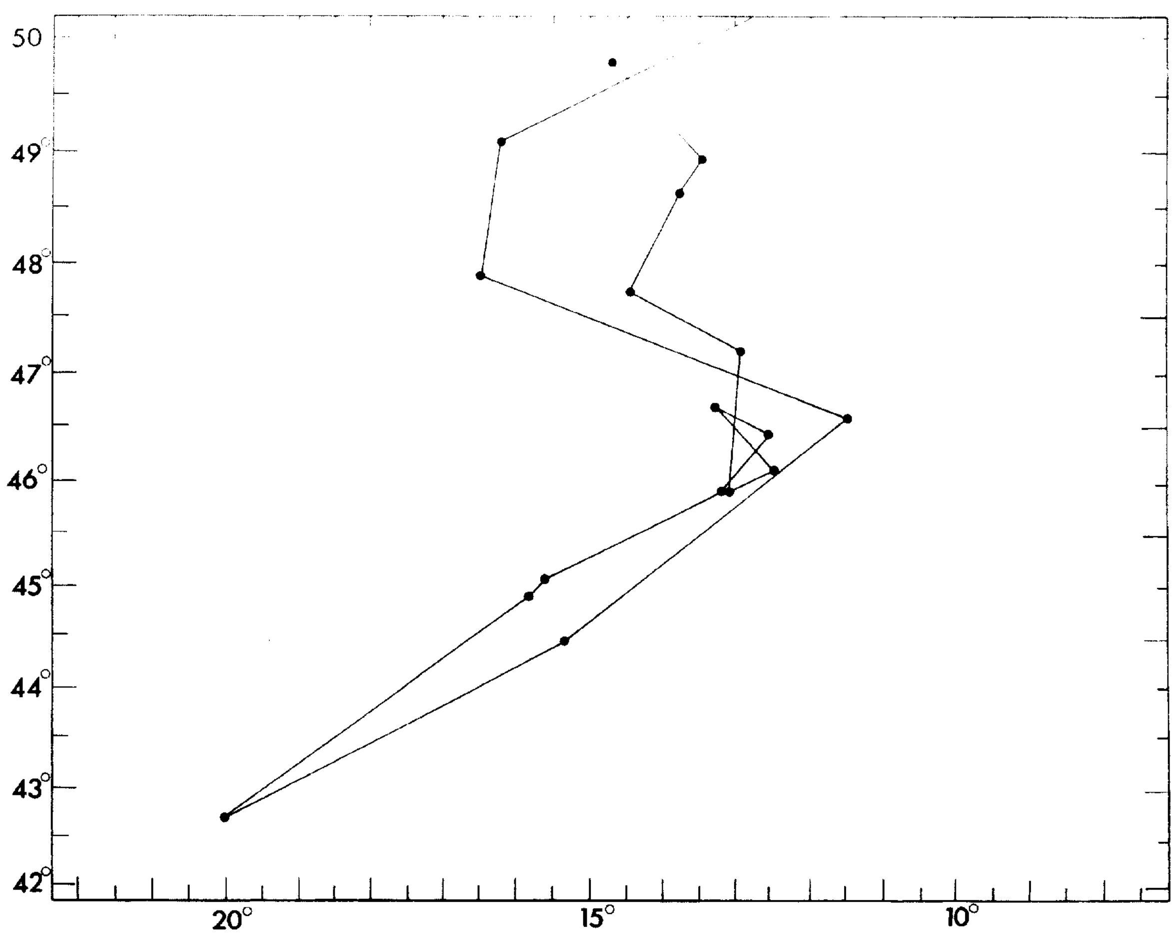
Institute of
Oceanographic Sciences
Deacon Laboratory

RRS Charles Darwin Cruise 63

02 Oct - 25 Oct 1991

Geochemical and geological investigations in the Porcupine Abyssal Plain area

Cruise Report No 232 1992



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CRUISE REPORT NO. 232

RRS *CHARLES DARWIN* CRUISE 63
02 OCT-25 OCT 1991

Geochemical and geological investigations in the
Porcupine Abyssal Plain area

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ABSTRACT

The cruise addressed three main objectives: mapping and sampling of actively-forming and relict metal bands within the sediment; determination of the state of carbonate preservation within the sediment; and investigation of the sedimentation history of the Porcupine Abyssal Plain.

Actively-forming iron bands were found in kasten cores at almost all sites on and above the Plain, except at sites 1 and 8/12. The box corer worked well recovering six good cores for detailed pore water analyses. Subcores were also profiled using newly developed oxygen electrodes. The multicorer failed to return cores on either of its two deployments, and post-cruise modifications will be required before it is suitable for deep-sea work.

The pore water sampler behaved reliably, but its usage was more limited because it had to be deployed over the stern, requiring a good sea state. Further development work is needed to determine sample viability for investigation of the carbonate system.

Inclement weather curtailed sampling in the northern part of the Porcupine Abyssal Plain, but the fourteen piston cores collected in the Southern area should provide adequate coverage for laboratory-based studies of the history of sedimentation and for identification of relict iron bands.

KEYWORDS

ARMORICAN SEAMOUNT
CARBONATES
"CHARLES DARWIN"/RRS - cruise(1991)(63)
FREEN DEEP
IRON
KASTEN CORES
NE ATLANTIC
PORCUPINE ABYSSAL PLAIN
PORE WATER
SEDIMENTATION
TURBIDITES

ISSUING ORGANISATION

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CONTENTS

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ITINERARY

Departed:	Barry	2 October 1991
Arrived:	Newport	25 October 1991

OBJECTIVES

To map more closely the area covered by a metal-rich layer previously identified at two locations within the study area. To search for traces of relict layers within the sediment column.

To determine the time history of preservation of carbonate in the sediments at various depths and sites both on and surrounding the Porcupine Abyssal Plain.

To determine the sedimentation history (including turbidites) of the Porcupine Abyssal Plain over the last few hundred thousand years using piston cores.

NARRATIVE

The majority of the scientific party arrived in Barry on the afternoon of 30 September, by which time most of the gear, including the chemistry analytical container, had been loaded on to the RRS *Charles Darwin*. Installation of the equipment was completed during 1 October and the morning of 2 October.

The *Charles Darwin* sailed from Barry at 14.00z on 2 October. After completing a DF communication calibration, passage was resumed until 18.30z, when the PES and 3.5 kHz fish were deployed. A SW course was set and followed until 10.30z on 4 October, when the vessel hove-to for an hour of preparatory work to be carried out on the midships A-frame. The SW course was then resumed, and at 19.00z a speed of 9 kts was attained following a reduction in sea swell.

We arrived at the first station (CD63 1) at 11.50z on 5 October. This was situated in the middle of the Porcupine Abyssal Plain. The first two instruments to be deployed were the kasten core (from the midships position) and the pore water sampler (over the stern because of its size). These were successful. The multicore was then deployed over the stern A-frame. On recovery, it was noted that all four core tubes had been broken off, all bolts were loose and there was some damage to the frame and plastic components. The sea state and deteriorating weather made further deployments impossible, and the station was terminated at 08.24z on 6 October. A course was set to the position where a bathysnap was to have been recovered and another deployed. This position (CD63 2) was reached at 14.15z, just after a particularly heavy wave had caused the porthole in crew cabin 2 to be stove in. The bathysnap was interrogated and it replied, but the conditions precluded either recovery or further deployment.

A SE course was then set to a station to the East of the Armorican Seamount, where it was hoped that sea and weather conditions would be better. We arrived at CD63 3 at 14.38z on 7 October and deployed the kasten, pH probe, piston corer and box core from the midships position. All deployments were successful except for the pH probe, which did not trolley down into the sediment. The piston core encountered sand, and one of the barrels was bent. A short core was recovered. Conditions were not good enough to launch the pore water sampler (PWS) because of excessive amounts of water being shipped over the stern. On completion of the station, at 13.18z on 8 October, a SW course was set to station 4, a deep water site chosen for the carbonate preservation study.

During the passage, it was noted (24.00z, 8 October) that the PES fish had parted from its cable and had been lost. Examination of the cable showed that corrosion of the connection on to the fish was the cause of the loss.

Sea water was collected for Ocean Scientific International at 10.00z on 9 October. The spare PES fish was deployed on reaching the next station position (15.33z, 9 October). Scientific activities were suspended at 16.00z because of deteriorating weather conditions, and the ship remained hove to on station until 07.50z, 10 October, by which time there had been an improvement, and work could commence with a kasten core. This over-penetrated a soupy turbidite unit. The box core and PWS were therefore omitted because it was considered that they would be unlikely to sample the surface layers. The piston core and pH probe were deployed. The station was completed by 23.36z on 10 October.

The nearest alternative deep water site (5200 m) was the Freen Deep at King's Trough. This site (CD63 5) was reached by 19.52z on 11 October. During the passage leg, the clips on the PES fish cable were checked, and some replaced, and the fish was redeployed at the start of the station. A full station was worked in this area, and was completed by 22.00z on 12 October. The PWS returned to the surface upside down, because the warp had caught round the mirror support. The instrument was successfully righted during the recovery. The termination on the conducting cable used for work over the stern was damaged during the deployment, and could not be repaired because the spare potting compound was out of date. Subsequent deployments over the stern required the midships warp to be transferred. This was easily managed and did not delay the scientific programme.

After the completion of Station 5, a NE course was then followed, heading towards two shallower sites where carbonate preservation studies were to be carried out. The sea swell slowed our progress to the first site (CD63 6), adding twelve hours to the journey. A kasten core was deployed at 09.20z on 14 October. This produced a very short core, which was not processed for pore waters. The piston core and PWS were successful. A further trial of the multicore did not retrieve cores. The tubes were again sheared off, and the instrument was weakened because the bolts loosened. The station was completed at 23.30z on 14 October.

A 3.5 kHz survey was then carried out for ten hours from 23.30z on 14 October, and an optimum position was then chosen for the next and shallowest station (CD63 7). A kasten core was attempted first, but returned empty apart from some rock fragments. In the light of this, the piston corer was then run as a gravity corer with a single barrel. It recovered a short core of stiff carbonate sediment. The PWS was not deployed because of the nature of the sediment, and a NE course was set at 15.00z on 15 October.

The next six stations were undertaken as part of a detailed investigation of the occurrence of actively forming and relict iron bands on and around the Armorican Seamount. Station CD63 8 was sited on the abyssal plain SW of the seamount. The kasten core overpenetrated, and sampled turbidites. A piston core was successful. The next site (CD63 9) was on top of the seamount. Work commenced at 02.00z on 16 October with a kasten which returned a core. This was followed by a pH probe, which failed to trolley down, and then by a box core deployment. Three attempts were then made to obtain a piston core: the acoustics failed to fire the pyro at the first attempt. During recovery of the successful core, the trigger core was lost when it became caught under the coring bucket, causing the chain to shear. There were no injuries. The last instrument to be deployed on this station was the PWS (no core recovered), and work was completed at 17.24z on 17 October. A piston core was then collected at station 10, on the western plateau of the Armorican Seamount. This was a re-occupation of RRS *Discovery* station 11342 (Cruise 160, 1986). A full chemistry station (CD63 11) was then worked on the SE side of the seamount, 42 m above the abyssal plain. This station also provided an opportunity to test a navigation beacon. This was deployed at the commencement of the station (09.20z 18 October), and was recovered before the station finished at 11.00z on 19 October. Station 12 was a re-occupation of Station 8, SW of the Armorican Seamount, and a box core was collected to provide a surface time reference for the turbidites collected previously by the kasten and piston cores. A piston core site (CD63 13) was then selected to the North of the Seamount for turbidite distribution studies. The first coring attempt was unsuccessful, because the pyro released after the corer had been in the bottom, but a core was obtained after a second attempt and the station was completed by 08.42z on 20 October.

The last three sites were chosen to determine the areal distribution of iron bands, and to sample a range of depths on the continental slope SW of Ireland and Great Britain. A full chemistry station was worked at station 14, 284 m above the abyssal plain. This was completed by 10.36z on 21 October. A kasten core at station 15 sampled a debris flow. A piston core was also collected, but the *in-situ* instruments were not deployed. Work commenced at station 16 at 02.20z on 22 October. This was a shallower station (3777 m) on the edge of the Pendragon escarpment. Deployments of the kasten core, PWS, piston core and pH probe were made, the latter being unsuccessful due to a logger failure. The box core was not used because of time constraints, and also because the metal-rich bands occurred below the sampling depth of the corer. The station was completed by 15.41z on October 22. The final station (CD63 17) was a re-occupation of RRS *Discovery* station 11147 (Cruise 149, 1984) for a piston core. This was completed by 01.05z on 23 October. The PES and 3.5 kHz fishes were then recovered, and a ENE course was set for Newport. The vessel entered Baileys dry dock at approximately 09.00z on 25 October.

SC

CORING OPERATIONS

Four different types of corer were utilised on this cruise to provide sediment samples for (i) immediate on-board pore water extraction and oxygen profiling, and (ii) subsequent shore-based compositional, sedimentological and palaeontological solid phase studies. These corer types were:

1. A box corer of IOS design to provide relatively large, undisturbed cores of the upper 0.5 m of the sediment column.

2. A new multicorer device (Bowers and Connelly, Taynuilt) designed to provide 10 cm diameter cores of 0.5 m length, but with a better quality sediment/water interface than obtainable from a box corer.

3. A 15 cm x 15 cm x 2 m open box gravity corer ("Kastenlot", Hydrowerkstatten, Kiel) to provide longer, relatively large volume cores, albeit with a poor recovery of surface sediment (0-10 cm).

4. A piston core of the Driscoll type, to provide long cores of 3, 6 or 9 m length.

The normal practice at each station on the cruise was to run the Kastenlot corer as the first device at each station to determine the nature of the underlying sediments. This provided valuable information for selecting piston corer barrel length and the probe configurations of the pore water sampler and pH profiler at that station.

Kastenlot Coring

Following difficulties with the catcher of this corer pre-triggering on RRS *Discovery* Cruise 187 in 1989, a modification had been made to the standard Hydrowerkstatten catcher. This involved re-design of the catcher triggers and removal of the catcher door springs. It was reasoned that the corer could not pre-trigger in this configuration, and that the lack of springs on the doors would allow a free entry into the sediments. On hauling out, the triggers would give an initial impetus to door closure, and this closure would be completed by the weight of the sediment in the barrel. This modification, suggested by R.D. Peters of the IOSDL Ocean Engineering Group, proved to work very well. The corer was used with eight weights on the weightstand, a 2 m stainless steel barrel and a run-in velocity of 40 m/min at all stations.

The Kastenlot was deployed at Stations 1, 3, 4, 5, 6, 7, 8, 9, 11, 14, 15 and 16. Good cores were obtained at all stations except 6, 7 and 16. Stations 6 and 7 encountered very stiff sediments at water depths of 3224 and 2448 m, respectively, and the resultant cores were very short and free-draining and unsuitable for pore water processing. At Station 16 the corer had apparently entered the sediment at very low speed and had fallen over. The remainder of the cores were satisfactory and revealed that turbidites were present at the deepest water depths on the Porcupine Abyssal Plain, but absent at shallower depths. Turbidite deposition did not appear to have been active in the past 10 ky, but this conclusion requires verification by dating. Well-developed metal-rich horizons were also present at most stations off the plain.

Box coring

The IOS box corer was used with an acoustic command actuating release *via* an IOSDL auto-retractor. In this mode the corer is prevented from pre-triggering. The corer is run into the sediments, and the retractor fired by a command pulse transmitted from the ship. This actuates the corer, so that the first action on hauling is the closure of the corer spades before the corer can be withdrawn from the sediment. On this cruise the corer was run fully weighted with run-in speeds of 30-40 m/min.

The box corer was used on Stations 3, 5, 9, 11, 12 and 14, and at each a good quality core was recovered. This corer performed entirely as planned; its only disadvantage for the purposes of this cruise was that the metal-rich layers being investigated were located just deeper than box coring depth.

Multicorer coring

This new instrument had been tested in shallow water and calm sea states, and this was its first use in NE Atlantic sea conditions. It was deployed only twice on this cruise, at Stations 1 and 6. At both stations the device failed, and all four coring tubes of each run were found to have been snapped off short on recovery. The multicorer had to be operated from the aft A-frame because of its size, where it was subjected to much more load more excursion in swell than it would have done in the preferred midships coring position. As a result of the surging on the wire, the multicorer was clearly vibrating or shaking intensely during deployment, because the entire frame assembly was found to be loose on recovery. The cause of this is almost certainly the T-shaped weightstand bar, and this is felt to be a design failing for deep-sea work.

JT

Piston coring

The piston coring was carried out by RVS and IOSDL technicians using a mix of IOSDL and RVS equipment. Fourteen piston coring stations and one gravity core station (CD63 7) were run, all of which successfully obtained cores. A total of 97 m of core section was recovered and P-wave velocity-logged on board ship prior to stowing in the ship's cold store.

The piston corer was set up with the RVS coring head and the IOSDL trigger arm with its acoustic release. The RVS coring head with the freefall "wire basket" worked very well and simplified the set-up and deployment of the corer. With hindsight, the IOSDL acoustic release was probably unnecessary on nearly all the stations. The midships winch, the corer set-up and the warp proved very stable through the water column. Until now, it has been IOSDL policy to run all piston cores with the acoustic release, but it would be worth reconsidering this in the future when working from *Charles Darwin* in anything other than rough seas.

There were only a few problems with the coring during the cruise. The acoustically-activated trigger arm safety pin failed on two occasions. On Station CD63 9#4P, the acoustics failed to fire the pyro release. This was later diagnosed as a low battery pack and replaced. On Station

CD63 13#1P, the pyro released after the corer had been in the bottom; the pyro was replaced and the station re-run. On Station CD63 9#4P, the trigger corer was lost during recovery when it caught up under the coring bucket and the chain sheared.

On the whole, the piston coring was very successful and the minor problems mentioned above did not prevent us from obtaining fifteen cores from fifteen stations.

DG, DW, KS, MD, SW, JE

PORE WATER EXTRACTION

Pore water extraction was carried out on 214 samples from box and kasten cores. The samples were loaded into 140 ml bottles under nitrogen amd centrifugation was used to separate the pore waters. Abstraction of the pore water was carried out using syringes and tubing in a clean glove bag. Subsequently, the samples were filtered through ready-loaded "Minisart" 25 mm diameter filters (a 5 μm prefilter and a 0.2 μm filter). The use of centrifugation greatly speeded up the sample processing time, especially for kasten cores, as did the use of ready-loaded, disposable filters.

SC, CG, MW

PORE WATER ANALYSIS

Dissolved Oxygen Analysis

Dissolved oxygen was measured in nine kastenlot cores and six box cores using a new design of oxygen electrode. These electrodes had been designed to be less fragile than the traditional micro-electrodes used previously and worked successfully. One box core was also profiled with a micro-electrode which gave similar results to the new electrodes, but it broke on removal from the sediment.

The new electrodes were also deployed on the *in-situ* pH profiler three times. Although the electrodes were apparently undamaged on retrieval, they gave no meaningful data and later developed stress cracks in the glass structure. Useful information on the requirements of *in-situ* oxygen measurement was obtained.

HFC

Nutrient and Trace Metal Analysis

Numbers of samples analysed

Nutrient and trace metal analyses were conducted on 214 samples of pore water extracted by centrifugation, 50 samples from the *in-situ* pore water sampler PWS and bottom water samples collected by the *in-situ* probe.

Treatment of pore water samples

Subsamples of pore water were filtered directly into the auto-analyser cups. Twenty-five µl of 40% v/v hydrochloric acid were placed in the 2.5 ml cup used for the determination of iron, manganese silicate and phosphate, prior to the sample addition to inhibit oxidation of iron (II). One problem with the new method for pore water extraction present was that mud contamination on the outside of the centrifuge bottles was transferred to the auto-analyser cups during sample processing. This may explain the few anomalous iron and manganese values found in oxic sediment, but did not otherwise appear to be a problem for the shipboard analyses. Samples collected for trace metal analysis may be similarly affected.

Analytical methods

The analytical methods used were the same as on previous cruises, (D135, D149, D160, D177, D187).

On previous cruises, residual nitrate concentrations of less than 3 µM have been detected in anoxic sediment. Previously, these had been thought to be due to contamination from the hardened filter paper used in the squeezer units. However, such residual nitrate concentrations were also present in samples of anoxic water collected on this cruise using centrifugation.

All aspects of the centrifugation process were checked for the source of the contamination. The syringes used for withdrawing the samples from the centrifuge tubes were found to be a source for nitrate. This was of similar magnitude to the residual nitrate found in the samples. Washing of the syringes with sea water prior to use was therefore instigated. This appeared to remove the contamination from the syringes but the samples still exhibited residual nitrate. Another possibility was that the nitrate results from bacterially-mediated nitrification of the ammonia present in the samples. Poisoning the samples with chloroform was therefore attempted for one set of samples. No significant difference in the residual nitrate was found between the poisoned set of samples and the normal set of samples. Although the source of nitrate contamination in the samples was not identified, the erratic amounts of nitrate in the samples still suggests that it is contamination rather than a real signal.

Data collection

A new version of the peak analysis software used on previous cruises was employed on this cruise. This uses an Acorn BBC-Master computer and an IOSDL-built A-to-D converter. The major changes to the software are: it now fits a third order equation to the data instead of a linear fit - this is more appropriate to the shape of the output from the analyser colorimeter - and, the data is saved to a disc file which can be converted to an IBM format comma-separated value file which can be read by spreadsheets such as "Excel".

All analytical data collected on the cruise was stored in "Excel" spread sheets and plotted using "Cricket Graph".

DJH

IN-SITU PORE-WATER SAMPLER (PWS III)

Due to the inclement weather which dominated the early stages of this cruise, only seven lowerings of the pore water sampler were possible, compared to seventeen on *Discovery* Cruise 187. The progress with improving the operation of the instrument which was made prior to and on D187 was continued on this cruise. The PWS III can now be considered to be a reliable piece of oceanographic gear. The most obvious improvement on this cruise is that the coring attachment is now working reliably.

The PWS III was operated over the stern of *Darwin* because of its size. Considering the heavy swells which were running during six of the seven deployments, launch and recovery of the instrument went smoothly on all occasions except the first. On that occasion, one of the steadying lines failed to disengage and the instrument had to be brought out of the water to free the line. While this was being done, it hit the stern of the ship hard, twice, but no damage occurred.

During the second deployment, the instrument sustained minor damage when the wire tangled round the sampler on lifting off from the bottom. The wire fouled round one of the stabilising leg mountings and the mirror mounting but did not form a knot. The instrument was upside down when it came out of the water. It was landed on its side and the wire was freed before being repositioned on to the frame. The leg mounting was bent, the mirror twisted out of position, some of the electrical cabling had been stressed and one of the long legs was missing. Subsequently to this drop, the second reed switch on the sample manifold failed to activate the pinger. The switch and leads were replaced but it still did not work. This suggests a fault in the pinger itself.

The sampler was landed at 0.5 m/s and then 50 m of extra wire were paid out. After that, the winch continued to pay out wire at the minimum possible rate. At the end of the sampling operation, there were between 200 and 300 m of extra wire out. On hauling, lift-off occurred with between 10 and 40 m more wire out than at touch down; this suggests, particularly given the poor weather conditions during the cruise, that the ship's position-keeping abilities are improved now that GPS is available round the clock.

The volumes of sample and lengths of core recovered are summarised in Table 1. Neoprene O-rings were used as piston rings on this cruise instead of the silicone rubber which had been used previously. The volumes of sample recovered on this cruise in the different depth ports better reflect the likely change in water content of the sediment with depth than has been the case on previous cruises.

For the PWS to work successfully when water is drawn into the sample ports, it must come from the volume of sediment immediately opposite the sampling port. If water is able to leak down the side of the probe from the surface during sampling then bottom water, rather than sediment interstitial water, will be sampled. The degree to which sediment seals around the probes after they have penetrated the sediment depends on the type of sediment, the angle at which the probes enter the sediment and the amount of horizontal movement of the probes as they enter the sediment. On cruise D187, cones were fitted on the sections of each probe which were at the top of the sediment with the idea of forcing good contact with the sediment and so stopping bottom water leakage. Less bottom water leakage occurred as a result.

Waters collected from the coned ports on D187 all contained detectable concentrations of Mn. To compare what effect the cones were having, they were left off the probes for the first three drops (Stations 1, 5 and 6) on CD63 until samples of analysable quantity had been collected at Station 6. No Mn was detectable in waters from the top of the sediment column at this site. At Station 9, relatively high Mn concentrations were found in the coned ports. At later stations, the cone spigots were washed thoroughly before fitting and the amount of detected Mn declined. This suggests that the detected Mn may be contamination. The contamination potential of the spigots must now be checked in the laboratory.

Inspection of the silicate data, (the best indicators of bottom water contamination) shows that fitting the cones improved the integrity of the samples, but at Station 9 the samples collected in the longest probe, #4, were largely bottom water. This probe, when set up to its design length, starts to enter the sediment before the descent of the plate has come under the control of the ram valve. For all subsequent drops, the probe lengths were shortened so that the ram valve was in circuit before they entered the sediment. (This requires confirmation in the workshop.) After this modification, the integrity of the samples improved but the sample concentrations from probe #4 (now not the longest probe) on the last two drops, were still low. The only explanation to account for this is that bottom roughness may have meant that the probe was not, in fact, as deep in the sediment as its depth relative to the bottom sensor would suggest that it was. This would also result if the frame did not land flat on the sediment. The new cursor system on the PES means that the displacement can now be read to a precision of about 2 m in 570 m. When the PWIII is vertical, the displacement of the accelerometer from the reference pinge is 570 m. The displacement was 517 m indicating that the frame was not 'flat' on the surface.

Total CO_2 and pH analysis

The analytical emphasis for the samples from the PWS on this cruise was the carbonate system. The filter combination used on previous cruises was again used. This was a Whatman 54 paper as pre-filter in front of a Nuclepore 0.4 μm sandwiched in plastic tape and backed by a nitex screen. The filter diameter was 16 mm. All the filters remained intact on all drops.

On recovery, the probes were removed and taken to the constant temperature laboratory where they were re-equilibrated to bottom water temperature (4°C) for an hour. This was done to minimise precipitation of $CaCO_3$ and loss of CO_2 by degassing. Samples were also extracted in the constant temperature laboratory. The samples were relatively gas free, except for those from the last station where the cooler was switched off, allowing the probes to warm to 15°C before being cooled down again to 4°C. Ideally, PWS sampling should be done at night to minimise temperature contrasts.

Measured pHs were higher than expected. The measurements appeared to become more consistent as the cruise progressed. Storage of the standard sea water reference solution in the probes in the cold room produced only a relatively small change in pH.

Total CO_2 measurements followed a set trend but were high. This was not consistent with loss of CO_2 by degassing the samples. Problems were encountered with Probe 4, thus giving dubious counts. (A contamination test was tried on Probe 4.) More storage tests need to be carried out on the probes back in the laboratory. A cleaner environment may be needed and lint-free wipes should be used for cleaning around the sampling ports.

The *in-situ* profiler was only successful at returning a sample at three stations, but good duplicate measurements were obtained.

Reproducibility was checked by running sub-standard test samples, and using freshly-opened ampoules of Standard Sea Water.

A few problems were encountered while maintaining the CO_2 equipment, *e.g.* occasional leaks in the system, and blockages in the frits of the Coulometer cells (these proved very difficult to clear). The system was found to take a very long time to settle after the bubbling solution was changed. The computer for the CO_2 analysis was unreliable and crashed, particularly after periods of heavy usage.

DJH, CG, WB

IN-SITU pH/POROSITY/Eh PROFILER

The pH/resistivity profiler was deployed from the midships winch seven times during the cruise. The equipment proved easy to deploy and recover from this position, even in heavy swell conditions.

Extra lead weights had been added since Cruise D187, which made it possible to lower the instrument at a speed of 50 metres/minute without kiting occurring.

During early deployments, a problem emerged with the instrument trolley, which would not run down its guides. This was eventually traced to a blockage in the "rate-of-fall" needle valve, although it was not possible to ascertain what was causing the blockage, or how it was getting into the hydraulic system.

It was decided to revert to the fixed, restrictor pipe system used on D187. The full travel was then restored but without the option to vary the rate of fall.

Initial impressions were that the pH profiles were noisier than on D187; the University of Liège scientific party reported difficulties with their electrodes but it is not certain that this was the problem.

Resistivity was logged well, with no unexpected problems.

It was decided to try an experimental redox potential (eH) electrode and this gave coherent-looking profiles, although the interpretation of these is still being discussed.

An *in-situ* oxygen sensor based on the successful lab. prototype was deployed at Stations 9, 14 and 16. The results from runs 9 and 14 were inconclusive although data were logged. At Station 16, the glass sensor was found on recovery to have broken off and the pre-amplifier flooded with sea water.

Corrosion problems on the frame, which were experienced on previous trials, appeared to have been eliminated by the frame re-design. Data recovery was good, although it is clear that further development of the sensor systems is needed and minor changes to the hydraulics to prevent valve blockage will also be required.

ACB, DW, SPW

ACOUSTICS AND TELEMETRY

Acoustics/electronics

CR200 acoustic releases were used on the piston corer and the box corer to arm them at the sea bed. CR2342 was used on the box corer and operated without any problems. CR2108 was used on the piston corer and operated without problems until Station 9. It failed to fire the pyro, although it worked on the deck when it came back aboard, so it was replaced with CR2414 which was used without problems for the remainder of the cruise.

A number of pyros showed evidence of pulling apart before the rod had melted through, and one piston core failed to trigger, probably due to the pyro not pulling apart. A longer run-in of 100 m to help shake the pin free was adopted.

The beacons on the pH profiler and the pore-water sampler required no attention.

The 10 kHz beacons used for coring were used without incident, apart from a change of batteries.

An acoustic transponder was deployed on a test mooring during Station 11. CR2402 was used to release the rig, and the high-speed design worked well. Deployment time in 4700 m was 36 minutes (130 m/min or 2.2 m/s) and recovery took 49 minutes (95 m/min or 1.6 m/s). The rig was deployed anchor first on the double-barrelled capstan through the A-frame, and recovered by hoisting the buoyancy on deck and recovering the electronics packages by hand. Lengths were: anchor strop, 5m; release to package, 100 m; package to buoyancy, 25 m; 12 m stray line, 250 kg anchor and 4 x 17" spheres. Initial analysis indicated that the transponder had performed data transmission over ranges of 0.5 to 0.8 miles.

Acoustic deck gear consisted of a waterfall display on a Viglen III/25 fed from an OIG amplifier from the fish. FM transmission was from the Mark-III deck units. These and the SIMRAD echo sounder were run through the hull transducers.

A bathysnap at 48°51.4'N, 16°29.2'W was interrogated. It was found to be in position and responded normally. Inclement weather precluded recovery of it, and the deployment of another unit.

DW

EQUIPMENT: RVS

SIMRAD EA 500

The SIMRAD EA 500 echo sounder operated well throughout the cruise without any electronic failures. There were a few problems during the first half of the cruise with the echo sounder failing to give consistent depth readouts. This was mainly due to operating the system in conjunction with the hull transducer in rough seas. Had the PES fish (which was being used with the IOSDL waterfall display) been employed in this respect, more consistent bottom depths would have resulted.

The loss of the PES fish was regrettable and probably due to corrosion of the two cable.

JW

3.5 kHz profiler

The 3.5 kHz profiling system generally worked well during the cruise, with the correlator and transceiver exhibiting no failures. The only faults were associated with the recorder causing approximately 24 hours' 'down-time' in total.

JW

ENGINEERING

No problems were encountered during the whole cruise with the main winches. Approximately fifty deployments were made at depths varying to maximum of 5621 metres of wire paid out. Considering a maximum available wire length of 5750 m, due to a short notice warp replacement, the main winch looked a little bare at times! Use was made of both starboard and stern A-frames for the deployment of the core warp; this did not really hinder station work as the re-routing of the cable was carried out without any mishap on numerous occasions.

The piston coring deployment bucket and davits functioned without any major problems. There were only a few minor hydraulic leaks.

KS, MD, SW, JE

SUMMARY

The cruise addressed three main objectives: mapping and sampling of actively-forming and relict metal bands within the sediment; determination of the state of carbonate preservation within the sediment; and investigation of the sedimentation history of the Porcupine Abyssal Plain.

Actively-forming iron bands were found in kasten cores at almost all sites on and above the Plain, except at sites 1 and 8/12. The box corer worked well recovering six good cores for detailed pore water analyses. Subcores were also profiled using newly developed oxygen electrodes. The multicorer failed to return cores on either of its two deployments, and post-cruise modifications will be required before it is suitable for deep-sea work.

The pore water sampler behaved reliably, but its usage was more limited because it had to be deployed over the stern, requiring a good sea state. Further development work is needed to determine sample viability for investigation of the carbonate system.

Inclement weather curtailed sampling in the northern part of the Porcupine Abyssal plain, but the fourteen piston cores collected in the Southern area should provide adequate coverage for laboratory-based studies of the history of sedimentation and for identification of relict iron bands.

ACKNOWLEDGEMENTS

On behalf of the scientific party, I wish to record my thanks to the Master, officers and crew of RRS *Charles Darwin* for their unstinting efforts in support of the scientific programme.

I also wish to express my gratitude to the scientific party for their hard work, enthusiasm and encouragement, despite the adverse weather conditions during the early part of the cruise.

SC

TABLE 1 – Station List for CD63

Station Number	Date	Latitude °N	Longitude °W	Equipment	Mean Water depth (m. uncorr.)	Time (z) Out	Time (z) In	Notes
1#1	5/10	19°03.0'	16°11.9'	Kasten core	4818	12.15	15.50	1.83 m core
1#2	5/10	49°02.5'	16°10.9'	Piston core	4817	16.45	21.00	8.33 m core with three barrels
1#3	5.10	49°01.8'	16°13.4'	PWS	4818	22.06	01.46	0.65 m core, 65 ml pore water
1#4	6/10	49°03.0'	16°19.5'	Multicore	4812	03.36	08.09	No cores. Core tubes sheared below plate
2#1	6/10	48°50.7'	16°29.9'	Bathysnap		14.15		Interrogated satisfactorily
3#1	7/10	46°31.9'	11°32.2'	Kasten core	4775	15.21	19.19	0.93 m core
3#2	7/10	46°30.2'	11°31.6'	pH probe	4772	20.35	00.30	
3#3	8/10	46°30.5'	11°31.1'	Piston core	4775	01.15	05.40	4.86 m. Corer hit sand: bent barrel
3#4	8/10	46°30.8'	11°30.2'	Box core	4772	08.36	12.15	Good core: 0.52 m
4#1	10/10	44°22.3'	15°25.0'	Kasten core	5463	08.33	12.49	Overpenetrated up weightstand. 1.93 m in core barrel
4#2	10/10	44°14.4'	15°25.7'	Piston core	5463	19.34	24.00	7.90 m core from three barrels
4#3	10/10	44°22.2'	15°24.0'	pH probe	5463	19.52	23.58	
5#1	11/10	42°41.9'	20°00.6'	Kasten core	5283	19.52	23.58	1.82 m core (Repenetration)
5#2	12/10	42°42.3'	19°58.5'	PWS	5283	00.36	06.12	No core or pore water
5#3	12/10	42°41.7'	19°58.7'	Piston core	5283	07.20	12.20	7.31 m core from three barrels
5#4	12/10	42°41.4'	20°01.7'	Box core	5287	13.00	17.12	Good core: 0.48 m
5#5	12/10	42°42.1'	19°59.7'	pH probe	5281	17.56	21.39	
6#1	14/10	44°53.8'	15°50.0'	Kasten core	3204	09.20	11.54	0.32 m core
6#2	14/10	44°53.3'	15°50.6'	Piston core	3221	12.44	15.20	3.51 m core from three barrels
6#3	14/10	44°54.4'	15°49.1'	PWS	3221	16.21	19.50	0.70 m core, 242 ml pore water
6#4	14/10	44°53.7'	15°49.2'	Multicore	3226	20.31	23.03	No cores. Core tubes sheared below plate
7#1	15/10	45°02.2'	15°39.1'	Kasten core	2448	10.18	12.15	No core. Stones in catcher
7#2	15/10	45°01.2'	15°39.6'	Gravity core	2448	12.59	14.51	0.41 m core with one barrel
8#1	16/10	45°50.5'	13°07.0'	Kasten core	4787	02.00	05.33	Overpenetrated up weightstand. 1.93 m in core barrel.
8#2	16/10	45°53.2'	13°06.2'	Piston core	4793	06.5	10.27	7.9 m core from three barrels
9#1	16/10	46°23.8'	12°32.8'	Kasten core	3849	14.49	17.45	1.78 m core
9#2	16/10	46°25.1'	12°32.1'	pH probe	3895	18.11	22.07	
9#3	16/10	46°25.3'	12°32.4'	Box core	3892	22.35	01.26	0.38 m core
9#4	17/10	46°24.9'	12°33.8'	Piston core	3863	02.42	05.46	Pyro failed to fire. No core.
9#5	17/10	46°24.9'	12°33.8'	Piston core	3892	06.15	09.20	Release failed to fire. No core.
9#6	17/10	46°25.2'	12°35.8'	Piston core	3892	09.33	12.30	6.47 m core from three barrels
9#7	17/10	46°25.1'	12°33.8'	PWS	3892	13.39	17.06	No core, 214 ml pore water
10#1	17/10	46°37.8'	13°16.4'	Piston core	4522	23.42	02.57	6.27 m core from three barrels

TABLE 1 – Station List for CD63 (continued 2)

Station Number	Date	Latitude °N	Longitude °W	Equipment	Mean Water depth (m. uncorr.)	Time (z) Out	In	Notes
11#1	18/10	46°04.6'	12°28.9'	Acoustic beacon	4643	09.20	10.22	Deployment
11#2	18/10	46°04.3'	12°28.3'	Kasten core	4744	10.55	14.25	1.78 m core
11#3	18/10	46°03.6'	12°29.2'	pH probe	4746	15.30	18.58	
11#4	18/10	46°04.1'	12°28.3'	Box core	4740	19.15	22.38	0.45 m core
11#5	18/10	46°03.3'	12°28.1'	Piston core	4749	23.51	03.37	8.14 m from three barrels
11#6	19/10	46°03.7'	12°27.4'	PWS	4749	04.25	08.41	0.45 m core, 120 ml pore water
11#7	19/10	46°04.4'	12°28.6'	Acoustic beacon		09.29	11.00	Recovery
12#1	19/10	45°52.5'	13°04.9'	Box core	4789	14.07	17.16	0.51 m core
13#1	20/20	47°09.4'	12°54.4'	Piston core	4613	02.12	04.53	Pyro did not fire completely. No core.
13#2	20/10	47°10.3'	12°55.4'	Piston core	4608	05.06	08.42	2.79 m core from two barrels.
14#1	20/10	47°40.0'	14°25.8'	Kasten core	4534	15.42	18.30	1.77 m core
14#2	20/10	47°40.0'	14°25.6'	pH probe	4535	18.48	22.00	
14#3	20/10	47°39.8'	14°25.5'	Box core	4540	22.26	01.39	0.52 m core
14#4	21.10	47°40.3'	14°26.1'	Piston core	4540	02.38	06.00	4.72 m core from three barrels
14#5	21/10	47°40.5'	14°23.5'	PWS	4540	06.34	10.36	0.4 m core, 218 ml pore water
15#1	21/10	48°34.8'	13°44.8'	Kasten core	4446	16.05	19.04	1.65 m core
15#2	21/10	48°34.4'	13°44.8'	Piston core	4446	19.29	23.15	4.95 m core from three barrels
16#1	22/10	48°54.2'	13°27.4'	Kasten core	3777	02.20	04.45	No core
16#2	22/10	48°54.9'	13°28.6'	PWS	3785	05.10	08.45	0.70 m core, 147 ml pore water
16#3	22/10	48°54.7'	13°27.2'	Piston core	3740	09.40	12.00	6.18 m core from three barrels
16#4	22/10	48°55.3'	13°27.8'	pH probe	3676	12.35	15.41	
17#1	22/10	49°42.8'	14°40.6'	Piston core	4343	21.58	01.05	6.44 m core from three barrels

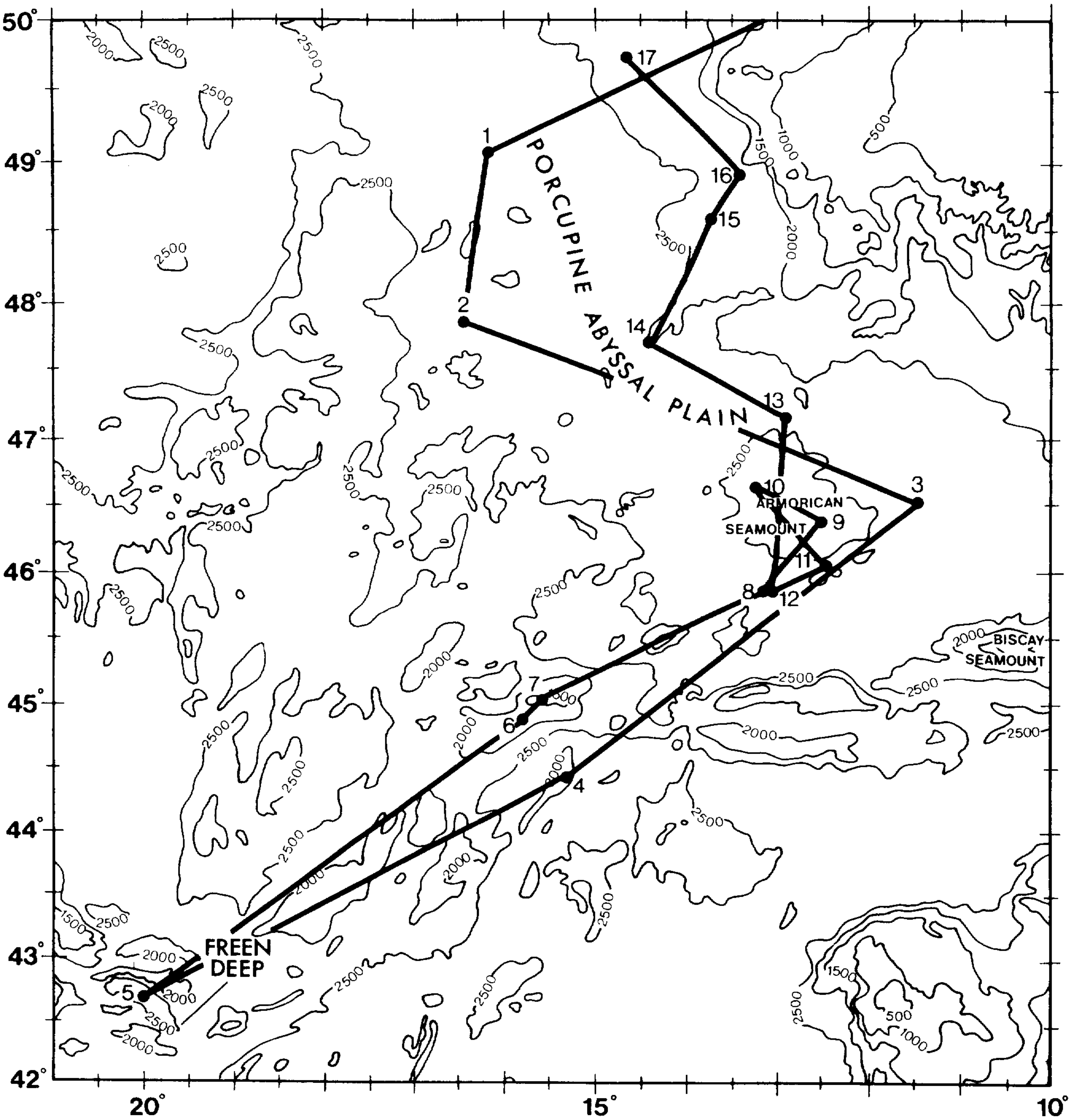

Figure 1. Track chart: RRS *Charles Darwin* Cruise 63, 02 Oct - 25 Oct 1991.