INTERPRETATION OF REPROCESSED SEISMIC DATA OVER T/30P, OFFSHORE TASMANIA

prepared for

BENARIS INTERNATIONAL N.V

by

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February, 1999

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INTERPRETATION OF REPROCESSED SEISMIC DATA OVER T/30P, OFFSHORE TASMANIA

Scope of Report

Benaris International N.V, (Benaris) the operator of T/30P purchased approximately 2200 km of scanned seismic data recorded in the permit by previous operators. The data scanned were essentially processed to final stack. Petroconsultants Digimap Pty Ltd, through their associates in Jakarta, migrated and carried out post-stack processing on the scanned data acquired on behalf of Benaris.

The author coordinated the purchase and monitored the migration of the data set on behalf of Benaris. Following the completion of the migration and poststack processing, the author carried out an interpretation of the migrated data. Three horizons, the Top Waarre, Top Belfast and Base Tertiary were interpreted and mapped over T/30P. Time maps were constructed for the 3 mapped horizons as a result of the interpretation carried out.

The data purchase, the migration and poststack processing, together with the interpretation, were carried out by Benaris in fulfilment of the Year 1 work program.

This report documents the work and interpretation carried out on behalf of Benaris.

Background

Permit T/30P was awarded to Benaris International N.V. on July 10, 1997. The permit is located off King Island, Tasmania. (Figure 1). Following the award of the permit, Benaris reviewed previous studies and selection of seismic data recorded within the permit. Benaris concluded that the previous studies carried out were generally regional in nature and lack the detail necessary to focus the Benaris exploration effort. Although there were some regional and semi-detailed seismic lines recorded within the permit, the available seismic data were of poor quality and existed only as stacked paper sections of different scales making any interpretation on them difficult, tedious and unreliable.

Benaris commissioned Petroconsultants Digimap Pty Ltd to scan all the regional and semi-regional lines within the permit. However, not all the lines requested by Benaris were utilized as several of the lines could not be scanned due to the very poor quality of the paper sections. A few lines were also missing from the government archives despite a concerted effort being made to locate them.

In total approximately 2200 km of data were scanned. The lines recovered and scanned are shown in Figure 2. The scanned data was then migrated and some poststack processing carried out to enhance the data. An Exabyte copy of the digital data, together with paper sections of all the lines reprocessed were produced on completion of the processing.

An interpretation was then carried out using the migrated data sections.

The objectives of the interpretation were

- to define the regional geological framework of the permit;
- to map leads and prospects;
- to understand the prospectivity of the permit;
- to gain an understanding of the reasons for the presence and absence of hydrocarbons in wells drilled in and adjacent to the permit.

Three horizons, namely, the Top Waarre, Top Belfast and Base Tertiary were interpreted and mapped in this study.

Geology

Permit T/30P lies offshore, to the west of King Island and covers an area of approximately 6309 square kilometres. It is located within the eastern portion of the Otway Basin. (See Figure 1)

Two wells, Prawn-A1 and Whelk-1 have been drilled within the permit and both wells were plugged and abandoned as dry holes. North of the permit, across the Victorian/Tasmanian offshore border, significant gas discoveries were made in Minerva-1 and Minerva 2/2A and La Bella-1.

The Otway Basin is a Late Jurassic to Recent age rift basin developed as the result of the break-up of the Australian and Antarctic continents. Details and timing of the break-up will not be addressed here but there is extensive literature addressing the subject.

A major part of T/30P is located in an area commonly known as the Prawn Platform. A regional tectonic elements map of the eastern Otway Basin is shown as Figure 3. The Prawn Platform is the eastern most portion of the Otway Basin and contains a significant thick stratigraphic section. The platform is bounded to the west by the Shipwreck Trough. The trough is a north-south trending major Late-Cretaceous syncline. West of the Shipwreck Trough, within the western limit of the permit, the Tartwaup-Mussel Fault is present. The fault formed a hinge zone and stepped down into another deeper depocentre, the Voluta Trough. The north-south striking Sorell Transform Fault forms the eastern limit, separating the platform from the King Island High, a submerged basement high.

The stratigraphy of the Otway Basin is depicted in Figure 4. However, within T/30P only the top of Eumeralla Formation and the younger successions have been drilled.

The shallowest unit in the area is the Port Campbell Limestone which overlies the Gellibrand and Narrawaturk Marls (Marls are calcareous mudstones). Below these marls are the Mepunga and Dilwyn sandstones which are excellent sources of groundwater in the onshore Victorian region. Underlying the Dilwyn are the Pember Mudstone and the Pebble Point Formation. These rocks are all Tertiary in age.

Unconformably below the Tertiary section is an Upper Cretaceous succession of the Sherbrook Group, the youngest sequence is the Paaratte Formation, consisting essentially of sandstones with intercalation of shale and coal. The Paaratte Formation overlies Belfast Mudstones. Onshore, within the Belfast Mudstones, two sub-units, the Skull Creek Member and the Nullawarre Greensand Member have been encountered. As these two sub-units are associated with proximal shoreline settings, both the sub-units are unlikely to be encountered in the more distal Belfast Mudstones present in the offshore area. The Belfast Mudstone is the sealing unit in the Minerva and La Bella gasfields. It is also the seal in all the gasfields in the onshore Port Campbell Embayment. The Belfast Mudstone thickens considerably in the Shipwreck and Voluta Troughs.

The Upper Cretaceous Waarre Formation is an inter-bedded sequence of sandstone and shales. Carbonaceous mudstones and coal are sometimes common, particularly in the basal section. The Waarre Formation can be divided into further sub-units, namely sub-unit A, B, C and D. Unit A being the oldest and Unit D the youngest. (Buffin, 1989). The complete Waarre sequence is generally not present in most wells, but in some wells, particularly offshore, the whole Waarre sequence has been penetrated. The sandstones in the Waarre have excellent porosity and permeability. All the gasfields in the eastern Otway Basin are reservoired within the Waarre Formation. The Waarre Formation is the main exploration objective within T/30P due to its excellent reservoir properties and the proven play in Otway Basin.

The Waarre Formation unconformably overlies the Lower Cretaceous Eumeralla Formation, a thick monotonous sequence of siltstone and claystone with minor sandstones containing abundant lithic fragments. The Eumeralla Formation is part of the Otway Group, a rift fill sequence of Early Cretaceous age. Other units within the Otway Group are the Katnook Sandstone, the Laira Formation, the Pretty Hill Formation and the Casterton Formation. The Pretty Hill Formation is the other gas reservoir and is actively pursued in Penola Trough on the South Australian side of the Otway Basin. These Lower Cretaceous units, if at all present in the permit are probably beyond the reach of the drill and are not considered as objectives here.

Methodology

The top of the Waarre Formation, Belfast Formation and Base Tertiary were picked in the Prawn-A1 and Whelk-1 wells from well-log data and converted to two way time using a velocity derived from check-shot data in the wells. The nearest peak event corresponding to these units in two way time on the seismic line through the well was then picked to represent the top of the Waarre, Belfast and Base Tertiary respectively. The ties at Whelk-1, particularly the Belfast, were complicated by the presence of a fault in the well.

Interpretation of the three horizons was then extended from the well tie. The three horizons were also picked in the Mussel-1 and La Bella-1 wells, (both outside the permit) and these were mapped into the permit provide confidence in the interpretation to the northern part of the permit.

Following completion of interpretation of the three horizons, the seismic picks were digitised and the time values annotated on a shot point map. The annotated map of each horizon was then manually contoured to produce two-way time maps of the interpreted horizons. The two-way time contoured maps were then digitised to produce the final time structure maps (Enclosures 1a & b, 2a & b, and 3a & b). The scale of the maps is 1:100,000.

Results of the Interpretation

The results of the mapping confirmed the presence of the Prawn Platform and the presence of a significant section of Upper Cretaceous sediments on the platform. The Prawn Platform itself is highly broken up. At the Waarre level, dominant down-to-basin normal faults strike in a northwest-southeast direction and traverse through the platform in the west and northwest part of the permit. The northwest-southeast trend of the faulting is typical of the Otway Basin.

Interrupting the normal down to basin dipping faults are some northeast dipping anti-thetic faults. The anti-thetic faults are generally not too common, but where they are present, the faults set up horst block at the Waarre level. This structural style is typical of many of the onshore Port Campbell fields. The northwest-southeast striking faults are active mainly during the Upper Cretaceous time, their intensity reduced as the basin developed into a passive margin when Australia and Antarctica separated. The Base Tertiary map shows a very reduced amount of faulting in the west and northwest part of the permit.

In the eastern part of the permit approaching the King Island High, the northwest- southeast trend of the faults stop abruptly as the north-south striking fault system takes over. The north-south trend is related to the very active Sorell Transform Fault Zone. Movement within this fault zone is very recent as can be seen on the Base Tertiary maps. There are also volcanics associated within this active area. The Upper Cretaceous section thins considerably from the west to the east onto the flanks of the King Island High.

The configuration of the Prawn Platform is further complicated by the presence of a late Cretaceous compressional event that set up the platform itself. This compressional event is related to the formation of the Shipwreck Trough on the western edge of the permit. Geary and Reid (1998) attributed this compression to the advent of the late Cretaceous NE-SW crustal extension. This crustal extension imparts an east-west component of compression which sets up the north-south trending Shipwreck Trough. On the platform, this compressional event also set up smaller order anticlinal and synclinal features.

Enclosure 1a and 1b are the Waarre Formation structure time map for T/30P. The maps show the predominant northwest southeast trending faulting in the western part of the permit, interrupted abruptly by the north-south trending faulting in the east approaching the King Island High. The Waarre Formation represents the main target within the permit. The depth to the top of the Waarre within the permit varies from about 1 second on the flanks of the King Island High and deepens to the southwest into the shelf edge and west into the Shipwreck Trough. The Waarre within the Shipwreck Trough has been interpreted to be at depth of at least 3 seconds. Over the main Lobster prospect, the shallowest part of the culmination is at less than 2 seconds.

Lobster Prospect
The most prominent feature observed as the result of the mapping is the Lobster prospect located in the northwest part of the permit. Lobster is fault bounded and consists of two highs, with a low separating an eastern and a western culmination. Figures 6 & 7 are selected seismic lines over the prospect. The location of the lines are shown in Figure 5.

The Prospect is set up as a result of the late Cretaceous compressional event. To the west, the Waarre plunges into the Shipwreck Trough and in the east the presence of a synclinal low, sets up the high. A series of northwest-southeast trending down to basin dipping faults break up the high in the south and in the north, a north dipping anti-thetic fault forms the northern limit. Closure can be mapped down to approximately 2.35 seconds and the closure area is approximately 210 square km.

Abalone Lead
The other prominent lead present in the permit is the previously known Abalone lead, which straddles the northern permit boundary and extends into Victorian offshore waters. The Abalone lead is more complex than interpreted from previous mapping. The lead is heavily faulted (see Figure 8), and the lead relies on closure against the down thrown side of a bounding fault for significant closure area.

Other Comments
The Early Cretaceous section is too deep within the block to be a worthwhile objective. On the flanks approaching the King Island High in the eastern part of the permit, as the Upper Cretaceous (Sherbrook Group) becomes thinner, it is uncertain whether the older Pretty Hill Formation, the known reservoir in South Australia is even present.

The Lobster prospect and Abalone lead persist at the Belfast level (Enclosure 2a), although they are not as well defined compared to at the Waarre level. This confirms the presence of the late Cretaceous compressional event.

The Base Tertiary maps (Enclosures 3a & b) show essentially a south-east dipping surface with some faults, predominantly north-south trending in the eastern part of the permit. During Base Tertiary time, the compressional event has ceased, and the main activity appears to be related to movement of the Sorell Transform Fault setting up the King Island High.

Discussion
The known reservoir and play types pursued in the permit, are associated with the Waarre Formation, and occur deeper than at the Minerva, La Bella and the Port Campbell Fields. While there are some negatives, such as degradation of reservoir properties with increasing depth of burial, the Waarre penetrated in the Prawn-A1 well still has good reservoir properties. It is also well known that once hydrocarbon is trapped in a reservoir, with onset of further burial, the hydrocarbons often prevent reservoir degradation.

The conventional view of most explorationists working in the basin is that the gas in the Waarre gasfields is sourced from the underlying Eumeralla Formation. The Eumeralla Formation is more likely to be gas prone within T/30P in view of a greater depth of burial than adjacent to the known fields. Gas generated from the deeper Eumeralla Formation migrates out of the Eumeralla and finds its way into traps formed by the Belfast seal over the Waarre reservoir.

Not much is known of the source potential and maturity of the Belfast and other younger rocks. Recent work by those associated with the Victorian Department of Natural Resources and Environment (DNRE) based on geochemical results from Minerva-2A suggests the potential for shales within the Waarre to provide a good oil source cannot be discounted.

There were two previous wells, Prawn-A1 and Whelk-1, drilled within the permit. Both of the wells were dry. The present mapping suggests that both wells may not be drilled on valid closure. The Waarre Formation in Prawn-A1 well is about the same depth as the Waarre in the Lobster feature. The Waarre Formation in Lobster is anticipated to be excellent reservoir quality as Prawn-1 has excellent Waarre sands.

Conclusions

A reprocessing program and comprehensive mapping of T/30P has been completed. Three horizons, the Top Waarre, Top Belfast and Base Tertiary have been interpreted. There is now a complete set of maps identifying the prospects and leads in the permit.

The mapping results confirm the presence of the Abalone lead and identify the presence of the Lobster feature in the northwest part of the permit. This feature has not been recognised by previous mapping of the block.

References

Buffin, A.J., 1989. Waarre Sandstone development within the Port Campbell Embayment. *Australian Petroleum Exploration Association Journal* **29(1)**, pp 299-311

Geary, G.C. and Reid, I.S.A., 1998. Hydrocarbon prospectivity of the offshore eastern Otway Basin, Victoria, for the 1998 Acreage Release. *Victorian Initiative for Minerals and Petroleum Report* **55**. Department of Natural Resources and Environment.

Limitations

This interpretation is based on information gathered from Benaris N.V files which consists of technical reports in the public domain and other unpublished information which is the property of Benaris N.V or held by Benaris N.V. under confidentiality arrangements. Such information was evaluated through analysis, inquiry and review and I believe on reasonable grounds that it is reliable and complete. I have no reason to believe that any material facts have been withheld but do not warrant that our technical effort has revealed all of the matters that an extensive examination might disclose.

Declaration

The author has no pecuniary or other interest that could reasonably be regarded as being capable of affecting his ability to give an unbiased view regarding interpretation of the T/30P other than to the extent of the professional fees received for the preparation of this report.

This review was carried out only for the purpose referred to above and may not have relevance in other contexts.

Signed:

Sheng M. Yu.

Date: 8/2/99

Qualifications of the Author

Sheng Yu has a M.Eng degree in Geotechnical Engineering from the University of British Columbia and a B.Sc.(Hon) degree in Applied Geology from the University of Malaya. He has over 17 years of technical experience in the international petroleum industry, working in Australia, Malaysia, Pakistan and Indonesia. This includes 13 years with Gas and Fuel Corporation of Victoria where he was the Senior Geophysicist in their exploration and production division. Prior to working in the petroleum industry, Sheng worked for 5 years in the geotechnical consulting industry where he has carried out groundwater studies and geotechnical investigations in Australia and Malaysia. Sheng is now a consultant working in the oil and gas industry. He is a member of the American Association of Petroleum Geologists and the Petroleum Exploration Society of Australia.

Figures

Enclosures

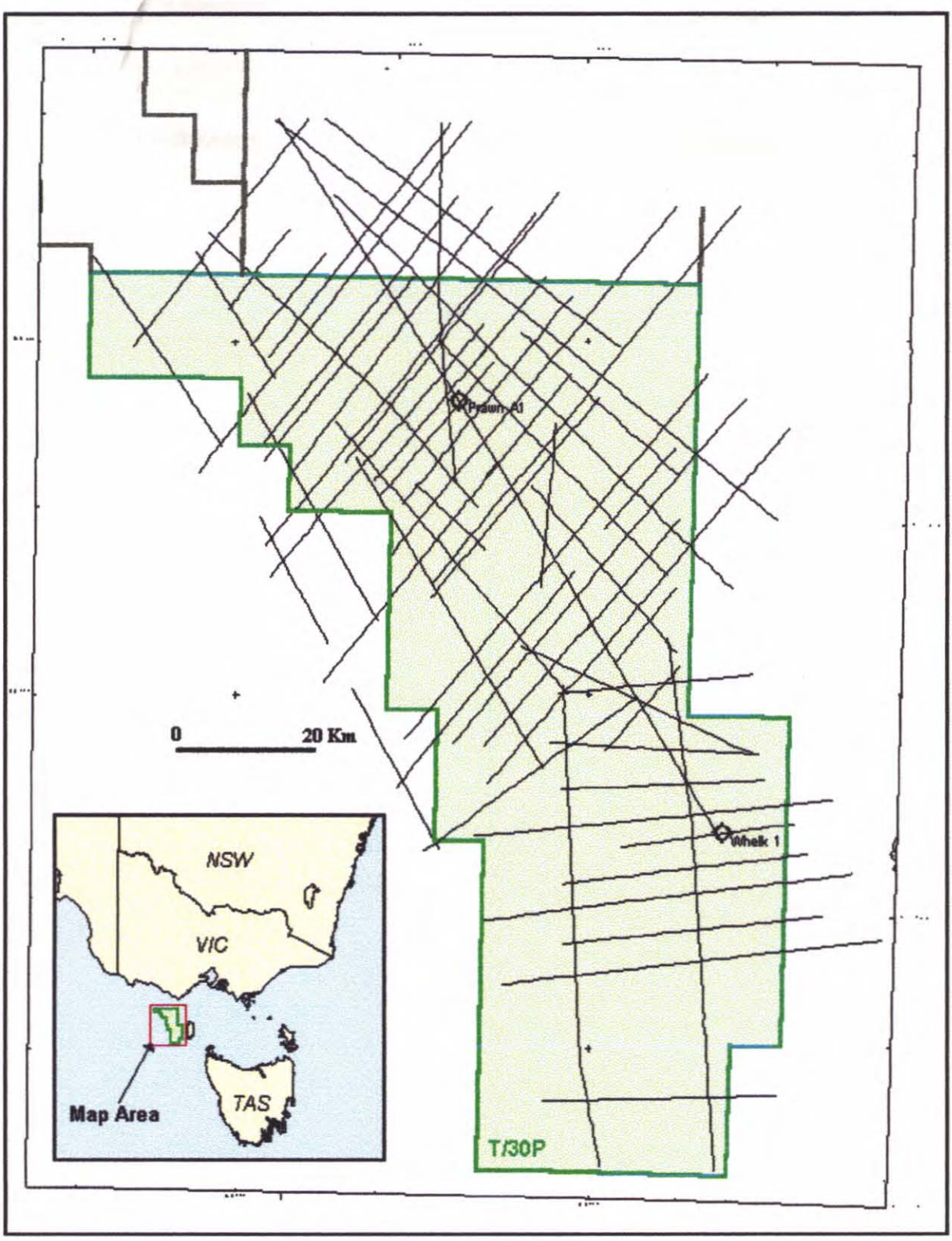

Figure 1 Location Map

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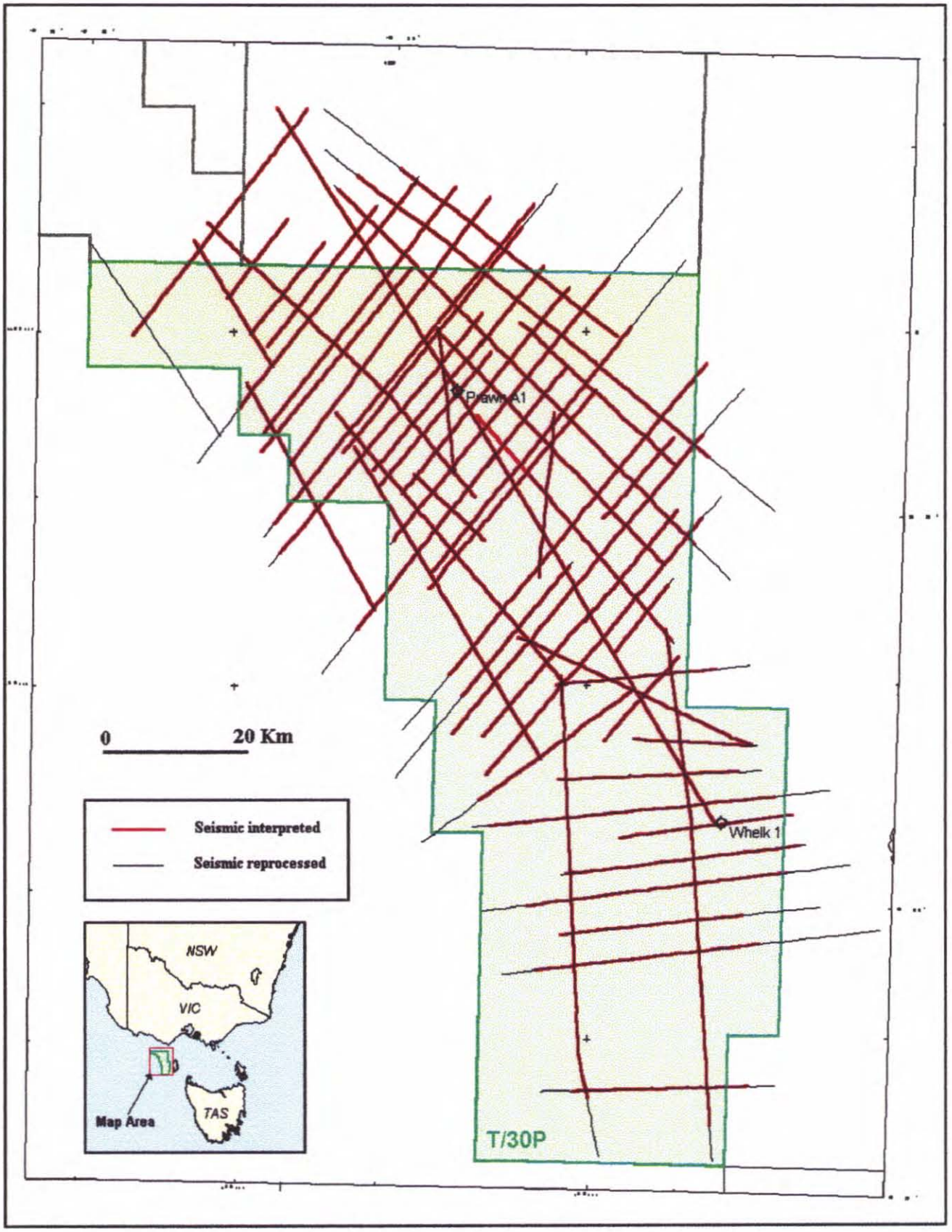

Figure 2 Seismic Data Reprocessed

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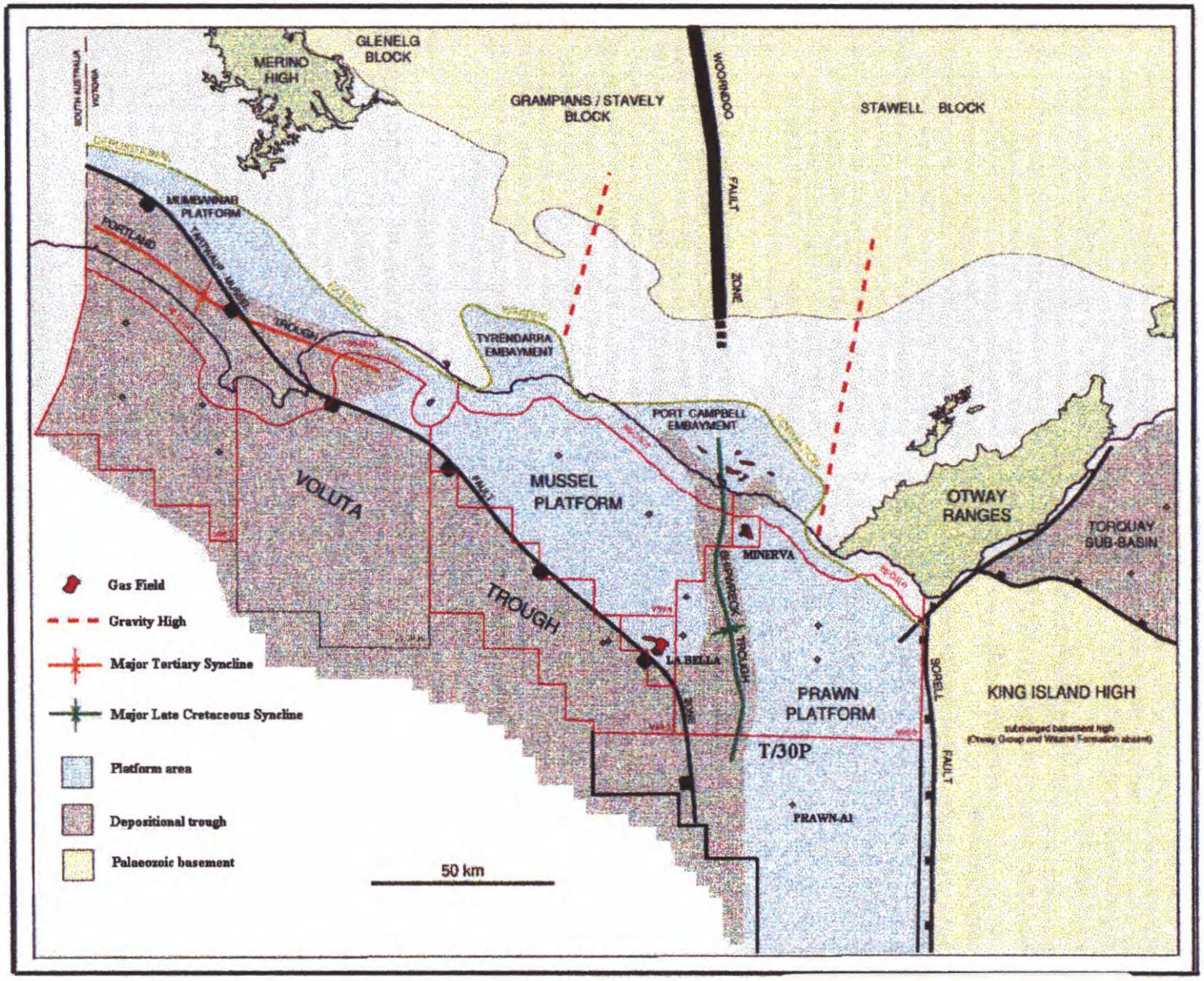

Figure 3 Regional Tectonic Elements (after Geary & Reid, 1998)

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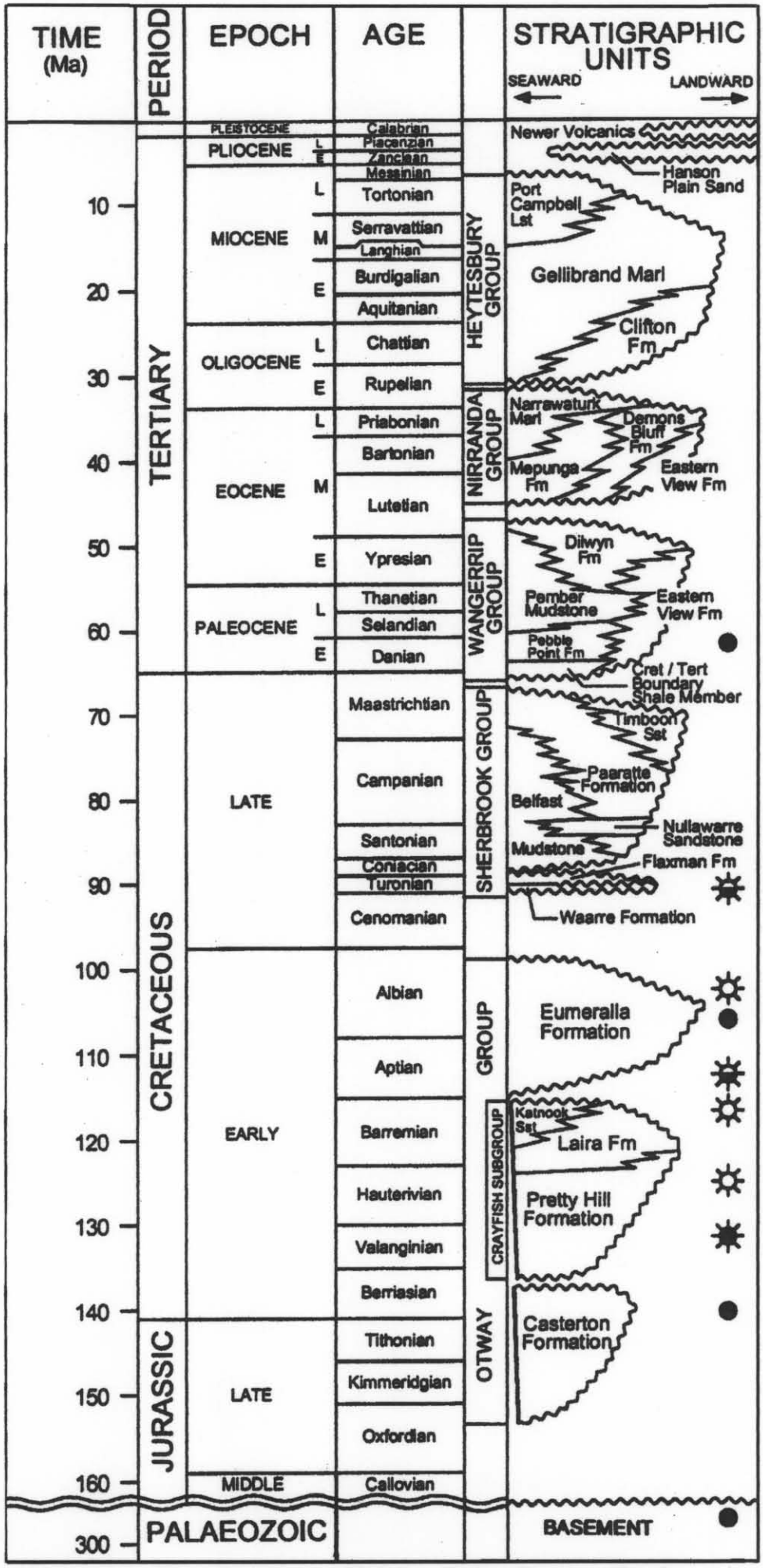

Figure 4 Stratigraphic Table of the Otway Basin

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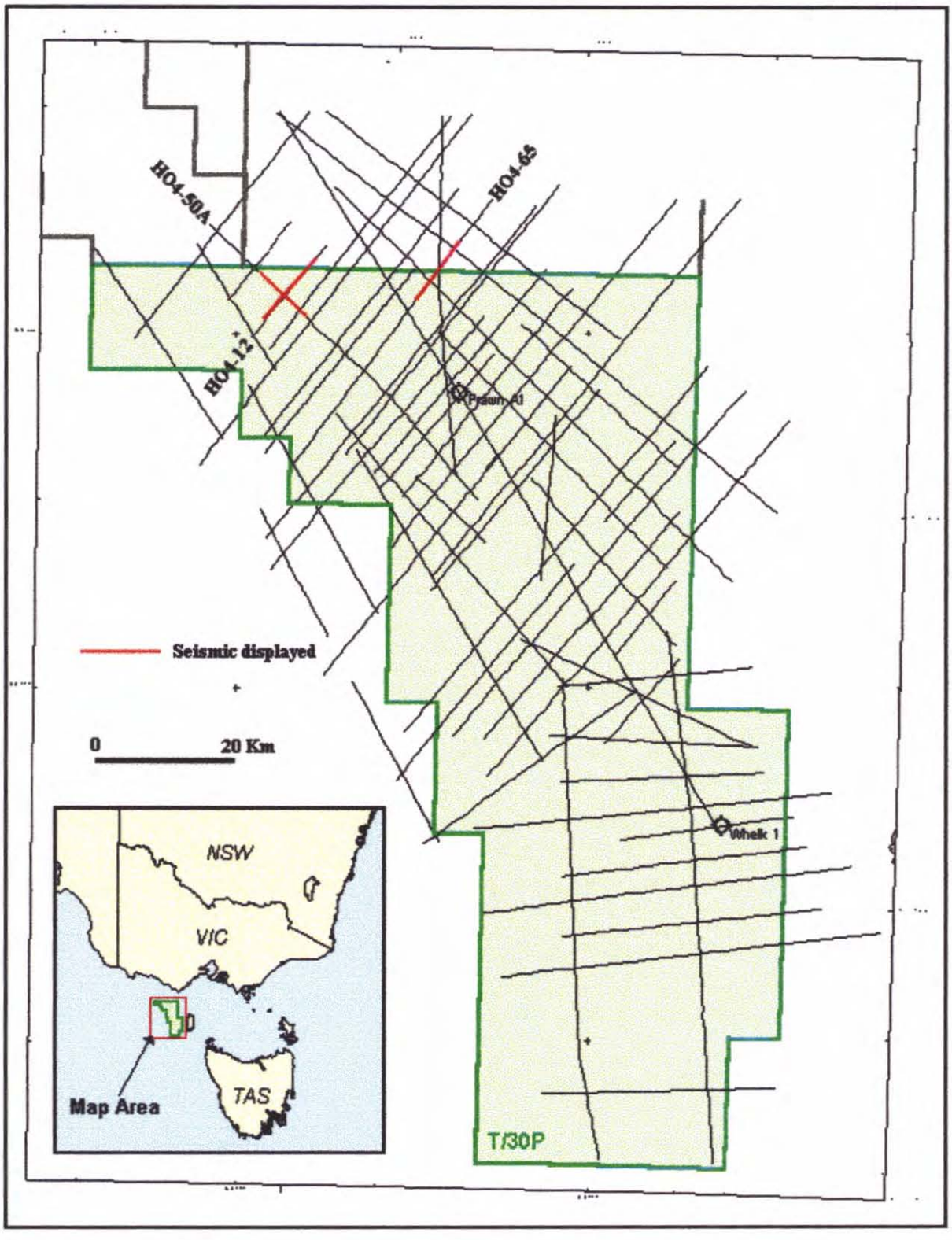

Figure 5 Location of seismic lines displayed

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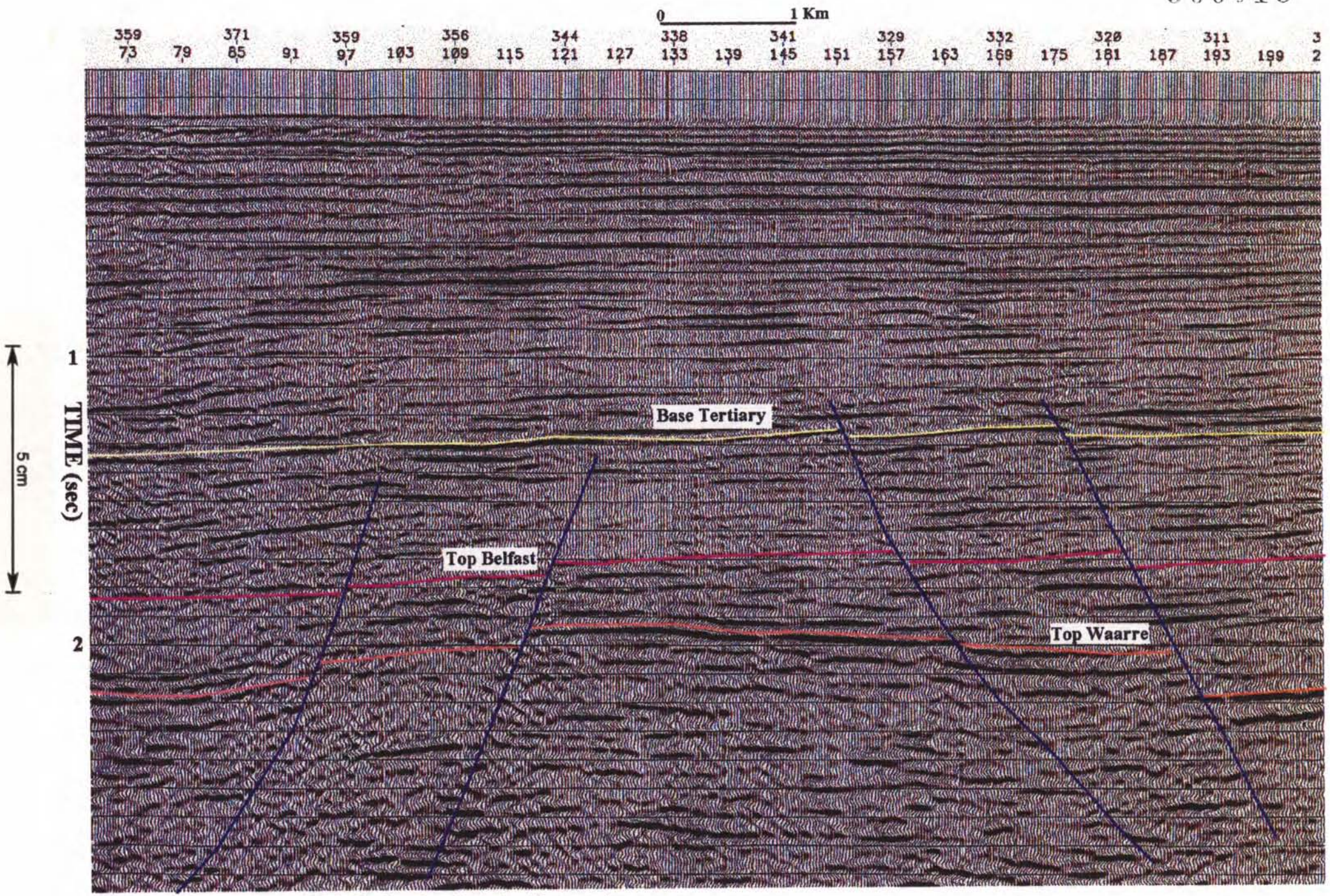


Figure 6 Seismic Line HO4-12 showing Lobster Prospect

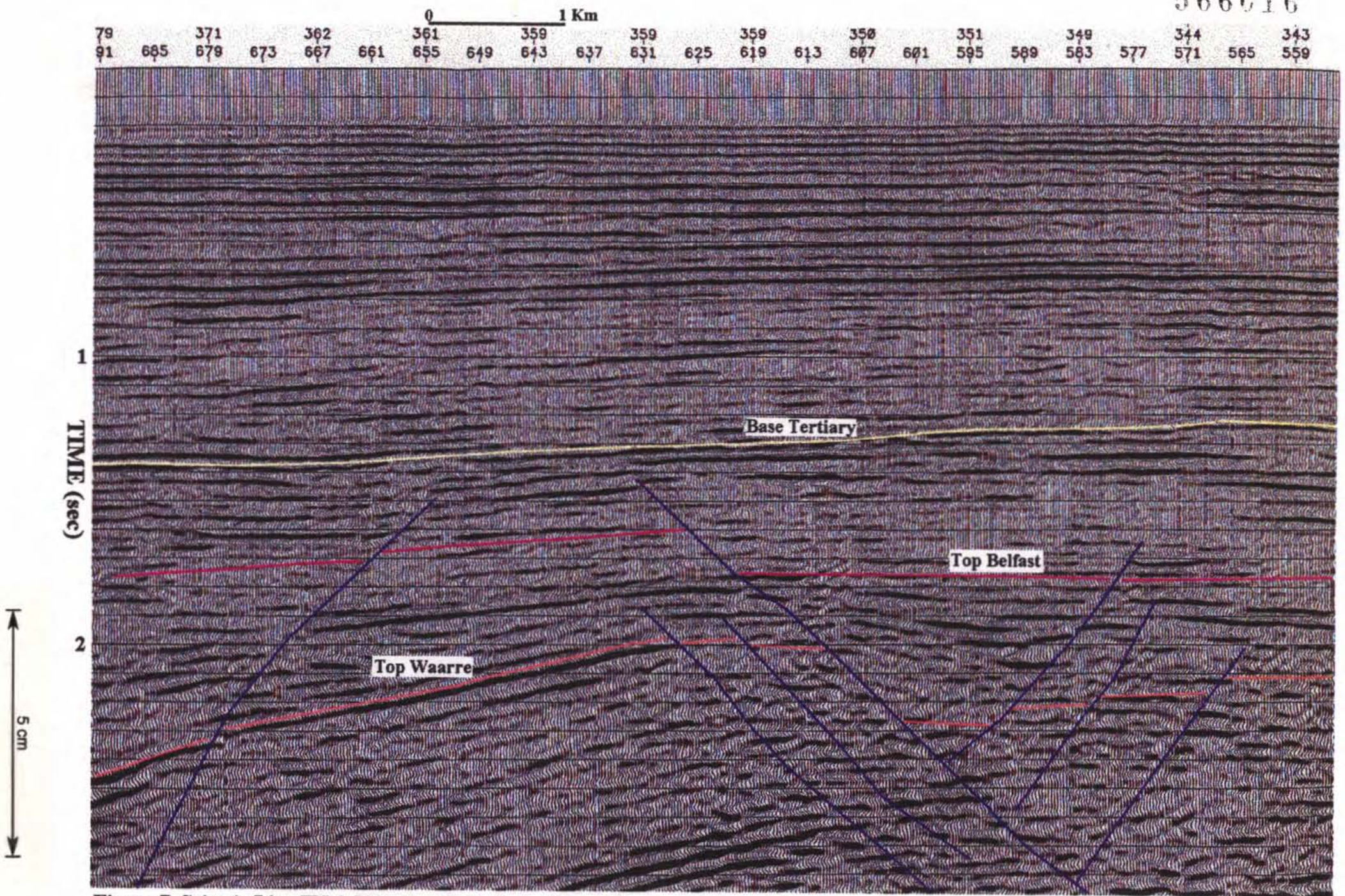


Figure 7 Seismic Line HO4-50A showing Lobster Prospect

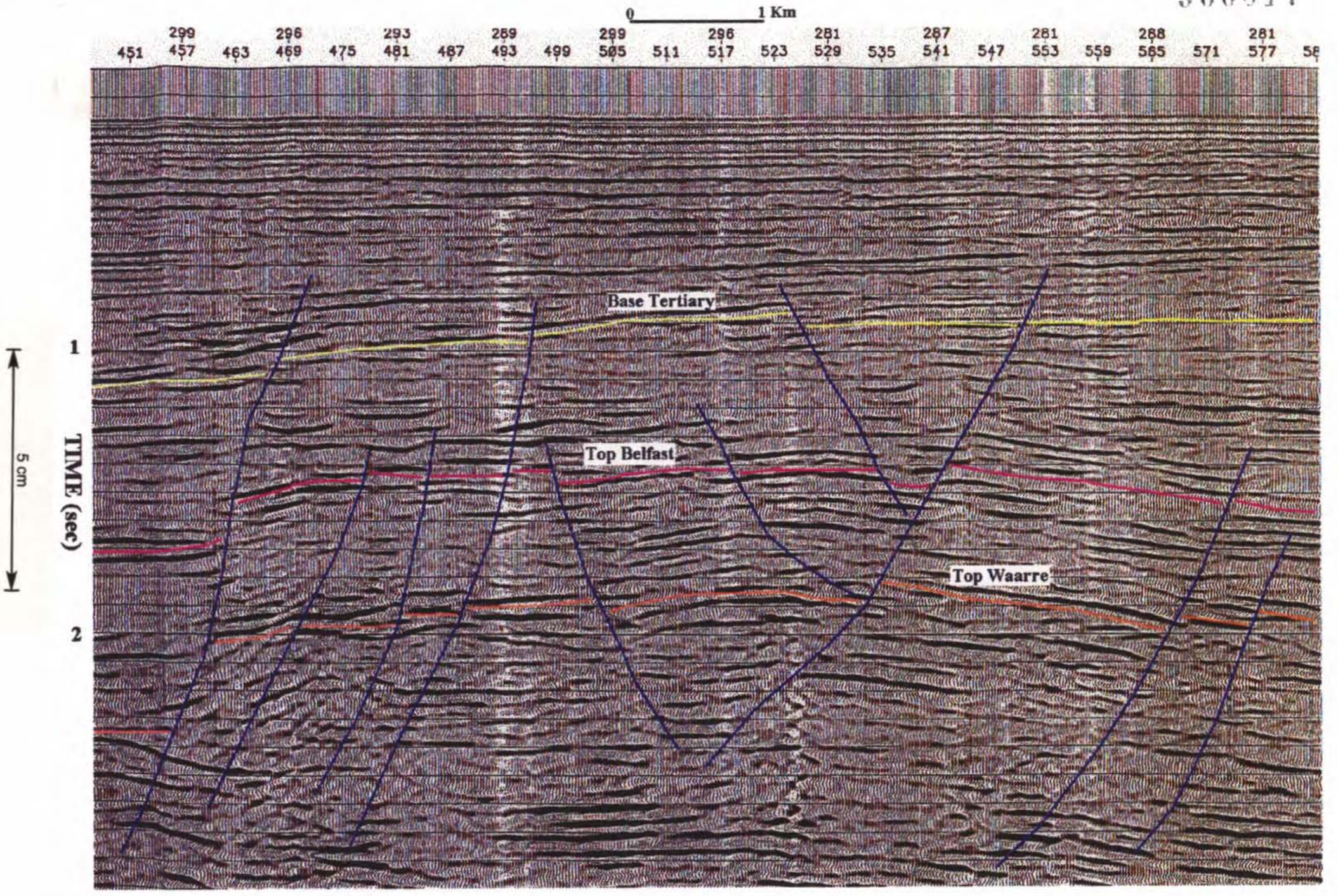


Figure 8 Seismic Line HO4-65 showing Abalone Lead

ABALONE
LEAD

LOBSTER
PROSPECT

Prawn A1

T/30P

142°29'
142°30'
650000 mE
142°45'
143°00'
675000 mE
143°15'
700000 mE
143°30'
143°32'
-39°00'
5675000 mN
-39°15'
5650000 mN
-39°30'
5625000 mN
-39°40'

SA
NSW
VIC
TAS
Map Area

North Sheet
T/30P
South Sheet

LEGEND
2000
Contour Interval 50msec
Two Way Time (milliseconds)

5 cm

BENARIS NV

T/30P OTWAY BASIN

TIME STRUCTURE MAP
TOP WAARRE FORMATION
TWO WAY TIME

North Sheet

Date: 2/2/1999	
Author: S.Yu	
Office:	
Drawing:	
Scale: 1:100000	Projection: AMG Zone 54 (AGD 66)

Enclosure 1a

0 2.5 5
kilometres

Map production by encom

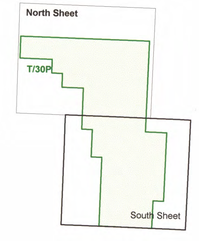
566618

OR-0449

142°52'
143°00'
675000 mE
143°15'
700000 mE
143°30'
725000 mE
143°45'
143°51'
-39°40'
-39°45'
-40°00'
-40°15'
-40°20'
-40°22'
5600000 mN
5575000 mN
5550000 mN

Wimmik 1

T/30P



LEGEND

2000 Contour Interval 50msec

Two Way Time (milliseconds)

5 cm

Map production by encom

BENARIS NV	
	T/30P OTWAY BASIN
Date:2/2/1999	TIME STRUCTURE MAP
Author: S. Yu	TOP WAARRE FORMATION
Office:	TWO WAY TIME
Drawing:	South Sheet
Scale: 1:100000	Projection: AMG Zone 54 (AGD 66) Enclosure 1b

0 2.5 5 kilometres

OR-0449

142°29'
142°30'
650000 mE
142°45'
143°00'
675000 mE
143°15'
700000 mE
143°30'
143°32'
-39°00'
5675000 mN
-39°15'
5650000 mN
-39°30'
5625000 mN
-39°40'

T/30P

Map production by encom

SA
NSW
VIC
TAS
Map Area

North Sheet
T/30P
South Sheet

LEGEND

2000 Contour Interval 50msec

Two Way Time (milliseconds)

5 cm

BENARIS NV

T/30P OTWAY BASIN

TIME STRUCTURE MAP
TOP BELFAST FORMATION
TWO WAY TIME

Date: 2/2/1999	
Author: S.Yu	
Office:	
Drawing:	North Sheet
Scale: 1:100000	Projection: AMG Zone 54 (AGD 66)

Enclosure 2a

0 2.5 5
kilometres

566020

OR-0449

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725000 mE
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143°51'
-39°40'
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5575000 mN
-40°00'
5550000 mN
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-40°22'
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Map Area
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North Sheet
T/30P
South Sheet
LEGEND
2000
Contour Interval 50msec
Two Way Time (milliseconds)
5 cm
BENARIS NV
T/30P OTWAY BASIN
TIME STRUCTURE MAP
TOP BELFAST FORMATION
TWO WAY TIME
South Sheet
Date:2/2/1999
Author: S. Yu
Office:
Drawing:
Scale: 1:100000
Projection: AMG Zone 54 (AGD 66)
Enclosure 2b
0 2.5 5
kilometres
Map production by encom
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OR. 0449

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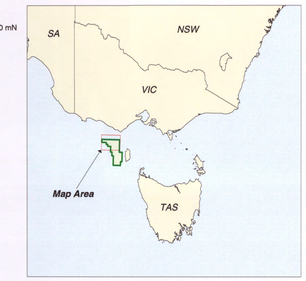
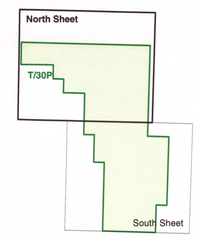
-39°40'

T/30P

Prawn A1





LEGEND

2000 — Contour Interval 50msec
Two Way Time (milliseconds)

5 cm

BENARIS NV

T/30P OTWAY BASIN

TIME STRUCTURE MAP
BASE TERTIARY
TWO WAY TIME
North Sheet

Date:2/2/1999	
Author: S.Yu	
Office:	
Drawing:	
Scale: 1:100000	Projection: AMG Zone 54 (AGD 66)

Enclosure 3a

0 2.5 5
kilometres

566022

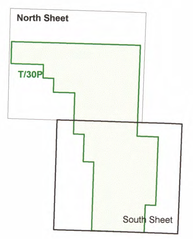
Map production by encom

CR-0449

142°52'
143°00'
675000 mE
143°15'
700000 mE
143°30'
725000 mE
143°45'
143°51'
-39°40'
-39°45'
5600000 mN
5575000 mN
-40°00'
-40°15'
-40°20'
5550000 mN
-40°22'

Otway 1

T/30P



LEGEND

2000 Contour Interval 50msec

Two Way Time (milliseconds)

566623

5 cm

Map production by encom

BENARIS NV

T/30P OTWAY BASIN

TIME STRUCTURE MAP
BASE TERTIARY
TWO WAY TIME

South Sheet

Date:2/2/1999	
Author: S. Yu	
Office:	
Drawing:	
Scale: 1:100000	Projection: AMG Zone 54 (AGD 66)

Enclosure 3b

0 2.5 5
kilometres

OR-0449