Petroleum and mineral resource potential of the nominated Cape Range–Ningaloo World Heritage area

Introduction

The World Heritage Consultative Committee at the recent meeting with representatives from the Department of Industry and Resources (DoIR) expressed an interest in obtaining additional information in relation to the petroleum and mineral resources of the areas that are likely to be affected by the Committee's recommendations.

The Geological Survey of Western Australia (GSWA), a division of DoIR, has carried out significant research in and adjacent to the nominated World Heritage area. The research highlights the resource potential of the region, particularly for onshore petroleum. A number of publications that provide an overview of the petroleum and mineral potential of the Carnarvon Basin and Gascoyne region are enclosed with this report.

The recent discoveries of new oil and gas fields in the Exmouth Gulf and the discovery of additional prospects in the Gulf and over the Giralia Range area, south of the Gulf serve to confirm this potential.

Copies of DoIR's "Resource Potential for Land Use Planning" maps for the Cape Range–Ningaloo and Lake Macleod areas have been submitted previously. A new map showing locations of very recent petroleum discoveries, prospects and targets ("leads") located in the Exmouth Gulf and Giralia Range areas accompanies this report (Figure 1).

Main areas of resource potential

A review of the petroleum and mineral resources, as well as potential resources, for the main areas of the nominated World Heritage area, and for adjacent areas that may be affected, follows.

Offshore Exmouth Sub-basin

Although not within the area under consideration for World Heritage nomination, there are several known and potential oil and gas fields offshore from the North West Cape that may be affected by a World Heritage nomination. Some of these are new fields and have not be reviewed in the accompanying technical reports.

The board of Woodside Petroleum Limited approved a $1.48 billion Australian dollar investment in the Enfield oilfield development in March 2004. The Enfield Area Development Project is in permit WA-28-L, about 40km northwest off the North West Cape and approximately 50Km northwest of Exmouth in Western Australia. Woodside Petroleum has a 60% interest in the permit, which includes the Enfield, Vincent and Laverda oil fields. The Enfield oil field was discovered in 1999, with recoverable oil reserves in excess of 125 million barrels. Oil production at Enfield will be a major contributor to Woodside Petroleum's future growth, with first oil production forecast by the second half of 2006.

Positive reports from the BHB Billiton–Woodside Petroleum Joint Venture from the Stybarrow appraisal drilling campaign in permit WA-255-P (2) and an Apache Energy report on the success of the Ravensworth-2 Well in July 2004, together with the confirmation of hydrocarbons on the western flank of the producing Woolybutt Field are indicators of the potential for the area to become a major new Australian oil province.

Exmouth Gulf/Rough Range

Petroleum

This Exmouth Gulf and adjacent Rough Range area are located in the Exmouth Sub-basin of the highly prospective North Carnarvon Basin. The numerous oil and gas fields of the Northern Carnarvon Basin demonstrate the petroleum potential of the region, particularly offshore. The sub-basin margins such as the Exmouth Gulf Sub-basin may hold the key to a major portion of the undiscovered reserves (GSWA, 2004).

Current petroleum exploration permits are shown on the accompanying map (Figure 1) and details are shown in Table 1.

Table 1. Petroleum Permits, Exmouth Gulf and Rough Range

Permit	Company	Company	Company	Company
EP-41	Lansvale Oil and Gas	Pace Petroleum	Rough Range Oil and Gas	Strike Oil
EP-325	Sun Resources	Victoria Petroleum		
EP-342	Apache Northwest	Strike Oil		
Ep-359	Lansvale Oil and Gas	Pace Petroleum	Rough Range Oil and Gas	Sun Resources

Information on existing gas resources and gas and oil potential in these tenements has been obtained from DoIR (2004). EP-325 contains the offshore Rivoli Gas Field with a resource of 10-20 billion cubic feet (BCF). Other satellite prospects to this field could contain 50-90 BCF giving a total value for the field in the order of between $180 and $330 million. Details of the Rivoli Gas Field and surrounding prospects and Cooper (previously known as the Champion) oil prospects located south and southwest of the Rivoli Gas Field are shown in Figure 2 that accompanies this report (DoIR, 2004). The Cooper oil prospects are estimated to amount to 47 million barrels worth almost $2.5 billion. Rough Range by comparison has reserves of approximately one million barrels.

It should be pointed out that parts of EP-342 lie within the proposed Murion/Sunday Island Marine Management area and that this permit area also includes the currently sub-economic Leatherback and Ridley Oil Fields.

Salt

Straits Resources Limited is investigating the feasibility of the Exmouth Salt Project located along the eastern margin of Exmouth Gulf. The company proposes to invest $120 million to produce up to 10 million tonnes of salt annually. It has been granted 10 exploration licences over the area of interest while it undertakes feasibility studies (DoIR, 2004).

Cape Range

Limestone outcrops over most of Cape Range. The limestones were mapped by Condon et al. (1953) and more recently described by Hocking et al. (1987).

Cape Range is one of the most important localities in Western Australia for high-grade metallurgical limestone but, until recently, the mining of limestone from the region has been limited by environmental constraints and remoteness.

BHP first explored the area for metallurgical limestone between 1961-1968. The Geological Survey of Western Australia (Kojan, et al., 1995) carried out an assessment of the eastern part of the Cape Range between 1992-1995. This assessment showed that the eastern Cape Range area has inferred resources estimated at 4000 Mt of high-grade limestone grading 55.3% CaO (98.7% $CaCO_3$), 0.4% MgO (0.8% $MgCO_3$) and 0.6% SiO_2. The southern part of the eastern Cape Range area contains approximately 2500 million tonne (Mt) of these resources. It is proposed that this area becomes a CALM 5 h reserve for conservation and resource management.

There are two main area of mining tenements located in the eastern Cape Range area, a northern group held by Alcoa and Whitecrest Enterprises, located west of Exmouth, and a southern group held by Learmonth Limestone in the area of the proposed 5h reserve. In 1998, Exmouth Limestone commenced quarrying operations

from the Exmouth area. The initial capacity of the operation is 1 million tonne per annum (Mtpa) of crushed metallurgical limestone (Flint and Abeysinghe, 2000).

Giralia Range

The Giralia Range is a major anticlinal structure located in the onshore part of the Southern Carnarvon Basin, south of Exmouth Gulf and west of the North West coastal highway. This Basin is one of the less explored sedimentary basins of Australia (DoIR, 2004). However, Giralia Range and the surrounding area have recently been investigated by seismic surveys and the results indicate high prospectivity for petroleum (Bounty Oil and Gas NL, 2004). Numerous occurrences of anomalous silver with barite have been reported from Giralia Range itself indicating high potential for these minerals and for base metal (copper, lead and zinc) mineralization. Bentonite is widespread in the Cretaceous Gearle Siltstone and Alinga Formation (Harrison, 1985). Bentonite is a clay that has numerous industrial and environmental usages including the sealing of dams, soil stabilization and absorbing heavy metals. Microdiamonds are also reported from a location south of the Range.

Petroleum

Flint and Abeysinghe (2000) reported hydrocarbons shows from shallow water bores and stated that there have been only a few valid tests for hydrocarbon plays in the region. The Giralia and Marilla Ranges represent parts of two large Middle Miocene anticlines that trends NNE through the central part of the area.

The Giralia Range and surrounding area is subject to EP 412 held by Bounty Oil and Gas, and Rough Range Oil and Gas. Bounty Oil and Gas has recently announced a major gas and/or oil prospect (the Jubilee Prospect) that occupies a NNE trending compressional fold located to the west of the Giralia Range anticline within Palaeozoic-age reservoir rocks. The Jubilee prospect and the other smaller targets or "leads" reported by Bounty Oil and Gas are shown on the accompanying petroleum prospectivity map (Figure 1).

The potential recoverable petroleum reserves associated with such a large structure could exceed several trillion cubic feet of gas and/or 200 million barrels of oil (Bounty Oil and Gas NL, 2004). Although the risks are high, the potential economic value is of the order of $3 billion for the gas and $10 billion for the oil. Two additional prospects shown on the map (Figure 1) are also considered highly prospective for gas, namely Victoria (150 BCF) and Yolande (50 BCF). Two of the largest Mesozoic (Cretaceous) leads, namely Hopes Corner and Rabbit Hill, have potential reserves between 10 and 20 million barrels of oil.

Silver, barite and base metals

The base metal (copper, lead and zinc) potential of the southern Carnarvon Basin has been reviewed by Flint and Abeysinghe (2000). In the Giralia Range (anticline), anomalous silver and zinc values have been reported from sulfide, and goethite nodules in the Cretaceous Gearle Siltstone in the Giralia Range. Barite nodules are widespread in the same areas. Barite crystals also occur in the upper part of the Gearle Siltstone at nearby Cardabia Creek.

The silver and associated sulfide mineralization may be related to steeply dipping faults cutting through the anticline, along its eastern margin. Asarco Exploration holds five exploration licences that cover the central part of Giralia Range, and is exploring for base metals.

Harrison (1985) reported that the barite nodules are the surface expression of stratiform, bedded deposits up to 40 cm thick apparently deposited in a series of local basins. He reported that the very extensive deposits could be of interest in view of the proximity of petroleum exploration, as barite is used as a weighting agent in oil and gas well drilling fluids. Currently, there is no production of barite in Western Australia and all our needs are imported.

Lake Macleod

The Lake Macleod area contains major resource of gypsum and salt and these support major gypsum mining and salt extraction operations. There is also some potential for

petroleum associated with the Salt Marsh anticlines exposed along the eastern and western shores of Lake Macleod (Flint and Abeysinghe, 2000).

Gypsum

The Lake Macleod gypsum deposit held by Dampier Salt, is the largest in Western Australia. In 1998, production of gypsum from this deposit was 792 852 tonnes (valued at $15.2 million) and represented 74% of the State's production of 1 074 741 tonnes.

The deposit was formed by barring of a former marine embayment, and contains gypsum both on the surface and within sediments of a saline playa (shallow ephemeral lake). The deposit is between 12 and 15 metres thick and consists predominantly of gypsum and halite (common salt). Dunes formed beside the lake and on the lake surface contain fine-grained gypsum dust (hydrated calcium sulphate). The potential resource is considered to be in excess of 1000 Mt (Flint and Abeysinghe, 2000). Associated deposits east, west and north of the lake contain another 100 Mt.

Salt

Dampier Salt obtains salt from natural brine from the southern section of Lake Macleod. Salt is recovered from depths of between 4 and 6 metres and is circulated through an evaporating pan system (Flint and Abeysinghe, 2000). Production from this operation in 1998 was 1.26 Mt valued at $33 million.

Summary

The Cape Range–Ningaloo area is of strategic value to Western Australia. It contains:

- the only known significant resource of high-grade metallurgical limestone;
- the largest gypsum deposit;
- significant salt production facilities, with another one proposed;
- high potential for major discoveries of silver, barite, bentonite and base metals (copper, lead and zinc), with lesser potential for diamonds; and
- known oil and gas fields, with significant potential for further discoveries within onshore geological structural features.

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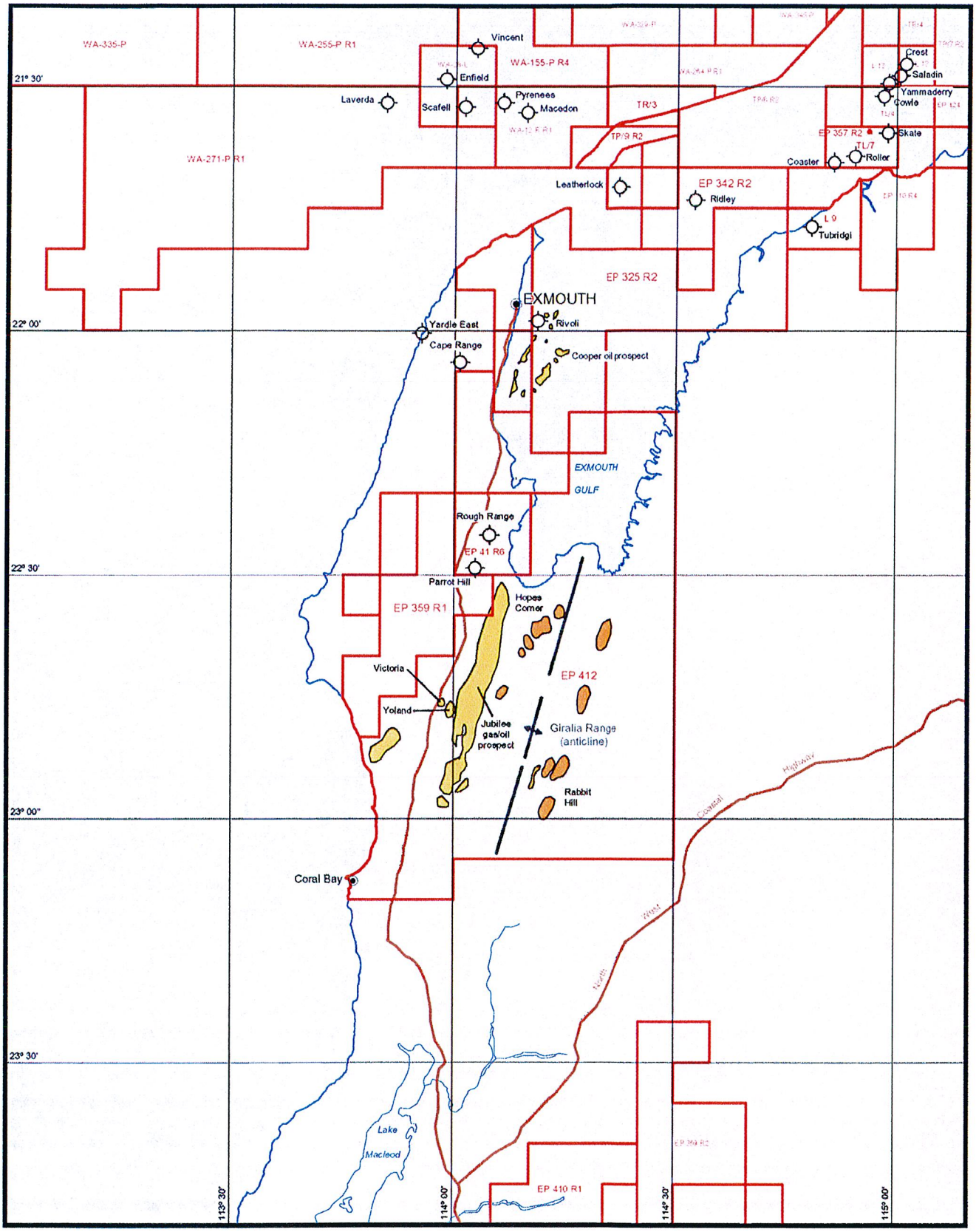

Petroleum Act Titles

Prospects

Leads

Petroleum occurences

Location

Major road

Figure 1. Petroleum prospectivity of the proposed Cape Range Ningaloo World Heritage area

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Geological Survey of Western Australia

0 25 50

kilometers

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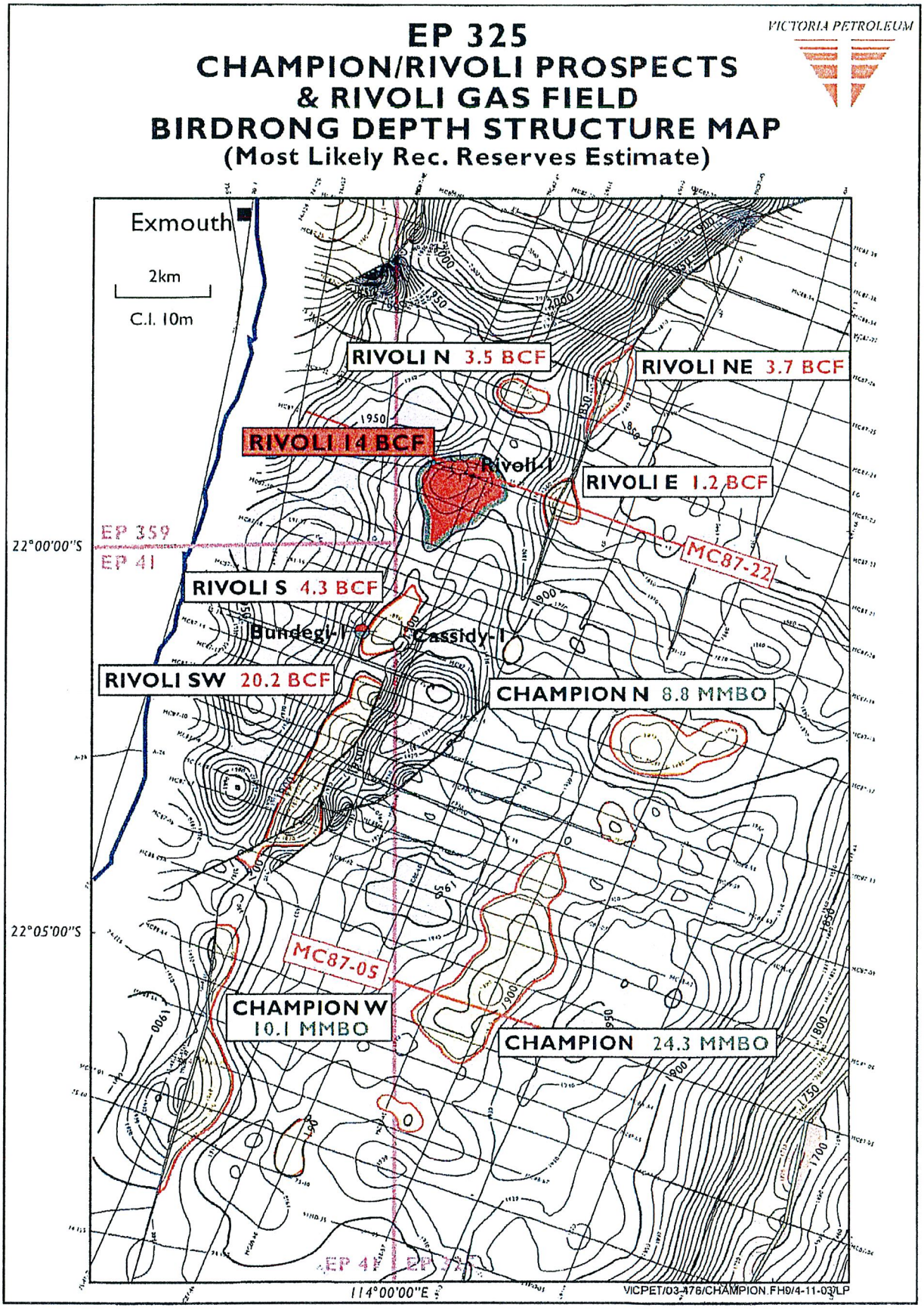
EP 325
CHAMPION/RIVOLI PROSPECTS
& RIVOLI GAS FIELD
BIRDRONG DEPTH STRUCTURE MAP
(Most Likely Rec. Reserves Estimate)
VICTORIA PETROLEUM
Exmouth
2km
C.I. 10m
RIVOLI N 3.5 BCF
RIVOLI NE 3.7 BCF
RIVOLI 14 BCF
Rivoli-1
RIVOLI E 1.2 BCF
EP 359
EP 41
22°00'00"S
MC87-22
RIVOLI S 4.3 BCF
Bundegi-1
Cassidy-1
RIVOLI SW 20.2 BCF
CHAMPION N 8.8 MMBO
22°05'00"S
MC87-05
CHAMPION W
10.1 MMBO
CHAMPION 24.3 MMBO
EP 4
EP 3
114°00'00"E
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