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~~APPENDIX D~~

SUMMARY REPORT OF REGIONAL GEOLOGY

AND PETROLEUM POTENTIAL OF OP 175,

NORTHERN TERRITORY, TO END FEBRUARY 1982

APPENDIX C IS PR 80/ 9

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SUMMARY REPORT OF REGIONAL GEOLOGY AND PETROLEUM POTENTIAL OF OP 175, NORTHERN TERRITORY, TO END FEBRUARY, 1982

by

J.D. GORTER & E.G. URSCHEL

M0950003

Report No. 28
Pancontinental Petroleum Limited

March, 1982

CONTENTS

APPENDICES

ENCLOSURES

1. INTRODUCTION

Pancontinental Petroleum Limited assumed operatorship of Operating Permit 175, Amadeus Basin, on 12th June, 1980. After preliminary geological studies, Geophysical Services International commenced the Amadeus Seismic Survey, in the eastern part of OP 175, in December, 1980. This seismic survey covered 706.7 km in OP 175 and is continuing in OP 178, immediately west of OP 178 (Figure 1). The survey delineated three drillable structures. Two of these, Wallaby-1 and Dingo-1 were drilled during 1981. Wallaby-1 was plugged and abandoned after encountering insignificant gas in the objective basal Cambrian reservoirs. Dingo-1 was completed as a suspended gas well after drillstem tests revealed possible commercial gas reserves in the basal Cambrian objective. The third prospect, West Walker-1, will be spudded during March, 1982.

The results of the seismic surveys, drill hole information and regional geochemical and palaeontological investigations have been incorporated into the ongoing research into the petroleum potential of the Amadeus Basin. A preliminary evaluation of these investigations is presented.

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2. BRIEF GEOLOGICAL HISTORY

The Amadeus Basin is an 800 kilometre long, east-west oriented intracratonic depression lying in the southern part of the Northen Territory and extending partly into Western Australia. Commencing with Late Proterozoic clastics, which rest on an older Precambrian basement of metamorphic and igneous rocks, the basin has had a long and diversified history of sedimentation (Figure 2). Following Late Proterozoic sedimentation, rocks of Cambrian, Ordovician, possibly Silurian, Devonian and minor Permian were laid down. Depositional and climatic conditions varied greatly in space and time throughout this long history. The Late Proterozoic, Cambrian and Ordovician were largely times of marine sedimentation resulting in the accumulation of great thicknesses of sandstone, shale, limestone and dolomite, with periods of evaporite (salt) deposition in the Late Proterozoic and Cambrian. Two periods of glaciation also occurred in the Late Proterozoic. Silurian?-Devonian sandstones, which were deposited during a period of aridity, are partly fluviatile and aeolian. Mountain building movements along the northern rim of the basin provided material for a thick wedge of fluviatile sediments in the Late Devonian. Minor lacustrine deposits in the Permian and again in the Tertiary concluded the sedimentary history of the Amadeus Basin.

Sedimentation was modified by tectonic movements which occurred intermittently from Late Proterozoic to Late Devonian. Tectonic movements in the Proterozoic established the shape of the basin, and formed the structural framework within which subsequent movement took place.

Two major cycles of sedimentation associated with tectonism are evident. The older cycle began in the Proterozoic with mature orthoquartzite and carbonate rocks and finished with relatively immature fluviatile sandstone in the early Cambrian (Petermann Range Orogeny). The second cycle commenced later in the Cambrian with marine sediment predominating and ended in the Late Devonian with the Alice Springs Orogeny. Smaller local cycles are associated with the four movements that have been named (Figure 2).

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AMADEUS BASIN

GENERALIZED STATIGRAPHIC TABLE – OP 175 & OP178

AGE	GROUP	FORMATIONS – WEST	FORMATIONS – CENTRAL	FORMATIONS – EAST	OROGENIES
TERTIARY – RECENT		Surficial deposits - Lakes, rivers and dunes.			
PERMIAN		Buck Formation	?	?	
LATE DEVONIAN	PERTNJARA	Undifferentiated	Brewer Conglomerate Hermannsburg S'st Parke Siltstone	Undandita Member, Brewer Conglomerate, Ljiltera Member Hermannsburg S'st. Amulda Member, Dare Siltstone, Harajica Sandstone, Deering Siltstone	ALICE SPRINGS
SILURO-DEVONIAN		MEREENIE		SANDSTONE	
					RODINGAN
? LATE ORDOVICIAN MIDDLE ORDOVICIAN	LARAPINTA	Gosse's Bluff S'st Carmichael S'stone	Rodingan		
?— —? MIDDLE ORDOVICIAN	LARAPINTA	Stokes Formation Stairway Sandstone	Erosion		
EARLY ORDOVICIAN	LARAPINTA	Horn Valley Siltstone Pacoota Sandstone	N'dhala Member		
LATE CAMBRIAN	PERTAOORRTA	Goyder Formation			UNNAMED
MIDDLE CAMBRIAN	PERTAOORRTA	Cleland Sandstone	Petermann S'st Deception Siltst. Illarra Fm. Tempe Fm.	Jay Ck. Hugh River Shale Giles Ck Shannon Fm Giles Ck Dolomite	
EARLY CAMBRIAN	PERTAOORRTA	Mt Currie Conglomerate	Enita Formation/ Quandong Conglomerate	Chandler Fm. Todd Rv. Dolomite Arumberra Sst	
		?	?	?	PETERMANN
LATE PROTEROZOIC VENDIAN		Maurice Formation Sir Frederick Conglom./ Ellis Sandstone ?	? Julie Fm. Winnall Beds	Julie Formation Pertatataka Fm. (Cyclops Member)	
? VENDIAN – RIPHEAN		Carnegie Formation / Boord Formation	Inindia Beds	Pioneer S'st/Olympic Fm Aralka Formation Areyonga Formation	SOUTHS RANGE
					AREYONGA
LATE ? RIPHEAN		Bitter Springs Formations		Loves Creek Member Gillen Member	
		Heavitree Quartzite			
					ARUNTA
PRECAMBRIAN		Arunta Complex			

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Plan No. 3/114

PANCONTINENTAL PETROLEUM LIMITED

FIGURE 2

Folding and faulting in the south western area initiated in the Proterozoic, sometimes associated with salt tectonics, produced east-west striking anticlines often faulted along the flanks and showing thinning of Late Proterozoic sediments over the crest. These structures were modified, and new ones created by the Alice Springs Orogeny in Late Devonian time - the final major tectonism in the Amadeus Basin. An important precursor to the Alice Springs Orogeny was the Late Ordovician Rodingan Movement. The low angle unconformity that indicates this movement is best developed in the north and north-east, where the earlier deposited Ordovician sediments were progressively eroded eastwards. The total sediment thickness and the stratigraphy of sediments preserved over any structure depend on the amount of Rodingan erosion to which that structure has been subjected. Thus more western structures, such as at Palm Valley and Mereenie, are more likely to have a more complete sedimentary section preserved over them than eastern structures, such as at Orange-1.

Structures may be further complicated by the occurrence of salt diapirs, emanating from the Bitter Springs Formation or Chandler Formation, flowing into the cores of structures, as for example at the Goyder Pass structure. These salt cored structures are known to have grown intermittently from Late Proterozoic to Devonian time, as shown by local thinning of units.

At least two generations of thrust faulting are present in the Amadeus Basin, with thrusting from both north and south-west. Thrusting events probably took place during the Petermann Range Orogeny (Late Proterozoic - Early Cambrian) in the south-west and during the Alice Springs Orogeny. These thrusting movements further complicate the geology and have lead to thickened section overthrust anticlines and possibly the development of fracture porosity.

3. EVALUATION OF THE PETROLEUM GEOLOGY OF OP 175

3.1 Source Rocks

Previous drilling in the basin delineated the Mereenie Oil and Gas Field, Palm Valley Gas Field, and located sub commercial gas in Ooraminna-1 and minor oil in Alice-1, (Figure 1). The former two fields proved the existance of Ordovician sourced hydrocarbons (Kurylowicz et al., 1976) in the basin, and Ooraminna-1 the presence of Proterozoic source rocks (McKirdy, 1977).

Pancontienntal Petroleum Limited initiated an extensive study of Cambrian and Precambrian source rocks in the Amadeus Basin (Core Laboratories, 1981 a,b,c, 1982). Based on the average measured total organic carbon content of Cambrian rocks in the eastern Amadeus Basin, there are no potential hydrocarbon source rocks present in the Cambrian sequence (cf McKirdy, 1977). Richer pockets of organic matter occur, particularly in the Lower Shannon Formation, parts of the Giles Creek Dolomite section and the Chandler Formation, as shown by TOC values of more than 0.50% from selected core samples (eg. ESSO, 1965, McKirdy, 1977, Felton, 1981). However, the average TOC values, determined from cuttings over a 10-15m interval, generally fall below the minimum TOC cut-off for source rocks (0.50%). The average TOC values give a more accurate picture of the quantative source rock potential of each formation.

Results of source rock analyses of cuttings from the Horn Valley Siltstone, Dingo-1 (Core Laboratories, 1982) suggest that source rock quality of this formation is not uniform across the basin (cf Mereenie and Palm Valley Fields). This poor source quality demonstrated at Dingo-1, coupled with the erosionally defined truncation edge of the Horn Valley (Enclosure 2), suggests that a large part of the eastern and southern OP 175 area is non prospective for Ordovician hydrocarbons.

No results have been received from analyses on potential Precambrian source rocks in OP 175.

3.2 Maturation

Maturity indicators used in the Pancontinental Petroleum Limited investigation include reflectance of coal-like particles (R_o), spore fluorescence (simple spores and acritarchs) (Marchioni, 1981, 1982), conodont colour alteration indicies (Nicoll, 1981), thermal alteration indicies (Glikson & Owen, 1981) and Rock-Eval pyrolysis (T_{max}) measurements (Core Laboratories, 1981, a,b,c, 1982).

None of the several measures of thermal maturity used in this study are unambiguous, but taken together suggest increasing maturation southwards from the Wallaby-1 area to Dingo-1. Less certain is the decrease in maturation further southwesterly to Highway-1. Contrary to expectations, the degree of maturation does not increase towards the Macdonell Tectonic Front. It is suggested that the differences in maturation at the different wells is a combination of present depth of burial below the Pertnjara Group and Mereenie Sandstone, the amount of Rodingan erosion and the thickness of the Chandler Formation salt core of each structure.

3.3 Timing of Migration & Trap Formation

The relative timing of structural growth, or trap formation and hydrocarbon generation must be favourable for entrapment to occur, ie. maturation and migration should occur contemporaneously or post trap formation.

In the eastern Amadeus Basin, seismic and field evidence suggest that the simplest trap types (anticlines) were developed by north-south compression during the Alice Springs Orogeny, and are Late Devonian in age. Simple, unfaulted folds of this type, which includes the Dingo and Orange structures, are sparse. Reverse and thrust faulting, contemporaneous with the Alice Springs Orogeny folding, has formed other structures (eg. Alice, Wallaby and Waterhouse).

Earlier structuring,which accompanies the Petermann Range Orogeny, affects only the southern area. Possible wedge-out of the Early Cambrian Arumbera Sandstone occurs along this east-west anticlinal belt, probably north of the James Range.

In the north, near the present basin margin, salt diapirism during the Early Palaeozoic (eg. Goyder Pass Diapir) has lead to possible trap formation, although this type of structure is not apparent throughout most of the eastern Amadeus Basin.

Possible early Late Devonian structuring is present in the area of the Hugh River uplift (north of Waterhouse Range) and onlapping of younger Devonian rocks over breached older rocks may form traps, dependent on seal.

Timing of maturation and migration can be derived from use of the Lopatin method (Waples, 1980). Preliminary calculations (Gorter, 1981) suggest that the Pertatataka Formation is generally post-mature during the time of Alice Springs Orogeny structuring (Late Devonian), the Todd River Dolomite was in the zone of peak oil generation and the Horn Valley Siltstone was immature. The Pertatataka Formation can thus be discounted from further liquid calculations, except possibly as a source of late generated dry gas. Dingo-1 proved the predicted presence of dry gas in the basal Cambrian section.

The Horn Valley Siltstone has matured either during (eg. Palm Valley Field) or post Late Devonian (eg. Mereenie Field) structuring.

3.4 Reservoir

Pancontinental Petroleum Limited initiated reservoir studies on the Pacoota Sandstone at Mereenie Field and Palm Valley Field (Davies, Almon & Associates, 1980) and the Arumbera Sandstone at Wallaby-1 (Davies & Associates, 1981) and Dingo-1 (results not yet to hand). The results of the Pacoota Sandstone study are tabulated below (Table 1).

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TABLE 1

POTENTIAL RESERVOIR PROBLEMS
PALM VALLEY AND MEREENIE FIELDS

Palm Valley Field	Mereenie Field
1. Low porosity and permeability due to extensive dolomite cementation. (Important).	1. Low permeability in some intervals due to extensive silica cementation.
2. Formation sensitivity to HF acidization due to dolomite cementation. (Severe).	2. Minor formation sensitivity to HF acidization due to dolomite cementation. (Moderate-minor).
3. Formation sensitivity to HCl acidization due to the presence of pyrite and chlorite within the rock pore system. (Important).	3. Formation sensitivity to HCl acidization due to the presence of pyrite and chlorite within the rock pore system. (Important).
4. Microporosity.	4. Minor formation sensitivity to fresh water due to the presence of illite-smectite within the rock pore system.
	5. Migration of fines problem related to the development of fibrous illite within the pore system.
	6. Microporosity.

EXTRACT FROM RESERVOIR ANALYSIS BY DAVIES, ALMON & ASSOCIATES, INC., 1980

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At Wallaby-1, Davies & Associates (1981) reported that the Arumbera Sandstone, examined in Core 2, is a feldspathic litharenite. Monocrystalline quartz is the dominant detrital grain but polycrystalline quartz, orthoclase, chert, and metamorphic rock fragments are other important constituents. Detrital clay is present in all sandstone samples, occurring as pedogenic clay rims on grains.

The Arumbera Sandstones are fine grained and vary widely in terms of sorting (poorly to well sorted), and are characterised by a primary intergranular pore system, partially occluded by anhydrite and silica cement. (1%).

The Arumbera Sandstone will be susceptible to formation damage from the following mechanisms:

a. Precipitation of fluosilicic salts during HF acidization.

b. Precipitation of Fe $(OH)_3$ gels during HCl acidization (very minor).

The Arumbera Sandstones may be safely drilled with a fresh water based mud system. Mud clean-up acidization, if required, may proceed with a mud dispersal agent consisting of 12% HCl plus a nonionic or anionic surfactant and a non-emulsifying surfactant. HF should not be employed in acidification of these sands.

The Arumbera Sandstones will not respond to a matrix acid stimulation. If stimulation is attempted, a hydraulic fracturing is recommended as the most effective technique. An N_2 foam frac should prove effective.

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3.5 Two-way Time Structure of top Pacoota Sandstone (B.J. Phillips)

The top Pacoota Sandstone structure map for OP 175 (Enclosure 2) reflects the complex geological history outlined earlier in this report. The permit is dominated by elongate east and southeast trending anticlinal structures associated in part at least with the compressional tectonics of the Alice Springs Orogeny. Most of these anticlines are breached at the Pacoota Sandstone level (eg. Waterhouse, James Range, Gardiner, Walker Creek, Petermann, Ochre Hill and Parana Hill Anticlines), and thus have very low hydrocarbon trapping potential for this reservoir. However, where the anticlines are not breached (eg. West Walker Creek, Mereenie, Palm Valley Anticlines), the hydrocarbon trapping potential is significantly improved.

Structural relief over the anticlines can be extremely large, sometimes plunging from surface outcrop to depths in excess of 4,000 metres (eg. the Waterhouse Anticline to the Missionary Plains syncline).

Thrust and compressional wrench faulting is often associated with the anticlines, being mapped in outcrop at the Gardiner Range and Waterhouse anticlines, and being easily identified on seismic data to the east and west of the Waterhouse anticline, and at the Wallaby anticline. Significantly more faulting would be observed if seismic data quality could be improved over other anticlinal features.

The thrust faults generally "sole-out" on a decollment surface within the Bitter Springs Formation. The Bitter Springs salts, and to a lesser extent, the Chandler salts provide the core material for the anticlines.

Enclosure 2 shows that most of the anticlinal features in OP 175 have been drilled (eg. Waterhouse-1, Orange-1, Wallaby-1, Highway-1, Dingo-1, James Range-1, Palm Valley Field, Mereenie Field, Johnny's Creek-1 and Ochre Hill-1). The Waterhouse-1, Highway-1, James Range-1, Johnny's Creek-1 and Ochre Hill-1 tests were breached at the Pacoota Sandstone level, while West Waterhouse-1 and Alice-1 were structurally invalid tests.

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Of the anticlines that aren't breached, Mereenie and Palm Valley found commercial quantities of oil and gas, while Orange-1, Wallaby-1 and Dingo-1 were dry. These features were probably dry due to the lack of suitable source rocks (see section 3.1).

Future exploration targets for the Pacoota Sandstone will have to be more subtle and much more complex than previous tests. These will include fault related underthrust plays (Areyonga and East Waterhouse), complex salt swells (Gosses Bluff) and stratigraphic plays associated with the buried truncation edge of the Pacoota Sandstone (Hugh River Uplift, North Alice). Most of these plays will be difficult to define seismically because of poor record quality over the culminations.

4. RESUME OF WORK PROGRAMME OP 175

4.1 Seismic

Pancontinental Petroleum Limited contracted Geophysical Service Inc. for a 48 trace Vibroseis crew to acquire proposed seismic in OP 175.

The field crew arrived in Alice Springs during late November, 1980. Experimental work began on December 2, 1980, in two locations on line P80-8 of the Alice Survey.

Production recording of the proposed Alice Seismic Survey commenced on December 5, 1980. This programme was completed on February 13, 1981, with a total of 443.2 kilometres being acquired. Data quality for this survey varied from poor, northeast of the Alice-1 well, to excellent in the area of the Dingo lead.

Production recording of the proposed Highway Seismic Survey commenced on February 13, 1981 and continued until March 7, 1981, when it was decided to acquire the Walker Creek Seismic Survey prior to completing the Highway Survey. The Highway Survey recommenced on April 9, 1981 and was completed on April 16, 1981. A total of 130.5 kilometres of seismic was acquired with data quality varying from excellent in the north (Line P81-H4) to very poor in the south (P81-H1, 2, 3).

Production recording of the proposed Walker Creek Seismic Survey commenced March 11, 1981, after two days move and one day of experimental work. This programme was completed on April 7, 1981 with a total of 81.0 kilometres being acquired. Data quality was good for the entire survey.

Production recording of the proposed Undandita Seismic Survey commenced on April 18, 1981 and was completed on May 21, 1981 with a total of 229.6 kilometres being acquired, of which approximately 52.0 kilometres were in OP 175, the remainder being in OP 178. Data quality varied from excellent to very poor.

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The processing of all the above acquired seismic was done by Seismic Data Processors in Calgary, Alberta, whose processing reports for the Alice, Highway and Walker Creek Surveys are appended.

4.2 Geological - Field Work

A ground geological traverse by Pancontinental Petroleum Limited geologists was carried out in September, 1980. The traverse ran from the Big Hole at Ellery Creek, down Ellery Creek, southwest across the sandplain, through Katapa Gap in the Gardiner Range to Areyonga Native Settlement, and south down Areyonga Creek to Tempe Down Homestead (Figure 1). A side traverse was made northwest along Horse Plain to inspect the Walker Creek Anticline. These traverses allowed inspection of the majority of the geological succession in the Amadeus Basin, an introduction to the various rock types, and close examination of the Pacoota Sandstone in outcrop. The latter is particularly important because the Pacoota Sandstone is the main reservoir at the Mereenie and Palm Valley Fields. Prior to the ground traverse, a low level overflight was made to assess accessability for seismic crews to the northern and western areas of the basin.

In July/August, 1981, PPL geologists accompanied Magellan consultant, R. Oaks, Bureau of Mineral Resources and N.T. Mines geologists on a field inspection of structural styles and field mapping over the eastern end of OP 175 and areas to the south (Figure 1). Following the excursion, PPL geologists made a traverse along the northern flank of the James Range from the Stuart Highway west to the James Range-Al wellsite (Figure 1). Limestone samples were collected from the Stokes Formation and the Jay Creek Limestone. These samples were submitted to Dr. R.S. Nicoll (BMR) for conodont dating. The Pacoota Sandstone outcrops were also examined.

In the coming field season, PPL geologists will continue surface mapping, especially of unidentified outcrops intersected by seismic lines in OP 175. Collection of samples for palaeontological dating will continue. Ground traverses will be conducted in areas where seismic and Landsat interpretation suggest the presence of faulting, not previously recognised on BMR mapping.

Inhouse Studies

A report on the Petroleum Potential of the Cambrian rocks of OP 175 is in preparation. This report brings together the results of geochemical, palaeontological and seismic studies mentioned herein, and previously published or unpublished data available to Pancontinental Petroleum.

Contractors

Davies, Almon & Associates completed an appraisal of the reservoir rocks at Palm Valley and Mereenie Fields (see above). A similar study was carried out on the Arumbera Sandstone at Wallaby-1 by Davies & Associates (see above), who are presently engaged in a detailed study of the reservoir potential of the Arumbera Sandstone at Dingo-1.

4.3 Geochemical

Pancontinental Petroleum Limited has conducted extensive sampling of wells previously drilled in the Amadeus Basin, and wells drilled in the current drilling programme, for several geochemical parameters:

a) Source rock distribution
b) Maturation
c) Oil/Gas correlation to source rock

The wells sampled, the parameters investigated, the contractors used and the disposition of the various reports are tabulated below (Table 2). The distribution of the sample sites is shown in Figure 3.

TABLE 2. GEOCHEMICAL SAMPLING OF PANCONTINENTAL PETROLEUM LIMITED, OP 175.

ELL NAME	YEAR DRILLED	DEPTH RANGE	PARAMETER	CONTRACTOR	REPORT
ighway-1	1965	716-838m	Maturation	Marchioni	NS
		716-883m	Source Rock	Core Lab	IP
Orange-1	1966	168-2659m	Maturation	Marchioni	NS
		792-2704m	Source Rock	Core Lab	RS
		2158m	Source Rock	Rob. Research	RS
yler-1	1969	2042-3261m	Maturation	Marchioni	NS
allaby-1	1981	741-1000m	Maturation	Marchioni	WCR
		735-2424m	Source Rock	Core Lab	RS, IP
			Canned Cuttings	BMR	IP
lice-1	1963	1384-2027m	Maturation	Marchioni	NS
osses Bluff-1	1965	479-488m	Maturation	Marchioni	NS
alm Valley-1	1965	Core 19	Source Rock	Rob. Research	RS
est Walker Seismic	1981	30m	Maturation	Marchioni	NS
Dingo-1	1981	1003-3055m	Maturation	Marchioni	WCR
		994-3092.5m	Source Rock	Core Lab	IP
			Canned Cuttings	BMR	IP
			Canned Cuttings	CSIRO	IP
East Mereenie-4	1967	823-2667m	Source Rock	Core Lab	RS
		1968-2615m	Source Rock	Rob. Research	RS
East Mereenie-2	1965	1280m	Source Rock	Rob. Research	RS

NS - Not yet submitted; WCR - in well completion report;
› - in progress; RS - report submitted to government

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An airborne hydrocarbon gas sensor survey flown by Vaporsearch Pty. Ltd. in 1981, over selected areas of OP 175,detected about 30 zones of anomalous hydrocarbon microseepage. The largest of these zones were associated with the Mereenie oilfield and the Palm Valley gasfield. Zones of major microseepage recorded at Hermannsburg, Merrick, Mt. Holder and Wallera have smaller areal dimensions than those at Mereenie or Palm Valley. A further 16 zones of moderate hydrocarbon microseepage were outlined, but previous drilling results into some of these have shown their source to be only minor gas or oil shows.

Limited ground surveys showed anomalous concentrations of methane, ethane and propane (C1, C2 and C3) above the Mereenie oilfield, but reliable samples could not be collected at Palm Valley because of the lack of soil development. Ten other microseepage zones were surveyed on the ground and weakly anomalous concentrations of C1, C2 and C3 occur in soil gas over the Mt. Holder, McMinn and, perhaps, the Merrick prospects. Other prospects sampled on the ground appear to have less potential, but deserve to be tested by a more comprehensive ground survey, utilising more sensitive collection methods for areas dominated by loose sand cover.

A copy of the report of this survey is appended.

4.4 Palaeontological

Although the Amadeus Basin has been the site of extensive and ongoing field work, several problem areas still exist. A major problem is the correlation of the various Cambrian units and in differentiating between lithologically similar sequences of Precambrian and Cambrian rocks. A comprehensive biostratigraphic study is required in order to solve these questions. Palaeontological studies of the Amadeus Basin sequence have, in the past, been generally concentrated on a few macrofossil groups and centred on the eastern end of the basin. While macrofossils may prove useful in surficial stratigraphic studies, their value is severely restricted in the subsurface, when only drill cuttings and, more rarely, sidewall cores are available. Such small and fragmented rock samples are obviously unsuitable for macrofossil preservation and microfossils are perhaps the only way of determining the age of the drilled formations.

Microfossil groups that may prove useful in the Late Precambrian and Cambrian would include acritarchs and possibly phosphate-secreting organisms. Suitable lithologies for preservation of both groups (ie. black-coloured marine siltstones and shales, and micritic limestones) are present in the Precambrian and Cambrian succession of the Amadeus Basin. However, there has been no significant study of Late Precambrian to Cambrian microfossils in Australia, although such studies have been carried out overseas, particularly in Europe and the USSR. There exists, therefore, a need for workers in this field in Australia, particularly because of the increasing emphasis in petroleum exploration of Late Precambrian to Cambrian basins (eg. Amadeus, Officer, Georgina and Ngalia Basins). Pancontinental Petroleum has recognised this need, and has taken several appropriate steps to resolve the lack of a biostratigraphy suited to rocks of Late Precambrian to Early Ordovician in Australia, and in particular, in the Amadeus Basin.

A major undertaking by the Amadeus Joint Venture partners, initiated by Pancontinental Petroleum Limited, has been the provision of a suitable microscope to Dr. M. Owen, BMR Micropalaeontologist, for Australia-wide biostratigraphic research on microfossil organisms, particularly acritarchs and chitinozoans.

Close co-operation has also been established with BMR micropalaeontologists working on phosphatic or phosphatized microfossils. Bulked cutting samples from Dingo-1 and Wallaby-1 have been submitted to Dr. J. Shergold for microfossil search. Pancontinental Petroleum may finance a technician to process these samples. Dr. R.S. Nicoll has been actively engaged in conodont research on samples submitted by Pancontinental from drilling, seismic shot holes and field collecting.

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A list of samples submitted is tabulated below.

TABLE 3. LIST OF SAMPLES SUBMITTED FOR PALAEONTOLOGICAL WORK

LOCALITY	DEPTH	FOSSIL GROUP	RESEARCHER	REPORTS
ighway-1	741m	Acritarchs	Harris	N.R.
	716-823m	"	Owen	N.S.
	689-960m	Phosphatic fossils	Shergold	N.S.
lice-1	1042-2292m	Acritarchs	Harris	N.R.
	1182-1184m	Conodonts	Nicoll	R.S.
	Core 12	Phosphatic fossils	Shergold	I.P.
range-1	792-2310m	Acritarchs	Harris	N.R.
	795.5-2338m	"	Owen	N.S.
	731-1402m	Conodonts	Nicoll/Cooper	R.S.
		Phosphatic fossils	Shergold	I.P.
	161-451m	Palynology	Glikson & Owen	N.S.
East Mereenie-1	1056-1058m	Acritarchs	Harris	N.R.
	1058-1091m	Conodonts	Nicoll/Cooper	R.S.
alm Valley-1	1696m	Acritarchs	Harris	N.R.
	908-917m	"	Owen	N.S.
	Core 19	"	Owen	N.S.
	1628-1701m	Conodonts	Nicoll/Cooper	R.S.
	213-917m	Palynology	Glikson & Owen	N.S.
East Mereenie-4	1966-2667m	Acritarchs	Owen	N.S.
Wallaby-1	735-2424m	Acritarchs	Owen	WCR
	735-2424m	Phosphatic fossils	Shergold/Nicoll	I.P.
ingo-1	1003-3092.5m	Acritarchs	Owen	I.P.
	1241m JS	Macrofossils	Laurie	N.S.
	1241m JS	Ostracods	Jones	I.P.
	1003-1030m	Conodonts	Nicoll	I.P.
	1021-3092.5m	Phosphatic fossils	Shergold/Nicoll	I.P.

..ereenie-1	1035-1128m	Conodonts	Nicoll/Cooper	R.S.
	152-488m	Palynology	Glikson & Owen	N.S.
West Mereenie-1	518-1631m	Conodonts	Nicoll/Cooper	R.S.
	91-366m	Palynology	Glikson & Owen	N.S.
est Waterhouse-1	1420-1789m	Conodonts	Nicoll/Cooper	R.S.
	743-948m	Palynology	Glikson & Owen	N.S.
..ast Johnnys Ck-1	61-487m	Conodonts	Nicoll/Cooper	R.S.
.alm Valley-3	1981-2039m	Conodonts	Nicoll/Cooper	R.S.
	515-805m	Palynology	Glikson & Owen	N.S.
James Range	outcrop	Conodonts	Nicoll	I.P.
P81-SP 270	30m	Palynology	Glikson & Owen	N.S.
Tyler-1	2042-3261m	Palynology	Glikson & Owen	N.S.
..ast Mereenie-2	61-655m	Palynology	Glikson & Owen	N.S.

..S - Report sent to government; IP - in progress
..S - Report not sent to government; JS - Junk sub
..CR - Report in WCR

Further work in these fields will be carried out as suitable lithologies become available through drilling, seismic work and field sampling. The sample localities are shown in Figure 4.

4.5 Drilling

Wallaby-1

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Wallaby-1 was the first well drilled by Pancontinental Petroleum Limited in OP 175, of the Amadeus Basin, under a farmout agreement with the Permit Holder - Magellan Petroleum (N.T.) Pty. Limited.

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The well, situated 28 km southeast of Alice Springs, was drilled as a petroleum test of an anticline up dip from Alice-1, 7 km to the west. Wallaby-1 was drilled primarily to assess the oil and gas potential of the Cambrian and Late Proterozoic sediments, as the only known productive reservoir formation in the basin, the Cambro-Ordovician Pacoota Sandstone, was breached.

The Arumbera Sandstone was the primary target with secondary objectives located stratigraphically higher, in the Chandler Formation, Giles Creek Dolomite and Goyder Formation.

Wallaby-1 was drilled to total depth of 2425 metres (Driller) in 1981. The well penetrated 480 metres of Devonian sandstones unconformably above 1425 metres of Cambrian sandstones, shales, limestones and dolomites.

The absence of the basal Cambrian Chandler salt sequence was interpreted to be due to a combination of leaching and facies change. The well then drilled 458 metres of Late Proterozoic to Early Cambrian molasse sediments and bottomed in Late Proterozoic dolomitic sandstones and dolomite.

The well encountered insignificant gas and fluorescence in the Early Cambrian dolomites and further small gas shows in the Late Proterozoic - Early Cambrian sandstones. The carbonate section was tight and often anhydrite filled, while the sandstones showed good permeability on drillstem testing.

Wallaby-1 was completed as a water well at 763 mKB in porous sandstones of the Upper Shannon Formation.

Dingo-1

Dingo-1 was the second well drilled by Pancontinental Petroleum Limited in OP 175, of the Amadeus Basin, under a farmout agreement with the Permit Holder - Magellan Petroleum (N.T.) Pty. Limited.

The well, situated 75 km south of Alice Springs, was drilled as a petroleum test of a seismically defined anticline. Dingo-1

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was drilled primarily to assess the oil and gas potential of the Cambrian and Late Proterozoic sediments and the Cambro-Ordovician Pacoota Sandstone.

The Arumbera Sandstone was the primary target, the Pacoota Sandstone the secondary target, with possible tertiary objectives located stratigraphically higher, in the Chandler Formation, Giles Creek Dolomite and Goyder Formation.

Dingo-1 was drilled to total depth of 3092.5 metres (Driller) in 1981. The well penetrated 974 metres of Devonian sandstone unconformably above 34 m of Ordovician siltstone and carbonate overlying 1358 metres of Cambrian sandstone, shale, limestone and dolomite. The well then drilled 240 metres of Late Proterozoic to Early Cambrian molasse sediments and bottomed in Late Proterozoic sandstone and shale.

The well encountered significant gas shows in the Late Proterozoic - Early Cambrian sandstones. The sandstones showed good permeability on drillstem testing with gas flared to surface during DST 2 and DST 6.

Dingo-1 was completed as a shut-in gas well with 7" production casing run to 3078 metres and a well-head installed.

<u>West Walker-1</u>

West Walker-1 will be the third well drilled by Pancontinental Petroleum Limited in OP 175, under a farmout agreement with the Permit Holder - Magellan Petroleum (N.T.) Pty. Ltd. The well is anticipated to spud in late March, 1982.

The West Walker Prospect is located 220 km west of Alice Springs, in OP 175, Amadeus Basin, Northern Territory, Australia. The nearest well control is East Mereenie-2, 28 km to the northwest, which is the eastern most well in the Mereenie Oil and Gas Field. The West Walker Prospect lies in a structurally similar, en-echelon anticline to the Mereenie Field structure, and the stratigraphic succession at the proposed West Walker-1 well is anticipated to be closely comparable to that penetrated by East Mereenie-2.

West Walker will be drilled primarily to assess the oil and gas potential of the Cambro-Ordovician Pacoota Sandstone. Secondary objectives are to assess the hydrocarbon potential of the Ordovician Stairway Sandstone, the Cambrian Cleland Sandstone and the sub-Tempe Formation rocks. The tertiary objective is to assess the hydrocarbon potential of the doubtfully sealed Mereenie Sandstone.

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APPENDIX 1

Pancontinental Petroleum Limited Reports

RELINQUISHMENT LIST OF REPORTS

OP175, AMADEUS BASIN

PANCONTINENTAL PETROLEUM LIMITED REPORTS

PPL NO. 1

Well Proposal and Drilling Programme
Exploration Well, Wallaby-1
OP 175, Amadeus Basin, Northern Territory
by J.D. Gorter, R.J. Schroder & C.W. Mann

PPL NO. 8

Application of Lopatin's Method to Source Rock Maturation at Alice-1, Orange-1 and Dingo-A.
by J.D. Gorter
May, 1981

PPL NO. 9

Well completion report for Pancontinental Petroleum Limited, Wallaby-1
by J.D. Gorter, C. Bellis, C. Dee, R.J. Schroder & G.G. Fenton
March, 1982

PPL NO. 10

Proposal to drill Exploration Well, Dingo-1, OP 175, Amadeus Basin, Northern Territory.
by J.D. Gorter, C.W. Mann & R.J. Schroder
September, 1981

PPL NO. 11

Proposal to drill Exploration Well, West Walker-1, OP 175, Amadeus Basin, Northern Territory.
by J.D. Gorter, M.P. Lynn, B.J. Phillips, R.J. Schroder & E.G. Urschel

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PANCONTINENTAL PETROLEUM LIMITED REPORTS

PPL NO. 13

Proposal to drill Exploration Well, Finke-1, OP 175, Amadeus Basin, Northern Territory
by J.D. Gorter
October, 1981

PPL NO. 14

Report on Shot hole samples from West Walker Creek Seismic Programme, April, 1981
by J.D. Gorter
May, 1981

PPL NO. 15

Proposal to drill Exploration Well, Mt. Winter-1
by J.D. Gorter & R.J. Schroder

PPL NO. 19

Proposed Drilling Programme, Mt. Winter-1, OP 178, Amadeus Basin, Northern Territory
by C.W. Mann & J.D. Gorter
November 1981

PPL NO. 21

Petroleum Potential of the Cambrian Marine sequence, eastern Amadeus Basin, Northern Territory
by J.D. Gorter (in preparation)

PPL NO. 22

Proposed Drilling Programme, West Walker-1, OP 175, Amadeus Basin, Northern Territory
by C.W. Mann & J.D. Gorter
February, 1982

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PANCONTINENTAL PETROLEUM LIMITED REPORTS

PPL NO. 23

Report on shot hole samples from Undandita Detail Seismic Survey, OP 178, Amadeus Basin
by J.D. Gorter
February, 1982 (in preparation)

PPL NO. 24

Structure Mapping of the West Walker Creek Prospect, OP 175, Amadeus Basin, Northern Territory
by M.P. Lynn
February, 1982

PPL NO. 27

Well Completion Report for Pancontinental Petroleum Limited, Dingo-1
by C. Dee, J.D. Gorter, R.J. Schroder & G.G. Fenton (in preparation)

APPENDIX 2

Reports from Contractors to Pancontinental Petroleum Limited

SERVICE COMPANY REPORTS

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File No. GCS 81070 (Unpublished)

CORE LABORATORIES, 1981 c: Hydrocarbon source-rock evaluation for Pancontinental Petroleum Limited. Well: Wallaby-1, Amadeus Basin, Australia.
File No. GCS 81096 (Unpublished)

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SERVICE COMPANY REPORTS

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(Unpublished)

ROBERTSON RESEARCH (SINGAPORE), 1981 b: A basic geochemical evaluation of one core sample from the East Mereenie-2 well.
Memorandum No. S/778 (Unpublished)

ROBERTSON RESEARCH (SINGAPORE), 1981 c: A basic geochemical evaluation of one core sample from the Orange-1 well.
Memorandum No. S/780 (Unpublished)