FRANKLIN

National Facility
Oceanographic Research Vessel

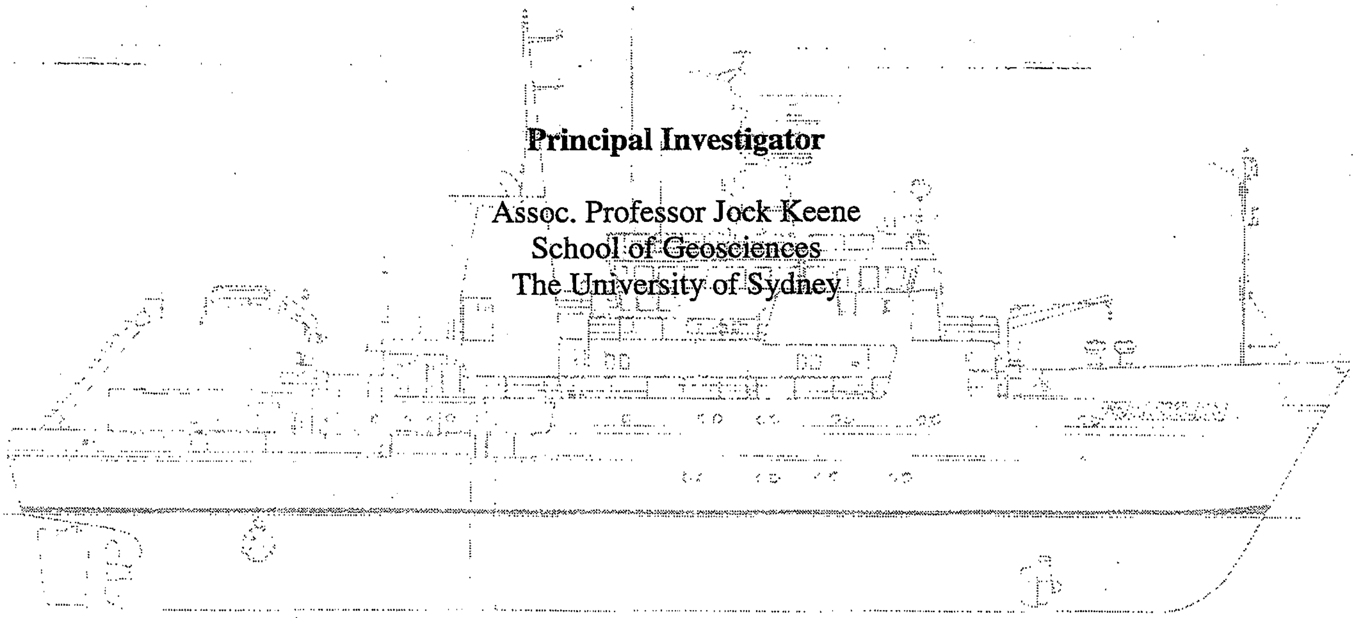
CRUISE SUMMARY

R/V FRANKLIN

FR 11/98

Anatomy and Growth History of Non-tropical Carbonate Shelves and Slopes in South-Eastern Australia.

Departed Hobart 1000 hrs, Friday 18 September, 1998
Arrived Sydney 0900 hrs, Monday 5 October, 1998



Principal Investigator

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R/V Franklin
Research Summary
Cruise FR 11/98

Itinerary

Sailed Hobart 1000 hrs, Friday 18 September, 1998
Arrived Sydney 0900 hrs, Monday 5 October, 1998

Scientific Program

The large wedge of sediments which has accumulated in the last 30 million years in the Gippsland Basin epitomises the geological history of Australia's southern margins. The sediment wedge contains an interesting assemblage of sedimentary rocks including brown coals, coastal barrier sands, marine non-tropical limestones and deeper water calcareous mudstones and older rocks cut by submarine canyons. Together these sediments and rock types make up a shelf and slope type which is quite unlike that found around most other continental margins and little is known of the way this type of shelf and slope is formed.

Objectives:
1. To obtain sediment and seismic transects across the shelf to enable the development of a sedimentological and environmental framework.

2. To obtain sediment, bottom photographs and seismic data from three canyon heads on the outer shelf and upper slope.

3. To obtain sediment, bottom photographs and seismic data from the slope and proximal basin floor to enable the correlation of this analogous modern sedimentary regime with that of the Tertiary Seaspray Group in order to develop a rigorous environmental framework for the shelf and slope.

4. To obtain rock samples from the strata outcropping on the sides of canyons to assess the rate of propagation, erosion and origin of submarine canyon/channel development in slope sediments and to extend the boundaries of offshore Gippsland Basin sedimentary facies. These rock samples will also confirm the age of seismic reflectors obtained from previous surveys and constrain the tectonic evolution of the basin.

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Results

Overall the cruise was successful in meeting all the scientific objectives. We were particularly fortunate with the weather as only 31 hours was lost due to bad weather. The ship track is shown in Figure 1 and an enlargement showing station locations is shown in Figure 2.

Grabs and seismic lines normal to the shore and parallel to the shelf edge provided ample data for delineating the surficial sedimentary environments. Coring was difficult in these sediments as they were often fine sand or coarse gravel with little or no mud to enable the corer to function. In some cases the substrate was lithified. Nevertheless cores were obtained and should record the recent history of the shelf (Table 1).

Sediments recovered will allow a sedimentary facies model for the offshore Gippsland basin to be developed. Previously, little work has been done on the Gippsland shelf, and cool-water carbonate shelves of this type have received little attention in Southeast Australia and elsewhere.

The sediments recovered from the inner shelf (~0-50 m water depth) range from yellow-light brown medium- to coarse-grained shelly quartzose sands with bryozoa at most localities (stations 10-16 and 33). A sand wave-form sampled at station 5 was composed of a medium shelly hash with little terrigenous material. The clastic component of all inner shelf samples was well-sorted, and was composed of dominantly quartz with some abraded bioclastic sand. Abraded bioclasts appeared to be composed largely of molluscan fragments with some bryozoal fragments. Minor components include faecal pellets, mica, minor feldspar and carbonaceous material. Epifaunal organisms recovered from the inner shelf include *Mytilus*, *Glycimerus*, pectinids, Crustacea, Bivalvia, Gastropoda, bryozoa, echinoids, ophiurids, holothuroids, sponges, and worm tubes.

Mid shelf sediments (~50-100 m water depth) recovered were dominated by yellow-light brown medium to coarse bryozoal sands (sometimes muddy) with living bryozoal 'thickets' with turritellid gastropods in life position (stations 17-26, 38-44, and 49). Other facies included grey-green fine muddy silts and sands with fine bioclasts (stations 34 and 35). Abraded bioclasts present in mid shelf environments appear to be composed predominantly of bryozoa and molluscan fragments. Epifaunal organisms recovered from the mid-shelf include brachiopods, turritellid gastropods, sheet and stick bryozoa, starfish, Bivalvia, sponges, pectinids, and Crustacea.

Sediments from the outer shelf (~100-200 m water depth) include two facies: A) coarse bryozoal and shelly sands (stations 27, 28, 50, 55); this facies is associated with the shallower outer edges of submarine canyon heads, and; B) muddy bioclastic sands (stations 45, 47, 54) associated with the outer shelf and shelf break. Epifaunal and infaunal organisms associated with the outer shelf depositional environment include bryozoa, sponges, Bivalvia (including *Chione*), turritellid gastropods, and worm tubes.

Samples recovered from the upper continental slope (upper- to mid-bathyal environments, 200-1000 m water depth) range from greenish grey to grey fine silty muds to fine sands (stations 31, 32, 56, 57, 69, 77, 78). However, sediments associated with canyons range from yellow-brown bioclastic sands to grey bioclastic silt (stations 46, 51 and 53). Epifaunal organisms associated with the upper continental slope include abundant sponges, Crustacea, bryozoa, Bivalvia, Gastropoda, barnacles, and worm tubes.

Sediments recovered from the lower continental slope and toe of slope (lower bathyl to abyssal environments, 1000-4000 m in water depth) were dominated by brown to green-grey foraminifera-bearing silty clays and muds with occasional sand and varying amounts of fine bioclasts (stations 61, 62, 65-68, 72-76, 89, 90, 92, 95, 97, 100, 101). However, one locality (station 89), on the floor of a channel at 3,693m in Bass Canyon contained clean well-sorted medium to fine sand. Occasional intraclasts were seen in samples at stations 95 and 97. These structures were probably associated with debris flows. Bioturbation was common in many samples with abundant feeding traces (?*Thalissinoides*) and near complete homogenisation of surface sediments. Epifaunal organisms present in samples from the lower continental slope include sponges, worms, irregular echinoids, and brachiopods. Deposition in the lower continental slope and toe of slope represents largely hemipelagic deposition with turbidity current influence.

The modern sediments of the Gippsland shelf do not appear to be analogous with sediments in the underlying Seaspray Group. The underlying Seaspray Group is composed of cool-water grainstones, packstones and wackestones with very little quartz sand present (<5%). The Seaspray Group sediments appear to represent deep-water (outer shelf and slope) environments with little terrigenous input. Also, sediments in the underlying Seaspray Group that are associated with submarine canyons are dominated by carbonate-rich, bioclast-bearing wackstones and packestones, sometimes with intraclasts, and often in association with spiculites and dolomites. In contrast, the modern submarine canyons in the Gippsland Basin are dominated by fine to medium terrigenous quartz sand with mud and fine bioclasts. Slope and canyon sampling transects show a diversity of environments including debris flow in the floor of Bass Canyon with angular dolomite and intraclasts along with clean channel floor sands. The canyon heads and deep canyon floor are dominated by siliciclastic sediment. The abrupt change in depositional environments from the carbonates of the Seaspray Group to the more quartz-rich sediments of the present day is possibly associated with the ?Pleistocene to Recent uplift of the Australian Highlands. However, this is only a tentative hypothesis based on preliminary results.

The seismic records from the upper slope and canyon heads did provide information as to how the modern and buried canyons erode and fill. Reflectors show unconformities, downlap and onlap of strata. These stratigraphic relationships for the near-surface layers (0.5 s TWT) should be further enhanced with shore based processing of the digital data. Grab sampling in these canyons was relatively successful in water less than 500m but deeper than 500m the canyons become very narrow (less than 200m wide) and difficult targets for sampling. Three runs with the deep sea camera were made and bottom photographs should further characterise the sedimentary environments.

Sampling the older, and hence deeper, rocks by dredging had mixed success. This was partly due to the slope being sediment covered and partly due to the limitations of the ship being able to hold position and dredge in specific directions. Twenty four dredge sites were attempted, compared to the planned eighteen (Figure 2, Table 1).

The rocks and sediments that were recovered in deep water fall broadly into four categories: volcanics and immature volcaniclastics of the Cretaceous rift phase, mature siliciclastic sedimentary rocks deposited on the passive margin in the latest Cretaceous and Paleogene, marly calcareous sediments of the Neogene, and calcareous oozes of the Quaternary to Holocene. Nearly all dredges contained oozes, which will not be discussed further here. Most rocks are bored and manganese veneers are common.

Dredges that recovered rift-phase rocks were DR4, 13, 15, 17, 18, 19, 24 and 25. These were all south of Bass Canyon on the outer continental margin. Water depths ranged from 2000 m to 4100 m. Common lithologies are feldspathic sandstone, siltstone and mudstone (and the weathered variants, silt and clay), usually with some lithic fragments and muscovite, and occasional quartz. The sediments are carbonaceous in part and plant remains are apparent in some beds. The sediments are often thin to medium bedded, burrowed and mottled in part. Load casts are present in DR18, and ripple marks in DR19. The easternmost dredges, on a rifted block elongated northwest (DR 7, 24 and 25), contain basalt, breccia, and volcaniclastic sandstone. These rocks were probably deposited in the rift involving eastern Australia, Lord Howe Rise, and the Gippsland Basin, and could be of Early or Late Cretaceous age. They are lithologically similar to the Strzelecki Group, but could possibly be considerably younger. Palynology of the less altered carbonaceous mudstone may give age control. The block, and several canyons, lie in the principal fault and fold direction in the Latrobe Group, caused by basin forming structures.

Mature siliciclastic sediments were recovered in DR5, 8, 10, 11, 12, 14, 21, 22 and 23. These rocks were recovered well landward from the continent-ocean boundary: in the tributary canyons of Bass Canyon, in the northern slope of Bass Canyon, and in the southerly trending canyon south of Bass Canyon. Water depths ranged from 1500 m to 3600 m. Their easternmost or lowest extent, from seismic and this dredge information, forms a horseshoe along the northern and western slopes of the Bass Canyon, thence swinging southeast to include DR14. Common lithologies are quartzose sandstone, siltstone and mudstone (and weathered silt and clay), with some lithic grains, feldspar and muscovite. Occasional beds contain environmental indicators such as cross-lamination, dolomitisation, ferruginous nodules, animal tracks, burrows and mottling. They are assumed to be part of the Latrobe Group of Palaeogene age. Palynology may give some age control.

Cruise Narrative

Days 1 and 2

We departed Hobart at 1000 hours and after some initial problems with the ship's gyro we steamed to collect a bathymetric transect along the upper slope on our way north. Early on day 2 we streamed 6,200m of wire from the main winch to stretch and relay the 2,000m of new wire spliced below the old wire. After lunch we deployed the sparker for testing prior to seismic line 1. Initially the circuit breakers could not handle the power surge, however the ship's electrician and David Mitchell ran a power line to the main circuit breaker and the sparker was able to fire at one second intervals. A 30amp circuit breaker would be required for the sparker to fire at a faster rate. Seismic lines 1-5 in canyon head A

(Flinders Canyon) were completed before winds of 32kts cancelled the planned sampling program and we steamed for the deeper water dredge sites.

Days 3 and 4

The performance of the vessel was encouraging in dredging in moderately difficult conditions in deep water. The meter wheel for the main winch was incorrectly calibrated for the first eight dredge sites, as was discovered later when running a deep piston core at station 61. It had been reading nearly 15% more wire out than was actually the case. As we were using about 15% as a safety margin to ensure the dredge was on the bottom, this probably explained the lack of success in the first three dredges in that they scarcely touched bottom! The fourth dredge in 3,500m of water and the fifth were successful. Returning to canyon head A we completed 5 grabs and 3 piston cores. The piston corer worked well considering the sandy and rocky substrate. One 2.4m core was obtained along with smaller samples (Table 1). It proved difficult to sample small targets as the ship could not stay in position above narrow (200-400m wide) canyons. Seismic lines 6-13 were collected in canyon head B (Bass Canyon) overnight.

Days 5 and 6

Completed seismic line 14 in to Ninety Mile beach and returned along the line grab sampling every 4nm and coring every third station. Weather prevented further sampling after station 25 so seismic lines 15 to 19 were completed. They covered the western head and tributary canyons of the large Bass Canyon system and showed details of buried channels and previous erosion surfaces. Four grab stations were completed based on this seismic before a squall hit and operations were suspended for 2.5 hours as we transited to a shallow dredge site identified on the seismic. This dredge was successful in obtaining outcrop of younger strata. With weather moderating two more grabs were completed before line 20 was commenced in the evening.

Days 7 and 8

Started seismic line 21, the northern line in to Ninety Mile beach. Sixteen stations were completed on the way back along this line, including 15 grabs, 5 piston cores and one dredge. All sampling was successful except for one piston core. In the evening began seismic line 22 parallel to the shelf break and along the mid shelf to pick up buried canyons and river channels. This took us back to canyon head A where we took five grabs and two piston cores. A successful camera run was also made in this canyon. Seismic line 23 to the north linked other upper slope lines and took us to locations for four more grabs and three piston cores. Deployed seismic again for line 24 to take us to Blackback Canyon for a camera run. Unfortunately the pinger did not function and the station was abandoned so we did a bathymetric transit to dredge sites down canyon.

Days 9 and 10

Two dredges (one successful) on the south side of the main canyon were followed by two successful grabs and two successful cores in water depths of over 3,000m in the floor of the main canyon. We discovered with the first core that the wire out calibration for the main winch was on the wrong setting leading to a 15% error. This was immediately corrected. Two dredges on the north side were both successful. These were followed by two more grabs and cores in the western floor of the canyon along with a deep water camera run across the canyon floor in 2,600m of water. The bottom return from the pinger was weak but sufficient to fly the camera. We then made three more successful cores and grabs up the western slope which is characterised by ridges and runnels before another, this time successful, camera run in Blackback Canyon.

Days 11 and 12

A successful dredge in a deep narrow canyon down slope from canyon head A retrieved deep water barnacles as well as Tertiary rocks. We then completed a transect of eight stations from the floor of Bass Canyon up the relatively smooth and gentle southern continental slope providing a good comparison to the western slope transect. Sampling was successful including a 5.25m long core. This sampling was followed by a bathymetric survey on our way east to dredge sites at the base of the continental slope where three successful dredge sites were completed. There were intermittent problems with the tensiometer for the main winch not recording. Allan Poole tried to rectify the problem but it persisted on and off throughout the cruise.

Days 13 and 14

Six dredges were completed during which time 7 hours were lost when operations were suspended due to bad weather. Three deep water grabs were taken in the canyon floor and one of these sampled clean, medium-grained sand in 3,693m of water located in a narrow,but shallow, channel in the floor of the canyon. Unfortunately the piston corer was unsuccessful in these water depths as it pre-triggered in the water column. Increasing oscillations on the tensiometer as the wire was played out beyond 2,000m appeared to be the cause. It may be that the quality of the main wire is too elastic for this type of coring in deep water. A camera run was made on the canyon floor in 3,719m of water. The pinger worked well but the tensiometer was down.

Days 15 and 16

Two dredges were followed by two successful grabs in over 3,900m of water enabling sampling of the mouth of Bass Canyon for the first time and the recovery of debris flow sediments at the surface. A further two dredges on the south side of the canyon followed by two grabs and a piston core on the north side were completed before operations were suspended because of wind gusting up to 50kts. Some bathymetric lines were run on the mid slope where data were lacking.

Days 17 and 18

Departed the survey area at 6am for the transit to Sydney with operations still suspended due to weather.

The Scientific Party stood watch from the time of departure from Hobart to the evening prior to arrival in Sydney.

SCIENTIFIC WATCH PERSONNEL
0000-0400, 1200-1600 Hill, Hughes, Daniels
0400-0800, 1600-2000 Exon, Gallagher, Smith
0800-1200, 2000-2400 Keene, Rae, Holdgate
All data and events were recorded in the Underway Geophysical Log and in the Station Log sheets. Bathymetric, navigation, TSG data were collected digitally and bathymetry and sampling events were annotated on the second printer. Seismic data were collected in analogue and digital format using an EPC recorder and a digital recorder provided by AGSO. Black and white and colour transparency film was used in the deep-sea camera.

Time allocation:

Transit to and from survey area	54.5 hours
Grab and core stations and transit between	122 hours
Bottom photography	9 hours
Dredge stations and transit between	117 hours
Seismic profiling	72.5 hours
Operations suspended due to weather	31 hours

Total: 16 days 22 hours

Summary of work completed

Table 1 lists the operations carried out at all 101 Stations. It also has their locations, water depth and results.

A Smith-McIntyre grab sampler was used for surface samples. It was deployed from the hydro-winch and was very successful. The grab was used at 73 stations on cruise with excellent recovery in all water depths (19.5-3910 m). The grab sampler was used 77 times with 5 unsuccessful grabs (6%), and of the 73 stations sampled, only 2 stations were unsuccessful (2%). Of the unsuccessful stations one station was aborted due to ships drift (station 9), and on the other station (station 52) the Smith-McIntyre grab was unable to recover sediment, possibly due to steep terrain or hard substrate. The high success rate of the grab sampler was probably helped by the nature of the sediments sampled, as no lithified substrates were collected.

Data description and sample collection from the Smith-McIntyre grab sampler was excellent. Of the 71 successful stations the amount of sediment recovered was good (greater than 1/3 full), with only one station reporting low yield (station 44). The grab sampler preserved the sea-bed surface faunas and sedimentary structures very well. Once the grab sampler was brought aboard the ship after sampling, the grab sampler's water exhaust flap was removed, a description of the sea-bed surface was taken and a shallow core (~50 mm) and surface (~5 mm) samples were taken of sea-bed sediments and faunas.

The exhaust flap was then replaced and bulk samples were taken by releasing sediment from the jaws of the sampler. By this method, very well preserved samples and descriptions were taken of both very shallow (0-5 mm and 0-50 mm) and shallow (0-15 cm) sea-bed sediments and faunas. In addition, staining of samples by using rose-bengal stain allowed living and remanie microfossil faunas to be distinguished.

Two piston corers were used, with barrel lengths of 3, 4.5 and 6m and approximately 300kg weight stand. The internal diameter of the core liners were 57 and 70 mm. Coring was more successful on the slope where sediments were generally muddier. It was difficult for the ship to hold station to enable sampling of the floor of narrow canyons.

A Benthos deep-sea camera was used for 5 bottom photo runs. It was towed from the main winch and flown using a Benthos pinger.

A sparker sound source was deployed from the port side and a hydrophone eel from the davit on the starboard side to collect seismic reflection data. The profiling was done at 5-6 knots and 24 Lines were completed over a distance of 720 km (Table 2).

Dredging was done from the main winch with a chain bag box dredge, a smaller solid box dredge and a pipe dredge. For the early stations we used conventional chain bag dredges, but experience showed that the dominantly soft sediments on the margin were being chewed up in the chain bag, giving very poor recovery. The bridles of the new chain bag dredges proved to be poorly made so that they both broke, leading to zero or little recovery at two stations. Fortunately, the safety strap worked in each case, the dredge coming back on deck tail first or sideways. The ship's engineering group re-welded the bridles successfully. The weak link broke at one station where the bridle also gave way (DR 14).

For later dredges (DR 18 onwards) a simple Diamantina-type box dredge was generally used, with better results. In all, we regard 15 dredge hauls as successful in that they recovered reasonable quantities of older rocks, three as moderately successful with some older rocks, and seven as unsuccessful with no recovery or only younger oozes.

When possible, and during weather delays, bathymetric surveys were carried out between stations. This was important on the upper slope where there is a data gap between the National Mapping 0-300m data and the swath mapping below 2,000m collected by RV Melville in 1997.

Sampling and Curating

Grab Samples

Sample splits were taken for Melbourne University and Sydney University. In addition Dr Gallagher stained surface samples with Rose Bengal for living foraminifers. Surface samples were also taken for Mr Won Je Lee, a PhD student in Biological Sciences at The University of Sydney, to study heterotrophic flagellates (Protista).

Core Samples

Cores were logged for magnetic susceptibility onboard by Dr Hughes using an instrument provided by Dr Harris from the Antarctic CRC. Cores will be split, logged and curated at Sydney University.

Dredge Samples

Samples were sorted and labelled onboard. Pipe dredge sediment samples were also collected. Rock samples will be curated at AGSO.

Bottom Photography

Both black and white (Ilford HP5 400 ASA) and colour slide film (Kodak Ektachrome 100PLUS Professional) was used and will be developed at The University of Sydney and curated there.

Seismic Data

Five rolls of EPC recorder seismic profiles were logged using a 0.5 second sweep (firing rate) and will be curated at The University of Melbourne. Navigation data for the seismic was recorded using Sydney University's GPS and a PC laptop computer. Copies of one minute fixes, course and speed are curated at Sydney University and Melbourne University.

The single channel seismic data was also recorded digitally from the start of Line 14 to the end of Line 24. Six Exabyte tapes in SEG-Y format were recorded and they are curated at the University of Melbourne and copies at The University of Sydney and AGSO.

Bathymetry

Unedited merged one minute navigation and PDR data was provided on Exabyte tape to Drs Keene and Hill. Dr Hill also received 5 second data on tape.

Edited navigation and PDR data to be sent FTP to Dr Jock Keene, Dr Stephen Gallagher and Dr Peter Hill post-cruise.

TSG

Thermo-salinograph data was recorded in the Underway Log once the TSG was online. TSG data is requested to be sent FTP to Dr Gallagher post-cruise.

Personnel

Scientific Party

Assoc. Prof. Jock Keene, School of Geosciences, The University of Sydney
Dr Michael Hughes, School of Geosciences, The University of Sydney
Mr David Mitchell, Marine Technician, School of Geosciences, The University of Sydney
Ms Karen Rae, Student, School of Geosciences, The University of Sydney
Dr Stephen Gallagher, School of Earth Science, University of Melbourne
Dr Guy Holdgate, School of Earth Science, University of Melbourne
Mr Jim Daniels, Postgraduate student, School of Earth Science, University of Melbourne
Mr Andrew Smith, Postgrad. student, School of Earth Science, University of Melbourne
Dr Neville Exon, AGSO, Canberra
Dr Peter Hill, AGSO, Canberra

We would like to thank the help given by the Master, the ship's crew and the CSIRO support staff which enabled the cruise to be both enjoyable and a success.

ORV Support

Bob Beattie, CSIRO Marine Research (cruise manager and computing)
Alan Poole, CSIRO Marine Research (electronics)

Ship's Crew

Master: Dick Dougal
1 Mate: Arthur Staron
2 Mate: John Lynch
Ch Engineer: John Morton
1 Engineer: Greg Pearce
Electrical Engineer: Andrew McLagan
Greaser: Wayne Browning
Bosun: Jannick Hansen
AB: Peter Genge
AB: Jerry O'Halloran
AB: Bill Hughes
Ch/Steward: Ron Culliney
Ch/Cook: Gary Hall
2/Cook: Tom Condon

Table 1: FR11/98 STATION DATA OFFSHORE GIPPSLAND BASIN

Station	Sample	Location		Water Depth(s)	
Number	Number	Latitude S	Longitude E	(metres)	Results
1	DR01	39 37.10	149 23.30	3900-3550	no recovery
2	DR02	39 27.02	149 25.82	3400-3200	no recovery
3	DR03	39 27.42	149 24.86	3400-3200	no recovery
3	DR04	39 17.63	149 24.02	3500-3100	successful,rocks
4	DR05	39 11.15	148 55.33	1750-1520	successful, rocks
5	MG01	39 20.00	148 30.28	46.5	shell hash, medium sand
5	PC01	39 19.97	148 30.20	47.5	sand, 0.8m
6	MG02	39 21.25	148 36.25	112	muddy, coars shelly sand
7	MG03	39 21.70	148 38.43	308.5	coarse sand
7	PC02	39 21.83	148 38.16	224	limestone rock
8	MG04	39 19.15	148 38.85	324	sandy mud
8	PC03	39 19.11	148 38.59	240	sandy mud, 2.4m
9	MG05	39 12.79	148 50.16	1440	unsuccessful
10	MG06	38 17.19	147 21.11	19.5	medium bioclastic quartz sand
11	MG07	38 20.62	147 21.86	25	medium bioclastic quartz sand
12	MG08	38 23.65	147 22.47	34	medium bioclastic quartz sand
12	PC04	38 23.78	147 22.40	34.5	muddy sand-shell hash 1.63m
13	MG09	38 24.26	147 25.59	39	medium bioclastic sand
14	MG10	38 24.59	147 29.52	42.5	coarse bioclastic sand
15	MG11	38 24.83	147 30.93	44	coarse shelly quartz sand
15	PC05	38 24.88	147 30.97	44	muddy sand 2.7m
16	MG12	38 25.56	147 35.46	48.5	coarse shelly sand
17	MG13	38 25.92	147 40.15	51.5	muddy coarse sand
18	MG14	38 28.37	147 43.36	55	bioclastic sand
18	PC06	38 28.43	147 43.40	55	2.9m
19	MG15	38 31.41	147 47.35	62	muddy bioclastic sand
20	MG16	38 33.18	147 52.24	66	muddy coarse sand
21	MG17	38 33.11	147 59.28	70	medium shelly sand
21	PC07	38 33.11	147 59.28	70	coarses sand-rock 1.1m
22	MG18	38 33.98	148 04.02	76	med coarse bioclastic sand
23	MG19	38 34.81	148 08.70	78	med coarse bioclastic sand
24	MG20	38 35.63	148 13.94	79	med coarse bioclastic sand
25	MG21	38 36.18	148 17.39	84	med coarse bioclastic sand
25	PC08	38 36.68	148 17.08	86	shelly sand 1.25m
26	MG22	38 24.09	148 21.66	88	muddy coarse sand
27	MG23	38 26.84	148 25.11	134	coarse bioclastic quartz sand
28	MG24	38 26.97	148 25.25	145	coarse bioclastic sand
29	MG25	38 28.87	148 27.20	232	not successful
29	MG25B	38 28.63	148 27.31	242	med bioclastic sand
30	DR06	38 30.97	148 34.48	632-737	successful, rocks
31	MG26	38 31.81	148 31.43	471	sandy marl
32	MG27	38 29.80	148 28.96	210	calcareous mud

33	**MG28**	37 59.68	147 45.69	24.5	coarse shelly sand
34	**MG29**	38 01.67	147 50.75	43.5	muddy silt
35	**MG30**	38 03.48	147 55.02	48.5	fine sandy silt
35	**PC09**	38 03.33	147 55.32	48.5	unsuccessful
36	**MG31**	38 05.36	147 59.60	52.5	muddy shelly fine sand
37	**MG32**	38 07.34	148 03.85	55	muddy sand
38	**MG 33**	38 07.86	148 06.77	56.5	coarse shelly sand
39	**MG34**	38 10.23	148 10.86	58	muddy shell hash
39	**PC10**	38 10.05	148 10.97	58	successful, 1.5m
40	**MG35**	38 11.64	148 15.14	60	coarse shelly sand
41	**MG36**	38 13.43	148 19.00	63	coarse shelly sand
42	**MG37**	38 13.95	148 23.57	66.5	muddy coarse sand
42	**PC11**	38 13.85	148 23.59	66.5	successful, 1.7m
43	**MG38**	38 14.69	148 27.05	77	shelly sand
43	**PC12**	38 14.58	148 27.05	76.5	successful, 2.24m
44	**MG39**	38 15.59	148 30.61	97	coarse bioclastic sand
45	**MG40**	38 16.15	148 33.03	122	muddy coarse bio sand
45	**PC13A**	38 16.95	148 33.16	123	unsuccessful
45	**PC13B**	38 16.86	148 33.17	122	successful, 2.9m
46	**MG41**	38 17.22	148 38.13	263	bioclastic fine sand
47	**MG42**	38 18.24	148 41.46	170	muddy fine sand
48	**DRO7**	38 17.38	148 36.53	277-284	very coarse sand
49	**MG43**	38 45.25	148 17.83	95	fine shelly sand
50	**MG44**	38 48.45	148 17.80	130.5	v coars shelly sand
51	**MG45**	38 48.13	148 22.20	467	calcareous silt
51	**PC14**	38 48.12	148 22.07	462.5	successful, 1.02m
52	**MG46A**	38 48.18	148 23.39	650	unsuccessful
52	**MG46B**	38 48.17	148 23.45	553	unsuccessful
52	**PC15**	38 48.17	148 23.23	513	successful, 1.0m
53	**MG47**	38 43.81	148 22.59	319	med fine shelly sand
53	**BP1**	38 44.34	148 21.32	204-287	successful
54	**MG48**	38 37.29	148 20.97	120.5	calcarous mud
55	**MG49**	38 38.45	148 23.44	190	bioclastic sand
55	**PC16**	38 38 70	148 23.54	196	successful, 1.85m
56	**MG50A**	38 38.81	148 24.54	173	unsuccessful
56	**MG50B**	38 39.00	148 24.70	209	shelly muddy sand
56	**PC17**	38 38.83	148 24.42	190	successful, 2.01m
57	**MG51**	38 39.48	148 26.09	276	muddy fine sand
57	**PC18**	38 39.33	148 25.99	255	successful, 1.88m
58	**BP2**	38 30.93	148 28.67	335-337	no photographs
59	**DR08**	38 47.40	149.01.00	2800-2600	successful, rocks
60	**DR09**	38 50.30	149 07.50	3030-2700	unsuccessful
61	**MG52**	38 48.44	149 08.63	3114	muddy silt
61	**PC19**	38 48.00	149 09.15	3137	successful 2.1m
62	**MG53**	38 43.28	149 14.59	3340	silty mud
62	**PC20**	38 43.14	149 14.75	3344	successful, 3.98m
63	**DR10**	38 40.04	149 19.08	3100-2700	successful, rocks

64	**DR11**	38 37.95	149 19.50	2700-2550	successful, rocks
65	**MG54**	38 40.05	148 59.28	2980	fine sandy mud
65	**PC21**	38 39.01	148 59.05	2975	0.9m disturbed core
66	**MG55**	38 33.84	148 48.81	2641	silty mud
66	**PC22**	38 33.16	148 49.09	2627	0.37m
66	**BP3**	38 32.29	148 47.50	2577-2609	successful
67	**MG56**	38 32.94	148 39.87	1802	calcareous mud
67	**PC23**	38 32.94	148 39.57	1814	successful, 2.47m
68	**MG57**	38 33.08	148 37.96	1137	sandy mud
68	**PC24**	38 33.37	148 37.27	1118	successful, 0.88m
69	**MG58**	38 33.00	148 34.87	603	calcareous silty mud
69	**PC25**	38 33.03	148 34.97	590	successful, 2.37m
70	**BP4**	38 31.76	148 28.04	346-260	successful
71	**DR12**	38 47.00	148 34.03	1725-1600	successful, rocks
72	**MG59**	38 42.91	148 47.93	2484	silty mud
72	**PC26**	38 42.86	148 48.07	2485	successful, 2.06m
73	**MG60**	38 47.81	148 47.84	2352	silty mud
73	**PC27**	38 47.59	148 47.59	2366	successful, 1.2m
74	**MG61**	38 49.64	148 43.68	2161	silty mud
74	**PC28**	38 50.20	148 43.48	2108	successful, 5.25m
75	**MG62**	38 52.16	148 40.60	1745	silty mud
75	**PC29**	38 52.71	148 40.45	1627	successful, 4.51m
76	**MG63**	38 54.02	148 37.97	1181	silty mud
76	**PC30**	38 54.58	148 38.36	1163	successful, 4.4m
77	**MG64**	38 55.58	148 35.06	577	muddy sand
77	**PC31**	38 56.14	148 35.36	548	successful, 0.65m
78	**MG65**	38 57.15	148 32.00	300	fine med sandy mud
79	**MG66**	38 58.05	148 30.06	132	muddy coarse sand
80	**DR13**	39 13.09	149 30.01	2040-3440	successful, rocks
81	**DR14**	39 05 .40	149 28.30	3100-2800	minor rocks
82	**DR15**	38 59.17	149 42.09	3700-3400	successful, minor rocks
83	**DR16**	38 57.10	149 52.40	3800-3220	unsuccessful
84	**DR17**	38 57.05	149 52.60	3800-3700	successful, rocks
85	**DR18**	38 51.80	149 35.80	3800-3700	successful, rocks
86	**DR19**	38 52.00	149 34.96	3375-2900	successful, rocks
87	**DR20**	38 45.20	149 36.80	3150-2610	unsuccessful
88	**DR21**	38 45.40	149 36.80	3200-2800	successful, rocks
89	**MG67**	38 47.67	149 29.51	3693	medium fine sand
89	**PC32**	38 48.08	149 28.55	3692	unsuccessful
90	**MG68**	38 46.63	149 28.52	3655	mud
91	**PC33**	38 46.18	149 28.42	3642	unsuccessful
91	**BP5**	38 47.58	149 29.36	3719-3702	successful
92	**MG69**	38 48.67	149 28.92	3692	mud with intraclasts
92	**PC34**	38 48.93	149 29.94	3695	unsuccessful
93	**DR22**	38 45.90	149 32.30	3500-3160	unsuccessful
94	**DR23**	38 47.40	149 37.50	3600-3100	successful, rocks
95	**MG70**	38 51.45	149 41.45	3910	mud with intraclasts

96	**PC35**	38 50.67	149 42.20	3921	unsuccessful
97	**MG71**	38 50.43	149 41.81	3931	mud wiht rock, intraclasts
98	**DR24**	38 53.20	149 45.15	3600-3300	successful, rocks
99	**DR25**	38 57.30	149 53.70	4115-3300	successful, rocks
100	**MG72**	38 37.09	149 33.01	1996	shelly mud
101	**MG73**	38 28.06	149 34.65	1469	muddy shelly sand
101	**PC36**	38 27.68	149 35.70	1446	successful, 1.5m

DR = dredge, **PC** = piston core, **MG** = Smith-McIntyre grab, **BP** = bottom photography

Table 2: FR11/98 SEISMIC DATA OFFSHORE GIPPSLAND BASIN

LINE No.	Julian Day	Latitude S	Longitude E	Distance km	Start Time	Finish Time	
1	262	148 35 09	39 30 97		start line @ 0530		
1	262	148 30 08	39 19 35	19.8km		finish line @ 0740	
2	262	148 30 08	39 19 35		start line @ 0740		
2	262	148 35 08	39 14 98	11.2		finish line @ 0857	
3	262	148 35 08	39 14 98		start line @ 0857		
3	262	148 41 48	39 22 43	16.4		finish line @ 1050	
4	262	148 41 48	39 22 43		start line @ 1050		
4	262	148 30 39	39 20 63	17.4		finish line @ 1320	
5	262	148 30 39	39 20 63		start line @ 1320		
5	262	148 45 99	39 32 45	33.2		finish line @ 1630	
6	264	148 41 86	39 12 95		start line @ 0440		
6	264	148 36 23	39 12 03	21.5		finish line @ 0540	
7	264	148 36 23	39 12 03		start line @ 0540		
7	264	148 24 88	39 49 78	55.6		finish line @ 0954	
8	264	148 24 88	39 49 78		start line @ 0954		
8	264	148 17 88	38 49 94	10		finish line @ 1055	
9	264	148 17 88	38 49 94		start line @ 1055		
9	264	148 17 89	38 45 31	9.2		finish line @ 1200	
10	264	148 17 89	38 45 31		start line @ 1200		
10	264	148 24 73	38 45 11	10		finish line @ 1320	
11	264	148 24 73	38 45 11		start line @ 1320		
11	264	148 25 00	38 48 04	5.6		finish line @ 1353	
12	264	148 25 00	38 48 04		start line @ 1353		
12	264	148 17 90	38 47 92	10.6		finish line @ 1456	
13	264	148 17 90	38 47 92		start line @ 1456		
13	264	148 26 02	38 39 24	20		finish line @ 1710	
14	264	148 26 02	38 39 24		start line @ 1710		
14	265	147 21 17	38 17 50	118.6		finish line @ 0332	
15	265	148 17 14	38 36 50		start line @ 1354		
15	265	148 36 62	38 11 56	54		finish line @ 2010	
16	265	148 36 62	38 11 56		start line @ 2010		
16	265	148 41 49	38 19 31	18.2		finish line @ 2146	
17	265	148 41 49	38 19 31		start line @ 2146		
17	265	148 40 33	38 22 66	7.5		finish line @ 2221	
18	265	148 40 33	38 22 66		start line @ 2221		
18	266	148 33 10	38 32 81	28.4		finish line @ 0035	
19	266	148 33 10	38 32 81		start line @ 0035		
19	266	148 21 79	38 24 07	23		finish line @ 0308	
20	266	148 29 40	38 29 57		start line @ 1027		
20	266	148 41 52	38 18 17	26.4		finish line @ 1314	
21	266	148 41 52	38 18 17		start line @ 1314		
21	267	147 46 37	38 00 04	90		finish line @ 2240	
22	267	148 34 45	38 00 25		start line @ 1110		
22	267	147 55 94	38 32 68	81		finish line @ 1904	
23	268	148 19 37	38 44 64		start line @ 0320		
23	268	148 20 97	38 37 29	14.2		finish line @ 0450	
24	268	148 26 02	38 39 33		start line @ 0831		
24	268	148 28 97	38 29 94	18.4		finish line @ 1020	

Figure 1. **Fr1198 Cruise Track**

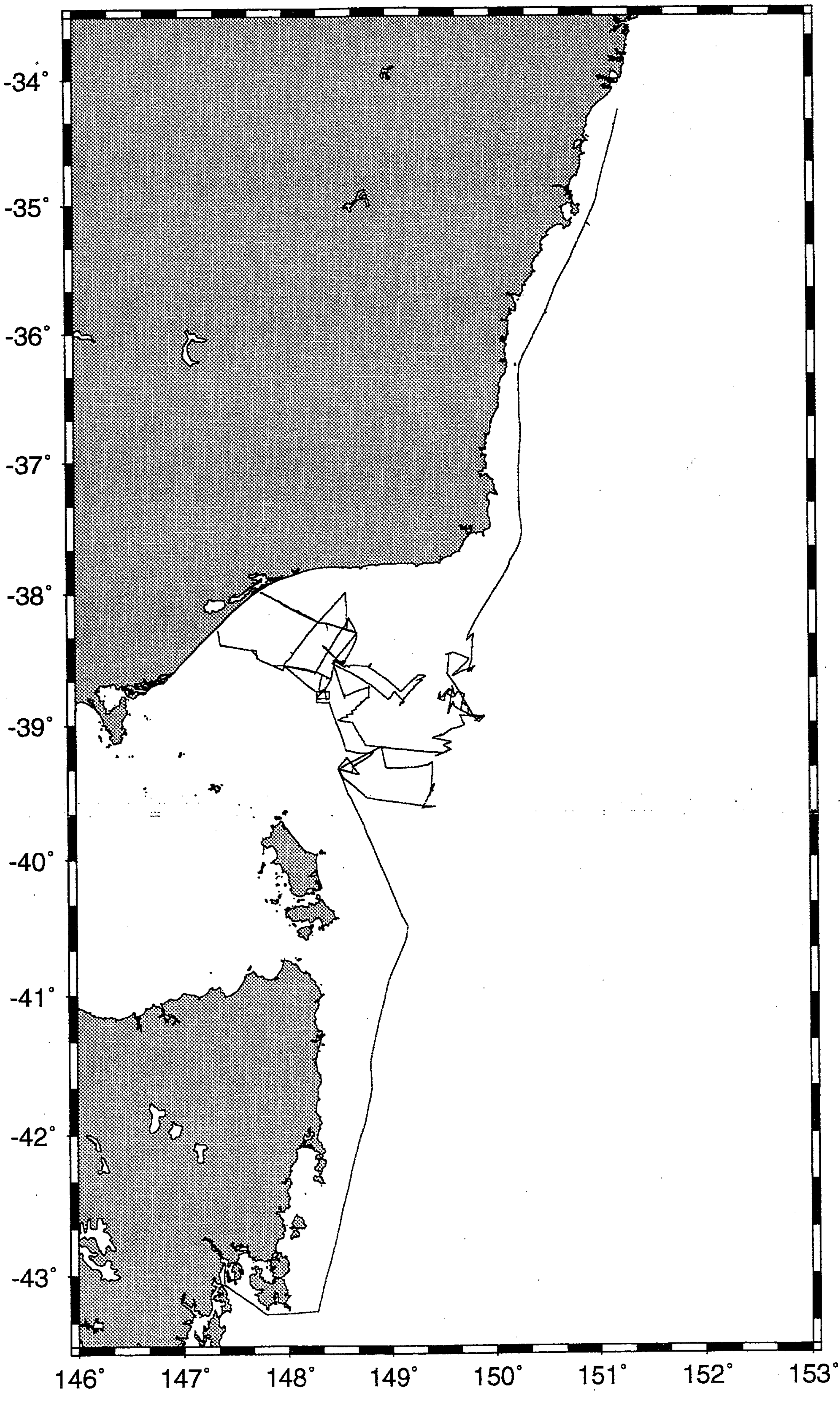

Figure 2. **Fr1198 Cruise Track**