a major problem causing frequent breaks in the cables.

The group interval was changed to 75 metre beginning with line JWH. JWA, JWB, JWF, JWG being the only lines shot with the 100 m spacing.

Line JWZ was cut short due to the inability of the vibrators to climb the steep dunes on the southern end of the line.

June

Shooting continued on Merrimelia until the 24th. The recording crew moved to the Spencer prospect and camped out rather than move the main camp for only 5 lines.

The northern portion of line JWA was not shot until after Spencer and while the crew was moving to Coonatie. JWA had to be shot to the north due to the asymetrical nature of the dunes.

Dingo problems continued.

The various parts of the operation were spread out over four different areas. The recording crew was at Spencer, the main camp remained at Merrimelia, the D6 was at Coonatie while the D8 and surveyors were at Patchawarra East.

July

The recording crew completed JWA and the Coonatie lines and moved to Patchawarra East. (Mulga Bore) This meant that the various groups were once again spread over a wide area.

The refraction crew was expanded and set up with a new full length cable (75 metre group interval) and production began on the 23rd, under the supervision of Doug Roberts from SAOGC.

August

The dingo problem finally caught up with the crew and the 19th was lost due to extensive cable repair being necessary.

High winds and heavy rain lowered production due to boggy conditions and leakage (20 - 24th).

September

Long travel times and long line moves kept the production low this month. In addition high winds blew in the sand hills and many detours had to be made by the recording truck to get around them. Part of the problem was poor line cutting by the dozers.

October

Before leaving Patchawarra East, 4 days of tests were done to see if closer group spacing would give a higher resolution product. This test period also tested 24 phones versus 12 phones and looked at broadside side noise to assist parameter design for the approaching 3D survey. (Results are reported under separate cover)

After moving to Patchawarra Central extensive dingo damage once again caused a serious lost of production (18th, 19th). Drifting sand also proved troublesome due to strong winds and the fine grain size of the sand. To help stop this the dozer began cutting the hills lower and pushing clay up the hills to help stabilization.

November

Cables and sand continued to cause problems.

The dozers finished the Yalchirrie dozing and moved on the 27th to the 3D prospect at Cuttapirrie.

December

The main crew moved to Yalchirrie on the first. The crew then shot 130.65 Km in 13 days, giving an average in excess of 10 Km day. This good production was due to low travel times and good terrain.

The crew moved camp to Cuttipirrie on the 16th and began preparations for the 3D survey.

Drilling was difficult at Yalchirrie due to hard rock conditions. The drills moved to Cuttapirrie before completing the refraction survey and will not return until after the 3D survey in March, 1981.

Final survey notes were also set aside for the 3D survey and will be finalised in March/April, 1981.

KEY PERSONNEL APPENDIX 2

Party Manager	Charlie Cook
Asst Party Manager	Bob Stephenson
Instrument Engineer	Clive Halvorson
Instrument Engineer	Terry Quayle
Trainee IE	Jack Hilton
Trainee IE	Steve Stephens
Refraction Observer	Jack Virgo/Alan Norris
Surveyor	Jeff Rose
Surveyor	Tom Rooney
Surveyor	John Henley/Soulis Kortedis
Seismologist	Alan Eaddy
Seismologist	Kevon Kenna
Supervisor	Bill Pailthorpe
Dozing Contractors	FB & BI Thomson
Drill Contractors	Australian Consolidated Exploration (ACE)
Drill Contractors	Thorpe Brothers
Client Representatives	Bruce Beer
Client Representatives	John Ackerman
Client Representatives	Frank Paynter
Client Representatives	Al Faloon

EQUIPMENT LIST APPENDIX 3

Recording Equipment

1 Texas Instruments DFS V 48 trace Digital Field System complete with electrostatic camera and all necessary equipment and spares
1 96 input, 48 output CDP switch
1 Field Timap System (FT-1)
400 Geophone strings, GSC 20D 10Hz, 6 per string with 10 metre geophone interval
26 CDP cable sections with 100 and 50 metre interval. Each cable capable of 4 x 1000 metre stations
4 Jumper cables 440 metres long
1 Geospace model GS 940 geophone anaylzer
1 Oscilliscope
1 Blaster for detonating dynamite charges
1 Texas Instruments recording vibrator control unit
10 FM radios
4 SSB HF radios, 100 watt output
1 4 x 4 model C-70 Chevrolet truck complete with recording cab, 24Kw generator and airconditioning.
4 4 x 4 model HJ 45 Toyota line trucks
1 4 x 4 model HJ 45 Toyota personnel truck

Refraction/Uphole Equipment

1 OYO refraction system, 24 trace
2 12 trace refraction cables, 5 metre takeouts
30 refraction geophones
2 4 x 4 model HJ 45 Toyota truck

Vibrators

4 TR-3 vibrators
4 Vibrator control units
1 4 x 4 model C-70 Chevrolet line maintenance truck equipped with hydraulic lift, welder and maintenance tools

Survey Equipment

2 Wilde T-2 theodolites and accessories
1 Autoranger II EDM
2 Precision chains
1 SR 59 programmable calculator with printer
1 770 survey terminal
1 Rotalite blue line printer
2 4 x 4 model HJ 45 Toyota survey trucks
Drafting equipment as required

Survey supplies as required

Camp Equipment

1	Fully equipped kitchen trailer	12m x 3m
1	Fully equipped ablution trailer	12m x 3m
1	Fully equipped office trailer	12m x 3m
1	Work shop/store trailer	12m x 3m
2	Marque tents for mess and recreation each 6m x 6m	
1	Forty KVA generator mounted on trailer	
40	One man sleeping tents, with bed and bedding	
2	4 x 4 model MJR Bedford supply trucks, two equipped for water supply	
1	4 x 4 HJ 45 Toyota camp workshop truck	
1	4 x 4 model HJ 45 Toyota party manager vehicle	

Complete work shop and electronic test equipment to maintain all equipment furnished by GSI

RECORDING PARAMETERS APPENDIX 5

1. Merrimelia

Source Array

3 vibs in line, 12 metre Pad to Pad
4 metre moveup
10 sweeps/pattern 10 - 70/10 - 84
16 sec sweep: 4 second listen: 7 second Taper
2 ms recording filter 8 - 90 Hz
12 fold

Receiver Array

(1,1,2,2,3,3,3,3,3,2,2,1,1)

24 phones symmetrical weighted array
7 metre spacing 75/100 metre group interval
2 station gap

2. Spencer

Source Array

3 vibs in line 18 metre Pad to Pad
9 metre moveup
10 sweeps/pattern 10 - 84 Hz sweep
16 sec sweep, 4 second listen; 7 sec Taper
2 ms Recording filter 8 - 90 Hz
12 fold

Receiver Array

(1,1,2,2,3,3,3,3,2,2,1,1)

24 phone symmetrically weighted
9 metre spacing 75 metre group interval
2 station gap

3. Coonatie

Source Array

3 vibs in line 16 metre Pad to Pad
4 metre moveup
10 sweeps/pattern 10 - 84 Hz sweep
16 sec sweep 4 second listen, .7 sec Taper
2 ms Recording filter 8 - 90 Hz
12 fold

Receiver Array

(1,1,2,2,3,3,3,3,2,2,1,1)

24 phones symmetrically weighted
7 metre spacing 75 metre group interval
2 station gap

4. Patchawarra East

Source Array

3 vibs in line 14/8 Pad to Pad
7/6 metre moveup
10 sweep/pattern 10 - 84 Hz sweep
16 sec sweep, 4 second listen; 7 sec Taper
2ms Recording filter 8 - 90 Hz
12 fold

Receiver Array

(1,1,2,2,3,3,3,3,2,2,1,1,)

24 phones symetrically weighted
8/7 metre spacing, 75 metre group interval
6 station gap

5. Patchawarra South West (Fly Lake)

Source Array

3 vibs in line 18 m Pad to Pad
6 metre moveup
10 sweep/pattern 10 - 84 Hz sweep
16 sec sweep, 4 second listen. .7 sec Taper
2ms Recording filter 8 - 90 Hz
12 fold

Receiver Array

(1,1,2,2,3,3,3,3,2,2,1,1,)

24 phones symmetrically weighted
8 metre spacing, 75 metre group interval
6 station gap

6. Yalcherrie

Source Array

3 vibs in line 14m Pad to Pad
7 metre moveup
10 sweeps/pattern, 10 - 84 Hz sweep
16 sec sweep; 4 second listen; 7 sec Taper
2ms recording filter 8 - 80 Hz
12 fold

Receiver Array

(1,1,2,2,3,3,3,3,2,2,1,1)

24 phone symmetrical weighted array
6 metre spacing, 75 metre ground interval
6 station gap

APPENDIX II

The following data processing sequence was followed for the 1980 Karawinnie Seismic Survey.

1. Correlation
2. Trace edit
3. TAR - Alpa 4DB/sec
   - T2 - 3.5 sec
4. TVS - 100 ms gates
   - 50% overlap
5. DBS - 2 x 100 ms ops
   - 20 msec gap
6. 12-fold common depth point gather
7. Velocity analysis
8. Brute stack
9. Residual statics
10. Velocity analysis
11. Intermediate stack
12. Residual statics
13. Normal moveout correction
14. Datum statics
15. 12-fold common depth point stack
16. Time variant filter
17. Film display

D Roberts

0045

SOUTH AUSTRALIAN OIL & GAS CORPORATION PTY. LTD.

226 Melbourne Street, North Adelaide, S.A. 5006
Telephone: 267 5699 Telex: AA 88900
P.O. Box 470, North Adelaide, S.A. 5006

Our Ref. 4.00064.CP09

KARAWINNIE SEISMIC SURVEY 1980

STATICS REPORT

D.C. Roberts

August, 1983

IMPORTANT NOTICE

C O N T E N T S

F I G U R E S

T A B L E S

A P P E N D I X

ABSTRACT

This report summarises the reciprocal refraction statics technique used in the 1980 Karawinnie seismic survey in the Cooper Basin. The reasons for using the method and the problems encountered are discussed. It is concluded that revisions to the method are necessary and that different methods are more appropriate in some areas. An appendix lists the prospects and lines from the survey and states the statics method used on each line.

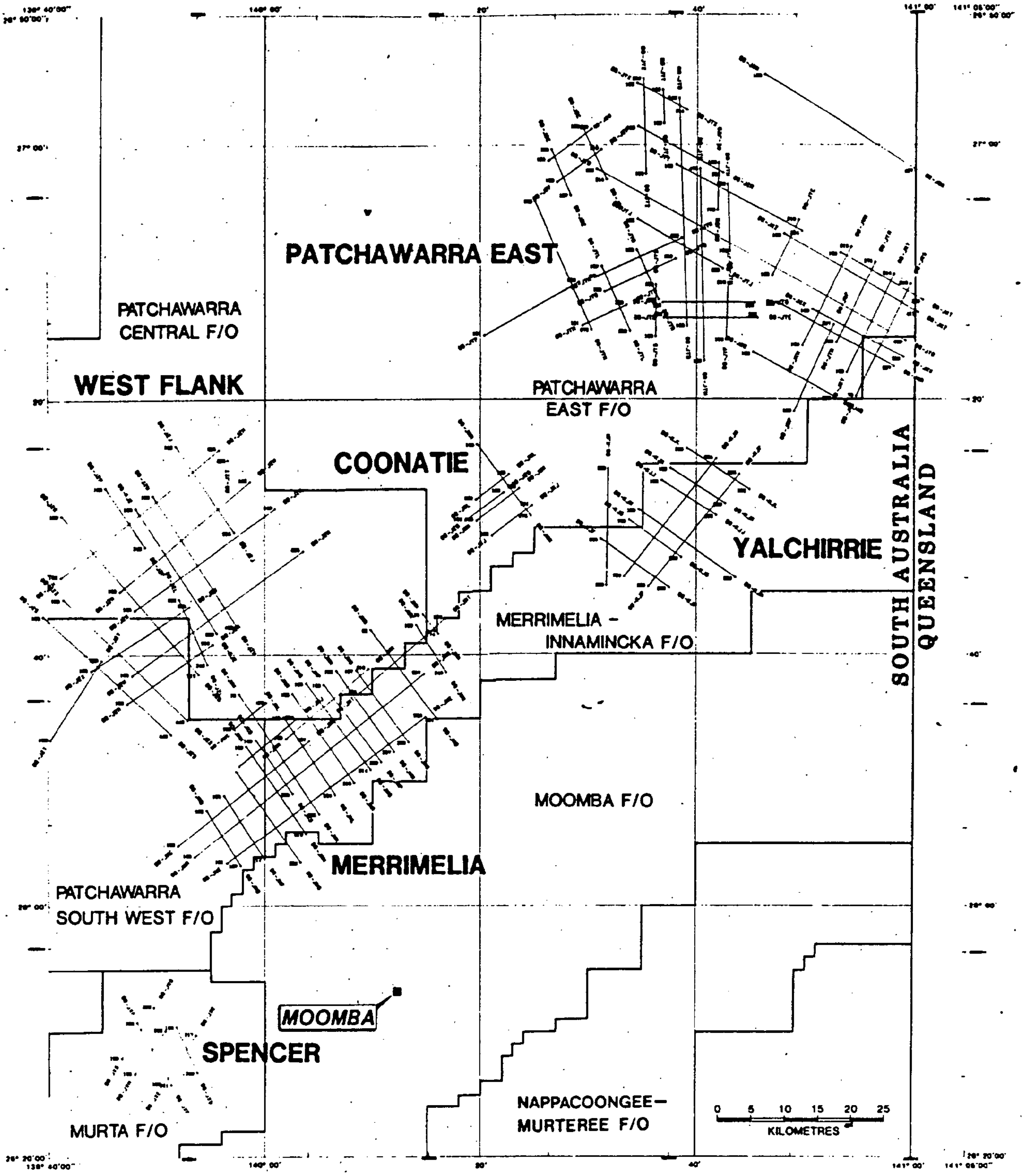
INTRODUCTION

During the acquisition of seismic reflection data for the 1980 Karawinnie Seismic Survey (Delhi, 1980) a variety of techniques were used to acquire the associated field static data. The Karawinnie seismic consisted of 1516 km of Vibroseis[1] data collected over six areas within the Coooper Basin in South Australia (Fig. 1). The survey was conducted as a sole risk project for South Australian Oil & Gas Corporation by Delhi Petroleum Pty. Ltd. as the Operator. In previous years a statics programme consisting of a combination of deep holes and mini-refraction spreads had been generally successful but failed in some cases. In this survey it was proposed to integrate longer offset refraction data with the mini-spreads and deep multiple uphole surveys and thus obtain an individual correction for each geophone station on the reflection recording survey. The earlier methods depended on extensive interpolation of the weathering data and relied heavily on automatic residual statics routines to correct the short wavelength variations. The choice of weathering model was an important consideration in those methods and had been changed several times, resulting in misties between data recorded in different surveys.

The use of the reciprocal refraction technique, otherwise known as the ABC or Hawkins' method, was designed to measure both short and long wavelength variations in the weathering model.

---

[1]Vibroseis is a registered trade mark of Continental Oil Co.



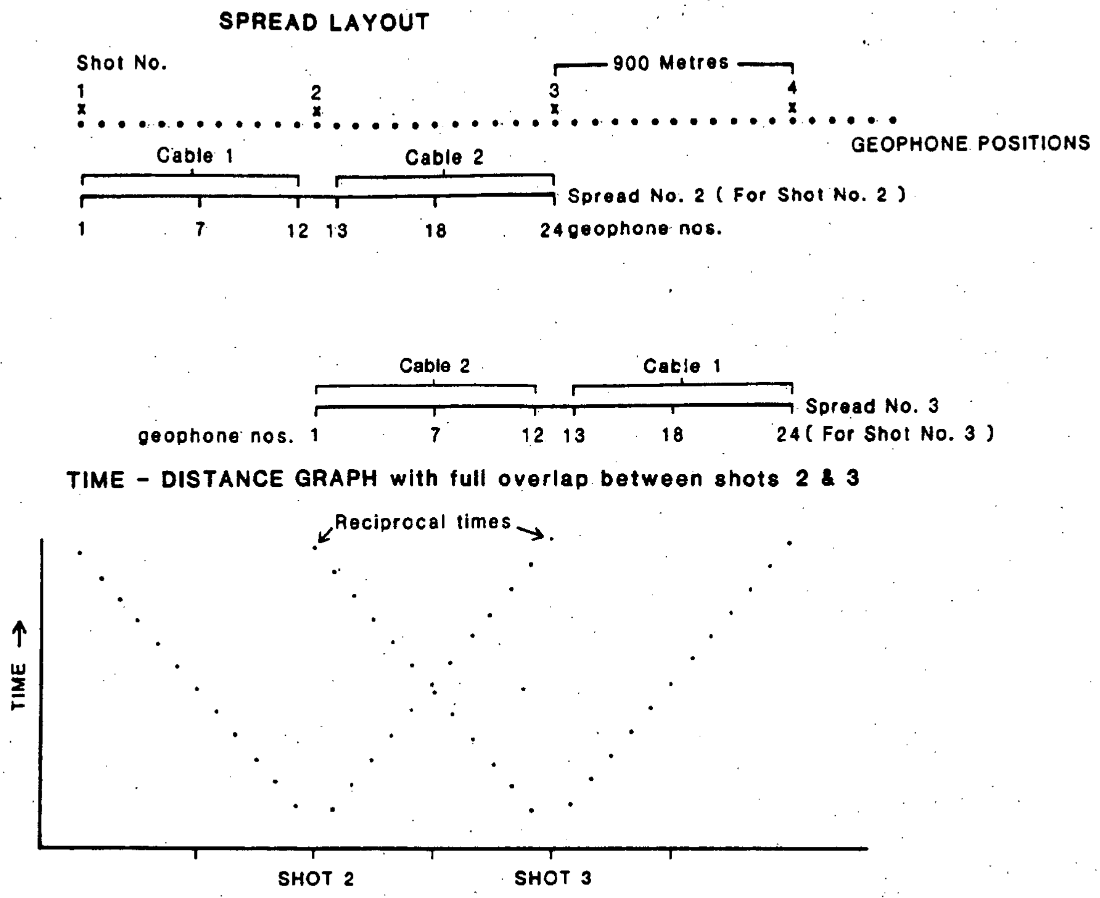
SOUTH AUSTRALIAN OIL & GAS CORP. PTY. LTD.		
COOPER BASIN 1980 KARAWINNIE SEISMIC SURVEY LINE AND PROSPECT LOCATIONS		
INT. D.Roberts	Aug. 1983	KA000.2936
DRN. C.K.		FIG. 1

THE RECIPROCAL REFRACTION METHOD

Field Acquisition

Two cables, each with 13 takeouts, were used together with an OYO 24 channel analogue recording seismograph. The distance between the takeouts was 75m which was equivalent to the spacing between stations for the reflection survey. The wiring of the cables was such that the takeouts 1 and 13 were equivalent on the recorder camera and these were located at successive shots. The shots were located 900m apart and fired into a split spread of two banks of 12 channels. For each shot the far traces were located at the position of both the previous and following shots. Figure 2 illustrates the cable configuration and the manner in which the cables were leapfrogged to give continuous reciprocal coverage. The shots consisted of 5 to 10 Kg of Gelignite AN60 and later Anzite Blue explosive, loaded into holes drilled to a depth of 6 to 10 metres. An uphole geophone was located next to the shot hole and recorded on an extra trace on the seismograph.

Due to the long shot to near trace offset of 75m the first arrival was generally a refracted event from the base of weathering. Before statics could be computed it was necessary to have an independent measurement of the low velocity zone, either from the uphole time, a mini refraction spread or a multiple uphole survey. Early in this survey all three measurements were made but the data collection was unacceptably slow. At a later stage a compromise was used to collect continuous reciprocal refraction data on all lines together with as many multiple uphole surveys as possible at line intersections.

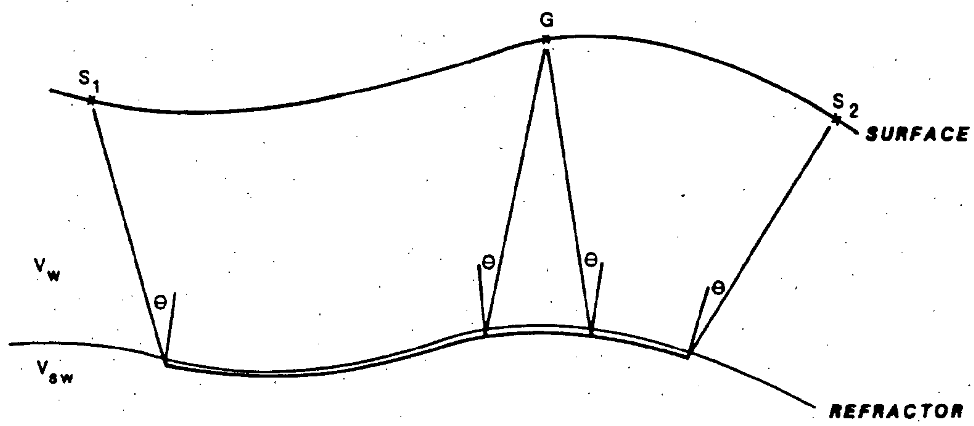


CONTINUOUS RECIPROCAL REFRACTION SEISMIC CABLE CONFIGURATION

FIG. 2

TIME - DEPTH RELATIONSHIP

FIG. 3



S_1 = SHOT 1
S_2 = SHOT 2
T = TIME MEASURED
θ = CRITICAL REFRACTION ANGLE
G = GEOPHONE LOCATION

TIME DEPTH

$$T_d = \frac{1}{2}(T_{S_1G} + T_{S_2G} - T_{S_1S_2})$$

TIME IN WEATHERED ZONE

$$T_w = T_d \frac{V_{sw}}{\sqrt{V_{sw}^2 - V_w^2}}$$

SOUTH AUSTRALIAN OIL & GAS CORP. PTY. LTD.		
1980 KARAWINNIE SEISMIC SURVEY		
INT . D.Roberts	DATE Aug. 1983	No KA000.2937
DRN . C.K.	Sc .	FIGS. 2 & 3

To acquire this quantity of static data required an increase in manpower and vehicles and a large increase in quantity of explosives, relative to earlier surveys. Eventually three vehicles were used instead of one and four persons instead of two in addition to the drilling crew.

Data Reductions

A computer system was established to expedite the computations of the statics. The first breaks were marked on the field monitor records which were digitised using a computer. The uphole time was added to all first arrival times to correct the shot to the surface. A least-squares straight line was used to determine the subweathering velocity and the uphole time and shot depth combined to give an estimate of the weathered layer velocity. The assumption that there was a single layer of weathering was used as a first approximation. The reciprocal times were analysed for each pair of shots. These times are theoretically equivalent and should match. In practice however, there were often large variations which indicated errors in one or both of the shots involved in a reciprocal pair. The average or the best of the two was used as the reciprocal time (Tr) for each geophone between the shots using the relationship:

$$Td = {}^{1}/_{2} \; (T_{s}1g + T_{s}2g - Tr)$$

where Ts1g and Ts2g are the arrival times at the geophone from shots 1 and 2 respectively and Td is the time-depth.

Figure 3 illustrates the relationships used to derive the time-depth, Td, and the technique used to convert this value to a travel time through the weathered zone and hence to a static time to the datum level. The time depth is a measurement of the time spent in the weathering zone at the geophone station. The effect of weathering at the shots and undulations of the subweathering are removed by using the reciprocal times. A correction needs to be made to the time depth to convert to vertical time (Tw) and the formula used for this is also shown on Figure 3. To convert the vertical weathering time to a static time (Ts) to datum the following relationship is used:

$$Ts = Tw + \frac{Es - (Tw * Vw)}{Vsw}$$

where Es = Elevation of station

Vw = Velocity of weathering zone

Vsw = Velocity in subweathering zone.

The computer system provided an automated computation of the statics with manual intervention in the digitising of first breaks, checking of velocities Vw and Vsw, picking reciprocal times and checking ties between lines. The velocities Vw and Vsw, were varied according to the values determined from the data in each area.

The final printout (e.g. Table 1) listed the stations, elevations, velocities, time depths and computed statics and were sent to the processing centre for input as field statics. An option was devised to output the field statics exactly in the format used by Geophysical Services Inc. who were processing the data.

TABLE 1

SAMPLE STATICS OUTPUT

STATIC DATA - LINE 80_JZH   DATE 16/12/1980

STATION		ELEVATION	VELOCITY		TIMEDEPTH	STATIC(MSEC)		
		M	V1	V2	TD1	REFR	FIELD	DIFFERENCE FIELD-REFR
80_JZH	212	27.3	800.	2060.	6.	17.	0.	0.
80_JZH	213	29.9	810.	2030.	8.	20.	0.	0.
80_JZH	214	30.5	820.	2000.	9.	21.	0.	0.
80_JZH	215	31.2	820.	1990.	11.	23.	0.	0.
80_JZH	216	35.3	820.	1990.	17.	29.	0.	0.
80_JZH	217	34.8	810.	1980.	17.	29.	0.	0.
80_JZH	218	33.4	810.	1980.	16.	27.	0.	0.
80_JZH	219	31.6	810.	1970.	14.	25.	0.	0.
80_JZH	220	28.2	810.	1970.	10.	21.	0.	0.
80_JZH	221	28.9	810.	1960.	12.	22.	0.	0.
80_JZH	222	27.6	810.	1960.	11.	21.	0.	0.
80_JZH	223	25.6	800.	1950.	9.	19.	0.	0.
80_JZH	224	25.7	800.	1950.	10.	19.	0.	0.
80_JZH	225	25.8	800.	1940.	11.	20.	0.	0.
80_JZH	226	25.9	800.	1940.	11.	21.	0.	0.
80_JZH	227	25.9	800.	1940.	12.	21.	0.	0.
80_JZH	228	26.0	800.	1940.	14.	22.	0.	0.
80_JZH	229	26.1	800.	1940.	8.	19.	0.	0.
80_JZH	230	28.2	800.	1940.	10.	21.	0.	0.
80_JZH	231	27.6	800.	1940.	12.	22.	0.	0.
80_JZH	232	25.1	800.	1950.	9.	19.	0.	0.
80_JZH	233	25.1	800.	1940.	9.	19.	0.	0.
80_JZH	234	25.1	800.	1940.	9.	19.	0.	0.
80_JZH	235	25.1	800.	1940.	9.	19.	0.	0.
80_JZH	236	25.1	800.	1940.	9.	19.	0.	0.
80_JZH	237	25.0	800.	1930.	9.	19.	0.	0.
80_JZH	238	25.0	800.	1930.	9.	19.	0.	0.
80_JZH	239	25.0	800.	1930.	9.	19.	0.	0.
80_JZH	240	26.6	800.	1930.	11.	21.	0.	0.
80_JZH	241	25.9	800.	1920.	10.	20.	0.	0.
80_JZH	242	25.1	800.	1920.	9.	19.	0.	0.
80_JZH	243	25.1	800.	1920.	9.	19.	0.	0.
80_JZH	244	27.3	800.	1920.	12.	22.	0.	0.
80_JZH	245	27.3	800.	1920.	13.	22.	0.	0.
80_JZH	246	27.4	800.	1920.	12.	22.	0.	0.
80_JZH	247	27.4	800.	1920.	11.	21.	0.	0.
80_JZH	248	27.4	800.	1920.	12.	22.	0.	0.
80_JZH	249	27.5	800.	1920.	9.	20.	0.	0.
80_JZH	250	27.5	800.	1920.	8.	19.	0.	0.
80_JZH	251	27.1	800.	1910.	7.	18.	0.	0.
80_JZH	252	26.9	790.	1910.	9.	20.	0.	0.
80_JZH	253	26.6	790.	1900.	9.	19.	0.	0.
80_JZH	254	26.3	780.	1900.	6.	17.	0.	0.
80_JZH	255	26.0	780.	1890.	6.	17.	0.	0.
80_JZH	256	26.8	770.	1890.	7.	18.	0.	0.
80_JZH	257	27.1	760.	1890.	7.	19.	0.	0.
80_JZH	258	27.4	750.	1890.	8.	19.	0.	0.
80_JZH	259	27.1	740.	1890.	7.	19.	0.	0.
80_JZH	260	26.0	740.	1890.	6.	18.	0.	0.
80_JZH	261	26.4	730.	1890.	6.	18.	0.	0.
80_JZH	262	28.3	720.	1890.	9.	21.	0.	0.
80_JZH	263	26.3	710.	1890.	6.	18.	0.	0.
80_JZH	264	26.9	700.	1890.	7.	19.	0.	0.
80_JZH	265	27.6	690.	1890.	8.	20.	0.	0.
80_JZH	266	28.3	690.	1890.	9.	21.	0.	0.
80_JZH	267	27.7	680.	1890.	8.	20.	0.	0.

RESULTS

Experimentation

A report by Roberts (1979) describes a field survey and computations used to test the reciprocal refraction method on field data. That report concluded that the method was relatively insensitive to error in the low velocity value but that multiple fold coverage of refraction was desirable. That report discussed the effect of computational assumptions.

At the beginning of the 1980 Karawinnie Seismic Survey on the Merrimelia prospect it was decided to try the method on a production basis by shooting dynamite shots into the main recording crew system. This was to be carried out in addition to conventional static data acquisition by a drilling rig (Mayhew 1000) and LVL (Low Velocity Layer) crew. The holes at every 900m along the lines were drilled and loaded prior to the reflection survey and when the recorder was in a convenient position the shots were fired and recorded by the reflection crew 48 channel system.

This system had many difficulties and disadvantages and was soon abandoned. As the recording system was a Vibroseis system it required time consuming modifications each time a dynamite shot was to be fired. The rollalong box was hardwired for a fixed spread gap and could not reduce to the minimum gap required for refraction and also be set at the optimum gap required for the reflection survey. The geophones were spread out in arrays 75m long and thus the first arrivals came from an indeterminate position as well as being smeared.

Several varieties of wide spaced takeout cables were tried before the arrival of the set of specially manufactured cables referred to above. The manpower of the LVL crew was upgraded to enable continuous reciprocal refraction coverage to be acquired and on good days production was equivalent to the main recording crew, i.e. about 10 kms/day. For the early part of the survey in Merrimelia, Spencer and Coonatie prospects it was also aimed to acquire mini-refraction spread data and deep multiple uphole surveys. This was very time-consuming and the LVL crew soon lagged several weeks behind the recording crew.

In the Patchawarra East Prospect a second drilling rig was brought in to concentrate on multiple uphole surveys in order to allow the refraction crew to catch up. The programme was split up and on some lines statics were computed using uphole surveys and on the rest continuous refraction coverage was used. Appendix 1 lists the lines and prospects and the techniques used on each line. The Yalchirrie prospect was completed by the LVL crew about 3 weeks after the main recording finished due to being diverted to record statics at the site of another survey.

Problems Encountered

Problems with the continuous refraction coverage included slow rate of coverage, poor first breaks, slow drilling in rock areas, cable problems and lack of low velocity information. Of these the most serious was the poor first breaks on the outer traces. The holes were pre-loaded by the drill to the refraction crew and thus it was too late to correct for wrong charge sizes. Often, due to windy conditions, poor outer breaks were inevitable. This meant that the reciprocal time estimates were subject to error and the individual time-depths were unreliable. As the coverage was single-fold there was no way to check the accuracy of individual time depths.

For these reasons in the 1981 Walkers Flat Seismic Survey (Delhi, 1981) the field method remained the same but the computation changed to using intercept times at the shots and using interpolation between shots 825m apart.

Another problem arose in the high elevation areas in the Yalchirrie and eastern Patchawarra East areas where the two layer model had to be changed to a three layer model. Also in this area outcropping high velocity silcretes caused problems both with drilling and with interpretation of the refraction data. A report by Smit (1983) discusses these problems and the preferred statics method in this area.

CONCLUSIONS

The method of continuous reciprocal refraction coverage described above was intended to provide control on both long and short wavelength statics and to reduce the size of misties at intersections. Due to practical problems the full potential of the method was not realised. The method was generally effective in the lower elevation areas of the West Flank Prospect but was less effective in the high elevation and silcrete areas of the Yalchirrie and eastern Patchawarra East prospects. In these areas the unreliability of the reciprocal times and the poor first breaks downgraded the results and it is recommended that multiple uphole information be used in those areas in future. To capitalise on the full potential of the time-depth method it would be necessary to use more sensitive digital recording equipment and preferably record multiple fold refraction coverage with shorter offsets to the end traces. In addition regular mini-spreads are required to provide near surface velocity control.

REFERENCES

Delhi Petroleum Pty. Ltd., 1980 Karawinnie Seismic Survey Final Report (In prep.)

Delhi Petroleum Pty. Ltd., 1981 Walkers Flat Seismic Survey Final Report (In prep.)

Roberts. D.C., 1979. Field Static Investigations, Cooper Basin, SAOGC Report No. 7.CP000.GP02.

Smit, R., 1983. 1981 Yanpurra Area Statics Report. SAOGC Report No. 4.00069.GP02.

APPENDIX 1

KARAWINNIE STATICS SUMMARY

Prospect/Line	Refraction Statics M= Main Crew R= refraction Crew	Uphole Statics U	Statics List H= Hand C= Computer	Statics Chart at SAOGC H=Hand P=Print C= Computer O= Original
Merrimelia				
JWA Pt 1	M	U	C	HP
2	M	U	-	HP
JWB	M	U	C	-
JWC	M	U	C	HP
JWD	M	U	C	HP
JWE	M	U	C	HP
JWF	M	U	C	-
JWG	M	U	C	HP
JWH	M	U	C	HO
JWJ	M	U	C	HP
JWK + ext	M	U	C	HP
JWL	-	U	-	HP
JWM	M	U	C	HP
JWN	M	U	C	HP
JWP	M	U	C	HP
JWQ	M	U	C	HP
JWR	M	U	C	HP
JWS	M	U	C	HP
JWT	M	U	C	HP
JWW	-	U	-	HP
JWX	-	U	-	HP
JXB	-	U	H	-
JXC	M	U	-	HP
Spencer				
JXD	R	U	C	HP
JXE	R	U	C	HP
JXF	R	U	C	HP
JXG	R	U	C	HP
JXH	R	U	C	HP
Coonatie				
JXJ	-	U	C	-
JXK	-	U	C	-
JXL	-	U	C	-
JXM	-	U	C	-
JZG	-	U	-	-

Prospect/Line	Refraction Statics M= Main Crew R= refraction Crew	Uphole Statics U	Statics List H= Hand C= Computer	Statics Chart at SAOGC H=Hand P=Print C= Computer O= Original
Patchawarra East				
JXN	R	-	C	C
JXP	R	U	C	C
JXQ	R	U	C	C
JXR	R	U	C	
JXS	R *	U	C	
JXT	R	U	C	
JXW	R	U	C	C
JXX	R *	U	C	
JXY	R *	U	C	
JXZ	R	U	C	
JYA	R	U	C	C
JYB Pt 1	R *		C	
Pt 2	R *		C	
JYC		U *	H	
JYD	R		C	C
JYE		U *	H	
JYF		U *	H	
JYG		U *	H	
JYH	R *		C	
JYJ		U *	H	
JYK		U *	H	
JYL		U *	H	
JYM	R		C	C
JYN	R		C	C
JYP	R *		C	
JYQ	R		C	C
JJR	R *		C	
JYS	R *		C	
JYT		U *	H	
JYW		U *	H	
JYX	R		C	C
JYY	R		C	C
JYZ	R		C	C
JZA	R		C	C
JZB		U *	H	
JZC	R		C	C
JZD	R		C	C
JZE	R		C	C
JZF	R		C	C

Prospect/Line	Refraction Statics M= Main Crew R= refraction Crew	Uphole Statics U	Statics List H= Hand C= Computer	Statics Chart at SAOGC H=Hand P=Print C= Computer O= Original
West Flank				
JZH	R	-	C	C
JZJ	R	-	C	C
JZK	R	-	C	C
JZL	R	-	C	C
JZM	R	-	C	C
JZN	R	-	C	C
JZP	R	-	H	C
JZQ	R	-	C	C
JZR	R	-	C	C
JZS	R	-	C	C
JZT	R	-	C	C
JZW	R	-	C	C
JZX	R	-	C	C
JZY	R	-	C	C
JZZ	R	-	C	C
KJE	R	-	C	C
Yalchirrie				
KJF	R	-	C	C
KJG	R	-	CH	CHO}
KJH	R	-	CH	CHO}
KJJ	R	-	CH	CHO} revised
KJK	R	-	CH	CHO}
KJL	R	-	CH	CHO}
KJM	R *	-	C	C
KJN	R	-	C	C
KJP	R	-	C	C

* Records not at SAOGC

4341-1

DELHI PETROLEUM PTY. LTD.

1980 KARAWINNIE SEISMIC SURVEY

P.E.L. 5 & 6 — SOUTH AUSTRALIA

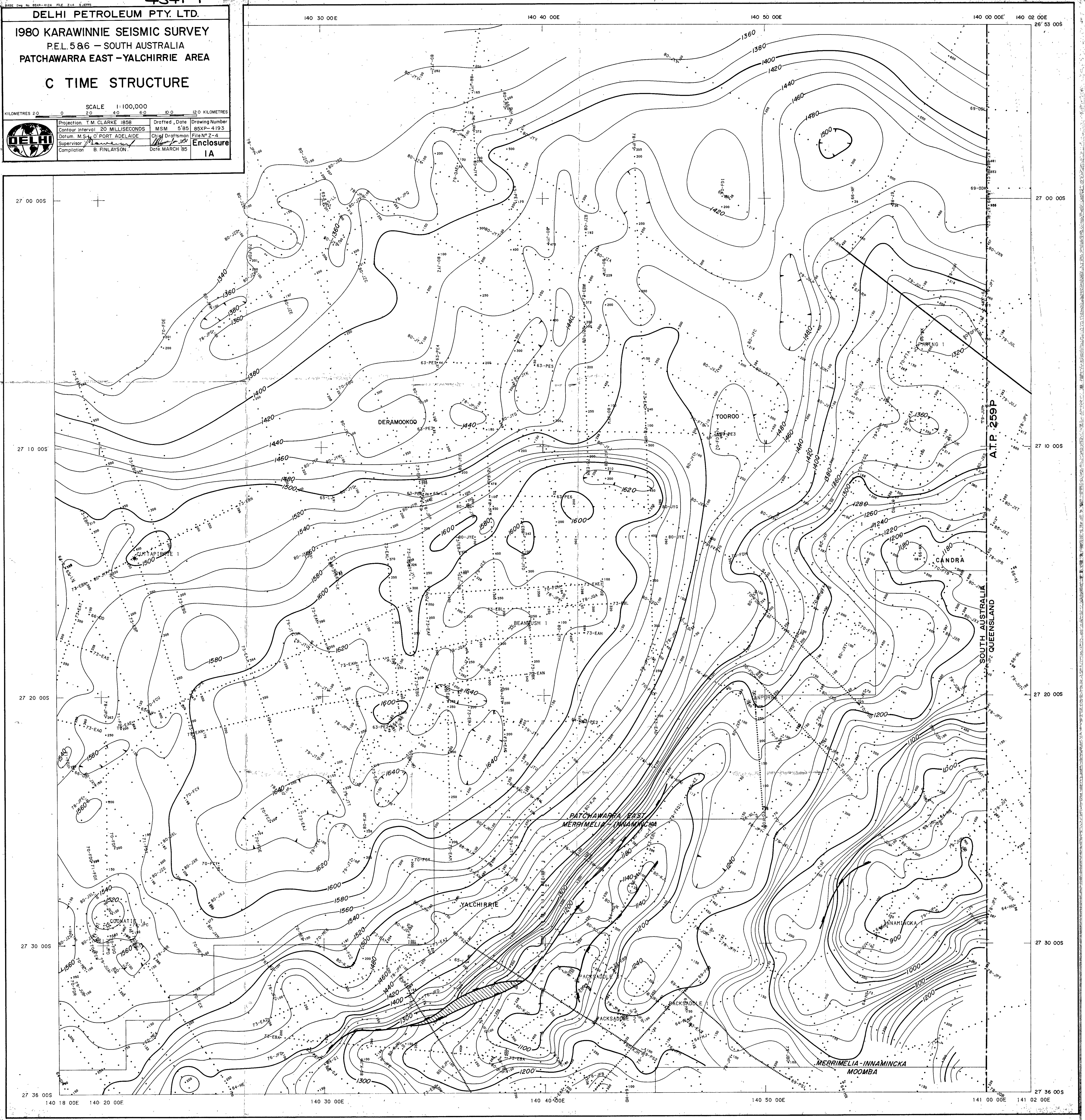
PATCHAWARRA EAST – YALCHIRRIE AREA

C TIME STRUCTURE

SCALE 1:100,000

KILOMETRES 2·0 0 2·0 4·0 6·0 10·0 12·0 KILOMETRES

Projection T.M. CLARKE 1858	Drafted, Date MSM 5'85	Drawing Number 85XP-4193
Contour interval 20 MILLISECONDS	Chief Draftsman	File Nº Z-4
Datum M.S.L. O' PORT ADELAIDE		Enclosure 1A
Supervisor		
Compilation B. FINLAYSON	Date MARCH '85	



4341-2

BASE Dwg No 85XP-4124 FILE Z-4

DELHI PETROLEUM PTY. LTD.

1980 KARAWINNIE SEISMIC SURVEY

P.E.L. 5&6 — SOUTH AUSTRALIA

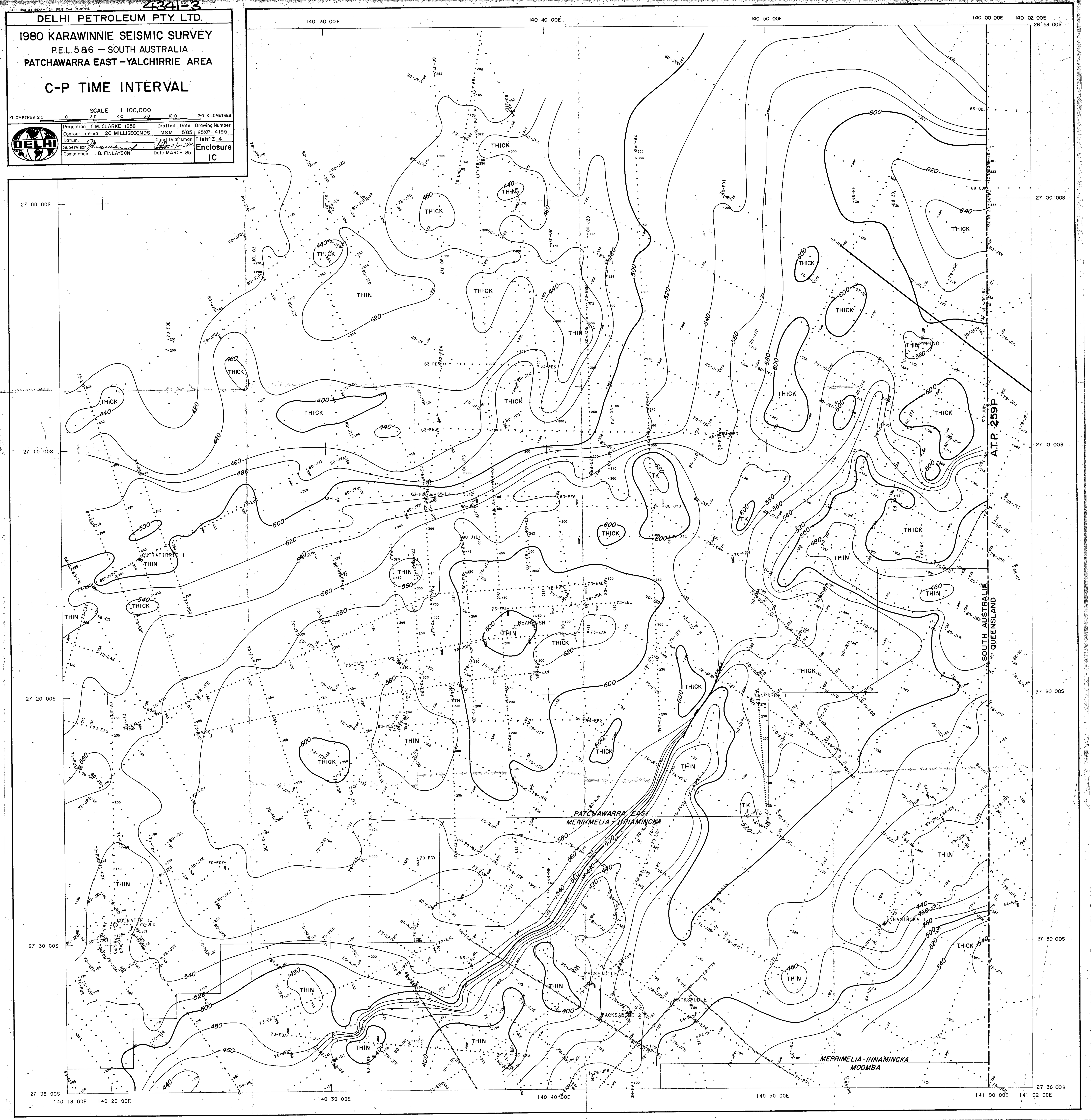
PATCHAWARRA EAST - YALCHIRRIE AREA

BASE MESOZOIC TIME STRUCTURE

SCALE 1:100,000

KILOMETRES 2.0 0 2.0 4.0 6.0 8.0 10.0 12.0 KILOMETRES

DELHI	Projection. T.M. CLARKE 1858	Drafted, Date MSM 5'85	Drawing Number 85XP-4194
	Contour Interval 20 MILLISECONDS	Chief Draftsman	File No Z-4
	Datum M.S.L. O' PORT ADELAIDE	Date MARCH '85	Enclosure 1B
	Supervisor		
	Compilation B. FINLAYSON		


4341-3
DELHI PETROLEUM PTY. LTD.
1980 KARAWINNIE SEISMIC SURVEY
P.E.L. 5 & 6 – SOUTH AUSTRALIA
PATCHAWARRA EAST – YALCHIRRIE AREA
C-P TIME INTERVAL
SCALE 1:100,000
KILOMETRES 2·0 0 2·0 4·0 6·0 10·0 12·0 KILOMETRES
Projection. T.M. CLARKE 1858
Contour Interval 20 MILLISECONDS
Datum.
Supervisor
Compilation B. FINLAYSON
Drafted, Date MSM 5'85
Chief Draftsman
Date. MARCH '85
Drawing Number 85XP-4195
File Nº Z-4
Enclosure IC
DELHI
27 00 00S
27 10 00S
27 20 00S
27 30 00S
27 36 00S
26 53 00S
140 18 00E
140 20 00E
140 30 00E
140 40 00E
140 50 00E
141 00 00E
141 02 00E
140 00 00E
140 02 00E
THICK
THIN
TK
CUTTAPIRRIE 1
BEANBUSH 1
YANPURRA 1
COONATTIE 1
INNAMINCKA 1
PACKSADDLE 1
PACKSADDLE 3
PATCHAWARRA EAST
MERRIMELIA – INNAMINCKA
MOOMBA
A.T.P. 259P
SOUTH AUSTRALIA
QUEENSLAND

BASE Dwg No 85XP-4125 FILE Z-4 S.JEFFS

DELHI PETROLEUM PTY. LTD.

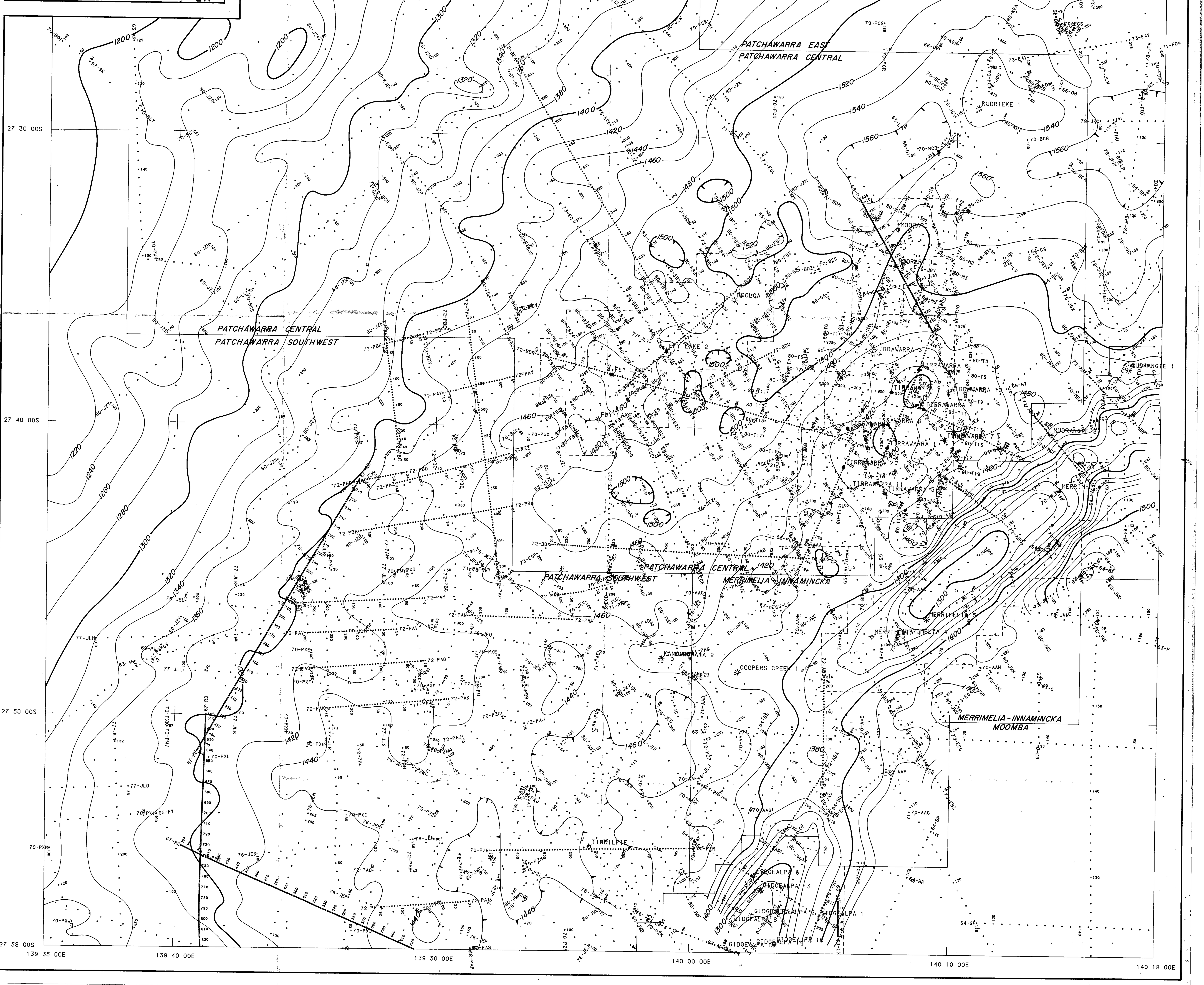
1980 KARAWINNIE SEISMIC SURVEY
P.E.L. 5&6 — SOUTH AUSTRALIA
WEST FLANK – MERRIMELIA

C TIME STRUCTURE

SCALE 1:100,000

KILOMETRES 1 0 1 2 3 4 5 6 KILOMETRES

Projection. T.M.CLARKE 1858	Drafted, Date MSM 5'85	Drawing Number 85XP-4196
Contour Interval. 20 MILLISECONDS	Chief Draftsman	File Nº Z-4
Datum. M.S.L. @ PORT ADELAIDE		Enclosure 2A
Supervisor	Date MARCH '85	
Compilation B. FINLAYSON		



4341-S

BASE Dwg No 85XP-4125 FILE Z-4 S JEFFS

DELHI PETROLEUM PTY. LTD.

1980 KARAWINNIE SEISMIC SURVEY

P.E.L. 5&6 — SOUTH AUSTRALIA

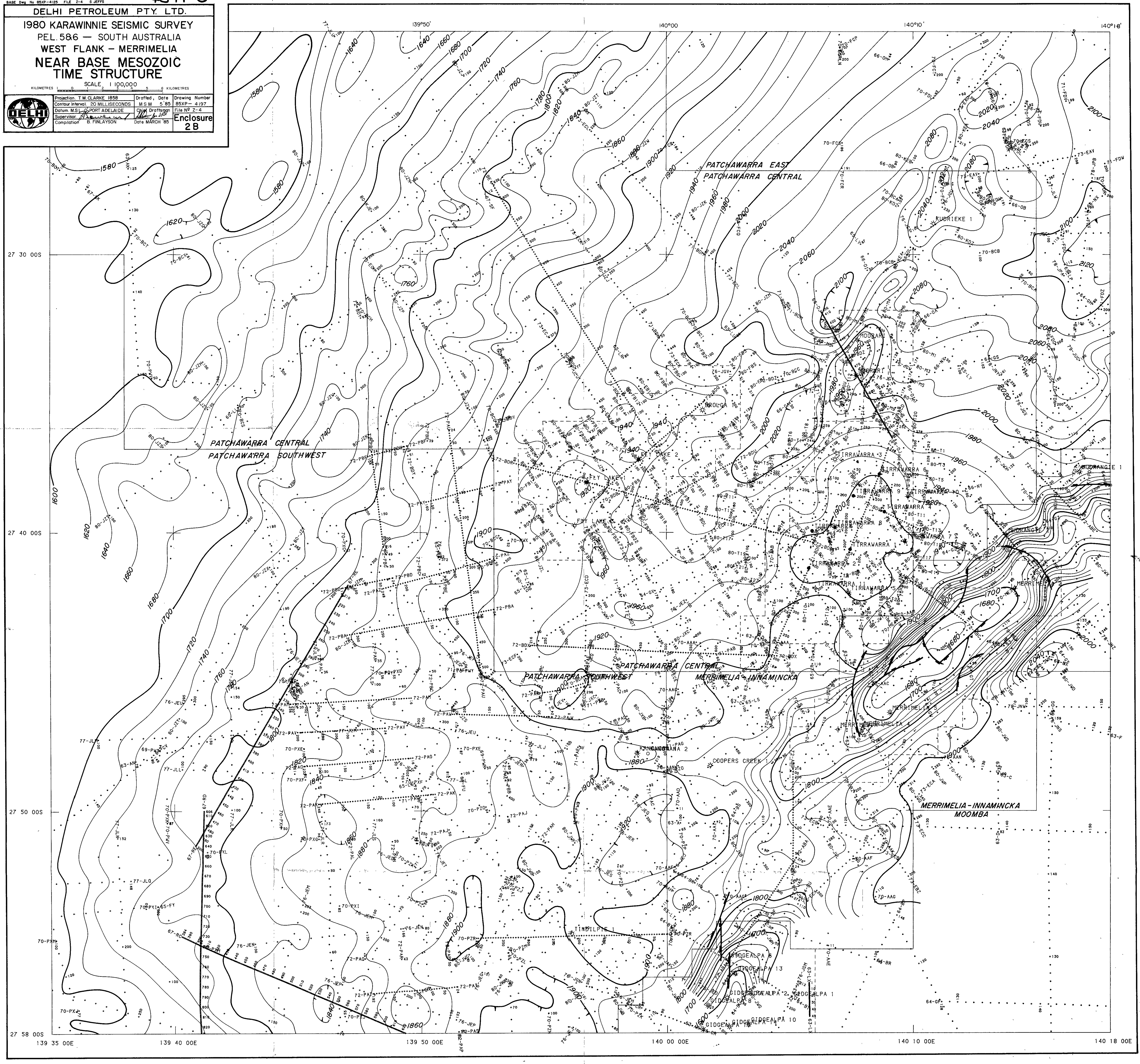
WEST FLANK – MERRIMELIA

NEAR BASE MESOZOIC TIME STRUCTURE

SCALE 1 100,000

KILOMETRES 1 0 1 2 3 4 5 6 KILOMETRES

DELHI	Projection. T.M. CLARKE 1858	Drafted, Date M S M 5'85	Drawing Number 85XP– 4197
	Contour Interval. 20 MILLISECONDS		
	Datum. M.S.L. @ PORT ADELAIDE	Chief Draftsman	File Nº Z-4
	Supervisor.		Enclosure 2B
	Compilation B. FINLAYSON	Date MARCH '85	



4341-6

DELHI PETROLEUM PTY. LTD.

1980 KARAWINNIE SEISMIC SURVEY

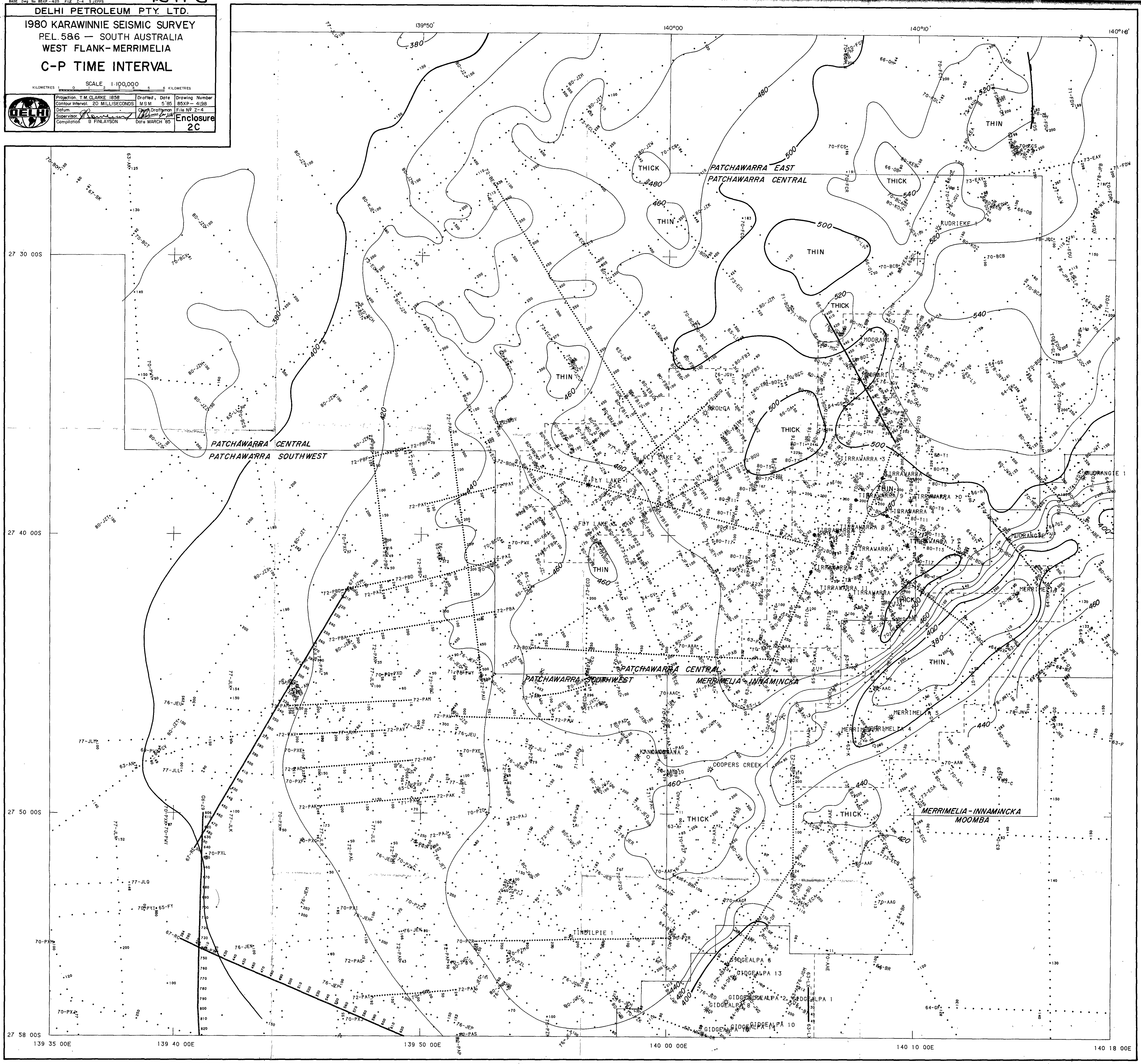
P.E.L. 586 — SOUTH AUSTRALIA

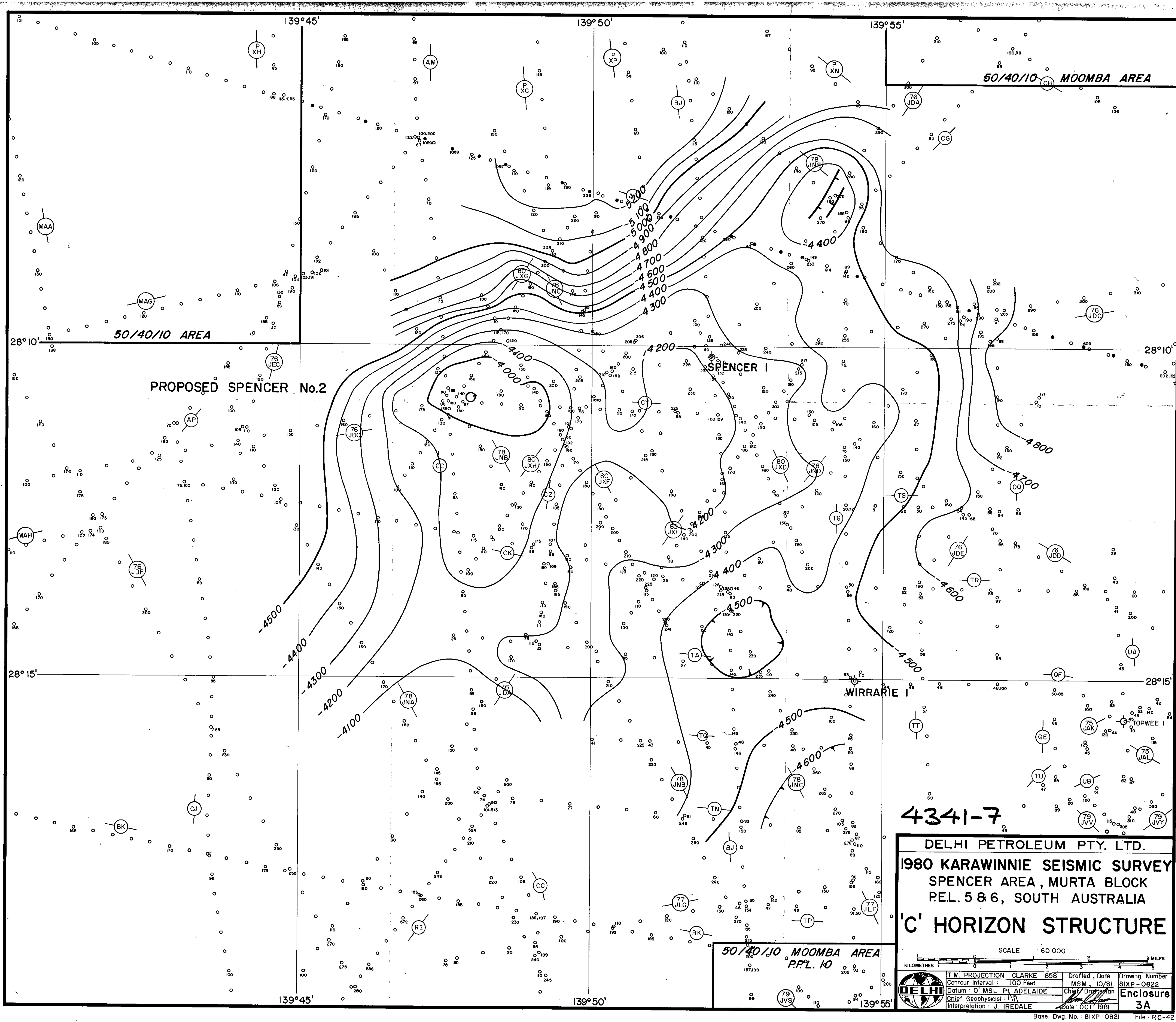
WEST FLANK - MERRIMELIA

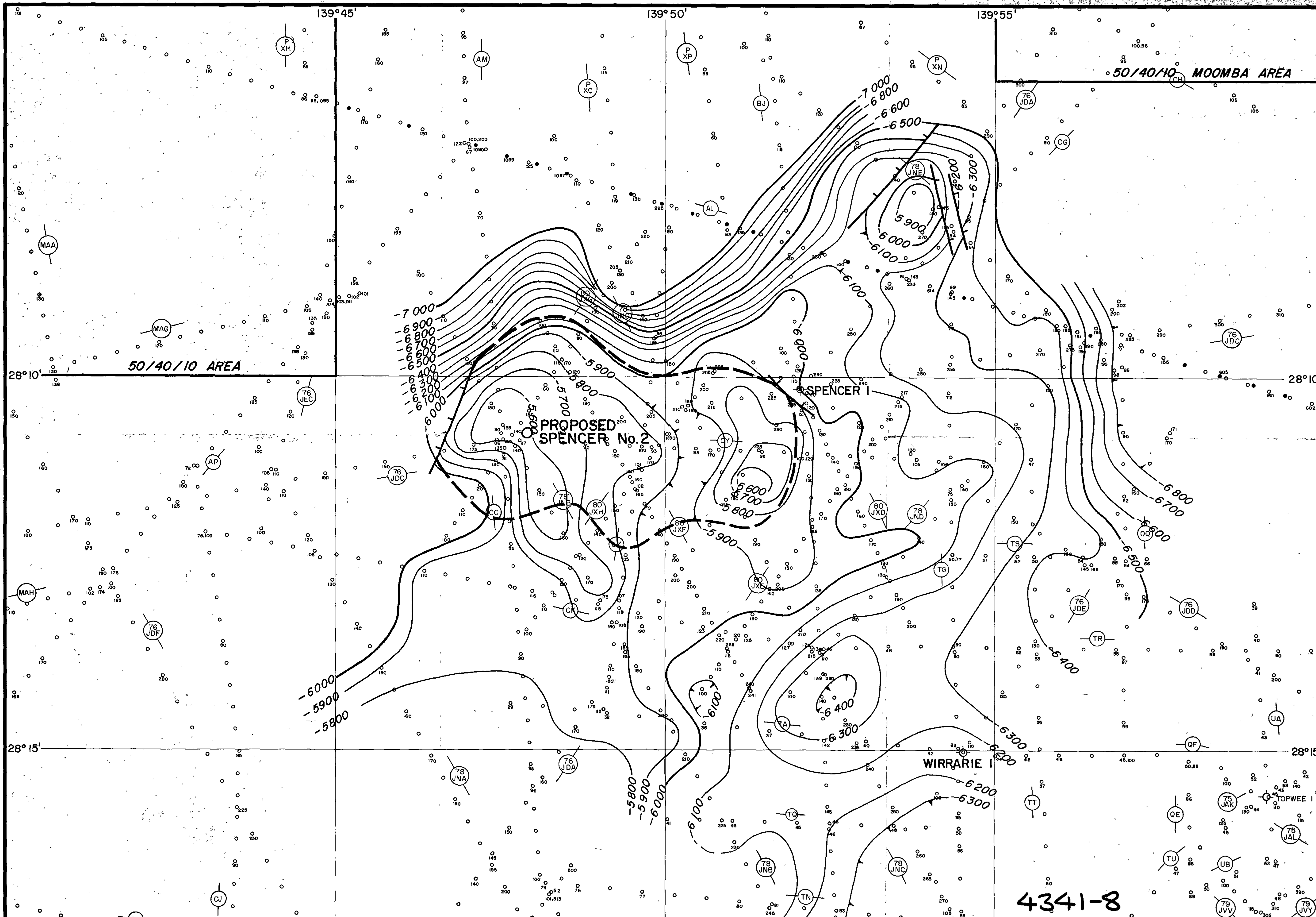
C-P TIME INTERVAL

SCALE 1:100,000

Projection: T.M. CLARKE 1858	Drafted, Date: MSM 5'85	Drawing Number: 85XP-4198
Contour Interval: 20 MILLISECONDS	Chief Draftsman	File Nº Z-4
Datum.		Enclosure 2C
Supervisor.		
Compilation: B. FINLAYSON	Date MARCH '85	




139°45'
139°50'
139°55'
28°10'
28°15'
50/40/10 AREA
50/40/10 MOOMBA AREA
50/40/10 MOOMBA AREA P.P.L. 10
PROPOSED SPENCER No.2
SPENCER 1
WIRRARIE 1
TOPWEE 1
4341-7
DELHI PETROLEUM PTY. LTD.
1980 KARAWINNIE SEISMIC SURVEY
SPENCER AREA, MURTA BLOCK
P.E.L. 5 & 6, SOUTH AUSTRALIA
'C' HORIZON STRUCTURE
SCALE 1 : 60 000
KILOMETRES
MILES
DELHI
T.M. PROJECTION CLARKE 1858
Contour Interval : 100 Feet
Datum : 0' MSL Pt. ADELAIDE
Chief Geophysicist :
Interpretation : J. IREDALE
Drafted, Date MSM, 10/81
Chief Draftsman
Date OCT 1981
Drawing Number 81XP-0822
Enclosure 3A
Base Dwg. No.: 81XP-0821
File · RC-42



DELHI PETROLEUM PTY. LTD.

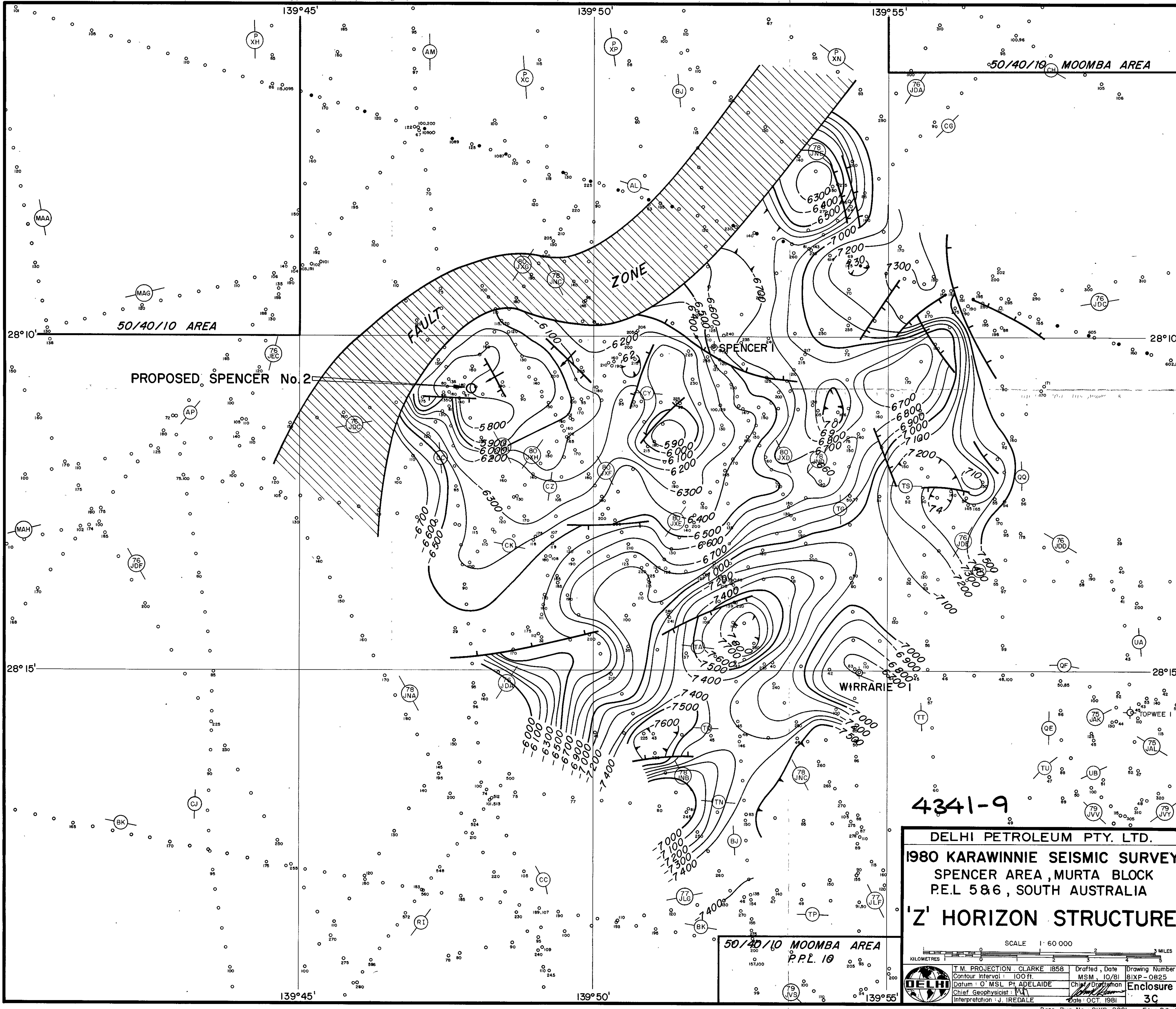
1980 KARAWINNIE SEISMIC SURVEY
SPENCER AREA, MURTA BLOCK
P.E.L. 5 & 6, SOUTH AUSTRALIA

'P' HORIZON STRUCTURE

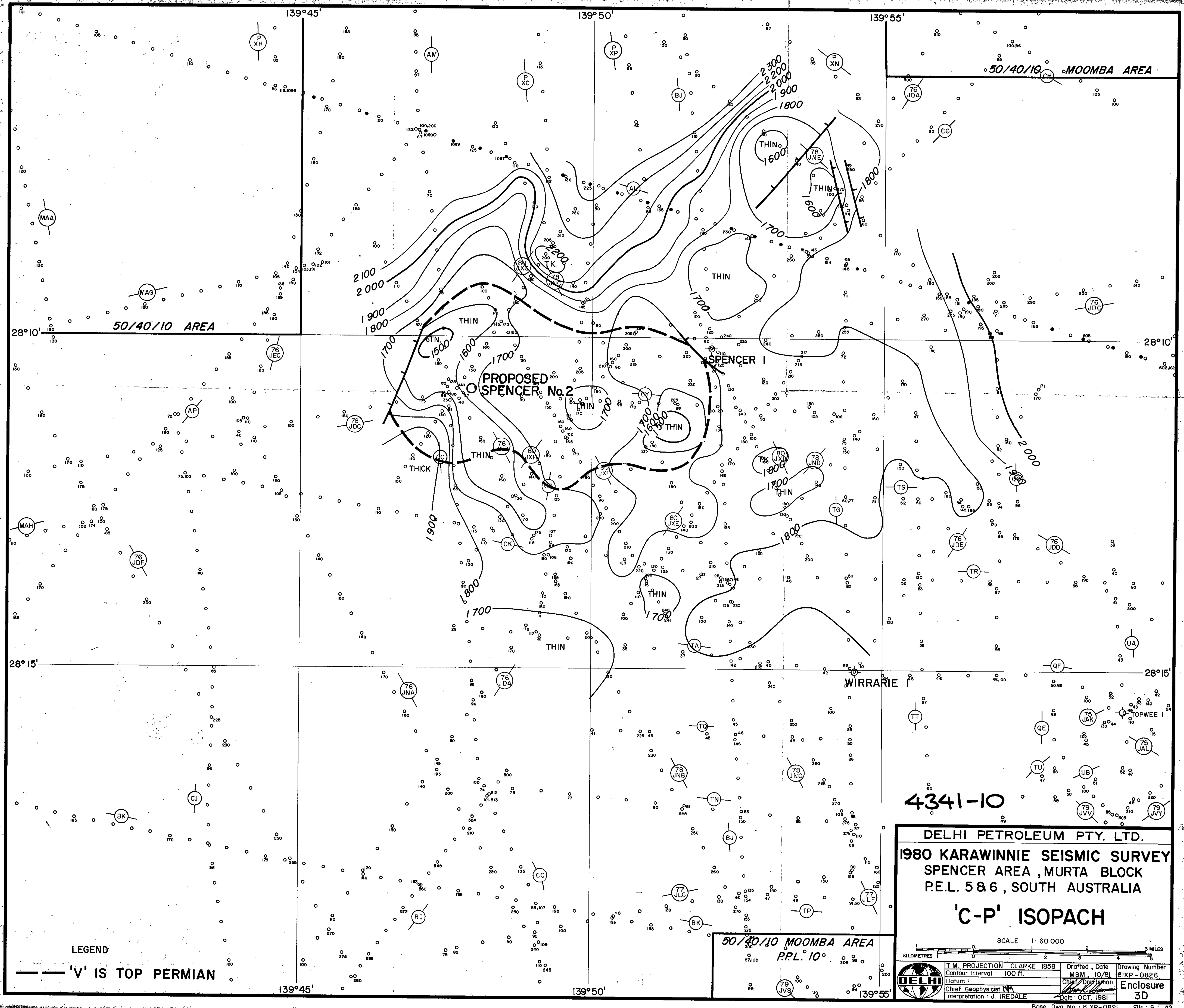
SCALE 1:60 000

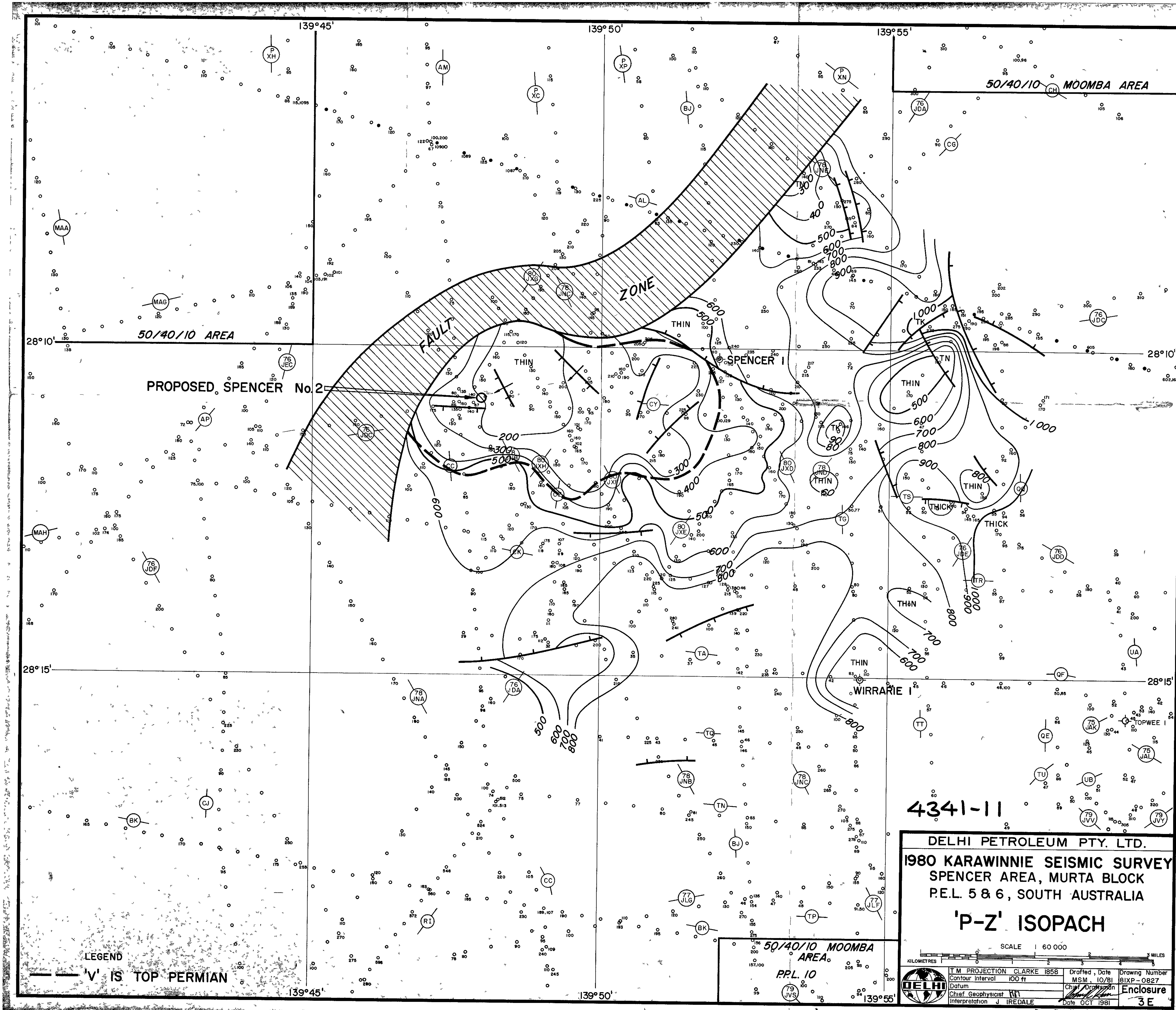
T.M. PROJECTION CLARKE 1858	Drafted, Date MSM, 10/81	Drawing Number 81XP-0824
Contour Interval: 100 ft.		
Datum: 0' MSL Pt. ADELAIDE	Chief Draftsman	Enclosure 3B
Chief Geophysicist:		
Interpretation: J. IREDALE	Date: OCT. 1981	

Base Dwg. No.: 81XP-0821 File: RC-42



Base Dwg No. : 81XP-0821 File : RC-42


139°45'
139°50'
139°55'
28°10'
28°15'
50/40/10 MOOMBA AREA
50/40/10 AREA
50/40/10 MOOMBA AREA
P.P.L. 10°
PROPOSED SPENCER No.2
SPENCER I
WIRRARIE I
TOPWEE I
THIN
THICK
4341-10
LEGEND
'V' IS TOP PERMIAN
DELHI PETROLEUM PTY. LTD.
1980 KARAWINNIE SEISMIC SURVEY
SPENCER AREA, MURTA BLOCK
P.E.L. 5 & 6, SOUTH AUSTRALIA
'C-P' ISOPACH
SCALE 1 : 60 000
KILOMETRES
MILES
T.M. PROJECTION CLARKE 1858
Contour Interval : 100 ft.
Datum :
Chief Geophysicist
Interpretation : J. IREDALE
Drafted, Date MSM. 10/81
Chief Draftsman
Date OCT. 1981
Drawing Number 81XP-0826
Enclosure 3D
Base Dwg. No. : 81XP-0821
DELHI



139°45'
139°50'
139°55'
28°10'
28°15'
50/40/10 AREA
50/40/10 MOOMBA AREA
FAULT ZONE
PROPOSED SPENCER No. 2
SPENCER 1
WIRRARIE 1
TOPWEE 1
THIN
THICK
4341-11
DELHI PETROLEUM PTY. LTD.
1980 KARAWINNIE SEISMIC SURVEY
SPENCER AREA, MURTA BLOCK
P.E.L. 5 & 6, SOUTH AUSTRALIA
'P-Z' ISOPACH
SCALE 1 60 000
KILOMETRES
MILES
T.M. PROJECTION CLARKE 1858
Contour Interval 100 ft
Datum
Chief Geophysicist
Interpretation J. IREDALE
Drafted, Date MSM, 10/81
Chief Draftsman
Date OCT 1981
Drawing Number 81XP-0827
Enclosure 3E
50/40/10 MOOMBA AREA
P.P.L. 10
LEGEND
'V' IS TOP PERMIAN
Base Dwg No 81XP-0821
File RC-42