THE

HYDROCARBON POTENTIAL

OF

EXPLORATION PERMIT

EP-439

ONSHORE CARNARVON BASIN

WESTERN AUSTRALIA

by

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for

ROUGH RANGE OIL PTY LTD

January, 2006

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EXECUTIVE SUMMARY

Exploration Permit EP-439 is located in the Gascoyne Sub-basin and covers an area of 7,200 sq kms (1.8 million acres). The Northwest Coastal Highway, an all weather sealed road, runs north-south through the western part of the permit, and the Dampier-Perth Natural Gas Pipeline transverses north-south through the eastern part of the permit. The port of Carnarvon is only 30 kilometres to the south of the permit.

The Gascoyne Sub-basin contains up to 6,000 metres of Late Cambrian, Ordovician, Silurian, Devonian, Carboniferous, and Permian marine clastic and carbonate sediments. The main play in EP-439 is the Late Devonian reefs, dolomites and carbonates of the Gneudna Formation, sealed and sourced by the intra-formational marine shales.

Carbonate and dolomite reservoirs within the Gneudna Formation have been demonstrated to have reservoir potential in the Gascoyne Sub-basin. Barrabiddy-1A intersected a dolomitised reef with Amphipora stromotoporoids and rugose corals in the Gneudna Formation. One core sample near the top of the reef had porosity of 15.5% with an effective permeability of 40.7 millidarcies. However, complete loss circulation during the drilling of the reef section attest to much higher permeabilities.

At Quobba-1, secondary porosity in a dolomite at 1,170 metres had log-derived values of up to 15%. This dolomite was open hole drill stem tested and flowed some 1,000 BWPD from about 5 metres of porosity. Permeabilities from this test were good.

Good oil-prone Type II source rocks are present in organic-rich marine shales of the Late Devonian Gneudna Formation. TOC's range from 0.12 - 13.56% with common to abundant sapropel and alginite. Rock-Eval S1+ S2 range up to 40 mg/gm with hydrogen indicies varying from 40 -347 indicating Type II source rocks. These source rocks are in the oil generation window over the northern half of EP-439.

The main structures in EP-439 formed either during the Early Devonian Pertnjara Movement or during the Miocene. The Miocene structures (Quobba-1, Pendock-1D and Wandagee-1) all post-date primary hydrocarbon migration and are dry. The Early Devonian structures, however, pre-date primary hydrocarbon migration from the Gneudna Formation source rocks which generated their hydrocarbons during the Late Carboniferous to Permian. None of these aged structures have been drilled in the Gascoyne Sub-basin.

In Exploration Permit EP-439, the main prospect is the Lake Macleod Prospect. Quobba-1 was drilled on a Miocene compressional anticline with the underlying Devonian sediments dipping to the west. A large structure is present to the east. The Devonian sediments drape over an older Silurian fault block and therefore the Lake Macleod structure has been present since Late Devonian times. Timing of oil migration from the Gneudna Formation source rocks into the Lake Macleod Prospect is excellent.

The Lake Macleod Prospect covers an area of 27,500 hectares (70,000 acres) with a vertical relief of 100 milliseconds (150 metres). Estimated potential recoverable reserves for the Lake Macleod prospect are of the order of 150 million barrels. It is planned to drill the Lake Macleod Prospect during the second half of 2006. Farmout terms are for farmines to contribute 100% of the well cost (estimated to be $1.5 million) to earn 75% interest in the entire permit.

1 INTRODUCTION

Exploration Permit EP-439 is located in the Gascoyne Sub-basin and covers an area of 7,200 sq kms (1.8 million acres). The Northwest Coastal Highway, an all weather sealed road, runs north-south through the western part of the permit, and the Dampier-Perth Natural Gas Pipeline transverses north-south through the eastern part of the permit. The port of Carnarvon is only 30 kilometres to the south of the permit (Figure 1).

2 PERMIT DETAILS

The permit was awarded on the 2nd February, 2006 for an initial six year period. The permit consists of 95 graticular blocks covering an area of 7,200 square kilometres (1.8 million acres).

Permit holders are summarised below:

Permit Holder	
Rough Range Oil Pty Ltd	44.44%
Euro Pacific Energy Pty Ltd	31.67%
Indigo Oil Pty Ltd	11.11%
Falcore Pty Ltd	11.11%
Vigilant Oil Pty Ltd	1.67%

The work obligations for the permit are summarised below:

Permit Year	**Period**	**Minimum Work Requirements**	**Estimated Expenditure**
One	2/2/05 – 1/2/06	Seismic Reprocessing	$100,000
Two	2/2/06 – 1/2/07	Seismic Interpretation	$100,000
Three	2/2/07 – 1/2/08	200 kms 2D Seismic Survey	$1,200,000
Four	2/2/08 – 1/2/09	100 kms 2D Seismic Survey	$600,000
Five	2/2/09 – 1/2/10	Seismic Processing & Interpretation	$150,000
Six	2/2/10 – 1/2/11	One (1) Exploration Well	$600,000
Total			**$2,750,000**

The Year One seismic reprocessing has been completed and the permit is in good standing.

3 EXPLORATION HISTORY

Only two wells have been drilled in the permit. These are a stratigraphic well Cape Cuvier-1 and Quobba-1 by Canada Northwest in 1984.

At the end of 1990, Western Geophysical Australia conducted a speculative vibroseis survey in the area between Wandagee-1 in the east and Lake Macleod in the west. This program comprised 312 kilometres of regional coverage and incorporating the reprocessed Wapet line 72-2, a long east-west regional line in EP-439.

The Geological Survey of Western Australia, in an attempt to upgrade the petroleum industry's perception of the hydrocarbon potention of the Palaeozoic sequences onshore Carnarvon Basin, drilled two stratigraphic wells, Gneudna-1 in 1995 and Barrabiddy-1A in 1997. The results of these wells have been described by Mory (1996) and Mory & Yasin (1997).

Exploration permit EP-439 was awarded to the current joint venture in 2005. The Operator has reinterpreted the existing seismic data and incorporated the drilling results of the Geological Survey of Western Australia stratigraphic wells, Gneudna-1 and Barrabiddy-1A into a full evaluation of the permit. This report summarises the results of this evaluation.

4 REGIONAL GEOLOGY AND STRATIGRAPHY

The Gascoyne Sub-basin contains a sequence of up to 6,000 metres of Cambrian to Lower Carboniferous sediments deposted between the Pilbara Block to the east, the Bernier Platform to the west, the Northampton Block to the south and which opens to the north where it plunges beneath the thick Mesozoic to Tertiary Exmouth Sub-basin (Figure 1).

The generalised stratigraphy of the Gascoyne Sub-basin is illustrated in Figure 2. This is based on formations outlined by Hocking et al (1987) and modified by Gorter et al (1994).

Sedimentation began in the Gascoyne Sub-basin during the Late Cambrian with tectonic activity and uplift of the Pilbara and Northampton blocks. This provided clastic sedimentation (Tumblagooda Sandstone) in the form of thick fluvial, alluvial and fan deposition which grade northwards into marginal marine to tidal deposits. These sediments were deposited in a transgressive system tract during progressive rising sea levels with transgression to the south (Gorter et al, 1994).

After a period of non-deposition during most of the Ordovician, a marine transgression began in the Late Ordovician allowing carbonate and evaporitic sedimentation (Dirk Hartog Group) to occur on a shallow, warm and partly restricted shelf. These sediments were deposited in alternating transgressive and high stand system tracts with a low stand (Yaringa Evaporite) during the Homerian (Gorter et al, 1994).

These conditions continued throughout the Silurian and were terminated by uplift and erosion with marginal marine and tidal clastic deposits of the Kopke Sandstone prograding across the shelf as a high stand system tract. Shallow, warm carbonate and evaporitic conditions (Sweeny Mia Formation) were again established over the area during the Early Devonian during a transgressive

and then high stand system tracts (Gorter et al, 1994). This phase of sedimentation was terminated by the Pertnjara Orogeny.

During the Givetian, a marine clastic shelf was established over the basin. Shallow marine sandstones (Nannyarra Sandstone) were deposited in beach, barrier island and tidal channel complexes with deeper water shoreface environments occuring in the central parts of the basin. The basin was closed to the south and opened out to the north where it was connected to the Canning and Bonaparte basins (Warris, 1993).

Rising sea levels during the late Givetian, Frasnian and early Famennian established a carbonate shelf Gneudna Formation) over the basin. Environments consisted of mud flats, lagoons, shallow shelf with Amphipora stromatoporoid reefs (Point Maud Member of Geary, 1970) and oolite banks. The shelf edge is interpreted to be to the north under the Exmouth Sub-basin but with a tongue of deep water interpreted to extend along the axis of the Gascoyne Sub-basin at least as far south as Quobba-1 (Figure 3). The Gneudna Formation is thick (at least 1000 metres) and comprises alternating transgressive and high stand system tracts. (Gorter et al, 1998).

During the Famennian, uplift of the Pilbara Block allowed the alluvial fan deposition of the Willaraddie Formation (Moors, 1981) along the eastern flanks of the Merlinleigh and Ashburton Sub-basins. To the west, these are believed to grade into the extensive marine clastics of the Munabia Sandstone (Nicoll, 1979 and Warris, 1993 & 1994).

By Tournaisian times, the basin deepened and quiet conditions prevailed and a broad carbonate shelf (Moogooree Limestone) was established over the basin (Hocking et al, 1987 and Baillie & Jacobsen, 1995). Tectonic activity and uplift of the Pilbara Block at the end of the Tournaisian allowed alluvial fan deposition (Williambury Formation) along the eastern flanks of the Merlinleigh and Ashburton Sub-basins (Hocking et al, 1987). To the west, these are believed to grade into marine clastics which were followed by Visean carbonate deposition (Yindagindy Formation) and Namurian clastic deposition (Quail Formation) (Nicoll & Gorter, 1994).

This sequence was terminated during the Mid-Carboniferous by the Alice Springs Orogeny. The major Giralia and Wandagee faults are believed to have formed at this time burying the Merlinleigh, Ashburton and northern Gascoyne sub-basins under considerable thicknesses of Permian sediments. The Gascoyne Sub-basin was uplifted 2000 - 3000 metres relative to the Merlinleigh Sub-basin (Blake et al, 1984) and became a major Permian depocentre.

It is not known if Triassic or Jurassic sediments were deposited in the Gascoyne Sub-basin. If they were, they, together with the Permian sediments, were eroded during major periods of uplift and block faulting during the Late Triassic, Late Jurassic and Early Cretaceous.

A major marine transgression began in the late Valanginian and flooded the basin with uniform marine clastics. With the decline in the influx of terrigenous sediment as Australia moved northward into more tropical latitudes, shelf carbonates became established during the Turonian to Santonian.

The Tertiary was mostly a period of erosion with nearshore marine carbonate and clastic deposition during the Eocene. Mid-Miocene compression and wrenching, caused by Australia colliding with the Asian plate, formed a number of reverse faulted anticlines (Baillie & Jacobsen, 1995) some of which are related to older Palaeozoic faults. These anticlines persist only down to the Base Cretaceous Unconformity below which the Palaeozoic structures are quite different (Warris, 1993).

5 HYDROCARBON POTENTIAL

5.1 Reservoir/Seal

5.1.1 Point Maud Member

One of the main objectives in EP-439 is the Frasnian reefal Point Maud Member of the Gneudna Formation. Point Maud reefs have only been encountered in two wells in the Gascoyne Sub-basin; Pendock-1D and Barrabiddy-1A.

In Pendock-1D, the Point Maud Member is composed of massive, fine to coarse grained dolomite containing abundant Amphipora stromatoporoids and rare rugose corals (Geary, 1970). It has sonic log-derived porosities of up to 10%.

In Barrabiddy-1A, the Point Maud Member consist of dolomitised limestones with Amphipora stromotoporoid floatstones, rugose coral packstones and boundstones, bryozoan-brachiopod-crinoid packstones, and brachiopod-crinoid grainstones. The section was continuously cored and had intercrystalline and leached vuggy and cavernous porosities, and was brecciated and fractured. Most of the core broke up and was unsuitable for core analysis. One sample at 283 metres near the top of the reef had porosity of 15.5% with an effective permeability of 40.7 millidarcies. However, complete loss circulation during the drilling of the reef section (Mory & Yasin, 1998) attest to much higher permeabilities.

In Barrabiddy-1A, the Point Maud Member reef was unconformably overlain by the Munabia Sandstone and therefore is not sealed. The Point Maud Member reef in Pendock-1D, was conformably overlain by 200 metres of interbedded marls and calcilutites of the upper Gneudna Formation which provides an excellent seal. However, it is believed that the Devonian section in Pendock-1D had been deeply buried, diagenetically altered and then uplifted prior to Cretaceous sedimentation. In addition, Pendock-1D was drilled on a Cretaceous anticline with the underlying Devonian section dipping at 20º to the west (Figure 6, Geary, 1970). It was not a valid test of the Point Maud Member reef.

In EP-410, seal is inferred to be provided by thick marine shales and marls of the upper Gneudna Formation overlying the Point Maud Member (Enclosure 1).

5.1.2 Gneudna Formation

Carbonate reservoirs within the Gneudna Formation have been demonstrated to have reservoir potential and are the main objectives for the Lake Macleod Prospect in EP-439. At Quobba-1, secondary porosity in a dolomite at 1,170 metres had log-derived values of up to 15% (Blake et al, 1984). This dolomite was open hole drill stem tested and flowed some 1,000 BWPD from about 5 metres of porosity. Permeabilities from this test were good.

Loss circulation in carbonates was also encountered in Quobba-1 between 482 - 500 metres.

Seal is provided by intra-formational marine shales and marls within the Gneudna Formation (Enclosure 1).

5.1.3 Nannyarra Sandstone

The Nannyarra Sandstone also provides a secondary objective in EP-439. These sandstones have log-derived porosities of 15-20% with good permeabilities in Wandagee-1; log-derived porosities of up to 30% in Echo Bluff-1 (Warris, 1993); and core-derived porosities of up to 18.3% with permeabilities of 28 millidarcies in Pendock-1D.

Vertical seal is provided by the regional marine shales of Sequence 1 at the base of the Gneudna Formation (Gorter et al, 1998). This shale unit is of the order of 100 metres thick in Pendock-1D, Quail-1 and Quobba-1 (Enclosure 1), and would also provide lateral seal across small faults.

5.2 Source

According to Klemme & Ulmishek (1991), 8% of the world's oil was generated from platform or intracratonic sag black shale facies of Frasnian to Tournaisian age. Eighty percent of these reserves are oil and were sourced from mostly Type 1 kerogens deposited within 45º of the equator. Palaeogeographical reconstructions show that the Gascoyne Sub-basin lay between 25º to 30º south of the equator during the Upper Devonian (Figure 3 of Ormiston & Oglesby, 1995).

Good oil-prone source rocks are present in organic-rich marine shales in the lower part of the Gneudna Formation. This is based on source rock analyses by AGSO (Edwards et al, 1997); Industry (Analabs, 1984 & 1985; Percival & Cooney, 1985; Purcell & Ingram, 1984; and Blake et al, 1984); Curtin University (Scott & Alexander, 1991) and the Geological Survey of WA (Ghori, in Mory & Yasin, 1998; Ghori, in Mory, 1996 and Ghori, 1998).

A summary of these source rocks is shown in the following table.

Well	TOC%	Kerogen	S1+S2	Hydrogen Index
Barrabiddy-1A	0.14-13.56		1.01-40.09	75-267
Cape Cuvier-1	0.27-0.93	25-50% Sapropel Tr-25% Alginite		
Gneudna-1	0.50-2.46		0.96-8.77	105-347
Pendock-1D	0.12-1.93	25-50% Sapropel 10-25% Alginite	0.13-4.50	97-256
Quobba-1	0.43-1.02	Tr-25% Sapropel 10-50% Alginite	0.37-3.62	40-313
Wandagee-1		10-50% Sapropel Tr-10% Alginite		

The best source rocks in the Gneudna Formation were intersected in Barrabiddy-1A. These source rocks have been characterised as containing Type II kerogens and being oil prone (Figure 4).

Lambert (1993) discussed the distribution of source rocks in Upper Devonian to Lower Carboniferous shales (Woodford and Chattanooga Shales) in North America and related them to the depositional framework via sequence stratigraphy. In Lambert's model, the best source rocks were deposited during the late transgressive phase at the time of maximum flooding.

5.3 Maturity

A thermal maturity map of the lower part of the Gneudna Formation is shown in Figure 5. This is based on cross plots of Tmax versus Production Index cross plots (Gorter et al, 1998); thermal alteration indices (TAI - Analabs, 1984 & 1985 and Purcell, in Mory & Yasin, 1998a) and conodont colour alteration indices (CAI - Gorter et al, 1994 and Mory & Yasin, 1998).

The lower Gneudna Formation is immature in Gneudna-1 (Mory, 1996) and in the early oil window in Barrabiddy-1A (Mory & Yasin, 1998), Pendock-1D (Scott & Alexander, 1991) and Qubba-1 (Purcell & Ingram, 1984). The unit is in the gas window in Quail-1 where it was deeply buried beneath thick Permian sediments of the Merlinleigh Sub-basin (Percival & Cooney, 1984).

Figure 5 illustrates that the Gneudna Formation source rocks are in the oil window in the northwestern quarter of EP-439 and extend south to the northern flanks of the Lake Macleod Prospect.

5.4 Timing

Due to tectonic events which caused uplift and erosion of the Gascoyne Sub-basin during the Mid-Carboniferous, Late Triassic, Late Jurassic and Early Cretaceous, it is not possible to produce a meaningful burial history plot of the Gneudna Formation.

However, based on the stratigraphic section onshore (Hocking et al , 1987), there is a mostly continuous sedimentary section from the Middle Devonian Nannyarra Sandstone to the Middle Carboniferous Quail Formation. The section above the Gneudna Formation in the northwest quarter of EP-439 is estimated to have been 2,000 metres thick where a full Late Devonian to Early Carboniferous section would have been present beneath the Base Cretaceous Unconformity.

Assuming a normal geothermal gradient of 2.5º to 3.0º C/100 metres, the Gneudna Formation source rocks are predicted to have generated most of their oil during the Early to Mid Carboniferous. The main structures in EP-439 formed either during the Early Devonian Pertnjara Movement or during the Miocene. The Miocene structures (Quobba-1, Pendock-1D and Wandagee-1) all post-date primary hydrocarbon migration and are dry. The Early Devonian structures, however, pre-date primary hydrocarbon migration from the Gneudna Formation source rocks which generated their hydrocarbons during the Late Carboniferous to Permian. None of these aged structures have been drilled in the Gascoyne Sub-basin.

6 SEISMIC INTERPRETATION

The initial seismic interpretation was carried out using paper section displays of the 1983 Lyell Range Seismic Survey and the reprocessed B72-1L line from the Lyndon Quobba Seismic Survey. The quality of this seismic is very good (Figures 7) with excellent seismic character providing reliable horizon ties at line intersections.

Five seismic horizons were mapped with time structure maps prepared for two of these. The horizons are:

(i) Base Cretaceous Unconformity
(ii) Intra-Gneudna Event
(iii) Top Dirk Hartog Group (Figure 6)
(v) Top Tumblagooda Sandstone

Significant tectonic movements took place during the Early Devonian Pernjara Movement (Warris, 1994) causing significal vertical uplift and block faulting in parts of the basin.

7 LAKE MACLEOD PROSPECT

In Exploration Permit EP-439, the main prospect is the Lake Macleod Prospect. Quobba-1 was drilled on a Miocene compressional anticline with the underlying Devonian sediments dipping to the west. A large structure is present to the east (Figure 6). The Devonian sediments drape over an older Silurian fault block and therefore the Lake Macleod structure has been present since Late Devonian times (Figure 7). Timing of oil migration from the Gneudna Formation source rocks into the Lake Macleod Prospect is excellent. The Devonian section in Quobba-1 is mostly shale so seal is not a problem. There were good oil and gas shows throughout the Gneudna Formation in Quobba-1 and in particular a dolomite at 1,170 metres. This dolomite was open hole drill stem tested and flowed some 1,000 BWPD from about 5 metres of porosity. Permeabilities from this test were good.

The Lake Macleod Prospect covers an area of 27,500 hectares (70,000 acres) with a vertical relief of 100 milliseconds (150 metres). Estimated potential recoverable reserves for the Lake Macleod prospect are of the order of 150 million barrels (Table 1).

TABLE 1
POTENTIAL RESERVE ESTIMATE
LAKE MACLEOD PROSPECT

Area	275 sq km	27,500 hectares
Maximum Gross Pay	100 milliseconds	150 metres
Net Dolomite Pay	5 metres	
Average Net Pay	5 metres	
Volume	137,500 hectare-metres	
Reservoir	Porosity = 12% (average)	
	Sw = 40%	
	FVF = 1.2	
Oil-in-Place	3,800 barrels/hm	
	522 million barrels	
Recovery Factor	30%	
Recoverable Oil Reserves	155 million barrels	

8 REFERENCES

Analabs, 1984. Summary of geochemical, palynological and petrological data for Quobba-1. *Unpublished Report* .

Analabs, 1985. Hydrocarbon source rocks characterisation study, Carnarvon Basin regional evaluation. *Unpublished Report* .

Baille, P.W. & Jacobsen, E., 1995. Structural Evolution of the Carnarvon Terrace, Western Australia. *The APEA Journal*, 35 (1) 321-332.

Blake, T., Burgess, I., Saruk, E. & Hartog, D., 1984. Quobba No 1 Well Completion Report, Carnarvon Basin, Gascoyne Sub-basin, EP-274. *Unpublished Report prepared for Canada Northwest Australia Oil NL*.

Edwards, D.S., Summons, R.E., Kennard, J.M., Nicoll, R.S., Bradshaw, J., Bradshaw, M., Foster, C.B., O'Brien, G.W. & Zumberge, J.F., 1997. Geochemical characteristics of Palaeozoic petroleum systems in northwestern Australia. *The APEA Journal*, 37 (1) 351-370.

Geary, J.K., 1970. Offshore Exploration in the southern Carnarvon Basin.*The APEA Journal*, 10 (1) 9-15.

Ghori, K.A.R., 1998 Palaeozoic petroleum generating potential and thermal history, Carnarvon Basin, Western Australia. In: Purcell, P.G. & R.R. (Eds). "West Australian Basins". *Proceedings of Petroleum Exploration Society of Australia Symposium*, Perth, 1994.

Gorter, J.D., Nicoll, R.S. & Foster, C.B., 1994. Lower Palaeozoic facies in the Carnarvon Basin, Western Australia: stratigraphy and hydrocarbon prospectivity. In: Purcell, P.G. & R.R. (Eds). "Sedimentary Basins of Western Australia". *Proceedings of Petroleum Exploration Society of Australia Symposium*, Perth, 1994, 447-470.

Gorter, J.D., Mory, A. & Nicoll, R.S., 1998. Sequence Stratigraphy and Hydrocarbon Potential of the Middle to Upper Devonian (Givetian - Frasnian) in the Carnarvon Basin, Western Australia. In: Purcell, P.G. & R.R. (Eds). "West Australian Basins". *Proceedings of Petroleum Exploration Society of Australia Symposium*, Perth, 1994.

Hocking, R.M., Moors, H.T. & Van de Graaff, J.E., 1987. Geology of the Carnarvon Basin, Western Australia. *Geological Survey of Western Australia*, *Bulletin* 133.

Klemme, H.D. & Ulmishek, G.F., 1991. Effective petroleum source rocks of the world: stratigraphic distribution and controlling depositional factors. *American Association of Petroleum Geologists, Bulletin* 75, 1809-1851.

Lambert, M.W., 1993. Internal stratigraphy and organic facies of the Devonian-Mississippian Chattanooga (Woodford) Shale in Oklahoma and Kansas. In: Katz, B.J. & Pratt, L.M. (Eds). "Source Rocks in a Sequence Stratigraphic Framework". *AAPG Studies in Geology* #37, 163-176.

Moors, H.T., 1981. An alluvial fan-fluvial plain depositional model for the Devonian Willaraddie Formation and Munabia Sandstone of the Carnarvon Basin, Western Australia. *Geological Survey of Western Australia Annual Report* 1980, 62-67.

Mory, A., 1996. GSWA Gneudna 1 Well Completion Report, Merlinleigh Sub-basin, Carnarvon Basin, Western Australia. *Geological Survey of Western Australia, Record* 1996/6.

Mory, A. & Yasin, 1998. GSWA Barrabiddy 1 and 1A Well Completion Reports, Wandagee Ridge, Southern Carnarvon Basin, Western Australia. *Geological Survey of Western Australia, Record In Press.*

Nicoll, R.S., 1979. A Late Devonian age for the Munabia Sandstone, Carnarvon Basin. *Australian BMR Professional Opinion Geol*. 79/034.

Nicoll, R.S. & Gorter, J.D., 1994. Interpretation of the Devonian-Carboniferous stratigraphy of Quail 1, onshore Carnarvon Basin: regional implications for geohistory and hydrocarbon prospectivity, *AGSO Journal of Geology & Geophysics*, 15 (4) 413-420.

Ormiston, A.R. & Oglesby, R.J., 1995. Effect of Late Devonian paleoclimate on source rock quality and location. In: Huc, A.Y. (Ed). "Paleogeography, Paleoclimate and Source Rocks". *AAPG Studies in Geology*, #40, 105-132.

Percival, I.G. & Cooney, P.M., 1985. Petroleum geology of the Merlinleigh Sub-basin, Western Australia.*The APEA Journal*, 25 (1) 190-203.

Purcell, R.R. & Ingram, B., 1984. Palynology Report AP38 Palynology and source rock assessment of Quobba No 1. *Unpublished Report for Canada Northwest*, May, 1984.

Scott, J. & Alexander, R., 1991. Geochemical analysis of Cane River-1, Dirk Hartog-17B, Fortescue-1, Mardie-1, Pendock-1D, Sholl-1, Tamala-1 and Rough Range-1. *WA Centre for Petroleum Exploration Curtin University (unpublished).*

Warris, B.J., 1993. The hydrocarbon potential of the Palaeozoic Basins of Western Australia. *The APEA Journal*, 33 (1) 123-137.

Warris, B.J., 1994. The hydrocarbon potential of the onshore Carnarvon Basin. In: Purcell, P.G. & R.R. (Eds). "Sedimentary Basins of Western Australia". *Proceedings of Petroleum Exploration Society of Australia Symposium*, Perth, 1994, 365-372.

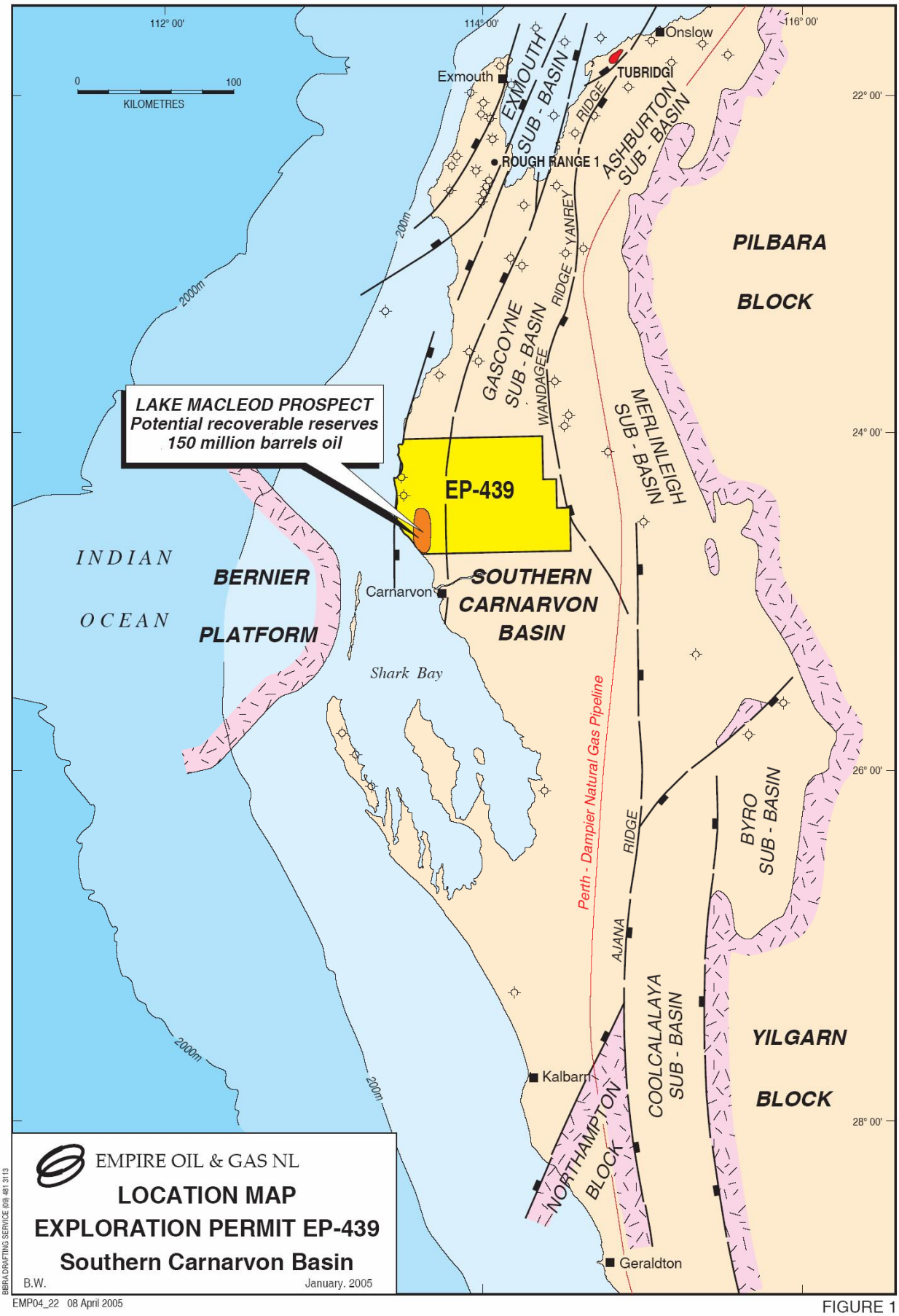
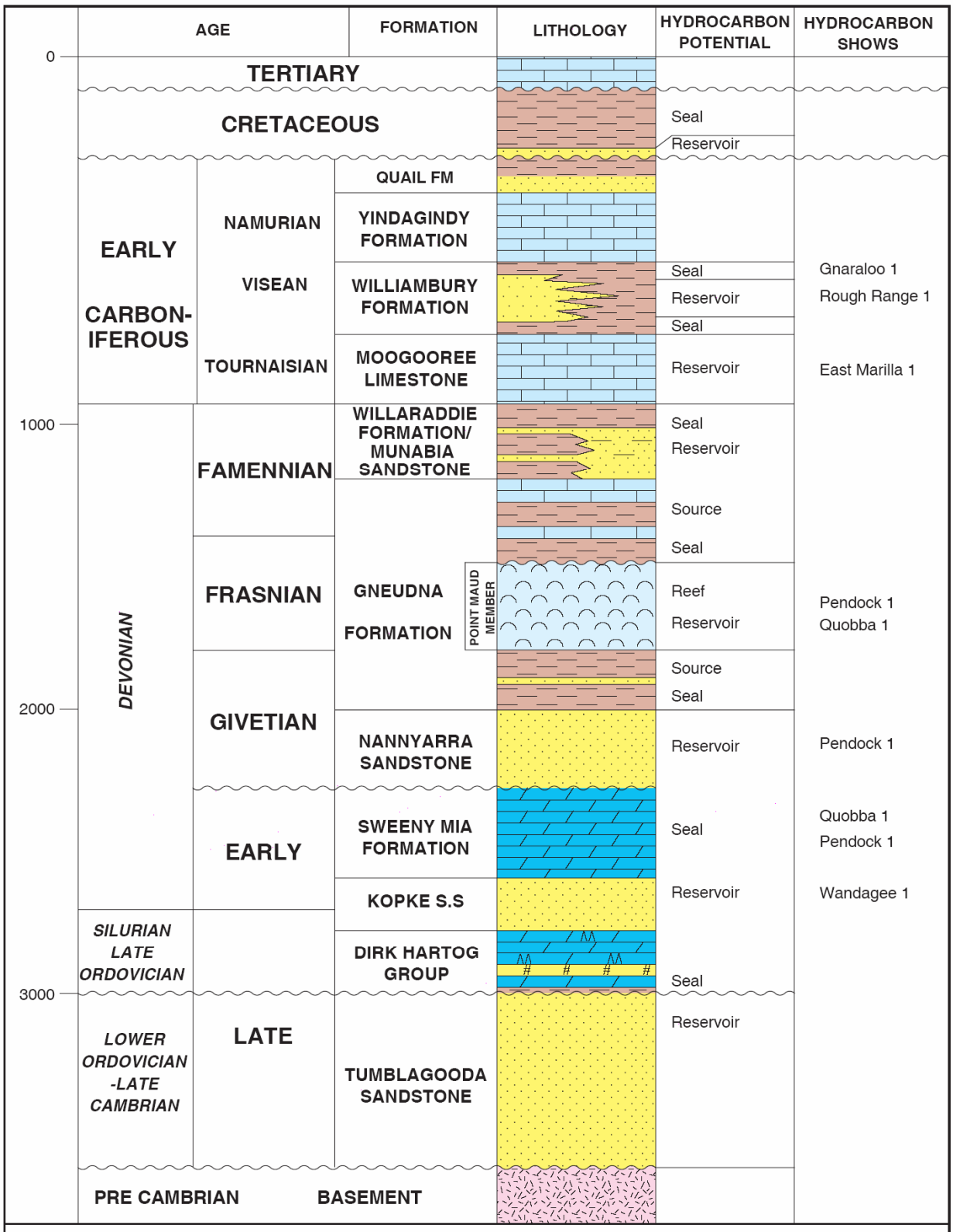

112° 00'
114° 00'
116° 00'
22° 00'
24° 00'
26° 00'
28° 00'
0
100
KILOMETRES
Onslow
Exmouth
TUBRIDGI
EXMOUTH SUB - BASIN
RIDGE
ASHBURTON SUB - BASIN
ROUGH RANGE 1
200m
2000m
YANREY RIDGE
PILBARA BLOCK
GASCOYNE SUB - BASIN
WANDAGEE RIDGE
MERLINLEIGH SUB - BASIN
LAKE MACLEOD PROSPECT
Potential recoverable reserves
150 million barrels oil
EP-439
INDIAN OCEAN
BERNIER PLATFORM
Carnarvon
SOUTHERN CARNARVON BASIN
Shark Bay
Perth - Dampier Natural Gas Pipeline
RIDGE
BYRO SUB - BASIN
AJANA
Kalbarri
COOLCALALAYA SUB - BASIN
YILGARN BLOCK
NORTHAMPTON BLOCK
Geraldton
EMPIRE OIL & GAS NL
LOCATION MAP
EXPLORATION PERMIT EP-439
Southern Carnarvon Basin
B.W.
January. 2005
BBRA DRAFTING SERVICE (09) 481 3113
EMP04_22 08 April 2005

FIGURE 1



GENERALISED STRATIGRAPHY
GASCOYNE SUB-BASIN

BIBRA DRAFTING SERVICE (08) 9481 3113
NOV., 1996
BEV96_16

FIGURE 2

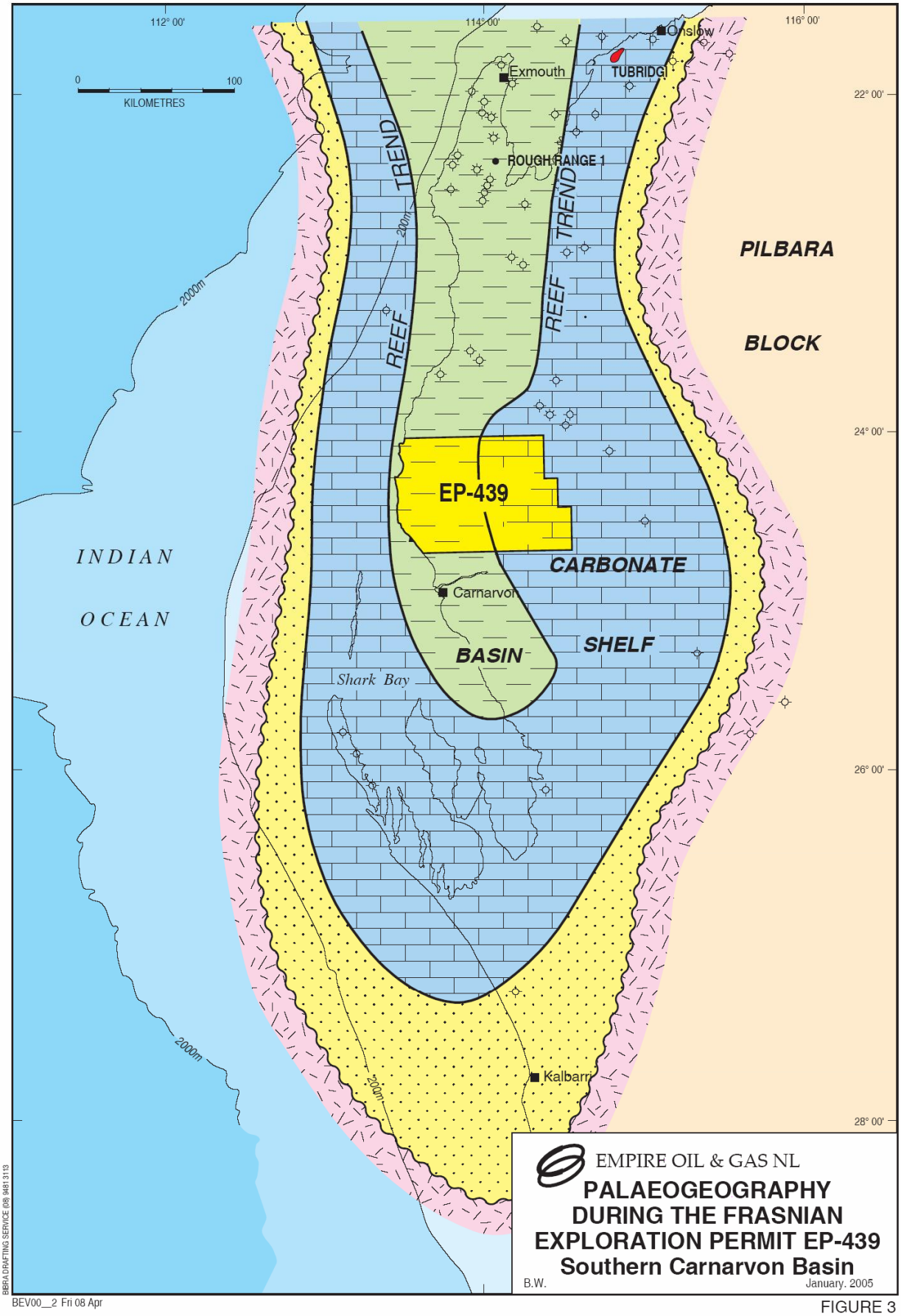
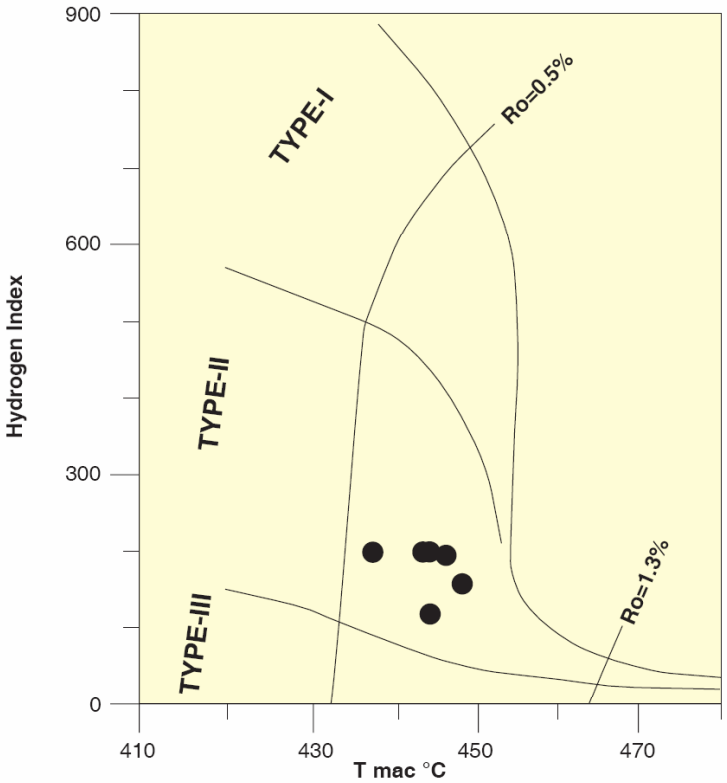

112° 00'
114° 00'
116° 00'
22° 00'
24° 00'
26° 00'
28° 00'
0
100
KILOMETRES
Onslow
Exmouth
TUBRIDGI
ROUGH RANGE 1
REEF TREND
REEF TREND
200m
2000m
PILBARA
BLOCK
EP-439
CARBONATE
SHELF
BASIN
Carnarvon
Shark Bay
INDIAN
OCEAN
Kalbarri
2000m
200m
EMPIRE OIL & GAS NL
PALAEOGEOGRAPHY
DURING THE FRASNIAN
EXPLORATION PERMIT EP-439
Southern Carnarvon Basin
B.W.
January. 2005
BEPA DRAFTING SERVICE (08) 9481 3113
BEV00__2 Fri 08 Apr

FIGURE 3

ROUGH RANGE OIL PTY LTD

Source-rock kerogen typing by Rock-Eval pyrolysis of the Gneudna Formation in Barrabiddy 1/1A



TOC versus C_{12} + hydrocarbons content plot for source rocks of the Gneudna Formation in Barrabiddy 1A

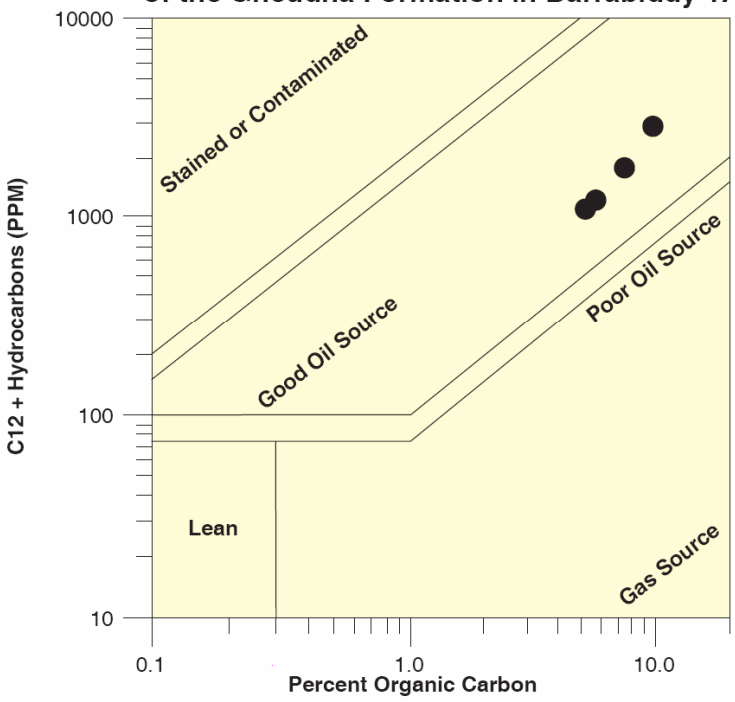


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FIGURE4

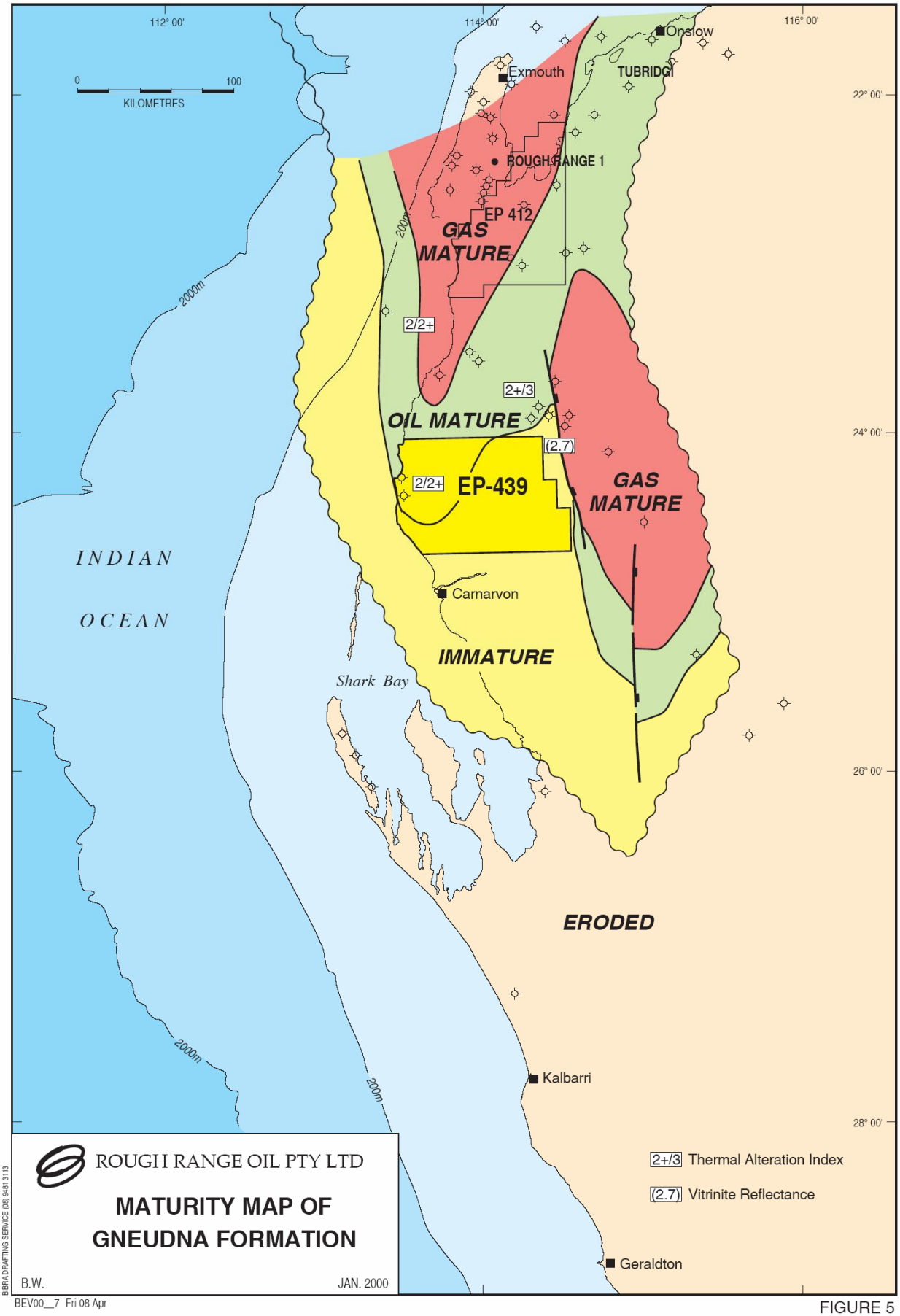

112° 00'
114° 00'
116° 00'
22° 00'
24° 00'
26° 00'
28° 00'
0
100
KILOMETRES
Onslow
Exmouth
TUBRIDGI
ROUGH RANGE 1
EP 412
GAS MATURE
200m
2000m
2/2+
2+/3
OIL MATURE
(2.7)
2/2+
EP-439
GAS MATURE
INDIAN
OCEAN
Carnarvon
IMMATURE
Shark Bay
ERODED
Kalbarri
Geraldton
2+/3 Thermal Alteration Index
(2.7) Vitrinite Reflectance
ROUGH RANGE OIL PTY LTD
MATURITY MAP OF
GNEUDNA FORMATION
B.W.
JAN. 2000
BBRA DRAFTING SERVICE (08) 9481 3113
BEV00__7 Fri 08 Apr

FIGURE 5

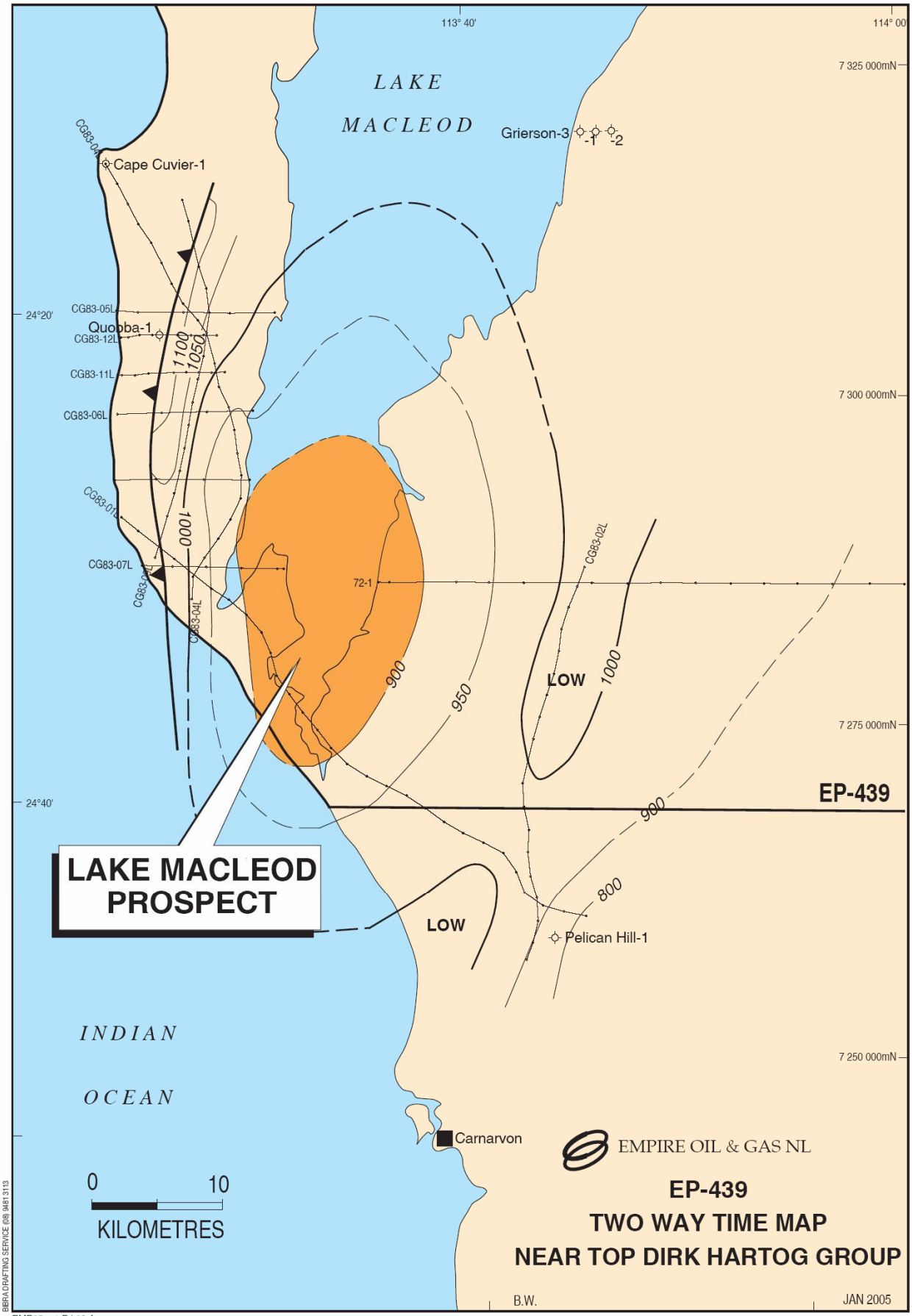
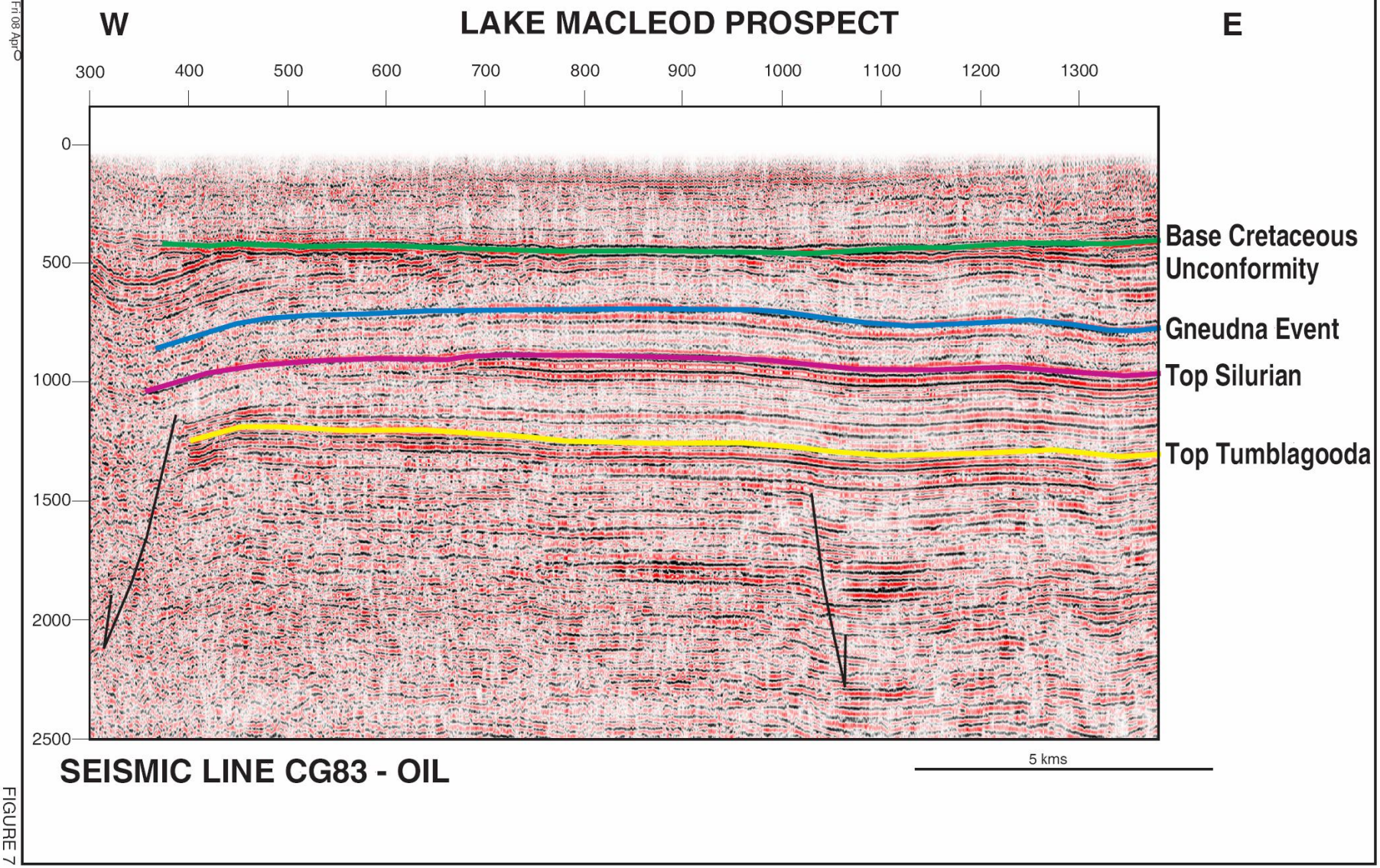
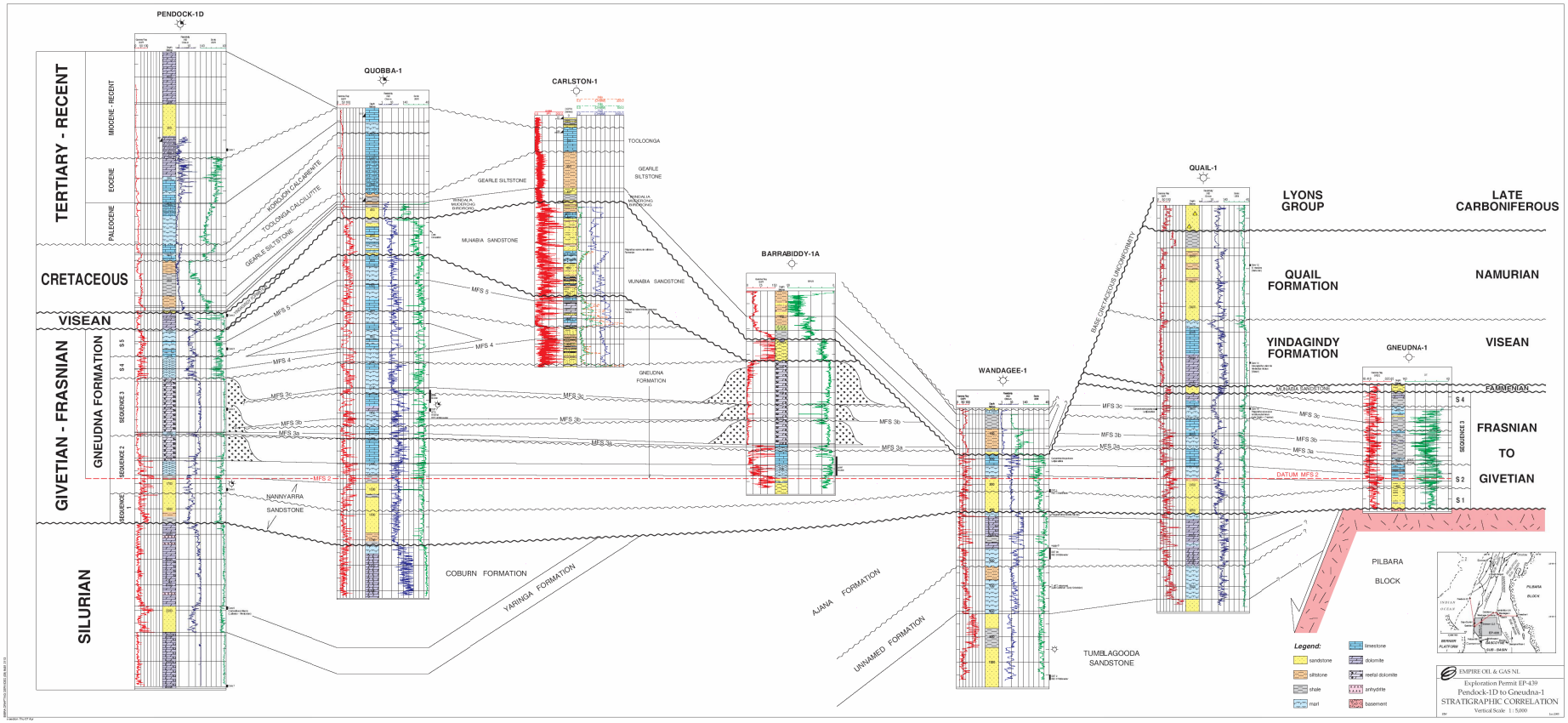

113° 40'
114° 00'
7 325 000mN
7 300 000mN
7 275 000mN
7 250 000mN
24°20'
24°40'
LAKE
MACLEOD
INDIAN
OCEAN
Grierson-3
-1
-2
Cape Cuvier-1
Quobba-1
CG83-04L
CG83-05L
CG83-12L
CG83-11L
CG83-06L
CG83-01L
CG83-07L
CG83-03L
CG83-04L
CG83-02L
72-1
1100
1050
1000
900
950
1000
900
800
LOW
LOW
EP-439
LAKE MACLEOD
PROSPECT
Pelican Hill-1
Carnarvon
0
10
KILOMETRES
EMPIRE OIL & GAS NL
EP-439
TWO WAY TIME MAP
NEAR TOP DIRK HARTOG GROUP
B.W.
JAN 2005
BBRA DRAFTING SERVICE (08) 9451 3113
EMP05__1 Fri 08 Apr

FIGURE 6



SEISMIC LINE CG83 - OIL

FIGURE 7


PENDOCK-1D
QUOBBA-1
CARLSTON-1
BARRABIDDY-1A
WANDAGEE-1
QUAIL-1
GNEUDNA-1
TERTIARY - RECENT
MIOCENE - RECENT
EOCENE
PALEOCENE
CRETACEOUS
VISEAN
GIVETIAN - FRASNIAN
GNEUDNA FORMATION
SEQUENCE 3
SEQUENCE 2
SEQUENCE 1
SILURIAN
KORDON CALCARENITE
TOOLONGA CALCILUTITE
GEARLE SILTSTONE
MUNABIA SANDSTONE
TOOLOONGA
GEARLE SILTSTONE
MUNABIA SANDSTONE
GNEUDNA FORMATION
MFS 5
MFS 4
MFS 3c
MFS 3b
MFS 3a
MFS 2
NANIMYARRA SANDSTONE
COBURN FORMATION
YARINGA FORMATION
AJANA FORMATION
UNNAMED FORMATION
TUMBLAGOODA SANDSTONE
BASE CRETACEOUS UNCONFORMITY
LYONS GROUP
LATE CARBONIFEROUS
QUAIL FORMATION
NAMURIAN
YINDAGINDY FORMATION
VISEAN
FAMENNIAN
FRASNIAN TO GIVETIAN
DATUM MFS 2
S4
S3
S2
S1
PILBARA BLOCK
Legend:
sandstone
siltstone
shale
marl
limestone
dolomite
metal dolomite
anhydrite
basement
EMPIRE OIL & GAS NL
Exploration Permit EP 439
Pendock-1D to Gneudna-1
STRATIGRAPHIC CORRELATION
Vertical Scale 1 : 5,000