Department of Primary Industries and Energy
Bureau of Resource Sciences

Australian Petroleum Accumulation Report 9

Canning Basin, W.A.

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ISBN 0 642 19548 X
ISSN 0817-9263

Bibliographic citation

Cadman, S. J., Pain, L., Vuckovic, V. & le Poidevin, S. R., 1993 - Canning Basin, W.A. *Bureau of Resource Sciences, Australian Petroleum Accumulations Report* 9, 1993.

Cover: Aerial view looking northwest along the Napier Range, an exhumed Devonian reef complex. Photograph: Phil Playford

In the Australian Petroleum Accumulations series :

Report 1 Amadeus Basin, Northern Territory, 1986.
Report 2 Bass Basin, Victoria and Tasmania, 1987.
Report 3 Gippsland Basin, Victoria, 1987.
Report 4 Adavale Basin, Queensland, 1988.
Report 5 Bonaparte Basin, Northern Territory and Western Australia, 1989.
Report 6 Otway Basin, Victoria and South Australia, 1990.
Report 7 Browse Basin, Western Australia, 1991.
Report 8 Carnarvon Basin, Western Australia, 1993.
Report 9 Canning Basin, Western Australia, 1993.
Report 10 Perth Basin, Western Australia, (in preparation).

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Its role is to provide professionally independent and timely scientific and technical analyses, assessments, advice and information to government, industry and the community, and to facilitate the formulation and implementation of policies and programs directly relevant to Australia's agricultural, minerals, petroleum, forestry and fishing industries.

FOREWORD

This report on the Canning Basin, Western Australia, is the ninth in the Australian Petroleum Accumulation Series. The series presents data on Australia's identified petroleum resources, together with an appraisal of their geological setting, hydrocarbon habitat and characteristics. In the case of commercial accumulations, details of their size, development and production history are included.

The APA database, on which this publication series is based, was developed in cooperation with petroleum companies, State and Northern Territory Mines Departments. Released in digital format in 1991, the database is available as ASCII files or Oracle tables and is linked to PEDIN, the petroleum exploration information database maintained jointly by the Bureau of Resource Sciences and the Australian Geological Survey Organisation.

Although a number of commercial hydrocarbon accumulations have been discovered in the onshore Canning Basin, most of the basin remains underexplored. The information compiled in this report is essential to explorationists interested in evaluating the hydrocarbon potential of one of Australia's largest sedimentary basins.

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ABSTRACT

As at January 1993, nineteen hydrocarbon accumulations, six of which are commercial, have been discovered in the Canning Basin. The commercial accumulations occur in Permian to Devonian reservoirs on an area of relatively shallow basement (Lennard Shelf) flanking the northern margin of the Fitzroy Trough. Oil is produced from Famennian reefs, associated drape structures, and four-way dip closures in Permo-carboniferous, Grant Group and Anderson Formation sandstones. The most likely sources of these hydrocarbons are Late Devonian and Carboniferous marine shales in the Fitzroy Trough kitchen area.

The small size of the accumulations in the Canning basin (less than 0.5 million barrels of recoverable oil) precludes the development of large infrastructure projects. Oil is trucked to the storage and shiploading facilities at Broome and then shipped to the Kwinana oil refinery in Western Australia.

On the southern margin of the Fitzroy Trough, oil and gas have been recovered from a transgressive Ordovician sequence of sandstones shales and carbonates. Although the Ordovician has yet to yield a commercial discovery, Devonian reef plays in the overlying section may enhance the attractiveness of Ordovician objectives in this area.

To date, exploration effort in the basin has been largely directed to the northern, onshore Canning Basin. The offshore Canning and the Kidson Sub-basin remain underexplored. Higher risk plays in these areas have yet to be adequately tested.

1. INTRODUCTION

This report contains technical data on the nineteen hydrocarbon accumulations discovered in the Canning basin to January 1993. It summarises the evolution of the basin, stratigraphy, exploration history, hydrocarbon habitat and development of the commercial accumulations.

A discrete, measured recovery of hydrocarbon during a well test qualifies an accumulation for inclusion in the Australian Petroleum Accumulations (APA) database. Where available on open file, test results from the discovery well are listed in the database. A copy of the database accompanies this report (Appendix 1). Hydrocarbon accumulations inferred from wireline log data are excluded. Fluorescence and high gas chromatograph readings recorded while drilling are included in a tabulation of hydrocarbon shows.

Hydrocarbon accumulations are classed as commercial if production has occurred or development plans have been announced by the operator(s). The category 'other discovery' covers any other accumulation.

The hydrocarbon accumulations discovered in the Canning Basin to January 1993 have yet to make a major contribution to Australia's oil and gas reserves or production. However, much of the basin remains underexplored and several play types have not yet been adequately tested.

2. BASIN SUMMARY

2.1 Basin Setting

The Canning Basin underlies an area of more than 595 000 sq km of northwest Australia. Seismic data indicate that a thickness of up to 18 km of Ordovician to Quaternary sediments may be present in the deepest depocentre (Gregory Sub-basin), (Yeates & others, 1984). Onshore, the basin is bounded to the north by the Precambrian Kimberley Block (Figure 1). The Pilbara and Musgrave Blocks define the basin's southern limits. Its boundary with the Amadeus Basin, to the east, is defined by an arch of Upper Proterozoic sediments. To the southeast, an area of shallow basement, (the Warri Arch), separates the Canning and Officer Basins.

Approximately one third of the Canning Basin lies offshore in water depths of up to 1000m. To the north, the Leveque shelf separates the offshore Canning Basin from the Browse Basin. To the south, the Pilbara shelf, the North Turtle arch and the northerly trending fault north of the arch, mark the boundary between the Canning and Carnarvon Basins (Beagle Sub-basin).

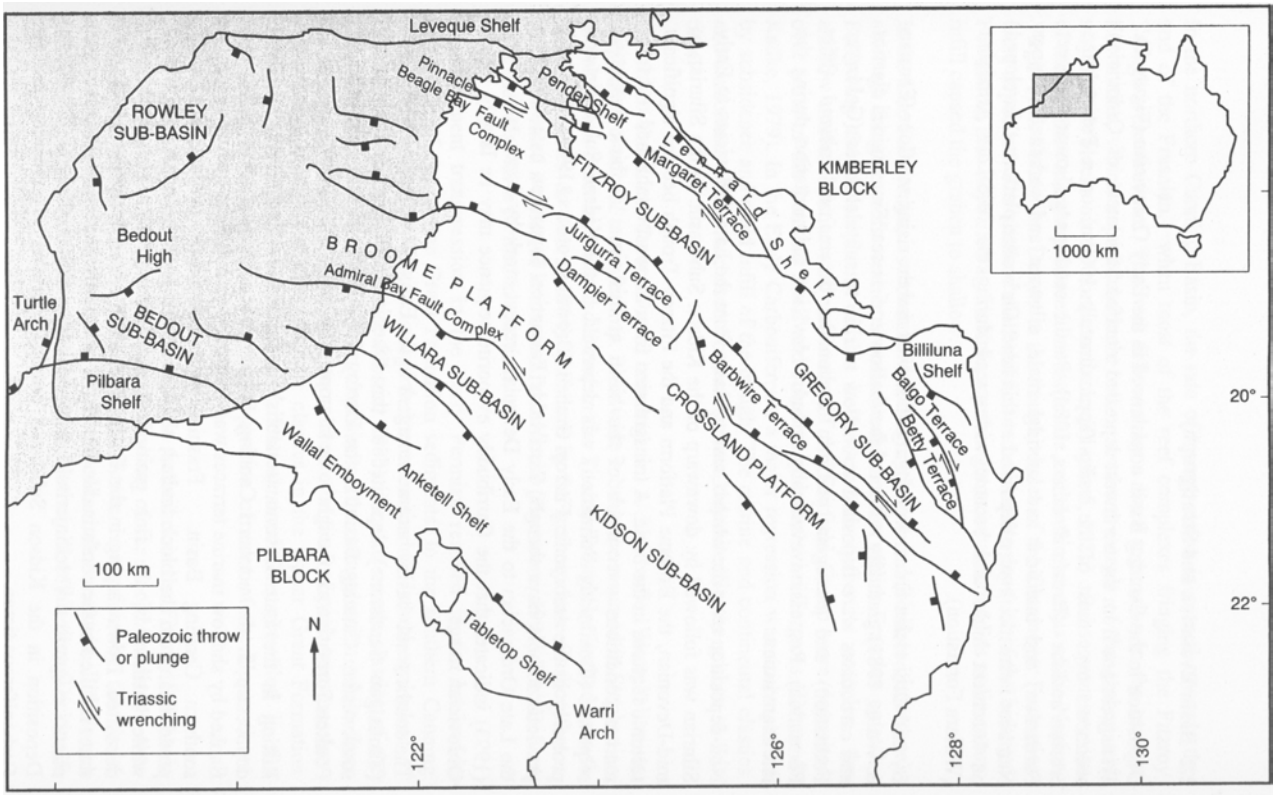
Onshore, a northwesterly Palaeozoic structural grain is recognised within the basin. The Fitzroy Trough, which is interpreted as a Palaeozoic rift, dominates the northern Canning Basin. The trough has been subdivided into two depocentres - the Fitzroy Sub-basin and the Gregory Sub-basin. The fault bounded Fitzroy Trough is flanked to the north by an area of relatively shallow (less than 4000m) basement termed the Lennard Shelf. Further to the southeast,on the same structural trend, the Balgo Terrace and Billiluna Shelf lie on the northern margin of the Gregory Sub-basin.

On the southern flank of the Fitzroy Trough, structurally complex downfaulted blocks form the Jurgurra, Dampier and Barbwire Terraces. A broad mid-basin platform of shallow (less than 2000m) basement forms the southern boundary of the Palaeozoic rift system. The northwestern part of the platform is termed the Broome Platform and the southeastern portion the Crossland Platform. The shallow basement of the mid-basin platform deepens to the south where it underlies the Willara and Kidson Sub-basins. The area of shallow basement flanking the Pilbara Block on the southern margin of the Canning Basin is referred to as the Anketell-Tabletop Shelf.

The northwesterly Palaeozoic structural grain which defines major tectonic units in the onshore Canning Basin continues offshore onto the continental shelf. On the continental slope and shelf in the southern offshore Canning, a northeasterly structural trend has been superimposed on the older structural grain during the rifting and breakup of Gondwana in the Mesozoic.

Offshore, the seaward extension of the Broome Platform delineates the northern boundary of the Bedout Sub-basin. To the northwest, separated from the Bedout Sub-basin by the Bedout High, is the Rowley Sub-basin. North of the Broome Platform, the Fitzroy Trough, the Pender Shelf and the Jurgurra Terrace extend seawards into the northern offshore Canning Basin.

Figure 1. Tectonics elements, Canning Basin, Western Australia.



2.2 Basin Evolution and Stratigraphy

Deposition in the Canning Basin commenced in the Early Ordovician (Figure 2). Transgressions from the northwest deposited a uniform thickness of Ordovician sediments over most of the basin (approximately 1000m) on a Precambrian erosion surface (Brown & others, 1984). Paralic sandstones (Lower Nambeet Formation) and intertidal and subtidal shale, siltstone and carbonate (Upper Nambeet Formation) were deposited at this time. Carbonate platforms developed on basement highs and became widespread during the Mid-Late Arenigian (Willara Formation).

By mid-Ordovician times, deposition had slowed and the rising sea floor (Forman & Wales, 1981) gradually restricted the shallow epeiric sea. Fine grained clastics and carbonates were deposited in shallow marine to subtidal areas (Goldwyer Formation) and emergent platform carbonates became dolomitized (Nita Formation). Regression eventually ended Ordovician sedimentation during the late Llanvirnian.

Non-deposition over the whole Canning Basin from the Late Ordovician to Early Silurian was followed by downwarp of the Kidson Sub-basin. In the Silurian to mid-Devonian, the Broome Platform and the Fitzroy Trough became significant tectonic features in the basin. A transgression from the west established restricted marine conditions over much of the basin at this time. A thick evaporitic sequence (Carribuddy Formation) was deposited in the Kidson Sub-basin and probably in the embryonic Fitzroy Graben (Brown & others, 1984). Although previous authors have thought Carribuddy Formation deposition extended from the Late Ordovician to the Early Devonian, recent work by Jones and Young (1993) indicates that the Carribuddy evaporite sequence may be largely Upper Ordovician in age.

The southern sub-basins became emergent in the Early Devonian. A red-bed unit (Tandalgoo Sandstone) deposited at this time is widespread throughout the southwestern Canning Basin. In the Fitzroy Trough, the marine clastics of the Poulton Formation are thought to be an upper Tandalgoo equivalent.

Rifting in the Late Devonian established the Fitzroy Trough as the major depocentre in the northern Canning Basin. The deep, fault bounded trough flanked by shallow marine terraces was connected to a shallow epeiric sea in the southern Canning Basin. Frasnian reef complexes (Pillara Formation) predominated on the block faulted, shallow marine shelves flanking the trough, while basinwards, the fine grained clastics of the Gogo Formation were deposited. Downwarping in the Kidson Sub-basin to the south during Givetian times resulted in the conformable deposition of a thin sequence of carbonates and minor evaporites (Mellinjerie Limestone) over the Tandalgoo Sandstone.

Deposition in the Kidson Sub-basin ceased from early Fammenian to Late Carboniferous times.

In the northern Canning Basin, the rate of transgression increased towards the end of the Frasnian, when most of the reef complexes fringing the Fitzroy Trough were drowned. This was followed by a brief regression in the earliest Famennian, which exposed both the entire southern margin of the graben and major fault blocks on the northern flank (Playford, 1980) . Subsequent erosion of the northern margin produced the carbonate and clastic breccias of the Napier-Virgin Hills Formation. Deeper in the trough, shales of the Clanmeyer Formation were deposited. The shallow shelf clastics and carbonate deposits of the Luluigui Formation, also deposited at this time, are thought to have formed as sedimentary infill caused the graben to shallow.

In the Late Famennian, a second reef building cycle occured (Nullara Limestone), although fringing reefs were less common than in the earlier Frasnian episode. Following the development of this Late Devonian carbonate complex, the shallow marine clastics and carbonates of the Fairfield Group were deposited over parts of the Lennard Shelf and Jurgurra and Barbwire Terraces (Druce & Radke, 1979). In the Early Carboniferous, a major regression was accompanied by subsidence and rapid infill of the trough. The marine and continental clastics and carbonates of the Anderson Formation were deposited in the graben at this time.

Uplift in the Late Carboniferous resulted in a basinwide Westphalian to Stephanian erosional unconformity. Basinwide subsidence resumed in Stephanian to Sakmarian times and was facilitated in the Fitzroy Trough by limited growth faulting (Yeates & others, 1984). Offshore in the graben, Late Carboniferous faulting formed a series of horsts and fault blocks (Passmore, 1991). The Bedout High may also have formed at this time.

A subsequent transgression in the Early Permian resulted in the basinwide deposition of the marine Grant Formation sediments. In the southern Canning Basin, the Paterson Formation is regarded as a continental lateral equivalent of the Grant Formation (Towner & Gibson, 1983). Fine to coarse clastics of the basal Grant characterise the earliest deposits of the transgression while finer clastics deposited in the mid-Sakmarian relate to the time of peak transgression. Non-marine, deltaic and minor marine clastics in the Upper Grant Formation represent a late Sakmarian regression. Glacial conditions prevailed in the surrounding cratonic highlands during deposition of most of the Upper Grant Formation.

In the Late Sakmarian, a period of sporadic tectonism in the Fitzroy Sub-basin (Crowe & others, 1978) preceded the deposition of the Poole Sandstone over most of the Canning Basin. The Poole Sandstone is overlain by the shale, siltstone and calcareous marine units of the Noonkanbah Formation. Lithologies

and macro fossil assemblages suggest a rise in relative sea at this time (Dickins & Jell, 1974).

Late in the Artinskian the sea began to regress. In the Kidson Sub-basin the sandy to silty Triwhite Sandstone was deposited. North of the Broome Platform, the marine, fluvial and deltaic sediments of the Liveringa Group infilled the Fitzroy Graben. A low angle unconformity between Late Permian and Early Triassic units in the Fitzroy Sub-basin may be a consequence of Late Permian rifting associated with events early in the break-up of Gondwanaland (Carey, 1976). The Permo-Triassic sequence is largely conformable in the Gregory Sub-basin.

In the Early Triassic, a transgression from the northwest deposited the fine grained clastics of the Blina Shale in the Fitzroy Graben. The fine, sandy to silty clastics of the overlying Erskine Sandstone represent a subsequent regression in the Late Scythian.

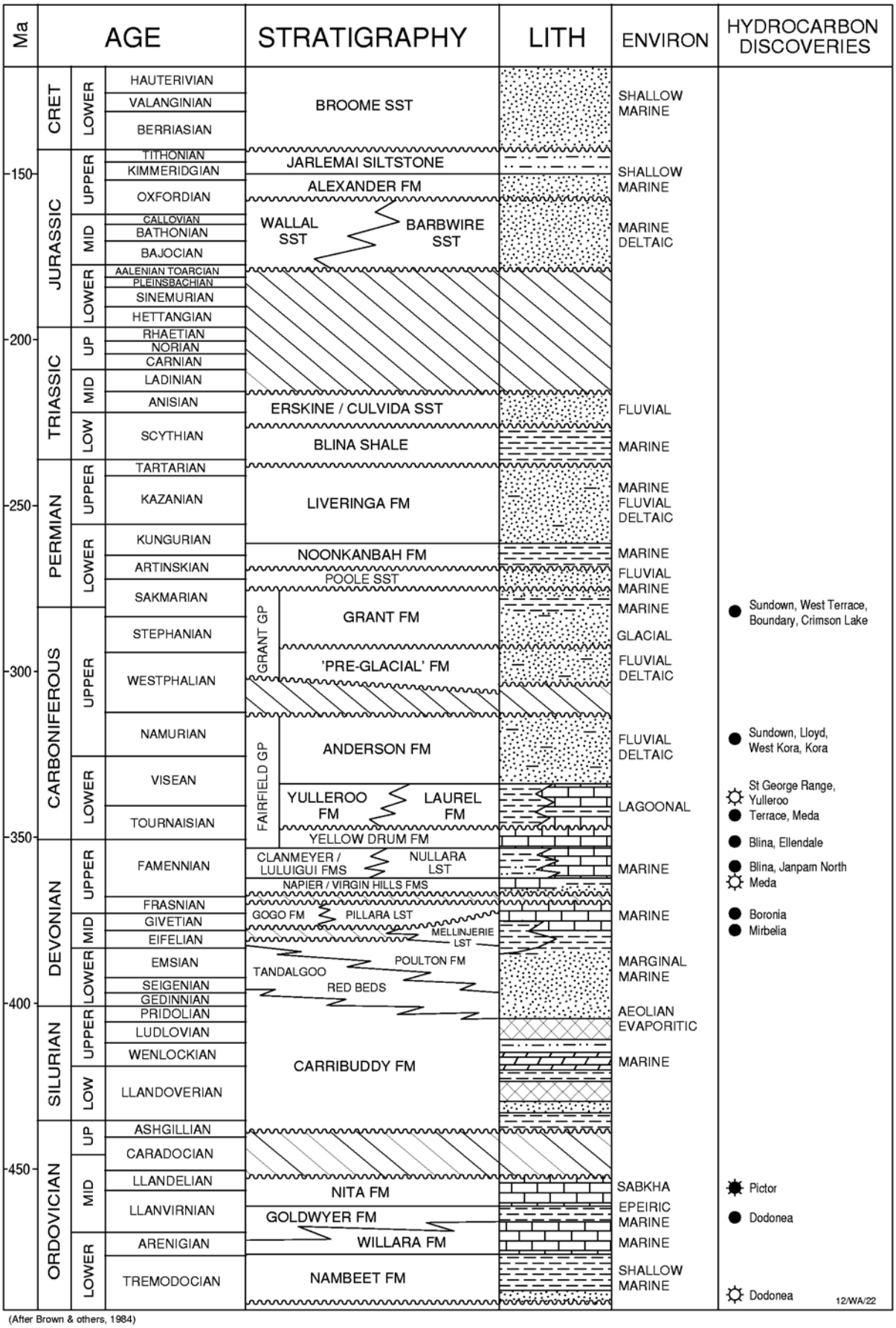
Rifting between the Late Triassic and Early Jurassic resulted in a regional erosional unconformity in the Canning Basin. Right lateral movements along the bounding faults of the Fitzroy Trough formed en-echelon anticlinal structures in the graben and may have initiated salt structures in the Kidson Sub-basin (Brown & others, 1984). Rifting in the offshore Canning occurred in Middle to Late Jurassic times. Deposition recommenced in the Canning Basin in the Middle Jurassic.

The rifting and break-up between Australia and a formerly adjoining continental mass resulted in a transgression from the northwest (Powell, 1976; Carey, 1976). Up to 700m of Early Jurassic to Early Cretaceous sediments are preserved onshore and up to 4000m offshore (Forman & Wales, 1981).

The aeolian, fluvial, deltaic and shallow marine clastics of the Wallal Sandstone are the oldest Jurassic sediments (Toarcian to Oxfordian) found in the Canning Basin. They are conformably overlain by the tidal sandstones and mudstones of the Alexander Formation. The Jarlemai Siltstone (Kimmeridgian to earliest Cretaceous in age) is conformable with the underlying Alexander Formation and represents the period of maximum transgression. The coarse fluvial clastics of the Barbwire Sandstone and the Meda Formation were probably deposited along the northern edge of the sea in which the Jarlemai Siltstone and Alexander Formation were deposited (Yeates & others, 1984).

The Early Cretaceous Broome Sandstone was deposited over the Jarlemai Siltstone. This shallow marine unit is widespread and forms part of a regressive sequence. After the retreat of the Early Cretaceous seas, most of the Canning Basin was probably a large plain. Gross features of this landscape have probably changed little since.

Figure 2. Generalised stratigraphy of the onshore Canning Basin, Western Australia



(After Brown & others, 1984)

2.3 Exploration History

Exploration in the Canning Basin began in 1922, when the Freney Oil Company, encouraged by indications of oil in a water bore in the Pillara Range, drilled 4 wells (Prices Creek-1 to 4) to test a massive limestone, thought to be Lower Carboniferous in age. In the pioneering phase of exploration between 1922 and 1950, surface mapping was the principal exploration tool. Ten wells were drilled during this period, a number of which recorded encouraging hydrocarbon shows. During this initial exploration phase, the stratigraphy was revised and Devonian limestones became the favoured exploration targets. Drilling established that oil had been generated in the Canning Basin and had migrated to at least two stratigraphic levels. At that time it was thought that structures on the flanks of the Fitzroy Graben had the most potential.

In 1952 and 1953 the Bureau of Mineral Resources (BMR) and West Australian Petroleum Pty Limited (WAPET) conducted gravity surveys in the northern and western parts of the Canning Basin. With the advent of geophysics as an exploration tool, exploration beyond the margins of the Fitzroy Trough began. Between 1954 and 1964 WAPET and the BMR embarked on a program of stratigraphic drilling. Wells were drilled on the Lennard Shelf, Broome Platform and Jurgurra Terrace. Important geological results obtained by WAPET during this period included the identification of reef anomalies from seismic data, the discovery of oil in Ordovician carbonates on the Broome Platform and the discovery of oil shows in Fairfield Group sediments draping reefs.

Between 1965 and 1976 a number of other companies became active in the Canning Basin. Gas flows were obtained from anticlines within the Fitzroy Graben (St George Range-1, Yulleroo-1), and Devonian reef plays on the Broome Platform and Lennard Shelf were tested. During this period, drilling results in the southern Canning Basin provided little encouragement.

A new phase of exploration began in 1977 when the Amax/Whitestone Joint Venture, Esso and others took up large areas of relinquished acreage. The improvement in seismic data quality which occurred in the mid 1970's had a major impact on prospect definition in the Canning Basin during this period. The most favoured objectives continue to be Devonian reef complexes, Permo-carboniferous clastics and the Ordovician section.

In 1981, commercial oil was finally discovered by Home Energy Company Limited with their Blina-1 well. The well was drilled on a prominent seismic anomaly above the edge of the Lennard Shelf and initially recovered oil from Fairfield Group sediments overlying a Devonian reef.

To December 1992, 247 wells have been drilled in the Canning Basin. Of these, 169 were new-field wildcats, 63 were stratigraphic tests and 15 were

development/appraisal wells. Nineteen hydrocarbon discoveries have been made (Plates 1 and 2), six of which are commercial. Hydrocarbon shows were encountered in an additional 57 of the new-field wildcat and stratigraphic wells. Only 14 new-field wildcats have been drilled in the offshore Canning Basin. Two of these recorded minor hydrocarbon shows.

3. HYDROCARBON HABITAT

3.1 Hydrocarbon Reservoirs

3.1.1 *Ordovician*

On the Broome Platform and the northern margin of the Fitzroy Trough, porosities of up 19% have been recorded in the marine sandstones and granite washes of Tremadocian to Arenigian age (Nambeet Formation) that onlap Precambrian basement. These sediments represent the earliest phase of an Ordovician transgression. Hydrocarbon seals are likely to be provided by tight carbonates, shales and siltstones of the Upper Nambeet Formation. Oil and gas shows in these basal transgressive sands were noted in the Acacia-2 and Hedonia-1 wells.

On the northern margin of the Broome Platform, leached porosity may enhance the reservoir potential of the Arenigian, Willara Formation carbonates. Seal is provided by Arenigian to Llanvirnian marine basin shales of the Goldwyer Formation. Oil and gas shows were recorded in these carbonates in the Goldwyer-1 and Thangoo-2 wells. Intraformational quartzose sandstones, sealed by marine shales within the Willara Formation also have reservoir potential. An oil show was noted in Pictor-1 over such an interval. Porosities generally average around 10% in these sandstones. Fracture and/or dolomite porosity are potentially present in Willara Formation carbonates along the Admiral Bay Fault Complex trend (Goldstein, 1989). Fractured carbonates within the Goldwyer Formation may also form potential reservoirs (an oil flow was reported from mid-Goldwyer carbonates in Dodonea-1).

Leached and dolomitised Llanvirnian to Llandeilian Nita Formation carbonates form potential reservoirs on the southern margin of the Fitzroy Trough. Porosities of 7 to 12% and permeabilities of up to 20md have been recorded in this formation. These reservoirs are sealed by tight zones within the Nita and shale and evaporitic facies of the overlying Carribuddy Formation. Across faults, fine grained clastics of the Goldwyer Formation may provide lateral seals. Pictor-1, flowed oil and gas in two DSTs from fractured dolostones in the Nita Formation. Several other wells have recorded oil and gas shows in this formation (Edgar Range-1, Canopus-1, Matches Springs-1, Acacia-2). Porosities of between three and 19% and permeabilities of up to 38md have been measured in the Nita Formation.

3.1.2 *Silurian to Devonian*

In the Kidson Sub-basin and on the Broome Platform, the thick evaporitic sequence (Carribuddy Formation) shows good reservoir/seal potential. Salt-cored swells, domes, diapirs, salt dissolution and salt evacuation structures related to

the Carribuddy Group are present in these areas. Oil shows in the Carribuddy are most prevalent in dolostones immediately above the Nita Formation (Goldstein, 1989). Carribuddy evaporites are absent from the Lennard Shelf and are at too great a depth in the Fitzroy Graben to constitute valid exploration targets.

The thick aeolian sandstones of the Devonian Tandalgoo Formation and the carbonates and clastics of the overlying Mellinjerie Formation provide excellent reservoir potential in the southern Canning Basin. Mirbelia-1, located on the mid-basin platform, flowed oil from the Mellinjerie Limestone. Porosities of up to 12% have been measured within dolostones in this formation. Generally, the ultimate potential of these units is constrained by lack of adequate seal and good quality source rocks (Reynolds & Flavelle, 1984).

Where leaching and dolomitisation have occurred, Late Givetian to Frasnian reef complexes (Pillara Formation) flanking the Fitzroy Trough have good reservoir potential. Marine fan sandstones and conglomerates associated with the fringing reefal carbonates (Gogo Formation) may also form hydrocarbon reservoirs (Mimosa-1 and Boronia-1 flared gas and recovered oil from Gogo Formation turbidites). Intraformational shales and transgression of basinal or lagoonal clastics (Gogo Formation) which drowned the reef complexes at the end of the Frasnian may provide a top seal to these reservoirs.

Carbonate complexes of the Late Famennian reef building cycle (Nullara Limestone) also form potential hydrocarbon reservoirs. Typically, porosity is best developed in leached or fractured carbonates. Blina-1 produces oil from this formation (Moors & others, 1984). Tight carbonate zones and Clanmeyer Formation shales provide seals for these reservoirs. Potential reservoirs exist in the overlying latest Famennian Fairfield Group sediments (the Blina field produces oil from leached oolitic dolostones of the Yellow Drum Formation (Moors, 1986)).

3.1.3 *Carboniferous*

In the Fitzroy Graben, fine grained sandstones and carbonates of the Tournaisian Laurel Formation (Fairfield Group) show porosities of up to 15%. Seals for these reservoirs are provided by intraformational marine shales. Oil flowed from Laurel Formation carbonates in Meda-1, while Yulleroo-1 and St George Range-1 measured gas flows from the same formation.

A regressive, Early Carboniferous, marine and continental clastic and carbonate sequence (Anderson Formation) overlies the Laurel Formation. Reservoirs are likely to occur in carbonate banks and shoals around the graben margins, or landwards, in fluvial tidal channel and bar sands. Towards the trough, thick deltaic sequences may provide excellent reservoirs (Brown & others, 1984). Intraformational shales provide the most likely seals in this formation. Oil flows

from quartzose, Anderson Formation sandstones were recorded in Lloyd-1 and Kora-1.

3.1.4 *Late Carboniferous to Permian*

Porosities of up to 20% are common in Grant Formation sandstones. Occasionally, porosities of up to 30% have been measured. Seals, which are of dubious quality in many places, are provided by thin, intraformational shales. The thin, tight carbonates, shales and siltstones of the Nura Nura Member may seal Upper Grant Formation sandstones. Oil discoveries in quartzose sandstones of the Grant Formation include Terrace-1, West Terrace-1, Crimson Lake-1 and Sundown-1.

Excellent porosities (more than 30%) characterise the Artiniskian Poole Sandstone. The overlying shales, siltstones and carbonates of the Noonkanbah Formation seal the Poole Sandstone. To date, hydrocarbon shows within the Poole have been rare. This may be indicative of either the poor sealing quality of the Noonkanbah or the stratigraphic remoteness of the reservoirs from mature source rocks (Goldstein, 1989).

3.2 Hydrocarbon Source Rocks and Maturation

In the Canning Basin, source rock data are inadequate for a meaningful detailed analysis of source rock potential to be made. Well control is poor and vertical sampling density low. Very little source rock quality data are available. Maturation measurements are sparse. Vitrinite reflectance measurements on Ordovician samples are of limited value as woody plants had not evolved at that time. In addition, lack of dense control to calibrate geohistory models is a problem in maturation modelling. For the above reasons, it is difficult to condemn the source potential of any stratigraphic unit or area of the basin.

3.2.1 *Ordovician*

The intertidal and subtidal shales and siltstones of the Upper Nambeet Formation may have some source potential, but the existing control is not sufficient to draw any reasonable conclusion. One TOC value of 1.41% has been reported from this formation (Horstman, 1984). The Nambeet formation is probably overmature over much of the Canning Basin.

The Upper Willara Formation appears to have sufficiently high TOC values on the Broome Platform to have source potential (McLarty-1, Edgar Range-1, Canopus-1). Organic matter is likely to be oil prone algal and bacterial material (Type I/Type II kerogen). Source potential for this unit on a regional scale is unknown, although Upper Willara Formation source rocks are likely to be overmature over much of the basin.

In places, the fine grained clastics and carbonates of the Goldwyer Formation have excellent source potential. Foster & others (1986), subdivided the Goldwyer into four members named Units 1 to 4, in ascending stratigraphic order. The upper member (Unit 4) contains the richest source rocks. TOC values range between 0.46 and 6.40% (mean 1.85%) in this unit. Approximately 90% of the organic matter in Unit 4 originates from the cyanobacterium *Gloeocapsamorpha prisca* (Foster & others, 1986). Rock-Eval pyrolysis (Tissot and Welte, 1978) of samples from this unit indicate that source rocks in the Upper Goldwyer Formation have the capacity to generate 12kg of hydrocarbon per tonne.

Maturation modelling by Brown & others (1984) shows the Goldwyer is overmature for oil generation in the Fitzroy Trough but within the oil window over much of the southern Canning basin and the mid-basin platform. In these areas, carbonate reservoirs in the Willara and Nita Formations are well placed to receive a hydrocarbon charge from Goldwyer Formation source rocks.

3.2.2 *Silurian to Devonian*

It is unlikely that the evaporites of the Carribuddy Formation have much source potential, although isolated samples in Kempfield-1, Sahara-1 and Wilson Cliffs-1 recorded moderately good TOC values (Horstman, 1984). The distribution of the samples with higher TOC values indicates that source potential could be restricted to the Kidson Sub-basin.

The continental Tandalgoo sandstones contain little organic matter. It is difficult to draw conclusions as to the source potential of the Poulton Formation (Upper Tandalgoo equivalent) due to inadequate sampling. TOC measurements of over 2.0% were made on one sample from White Hills-1 and one from Mimosa-1.

Generally, Devonian carbonates show poor source potential. This is to be expected (oxygenated waters associated with reef building are not conducive to the preservation of organic matter). However, shaley intervals within the carbonate section in Matches Springs-1 and Tappers Inlet-1 yielded moderately good TOC values (Horstman, 1984). The basinal lateral equivalents to the Devonian reefs (Gogo, Clanmeyer and Luluigui Formations) are thought to contain intervals with good oil source potential. The Blina oil accumulation is thought to have been sourced from Frasnian Gogo Formation shales (Playford, 1982). The importance of these basinal source facies is constrained by a lack of data. Maturation modelling by Brown & others (1984) indicates the Upper Devonian section is overmature for oil generation in the centre of the Fitzroy Graben and oil generative on the margins of the trough.

3.2.3 *Carboniferous*

TOC levels recorded in the shallow marine clastics and carbonates of the Early Carboniferous Fairfield Group suggest good quality hydrocarbon source rocks may be present in this unit. Geochemical data indicate that the most important potential source rocks are in the shallow marine to lagoonal facies of the lower Laurel Formation (Langoora-1, Blackstone-1 and Lake Betty-1). This unit is believed to be the source for the oil recovered in West Kora-1, Sundown-1 and West Terrace-1 (Lehmann, 1986). The Laurel Formation is probably oil generative on the margins of the Fitzroy Graben and overmature within the graben (Brown & others, 1984).

To date, TOC data from the marine and continental clastics and carbonates of the Anderson Formation indicate this unit has limited source potential. However, sparse control does not preclude the possibility that a local organic rich source facies may be present.

3.2.4 *Late Carboniferous to Permian*

Generally, sediments of the Late Carboniferous to Early Permian Grant Formation are sandy and contain very little organic matter. TOC values usually average less than 0.5% in this unit. In Lake Betty-1, high TOC values were recorded in the Upper Grant. Discontinuous shales within the Upper Grant Formation (which relate to a time of maximum transgression in the mid-Sakmarian), may be capable of sourcing significant quantities of hydrocarbons. The Early Permian is currently only moderately mature (0.6 to 0.7% VR) throughout the southern Canning Basin and the margins of the Fitzroy Trough (Brown & others, 1984). Grant Formation source rocks are probably only oil generative in the Fitzroy Graben.

Data from Meda No. 1 indicates that the black fossiliferous and lignitic shales of the Noonkanbah Formation may have source potential. However, the Noonkanbah is probably mature only in the offshore Canning Basin (Lehmann, 1986).

3.3 Play types

Early exploration targets in the Canning Basin were surface anticlines in the Fitzroy Graben. Lack of seismic control and an inability to reach target depths hampered the success of these early tests. Three wells drilled in the graben since 1970 to test Devonian carbonate objectives have all been unsuccessful. Recent structures within the Fitzroy Trough (related to Triassic wrench movements), are likely to have trapped only gas. Older Devonian or Carboniferous traps, formed on the margin of the graben shortly after deposition, are more likely to have received an oil charge (Brown & others, 1984).

In the 1950's, with the advent of seismic data, the importance of Devonian reefs became apparent. Famennian carbonates (Nullara Limestone), in combination

with stratigraphic/structural traps in the overlying sediments are likely to remain prime exploration targets on the shelves and terraces flanking the Fitzroy Trough. The discovery of oil at Blina in 1981 stimulated interest in this play. Basinwards, Famennian-Tournasian highstand ramps and lowstand fans remain virtually untested.

Ordovician carbonates and sandstones are potential objectives in the central Canning Basin. On the Broome Platform and Jurgurra Terrace, many wells have encountered encouraging hydrocarbon shows in these sediments. To date, the Ordovician section has yet to yield a commercial discovery. On the southern margin of the Fitzroy Trough, Devonian reef plays in the overlying section may enhance the attractiveness of Ordovician objectives.

Following the discovery of oil in Late Carboniferous to Permian sandstones of the Grant Formation (Sundown-1), the Permian sequence has become an attractive exploration target in areas marginal to the Lennard Shelf. Here, structural and stratigraphic traps (related to Late Triassic wrenching), drape over highs and carbonate buildups are likely to be present.

Towards the axis of the Fitzroy Trough, a thick Carboniferous deltaic sequence (Anderson Formation) may provide good quality reservoirs. Anderson Formation deltaic complexes remain largely untested.

Pillara Formation carbonates may form valid exploration objectives on the southern margin of the Fitzroy Trough. Draped pinnacle reefs and reef fronts of Frasnian age have, as yet, failed to yield commercial quantities of hydrocarbons. The Pillara Formation was largely eroded from the northern margin of the graben during a regression in the Early Famennian. The remnants of these carbonates (breccias of the Napier-Virgin Hills Formation) are not regarded as viable exploration targets. In many instances, identification of Frasnian, reef-like anomalies on seismic data is made difficult by overlying Fammennian carbonates (Jackson & others, 1992). Basinwards, Frasnian lowstand fans may form potential stratigraphic traps.

In the Kidson Sub-basin and on the Broome Platform, salt diapirs, domes and salt evacuation 'turtle back' structures in the Carribuddy Formation evaporites may form hydrocarbon traps. The prospectivity of this play is constrained by a scarcity of good quality source rocks.

Offshore, Late Carboniferous faulting formed a series of horsts and faulted blocks in the offshore Fitzroy Trough (Passmore, 1991). These structural traps form valid exploration objectives in this area. Incipient rifting in Permian to Triassic times produced block faulting in the Bedout and Rowley Sub-basins. Here, reactivation of these faults and differential compaction over buried fault blocks in the Late Triassic to Early Jurassic have created potential hydrocarbon traps. However, well control in the offshore Canning Basin is sparse (13

exploration wells drilled to January 1993) and the validity of these plays is speculative.

Canning Basin plays validated by hydrocarbon discoveries are listed in Table 1.

A number of higher risk Canning Basin plays yet to be validated by hydrocarbon discoveries are listed in Table 2.

Table 1. Play types validated by hydrocarbon discoveries, Canning Basin, W.A.

Reservoir	Seal	Trap / Objective	Source	Discovery
L A T E C A R B O N I F E R O U S to P E R M I A N				
Grant Fm *sandstone*	Grant Fm *shales/siltst*	Compressional culmination with internal stratigraphic traps	Laurel Fm *shales*	Sundown No. 1 **Oil**
Grant Fm *sandstone*	Grant Fm *shales/siltst*	Unfaulted four-way dip closure within palaeo-monadnock	Laurel Fm *shales*	West Terrace No.1, **Oil**
Grant Fm *sandstone*	Grant Fm *shales/siltst*	?	Laurel Fm *shales*	Boundary No. 1 **Oil**
Grant Fm *sandstone*	Grant Fm *shales/siltst*	Faulted, four-way dip closure on Laurel Fm carbonate horizon	Laurel Fm *shales*	Crimson Lake No.1, **Oil**
C A R B O N I F E R O U S				
Anderson Fm *sandstone*	Anderson Fm *shales*	Faulted four-way dip closure	Laurel Fm *shales*	Lloyd No. 1 **Oil**
Anderson Fm *sandstone*	Anderson Fm *shales*	?	?	Point Torment No.1, **Gas**
Anderson Fm *sandstone*	Anderson Fm *shales*	Unfaulted four-way dip closure	Laurel Fm *shales*	Kora No. 1 **Oil**
Laurel Fm *carbonates*	Laurel Fm *shales*	Four-way dip closure	Laurel Fm *shales*	Terrace No.1 **Oil**
Anderson Fm *sandstone*	Anderson Fm *shales*	Four-way dip closure	Laurel Fm *shales*	West Kora No. 1 **Oil**
Anderson Fm *sandstone*	Anderson Fm *shales*	Compressional culmination with internal stratigraphic traps	Laurel Fm *shales*	Sundown No. 1 **Oil**
Laurel Fm *sandstone*	Laurel Fm *shales*	Reef-like seismic anomaly	Laurel Fm *shales*	Meda No. 1 **Oil**
Laurel Fm *clastics*	Fairfield Group *shales*	Faulted, four-way dip closure on Intra-Fairfield Group	Gogo Fm *shales*	Ellendale No. 1 **Oil** and **Gas**
Laurel Fm *limestone*	Laurel Fm *shales*	Anticline	Laurel Fm *shales*	St George Range No. 1 **Gas**
Laurel Fm *sandstone*	Laurel Fm *shales*	Anticline	Laurel Fm *shales*	Yulleroo No. 1 **Gas**
D E V O N I A N				
Yellow Drum Fm, *leached dolostones*	Fairfield Group *shales*	Compaction drape closure over Devonian reef	Gogo Fm *shales*	Blina No. 1 **Oil**
Nullara Fm *carbonates*	Nullara Fm *shales*	Reef-like seismic anomaly	Gogo Fm *shales*	Janpam North No.1, **Oil**
Nullara Fm *calcarenite*	Nullara Fm *shales*	Reef-like seismic anomaly	Gogo Fm *shales*	Meda No. 1 **Gas**
Nullara Fm *leached dolostones*	May River Member *shales*	Unfaulted shale draped biohermal and biostromal mound	Gogo Fm *shales*	Blina No. 1 **Oil**
Gogo Fm *clastics*	Gogo Fm *shales*	?	Gogo Fm *shales*	Boronia No. 1 **Oil**
Mellinjerie Lst *dolostones*	Lower Pillara Fm *shales*	Fault dependent closure at top Nita Fm level.	?	Mirbelia No. 1 **Oil**
O R D O V I C I A N				
Nita Fm *dolostones*	Nita Fm *shales*	Tilted fault block with internal four- way dip closure	Goldwyer Fm *shales*	Pictor No. 1 **Oil**
Goldwyer Fm *carbonates*	Goldwyer Fm *shales*	Fault dependent closure at top Nita Fm level.	Goldwyer Fm *shales*	Dodonea No. 1 **Oil**
Nambeet Fm *dolomitic ss*	Upper Nambeet Fm ?	Fault dependent closure at top Nita Fm level.	Upper Nambeet Fm ?	Dodonea No. 1 **Gas**

Table 2. Play types yet to be validated by hydrocarbon discoveries, Canning Basin, Western Australia

Trap	Formation/Trap Age	Test
Salt Diapirs	Carribuddy Formation evaporites in the Kidson Sub-basin and on the Broome Arch. Trap formation from Mid-Devonian to Recent.	Frome Rocks No. 1 and 2
Salt domes / Salt evacuation related `turtle back' domes	Carribuddy Formation evaporites in the Kidson Sub-basin and on the Broome Arch. Trap formation from Mid-Devonian to Recent.	Babrongan No. 1, Doran No. 1, Mowla No. 1, Munda No. 1, Munro No. 1
Fammenian - Tournasian lowstand fans	Clanmeyer/Luluigui Formations and Lower Fairfield Group clastics in the trough and on the margins of the Fitzroy Graben.	Untested
Devonian, marine fan sandstones	Gogo Formation clastics in the trough and on the margins of the Fitzroy Graben. Givetian to Frasnian in age.	Mimosa No. 1, Boronia No. 1, Kennedia No. 1.
Draped Frasnian pinnacle reefs and reef fronts.	Pillara Formation carbonates on the southern margin of the Fitzroy Graben. Frasnian in age.	Justago No. 1, Needle Eye Rocks No. 1.
Stratigrahic pinchouts in Carboniferous deltaic sequences	Anderson Formation sandstones on the margins and within the Fitzroy Graben. Visean to Namurian in age.	Untested
Channel-form stratigraphic pinchouts	Grant Formation sandstones within the Fitzroy Graben. Permo-Carboniferous in age.	South Auld No. 1

4. HYDROCARBON ACCUMULATIONS AND SHOWS

4.1 Commercial Accumulations

4.1.1 *Blina*

4.1.1.1 *Discovery and Development*

Blina-1 tested a structural culmination on a Famennian carbonate bank or reef trend located on the margin of the Lennard Shelf. The well spudded on April 18, 1981 and drilled through a sequence of Triassic and Permo-Carboniferous clastics before encountering the top of the Yellow Drum Formation at 1174m (Figure 3). DST-2 tested porous dolostones over the interval 1160-1254m and produced 37º API oil at a rate of 36 b/d.

After drilling ahead, the top of the Famennian Nullara Limestone was encountered at 1438m. DST-3, conducted in fractured carbonates over the interval 1402-1478m, produced 35.7º API oil at a rate of 905 b/d. No effective reservoir was found in the underlying Windjana Limestone (Famennian, platform margin carbonates) and the well was terminated in Frasnian clastics at 2498.1m.

In October and December of 1981, the Blina-2 and Blina-3 appraisal /development wells were drilled into the Nullara reservoir. This was followed in April 1982 by the Blina-4 well. This was drilled to drain the Yellow Drum Formation at the high point of this unit. Gathering facilities were built at Blina, a 28km pipeline was laid to a truck terminal on the Great Northern Highway and a holding tank and shiploading facilties were built at Broome. In September 1983, the Blina field was placed in production at an initial production rate of 1000 b/d. To date, eight appraisal/development wells have been drilled on the Blina structure, six of which are producing (Blina-7 and Blina-8 failed to encounter hydrocarbons).

Cumulative production from the Blina accumulation to 30 June 1991 is 1.386 million barrels of oil. Remaining recoverable reserves at that time were estimated at 0.673 million barrels of oil at the 90% probability level and 1.390 million barrels of oil at the 50% probability level (WADME, 1991).

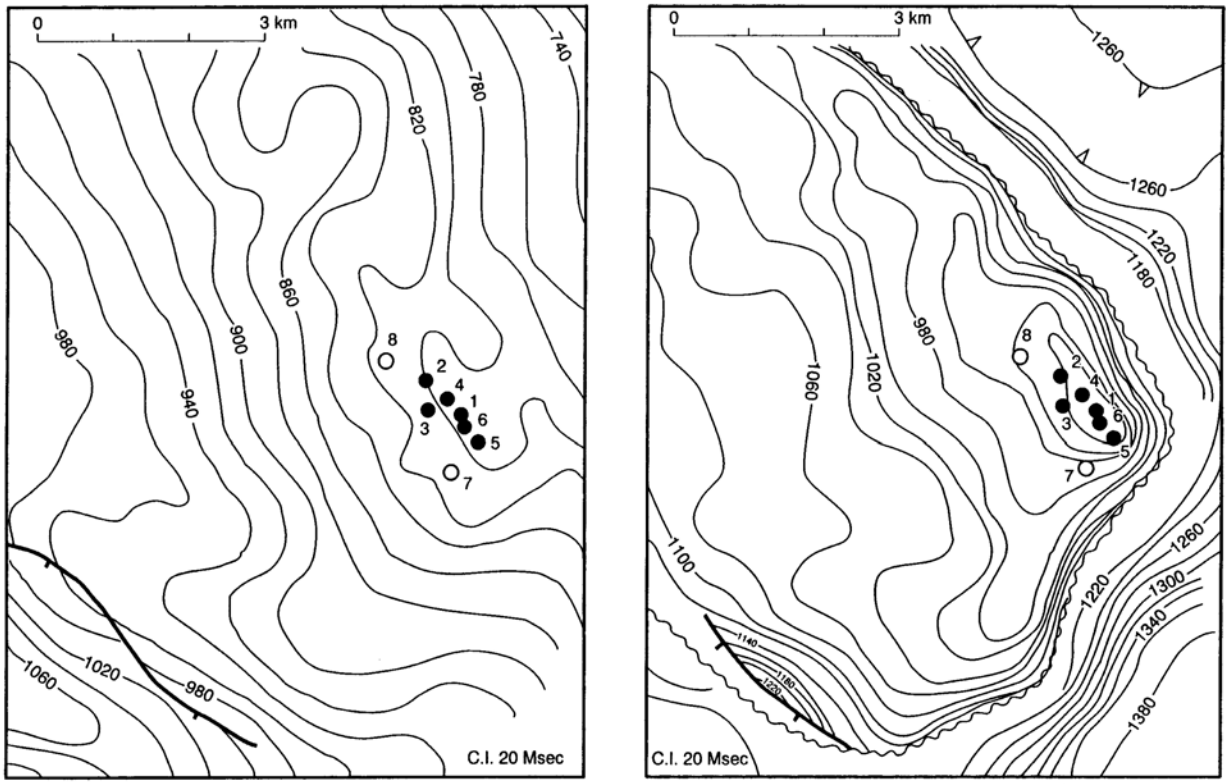
4.1.1.2 *Reservoirs*

The Yellow Drum Formation is sequence of very shallow water lime mudstones, evaporites and sharpstone breccias (Moors & others, 1984). The limestones have been extensively dolomitised. Two types of porosity have been identified within the Yellow Drum. A pervasive intergranular porosity is associated with the dolomitisation of sediments and a discontinuous vuggy porosity which is due to leaching of large skeletal fragments (Moors & others, 1984). Neutron-density porosities in excess of 30% have been derived in this formation.

The Nullara Limestone is a shallow water platform carbonate consisting of lime grainstones and packstones. Primary porosity has been occluded by cementation and compaction. Present day porosity is seen as either fracture porosity or leached, vuggy porosity.

4.1.1.3 *Oil*

Geochemical studies on the Blina oils have indicated that the hydrocarbons in the two reservoirs are essentially identical and were probably generated from the Frasnian shales of the Gogo Formation (Moors & others, 1984). The oils are light (36^{o} API), parafinic crudes, low in sulphur and with very little associated gas. A geochemical study of four Canning Basin oils by Alexander & others (1984), showed the Blina hydrocarbons were probably derived from marine plants deposited in an extremely reducing (anoxic) depositional environment. They appear to have been subjected to levels of thermal maturation in the source rocks approaching that for peak oil generation.



Top Yellow Drum Formation (TWT)

Top Nullara Limestone (TWT)

Figure 3 Structure maps (TWT) on the two reservoir horizons, Blina accumulation. (After Moors and others, 1984)

4.1.2 *Sundown*

4.1.2.1 *Discovery and Development*

Sundown-1 was spudded 26km northwest of the Blina accumulaution on the Lennard Shelf in October 1982. The well tested a compressional culmination of Mid-Triassic age, though seismic data indicate that some structuring may have occurred in the Permo-Carboniferous (Goldstein, 1989). With the discovery of oil in the Permo-Carboniferous Grant and Anderson Formations, between 1983 and 1985, a further three appraisal/development wells were drilled on the structure. In the Sundown accumulation, oil has been recovered from six separate levels in the Grant through Anderson sequence. DST-1 (1087-1089m), conducted in the Sundown No. 2 well, flowed 38-40º API oil from Grant Formation sandstones at the rate of 230 b/d. (Additional test data from the Sundown wells is shown on the Sundown accumulation summary sheet).

Production from the Sundown accumulation commenced in July 1984. Oil is trucked by road to Blina, where it enters the pipeline to the Eskine terminal on the Great Northern Highway. From there, it is transported to the holding tank and shiploading facilities at Broome. Cumulative production from the Sundown accumulation to 30 June 1991 is 0.202 million barrels of oil. Remaining recoverable reserves at that time were estimated at 0.101 million barrels of oil (WADME, 1991).

4.1.2.2 *Reservoirs*

Both Anderson and Grant Formation reservoirs comprise quartzose sandstones, sealed by intraformational shales and siltstones. Porosities of up to 20% are common .

4.1.2.3 *Oil*

The oil produced at Sundown is a light (38-40º API), low sulphur crude. The shallow marine, lagoonal shales of the Lower Laurel Formation, in the Fitzroy Trough, are believed to be the probable source of this oil (Lehmann, 1986).

4.1.3 *West Terrace*

4.1.3.1 *Discovery and Development*

West Terrace-1 was drilled on the Lennard Shelf in May 1985, seven kilometres north of the Sundown accumulation. It tested an unfaulted, four-way dip closure within what was interpreted to be an intra-Grant Formation palaeo-monadnock. Mapping indicated areal closure of 0.9 sq km was present at this level. DST-1, conducted in Grant Formation sandstones over the interval 1147-1159m, flowed 32.8º API oil at the rate of 700 b/d. Production from the West Terrace

accumulation commenced in June 1985 at an initial production rate of 686 b/d. Oil is trucked to the gathering facilities at Blina and from there, to the holding tank and shiploading facilities at Broome. In July 1987 the West Terrace-2 development well was spudded. West Terrace-2 was suspended for future testing in September 1987. Cumulative production from the West Terrace accumulation is 0.148 million barrels of oil and remaining recoverable reserves have been estimated at 0.006 million barrels of oil (as at 30 June 1991, WADME, 1991).

4.1.3.2 *Reservoirs*

In West Terrace, Grant Formation sandstones are massive, quartzose and contain abundant igneous and metamorphic fragments. Porosities of up to 20% are common. Seal is provided by intraformational shales, which are frequently silty and sandy.

4.1.3.3 *Oil*

The West Terrace oil is a light (32.8º API), low sulphur crude, very similar to the oil produced from the Sundown accumulation. Lower Laurel Formation shales within the Fitzroy Graben are the most likely source of this oil.

4.1.4 *Lloyd*

Lloyd-1 was spudded in June 1987, four kilometres north of the the West Terrace accumulation. Programmed as a test of a four-way dip closure at Carboniferous level (Anderson Formation), Lloyd-1 flowed 40.4º API oil at the rate of 392 b/d from sandstones in the Anderson Formation (1512-1523m). Oil production from Lloyd commenced in July 1987. Oil is trucked to Blina and from there, to the Broome shiploading facilities (via the Erskine Terminal and Great Northern Highway). As at 30 June 1991, cumulative production from the Lloyd accumulation stood at 0.137 million barrels of oil. The remaining recoverable reserves at this time were estimated at 0.006 million barrels of oil (WADME, 1991).

Lloyd-2, spudded in November 1987, failed to recover commercial quantities of hydrocarbons from either the Grant or Anderson Formations.

The Anderson Formation reservoir consists of massive, quartzose sandstones sealed by intraformational shales. The Lloyd oil is similar to the crudes recovered at West Terrace and Sundown. Lower Laurel Formation shales within the Fitzroy Trough are the most likely source of this hydrocarbon.

4.1.5 *West Kora*

West Kora-1 (spudded in July 1984), tested a four-way dip closure at Permian level. 20 km northeast of Derby, on the Lennard Shelf. 49º API oil was recovered in three DST's from two intervals within the Anderson Formation (1738-1756m and 1987-1990m). Production from the West Kora accumulation commenced in October 1989. The wellstream is gathered, separated and stored at the wellsite until it is conveyed by road transport to the Broome shiploading facilities. Cumulative production from West Kora, as at 30 June 1991, stands at 0.024 million barrels of oil (WADME, 1991). No estimates of remaining recoverable reserves are available at this time.

The reservoirs at West Kora are massive, quartzose sandstones with minor interbedded shales and siltstones. Seal is provided by intraformational shales. The most probable source of the West Kora oil is Lower Laurel Formation shale within the Fitzroy Trough.

4.1.6 *Boundary*

Boundary-1 was spudded in August 1990, two km south of the Lloyd accumulation to test a fault dependent closure at Anderson Formation level. An oil flow of 300 b/d was recorded in Grant Formation sandstones around 1277m (DST-1). Oil has been produced from Boundary and trucked to the Blina gathering facilities. Cumulative production from the Boundary accumulation, as at 30 June 1991, is 0.011 million barrels of oil (WADME, 1991). At the time of writing, commercial production from Boundary had ceased.

Table 3. Recoverable reserves and cumulative production data, commercial accumulations, Canning Basin, Western Australia. Figures as at 30 June 1991, (WADME, 1991).

ACCUMULATION	INITIAL RECOVERABLE RESERVES (MMSTB)		CUMULATIVE PRODUCTION (MMSTB)	REMAINING RECOVERABLE RESERVES (MMSTB)	
	90% Prob	50% Prob		90% Prob	50% Prob
Blina	2.059	2.776	1.386	0.673	1.390
Boundary	0.017	0.017	0.011	0.006	0.006
Lloyd	0.143	0.143	0.137	0.006	0.006
Sundown	0.303	0.303	0.202	0.101	0.101
West Terrace	0.154	0.154	0.148	0.006	0.006
West Kora	0.024	0.024	0.024	-	-

AGE	FORMATION	LENNARD SHELF					
		Blina	**Sundown**	**West Terrace**	**Lloyd**	**West Kora**	**Boundary**
MESOZOIC							
M.-L. Permian	LIVERINGA						
M. Permian	NOONKANBAH						
E.-M. Permian	POOLE						
L. Carb - Permian	GRANT		**OIL**	**OIL**			**OIL**
M. Carboniferous	ANDERSON		**OIL**		**OIL**	**OIL**	
E. Carboniferous	LAUREL /YELLOW DRUM	**OIL**					
L. Devonian	NULLARA	**OIL**					
L. Devonian	NAPIER / BABRONGAN						
M.-L. Devonian	PILLARA / GOGO						
M.-L Devonian	MELLINJERIE						
M. Devonian	POULTON						
E.-M. Devonian	TANDALGOO						
Silurian - E. Devonian	CARRIBUDDY						
M. Ordovician	NITA						
M. Ordovician	GOLDWYER						
E.-M. Ordovician	WILLARA						
E. Ordovician	NAMBEET						

Table 4. Commercial hydrocarbon accumulations, Canning Basin, Western Australia

4.2 Other Accumulations

4.2.1 *Pictor*

Pictor-1 was spudded on the northern margin of the Broome Platform in August 1984. The well drilled a faulted, tilted horst trap with a small internal, dip-closed culmination at Ordovician level. Three DST's conducted between 905 and 965m in Nita Formation carbonates flowed both gas and 45-47º API oil (detailed test data from the Pictor-1 well are tabulated on the Pictor accumulation summary sheet).

In Pictor-1, Nita Formation reservoirs are fractured dolostones with porosities of between 9 and 13%. Permeabilities average around 5 mD. Seal is probably provided by tight carbonates and intraformational shales. The oil recovered at Pictor was sourced from Ordovician shales containing predominantly Type II organic matter (Goldstein, 1989).

4.2.2 *Janpam North*

In September 1987, Janpam North-1 was spudded on the Lennard Shelf, 10km northwest of the Blina accumulation. Programmed to test a reef-like seismic anomaly, DST-1 (1644m), recovered 2.5 bbls of 23º API oil from carbonates of the Late Devonian Nullara Limestone.

4.2.3 *Mirbelia*

In May 1985, Mirbelia-1 tested a fault dependent closure at Ordovician level on the southern margin of the Fitzroy Trough (Barbwire Terrace). 1.5 litres of clean oil were recovered in DST-2, conducted in dolostones of the Middle to Late Devonian Mellinjerie Limestone. Porosities of between 2.7% and 14.1% and permeabilities of between 0.003 mDand 8.4 mD were measured in the reservoir. Seal is provided by shales of the Lower Pillara Formation. The most likely source of the oil is Gogo Formation shales within the Fitzroy Trough.

4.2.4 *Kora*

Kora-1 was spudded in July 1982, on the Lennard Shelf, 8km east of the township of Derby. The well tested an unfaulted, structural four-way dip closure within the Permo-Carboniferous section. 2-3 gallons of oil were recovered in DST-1 (1760m) from quartzose sandstones in the Early Carboniferous Anderson Formation. Porosities of up to 30% were measured in these sandstones. Thin, intraformational shales provide a top seal for the accumulation. Early Carboniferous Laurel Formation shales are the most likely source of the hydrocarbons recovered at Kora.

4.2.5 *St George Range*

In 1966, St George Range-1 was drilled on a surface anticline in the Fitzroy Trough. In DST-2 (3154m), gas flowed to the surface at the rate of 2.9 Mm^3/day, from Early Carboniferous (Laurel Formation) carbonates. Laurel Formation shales provide both seal and source for this accumulation.

4.2.6 *Yulleroo*

In 1967, Yulleroo-1 tested a surface anticline in the Fitzroy Trough. Gas flowed at an estimated rate of 14 m^3/hour from sandstones around 3341.9m within the Laurel Formation. Porosities of up to 11% and permeabilities of 0.5 mD were measured in the reservoir. Intraformational shales seal the accumulation. Lower Laurel Formation lagoonal shales within the Fitzroy Trough are the likely source of the Yulleroo hydrocarbons.

Table 5. Gas analyses, DST-5, DST-6 and Core samples, Yulleroo-1.

COMPONENT (Mole %)	SAMPLE FROM DST-5 (3217-3355 m) **Laurel Formation** Analysis by :		SAMPLE FROM DST-6 (3395-3408 m) **Laurel Formation** Analysis by :			SAMPLE FROM Cores (3396-3402 m) **Laurel Formation** Analysis by :	
	BP	BP	BP	BMR	BMR	BP	BP
Nitrogen					5.980		
Oxygen			1.400	2.000	0.280		
Hydrogen					0.070		
Helium					0.047		
Argon					0.028		
Carbon Monoxide							
Carbon Dioxide			2.000	0.200			
Hydrogen Sulphide							
Methane	79.000	75.700	82.100	81.000	77.800	80.700	80.700
Ethane	11.700	13.500	10.000	10.300	8.590	10.300	10.200
Propane	6.800	7.600	5.300	6.100	4.760	7.100	7.100
Isobutane	0.700	0.700	0.700	0.700	0.560	0.700	0.800
n-Butane	1.800	2.500	1.300	1.200	1.022	1.200	1.200
Isopentane			0.400	0.400	0.241		
n-pentane			0.200		0.193		
2-methylbutane					0.033		
2-methylpentane					0.072		
3-methylpentane				0.300	0.026		
Hexane +					0.036		

4.2.7 *Terrace*

Terrace-1 was spudded in May 1984, 6 km northeast of the Sundown accumulation. The well tested a four-way dip closure at Yellow Drum Formation level. 1.9 bbls of 38º API oil was recovered from the Early Carboniferous, Laurel Formation (DST-3, 1837m).

4.2.8 *Meda*

In 1958, Meda-1 was drilled towards the northern margin of the Fitzroy Trough on an apparent reefal anomaly. Oil was recovered in two DST's from a sequence of calcareous sandstones and dolomites within the Laurel Formation. Logs indicate that the water saturation in the interval tested exceeds 50%, thus making oil production non-commercial. Porosity averaged 6% over this interval.

Gas flows were recorded in two DST's conducted in recrystallised calcarenites of the underlying Nullara Limestone. Gas analyses of samples from DST-6C and DST-7C are shown in Table 5. Porosities of 2.2% and permeabilities of 0.1 mD were measured in this formation. Details of DST test data are shown on the Meda accumulation summary sheet.

Table 6. Gas analyses, DST-6C and DST-7C, Meda-1

COMPONENT (% by Volume)	SAMPLE FROM DST-6C, (2315m) **Nullara Limestone**	SAMPLE FROM DST-7C, (2009.8m) **Nullara Limestone**
Nitrogen	19.4	21.2
Oxygen	3.1	11.2
Hydrogen	n.d.	2.9
Carbon monoxide	n.d.	n.d.
Carbon Dioxide	1.5	6.5
Methane	75.2	56.7
Alkenes	n.d.	n.d.
Ethane	0.9	1.2
Propane	0.14	0.37
n-butane	0.02	0.09
isobutane	0.02	0.12
n-pentane	n.d.	Trace

4.2.9 *Ellendale*

In 1979, Ellendale-1 was drilled on the northern margin of the Fitzroy Trough. The well tested a four-way dip closure at Fairfield Group level. DST-2, taken over the interval 2155-2173m, flowed oil and gas from Laurel Formation clastics.

4.2.10 *Dodonea*

In 1985, Dodonea-1 was spudded on the southern margin of the Fitzroy Trough (30 km northwest of Mirbelia accumulation). Programmed as a test of a fault dependent closure at the top of the Nita Formation, ten litres of clean oil were recovered from fractured and vuggy carbonates within the Ordovician Goldwyer Formation (DST-1, 1525m). Porosities of between 0.6% and 2.9% and permeabilities of between 0.005mD and 58mD were measured in these carbonates. Marine shales within the Goldwyer Formation provide both source and seal for this accumulation.

A gas flow of 85 m^3/day was recorded in dolomitic sandstones of the Early Ordovician Nambeet Formation (DST-2, 2014m). Intraformational shales seal the Nambeet gas reservoir.

4.2.11 *Boronia*

In 1982, Boronia-1 tested an apparent Fammenian reef on the northern margin of the Fitzroy Trough. The well intersected an oil bearing Devonian turbidite sequence (Gogo Formation). Less than one barrel of oil was recovered in DST-1, taken at 2799.5m.

4.2.12 *Crimson Lake*

Crimson Lake-1 was drilled on a faulted, four-way dip closure at Laurel Formation level on the northern margin of the Fitzroy Graben (265 km east of Broome). 0.5 bbls of 37.9º API oil were recovered from Grant Formation sandstones at 1038m (DST-1).

4.2.13 *Point Torment*

Point Torment-1 was spudded in November 1992, 15km northwest of the West Kora accumulation. Three significant hydrocarbon shows were encountered (between 2029-2036m, 2054-2059m and 2094-2097m) in sandstones of the Anderson Formation. A drill stem test over the interval 2085.8-2096.5m achieved a stabilised gas flow rate of 5073m^3/hour. The horizon tested was not originally mapped and as a consequence, was not considered to be an exploration target in the well. Point Torment-1 has been suspended for further evaluation.

4.3 Hydrocarbon Shows

In addition to the 19 hydrocarbon accumulations described in 3.1 and 3.2, 57 new-field wildcat and stratigraphic wells have encountered significant hydrocarbon shows. Descriptions of these shows are summarised in Tables 7 and 8.

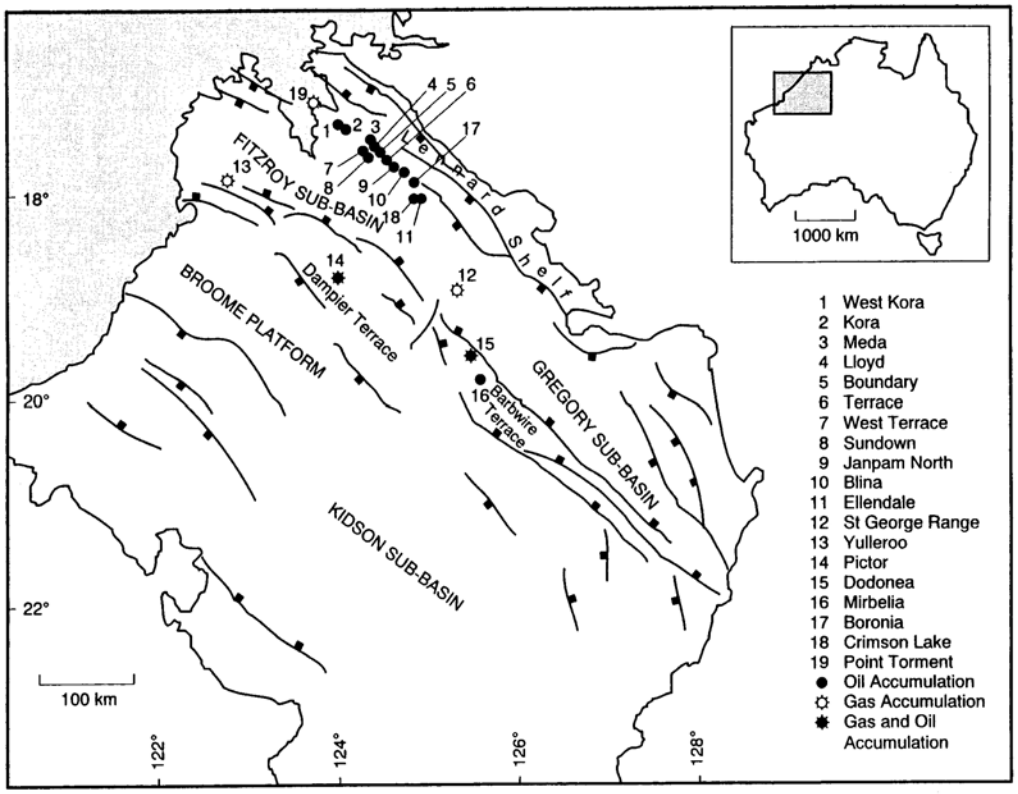


Figure 4. Hydrocarbon accumulations, Canning Basin, Western Australia

AGE	FM	LENNARD SHELF								FITZROY TROUGH		BARBWIRE TERRACE		DAMPIER TERRACE
		Janpam North	**Kora**	**Terrace**	**Meda**	**Ellendale**	**Boronia**	**Crimson Lake**	**Point Torment**	**Yulleroo**	**St George Range**	**Mirbelia**	**Dodonea**	**Pictor**
MESOZOIC														
M-L Perm.	Liveringa													
M Permian	Noonkanbah													
E-M Perm	Poole													
L Carb-Per	Grant							**OIL**						
M Carb	Anderson		**OIL**						**GAS**					
E Carb	Laurel			**OIL**	**OIL**	**OIL/GAS**				**GAS**	**GAS**			
L Devonian	Nullara	**OIL**			**GAS**									
L Devonian	Napier													
M-L Dev	Pillara/Gogo						**OIL**							
M-L Dev	Mellinjerie											**OIL**		
M Devonian	Poulton													
E-M Dev	Tandalgoo													
Silur-E Dev	Carribuddy													
M Ordov	Nita													**GAS/OIL**
M Ordov	Goldwyer												**OIL**	
E-M Ordov	Willara													
E Ordov	Nambeet												**GAS**	

Table 7. Other hydrocarbon accumulations, Canning Basin, Western Australia

Table 8. Hydrocarbon shows, onshore Canning Basin, Western Australia

Wellname	TD Date	Formation / Age	Hydrocarbon Show
L E N N A R D S H E L F			
Prices Creek No. 1	1 Dec 1922	?	minor oil show
Prices Creek No. 3	1 May 1923	?	minor oil show
Blackstone No. 1	9 Oct 1967	Laurel Fm Fairfield Fm	fluorescence in cores brown oil stain in cores
Napier No. 1	8 Aug 1969	Fairfield Fm Equ. E-M Devonian	trace of gas trace of bitumen
Tappers Inlet No.1	5 Aug 1971	Pillara Lst	minor oil show
Yarrada No. 1	29 Jun 1981	Anderson Fm	minor hydrocarbon show
Grevillea No. 1	8 Sep 1982	Pillara Lst ?	trace of oil
Jum Jum No. 1	18 Sep 1982	Anderson Fm	oil show
Whitewell No. 1	17 May 1984	?	oil show
Philydrum No. 1	22 Nov 1984	?	trace of oil
West Blackstone No. 1	1 Jun 1985	?	minor fluorescence
F I T Z R O Y T R O U G H			
Mt. Wynne No. 3	25 Sep 1924	?	minor oil show
Poole Range No.3	15 April 1933	?	minor oil show
FKO Nerrima No.1	9 Sep 1955	Grant Fm	minor oil show
The Sisters No. 1	3 Jun 1957	Fairfield Gp	minor oil show
Frome Rocks No.2	1 Jun 1959	Fairfield Group	minor amounts of waxy, brown oil, fluorescence.
Barlee No. 1	25 Jul 1960	Anderson Fm E. Carboniferous	minor gas show bitumen
Doran No. 1	5 Aug 1968	Upper Grant Fm	bitumen
Logue No. 1	31 Aug 1972	Lower Grant Fm	fluorescence and staining.
Mimosa No. 1	17 Aug 1973	Clanmeyer Fm Napier Fm Equ.	minor oil staining gas show, oil stng, fluor.
Puratte No. 1	31 Dec 1979	Noonkanbah Fm U. Anderson Fm Laurel Fm	oil show oil show oil show
Moogana No. 1	16 Mar 1980	Noonkanbah Fm Gogo Fm	oil show oil show
Fitzroy River No.1	29 Aug 1980	?	minor hydrocabon show
Cycas No. 1	17 Aug 1983	Noonkanbah Fm Grant Fm Anderson Fm	oil show oil show oil show
Cow Bore No. 1	23 Dec 1983	Grant Fm Laurel Fm	oil show gas show
Crab Creek No. 1	18 Dec 1987	Basal Grant Fm	minor oil show
Petaluma No. 1	28 Dec 1987	Poole Sst	oil show
G R E G O R Y S U B - B A S I N			
Point Moody No. 1	10 Jan 1966	Poole Sst Grant Fm	minor gas show minor gas show
Lake Betty No. 1	2 Dec 1971	Laurel Fm	minor gas show
White Hills No. 1	30 Nov 1982	Poole Sst Grant Fm Anderson Fm Laurel Fm Nullara Lst	minor oil show minor oil show minor oil and gas show minor oil and gas show minor gas show
Bindi No. 1	9 Aug 1984	Anderson Fm	minor gas show

Table 8. continued.

Wellname	TD Date	Formation / Age	Hydrocarbon Show
D A M P I E R T E R R A C E			
Babrongan No. 1	15 July 1962	Grant Fm Virgin Hills Fm	minor gas bitumen
Matches Springs No. 1	13 Nov 1969	Goldwyer Fm Nita Fm	fluorescence fluorescence and staining
Nuytsia No. 1	30 Oct 1984	?	oil show
Crystal Creek No.1	15 Sep 1988	?	oil show
B A R B W I R E T E R R A C E			
Acacia No. 1	16 Sep 1981	Nita Fm	free oil in core, minor gas
Dampiera No. 1	10 Feb 1982	Pillara Lst	oil show
Eremophila No.1	16 May 1982	Grant Fm Laurel Fm Pillara Lst	minor oil show oil show oil show
Acacia No. 2	6 July 1982	Nita Fm Goldwyer Fm Willara Fm Basal Nambeet Fm	minor oil and gas shows minor oil show minor oil and gas shows oil and gas shows
B R O O M E P L A T F O R M			
Goldwyer No. 1	25 Sep 1958	Goldwyer Fm Willara Fm	fluorescence and staining fluorescence and staining
Thangoo No. 1A	15 Feb 1960	Goldwyer Fm Willara Fm	fluorescence and staining fluorescence and staining
Parda No. 1	16 May 1965	Goldwyer Fm	minor oil stng, fluorescence
Willara No. 1	13 Oct 1965	Grant Fm	gas show, fluorescence
McLarty No. 1	14 May 1968	Goldwyer Fm Willara Fm	fluorescence and cut pinpoint fluorescence
Edgar Range No. 1	14 Sep 1968	Nita Fm Willara Fm	yellow fluorescence in cores bleeding gas from core
Thangoo No. 2	30 May 1973	Grant Fm Willara Fm Nambeet Fm	minor oil show minor oil show minor oil shows
Great Sandy No. 1	28 Oct 1981	Nita Fm	oil show
Canopus No. 1	9 Aug 1982	Nita Fm Goldwyer Fm	minor oil and gas show minor oil and gas shows
Musca No. 1	21 Oct 1982	Carribuddy Fm	oil show
Hedonia No. 1	11 May 1984	Basal Grant Fm Goldwyer Fm Willara Fm Nambeet Fm	minor gas show minor oil and gas show minor gas shows minor gas show
Cudalgarra No. 1	10 Aug 1984	Carribuddy Fm Nita Fm	oil show oil show
Cudalgarra No. 2	30 Aug 1985	Nita Fm Willara Fm	oil show oil show
Hilltop No. 1	8 Aug 1987	Goldwyer Fm Nambeet Fm	minor gas show minor gas show
Leo No. 1	18 Aug 1988	Nita Fm Willara Fm	minor hydrocarbon show minor hydrocarbon show
K I D S O N S U B - B A S I N			
Kemp Field No. 1	12 Oct 1968	Mellinjerie Lst	Fluorescence
Auld No. 1	29 Apr 1985	Grant Fm	minor oil show

Table 9. Hydrocarbon shows, offshore Canning Basin, Western Australia

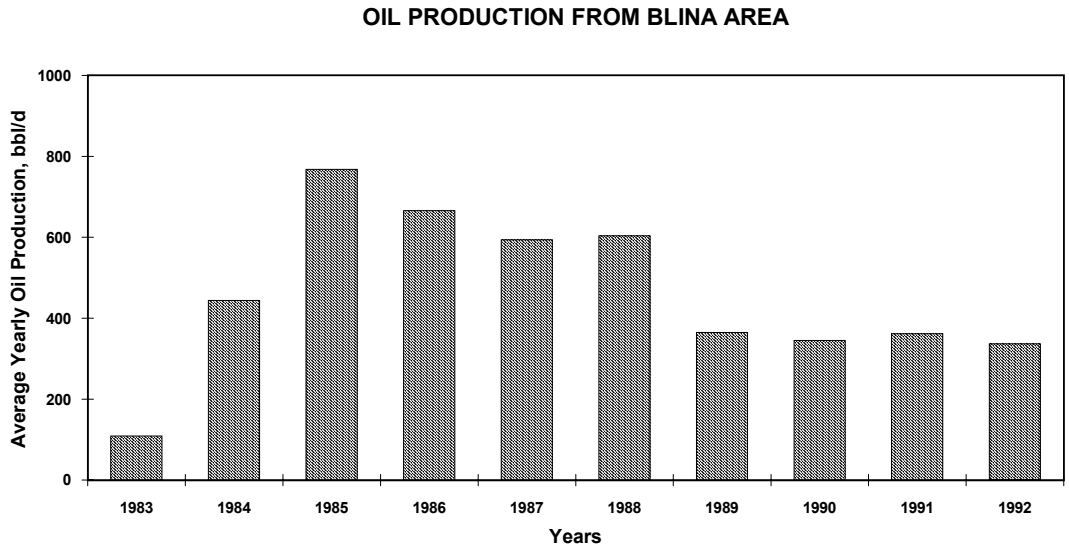
Wellname	TD Date	Formation / Age	Hydrocarbon Show
Phoenix No.1	30 May 1980	Cossigny Fm	gas shows
Perindi No. 1	2 Jun 1983	Poole Sst Grant Fm Laurel Fm	oil staining, fluorescence minor oil show oil staining

5. DEVELOPMENTS IN THE CANNING BASIN

5.1 Development : Blina

Operator:	Petroleum Securities	
Location:	105 km southeast of Derby	
Discovered:	June 1981, Blina No1	
Production started:	September 1983	
Product:	Oil	
No. of wells:	Oil producers	6
	Gas producers	0
	Shut in	0
	Plugged and abandoned	2
	Injection and water source	0
	Suspended	0
	Total	8

Gathering, separation and storage facilities were built at Blina. Oil is transported through a 27 km gravity pipeline to the Erskine truck terminal on the Great Northern Highway. From the terminal, the oil is trucked to a holding tank and shiploading facilities at Broome.



5.2 Development : Boundary

Operator:	Petroleum Securities	
Location:	3 km south of Lloyd and 70 km southeast of Derby	
Discovered:	August 1990, Boundary No 1	
Production started:	December, 1990	
Product:	Oil	
No. of wells:	Oil producers	1
	Gas producers	0
	Shut in	0
	Plugged and abandoned	0
	Injection and water source	0
	Suspended	0
	Total	1

Wellstream flows from the Boundary-1 well to the Meda battery, via a pipeline, for further processing and transport.

5.3 Development : Sundown

Operator:	Petroleum Securities	
Location:	26 km northwest of Blina and 70 km southeast of Derby	
Discovered:	November 1982	
Production started:	November 1983	
Product:	Oil	
No. of wells:	Oil producers	3
	Gas producers	0
	Shut in	0
	Plugged and abandoned	1
	Injection and water source	0
	Suspended	0
	Total	4

Gathering, separation and storage facilities were built at Sundown. Oil is transported through a gravity pipeline to the Meda battery for further processing and transport.

5.4 Development : West Terrace

Operator:	Petroleum Securities	
Location:	8 km north of Sundown, 70 km southeast of Derby	
Discovered:	November 1985, West Terrace No 1	
Production started:	June 1985	
Product:	Oil	
No. of wells:	Oil producers	2
	Gas producers	0
	Shut in	0
	Plugged and abandoned	0
	Injection and water source	0
	Suspended	0
	Total	2

Gathering, separation and storage facilities were built at West Terrace. Oil is transported through a gravity pipeline to the Meda battery for further processing and transport.

5.5 Development : Lloyd

Operator:	Petroleum Securities	
Location:	4 km north of theWest Terrace field and 70 km southeast of Derby	
Discovered:	July 1987, Lloyd No1	
Production started:	August, 1987	
Product:	Oil	
No. of wells:	Oil producers	1
	Gas producers	0
	Shut in	0
	Plugged and abandoned	0
	Injection and water source	0
	Suspended	0
	Total	1

Wellstream flows from the Lloyd-1 well to the Meda battery, via a pipeline, for further processing and transport.

6. HYDROCARBON ACCUMULATION SUMMARIES

ACCUMULATION:	BLINA
PRESENT OPERATOR:	Petroleum Securities
TYPE:	Oil
COMMERCIAL STATUS:	Commercial
LOCATION:	105 km southeast of Derby on the Lennard Shelf.
STATE:	WA
PETROLEUM TITLES:	WA-EP-129; PPL-6
SUB-BASIN:	Lennard Shelf
DISCOVERY WELL:	Blina 1
Longitude (E):	124.5014
Latitude (S):	-17.6233
Date total depth reached:	08 JUN 81
Ground level:	57 m
Operator:	Petroleum Securities
NUMBER OF WELLS DRILLED:	Exploration and appraisal: 1 Development: 7
STRUCTURE:	Famennian carbonate bank draped by Fairfield Group sediments.
AREAL CLOSURE:	17.8 sq km
RESERVOIR UNITS:	A total of 2 petroleum-bearing unit(s)
PRODUCING UNITS:	A total of 2 petroleum producing unit(s)
DRIVE MECHANISM:	Effective water drive
PRODUCTION:	Oil: commenced in SEP 83
INFRASTRUCTURE:	Gathering facilities were built at Blina and a 28 km pipeline laid to a truck terminal on the Great Northern Highway.Oil is trucked from the terminal to a holding tank and shiploading facilities at Broome.

PETROLEUM-BEARING UNIT No 1:	Yellow Drum Formation
CONTENTS:	Oil
FORMATION:	Yellow Drum Formation
AGE:	Early Carboniferous
LITHOLOGY:	Dolomite, with both intergranular and vuggy porosity.
DEPTH (mSS):	1098
POROSITY:	Up to 24 %
PERMEABILITY:	Up to 4000 mD
PRODUCTION STATUS:	Developed

PETROLEUM-BEARING UNIT No 2:	Nullara Limestone
CONTENTS:	Oil
FORMATION:	Nullara Limestone
AGE:	Late Devonian
LITHOLOGY:	Limestone: packstones and grainstones
DEPTH (mSS):	1340
POROSITY:	Up to 24 %
PERMEABILITY:	Up to 4000 mD
PRODUCTION STATUS:	Developed

TEST DATA FROM THE DISCOVERY WELL (Blina 1):

DST 2, 1160 m. Flowed oil at estimated an rate of 37.5 bbls/d. Recovered 13 bbls clean oil, 7bbls mud cut oil and 450 m oil cut mud from drill string.	Yellow Drum Formation
DST 3, 1402 m. Flowed oil at a measured rate of 575 bbls/d,and a cleaned up stabilised non-restricted flow rate of 905.7 bbls/d after 102 minutes.	Nullara Lst.
DST 8, 1485 m. Flowed 70 bbls/d of oil and gas cut mud.	Nullara Lst.
DST 9, 1515 m. Recovered 63.5 bbls of slightly mud cut formation water during a two hour flow period.	Unknown Fm.
DST 14, 1538 m. Recovered 67.5.bbls of formation water from the drill pipe.	Unknown Fm.
DST 4, 1774 m. Recovered 480m drilling mud, 142m of water cut drilling mud and 966m of dirty salt water.	Unknown Fm.
DST 13, 1780 m. Recovered 68.5 bbls of very slightly oil cut drilling mud.	Unknown Fm.
DST 12, 2144 m. No flow due to tight formation.	Unknown Fm.
DST 11, 2207 m. No flow due to tight formation.	Unknown Fm.
DST 5, 2224 m. Misrun.	Unknown Fm.
DST 6, 2228 m.	Unknown Fm.

Misrun.

DST 10, 2237 m.	Unknown Fm.

Misrun.

DST 7, 2269 m.	Unknown Fm.

Recovered 76 m of drilling mud.

DST 1.	Unknown Fm.

Misrun due to mechanical failure.

ACCUMULATION:	BORONIA
PRESENT OPERATOR:	Inter Energy Dev Corp of Australia
TYPE:	Oil
COMMERCIAL STATUS:	Other discovery.
LOCATION:	10 km southeast of Blina.
STATE:	WA
PETROLEUM TITLES:	WA-EP-103
SUB-BASIN:	Lennard Shelf.
DISCOVERY WELL:	Boronia 1
Longitude (E):	124.5716
Latitude (S):	-17.7583
Date total depth reached:	14 JUN 82
Ground level:	59 m
Operator:	Inter Energy Dev Corp of Australia.
NUMBER OF WELLS DRILLED:	Exploration and appraisal: 1
STRUCTURE:	Famennian Reef.
AREAL CLOSURE:	3.8 sq km
RESERVOIR UNITS:	A total of 1 petroleum-bearing unit(s)

PETROLEUM-BEARING UNIT No 1:	Gogo Formation.
CONTENTS:	Oil
FORMATION:	Gogo Formation
AGE:	Late Devonian
LITHOLOGY:	Turbidite sequence.
DEPTH (mSS):	2733

TEST DATA FROM THE DISCOVERY WELL (Boronia 1):

DST 2, 1624.5 m.	Unknown Fm
No hydrocarbons were recovered. (Proved to be very tight before and after acid treatment).	
DST 1, 2799.5 m.	Gogo Fm
Recovered 1940 m of fluid with less than 1bbl of oil on top of gas cut mud.	

ACCUMULATION:	BOUNDARY
PRESENT OPERATOR:	Petroleum Securities
TYPE:	Oil
COMMERCIAL STATUS:	Commercial
LOCATION:	3 km south of the Lloyd accumulation, 70 km southeast of Derby.
STATE:	WA
PETROLEUM TITLES:	WA-EP-129
DISCOVERY WELL:	Boundary 1
Longitude (E):	124.2436
Latitude (S):	-17.4861
Date total depth reached:	16 AUG 90
Ground level:	44 m
Operator:	Petroleum Securities.
NUMBER OF WELLS DRILLED:	Exploration and appraisal: 1 Development: 1
STRUCTURE:	Fault dependant closure at Anderson formation level.
RESERVOIR UNITS:	A total of 1 petroleum-bearing unit(s)
PRODUCING UNITS:	A total of 1 petroleum producing unit(s)
INFRASTRUCTURE:	The wellstream flows from the Boundary-1 well to the Meda battery, via a pipeline, for processing and transport.

PETROLEUM-BEARING UNIT No 1:	Grant Formation
CONTENTS:	Oil
FORMATION:	Grant Formation
AGE:	Late Carboniferous-E. Permian
DEPTH (mSS):	1229
PRODUCTION STATUS:	Developed

TEST DATA FROM THE DISCOVERY WELL (Boundary 1):

DST 1, 1277 m. Flowed 300 bbls of oil/d through a 1/2" choke.	Grant Fm
DST 2. Misrun.	Unknown Fm.
DST 3. Recovered water.	Unknown Fm.

ACCUMULATION:	CRIMSON LAKE
PRESENT OPERATOR:	Kufpec Australia
TYPE:	Oil show
COMMERCIAL STATUS:	Other discovery
LOCATION:	265 km east of Broome
STATE:	WA
PETROLEUM TITLES:	WA-EP-101
DISCOVERY WELL:	Crimson Lake 1
Longitude (E):	124.6758
Latitude (S):	-17.8848
Date total depth reached:	02 AUG 88
Ground level:	102 m
Operator:	Kufpec Australia
NUMBER OF WELLS DRILLED:	Exploration and appraisal: 1
STRUCTURE:	Faulted fourway-dip closure at Laurel Formation level.
RESERVOIR UNITS:	A total of 1 petroleum-bearing unit(s)

PETROLEUM-BEARING UNIT No 1:	Grant Formation
CONTENTS:	Oil
FORMATION:	Grant Formation
AGE:	Late Carboniferous-E. Permian
LITHOLOGY:	Sandstone
DEPTH: (mSS)	929

TEST DATA FROM THE DISCOVERY WELL (Crimson Lake 1):

DST-2, 1025 m.	Grant Fm
Misrun.	
DST-1, 1038 m.	Grant Fm
Recovered 0.5 bbls of 37.9 deg. API oil and 6.5 bbls of drilling fluid.	

ACCUMULATION:	DODONEA
PRESENT OPERATOR:	Western Mining Corp Ltd
TYPE:	Oil and gas
COMMERCIAL STATUS:	Other Discovery
LOCATION:	30 km northwest of the Mirbelia accumulation
STATE:	WA
PETROLEUM TITLES:	WA-EP-143
SUB-BASIN:	Barbwire Terrace
DISCOVERY WELL:	Dodonea 1
Longitude (E):	125.1608
Latitude (S):	-19.3864
Date total depth reached:	25 SEP 85
Ground level:	212 m
Operator:	Western Mining Corp Ltd
NUMBER OF WELLS DRILLED:	Exploration and appraisal: 2
STRUCTURE:	Fault dependent closure at Nita Formation level.
AREAL CLOSURE:	4.4 sq km
RESERVOIR UNITS:	A total of 2 petroleum-bearing unit(s)
PETROLEUM-BEARING UNIT No 1:	Goldwyer Formation
CONTENTS:	Oil
FORMATION:	Goldwyer Formation
AGE:	Middle Ordovician
LITHOLOGY:	Carbonate: fractured and vuggy
DEPTH (mSS):	1307
POROSITY:	0.6 - 2.9 %
PERMEABILITY:	0.005 - 58 mD
PETROLEUM-BEARING UNIT No 2:	Nambeet Formation
CONTENTS:	Gas show
FORMATION:	Nambeet Formation
AGE:	Early Ordovician
LITHOLOGY:	Dolomite sandstone
DEPTH (mSS):	1796

TEST DATA FROM THE DISCOVERY WELL (Dodonea 1):

DST 1,1525 m. Recovered 10 litres of clean oil, 60m oil and water cut drilling mud.	Goldwyer Fm
DST 2, 2014 m. Flowed 85 m^3/d gas, 43m of gas cut mud recovered from pipe.	Nambeet Fm

ACCUMULATION:	ELLENDALE
PRESENT OPERATOR:	Amax Petroleum
TYPE:	Gas and Oil
COMMERCIAL STATUS:	Other Discovery
LOCATION:	26 km northwest of Mount Hardman.
STATE:	WA
PETROLEUM TITLES:	EP 101
SUB-BASIN:	Fitzroy Trough
DISCOVERY WELL:	Ellendale 1
Longitude (E):	124.7042
Latitude (S):	-17.9050
Date total depth reached:	30 SEP 79
Ground level:	95 m
Operator:	Amax Petroleum
NUMBER OF WELLS DRILLED:	Exploration and appraisal: 1
STRUCTURE:	Four-way dip closure at the Fairfield Group level.
RESERVOIR UNITS:	A total of 1 petroleum-bearing unit(s)
PETROLEUM-BEARING UNIT No 1:	Laurel Formationn
CONTENTS:	Gas and oil
FORMATION:	Laurel Formation
AGE:	Early Carboniferous
DEPTH (mSS):	2055
REMARKS:	Objectives were Early Carboniferous and Late Devonian sands.

TEST DATA FROM THE DISCOVERY WELL (Ellendale 1):

DST 3, 1649 m. Encountered a small amount of gas and some condensate.	Unknown Fm.
DST 2, 2155 m. Flowed a small amount of gas and some oil.	Laurel Fm.
DST 1, 2366 m. Mechanical failure.	Unknown Fm

ACCUMULATION:	JANPAM NORTH
PRESENT OPERATOR:	Home Energy Co Ltd
TYPE:	Oil
COMMERCIAL STATUS:	Other discovery.
LOCATION:	Approximately 10 km northwest of the Blina accumulation.
STATE:	WA
PETROLEUM TITLES:	WA-EP-129
SUB-BASIN:	Lennard Shelf
DISCOVERY WELL:	Janpam North 1
Longitude (E):	124.4165
Latitude (S):	-17.5683
Date total depth reached:	22 SEP 87
Ground level:	56 m
Operator:	Home Energy Co Ltd
NUMBER OF WELLS DRILLED:	Exploration and appraisal: 1
STRUCTURE:	Reef-like seismic anomaly.
RESERVOIR UNITS:	A total of 1 petroleum-bearing unit(s)

PETROLEUM-BEARING UNIT No 1:	Nullara Limestone
CONTENTS:	Oil
FORMATION:	Nullara Limestone
AGE:	Late Devonian
LITHOLOGY:	Limestone: and shale
DEPTH (mSS):	1584

TEST DATA FROM THE DISCOVERY WELL (Janpam North 1):

DST 1, 1644 m.	Nullara Lst (Gumhole Fm).
Recovered 2.5 bbls of 23 deg. API oil and 10 bbls of water cushion.	
DST 2, 1662 m.	Unknown Fm.
Recovered 0.3 bbls of oil and 3.7 bbls rathole mud.	
DST 3, 1852.3 m.	Unknown Fm
Recovered 5 litres mud.	
DST 4, 1980 m.	Unknown Fm.
Recovered 13 litres drilling mud.	
DST 5, 2022 m.	Unknown Fm.
Recovered 120 litres drilling mud.	

ACCUMULATION:	KORA
PRESENT OPERATOR:	Esso Explor and Prod Aust Ltd
TYPE:	Oil
COMMERCIAL STATUS:	Other discovery.
LOCATION:	8 km east of the township of Derby.
STATE:	WA
PETROLEUM TITLES:	WA-EP-104; PL-8
SUB-BASIN:	Lennard Shelf
DISCOVERY WELL:	Kora 1
Longitude (E):	123.8289
Latitude (S):	-17.2600
Date total depth reached:	26 SEP 82
Ground level:	9 m
Operator:	Esso Explor and Prod Australia
NUMBER OF WELLS DRILLED:	Exploration and appraisal: 1
STRUCTURE:	Unfaulted,four-way dip closure.
AREAL CLOSURE:	1.0 sq km
RESERVOIR UNITS:	A total of 1 petroleum-bearing unit(s)

PETROLEUM-BEARING UNIT No 1:	Anderson Formation
CONTENTS:	Oil
FORMATION:	Anderson Formation
AGE:	Early Carboniferous
LITHOLOGY:	Sandstone, quartzose.
DEPTH (mSS):	1746
POROSITY:	Up to 30 %

TEST DATA FROM THE DISCOVERY WELL (Kora 1):

Cased hole DST, 1608 m.	Unknown Fm.
Result of this test is unknown.	
Cased hole DST, 1674 m.	Unknown Fm.
Recovered 43 bbls of a mixture of brine and formation water.	
DST 1, 1760 m.	Anderson Fm.
Recovered 85 bbls of formation water and 2-3 gallons of oil.	
DST 2, 2086 m.	Unknown Fm.
Recovered a small amount of gas and mud (tight formation).	
DST 3, 2905.7 m.	Unknown Fm
Tight formation.	

ACCUMULATION:	LLOYD
PRESENT OPERATOR:	Petroleum Securities
TYPE:	Oil
COMMERCIAL STATUS:	Commercial
LOCATION:	70 km southeast of Derby; 4 km north of the West Terrace accumulation.
STATE:	WA
PETROLEUM TITLES:	WA-EP-129; PL 8
DISCOVERY WELL:	Lloyd 1
Longitude (E):	124.2492
Latitude (S):	-17.4675
Date total depth reached:	09 JUL 87
Ground level:	39 m
Operator:	Petroleum Securities
NUMBER OF WELLS DRILLED:	Exploration and appraisal: 2 Development: 1
STRUCTURE:	Unfaulted, structural four-way dip closure at Anderson Formation level.
RESERVOIR UNITS:	A total of 1 petroleum-bearing unit(s)
PRODUCING UNITS:	A total of 1 petroleum producing unit(s).
PRODUCTION:	Oil: commenced in JUL 87
INFRASTRUCTURE:	The wellstream flows via a pipeline to the Meda battery for further processing and transport.

PETROLEUM-BEARING UNIT No 1:	Anderson Formation
CONTENTS:	Oil
FORMATION:	Anderson Formation
AGE:	Mid-Carboniferous
LITHOLOGY:	Sandstone, massive; interbedded siltstone; shales and carbonates.
DEPTH (mSS):	1468
PRODUCTION STATUS:	Developed

TEST DATA FROM THE DISCOVERY WELL (Lloyd 1):

DST 1.	Unknown formation.
Misrun.	
DST-2.	Unknown formation.
Tool failure.	
Production Test, 1512-1523 m.	Anderson Formation.

Flowed 392 bbls of 40.4 deg. API oil/day.

ACCUMULATION:	MEDA
PRESENT OPERATOR:	WAPET
TYPE:	Oil and gas
COMMERCIAL STATUS:	Other Discovery
LOCATION:	56 km east of the township of Derby.
STATE:	WA
PETROLEUM TITLES:	WA-PE-30-H; LP-54-H
SUB-BASIN:	Lennard Shelf
DISCOVERY WELL:	Meda 1
Longitude (E):	124.1917
Latitude (S):	-17.4000
Date total depth reached:	21 NOV 58
Ground level:	27 m
Operator:	WAPET
NUMBER OF WELLS DRILLED:	Exploration and appraisal: 2
STRUCTURE:	Reef structure.
RESERVOIR UNITS:	A total of 2 petroleum-bearing unit(s)
PETROLEUM-BEARING UNIT No 1:	Upper Laurel Formation
CONTENTS:	Oil
FORMATION:	Laurel Formation
AGE:	Devonian/Carboniferous
LITHOLOGY:	Sandstone, siltstone,interbedded; calcareous; dolomitic in part, grading to a sandy dolomite.
DEPTH (mSS):	1527 (Top)
POROSITY:	20%
PETROLEUM-BEARING UNIT No 2:	Nullara Limestone.
CONTENTS:	Gas
FORMATION:	Nullara Limestone
AGE:	Late Devonian
LITHOLOGY:	Calcarenite, recrystallised; with fragments of limestone and fossils. Limestone contains irregular algal growths.
DEPTH (mSS):	1979 (Top)
POROSITY:	2.2 %
PERMEABILITY:	0.1 mD

TEST DATA FROM THE DISCOVERY WELL (Meda 1):

DST 1, 1548.9 m.	Laurel Fm
Recovered 152 m water cushion and 137 m of drilling mud.	
DST 9B, 1557.1 m.	Laurel Fm.
Recovered 3066 L of gas cut water	

(10,800-14,800 ppm NaC1) with trace-7% of crude oil.

DST 9A, 1557.1 m. Laurel Fm.
Recovered gas cut salty water (10500 ppm NaC1), with a trace of crude oil.

DST 9, 1557.1 m. Laurel Fm.
Recovered approx 13 L of crude oil and 566 cc of water (4600 ppm NaC1).

DST 9C, 1557.1 m. Laurel Fm.
Recovered 45066 L of slightly gas cut water (9000 ppm NaC1), with approx 1% crude oil.

DST 9B, 1557.1 m. Laurel Fm.
Recovered 20 L of oil.

DST 8, 1600.1 m. Laurel Fm.
Recovered 24466 L of displacing water cut with spent acid.

DST 8A, 1600.1 m. Laurel Fm.
Recovered gas cut salty water, with green fluorescence. Slight, intermittent gas flow.

DST 7C, 2009.8 m. Nullara Lst.
Recovered 15366 L of spent acid, strongly gas cut.

DST 7A , 2009.8 m. Nullara Lst.
Recovered drilling mud, displacing water and weak gas flow.

DST 7D, 2009.8 m. Nullara Lst.
Recovered 25666 L gas cut spent acid.

DST 7B, 2009.8 m. Nullara Lst.
Formation reacidized.

DST 7, 2009.8 m. Nullara Lst.
Flowed gas at 234 L/min (2566 L produced).

DST 2, 2027.9 m. Nullara Lst.
Gas flowed through water cushion at a rate of 0.8-2.8 million m^3/day.

DST 3, 2086 m. Unknown Fm.
Recovered 111466 L water cushion and 166 L of drilling mud (6000 ppm NaC1).

DST 4, 2151.9 m. Unknown Fm.
Recovered 15366 L water cushion and 866 L of gas cut drilling mud (6000 ppm NaCl).

DST 5, 2261.2 m. Unknown Fm.
Recovered 1366 L water cushion and 166 L of drilling mud.

DST 6B, 2308.1 m. Unknown Fm.
Test mechanically unsuccessful.
DST 6, 2311 m. Unknown Fm.
Tool did not open.
DST 6A, 2311 m. Unknown Fm.
Test mechanically unsuccessful.
DST 6C, 2315 m. Unknown Fm.
Recovered 15166 L of mud cut water and
gas and 30766 L of gas cut salt water.
DST 6C, 2315 m. Unknown Fm.
Recovered salt water (50700 ppm NaC1).

ACCUMULATION:	MIRBELIA
PRESENT OPERATOR:	Western Mining Corp Ltd
TYPE:	Oil
COMMERCIAL STATUS:	Other Discovery
LOCATION:	260 km southwest of the Blina accumulation.
STATE:	WA
PETROLEUM TITLES:	WA-EP-143
SUB-BASIN:	Barbwire Terrace
DISCOVERY WELL:	Mirbelia 1
Longitude (E):	125.3603
Latitude (S):	-19.6522
Date total depth reached:	07 MAY 85
Ground level:	199 m
Operator:	Western Mining Corp Ltd
NUMBER OF WELLS DRILLED:	Exploration and appraisal: 2
STRUCTURE:	Fault dependent closure at Ordovician level.
AREAL CLOSURE:	17.5 sq km
RESERVOIR UNITS:	A total of 1 petroleum-bearing unit(s)

PETROLEUM-BEARING UNIT No 1:	Mellinjerie Limestone
CONTENTS:	Oil
FORMATION:	Mellinjerie Limestone
AGE:	Middle-Late Devonian
LITHOLOGY:	Dolostone.
DEPTH (mSS):	1633 (Top)
POROSITY:	2.7 - 14.1%
PERMEABILITY:	0.003 - 8.4 mD

TEST DATA FROM THE DISCOVERY WELL (Mirbelia 1):

DST 1, 1829.6 m.	Mellinjerie Fm.
Recovered 5m oil and gas cut drilling mud.	
DST 2,1837.1 m.	Mellinjerie Fm
Recovered 20m oil and gas cut drilling mud and 1.5 litres of clean oil.	
DST 3, 1885.5 m.	Mellinjerie Fm
Failed to recover hydrocarbons.	
DST 4, 1963 m.	Unknown formation.
Recovered 14bbls of muddy salty water.	

ACCUMULATION:	PICTOR
PRESENT OPERATOR:	BHP Petroleum
TYPE:	Oil and gas
COMMERCIAL STATUS:	Other discovery.
LOCATION:	180 km south of Derby.
STATE:	WA
PETROLEUM TITLES:	WA-EP-175
SUB-BASIN:	Broome Arch
DISCOVERY WELL:	Pictor 1
Longitude (E):	123.7147
Latitude (S):	-18.7644
Date total depth reached:	20 SEP 84
Ground level:	133 m
Operator:	BHP Petroleum
NUMBER OF WELLS DRILLED:	Exploration and appraisal: 2
STRUCTURE:	Faulted,tilted horst with a small,internal dip-closed cumination.
AREAL CLOSURE:	17.2 sq km
RESERVOIR UNITS:	A total of 1 petroleum-bearing unit(s)

PETROLEUM-BEARING UNIT No 1:	Nita Formation
CONTENTS:	Oil and gas
FORMATION:	Nita Formation
AGE:	Middle Ordovician
LITHOLOGY:	Fractured dolostone.
DEPTH (mSS):	765
POROSITY:	9 to 13 %
PERMEABILITY:	5 mD

TEST DATA FROM THE DISCOVERY WELL (Pictor 1):

DST 1, 905 m.	Nita Fm
Flowed 5380 m^3/d of gas.	
DST 4, 940 m.	Nita Fm.
Flowed 56634 m^3/d of gas, and 216bbls/day liquid (on 1"choke at 252psi). Liquids contain approx.20% 47deg API oil.	
DST 5, 940 m.	Nita Fm.
Stabilised gas flow of 62297 m^3/d of gas and180 b/d liquids, (gross), 24bbls liquid hydrocarbons net(with API of 45deg) on a 1/4"choke at 180 psi.	
DST 2, 1550 m.	Unknown formation.
Misrun.	
DST 3, 1550 m.	Unknown formation.
Misrun.	

ACCUMULATION:	POINT TORMENT
PRESENT OPERATOR:	Anzoil NL
TYPE:	Gas
COMMERCIAL STATUS:	Other discovery.
LOCATION:	25 km southeast of Derby.
STATE:	WA
PETROLEUM TITLES:	EP 104
DISCOVERY WELL:	Point Torment 1
Longitude (E):	123.7375
Latitude (S):	-17.1661
Date total depth reached:	25 NOV 92
Water depth/ground level:	0 m
Operator:	Anzoil NL.
NUMBER OF WELLS DRILLED:	Exploration and appraisal: 1

PETROLEUM-BEARING UNIT No 1:	Anderson Formation
CONTENTS:	Gas
FORMATION:	Anderson Formation
AGE:	Early Carbonifereous

TEST DATA FROM THE DISCOVERY WELL (Point Torment 1):

DST-1, 2085.8-2096.5 m.	Anderson Formation
Flowed 121 760 m^3/d of gas at 685 psi through a 1/2" choke.	

ACCUMULATION:	SAINT GEORGE RANGE
PRESENT OPERATOR:	Continental Oil Co of Aust Ltd
TYPE:	Gas
COMMERCIAL STATUS:	Other Discovery
LOCATION:	70 km wouthwest of Fitzroy Crossing and 225 km south-east of Derby.
STATE:	WA
PETROLEUM TITLES:	WA-132-H
SUB-BASIN:	Fitzroy Trough
DISCOVERY WELL:	Saint George Range 1
Longitude (E):	125.1381
Latitude (S):	-18.6914
Date total depth reached:	13 MAY 66
Ground level:	172 m
Operator:	Continental Oil Co of Au
NUMBER OF WELLS DRILLED:	Exploration and appraisal: 1
STRUCTURE:	Anticline, St George Range, topographic feature.
AREAL CLOSURE:	919.0 sq km
VERTICAL CLOSURE:	914.0 m
RESERVOIR UNITS:	A total of 1 petroleum-bearing unit(s)
PETROLEUM-BEARING UNIT No 1:	Laurel Formation
CONTENTS:	Gas
FORMATION:	Laurel Formation
AGE:	Early Carboniferous
LITHOLOGY:	Limestone: marine; shale; siltstone and sandstone.
DEPTH (mSS):	2976
POROSITY:	< 3%

TEST DATA FROM THE DISCOVERY WELL (Saint George Range 1):

DST 2, 3154 m.	Laurel Fm
Gas to surface at 2.9 million m^3/d.	
Recovered 914m water cushion and	
183m of slightly gas cut mud.	
DST 1, 3172 m.	Laurel Fm.
Packer failed.	

ACCUMULATION:	SUNDOWN
PRESENT OPERATOR:	Petroleum Securities
TYPE:	Oil
COMMERCIAL STATUS:	Commercial
LOCATION:	26 km northwest of the Blina accumulation and 70 km southeast of Derby.
STATE:	WA
PETROLEUM TITLES:	WA-EP-129; PL-8
DISCOVERY WELL:	Sundown-1
Longitude (E):	124.2419
Latitude (S):	-17.5528
Date total depth reached:	23 NOV 82
Ground level:	39 m
Operator:	Petroleum Securities
NUMBER OF WELLS DRILLED:	Exploration and appraisal: 1 Development: 3
STRUCTURE:	Compressional culmination of Mid-Triassic age.
AREAL CLOSURE:	5.3 sq km
RESERVOIR UNITS:	A total of 6 petroleum-bearing unit(s)
PRODUCTION:	Oil: commenced in JUL 84
INFRASTRUCTURE:	Oil is separated on site and transported by gravity pipeline to the Meda battery.
PETROLEUM-BEARING UNIT No 1:	1100 m sand.
CONTENTS:	Oil
FORMATION:	Grant Formation
AGE:	Early-Middle Carboniferous
LITHOLOGY:	Sandstone, siltstone; shale; minor carbonates and hydrites.
DEPTH (mSS):	1054 (Top)
POROSITY:	Up to 30 %
PRODUCTION STATUS:	Developed

PETROLEUM-BEARING UNIT No 2:	1180 m sand
CONTENTS:	Oil
FORMATION:	Grant Formation
AGE:	Early-Middle Carboniferous
LITHOLOGY:	Sandstone, siltstone; shale; minor carbonates; and hydrite.
DEPTH (mSS):	1136 (Top)

PETROLEUM-BEARING UNIT No 3:	1200 m sand.
CONTENTS:	Oil
FORMATION:	Grant Formation
AGE:	Early-Middle Carboniferous
LITHOLOGY:	Sandstone, siltstone; shale; minor carbonates and hydrite.
DEPTH (mSS):	1176 (Top)

PETROLEUM-BEARING UNIT No 4:	1470 m sand.
CONTENTS:	Oil
FORMATION:	Grant Formation
AGE:	Early-Middle Carboniferous
LITHOLOGY:	Sandstone, silstone; shale; minor carbonates; and hydrites.
DEPTH (mSS):	1426 (Top)

TEST DATA FROM THE DISCOVERY WELL (Sundown 1):

Production Test, 1092.5-1097 m.	Grant Formation.
Flowed 755 bbls of 38.5 deg. API oil/day.	
Production Test, 1564-1566 m.	Anderson Formation.
Flowed 597 bbls of oil/day, decreasing to 201 bbls/day.	

ACCUMULATION:	TERRACE
PRESENT OPERATOR:	Petroleum Securities
TYPE:	Oil
COMMERCIAL STATUS:	Other Discovery
LOCATION:	6 km northeast of the Sundown accumulation.
STATE:	WA
PETROLEUM TITLES:	WA-EP-129
SUB-BASIN:	Lennard Shelf
DISCOVERY WELL:	Terrace 1
Longitude (E):	124.2642
Latitude (S):	-17.5064
Date total depth reached:	25 JUN 84
Ground level:	32 m
Operator:	Petroleum Securities
NUMBER OF WELLS DRILLED:	Exploration and appraisal: 1
STRUCTURE:	Four-way dip closure at Laurel Formation level.
AREAL CLOSURE:	3.0 sq km
RESERVOIR UNITS:	A total of 1 petroleum-bearing unit(s)
PETROLEUM-BEARING UNIT No 1:	Laurel Formation
CONTENTS:	Oil show
FORMATION:	Laurel Formation
AGE:	Late Carboniferous-E. Permian
LITHOLOGY:	Sandstone, claystone and shale.
DEPTH (mSS):	1798

TEST DATA FROM THE DISCOVERY WELL (Terrace 1):

DST 1, 930.5 m. Recovered formation water.	Unknown Fm.
DST 2, 1837 m. Misrun.	Laurel Fm.
DST 3, 1837 m. Recovered 1.9 bbls of 38 deg. API oil and 6.1 bbls of muddy water.	Laurel Fm.

ACCUMULATION:	WEST KORA
PRESENT OPERATOR:	Anzoil NL
TYPE:	Oil
COMMERCIAL STATUS:	Commercial
LOCATION:	20 km east-northeast of Derby; 5 km from the Kora accumulation.
STATE:	WA
PETROLEUM TITLES:	WA-EP-104
SUB-BASIN:	Lennard Shelf
DISCOVERY WELL:	West Kora 1
Longitude (E):	123.8167
Latitude (S):	-17.2466
Date total depth reached:	27 AUG 84
Ground level:	9 m
Operator:	Esso Explor and Prod Australia.
NUMBER OF WELLS DRILLED:	Exploration and appraisal: 1 Development: 1
STRUCTURE:	Four-way dip closure at Permian level.
RESERVOIR UNITS:	A total of 2 petroleum-bearing unit(s)
PRODUCING UNITS:	A total of 2 petroleum producing unit(s)
PRODUCTION:	Oil: commenced in OCT 89
INFRASTRUCTURE:	Wellstream is gathered separated and the crude is stored at the plant until it is transported by tanker to the Broome storage and shipping facilities.

PETROLEUM-BEARING UNIT No 1:	Anderson Formation
CONTENTS:	Oil
FORMATION:	Anderson Formation
AGE:	Early-Middle Carboniferous
LITHOLOGY:	Sandstone, siltstone and shale; minor carbonates and hydrite.
DEPTH (mSS):	1678
REMARKS:	Anzoil NL re-entered West Kora-1 and discovered this oil zone.

PETROLEUM-BEARING UNIT No 2:	Anderson Formation
CONTENTS:	Oil
FORMATION:	Anderson Formation
AGE:	Early Carboniferous
LITHOLOGY:	Sandstone, massive; with siltstones, interbedded shales and carbonates.
DEPTH (mSS):	1736 (OWC)
REMARKS:	This 16 m gross unit contains 3 oil zones.

TEST DATA FROM THE DISCOVERY WELL (West Kora 1):

DST 3, 1735 m.	Anderson Fm.
Recovered 140 bbls of 49 deg. API oil and 104 bbls of water.	
DST 1, 1738 m.	Anderson Fm.
Recovered 6 bbls of oil and 7 bbls of filtrate.	
DST 2, 1987 m.	Anderson Fm.
Recovered 36 bbls of water.	

ACCUMULATION:	WEST TERRACE
PRESENT OPERATOR:	Petroleum Securities
TYPE:	Oil
COMMERCIAL STATUS:	Commercial
LOCATION:	70 km southeast of Derby and 7 km north of the Sundown accumulation.
STATE:	WA
PETROLEUM TITLES:	WA-L8
SUB-BASIN:	Lennard Shelf
DISCOVERY WELL:	West Terrace 1
Longitude (E):	124.2589
Latitude (S):	-17.5072
Date total depth reached:	28 MAY 85
Ground level:	31 m
Operator:	Petroleum Securities
NUMBER OF WELLS DRILLED:	Exploration and appraisal: 1 Development: 2
STRUCTURE:	Intra-Grant Formation palaeo-monadnock.
AREAL CLOSURE:	0.9 sq km
RESERVOIR UNITS:	A total of 1 petroleum-bearing unit(s)
PRODUCTION:	Oil: commenced in JUN 85
INFRASTRUCTURE:	Oil is trucked to the gathering facilities at Blina where it enters the pipeline to the terminal on the Great Northern Highway.Oil is then trucked to the storage and ship-loading facilities at Broome.

PETROLEUM-BEARING UNIT No 1:	Upper Grant Formation
CONTENTS:	Oil
FORMATION:	Grant Formation
AGE:	Late Carboniferous-E. Permian
LITHOLOGY:	Sandstone, massive; containing igneous and metamorphic rock fragments.
DEPTH (mSS):	1108
POROSITY:	Up to 20%
PRODUCTION STATUS:	Developed

TEST DATA FROM THE DISCOVERY WELL (West Terrace 1):

DST 1, 1147 m. Flowed 700 bbls of light crude/d to surface.	Grant Fm.

ACCUMULATION:	YULLEROO
PRESENT OPERATOR:	Gewerkschaft Elwerath
TYPE:	Gas
COMMERCIAL STATUS:	Other Discovery
LOCATION:	Within Fitzroy Sub-basin
STATE:	WA
PETROLEUM TITLES:	WA-PE-251-H;LP-184-H
SUB-BASIN:	Fitzroy Trough
DISCOVERY WELL:	Yulleroo 1
Longitude (E):	122.9070
Latitude (S):	-17.8544
Date total depth reached:	13 NOV 67
Ground level:	50 m
Operator:	Gewerkschaft Elwerath
NUMBER OF WELLS DRILLED:	Exploration and appraisal: 1
STRUCTURE:	Anticline: trending WNW-ESE striking under flat Mesozoic sediments.
AREAL CLOSURE:	102.4 sq km
RESERVOIR UNITS:	A total of 2 petroleum-bearing unit(s)
PETROLEUM-BEARING UNIT No 1:	Laurel Formation
CONTENTS:	Gas show
FORMATION:	Laurel Formation
AGE:	Early Carboniferous
LITHOLOGY:	Sandstone: massive; siltstone with interbedded shales and carbonates.
DEPTH (mSS):	2245
POROSITY:	Up to 11 %
PERMEABILITY:	0.5 mD
TEMPERATURE (C):	121 Max BHT
PETROLEUM-BEARING UNIT No 2:	Unknown Formation
CONTENTS:	Gas
AGE:	Early Carboniferous
DEPTH (mSS):	3339
TEMPERATURE (C):	121 Max BHT

TEST DATA FROM THE DISCOVERY WELL (Yulleroo 1):

DST 2, 3216.9 m.	Unknown formation.
Misrun.	
DST 3, 3216.9 m.	Unknown formation.
Recovered 6 barrels of gas cut mud.	
DST 5, 3216.9 m.	Unknown formation
Recovered 15 barrels of gas cut mud.	

DST 1, 3243.1 m. Misrun.	Unknown formation.
DST 8, 3341.9 m. Recovered 0.28 m^3 of gas (est. rate 14 m^3/hour), 5 barrels of water and 6 barrels of mud.	Laurel Fm
DST 4, 3346.1 m. Misrun.	Laurel Formation.
DST 6, 3395 m. Recovered 6 m^3 gas (56 m^3/hour), 5 barrels water and 10 barrels mud.	Unknown formation.
DST 7, 3395 m. Flowed 6 m^3 gas at approximate rate of 56 m^3/hour.	Unknown formation.

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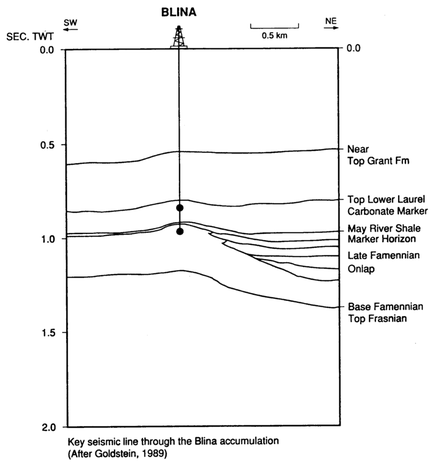
PLATE 1

AUSTRALIAN PETROLEUM ACCUMULATIONS

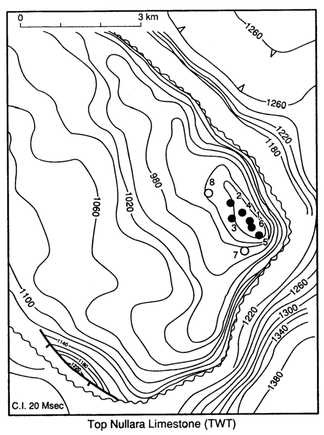
CANNING BASIN

DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY
Compiled by S.J. Cadman and L. Pain
Bibliographic citation: Cadman, S.J. & Pain, L., 1993
Canning Basin, Western Australia
Bureau of Resource Sciences, Australia,
Australian Petroleum Accumulations Report 9.

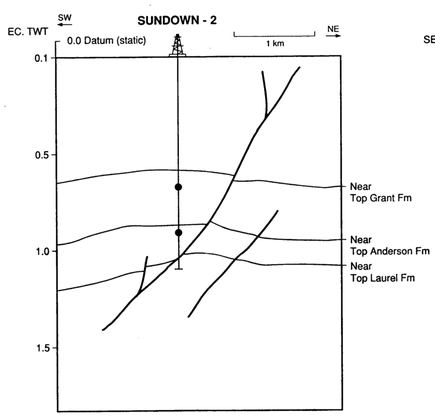
STATUS	COMMERCIAL DISCOVERIES										OTHER DISCOVERIES
LOCATION	LENNARD SHELF										
ACCUMULATION	BLINA	SUNDOWN	WEST TERRACE	LLOYD	WEST KORA	BOUNDARY	TERRACE	JANPAM N'TH	BORONIA	KORA	
AGE											
Cretaceous											
Jurassic											
Triassic											
Permian		Grant Fm ✳	Grant Fm			Grant Fm					
Carboniferous	Yellow Drum Fm	Anderson Fm ✳		Anderson Fm	Anderson Fm		Laurel Fm	Nullara Lst		Anderson Fm	
Devonian	Nullara Lst								Gogo Fm		
Silurian											
Ordovician											
TRAP TYPE	Compaction Drape Closure over Famennian Reef	Famennian Reef	Compressional Culmination with Internal Stratigraphic Traps	Compressional Culmination with Internal Stratigraphic Traps	Four-way Dip Closure	Faulted Four-way Dip Closure	Four-way Dip Closure	Fault Dependent Closure with Internal Four-way Dip Closure	Four-way Dip Closure	Famennian Reef	Four-way Dip Closure	Four-way Dip Closure
HYDROCARBON DISCOVERY	●	●	●	●	●	●	●	●	●	●	●	●



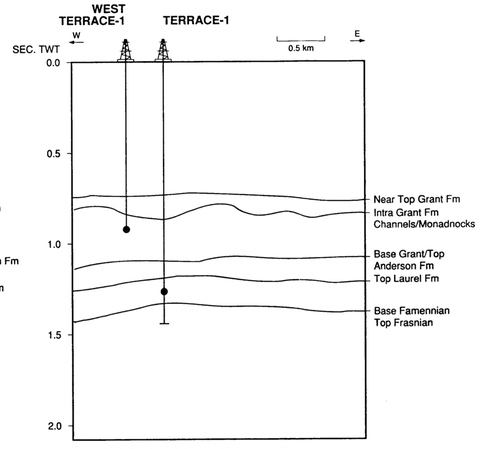
Key seismic line through the Blina accumulation (After Goldstein, 1989)



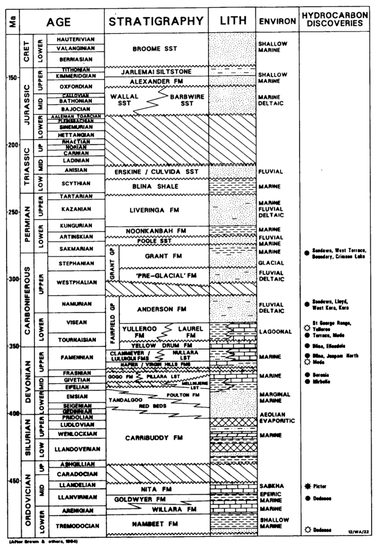
Top Nullara Limestone (TWT)



Key seismic line through the Sundown accumulation (After Goldstein, 1989)



Key seismic line through the West Terrace and Terrace accumulations (After Goldstein, 1989)



After Brown & others, 1994)

PETROLEUM RESERVES AND PRODUCTION

REMAINING RECOVERABLE RESERVES as at	30	6	91
Gas (Sales)			
LPG			
Condensate			
Oil	1.509 Gigalitres		
CUMULATIVE PRODUCTION as at	30	6	91
Gas (Sales)			
LPG			
Condensate			
Oil	0.303 Gigalitres		

COMMENTS

Estimates listed above are for the six commercial accumulations shown on Plate 1.
Figures supplied by WADME
Recoverable reserve estimates at 50% probability level.

Reserve estimates for individual accumulations are shown in Table 3.

● Oil Discovery
○ Gas Discovery
✹ Oil and Gas Discovery
✳ Multiple reservoirs

PLATE 2

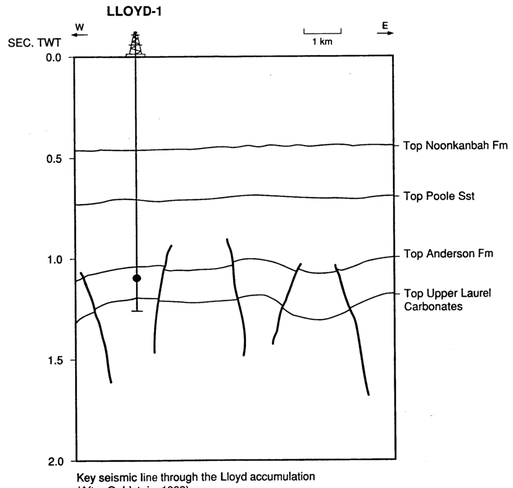
AUSTRALIAN PETROLEUM ACCUMULATIONS

CANNING BASIN

DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY
Compiled by S.J. Cadman and L. Pain
Bibliographic citation: Cadman, S.J. & Pain, L., 1993
Canning Basin, Western Australia
Bureau of Resource Sciences, Australia,
Australian Petroleum Accumulations Report 9.

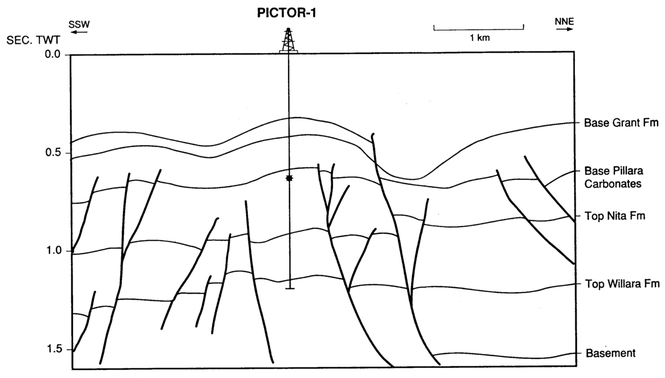
STATUS	OTHER DISCOVERIES									
LOCATION	LENNARD SHELF				FITZROY TROUGH		BARBWIRE TCE			DAMPIER TCE
ACCUMULATION	MEDA	ELLENDALE	CRIMSON LAKE	POINT TORMENT	YULLEROO	ST GEORGE RANGE	MIRBELIA	DODONEA		PICTOR
AGE										
Cretaceous										
Jurassic										
Triassic										
Permian			Grant Fm							
Carboniferous	Laurel Fm	Laurel Fm		Anderson Fm ✳	Laurel Fm	Laurel Fm				
Devonian	Nullara Lst						Mellinjerie Lst			
Silurian										
Ordovician										
TRAP TYPE	Four-way Dip Closure	Famennian Reef	Faulted Four Way Dip Closure (Drilled off structure)	Faulted Four Way Dip Closure	?	Anticline	Anticline	Fault Dependent Closure	Fault Dependent Closure	Fault Dependent Closure	Tilted Fault Block with Internal Four-way Dip Closure
HYDROCARBON DISCOVERY	●	☼	✹	●	☼	☼	☼	●	●	☼	✹

LLOYD-1

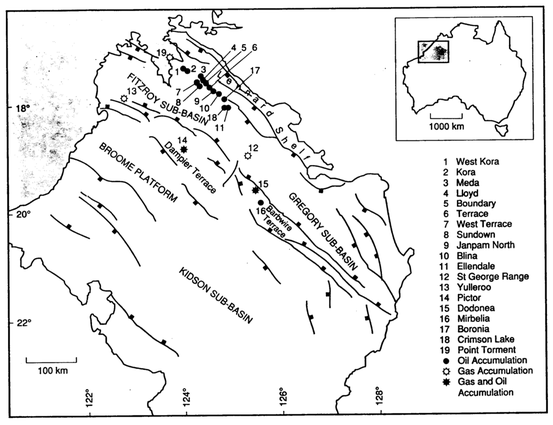


Key seismic line through the Lloyd accumulation
(After Goldstein, 1989)

PICTOR-1



Key seismic line through the Pictor accumulation
(After Goldstein, 1989)



Location map, hydrocarbon discoveries, Canning Basin.

PETROLEUM RESERVES AND PRODUCTION

REMAINING RECOVERABLE RESERVES as at	30	6	91
Gas (Sales)			
LPG			
Condensate			
Oil	1.509 Gigalitres		
CUMULATIVE PRODUCTION as at	30	6	91
Gas (Sales)			
LPG			
Condensate			
Oil	0.303 Gigalitres		
COMMENTS			
Estimates listed above are for the six commercial accumulations shown on Plate 1. Figures supplied by WADME Recoverable reserve estimates at 50% probability level.			
Reserve estimates for individual accumulations are shown in Table 3.			

● Oil Discovery
☼ Gas Discovery
✹ Oil and Gas Discovery
✳ Multiple reservoirs