MINERAL RESOURCES TASMANIA
DEPARTMENT *of* INFRASTRUCTURE, ENERGY *and* RESOURCES

Tasmanian Geological Survey
Record 1995/04

Hydrocarbon prospectivity of the offshore West Coast of Tasmania

prepared by Dr J. Conolly and Dr M. J. Galloway,
Lonman Pty Ltd

for Mineral Resources Tasmania

MINERAL RESOURCES TASMANIA PO BOX 56 ROSNY PARK TASMANIA 7018

Contents

Text Figures

Tables

Enclosures

Summary

The area offshore from western Tasmania is a passive rifted margin which has received sediment from the Tasmanian hinterland since rifting began in the Late Jurassic/Early Cretaceous. The continental shelf off western Tasmania is an under-explored region. Three wells have been drilled and there is sufficient seismic data to show that there is good oil and gas potential. Five areas have been identified. The southern end of the Otway Basin lies to the west and northwest of King Island, and is followed southwards by the Sorell Basin comprising the King Island, Sandy Cape, Strahan and Port Davey Sub-basins. Each of these has sufficient sediment (3 to 5 km) thickness to have generated hydrocarbons. The Strahan Sub-basin has been intensively explored by the Amoco Australia Oil Company (Amoco) with seismic surveys being conducted and one well (Cape Sorell-1) drilled in 1982. The Maxus Energy Corporation (Maxus) shot seismic and remapped the area in 1991 and 1992.

Some of the prospects mapped by Maxus in the Strahan Sub-basin are ready to drill. Burial history analysis suggests that oil could have been generated in Paleocene and Upper Cretaceous source rocks with migration into these features during the past 10–15 ma. An extensive lower Eocene submarine canyon system has sculptured the pre-Eocene rift valley fill forming a number of potential traps. Some of these resemble the trap formation in the Gippsland Basin where parts of the Marlin, Halibut and Tuna fields have been sealed by Tertiary canyon-fill shales. Three of these prospects have been mapped by Maxus in the Strahan Sub-basin; the Braddon Point, Trial Harbour and Sloop Point prospects have the potential for 200 million barrels of recoverable oil.

Other prospects exist in the Strahan Sub-basin including an Eocene canyon fill sand with a direct hydrocarbon indicator (DHI) and potentially up to 50 million barrels of recoverable oil.

Seismic control in the remaining sub-basins is too sparse to delineate prospects. However, similar depositional conditions to the Strahan Sub-basin occur in the Sandy Cape and Port Davey Sub-basins. Both of these sub-basins are very poorly mapped. In the case of the Port Davey Sub-basin only three lines have been shot in the region which has the same Eocene canyon-cutting episodes and similar sediment thicknesses to the Strahan Sub-basin, to the north. Quartzose sands occur throughout the Palaeogene sequence and make attractive reservoir targets. Live oil shows found in the Paleocene sands in Cape Sorell-1 indicate that oil has been generated.

Introduction

The area offshore from western Tasmania has been under explored. Four wells have been drilled, the first three during the 1970s by Esso[1] in conjunction with BHP[2] (Esso-BHP), with the last (Cape Sorell-1) being drilled by the Amoco Australia Oil Company (Amoco) in 1982.

Thirteen years have elapsed since the drilling of Cape Sorell-1, a hole which encountered live oil shows beneath a Tertiary/Cretaceous age unconformity which has since been shown to have no closure. During this period, the only serious exploration effort was made by Maxus Energy Corporation (Maxus). This work included seismic surveys in T/24P in the Strahan Sub-basin to further investigate the encouraging oil shows found in the Cape Sorell-1 well.

Several prospects close to the Cape Sorell-1 well were extensively mapped. The permit was relinquished after failure to attract farm-in partners.

No permits are currently being actively explored off the west coast of Tasmania.

This report contains sufficient data to re-introduce the west coast of Tasmania as a potential hydrocarbon province, and shows that there is good cause to explore this region. The general tectonic setting, geology of the region, and the hydrocarbon prospectivity of each of the five identified areas is discussed in some detail.

The report draws from the previous work, and uses existing maps to illustrate the major hydrocarbon prospects. A number of full-scale interpreted seismic lines are also included to illustrate the prospectivity of the region.

Detailed data bases are held by Mineral Resources Tasmania in Hobart and the Bureau of Resource Science (BRS) in Canberra. This material is readily accessible, giving the serious explorer a chance to re-interpret the province in more depth.

Recent advances in geohistory analysis techniques have been used to more accurately model thermal maturation, and the timing of oil generation.

Exploration history

Exploration of the west Tasmanian continental shelf commenced in 1968. Permits which have been held since this time are shown in Table 1.

Structural Units

The main basins and sub-basins, and various structural units, are shown in Figure 1. Four wells provide relevant data (Table 2, Figure 2).

Exploration Wells

The location of Whelk-1, Clam-1 and Cape Sorell-1 are shown on Figure 1. Stratigraphic columns of these three wells and Prawn-1 (drilled 77 km WNW of Cape Wickham on King Island) are given in Figure 2, with generalised stratigraphy in Table 3 and Figure 3.

Seismic Surveys

Seismic surveys are shown in Table 4. Coverage is sparse except in the Strahan Sub-basin, where surveys by Amoco and Maxus cover a 1.25 km seismic grid.

1 "Esso" has operated in Tasmanian waters under various names, including Esso Exploration and Production Australia Ltd and Esso Standard Oil (Australia). In this document these will be referred to as Esso.

2 "BHP" has operated under various names including Haematite Explorations, Hematite Petroleum, BHP Petroleum (North West), and BHP Petroleum (Bass Strait) In this document these will be referred to as BHP.

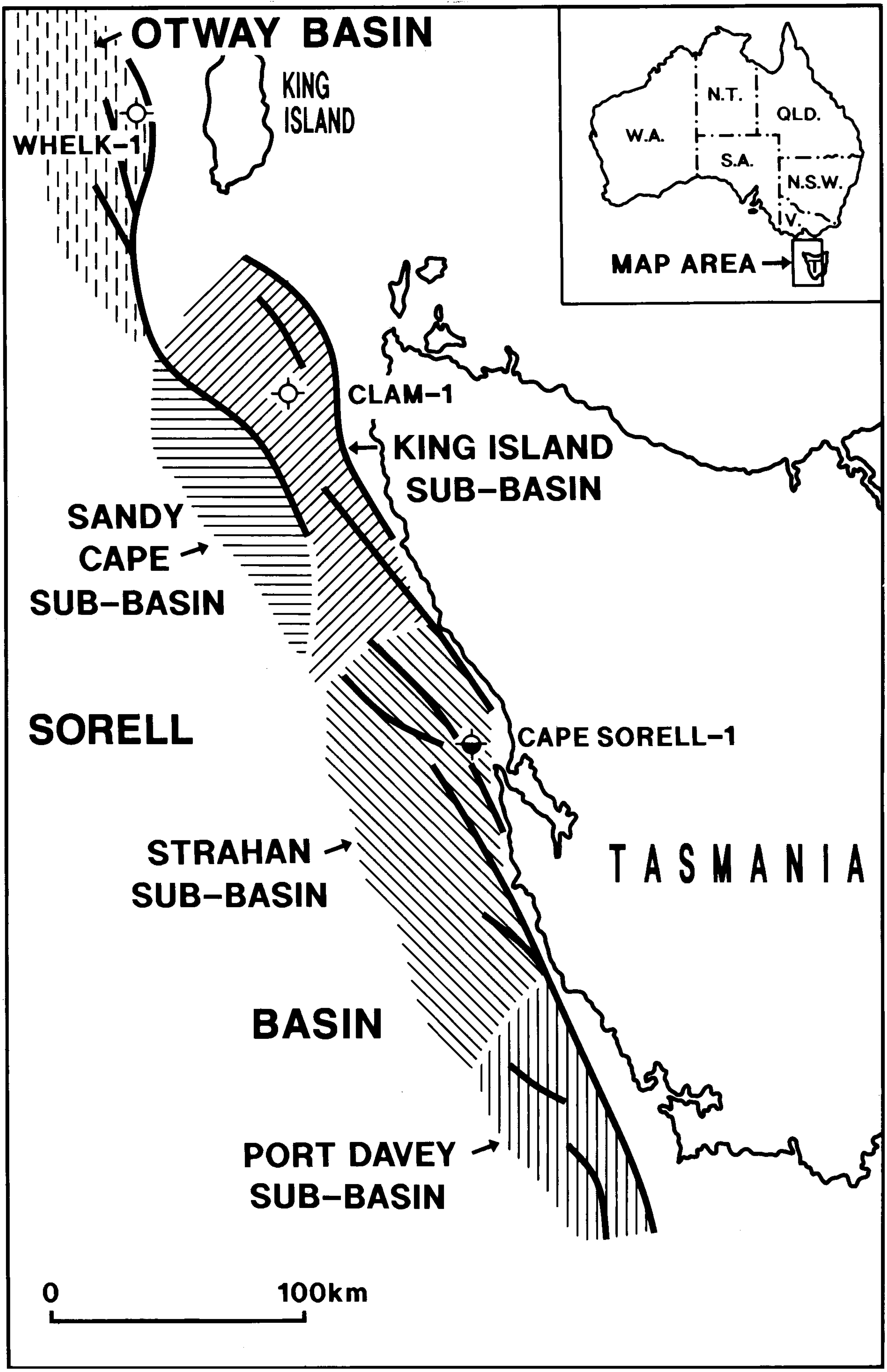


Figure 1

West coast of Tasmania, showing locations of the major sub-basins

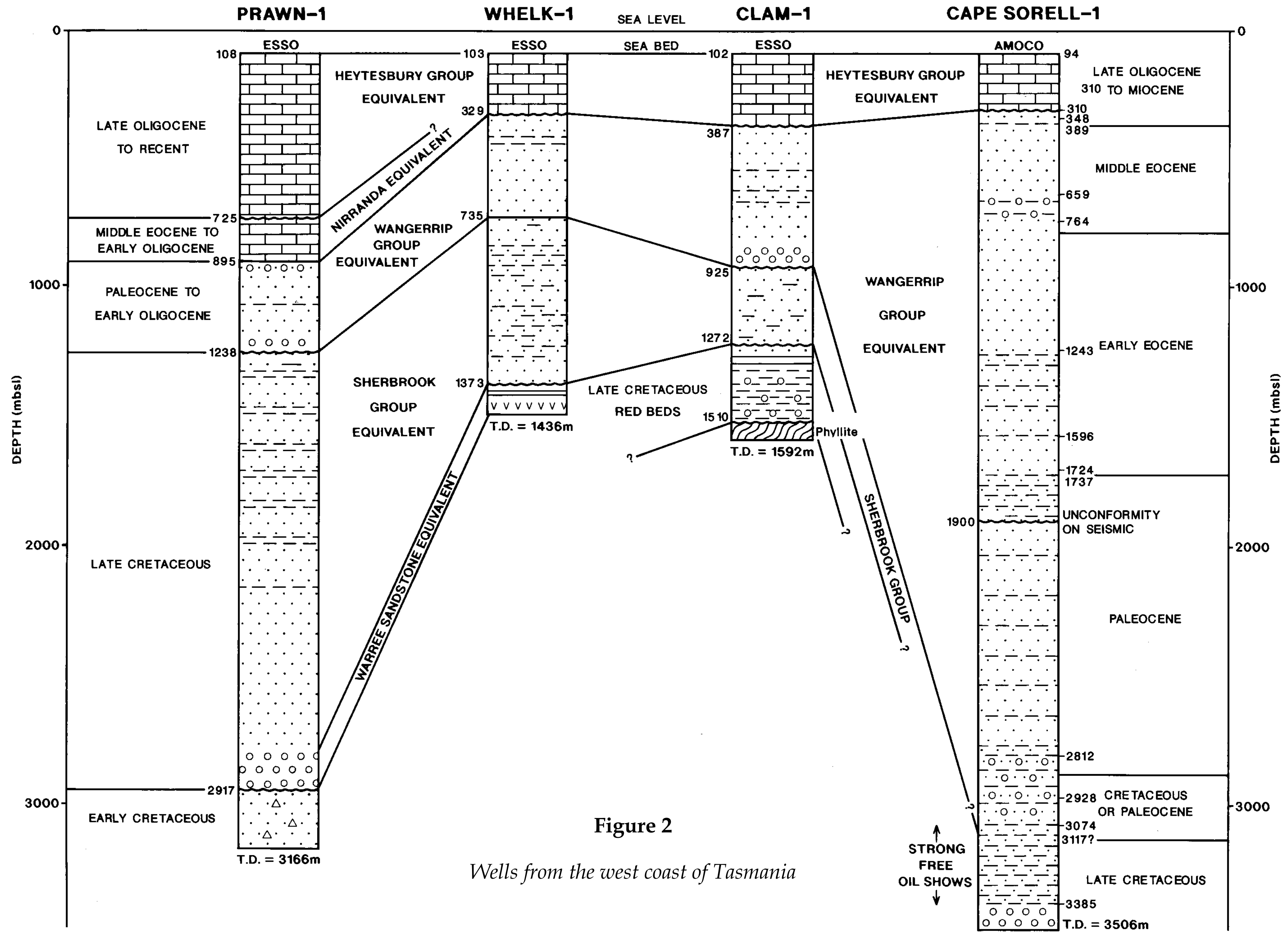


Figure 2

Wells from the west coast of Tasmania

Table 1

Petroleum exploration permit holders, western Tasmania

Date	*Company*	*Licence*
7/1968–3/1971	Magellan Petroleum Southern Pty Ltd Transferred 8 October 1969 to Magellan Petroleum Australia Ltd	T/2P
9/1968–11/1972	Esso Exploration and Production Australia Inc.	T/8P
4/1969–3/1971	Magellan Petroleum Southern Pty Ltd Transferred 8 October 1969 to Magellan Petroleum Australia Ltd	T/10P
4/1979–8/1983	Terra Marine Pacific Inc. Transferred 1 April 1980 to Amoco Australia Petroleum Company and Tasman Oil Inc. Transferred 15 July 1982 to Amoco Australia Petroleum Company, Tasman Oil Inc and The Anschutz Overseas Corporation. Transferred 11 January 1983 to Amoco Australia Petroleum Company, Tasman Oil Inc., The Anschutz Overseas Corporation and ACI Operations Pty Ltd.	T/12P
8/1980–10/1985	Van Diemen's Land Resources NL, Oil and Minerals Quest NL, Nickel and Minerals Search NL (now Terrex Resources NL) , Bulldog Oil and Gas Ltd, Pasadena Projects Pty Ltd and Theseus Investments Ltd.	T/17P
11/1981–10/1985	Van Diemen's Land Resources NL, Oil and Minerals Quest NL, Terrex Resources NL, Bulldog Oil and Gas Ltd, Pasadena Projects Pty Ltd and Theseus Investments Ltd	T/20P
2/1990–2/1993	Maxus Energy Corporation Transferred 14 March 1991 to Maxus Tasmania Inc.	T/24P
1992–1995	Ansbachall Pty Ltd	T/26P

Regional geology of the West Tasmanian continental margin

Stratigraphic Nomenclature

The biostratigraphy of the Late Cretaceous to Eocene depends on precise palynology. Detailed palynology does not exist for any of the four west coast wells. No further palynology of Prawn-A1, Whelk-1 or Clam-1 wells has been done since the original Esso work, and the palynological work on Cape Sorell-1 needs major revision. Correlation between the wells is therefore based on lithology and log matching as well as seismic correlation. This varies from that of Moore (1991) and Moore *et al*. (1992) primarily in two matters.

1. The red beds below 1372 m in Whelk-1 and from 1272 m to 1462 m in Clam-1 are almost certainly not Devonian but more likely to be equivalents of the *C. triplex* to *T. longus* age Late Cretaceous rocks of the Boobyalla Sub-basin (Moore *et al*., 1984).

2. The top of the Wangerrip Group in Whelk-1, Clam-1 and Cape Sorell-1 is taken as being at 329 m, 387 m and 310 m respectively. This is at the top of the coarse clastic sequence and identical to the changes in lithology and log characteristics (gamma, resistivity, sonic, density and neutron) seen in the Bass Basin at the top of the Eastern View Coal Measures and in the Gippsland Basin at the top of the Latrobe Group. Whether the top of the Wangerrip Group is time transgressive from Paleocene to early Eocene at Prawn-1A to middle Eocene at Cape Sorell-1 is dependent on the reliability of age determinations.

Basins

Otway Basin

The Otway Basin is largely covered by the jurisdictions of Victoria and South Australia, but the southern tip extends into Tasmanian waters northwest of King Island. The Otway Basin is separated from the Bass Basin by the King Island–Mornington Peninsula Ridge (fig. 7.2 in Douglas and Ferguson, 1988) and from the Sorell Basin of western Tasmania by the ridge which extends southwest from King Island and which is a southwest continuation of the King Island–Mornington Peninsula Ridge.

Seismic coverage is by 1964–67 Esso K- and EO-lines with a line spacing of about 9 km normal to the coastline, with just two lines parallel to the coast 20 km apart.

Two wells, Prawn-A1 and Whelk-1, were drilled in the Otway Basin by Esso. Summarised data on the wells are shown in Tables 3 and Figure 2. The stratigraphic nomenclature used for these two wells is derived from the onshore Victoria/South Australian Otway Basin and has been adapted for use in the wells off western Tasmania. Thompson (1986) has related the stratigraphy to the main sea level eustatic chart (Vail *et al.*, 1977).

Sorell Basin

The Sorell Basin extends from the southeast extension of the King Island–Mornington Peninsula Ridge towards the southeast along the entire west coast of Tasmania. The basin consists of a number of sub-basins which, in order from north to south, are:–

- the King Island Sub-basin (Culp, 1968);
- the Sandy Cape Sub-basin (Moore *et al.*, 1992);
- the Strahan Sub-basin;
- and the Port Davey Sub-basin (Moore, 1991).

Only two wells have been drilled in this basin; Clam-1 in the King Island Sub-basin and Cape Sorell-1 in the Strahan Sub-basin.

King Island Sub-basin

The King Island Sub-basin is located due south of King Island off the northwest tip of Tasmania. It is about 120 km from north to south and about 20 km in width (Enclosure 1).

Seismic coverage for the King Island Sub-basin is provided by a 7 km grid of 1968 Esso EP-lines.

Clam-1 was drilled in the King Island Sub-basin in 1969. The stratigraphy is summarised in Table 3 and Figure 2. Stratigraphic nomenclature is derived from the adjacent Otway Basin. Below 1272 m (fig. 2) the red bed interval, originally believed to be Devonian, is re-interpreted to be Cretaceous similar to those beds recently recognised in the onshore Boobyalla Sub-basin of the Bass Basin (Moore *et al.*, 1984).

Sandy Cape Sub-basin

The Sandy Cape Sub-basin is located directly southwest of the King Island Sub-basin (Enclosure 1). The two are separated by the Clam High which is orientated parallel to the coast. The sub-basin is about 70 km long and 25 km wide. No wells have been drilled in this sub-basin and it is covered by only three seismic lines. The sub-basin is located in water depths ranging from less than 200 to 1000 metres. Seismic line BMR78-5 shows a potential one line fault trap in under 200 m of water. The extent of this lead cannot be estimated because of lack of control. The seismic character suggests that this sub-basin contains rocks which were deposited in an upper slope–outer shelf environment. The sub-basin has potential to generate and trap hydrocarbons migrating from depocentres under the upper continental slope.

Strahan Sub-basin

The Strahan Sub-basin is located west of Strahan, mainly in waters less than 200 m deep, and consists of Late Cretaceous and Tertiary rocks in a series of half grabens parallel to the coast and rotated in a clockwise direction. Near the Cape Sorell-1 well there is a 125° bend in the faults (Enclosure 1). The sub-basin is covered by a series of parallel seismic lines, one set parallel to the coast and the other set normal to the coast. Both sets of lines are about 1.25 km apart. Amoco shot a series of lines in 1981 which Maxus reprocessed in 1990. At the same time Maxus shot an infill grid which achieved a 1 to 1.25 km grid over the sub-basin.

Cape Sorell-1 was drilled in the Strahan Sub-basin and reached TD in the Late Cretaceous Sherbrook Group. The stratigraphy of the well is shown in Table 3 and Figure 2.

Geochemistry of cuttings and sidewall cores was carried out by three different laboratories and is summarised in Table 5. While the TOC from the different laboratories produced similar results, the vitrinite reflectances obtained at 3201.3 m and 3426.6 m, both from sidewall cores (Dow, 1982), produced vitrinite values double those of Ross (1982) and Armstrong *et al.* (1983) from similar depths. The lower vitrinite values are thought to be more reliable.

Table 2

Petroleum exploration wells, western Tasmania

Well Name	*Operator*	*Basin/Sub-basin*	*Reference*
Prawn A-1	Esso Exploration and Production Australia Ltd	Otway	Culp, 1968
Clam-1	Esso Standard Oil (Australia) Limited	King Island	Davidson, 1970
Whelk-1	Esso Standard Oil (Australia) Limited	Otway	Lunt, 1969
Cape Sorell-1	Amoco Australia Petroleum Company	Strahan	Amoco, 1982

Table 3

Summary of well results, offshore western Tasmania.
Depths, except KB, are in metres sub sea

Basin	*Otway*	*Otway*	*King Island*	*Cape Sorell*
Well	Prawn	Whelk	Clam	Cape Sorell
Spud Date	January 1968	June 1970	July 1969	July 1982
Operating Company	Esso Exploration and Production Australia Ltd	Esso Standard Oil (Australia) Ltd	Esso Standard Oil (Australia) Ltd	Amoco Australian Petroleum Company
KB	30	30	30	22
Stratigraphy				
Heytesbury Group	108	103	102	94
Nirranda Group	725	?	?	?
Wangerrip Group	895	329	387	389
Sherbrook Group	1238	735	925	1759
Curdies Formation	-	735	-	-
Paaratte Formation	-	1248	-	-
Waarre Sandstone	-	1278	-	-
Late Cretaceous Red Beds		1373	1462	
Otway Group	2917	-	-	-
Pz/Late Proterozoic	-		1510	-
TD	3166	1436	1592	3528

Table 4

Seismic surveys run in western Tasmanian waters

Line Name	*Operator/Survey Name*	*Year*
K-	Hematite Cape Grim–Cape Jaffa (Maureira and Reed, 1965)	1964–65
EO-	Esso Offshore Otway Basin — 1966 (Wiggin *et al.*,1967)	1966–67
EP-	Esso South King Island, part of Esso Offshore Otway Basin — 1967 (Parsons, 1968)	1968
EE-	Esso Tasmania (Horgan, 1969*a*)	1968
T69A-	Esso West Tasmania (Horgan, 1969*b*)	1969
T70A-	Esso West Tasmania (Western Geophysical, 1970)	1970
T70C-	Esso West Tasmania (Geophysical Service International, 1971)	1970
BMR 16-	BMR Continental Margins Survey 16 (Tilbury, 1974)	1973
N-	'Petrel' Survey (Shell, 1973)	1973
W81-	Amoco West Tasmanian Basin (Amoco, 1981)	1981
BMR40	BMR Survey 40, MV *Vilma*	1982
BGRS036	BGR Survey 36, RS *Sonne* (Hinz *et al.*, 1985)	1985
BMR78-	BMR Survey 78, RV *Rig Seismic* (Exon *et al.*, 1989)	1988
MXT90-	Maxus Energy CPN Survey (Maxus, 1990; Kovas, 1993)	1990

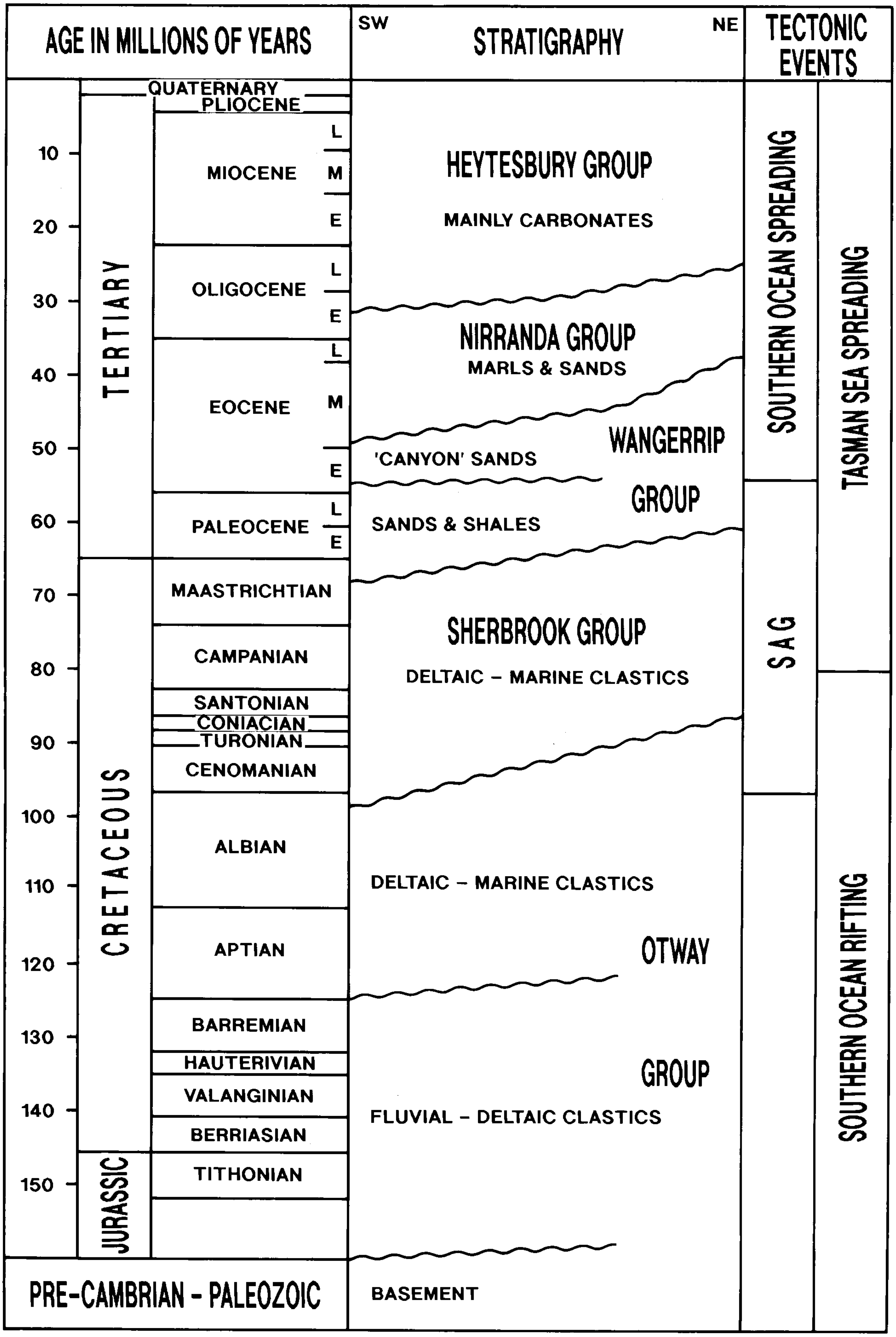


Figure 3

Stratigraphy of the west coast of Tasmania

Table 5

Geochemical evaluation of Amoco Cape Sorell-1 well

Depth	*Sample*	*TOC*	*T Max (°C)*	*Potential Yield (kg/ton)*	*% Ro*	*Author*
1268.5	Ctgs	5.8	425	-	0.48	A1
1335	Ctgs	3.3	426	-	0.55	A1
1400	Ctgs	2.0	417	-	-	A1
3103	SWC	1.07	436	0.79	-	R2
3118–3124	Ctgs	1.6	429	-	-	A1
3143.4	SWC	3.97	421	14.82	-	R2
3163.8–3170	Ctgs	8.2	419	-	0.45	A1
3181	SWC	0.96	440	0.84	0.46	R2
3201.3	SWC	1.89	421	-	0.90	R1
3228–3234	Ctgs	5.6	418	-	0.45	A1
3233.3	SWC	3.83	420	13.93	0.47	R2
3233.3	SWC	18.60	422	71.60	-	R2
3283	SWC	4.46	428	17.00	0.54	R2
3283	SWC	1.99	432	6.16	-	R2
3313.8	SWC	1.34	435	1.54	-	R2
3326.6	SWC	1.14	438	1.60	-	R2
3344.9	SWC	0.80	436	1.12	-	R2
3426.6	SWC	1.36	437	-	1.00	R1

A1 Ctgs analyses by Ross (1982) of Amoco.
R1 SWC analyses by Dow (1982) of Robertson Research (US) Inc.
R2 SWC analyses by Armstrong *et al*. (1983) of Robertson Research (Singapore).

Deep Sea Drilling Project (DSDP) hole 283 was located about 125 km due west of Macquarie Heads in about 4200 m of water. Rocks encountered in this hole were:–

1. 192 m of Pleistocene–Oligocene ooze;

2. 103 m of late Eocene organic rich silt and clay;

3. fine-grained pillow lava (Kennett *et al.*, 1975)

Unit 2, especially where it thickens under the shelf, could provide excellent source rocks. Similar rocks were dredged off the west coast by RV *Rig Seismic* (Exon and Lee, 1987; Exon *et al*., 1989) and by RV *Sonne* (Hinz *et al.*, 1985, 1986).

Port Davey Sub-basin

The Port Davey Sub-basin is located southwest of Port Davey. It is defined by one seismic line, Esso T70A-38 but with BGR Sonne line 48 near the southern end and BMR 16/55 sparker line near the seaward extremity. From what little is known of the sub-basin it appears to consist of two or three half grabens bounded in the east by faults that parallel the coast. This is similar to the situation in the Strahan and Sandy Cape Sub-basins (Enclosures 1 and 2).

The dimensions of the sub-basin, as mapped by Moore (1991) and shown on Enclosure 2, indicate that it is some 50 km long by 25–30 km wide. There is poor seismic control over the shape of the sub-basin, especially to the northwest, and there is clearly room for additional sub-basins and/or continuation of existing sub-basins between the Port Davey and Strahan Sub-basins.

The stratigraphy of the Port Davey Sub-basin is difficult to predict, as the vintage and processing of the seismic is very different to that at the nearest well, Cape Sorell-1. The stratigraphy is most likely to be similar to that of the Strahan Sub-basin, with Late Cretaceous and Paleocene rocks overlain by Eocene and younger sequences.

Structural Setting

The continental shelf off the west coast of Tasmania is underlain by a seaward-thickening wedge of sediment deposited as a result of the rifting of Tasmania from Antarctica commencing in the Late Jurassic.

Seafloor spreading started in the Palaeogene off northern Tasmania, with younger seafloor developing southwards against the Tasmanian margin as time progressed. For this reason it is thought that the southernmost sub-basins (Strahan and Port Davey) may have much later sediment filling than the northern sub-basins and basin (King Island, Sandy Cape and Otway) (Moore *et al.*, 1992, fig. 5 and 6).

A detailed summary of the geological setting of the west coast of Tasmania was given in Moore *et al*. (1992) (fig. 2 to 4).

Since Moore's work, Maxus has released the results of its detailed seismic shot in 1990 in the Strahan Sub-basin (Maxus, 1993).

RV *l'Atalante* carried out a swath-mapping and reflection seismic survey, primarily of the South Tasman Rise and the area extending northwards and west of Tasmania (fig. 4), in February–March 1994. The survey mapped major fault systems that trend 345° and 320° with escarpments of up to 2300 m (Exon *et al.*, 1994). These fault trends fit very well with the fault directions mapped in the Tasmanian west coast basins and are clearly related to the breakup of Australia from Antarctica.

The RV *l'Atalante* cruise was followed up by a RV *Rig Seismic* cruise which has just been completed (February–March 1995), collecting dredge samples off the Tasmanian coast including the South Tasman Rise. One result of this was to successfully sample the rocks associated with the major escarpments (Exon, 1995 and pers. comm.). Deep crustal seismic surveys are planned by the Australian Geological Survey Organisation (AGSO) in the near future. The data from these two cruises, together with new and yet to be released aeromagnetic and gravity surveys (also run by AGSO), will certainly update the present 'old' database and will eventually be used to make more refined interpretations of the structural geology of the western Tasmanian margin.

Enclosure 17 is an attempt to summarise the tectonic architecture of the west coast of Tasmania using all the available data, and drawing mainly from the regional work done by Moore (1991). This enclosure shows the thickness of sediment, easily measured, under the west coast of Tasmania to depths of 2000 m or halfway down the continental slope. More sediment than this may be preserved in the deeper parts of the individual grabens, but it is difficult to measure this with the older vintage seismic data used by Moore (1991), which still forms the present data base. In fact Moore *et al.* (1992) report a maximum thickness of 4300 m in the Southern Otway Basin; 3600 m in the King Island Sub-basin; 5100 m in the Sandy Cape Sub-basin; 6500 m in the Strahan Sub-basin; and 3000 m in the Port Davey Sub-basin. Enclosure 17 does not show the thickest portions of the graben (rift valley) fill but rather the contours are meant to convey the thickness trends as can be easily recognised on the old seismic (this often does not include the narrow but thick rift valley fill of the Lower Cretaceous, Otway Group sequence).

Bearing this in mind, and realising that Enclosure 17 is an attempt to show the main depocentres and faults, several conclusions can be made:–

- Bounding faults trend generally more northwest than parallel to the present day Tasmanian coastline. This direction is similar to the direction of north Macquarie Harbour, which is an Eocene half graben still preserved today.
- The northern bounding fault of the Macquarie graben, called here the Conical Rocks Fault, trends northwestwards offshore towards the Clam High and further north may intersect the continental margin west of the Whelk High off King Island.
- Other fault zones, such as the Point Hibbs Fault Zone, parallel the Macquarie graben. The Point Hibbs Fault Zone extends northwards into the central Strahan Sub-basin, where it forms an important mid-basin fault (Enclosures 3, 6 and 7).
- The Point Hibbs Fault Zone probably extends southeastwards along the present day coastline and forms a faulted basin boundary in the updip region of the Port Davey Sub-basin. However this is somewhat conjectural as there are no seismic lines normal to the coast throughout this area.

It would be tempting to join these major lineaments with others that occur along strike. If so they would form prominent fracture zones similar to the giant Tasman Fracture Zone that has been mapped bounding the Tasmanian Sub-continent against Antarctic seafloor (Exon, 1994, fig. 4). Even though the Tasman Fracture Zone quite clearly bounds the South Tasman Rise it trends more northwards by an angle of about 25° than the Macquarie Graben. This variance in trend is quite easily seen in the seafloor relief diagram produced by Exon *et al.* (1994, fig. 4) of the South Tasman Rise.

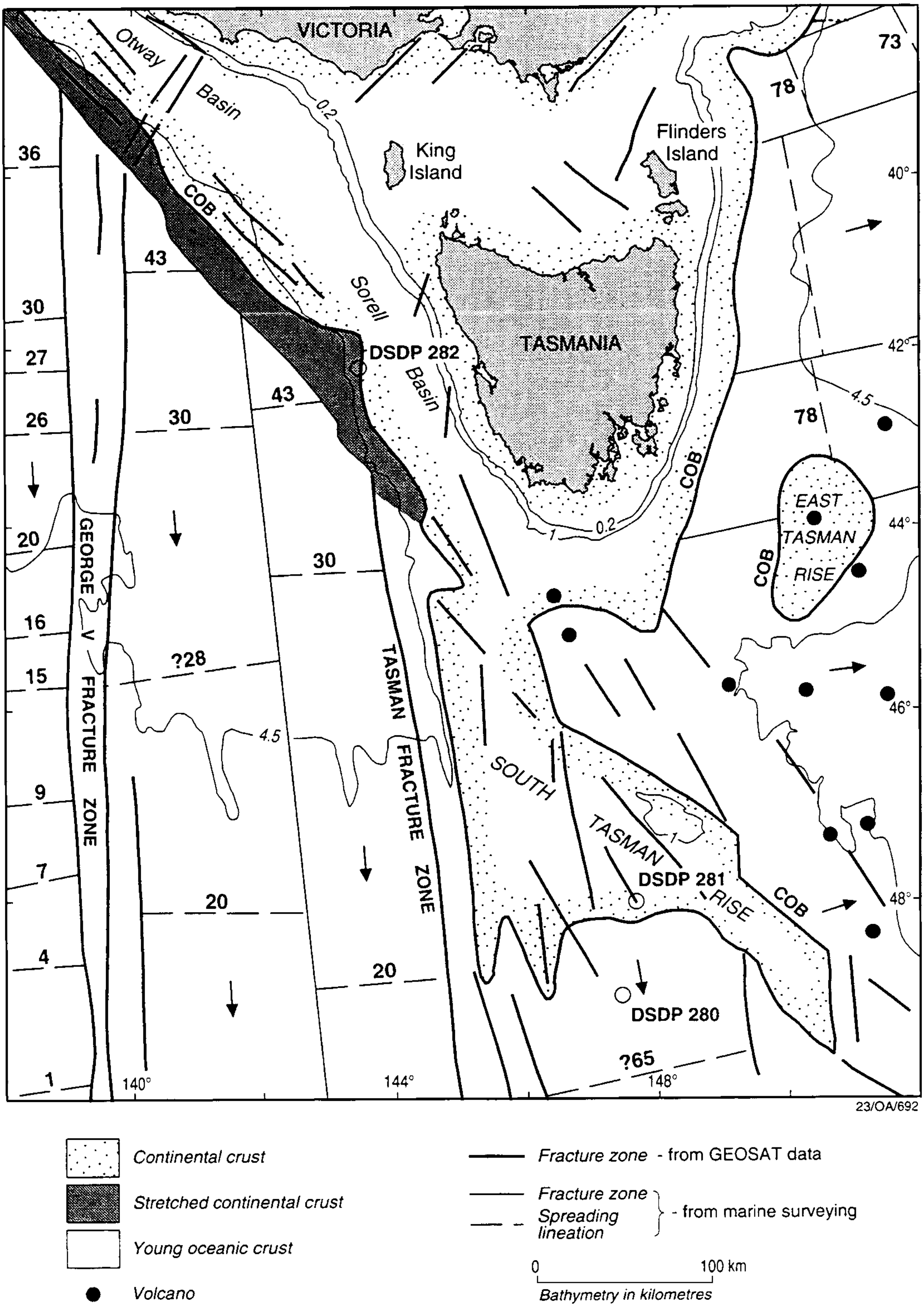


Figure 4

Tectonic elements of the offshore Tasmanian region (from Exon et al., 1994)

Exon *et al.* (1994) describe the Macquarie Harbour direction at 320° as an older fault system and the Tasman Fracture Zone at 345° as a younger fault system.

We conclude that the 320° fault direction in the Macquarie Graben, and the Point Hibbs Fault Zone and many of the other faults seen both off the western Tasmanian margin and the South Tasman Rise, would owe their origin to original directions established during the rifting of Gondwanaland in the Upper Triassic and Lower Cretaceous.

Major transfer zones offsetting the fault pattern formed during this rifting period are not obvious using the present data. The deep crustal seismic that will be shot by AGSO in the near future will probably be able to define these zones, which can generally be recognised by major offsets in the strike of the onshore geology. We suspect that transfer zones might explain the offset of the Otway Basin off King Island from the King Island Sub-basin. This is similar in size to the offset of the Macquarie Graben from the Point Hibbs Fault Zone, or about 20 to 25 km. Such transfer zones are areas where cross structural trends could form favourable hydrocarbon traps.

It is suggested the Strahan Sub-basin is bounded by a transfer zone, as is evidenced by the east-trending fault that bounds the northern margin of the basin. It is also suggested that the Sandy Cape–King Island region and the Port Davey Sub-basin all owe their origin, not just to 'bends' in the fault trends, but to cross faulting caused by adjustment along transfer zones associated with the Jurassic rift architecture.

Source Rocks and Geochemistry

Source rocks that have the potential to produce hydrocarbons, or are currently generating and releasing hydrocarbons along the western coast of Tasmania, are evident from:–

1. The presence of free oil traces in Amoco Cape Sorell-1 below 3000 metres. This indicates that the Palaeocene and Maastrichtian rocks contain source material and these have been elevated to maturation temperatures.

2. Surface geochemistry of samples from the Sandy Cape Sub-basin and the Otway Basin from southwest of Prawn-A1 contain thermogenic hydrocarbons (Exon and Lee, 1987; Heggie *et al.*, 1988; Exon *et al.*, 1989).

3. DSDP Site 282 samples indicate that upper Eocene organic-rich shales are potential source rocks (Kennett *et al.*, 1974).

4. Gas yields and molecular composition of surface samples collected during the RV *Sonne* cruise, and reported by Whiticar *et al.* (1985), showed the presence of wet thermogenic hydrocarbons. The highest yields were from the upper continental slope of the Strahan Sub-basin about 25 km southwest of Cape Sorell-1. The total C1–C5 yield was high by world standards (1363 ppb). The proportion of C2–C5 was high, indicating wet gas around 40–45%. Other geochemical ratios also indicated a thermogenic source.

5. The average TOC from the lower half of the Sherbrook Group in Prawn-A1 (Preston, 1992) was 3.26, based on the 31 samples with values more than 1 and less than 10. For Cape Sorell-1 the average TOC was 3.03 (based on 12 samples; Table 5) but for Whelk-1 (Preston, 1992), based on four samples, it was 1.45. These average TOCs indicate good source potential, especially for Cape Sorell-1 and Prawn-A1. No geochemistry results were available for Clam-1.

Reservoir and Seal

The Eocene/Palaeocene interval in all four wells is sandy, with only moderate potential seals. This is especially the case in Cape Sorell-1. Porosities in the sand from 370–1230 m are very high (30%+) and the overlying carbonate sequence has scattered high porosity intervals which may destroy its sealing ability. Potential seals occur from about 1250 m to 1310 m, with other thinner potential seals occurring down to about 1480 metres. Interbedded sands have porosities of 20–30%. Significant seals are not present from 1480 m to about 3050 m. Interbedded sands from 3050 m to TD have poor to moderate porosities (10–15%). Overall this well is very sandy with few potential seals.

Table 6 shows the gamma ray variation throughout the well and shows clearly that readings only exceed 85 API below 3074 metres. As oil is produced from reservoirs in the Tuna field of the Gippsland Basin from crevasse splay sands with gamma counts of 75 API (these are not radioactive beach sands) it is not surprising that there are apparently no trapped hydrocarbons in Cape Sorell-1 above 3070 metres. However traps further westward may well have cleaner sands and better seals distal to the source, and greater chance of there being marginal marine conditions in which sediments could have been winnowed into clean sand reservoirs and clean mudstone seals.

The channel fill of the late Eocene channels may be mainly mudstone, like the *P. asperopolus* age mudstone that fills the Tuna–Flounder Channel of the Gippsland Basin. These channel fill shales could form seals around westward-dipping noses in a similar manner to the way the Marlin Channel shales seal and trap the large Marlin gas field of the Gippsland Basin.

The Palaeocene and Eocene section is similarly sandy in the Whelk-1 and Clam-1 wells. The Maastrichtian section however has sand with moderate to good porosities and a higher shale content, which increases the probability of seals.

In general the areas basinwards (westward) of the existing wells should be more marine, therefore be better winnowed and have cleaner reservoir sands and more effective seals to ensure hydrocarbon entrapment. It is interesting that the sand in Cape Sorell-1 is so even grained and clean, as the provenance must have been only about 25 km west of the well.

Table 6

Gamma ray defined intervals of Cape Sorell No 1 well, Sorell Sub-basin, west Tasmania. Depths are in metres sub sea; KB is 22 m (72′)

Top	API Gamma "Base"	API Gamma Range	Lithology and comments
310	40	20–90	sandstone, glauconitic and mudstone/siltstone. Raised gamma compared to above and below, sonic and resistivity drop compared to above
348	25	15–45	sand — very fine, mudstone and dolomite
659	40	20–60	sand fine–coarse, 10–80%, mudstone 20–90%
764	20–30	15–60	sand fine–medium, minor siltstone/mudstone
1243	45	30–75	sand and sandstone, fine–very coarse 85%, siltstone 15%
1596	60–65	20–75	sandstone, very fine–medium 80%, mudstone 20%
1724	65–70	45–85	sandstone, fine–coarse 70%, mudstone 30%
1901	55	40–65	sandstone, fine–medium (rare coarse to very coarse), minor silt
2812	55–60	45–75	conglomerate and conglomeratic sandstone, fine–very coarse clay matrix
2928	40	30–70	conglomerate and conglomeratic sandstone, fine–very coarse, cleaner than above
3074	60	35–110	shale, siltstone and sandstone, fine–coarse; good shows with free oil throughout
3385	45	35–55	conglomerate, cobble to boulder size
3506			Total depth

Strahan Sub-basin

A farmout package was prepared (Maxus, 1993) for permit T/24P. The following section draws from this work. Unfortunately Maxus were unable to farmout an interest in the Strahan Sub-basin and relinquished the permit in 1993.

The figures generated by Maxus illustrate the prospects in the Strahan Sub-basin and some have been reproduced and used in this report, basically without much change. An additional prospect has been described which shows as a distinct DHI (direct hydrocarbon indicator) in an Eocene channel on three seismic lines.

A new geohistory analysis has been made of the Cape Sorell-1 well area, and a region located to the west of Cape Sorell-1 (Enclosure 5) by Aiden Moore of AGSO in conjunction with Lonman Pty Ltd. These analyses have attempted to model the past burial history of the Strahan Sub-basin to understand trap formation and timing of hydrocarbon migration.

Cape Sorell-1 Well

Cape Sorell-1, drilled by Amoco in 1982, encountered a sequence of Palaeogene sand-dominated sediments overlain by a cap of Miocene to Recent limestone. Sand-rich Upper Cretaceous sediments were penetrated deeper in the well and live oil shows were recorded from 3170 m to near the bottom of the hole at 3445 metres.

Both reservoir and some thin shale units occur in the Cape Sorell-1 well (fig. 2). The sequence was mainly deposited in a location proximal to the basin boundary fault to the east and it is not considered representative of the type of section expected in areas located further offshore, where thicker shale units should provide effective seals and source rocks.

On the basis of the results of the Cape Sorell-1 well and other general geology, Maxus (1993) made the following remarks:–

"The Cape Sorell-1 well encountered live oil shows below the Sherbrook/Wangerrip interface (an unconformity) which demonstrates no structural closure at the well location. While no true source rocks were indicated due to poor facies development and marginal thermal maturity (both due to close proximity to a major basin-forming fault), scattered, favourable TOC values were measured below 10,000′ (3050 m)" (Table 5).

"Thermal maturation modelling (BasinMod), supports the premise that generative conditions have existed (and currently exist), within targeted continental and marine intervals in the block."

A marine, sea floor survey detected thermogenic hydrocarbons on the continental slope for the deeper waters off the Strahan Sub-basin. (Hinz *et al.*, 1986)

Prospects and Leads

Several prospects and leads in T/24P were mapped by Maxus. A summary of these follows:–

Braddon Point Prospect

This prospect is a broad nose which has both fault closure (to the west) and is sealed by the Eocene canyon on the east. The targets lie within the Palaeocene lower Wangerrip and are mapped as pink and orange on Figures 6 and 7.

Enclosure 6 shows seismic line MXT90-5 which crosses both the Braddon Point and Trial Harbour prospects. On this line the orange reflection marks the base of the lower Eocene channel. The Eocene channel and fill have substantial relief on both sides of the Braddon Point prospect area (0.3 seconds TWT) and in this regard are similar to the marine canyon system that sculpted parts of the Gippsland Basin during the Tertiary and was responsible for forming seals on a number of major oil and gas fields. These fields include:–

1. The Marlin gas field where the Eocene Marlin Channel fill mudstone holds in a 180 m gross gas column (Griffith and Hodgson, 1971; Svalbe, 1975; Mebberson, 1989); the Marlin structures' northeast flank is entirely eroded by the Marlin Channel and relies on the mudstone of the channel fill to trap the gas in the reservoir.

2. The Halibut oil field, which had a 125 m gross oil column, is the second largest Gippsland Basin oil field and originally had some 800,000 million barrels of reserves. The field is deeply eroded by the Marlin Channel along its eastern limb where the seal is the Eocene mudstone of the Marlin Channel fill (Griffith and Hodgson, 1971; Mebberson, 1989).

3. The Mackerel oil field, which has produced over 400 million barrels of oil to date and is the third largest Gippsland oil field, was eroded at its northeastern end by the Marlin Channel and is sealed by the channel's mudstone fill (Mebberson, 1989; Cousins, 1995).

4. The Tuna field is also sculpted by the slightly older early Eocene submarine canyons of the

Tuna–Flounder Channel (O'Byrne and Henderson, 1983). The uppermost reservoir of the field, the oil and gas-filled M-1, occurs in beach sand at the top of the channel fill. Other sand at the base of the channel holds hydrocarbons, while others (e.g. M-2) are in adjacent Lower *M. diversus* pre-channel rocks to the east of the channel and sealed by the channel's mudstone fill in a similar manner to the Halibut and Marlin Fields.

The 3-D perspective figure (fig. 8) shows how the Eocene canyons coalesce seawards of the Braddon Point erosional remnant. A geohistory analysis of the Cape Sorell-1 well suggests that oil could have been generated from potential Upper Cretaceous source rocks to fill this feature after the channel fill was formed (Enclosure 5).

A closure of 7,800 acres for the Braddon Point prospect (fig. 6) was mapped by Maxus. According to Maxus (1993) this prospect could have up to 200 million barrels of estimated recoverable reserves (Table 7).

Trial Harbour Prospect

The Trial Harbour prospect is located along the northern boundary fault of the Strahan Sub-basin, against which it closes. The prospect has sandstone targets within the Late Cretaceous Sherbrook Group, and early Tertiary lower Wangerrip Group (figs 9, 10, 11 and 12).

Enclosure 6 shows seismic line MXT90-5 at a larger scale. The prospect is partly sealed by Eocene channel fill particularly to the southeast, and it mainly relies on closure against the main basement bounding fault in the north.

Source rocks would be Cretaceous Sherbrook Group shales and hydrocarbons which could have migrated updip from a more basinwards location after the Eocene channel was formed and filled. Recoverable reserves were estimated to be as much as 200 million barrels by Maxus (1993) (Table 7).

Sloop Point Prospect

This prospect is located in the southern central portion of the Strahan Sub-basin and relies on broad anticlinal and fault closure (figs 12, 13). Target sands occur in both Sherbrook and Otway Group sequences. The Otway Group is shown as the yellow section, and the Sherbrook the blue section on the seismic section on Figure 14.

A 3-D perspective (fig. 12) drawn at the base Wangerrip (top Sherbrook) shows the Sloop Point prospect viewed from the wall of the mid-basin fault, which has been called the Point Hibbs Fault in this report. Enclosure 3 shows the location of the Point Hibbs Fault Zone.

The Sloop Point prospect, according to Maxus (1993), could have up to 154 million barrels of recoverable oil in Sherbrook Group sand with another 90 million barrels of potential in Otway Group sand (Table 7).

Sourcing for this feature could be from either side of the Point Hibbs Fault Zone from Upper Cretaceous and/or even Palaeocene rocks.

Northern Strahan Wedgeout Lead

A reconnaissance line in the northern portion of the block shows a major anticline which plunges to the northwest (Enclosure 8). Updip to the southeast, the feature becomes a shallow basement high. The tentatively identified marine Sherbrook Group section possibly wedges out on the flanks of the high, thus creating a major stratigraphic trap (Maxus 1993).

More seismic would be needed to properly define this lead. It sits in deep water (greater than 1000 m) but could have giant-size reserves which may be commercially attractive.

Eocene Canyon Sand Leads

A large submarine canyon system developed in the Strahan Sub-basin during a low stage of sea level in the earliest Eocene. This system cut down through

Table 7

Estimated recoverable reserves by prospect

Prospect	*Most Likely Acreage*	*Potential Pay (Ft.)*	*BBL/Ac.Ft.*	*Estimated Recoverable Reserves(BBLS)*
Braddon Point				
Wangerrip	7,800	100	258	201,240,000
Trial Harbour				
Sherbrook	11,000	70	258	198,660,000
Sloop Point				
Sherbrook	7,500	80	258	154,800,000
Otway	4,400	80	258	90,816,000
			Total	**645,516,000**

Palaeocene sediments and eventually filled with Eocene sediment.

Potential stratigraphic traps exist within the canyon system where Eocene canyon sands are sealed by overlying shale and the canyon wall (fig. 8, Enclosure 4).

It was pointed out by Maxus that a potential stratigraphic trap could form in a "deep" part of the canyon where the two canyon tributaries meet. This location is shown as the blue region near the intersection of seismic lines W81-11, MXT90-15, and MXT90-12 on Figure 15.

A map of the Eocene channel fill is also shown on Enclosure 4 (after Maxus, 1993).

Of greater interest is the occurrence of a substantial high amplitude reflector that is confined by the channel at depths of 1.8 seconds and located on three seismic lines (Enclosure 5 — seismic line BMR78-8, Enclosure 6 — seismic line MXT90-5, Enclosure 7 — seismic line MXT90-8).

This flat-lying reflector abuts against the eastern wall of the canyon and extends westwards out into the canyon fill. On seismic line BMR 78-8, the flat-lying reflector is at least 1.5 km long; on seismic line MXT90-8 it is about 1.5 km long and on seismic line MXT90-5 it may extend almost 2 km across the channel from one wall to another.

The area covered by this DHI (direct hydrocarbon indicator) could be greater than 1,000 acres. If there were a 70 m canyon sand oil pay, this prospect could have up to 50 million barrels of recoverable oil reserves using the recovery factors used by Maxus (1993) (Table 7).

Shelf west of King Island

Tasmanian waters extend northwards from the west coast of Tasmania to west of King Island. The area has been referred to by earlier workers such as Moore *et al.* (1992) as the southern extension of the Otway Basin. It has most of the attributes of the Otway Basin including its petroleum potential.

This area is separated from the remainder of the west of Tasmania by a major basement high, the King Island High. The King Island High extends southwards from King Island for about 100 km, where it makes the northern boundary of the Sandy Cape Sub-basin, which itself is separated from the King Island Sub-basin by a southeast extension of the King Island High which is called the Clam High (fig. 1).

Two seismic lines (ER61 — Enclosure 9 and EO-51 — Enclosure 10) are included in this report to illustrate the general geology of the area west of King Island, as well as the depth to basement map (Enclosure 1). The present seismic grid in this region is shown on Enclosure 1; this grid consists of several widely-spaced lines shot by Esso Australia in the late 1960s. The regional work by Moore (1991) and Moore *et al.* (1992) quite clearly indicates that this part of the Otway Basin probably has mature oil source rocks. The mudlogs for the Prawn-A1 and Whelk-1 wells show higher background gas levels throughout the Late Cretaceous Sherbrook Group compared to the levels of the section above.

Seismic Line ER-61 and the tie to Whelk-1

This line was shot by Hematite Petroleum in 1968 and illustrates the geology of the Southern Otway Basin west of King Island. The line shows that the Whelk-1 well was drilled on a faulted (probably a large tilted fault block) basement block with thin Otway Group deposited in half grabens on each side.

This syn-rift sequence is a thick (up to 2 km) Upper Cretaceous sequence overlain by a fairly thin Palaeogene sequence. This is in contrast to the Strahan Sub-basin where the Palaeogene sequence is much thicker, indicating a later development of the subsiding passive margin sequence off southern Tasmania as could well be predicated from the later growth of the Antarctic seafloor in a southwards direction.

Seismic line EO-51 (Enclosure 10) similarly illustrates the presence of a thick (1–2 km) Upper Cretaceous sequence and a thinner Palaeogene sequence.

This implies that oil would have to have been generated by at least Palaeogene times, as there would have been little subsequent heat flow to generate large quantities of oil, unless generation occurred (or is occurring) under the continental slope where thicker Neogene sequences are deposited.

This is reflected in the burial history synthesis made by Moore *et al.* (1992, fig. 8) which shows that only the lower half of the Upper Cretaceous has been in the oil window in the past 40 million years at Prawn-A1 whereas the whole section penetrated by the Whelk-1 well was thermally immature.

It would be necessary to generate hydrocarbons in basinal areas west of the Whelk-1 well under the continental slope to enable hydrocarbons to migrate to possible traps underneath the continental shelf.

More seismic would be required to map prospects which could trap gas/condensate reserves. At this time this remains the most obvious play in the region immediately west of King Island where analogies must be made with exploration efforts and successes (La Bella and Minowa discoveries) in the Otway Basin on the continental shelf off Victoria and South Australia.

King Island Sub-basin

The King Island Sub-basin lies shelfward of the Clam High as shown on the depth to basement map (Enclosure 1). The Sub-basin is a 100 km long, narrow (10–20 km wide) rift valley which parallels the present west coast of Tasmania. Only a widely-spaced seismic grid defines the basin (Moore, 1991; Moore *et al.*, 1992). Most of this seismic was shot in the 1960s, with some more recent shooting in the late 1970s by the Bureau of Mineral Resources. Four seismic lines are used as enclosures in this report to illustrate the geology of this sub-basin and the next rift valley seawards, which has been called the Sandy Cape Sub-basin by Moore *et al.* (1992) (Enclosures 11, 12, 13, 14).

Only one well, Clam-1 drilled in 1970 by Esso, has been drilled in this area. Enclosure 12 shows the Clam-1 well tie along seismic line BMR 78-5, eastwards to the King Island Sub-basin and westwards to the Sandy Cape Sub-basin.

The Clam-1 well penetrated a prograding wedge of Palaeogene sediment which is up to 0.5 seconds thick overlying a thin sandy Upper Cretaceous sequence containing red beds (1272–1510 m). These directly overlay basement phyllites of probable Palaeozoic age (1510–1592 m).

The Palaeogene sequence is more similar to that in the Strahan Sub-basin than that in the Otway Basin, being thicker and resting on a 'thinner' Upper Cretaceous sequence. Most of the Palaeogene– Cretaceous section in the well is sand with only a few thin shale intervals (fig. 2).

Seismic lines T69A-2 and T69A-6 both cross an inter-basin high which could eventually map out as a prospect with more seismic (see leads shown on Enclosures 13 and 14).

The lower Eocene canyons mapped in the Strahan Sub-basin also occur in the southern part of the King Island Sub-basin and could well help form effective traps here as they do further south.

The Eocene canyon system should extend southwards and then westwards out across the continental slope. The canyons may act as a conduit for migrating hydrocarbons generated in the thicker sedimentary sequences that occur under the continental slope into shallower sandstone targets under the continental shelf.

Sandy Cape Sub-basin

West of the Clam High is a seaward-thickening prism of sediment (Enclosure 1) which reaches a thickness of up to 5 km underneath the lower continental slope (Moore *et al.*, 1992, fig. 6). This area could well have generated significant quantities of hydrocarbons as inferred by Moore *et al.* (1992, fig. 9) in their synthetic geohistory plot for a basin depocentre within the Sandy Cape Sub-basin.

Studies of headspace gases separated from five surface cores taken on the upper continental slope by Exon and Lee (1987) show anomalous values of C1 to C4 gases. Similar anomalous values occur in a number of cores taken on the same survey from an area on the continental slope directly west of the Cape Sorell-1 well.

The occurrence of these rather high concentrations of C1 to C4 gases shows that hydrocarbons have been generated within the continental slope sequence. These hydrocarbons could be generated largely from carbonaceous shale and coal, and/or shallow marine source rocks of Maastrichtian or lower Palaeocene age. Lower Cretaceous Otway Group rocks could also be source rocks, as they are in the Otway Basin further north.

Three seismic lines are used to illustrate the geology of the Sandy Cape Sub-basin (Enclosures 12, 13 and 14). Some potential leads occur on these lines. On seismic line BMR78-5, for example, arching of the Upper Cretaceous sequence occurs over a tilted basement high block near the edge of the continental shelf (shotpoints 4840 to 4440). This may be just a plunging nose but it is well located to catch hydrocarbons generated in the rift valley fill on either side of this high.

This outer shelf lead is also crossed by seismic line T69A-2 between shotpoints 3162 and 3132 (Enclosure 13). Significant Eocene submarine canyons can be observed on this line and these may form substantial traps which could catch hydrocarbons sourced from underlying thick Upper Cretaceous shale.

Port Davey Sub-basin

Two seismic lines, which illustrate the geology of the Port Davey Sub-basin, are included with this report. Both lines were shot in 1970 by Esso; their location is shown on the depth to basement map (Enclosure 2).

Seismic Line T70A-17 (Enclosure 15) was shot parallel to the coastline along the continental shelf. Most of this line traversed a thin sediment cover (less than 0.3 seconds TWT) over a strong basement reflection. A fault-bounded half graben occurs between shotpoints 4740 and 5000.

This is the proximal end of the Port Davey Sub-basin which has up to 3 seconds (TWT) of sediment fill in this location. It is not possible to tie directly to the closest well (Cape Sorell-1) as this is separated from this location by basement and some major faulting. Hence the ages placed on the major sequences are a best guess, knowing the general geological history of the region.

The upper Oligocene unconformity (shown as the green horizon) is covered by up to 0.6 seconds of mostly Miocene outer continental shelf and upper slope carbonates. The lower Eocene canyon surface is shown as the orange horizon on seismic line T70A-17 but is more difficult to locate on seismic line T70A-38 where several channel surfaces occur within the Palaeogene sequence (Enclosure 15).

The Palaeogene sequences shown on both lines are quite thick (up to 1 second TWT). This is similar to the thickness in the Strahan Sub-basin and is in keeping with the general tectonic history of the continental margin off southwest Tasmania, which subsided during the formation of oceanic crust.

The rift valley fill sequence of Cretaceous age is over 1 second (TWT) thick on both lines and probably ranges up to 2 seconds (TWT) thick elsewhere in the sub-basin.

It is concluded that the Port Davey Sub-basin has a similar sediment thickness to the Strahan Sub-basin and as such could have similar hydrocarbon prospectivity.

The Port Davey Sub-basin possibly has a thick potential Upper Cretaceous source sequence overlain by a thick Palaeogene wedge of clastic sediment with potentially good sand reservoirs. A lower Eocene submarine canyon cutting event possibly occurred which would have sculpted the earlier topography and formed traps, as in the Strahan Sub-basin.

At this time insufficient seismic data exist to locate leads. Further seismic shooting is essential to further assess the Port Davey Sub-basin's hydrocarbon potential.

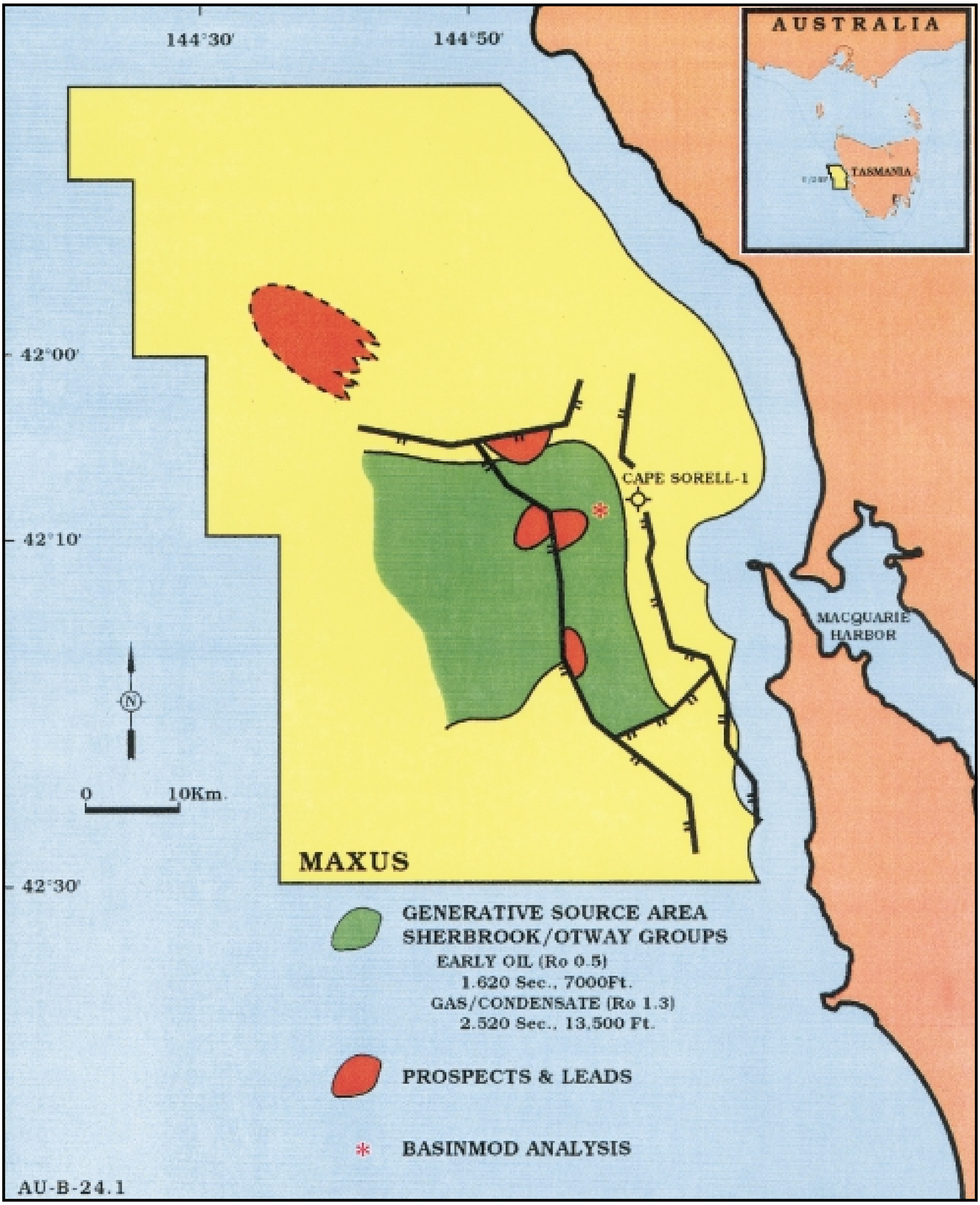


Figure 5

T24/P source areas, prospects and leads
(from Maxus, 1993)

[Reproduced with kind permission of the Maxus Energy Corporation]

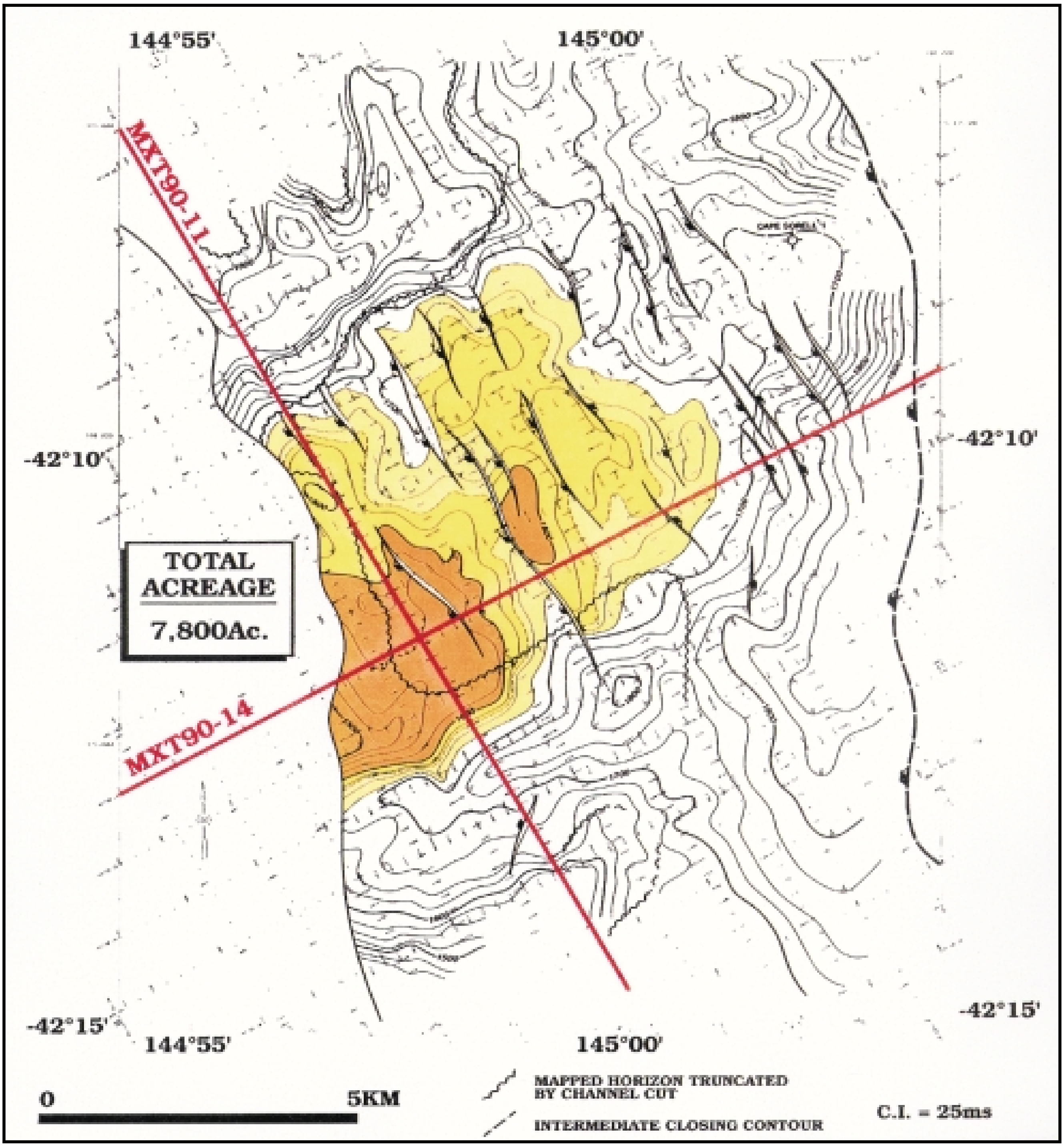
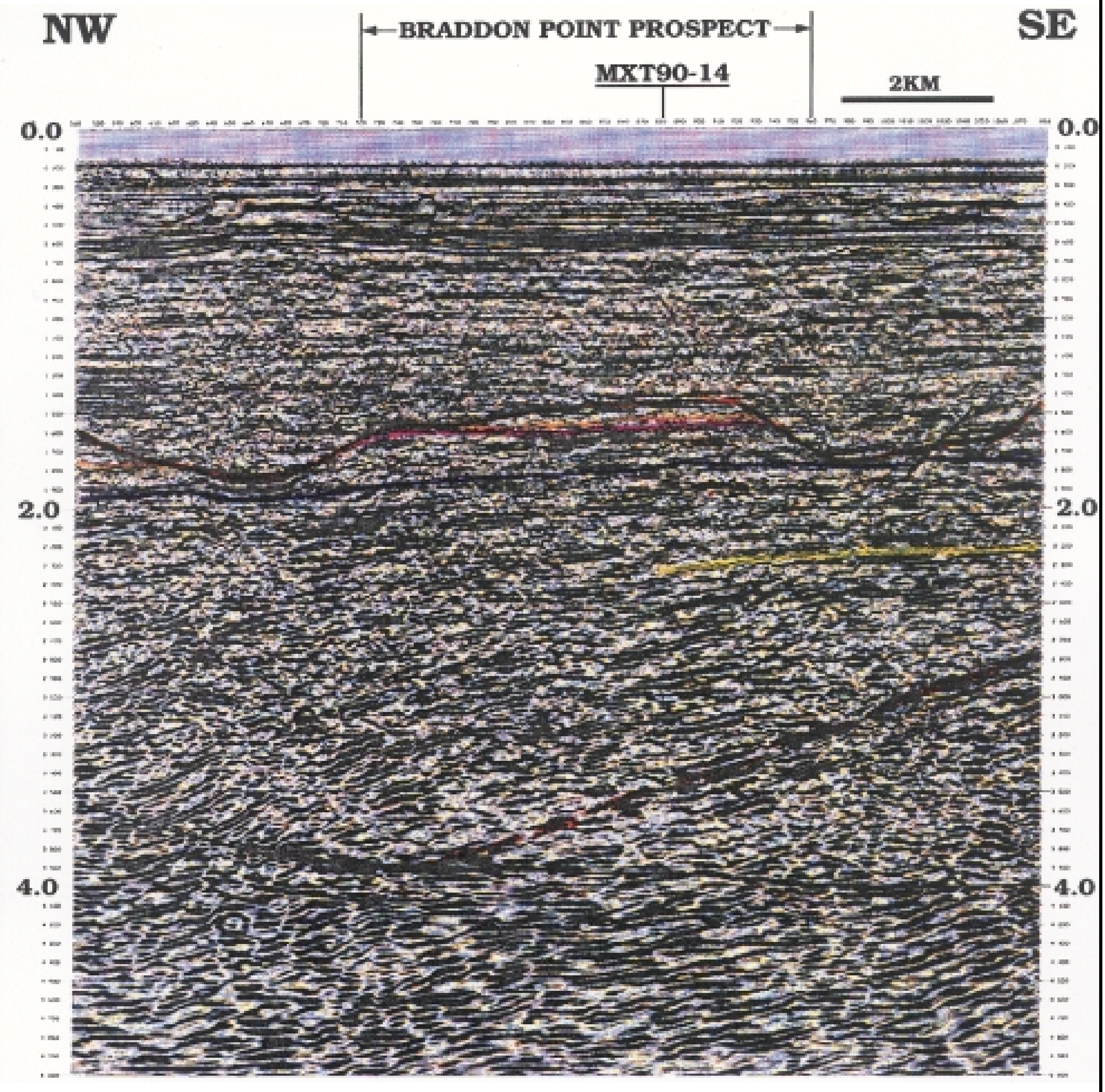


Figure 6

Braddon Point Prospect.
Map of intra-Wangerrip reflector time structure
(from Maxus, 1993)

[Reproduced with kind permission of the Maxus Energy Corporation]



MAPPED HORIZON = PINK, OTHERWISE ORANGE WHERE PINK TRUNCATED

Figure 7

Braddon Point Prospect.
Seismic line MXT 90–11
(from Maxus, 1993)

[Reproduced with kind permission of the Maxus Energy Corporation]

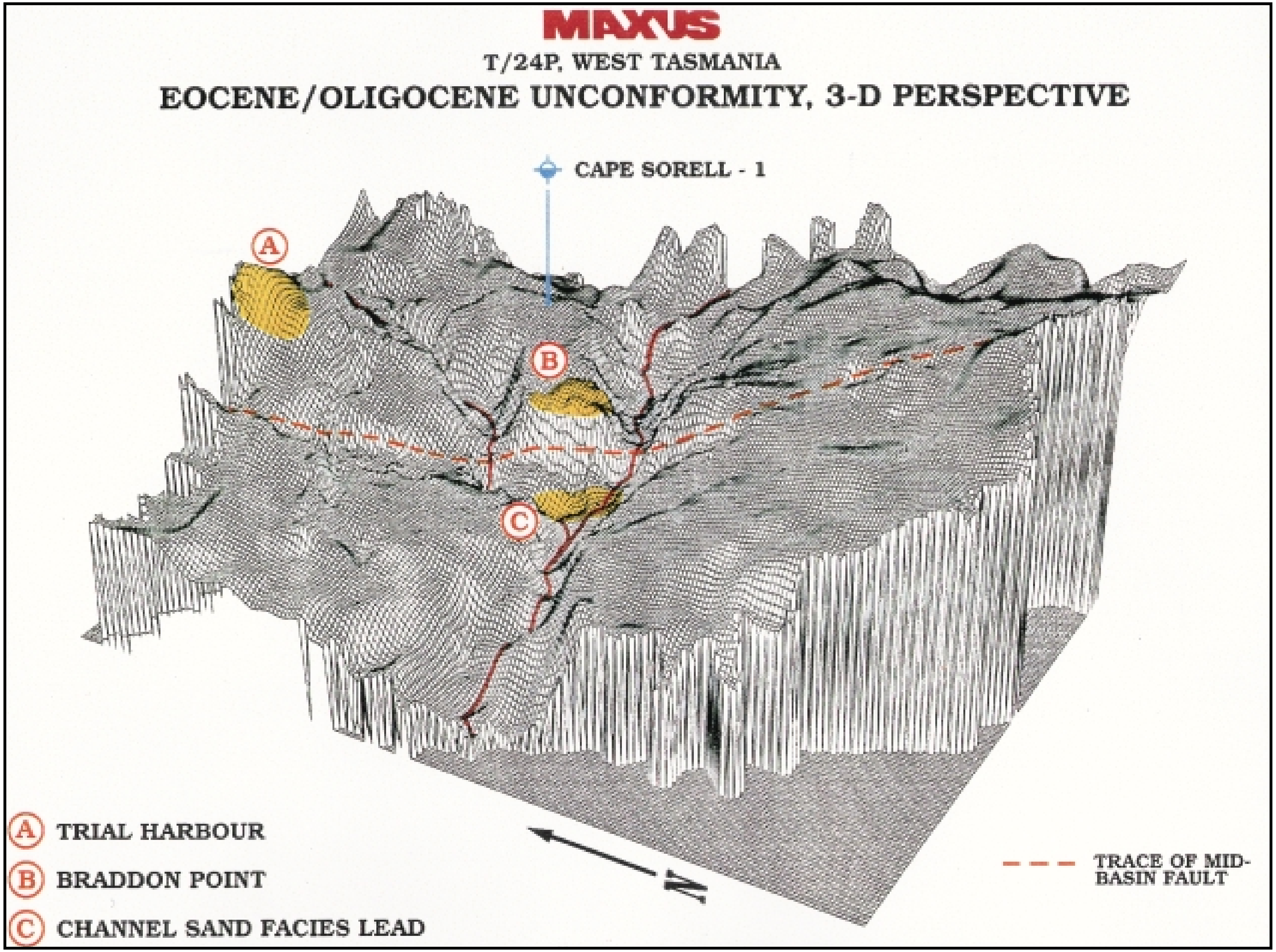


Figure 8. *(from Maxus, 1993)*

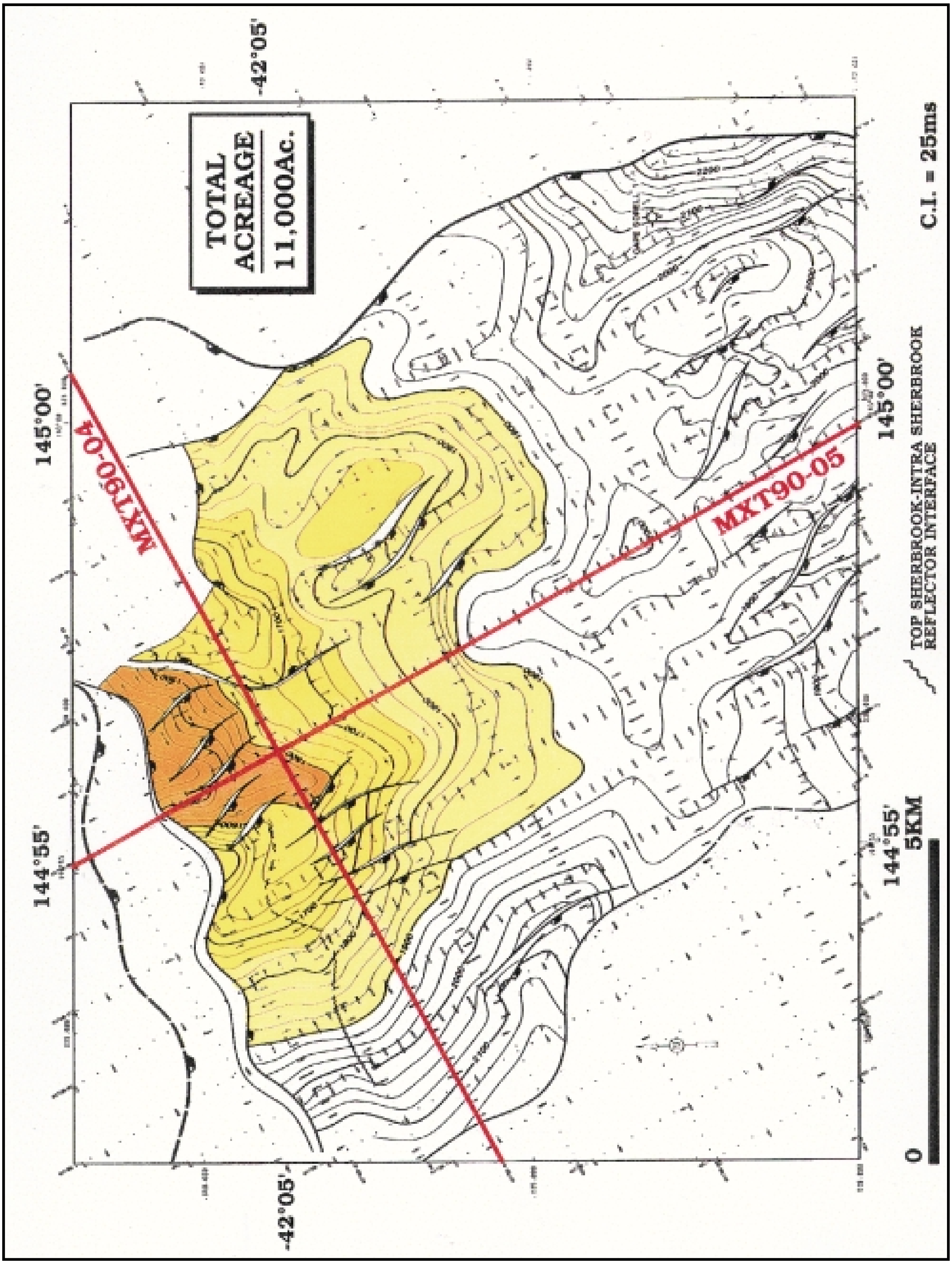
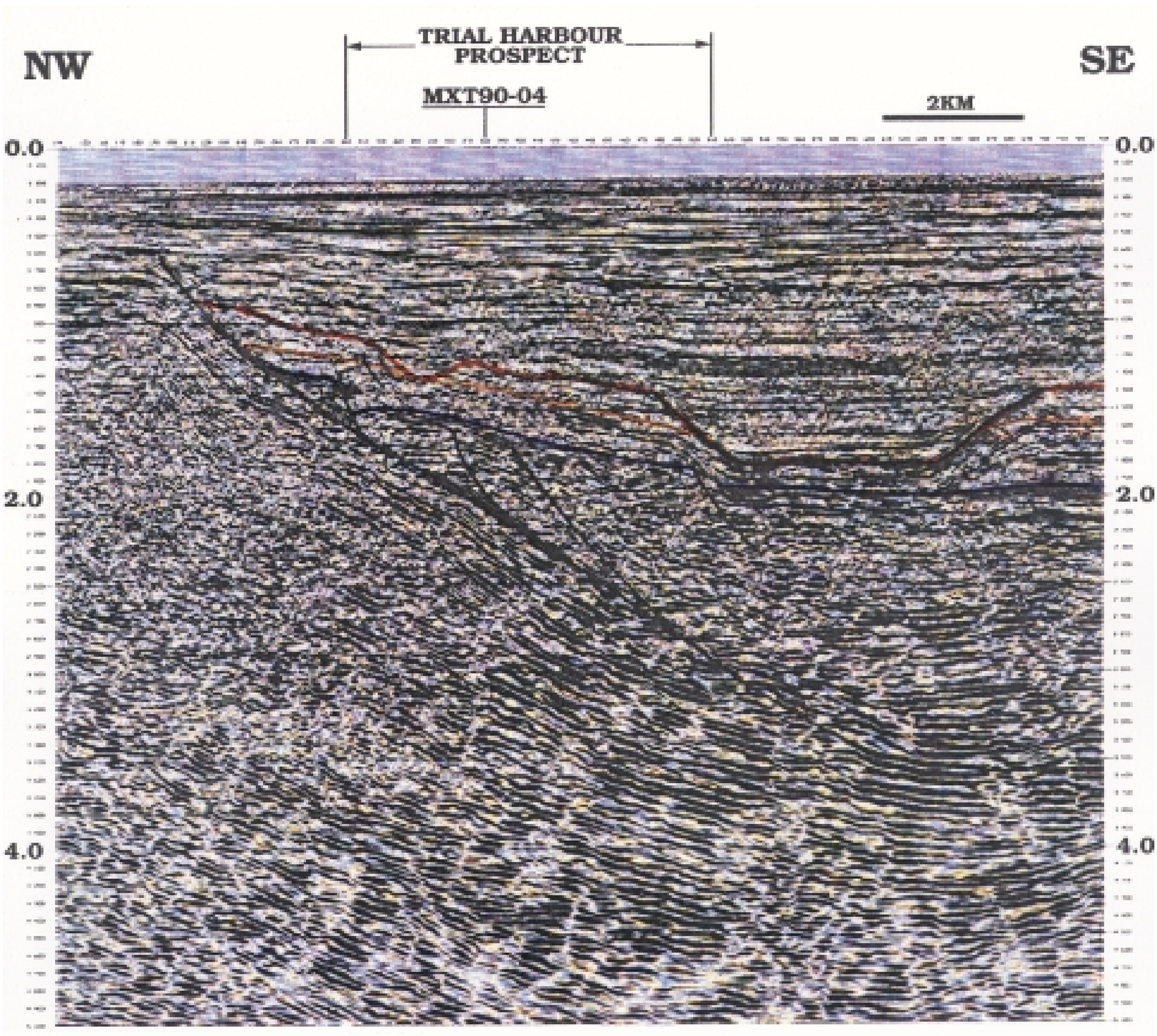


Figure 9

Trial harbour Prospect. Intra-Sherbrook structure map (from Maxus, 1993)

[Reproduced with kind permission of the Maxus Energy Corporation]

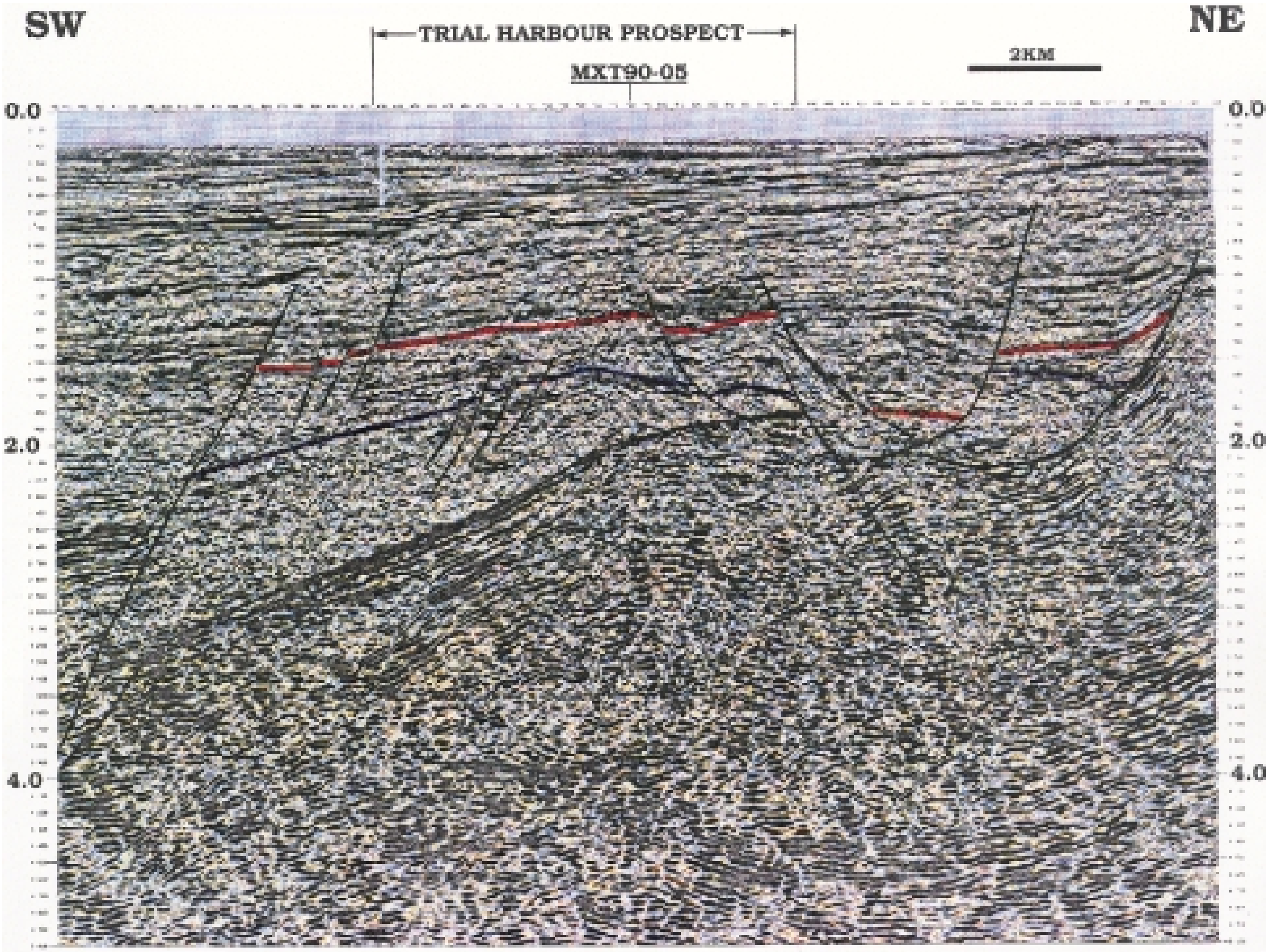


MAPPED HORIZON = BLUE

Figure 10

Trial Harbour Prospect.
Seismic Line MXT 90-05
(from Maxus, 1993)

[Reproduced with kind permission of the Maxus Energy Corporation]



MAPPED HORIZON = BLUE

Figure 11

Trial Harbour Prospect.
Seismic Line MXT 90-04
(from Maxus, 1993)

[Reproduced with kind permission of the Maxus Energy Corporation]

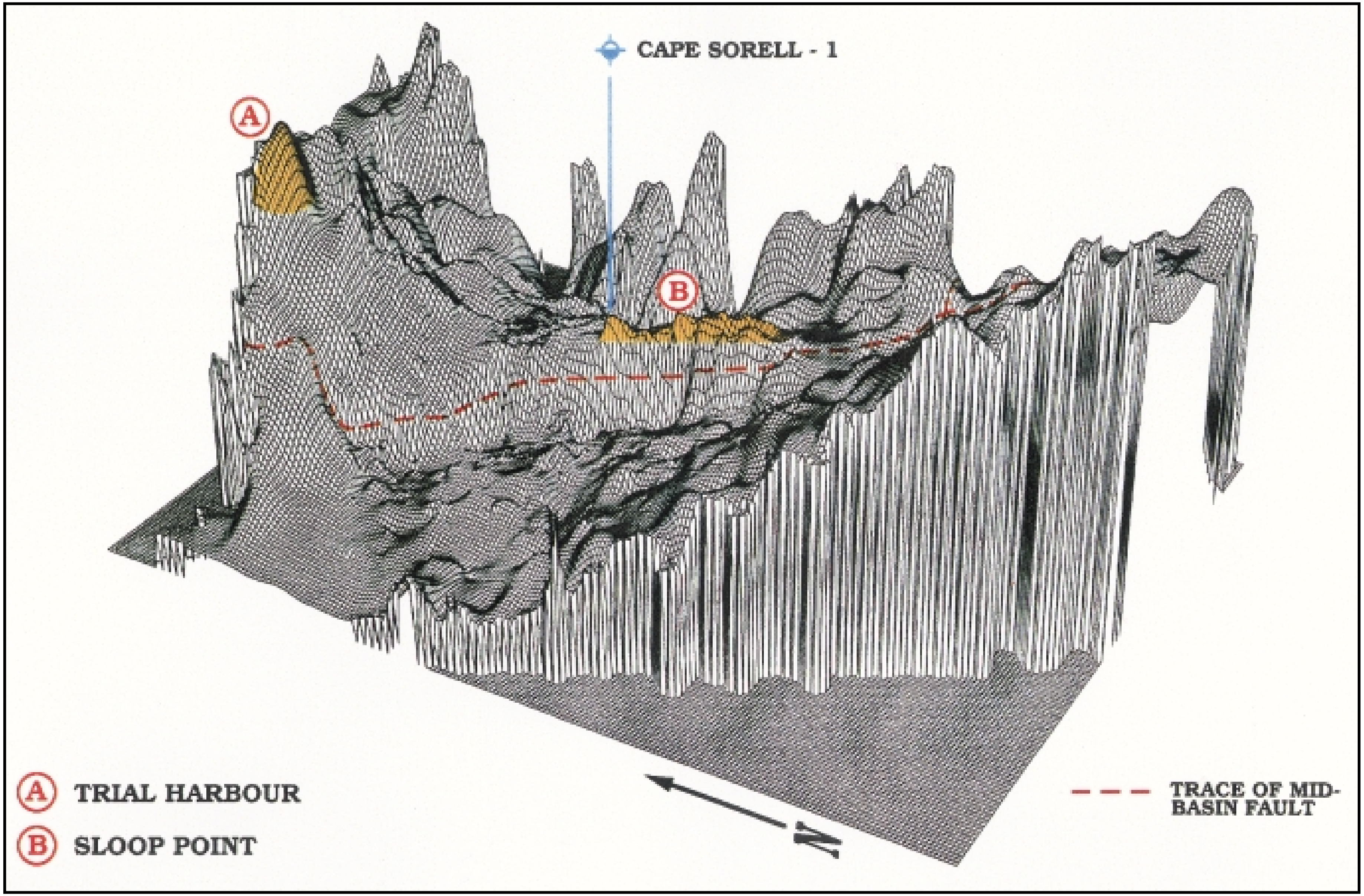


Figure 12. Base Wangerrip Group showing 3-D perspective of Trial Harbour and Sloop Point Prospects (from Maxus, 1993)

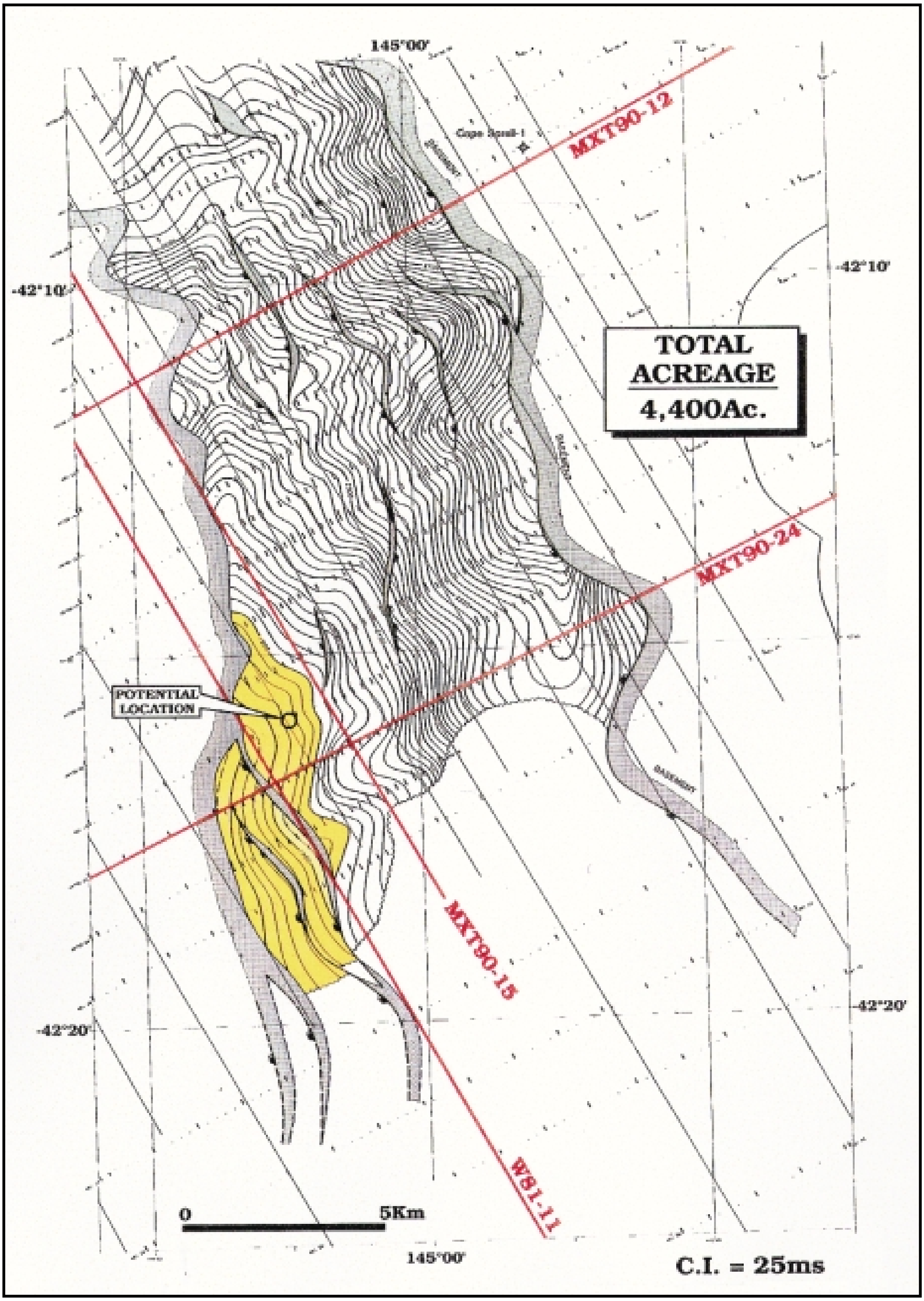


Figure 13

Top Otway Group – Sloop[Point Prospect
(From Maxus, 1993)

[Reproduced with kind permission of the Maxus Energy Corporation]

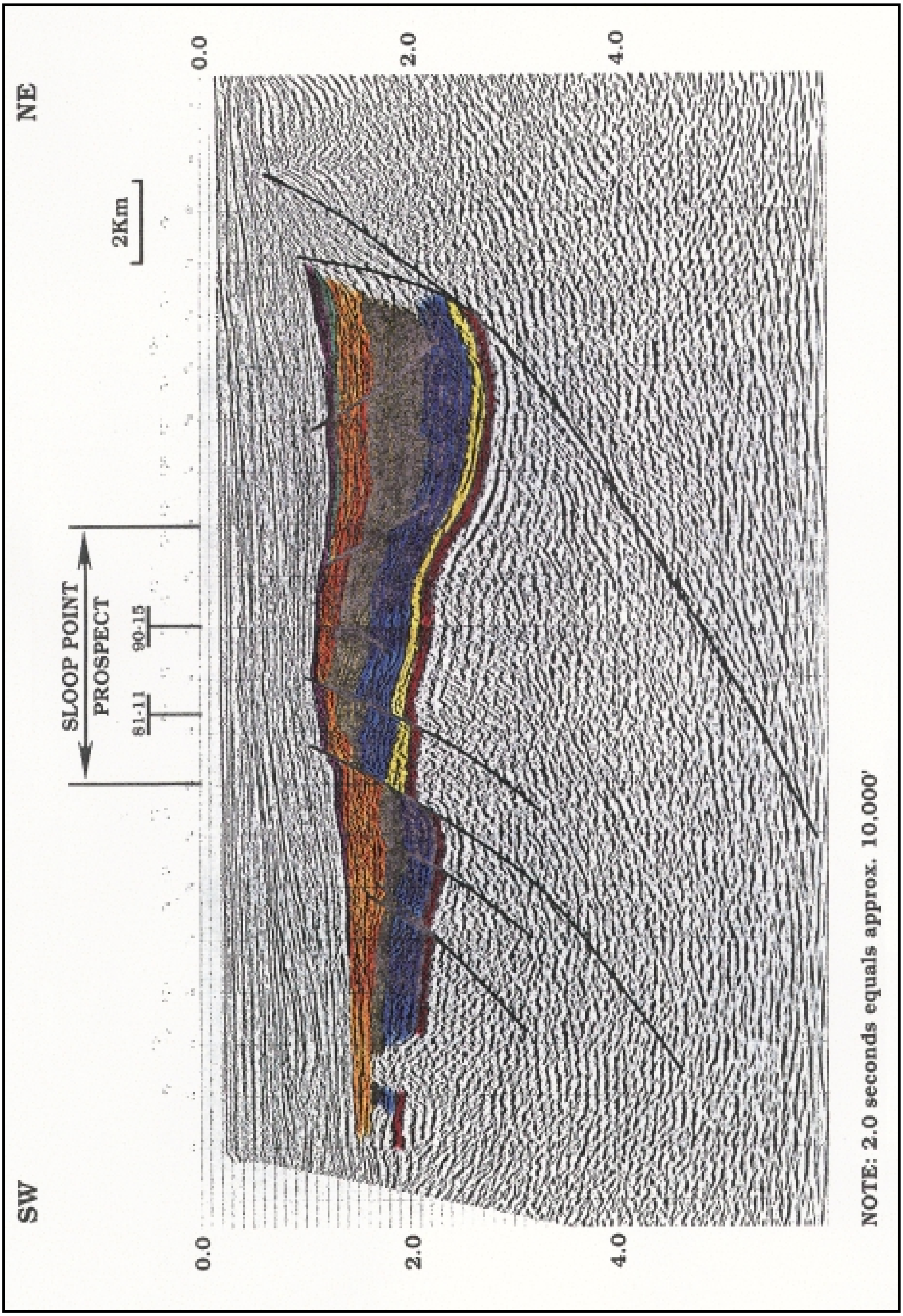


Figure 14. *Sloop Point Prospect, Line MXT90-24 (from Maxus, 1993)*

[Reproduced with kind permission of the Maxus Energy Corporation]

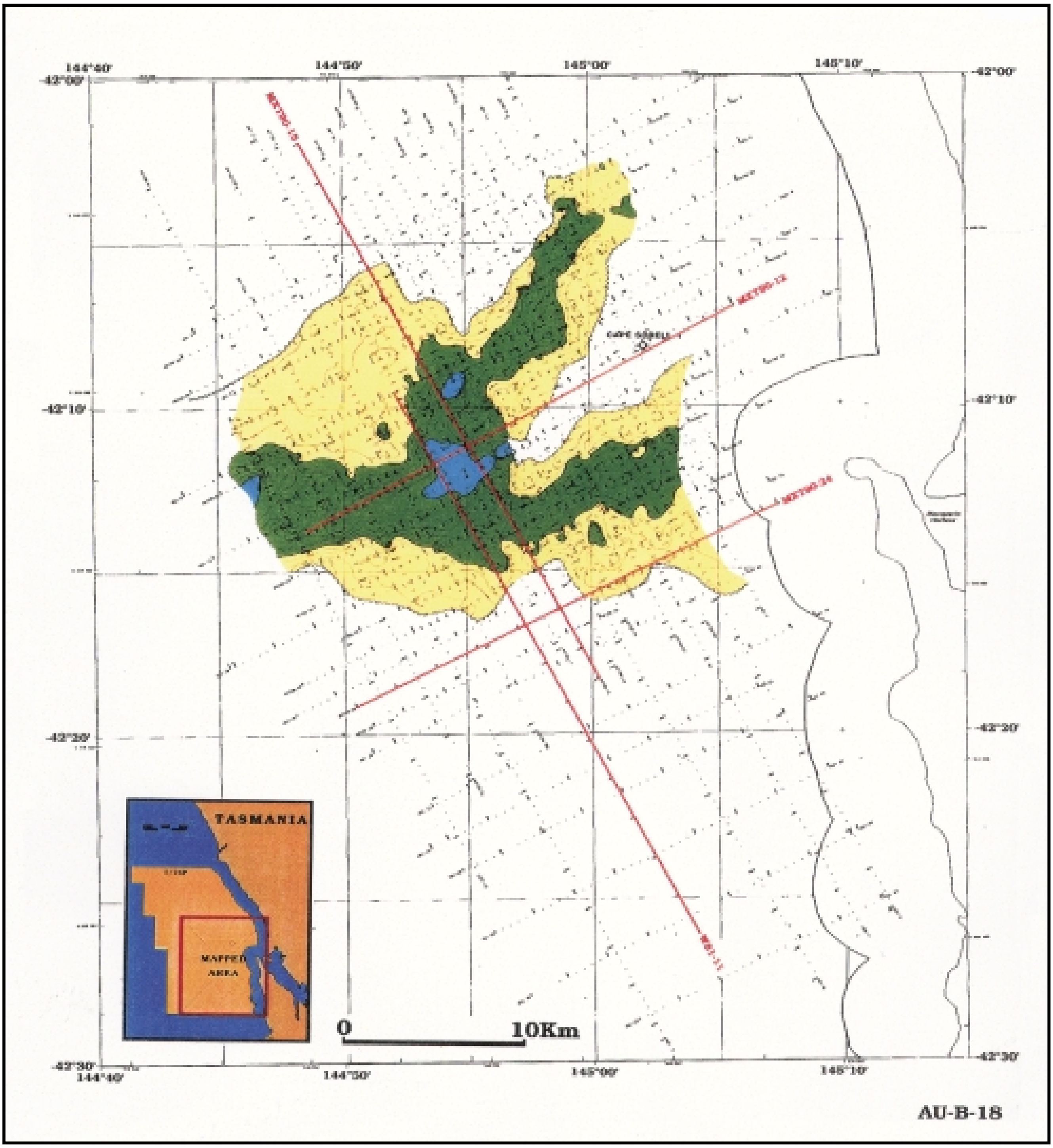


Figure 15

Eocene channel fillshowing thickness of the channel
(from Maxus, 1993)

[Reproduced with kind permission of the Maxus Energy Corporation]

Reservoir Provenance

Little is know about the quality of potential reservoirs in the sequences underlying the west coast of Tasmania margin as only four wells have been drilled and, except for the lower Eocene of Macquarie Harbour, the sequences do not crop out onshore.

An equivalent situation exists for the most part in the Gippsland Basin, where the onshore portion of the basin is thin and the thick wedge of sediment deposited in the Upper Cretaceous to early Oligocene lies offshore.

This comparison shows that the two areas have some similar attributes, thereby upgrading the potential for both reservoir and seal.

In the Gippsland Basin reservoir quality generally diminishes with depth and age. The same situation could be predicted for the west coast of Tasmania. Both the Sorell and Gippsland Basins are filled with early rifted sequences of Lower Cretaceous age. These rocks were rapidly deposited (compared to the overlying Cainozoic sequence) within subsiding rift valleys. The rift valley fill will generally be deposited by rivers and be entirely non-marine. Most of the potential reservoir sands deposited in this environment will contain a relatively high proportion of lithic rock fragments and feldspar, except for some reworked beach sands deposited on lake shores. This is confirmed by onshore drill hole and outcrop geology in the southern part of the Macquarie Harbour Half Graben.

It would be reasonable to predict that most sandstone deposited within the west coast of Tasmania's sub-basin rift valleys (Lower Cretaceous), and to a certain extent even the Upper Cretaceous sag fill, would contain a moderate content of lithic and feldspar grains.

Enclosure 17 shows the general distribution of source rock lithologies in western Tasmania. For the most part western Tasmania contains a majority of Precambrian and lower Palaeozoic basement rocks characterised by a high quartz content. These rocks include granite, quartzose sandstone and conglomerate, quartz schist, and quartz-bearing finer sediments and metamorphic rocks.

One group of rocks, deposited in the Cambrian and Lower Palaeozoic Dundas Trough, is characterised by volcaniclastic sediments and could certainly contribute a high lithic content to sandstones derived from them. Dundas Trough rocks currently crop out along the central Tasmanian coastline (Enclosure 17) and would have contributed lithic grains to a mainly quartz-sand dominated offshore region.

Lithic fragments and feldspar could also be expected to come from Jurassic age dolerite.

The sands in the four wells are highly quartzose, particularly in the Palaeocene and Eocene sequences. However the lithic content increases with age, and there is some deterioration in reservoir quality in the Cretaceous.

The occurrence of an Eocene canyon cutting sequence in the offshore west coast of Tasmania is remarkably similar to the occurrence of the canyon systems in the offshore Gippsland Basin. The Eocene canyons can be easily recognised in all the sub-basins that lie adjacent to the coast of mainland Tasmania (King Island, Strahan, Port Davey Sub-basins).

The Eocene canyon system has been mapped in detail in the Strahan Sub-basin by Moore (1991) and Maxus (1993). It was probably formed during a world-wide low stand of sea level in the earliest Eocene. The canyon system has been studied in detail by Polomka (1991) using the Amoco seismic database. Polomka attempted to map facies changes within the canyon fill using seismic signatures and several seismic facies were mapped in this manner, showing that the patterns of sediment fill tended to change systematically downstream. The important features of the canyon system are its size and the depth of canyon cutting, both of which can be favourably compared to the Eocene canyons of the Gippsland Basin.

The Eocene canyons system on the west coast of Tasmania has the potential not only to form traps by cutting and sealing along the canyon walls but also to form potential stratigraphic traps within the canyon fill.

Geohistory modelling indicates that the timing of major late oil migration would mostly post-date the Eocene canyon cutting and filling episodes, suggesting that every Eocene canyon system preserved in the west coast of Tasmania province has trapping potential provided that suitable migration pathways from older (Palaeocene and Upper Cretaceous) rocks can be established.

The Eocene canyon system needs to be mapped along the entire Tasmania margin. Once this is achieved it is predicted that many more prospects will be located.

Acknowledgements

Drafting of Figures 1–3 and Enclosures 1, 2 and 17 was carried out by *Oil on Film* of 6 Pacific Highway, St Leonards, NSW. The text was written by Drs John Conolly and Malcolm Galloway of Lonman Pty Ltd of 4 Black Street, Vaucluse, NSW 2030, in co-operation with staff of Mineral Resources Tasmania, Hobart.

Geohistory reconstructions have been made of the Strahan Sub-basin in conjunction with AGSO in Canberra, and we gratefully acknowledge their co-operation and in particular the help of Aiden Moore in this regard. Constructive discussions were also held with Dr Neville Exon of AGSO concerning recent RV *l'Atalante* and *Rig Seismic* cruises, with Alan Partridge of Melbourne, Dr Michael Macphail of Canberra, and Steve Forsyth of Mineral Resources Tasmania concerning palynology and the Macquarie Harbour area.

Figures 5 to 15 are reproduced with the permission of the Maxus Energy Corporation. Figure 4 is repoduced with the permission of the Australian Geological Survey Organisation.

References

AMOCO, 1981. *Final report of operations and field work. Amoco Australia Petroleum Company, West Tasmania Basin. March 1–16, 1981.* Western Geophysical for Amoco Australia Petroleum Company [OR-92].

AMOCO, 1982. *Cape Sorell No. 1. Geological completion report, Exploration Permit T-12-P, Offshore West Tasmania, Australia*. Amoco Australia Petroleum Company [OR-358A].

ARMSTRONG, J. P.; ALIMI, M. H.; COLE, J. M.; NG, K. H. 1983. *A basic geochemical evaluation of eight sidewall cores from the Cape Sorell-1 well drilled in Australia.* Robertson Research (Singapore) P/L, Report 1170 [OR-358E].

COUSINS, M. G. 1995. Geophysical optimisation of the Mackerel Field re-development — Gippsland Basin, Australia. *Journal Australian Petroleum Exploration Association* 35:79–91.

CULP, B. L. 1968. *Esso Prawn A-1. Well completion report*. Esso Exploration and Production Australia Incorporated [OR-343].

DAVIDSON, J. K. 1970. *Whelk-1 well completion report.* Esso Standard Oil (Australia) Limited. [OR-347].

DOUGLAS, J. G.; FERGUSON, J. A. 1988. *Geology of Victoria*. Geological Society of Australia, Victorian Division.

DOW, W. G. 1982. *Geochemical analysis of two sidewall cores from Cape Sorell-1 Well, Tasmania*. Robertson Research (US) Inc for Amoco Production Co. [OR-358A].

EXON, N. F. 1995. Cruise proposal. AGSO Cruise 147: Stratigraphy, tectonic history and paleoclimate of the offshore Tasmanian region. *Record Australian Geological Survey Organisation* 1995/1.

EXON, N. F.; LEE, C. S. 1987. *Rig Seismic* research cruise 1987: Otway Basin and west Tasmania sampling. *Record Bureau Mineral Resources Geology and Geophysics Australia* 1987/11.

EXON, N. F.; LEE, C. S.; HILL, P. J. 1989. RV *Rig Seismic* geophysical and geological research cruise off western and southeastern Tasmania. *Record Bureau Mineral Resources Geology and Geophysics Australia* 1989/12.

EXON, N. F.; HILL, P. J.; ROYER, J. -Y.; MULLER, D.; WHITMORE, G.; BELTON, D.; DUTKIEWICZ, A.; RAMEL, C.; ROLLET, N.; WELLINGTON, A. 1994. *Tasmante* swath-mapping and reflection seismic cruise off Tasmania using RV *L'Atalante*. *Record Australian Geological Survey Organisation* 1994/68.

GEOPHYSICAL SERVICE INTERNATIONAL, 1971. *Operations report marine seismic survey. South Australia, Victoria and Tasmania, Australia.* Geophysical Service International for Esso Standard Oil (Australia) Ltd [OR-12].

GRIFFITH, B. R.; HODGSON, E. A. 1971. Offshore Gippsland Basin Fields. *The APEA Journal* 11:85–94.

HEGGIE, D.; MCKIRDY, D.; EXON, N.; LEE, C. S. 1988. Hydrocarbon gases, heat-flow and development of the offshore Otway Basin. *PESA Journal* 13:32–42.

HINZ, K.; *and Shipboard Party*. 1985. Geophysical, geological and geochemical studies off West Tasmania and on the South Tasman Rise. *Report Bundesanstalt für Geowissenschaften und Rohstoffe Cruise* SO36(2).

HINZ, K.; WILLCOX, J. B.; WHITICAR, M.; KUDRASS, H. R.; EXON, N. F.; FEARY, D. A. 1986. The West Tasmanian margin: an underrated petroleum province? *in:* GLENIE, R. C. (ed.). *Proceedings Second South-Eastern Australia Oil Exploration Symposium*. 395-410. Petroleum Exploration Society of Australia : Melbourne.

HORGAN, C. C. 1969. *Final subsidy report of Tasmania EE-68 marine seismic and magnetic survey*. Esso Exploration and Production Australia Inc. [OR-78].

HORGAN, C. C. 1969. *Final subsidy report of West Tasmania T69A marine seismic and magnetic survey.*. Esso Exploration and Production Australia Inc. [OR-75].

KENNETT, J. P.; HOUTZ, R. E.; ANDREWS, P. B.; *et al.*. 1975. Site 282, *in: Initial Reports of the Deep Sea Drilling Project* 29:317–363. US Government Printing Office : Washington.

KOVAS, E. J. 1993. *[Compilation of interprtative maps, Strahan Sub-basin]*. Maxus Energy Corporation [OR-373].

LUNT, C. K. 1969. *Clam-1 well completion report*. Esso Exploration and Production Australia Inc. [OR-335].

MAUREIRA, A. S.; REED, L. C. 1965. *Cape Grim to Cape Jaffa marine seismic survey, 1964–1965*. Haematite Explorations Pty Ltd [OR-61].

MAXUS, 1990. *Offshore Tasmania, Prospect T24/P {Diagrams only]* Maxus Energy Corporation [OR-252].

MAXUS, 1993. *Block T/24P West Tasmania, Australia. An exploration opportunity*. Farmout brochure, Maxus Energy Corporation [OR-381]

MEBBERSON, A. J. 1989. The future for exploration in the Gippsland Basin. *The APEA Journal* 29:430–439.

MOORE, A. M. G. 1991. Western Tasmanian margin seismic interpretation and mapping. *Record Bureau Mineral Resources Geology and Geophysics Tasmania* 1991/70.

MOORE, A. M. G.; WILLCOX, J. B.; EXON, N. F.; O'BRIEN, G. W. 1992. Continental shelf basins on the West Tasmania Margin. *The APEA Journal* 32:231–250.

MOORE, W. R.; BAILLIE, P. W.; FORSYTH, S. M.; HUDSPETH, J. W.; RICHARDSON, R. G.; TURNER, N. J. 1984. Boobyalla Sub-basin; a Cretaceous onshore extension of the southern edge of the Bass Basin. *The APEA Journal* 24:110–117.

O'BYRNE, M. J.; HENDERSON, D. J. 1983. The Tuna Field, a recent Gippsland development. *The APEA Journal* 23:44–52.

PARSONS, M. G. 1968. *Final subsidy report of the offshore Otway Basin marine seismic and magnetic survey, EP-67.* Esso Exploration and Production Australia Inc. [OR-63].

POLOMKA, S. M. 1991. *The structural and stratigraphic interpretation of the Strahan Sub-basin*. Thesis University of South Australia.

PRESTON, J. 1992. *Geochemical analysis of samples from Prawn-1A and Whelk-1, Otway Basin, Offshore Victoria, Australia*. BHP Petroleum Pty Ltd [OR-249].

ROSS, L. M. 1982. *Source rock evaluation Amoco No. 1 Cape Sorell well, offshore Tasmania, Australia*. Amoco Production Company Research Centre [OR-358E].

SHELL, 1973. *Marine geophysical survey offshore Australia conducted with MV Petrel*. Shell Development (Australia) Pty Ltd [OR-87].

SVALBE, A. K. 1975. Dolomitized sandstones: A Marlin field gas-reserves assessment problem. *The APEA Journal* 15:111–115.

THOMPSON, B. R. 1986. The Gippsland and Otway Basins — development and stratigraphy, *in:* GLENIE, R. C. (ed.). *Proceedings Second South-Eastern Australia Oil Exploration Symposium*. 57–64. Petroleum Exploration Society of Australia, Melbourne.

TILBURY, L. A. 1974. Continental margin survey preview report for western Tasmania and the eastern Bight. *Record Bureau of Mineral Resources Geology and Geophysics Australia* 1974/155.

VAIL, P. R.; MITCHUM, R. M.; THOMPSON, S. 1977. Seismic stratigraphy and global changes of sea level, Part 4: Global cycles of relative changes in sea level, *in:* PAYTON, C. E. (ed.). Seismic stratigraphy — applications to hydrocarbon exploration. *Memoir American Association of Petroleum Geologists* 26:83–97.

WESTERN GEOPHYSICAL, 1970. *Final operations report, Australia marine seismic survey. T70A western Tasmania*. Western Geophysical Company of America for Esso Standard Oil (Australia) Ltd [OR-77].

WHITICAR, M. J.; BERNER, U.; POGGENBURG, J.; TOSTMANN, H. 1985. Shipboard report of geochemical surface exploration off western Tasmania and on the South Tasman Rise, *in:* HINZ, K. *and Shipboard Party*. Geophysical, geological and geochemical studies off West Tasmania and on the South Tasman Rise. *Report Bundesanstalt für Geowissenschaft und Rohstoffe Cruise* S036(2):141–171.

WIGGIN, R. W.; HIGGINS, N. C.; HORGAN, C. C.; *et al*. 1967. *Final subsidy report of the offshore Otway Basin marine seismic survey*. Esso Exploration and Production Australia Inc. [OR-62]

Note: OR numbers refer to open file oil exploration reports and/or diagrams held in the Mineral Resources Tasmania library, Rosny Park.

[1 June 1995]