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SYDNEY OIL COMPANY (ARUNTA) PTY LIMITED

INTERPRETATION REPORT OP 236

GEOPHYSICAL AND GEOLOGICAL OPERATIONS

1984-1985

Prepared by: M. Van Schoten/R.J. Schroder/ S.H. Perlman Date: January 1986

Approved by: .... Geology Date: 12.3.86

.... Geophysics Date: 20.3.86

.... Management Date: 1.4.86

1986/5

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1. SUMMARY

Investigation of the recently acquired data from the 1984-1985 work programme has provided the following conclusions about OP 236:

1. It lies south of the main Amadeus Basin depocentre. The youngest prospective sediments are Devonian to Carboniferous in age. Seismic horizon identification is difficult and evidence sometimes contradictory (see page 13), but over 4 km of Upper Proterozoic to Upper Palaeozoic sediments are indicated in some areas.

2. A major east-west hinge-line in the north was probably active throughout sedimentation.

3. Upper Proterozoic and Cambrian carbonates and sandstones, with some shales, are thought to occur in large areas of the permit; and Ordovician to Upper Devonian sandstones and shales with minor carbonate occur within relatively small sub-basins in central areas of the permit. These lithologies tend to become sandier in western and southern directions.

4. The permit can be divided into 3 provinces (west, north, east/south) with different structural elements, based on aeromagnetic, photogeological and gravity trends. In the west of the permit structures trend northwesterly and anticlines show an en-echelon character suggestive of strike-slip movement. In the north, an east-west grain is apparent, while in east and southern areas a northeasterly trend is mapped.

5. The permit has been subject to intense compressional and possibly wrench tectonics, primarily as a result of the Alice Springs and Petermann Ranges Orogenies. These deformations have produced tight folding and thin fault slices much of which cannot be resolved or even identified by routine seismic exploration. Faulting is commonly high angle reverse, with the northern block uplifted (possibly reactivated normal faults), or of normal character.

6. At least nine areas host anomalously high microseepages of hydrocarbons, six of which occur over anticlinal structures. It is unclear whether these anomalies reflect hydrocarbon accumulations or are simply a reflection of the maturity of the source rocks. Some of these anomalies are correlated with faulting.

7. The perceived hydrocarbon potential is as follows: the Ordovician Larapinta Group contains the most prospective sediments for oil; the shales are probably mature, oil prone and the reservoirs porous. The Cambrian rocks are likely to have limited oil source potential, but are mature and have adequate porosity and permeability. Late Proterozoic rocks probably have oil source potential (especially the Bitter Springs Formation), should be mature but are expected to have poor reservoir potential. High risk is associated with seal and trapping configurations at all levels.

8. Areas are indicated for further study, but no large unbreached prospects worthy of a 2000m test have been identified by the present work.

AMADEUS BASIN
GENERALISED STRATIGRAPHY

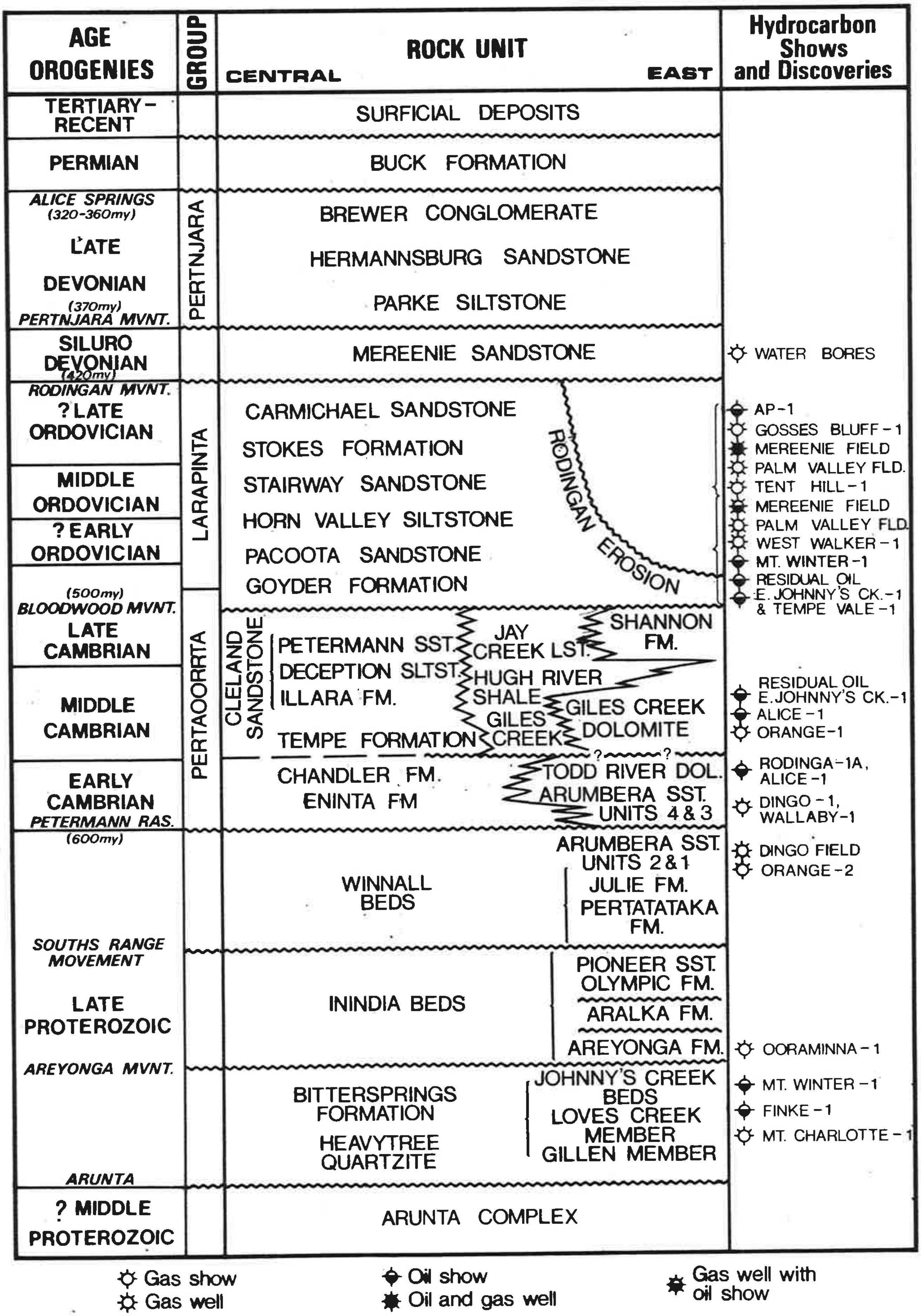


Figure 2

2. INTRODUCTION

The Amadeus Basin is an 800 kilometre long east-west trending intracratonic depression extending across the Northern Territory south of 23° 30" south. An intensely folded and faulted late Proterozoic to Upper Palaeozoic sedimentary section in excess of 10,000 metres is contained within the Basin. OP 236 lies wholly within the Basin between latitudes 24° 00" south and 25° 00" south and longitudes 131° 15" east and 133° 30" east, and is 8,839 square kilometres/2.18 million acres in area, see Figure 1.

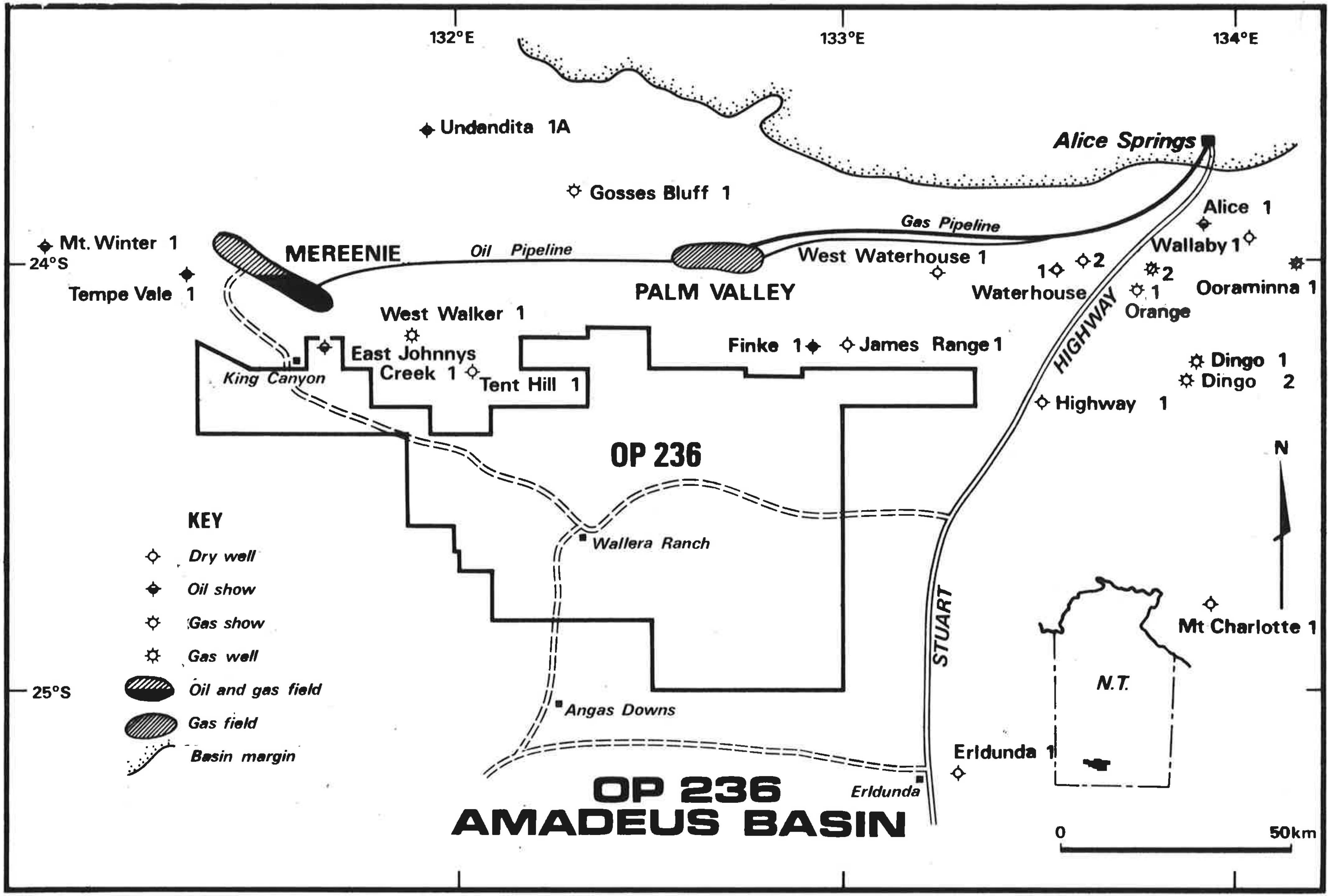
3. GEOGRAPHICAL SETTING

OP 236 is situated approximately 175 kilometres south-west of Alice Springs, Northern Territory. The permit boundary is 20 kilometres southeast of the Mereenie Oil and Gas Field and 20 kilometres south of Palm Valley Gas Field. OP 236 lies immediately south and incorporates part of the James Ranges and strike ridge bluffs of the Walker, Parana Hill, and Johnny Creek anticlines.

The permit is largely sand covered; however, areas of outcropping sediments exist in the centre and north of the permit. Most of the dunes are stabilised by spinifex and scrub cover with large desert oaks proliferating. River gums abound along water courses.

4. ACCESS

The permit is served by a good dirt road which joins the Stuart Highway at Henbury, approximately 130 kilometres south of Alice Springs. Wallera Ranch (near the centre of the permit) and Kings Canyon (a popular tourist resort just outside its northwestern boundary) are on this road. Access from the south is by a good road via Angas Downs which joins the Stuart Highway at Erldunda. The access away from roads is difficult, due to the presence of steep dunes of fine grained sand, and thick scrub. The southeastern part of the permit is poorly served by either seismic tracks or roads. The northern margin of the permit is largely inaccessible to vehicular traffic due to the rugged topography. Enclosure 1 is a map of the Amadeus Basin showing regional structural and geographical features.



132°E
133°E
134°E
24°S
25°S
Undandita 1A
Gosses Bluff 1
Alice Springs
Alice 1
Gas Pipeline
Mt. Winter 1
MEREENIE
Oil Pipeline
Wallaby 1
West Waterhouse 1
1
2
2
Tempe Vale 1
PALM VALLEY
Waterhouse
1
Ooraminna 1
Orange
West Walker 1
HIGHWAY
Finke 1
James Range 1
East Johnnys
Creek 1
Dingo 1
King Canyon
Tent Hill 1
Dingo 2
Highway 1
OP 236
N
KEY
Dry well
Oil show
Gas show
Gas well
Oil and gas field
Gas field
Basin margin
Wallera Ranch
STUART
Mt Charlotte 1
N.T.
Angas Downs
Erldunda 1
Erldunda
OP 236
AMADEUS BASIN
0
50km

FIGURE 1

5. REGIONAL GEOLOGICAL SETTING

The Amadeus Basin is a Late Proterozoic to Mid Palaeozoic depression, which has been subjected to two major episodes of tectonic deformation. The major structural elements of the Basin are shown on Enclosure 1. The Basin margin is overthrust in the north by the Arunta Complex and in the south by the Musgrave-Mann Complex. The western margin is sand covered and the eastern margin is obscured by sediments of the Pedirka and Eromanga Basins. The stratigraphic column of the Amadeus Basin is presented in Figure 2.

Stratigraphy, palaeography, and tectonic history have been described by Jackson et al (1984). The following is adapted from their work:

5.1 Stratigraphy and Palaeogeography

5.1.1 Late Proterozoic

Sedimentation in the Amadeus Basin began during the Late Proterozoic with the deposition of the Heavitree and Dean Quartzites. These sands accumulated on a stable epicontinental shelf during a transgressive marine phase. Subsequent shallowing of the Basin led to the deposition of the carbonates, evaporites (including salt), and clastics of the Bitter Springs Formation in restricted, euxinic, and locally hypersaline marine waters. This formation contains source beds, reservoir rocks, and seals, and is an exploration objective throughout the Basin.

The Areyonga Movement uplifted blocks along the western, northern and southern margins of the Basin thereby increasing sedimentation in the Basin. Consequent paralic deposition occurred in the north (Areyonga Formation), and paralic and possibly continental deposition in the south (Inindia Beds).

Renewed uplift of a southern provenance area during the Souths Range Movement resulted in deposition of shallow marine sandstones and shales in a southern trough (the Winnall Beds), while carbonates (Julie Formation) and fine-grained marine clastics accumulated on a northern shelf (Pertatataka Formation). These two depocentres were separated by an east-west trending hinge-line. The northern land mass by this time had become a less significant source of sediment.

The Late Proterozoic phase of deposition was terminated in the southwest by a period of mountain building, recumbent folding and northward overthrusting associated with the Petermann Ranges Orogeny. The Petermann Ranges Nappe, exposed on the southwestern margin of the Basin, is the major structural feature resulting from this orogeny. Salt within the Bitter Springs Formation is believed to have acted as a decollement surface for the thrusting. Molasse sediments were shed to the north and northeast, and deposited in a predominantly deltaic environment (Arumbera Sandstone). The Petermann Ranges Orogeny shaped the framework of the Palaeozoic basin which had an east-trending depocentre north of the present Basin margin.

5.1.2 Early Palaeozoic

During the Cambrian, continental sedimentation persisted in the west (Cleland Sandstone), while shallow marine shales, carbonates and evaporites were deposited in the east (Shannon, Giles Creek and Chandler Formations). Bedded evaporites in the Chandler Formation may seal the underlying Arumbera Sandstone in the eastern part of the Basin. A widespread transgression in the Late Cambrian lead to the deposition of the overlying Goyder Formation. Intertidal flats and barrier bars (Pacoota Sandstone) formed landward of this open shelf. Deepening water in the Early Ordovician resulted in deposition of euxinic marls, muds and silts (Horn Valley Siltstone). Younger Ordovician sediments (Stairway Sandstone and Stokes Formation) were deposited in similar environments to the Pacoota Sandstone during subsequent transgressive and regressive cycles. A final Ordovician regression led to sedimentation in a dominantly estuarine environment (Carmichael Sandstone). The Pacoota Sandstone and Stairway Sandstone, sealed by the Horn Valley Siltstone and the Stokes Formation respectively, are primary exploration targets.

A marine regression during the Early Silurian, caused by uplift associated with the Rodingan Movement in the northeast, led to the erosion of 1-3 kilometres of Cambro-Ordovician section from the eastern part of the Basin. Arid climatic conditions became established over the emergent land mass. During the Early Devonian, sediments were transported from the eastern desert areas by aeolian and fluvial action and deposited, in part, in a shallow sea transgressing from the west (Mereenie Sandstone).

5.1.3 Late Palaeozoic to Recent

Late Devonian uplift of the Arunta Block along the present northern margin of the Amadeus Basin marked the onset of the Alice Springs Orogeny. Continental deposition continued as thick molasse deposits (Pertnjara Group) accumulated in an adjacent foredeep. The Parke Siltstone was deposited under lacustrine conditions which prevailed locally. The Hermannsburg Sandstone was deposited under widespread alluvial fan/alluvial plain environments, with marine influence in the south. The Brewer Conglomerate formed a sedimentary wedge which depositionally thinned southward from some 3000 metres to 1500 metres in 17 kilometres. After this phase of uplift, and until the Early Carboniferous, the Alice Springs Orogeny caused widespread tectonic deformation throughout the Basin.

The Amadeus Basin has been relatively stable since the Mid-Carboniferous although subsequent extensive erosion led to the present exposure of Proterozoic rocks in the cores of some anticlines. Triassic to Cretaceous sediments are absent and it is thought that this area suffered continuous erosion from the Permian. Deposition and subsequent erosion of Triassic to Cretaceous rocks cannot be ruled out. Measured vitrinite reflectance (near Alice Springs) of coal in the Brewer Conglomerate averages 0.66% and therefore over 1km of cover could have existed in the area.

5.2 Tectonic History

The Late Proterozoic Petermann Ranges Orogeny and the Late Devonian to Early Carboniferous Alice Springs Orogeny controlled present day structural expression and potential hydrocarbon traps within the Basin. Of the two orogenies, the latter is believed to define the timing of trap formation in all but the southwestern and southernmost regions of the Basin. Structural features related to the earlier Petermann Ranges Orogeny are evident, particularly in the southwest, but are less apparent elsewhere.

In the permit area there is evidence for structural growth in Early Palaeozoic time. Cook (1966), after a study of the Illamurta and Seymour Range structures suggests that growth has occurred at varying rates on these (salt cored?) structures as is the case with the Goyder Pass Structure.

Structures resulting from the Late Devonian to Early Carboniferous deformation are well exposed at the surface. In the eastern part of the Basin, recumbent nappes and overthrusts formed in the Arunta Complex while folds, strike-slip faults and thrust sheets deformed the overlying sedimentary section. The central and western parts of the basin are characterised by numerous large-scale folds, e.g. the Mereenie Anticline. Fold axes trend east-west in the centre of the Basin, but further west are aligned northwest-southeast. Folds are periclinal, commonly asymmetric, and in some cases have thrust-faulted cores.

Halokinesis within the Bitter Springs and Chandler Formations generated salt domes and piercement structures throughout the Basin. Studies of the Goyder Pass and Illamurta Structures indicate that migration of salt in the Bitter Springs Formation began in the Late Proterozoic, and continued thereafter at different rates until the Devonian. The timing of Chandler salt movement is less certain. Many of the salt-induced structures were affected by subsequent overthrusting.

The tectonic history of the Basin is not a simple one, as it embraces at least 6 tectonic events. However, most of the major structural features in the basin are, at least in part, related to the Alice Springs Orogeny.

6. SUMMARY OF PREVIOUS WORK

Frome-Broken Hill Pty Limited was the first company to explore for hydrocarbons in the Amadeus Basin conducting geological and geophysical investigations in 1958. The stratigraphy and structural geology of the Basin have been studied by groups led by the Bureau of Mineral Resources, Exoil Pty Limited and Magellan Australia Petroleum Limited. Regional gravity, aeromagnetic and radiometric surveys conducted for the Bureau of Mineral Resources provide regional coverage of the permit and delineate major structural sub-divisions of the Amadeus Basin.

Petroleum exploration drilling was begun by Exoil in 1963 with the drilling of Ooraminna #1 and continued into the very early 1970s. Since 1980, the pace of work has accelerated. Pancontinental Petroleum Limited has been active in OP 175 and OP 178 to the north of OP 236, while Weeks Australia Limited has flown the Curtin Springs Aeromagnetic Survey and shot two seismic surveys in OP 213 and OP 214 south of OP 236.

Since 1963, 34 exploration wells have resulted in discoveries of oil and gas from the Mereenie Anticline and gas from Palm Valley, Walker Creek and Dingo Anticlines.

6.1 OP 236

The area included in this permit formed part of OP 175 which was mandatorily relinquished by the OP 175 Joint Venture in May 1982 with no seismic conducted nor well drilled by the joint venture.

Only 95 kilometres (59 miles) of seismic data had been acquired and one petroleum exploration well drilled within OP 236 prior to 1985.

Exploration in the permit area began with regional mapping and drilling by the Bureau of Mineral Resources in the early 1960s. In 1963, the Henbury and Lake Amadeus 1:250,000 sheet areas were geologically mapped. Four shallow bore holes (AP-1, AP-2, AP-3, Henbury #4) were drilled through the Stairway Sandstone and Horn Valley Siltstone. AP-1 encountered good oil shows in the basal Stairway Sandstone. AP-1, AP-2 and AP-3 were later renamed Lake

Amadeus #1, and Henbury #1 and #2, respectively. B.M.R. Henbury #5 provides a continuously cored section through the Cambrian Tempe Formation almost to its base. Geological mapping by Magellan (Hopkins 1964) led to the drilling of East Johnny's Creek #1 petroleum exploration well which encountered hydrocarbon indications in the Cambrian and Ordovician sandstones and late Proterozoic vuggy carbonates. Magellan in 1970 shot seismic line SR-A in the southeast of the permit. 95 kilometres of six fold data were recorded using cord explosives as a source. Considerable Proterozoic to Early Palaeozoic section was indicated as a result of this survey.

BMR Record 1964/95 J. Barrie
Phosphate Drilling. Amadeus Basin
AP1, AP2, AP3, AP4.
Lake Amadeus 1 Henbury 1, 2 Lake Amadeus 2

BMR Record 1985/9 M. Owen & D.C. Morris
BMR Stratigraphic Drilling in the Amadeus
Basin Northern Territory 1983
Henbury 4, 5, 6.

7. OP 236 RECENT WORK PROGRAMME

The 1984/1985 work programme was undertaken by the OP 236 joint venture partners. Details of most of the programmes undertaken and associated reports and illustrations produced by this work are summarised in the Annual Report, OP 236, Amadeus Basin, Northern Territory, Permit Year 1: 3 July 1984 to July 2, 1985.

Listed below are the reports generated by the 1984/1985 work programme:

1.	OP 236 Amadeus Basin Aeromagnetic Survey Northern Territory	Geometrics (Pratt 1985a)
2.	Wallera Ranch Seismic Survey	Western Geophysical (Douglass 1985) (Hosking Geophysical 1985)
3.	OP 236 Soil-Geochemical Survey	Petrofocus Pty Limited (Ryall 1985)
4.	Geological Cross Sections OP 236	Sydney Oil Company (Arunta) Pty Limited (Van Schoten 1985a)
5.	Photogeology OP 236	Sydney Oil Company (Arunta) Pty Limited (Van Schoten 1985b)
6.	Outcrop Field Mapping OP 236	Sydney Oil Company (Arunta) Pty Limited (Van Schoten 1985c)
7.	Geological Sampling of BMR Seismic Survey shotholes and selected water bores, OP 236	Sydney Oil Company (Arunta) Pty Limited (Van Schoten 1985d)

8. AIMS OF EXPLORATION EFFORT 1984/85

The intention of the recent work programme was to evaluate the permit on the basis of:

1. structure,
2. potential sedimentary section,
3. hydrocarbon potential.

Upon completion of the programme it has been possible to:

1. establish trends of anticlines and synclines (seismic gravity/aeromagnetics),
2. establish location of potentially petroliferous areas (soil-gas geochemistry),
3. deduce structural style and tectonic history (seismic/geological mapping),
4. assess the hydrocarbon potential of OP 236 in relation to plays in Ordovician, Cambrian and Late Proterozoic rocks,
5. generate leads for follow up work programme.

9. GRAVITY

A detailed gravity survey by Wongela Geophysical was run in conjunction with the Wallera Ranch Seismic Survey. A total of 186km of data were acquired over the seven seismic lines at 210m station spacing. These data have been incorporated into the BMR regional gravity data base. Enclosure 2 is a compilation of the 11km spacing BMR Regional Gravity and detailed Bouguer Gravity in the Henbury and Lake Amadeus sheet areas calculated with a rock density of 2.67 g/cc. Considerable increase in definition of the broad scale tectonic framework of OP 236 was accomplished by this survey.

9.1 Interpretation

Recognisable trends are:

(1) a regional increase in Bouguer Gravity from north to south from approximately -100mgal to -60 mgal; and

(2) east west linears (in the north and southeast) or northwest linears (central and west) (Enclosure 2).

Regional geological features are easily discernible. Large highs are present in the south/southwest (Angas Downs Gravity Ridge) and in the east (Mt. Burrell Anticlinorium). The Amadeus Basin Trough to the north is represented, and major embayments from this trough exist in an east-west orientation through the centre of OP 236 (Enclosure 2).

The gravity highs and lows in OP 236 are considered to reflect the areal extent of basement highs and lows.

Qualitative analysis of this data suggests that the gravity response strongly reflects the Mereenie Sandstone and Bitter Springs Formations in subcrop and differentiates Cambro-Ordovician and Proterozoic rocks in the subsurface.

10. SEISMIC

10.1 Acquisition and Processing

The Wallera Ranch Seismic Survey was conducted in OP 236 for the OP 236 Joint Venture during the first permit year. A total of 186 kilometres of 12 fold vibroseis data was acquired from February 7 to March 3 1985.

Prior to shooting seismic in OP 236 it was known that the previous workers (Ripper & Smith 1982, Schroder and Gorter 1984) experienced tremendous variations in seismic data quality. Many areas were devoid of coherent reflectors due to lack of sedimentary section or tight, complex structuring. Therefore the Wallera Ranch seismic survey was programmed in a regional fashion to help locate areas of good data quality for follow up work. A total of 7 dip lines were shot within the block between areas of sedimentary outcrop. The eastern lines of the survey were programmed to tie with the existing Magellan seismic line SR-A. No well ties were possible, and no strike tie lines were used because of the probability of bad ties in poor data zones.

Generally data quality was poor to fair. Very poor data were recorded sporadically through the survey. Approximately 72 kilometres of the 186 kilometres of seismic collected in the survey contained coherent, potentially mappable reflectors (see Table 1).

Hosking Geophysical Company was contracted for seismic processing. Final stacks were available by May 1985 and migrated stacks by July 1985.

10.2 Horizon Identification

Decisions regarding a reflector's age and stratigraphic position were based upon qualitative analysis of gravity and aeromagnetic data, outcrop information, reference to stratigraphic cross sections and identification of unconformities. However, the poor data quality, lack of well and seismic ties, together with sparse outcrop information made positive identification difficult. Plots of seismic interval velocities versus depth in areas of good data quality were compared with formation interval velocities for exploration wells adjacent to OP 236 to provide corroborative evidence for the stratigraphic interpretations (Table 2).

On the basis of the above, five seismic horizons were identified (Figure 2):

1. Base Mereenie Sandstone
2. Top Pacoota Sandstone
3. Base Cambrian (Arumbera, Tempe/Chandler)
4. Top Bitter Springs (Love's Creek Member)
5. Intra-Proterozoic (probably Bitter Springs Gillen Member)

These "picks" were first identified on lines WR-04, WR-05 and WR-07, which have best seismic data quality and thickest sedimentary section (Enclosures 3-9).

The Base Mereenie Sandstone horizon is a fairly weak, discontinuous reflector which is unconformable to the underlying Ordovician and Cambrian formations.

The Top Pacoota Sandstone horizon is a strong and semi-continuous reflector. At VP280 line WR-05 it is tied to a Pacoota sandstone outcrop recognized from field mapping. The suite of reflections between the Mereenie Sandstone and Base Cambrian horizons are Cambro-Ordovician rocks that can be correlated on lines WR-04 and WR-05. Additional evidence for the presence of Cambro Ordovician rocks at this locality is afforded by:

1. a lower than regional gravity response, and
2. moderately fast interval velocities.

The Base Cambrian reflector appears strong and coherent on many lines from the Wallera Ranch survey. This reflector is unconformable on lines WR-04 and WR-05. Pre-Cambrian rocks are indicated to have been uplifted and eroded following the Petermann Ranges Orogeny.

Immediately above the Base Cambrian horizon high interval velocities support the presence of a dense formation thought to be limestones of the Tempe Formation.

The Top Bitter Springs Formation reflector is a strong, fairly coherent event that has undergone intense folding, faulting, thrusting and erosional truncation. Identification as Bitter Springs Formation is dependent upon:

1. proximity to outcrop information,
2. a dense gravity signature, and
3. fast interval velocities.

The Intra-Proterozoic event is the last semi-continuous horizon. Loss of seismic character below this reflector could result from either:

(a) salt tectonics or
(b) presence of basement.

Occasionally discontinuous and poor reflectors are seen below the Intra-Proterozoic reflector e.g. (1.7 seconds, VP760 line WR-05). These reflections often exhibit contrary dip and may be a consequence of salt flow or major thrusting.

10.3 Interpretation

Reproductions of the final interpreted seismic sections in OP 236, with the above five horizons marked on them, have already been distributed to the OP 236 joint venture partners. Interpreted compressed sections are included in this report (Enclosures 3-9).

Two-way time structure maps were produced for the top Pacoota Sandstone, and top Bitter Springs Formation (Enclosures 10 and 11). The Pacoota Sandstone is a major hydrocarbon producer in the basin and therefore is considered the primary objective for hydrocarbon exploration in OP 236. The Pertaoorrta Group and Bitter Springs Formation have hydrocarbon potential but because of less favourable source and reservoir conditions than in the Larapinta Group, are secondary targets (see chapter 12). The maps therefore show that the Pacoota Sandstone play has limited potential and that the secondary targets are more widespread in OP 236.

Enclosure 12 shows the zones of good seismic data quality. Interpretation reliability within these zones is considered to be fair. Enclosure 13 shows possible faults identified on the seismic lines. The trend of the faults is based on an interpretation of the seismic, magnetic, gravity and geologic control. The fault slices are thin and range in width from less than 1 kilometre to almost 5 kilometres. The area of OP 236 which is undisturbed by faulting is relatively small. The highly dissected nature of OP 236 further downgrades its hydrocarbon potential.

10.3.1 Detailed Seismic Line Interpretation

Line WR-01 (Enclosure 3) demonstrates a large anticline at VP400; this feature has been mapped at all levels and trends north-west by south-east. The structure is slightly asymmetric with a steep southern limb and uplifted northern flank. A north dipping thrust is mapped near the crest of the structure. Data quality is poor over its crest, however the possibility of rollover on the sub-thrust Bitter Springs Formation exists. Dramatic thinning between Base Cambrian and Bitter Springs Formation suggests growth through the Late Proterozoic. Salt injection along the fault plane may explain poor data quality and anomalously low gravity at the crest of the structure.

Line WR-02 (Enclosure 4) is of poor quality, resulting from intense faulting along proposed, up to the north, high angle reverse faults. At VP320 this uplift brings the Bitter Springs Formation close to the surface. Deformation has been late, affecting the Mereenie Sandstone. Based on outcrop control the Base Cambrian unconformity must have incised deeply into the Proterozoic section north of VP400. Seismic lines are of little help in this area of poor data quality. A further structural lead is indicated at VP502. The depth to the top of the Bitter Springs Formation is 300 metres sub-sea at VP390.

Line WR-03 (Enclosure 5) is the line of poorest seismic quality. It lies across a complex zone of aeromagnetic trends. Ancient eroded highs occur at VP250, VP582 and VP894. The Winnall and Inindia Beds are eroded at the crests of these highs; however, the Bitter Springs Formation appears to be preserved. The Base Cambrian, Top Bitter Springs and Intra-Proterozoic have been intensely folded and faulted. Faulting is thought to be high angle reverse up to the north. Normal block faulting is also apparent. Flat lying reflectors close to the surface in the northern section of the line are of unknown age.

Line WR-04 (Enclosure 6) has some windows of good data quality. In the middle of the line a syncline preserves approximately 2700m of section above the presumed Bitter Springs Formation. Reflectors at 0.55 sec are proposed to be Pacoota Sandstone. This is suggested because the sediments in the syncline have the same seismic character and a similar (low) gravity response as the known Palaeozoic sediments on line WR-05. Additionally, photogeological trends suggest continuity with Palaeozoic outcrop near line WR-03. However the only outcrop is in the south near VP400, and is mapped as Winnall Beds by the BMR. Field work has confirmed Winnall Beds dipping at between 30°N and 50°N at this locality.

The sedimentary sequence thins from north to south onto a pronounced high. High residual gravity response south of VP400 suggest shallow Proterozoic rocks there. There are three large anticlines which have lost the lower Palaeozoic section over their crests. Fault movement has been along both reverse and normal faults. A major down to the south normal fault occurs at VP660. Further to the south a possible flower structure occurs between VP320 and VP440. Up to 0.8 seconds of throw occurs across the fault. A second possible flower structure occurs in the middle of a syncline between VP520 and VP560.

Line WR-05 (Enclosure 7) has the best seismic quality in OP 236. Definition and continuity of reflectors is fair to good as are horizon identification and seismic interpretation. Cambro-Ordovician outcrop control affords confidence in horizon identification on this line. The Base Cambrian unconformity is quite pronounced and acts as an excellent marker. Above the Bitter Springs reflector and below the Base Cambrian reflector a bland zone with few reflectors indicates a thick late Proterozoic section. Faulting is either reverse or normal. A large normal fault similar to that on line WR-04 is evident at VP600, with 0.8 seconds downthrow to the south.

Line WR-06 (Enclosure 8) is of poor to fair quality and of poor reflector continuity. Outcrop ties are fair in the south and poor in the north. Seismic data quality is poor in the south due to either steep dip and/or severe faulting. A change in seismic character at VP560 occurs at a transition zone from high regional gravity values in the south to a low in the north. Seismic data showed that a major strike slip (?) fault cuts the late

Proterozoic rocks at this location. Faulting, either high angle normal or reverse separates zones of good and bad quality. To the north the Bitter Springs Formation is uplifted to less than 300 metres sub-sea at VP840.

Line WR-07 (Enclosure 9) is structurally complex with a deterioration of seismic quality over structural highs. Outcrop control is fair and the gravity profile reflects the Base Cambrian unconformity. Most of the structures on the line are bald of the Cambro-Ordovician section and are intensely faulted. Faulting is of a similar style to that on other lines and affects all of the section. The Proterozoic thins to the north and to the south. It has a maximum thickness at the Petermann Creek Anticline between VP800 and VP1000. Therefore subsidence in the Proterozoic, and structural growth in the Late Palaeozoic has occurred in this region.

11. GEOLOGICAL INTERPRETATION

11.1 Discussion

Due to the distance between the lines and lack of any tie lines only a broad regional interpretation is possible. Correlations between lines on the maps (Enclosures 10-13) are conceptual and rely on regional trends such as those from the OP 236 aeromagnetic survey (Enclosure 14): additionally, broad magnetic highs suggested sub-cropping Bitter Springs Formation.

The permit can be divided into three provinces on the basis of the recently acquired data. In the west structures trend northwesterly. Anticlines show an en-echelon character suggestive of eastwest strike slip movement. The northern part of the permit has an east-west structural grain. In the east and south a northeasterly grain is apparent. These trends are best seen in the areas of good outcrop skirting the northern permit boundary. Trends can be best identified on data that offers complete coverage such as airphotos, aeromagnetic and to a lesser extent gravity. These sub-divisions have been used as a framework for the seismic interpretation. The various and contrary trends are best displayed by reference to the top Bitter Springs Formation time structure map (Enclosure 11).

In OP 236 structuring has strongly affected the whole sedimentary section producing bald highs and preserving pockets of section in synclines. The Ordovician and younger sediments are not as extensive on seismic lines, but where present, have also been strongly deformed. Most structures appear to be late formed as is shown by the relatively constant time thickness between horizons across faults. Regional thinning of the whole stratigraphic sequence from north to south is evident especially on lines WR-01 and WR-04. However some unconformable strata high in the section on seismic lines may be Ordovician (or younger) resulting from the Bloodwood and Rodingan movements. Cook (1966) has demonstrated thinning in the middle Palaeozoic strata, and pronounced Rodingan and Pertnjara age unconformities on the Illamurta Structure.

A compressional tectonic style is recognised from the seismic data, and outcrop expression is indicative of wrench tectonics. The gentle style of folding present in the northern Amadeus Basin is replaced in OP 236 by a highly fragmented, tight and contorted fault and fold system. Relative displacements are commonly up to the north along high angle reverse or reactivated normal faults. Evidence for wrench tectonism with basement involvement (quite unlike the decollement style proposed for the Amadeus Basin (Wells et al, 1970)) is indicated by flower structures (lines WR-04 and WR-07) and high angle reverse faults. Suggestion of basement faulting can be seen on lines WR-04 and WR-06 and is supported by gravity and aeromagnetic control.

Throughout the western half of the permit structures are tightly folded and faulted along northwesterly trending strike faults. Two en-echelon anticline trends are evident, separated by approximately 10 kilometres across strike. Half grabens bound the southern edge of these anticlinal trends.

The structural trend is similar to that described by Weeks Australia in the north of OP 213 and OP 214 south of OP 236. Ripper and Smith (1982) found that late Proterozoic structures, spaced at 9 kilometre intervals across strike, have a northwesterly trend and are bounded on the northern side by south dipping strike faults where the southern block has overridden the northern block. Consequently half grabens have been preserved especially at Mt. Ebenezer. Movement was during the early Cambrian Petermann Ranges Orogeny.

In the east of the permit the gravity, aeromagnetic and outcrop data imply a northeasterly trend. Palaeozoic and Proterozoic sediments are preserved in two large lows running through the northern part of line WR-06 and through the central southern parts of line SR-A respectively. A major northeast trending, up to the south, reverse fault with possible left lateral strike slip movement is postulated to account for the depression on line SR-A and to explain the displacements in the Seymour Ranges and outcrops to the north. It is likely that major faulting in this area was late (Alice Springs orogeny) due to the fairly constant stratigraphic time thicknesses. However, thinning of intervals between the Base Cambrian and Top Bitter Springs horizons on lines WR-06 and WR-07 suggest palaeo-highs existed in the Cambrian near the southern end of line WR-07 and the middle of line WR-06 (probably extensions of the Mt. Burrell Anticlinorium to the east).

In the north of OP 236 structures are orientated east-west. These are tightly folded, elongate and bounded to the south by high angle reverse faults and flower structures with the northern block uplifted. The Proterozoic/Cambrian sequence is deformed and rejuvenated folding has occurred post Cambrian. A slight unconformity is indicated above the Cambrian sediments in the north of line WR-07. If this reflector is Ordovician or Mereenie Sandstone it would indicate structural growth through the early Palaeozoic; this is also evident on a hinge line stretching from Parana Hill to the Illamurta structure. The east-west grain is a product of the latest deformation, the Alice Springs orogeny.

Overall the recently acquired data indicate OP 236 had an early structural evolution in the south. The Petermann Ranges Orogeny resulted in reverse faulting preserving a trough through the centre of the permit from west to east, and another in the north near the Levi Ranges. Old normal faults established during the late Proterozoic bounded this trough which received a thick Late Proterozoic sediment pile and some of these faults were rejuvenated and became reverse faults during the Petermann Ranges Orogeny. Meanwhile an old high or platform existed in the east and a basement high may have existed in the extreme south during the late Cambrian explaining the lack of Bitter Springs reflections in this area. Depocentres existed in the centre, north, and southeast of OP 236 throughout the Cambrian and Ordovician. Sedimentation covered old Proterozoic highs in the north and south of the seismic survey area. Tectonic movements (Bloodwood/Rodingan) may have affected the north and west of the permit in early Palaeozoic times causing unconformities above the Base Cambrian reflector. During the Alice Springs Orogeny basement involved wrench faulting complexly faulted and folded the troughs under compression from the north, producing structures including the West Petermann Creek Anticline. Possible southwest northeast left lateral strike slip faulting accompanied this episode.

12. HYDROCARBON POTENTIAL

Enclosures 15 and 16 summarize the hydrocarbon potential of OP 236 in relation to the known occurrences in the Amadeus Basin. Enclosure 15 displays the potential of Late Proterozoic and Cambrian sediments; while Enclosure 16 summarizes the production, shows and maturity of the Cambro-Ordovician sequence.

Proven commercial hydrocarbon accumulations are present at Mereenie Oil and Gas Field (37 MMBOR), Palm Valley Gas Field (50BSCFG) and the Dingo Gas Field.

Within OP 236 oil shows were recorded in the Stairway and Pacoota Sandstones in AP-1, and oil staining is common in the Pacoota, Goyder and Illara Sandstones and Bitter Springs Formation, in the East Johnny's Creek #1 well.

The Ordovician Stairway and Pacoota Sandstones have the best proven hydrocarbon potential in areas adjacent to OP 236; they have adequate porosity, are sourced and effectively sealed by Larapinta Group shales. Such plays cannot be demonstrated with the available data within OP 236.

Cambrian rocks have not as yet been shown to have generated significant quantities of hydrocarbons. The Pertaoorrta Group has limited oil-source potential in the Chandler Limestone and Tempe Formation. Adequate porosity and permeability occurs in the Arumbera and Cleland Sandstones, and the Giles Creek Dolomite.

The Late Proterozoic rocks have some oil source potential (especially in the Bitter Springs Formation), and were generating oil after trap formation in this part of the Amadeus Basin (e.g. live oil in Finke #1). However, the age of significant oil and gas generation is not known for this formation, and all the reservoirs have suffered severe diagenetic destruction of porosity and permeability.

Structural traps within OP 236 are now severely affected by faulting or breached due to erosion.

12.1 Hydrocarbon Indications

The Cambro-Ordovician Pacoota Sandstone and Lower Ordovician Stairway Sandstone are the major hydrocarbon producers in the basin and hold the best potential for oil. Flows up to 1300 BOPD (East Mereenie #18) and 137 MMSCFD (Palm Valley #6) are recorded from the Pacoota Sandstone and 7.3 MMSCFD (East Mereenie #8) have been recorded from the Stairway Sandstone.

The late Proterozoic Johnny's Creek Beds of the Bitter Springs Formation has had live oil shows in Finke #1 and Mount Winter #1 and residual oil in East Johnny's Creek #1. The Finke #1 and Mount Winter #1 occurrences show oil prone source rocks in the Late Proterozoic. The Gillen Member of the Bitter Springs Formation has been shown to have oil source potential (Jackson et al 1984). The late Proterozoic Julie Formation and Areyonga Formations have produced gas on test (Enclosure 15).

Cambrian oil was reported from a core cut in the Giles Creek Limestone in Alice #1. Residual oil has been encountered in the Chandler Limestone. BMR Rodinga 1, 1A and Illara Sandstone (East Johnny's Creek #1), and fluorescence noted in the Tempe Formation (Undandita #1).

Gas shows in Upper Proterozoic/Cambrian rocks have been encountered in four wildcat oil wells in the Amadeus Basin. Gas flows on test came from the Dingo wells and Orange #2 (Arumbera 5MMCFGD), with a small show in Orange #1 (Giles Creek Formation).

12.2 Source

Jackson et al (1984) gives an excellent summary of quantitative geochemical data on the hydrocarbon potential of the whole Amadeus Basin, based on numerous studies of cores and hydrocarbon samples from oil and stratigraphic wells. Significant oil source-rock potential is indicated in the Ordovician Larapinta Group, (particularly in the Horn Valley Siltstone). Poor to good oil source potential was recognised in the Late Proterozoic sequence (particularly in the Gillen Member). The Cambrian samples were mostly organically lean except for the Tempe/Chandler intervals; most of the Pertaoorta Group samples are gas prone.

Average TOC and EOM values derived from analysis of selected cores of Larapinta Group sediments from wells close to OP 236 are presented in Table 3. Marine shales of the Horn Valley Siltstone (TOC up to 9%) and some shale interbeds of the Pacoota Sandstone (TOC up to 0.9%) are good to very good source rocks. The Stairway Sandstone is a poor to fair source of gas and condensate. Kerogen in organic rich shales of the Horn Valley Siltstone is predominantly amorphous algal sapropel in the west and 'herbaceous' in West Walker-1 (Garter 1984). The Horn Valley Siltstone has been shown to be oil prone in the western Amadeus Basin in the vicinity of OP 236 (Gorter, 1984), and to have sourced the Mereenie and Palm Valley fields.

Source potential of the analysed Late Proterozoic to Cambrian sediments is generally poor through the Amadeus Basin, however the richer samples with TOC greater than 0.2% are presented in Table 4. The Gillen Member of the Bitter Springs Formation is a very poor to good source rock (TOC up to 1.37% in Mt. Charlotte #1). In Bluebush #1 and Mt. Charlotte #1 it is presently oil mature and contains oil prone kerogen. Some samples of the Upper Proterozoic Winnall/Pertatataka and Inindia/Areyonga units from Erldunda #1 and Ooraminna #1 have TOC greater than 0.3% and may have been oil source rocks. However, poor quality gas prone kerogen is a major constituent of their DOM.

Evidence for fair to good Cambrian oil source rocks is only obtained from the Chandler and Tempe Formations in BMR Rodinga #1A and Undandita #1A, respectively. Total organic carbon is up to 3% in Chandler Limestone and 5.45% in Tempe shales. However, the kerogen is gas prone and their DOM is almost exclusively Micrinite - possibly representing the organic residue after the expulsion of hydrocarbons.

12.3 Reservoirs

Reservoir potential exists in Ordovician, Cambrian and Late Proterozoic intervals the Amadeus Basin sedimentary sequence. The best hydrocarbon producers are the Stairway and Pacoota sands within the Ordovician Larapinta Group (Kurylowicz et al 1976). They showed that average porosity in these sandstones tends to increase to the south and west of Palm Valley. Porosity in the Stairway Sandstone averages 12.6% in stratigraphic wells drilled in

OP 236. The Pacoota Sandstone has porosity of 11.7% in AP-1 and varies between 1% and 14% (averages 6%) and permeability ranges from 0.1md to 500md in the Mereenie field.

The Cambrian Pertaoorrta Group have produced numerous good water flows (Van Schoten 1985a Enclosure 1) which prove adequate porosity and permeability. The Petermann Sandstone and Illara Sandstones (the only sandstones analysed) in East Johnny's Creek #1 have average porosity of 10% and permeability up to 56 millidarcys. The Arumbera Sandstone, Giles Creek Dolomite and Cleland Sandstone are the best reservoirs.

The Late Proterozoic rocks are generally of poorer quality. Those in Erldunda #1 and Highway Anticline #1 were examined by Schmerber (1966a, 1966b) and found to have no intergranular porosity or open fractures. These rocks have undergone stylolitization, recrystallization, dolomitization and silicification in the carbonates with development of chlorite and silica overgrowths in the clastics. Tested shows in vuggy Bitter Springs carbonates have demonstrated extremely low permeability and porosity. Schmerber (1966b) estimate less than 1% vuggy porosity in these rocks. Fractures in Bitter Springs carbonates are likely to be filled with anhydrite and gypsum, or calcite. Ripper and Smith (1982) have analysed potential Late Proterozoic reservoirs from wells near OP 236, and have shown low porosity (less than 5%) and permeability in these formations. The Pertatataka Formation which flowed gas at Ooraminna #1 (12,000 SCFD) has porosity of 5%.

In outcrop the Late Proterozoic Winnall Beds and Inindia Beds are strongly silicified. The Areyonga Formation in outcrop is coarse grained, appears subarkosic in composition, and is often microfaulted and fractured (the veins filled with quartz). Some intergranular porosity noted in outcrop is probably produced by leaching, because these formations appears tight in cuttings from seismic shotholes drilled in OP 236 (appendix 1).

12.4 Seals

Effective seals are expected to be rare in OP 236 due to breaching by erosion and fracturing by extensive faulting. Regional seals such as the Ordovician Stokes Siltstone and Horn Valley Siltstone, Cambrian Chandler Formation (evaporite facies) and Late Proterozoic Pertatataka Formations effectively seal the Mereenie/Palm Valley, Dingo/Orange and Ooraminna hydrocarbon accumulations respectively. Additionally, potential seals are present within the Cambrian Pertaoorta Group and Late Proterozoic rocks. However, the presence of leaky seals in OP 236 is suggested by the correlation of discontinuous (faulted) reflections on seismic sections with some areas of anomalously high hydrocarbon microseepages, such as on lines WR-06 (SP 760-1000) and WR-04 (SP 780-920).

12.5 Maturation

Thermal maturity of the Amadeus Basin sediments has been estimated by Jackson et al (1984) from interpretation of organic, geochemical and petrographic data (on carbonaceous materials e.g. graptolites), conodont colour alteration index values (Gorter 1984) and from Lopation modelling methods. Maturity levels have been calculated from burial and heat-flow history and expressed in terms of equivalent vitrinite reflectance (VRE), allowing the reconstruction of oil fairways for the present (Enclosures 15 & 16) and the past. Enclosures 15 and 16 show that the Bitter Springs Formation, Goyder Formation and Horn Valley Siltstone are expected to be presently mature (VRE values between 0.6% and 1.3%) in the permit area. Measured VRE values for the Horn Valley Siltstone in BMR stratigraphic wells in the permit range from 0.68% to 0.90%.

Calculated maturity at 350my BP (Early Carboniferous, and time of latest trap formation) suggests that the Bitter Springs Formation was at or near the boundary between oil and gas generation while the Cambro-Ordovician sequence was oil generative over the whole Basin.

The proposed onset of oil generation in the Bitter Springs Formation at Dingo (Silurian) was earlier than at Mereenie (Late Devonian), suggesting more favourable timing of maturation in the west. Hence the Ooraminna and Dingo structures retained a gas charge, whereas the oil shows in East Johnny's Creek #1 and Finke #1 support the migration and entrapment of oil from mature Late Proterozoic to Cambrian rocks in the OP 236 area.

The Horn Valley Siltstone probably began generating oil at Mereenie in the Early Carboniferous, after trap formation.

12.6 Traps

Trap formation is primarily a function of the Alice Springs Orogeny, however some structures in the north and southeast of the permit (Illamurta/Seymour Ranges) were growing through Pertaoorta, Larapinta and Pertnjara Group time (Cook, 1966). As a result of timing of maturation and trap formation outlined above most structures in OP 236 could have received a late oil or a gas charge from the Bitter Springs Formation, and an oil charge from Cambro-Ordovician sediments. Intense faulting and erosion have subsequently breached many of these traps in OP 236.

12.7 Conclusion

The perceived hydrocarbon potential is as follows: the Ordovician Larapinta Group contains the most prospective sediments for oil; the shales are probably mature, oil prone and the reservoirs porous. The Cambrian rocks are likely to have limited oil source potential, but are mature and have adequate porosity and permeability. Late Proterozoic rocks probably have oil source potential (especially the Bitter Springs Formation), should be mature but are expected to have poor reservoir potential. High risk is associated with seal and trapping configurations at all levels.

13. LEADS AND FOLLOW-UP WORK PROGRAMME

The strongest leads in the Wallera Ranch survey have been grouped into four areas. They are summarised on Table 5 and have their locations shown on Enclosure 18. Table 6 details a possible follow-up work programme.

In addition to field work, a minimum of three seismic lines totalling 60 kilometres would be needed in two of these lead areas, areas I and IV. Twelve shallow stratigraphic test holes of 150 metres, totalling 1800 metres, have been proposed for determining the stratigraphy of the leads, for identifying seismic reflectors, and for obtaining unweathered samples for source rock and for reservoir rock analyses. Three of the stratigraphic test holes would be in lead area I, one in lead area II, two in lead area III, and four in lead area IV. Two additional stratigraphic test holes have been suggested to check leads on S85-WA-2 and S85-WR-3 seismic lines.

Before any field geology or seismic can be done reprocessing of the SR-A seismic line, the making of a synthetic for the East Johnny's Creek well and the processing of BMR's regional seismic line that now crosses OP 236 would all be advantageous.

The leads identified in the Wallera Ranch seismic survey indicate areas for further study but no lead at present is considered strong enough to warrant the drilling of a 2000 metre exploration test.

REFERENCES

Cook, P.J. (1966) - The Illamurta Structure of Central Australia, its development and relationship to a major fracture zone. BMR Record 1966/46.

Douglass, J., (1985) - Operations Report, 1985 Wallera Ranch Seismic Survey January-March 1985. Report for Sydney Oil Co. (Arunta) Pty Limited (Unpub.)

Gorter, J.D., (1984) - Source Potential of the Horn Valley Siltstone, Amadeus Basin. A.P.E.A. Journal, 24(1)

Hopkins, R.M., (1964) - Reconnaissance geology of the Johnny's Creek-Ochre Hill area, OP 43, Northern Territory. Unpublished report for Magellan Petroleum Corporation.

Hosking Geophysical Corporation (1985) - Processing Report Wallera Ranch Seismic Survey - Report for Sydney Oil Company (Arunta) Pty Limited (Unpub.)

Jackson, K.S., McKirdy D.M., Deckleman J.A., (1984) - Hydrocarbon Generation in the Amadeus Basin, Central Australia. A.P.E.A. Jrnl, V24(1), 1984 p 42-65.

Kurylowicz, L.E., Ozimic S., McKirdy D.M., (1976) - Reservoir and Source Rock Potential of the Larapinta Group, Amadeus Basin, Central Australia. A.P.E.A. Jrnl 1976.

Pratt, D., (1985a) - A Preliminary Interpretation of the Amadeus Basin Aeromagnetic Survey, OP 236, N.T. Report for Sydney Oil Company (Arunta) Pty Limited (Unpub.)

Ryall, W.R., (1985) - Soil Gas Reconnaissance Survey, OP 236, N.T. Report for Sydney Oil Company (Arunta) Pty Limited (Unpub.)

Ripper & Smith (1982) - Permits OP 213 and OP 214 Amadeus Basin, Geological and Geophysical Operations 1982. Report for Weeks Australia Limited (Unpub.)

Schroder, R.J. and Gorter, J.D., (1984) - A Review of the Recent Exploration and Hydrocarbon Potential of the Amadeus Basin, N.T. A.P.E.A. Jnl. 24(1) 1984, pp. 19-41

Schmerber, G., (1966a) A Petrological Study of the Sediments from Erldunda - No. 1 Well, Amadeus Basin, Northern Territory., BMR Record 1966/182.

Schmerber, G., (1966b) A Petrological Study of the Sediments from Highway - No. 1 Well, Amadeus Basin, Northern Territory., BMR Record 1966/183.

Van Schoten, M.W. (1985a) - Geological Cross-Sections, OP 236 - in Annual Report, OP 236, Amadeus Basin, N.T., Permit Year 1: July 3, 1984 to July 2, 1985. Report for Sydney Oil Company (Arunta) Pty. Limited, pp 8 - 9 (Unpub.)

Van Schoten, M.W., (1985b) - Photogeology OP 236 in Annual Report, OP 236 - Amadeus Basin, N.T., Permit Year 1: July 3, 1984 to July 2, 1985. Report for Sydney Oil Company (Arunta) Pty Limited, pp. 11-15 (Unpub.)

Van Schoten, M.W., (1985c) - Field Work in Annual Report, OP 236 - Amadeus Basin, N.T., Permit Year 1: July 3, 1984 to July 2, 1985. Report for Sydney Oil Company (Arunta) Pty Limited, pp. 16-18 (Unpub.)

Van Schoten, M.W., (1985d) - Geological Sampling of BMR Seismic Survey Shotholes and selected water bores, OP 236. Report for Sydney Oil Company (Arunta) Pty Limited (Unpub.)

Wells, A.J., Forman, D.J., Randford, L.C. and Cook, P.J., (1970) - Geology of the Amadeus Basin, Central Australia. Bureau of Mineral Resources, Australia, Bulletin 100.

TABLE 1

WALLERA RANCH SEISMIC SURVEY DATA QUALITY

SEISMIC LINE	LENGTH	KM OF GOOD DATA	GOOD % DATA
S85-WR-01	13.8 km	6.0	43
02	15.5 km	4.0	26
03	26.5 km	4.5	17
04	30.6 km	11.5	38
05	25.8 km	15.5	60
06	35.8 km	10.0	28
07	37.9 km	20.0	53
TOTAL	185.9 km	71.5	38.4%

TABLE 2

INTERVAL VELOCITIES FOR EXPLORATION WELLS AND SEISMIC WALLER RANCH

FORMATION	EAST JOHNNY'S CREEK #1* *	ERLDUNDA #1 +	ORANGE #1 +	MT CHARLOTTE #1 +	S85-WR LINE 4 SP 503 **	S85-WR LINE 4 SP 299 **
Pertnjara Fmn		3000				
Mereenie Sst			4100		3700	
Larapinta Grp						
Stairways Sst		4700	4300			
Pacoota Sst			4700		4200	3300
Goyder Fmn	5500					
Petermann Sst	4500					
Jay Creek Lst			5400			
Deception Fmn	4700			4400	4600	4300
Hugh River Sh.			5500			
Illara Sst	4900					
Tempe Fmn	4900 -5800					
Chandler Fmn				4000	5400	4800
Arumbera Sst						
Pertatataka Fmn				4200		
Winnall Sst		4300-5200				
Areyonga Fmn	5100				4800	
Inindia Beds		5700				
Johnny's Creek Beds	6800					
Loves Creek Mbr	6100	6000		6300	7600	7400
Gillen Mbr				4600	6700	6400

+ derived from velocity surveys
* derived from sonic log
** interval velocities seismic

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TABLE 3

SOURCE-ROCK DATA FROM SELECTED CORES FROM ORDOVICIAN ROCKS IN WELLS NEAR TO OP 236

FORMATION	WELL	TOC (%) (Mean)	EOM (%) (Mean)
Stairway Sst	BMR AP-1	0.23	40.9
	BMR AP-2	0.25	33.9
	BMR AP-3	0.17	54.9
	BMR AP-4	0.21	27.8
	E. Mereenie #1	0.23	32.2
	Palm Valley #1	0.27	44.8
Horn Valley Siltstone	BMR AP-1	0.69	60.1
	BMR AP-2	0.33	26.6
	BMR AP-3	0.51	21.8
	E. Mereenie #1	1.31	83.9
	Palm Valley #1	0.34	52.3
	Tempe Vale #1	4.20	63.2
Pacoota Sandstone	E. Mereenie #1	0.32	45.2
	E. Mereenie #2	0.46	56.2
	Palm Valley #1	0.32	51.6
	Palm Valley #3	0.30	37.4

Source; Jackson *et al* (1984)

TABLE 4

SOURCE-ROCK DATA FOR SELECTED LATE PROTEROZOIC TO CAMBRIAN SAMPLES FROM WELLS IN THE AMADEUS BASIN

FORMATION	WELL	TOC (%) (Mean)	EOM (%) (Mean)
Goyder Formation	Alice #1	0.30	35.5
	Orange #1	0.27	
Shannon Formation	Alice #1	0.24	57.9
	Highway Anticline #1	0.15	21.3
Giles Creek Dolomite	Alice #1	0.32	17.9
	Orange #1	0.30	
Tempe Formation	Undandita #1A	1.31	22.9
Chandler Formation	BMR Rodinga #1A	1.01	25.8
Winnall Beds/Pertatataka Fmn	Erldunda #1	0.53	41.4
	Ooraminna #1	0.73	44.3
	Mt. Charlotte #1	0.19	16.7
Inindia Beds/Areyonga Fmn	Erldunda #1	0.50	33.3
	Ooraminna #1	0.56	27.3
Bitter Springs Formation (Gillen Member)	Bluebush #1	0.75	43.3
	BMR Alice Springs #3	0.84	36.8
	BMR Illogwa Creek #5	0.20	16.3
	Mt. Charlotte #1	0.18	47.2
	Ooraminna #1	0.95	

Source; Jackson et al (1984)
Ripper & Smith (1982)
In-house data

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TABLE 5

WALLERA RANCH SEISMIC SURVEY

LEADS SUMMARY TABLE

AREA	SEISMIC LEAD	SEISMIC	AEROMAG.	GRAVITY	GEOCHEM.	PHOTOGEOL.	TREND	PLAYS
I	S85-WR4 VP720	Rollover	High	High	NIL	NIL	-	Proterozoic
	S85-WR4 VP540	Rollover	NIL	NIL	Moderate; gas rich anomaly	Large syncline plunges to NW	NW-SE	Pacoota/Stairway and Goyder
II	S85-WR4 VP980	Rollover faulted	Broad high	Low	NIL	Closure in lineations 8km SE	NW-SE	Late Proterozoic
	S85-WR5 VP900	Rollover	High	High	NIL	Anticlinal nose to NW in Ordovician sediments	Partly NW-SE	Base Cambrian and Proterozoic
III	S85-WR6 VP840	Faulted rollover	NIL	NIL	Moderate; oily anomaly	Topographic high to NE (4km) lineations	WNW-ESE	Proterozoic
IV	S85-WR6 VP400	Faulted rollover	NIL	High	NIL	NW trending anticline in Stairways Sst	NW-SE	Pacoota & Base Cambrian
Stratigraphic test holes (locations outside of lead areas)	S85-WR2 VP380	Faulted rollover	Broad High	High	NIL	Lineations	NW-SE	Proterozoic targets
	S85-WR3 VP800	Faulted rollover	Broad High	High	Moderate; oily anomaly	Anticlinal nose in Ordovician rocks 6km NW	NW-SE	Proterozoic targets

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TABLE 6

LEADS
FOLLOW-UP WORK SUMMARY

AREA	PROPOSED SEISMIC	PROPOSED STRATIGRAPHIC TEST	PROPOSED FIELD WORK
I	30 km (1 line)	3	No?
II	-	1	Yes
III	-	2	Yes
IV	30 km (2 lines)	4	Yes
TOTAL	60 km (3 lines)	10	

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APPENDIX 1

GEOLOGICAL SAMPLING OF BMR SEISMIC SURVEY SHOTHOLES

AND SELECTED WATER BORES; OP 236

GEOLOGICAL SAMPLING BMR SEISMIC SURVEY SHOTHOLES AND SELECTED WATER BORES; OP 236

The object of the fieldwork was to collect cuttings samples from those shot holes drilled for the Regional BMR Seismic line within OP236, in order to identify lithologies beneath surficial cover. The sampled line traversed 65.5 km of OP 236 south of Tempe Downs where the sampling began. A total of 218 holes were drilled at a spacing of 332m apart. I described and sampled approx. 100 of these holes. Fifteen of the sample wells intersected subcropping Amadeus Basin sediments. Another ten bores may have penetrated subcropping sediments, but weathering has severely affected these samples.

The great majority of wells intersected either Quaternary clays, siltstones, gravels, calcrete and gypsum or Quaternary/Tertiary claystones and soft, very porous sandstone and gravels.

Samples for all the holes are stored with Sydney Oil Company.

(a) List of holes penetrating Amadeus sediments:

Location	Hole #	T.D.	FMN
SP 5664	(H7)	17m	Pacoota SST
SP 5580	(H12)	32m	Areyonga FMN
SP 5548	(H22)	40m	Stairways SST
SP 5552	(23)	35m	Stairways SST
SP 5476	(28)	40m	Stokes Siltstone
SP 5468	(29)	40m	Stokes Siltstone
SP 5452	(31)	40m	Stairways SST
SP 5455	(32)	36m	Stairways SST
SP 5461	(33)	40m	Stairways SST
SP 5464	(34)	40m	Stokes Siltstone
SP 5440	(35)	22m	Stairway SST
SP 5436	(37)	27m	Basal Stairway SST
SP 4958	(95)	13m	Winnall Beds
SP 4836	(109)	40m	Inindia Beds
SP 4827	(110)	40m	Inindia Beds

(b) Holes which intersected badly weathered formations:

Location	Hole #	T.D.	FMN
SP 5604	(19)	40m	Goyder FMN. ? Silicified
SP 5600	(20)	18m	? Goyder FMN
SP 5282	(49)	40m	? Goyder FMN
SP 5296	(47)	40m	? Weathered Goyder
SP 5204	(59)		? Cambrian SST
SP 5112	(71)	40m	? Cambrian SST + siltstone
SP 5012	(83)	40m	? Cambrian SST + siltstone
SP 5004	(84)	40m	? Cambrian shale
SP 4484	(86)	40m	? Cambrian lst + SST (Glauconitic?)
SP 4956	(89)	40m	? Weathered Winnall Beds

Additionally, the following water bores were examined and sampled in the Water Resources Commission in Alice Springs; their registration numbers (Rn) and formations penetrated are listed below:-

Rn	Fm	TD	Rn	Fm	TD
13192	Quaternary	18m	11929	Stairway?	122m
10288	Tertiary	61m	13193	Goyder	149m
14254	Pacoota	117m	14484	Winnall	106m
14483	Pacoota	165m			

Information on depth of weathering and locations for these data are shown on the Water Bore and Shallow Seismic Borehole Map, OP 236 at 1:250,000 scale.

WATER BORE EXAMINATION OP236

One day in October 1985 was spent with the Water Resources Commission in Alice Springs checking which bores have stored cuttings with the Commission and examining samples from seven of these bores. Bores with cuttings samples available for study have been listed in tables against the relative bore registration number and sample tray number. Ten gram samples were taken in fresh rock and in representative rock types.

Bore 14254

Depth		Sample Yes/No
0 - 20 m	r. Sd. and Gravel	Y
20 - 45 m	Sst, red & white, crs., soft	Y
45 - 63 m	Qtzte, wh., f.gr., subang., well sorted, tite. and Claystone, wh.	Y
63 - 90 m	Qtzte, lt. br., crs., gd. intgr., por., (base weathering) & Claystone, wh.	N
90 - 117 m	Qtzte., lt. br., med., rd-subang., well sorted, gd. intgr. por., soft, slt. silica cmnt.	Y
Rock	Pacoota Sandstone Base weathering 90 m	

Bore 14484

Depth		Sample Yes/No
0 - 6 m	red Sd.	N
6 - 33 m	Slts., br. gr., & Sst., wh., tite.	Y
33 - 57 m	Slts., grey, & Sst., wh., f., v. hard, silica cmnt. & Pwdr wh.	N
60 - 90 m	Qtzte, wh., f., v. hard, silica & Pwdr. wh.	Y
90 - 106 m	Qtzte., lt. br. - wh., f.-med., well rd., silica cmnt., v. hard	Y
Rock	Winnall Beds Base weathering 33 m	

Bore 14483

Depth		Sample Yes/No
0 - 12 m	r., Sd.	N
12 - 21 m	Slts., br.- wh.	N
21 - 30 m	Sst., wh. - rd., crs., slt arg.,	N
30 - 48 m	Sst., wh., crs., & Sd., wh., & Clay, wh.	Y
48 - 156 m	Sst., wh., md - crs., & Sd.	Y
156 0165 m	Qtzte., wh., med., well srted., subang (overgrowths) pr. intg. por.	Y

Rock Type   Pacoota Sandstone Base Weathering 50 m.

Bore 13193

Depth		Sample Yes/No
0 - 6 m	r. Sd.	N
6 - 21 m	Clyst., wh., (kaol.) lam.	N
21 - 60 m	Clyst., wh., (kaol.) swllg., & Sst., wh., med. crs.	Y
60 - 69 m	Sltst., gy - gr. & grvl.	Y
69 - 144 m	granule Grvl., & qtzte., pnk., crs., well srtd., slt. intg. por., & Sltst., r., mic., lam.	Y
144 - 149 m	Qtzte., wh. - pnk., med., well rd., well srtd., siliceous, hard.	N

Rock Type   ? Tertiary sediments (some Pacoota & Goyder)
Base weathering 70 to 144 m

Bore 13192

Depth		Sample Yes/No
0 - 3 m	Calcrete	N
3 - 6 m	Sd. + Calcrete	N
6 - 18 m	Sd., rd., slt. arg., por.	Y

Rock Type   Alluvium

2124G

Bore 11929

Depth		Sample Yes/No
0 - 40 m	Clst., rd., hard	N
40 - 81 m	Sd., f., & Qtzte., red, f - med., well srtd. arg., soft., por.	N
81 - 100 m	Qtzte., pnk, f - med. gr., well srtd., well rd., mod. sph., ? kaol., pr. intgr. por., soft., ? phosph., & Sd.	Y
100 - 114	Clst., r., granular	Y
114 -122	Qtzte., wh., crs., as above	Y
Rock Type	Stairway Sandstone Base Weathering 122 m?	

Bore 10288

Depth		Sample Yes/No
0 - 16 m	Grvl., Qtz. & Sh.	N
16 - 25 m	Slts., wh., mttld.	Y
25 - 31	Sd., red-br., Qtz., grnl.	N
31 - 53	Sst., gy., soft	Y
53 - 62	Sd., wh., crse. & Chert.	Y
Rock Type	Tertiary sediments	