NORTHERN TERRITORY GEOLOGICAL SURVEY
AMADEUS BASIN UPDATE - JANUARY 1994

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NORTHERN TERRITORY GEOLOGICAL SURVEY
PETROLEUM BASIN STUDY

AMADEUS BASIN UPDATE

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Geoweste Pty Ltd
Adelaide

March 1994

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1 SUMMARY

Exploration and development of the Amadeus Basin was essentially covered by Northern Territory Geological Survey Petroleum Basin Studies “WESTERN AMADEUS BASIN” and “EASTERN AMADEUS BASIN” released in April 1989 and March, 1990. Since these studies were completed significant exploration has occurred, principally in the eastern half of the basin. The most significant achievements have been the first attempts in 25 years to assess the southern portions of the basin. Although no new oil or gas fields were discovered by the three wells drilled, they did produce significant advances in the knowledge of the hydrocarbon potential of this major portion of the basin.

Exploration activity has declined since 1992, with no new exploration wells drilled, and the basin's long term and only successful explorer, Magellan Petroleum and joint venture partners, ceasing exploration and relinquishing their exploration permits. The opportunity now exists for new explorers to try new exploration concepts.

The Amadeus Basin still remains Australia’s least explored oil and gas producing basin. Covering an area of 100,000 square kilometres, it is large by world standards and has very large structures untested by the drill. Many of those structures which have been tested were drilled in the early days of exploration, the mid sixties, when the knowledge of formation evaluation was scant and the effects of drilling with much overweight muds was little appreciated.

There are still the opportunities to discover large oil and gas fields, although the risks are high. The basin is a challenge to the innovative explorer willing to test plays in the Proterozoic, as yet unproductive, but little tried in Australia. Late Proterozoic sequences very similar to those of the Amadeus Basin are host to giant oil and gas fields in the Eastern Siberian Basin and in the Sichuan Basin, China. These fields are sealed beneath salt horizons which are correlatives of the Bitter Springs salt. A large proportion of the oil in Oman is sourced from Late Proterozoic algal shales.

There are still opportunities in the proven oil and gas play, the Horn Valley Siltstone / Pacoota sandstone seal/source/reservoir sequence trapped in thrusted anticlines. This play type is restricted to the northern portion of the basin and most known prospects have the potential for moderate to small reserves of oil and gas. Although the risks are lower for the proven plays, the potential reserves are not as large as for the Late Proterozoic plays.
2 INTRODUCTION

2.1 PURPOSE OF UPDATE

Since the last petroleum basin studies of the Amadeus Basin were completed in 1990 there have been two significant developments in the basin. The principal long term explorers of the basin have relinquished their exploration permits and quit exploration, freeing up acreage; and exploration of the southern portion of the basin resumed following a 25 year break.

It is therefore time to update the basin studies as part of an effort to encourage new explorers into the basin. The purpose of this update is to assist potential explorers assess the hydrocarbon potential of the basin. This update complements the Northern Territory Geological Survey's two previously released basin studies:

WESTERN AMADEUS BASIN (April, 1989)

EASTERN AMADEUS BASIN (March, 1990)

This update does not replace the earlier basin studies, and is meant to be read in conjunction with them.

2.2 STUDY AREA

For the purpose of this review the Amadeus Basin is defined as the sedimentary basin bounded to the north by the Arunta Block, to the south by the Musgrave Block, to the east by the Warbuton Basin. Although the Amadeus Basin extends west into Western Australia beneath the Canning Basin, the study area ceases at the Western Australian border.

2.3 UPDATE OBJECTIVES

The principal objectives of this study are to:
- review the exploration history since compilation of the earlier released studies
- re-assess the basin's prospectivity
- present some prospects and leads
- produce a document that can be merged with the earlier released studies.

2.4 SCOPE AND FORMAT OF UPDATE

This review updates all aspects of the Amadeus Basin that are relevant to the petroleum explorer. The format is the same as that used in the two previous Amadeus Basin studies, utilising the same chapter and section headings. Tables are simply updates to those in the earlier studies and use identical layouts. Similarly the descriptive appendices use identical formats. This enables the reader to read easily this document in conjunction with the Eastern and Western Amadeus Basin studies.
2.5 PRINCIPAL REFERENCES

Two principal references have been published since compilation of the earlier studies. They are

1. BMR Bulletin 236
   Geological and Geophysical Studies in the Amadeus Basin Central Australia.
   Compiled and edited by R.J. Korsch and J.M. Kennard
   Australian Government Publishing Service Canberra 1991

2. Geological Atlas of the Amadeus Basin
   Editor: J.F. Lindsay
   Australian Geological Survey Organisation
   Australian Government Publishing Service Canberra 1993

Bulletin 236 is the first significant comprehensive publication on the Amadeus Basin by the BMR (Bureau of Mineral Resources) now AGSO (Australian Government Survey Organisation) since BMR Bulletin 100 “Geology of the Amadeus Basin Central Australia”, published in 1970, but covering work completed in 1965. Bulletin 236 is the culmination of the BMR’s research on the basin since 1965. The Bulletin also includes contributions from industry and other organisations. Contributions cover the tectonics, stratigraphy, sedimentology and palaeontology of the basin. There are few but significant contributions on hydrocarbon exploration.

The Geological Atlas is a complementary work to Bulletin 236, and presents a comprehensive map portfolio covering outcrop geology, structure and palaeogeography. There are isopach and structure maps for all the significant sedimentary and seismic sequences, together with accompanying descriptive notes.

2.6 DATA SOURCES

Data sources are unchanged from those described in the Eastern Amadeus Basin study.

Tenement lists and plans, 1:250 000 scale plans showing Aboriginal lands and claims, geological publications and maps are available from:

The Director
Northern Territory Geological Survey
Department of Mines and Energy
GPO Box 2901
DARWIN  N.T. 0801
AUSTRALIA
Telephone 089 895511, international 6189 895511
Facsimile 089 814806, international 6189 814806

2.7 ACKNOWLEDGEMENTS

Invaluable assistance for the preparation of this report was received from the officers of the Northern Territory Geological Survey, particularly the library staff; the Australian Geological Survey Organisation; Magellan Petroleum Australia Limited; Pacific Oil & Gas Pty limited.
3 BASIN LOCATION

3.1 INFRASTRUCTURE UPDATE
Only minor improvements to infrastructure have occurred since 1990. The road linking the Lasseter Highway to Wallara and on to Kings Canyon has been sealed. Accommodation is now available at a tourist resort at Kings Canyon and Wallara Ranch motel has been bulldozed. Tourist cabins and caravan parks are situated on the Stuart Highway.

3.2 EXPLORATION LOGISTICS UPDATE
Logistics for exploration are unchanged.

The Mereenie Rig 1 is still in the region and has the capacity to test all known prospects.

Rockdril Contractors Pty Ltd, a slim-hole petroleum contractor has a base in Alice Springs.

3.3 MARKETS UPDATE
Existing and proposed pipelines are shown in Figure 1. Negotiations are still ongoing regarding a pipeline linking the Palm Valley Gas Field to Adelaide. Concerns are that there are insufficient reserves at Palm Valley to meet the long term needs of both Adelaide and the Northern Territory.

Spur pipelines off the Palm Valley - Darwin pipeline to the McArthur River zinc-lead project and possibly to Gove Aluminium are proposed.
4 TECTONIC SETTING

No significant advances in the knowledge of the tectonic evolution, basin morphology and structural history of the basin have been made since the release of the Eastern Amadeus Basin study. The reader is referred to that study. The results of Wallara 1 well downgrade the size and importance of the "Central Ridge" and constrain significant evolution of the ridge to the Petermann Ranges Orogeny and later. Exploration in the south of the basin by Pacific Oil & Gas has emphasised the effects of the Bitter Springs salt on structural development and how the salt has separated structural development in the overlying strata from that in the underlying rocks in the southern portion of the basin.

A number of relevant papers have been published since release of the Eastern Amadeus Basin study. They were accessed only in draft form for that study. They are:

BMR Bulletin 236
Korsch, R.J., Geological and Geophysical studies of the Amadeus Basin.
Shaw, et al, Seismic Interpretation and Thrust tectonics of the Amadeus Basin, Central Australia, Along the BMR Regional Seismic Line.
Lambeck, K., Teleseismic Travel-time Anomalies and Deep Crustal Structure of the Northern and Southern margins of the Amadeus basin.
Shaw, R.D., The Tectonic Development of the Amadeus Basin.

5 STRATIGRAPHY UPDATE

The stratigraphy of the basin is well covered in the two earlier basin studies and will not be repeated here. Recent advances in stratigraphy can be found in the following publications

Shergold et al, 1991
Kennard & Lindsay, 1991

New stratigraphic data have been obtained by the drilling of wells Wallara 1, Murphy 1 and Magee 1 and this is presented and discussed here. Enclosure 2 correlates these wells and earlier wells Finke 1, Eldunda 1 and Mt Charlotte 1.

Different stratigraphic nomenclatures have been used in the north, south and west of the basin. They are discussed here and some relationships are shown in Table 1.

5.1 PRE AREYONGAN MOVEMENT

Wallara 1, Murphy 1 and Magee 1 all intersected significant thicknesses of pre Areyongan Movement sediments. Magee 1 made history by being the first well to penetrate through the Proterozoic sediments to intersect metamorphic basement.

Stratigraphic definitions for the older sequences have been based entirely on outcrop mapping, mainly in the northeast corner of the basin. The presence of large thicknesses of salt which do not outcrop and which form a decollement across the basin has resulted in some confused nomenclature. This is discussed below.

5.1.1 Heavitree Quartzite

Magee 1, the first well in the basin to reach basement, intersected a 4.5m thick intersection of Heavitree Quartzite (Wakelin-King, 1994). It is described as clear, pale grey, fine to coarse grained, with trace silica cement. The intersection was much thinner than anticipated and indicates that the formation thins southwards in the southern part of the basin. In Magee 1 the Heavitree Quartzite unconformably overlies Arunta Block migmatite and is overlain probably conformably by the Bitter Springs Formation Gillen Member.

5.1.2 Bitter Springs Formation

A much increased knowledge of the nature of the Bitter Springs Formation in the southern half of the basin has been gained from two recent wells. Magee 1, in the south, drilled a complete Bitter Springs section (Wakelin-King, 1994), and Wallara 1 (Weste, 1990), in the central south, continuously cored a complete Loves Creek Member section (see Enclosure 2).
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Gillen Member
Magee 1, in the southeast of the basin (see Figure 9 and Enclosures 2 and 4), fully penetrated the Gillen, the first complete intersection in the basin. The 840m thick section drilled was very similar to that mapped from outcrop in the northeastern corner of the basin. In Magee 1 a 121.7m thick basal unit of interbedded massive dolostones and dark grey, apparently organic rich siltstones, overlies Heavitree Quartzite. The basal unit is overlain by a 388m thick salt unit comprising two cycles of massive halite/anhydrite/dolomite. The upper Gillen Unit is a 330m thick interval of interbedded dolostone and siltstone with minor anhydrite, capped by a sandstone which is unconformably overlain by the Loves Creek Member.

Murphy 1 (see Figure 9 and Enclosures 2 and 4), was terminated within a thick Gillen salt sequence (Menpes, 1991). In Murphy 1 the salt unit is over 840m thick (compare with Magee 1 drilled over a basement high), and the upper unit is 464m thick.

Wallara 1 (Weste, 1990), a core hole, was terminated 5m into massive anhydrite which was probably the top of the salt unit. A 58m upper unit interval of dolomudstone and subordinate dolowackestone was cored.

The top of the Gillen Member has been poorly defined. Methods used by various authors include stromatolite type (outcrop mapping in northeast of basin), first halite, and first massive anhydrite. Stromatolites are not recognisable in cuttings and halite does not outcrop, so it is difficult to correlate drill logs with the surface mapping derived stratigraphy. Recent seismic data recorded in the vicinities of the three recent wells show an angular unconformity between the Gillen and Loves Creek members.

Loves Creek Member
Southgate (1991), subdivided the member into a lower marine unit and an upper lacustrine unit. Complete intersections of Loves Creek Member were made in Wallara 1 (fully cored), Magee 1 and Murphy 1. In all three wells the “marine” and “lacustrine” units are clearly identified.

The most useful intersection is the fully cored interval in Wallara 1. Here the base of the 201m thick “marine” unit is a very thin carbonate quartz sand conglomerate overlain by dolopackestones and dolowackestones with common anhydrite, overlain by stromatolytic boundstone. In Murphy 1 this unit is 169m thick and in Magee 1 it is 89m thick. In Mt Charlotte 1 it is approximately 195m thick (see Enclosure 2). In Wallara 1 the “marine” unit is erosionally overlain by a 280m thick “lacustrine” unit comprising a sequence of interbedded dolomudstone/lime mudstone and laminated dolomitic siltstone. Individual cycles can be correlated with those mapped in the northeast of the basin. This thins eastwards and is recognisable thinning progressively in Murphy 1, Magee 1 and Mt Charlotte 1. The northwestern correlative of the “lacustrine” unit, the Johnny’s Creek Beds show a very similar log character in Finke 1, on the central ridge.

The Loves Creek Member is unconformably overlain by the Areyang Formation/Winnall Beds in the north and east of the basin and by “Finke Beds” in the northwest.
FIGURE 4 DISTRIBUTION OF PRE-SOUTHS RANGE MOVEMENT ROCKS
5.2 PRE SOUTHS RANGE MOVEMENT

Wallara 1, Murphy 1 and Magee 1 also greatly increased knowledge of the nature and distribution of these rocks in the southern part of the basin. The Inindia Beds have previously been described as the southern correlative of the Areyonga-Aralka-Pioneer package found north of the central ridge. The northern package is clearly identifiable from wireline logs and cores in Wallara 1, Murphy 1 and Erldunda 1 and the need for the stratigraphic name “Inindia Beds” is questionable. The recognition of typical Areyonga Formation, Aralka Formation and Pioneer Sandstone south of the basin’s central ridge places some timing constraints on this structure.

Revised distributions for pre Souths Range Movement, post Areyongan Movement rocks are shown in Figure 4.

5.2.1 “Finke Beds”

Previously only described informally in continuously cored petroleum slim-hole Finke 1 (Gorter, 1983), this sequence of dolomite, dolomitic siltstone and sandstone is capped by a dolomite showing karstic erosion in Wallara 1. Because the top and bottom of the Finke Beds are at least relatively long exposure erosional events they are a separate stratigraphic entity. The Finke Beds thin rapidly to the east and southeast from Wallara 1 (85m thick) bed to be represented by 17m of basal dolostones of the Areyonga Formation in Murphy 1.

5.2.2 Areyonga Formation

The Areyonga Formation has previously been described as being restricted to the north of the central ridge (see Eastern Amadeus Basin Study). To the south of the central ridge, a correlative, the Inindia Beds has been described. Wallara 1 located south of the ridge (see Figure 4) cored 115m of typical Areyonga Formation massive unbedded diamicite. On log character, eastwards thinning Areyonga Formation is recognisable in Murphy 1 and Erldunda 1. Further east in Magee 1 and Mt Charlotte 1 the Areyonga/Inindia package has been completely eroded (see Enclosure 2).

In Wallara 1 core the Areyonga Formation overlies karstified “Finke Beds” and has a sharp but conformable contact with the overlying Aralka Formation.

5.2.3 Aralka Formation

Also previously unrecognised south of the central ridge, a much thinned Aralka Formation was cored in Wallara 1. Here the formation is a 26m thick dark grey flat laminated dolomitic siltstone with rare dropstones which become more common with depth. The abrupt contact with the overlying Pioneer Sandstone shows soft sediment penetration across the contact indicating a simple regression without exposure. Thicker Aralka Formation is clearly recognisable on the logs from Murphy 1 and Erldunda 1.
FIGURE 5  DISTRIBUTION OF POST SOUTHS RANGE MOVEMENT
LATE PROTERozoIC ROCKS

ELLIS SANDSTONE

ARUNTA BLOCK

GAYLAD

PERTATATAKA + JULIE FORMATIONS

CENTRAL RIDGE

MUSGRAVE BLOCK

WINNALL BEDS

PERTATATAKA FORMATION

ERODED

ERODED

W

Well - Winnall Beds

P Well - Pertatataka Fm

PJ Well - Pertatataka and Julie Fm

P Well - Formations absent
5.2.4 Pioneer Sandstone

Another Formation previously unrecognised south of the central ridge, it is represented by a very thin (9m) interval in Wallara 1 (Weste, 1990). A basal coarsening upwards pebbly sandstone is erosionally overlain by dark grey dolomitic siltstone which is overlain by dolostone. A thicker Pioneer sandstone is recognisable in Murphy 1 and Erdunda 1 but is eroded from Magee 1 and Mt Charlotte 1. In Wallara 1 core the Pioneer Sandstone is gradationally overlain by Pertataataka Formation.

5.3 POST SOUTHS RANGE MOVEMENT
PERTATATAKA FORMATION - WINNALL BEDS

Revised distributions for the Pertataataka Formation and Winnall Beds are shown in Figure 5. Recent drilling has identified typical Pertataataka Formation south of the central ridge which places further time constraints on the evolution of this structure.

5.3.1 Pertataataka Formation

Continuously cored petroleum slim-hole Wallara 1 intersected a 553m thick monotonous interval of thinly interbedded dark greenish grey siltstone and claystone. Very thin interbeds of light grey very fine grained sandstone steadily increase in abundance upwards over the upper 100m. Contourite-turbidite cycles and slumping are common features. Sedimentary structures indicate deposition below wave-base and there is no indication of a nearby central ridge. A 439m thick interval of dark greenish grey siltstone with minor sandstone stringers was intersected in Magee 1 and correlates well with Wallara 1. The Pertataataka appears to coarsen to the south and west of Wallara 1 to become the Winnall Beds.

In Wallara 1 the Pertataataka Formation gradationally overlies Pioneer Sandstone, with a relatively rapid increase in water depth. In this well the Pertataataka is unconformably overlain by Arumbera Sandstone.

5.3.2 Winnall Beds

Winnall Beds described from Erdunda 1 show a very similar log character to Pertataataka Formation intersected in Wallara 1 and Magee 1, although there is some increase in sandiness. Rocks of this age have been eroded from the Murphy 1 area.

5.4 LATE PROTEROZOIC - CAMBRIAN
PERTAOORRTA GROUP

A revised distribution for the Arumbera Formation, Chandler Formation and Pertaoorrrta Group is shown in Figure 6.

5.4.1 Arumbera Sandstone

Wallara 1, located not far south of the central ridge, intersected thin Arumbera Sandstone, previously unrecognised south of the central ridge and not mapped on the Henbury 1:250 000 sheet. Wallara 1 cored an 88m thick very silty sandstone, bounded by a disconformity at its top and an unconformity at its base. The sandstone is very poorly sorted,
FIGURE 6  DISTRIBUTION OF THE ARUMBERA FORMATION, TODD RIVER DOLOMITE, CHANDLER FORMATION AND PERTAOORTA GROUP
massively bedded and occasionally grades to sandy siltstone. A 6m thick basal pebbly sandstone shows good visible porosity. A 60m thick interval of interbedded sandstone and siltstone, unconformably overlying Pioneer Sandstone/Inindia Beds in Murphy 1, correlates with the Arumbera in Wallara 1.

5.4.2 Tempe Formation

A fully cored 182m thick interval of siltstone with minor sandstone and dolostone was intersected by Wallara 1. Sedimentary textures indicate deposition in a shallow marine - subtidal to occasionally intertidal environment. In Wallara 1 the Tempe disconformably overlies Arumbera Sandstone and is capped by a subaerially exposed vuggy dolostone. A 46m interval in Murphy 1 correlates poorly with Wallara 1 (see Enclosure 2).

5.4.3 Illara Sandstone

In Wallara 1 the Aralka is a 41m thick interval of interbedded reddish moderately well sorted sandstone with an argillaceous matrix and mottled massive siltstone. Sedimentary textures indicate a very shallow marine - intertidal depositional environment. A 13m thick sandstone - siltstone interval in Murphy 1 may be Illara Sandstone or its correlative. In Wallara 1 the Illara Sandstone disconformably overlies Tempe Formation.

5.4.4 Deception Siltstone

A 215m thick interval of reddish brown disrupted gypsiferous siltstone in Wallara 1 is ascribed to the Deception Siltstone. Sedimentary textures are distinctively those of a sabkha environment. In Wallara 1 the Deception Siltstone conformably overlies Illara Sandstone and is gradationally overlain by Petermann Sandstone.

5.4.5 Petermann Sandstone

A 152m interval of fine grained sandstone and minor siltstone and claystone, intersected in Wallara 1 is ascribed to the Petermann Sandstone. It gradationally overlies Deception Siltstone and is conformably overlain by Goyder Formation.
6 DEPOSITIONAL HISTORY AND PALAEOGEOGRAPHY

The following references have considerably advanced the knowledge of the basin's depositional history and palaeogeography.

Walley et al, 1991
Palaeozoic palaeogeography
whole basin

Jones, 1991
Pertnjara Group
northern portion

Nicoll et al, 1991
Ordovician
Waterhouse Range, central north of basin

Deckelman, 1991
Pacoota Sandstone
northern portion

Gorter, 1991
Pacoota Sandstone
northern portion

Gorter, 1991
Larapinta Group, Pertaoorna Group
whole basin

Kennard & Lindsay, 1991
Pertaoorna Group
northern portion

Kennard, 1991
Todd River Dolomite
northeast of basin

Bradshaw, 1991A
Chandler Formation
eastern portion

Bradshaw, 1991B
Tempe Formation
central portion

Field, 1991
Olympic Formation, Pioneer and Gaylad sandstones,
northeast of basin

Freeman et al, 1991
Gaylad Sandstone
northeast of basin
FIGURE 7  DINGO FIELD. DEPTH STRUCTURE ON ARUMBERA
7 EXPLORATION HISTORY UPDATE

7.1 DINGO GAS FIELD

After a six year drilling hiatus, two more wells, Dingo 3 (Deckelman et al., 1991) and Dingo 4 (Deckelman et al., 1992), were drilled by Magellan Petroleum in late 1990 and early 1992 (see figures 7 and 8).

Dingo 3, in the northwest corner of the Dingo structure was drilled to determine whether commercial flows of gas could be produced from the Arumbera Sandstone if formation damage, caused at Dingo 1 and Dingo 2 by mud drilling, was eliminated by drilling with air. The well was terminated at 3045m in the top of the Julie Formation. The lower part of the Arumbera Sandstone producing interval, a lower delta plain facies was replaced by an interdistributary shallow marine facies with insufficient porosity to flow gas. In spite of the reduction in pay zone, the well flowed 2.864MMSCF/D, 200% greater than Dingo 1 or Dingo 2.

Dingo 4 was located to test the southwest flank of the Dingo dome. The well was terminated at 3130.5m in the top of the Pertatataka Formation without encountering any gas flows. The Arumbera Sandstone was water wet. The well showed that the Dingo structure is not full to spill. The total gas column length is estimated at 129m compared to a mapped vertical closure of 194m for the field.

Following the disappointing results, Magellan Petroleum and exploration partners (see Appendix 4) applied for and were granted a retention licence over the field.

7.2 EXPLORATION

7.2.1 OP 175 and OP 178

OP 175 and OP 178 are shown in Eastern Amadeus Basin Study Figure 5 and Western Amadeus Basin Study Figure 5.

**Undandita 2** (see Appendix 2)
Magellan Petroleum and their exploration partners resumed drilling in the basin in 1988 following a three year break. Undandita 2 (Berry et al., 1989) was a retest of the Undandita structure, previously tested by Undandita 1A in 1982/83. Undandita is a faulted anticline, overturned to the south, with Cambrian and Proterozoic sediments in the upper fault plate overlying early Devonian sediments in the lower plate. Undandita 1A tested only the upper plate but recorded fair gas shows in the Illara Sandstone and Tempe Formation and good oil shows in the Arumbera Sandstone. Undandita 2, located 315m south of Undandita 1, was to test the Devonian to Orobian section in the lower plate. The well was terminated at 2560.3m in Goyder Formation. Because of very low porosities, probably a result of the area's burial history, there were only minor indications of gas in the primary objective Pacoota and Stairway sandstones. The well was plugged and abandoned.
FIGURE 8  SIMPLIFIED CROSS SECTION THROUGH DINGO FIELD
Gosses Bluff 2 (see Appendix 2)
In 1988/89 Magellan drilled a retest of the Gosses Bluff astrobleme. Gosses Bluff 1, drilled in 1965, failed to reach the main objective, the Pacoota Sandstone. Gosses Bluff 2 (Berry et al, 1989), located 514m east-northeast of Gosses Bluff 1, was terminated at 2631.9m. The primary objective Pacoota Sandstone, although fractured, failed to flow gas to the surface and the well was plugged and abandoned. Although there were gas shows in the Horn Valley Siltstone and Pacoota Sandstone an extensive network of interconnected open fractures was not intersected.

Following the disappointing results from these wells OP 175 and OP 178 were relinquished.

7.2.2 EP 20

EP 20 (see Weste, 1990, Figure 5) was granted to Indigo Oil Pty Ltd., a wholly owned subsidiary of Indigo Oil Inc. of Texas, U.S.A. Following a series of airborne and soil hydrocarbon microseepage surveys, Sirgo Exploration Inc., also of Texas farmed into EP 20 to drill a well on a broad microseepage anomaly in the Wallara Ranch area, south of the basin’s central ridge.

Wallara 1 (see Appendix 2)
Wallara 1 was sited on a broad microseepage anomaly in an area where scattered Goyder Formation rubble occurred on a satellite interpreted anticlinal structure. There was no seismic coverage of the structure. Wallara 1 (Weste, 1990) was drilled in 1990 as a slim-hole well continuously cored from 334m (Deception Siltstone) to the total depth of 2001m (top Bitter Springs Gillen Member). No significant oil or gas shows were detected. The well was sited 4km from the structural apex. Although unsuccessful as a petroleum test the well intersected Arumbera Sandstone and other formations previously unrecognised south of the basin’s central ridge.

Following Wallara 1 a 100km seismic survey was recorded to delineate the Wallara structure and other possible rollovers in EP 20 (Geoweste, 1991). The seismic data showed Wallara 1 to be sited well outside structural closure and was therefore not a valid test of the structure. EP 20 expired early in 1992 and was not renewed.

7.2.3 EP 26, EP 34 and EP 38

These three tenements were granted to Pacific Oil & Gas Pty Limited, a wholly owned subsidiary of CRA Exploration Limited. They cover areas in the little explored southern portion of the basin. The company has been pursuing an exploration model based on hydrocarbon fields in the Eastern Siberian Basin which has close similarities to the Amadeus Basin. In Siberia giant hydrocarbon fields are reservoired beneath a Bitter Springs equivalent Late Proterozoic salt sequence. Pacific Oil & Gas target traps developed in the Heavitree Quartzite sands, sourced by organic rich sub-salt Gillen shales and sealed by the Gillen salt.

EP 26 was granted in October, 1988. The company flew airmag in 1989 and recorded a 103km seismic/gravity survey in the Murphy and Parrarra areas.
Murphy 1 (see appendix 2)
Murphy 1 (Menpes, 1991) was drilled in 1990/91 to test a culmination on a large seismically mapped anticline. The objective was Heavitree Quartzite. Murphy 1 was terminated at 2882m in a very thick salt sequence in the Bitter Springs Formation Gillen Member, without reaching the objective. There were no significant hydrocarbon shows and the well was plugged and abandoned. The interpreted basement reflector was, in fact, an intra salt reflector. Source rock studies indicate that the Bitter Springs Formation in the Murphy area is overmature.

In 1992 Pacific Oil & Gas acquired 74.6km of seismic in the Depot Hill area. Structuring was found to be developed over Bitter Springs salt, independent of basement and the Heavitree Quartzite. EP 26 was then relinquished.

EP 34 granted in March, 1990, was relinquished in March, 1992, without any significant exploration activity, following the negative results from Murphy 1.

Pacific Oil & Gas then focused their attention on EP 38, granted in 1991 (see Figure 3). One seismic line tying the Depot Hill survey to Mt Charlotte 1 showed that the Mt Charlotte structure involves basement and is a faulted anticline.

Magee 1 (see Appendix 2)
Magee 1 (Wakelin-King, 1994), was drilled in 1992 to test Heavitree Quartzite in an anticlinal structure. The well was terminated at 2396m in metamorphic basement. A very thin (4.5m) Heavitree Quartzite was intersected from which a small flow of 63.1 MSCFD was obtained during air drilling from an estimated 3.6m net pay zone. The porosity (9%) observed in the Heavitree, the presence of bitumen in lower Gillen Member shales, and the possibility of thicker pay zone to the north give encouragement for further exploration in the region.

At the time of this report compilation Pacific Oil & Gas have an EP Application pending over an area south of Magee 1 (see Figure 3). This application covers a southerly extension of the Magee structure.

7.2.4 EP 36

EP 36 was granted to Anzoil Exploration Limited in April, 1993 and expires in April, 1997. To date no field exploration has been carried out.

7.2.5 Other Applications

Two other EP Applications are pending (see Figure 5). They are:

EP(A) 35
Kiwi Coal Corporation Ltd.

EP(A) 44
Australian Petroleum Resources Pty Ltd.
7.3 CURRENT EXPLORATION METHODS

Exploration methods which have been most useful in the basin, in recent years, are briefly discussed.

7.3.1 Remote Sensing

Magnetics
The most useful technique for detecting structures involving basement is high resolution airborne magnetics. Using a close station interval, a line spacing of 200m and a low flight height, modern data imaging can provide detailed knowledge of structural development. Additional valuable information on the presence of hydrocarbons may be gained by the presence of high frequency, low amplitude anomalies sometimes associated with microseepages.

Hydrocarbon Microseepage
Improved microseepage survey techniques involving soil gas, ground borne radiometrics, and soil magnetic susceptibility, allow discriminant analysis of microseepage data and elimination of false anomalies. The basin's known hydrocarbon fields have associated marked microseepage anomalies.

7.3.2 Seismic

High resolution surveys incorporating high fold (e.g. 60 fold) and short group intervals (e.g. 10m) are required in the Amadeus Basin. This is because of the relatively high velocities of the well indurated rocks, velocity inversions through salt and anhydrite intervals, steep dips near structural apexes, complex faulting, and complicated weathering statics. Thorough experimental testing early in a survey is essential, particularly if sub-salt data are important.

7.3.3 Drilling

In the Amadeus Basin fracturing often plays an important role in reservoir performance. Mud drilling can cause severe formation damage in these instances. At Dingo a 200% increase in reservoir performance resulted from the change from mud drilling to air drilling. The hard, well indurated nature of the rocks in the basin makes conventional rotary mud drilling slow and expensive. These rocks are particularly well suited to down hole hammer drilling. With this technique low drill bit costs, high R.O.P., and straight hole can be obtained.

7.3.4 Gravity

Detailed gravity profiling along seismic lines allows integrated imaging of magnetic and gravity data. This is particularly important in estimating salt thicknesses and basement structure.
8 EXPLORATION POTENTIAL

8.1 PLAY COMPONENTS

8.1.1 Traps

Four way dip closure
Large and small doubly plunging anticlinal traps are common in the basin. Most are are bauld to the basin’s two principal reservoirs, the Pacoota Sandstone and Arumbera Sandstone. Although the larger four way dip closures involving these reservoirs have been tested, there are a number of medium to small closures awaiting the drill. Examples are Harajica Prospect (top plate), Wallara Prospect and North Dingo Lead (see section 9).

Subthrust - three way dip closure
This is the most common untested trap type involving the Pacoota Sandstone and/or the Arumbera sandstone. They occur on the flanks of thrusted salt cored anticlines in the bottom plate and rely on the fault for the updip seal. Untested example prospects are Johnstone, Gypsum, Tarawarra, Harajica, Glen Edith, and Waterhouse (see section 9).

Pinchout
Pinchouts of reservoir facies, particularly the Arumbera Sandstone, occur on the flanks of structures. At these locations shoaling can lead to good primary porosity and subsequent exposure can lead to secondary porosity by solution of cements. Examples include the Centenary Anticline, Train Hills and Magee leads (see section 9).

8.1.2 Reservoirs

Pacoota Sandstone
The Pacoota is the only reservoir currently in production in the basin. It is potential reservoir north of the central ridge. Isopachs of the main Pacoota Reservoir unit, the Fluvial P3B, are shown as figure 10B and the structure on the Pacoota is shown as Figure 10A. The Pacoota Sandstone and overlying formations thicken rapidly toward the basin’s northern margin and this resulted in a greater depth of burial, with associated loss of porosity. Pacoota plays along the central northern margin of the basin need an added porosity factor, such as an interconnected network of open fractures.

Arumbera Sandstone
Reservoir to the Dingo Gas Field, the Arumbera Sandstone shows variable porosity. At Dingo the basal lower delta plain facies of the basal unit is the best reservoir. Reservoir quality should improve in pinchouts where the Arumbera, initially deposited in non marine environments over a major unconformity surface, will show better porosity from reworking and exposure.
FIGURE 10A STRUCTURE ON PACOOTA SANDSTONE
(note: different structural trends across Areyonga Thrust)

FIGURE 10B PACOOTA P38 (FLUVIAL UNIT) ISOPACHS

- Surface thrust or reverse fault
- Subsurface thrust or reverse fault at Pacoota level
- 20 - Isopach contour (20m interval)
Heavitree Quartzite
Magee 1 showed the Heavitree to have reservoir potential. Although only very thin in that well, the observed 9% porosity is worthy of chasing into a thicker interval.

Fracture reservoir
The Amadeus Basin’s most prolific producer, the Palm Valley Gas Field is dependent on fracture reservoir supported by some matrix porosity. Networks of interconnected open fracture systems can be developed by extensional stresses induced by the often very tightly folded anticlines. Well developed fracture networks could be found in any competent rock and these reservoirs could be sought in the Precambrian rocks in the large, bald doubly plunging anticlines.

8.1.3 Source Rocks

The reader is referred to the Eastern Amadeus Basin Study, section 8.2. The only additional information gained since then is the presence of bitumen in the shales of the basal Bitter Springs Formation Gillen Member in Magee 1. Analysis of the bitumen by Pacific Oil & Gas indicates that the rocks are oil prone and in the oil window. The basal shale sequence is below the thick Gillen salt and is therefore well placed to source traps developed in the Heavitree Quartzite.

8.2 PLAY TYPES

The principal play types recognised in the basin are briefly outlined below. Examples mentioned are those prospects and leads described in detail in section 9. Other play types, not so well recognised, such as various carbonate associated plays, may be important and await the intrepid explorer.

Figure 11, “Oil and Gas Prone Areas”, summarises the oil and gas fairways. Although the principal plays north of the central ridge are those sourced by the Horn Valley Siltstone, common oil shows in the Precambrian rocks indicate the existence of potential oil source rocks. The Horn Valley Siltstone / Pacoota Sandstone source rock / reservoir play combination is not significant south of the central ridge.

8.2.1 Four way dip closure/Pacoota/Horn Valley

The preferred play in the basin. It occurs north of the central ridge. Large plays in the most favourable locations have all been tested. Plays with small to medium possible reserves occur in the northwest of the basin where the Pacoota is thinner, but porous, and the Horn Valley Siltstone, also thinner, is more organic rich and oil prone. Plays with larger possible reserves occur along the central northern margin of the basin (e.g. Harajica), but intergranular porosity has suffered from greater depths of burial in that portion of the basin. Fracturing may enhance this play (e.g. Gosses Bluff rim syncline structuring).

8.2.2 Subthrust/Pacoota/Horn Valley

The most common play north of the central ridge. Estimated reserves vary from small (Glen Edith) to moderately large (Harajica, Waterhouse). There is often some potential in the top plate over these plays.
FIGURE 11  OIL AND GAS PRONE AREAS
8.2.3 Fracture/Pacoota/Horn Valley

The fracture component of this play is difficult to predict and difficult to test. This play is valid only north of the central ridge. It is a possible variant on the flank of the Gosses Bluff rim syncline.

8.2.4 Four way dip closure/Arumbera or Proterozoic

There are very few known occurrences with Arumbera reservoir (e.g. North Dingo). Most large to very large structures, bald at Arumbera level, still have closure in the Proterozoic rocks (e.g. Ooraminna). Although source rocks are not clearly identified, the Dingo Gas Field and other shows in the Proterozoic bear testimony to their existence. A fracture component to porosity is probably required.

8.2.5 Subthrust/Arumbera

These plays occur with Pacoota plays, but at greater depth and also as plays where Pacoota is not present or is too shallow. Examples occur on the flanks of anticlines in the most eastern portion of the basin (e.g. Centenary Anticline).

8.2.6 Pinchout/Heavitree/Gillen salt

This play type is based on the giant Proterozoic fields of the Eastern Siberian Basin and Sichuan Basin. It has only been seriously tested by one well, Magee 1, which flowed gas. Although large areas of the basin may be prospective, the limited data so far obtained indicate that the southeast and east of the basin has the most favourable Bitter Springs source rock maturation (e.g. Magee lead).
FIGURE 12  JOHNSTONE PROSPECT TWT STRUCTURE ON TOP PACOOTA SANDSTONE
(FOR LOCATION SEE ENCLOSURE 3)
9 PROSPECTS AND LEADS

9.1 JOHNSTONE PROSPECT
See Figure 12 and Enclosure 3.

LOCATION
Northwest corner of basin.
390km west of Alice Springs.
Lat 23 deg 40 min  Long 130 deg.

TRAP TYPE
Sub thrust - three way dip closure.

OBJECTIVES
Primary: Pacoota Sandstone.
Secondary: Stairway Sandstone, Arumbera Sandstone / Cleland Sandstone.

STRUCTURE
Subthrust trap controlled by an east-west thrust fault (north block thrust over south block). There are two subculminations, with the eastern culmination having approximately 30ms of independent four way dip closure. There is potential for additional reservoir north of the thrust fault but seismic coverage is insufficient to determine.

RESERVOIR
Primary reservoir is the Pacoota Sandstone, the principal producing reservoir in the Mereenie and Palm Valley fields. Mapping (Deckelman, 1991) indicates 45m of unit P1 and 18m of unit P3B. Applying Mereenie net-to-gross sand ratios produces a net pay thickness of approximately 10m (4.5m P1 and 6m P3B). Although thinner than at Mereenie, the Pacoota is likely to be cleaner and better sorted, resulting in a higher than predicted net pay.

SEAL
Seal updip is predominantly provided by the thrust fault. Salt is commonly present in the basin’s thrusts and the occurrence of a diapir just north of the fault indicates that salt may be present in the fault, enhancing the seal. The Horn Valley Siltstone, an effective seal in the producing fields, forms the vertical seal to the trap.

SOURCE
The Horn Valley Siltstone is the principal source rock to the Mereenie and Palm Valley fields. Studies show that it becomes more oil prone and richer, but thinner, west of Mereenie. Thickness at Johnstone is measured at 48m which should be sufficient to provide enough oil to fill the structure given the relatively large area down dip for generation and migration.
RECOMMENDED WELL LOCATION
See Figure 12.
A well located at VP 216 on line P81-J15 would adequately test the trap.

PROGNOSED DEPTH
Prognosed depth to the top of the Pacoota Sandstone is 1750m. A shallow well drilled to 1800m would test the Pacoota. A well drilled to 2900m would also test the basal Cambrian Arumbera/Cleland sandstones.

RESERVES
Areal closure is calculated at 53.5 sq. kms. On a full to spill basis, using a net pay of 10m and a RF of 0.3, reserves are calculated at 35 MMSTB.

NEAREST WELL
Mt. Winter 1.
80km to east-southeast.
Good oil shows in Stairway Sandstone and Bitter Springs Fm. Poor oil shows in Horn Valley Siltstone.
Drilled off structural closure.

TENEMENT STATUS
See Figures 3 and 9.
Currently within EP application 44; Australian Petroleum Resources Pty Ltd. Granting of EP44 is pending finalisation of negotiations with the Central Land Council. The applicant is interested in joint venture enquiries.

PREVIOUS EXPLORATION
Seismic: see Western Amadeus Basin Report Enclosure 3 and Appendix 1.
- Pancontinental Petroleum 1981/82, 12 and 24 fold, 50m groups.
- Magellan Petroleum 1965/66 Mt. Rennie survey, 12 channel analog, reprocessed by Pancontinental.
Prospect assessment: Magellan Petroleum.

ADDITIONAL WORK REQUIRED
Seismic reprocessing.

9.2 GYPSUM PROSPECTS
See Figure 13 and Enclosure 3.

LOCATION
Northwest corner of basin.
365km west of Alice Springs.
Lat 23 deg 45 min  Long 130 deg 10 min.

TRAP TYPE
Gypsum 1: overthrust - four way dip closure.
Gypsum 2: subthrust - three way dip closure.
OBJECTIVES
Primary: Pacoota Sandstone.
Secondary: Stairway Sandstone, Arumbera Sandstone / Cleland Sandstone.

STRUCTURE
Gypsum 1: mainly four way dip closure with part closure against an east-west thrust fault (south block thrust over north block).
Gypsum 2: Subthrust trap controlled by an east-west thrust fault (south block thrust over north block).

RESERVOIR
Primary reservoir is the Pacoota Sandstone, the principal producing reservoir in the Mereenie and Palm Valley fields. Mapping indicates significant thinning of the Pacoota Sandstone in the prospect area and Mereenie net-to-gross sand ratios produces a net pay thickness of approximately 5m. Although thinner than at Mereenie, the Pacoota is likely to be cleaner and better sorted, resulting in a higher than predicted net pay.

SEAL
Seal updip is provided wholly by the thrust fault at Gypsum 2 and in part at Gypsum 1. Salt is common in the basin’s thrust faults and if present would enhance the integrity of the seal. The Horn Valley Siltstone, an effective seal in the producing fields, forms the vertical seal to the Gypsum 1 and Gypsum 2 traps.

SOURCE
The Horn Valley Siltstone is the principal source rock to the Mereenie and Palm Valley fields. Studies show that it becomes more oil prone and richer, but thinner, west of Mereenie. Thickness in the Gypsum area should be sufficient to provide enough oil to fill the structures given the relatively large areas down dip for generation and migration. The source area for Gypsum 1 lies south of the thrust and for Gypsum 2 lies north of the thrust.

RECOMMENDED WELL LOCATION
See Figure 13.
Gypsum 1: a well located at VP 658 on line P81-J13 would adequately test the trap.
Gypsum 2: a well located at VP 256 on line P81-J14 may adequately test the trap.
Seismic reprocessing may provide better definition of proposed well sites.

PROGNOSED DEPTH
Gypsum 1: prognoosed depth to the top of the Pacoota Sandstone is 700m. A shallow well drilled to 800m would test the Pacoota. A well drilled to 1800m would also test the basal Cambrian Arumbera/Cleland sandstones.
Gypsum 2: prognoosed depth to the top of the Pacoota Sandstone is 1600m. A shallow well drilled to 1700m would test the Pacoota. A well drilled to 2700m would also test the basal Cambrian Arumbera/Cleland sandstones.

RESERVES
Gypsum 1: Areal closure is calculated at 8 sq. kms. On a full to spill basis, using a net pay of 4.8m and a RF of 0.3, reserves are calculated at 3 MMSTB.
Gypsum 2: Areal closure is calculated at 13 sq. kms. On a full to spill basis, using a net pay of 4.8m and a RF of 0.3, reserves are calculated at 5 MMSTB.
FIGURE 13  GYPSUM PROSPECTS: TWT STRUCTURE ON TOP PACOOTA SANDSTONE
(for location see Enclosure 3)
NEAREST WELL
Mt. Winter 1.
80km to east-southeast.
Good oil shows in Stairway Sandstone and Bitter Springs Fm. Poor oil shows in Horn Valley Siltstone.
Drilled off structural closure.

TENEMENT STATUS
See Figures 3 and 9.
Currently within EP application 44; Australian Petroleum Resources Pty Ltd.
Granting of EP44 is pending finalisation of negotiations with the Central Land
Council. The applicant is interested in joint venture enquiries.

PREVIOUS EXPLORATION
Seismic: see Western Amadeus Basin Report Enclosure 3 and Appendix 1.
Pancontinental Petroleum 1981/82, 12 and 24 fold, 50m groups.
Magellan Petroleum 1965/66 Mt. Rennie survey, 12 channel analog,
reprocessed by Pancontinental.
Prospect assessment: Magellan Petroleum.

ADDITIONAL WORK REQUIRED
Seismic reprocessing.

9.3 TARAWARRA PROSPECT
See Figure 14 and Enclosure 3.

LOCATION
Northern margin, western portion of basin, at northwestern termination of the
Gardiner Range.
250km west of Alice Springs.
Lat 23 deg 37 min Long 131 deg. 22 min.

TRAP TYPE
Subthrust - three way dip closure.

OBJECTIVES
Primary: Pacoota Sandstone.

STRUCTURE
Complex subthrust trap controlled by an east-west trending re-entrant fault complex
(the Tarawarra Fault Zone) on the northern flank of the Glen Edith Syncline. In this
area the Gardiner Range is terminated at the underthrust basin margin.

RESERVOIR
Primary reservoir is the Pacoota Sandstone, the principal producing reservoir in the
Mereenie and Palm Valley fields. Mapping (Deckelman, 1991) indicates 40m of
unit P1 and 200m of unit P3. Applying Mereenie net-to-gross sand ratios produces
a net pay thickness of approximately 68m (4m P1 and 64m P3).
FIGURE 14  TARAWARRA PROSPECT DEPTH STRUCTURE ON TOP PACOOTA SANDSTONE
Seal updpip is wholly provided by the thrust fault. Salt is commonly present in the basin's thrusts and if present in this system would enhance the seal. The Horn Valley Siltstone, an effective seal in the producing fields, forms the vertical seal to the trap.

Source
The Horn Valley Siltstone is the principal source rock to the Mereenie and Palm Valley fields. Studies show that it becomes more oil prone and richer, northwest of Mereenie. Thickness in the Glen Edith Syncline would be sufficient to provide enough hydrocarbons to fill the structure given the relatively large area down dip for generation and migration. The depth of burial would favour gas as the primary reservoired hydrocarbon.

Recommended Well Location
See Figure 14.
A well located at VP 560 on line M87-TA04 would adequately test the trap.

Prognosed Depth
Prognosed depth to the top of the Pacoota pay is 2843m. A well drilled to 3420m would fully test the Pacoota.

Reserves
Areal closure is calculated at 11.0 sq. kms. On a full to spill basis, using a net pay of 68m, 8% porosity and RFs of 0.3 for oil and 0.86 for gas, prognosed recoverable reserves have been calculated by Magellan Petroleum to be 68 MMSTB of oil and 290 BCF of gas.

Nearest Well
Mereenie Oil and Gas Field.
32km to the south-southeast.
Proven reserves of 185.6 MMSTB in place, 436 BCF cap gas and 58 BCF solution gas.

Tenement Status
See Figures 3and 9.
Currently within EP application 44; Australian Petroleum Resources Pty Ltd. Granting of EP44 is pending finalisation of negotiations with the Central Land Council. The applicant is interested in joint venture enquiries.

Previous Exploration
Seismic: see Western Amadeus Basin Report Enclosure 3 and Appendix 1.
Pancontinental Petroleum 1981/82, 24 fold, 50m groups, 117km reprocessed in 1987 by Magellan Petroleum.
Magellan petroleum 1965/66 Mt. Rennie survey, 12 channel analog.
Prospect assessment: Magellan Petroleum.
Magellan Petroleum, 1988A.

Additional Work Required
None.
FIGURE 15  GLEN EDITH PROSPECT. DEPTH TO TOP PACOOTA SANDSTONE
(for location see Enclosure 3)
9.4 GLEN EDITH PROSPECTS
Four related prospects.  
See Figure 15 and Enclosure 3.

LOCATION
Northwestern portion of basin, on northern extension of Mereenie Anticline structure and thrust.  
250km west of Alice Springs.  
Lat 23 deg 50 min  Long 131 deg. 20 min.

TRAP TYPE
Subthrust - three way dip closure.

OBJECTIVES
Primary: Pacoota Sandstone.

STRUCTURE
Closures on the underthrust side of the northwest - southeast trending Glen Edith Anticline.  Glen Edith A and Glen Edith B are located against a southern thrust, overthrusting from the north.  Glen Edith C and D are located against a northern thrust which overthrusts from the south.

RESERVOIR
Primary reservoir is the Pacoota Sandstone, the principal producing reservoir in the Mereenie and Palm Valley fields.  Mapping (Deckelman, 1991) (see Figure 10B) indicates that a sufficient thickness of Pacoota is present, including the best reservoir unit, the P3.  Applying net-to-gross sand ratios from the nearby Mereenie Oil and Gas Field produces a net pay thickness of approximately 26.3m for Glen Edith A and Glen Edith B and 33.2m for Glen Edith C and D.

SEAL
Seals updip are wholly provided by the thrust fault.  The Horn Valley Siltstone, an effective seal in the producing fields, forms the vertical seal to the traps.

SOURCE
The Horn Valley Siltstone is the principal source rock to the Mereenie and Palm Valley fields.  Studies show that it becomes more oil prone and richer, northwest of Mereenie.  Thickness in the Glen Edith Syncline would be sufficient to provide enough hydrocarbons to fill the structure given the relatively large area down dip for generation and migration.  The depth of burial would favour gas and oil as the reservoired hydrocarbons.

RECOMMENDED WELL LOCATION
Seismic reprocessing is required accurately to locate wells to test each trap.

PROGNOSED DEPTH
Prognosed depths to the top of the Pacoota pay is:
- Glen Edith A  2590m
- Glen Edith B  1828m
- Glen Edith C  1981m
- Glen Edith D  1767m
RESERVES
On a full to spill basis, using 8% porosity for gas and 10.5% for oil and RFs of 0.3 for oil and 0.86 for gas, proxed recoverable reserves have been calculated by Magellan Petroleum to be:

Total Glen Edith prospects
Oil 42.3 MMSTB
Gas 199 BCF

Glen Edith A (area 8.0 sq km, net pay 26.3m)
Oil 59.55 MMSTB in place, 17.86 MMSTB recoverable.
Gas 110.1 BCF in place, 94.7 BCF recoverable.

Glen Edith B (area 5.9 sq km, net pay 26.3m)
Oil 43.92 MMSTB in place, 13.17 MMSTB recoverable.
Gas 64.7 BCF in place, 55.6 BCF recoverable.

Glen Edith C (area 2.0 sq km, net pay 33.2m)
Oil 18.79 MMSTB in place, 5.64 MMSTB recoverable.
Gas 29.2 BCF in place, 25.2 BCF recoverable.

Glen Edith D (area 2.0 sq km, net pay 33.2m)
Oil 18.79 MMSTB in place, 5.64 MMSTB recoverable.
Gas 27.0 BCF in place, 23.3 BCF recoverable.

NEAREST WELL
Mereenie Oil and Gas Field.
15km to the southeast.
Proven reserves of 185.6 MMSTB in place, 436 BCF cap gas and 58 BCF solution gas.

TENEMENT STATUS
See Figures 3 and 9.
Currently within EP application 44; Australian Petroleum Resources Pty Ltd.
Granting of EP44 is pending finalisation of negotiations with the Central Land Council. The applicant is interested in joint venture enquiries.

PREVIOUS EXPLORATION
Seismic: see Western Amadeus Basin Report Enclosure 3 and Appendix 1.
Magellan Petroleum 1983.
Pancontinental Petroleum 1982/83, 24 fold, 50m.
Prospect assessment: Magellan Petroleum.

ADDITIONAL WORK REQUIRED
Reprocessing of up to 440km of seismic.
9.5 WATSON RANGE PROSPECT
See Figure 16 and Enclosure 3.

LOCATION
Western portion of basin.
275km west of Alice Springs.
Lat 23 deg 55 min   Long 131 deg 10 min.

TRAP TYPE
Subthrust - three way dip closure.

OBJECTIVES
Primary: Pacoota Sandstone.
Secondary: Stairway Sandstone.

STRUCTURE
Subthrust trap controlled by a southeast-northwest thrust fault (south block thrust
over north block). There is no independent four way dip closure. The structure is
narrow and steep, extending for 22km along the fault.

RESERVOIR
Primary reservoir is the Pacoota Sandstone, the principal producing reservoir in the
Mereenie field, 24km to the east. Applying Mereenie net-to-gross sand ratios to
the mapped Pacoota thickness produces a net pay thickness of approximately 16.7m.
The Pacoota intersected in Mt Winter 1, to the west, appears to be cleaner than at
Mereenie to the east. Net-to-gross sand ratios may therefore be greater than at
Mereenie. The Stairway Sandstone may also contribute reservoir.

SEAL
Seal updip is wholly provided by the thrust fault. The Horn Valley Siltstone, an
effective seal in nearby Mereenie, forms the vertical seal to the trap.

SOURCE
The Horn Valley Siltstone is the principal source rock to the adjacent Mereenie Oil
and Gas Field. Studies show that it becomes more oil prone and richer, but thinner,
west of Mereenie. Thickness at Watson Range is approximately 70m which is
sufficient to provide enough oil to fill the structure given the area down dip for
generation and migration.

RECOMMENDED WELL LOCATION
A well location would be best determined following seismic reprocessing.

PROGNOSED DEPTH
Prognosed depth to the top of the Pacoota Sandstone is 850m. A shallow well
drilled to 1000m would test through the Pacoota.

RESERVES
Areal closure is calculated at 15.9 sq. kms. On a full to spill basis, using a net pay
of 16.7m, an average porosity of 10.5% and a RF of 0.3, reserves are calculated at
23 MMSTB.
FIGURE 16  WATSON RANGE PROSPECT, DEPTH TO TOP PACOOTA SANDSTONE
(for location see Enclosure 3)
NEAREST WELL
Mereenie Oil and Gas Field.
22km to the east.
Proven reserves of 185.6 MMSTB in place, 436 BCF cap gas and 58 BCF solution gas.

TENEMENT STATUS
See Figures 3 and 9.
Currently within EP application 44; Australian Petroleum Resources Pty Ltd.
Granting of EP44 is pending finalisation of negotiations with the Central Land Council. The applicant is interested in joint venture enquiries.

PREVIOUS EXPLORATION
Seismic: see Western Amadeus Basin Report Enclosure 3 and Appendix 1.
Pancontinental Petroleum 1981/82, 12 and 24 fold, 50m groups.
Magellan Petroleum 1965/66 Mt Rennie-Ooraminna survey 12 channel analog, reprocessed by Pancontinental.
Prospect assessment: Magellan Petroleum.

ADDITIONAL WORK REQUIRED
Seismic reprocessing.

9.6 AREYONGA PROSPECT
See Figure 17 and Enclosure 3.

LOCATION
Central northern Amadeus Basin.
190km west of Alice Springs.
Lat 23 deg 50 min  Long 132 deg 0 min.

TRAP TYPE
Subthrust - three way dip closure with possible top plate closure.
Associated hydrocarbon microseepage anomaly

OBJECTIVES
Primary: Pacoota Sandstone.
Secondary: Stairway Sandstone.

STRUCTURE
A long, narrow, west-northwest trending trap on the northern underthrust plate of the Areyoga Fault. Fault strands and dip reversals in the top plate indicate an overlying, shallow play against the thrust. Thrusting and folding, mainly Alice Springs Orogeny, produced the trap.

RESERVOIR
Primary reservoir is the Pacoota Sandstone, the principal producing reservoir in the Mereenie and Palm Valley fields. Mapping (Deckelman, 1991) shows that the Pacoota Sandstone thickness increases significantly northwest from the Mereenie and Palm Valley fields. The prospect has good reservoir potential. Applying Mereenie net-to-gross sand ratios produces a net pay thickness of 54.8m. Porosity is anticipated to be 10.5%. Significant reservoir may also occur in the Stairway Sandstone, increasing net pay.
FIGURE 17 AREYONGA PROSPECT. TOP PACOOTA DEPTH STRUCTURE MAP
(for location see Enclosure 3)
SEAL
The Horn Valley Siltstone, an effective seal in the producing fields, forms the vertical seal to the trap. The trap relies on the thrust for updip seal. Salt is commonly present in the basin’s thrusts and its presence in the fault would enhance the seal.

SOURCE
The Horn Valley Siltstone is the principal source rock to the Mereenie and Palm Valley fields. Thickness at Areyonga is prognosed to be sufficient to provide enough hydrocarbons to fill the structure given the relatively large area down dip for generation and migration. The burial history of the structure and the surrounding down-dip hydrocarbon generation areas indicate that gas and oil are likely. A number of hydrocarbon microseepage anomalies are associated with the structure, indicating that significant volumes of hydrocarbons have migrated into the structure.

RECOMMENDED WELL LOCATION
See Figure 17.

PROGNOSED DEPTH
A well drilled to 3300m would adequately test the Pacoota Sandstone in the structure.

RESERVES
Areal closure is calculated at 7.5 sq. kms. for the overthrust. On a full to spill basis, using a net pay of 54.8m, porosity of 10% and recovery factors of 86% for gas and 30% for oil, recoverable oil is calculated to be 34.9 MMSTB and recoverable gas 209.3 BCF.

NEAREST WELL
Undandita 1A
17 km north
Dry well.
Drilled to test potential of Pacoota and Stairway sandstones.
Encountered good oil show (water washed live oil) in an obviously porous fault zone.

TENEMENT STATUS
Currently within EP Application 44: Australian Petroleum Resources Pty Ltd.
The applicant is interested in joint venture enquiries.

PREVIOUS EXPLORATION
Seismic: see Figure 19, also Western Amadeus Basin Report Enclosure 3 and Appendix 1.
Pancontinental Petroleum 1983, 42km, Vibroseis, 24 fold, 50m groups.
Prospect assessment: Magellan Petroleum.

ADDITIONAL WORK REQUIRED
None.
FIGURE 18A  GOSSES BLUFF, SHOWING ROLLOVER ON FLANK OF RIM SYNCLINE

FIGURE 18B  DIAGRAMMATIC CROSS SECTION OF GOSSES BLUFF
9.7 GOSSES BLUFF RIM SYNCLINE LEAD

LOCATION
Central northern Amadeus Basin.
160km west of Alice Springs.
Lat 23 deg 49 min  Long 132 deg 18 min.

TRAP TYPE
Possible four way dip closures developed on anticlinal structure.

OBJECTIVES
Primary: Pacoota Sandstone.
Secondary: Stairway Sandstone.

STRUCTURE
The Gosses Bluff impact crater (astroblème) has a central crater over highly fractured steeply upturned rocks investigated by petroleum wells Gosses Bluff 1 and 2. The central crater is surrounded by a rim syncline which has an anticlinal rollover on its outer flank (see Figure 18). This rollover occurs approximately 8km out from the centre of the structure. Faulting and complex structuring of the outer flank of the rim syncline have probably produced four way dip closures in the circular anticline.

RESERVOIR
Primary reservoir is the Pacoota Sandstone, the principal producing reservoir in the Mereenie and Palm Valley fields. Mapping (Deckelman, 1991) shows that the Pacoota Sandstone thickness increases significantly northwards from the Mereenie and Palm Valley fields. In the vicinity of Gosses Bluff it is very thick (see Figure 18A). The increase in reservoir thickness is somewhat offset by the decreased porosity along the central northern margin of the basin.

SEAL
The Horn Valley Siltstone, an effective seal in the Palm Valley Gas Field to the southeast and in the Mereenie Oil and Gas Field to the southwest, together with intra Pacoota Sandstone siltstones, form an effective seal in the Gosses Bluff area.

SOURCE
The Horn Valley Siltstone is the principal source rock to the Mereenie and Palm Valley fields. Thickness in the Gosses Bluff area is sufficient to provide enough hydrocarbons to fill the structure. The burial history of the structure and the surrounding down-dip hydrocarbon generation areas indicate that gas and oil are likely to be found.

RECOMMENDED WELL LOCATION
Seismic is required to identify closure and locate a well site.

PROGNOSED DEPTH
Existing seismic data show that the top of the Pacoota is approximately 3000m below the surface.

RESERVES
Reserve calculations are not possible at the present level of information.
FIGURE 19  HARAJICA PROSPECT. TOP PACOOTA TWT STRUCTURE
(from L. Roe, Magellan Petroleum)
NEAREST WELL
Gosses Bluff 1, 2.
At centre of astrobleme, eight km inside the outer rim anticline.
Gosses Bluff 1: small gas flow from Stairway Sandstone, Pacoota Sandstone reservoir not reached.
Gosses Bluff 2: no flows, gas shows in Stairway Sandstone, Horn Valley Siltstone, Pacoota Sandstone.

TENEMENT STATUS
See Figures 3 and 9.
Vacant.

PREVIOUS EXPLORATION
Seismic: see Figure 19, also Western Amadeus Basin Report Enclosure 3 and Appendix 1.
Pancontinental Petroleum 1982 and 1983, 42km, Vibroseis, 24 fold, 50m groups.
Prospect assessment: G. Weste.
References: Berry, Milne & Roe, 1989.

ADDITIONAL WORK REQUIRED
Seismic survey to cover rim anticline area.

9.8 HARAJICA PROSPECT
See Figure 19 and Enclosure 4.

LOCATION
At centre of northern margin of basin.
165km west of Alice Springs.
Lat 23 deg 40 min   Long 132 deg 15 min.

TRAP TYPE
Combination subthrust - three way dip closure with overthrust - four way dip closure.

OBJECTIVES
Primary: Pacoota Sandstone.
Secondary: Stairway Sandstone.

STRUCTURE
A broad shallow east-west domal-anticlinal trap developed in the upper plate of a southerly directed, east-west trending overthrust. Significant additional closure probably occurs against the thrust. The thrusting produced a second, deeper closure in the subthrust plate with updip closure provided by the thrust fault. The structure is predominantly an Alice Springs Orogeny feature, but may have been initiated earlier in the basin's history.
RESERVOIR
Primary reservoir is the Pacoota Sandstone, the principal producing reservoir in the Mereenie and Palm Valley fields. Mapping (Deckelman, 1991) shows that the Pacoota Sandstone thickness increases significantly northwards from the Mereenie and Palm Valley fields. In the vicinity of Harajaca it appears to be greater than 1200m thick. The important reservoir unit, P3, is likely to be greater than 240m thick. The increase in reservoir thickness is somewhat countered by poorer porosities along the northern margin of the basin. Applying Mereenie net-to-gross sand ratios produces a net pay thickness of approximately 46m in the overthrust and a similar net pay for the subthrust. Porosity is anticipated to be between 10% in the overthrust degraded and 8% in the underthrust. Significant reservoir may also occur in the Stairway Sandstone, increasing net pay.

SEAL
The Horn Valley Siltstone, an effective seal in the producing fields, forms the vertical seal to the trap. In the overthrust portion of the trap, closure in addition to that provided by four way dip is by updip seal against the thrust fault. The subthrust portion of the trap relies on the thrust for updip seal. Salt is commonly present in the basin’s thrusts and its presence in the fault would enhance the seal.

SOURCE
The Horn Valley Siltstone is the principal source rock to the Mereenie and Palm Valley fields. Thickness at Harajaca is prognosed to be 196m which is sufficient to provide enough hydrocarbons to fill the structure given the relatively large area down dip for generation and migration. The burial history of the structure and the surrounding down-dip hydrocarbon generation areas indicate that gas is the most likely hydrocarbon.

RECOMMENDED WELL LOCATION
See Figure 19.
A well located at VP 280 on line P83-HJ3 would adequately test the combination trap.

PROGNOSED DEPTH
A well drilled to 3250m would adequately test the reservoir units of the Pacoota Sandstone in the overthrust block. Drilling on to 3950m would also test the Pacoota reservoir units in the subthrust block.

RESERVES
Areal closure is calculated at 17.2 sq. kms. for the overthrust block and 17.2 sq. kms. for the subthrust block. On a full to spill basis, using a net pay of 46.3m for each block, porosities of 10% (overthrust) and 8% (underthrust), and a RF of 0.86, reserves are calculated at 410 BCF for the overthrust play and 830 BCF for the underthrust play.

NEAREST WELL
Tyler 1.
20km to southeast.
Dry well.
Drilled off structural closure and failed to reach Pacoota Sandstone.
TENEMENT STATUS
See Figures 3 and 9.
Vacant.

PREVIOUS EXPLORATION
Seismic: see Figure 19, also Western Amadeus Basin Report Enclosure 3 and Appendix 1.
   Pancontinental Petroleum 1983, 42km, Vibroseis, 24 fold, 50m groups.
Prospect assessment: Magellan Petroleum.
   Magellan Petroleum, 1988b.

ADDITIONAL WORK REQUIRED
None.

9.9 WATERHOUSE PROSPECT
See Figures 20 and 21, and Enclosure 4.

LOCATION
Northeastern Amadeus Basin.
55km southwest of Alice Springs.
Lat 24 deg 00 min  Long 133 deg 30 min.

TRAP TYPE
Two traps: ‘four way dip’ - four way dip closure, fracture play
‘subthrust’ - three way dip closure, fracture play

OBJECTIVES
Four way dip trap: Pioneer Sandstone, uppermost Bitter Springs Formation carbonates.
Subthrust trap: Pacoota Sandstone, Stairway Sandstone.

STRUCTURE
The Waterhouse Anticline is a very large easterly elongate and trending, locally asymmetric, doubly plunging, tightly folded anticline, bounded to the south by a system of north dipping thrust faults (see Figure 21). The anticline is breached to the Cambrian Jay Creek Limestone. Although significant uplift occurred during Rodingan Movement time (Silurian), the major structuring is Alice Springs Orogeny time (Devonian). Thrusting and folding were of sufficient intensity to result in significant fracturing of strata along the axis of the anticline. The east - west trending thrust fault system along the southern flank of the structure has Cambro-Ordovician Pacoota and Stairway sandstones in the southern underthrust block overturned by the older sequences in the northern block, providing the underthrust play.
FIGURE 20   WATERHOUSE PROSPECT: TWT ON TOP PACOOTA SANDSTONE
(for location see Enclosure 4)
RESERVOIR
Four way dip trap
Matrix porosities in the Pioneer Sandstone and Bitter Springs Formation are considered to be low. The acute arcuate flexure along the axis of the fold will have induced steeply dipping extensional fractures in the already indurated sandstones and in carbonates. Significant fracturing, observed in cores taken from wells in the structure, and from Landsat images, is considered necessary for development of reservoir, particularly in the Pioneer Sandstone. Secondary porosity is anticipated in the uppermost Bitter Springs carbonates as a result of the fracturing and karstification at the unconformity with the overlying Cambrian strata.
Subthrust trap
Although Pacoota and Stairway sandstones are untested in the vicinity of this play, mapping by Deckelman (1991), indicates a sufficient thickness for a significant pay zone. The Arumbera Sandstone, reservoir in the Dingo Field not far to the southeast, is also a potential reservoir.

SEAL
Four way dip trap
Thick Pertatataka Formation siltstones and shales would provide an effective seal to the underlying reservoir formations. The fracturing anticipated in the competent reservoir sandstones and carbonates will be much less severe in the less competent Pertatataka siltstones and shales.
Subthrust trap
Vertical seal to the subthrust reservoirs will be provided by the Horn Valley Siltstone and intraformational siltstones within the Pacoota and Stairway sandstones.

SOURCE
Four way dip trap
The principal source rock is considered to be the Pertatataka Formation which appears to be the source for the gas in nearby wells West Waterhouse 1 and Orange 2. The Bitter Springs Formation is also a possible source. Further evidence for Precambrian source rocks is provided by the existence of the Dingo Gas Field, 25km to the southeast, the source for which has yet to be proven, but is surely pre Arumbera Sandstone time (latest Precambrian-basal Cambrian). The existence of a significant hydrocarbon microseepage anomaly over the Waterhouse Anticline is strong evidence that hydrocarbons have migrated into the structure.
Subthrust trap
Horn Valley Siltstone, source rock to the nearby Palm Valley and Merenecie fields and present in the large syncline to the south of the trap, should have provided an adequate supply of gas and oil to the trap.

RECOMMENDED WELL LOCATION
See Figure 20.
Four way dip trap
A suitable location for a test well is 5km east-northeast of Waterhouse 2 on the axis of the Waterhouse Anticline at the previously untested culmination of the structure. The location is also an area of fracturing and coincides with a hydrocarbon microseepage anomaly.
Subthrust trap
A well located at SP 215 on line 73-3-3.3S would adequately test the trap. A well at this location would also test reservoir facies in the overthrust block on the southern flank of the Waterhouse Anticline.
FIGURE 21  WATERHOUSE PROSPECT : N-S SEISMIC SECTION
(for location see Enclosure 4)
PROGNOSED DEPTH
Four way dip trap
At the proposed well location the top of the reservoir sequence (Pioneer Sandstone) is prognosed at 1740m. A well drilled to 2390m would test the Pioneer, the Bitter Springs Loves Creek Member 'lacustrine' unit and the top of the Loves Creek 'marine' unit (a subaerially exposed dolomite).
Subthrust trap
A well drilled to 3100m would test the reservoir sequence including the basal Arumbera Sandstone.

RESERVES
Four way dip trap
Reserves in fracture plays are difficult to estimate. The trap is large and could contain well in excess of 2000 BCF of gas.
Subthrust trap
Accurate definition of the reservoir volumes in the trap is not possible, but it appears to extend for tens of kilometres along the structure. Reserves in excess of 2000 BCF of gas are feasible.

NEAREST WELLS
Waterhouse 1 (1965), Waterhouse 2 (1985)
5km to west of proposed four way dip trap test
14km east of proposed subthrust trap test
Dry wells.

West Waterhouse 1 (1969)
48km west of proposed four way dip trap test
30km west of proposed subthrust trap test
gas flare from Stairway/upper Horn Valley.

TENEMENT STATUS
See Figures 3 and 9.
Vacant.

PREVIOUS EXPLORATION
Microseepage: Magellan Petroleum.
Prospect assessment: Magellan Petroleum.
  Do Rozario, 1986.

ADDITIONAL WORK REQUIRED
None.
FIGURE 22  OORAMINNA STRUCTURE OUTCROP GEOLOGY
9.10 OORAMINNA PROSPECT
See Figure 22 and Enclosure 4.

LOCATION
Northeastern corner of Amadeus Basin.
45km southeast of Alice Springs.
Lat 24 deg 00 min  Long 134 deg 10 min.

TRAP TYPE
Four way dip closure.

OBJECTIVE
Primary: Areyonga Formation.
Secondary: uppermost Bitter Springs Loves Creek Member.

STRUCTURE
A large surface feature, the Ooraminna Anticline trends east-southeast to west-northwest and plunges to the west. The data quality of the very limited seismic is very poor and closure at depth in the Proterozoic section although observed in three directions is largely inferred to the east. A residual gravity low over the structure indicates a salt cored growth structure. Growth is interpreted to have commenced in the Cambrian and to have terminated at the conclusion of the Alice Springs Orogeny.

RESERVOIR
Primary reservoir is the Areyonga Formation which tested 12 MCFPD in Ooraminna 1 drilled on the apparent apex of the structure. The Ooraminna 1 well was tested after the Areyonga Formation was left exposed to overweight drilling mud for 60 days. Drilling with in-balance mud elsewhere in the basin has caused significant formation damage and it is considered that a commercial flow of gas may have occurred if the hole had been air drilled and tested immediately. Reservoir lithology is fractured vuggy dolomite and sandstone interbeds. The secondary objective Bitter Springs Formation Loves Creek Member comprises two sequences of interbedded dolomites and siltstones. Unconformities top each sequence and there is potential for development of good secondary porosity by karstification.

SEAL
The Pertatataka Formation, 548m thick in Ooraminna 1 is a siltstone shale sequence and is an excellent seal.

SOURCE
No source rock has been clearly defined in the area. Dingo Gas Field is evidence of a significant source rock presence in the Precambrian, possibly the Areyonga Formation. The Bitter Springs Formation is also a potential source.

RECOMMENDED WELL LOCATION
See Figure 22.
A seismic line along the crest of the structure would better locate a well site.
FIGURE 23 DINGO NORTH LEAD: TWT STRUCTURE ON TOP ARUMBERA SANDSTONE
(for location see Enclosure 4)
PROGNOSED DEPTH
A well drilled to 1400m would adequately test the structure. It would penetrate through the primary objective Areyonga Formation and also test the uppermost Bitter Springs Formation Loves Creek Member dolomites.

RESERVES
Reserves are difficult to calculate because the porosity and pay zone data for the primary objective are highly speculative. The structure is very large (surface expression 30km long) and areal closure is anywhere in excess of 75 sq km. Reserve estimates vary from a low of 31 BCF to a high of 1000 BCF.

NEAREST WELL
Ooraminna 1.
6km to west-southwest
flowed 12 000 CFGPD from Areyonga Fm.

TENEMENT STATUS
See Figures 3 and 9.
Vacant.

PREVIOUS EXPLORATION
Seismic: Magellan Petroleum: 1 line across structure - very poor data quality
Gravity: Magellan Petroleum
Mapping: Magellan Petroleum
Prospect assessment - Magellan Petroleum.
References: Magellan Petroleum, 1987
Hooper & Elliot, 1991
McNaughton, 1990

ADDITIONAL WORK REQUIRED
A 26km seismic line along the axis of the Ooraminna Anticline.

9.11 NORTH DINGO LEAD
See Figures 23 and Enclosure 4, also Figures 7 and 8.

LOCATION
Central northeastern Amadeus Basin.
45km south of Alice Springs.
Lat 24 deg 08 min  Long 133 deg 53 min.

TRAP TYPE
Four way dip closure.

OBJECTIVES
Primary: Arumbera Sandstone.

STRUCTURE
A broad circular domal feature on the northern flank of the larger Dingo dome. The Dingo North structure has 60m of closure independent of the main Dingo dome.
RESERVOIR
Primary reservoir is the Arumbera Sandstone, reservoir to the Dingo Gas Field semi-connected to the immediate south. Best reservoir in the Dingo Field is the lower delta plain facies of the lower producing unit. This facies may be replaced by a less porous interdistributary shallow marine facies in the North Dingo area.

SEAL
Chandler Formation halite forms the seal to the Dingo Field and is present in the North Dingo structure. Halite is the best of seals.

SOURCE
A source rock to the Dingo Field has not yet been identified. Most likely sources are Late Proterozoic rocks including the shales and siltstones of the Areyinga and Pertatatak formation and carbonates of the Bitter Springs Formation. The source rocks must be mature to have produced the dry gas found in the Dingo Field.

RECOMMENDED WELL LOCATION
Additional seismic is required accurately to locate a well.

PROGNOSED DEPTH
The depth to the top of the reservoir at the apex of the structure is approximately 3200m. A well drilled to 3400m would adequately test the trap.

RESERVES
Areal closure is calculated at 18.1 sq. kms. On a full to spill basis, using a net pay of 18.3m, a porosity of 11% and a RF of 0.75, recoverable reserves are calculated at 145 BCF.

NEAREST WELL
Dingo 3.
8km to south.
Arumbera Sandstone flowed 2.864 MMSCFGD

TENEMENT STATUS
See Figures 3 and 9.
Part vacant, part within R.L. 2

PREVIOUS EXPLORATION
Seismic: Pancontinental Petroleum 1980, 42km, Vibroseis, 24 fold, 50m groups.
Prospect assessment: Magellan Petroleum.

ADDITIONAL WORK REQUIRED
20km seismic to define the well site.
9.12 WALLARA PROSPECT
See Figure 24 and Enclosure 4.

LOCATION
Central south of basin.
185km southwest of Alice Springs.
Lat 24 deg 37 min Long 132 deg 21 min.

TRAP TYPE
Four way dip closure.
Associated hydrocarbon microseepage survey.

OBJECTIVES
Primary: Heavitree Quartzite.
Secondary: Arumbera Sandstone.

STRUCTURE
An east-west trending complex anticline, swinging northwest from a southerly limb. There is in excess of 30ms TWT (110m minimum) of four way dip closure. Infill seismic is required to provide more accurate delineation of the structure and 50ms TWT of possible closure. Although the structure appears to be basement induced, seismic quality below the Bitter Springs Gillen Member salt is very poor and the sub-salt structure is difficult to define.

RESERVOIR
Primary reservoir is the Proterozoic Heavitree Quartzite which has been tested in only one other well, Pacific Oil & Gas Magee 1. Magee 1 flowed 63 MSCFD from a very thin (6.3m) intersection of Heavitree Quartzite (porosity 9%, net pay 3.6m). Magee is located in the southeast of the basin and the Heavitree Quartzite thickens significantly northwards. A significant thickness should occur in the Wallara structure. Nearby Wallara 1, drilled off the structural closure, intersected 12m of porous Arumbera Sandstone. Although prognosed to be at relatively shallow depth at the structural apex, the Arumbera could reservoir hydrocarbons.

SEAL
Seal to the Heavitree Quartzite is provided by the Bitter Springs Formation Gillen Member salt sequence. Because of its tendency to flow rather than fracture, salt is the perfect seal. Approximately 300m of salt is prognosed. Seal to the Arumbera Sandstone is provided by the clayslates, siltstones and dolomites of the Tempe Formation and Deception Siltstone which have a prognosed total thickness of approximately 240m.

SOURCE
Shales in the basal portion of the Bitter Springs Gillen Member, similar to those intersected in Magee 1, should be sufficiently rich in organic matter. Progressively deeper burial down dip should move the source rocks through the oil window into the gas window. Oil and gas are therefore to be anticipated in the Heavitree. No source rock is as yet identifiable to provide hydrocarbons to the Arumbera Sandstone. A broad hydrocarbon microseepage anomaly corresponds to the structure, indicating that significant volumes of hydrocarbons have migrated into the structure.
WALLARA RANCH GRID
STRUCTURE ON ARUMBERA SANDSTONE

Contours of two-way time in seconds from datum to top Arumbera Sandstone
DATUM: 500m ASL

FIGURE 24  WALLARA PROSPECT: TWT STRUCTURE ON ARUMBERA SANDSTONE
(for location see enclosure 4)
RECOMMENDED WELL LOCATION
See Figure 24.
Additional seismic is required to locate a well at the structural apex.

PROGNOSED DEPTH
The progonosed depth to the top of the Heavitree is 2000m. A well drilled to 2100m would adequately test the Heavitree.

RESERVES
Additional seismic is required to define the structure. Figure 24 indicates at least 8 sq. km. of areal closure and 50 ms of vertical closure at Arumbera level, sufficient to trap hydrocarbons in economic volumes.

NEAREST WELL
Wallara 1.
4km to the west.
Failed to reach Heavitree sands.
Dry well.
Drilled prior to seismic, 4km off structural closure.

TENEMENT STATUS
See Figures 3 and 9.
Vacant.

PREVIOUS EXPLORATION
Seismic: see Appendix 1.
Sirgo Exploration, 1990, Vibroseis, 60 fold, 12m group interval.
Prospect assessment: G. Weste
References: Geoweste Pty Ltd, 1991

ADDITIONAL WORK REQUIRED
20km of fill-in seismic more accurately to define closure and well site.

9.13 NE HIGHWAY PROSPECT
See Figures 23 and Enclosure 4, also Figures 7 and 8.

LOCATION
Central northern Amadeus Basin.
70km southwest of Alice Springs.
Lat 24 deg 18 min  Long 133 deg 35 min.

TRAP TYPE
Four way dip closure.

OBJECTIVES
Primary: Arumbera Sandstone.

STRUCTURE
Four way closure on a double plunging northwest - southeast trending, narrow anticline.
FIGURE 25  N.E. HIGHWAY PROSPECT : TWT STRUCTURE ON NEAR TOP ARUMBERA
(for location see Enclosure 4)
RESERVOIR
Primary reservoir is the Arumbera Sandstone, reservoir to the Dingo Gas Field 34km to the northeast. Net pay is estimated at 18.3m and porosities of about 11% are anticipated.

SEAL
Chandler Formation halite forms the seal to the Dingo Field and is present in the NE Highway structure. Halite is the best of seals.

SOURCE
The same source rocks that have sourced the gas in the Dingo Field. Most likely sources are Late Proterozoic rocks including the shales and siltstones of the Areyonga and Pertatataka formations and carbonates of the Bitter Springs Formation. The source rocks must be mature to have produced the dry gas found in the Dingo Field.

RECOMMENDED WELL LOCATION
Additional seismic is required accurately to locate a well.

PROGNOSED DEPTH
The depth to the top of the reservoir at the apex of the structure is approximately 2960m. A well drilled to 3300m would adequately test the trap.

RESERVES
Areal closure is calculated at 3.6 sq. kms. On a full to spill basis, using a net pay of 18.3m, a porosity of 11% and a RF of 0.75, recoverable reserves are calculated at 37 BCF.

NEAREST WELL
Highway 1
13km to southwest.
Bald structure, no Arumbera Sandstone, no reservoir.

TENEMENT STATUS
See Figures 3 and 9.
Vacant.

PREVIOUS EXPLORATION
Prospect assessment: Magellan Petroleum.

ADDITIONAL WORK REQUIRED
30km seismic to define the well site.
9.14 MAGEE LEAD
See Enclosure 4.

LOCATION
Southern Amadeus Basin.
130km south of Alice Springs.
Lat 24 deg 58 min  Long 134 deg 00 min.

TRAP TYPE
Possible four way dip closures.
Stratigraphic pinchout.

OBJECTIVES
Primary: Heavitree Quartzite
Secondary: Bitter Springs Formation

STRUCTURE
No actual traps yet identified, but to be looked for. Heavitree Quartzite pinches out just south of Magee 1 in an area of apparent sub-salt structuring. Updip pinchouts on flanks of anticlines and four way dip closures further north where the Heavitree is thicker are possible targets.

RESERVOIR
Primary reservoir is the Heavitree Quartzite which was intersected in Magee 1 close to its southerly pinchout. Although only 4.5m thick in Magee 1 the Heavitree showed porosity of 9% enabling a small gas flow from the well. This provides encouragement to search for traps in the Heavitree north of Magee 1 where the reservoir is thicker.

SEAL
Thick Bitter Springs Gillen Member halite and subordinate anhydrite form an excellent, totally impermeable and probably basin wide, seal to any four way dip structures and pinchouts in the Heavitree.

SOURCE
Shales in the basal portion of the Bitter Springs Formation Gillen Member intersected in Magee 1 contained bitumen. These are possible source rocks which could have produced economic volumes of oil and gas to the Heavitree. The presence of bitumen is evidence of oil generation and migration.

RECOMMENDED WELL LOCATION
No traps have yet been identified for testing.

PROGNOSED DEPTH
Magee 1 intersected the reservoir Heavitree at 2300m. Tests of any traps identified to the north of Magee 1 will require drilling to a similar depth.

RESERVES
It is not possible to calculate reserve figures.
NEAREST WELL
Magee 1 (1992)
At southern margin of lead area.
Small gas flow from very thin but porous Heavitree.
Mt Charlotte 1 (1964)
1.2km north of Magee 1, over southern portion of lead area.
Dry well, did not reach Heavitree.

TENEMENT STATUS
See Figures 3 and 9.
Within EP 38, Pacific Oil & Gas Pty Limited.
Permit holders are willing to discuss joint ventures.

PREVIOUS EXPLORATION
Seismic: Pacific Oil & Gas, 1991/92, 90.5km high resolution, high fold Vibroseis.
Prospect assessment: Pacific Oil & Gas.

ADDITIONAL WORK REQUIRED
100km high resolution seismic required to locate traps in lead area.

9.15 CENTENARY WEST ANTICLINE LEAD
See Enclosure 4.

LOCATION
Eastern Amadeus Basin.
110km southeast of Alice Springs.
Lat 24 deg 15 min Long 134 deg 50 min.

TRAP TYPE
Four way dip closures.
Subthrust - three way dip closure.
Pinchout in anticline limb.

OBJECTIVES
Primary: Arumbera Sandstone.
Secondary: Areyonga Formation.

STRUCTURE
The Centenary West Anticline is a faulted northeast trending structure located within
the Camel Flat Thrust Sheet. The anticlinal core of Chandler Formation is thrust
north against Mereenie Sandstone. Although the structure is complex and has very
limited seismic coverage, plunge is visible to the east and south.
RESERVOIR
Primary reservoir is the Arumbera Sandstone, reservoir to the Dingo Field. The prospect is located near the depositional edge of the Arumbera where reworking and shoaling, combined with the secondary effects of exposure, should result in good porosities. Reservoir development in the secondary objective Areyonga Formation will be partially dependant on fracture enhancement of matrix porosity induced by the severe structuring of the anticline. The Areyonga Formation flowed gas under adverse testing conditions in Ooraminna 1, 60km to the northeast.

SEAL
Chandler Formation, mainly salt, is 800m thick in the structure and forms an excellant seal, even where faulted.

SOURCE
Possible source rocks are Chandler Formation and Bitter Springs Formation. They have been less deeply buried at Centenary West and in the Camel Flat Syncline kitchen area and should have provided oil and gas to the structure.

RECOMMENDED WELL LOCATION
Additional seismic is required to locate a well site.

PROGNOSED DEPTH
The base of the Arumbera Sandstone is estimated to be at approximately 2100m depth within the structure. A 2600m well would test both the Arumbera and the Areyonga.

RESERVES
There is insufficient seismic coverage to calculate reserve figures. Minimum horizontal closure is estimated at 30 sq km and vertical closure is estimated at 80m to 150m. The trap is therefore large.

NEAREST WELL
Bluebush 1 (1983)
45km to south.
Dry well.
Bitter Springs potential source rocks in oil window.

TENEMENT STATUS
See Figures 3 and 9.
Tenement holders are willing to discuss joint venture farm-in opportunities.

PREVIOUS EXPLORATION
Prospect assessment: Magellan Petroleum.
Deckelman, 1984.

ADDITIONAL WORK REQUIRED
30km detailed seismic required to define closure and to map the distributional limits of the Arumbera Sandstone.
9.16 TRAIN HILLS LEAD
See Enclosure 4.

LOCATION
Eastern Amadeus Basin.
95km southeast of Alice Springs.
Lat 24 deg 22 min  Long 134 deg 36 min.

TRAP TYPE
Thrust anticline.

OBJECTIVES
Primary: Arumbera Sandstone.
Secondary: Areyonga Formation.

STRUCTURE
A northeast - southwest trending southwest plunging asymmetrical anticline, closed to the northeast by a north dipping thrust fault.

RESERVOIR
Primary reservoir is the Arumbera Sandstone, reservoir to the Dingo Field. The prospect is located near the depositional edge of the Arumbera where reworking and shoaling, combined with secondary porosity resulting from the effects of exposure, should result in good porosities. Reservoir development in the secondary objective Areyonga Formation will be partially dependant on fracture enhancement of matrix porosity induced by the severe structuring of the anticline. The Areyonga Formation flowed gas under adverse testing conditions in Ooraminna 1, 60km to the northeast.

SEAL
Chandler Formation, mainly salt, is 1400m thick in the structure and forms an excellent seal, even where faulted.

SOURCE
Possible source rocks are Chandler Formation and Bitter Springs Formation. They have been less deeply buried at Centenary West and in the Camel Flat Syncline kitchen area and should have provided oil and gas to the structure.

RECOMMENDED WELL LOCATION
Additional seismic is required to locate a well site.

PROGNOSED DEPTH
The base of the Arumbera Sandstone is estimated to be at approximately 2100m depth within the structure. A 2600m well would test both the Arumbera and the Areyonga.

RESERVES
There is insufficient seismic coverage to calculate reserve figures. Minimum horizontal closure is estimated at 4 sq km and minimum vertical closure is estimated at 200m. The trap is therefore large enough to contain commercial volumes of hydrocarbons.
NEAREST WELL
Bluebush 1 (1983)
27km to south.
Dry well.
Bitter Springs potential source rocks in oil window.
Ooraminna 1 (1963)
50km to northeast.
gas flow from Areyonga Formation.

TENEMENT STATUS
See Figures 3 and 9.
Within EP 36.
Anzoil Exploration Limited.
Tenement holders are willing to discuss joint venture farm-in opportunities.

PREVIOUS EXPLORATION
Prospect assessment: Magellan Petroleum.
Deckelman, 1984.

ADDITIONAL WORK REQUIRED
20km detailed seismic required to define closure and to map the distributional limits of the Arumbera Sandstone.
10 EXPLORATION OPPORTUNITIES

10.1 VACANT PROSPECTIVE ACREAGE

Production Licences, Retention Licences, Exploration Permits and Exploration Permit Applications at January, 1994, are shown in Figure 3. The oil and gas fairways, shown in Figure 11 extend well beyond the tenemented areas and are worthy of assessment.

10.2 OTHER EXPLORATION OPPORTUNITIES

All current Exploration Permit holders and applicants have indicated a willingness to discuss joint ventures. Their tenements include a range of prospect and lead play types. Joint venturers can enjoy the benefits of accessing exploration through an existing tenement where initial prospect evaluation has commenced, and risks are shared. Exploration Permit holders and applicants are named on Figure 3. Where covered by permit or application, prospect descriptions in section 9 include permittees and applicants.
11 APPLYING FOR EXPLORATION TENEMENTS

11.1 TENEMENT TYPES AND CONDITIONS.


The Act was the first in Australia to introduce the concept of a retention tenement to provide a permittee with security of tenure over a currently non-commercial discovery. Exploration Permits (EP’s) are granted on a 5 minute x 5 minute graticular block basis. The maximum number of blocks is 200 (16 000 sq km). One million scale graticular plans showing existing tenements are available from the Department. They are essential to drawing up an application. An EP is granted for an initial term of five years and can be renewed for a further two terms following relinquishment of 50% of the area held at the end of each term. Specific work commitments must be met year by year. Exploration is carried out according to the Schedule (Department of Mines and Energy, 1993).

Production Licences cover a maximum of 12 blocks, are granted for a period of 21 years and are renewable. Retention Licences over currently non-commercial discoveries are granted for five year, renewable periods.

11.2 PERMIT APPLICATION PROCEDURES

An application for a permit may be made over any land that is not already the subject of a petroleum tenement. An applicant should provide the following information:-

- the name and address of the applicant and an address for service within the Northern Territory,
- the designated number of each block the subject of the application,
- a map clearly delineating the application area and the boundaries of existing permit or licence areas in the immediate vicinity of the application area,
- a proposed technical works programme for exploration of the blocks during each year of the term of the proposed permit,
- evidence of the technical and financial capacity of the applicant to carry out the proposed technical works programme and to comply with the Act,
- where the application is made by two or more persons, the proposed sharing arrangements between the applicants,
- the name of the designated operator and evidence of his technical capacity to carry out the proposed technical works programme,
a statutory declaration stating the applicant's interest, if any, in or in
relation to a permit or licence applied for or granted under, or in force
by virtue of, the Act or the repealed Act,
the application fee of $3000, and
such other information in support of the application as the applicant
thinks fit.

11.3 ADDRESSES AND CONTACTS

Applications should be lodged with

The Director of Energy
Department of Mines and Energy
Centrepoint Towers Building
The Mall
DARWIN NT 0800
(GPO Box 2901, Darwin NT 0801)
Phone (089) 89 5511
Fax (089) 81 4806
Telex AA 85766 MINDAR
Enquiries should be directed as follows
Exploration policy - Bill Tinapple
(Director of Energy)
(089) 89 5460
Tenement enquiries - Ross Elvish
(Petroleum Registrar)
(089) 89 5234
12 REFERENCES


84


86
APPENDIX 1

GEOPHYSICAL SURVEYS UPDATE
1A SEISMIC SURVEYS

(1) Gosses Bluff Reprocessing
Magellan Petroleum.
1986.

(2) Harajica Seismic Survey
Magellan Petroleum.
1987.
36km survey to help define the Harajica prospect.
Mines and Energy open file report PR88/047 parts A to D

(3) Tarawarra Seismic Survey
Magellan Petroleum.
1987.
50km detailed grid to define Tarawarra prospect.
Mines and Energy open file report PR88/046 parts A to D

(4) Tarawarra Reprocessing
Magellan Petroleum.
1987.

(5) Areyonga Seismic Survey
Magellan Petroleum.
1987
Detailed fill-in survey to delineate Areyonga Prospect
Mines and Energy open file report PR88/045 parts A to D

(6) Undandita Reprocessing
Magellan Petroleum.
Reprocessing of 121km of Pancontinental Petroleum 1981/82 Vibroseis.
Mines and Energy open file report PR088/044 parts A, B

(7) Murphy’s Range Seismic Survey
Pacific Oil & Gas
1989
48km, 12m groups, 60 fold.
Mines and Energy Open File Reports PR90/091 parts A - D and PR92/065 part C.

(8) Parrarra Seismic Survey
Pacific Oil & Gas
1989
64km, 12m groups, 60 fold.
Mines and Energy open file report PR90/092 parts A - D

88
(9) Reprocessing Amadeus Seismic Survey
Pacific Oil & Gas
1990
118km of 1982 Vibroseis data.

(10) Reprocessing BMR Amadeus Seismic Survey
Pacific Oil & Gas
1990
119km 1985 BMR deep focus long groups data.

(11) Depot Hill Seismic Survey
Pacific Oil & Gas
1992
90.3km (74.6km in EP 26, 15.7km in EP 38), 15m groups, 275 fold.

(12) Wallara/Tempe Downs Seismic Survey
Indigo Oil
1990
100km, 60 fold, 12m groups.
Mines and Energy open file report PR92/109 parts A, B.

1B MAGNETIC SURVEYS

Southern Amadeus Airborne Survey
Pacific Oil & Gas
1989
3500 sq km, 1000m line spacing, N-S lines, 9m readings.
Mines and Energy open file report PR90/040, parts A-C.

1C GRAVITY SURVEYS

(1) Murphy’s Range Gravity Survey
Pacific Oil & Gas
1989
51km, readings taken at 240m spacing along Murphy’s Range Seismic Survey lines, EP 26.

(2) Parrarra Gravity Survey
Pacific Oil & Gas
1989
67km, readings taken at 240m spacing along Pararra Seismic Survey lines, EP 26.

1D MAGNETO-TELLURIC SURVEYS

(1) Southern Amadeus MT Survey
Pacific Oil & Gas
1991
APPENDIX 2

PETROLEUM WELLS UPDATE
### 2A WELL LISTING

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**Note**

Magellan = Magellan Petroleum  
Pacific = Pacific Oil & Gas
### 2B FORMATION TOPS AND THICKNESSES

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**Note:** For each formation the upper figure is the depth in metres from the Kelly bushing and the lower figure is the true thickness in metres. Figures in brackets ( ) match the formation in brackets.
(i) UNDANDITA 2

Operating company
Magellan Petroleum Australia Ltd.

Permit and location
central northern margin of Amadeus Basin, OP178;
lit. 23 42 49.0, long. 131 55 59.5
799085E 7374389N (AMG66, Zone 53)
seismic line P82-U16  VP3-00

Type of well
wildcat retest

Spud date - completion date
01/10/1988 - 15/12/1988

Trap type
subthrust - three way dip closure in an overturned anticline

Objective
primary: Pacoota Sandstone
secondary: Stairway Sandstone

Nearest pre-existing well
Undandita 1A
315m to north
good oil shows in Arumbera Sandstone
good to good gas shows in Illara Sandstone and Tempe Formation

Elevation
ground 764.2m (AHD), KB 770.8m (AHD)

Total Depth
2560.3mKB

Status
plugged and abandoned as a dry hole

Stratigraphy (formation tops in mKB)
as presented in well completion report

<table>
<thead>
<tr>
<th>Formation</th>
<th>Top Depth</th>
<th>Thickness</th>
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<td>Gosses Bluff Unit</td>
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<td>Carmichael Sandstone</td>
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Stokes Siltstone 1526.1 54.3
Stairway Sandstone 1592.3 103.0
Pacoota Sandstone
  P1 Unit 1848.0 63.7
  P2 Unit 2020.8 21.9
  P3A Unit 2081.8 8.9
  P3B Unit 2106.2 21.6
  P4 Unit 2161.9 41.1
Goyder Fm. 2268.3 116.4
total depth 2560.3

Shows
no flows to surface
minor gas shows in Stairway Sandstone and Pacoota Sandstone

Tests
no formation testing

Failure analysis
insufficient porosity to allow gas to flow

Cores
7 out 30 sidewall cores successfull
sidewall cores at 1874.5m
2076.2m
2450.5m
2482.5m
2487.7m
2500.8m
2533.4m

Wireline logging
Schlumberger
  1536.8 - surface BHC-GR
  1535.3 - 473.2m FMS
  2556.7 - 1493.5m SLS-GR
  2558.5 - 1652.0m FMS
  2553.0 - 1652.0m DLL-MSFL-GR-SP
  2552.4 - 1652.0m LDL-CNFL-GR
  2545.1 - 30.5m 24 level velocity survey

Drilling contractor and rig
Century Drilling
National 80UE

Drilling Methods
  26" hole to 20m 20" conductor air
  17 1/2" hole to 475.5m 13 3/8" casing air/mud
  12 1/4" hole to 1652.6m 9 5/8" casing air/foam/mud
  8 1/2" hole to 2560.3m 7" casing air/mud

References
(ii) GOSSES BLUFF 2

Operating company
Magellan Petroleum Australia Ltd.

Permit and location
Northern Amadeus Basin, OP175;
latt. 23 45 18.0, long. 132 18 37.5
225994E 7362909N (AMG66, Zone 53)
seismic line P82-GB1 150m SE of station 470

Type of well
wildcat retest

Spud date - completion date
26/12/1988 - 06/03/1989

Trap type
fracture play in extra-terrestrial impact structure

Objective
primary: fractured Pacoota Sandstone
secondary: fractured Stairway Sandstone

Nearest pre-existing well
Gossess Bluff 1
514m to west-southwest
dry hole with very small gas flow from Stairway Sandstone

Elevation
ground 737m (AHD), KB 743.1m (AHD)

Total Depth
2651.8mKB

Status
plugged and abandoned as a dry hole

Stratigraphy (formation tops in mKB) as presented in well completion report

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<th>Formation</th>
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96
Shows
no flows to surface
minor gas shows 850m in Stairway Sandstone, Stokes Siltstone, Horn Valley Siltstone, Pacoota Sandstone

Tests
DST No 1 2327.1 - 2382.6m misrun
DST No 2 2573.4 - 2651.8m weak blow, tool plugged
DST No 3 2387.2 - 2420.7m recovered mud
DST No 4 2332.6 - 2336.2m recovered mud

Failure analysis
insufficient porosity to allow gas to flow
anticipated abundant large scale open fracturing did not occur in objective Pacoota Sandstone
Pacoota Sandstone matrix porosity 3%

Cores
fishing core Middle Stairway Sandstone 0.4m

Wireline logging
Schlumberger Seaco 1649.4 - 415.1m SLS-WFT-GR
1652.0 - 415.1m SHVT-GR
1648.4 - 518.2m DLL-MSFL-GR-SP
1652.0 - 518.2m LDL-CNGL-GR
2552.7 - 1615.4m SLS-GR
2553.6 - 1645.9m FMS-GR
2550.6 - 1645.9m DLL-MSFL-GR-SP
2552.4 - 1645.9m LDL-CNGL-GR
2551.1 - 60.3m 23 level velocity survey

Drilling contractor and rig
Century Drilling
National 80UE

Drilling Methods
26" hole to 19.8m 20" conductor air
17 1/2" hole to 415.7m 13 3/8" casing air/foam/mud
12 1/4" hole to 1652.6m 9 5/8" casing air/foam/mud
8 1/2" hole to 2651.8m 7" casing air/mud

References
(iii) WALLARA 1

Operating company
Sirgo Exploration Inc.

Permit and location
South of the central ridge, EP20;
lat. 24 36 54.99, long. 132 20 23.01

Type of well
wildcat

Spud date - completion date
30/06/1990 - 24/08/1990

Trap type
poorly mapped anticlinal structure

Objective
Primary: to test the source of a broad hydrocarbon microseepage anomaly partly coincident with a poorly defined anticlinal structure in an area of poor outcrop
Secondary: identify reservoir in an area of the Amadeus Basin previously not drilled test for reservoir and source rocks below the Bitter Springs salt

Nearest pre-existing well
Tent Hill 1, 52km to northwest
dry well

Elevation
ground 544.7m (AHD), KB 547.1m (AHD)

Total Depth
2001mKB

Status
plugged and abandoned as a dry hole

Stratigraphy (formation tops in mKB) as presented in well completion report

ground surface 2.4
Goyder Fm. 2.4 30m thick
Petermann Sandstone 30 152
Deception Siltstone 183 215
Illara Sandstone 400 41
Tempe Fm. 441 182
Arumbera Sandstone 625 88
Pertatataka Fm. 714 553
Pioneer Sandstone 1272 9
Aralka Fm. 1281 26
Areyonga Fm. 1307 115
"Finke Beds" 1424 85
Bitter Springs Fm.
  Loves Ck.Mbr."Lacustrine" 1510 280
  Loves Ck.Mbr."marine" 1792 201
  Gillen Mbr. 1996 5+
total depth 2001

98
Shows
none

Tests
none

Failure analysis
well located 4km off structural closure
Bitter Springs salt too deep for rig to penetrate through

Cores
continuously cored from 333m to 2001mTD

Wireline logging
BPB Slimline 321 - surface sonic
329 - 135 caliper-gamma
(density, neutron, electric tools failed)
1998 - 329 RR2 dual focussed electric
1998 - 330 DDR dual density-gamma-caliper
1999 - 120 MS1 sonic
1999 - 330 NN1 neutron
1998 - 330 DV1 dipmeter-verticality

Drilling contractor and rig
Rockdril Contractors Pty Ltd
Rig 20

Drilling Methods
12" hole to 8.5m 9 5/8" conductor auger
8.5" hole to 134.6m 7" casing @ 132m air hammer
6.25" hole to 332.8m 5" casing @ 331m air hammer
4.35" hole to 2001.1m open wireline coring

References
(iv) DINGO 3

Operating company
Magellan Petroleum Australia Ltd.

Permit and location
Dingo Gas Field OP175;
l lat. 24 13 1.7, long. 133 51 43.4
384448E 7321253N (AMG66, Zone 53)
seismic line P80-11, 13m N of station 677

Type of well
appraisal

Spud date - completion date
28/09/1990 - 02/12/1990

Trap type
Four way dip closure in a seismically mapped domal structure

Objective
Primary: to test producibility of the Dingo Field Arumbera Sandstone by air drilling and assess possible formation damage caused by drilling with liquids as used in previous wells.

Nearest pre-existing well
Dingo 2, 2km to southeast
Dingo 1, 3.6km to southeast
potential gas producers

Elevation
ground 532.1m (AHD), KB 538.2m (AHD)

Total Depth
3045mKB

Status
suspended gas well

Stratigraphy (formation tops in mKB)
as presented in well completion report

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10.4m thick
L. Giles Ck. 2413.5 33.0
Dingo Member 2446.5 12.5
Chandler Fm. 2459.0 237.5
Todd River Dolomite 2696.5 22.5
Arumbera Sandstone 2719.0 314.9
   Arumbera 4 2719.0 10.0
   Arumbera 3 2729.0 86.5
   Arumbera 2B 2815.5 42.4
   Arumbera 2A 2858.0 64.0
   Arumbera 1 2922.0 112.0
Julie Formation 3034.0 11.0+
total depth 3045.0

Shows
2980m 5 min flare trip gas
below 2992m continuous gas flare

Tests
open hole tests of Arumbera Sandstone to 3003m: 2.864 MMSCFGD
2996.5m 0.06673 MMSCFGD
3002.2m 0.865 MMSCFGD
3012.1m 2.775 MMSCFGD
3015.0m 2.864 MMSCFGD
3039.0m 2.739 MMSCFGD
3045.0m 2.712 MMSCFGD

Failure analysis
flow rates significantly greater than in Dingo 1 and 2 indicating formation damage caused
by drilling with mud
Arumbera Sandstone lower producing zone, present in Dingo 1 and 2, absent in Dingo 3.

Cores
none

Wireline logging
Schlumberger Seaco
1550.5 - surface SLS-GR
1553.0 - 302.4m LDL-GR
2887.0 - 1553.0 LDL-CNL-GR
2899.0 - 1467.0 BHC-GR
2891.5 - 1553.0 DLL-MSFL-GR
3040.7 - 2824.5 GR-CCL

Drilling contractor and rig
O.D. & E. Pty Limited
Mereenie Rig No. 1

Drilling Methods
26" hole to 18.5m 20" conductor rotary mud
17 1/2" hole to 302.6m 13 3/8" casing air/hammer
12 1/4" hole to 1554.4m 9 5/8" casing air
8 1/2" hole to 2983m 7" casing air/mud
6" hole to 3045m T.D. 2 7/8" tubing hammer/air

References
Completion Report, unpublished report for Magellan Petroleum Australia Ltd. Open
File report PR90/077B.
(v) MURPHY 1

Operating company
Pacific Oil & Gas Pty Limited

Permit and location
Southern Amadeus Basin, EP26;
l. 25 19 42.12, long. 132 37 50.03
261496E 7196572N (AMG66, Zone 53)
seismic line M89-107 SP531

Type of well
wildcat

Spud date - completion date
09/11/1990 - 28/01/1991

Trap type
possible four way dip closure in a seismically mapped anticline

Objective
Primary: to test the reservoir potential of the Heavitree Quartzite at the base of the
Proterozoic Amadeus Basin sequence in a culmination on a seismically mapped NW
trending anticline
Secondary: identification of potential source rocks in the Bitter Springs Formation Gillen
Member

Nearest pre-existing well
Erdunda 1 55km to east
dry well

Elevation
ground 450.0m (AHD), KB 455.6m (AHD)

Total Depth
2882mKB

Status
plugged and abandoned as a dry hole

Stratigraphy (formation tops in mKB)
as presented in well completion report

<table>
<thead>
<tr>
<th>Formation</th>
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<td>152.0</td>
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<td>Pertacoorta Group</td>
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<tr>
<td>undifferentiated</td>
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<td>150.9</td>
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<tr>
<td>Inindia Beds</td>
<td></td>
<td></td>
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<tr>
<td>unit 1</td>
<td>878.4</td>
<td>82.0 )</td>
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<tr>
<td>unit 2</td>
<td>960.4</td>
<td>135.6 )</td>
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<td>unit 3</td>
<td>1096.0</td>
<td>137.0 )</td>
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Bitter Springs Formation

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<tr>
<th>Mbr.</th>
<th>Depth</th>
<th>Age</th>
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<tr>
<td>Loves Ck. Mbr. &quot;lacustrine&quot;</td>
<td>1233.0</td>
<td>239.3</td>
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<tr>
<td>Loves Ck. Mbr. &quot;marine&quot;</td>
<td>1472.3</td>
<td>108.0</td>
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<tr>
<td>Gillen Mbr.</td>
<td>1580.3</td>
<td>1243.2+</td>
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<td>total depth</td>
<td>2884.5</td>
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**Shows**

none

**Tests**

none

**Failure analysis**

Bitter Springs Fm. much thicker than prognosed - objective not reached

seismic pick of top Heavitree Quartzite is intra Bitter Springs Fm.

**Cores**

Bitter Springs Gillen Mbr.: 1 core (8.9m)

**Wireline logging**

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<tr>
<th>Depth</th>
<th>Logs</th>
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<td>1622.5 - 198.0m</td>
<td>DLL-MSFL-GR</td>
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<tr>
<td>1622.5 to surface</td>
<td>BHC-GR</td>
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<tr>
<td>2880.0 - 1622.5</td>
<td>DLL-MSFL-GR</td>
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<tr>
<td>2882.0 - 1622.5</td>
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<td>2883.5 - 1622.5</td>
<td>LDL-CNL-GR</td>
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**Drilling contractor and rig**

Rockdril Contractors Pty Ltd

Rig 22

**Drilling Methods**

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<td>13 3/8&quot; conductor</td>
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<tr>
<td>12 1/4&quot; hole</td>
<td>201m</td>
<td>9 5/8&quot; casing @ 198m</td>
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<tr>
<td>8 1/2&quot; hole</td>
<td>1626m</td>
<td>7&quot; casing @ 1624m</td>
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<table>
<thead>
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<td>6&quot; hole</td>
<td>288.2m</td>
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**References**

(vi) DINGO 4

Operating company
Magellan Petroleum Australia Ltd.

Permit and location
Dingo Gas Field, OP175;
lat. 24 14 31.8, long. 133 55 17.4
390505E 7318531N (AMG66, Zone 53)
seismic line P80-12, station 378

Type of well
appraisal

Spud date - completion date
09/12/1991 - 26/01/1992

Trap type
Four way dip closure in a seismically mapped domal structure

Objective
Primary: to test the Arumbera Sandstone in the southeastern flank of the Dingo Gas Field.

Nearest pre-existing well
Dingo 1, 3.15km to northwest
potential gas producer

Elevation
ground 554.0m (AHD), KB 560.1m (AHD)

Total Depth
3130.5mKB

Status
plugged and abandoned as a dry hole

Stratigraphy (formation tops in mKB)
as presented in well completion report

ground level/Quaternary 6.1 16.4m thick
Pertnjara Group 22.5 703.6
Mereenie Sandstone 727.5 339.3
Stairway Sandstone not present
Horn Valley Siltstone 1067.5 24.5
Pacoota Sandstone 1092.0 329.3
P1 1092.0 112.1
P2 1204.3 80.5
P3 1285.0 90.2
P4 1375.4 46.5
Goyder Fm. 1422.0 105.1
Shannon Fm. 1527.3 384.0
Upper Shannon 1527.3 209.8
Lower shannon 1737.5 174.2
Hugh River Shale 1912.0 233.5
Giles Ck. Dolomite 2146.0 294.1
U.Giles Ck. 2146.0 162.0
M.Giles Ck. 2308.3 97.8
L.Giles Ck. 2406.3 34.4
Dingo Member 2440.8 11.7
Chandler Fm. 2452.5 307.4
Todd River Dolomite 2760.5 25.0
Arumbera Sandstone 2785.5 308.9
Arumbera 4 2785.5 14.5
Arumbera 3 2800.0 83.8
Arumbera 2B 2884.0 38.4
Arumbera 2A 2922.5 67.0
Arumbera 1 2989.6 105.2
Julie Formation 3095.0 32.9
Pertatataka Fm. 3128.0 2.5+
total depth 3130.5

**Shows**
none

**Tests**
2977.5 - 3084m. RFT tool set 30 times for 13 valid tests, formation water taken at 3073m. Interpreted results indicate a GWC between 3048m and 3078m reservoir water wet, no completion testing

**Failure analysis**
Dingo Field not full-to-spill - 129m gross gas column interpreted in a mapped vertical closure of 194m

**Cores**
none

**Wireline logging**
Schlumberger Seaco 1095m - surface GR
1108 - 261 SLS-LDL-GR-CAL
2968.5 - 1109.5 SLS-LDL-GR-CAL
2970.5 - 22.5 Well Seismic Tool
3129.0 - 2968.0 GR-DLL-ARRAY SONIC-MSFL-SP
3117.5 - 2968.0 LDL-CNL-GR
3084.02 - 2977.52 RFT-HP-GR

**Drilling contractor and rig**
O.D. & E. Pty Limited
Merceenie Rig No. 1

**Drilling Methods**
26" hole to 17.6m 20" conductor air
17 1/2" hole to 261.0m 13 3/8" casing air/hammer
12 1/4" hole to 1109.5m 9 5/8" casing air
8 1/2" hole to 2972m 7" casing air/mud
6" hole to 3023m T.D. 2 7/8" tubing air

**References**
(vii) MAGEE I

Operating company
Pacific Oil & Gas Pty Limited

Permit and location
Southern Amadeus Basin, EP38;
latt. 24 53 59.87, long. 133 59 22.50
397953E 7245741N (AMG66, Zone 53)
seismic line DH91-2N VP 2152

Type of well
wildcat

Spud date - completion date
22/09/1992 - 21/10/1992

Trap type
Four way dip closure in a seismically mapped faulted anticline

Objective
Primary: to test the reservoir potential of the Heavitree Quartzite at the base of the
Proterozoic Amadeus Basin sequence in the Mt Charlotte structure at the seismically
mapped apex of the thrust faulted anticline.
Secondary: Winnall Beds and identification of potential source rocks in the Bitter Springs
Formation Gillen Member

Nearest pre-existing well
Mt Charlotte 1 1.2km to north
dry well

Elevation
ground 373m (AHD), KB 378.9m (AHD)

Total Depth
2395.8mKB

Status
plugged and abandoned as a water well

Stratigraphy (formation tops in mKB)
as presented in well completion report

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<td>Stairway Sandstone</td>
<td>360</td>
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<td>Jay Ck. Limestone</td>
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<td>Chandler Fm.</td>
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<td>235</td>
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<td>Winnall Beds</td>
<td>954</td>
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<td>Bitter Springs Formation</td>
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<td>109</td>
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<td>2220</td>
<td>121.7</td>
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<td>Heavitree Quartzite</td>
<td>2341.7</td>
<td>6.3</td>
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<td>Basement</td>
<td>2348</td>
<td>50+</td>
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<td>total depth</td>
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</table>
Shows
gas from Heavitree Quartzite

Tests
open hole test at T.D. 2395m: 63.1 MSCFD @ 38 psig, 1/4" choke
DST 1: 2340-2395.8m recovered drilling fluid, part misrun

Failure analysis
primary objective reservoir formation, Heavitree Quartzite, too thin at well location

Cores
none

Wireline logging
Schlumberger Seaco 2378 - 1004m DDL-MSFL-GR
2380 - 1004 LDL-CNL-GR-AS
2350 - 100 WST
2370 - 1004 Array sonic
2883.5 - 1622.5 LDL-CNL-GR

Drilling contractor and rig
O.D. & E. Pty Limited
Mereenie Joint Venture Rig No. 1

Drilling Methods
air drilled

References

Well completion reports not yet on open file.
# APPENDIX 3

## SOURCE ROCK ANALYSES UPDATE

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<tr>
<th>Formation / Well</th>
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<th>S1</th>
<th>S2</th>
<th>S3</th>
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<th>Maturity</th>
<th>Ref.</th>
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<td>1050 -1056</td>
<td>1</td>
<td>-</td>
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<td>3.19</td>
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<td>U GILLEN Murphy 1</td>
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<td>-</td>
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<td>1.17 to 0.49</td>
<td>3.25 to 4.0</td>
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<td>GILLEN Murphy 1</td>
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<td>-</td>
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<td>0.81</td>
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<td>L WINNALL Erdunda 1</td>
<td>? ?</td>
<td>-</td>
<td>low</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.2 to 0.73&lt;sup&gt;c&lt;/sup&gt;</td>
<td>&lt; 0&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>? ?</td>
<td>-</td>
<td>low</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.5 to 3.23</td>
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<td>0.5 to 1.0&lt;sup&gt;d&lt;/sup&gt;</td>
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<td>U BITTER SPRINGS Erdunda 1</td>
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<td>-</td>
<td>low</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.13 to 0.6</td>
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<td>.29</td>
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<td>.03</td>
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- a  Thermal alteration index
- b  Ro value
- c  Hydrogen index
- d  Production index

Reference A: PR93/028
Reference B: PR92/065D
AMDADEUS BASIN PRODUCTION LICENCE AND RETENTION LICENCE HOLDERS AT FEBRUARY 1994

PRODUCTION LICENCES

Palm Valley Gas Field

OL 3 (expires 08/11/2003)
Magellan Petroleum (NT) Pty Ltd.
Canso Resources Ltd.
Farmout Drillers NL
Gas & Fuel Corporation of Victoria
Santos Exploration Pty Ltd.
Santos Ltd.
Kufpec Australia Pty Ltd.
Amadeus Oil NL

Mereenie Oil and Gas Field

OL 4 (expires 17/11/2002)
United Oil & Gas Co. (NT) Pty Ltd.
Canso Resources Ltd.
Petromin No Liability
Moonie Oil NL
Transoil No Liability
Farmout Drillers NL
Santos Exploration Pty Ltd.

OL 5 (expires 17/11/2002)
Magellan Petroleum (NT) Pty Ltd.
Canso Resources Ltd.
Petromin No Liability
Moonie Oil NL
Transoil NL
Farmout Drillers NL
Santos Exploration Pty Ltd.

RETENTION LICENCES

Dingo Gas Field

R.L. 2 (expires 24/05/97)
Amadeus Oil NL
Canada Southern Petroleum Limited
Canso Resources Ltd.
Gas & Fuel Corporation of Victoria
Farmout Drillers NL
Magellan Petroleum (NT) Pty Ltd.
Moonie Oil NL
Petromin NL
Santos Exploration Pty Ltd.
Santos Ltd.
Transoil NL
APPENDIX 5

NORTHERN TERRITORY DEPARTMENT OF MINES AND ENERGY

OPEN FILE PETROLEUM REPORTS
Relevant open file reports not listed in Eastern Amadeus Basin Study or in Western Amadeus Basin Study.

<table>
<thead>
<tr>
<th>REPORT No</th>
<th>PERMIT</th>
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<tr>
<td>PR84/039</td>
<td>OP175/178</td>
<td>Magellan</td>
<td>Stratigraphy and tectonics of Arumbera Sandstone.</td>
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<tr>
<td>PR84/058</td>
<td>OP175</td>
<td>Magellan</td>
<td>Rpt on Photogeological Mapping</td>
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<tr>
<td>PR84/059</td>
<td>OP175</td>
<td>Pancontinental</td>
<td>Rev of Seis Data Processing &amp; Acquisition Parameters</td>
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<td>PR84/060</td>
<td>OP175</td>
<td>Pancontinental</td>
<td>Glen Edith, West Glen Edith, Areystonga &amp; Harlica S/S</td>
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<td>OP175</td>
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<td>Seismic Reinterpretation of the Orange Structure</td>
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<td>PR85/007</td>
<td>OP175</td>
<td>Pancontinental</td>
<td>Well Completion Report, Dingo No.2</td>
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<tr>
<td>PR85/019</td>
<td>OP175/178</td>
<td>Pancontinental</td>
<td>Glen Edith Uphole/Coring and Recommendations</td>
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<td>PR85/046</td>
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<td>The Geology of the North Glen Edith Hill N.T.Aust.</td>
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<td>PR85/048</td>
<td>OP175/178</td>
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<td>The Structural Geology of the Mereenie Trend</td>
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<td>PR85/077</td>
<td>OP178</td>
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<td>Mt Winter Core Hole Report, Cambro-Ordovician Geology</td>
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<td>PR86/037</td>
<td>OP175</td>
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<td>Well Completion Report, Mt Winter No.2.A</td>
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<td>OP175</td>
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<td>Geology of the Areystonga Hydrocarbon Prospect</td>
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<td>OP178</td>
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<td>Well Completion Report, Mt Winter No.2.A</td>
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<td>OP175/178</td>
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<td>PR86/057</td>
<td>OP185</td>
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<td>Report for Gosses Bluff Reprocessing 1986</td>
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<td>PR87/030</td>
<td>OP175/178</td>
<td>Magellan</td>
<td>A Collection of Data from Surface Exposures</td>
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<td>PR87/052</td>
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<td>Tarawarra Prospect Reprocessing Report</td>
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<td>Undandita Seismic Survey</td>
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<td>Areystonga Seismic Survey</td>
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Note:
Magellan = Magellan Petroleum
Pancontinental = Pancontinental Petroleum
Pacific Oil = Pacific Oil & Gas
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<td>PR89/019</td>
<td>OP175</td>
<td>Magellan</td>
<td>Application for Extension OP178 Report</td>
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<td>PR90/101</td>
<td>EP020</td>
<td>Indigo Oil</td>
<td>Well Completion Report Dingo No.4</td>
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Note:
Magellan = Magellan Petroleum
Pancontinental = Pancontinental Petroleum
Pacific Oil = Pacific Oil & Gas