CRUISE PROPOSAL - OTWAY BASIN, SOUTHEASTERN AUSTRALIA: DEEP CRUSTAL SEISMIC DATA ACQUISITION, LATE 1994/EARLY 1995

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RECORD 1994/61

AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

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Marine, Petroleum & Sedimentary Resources Division

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Otway Basin, South-Eastern Australia: Deep Crustal Seismic Data Acquisition, Late 1994/Early 1995

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MPSR

DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY

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Summary

It is proposed to acquire up to approximately 4000 km of deep crustal seismic data across the offshore Otway Basin in the period from early December 1994 to late January 1995. The principal goals of the survey (AGSO Survey 137) are to determine the deep crustal architecture of the offshore Otway Basin, to characterise the linkages between the Otway Basin and the flanking Bass Basin, Kanmantoo High and oceanic crust, and thereby to characterise the large scale extensional processes which led to the development of the Otway Basin as part of the larger Southern Rift System. In addition, the survey is designed to test many of the newer concepts which have arisen from the interpretation of AGSO's recently acquired aeromagnetic data. The integration of the deep crustal seismic and the aeromagnetic data sets should significantly enhance our understanding of the basin architecture, as well as provide new insights into the usefulness of high resolution aeromagnetic data in sedimentary basins. In order to constrain crustal velocities, seismic refraction data will be recorded on key lines.

In line with recent AGSO deep-seismic surveys, the Otway Basin survey will use a 4800 m streamer, configured with 192 x 25 m active groups; data will be recorded with a 16 second record length, and a 2 millisecond sample interval; the seismic source will be tuned airgun arrays with a total capacity of 49 litres, and will be fired every 50 metres to give 48-fold CDP coverage. Navigation will be by differential GPS. Using these parameters on the North West Shelf and in the Gippsland Basin, AGSO has consistently obtained high-quality deep seismic data, with interpretable reflectors down to 8-12 s TWT, as well as obtaining good resolution in the upper 6 s of seismic data, which is normally the limit recorded by industry.

Exploration Background

The northwest-southeast trending Otway Basin is located on the south-eastern Australian margin (Fig. 1), straddling the Victorian and South Australian coastlines for 500 km between the Mornington Peninsula in Victoria and Cape Jaffa in South Australia. The basin, which covers approximately 150 000 square km, developed in the latest Jurassic and Early Cretaceous as a series of extensional and oblique extensional rift segments, in response to the rifting between Australia and Antarctica (O'Brien et al., 1994).

The basin has been an area of active hydrocarbon exploration since the late 1950s. In fact, the western onshore Otway Basin was the site of Australia's first oil well, which was drilled at Alfred Flat, near the Coorong, South Australia, in 1866 (Sprigg, 1986). In the onshore Otway Basin, sub-commercial gas was encountered in the Port Campbell 1 well (Victoria) in 1959, while in 1967 a small commercial carbon dioxide (CO_2) discovery was made in South Australia at Caroline 1 (Mulready, 1977). More recently, exploration resulted in the discovery of small but significant gas accumulations at North Paaratte (1979), Katnook (1987) and Ladbroke Grove (1989; Parker, 1992), and Iona (1988; Miyazaki et al., 1990); significant CO_2 was associated with the gas at Ladbroke Grove. Oil shows were recorded in the Lindon 1 well in 1983, while some heavy crude oil was recovered from Sawpit 1 in 1992.

Offshore, the only significant hydrocarbon shows recorded between 1967 and 1993 were minor gas flows from Pecten 1A (eastern Otway Basin) and Troas 1 (western Otway Basin) wells. However, a recent increase in exploration activity in the offshore area has been rewarded by two large gas discoveries in early 1993 (the Minerva and La Bella accumulations) off Port Campbell, in western Victoria. These recent discoveries, as well as previous finds in the onshore part of the basin, have established the Otway Basin as a potential major gas province.

Previous AGSO-BMR Acquisition Programs

In 1985, the Bureau of Mineral Resources (BMR) acquired 3700 km of conventional regional seismic lines in the Otway Basin (Exon, Williamson et al., 1987). This data set, in conjunction with earlier regional lines acquired in 1972 by Shell using M.V. *Petrel*, provides a regional seismic grid extending from nearshore to the abyssal plain (Fig. 2). Interpretation of these data, along with information from the GEOSAT imagery and the 1994 *l'Atalante* swath-mapping and seismic survey in the southeast (Exon, Hill et al., in prep.), shows that the edge of the abyssal plain is not equivalent to the continent-ocean boundary (COB). In fact, the COB lies about 50 km southwest of the foot of the continental slope mapped by *l'Atalante*. The seismic data (Heggie et al., 1988; Schwab, 1993) indicate that most faults in the continental crust are normal and dip oceanward: steeply with little extension on the shelf and upper slope, moderately with more extension on the lower slope, and shallowly with much extension on the inner abyssal plain. Sampling at the foot of the slope has recovered basement volcanics and metamorphic rocks, and Late Cretaceous and Palaeogene shallow marine detrital sediments (Exon, Lee et al., 1992).

In 1993, the Australian Geological Survey Organisation (AGSO; formerly BMR) acquired 14 200 km of regional (1400 m line spacing) high-resolution aeromagnetic data within the South Australian part of the Otway Basin, with the survey extending offshore to about the 500 m isobath. More recently (May-June 1994), a further 45 000 km of detailed (500 m line spacing) aeromagnetic data were acquired over the offshore Victorian part of the basin. These magnetic data have provided, for the first time, a consistent, regional interpretative framework for the nearshore part of the Otway Basin.

Interpretation of these magnetics has allowed:

- accurate mapping of the geometry of the Otway Group rift segments (trend NNE);
- determination of the position and trend of syn- and post-rift faults (strike generally WNW);
- mapping of the distribution of Tertiary volcanics; and
- determination of detailed basement geometries and depths (note that the oldest faults strike N-S)

The swath-mapping results from the *l'Atalante* (Exon, Hill et al., in prep.) show offsets in the foot of the slope that seem to correspond to north-northeasterly aeromagnetic trends.

Models for Basin Development

The architecture of the southern continental margin of Australia is dominated by the Mesozoic 'Southern Rift System' which was associated with the fragmentation of Gondwana (Willcox, 1990; Willcox & Stagg, 1990). This rift system developed in the latest Jurassic and earliest Cretaceous and was largely formed by extension oriented approximately NW-SE. It extends for over 4000 km from Broken Ridge in the west to the South Tasman Rise in the southeast. In most places this system underlies the continental slope, where it has physiographic expression in such margin features as the Eyre, Ceduna and Beachport Terraces, and the South Tasman Rise. However, in some areas, most notably south of the Eyre Terrace and off the Otway and Sorell Basins of west Tasmania, it appears to give rise to an abnormally wide (*ca.* 200 km) lower continental slope/continental rise at nearly abyssal depths (4000-5000 m).

Traditionally, the Bassian Rift, of which the Otway Basin is one part, is considered to have developed via NNE-SSW lithospheric extension, largely during the Early Cretaceous (Etheridge et al., 1985, 1987; Perincek et al., 1994). This extension apparently led to the development of a linked array of WNW-ESE-oriented, shallow-dipping, normal extensional faults and orthogonal, steeply-dipping, transfer or accommodation faults. In this model, the tectonic evolution proceeded smoothly from rift initiation, to active rifting, to sea-floor spreading and associated post-rift subsidence.

The Bassian Rift appears to be a splay off the 'Southern Rift System' of Willcox & Stagg (1990). Further afield, Late Jurassic to Early Cretaceous NW-SE extension formed extensional basins in the Great Australian Bight (Stagg & Willcox, 1992), and also the Gippsland Basin as an extensional feature (Willcox et al., 1992; Colwell & Willcox, 1993), as well as strike-slip basins on the west Tasmanian margin (Moore et al, 1992). Looking at the Bassian Rift as a whole (Gippsland, Bass and Otway Basins), Willcox et al. (op. cit.) proposed that the early history of the Otway Basin was dominated by extension in the same sense as the other parts of the rift, namely by NW-SE extension. It is possible that there was an early phase of Australian-Antarctic seafloor speading in the Neocomian, at least off the western part of Australia's southern margin (Stagg & Willcox, 1992).

Williamson et al. (1990) proposed two stages of rifting in the Otway Basin. The first stage was from about 140 to 120 Ma, and formed an onshore rift that included the present-day Crayfish Platform, within which faults are steeply dipping and oriented east-west or east-northeast. The second stage of rifting, at about 95 Ma and just prior to seafloor-spreading, had fault trends between east-southeast and southeast, and maximum extension near oceanic crust.

O'Brien et al. (1994), have also proposed that Otway Basin rift development proceeded in two distinct stages. In their model the first stage, which was essentially intra-cratonic, spanned from the Tithonian through the Hauterivian (150-120 Ma), and was dominated by NW-NNW extensional transport which produced ENE-trending extensional half-graben (eg. Crayfish Platform, Robe Trough, Torquay Sub-Basin) and NW-trending oblique extensional features such as the Penola and Ardonachie Troughs. In this model, a changing stress field at about 120-117 Ma (time scale of Harland et al., 1982) produced uplift and erosion of the Tithonian to Hauterivian fault blocks. Extension recommenced at about 117 Ma with a generally NNE-trending extension transport direction (ETD), forming WNW trending normal faults. This rift phase, which was located outboard of the earlier episode, ultimately led to continental margin formation

Irrespective of uncertainties surrounding the early rift tectonics, final continental break-up (i.e. the initiation of north-south seafloor spreading) took place off the Otway Basin between 96 Ma (Veevers et al., 1991), and 42 Ma (oldest magnetic lineations, J.Y. Royer, pers. comm.).

Morpho-Tectonics and Stratigraphy

The morpho-tectonics and stratigraphic distribution in the Otway Basin reflect the complex tectonic history discussed above. Onshore, the basin is composed of a series of predominantly SE-trending Early Cretaceous troughs or half-grabens separated by basement highs. In the northwestern Otway Basin, significant features reflected in AGSO's 1992 aeromagnetic data (O'Brien et al., 1994) include the Penola Trough, the Beachport and Kalangadoo Highs, the Padthaway Ridge, and the ENE-trending Robe Trough, Lake Eliza High and Saint Clair Trough.

Offshore, the basin can be broadly subdivided into three distinct structural provinces. Forom northwest to southeast these are: the ENE-trending Crayfish Platform with steeply dipping normal faults trending east-west, the Voluta Trough (western and eastern) with WNW-trending faults, and the Mussel Platform, also with predominantly

WNW-trending faults. These three structural provinces have existed since at least the early Late Cretaceous, and have controlled sedimentary facies development throughout the basin.

The known stratigraphy of the Otway Basin, drawn from the onshore and continental shelf regions, is illustrated in Figure 3, and a schematic northwest-southeast cross-section in Figure 4. The oldest sediments known from the Otway Basin are the Casterton beds, a latest Jurassic sequence of inter-bedded non-marine siltstones, mudstones, minor coals and volcanics (Wopfner et al., 1971; Dettmann and Douglas, 1976). Lacustrine sediments with good source rock potential have also been reported from this unit (Kopsen and Scholefield, 1990). To date, the Casterton beds have only been drilled onshore.

Overlying the Casterton beds is the Early Cretaceous Crayfish Subgroup of the Otway Group (Morton, 1990), which consists principally of fluvial sands deposited in a high-energy environment (the Pretty Hill Sandstone). These sands contain significant amounts of feldspar and acid volcanogenic lithics (Alexander, 1992), which suggest contemporaneous volcanism. The Pretty Hill Sandstone is overlain by overbank and lacustrine siltstones and shales (Laira Formation), which inter-finger with, and are overlain by, meandering fluvial to distal braided fluvial sands of the Katnook Sandstone (Morton, 1990). The Crayfish Subgroup was deposited in strongly fault-controlled grabens, and is very thick in the northwestern Otway Basin: over 1500m were drilled in the Crayfish 1A well on the Crayfish Platform, with up to 4700 m present within the onshore Robe Trough (Kopsen & Scholefield, 1990). Crayfish Subgroup deposition appears to have terminated at about 120 Ma, and was followed by a brief period of block faulting, uplift and erosion. The 'top Crayfish Subgroup horizon' became highly structured at this time, particularly on the Crayfish Platform (Williamson et al., 1990).

Deposition of the lower energy, less fault-controlled Eumeralla Formation of the Otway group commenced at approximately 117 Ma, and largely blanketed the underlying Crayfish Subgroup. Dominant lithologies were shales and siltstones, with minor coals, argillaceous sands and sandstones, which were probably deposited in low energy flood-plain (low sinuosity stream, lacustrine and back-swamp) environments (Morton, 1990). A significant amount of volcanogenic detritus has been described in the Eumeralla Formation (Robertson, 1966).

Early Cretaceous sedimentation was terminated by a mid-Cretaceous period of block faulting, differential uplift, and erosion between 100 and 95 Ma, which may have been related to continental breakup and the initiation of seafloor spreading, or perhaps simply to continental stretching. Offshore, the basin became subdivided into a series of slowly subsiding platforms (Crayfish and Mussel Platforms) and rapidly subsiding troughs (western and eastern Voluta Trough). Subsequently, deposition of the Late Cretaceous Sherbrook Group commenced in the Cenomanian. The margin continued to subside throughout the Tertiary, eventually leading to widespread carbonate deposition. After fast seafloor-spreading started at 42 Ma, the margin collapsed by rotation, with the shallow-water Oligocene unconformity being present and unfaulted right down the continental slope (Heggie et al., 1998).

Tertiary volcanic rocks, which have astrong magnetic signature, are present at two distinct levels in the Otway Basin (Megallaa, 1986). The Older Volcanics were erupted in the Paleocene, whereas extensive volcanic eruptions of basalts of the Newer Volcanics occurred in the Neogene in central and western Victoria. The Newer Volcanics are up to 200 m thick in the area of the present study.

Program Objectives

The structural architecture of the Otway Basin needs to be determined before the widely differing tectonic models which were discussed previously can be resolved, and an improved exploration model for the Otway Basin can be developed To address these issues, AGSO proposes to acquire approximately 4 000 km of deep crustal seismic reflection data over the offshore Otway Basin, as well as linking key elements of the Otway Basin to the adjacent Bass Basin and Kanmantoo High. This program consists of a maximum of 14 dip lines and 5 strike lines, with 10 dip lines and 4 strike lines being of highest priority. It will map all the major offshore tectonic elements with high quality, deep seismic data for the first time. In addition, seismic refraction data will be acquired on key lines to provide information on crustal velocities. The program will focus on:

- Determining the under-pinning structural architecture and ages of the entire basin from the shelf to the lower continental slope, including the Crayfish Platform-Robe Trough, the Voluta Trough, the Mussel Platform and the Torquay Sub-Basin, as well as establishing the nature of the linkages between these elements, and with oceanic crust. The characterisation and contrasting of the underpinning structural architecture of the ENE-trending Crayfish Platform/Robe Trough/ Sub-Basin versus the NNW-trending Voluta Trough, for example, may allow the relative merits of the above models to be determined, as well as allowing the interpretation of the aeromagnetic data to be much better constrained.
- Imaging the linkages between the Otway Basin and the flanking Bass Basin to the east and the Kanmantoo High to the west, and thereby helping to determine the large-scale extensional processes which led to the development of the Otway Basin, as part of the larger Bassian Rift System and indeed the larger Southern Rift System.
- Characterising the manner in which the large-scale rift elements (eg. accommodation/relay zones, basement fractures etc), through time, control structuring in the overlying section.
- Characterising the extensional transport direction (ETD) from the Tithonian to the Hauterivian (Crayfish Sub-Group time), determining the tectonic driving mechanism for the Hauterivian Unconformity (Top Crayfish Sub-Group time), and characterising of the ETD from the Barremian to Albian (Eumeralla Formation time).
- AGSO's new aeromagnetic data in the offshore Victorian part of the basin have delineated major NNE-trending structural boundaries on the shelf, which actually define the boundaries of the eastern and western Voluta Troughs, that are presumed to be "accommodation" zones. On the basis of GEOSAT imagery and swath-mapping we assume these continue to the continent-ocean boundary. In the framework of Etheridge et al. (1985, 1987) and Perincek et al. (1994), these

accommodation zones would be long-lived (Tithonian to Albian), and potentially bracket deep Tithonian to Hauterivian source rock depocentres. In the framework of O'Brien et al. (1994), however, the Tithonian to Hauterivian sediments would be thin to absent (as this represents the intra-cratonic phase of basin evolution), and the accommodation zones would effectively be shorter lived (Barremian to Albian).

- Determining the offshore distribution of sediments of Crayfish Sub-Group age. In O'Brien et al.'s (1994) model, these sediments would be absent under the Mussel Platform and Voluta Trough, because the intra-cratonic rift phase was *largely* restricted to the present-day onshore areas. As the basal Crayfish Sub-group sediments are a potential oil-prone source rock, and, if present, would be in the oil window over the eastern Mussel Platform, their presence or absence offshore has important exploration implications.
- Providing a fundamental framework within which to interpret the large amount of conventional seismic data which has recently been acquired throughout the basin, in order to examine spatial and temporal changes in geological development across this complex basin.

Timing of Survey

Survey 137 as laid out consists of a maximum of about 5600 kms of deep crustal seismic acquisition (14 dip lines and 4 strike lines). Realistically, a maximum of about 4000 km (10 dip lines and 3-4 strike lines) may be acquired. The acquisition may take place in two phases:

Phase 1: November 30 to December 22, 1994 (21 days). Departing Portland, Victoria, docking Melbourne, Victoria.
Phase 2: January 2 to 22, 1995 (up to 20 days depending on other requirements). Departing Melbourne, Victoria, docking Melbourne, Victoria

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Appendix I: Otway Basin Survey Way-Points

Line	WP	Comments	Latitude DDMMSS	Longitude DDMMSS
A1	1	SOL	385640.4S	1411912.9E
A1	2	DOGLEG	373542.8S	1383943.2E
A1	3	EOL	371058.3S	1371322.7E
A2	1	SOL	385640.0S	1411913.0E
A2	2	DOGLEG	394117.7S	1425305.6E
A2	3	WHELK-1	395352.5S	1433325.8E
A2	4	EOL	395752.7S	1434726.2E
B	1	SOL	364546.7S	1374247.2E
B	2	EOL	380640.1S	1374305.6E
C	1	SOL	364546.2S	1383013.9E
C	2	DOGLEG	373956.7S	1382951.6E
C	3	EOL	381700.7S	1375158.0E
D	1	SOL	365305.8S	1393645.8E
D	2	TRUMPET-1	370542.1S	1392447.3E
D	3	EOL	382648.9S	1380350.1E
E	1	SOL	363904.5S	1392519.3E
E	2	TRUMPET-1	370542.1S	1392447.3E
E	3	TROAS-1	372156.5S	1392327.2E
E	4	EOL	394200.0S	1391613.9E
F	1	SOL	373236.5S	1395308.3E
F	2	COPA-1	374113.0S	1394527.0E
F	3	EOL	391000.0S	1382400.0E
G	1	SOL	364742.5S	1390426.3E
G	2	TRUMPET-1	370542.1S1392447.3E	
E				
G	3	CRAYFISH A-1	371717.0S	1393555.0E
G	4	COPA-1	374113.0S	1394527.0E
G	5	DOGLEG	381500.0S	1403000.0E
G	6	BRIDGEWATER BAY-1	383220.7S	1412152.8E
G	7	MUSSEL-1	385746.0S	1424621.7E
G	8	EOL	391133.3S	1433435.9E
H	1	SOL	380613.8S	1403935.0E
H	2	BREAKSEA REEF-1	380925.7S	1403649.3E
H	3	EOL	394200.0S	1391300.0E
I	1	SOL	381450.6S	1411310.6E
I	2	DISCOVERY BAY-1	382437.6S	1410426.0E
I	3	EOL	394620.2S	1395046.3E

J	1	SOL	382548.0S	1412813.2E
J	2	BRIDGEWATER BAY-1	383220.7S	1412152.8E
J	3	EOL	401300.0S	1394500.0E
K	1	SOL	382630.7S	1421216.6E
K	2	EOL	404403.3S	1401859.3E
L	1	SOL	383601.1S	1424346.6E
L	2	PECTEN-1A	384041.0S	1423956.0E
L	3	EOL	405712.0S	1404227.8E
M	1	SOL	383949.8S	1425903.6E
M	2	MINERVA-1	384206.9S	1425717.3E
M	3	LA BELLA-1	390008.9S	1424147.9E
M	4	EOL	411200.0E	1404630.0E
N	1	SOL	382301.7S	1443513.8E
N	2	NERITA-1	383737.8S	1441349.6E
N	3	PRAWN A-1	392119.4S	1430646.8E
N	4	DOGLEG	394500.0S	1422958.0E
N	5	EOL	411800.0S	1405400.0E
O	1	SOL	394803.4S	1455324.0E
O	2	YOLLA-1	395013.5S	1454825.3E
O	3	EOL	412543.2S	1415409.3E
P	1	SOL	383122.7S	1440435.8E
P	2	NERITA-1	383737.8S	1441349.6E
P	3	KONKON-1	391214.2S	1450344.5E
P	4	CORMORANT-1	393417.4S	1453140.4E
P	5	YOLLA-1	395013.5S	1454825.3E
P	6	SQUID-1	401148.1S	1461832.3E
P	7	EOL	401530.0S	1462330.0E
Q	1	SOL	382502.8S	1411428.8E
Q	2	VOLUTA-1	382541.4S	1411852.4E
Q	3	PECTEN-1	384019.0S	1424042.0E
Q	4	MINERVA-1	384206.9S1425717.3E	
5				
Q	5	LOCH ARD-1	385549.4S	1431100.1E
Q	6	EOL	392110.9S	1433340.3E
R	1	SOL	370945.1S	1373647.6E
R	2	EOL	410831.4S	1425229.6E

Appendix II: Suggested Line Acquisition Sequence, Direction, Length and Priority

1. H to south	194 km	6. J to south	211 km
2. E to north	316 km	7. K to north	301 km
3. D (part) to south	110 km	8. M to south	306 km
4. A (part) to east	500 km	9. N to north	398 km
5. Q to west	242 km	10. P to east	218 km

Line Distances and Priorities - Survey 137

All distances are measured in kilometres.

Line	Dist	Pri	Line	Dist	Pri	Line	Dist	Pri	Line	Dist	Pri
A1	412.06	A	E	316.27	A	J	211.90	A	O	382.91	A-/B
A2	241.45	A	F	178.21	A	K	301.68	A	P	218.76	A/B
B	149.72	B	G	495.13	A	L	313.53	B	Q	242.05	B
C	188.47	A	H	194.17	A	M	306.56	A	R	633.75	B
D	220.75	A-	I	206.82	B	N	398.38	A			

Priority A *12 lines. Distance - 3408.18km

Priority A- *2 lines. Distance - 496.04km

Priority B *7 lines. Distance - 1708.50km

TOTAL: 5612.60 kilometres.

Appendix III: Seismic Acquisition Parameters for the Otway Basin Survey

Seismic Cable Configuration

Standard	length	4800 m
	group length	25 m
	no. channels	192

Seismic Source

Sleeve gun capacity	50 litres (3000 cu in)
Gun pressure	1800 psi (normal)
	1600 psi (minimum)
Shot interval	50 m
Shot rate	19.4 s @ 5 knots
	21.6 s @ 4.5 knots

Recording Parameters

Fold	4800%
Record length	16 s
Sample interval	2 ms

Appendix IV: Equipment to be used on the Otway Basin Survey

FJORD Instruments seismic receiving array: 6.25 m, 12.5 m, 18.75 m, or 25 m group lengths; up to 288 channels; up to 6000 m active streamer length.

Syntron RCL-3 cable levellers; individual remote control and depth readout

Haliburton Geophysical Service 32 x 150 cubic inch airguns in two 16-gun arrays; normal operating array is two x 10 guns, giving a total of 3000 cubic inches normal operating volume

Air compressor system: 6 x A-300 Price compressors, each providing 300 scfm at 2000 psi (62 litres/min at 14 MPa)

Digital seismic acquisition system designed and built by BMR: 16-bit floating point, SEG-Y output on cartridge tape

Raytheon echo-sounders: 3.5 KHz (2 kW) 16-transducer sub-bottom profiler, and 12 KHz (2 kW) precision echo-sounder

Geometrics G801/803 magnetometer/gradiometer

Bodenseewerk Geosystem KSS-31 marine gravity meter

Racal 'Skyfix' differential GPS

Magnavox T-Set stand-alone GPS receiver

Magnavox MX 1107RS and MX 1142 transit satellite receivers

Magnavox MX 610D and Raytheon DSN 450 dual axis sonar dopplers; Ben paddle log

Sperry, Arma-Brown, and Robertson gyro-compasses

Appendix V: Processing Parameters for Otway Basin Seismic Data

Resample to 4 ms

Static correction for gun delay

Gain correctionFshape, low cut filter 3-5 Hz

FK filter

Wavelet processing - decon using Taner's exponential method

NMO velocity analysis every 4 km

Anti-alias filter - interleaved 192-fold CDPs

Radon demultiple - Tau-Q rejection used to attenuate multiples

NMO-DMO velocity analyses every 2 km

Mute

NMO-DMO stack

Static correction for gun and cable depths

Decon after stack

Migration

Bandpass filter

Scaling

Mild 5 trace mix

Appendix VI: Companies and Government Agencies consulted during Cruise Planning Phase

During preparation of these cruise proposals, the following exploration companies and organisations were contacted to provide input.

Ampol Exploration Ltd
BHP Petroleum Pty Ltd
Bridge Oil Ltd
Cultus Petroleum Pty Ltd
Gas And Fuel Resources
Santos Ltd
Sagasco Resources Pty Ltd
Geological Survey Of Victoria
Mines And Energy South Australia
VIEPS

Appendix VII: Crew list

The ship's complement will be the following:

AGSO Representatives	
Jane Blevin	Client Representative
Kevin Webber	Ship Manager
Mark Alcock.	QC Scientist
Tony Hunter	TO Science
Tiernan McNamara	TO Science
John Ryan	TO Science
Harley Reynolds	TO Science
Steven Ridgway	TO Science
Mark Timms	TO Electronics
Claude Saroch	TO Electronics
Brian Dickinson	Gun Mechanic
Mark James	Gun Mechanic
Alan Radley	Gun Mechanic
Simon Milnes	Gun Mechanic
Andrew Hinds	Gun Mechanic
AMSA crew	
Mike Gusterson	Master
John Weeks	1st Mate
Danny Watson	2nd Mate
Peter Pitiglio	Chief Engineer
John Scott	1st Engineer
Ian McCulloch	Electrician
Tony Dale	Chief Integrated Rating
John Fraser	Integrated Rating
Matt Stapleton	Integrated Rating
Merv Hagner	Integrated Rating
Kenny Beu	Chief Cook
Ted Strange	Cook
Steve Stavely	Catering Attendent
Bernie Goerner	Catering Attendent

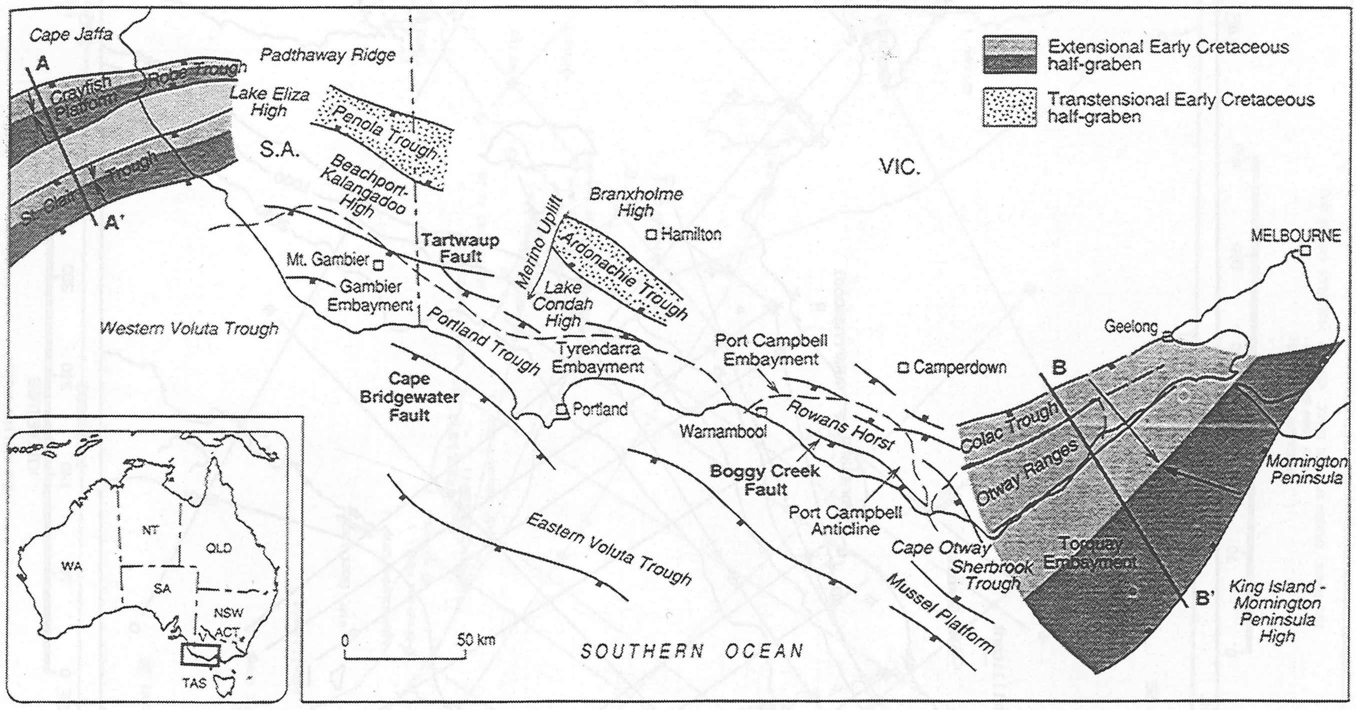

Figure 1. Location map and tectonic elements of the Otway Basin. Interpreted Late Jurassic to Early Cretaceous (Tithonian to Hauterivian) extensional and trans-tensional rift segments are highlighted. Modified by O'Brien et al. (1994) from Laing et al. (1989).

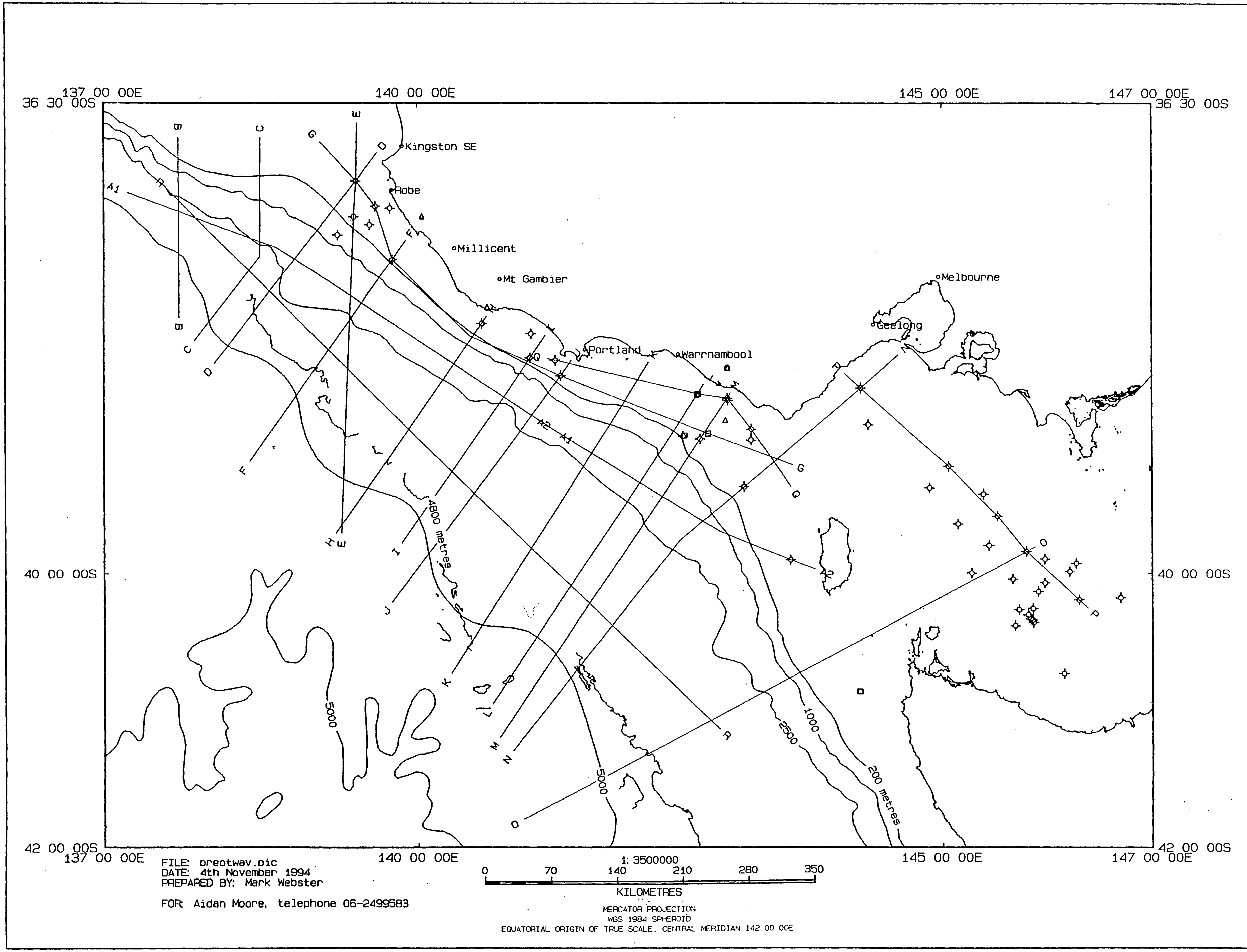

Figure 2. Map of proposed seismic tracks, bathymetry and well locations. The 4800m bathymetric contour is derived from *l'Atalante* swath-mapping and represents the foot of the continental slope.

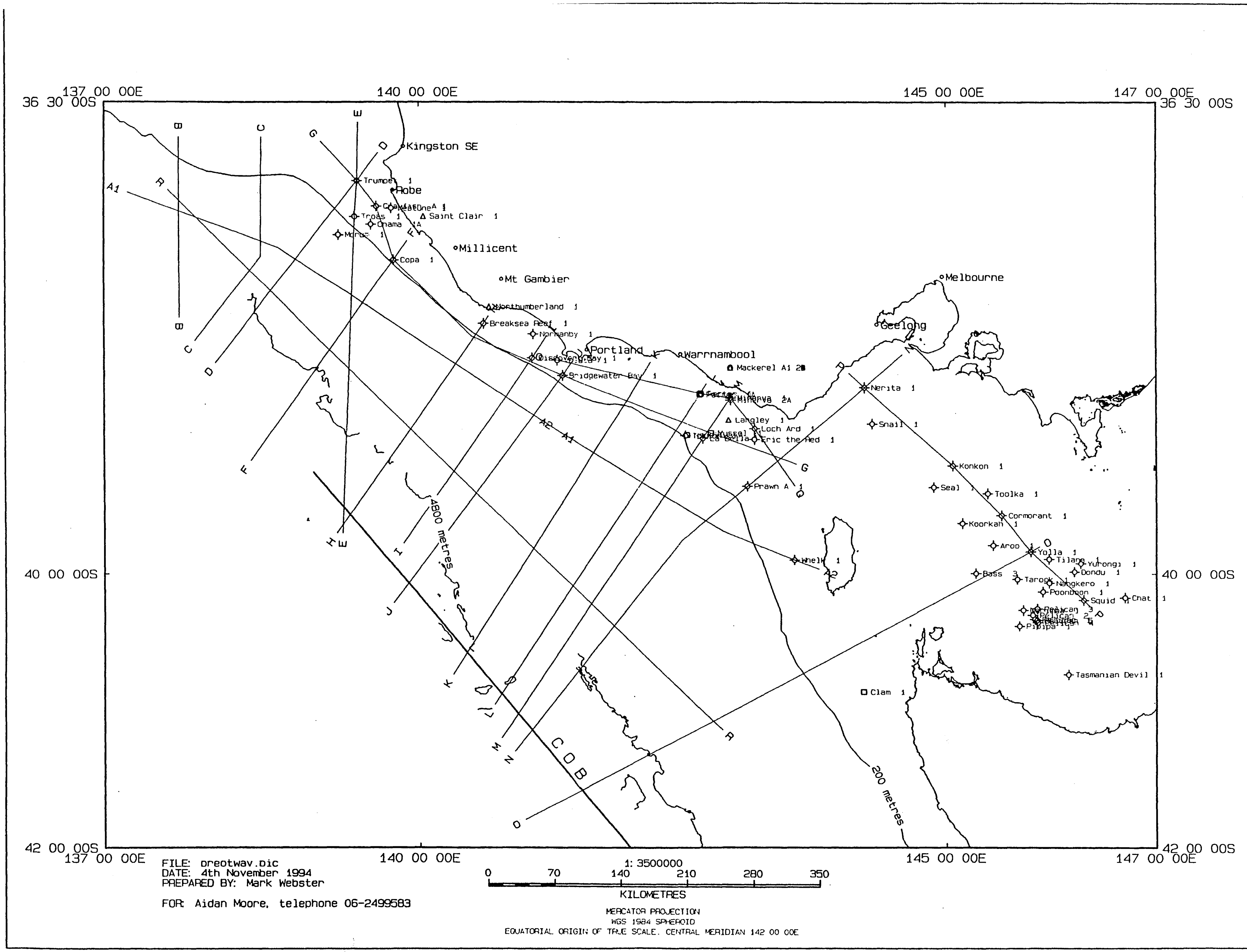

Figure 3. Map of proposed seismic tracks, 200m and 4800m bathymetric contours, and well locations and names. COB=Continent-Ocean Boundary as derived from GEOSAT and other data.

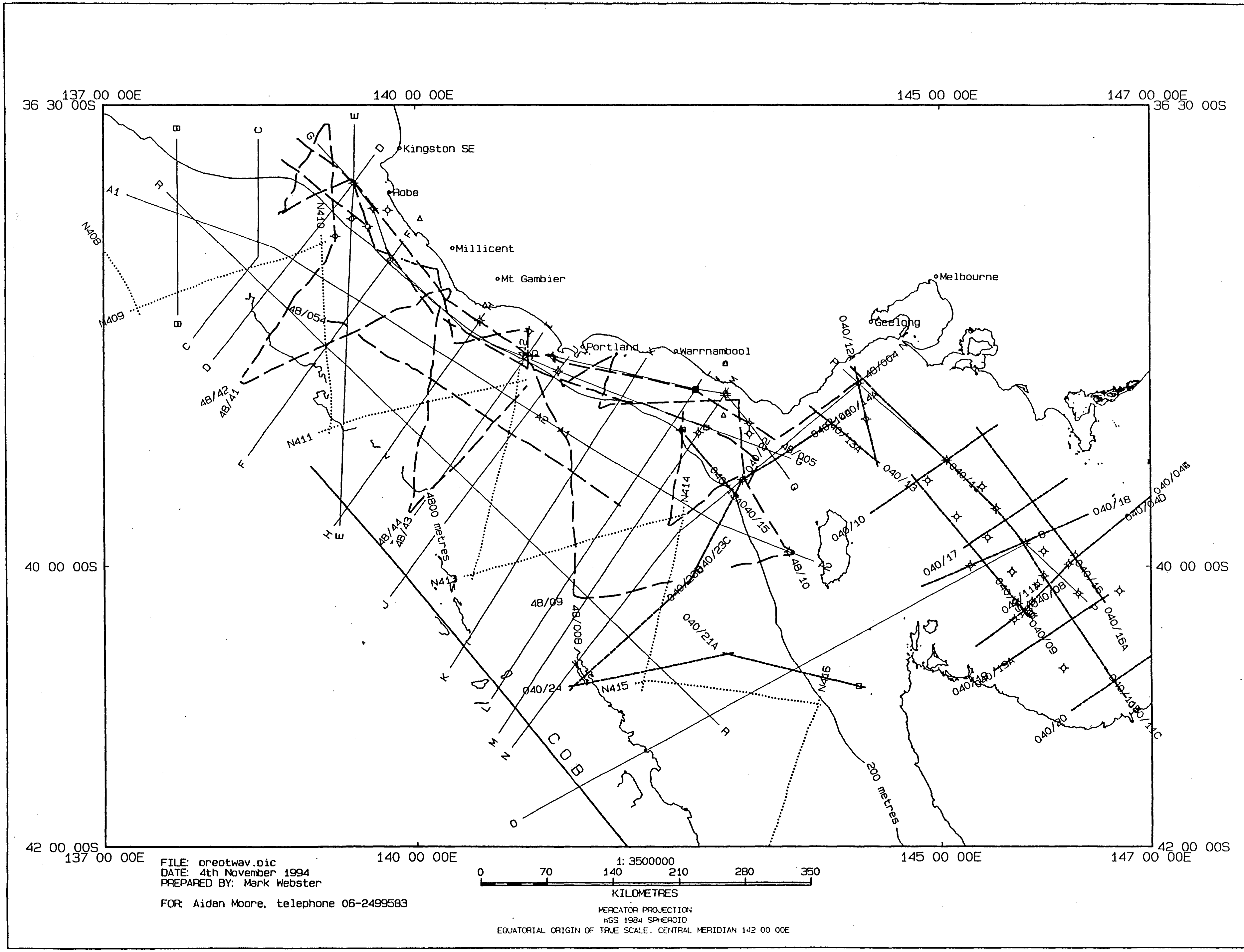

Figure 4. Map of proposed survey lines (solid). Also shown are pre-existing regional seismic lines recorded by Shell *Petrel* (1972, dotted) and BMR (1984, contract, short dashes; and 1985, *Rig Seismic*), the 200 m isobath, the 4800 m isobath at the foot of the slope swath-mapped by *l'Atalante*, and the continent-ocean boundary from GEOSAT and other data

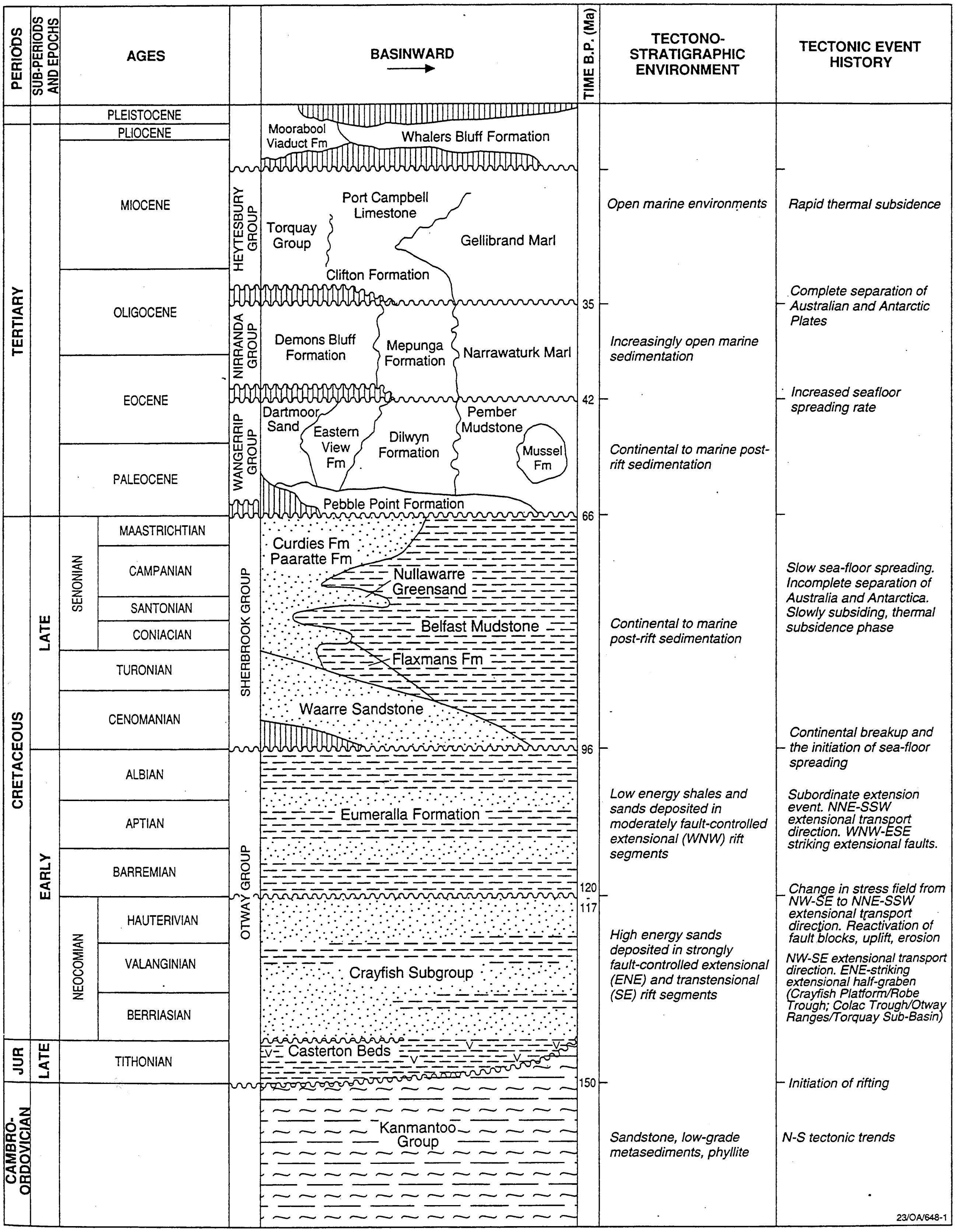

Figure 5. Simplified stratigraphic column for the Otway Basin, onshore and beneath the continental shelf, shown in relation to the interpreted tectonic event history (after O'Brien et al., 1994). Post-Cretaceous history modified from Hinz et al. (1986).

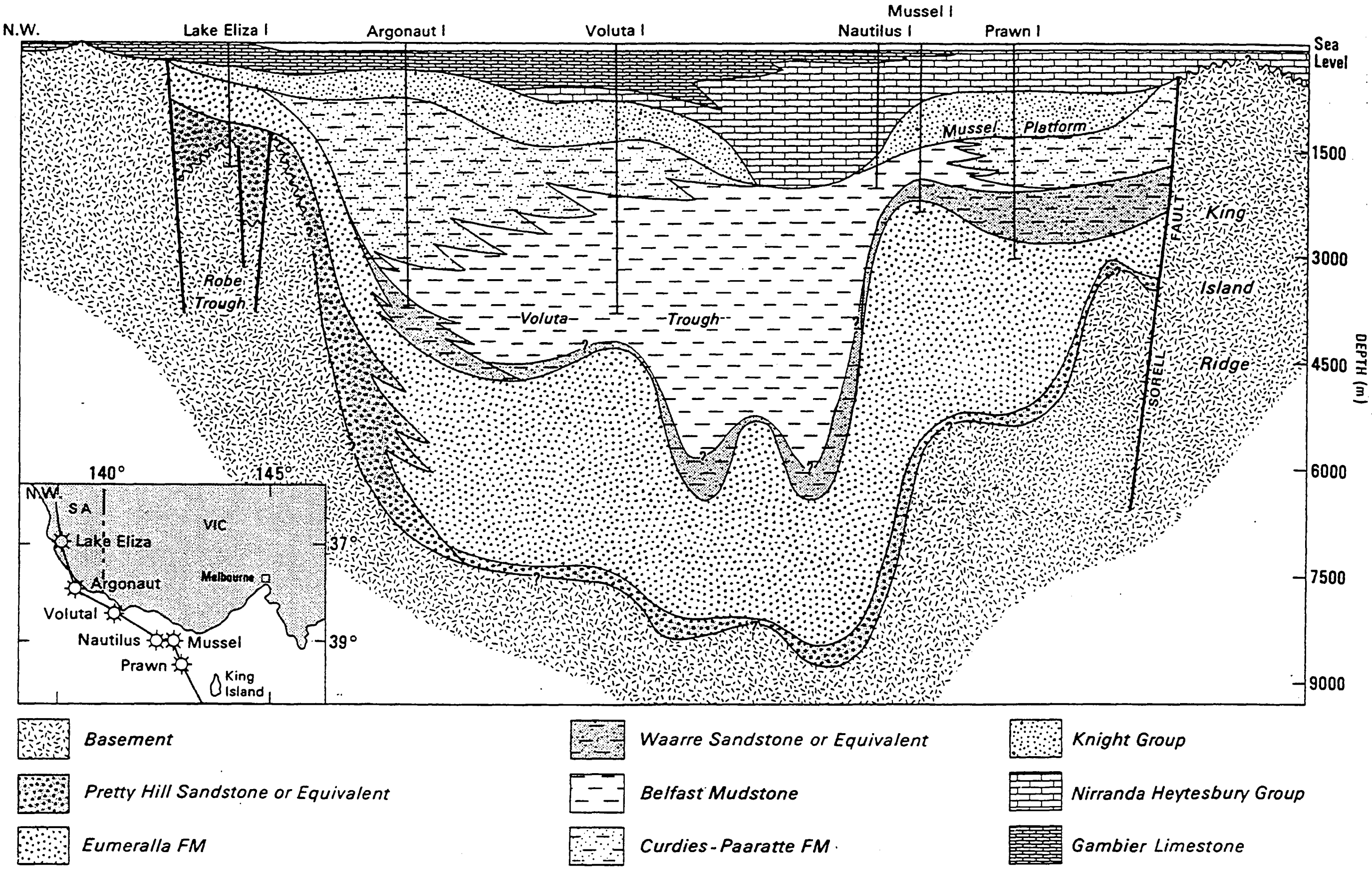

Figure 6. Schematic cross-section across the Otway Basin (after Williamson et al., 1987).