FRANKLIN

National Facility
Oceanographic Research Vessel

Warm seeps at the shelf margin of the Great Australian Bight: Search for indications of a new analogue for ore-forming environments.

CRUISE SUMMARY

RV FRANKLIN

FR 01/01

Depart Fremantle 0735 hrs, Wednesday 31 January 2001 (Western time)
Arrive Adelaide 1005 hrs, Thursday 15 February 2001 (Central summer time)

Principal Investigators

Dr Raymond A Binns
Chief Research Scientist
CSIRO Exploration and Mining
PO Box 136
North Ryde NSW 1670

Dr Tim McConachy, CSIRO Exploration and Mining, Sydney, (unable to join cruise)

For Further information contact:

Operations Officer
CSIRO Marine Research
GPO Box 1538, Hobart TAS 7001

Phone: (03) 6232 5222
Fax: (03) 6232 5028

CRUISE SUMMARY

RV FRANKLIN

FR01/2001
(GABSEEPS Cruise)

Title

Warm seeps at the shelf margin of the Great Australian Bight: Search for indications of a new analogue for ore-forming environments.

Itinerary

Departed Fremantle 0735 hrs, Wednesday 31 January 2001 (Western time)
Arrived Adelaide 1005 hrs, Thursday 15 February 2001 (Central summer time)

Principal Investigators

Dr Ramond A Binns
Chief Research Scientist
CSIRO Exploration and Mining
PO Box 136
North Ryde NSW 1670
Tel: 02-9490 8741 (H) 02-4883 6069 Fax: 02-9490 8921
r.binns@syd.dem.csiro.au

Dr Tim McConachy*, CSIRO Exploration and Mining, Sydney
(* unable to join cruise)

Scientific Objectives

Our prime objective was to test the hypothesis that hydrothermal "warm seeps" exist along the edge of the Great Australian Bight, venting basin brines or fluids rising up faults from basement. We anticipated that such sites might host mineral-rich deposits, or that the vent fluids might have compositions implying operation of subsurface ore-forming processes. Such a discovery would imply a unique modern analogue for "Mississippi Valley type" lead zinc mineralisation, and possibly also for a form of uranium mineralisation.

The second objective was to maximise value of data and samples collected during the cruise, especially in terms of contributing to the national petroleum prospectivity and biodiversity databases.

Cruise Objectives

The main aim, using existing reflection seismic profiles as a guide to suitable structural sites, was to locate, photograph and sample "warm seeps" at three transects across the outer shelf margin of the Great Australian Bight:

- Recherche Transect
- Eucla Canyon Transect
- Nullarbor Canyon Transect

Methods to be used included precision echo sounding to define targets, testing for proximity to venting with CTD-transmissometer hydrocasts (including salinity and dissolved oxygen sensing), collecting profiles of near-bottom seawater for on-board analysis of methane content, sediment sampling at prospective sites by tube and box corer and by grab, bottom-tow video photography at appropriate sites looking first for rising abundance of macrofauna expected around vent sites or seeps, then homing in on these, and finally sampling prospective sites by precision dredging and sediment coring.

Cruise Track

From Fremantle we sailed south round Cape Leeuwin and past Esperance to enter the Great Australian Bight. The three study areas or transects were addressed in turn from west to east. A minor amount of back-tracking, partly dictated by weather, occurred in the third transect area near the Nullarbor submarine canyon. On completion of operations at this transect we continued east past the Neptune Islands and travelled up St Vincents Gulf to Adelaide.

The cruise track and study areas are indicated in Fig. 1, and a list of operations with their locations is given in the Appendix.

Results

Although the GABSEPS Cruise was a technical success, insofar as we visited all three transect areas and successfully conducted the planned operations at each, we found no evidence of active or fossil warm seeps. Our results suggest that the structural features examined are all relatively old, and that since their formation they have been modified by submarine erosion. Thereby we have discounted what was known from the beginning to be a concept that carried a high risk of proving untrue, but which nevertheless required testing.

Sediment cores smelling of H_2S were taken at a fault site south of drilling operations during Ocean Drilling Program Leg 182, which found evidence for subsurface brines rich in H_2S and methane. Athough this suggests these brines are being expelled at the toe of a Pleistocene carbonate wedge, no signs of any resultant mineral deposit were encountered.

We returned with an abundance of new geological and biological information on the deeper sea floor of the Great Australian Bight and especially of the GAB Marine Park. We discovered a new site of manganese crusts on a seamount, and collected photographs and some samples of hitherto unknown seafloor biota at this site. Further investigations were undertaken in the shallower "holes" of the Nullarbor submarine canyon where, however, no evidence was found of the anticipated brine pools. Extensive collections were taken of near-surface zooplankton during the cruise. Despite reaching a negative conclusion in regard to our prime objective, these results received widespread media attention that reflected favourably on scientific activities of the ORV National Facility. We anticipate that a number of scientific publications will arise.

Cruise Narrative

Tuesday January 30, 2001

An evening tour of the ship and discussion of cruise objectives was held for representatives of the minerals industry and Perth staff from CSIRO.

Wednesday January 31

Cast off at 07:35 in perfect weather, and rounded Rottnest Island in calm sea, with a light northwesterly breeze. About 2 pm, the weather changed to southwest and we commenced beating into a rising swell. Installation of equipment and securing it for heavy weather continued during the day. Ship pitching heavily during the night.

Thursday February 1

Turned off Cape Leeuwin at 02:30, when pitching motion changed to rolls, sometimes severe, in 6m SW swell and strong wind. Passed Point D'Entrecasteaux at 11:30, after which conditions improved. Scientists meeting held at 13:00 (held daily throughout the cruise), continuing our discussion of objectives and operational procedures. Further unpacking and equipment preparation conducted during transit.

Friday February 2

The transit was slowed to 10 kts overnight by an easterly set, requiring the first daylight Bongo deployment to be brought forward to southwest of Esperance. Several dummy echosounder traverses along the track were conducted to familiarise watch members with record-keeping procedures and the trackPlot navigation system.

Bongo Net Haul GBN-01 commenced at 15:00 along the 100m isobath south of Temptation Island, in the Archipelago of the Recherche south of Esperance. Three hauls were conducted, each recovering a significant load of small salps and gelatinous zooplankton. Following this, the transit to our Recherche Transect was resumed.

Saturday February 3

Arrived in fine weather over the Recherche Basin at 06:00 and conducted **Camera/Video Leak Test #1**. The wire-out and tension meters on the main sheave failed to record, so we deployed the system to about 550m and recovered it without marking the cable as intended. On recovery the Benthos camera and strobe were dry, but the video housing had leaked as the O-ring had not been properly seated. On completion, the A-frame was climbed to rectify a fault in the GO block wiring.

At the same station, **CTD-Hydrocast GH-01** was a test of the Niskin bottles. The rosette was lowered to the salinity minimum near 1000m and all bottles fired. Subsequent salinity measurements confirmed that all bottles were sound. Three samples were used to test methane analysis protocols.

Camera/Video Leak Test #2 was then conducted at the same place. With tension and cable readout working, the sled was lowered to 100 and 200m where the cable was marked to assist later corer operations using the unmetered block, then to 500m and recovered. All pressure housings were sound this time. Comparison of the sled CTD pressure with nominal wire-out readings indicated the latter underestimated the correct figure by 13%, the same figure as was experienced on FR-03/00. After several more operations confirmed this figure, the calibration was changed accordingly.

Echosounder Traverse GES-01 commenced at 09:00, being a box designed to locate and establish the trend of the fault zone at our first hydrothermal target, ***Station Recherche A***. The fault was located 0.8 nm south of its apparent position on seismic profile N403-1 (shotpoint 1160) and was crossed twice, defining a trend of 084°. It appears as a V-shaped trough with a steeper 150 m scarp on the northern side.

Sediment Core GS-01 was attempted with the large AGSO corer, to obtain a background reference sample and stratigraphic section at a position 3 nm north of the fault zone. Because this used an unmetered block, a pinger was attached at the previously marked "100m" point above the corer (actually nearer 113m) . In this water depth (3733 m), early crossovers of direct and reflected pinger signals could not be seen, but the corer was correctly placed on bottom by estimating pay-out rate, noting a splice at 2000m where new cable had been joined, and finally obtaining crossovers. Deployment and recovery were very efficient with the new trolley system installed on the port side of the afterdeck. On recovery, the corer contained no sample apart from a few particles of calcareous sand. However white to pale pink calcareous ooze was smeared on the outside of the pipe to about 3.5 m, with none on the weights, so the corer definitely penetrated this far. Although nothing was clearly wrong to explain the apparent washout, the blades of the core catcher were straightened, and it was decided to lightly grease the flapper valve.

Bongo Net Tow GBN-02, again involving what became the usual three hauls, was conducted after the corer, while slowly recrossing the fault trough to verify its position. Only a small recovery of zooplankton and larvae with no salps resulted.

CTD-Hydrocast GH-02 was then conducted as a reference profile and to test for hydrothermal anomalies close to bottom. No anomalies were seen on the readout. Conditions allowed an approach to 5 mab. Eleven water samples were taken on the upcast, close-spaced near bottom (at 3943 m) and then staged to 500 m depth. Subsequent methane analysis revealed no anomalies.

At dusk, **Sediment Box Core GBC-01** was taken at the foot of the fault trough. This returned with 20 cm of very cohesive, pale pinkish buff, sandy calcareous ooze. Minicore and surface samples were taken for sedimentology and geochemistry, then the remainder was sieved for biota with negligible recovery.

The small CSIRO gravity corer was deployed at the same position for **Sediment Core GS-02**, returning 21 cm of pale pink calcareous sediment. This was massive and very cohesive except for the top cm which was slightly more sloppy. Station-holding to within 80 m was performed during this and the previous operation.

Sunday February 4

These latter samples and the lack of any hydrocast anomaly indicated that no active seeps of significance occur at Recherche Station A, so the site was abandoned and **Echosounder Traverse GES-02** commenced. This involved a zig-zag crossing of a gap or offset in the major 1.5 km high scarp forming the northern border of the Recherche Basin, to test whether this might be an oblique fault. The survey established that the eastern scarp is dragged northwards into the gap in a manner consistent with dextral movement on a north to north-westerly trending oblique structure, but was insufficiently detailed to locate the latter or define targets for further study during this cruise.

The traverse ended with a triangular box around a fault cutting the entire Tertiary sequence at ***Station Recherche B*** (seismic profile JA90-16, shotpoint 3647). This fault was confirmed as a shallow trough at the foot of a south-facing scarp 60 m high (floor at 672 m), but was located 0.4 nm east of its indicated position on seismic line JA90-16. The apparent trend was 075°, although the scarp was subordinate at the eastern intersection (30 m high with foot at 655 m, 0.9 miles along the trend) and did not appear at all during the transit (1.5 miles to the west). Subsequent crossings (see GG-02) indicated, however, the trend is more easterly at shotpoint 3647.

Sediment Core GS-03, taken with the large AGSO corer, was aimed at the trough near shotpoint 3647 but hit high on the northern edge of the scarp in 620 m of water. No pinger was attached. Pullout required a relatively high tension. Both deployment and recovery with the trolley were performed without difficulty, but on recovery the pipe was bent about 3 m above the nosecone, although the ship had not moved away at pullout. An 84 cm core was recovered. The nosecone contained a 2 cm layer of lithified, almost white, chalky limestone, above which and in the core catcher was a somewhat darker unlithified but very cohesive calcareous ooze which is apparently the dominant young sediment on the northern wall of the scarp.

Because the initial crossing of the fault was on a subparallel track, a short **Echosounder Traverse GES-03** was run normal to the trend to confirm the position of the scarp. No correction was necessary.

CTD Hydrocast GH-03 was a single dip placed over the trough floor at the same site as core GS-03. This showed a somewhat anomalous profile, with a slight and broad drop in dissolved oxygen, temperature and salinity but not transmissivity about 300-350m above bottom. All signals except density (sigma-t) decreased slightly 70 m above bottom. Seven water samples were collected between 5 and 200 mab. No anomalous methane contents were measured.

Bongo Net Tow GBN-03 of three replicate hauls was conducted in the vicinity prior to positioning the ship for the next operation. Only low volumes of plankton were recovered. During the transit from this operation to the next, the scarp was recrossed southwest of the GH-03 position in a manner suggesting it bends in that direction, a possibility confirmed by later sled CTD sounding during two camera tows

Camera-Video Tow GCV-01 commenced as a slightly oblique slalom into the trough floor, to cross the position of GH-03 and starting on the northern side of the trough. This was to be a hover-and-move operation involving five waypoints in line. While the ship was at the first hover point, there was an inexplicable drop in tension, indicative of grounding, at a time when pinger signals indicated the camera was well off bottom. This was followed by erratic behaviour of the tension signal. Being concerned we might have fouled some fishing gear or abandoned cable, the tow was aborted and the camera retrieved before it had descended into the trough. No damage

was evident, and the problem was attributed to a corroded contact in the tension meter box atop the a-frame, which was rectified during the next operation. About 15 minutes of excellent video were recorded, showing bioturbated sediment bottom colonised by a varied fauna, and an interval of subhorizontal, platy outcrops at the top of the steep scarp. Recorded data from a CTD attached to the camera showed that the tow did not descend into the trough, being aborted at a depth of about 615m.

Smith McIntyre Grab GG-01 was aimed at the trough floor to provide time for recharging the camera system batteries, and to test performance of this sampling tool for the difficult sediment being experienced. During deployment, however, the ship moved north of the waypoint and like GS-03 the grab hit bottom just north of the scarp. The grab returned with only a small load, about 3 cm thick, of pale khaki calcareous sediment, resembling the upper unit of the GS-03 core catcher. This was sampled for sedimentology, geochemistry and biota studies.

Camera-Video Tow GCV-02 was intended to repeat the GCV-01 traverse, but a 20kt easterly wind that had blown up in the meantime required a change of waypoints to a east-southeasterly oblique crossing the trough from the northern side. Deployment and recovery were without incident, and the tension meter worked well. The 60 m drop-off from the northern wall onto the scarp, and also the foot of the scarp, were very sharp. The CTD on the camera sled showed the tow descended into the trough (about 10 m deep with its floor at a depth equivalent to 660 db) then climbed a low rise on the southeastern side of the trough. A layer of water was detected 60-70 mab which was slightly colder and less saline than the normal profile. A full videotape was taken, with high quality imagery of bioturbated sediment bottom and fauna, including a large ray. A short interval of subhorizontal platy rock outcrops was again recorded, in the equivalent position to those on GCV-01 just prior to the drop-off on the northern wall. No hints of hydrothermal deposit or activity were observed, especially at the trough floor. It appears that an older, faulted sequence of calcareous rocks is here overlain with minor unconformity by less consolidated younger sediment.

While waiting to view the videotape from GCV-02, **Smith-McIntyre Grab GG-02** was dropped about 1 km north of the fault zone to collect a remote "background" sediment sample for geochemistry. However the grab failed to trigger and no sample was recovered. While transiting into position for this operation, a further crossing of the trough indicated that it is gently curved.

Although it was not realised until later that no sediment sample had been acquired from the actual trough, and the near-bottom CTD anomaly remained unexplained, our camera operations and the lack of a methane anomaly once again suggested that the fault zone at Station Recherche B is not hydrothermally active, so the site was abandoned and at 22:00 the transit commenced to the Eucla Canyon Transect further east. With 25 kt easterly wind opposing the mild south-westerly swell, speed was reduced to 8 kts over ground, and conditions aboard were quite uncomfortable.

Monday February 5

In transit, thermosalinograph records were monitored to locate a site of high surface temperature and high chlorophyll for another bongo net tow. When one was encountered, sea state was not suitable. After lunch, an easterly swell built up.

Echosounder Traverse GES-04 was a zig-zag track designed to locate two faults shown on seismic profiles just south of ODP Leg 182 Site 1127, where pore fluids rich in H_2S and CH_4 had been discovered during drilling in Pleistocene

sediments. One fault was at the toe where this sequence thinned out (seismic profile JA-31 shotpoint 1740), and the other was a major growth fault cutting from the Cretaceous though older Tertiary sequences to surface (seismic profile JA-12, shotpoint 15530), both being represented by sharp troughs. The first three legs indicated that these were probably the same structure, trending northwest rather than the usual west-southwest for this region. The sounder survey was then diverted to make two further crossings of this structure to confirm that trend. These indicated a trough-like feature 50 to 100m deep and deepening to the southeast, trending 320°, with a steeper scarp on its northeastern side. It may be at least in part erosional in origin (a tributary of the Eucla Canyon). The site is referred to as ***Station Eucla A***.

At dusk, **CTD-Hydrocast GH-04** was deployed in 1095m of water to the floor of the trough near the JA-31 crossing, to test for anomalies and collect samples for methane analysis. No CTD-transmissometer anomalies, and only background levels of methane, were measured, although a faint nephel layer was present near bottom on the transmissometer trace.

Camera-Video Tow GCV-03 was an oblique crossing of the valley from its southern wall, dictated by a rising easterly wind. It was navigated with great precision as a hover-and-move operation, and also flown well. The excellent quality videotape showed bioturbated ooze, no rocks or hydrothermal deposits, and common fauna. Heave of the camera caused by the swell led to many close encounters with and crashes onto the floor. Only depth-related temperature changes were recorded by the sled CTD. Removal of the nalgene tubing from the conductivity sensor had been overlooked at deployment, so salinity was not recorded.

Because of a rising swell, a planned deployment of the large sediment corer on the trough floor was replaced by **Smith-McIntyre Grab GG-03**, but this failed in an unusual manner with one side not triggering. No sample was obtained.

Tuesday February 6

A short **Echosounder Traverse GES-05** consisting of two north-south legs was conducted to extend our mapping of this scarp further to the northwest. The westernmost leg showed no trough, establishing that the valley stopped abruptly.

Smith-McIntyre Grab GG-04, deployed on the floor of the trough along strike from CG-03, recovered an undisturbed 3 kg sample of khaki surface sediment. This was followed at the same position by a deployment of the small gravity corer, **GS-04**, which returned with no sample. **GG-05** was another attempt to collect sediment with the Smith-McIntyre grab, to the northeast of the trough at a background reference position. Although the grab triggered one of its cables was jammed and it returned empty. These failures discouraged further use of the Smith McIntyre grab for the remainder of the cruise.

CTD-Hydrocast GH-05 was placed towards the head of the trough reaching 11m from bottom at 1040m and yielding a similar profile to GH-04 but with a very faint transmissometer anomaly (<0.1%) at 30-60 m above bottom. This was included in the water samples, taken from 11 to 200 mab, but no methane anomaly was measured.

Box Corer GBC-02 was deployed at the GG-05 site in another attempt to obtain a background sediment sample. During its recovery the main winch stopped hauling when a solenoid failure caused the brake to apply. When brought on deck two hours later after this malfunction was temporarily overcome, the box corer was empty, possibly having washed out during the delay. The computing network crashed during this interval, causing loss of GPS navigation.

Echosounder Traverse GES-06 was inserted while the winch fault was further investigated and rectified, initially as a single line placed between the legs of GES-05 to further delineate the head of the trough. When this encountered no trough, a second line was sailed slightly to the east. This also found no extension to the trough, but crossed a scarp to the north that may represent a bounding fault.

With a pinger attached to the large corer, **Sediment Core GS-05** recovered a 5.6m core smelling of H_2S from the floor of the trough, the first significant penetration of the cruise. The odour was gone when the core was cut into 1m sections some hours later for transport ashore. The core cutter and catcher contained a khaki-coloured mud similar to GG-04, indicating that this is not merely a surficial layer.

Bongo Net Tow GBN-04 of three hauls was commenced on recovery of the corer. During the first dip, however, the hydrowinch failed to respond to its controls and the deployment was halted. The CTD winch controls were swapped to the hydrowinch and retrieval of the nets commenced until these controls also failed. The nets were eventually manhandled aboard two hours later. Following an apparently successful attempt to repair the winch controls another bongo net dip was commenced, but they again failed. For a period of 7 hours while the engineers stripped and repaired the hydraulic valves, no further operations from the side A-frame were possible. Fearing this might prevent vital CTD hydrocasts later in the cruise, a Niskin bottle was quickly adapted for deployment on the main cable, to be triggered by messenger weight. Together with attaching our recording CTD intended for the camera sled, we could at least obtain temperature salinity profiles and collect one near-bottom water sample for methane analysis. Fortunately the system was not required, since the winch problems were rectified eventually.

Camera-Video Tow GCV-04 was commenced as a south-southeast haul from the north-western valley head down into the trough. When only 718 m of cable was paid out, however, the thruster controls failed and the tow was aborted because station holding was impossible. The computer and navigation systems then crashed for two hours, compounding the problems for engineering and technical personnel.

On rectification of the computer system and thruster controls, a repeat **Camera-Video Tow GCV-04R** was successfully conducted. This descended an unexpectedly steep scarp into the trough, representing the probable bounding fault also noted in GES-06. Since difficulty was experienced holding the ship at the first intended hover position, the tow was conducted at a uniform speed of 0.5 kt. Good video was taken, of totally sedimented bottom without rocks or evidence of hydrothermal activity. Spiked temperature increases to 0.1°C at the end of the tow were assumed to arise from crashes on bottom and a consequent warming of surrounding water by the floodlamp. Similar spikes were not recorded during crashes on later tows, so this assumption might be wrong.

Using the large corer, **Sediment Core GS-06** was taken at 954 m water depth in the floor of the trough near its head. A 4.75 m core of calcareous ooze was retrieved, again smelling strongly of H_2S.

Wednesday February 7

Operation of the CTD winch was reinstated just in time for **CTD-Hydrocast GH-06**, which yielded a vertical profile 400m north-northwest of this site, approaching to 6 m from bottom at 830m which indicates it was placed just on the higher side of the bounding fault. A 0.5% transmissometer anomaly or nephel layer was recorded 30 m above bottom, and was sampled. No methane anomaly was

evident. The CTD winch behaved erratically at the final recovery to deck, which took 10 minutes.

Sediment Core GS-07 was taken at a "background" site over the Pleistocene wedge, at 832 m water depth approximately half way between previous operations and ODP Site 1127. A 5.25 m core of grey calcareous ooze, once more smelling strongly of H_2S, was recovered.

Apart from the presence of H_2S in the three cores taken at this site, these investigations provided no definite signs of warm seeps at station Eucla A, so we commenced a four-hour transit to ***Station Eucla B***, where several seismic lines indicated faults cutting both the Tertiary sequences and the overlying Pleistocene wedge. **Echosounder Traverse GES-07** involved two legs placed to establish the location and orientation of a fault at shotpoint 5060 on seismic profile HRGAB-102. At around 340m depth, this was the shallowest station of our cruise. The first leg of the traverse intersected the scarp as a 150 m high south-facing feature at the expected position from seismic, and it was also intersected as a 50 m scarp on the transit to GES-07, indicating a northeast trend. The second leg of GES-07, placed about 1 km east, crossed two subordinate features on the extension of this trend, suggesting the fault had splayed and its throw decreased. At its southern end there was an unrelated trough at 420 m depth.

The large corer was deployed for **Sediment Core GS-08**, at the foot of this scarp on the seismic line. No pinger was attached to the cable for this shallow operation. Although mud smeared on the outside indicated full penetration, only a little shelly material was recovered.

Echosounder Traverse GES-08 followed, a single line placed about 1 km west to further confirm the presence and trend of the scarp. This was encountered in the expected position, being 100 m high and a little deeper (foot at 355 m).

Camera-Video Tow GCV-05 was sailed northeast along the foot of this fault. Unfortunately the videotape did not start because of a faulty connection, although photographs are expected on the 35mm film to be processed ashore. From the sled CTD records, the camera initially descended down several ledges and crashed into a pinnacle a few metres high, crossed a trough at 362 db (CTD pressure), then became grounded after crashing onto a second low pinnacle for 20 minutes in a second trough at 357m db. After this the cage crossed a third pinnacle about 5 metres high, traversed a third trough (358 db), then climbed two ledges at about 345 and 330 db pressure. Anomalous but slight rises in temperature and salinity were recorded in the region of the basal troughs.

Bongo Net Tow GBN-05 was conducted where the tow ended after brief trials of the CTD and hydro winches, recovering the usual plankton load. Streaks of red plankton bloom were present on the sea surface, but were too fine to be collected in the net. There was a short malfunction of the hydrowinch during the initial tow.

CTD-Hydrocast GH-07 obtained a vertical profile and samples slightly above the foot of the scarp where bottom pressure was at 330db. There was an unusually pronounced drop in transmissivity, salinity and temperature at the base of the thermocline, near 260 m, but no obvious plume-type anomalies except miniscule transmission decreases about 20 and 40 mab, which were included in a sample profile from 7 to 100 mab. Once again, only background methane contents were measured on water samples.

Camera-Video Tow GCV-06 repeated the track of GCV-05 along the foot of the scarp. Frustratingly, a separate electronic malfunction terminated video recording two minutes after the camera switched on, before it had reached bottom, although

35mm photographs were again taken. The sled CTD profile was similar to that of GCV-05, descending a ledge at 345 db, passing two low ledges or pinnacles between which maximum depth (pressure) was 363 db, climbing slightly to a 346 db ledge then crossing a low trough at 350db before ascending ledges at 333 and 290 db. Again, minor increases in temperature and salinity were recorded crossing the troughs.

The large corer was deployed for **Sediment Core GS-09** to acquire a stratigraphic section of sediments at the foot of the Eucla B fault. It hit hard bottom, possibly a reef, and recovered a solitary coral, worm casings, and fragments of bivalve and gastropod shells but no sediment.

Dredge GD-01, the first of this cruise, was aimed at the lower ledges and pinnacles encountered by GCV-05 and GCV-06, hoping these might be vent deposits. After only minor bites, it returned a large load of khaki ooze comparable with that recovered in GS-09, remarkable for the great numbers of solitary corals and derivative carbonate fragments embedded in it. Most were grey and dead but several coloured corals were also recovered as well as other biota in much lesser abundance. The sediment traps contained fine khaki ooze lacking coral fragments. No rocks were recovered, suggesting the ledges might be some kind of reef structure. There was no H_2S odour from the sediment. An unusual faint sounder echo about 50 metres above bottom was noted during the haul, possibly a side-echo from an outcrop on the main scarp.

Bongo Net Tow BN-06, the first night haul and again with phytoplankton bloom at the surface, was conducted on completion of the dredge.

A third attempt to obtain video of this site was abandoned because charging the video batteries after previous tows was incomplete, and even though station Eucla B had not been adequately explored (and hoping 35mm photographs will later confirm the inferred reefs of GD-01) we wanted to leave enough time for investigations at Nullarbor Canyon. We commenced the 8-hour transit to this transect and, just after leaving station Eucla B, another south-facing 120 m high scarp (foot at 380 m) was crossed 2.5 miles to the east of the scarp we had been investigating. Since echosounder leg GES-07B with no equivalent scarp intervened, this is apparently a separate feature possibly connecting with the trough seen at the southern end of GES-07B. Several smaller scarps were passed further east. During the transit, a further recalibration was made to the wire-out measurement program, since it now seemed to be overestimating the true reading by around 5.5%.

Thursday February 8

Station Nullarbor A on the continental slope was a background reference site for our geochemical and biological studies, covering three sites within petroleum exploration tenements where Woodside Energy Ltd was interested to gain information relating to petroleum prospectivity and to foundation engineering for any future wells in the vicinity.

Camera-Video Tow GCV-07 was flown west to east at site WEL-01, climbing slightly from 1300 to 1280 metres. Good video was taken, revealing a bioturbated sediment floor with scattered fauna. The CTD on the camera cage shut down part way because of flat batteries, which were replaced. No temperature or salinity anomalies were recorded on bottom during the first hour.

Sediment Core GS-10 was taken with the large corer at site WEL-2 (1445 m depth by sounder), recovering 4.2 m of pale calcareous ooze. No trace of H_2S was

detected in this or subsequent cores during the remainder of the cruise. **Bongo Net Tow GBN-07** was conducted on completion.

A wind shift increasing to 25 kts from the south, arising from a crossing front, required **Camera-Video Tow GCV-08** across the WEL-2 corer site to be flown from north to south, depth falling from 1405 to 1425 m (as measured by the sled CTD) while the camera was on bottom. The intended 120-minute videotape terminated after 1 hour 40 minutes following a crash caused by heave in the increasing southerly swell. The reflector from the 35mm camera strobe was also lost. Bioturbated ooze and scattered fauna were again recorded. Two prolonged groundings of the camera occurred during the tow, both corresponding with spiked *drops* in salinity up to 0.10%, suggesting at face value that less saline pore fluids were released from bottom ooze.

A second large corer deployment, **Sediment Core GS-11** was then conducted at the same site as GS-10 to obtain additional material for stratigraphic and sedimentological studies at AGSO. This also recovered a good core, 4.2 m in length, of pale calcareous ooze.

At site WEL-3 further southwest in 1790 metres of water, **Sediment Core GS-12** was taken with the large corer, recovering 4.4 metres of sediment. A planned camera-video tow at this site was cancelled because of worsening weather.

A three-hour transit then took us to ***Station Nullarbor B***, where two small cones presumed to be volcanoes had been discovered by swathe mapping with *L'Atalante* early in 2000. Operations at the northern feature were postponed for over an hour because the seismic survey ship *Geco Angler* was heading across the same position. While standing aside, **Bongo Net Tow GBN-08** was conducted to provide further nocturnal measurements of plankton in the upper mixing layer.

Friday February 9

Two orthogonal legs were sailed in **Echosounder Traverse GES-09** to confirm the position of the northern cone, which we have called ***North Plook*** from a Caledonian term for pimple. Its crest was located at 34°42.80'S 130°40.38'E with the highest measured point at 1613 m depth, some 80 m higher than indicated on the swathe map.

Dredge GD-02 was hauled up the northeastern slope of the cone from near its base. It returned with the first weak link broken after only one good bite. A piece of gorgonian coral and several ophiuroids were caught in the net, but no other material was recovered. **Dredge GD-03** repeated this operation, starting slightly higher up the slope. After several weak bites it again returned with the first weak link broken. The recovery was about 10 kg of black manganese crusts in the bag, plus pieces of coral, several ophiuroids, and a smashed crab caught on the outside of the net liner. A planned camera tow was deferred because of weather, which subsequently improved as wind swung to the southeast.

A 3-hour transit followed to ***Station Nullarbor C***, the canyon floor. **CTD-Hydrocast GH-08** was a vertical profile over the centre of 2720 m deep ***Western Hole*** at the intersection of seismic profiles DWGAB-08 and DWGAB-28 (station 399 of *Southern Surveyor* cruise SS-01/00, where a gravity core had recovered dark brown mud overlain by pale ooze). No salinity anomaly indicating any dense brine pool in the 130 m-deep enclosed part of the hole was recorded. A slight decrease in transmissivity occurred at 2140 db, but this was subsequently assigned no significance. It was included as the topmost water sample in a profile commencing 11 mab from which, however, no methane anomalies were measured. Temperature was

constant at 1.84°C below the 2590 m sill of the hole. The floor of the hole (2756 db at 11 mab) is some 30m below the depth indicated on *L'Atalante* swathe bathymetry.

Box Core GBC-03 was dropped to the floor of the Western Hole to collect near-surface sediment. It failed to trigger and no sample was recovered.

Camera-Video Tow GCV-09 was flown in an easterly direction across the floor of the Western Hole. Numerous ledges on the floor, and a weak reflected pinger signal, made pilotage difficult. On recovery the battery was completely discharged (3 hours 15 minutes after the floodlight turned on), although it had been alight during the whole tow on bottom. Since the calculated battery life with the 250W flood was about 2.5 to 3 hours and complete discharging is not recommended by the manufacturer, we decided to use 80 minute tows (video camera on standard play) for future deep deployments. The videotape ran through, but apparently the zoom lever had been knocked during installation since only out-of-focus telephoto imagery was obtained. Bioturbated ooze and probable rock outcrops were crossed. Throughout the tow, numerous neutrally buoyant bubble-like objects swirled in front of the camera lens. These seem to be near-transparent organisms of some kind (ostracods?). The 35mm camera should provide better images of bottom, though it was set to fire as backup at only 50 second intervals. Pressure measurements during the tow show the camera crossed a western deep at 2700 db, then a 50 m high rise, before descending to 2750 db in the main hole where it became grounded. No temperature anomalies were recorded by the sled CTD on bottom. Two periods of spiked reduction in salinity during severe groundings were noted towards the end of the tow, again suggesting that less saline pore fluids were released from bottom ooze.

The box corer having failed, the small gravity corer was deployed for **Sediment Core GS-13** on the central floor of the Western Hole, to acquire a mudline sample. The 13cm sample recovered was of very faintly laminated pink calcareous ooze, slightly more sloppy at the top.

Dredge GD-04 was aimed at the southern wall of West Hole, starting at about 2680 m. It returned after only minor bites with the weak link intact, the net lining shredded, but empty except for some pink ooze in the sediment traps.

CTD-Hydrocast GH-09 was placed centrally over the floor of northernmost ***Hole #1*** on the main line of the canyon. Ten metres above bottom by altimeter, the CTD pressure was 2794 db, indicating a 2775m depth about 35m more than shown on the *L'Atalante* swathe bathymetric chart. The temperature, salinity, dissolved oxygen and sigma-t profiles were identical to those of GH-08 in West Hole, as was the transmissometer profile except its readings were consistently 0.2% lower reflecting the usual changed calibration between dips. A just detectable nephel layer was evident close to bottom. Water samples taken from 10 to 200 mab showed no methane anomalies.

Saturday February 10

Bongo Net Tow GBN-08 of three hauls was taken where GH-09 ended, yielding a nocturnal recovery of small and large salps.

Sediment Core GS-14 was taken with the large corer from the floor of Hole #1. The barrel was bent 1.5 m from its end, and a small 48 cm core was recovered. The unconformity between overlying pale ooze and a dark brown plasticine-like clay was preserved in the core catcher.

Dredge GD-05 was hauled up the south-eastern wall of Hole #1, starting at about 2650 m but recording no significant bites. With the weak link intact, about 50 kg of mud was recovered that included a number of fragments up to 40 cm across of

variably oxidised and indurated shale (one with a concretion structure), plus several pieces of dark brownish grey plasticine-like clay similar to that encountered at the base of GS-15. The sediment in most of the bag was pale pink calcareous ooze, while that at the bottom of the bag (i.e. collected earlier) was tan in colour.

Bongo Net Tow GBN-09 was inserted at short notice after sunrise when the thermsalinograph fluorimeter indicated we were passing through a high chlorophyll surface layer.

Camera-Video Tow GCV-10 was flown southwest across the floor of Hole #1. To avoid fully discharging the battery, it was limited to 80 minutes on bottom with the video camera on standard play. Both video and still cameras functioned, but the video camera again zoomed to telephoto and the depth of field was consequently poor. The sled CTD indicated the camera commenced photography at a depth equivalent of 2700 db, climbed a 20 m high outcrop before plunging down a steep 60 m high cliff then a ledged slope of 20 m to the floor of the hole at 2780 db. It then climbed gently to 2710 db up the low south-western wall of Hole 1. No temperature or salinity anomalies were recorded.

CTD-Hydrocast GH-10 was then made into the floor of ***Hole #2*** on the main line of the canyon, the bottom sounding being 3054 m, about 25m deeper than indicated on the swathe bathymetric chart. The floor of this hole is some 200m below its sill at the rise between it and Hole #3, so was considered a possible trap for dense brines or stagnant water poor in dissolved oxygen. However, except for a thin layer of warm water at 320 m depth that was absent in earlier casts, the CTD profiles resembled those of GH-08 and GH-09 with no bottom salinity anomaly. The transmissometer profile was slightly noisy but not anomalous below sill level. About 100 m of kinked wire was cut from the main cable during this operation and later discarded nearby.

The small corer with pinger attached 100m up the cable was used for **Sediment Core GS-15** to collect a surficial sediment sample from the floor of Hole #2. A 21 cm core was obtained of massive pale pink ooze, slightly fluid at the top 2 cm. This was followed by **Sediment Core GS-16**, a deployment of the large corer at the same position. Although the corer penetrated 95 cm in mainly pale calcareous ooze judging from material smeared on the outside of the barrel, little sample was recovered. The core cutter and catcher contained a 15cm plug of dark brownish grey plastic clay and a fragment of indurated, Fe-stained shale. This evidently stopped the penetration.

Dredge GD-06 was hauled from about 2920m up the southeastern wall of Hole #2. No significant bites occurred before the dredge lifted off bottom. It returned with an intact weak link and a shredded net, but no recovery except for pale ooze in the sediment traps.

Camera-Video Tow GCV-11 was flown southwest along the westernmost floor of shallow ***Hole #4*** in the main line of the canyon floor, which on the swathe bathymetric chart appeared a possible longitudinal fissure. The sled CTD record showed that the tow commenced at a depth equivalent to 2702 db, and dipped to 2725 db before climbing a ledge and sill before descending to 2776 db on the main floor. The 80 minute standard play videotape provided high quality imagery, though flying height was severely affected by ships heave. A rocky outcrop of pale and dark grey bedded sediment was climbed with many crashes soon after the start of the tow. The flat, pale ooze floor that dominated the remainder of the tow was in places littered with rock fragments presumably fallen from the adjacent western wall, while other intervals with a speckled appearance were interpreted as earlier talus, now heavily

covered with ooze. No temperature or salinity anomalies were recorded. On recovery, the front shield of the camera cage and a strut had sprung off the port side, requiring welding and re-bolting.

Sunday February 11

With a shorter 4 m barrel installed on the large corer to avoid bending on impact with the hard ground now expected, **Sediment Core GS-17** was taken from the floor of Hole #4. While pale ooze smeared on the outside indicated penetration to 2.6 m, 1.1 m of core was returned, again mainly of pale pink calcareous ooze with a plug of dark brownish grey, plastic clay in the cutter.

CTD-Hydrocast GH-11 was made over the floor of ***Hole #5*** on the main line, reaching 3237 db pressure at an altitude of 10 m above the floor. This hole, whose sill adjoining Hole #6 is 200 m above its floor, was also examined as a possible sink for dense or stagnant water. Again, however, the CTD profiles showed no anomalies to indicate this was the case. The layer of warm water at about 320 m, seen on GH-10, was present but subdued. Below the sill the temperature, salinity, density and light transmission were constant, but dissolved oxygen dropped progressively but in conformity normal profiles. Water samples collected from 10 to 200 mab showed no methane anomalies.

Dredge GD-07 was hauled from about 2990 m up the south-eastern wall of Hole #5. Once again, only minor bites were experienced. A 10 kg load of brown mudstone and sandy mudstone fragments was recovered, somewhat less indurated than the haul from GD-05. This had been washed free of pale pink calcareous ooze, some of which was collected by the sediment traps. **Bongo Net Tow GBN-10** of 3 dips was conducted mid morning on completion of the dredge. Another 200m of kinked wire was removed from the main cable, and disposed at 33°7.0'S 130°47.5'E.

We then moved 2 miles west to a subparallel northeast-trending line of shallow holes, where ***Far West Hole*** was examined as a possible hydrothermal site near the intersection with a weak southeast-trending cross-cutting feature evident on the swathe bathymetric chart. **CTD-Hydrocast GH-12** was dropped to the floor of this hole, reaching a pressure of 2847 db at 10 mab, indicating a depth about 25 m more than the 2805m shown on the bathymetric chart. No CTD or transmissometer anomalies were noted, and no anomalous methane contents were measured in water samples taken from 10 to 500 mab and at a very weak transmissometer deflection at 1945 db depth.

Realising that no marks had yet been made on the re-terminated main cable, a planned sediment core at this site was deferred (see GS-20), and we commenced a transit back to Station Nullarbor B. On the way to the North Plook cone, **Echosounder Traverse GES-10** was made across the southern presumed volcanic cone, which we named ***South Plook***. This confirmed the position of this feature as shown on the *L'Atalante* swathe bathymetric chart, but it was found to be larger and higher than indicated thereon and similar to North Plook in size, with a basal diameter just below 1 km and a height of 150 m above the surrounding floor (crest at 1667 m, 34°46.0' 130°42.4'E).

Continuing on to North Plook, **Dredge GD-08** was hauled up its southern flank from a depth of 1750 m. After weak bites, it returned intact with a small load, about 5 kg, of manganese crusts plus a few corals and a deep sea fish (dory).

Camera-Video Tow GCV-12 was flown over the crest of North Plook, first from north to south then, after raising the sled and turning the ship, from west to east. The CTD pressure shows the first leg commenced at 1674 db on the northern flank,

climbed over the sharp crest at 1612 db, then descended the southern flank to 1700 db before lifting off. The second leg commenced at 1754 db, climbed over a sharp false crest at 1624 m, then descended the eastern flank to 1695 db where photography ended. There is no crater at the crest, but a ledge (lava flow?) is present at 1640 db to its east. Ship's heave and rough topography led to numerous crashes. Excellent video imagery was obtained of lava outcrops with bulbous manganese crusts, and of abundant fauna including various corals and fishes. Orientation of fan corals on the northern flank indicate either a north-easterly or south-westerly bottom current, which was not strong judging from the radial movement of dust clouds after crashes. The climb of the western flank was greatly obscured by dust clouds high above bottom. If as seems likely these emanated from crashes early on the first leg, a south-westerly current of about 0.5 kts is indicated. The western flank of the cone is more heavily sedimented than elsewhere. After a crash near the crest on the second leg, the camera was thrown out of focus, although the images remain interpretable as scattered lava outcrops. No salinity or temperature anomalies were recorded.

Dredge GD-09 was hauled a short distance in a northerly direction across the crest of North Plook, commencing at 1620 m. Two pieces of manganese crust, a sea whip coral, several ophiuroids, and a solitary coral were recovered.

Monday February 12

On completion of GD-09, **Bongo Net Tow GBN-11** was undertaken to provide further nocturnal plankton samples.

Dredge GD-10 was placed on flat seafloor 1790 m deep between North Plook and South Plook, to obtain a large "background" sediment sample for biological examination. About 500 kg of ooze was collected and later sieved, yielding only a little meiofauna.

Dredge GD-11, hauled up the southern flank of South Plook from 1830mm depth, was intended to characterise this cone. Having probably landed too low on this feature, it returned with weak link intact but no sample in the bag. Pale pink calcareous ooze was present in two sediment traps.

We then transited to ***Station Nullarbor D***, where **Echosounder Traverse GES-11** was conducted to locate a fault scarp cutting to surface through the Tertiary sediment sequence on seismic profile 065-14, shotpoint 760, and to determine its trend. Two longitudinal legs were initially sailed, the first along the seismic line and the second 1.5 km to the east, then a third leg was placed 1.5 km west of the first. These indicated only a very subdued east-west trending south-facing scarp about 20 m high. **Echosounder Traverses GES-12 and GES-13** were inserted between these legs to confirm this interpretation.

Returning to the foot of the scarp on the seismic line, **CTD-Hydrocast GH-13** was conducted in 2270 m of water. The seismic ship *Geco Angler* passed 1.7 miles away during this operation but did not interrupt it. Apart from a slight transmissometer anomaly (<0.1%) at 170 mab, which was bracketed within samples taken from 10 to 200 mab, the CTD profiles were standard, and no methane anomalies were measured.

Sediment Core GS-18 was taken at the same position using the large corer with the 6m barrel again fitted. Although it penetrated 1.5 m from the outside smear, only 1.0 m of calcareous ooze and sediment was recovered. **Bongo Net Tow GBN-12** followed mid-afternoon.

We then moved south 5 miles to ***Station Nullarbor* E** where another small fault scarp was evident at shotpoint 1246 on seismic profile 065-14. Only a very

subdued feature was seen on the first leg of **Echosounder Traverse GES-14**, placed 0.5 miles west of the seismic profile. The second leg followed the seismic line and showed a shallow trough about 10m deep close to the position expected.

Although this did not appear a promising target, **CTD-Hydrocast GH-14** was conducted into the trough. No CTD, transmissometer, or methane anomalies were detected.

Sediment Core GS-19 was taken at the same position with the large corer. Although the outside smear again indicated significant penetration to 2.1 m, only 10 cm of sloppy calcareous ooze was recovered. A semiconsolidated, pale beige clay was present in the catcher and cutter.

Echosounder Traverse GES-15, placed between the two legs of GES-14, was run while transiting back to Station Nullarbor D in order to test the orientation of the Station E feature. The shallow trough, slightly steeper on its northern side, was encountered at a position indicating a 035° trend which extrapolated to the subdued feature on the first (eastern) leg of GES-14.

Returning to Station Nullarbor D, **Camera-Video Tow GCV-13** was run easterly along the scarp through the positions of GH-13 and GS-18. On recovery the floodlamp was off, the bulb having blown late in the tow. Condensation on the inside of the pressure housing window affected the focus and intensity of the videotape imagery which, however, revealed only mildly bioturbated sediment and sparse fauna. No temperature or salinity anomalies were recorded by the sled CTD.

Tuesday February 13

Discounting Stations D and E as likely hydrothermal sites, we then returned to the South Plook cone at Station Nullarbor B to attempt improved sampling. **Dredge GD-12** was hauled up the upper northern slope of the cone, starting at 1720 m depth. After weak bites, some pale pink ooze was recovered in one sediment trap, but the bag was empty except for a fragment of dead gorgonian coral and a single 5cm ferruginous rock, later identified as a microbial sediment. **Dredge GD-13** repeated this operation, starting lower on the flank at 1810 m. It returned empty after insignificant bites, except for some pink calcareous ooze in a sediment trap. No bites were observed and an identical result (ooze in a sediment trap, but no rocks) was obtained in **Dredge GD-14**, the fourth deployment on South Plook, starting between GD-12 and GD-13 on the northern flank.

A 2-hour transit followed, back to Far Western Hole at the Nullarbor Canyon station C, where **Sediment Core GS-20** performed the previously deferred sampling of the floor. The 4 m barrel was again fitted to the large corer, and the result was similar to those on the floor of other holes. A penetration of 2.5 metres was indicated by the outer smear, yet only 1.77m of calcareous ooze was present in the barrel and the core cutter was plugged with a dark brown plastic clay.

Dredge GD-15 was hauled up the southwestern wall of Hole #2 in the main line of the canyon, hoping to obtain samples from a likely cross fault defining this wall for comparison with those collected from the side wall of Holes #1 and #5 by GD-05 and GD-07. Although no bites were experienced, the dredge returned with weak link broken and the net liner shredded and wrapped around the swivel. No sample at all was recovered. **Bongo Net Tow GBN-13** of two hauls followed.

Proceeding to ***East Hole***, a subdued feature on a smaller north-east trending valley 1.3 miles east of the main line and located on the same cross feature as Far West Hole, a planned CTD-hydrocast was abandoned because of the approaching deadline for departure to Adelaide. With the larger corer, **Sediment Core GS-21**

sampled the floor of the hole, with a similar result to deployments in all other holes. The indicated penetration of 1 metre was stopped by 15 cm of dark brownish grey plastic clay which plugged the nosecone, and which was overlain by 69 cm of calcareous ooze.

The transit to Adelaide commenced at 17:50 (Perth time, which had been maintained throughout operations). Watches were stood down but scientists continued work preparing reports and dismantling equipment for packing. Ship's clocks were advanced 1½ hours at midnight.

Wednesday February 14

Continuing the transit to Adelaide, nutrient analyses on hydrocast samples were completed, showing no anomalous values. The daily scientists meeting at 13:00 reviewed achievements and highlights of the cruise. Report writing and packing of equipment continued throughout the day. A burst hydraulic hose on the HIAB crane prevented removal of pallets and cages via the afterdeck hatch. The Neptune Islands were passed at dusk, and Althorpe Island just before midnight, when clocks were advanced another hour to Central Summer Time.

Thursday February 15

Fine weather and calm seas returned for the passage up St Vincents Gulf, with Adelaide in sight at dawn. The pilot joined at 09:00, and *Franklin* tied up at 10:05 astern of the liner *QE-II* at Berth 3, Outer Harbour, where television crews waited in response to a media release issued by CSIRO and Environment Australia. Discharge of equipment was delayed by the need to use a shore crane to remove pallets and cages before these were packed with our equipment for land transport.

Summary

For most of this cruise we experienced fine weather but sea states and winds often bordered on the limits of acceptability for using *Franklin* to conduct geoscientific operations. Nevertheless, little time was lost for this reason, nor were our operations seriously affected. Malfunction of the winch controls required some re-scheduling of operations. While we were fortunate that the ship's engineers were able to rectify the problems with some ingenuity, it would be preferable in future that these vital components of the vessel get checked out before leaving port. The same applies to the tensiometer and wire-out metering systems for the main cable, which failed to operate adequately at the start and whose calibration was suspect throughout the cruise. In the absence of acoustic instrumentation to locate the towed video system relative to the ship, accurate wire-out measurements are important for calculating the position of recorded objects. Had we photographed any hydrothermal deposits, we might have been unable to dredge with sufficient precision to recover samples.

Given conditions in the Bight and the nature of our targets, the LIPS positioning system installed since our previous cruise allowed adequate station holding during operations, with considerably less manual effort required of bridge officers than for the old TAC controls. On a few occasions, GPS spikes caused temporary problems such as unnecessary thruster load. A system for filtering these spikes or for using positions averaged over 30 seconds or so during stationary activities would be an improvement.

The new cradle system for AGSO's large corer, installed for the first time on *Franklin* for this cruise, proved very effective, allowing safe and rapid deployment and recovery even in heavy swells. Its installation on the port side of the afterdeck hindered access to the container laboratory, and its overall bulk interfered with recovery of camera and dredge. However these difficulties were tolerable, especially considering the advantages of the system.

Overall, we were pleased with the outcomes of GABSEEPS even though we found no actual warm seeps. For a relatively short cruise involving lengthy transits, we conducted a large number of operations and addressed all high priority targets. The scientific team, with diverse disciplinary interests, worked together particularly well, and enjoyed exceptional support and cooperation from ORV personnel and the ship's crew.

Post-cruise research, including logging of the large sediment cores and chemical analyses of mudline calcareous oozes, has found no evidence of hydrothermal deposits or anomalous base metal concentrations. The dredged sedimentary rocks and the brown plastic clay at the base of Nullarbor canyon gravity cores are believed Cretaceous in age, while the white chalk at the base of GS-03 (Recherche B) is Tertiary. Analyses of Mn crusts from North Plook average 0.7 % Co, 0.2% Ni, and 0.05% Cu, comparable with other occurrences south of Australia.

Scientific Personnel

Ray Binns	CEM	Chief Scientist, Geology
Chris Yeats	CEM	Watch Leader, Geology
John Waters	CEM	Watch Leader, Geology
Geoff Denton	CEM	Watch Leader, Geology
Linda Stalker	CPR	Organic Geochemistry
Melissa Fellows	AGSO	Sedimentology
John Stratton	AGSO	Sediments
Marnie Campbell	EA	Biology
Alistair Hobday	CMR	Biology
Pamela Brodie	CMR	Cruise Manager, Computing
Mark Underwood	CMR	Electronics
Dave Terhell	CMR	Hydrochemistry, Microbiology

Ship's Crew

Neil Cheshire	Master
Jürgen Rust	First Mate
John Boyes	Second Mate
John Morton	Chief Engineer
Greg Pearce	First Engineer
Hugh McCormick	Electrical Engineer
Bill Hughes	Bosun
Tony Hearne	Able Seaman
Terry Ganim	Able Seaman
Mal McDougall	Able Seaman
Dan Davies	Greaser
Dave Wilcox	Chief Steward
Tom Condon	Chief Cook
Mark Wheeler	Second Cook

Acknowledgements

We thank Master Neil Cheshire and all the ship's crew for their usual expert handling of *Franklin* and her equipment and for their untiring assistance throughout the cruise, and we express our appreciation to the ORV National Facility Steering Committee for allocating us ship time and to the shore personnel responsible for efficient operation of the vessel.

Ray Binns
Chief Scientist

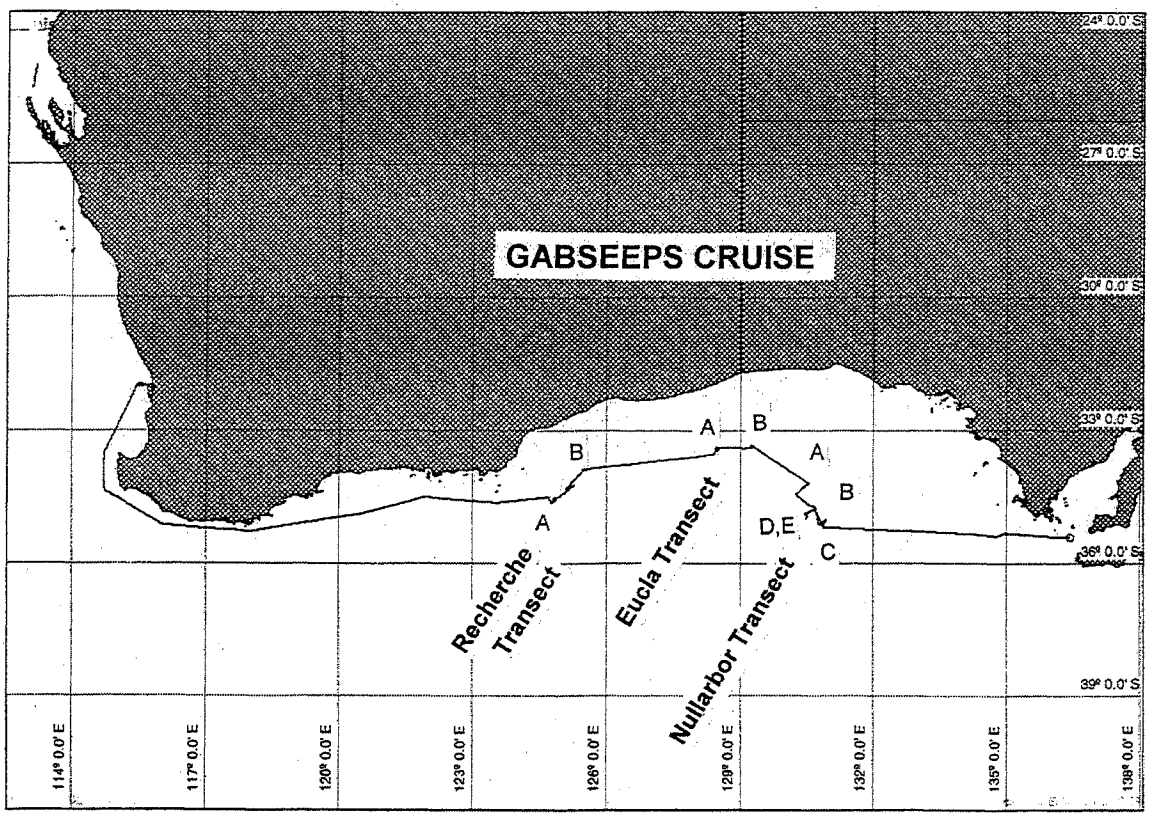

Fig. 1 Cruise Track FR01/2001

Appendix
Station List FR-01/01

Operation		Date	Time (Local) GMT+8	Latitude (° S)	Longitude (° E)	Water Depth (m)
Transit	Start	31-Jan-01	0735:00			
Test	Start	02-Feb-01	1110:00	34º 43.55'	121º 05.47'	2096
	End	02-Feb-01	1140:00	34º 41.95'	121º 11.77'	1604
GBN-01	Start	02-Feb-01	1516:07	34º 29.92'	121º 54.09'	103
	End	02-Feb-01	1642:48	34º 30.37'	121º 57.60'	98
Transit	Start	02-Feb-01	1701:00	34º 30.29'	121º 57.62'	97
	End	03-Feb-01	0530:01	34º 30.23'	124º 41.52'	3636
Camera Test	Start	03-Feb-01	0600:00	34º 29.88'	124º 42.87'	3621
	End	03-Feb-01	0643:32	34º 30.01'	124º 42.95'	3627
GH-01	Start	03-Feb-01	0720:27	34º 29.95'	124º 42.99'	3625
	End	03-Feb-01	0807:30	34º 30.00'	124º 42.98'	3625
Camera Test	Start	03-Feb-01	0824:04	34º 30.00'	124º 42.98'	3626
	End	03-Feb-01	0855:04	34º 30.02'	124º 42.93'	3627
GES-01	Start	03-Feb-01	0907:30	34º 30.07'	124º 42.99'	3628
	End	03-Feb-01	1105:02	34º 30.45'	124º 50.93'	3613
GS-01	Start	03-Feb-01	1143:25	34º 33.01'	124º 50.01'	3733
	On bottom	03-Feb-01	1242:47	34º 33.00'	124º 49.99'	3733
	End	03-Feb-01	1342:50	34º 33.01'	124º 50.00'	3732
GBN-02	Start	03-Feb-01	1411:43	34º 33.59'	124º 49.67'	3741
	End	03-Feb-01	1543:24	34º 37.97'	124º 48.52'	3962
GH-02	Start	03-Feb-01	1646:07	34º 36.10'	124º 48.90'	3943
	End	03-Feb-01	1934:22	34º 36.19'	124º 48.94'	3943
GBC-01	Start	03-Feb-01	1952:12	34º 36.19'	124º 48.94'	3943
	On bottom	03-Feb-01	2151:21	34º 36.17'	124º 48.91'	3946
	End	03-Feb-01	2254:34	34º 36.12'	124º 49.08'	3948
GS-02	Start	03-Feb-01	2310:51	34º 36.18'	124º 48.97'	3939
	On bottom	04-Feb-01	0015:40	34º 36.14'	124º 48.98'	3129?
	End	04-Feb-01	0107:21	34º 36.09'	124º 48.99'	3946
GES-02	Start	04-Feb-01	0117:00	34º 36.10'	124º 49.09	3939
	End	04-Feb-01	0905:03	33º 53.43'	125º 30.70	576
GS-03	Start	04-Feb-01	0949:27	33º 53.45'	125º 32.03'	619
	On bottom	04-Feb-01	0957:15	33º 53.44'	125º 32.05'	619
	End	04-Feb-01	1014:34	33º 53.44'	125º 32.06'	620
GES-03	Start	04-Feb-01	1032:45	33º 52.98'	125º 31.87'	589
	End	04-Feb-01	1046:02	33º 54.01'	125º 32:16'	665
GH-03	Start	04-Feb-01	1124:32	33° 53.49'	125º 32.04'	632
	End	04-Feb-01	1207:58	33° 53.45'	125º 31.99'	617
GBN-03	Start	04-Feb-01	1220:20	33° 53.43'	125° 32.05'	620
	End	04-Feb-01	1306:41	33° 53.43'	125° 33.68'	677
GCV-01	Start	04-Feb-01	1355:17	33° 53.55'	125° 31.63'	604
	On bottom	04-Feb-01	1413:00	33° 53.51'	125° 31.67'	604
	Off bottom	04-Feb-01	1444:16	33° 53.43'	125° 32.21'	627
	End	04-Feb-01	1501:29	33° 53.32'	125° 32.65'	631
GG-01	Start	04-Feb-01	1534:35	33° 53.45'	125° 32.05'	665
	On bottom	04-Feb-01	1545:17	33° 53.35'	125° 31.98'	606
	End	04-Feb-01	1601:10	33° 53.22'	125° 32.04'	604
GCV-02	Start	04-Feb-01	1627:02	33° 53.71'	125° 31.58'	605
	On bottom	04-Feb-01	1825:00	33° 53.35'	125° 31.69'	596
	Off bottom	04-Feb-01	2025:00	33° 53.85'	125° 33.20'	669
	End	04-Feb-01	2045:02	33° 53.93'	125° 33.23'	668
GG-02	Start	04-Feb-01	2127:28	33° 52.89'	125° 32.03'	589
	On bottom	04-Feb-01	2138:15	33° 52.82'	125° 32.03'	588
	End	04-Feb-01	2150:00	33° 52.81'	125° 32.07'	586
Transit	Start	04-Feb-01	2150:00	33° 52.81'	125° 32.07'	586
	End	05-Feb-01	1458:03	33° 32.93'	128° 23.75'	1184
GES-04	Start	05-Feb-01	1458:03	33° 32.93'	128° 23.75'	1184
	End	05-Feb-01	1700:34	33° 27.22'	128° 28.33'	967
GH-04	Start	05-Feb-01	1816.04	33° 25.78'	128° 28.81'	1091
	End	05-Feb-01	1911:23	33° 25.78'	128° 28.79'	1091
GCV-03	Start	05-Feb-01	1947:28	33° 25.67'	128° 28.18'	931
	On bottom	05-Feb-01	2023:29	33° 25.67'	128° 28.17'	929
	Off bottom	05-Feb-01	2225:01	33° 25.85'	128° 29.38'	985
	End	05-Feb-01	2246:48	33° 25.85'	128° 29.38'	987
GG-03	Start	05-Feb-01	2316:25	33° 25.76'	128° 28.80'	1071
	On bottom	05-Feb-01	2336:56	33° 25.79'	128° 28.79'	1090
	End	06-Feb-01	0002:48	33° 25.77'	128° 28.80'	1091

GES-05	Start	06-Feb-01	0022:03	33° 25.23'	128° 28.28'	955
	End	06-Feb-01	0118:19	33° 24.91'	128° 28.11'	968
GG-04	Start	06-Feb-01	0131:44	33° 25.05'	128° 28.33'	988
	On bottom	06-Feb-01	0151:33	33° 25.05'	128° 28.33'	985
	End	06-Feb-01	0216:21	33° 25.05'	128° 28.33'	983
GS-04	Start	06-Feb-01	0236:53	33° 25.07'	128° 28.35'	990
	On bottom	06-Feb-01	0256:23	33° 25.05'	128° 28.32'	982
	End	06-Feb-01	0310:17	33° 25.05'	128° 28.32'	983
GG-05	Start	06-Feb-01	0338:15	33° 24.00'	128° 29.51'	910
	On bottom	06-Feb-01	0358:43	33° 24.98'	128° 29.46'	906
	End	06-Feb-01	0424:12	33° 24.95'	128° 29.39'	906
GH-05	Start	06-Feb-01	0525:00	33° 24.99'	128° 28.38'	1043
	End	06-Feb-01	0616:57	33° 24.99'	128° 28.39'	1045
GBC-02	Start	06-Feb-01	0709:02	33° 24.99'	128° 29.50'	905
	On bottom	06-Feb-01	0736:45	33° 24.99'	128° 29.50'	907
	End	06-Feb-01	0941:01	n.r.	n.r.	n.r.
GES-06	Start	06-Feb-01	1014:30	33° 24.42'	128° 27.00'	838
	End	06-Feb-01	1104:01	33° 24.40'	128° 27.51'	858
GS-05	Start	06-Feb-01	1126:56	33° 25.00'	128° 29.00'	1046
	On bottom	06-Feb-01	1154:13	33° 25.00'	128° 28.38'	1339?
	End	06-Feb-01	1215:01	33° 24.98'	128° 28.38'	1035
GBN-04	Start	06-Feb-01	1236:16	33° 24.79'	128° 28.14'	935
	End	06-Feb-01	1402:07	33° 24.86'	128° 26.70'	844
GCV-04	Start	06-Feb-01	1430:09	33° 24.07'	128° 27.17'	n.r.
	On bottom	06-Feb-01	-	-	-	-
	Off bottom	06-Feb-01	-	-	-	-
	End	06-Feb-01	1554:18	33° 23.32'	128° 27.62'	795
GCV-04R	Start	06-Feb-01	1904:02	33° 23.22'	128° 27.82'	793
	On bottom	06-Feb-01	1930:01	33° 23.22'	128° 27.83'	794
	Off bottom	06-Feb-01	2125:01	33° 24.54'	128° 28.30'	1000
	End	06-Feb-01	2147:22	33° 24.87'	128° 28.65'	953
GS-06	Start	06-Feb-01	2253:49	33° 23.68'	128° 27.97'	942
	On bottom	06-Feb-01	2317:07	33° 23.69'	128° 28.00'	943
	End	06-Feb-01	2339:10	33° 23.69'	128° 28.01'	930
GH-06	Start	07-Feb-01	0013:43	33° 23.51'	128° 27.91'	832
	End	07-Feb-01	0115:36	33° 23.51'	128° 27.90'	n.r.
GS-07	Start	07-Feb-01	0143:29	33° 24.02'	128° 28.89'	832
	On bottom	07-Feb-01	0211:17	33° 24.03'	128° 28.88'	834
	End	07-Feb-01	0231:44	33° 24.03'	128° 28.88'	833
GES-07	Start	07-Feb-01	0610:01	33° 24.02"	129° 14.39'	398
	End	07-Feb-01	0702:29	33° 23.96'	129° 15.33'	400
GS-08	Start	07-Feb-01	0751:24	33° 21.90'	129° 14.59'	324
	On bottom	07-Feb-01	0754:00	33° 21.90'	129° 14.60'	324
	End	07-Feb-01	0804:17	33° 21.93'	129° 14.69'	315
GES-08	Start	07-Feb-01	0833:29	33° 24.02'	129° 13.71'	357
	End	07-Feb-01	0859:21	33° 21.20'	129° 13.69'	196
GCV-05	Start	07-Feb-01	0949:52	33° 22.38'	129° 13.68'	357
	On bottom	07-Feb-01	1007:46	33° 22.38'	129° 13.68'	330
	Off bottom	07-Feb-01	1215:00	33° 21.68'	129° 14.89'	n.r.
	End	07-Feb-01	n.r.	n.r.	n.r.	n.r.
GBN-04B	Start	07-Feb-01	1244:30	33° 21.66'	129° 14.91'	256
	End	07-Feb-01	1332:42	33° 20.28'	129° 15.52'	160
GH-07	Start	07-Feb-01	0216:04	33° 21.87'	129° 14.48'	302
	End	07-Feb-01	0247:05	33° 21.78'	129° 14.49'	271
GCV-06	Start	07-Feb-01	1514:18	33° 22.37'	129° 13.67'	357
	On bottom	07-Feb-01	1533:01	33° 22.37'	129° 13.66'	-
	Off bottom	07-Feb-01	1738:00	33° 21.69'	129° 14.83'	267
	End	07-Feb-01	1747:22	33° 21.71'	129° 14.90'	281
GS-09	Start	07-Feb-01	1814:21	33° 21.84'	129° 14.62'	328
	On bottom	07-Feb-01	1817:05	33° 21.84'	129° 14.63'	330
	End	07-Feb-01	1824:06	33° 21.84	129° 14.62'	328
GD-01	Start	07-Feb-01	1900:00	33° 22.38'	129° 13.72'	357
	On bottom	07-Feb-01	1907:52	33° 22.38'	129° 13.72'	360
	End	07-Feb-01	1942:55	n.r.	n.r.	346
GBN-05	Start	07-Feb-01	2000:32	33° 22.01'	129° 14.53'	321
	End	07-Feb-01	2050:29	33° 20.88'	129° 14.52'	188
GCV-07	Start	08-Feb-01	0514:34	34° 11.13'	130° 32.00'	1300
	On bottom	08-Feb-01	0607:24	34° 11.12'	130° 32.00'	1298
	Off bottom	08-Feb-01	0813:02	34° 11.10'	130° 33.59'	1278
	End	08-Feb-01	0844:04	34° 11.40'	130° 33.98'	1272
GS-10	Start	08-Feb-01	1004:02	34° 16.90'	130° 26.07'	1444
	On bottom	08-Feb-01	1028:43	34° 16.90'	130° 26.06'	1555
	End	08-Feb-01	1103:58	34° 17.19'	130° 25.89'	1444
GBN-06	Start	08-Feb-01	1111:38	34° 17.27'	130° 25.97'	1440

	End	08-Feb-01	1200:20	34° 16.98'	130° 27.75'	1388
GCV-08	Start	08-Feb-01	1234:57	34° 16.07'	130° 26.03'	1423
	On bottom	08-Feb-01	1309:07	34° 16.09'	130° 26.04'	1424
	Off bottom	08-Feb-01	1522:37	34° 17.59'	130° 26.08'	1429
	End	08-Feb-01	1550:18	34° 17.60'	130° 26.05'	1430
GS-11	Start	08-Feb-01	1608:29	34° 17.60'	130° 26.06'	1429
	On bottom	08-Feb-01	1640:01	34° 17.59'	130° 26.02'	1432
	End	08-Feb-01	1721:07	34° 17.97'	130° 25.90'	1433
GS-12	Start	08-Feb-01	1927:07	34° 26.08'	130° 16.10'	1786
	On bottom	08-Feb-01	1946:23	34° 26.08'	130° 16.07'	1689
	End	08-Feb-01	2028:00	34° 27.10'	130° 16.06'	1825
GBN-07	Start	08-Feb-01	2341:01	34° 41.54'	130° 35.85'	1767
	End	09-Feb-01	0033:32	34° 41.13'	130° 37.73'	1734
GES-09	Start	09-Feb-01	0153:46	34° 43.81'	130° 39.00'	1768
	End	09-Feb-01	0242:44	34° 43.08'	130° 40.37'	1758
GD-02	Start	09-Feb-01	0322:29	34° 43.57'	130° 40.50'	n.r.
	On bottom	09-Feb-01	0345:22	34° 43.57'	130° 40.50'	1674
	End	09-Feb-01	0446:59	34° 44.22'	130° 40.09'	n.r.
GD-03	Start	09-Feb-01	0533:15	34° 43.57'	130° 40.49'	1661
	On bottom	09-Feb-01	0548:36	34° 43.56'	130° 40.50'	1654
	End	09-Feb-01	0641:32	34° 44.17'	130° 40.18'	1782
GH-08	Start	09-Feb-01	0919:15	35° 04.24'	130° 50.46'	2722
	End	09-Feb-01	1119:00	35° 04.07'	130° 50.22'	2712
GBC-03	Start	09-Feb-01	1133:17	35° 04.16'	130° 50.42'	2678
	On bottom	09-Feb-01	1248:21	35° 04.26'	130° 50.40'	2707
	End	09-Feb-01	1341:33	35° 04.34'	130° 50.26'	2676
GCV-09	Start	09-Feb-01	1406:58	35° 04.27'	130° 49.60'	2634
	On bottom	09-Feb-01	1505:16	35° 04.31'	130° 49.59'	2622
	Off bottom	09-Feb-01	1710:00	35° 04.20'	130° 50.89'	2541
	End	09-Feb-01	n.r.	n.r.	n.r.	n.r.
GS-13	Start	09-Feb-01	1813:45	35° 04.24'	130° 50.43'	2716
	On bottom	09-Feb-01	1845:15	35° 04.24'	130° 50.45'	2723
	End	09-Feb-01	1916:00	n.r.	n.r.	n.r.
GD-04	Start	09-Feb-01	1951:19	35° 04.40'	130° 50.48'	2684
	On bottom	09-Feb-01	2017:31	35° 04.37'	130° 50.58'	2671
	End	09-Feb-01	2139:26	35° 05.48'	130° 50.04'	2654
GH-09	Start	09-Feb-01	2243:34	35° 01.73'	130° 55.75'	2679
	End	10-Feb-01	n.r.	35° 01.57'	130° 55.51'	2758
GBN-08	Start	10-Feb-01	0103:48	35° 01.59'	130° 55.78'	2698
	End	10-Feb-01	0152:35	35° 00.78'	130° 57.03'	2376
GS-14	Start	10-Feb-01	0230:50	35° 01.66'	130° 55.84'	2675
	On bottom	10-Feb-01	0312:13	35° 01.72'	130° 55.91'	2661
	End	10-Feb-01	0350:24	35° 01.71'	130° 55.79'	2734
GD-05	Start	10-Feb-01	0415:30	35° 01.89'	130° 55.92'	2613
	On bottom	10-Feb-01	0440:20	35° 01.92'	130° 55.88'	2608
	End	10-Feb-01	n.r.	n.r.	n.r.	n.r.
GCV-10	Start	10-Feb-01	0833:38	35° 01.51'	130° 55.88'	2660
	On bottom	10-Feb-01	0938:11	35° 01.56'	130° 55.78'	n.r.
	Off bottom	10-Feb-01	1105:06	35° 02.21'	130° 55.04'	n.r.
	End	10-Feb-01	1202:21	35° 03.22'	130° 55.02'	n.r.
GBN-09	Start	10-Feb-01	0659:00	35° 01.53'	130° 55.77'	2691
	End	10-Feb-01	0748:00	35° 00.95'	130° 56.99'	2349
GH-10	Start	10-Feb-01	1240:11	35° 03.19'	130° 54.21'	3052
	End	10-Feb-01	1438:46	35° 03.16'	130° 54.23'	3053
GS-15	Start	10-Feb-01	1457:31	35° 03.18'	130° 54.22'	3015
	On bottom	10-Feb-01	1547:04	35° 03.18'	130° 54.23'	3053
	End	10-Feb-01	n.r	n.r	n.r	n.r
GS-16	Start	10-Feb-01	1643:15	35° 03.24'	130° 54.25'	3015
	On bottom	10-Feb-01	1735:09	35° 03.25	130° 54.20	3014
	End	10-Feb-01	n.r	n.r	n.r	n.r
GD-06	Start	10-Feb-01	1902:27	35° 03.35'	130° 54.43'	2912
	On bottom	10-Feb-01	1938:45	35° 03.36'	130° 54.43'	2911
	End	10-Feb-01	n.r	n.r	n.r	n.r
GCV-11	Start	10-Feb-01	2203:39	35° 04.73'	130° 52.66'	2770
	On bottom	10-Feb-01	2300:50	35° 04.74'	130° 52.66	n.r.
	Off ottom	11-Feb-01	0023:00	35° 05.33'	130° 52.15'	n.r.
	End	11-Feb-01	0116:23	35° 05.29'	130° 51.51'	n.r.
GS-17	Start	11-Feb-01	0146:55	35° 05.46'	130° 52.19'	2829
	On bottom	11-Feb-01	0230:17	35° 05.47'	130° 52.24'	2902
	End	11-Feb-01	0306:22	35° 05.32'	130° 52.02'	2692
GH-11	Start	11-Feb-01	0406:05	35° 07.36'	130° 51.53'	3195
	End	11-Feb-01	0616:37	35° 07.39'	130° 51.54'	3179
GD-07	Start	11-Feb-01	0709:50	35° 07.60'	130° 51.88'	2989
	On bottom	11-Feb-01	0747:14	35° 07.60'	130° 51.88'	2985

	End	11-Feb-01	0947:03	35° 09.29'	130° 52.62'	2777
GBN-10	Start	11-Feb-01	1007:02	35° 09.10'	130° 52.69'	2802
	End	11-Feb-01	1053:06	35° 07.69'	130° 52.10'	2928
GH-12	Start	11-Feb-01	1153:44	35° 06.27'	130° 46.25'	2819
	End	11-Feb-01	1351:32	35° 06.31'	130° 46.32'	2823
GES-10	Start	11-Feb-01	1620:34	34° 47.02'	130° 42.41'	1855
	End	11-Feb-01	1631:51	34° 45.01'	130° 42.40'	1791
GD-08	Start	11-Feb-01	1710:44	34° 43.85'	130° 40.34'	~1750
	On bottom	11-Feb-01	1738:45	34° 43.82'	130° 40.34'	~1750
	End	11-Feb-01	1832:03	34° 43.02	130° 40.65'	1774
GCV-12	Start	11-Feb-01	1859:18	34° 43.63'	130° 40.37'	1624
	On bottom	11-Feb-01	1941:38	34° 43.63'	130° 40.37'	n.r.
	Off bottom	11-Feb-01	2106:36	34° 43.74'	130° 40.67'	n.r.
	End	11-Feb-01	2140:11	34° 43.71'	130° 41.62'	n.r.
GD-09	Start	11-Feb-01	1016:13	34° 43.74'	130° 40.34'	1616
	On bottom	11-Feb-01	1042:25	34° 43.67	130° 40.37'	1628
	End	11-Feb-01	1147:12	34° 42.84'	130° 40.12'	1768
GBN-11	Start	12-Feb-01	0001:19	34° 42.71'	130° 40.12'	1769
	End	12-Feb-01	0058:55	34° 43.08'	130° 41.88'	1742
GD-10	Start	12-Feb-01	0138:18	34° 44.98'	130° 41.50'	1792
	On bottom	12-Feb-01	0200:04	34° 44.97'	130° 41.51'	1790
	End	12-Feb-01	0327:35	34° 44.94'	130° 42.32'	1792
GD-11	Start	12-Feb-01	0410:00	34° 46.29'	130° 42.31'	1822
	On bottom	12-Feb-01	0432:36	34° 46.29'	130° 42.33'	1831
	End	12-Feb-01	0527:23	34° 47.28'	130° 42.62'	1883
GES-11	Start	12-Feb-01	0635:04	34° 51.67'	130° 30.10'	2184
	End	12-Feb-01	0747:48	34° 52.96'	130° 30.21'	2260
GES-12	Start	12-Feb-01	0810:00	34° 52.81'	130° 29.06'	2251
	End	12-Feb-01	0835:01	34° 54.54'	130° 30.34'	2325
GES-13	Start	12-Feb-01	0840:01	34° 53.90'	130° 30.23'	2299
	End	12-Feb-01	0850:01	34° 52.65	130° 30.26'	2220
GH-13	Start	12-Feb-01	0921:56	34° 53.09'	130° 30.17'	2268
	End	12-Feb-01	1105:37	34° 53.08'	130° 30.20'	2268
GS-18	Start	12-Feb-01	1121:59	34° 53.08'	130° 30.16'	2268
	On bottom	12-Feb-01	1159:15	34° 53.02'	130° 30.15'	n.r
	End	12-Feb-01	1237:34	34° 00.00'	130° 29.43'	2261
GBN-12	Start	12-Feb-01	1254:28	34° 53.19'	130° 29.67'	2282
	End	12-Feb-01	1344:35	34° 53.62'	130° 31.32'	2277
GES-14	Start	12-Feb-01	1433:32	34° 58.23'	130° 30.52'	2402
	End	12-Feb-01	1409:04	34° 57.86'	130° 30.15'	2401
GH-14	Start	12-Feb-01	1538:21	34° 59.27'	130° 29.95'	2456
	End	12-Feb-01	1716:49	34° 59.27'	130° 30.00'	2455
GS-19	Start	12-Feb-01	1747:21	34° 59.28'	130° 29.97'	2458
	On bottom	12-Feb-01	1821:43	34° 59.29'	130° 29.99'	2456
	End	12-Feb-01	1900:34	34° 59.77'	130° 29.49'	2479
GES-15	Start	12-Feb-01	1906:11	34° 59.42'	130° 30.14'	2451
	End	12-Feb-01	1911:22	34° 58.49'	130° 30.16'	2413
GCV-13	Start	12-Feb-01	2007:58	34° 53.08'	130° 29.93'	2272
	On bottom	12-Feb-01	2053:24	34° 53.07'	130° 30.21'	n.r.
	Off bottom	12-Feb-01	2225:05	34° 53.10'	130° 30.76'	n.r.
	End	12-Feb-01	2306:54	34° 53.91'	130° 30.52'	2292
GD-12	Start	13-Feb-01	0052:06	34° 45.84'	130° 42.35'	1717
	On bottom	13-Feb-01	0116:53	34° 45.85'	130° 42.36'	1719
	End	13-Feb-01	0232:19	34° 46.62'	130° 42.37'	1836
GD-13	Start	13-Feb-01	0321:51	34° 46.79'	130° 42.28'	1814
	On bottom	13-Feb-01	0344:16	34° 45.79'	130° 42.29'	1814
	End	13-Feb-01	0458:51	34° 47.28'	130° 42.33'	1875
GD-14	Start	13-Feb-01	0548:50	34° 45.91'	130° 42.28'	1826
	On bottom	13-Feb-01	0611:14	34° 45.92'	130° 42.30'	1698
	End	13-Feb-01	0718:20	34° 47.15'	130° 42.19'	1820
GS-20	Start	13-Feb-01	0950:28	35° 06.24'	130° 46.24'	2817
	On bottom	13-Feb-01	1034:36	35° 06.23'	130° 46.26'	n.r.
	End	13-Feb-01	1124:01	35° 06.21'	130° 46.25'	2834
GD-15	Start	13-Feb-01	1224:29	35° 03.48'	130° 53.91'	2835
	On bottom	13-Feb-01	1301:07	35° 03.48'	130° 53.88'	2801
	End	13-Feb-01	1437:21	35° 03.42'	130° 53.13'	2608
GBN-13	Start	13-Feb-01	1450:39	35° 03.81'	130° 53.37'	2775
	End	13-Feb-01	1527:44	35° 04.47'	130° 54.46'	2636
GS-21	Start	13-Feb-01	1632:12	35° 10.90'	130° 53.28'	2844
	On bottom	13-Feb-01	1711:22	35° 10.90'	130° 53.31'	2839
	End	13-Feb-01	1748:00	35° 11.01'	130° 53.28'	2826

n.r. = not recorded