



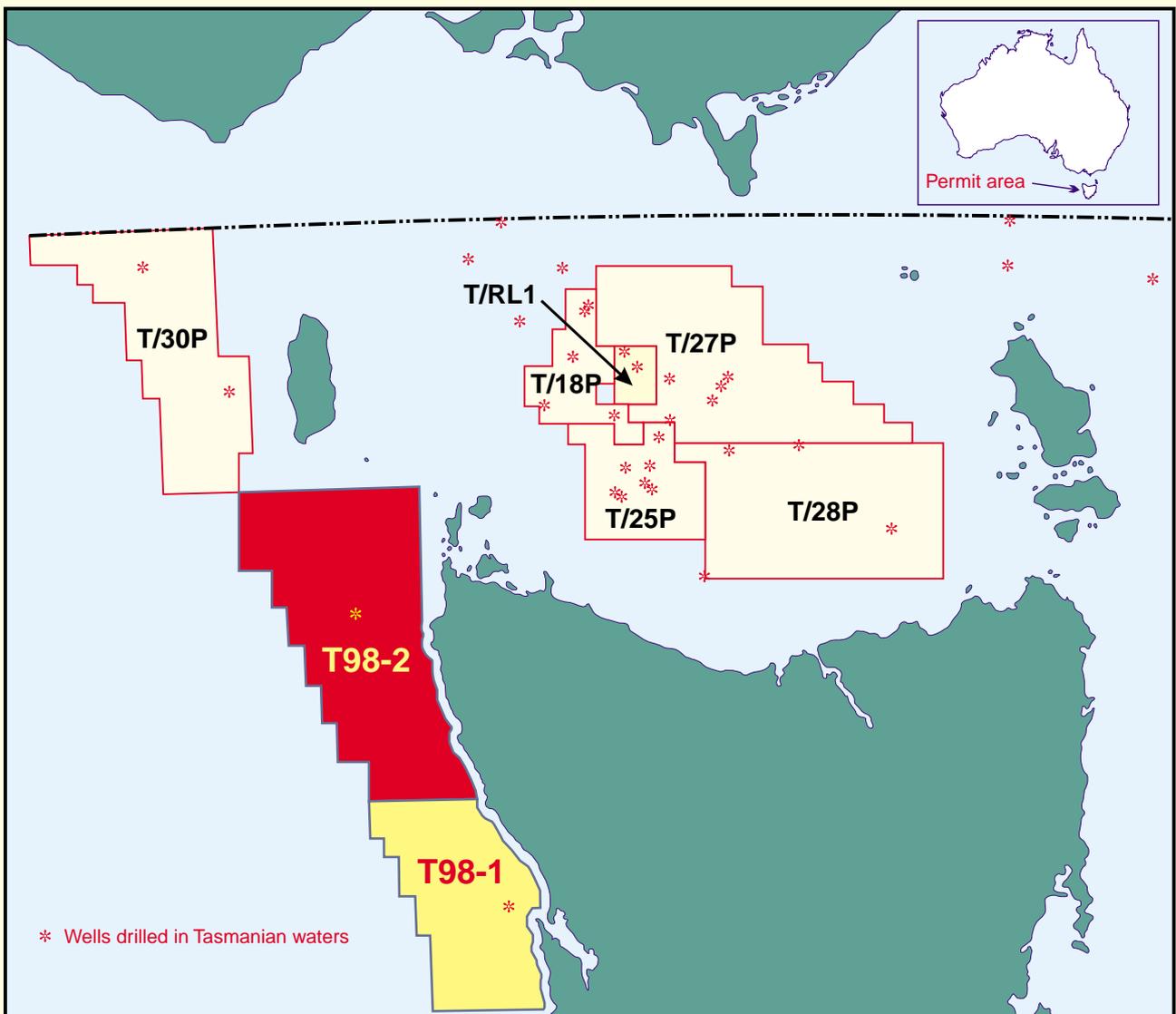
Mineral Resources
Tasmania

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Report 1998/03

Sorell Basin, Tasmania

Release of offshore petroleum exploration areas in 1998 — T98-1 and T98-2





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Sorell Basin, Tasmania, Australia

Release of offshore petroleum exploration areas in 1998 T98-1 & T98-2

by C. R. Calver

Amongst the areas to be released for petroleum exploration under Australia's competitive work program bidding system in 1998 are two adjoining acreages off the west coast of Tasmania. These areas cover the most prospective parts of the Sorell Basin, an underexplored, Jurassic to Tertiary passive-margin basin with a history broadly similar to the nearby, prolific Gippsland Basin. Some prospects in T98-1 are mature for drilling. Both areas overlie continental shelf (mostly <200 m water depth).

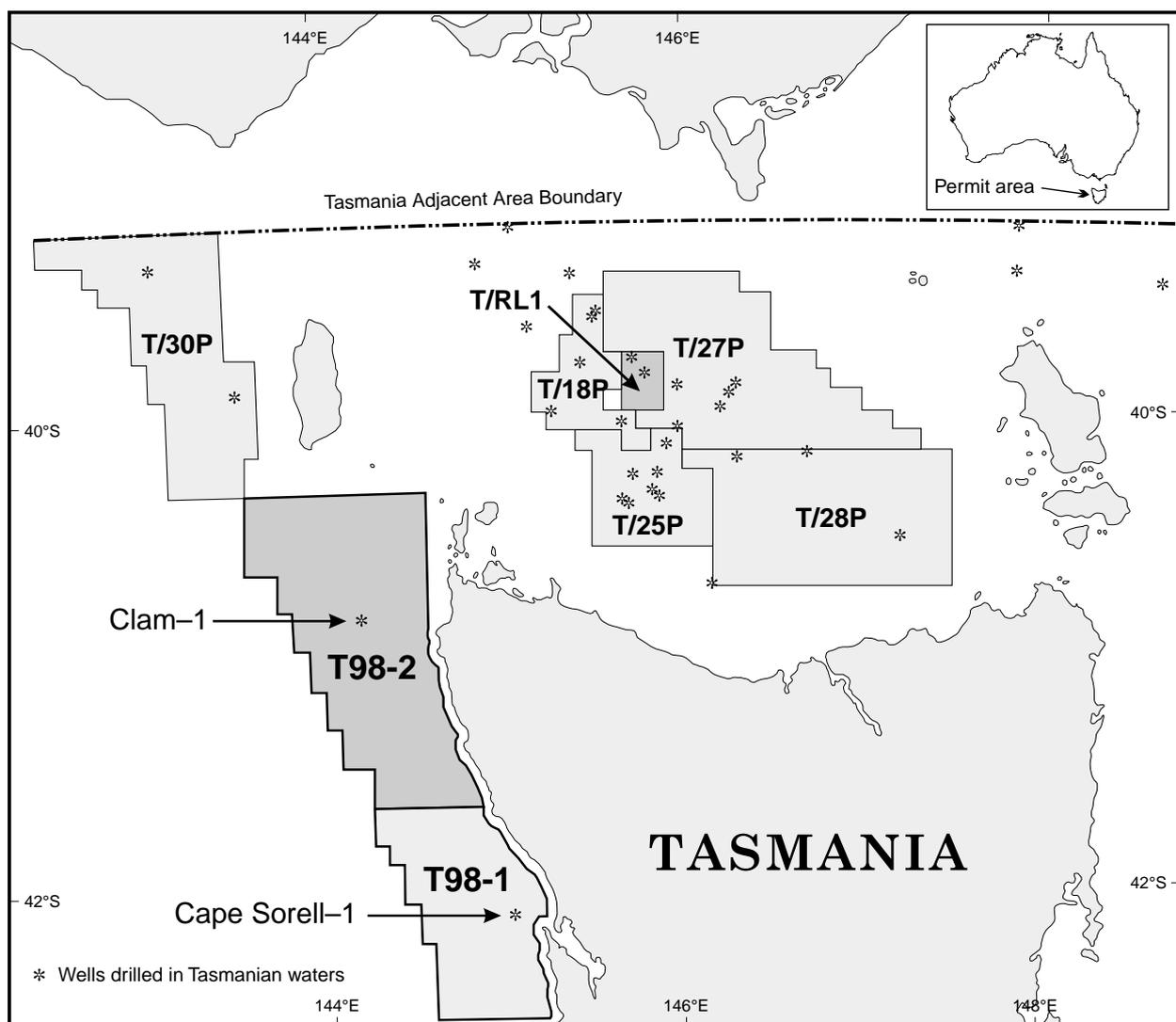


Figure 1. Location of T98-1 and 2, offshore western Tasmania, and other current offshore petroleum tenements in Tasmanian state waters.

Summary

The Sorell Basin and neighbouring, related coastal southeast Australian basins — the Gippsland, Otway and Bass Basins — were produced by extensional tectonics in the Jurassic to Tertiary. The Gippsland Basin is a world-class oil and gas province and has produced almost 70% of Australia's oil. Prospective acreage in the Bass Basin is almost fully held, with four or more wells planned for 1998, including at least one appraisal well on the Yolla gasfield. The Otway Basin, adjoining the Sorell Basin to the north, is a gas producer in onshore mainland Australia, and has recently yielded a commercial offshore gas discovery.

Of these basins, the Sorell Basin remains the least explored with only two wells drilled, despite live oil shows, evident parallels with the nearby producing basins, and the potential for a variety of structural/stratigraphic traps in three or more thick depocentres under the continental shelf.

Petroleum exploration in the Sorell Basin dates back to the 1960s, when a reconnaissance seismic data set was acquired. More recent exploration activity (Amoco in the early 1980s, Maxus in the early 1990s) has been concentrated in the Strahan Sub-basin in area T98-1. Only two exploration wells have been drilled: Clam-1 in the King Island Sub-basin and Cape Sorell-1 in the Strahan Sub-basin. Live oil shows were found in Cape Sorell-1 below the Cretaceous–Palaeocene unconformity, which has since been shown to have no closure.

The Sorell Basin is considered to be both oil and gas prone. The deregulation of gas markets in the nearby mainland Australian States of Victoria and New South Wales could provide gas from the Sorell Basin with a number of market opportunities.

The acreage offers a rare opportunity to participate in a promising, nearly unexplored basin, within a favourable economic and political environment.

Sorell Basin: Structure and stratigraphy

The Sorell Basin formed as a result of the latest Jurassic to earliest Cretaceous rifting that heralded the separation of Australia and Antarctica. The rifting had a left-lateral, transtensional component that resulted in a number of small, deep, mainly fault-bounded depocentres, including a number of prospective sub-basins under the west Tasmanian continental shelf (fig. 3).

The stratigraphy of the Sorell Basin is similar to that of the better-known, adjoining Otway Basin to the north (fig. 4) and there are also strong parallels with the stratigraphy of the prolific Gippsland Basin.

The earliest rift fill sediments are correlatives of the Early Cretaceous Otway Group and rest unconformably on Proterozoic and Palaeozoic basement. The Otway Group has not been reached by wells in the Sorell Basin, the nearest penetration being Prawn-1 located in the nearby southern part of the Otway Basin. However seismic packages predicted to be Otway Group correlatives are observed in the deeper sub-basins and onlapping early rift basement highs. In the Otway Basin, the Otway Group includes low-energy fluvial/lacustrine deposits and is known to have sourced the Minerva commercial offshore gas discovery.

A prominent mid-Cretaceous unconformity is succeeded by the Cenomanian–Maastrichtian Sherbrook Group, consisting of marginal marine to fluvial clastic sediments that include gas and oil prone source rocks where intersected by Cape Sorell-1 in the Strahan Sub-basin. Oil shows were also seen in the Sherbrook Group in this well.

Continental breakup west of Tasmania in the Maastrichtian coincided with a major wrenching event, seen in the continental shelf sub-basins as anticlinal flower structures that are potential traps (fig. 5). Wrench movement continued until the mid-Oligocene, when the Australian and Antarctic plates finally cleared each other.

The Maastrichtian breakup unconformity is succeeded by the thick fluvial to shallow marine sandy clastic rocks of the Wangerrip Group, of Palaeocene to early Eocene age. These sediments are broadly equivalent to the upper part of the Latrobe Group, the main reservoir interval of the Gippsland Basin. A top Palaeocene unconformity within the Wangerrip Group, locally displaying hundreds of metres of erosional relief, has led to an erosional remnant stratigraphic play concept directly analogous to several of the giant Gippsland Basin fields. At least one such prospect has been mapped in the Strahan Sub-basin (see below).

The section is completed by Eocene to Miocene shelfal marls and temperate carbonates of the Heytesbury Group, broadly equivalent to the Seaspray Group, the base of which forms the regional seal in the Gippsland Basin.

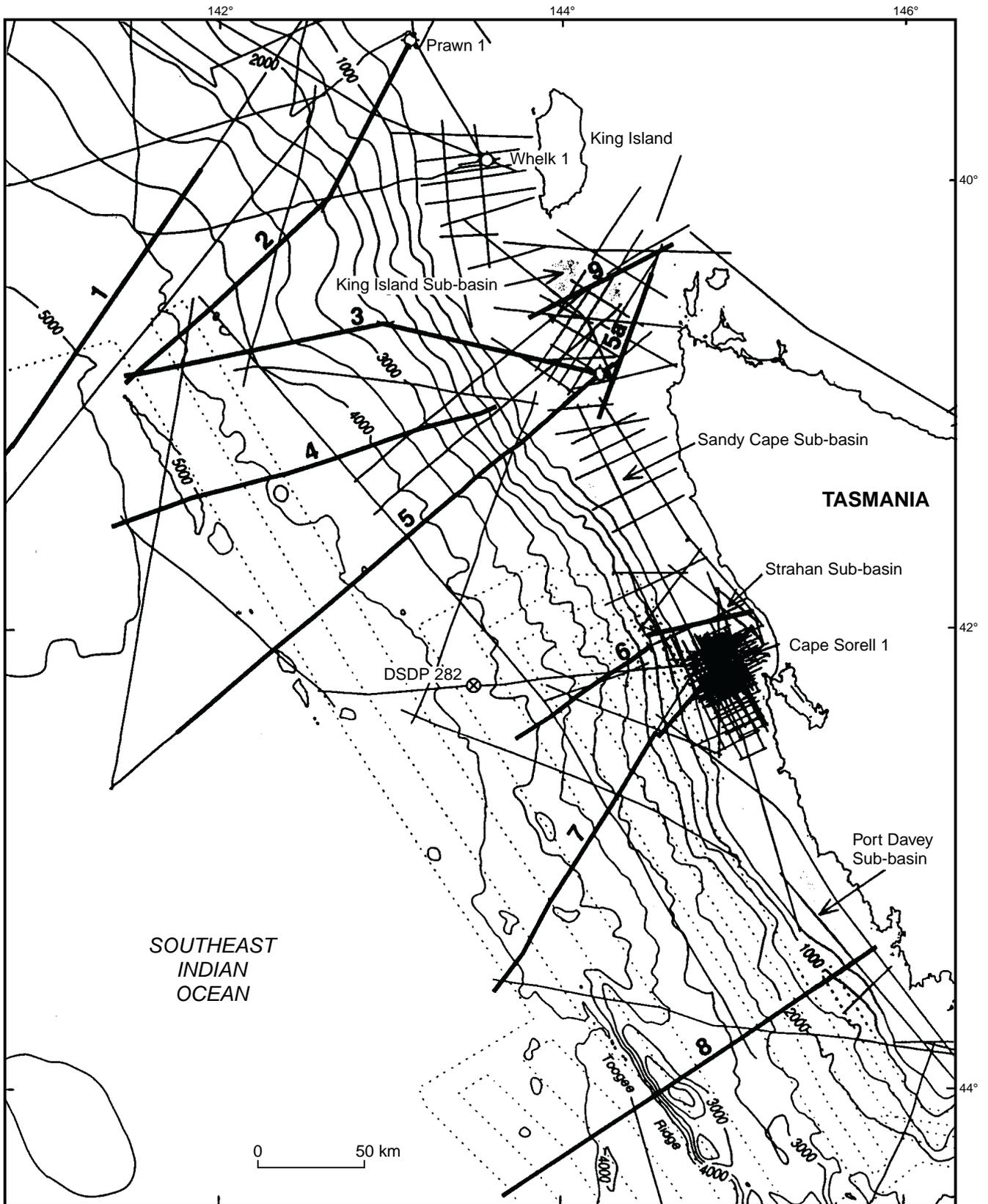


Figure 2.
Bathymetry and seismic coverage (solid lines) on the west Tasmanian margin and location of exploration wells. From Hill et al. (1997).

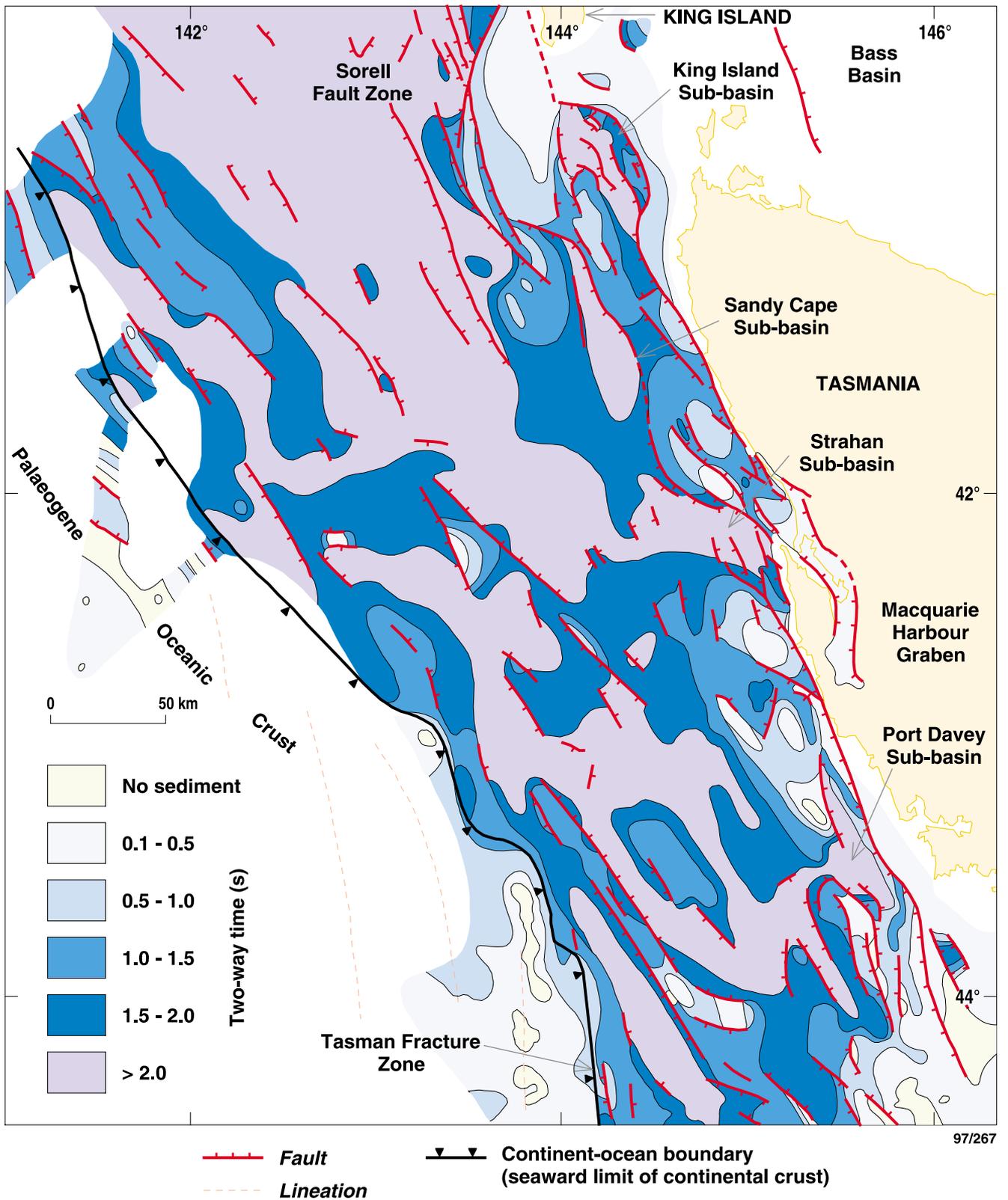


Figure 3.
Sediment thickness and main structure, Sorell Basin. From Hill et al. (1997).

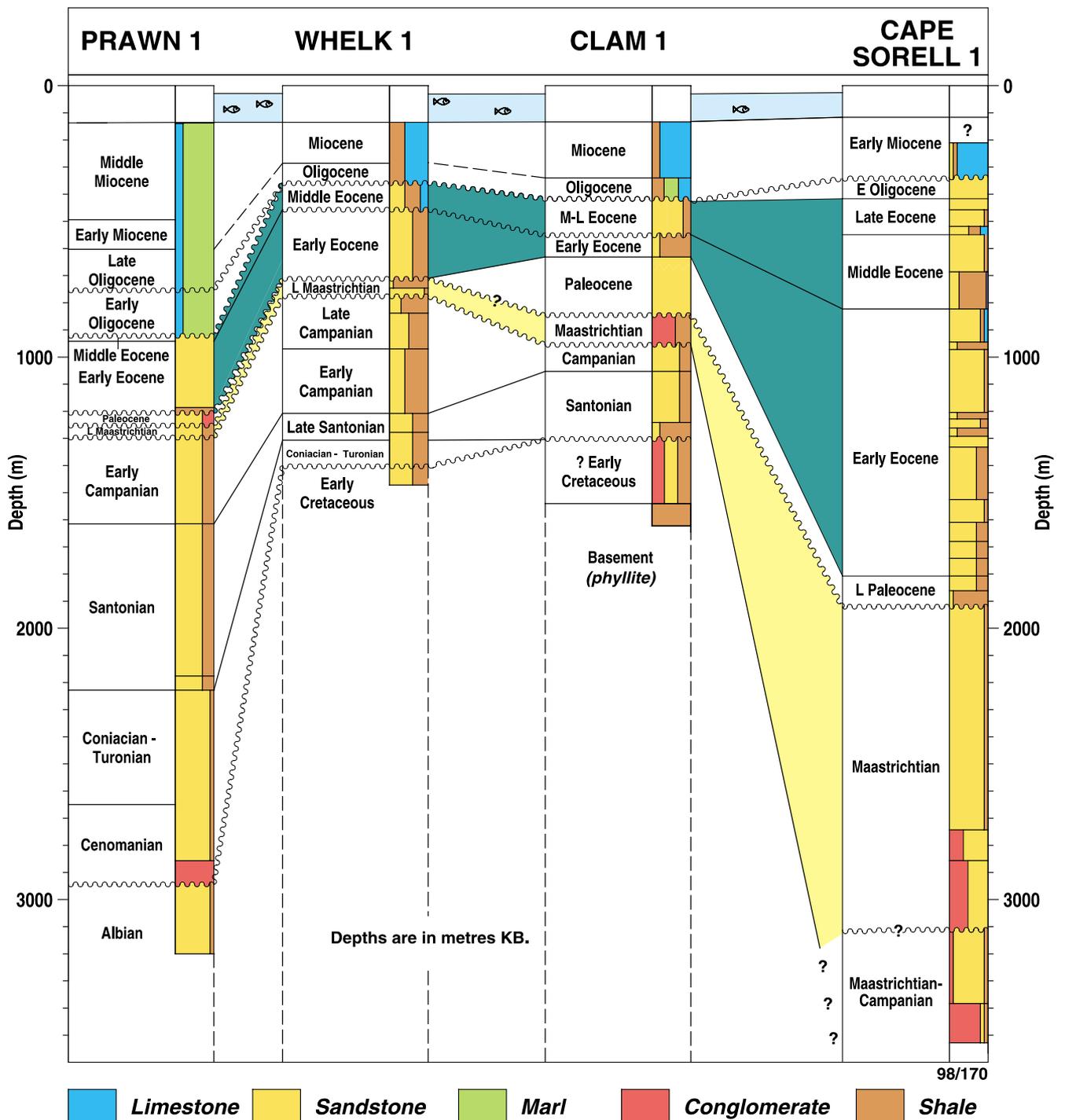


Figure 4.
West Tasmanian well stratigraphy and correlations. [Diagram provided by P. Hill]

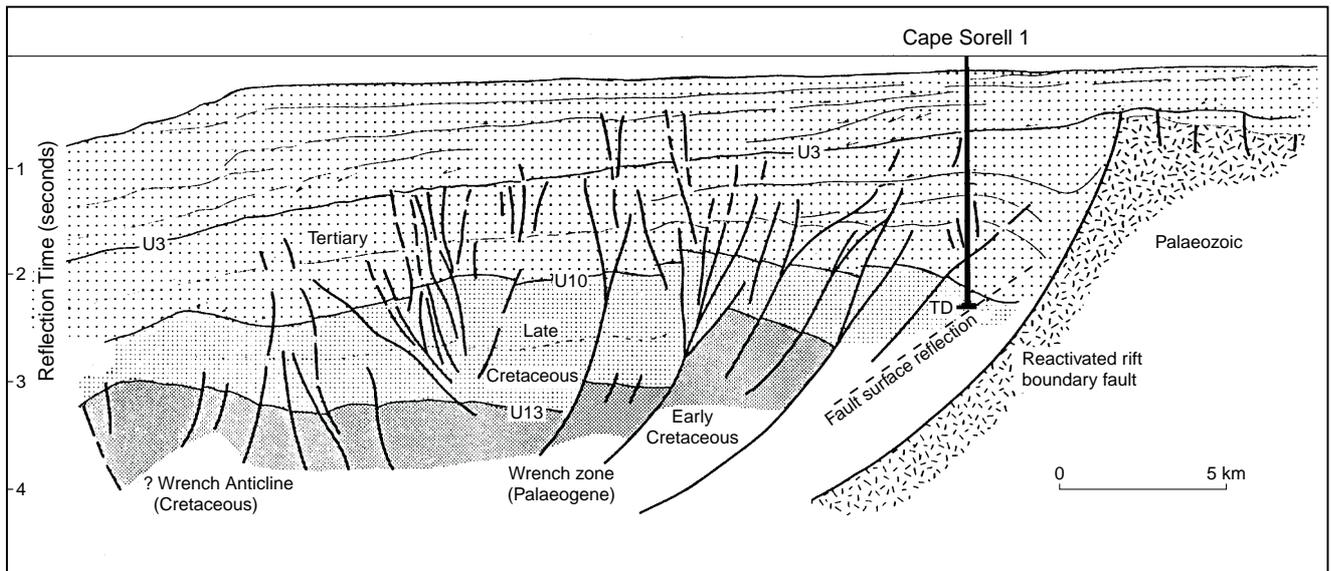


Figure 5.

An interpretation by Hinz et al. (1986) of Amoco line W-81-12 oriented SW-N through Cape Sorell-1 well. Note the 'flower structures' that signify wrenching. Cape Sorell-1 may have been better sited about 8 km to the SW.

Area T98-1: Strahan Sub-basin

Area T98-1 overlies the highly prospective Strahan Sub-basin, which is a complex half-graben that contains up to 6.5 km of Cretaceous and Tertiary sediments. The Strahan Sub-basin has been explored by Esso, Amoco and most recently by Maxus Energy Corporation. A dense 2D seismic grid (1 × 1.25 km spacing) shot by Amoco and Maxus covers most of the sub-basin. Several prospects and leads have been mapped (fig. 6) and some of the prospects are ready to drill. Amongst these is an erosional remnant play sealed by Eocene canyon-fill shales, resembling the giant Marlin, Halibut and Tuna fields of the Gippsland Basin. Another prospect exhibits a direct hydrocarbon indicator (flat-spot) on three seismic lines.

Hydrocarbon prospectivity

The only well drilled in T98-1, Cape Sorell-1, was drilled close to a basin boundary fault and intersected a succession dominated by a thick, very sandy Palaeogene section. Basinward sections are expected to be more shale-prone, providing effective seals and source rocks. Live oil shows were recorded from below the top of the Sherbrook Group (Maastrichtian) to near the bottom of the hole at 3445 metres. The Sherbrook Group includes oil and gas-prone source rocks, with TOCs averaging 3%. The unconformity at the top of the Sherbrook Group demonstrates no structural closure at the well location.

In 1990 Maxus reprocessed Amoco's (1981) seismic and shot infill lines to give a close (1 × 1.25 km) grid in the Strahan Sub-basin. Several prospects and leads were mapped, and further potential remains within the block. Play concepts derive, in part, from

those pursued successfully in the Gippsland Basin. Maxus estimated the recoverable reserves from each of the Braddon Point, Sloop Point and Trial Harbour prospects to be 150 to 200 million barrels.

The Braddon Point Prospect occurs at the top Palaeocene unconformity, which is a deeply channelled surface overlain by a shaly canyon fill (the Pember Mudstone equivalent). This prospect displays fault-dip closure in an east-west direction, and is closed off by Eocene channel fill to the north and south (fig. 7). The canyons appear to be comparable in age and topographic relief to the early to mid Eocene canyons of the Gippsland Basin that are important in sealing the Marlin, Halibut, Tuna and Mackerel fields.

The Sloop Point prospect consists of two stacked targets, testable with a single well, on the southern side of the sub-basin. The lower target, at the top of the Otway Group, exhibits closure by southward, updip wedgeout of the Otway Group and fault-dip closure in the east-west direction. The higher target, at the top of the Sherbrook Group, has a larger potential acreage with a simple dip and fault closure against the mid-basin fault.

The Trial Harbour Prospect is a downthrown rollover feature at the level of the top Sherbrook unconformity, with structural dip and fault closure adjacent to the northern boundary fault of the sub-basin (fig. 8). A seismic anomaly, believed to be indicative of vertical gas migration, is associated with this location. This prospect is conceptually similar to that penetrated by Cape Sorell-1, but in the Trial Harbour Prospect the non-closing section, within which the shows were encountered in the well, does exhibit closure.

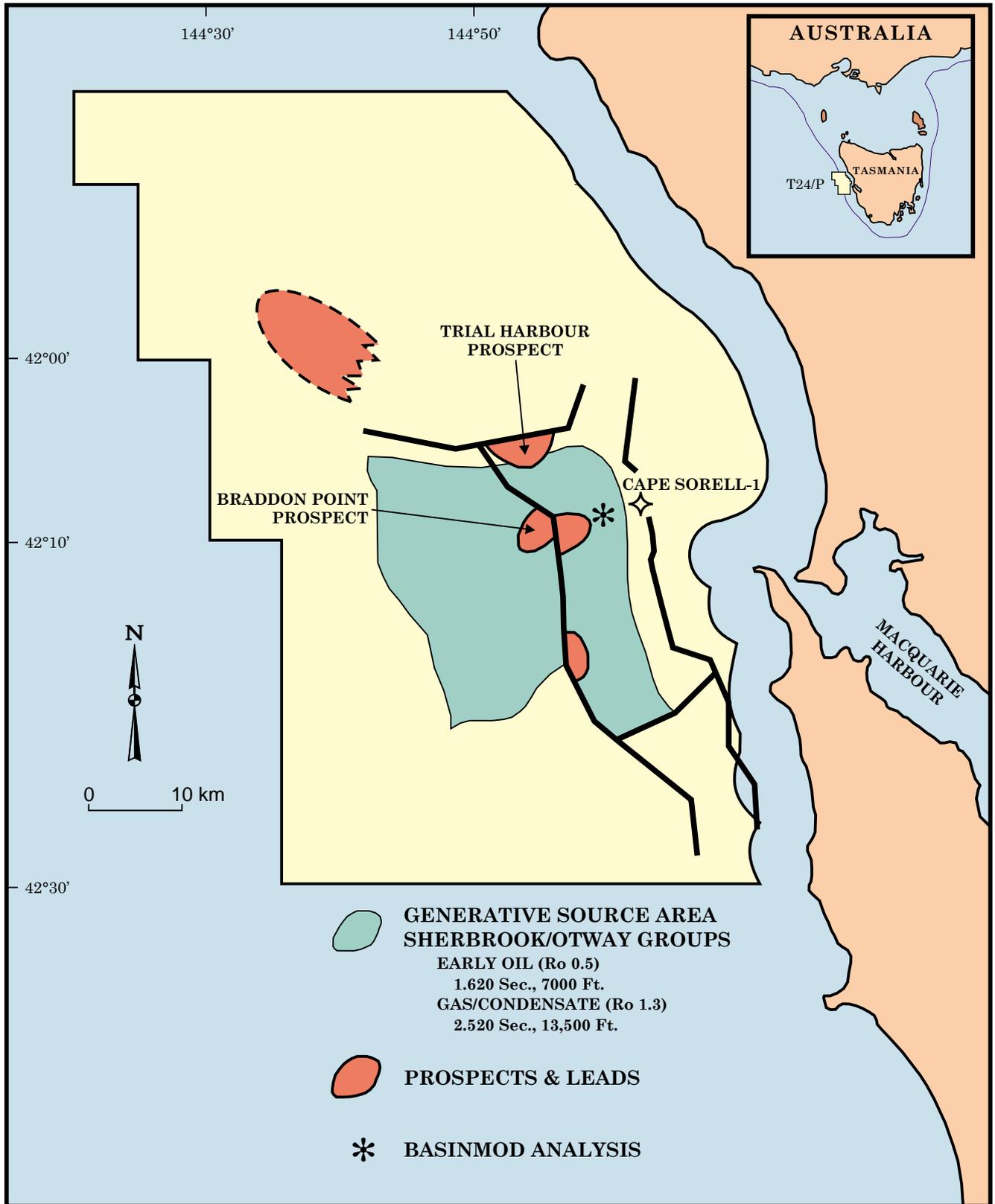


Figure 6

Strahan Sub-basin in T98-1, showing generative source area, and main prospects and leads mapped by Maxus. Courtesy of Maxus Energy Corporation.

The Eocene Canyon Sand Leads comprise potential stratigraphic traps within the canyon system where sands may be sealed by overlying shale and the canyon wall. One lead is located in a thick (450 milliseconds) section of channel fill at the point where two channels merge immediately west of the

Braddon Point erosional high. A recent re-appraisal of the seismic has resulted in the interpretation of a direct hydrocarbon indicator (flat-spot) within the northern channel fill, about 1000 acres in extent, on three seismic lines.

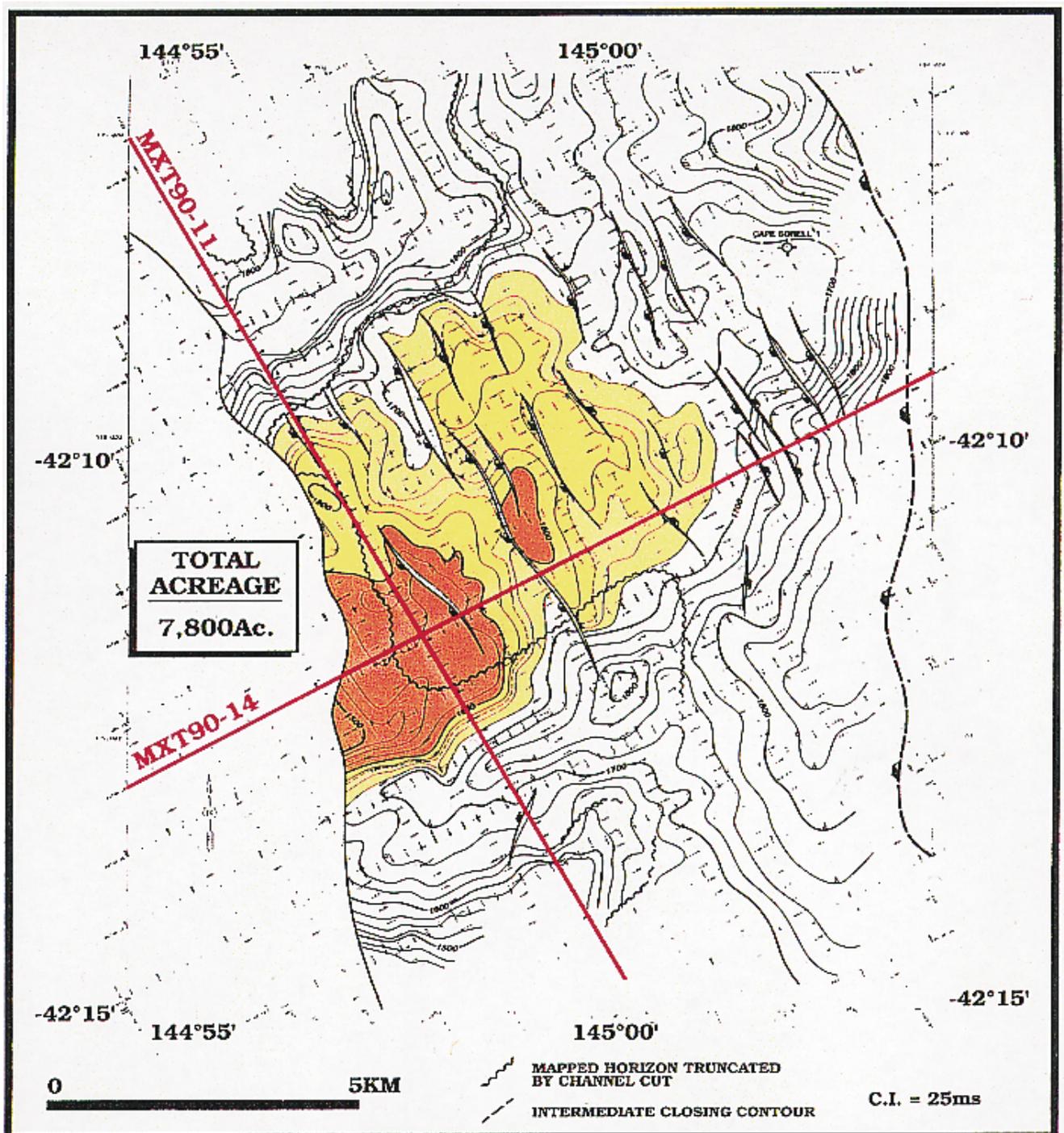


Figure 7

*Time structure on Palaeocene erosional surface (intra-Wangerrip Group) defining Braddon Point prospect.
Courtesy of Maxus Energy Corporation.*

The Northern Strahan Wedgeout Lead is a potentially very large structural-stratigraphic trap that lies outside the sub-basin and the main seismic grid, in deep (>1000 m) water.

Geohistory modelling suggests Late Cretaceous to Palaeocene levels are in the oil window, and older successions are in the gas window in those parts of the sub-basin distal to the Cape Sorell-1 well. Significant maturation occurred post-early Eocene (after trap formation).

A 1985 marine seafloor survey recovered thermogenic hydrocarbons from upper continental slope sediments over the western Strahan Sub-basin. This is consistent with thermal maturation modelling which indicates that generative conditions have existed — and currently exist — within T98-1.

Exploration History

Area T98-1 has been held by Esso Exploration and Production Australia Ltd (1968–1972), Amoco Australia Oil Company (1980–1983), and most

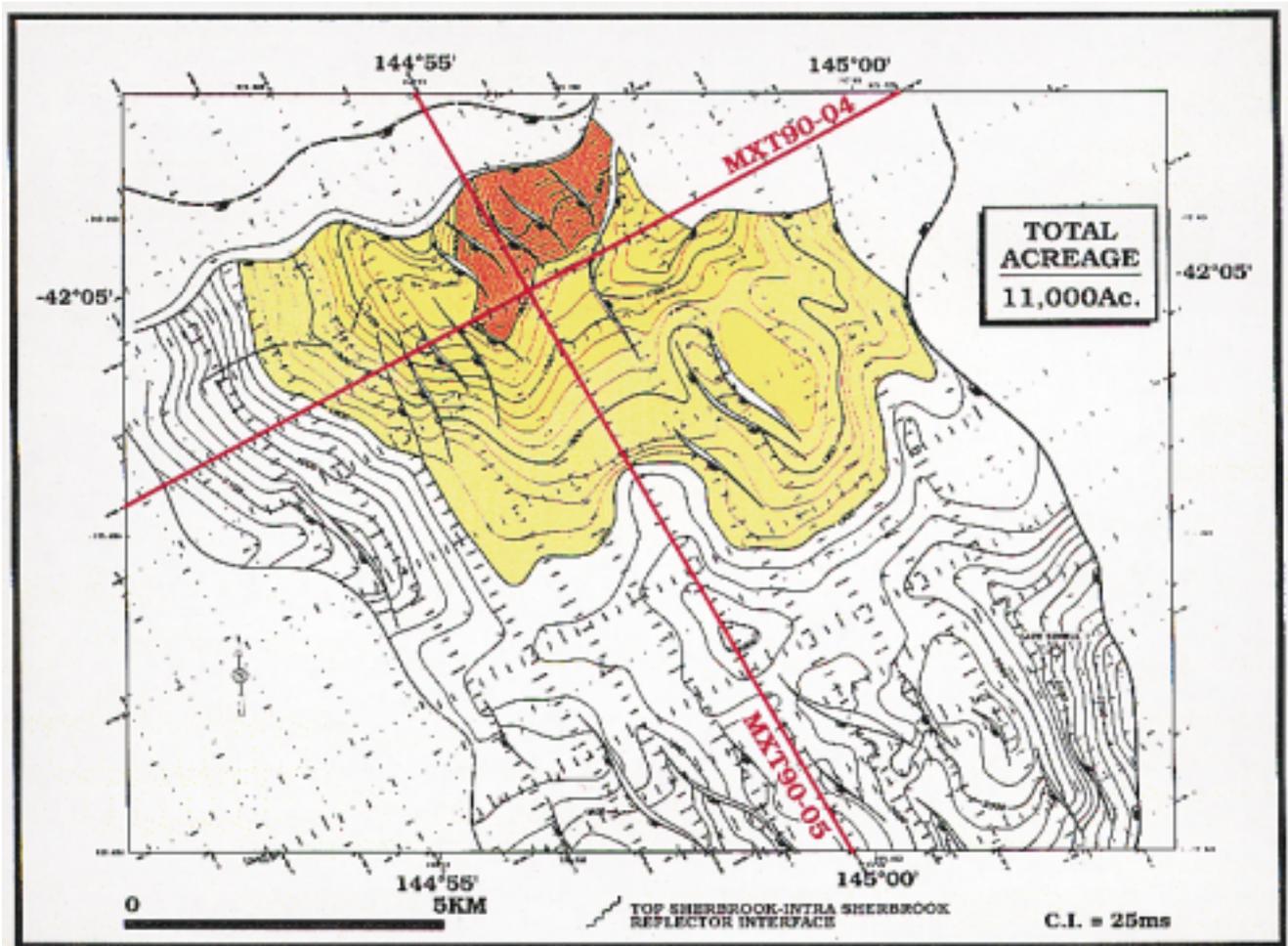


Figure 8

*Time structure on top Sherbrook Group reflector defining the Trial Harbour prospect.
Courtesy of Maxus Energy Corporation.*

recently by Maxus Energy Corporation (1990–1993). Maxus relinquished the permit after failing to attract farm-in partners. The Strahan Sub-basin is covered by a 2D seismic grid of 1 × 1.25 km shot by Amoco and Maxus Energy Corporation. Several prospects and leads have been mapped by Maxus. In 1995 the Australian Geological Survey Organisation (AGSO) carried out a deep crustal seismic survey along the length of the west Tasmanian margin, with multiple lines over the Strahan Sub-basin. Cape Sorell-1 (Amoco, 1982) is the only well drilled in T98-1.

Wells

Well: **Cape Sorell-1**
 Operator: Amoco Australian Petroleum Company
 Rig Release date: 1982
 KB: 22 m
 Stratigraphy:
 Heytesbury Group 94 m

Nirranda Group ?
 Wangerrip Group 389 m
 Sherbrook Group 1759 m

TD: 3528 m
 Water depth: 94 m
 Status: P & A dry, minor oil shows

Seismic surveys

Part or all of the following surveys are located in T98-1. Shotpoint maps, seismic sections and reports are available from Mineral Resources Tasmania.

Line prefix	Survey	Operator/year
EE	Esso Tasmania	1968
T69A	Esso West Tasmania	1969
T70A	Esso West Tasmania	1970
T70C	Esso West Tasmania	1970
N	'Petrel' survey (Shell)	1973
W81	Amoco West Tasmanian Basin	1981
MXT 90	Maxus Energy CPN survey	1990
148	Circum-Tasmania deep seismic	AGSO — 1995

Area T98-2: King Island and Sandy Cape Sub-basins

Area T98-2 encompasses the King Island and Sandy Cape Sub-basins. These sub-basins contain up to 3.6 and 5 km of sediment respectively, and have only been lightly explored. Recent discoveries in the offshore Otway Basin enhance the area's prospectivity. The King Island Sub-basin is covered by a 7 km grid of 1968 Esso seismic lines, while AGSO's 1995 deep crustal seismic survey included multiple lines over the King Island Sub-basin. Seismic coverage of the Sandy Cape Sub-basin is sparse, but enough to suggest some potential leads. Apparent drape closures over tilted fault blocks are present in both sub-basins. The Sandy Cape Sub-basin is in a favourable position for updip hydrocarbon migration from thick depocentres under the continental slope. As in T98-1, traces of thermogenic hydrocarbons have been recovered from shallow sediment samples from the upper continental slope.

Clam-1, drilled in the King Island Sub-basin by Esso in 1969, is the only well drilled in T98-2. Sited on the eastern flank of a large basement high, the well intersected reservoir-quality sands but reached basement at only 1510 metres.

Hydrocarbon Prospectivity

The King Island Sub-basin, lying shelfward of the Clam High, is defined by a widely-spaced seismic grid, mostly of 1960's vintage. Clam-1, on the flank of the Clam High, penetrated a prograding wedge of Palaeocene sediment sands overlying a thin sandy Upper Cretaceous sequence containing redbeds. These overlie basement phyllite of probable Proterozoic age.

In the relatively shallow depocentre of the King Island Sub-basin, the best prospects are offered by the lowermost Cretaceous sediments, draped over tilted fault blocks in the deepest parts of the trough.

The lower Eocene canyons mapped in the Strahan Sub-basin also occur in the southern part of the King Island Sub-basin and may help form effective traps.

The Sandy Cape Sub-basin extends for 120 km along the margin, partly under the continental shelf, and has a maximum sedimentary thickness of over 5000 metres. Similar sediment thicknesses underlie large areas of the adjacent continental slope (fig. 3), which therefore represents a vast downdip 'kitchen area' for hydrocarbon generation offshore.

Seismic coverage is sparse but enough to delineate some potential leads, for example drape over tilted basement fault blocks on BMR78-5, and dip and fault closures at the northern end of the sub-basin (fig. 9). The lower Eocene submarine canyons are present (line t69A-2) and may form substantial stratigraphic traps, and may act as conduits for migrating hydrocarbons generated in the thick depocentres under the continental slope into shallower sandstone targets under the shelf.

Exploration History — Wells

Well: Clam-1
 Operator: Esso Standard Oil (Australia) Ltd
 Rig Release date: 1969
 KB: 30 m

Stratigraphy:

Heytesbury Group	102 m
Nirranda Group	?
Wangerrip Group	387 m
Sherbrook Group	925 m
Lower Cretaceous Redbeds	1462 m
Pz/Late Proterozoic	1510 m

TD: 1592 m
 Water depth: 102 m
 Status: P & A dry

Seismic surveys

Line prefix	Survey	Operator/year
K	Cape Grim to Cape Jaffa	Hematite/1964–65
EO	Offshore Otway Basin, 1966	Esso/1966–67
EE	Tasmania 1968	
	Esso/1968	
EP	Offshore Otway Basin, 1967	Esso/1967–68
M	West Otway	Magellan/1969
N	Roving Petrel	Shell/1969
BMR		
1970–73	Continental Margins	BMR/1973
BMR 82	Survey 40	BMR/1982

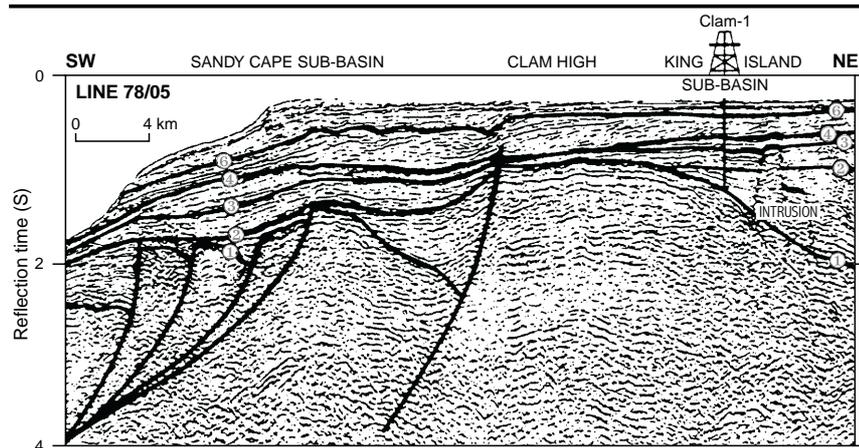


Figure 9

Interpreted seismic line across T98-2, showing fault drape in Sandy Cape Sub-basin, the Clam High, and the western part of the King Island Sub-basin (from Moore et al., 1992).

SO-36	Survey 36	BGR/1985
78	Survey 78	BMR/1988
148	Circum-Tasmania deep seismic	AGSO/1995

Work Program Bidding System

Offshore petroleum exploration in Australian waters is administered jointly by the Commonwealth (Federal) Government and the relevant State Government.

Intending explorers are referred to the brochures produced by the Department of Primary Industries and Energy (*Release of Offshore Petroleum Exploration Areas Australia 1998*) for full information on exploration protocols in Australian offshore waters.

Under the work program bidding system, the applicant is required to propose a six-year exploration program. The first three years of the program — the 'minimum guaranteed dry hole work program' — should comprise work of an exploratory (rather than appraisal) nature. All the work must be completed to avoid cancellation of the permit. The applicant also identifies a 'secondary work program' to cover the second three years of the permit.

Work program permits are issued for an initial six years, and may be renewed for an unlimited number of five year periods. At each renewal 50% of the permit area must be relinquished.

Closing date for work program bids for T98-1 and T98-2 is Thursday 15 October 1998.

Data availability

Open File Exploration Databases

Australia's offshore petroleum legislation requires companies to submit data and technical reports on exploration activities. Most basic data then becomes publicly available two years after submission, with interpretative data becoming available five years after submission.

Seismic (and magnetic) survey lines and reports, well completion reports, and logs pertaining to T98-1 and 2 are available from Mineral Resources Tasmania, Hobart, and the Bureau of Resource Sciences, Canberra. Seismic and well survey data on magnetic tape is stored by Australian Archives in Sydney. The Bureau of Resource Sciences manages the tape archive and the lending service, and has established a computerised database allowing on-line access to information on data held.

Digitised E-logs and well cards are available from Wiltshire Geological Services, Adelaide. Digitised shotpoint maps are available from Petroconsultants Digimap, Sydney. BMR and AGSO surveys are available from AGSO, Canberra.

Geological and Prospectivity Studies

CONOLLY, J.; GALLOWAY, M. J. 1995. Hydrocarbon prospectivity of the offshore west coast of Tasmania. *Tasmanian Geological Survey Record 1995/04*. [A 34-page report summarising prospectivity of the Sorell and southern Otway Basins, including 15 figures and 12 key interpreted seismic lines, available for \$A250 from Mineral Resources Tasmania (address below).]

HILL, P. J.; EXON, N. F.; ROYER, J-Y.; WHITMORE, G.; BELTON, D.; WELLINGTON, A. 1997. *Atlas of the Offshore Tasmanian Region: Swath-mapping and Geophysical Maps from AGSO's 1994 Tasmante survey*. [Available as hard-copy and CD-ROM. Presents the results of swath-mapping of 200 000 km² of seabed off western and southern Tasmania, with most maps at 1:1 000 000 scale. Includes bathymetric contours, gravity and magnetic profiles and contours, seabed sampling location and information, sediment thickness and main structures, and other data. Available at \$A250 from the AGSO Sales Centre (tel. +61 2 6249 9519; GPO Box 378, Canberra, ACT 2601).]

HILL, P. J.; MEIXNER, A. J.; MOORE, A. M. G.; EXON, N. F. 1997. Structure and development of the west Tasmanian offshore sedimentary basins: results of recent marine and aeromagnetic surveys. *Australian Journal of Earth Sciences* 44:579-596. [A concise summary of the development of the Sorell Basin based on new regional seismic, aeromagnetic and bathymetric data sets.]

LODWICK, W. 1998. *Petroleum prospectivity study, Sorell Basin*. [Available on CD-ROM. A comprehensive account of geology, exploration history, and prospectivity, including a 1998 interpretation of the last detailed seismic survey (Maxus, 1990) in the Strahan Sub-basin (area T98-1). Package includes two 8 mm tapes containing 1990 Maxus survey in SEG Y format; stack, migration and RPF migration; and Landmark interpretation. Available from Bureau of Resource Sciences (address below).]

MOORE, A. M. G. 1991. Western Tasmanian margin: seismic interpretation and mapping. *Record Bureau Mineral Resources Geology & Geophysics Australia* 1991/70. [Interpretation of pre-1990 seismic, with illustrative seismic sections and TWT maps at 1:250 000 and 1:100 000 scale.]

MOORE, A. M. G.; WILLCOX, J. B.; EXON, N. F.; O'BRIEN, G. W. 1992. Continental shelf basins on the west Tasmania margin. *APEA Journal* 32:231-250. [A detailed account of petroleum prospectivity of the Sorell and southern Otway Basins, based on Moore's (1991) interpretation, incorporating well data and geohistory modelling.]

[1 May 1998]

Further information on these areas is available from:

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