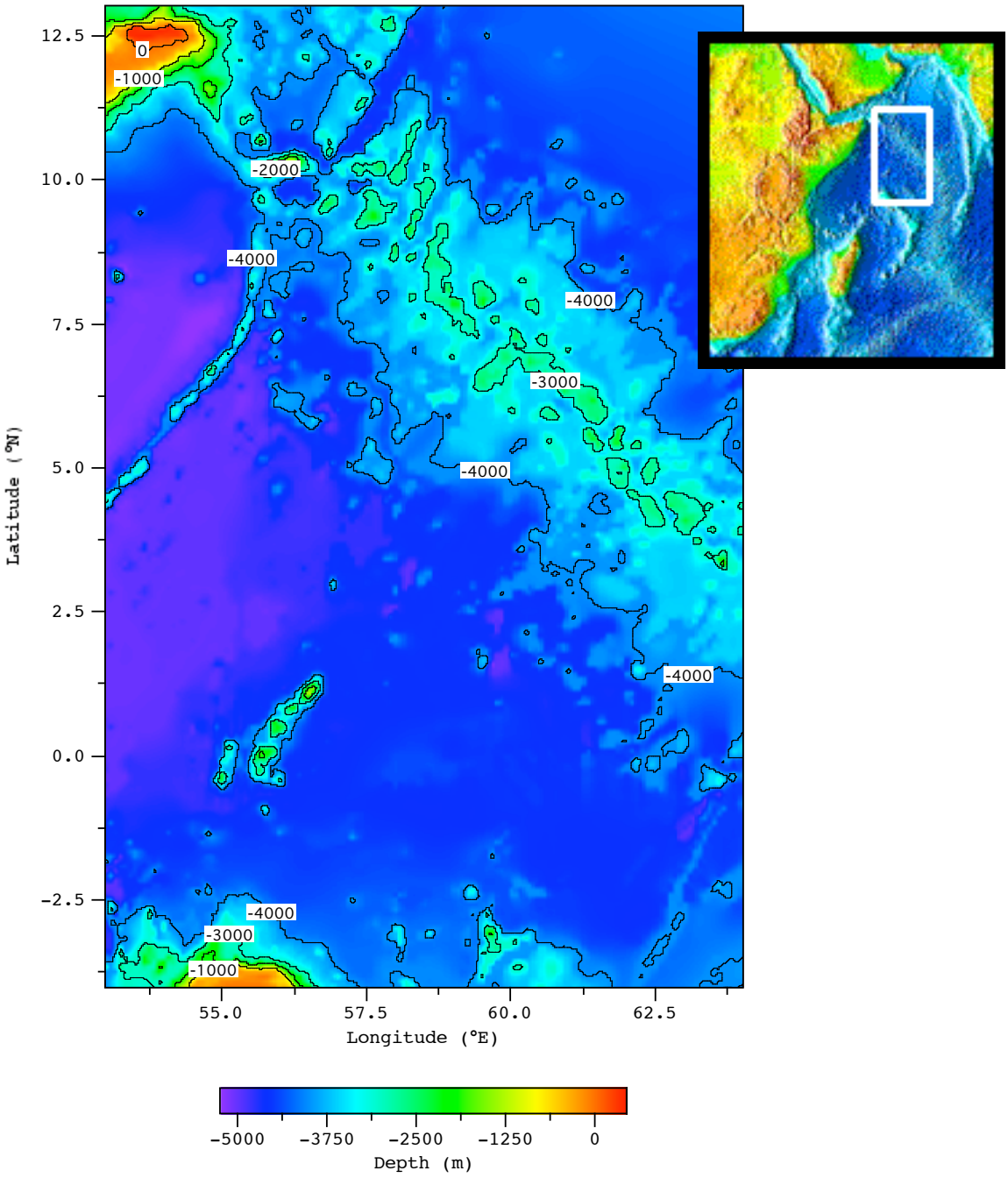
Cruise Report: CD149 – RRS Charles Darwin
18th July to 6th August, 2003

Spreading-ridge geometry, hydrothermal activity, and the influence of modern and ancient hotspots on the Carlesberg Ridge - Northwestern Indian Ocean.

PI: B. J. Murton
Co-PI: R. N. Taylor
Southampton Oceanography centre, Empress Dock, European Way, Southampton, SO14 3ZH, UK



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1. Summary

Cruise CD149 on board the RRS *Charles Darwin* aimed to explore the Carlsberg Ridge, Northern Indian Ocean. The cruise recovered multibeam swath bathymetry (EM12), dredge samples from 20 stations, water column profiles from 16 stations and water samples from one station, between 57 and 61.5°E. The initial results were: a discovery of a hydrothermal super plume – a plume signal rising 1200m above the seafloor and extending 30km along the ridge crest (named by the ship's company as the iGass Plume); recovery of an extinct hydrothermal site with oxidised sulphide chimney fragments; imagery of a megamullion site with recovery of dolerite, flazer gabbro and moderately fresh peridotite from a core complex of lower crust and upper mantle; and fresh basaltic glass samples from 95% of the sites sampled.

Until this cruise, the western Carlsberg Ridge was almost unknown, with only two or three poorly located rock samples, no continuous bathymetry, only a few single-track geophysics lines and no exploration for hydrothermal activity. However, the ridge is important since it probably includes the unradiogenic end-member of the Indian Ocean mantle source (at its eastern end), is likely to have a distal influence from the Afar hotspot (at its western end), and has a history of recent changes in spreading geometry reflected in an unusual segmentation pattern. It also represents a distal portion of the mid-ocean ridge system that is connected through its eastern end only, thus having significant implications for the dispersal and colonisation of hydrothermal ecosystems.

2 Scientific background

The vertical or horizontal extent of mantle melting, its depth, and the extraction and delivery of melt from the asthenosphere to the lithosphere are all thought to be affected by temperature, composition and strain rate[1]. Numerical models indicate hot and buoyant asthenosphere, associated with mantle plumes and hotspots, migrates towards active mid-ocean ridges where it is consumed by seafloor spreading[2,3]. This lateral flow appears to be disrupted by lithospheric barriers, such as [long-offset] transform faults, causing a marked change in hotspot influence to either side[4]. Melt inclusions in phenocrysts from MORB lava offer a unique way of preserving aliquots of melt during or before mixing in sub-axial magma chambers[5,6] thus providing a window into melt formation and delivery to spreading systesm[7,8,9]. Applying these petrological techniques to samples from the Carlsberg Ridge (Fig. 1) can define the source and origin of melt fractions along the axis and provide crucial data toward a general understanding of the construction of oceanic lithosphere and mantle interaction in the vicinity of hotspots and plumes. A background to the Carlsberg Ridge is summarised in Appendix 1. Sampling along the Carlesberg Ridge provides an opportunity to test the hypothesis that the Afar hotspot affects the ridge across the Owen fracture zone. Also, it offers the chance to test whether there is an ancient and inherited signature from the Deccan hotspot.

3 Scientific rational

3.1 To test the hypothesis that hot mantle migrates away from the Afar plume towards the Carlsberg Ridge to the east.

The Afar hotspot affects the opening of the Red Sea-Gulf of Aden and East African Rift system by promoting mantle melting and volcanism. The Carlsberg Ridge also appears to exhibit a hotspot influence[10]. To the west of the north-south trending, 300km-long Owen Fracture Zone (OFZ) the spreading ridge and crust are relatively shallow (deeper than 1700m). To the east they are predicted (Sandwell and Smith, 1999) to get progressively deeper (towards 4400m). This indicates thicker crust and hotter or less dense asthenosphere to the west of the OFZ, consistent with a model for eastward migration of hot mantle away from the Afar hotspot along the spreading ridge.

3.2 To assess the timing of impact and compositional variation through time of the Afar plume as recorded by the Carlsberg Ridge.

Recent studies reveal that lateral plume migration and its complex interaction with the surrounding mantle can be traced geochemically[11]. The most diagnostic isotope systems are $^{3}He/^{4}He$ and Pb, which can distinguish primordial, deep mantle sources from asthenospheric components. In the case of the Afar plume, the hot, enriched mantle source of the plume head is encroaching on the Carlsberg spreading centre and is likely to be polluting its upper mantle source.

3.3 To use double spike, high-resolution Pb isotopic studies to define the Indian Ocean mantle end-members and examine the variation in mantle source along the ridge.

Indian Ocean ridge volcanics, including the Carlsberg Ridge, are known to have a distinctive Pb isotopic signature generated by >100Ma of contamination by DUPAL hotspots (e.g. Reunion). The unradiogenic Indian Ocean mantle is similar to the mantle wedge beneath the Western Pacific forearc. Studies of the pristine Indian Ocean mantle will yield information on the subduction factory process.

3.4 To test whether the Carlsberg Ridge has a spreading history possibly involving recent changes in direction, thought to have caused compression across the active part of the Owen Fracture Zone.

Bathymetry data from the EM12 multibeam system will be used to define relative plate motion and absolute spreading directions.

3.5 To test the hypothesis that core complex formation is related to shortening of ridge segments and a decrease in magma supply.

Studies of melt inclusions show variations in composition of crystal-hosted melt inclusions that reflect changes in mantle temperature and the diversity and depth of extraction of melt from the asthenosphere. We will address the effect that changes in mantle temperature, independent of spreading rate, have on the generation, extraction and delivery of melt in the formation of oceanic crust by examining melt inclusions and basaltic glass composition.

3.6 To constrain the water content of melts along the ridge and provide indirect constraints on the water content of the source region of the melts, which is crucial to understanding the thermal implications of melt generation.

Numerous lines of evidence suggest that the sub-lithospheric mantle has a heterogeneous distribution of water[11,12]. Whereas, N-MORB is likely to be anhydrous, containing only 100 –200ppm H_2O, E-MORB and Ocean Island Basalts suggest derivation from a water-rich mantle with 200-550ppm H_2O ([13,14,15]). We will estimate the water content of olivine crystals from basalts dredged along the Carlsberg Ridge, by non-polarised Fourier Transform Spectrosocopy.

3.7 To explore for evidence of active hydrothermal systems, laying the ground-work for future investigations of vent biogeography.

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4. Methodology

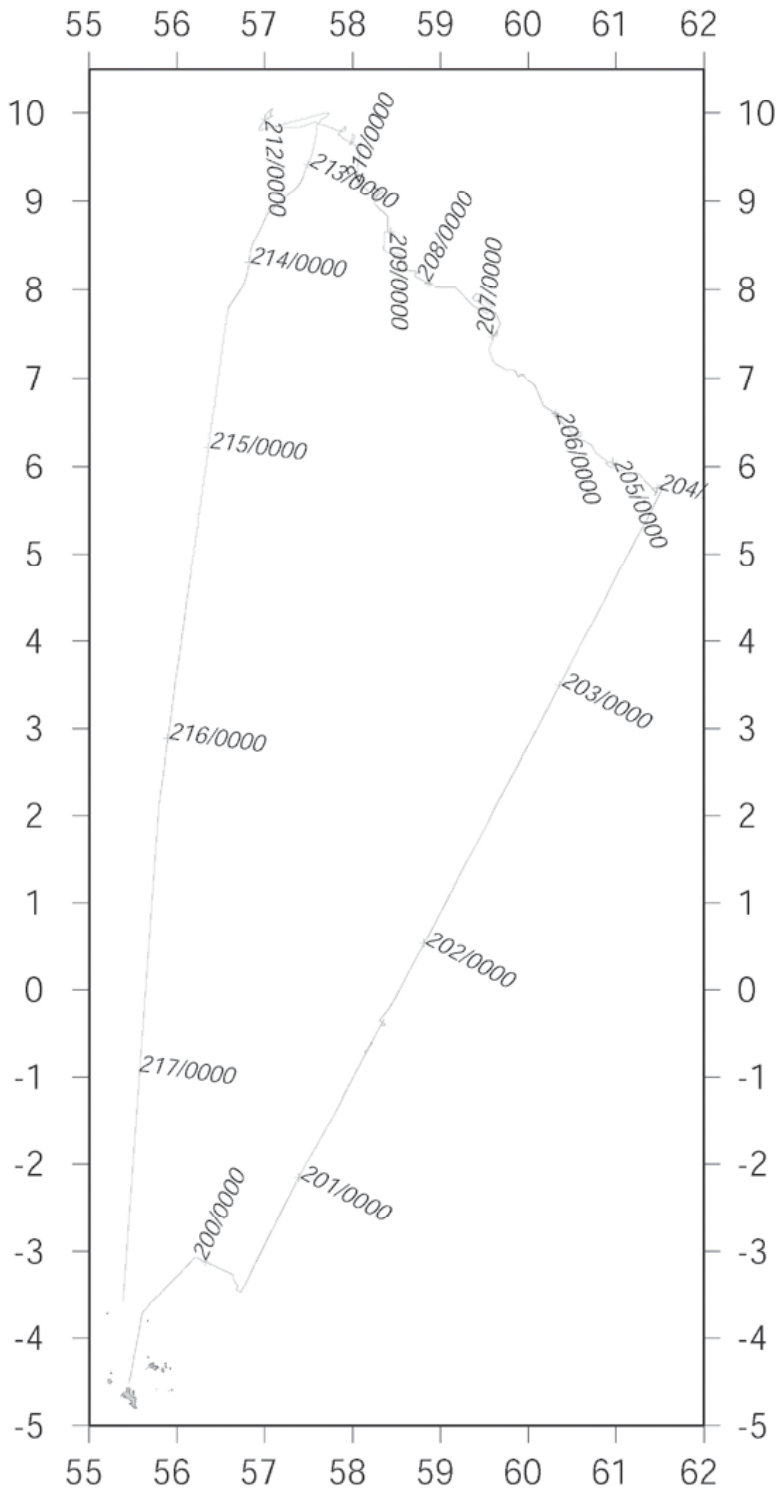
On the basis of available bathymetry (GEBCO) and satellite-derived gravity, the active Carlsberg Ridge axis was located for sampling by dredging. Sample sites were selected on the basis of multibeam bathymetry acquired and processed *in situ*. About twenty dredging sites were chosen (see Appendix 1 for methods). In addition, MAPRs (Mini Autonomous Plume Recorders) were attached to the dredge wire and recorded depth, pressure, temperature and particulate backscatter. A CTD was also deployed to extract sound velocity profiles and sample the water column using a 24 niskin-bottle rosette. In addition, XBTs were deployed at regular (daily) intervals.

The weather was poor throughout the cruise. Southwest Monsoon winds of 20 to 30 kts maintained a sea-state of Force 8-9. As a result, passage between stations was slow, station keeping difficult and handling equipment on deck required special procedures and safety considerations. These are described in the appendix. A consequence of the high swell height and waves, CTD operations were not possible for most of the cruise.

Dredge recovery during SW Monsoon conditions.

4.1 Track chart

Latitude and longitude in degrees East and North. Time stamps in Julian Day and GMT. See appendix for list of dredge sites and sample recovery.



4.2 Highlights

Samples recovered were mostly basaltic. However, the SIMRAD EM12 showed a megamullion structure at 9° 06.37'W, 58° 19.27"N with striated seafloor structures oriented perpendicular to the spreading direction and a large, shallow inside corner high. Dredges WP15 and WP16 recovered peridotites, sheared gabbros and dolerites from this locality.

Large mega-plume discovered at WP4 and WP5: 5° 41.68'N; 061° 28.00'W and 5° 53.95'N; 061° 13.4'W respectively with particulates in water column 1200m above the seafloor and forming a plume 500m thick. The plume was found over 25 km apart at the two stations.

5 Results

5.1 Dredge locations CD149

See appendix for summary of dredge stations

Way Point	year	date	time	Lon	lat
2	3	200	02:00:00	3 14.80S	56 35.93E
3	3	200	08:30:00	3 23.77S	56 41.88E
4	3	203	17:18:00	5 43.73N	61 27.84E
4a	3	203	23:30:00	5 44.92N	61 28.34E
5	3	204	13:35:00	5 53.95N	61 13.40E
6	3	204	23:25:00	6 3.10N	60 58.17E
7	3	205	11:30:00	6 20.71N	60 36.11E
8	3	205	21:00:00	6 36.27N	60 20.76E
9	3	206	07:30:00	7 2.50N	59 57.05E
10	3	206	20:00:00	7 29.34N	59 38.54E
11	3	207	07:15:00	7 52.47N	59 28.64E
13	3	208	03:17:00	8 12.40N	58 45.57E
14	3	208	15:02:00	8 22.71N	58 34.32E
15	3	209	09:46:00	9 5.40N	58 19.34E
16	3	209	17:07:00	9 9.25N	58 16.94E
17	3	210	06:00:00	9 44.18N	58 1.77E
19	3	211	19:00:00	9 58.23N	57 5.84E
18	3	212	11:10:00	9 55.31N	57 38.43E

5.2 MAPR and hydrothermal plume exploration

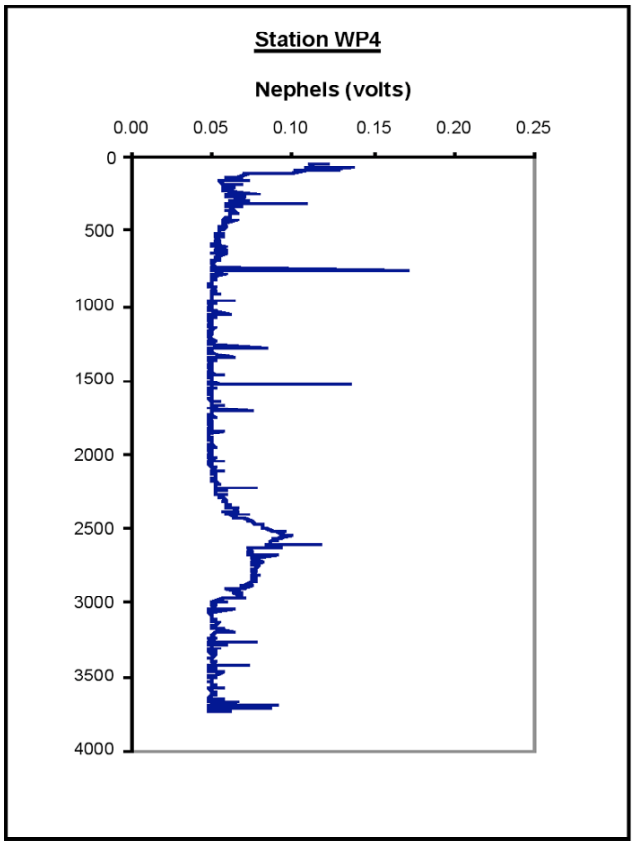
MAPRs (miniature autonomous plume recorder) are self-contained instruments that record data from pressure, temperature and nephelometer sensors. The instruments

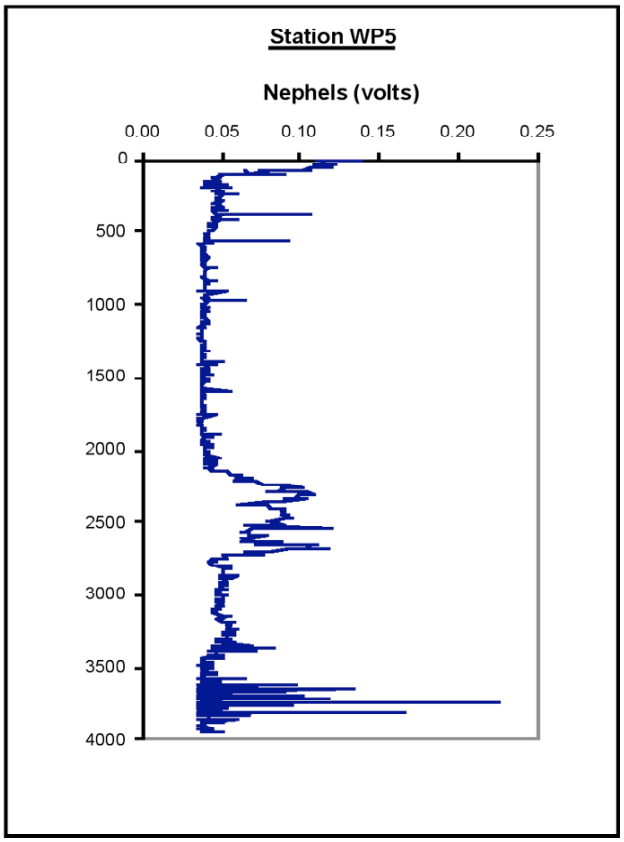
cannot be accessed during deployment, they are configured via connection to a PC prior to deployment and data is accessed and transferred to a PC upon recovery of the instrument. MAPRs are designed to take advantage of any operation where a wire is lowered to the seafloor (e.g. dredging or deep towed geophysical packages), allowing opportunistic collection of hydrothermal plume data.

A MAPR was deployed at each dredge site on the dredge wire at either 150m or 300m above the dredge and 1m above the pinger.

Deployment at WP2 served as a test deployment to ensure the MAPR was functioning correctly. Successful measurements were made at sites WP4, 4A, 5, 6, 7, 8, 9, 10, 11, 13, 17, 19. At WP14 and 16 there were problems with a leaky blanking plug resulting in data corruption. At WP15 the MAPR failed to log at the correct time, while at WP18R there was a problem with the sensor voltage, which meant there were no valid sensor readings.

Of the successful measurements, three sites showed anomalous nephelometer signals indicating a possible hydrothermal plume, WP4 (and 4A), 5 and 6. Plots from WP4 and 5 are shown below. The signal at WP6 was weaker than the signal at WP4 & 5 (~0.015V above background compared to ~0.068V at WP5).



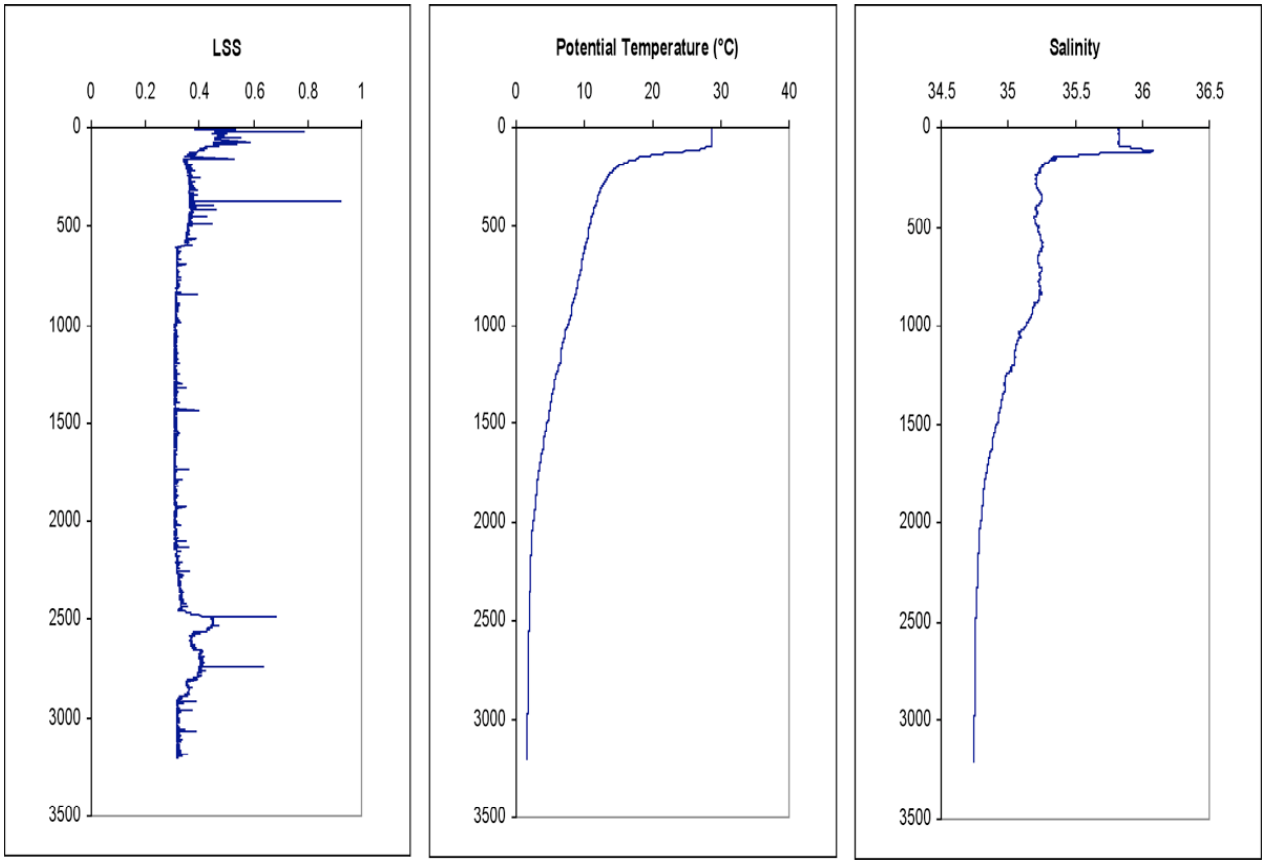


5.3 CTD Deployments

The CTD was initially deployed just after WP3 at 3°27.4S, 56°42.0E to a depth of 600m (load cell failure prevented deeper deployment) and all Niskin bottles tripped at this depth. On recovery, ~100ml concentrated Aristar HCl was added to each full Niskin bottle and left to soak until the CTD was required for the next deployment.

The CTD was deployed after the WP4 dredges at 5°43.087N, 61°28.305E. The aim was to take water samples over the depth range of the possible hydrothermal plume, hence the Niskin bottles were fired at the following depths (in metres), 3198, 3104, 3005, 2906, 2850, 2803, 2769, 2705, 2658, 2606, 2555, 2506, 2450, 2400, 2350, 2300 and 2203.

Water samples were collected from the Niskins in acid cleaned 1.0l LDPE bottles and acidified using 3.5ml of 20% nitric acid (sub-boiling distilled) in a laminar flow hood. They will be analysed for total dissolvable manganese (TDM) back on land to confirm the hydrothermal origin of the anomalous nephelometer signal.



LSS (nephelometry), temperature and salinity data from the CTD deployment is displayed below.

5.4 Biology

The original intention was to sample benthic fauna associated with the rocks that were brought up in the dredge. Primarily non-vent deep-sea fauna was expected to be collected however vent fauna was considered a possibility. The table below shows the total biology collected over the entire cruise.

Way Point	Fauna (quantity)	Details
5	Neogastropod (1)	Opaque shell with grey banding. Protoconch absent. T.L.=11mm. A.L. > T.L. * 2
15	Polychaete (1)	Palps visible. T.L.=14mm Found within burrow made of coarse sediment predominately calcite. Burrow 22mm long. Additional burrow found but empty.
18®	Bacterial mat (5-10 colonies)	Rock collection

T.L. Total length, A.L. Aperture Length

Due to the lack of benthic fauna collected in the dredge a net was constructed, see overleaf. The mesh size of 5mm was designed to collect nekton and large zooplankton, specifically larval/juvenile *Rimicaris exoculata* (hydrothermal vent shrimp). The net was weighted, to ensure that it would hang vertically regardless of the angle of the wire.

The net was attached to the pennant, approximately 2m below the swivel, 200m above the dredge. The net was attached when dredging at WP11, 13 and 14. Initially (WP11) the two iron rings supporting the net were absent and a single plastic hoop of the same diameter (0.5m) was used. On retrieving the net the plastic hoop was found to be snapped and the net had folded in on its self. Two iron rings replaced the plastic hoop. At WP13, due to an unclear bottom signal the net was trawled along the sea-bed and when retrieved was found to have collapsed. The iron rings were re-shaped and as no damage had been caused to the mesh, the net was used again at WP14. At WP14 the clamp which attaches the net to the pennant worked loose causing the net to slip to the bottom of the wire resulting in the net again being trawled along the sea-bed. The net was not repaired due to tearing of the the 5mm mesh and extensive damage to the iron rings.

No fauna was collected at any of the three way points. However at WP14 rocks were found in the net.

The lack of biology found in the dredge collections is surprising. One explanation could be the low levels of productivity found in the surface waters around the Carlsberg Ridge (PML) result in a sparse deep-sea community.

6. Diary of Events.

Thursday 17th July: Scientific complement for cruise join.

Friday 18th July: Sailed form Victoria at 1554 local time into a strong SSW wind. Deployed 3.5Khz sub-bottom profiler and activated SIMRAD EM12 multibeam swath bathymetry system. 3.5Khz system found to be very noisy and suffering repeated logging lock-out. Fairings were replaced on fish-cable but the problem persisted.

Saturday 19th July: Steamed through a dog-leg over an area of a possible sediment slide while operating the 3.5kHz profiler. Unfortunately the profiler was still noisy and the data poor. Between 0620 to 1122z made the first dredge deployment (WP02) over a seamount on the north Seychelles margin (03 15.3S 56 37.0E). The attempt recovered large amounts of basalt and manganese crust. At 1218 to 1632h, a second dredge station (WP03) was attempted on other another seamount a few kilometres to the west of the first (03 23.5S 56 41.5E. This recovered only pelagic calcareous mud. A third dredge station was attempted at 1733 to 1832h (03 27.4S 56 42.0E). Again, this returned only pelagic mud. A CTD station was also occupied at this position. A fault with the load cell prevented tension data to be displayed, and the CTD was only lowered to 600m, the bottles (24) fired and the system cleaned. The weather was F6/7 and no more CTD deployments were possible. Resumed course for the Carlesberg Ridge, due NNW.

Sunday 20th July: 1418 to 1543h began Simrad EM12 calibration but abandoned due to erratic GPS. 1556 to 1635h attempted again to calibrate the Simrad EM12, but abandoned again due to erratic GPS. Third attempt, 1858 to 2103h was completed.

Monday 21st July: Steaming for working area. 3.5lHz system failure unserviceable, and the echo-sounder was disconnected.

Tuesday 22nd July: Arrived at working area and confirmed position of axial valley. Simrad multibeam imagery, projected on large screen in real time in main lab., allowed us to select neovolcanic targets. WP04, dredge deployed at 2124h (05 43.7N 61 22.8E) with MAPR (miniature autonomous plume recorder).

Wednesday 23rd July: 0146h (05.39.8N 61 26.7E) WP04 dredge recovered –empty – but large plume signal recorded. 0317h (05 45.0N 61 28.4E) dredge re-deployed at WP04a. 0845h [05 41.0N 61 27.0E], dredge recovered, basalt samples and strong plume signal. 0954 to 1406h [05 43.6N 61 28.1E] CTD station occupied to full depth. Difficulty with load cell overcome by switching to old analogue system. 24 bottles fired through plume. Steaming to next dredge site.
1721h [05 54.0N 61 13.4E] WP05 dredge deployed and recovered at 2329h [05 53.6N 61 10.2E] with basalt samples. Steaming to next dredge site.

Thursday 24th July: 0324h 06 03.1N. Dredge deployed at WP06
0926h 06.02.5N 60 54.9E. Dredge recovered. Steaming to next dredge site.
1316h 06 20.8N 60 36.1E. Dredge deployed at WP07.

1943h 06 19.9N 60 33.3E. Dredge recovered. 2020h Ship secure steaming for next station.

Friday 25th July: 0054h 06 36.3N 60 20.8E. Dredge deployed at WP08.
0438h 06 35.7N 60 17.9E. Dredge recovered. 0458h Ship secure, steaming for next station.
1110h 07 02.3N 59 57.1E. Dredge deployed at WP09.
1535h 07 01.6N 59 53.7E. Dredge recovered. 1629h Ship secure, steaming for next station.

Saturday 26th July: 0004h 07 29.4N 59 38.5E. Dredge deployed at WP10.
0456h 07 28.4N 59 34.8E. Dredge recovered. 0522h Ship secure, steaming for next station.
1100h 07 52.4N 59 28.7E. Dredge deployed at WP11.
1536h 07 52.2N 59 24.3E. Dredge recovered.1607h Ship secure, steaming for next station.

Sunday 27th July: 0647h 08 12.5N 58 46.0E. Dredge deployed at WP12.
1205h 08 12.8N 58 39.0E. Dredge recovered. 1330 Ship secure, steaming for next station.
1826h 08 22.7N 58 34.9E. Dredge deployed at WP13.
2332h 08 22.9N 58 30.5E. Dredge recovered. 0014h Ship secure, steaming for next station.

Monday 28th July: 1333h 09 05.5N 58 19.1E. Dredge deployed at WP14.
1832h 09 01.7N 58 14.7E. Dredge recovered. 1905h Ship secure, steaming for next station.
2044 09 09.3N 58 17.4E. Dredge deployed at WP15.

Tuesday 29th July: 0132h 09 07.9N 58 13.2E. Dredge recovered. 0200h Ship secure, steaming for next station.
1000h 09 44.2N 58 01.8E. Dredge deployed at WP16.
1444h No GPS signal. Dredge recovered. 1520h Ship secure, steaming for next station.
2012h 09 49.2N 57 55.5E. Ship hove to in adverse weather (F9 WSW deteriorating).
2048h 09 48.3N 57 55.3E. Commenced Swath survey towards west – poor data quality.

Wednesday 30th July: Swath survey until,
2245h 09 58.3N 57 06E. Dredge deployed at WP17, sea state poor.

Thursday 31st July:0400h 09 55.7N 57 00.3E Dredge recovered. 0420 Ship secure, steaming for next station.
1508h 09 55.3N 57 38.3E. Dredge deployed at WP18.
2055h 09 51.7N 57 35.7E. Dredge recovered. 2118 Ship secure, steaming for Seychelles.

Friday 1st to Sunday 6th August: Steaming south in Force 7 to 8, arrive at Seychelles.

Appendix 1

Dredging procedure

The following describes the criteria for site selection and procedure followed for dredging during cruise CD149. A risk assessment o the procedure is given in appendix 2.

1. Site selection was based upon the factors of geological relevance, suitable bathymetric form, wind speed and direction, and prevailing water currents. Bridge advised science party of likely wind and current conditions in the proposed dredging section. Science party determined way point locations based on this information and knowledge of the geological and bathymetric disposition informed from the multibeam bathymetry.
2. Heave to around 1-2 nautical miles up-wind from the proposed dredge site. Exact distance dependent on the prevailing wind strength and water currents. Bridge to inform science lab as to arrival at the way point and hold the ship in a stationary position or less than 0.5 knots through the water during the dredge deployment. Science party to inform bridge when dredge has been deployed. Bridge to hold ship stationary or less than 0.5 knots through the water during the wire out.
3. Reel out the dredge and pennant at ~10m.min^{-1}. Science party to note time and position of dredge deployment in the log.
4. Place the pinger ~50 m up the wire after the pennant. Attach the MAPR ~1m above the pinger.
5. Continue reeling out at ~30m.min^{-1} monitoring the position of the pinger and bottom echo on the echo sounder trace, until the dredge is on the bottom. Science party to note time and position of dredge on the bottom in the log. Lab to inform bridge of dredge on the bottom: Bridge to maintain course at 0.5 knot.
6. Winchman and science party to monitor the tension meter for "bites" (sporadic increases in cable tension from 3-8 tonnes). Wire tension will start at ~1tonne per 1km of wire out (i.e. 3500m = 3.5tonnes). Science party to note time, position and size of bites in the log. Tension should not exceed 3 tonnes more than the wire out weight as the first weak link will fail at this point. This will strangle the dredge but make further sample collection impossible. Weak link failure is often marked by a sudden increase and sharp fall off of the wire tension. If tension exceeds 5 tonnes more than the wire out weight, the second weak link will fail and the dredge will be lost. If wire tension is building to failure levels, pay out further to reduce wire tension. Ensure that pinger remains ~50m off the bottom at all times.
7. After 2-5 good "bites" (judgment call), begin hoisting dredge at 5m.min^{-1} until pinger is 180m off the bottom. Continue hoisting at 40-60m.min^{-1} until 500m from the surface then hoist at 10m.min^{-1}.
8. Slow hoisting to <1m.min^{-1} when pinger is close to breaking surface. Lash cable to safety rail while removing pinger and MAPR.
9. Continue hoisting wire until dredge is close to breaking surface. Two personnel to be stationed on the afterdeck to recover the dredge. *If safety rail is removed while recovering dredge, all hands must be harnessed to the tensioned wire. None of the science party must enter the red non-slip area to aft until the safety rail is in place and permission is given by the technical staff. In adverse weather conditions,*

technical staff will advise as to whether science party should remain in main lab while dredge haul is transported to wet lab. During operations it is recommended that 3 trained personnel are on hand to assist with the dredging. These should include a trained winch operator, and two deck hands. During night operation if only one deck hand is available, a designated member of the science party will assist with recovery on the aft deck.

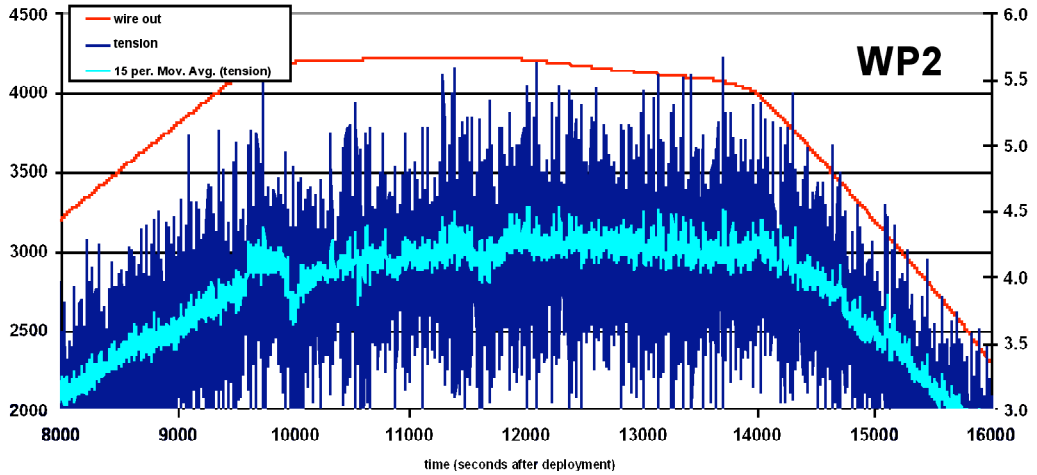
10. Science party to note the time and position of dredge on deck, and to photograph the dredge contents (even if empty) at the earliest opportunity.
11. Once the technical staff have confirmed that the dredge is secure, the science party should inform the bridge of the outcome of the dredging and to proceed to the next way point.

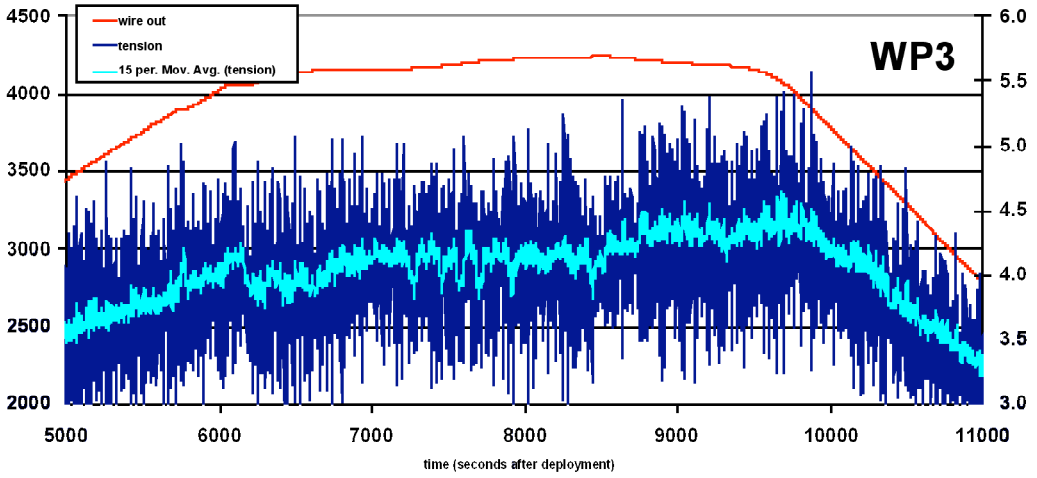
Sample curation and safe handling procedure

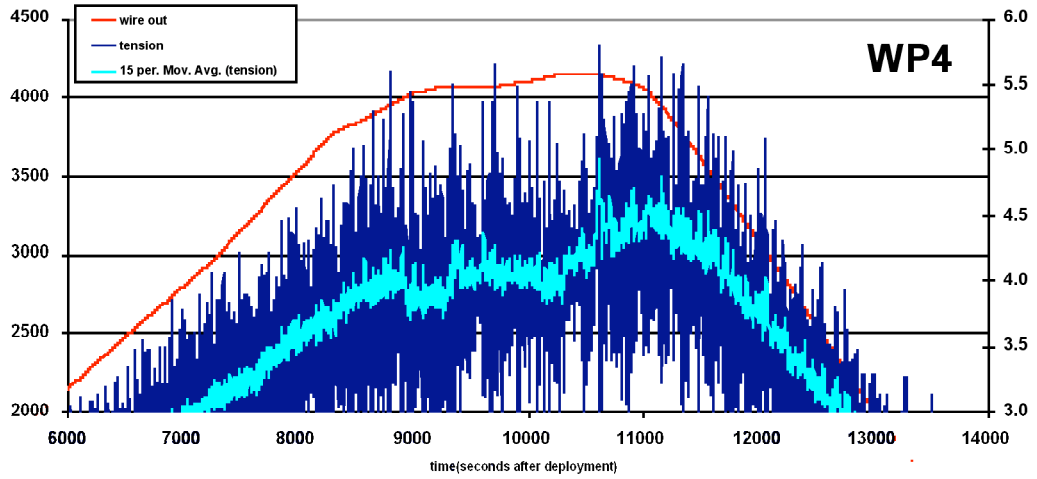
1. Scientists on watch to transfer contents of dredge bag to container and transport to wet lab. *Safety shoes and hard hats must be worn at all times on the deck.* All contents of pipe dredge to be transferred to container and transported to wet lab. *When handling rocks kevlar safety gloves should be worn at all times as all surfaces could potentially have freshly broken volcanic glass which could cause severe laceration.*
2. Dredge bag should be carefully checked for any remaining material, and any finds removed. Pipe dredge should be carefully checked for any remaining material, finds removed, and pipe hosed out to ensure no cross-dredge contamination is possible.
3. Once the dredge contents are laid out on the wet lab bench (if feasible) Photograph the collection, including a scale reference and an identity label.
4. Dredge bag contents to be washed in fresh water separated into any visibly different types. Each type should be labelled with a marker pen (on the sample where possible) and bagged (bag also to be labelled with marker pen). Collection from each dredge haul should be placed into a singe, labelled, white sack. Oversize samples (>20x20cm) can be labelled on surface and placed in the white sack.
5. If a quantity of friable glass is present on the surface of the samples, a sub sample of this glass (from a single piece only) should be removed with the small geological hammer onto a clean sheet, prior to transfer to a labelled bag or plastic container. 50cc is a suitable sub-sample quantity. *Personnel removing the glass sample, and those in close proximity, should wear safety glasses and gloves during this operation.*
6. Very large samples (>50cm) should be washed in fresh water, labelled and stowed temporarily until advice is sought as to future storage. *When handling very large samples care should be taken when moving and lifting to prevent injury. Safety shoes must be worn at all times when in the wet lab.*
7. Pipe dredge contents to be examined and any large glass fragments to be removed, cleaned, and placed in a labelled bag (especially if the dredge bag is empty). If sedimentary material is present in the pipe dredge, this should be sub-sampled (~50cc) into a labelled bag or plastic container.
8. A log should be made of all samples from each dredge on the PC, including a record of the approximate quantity of material in the haul.

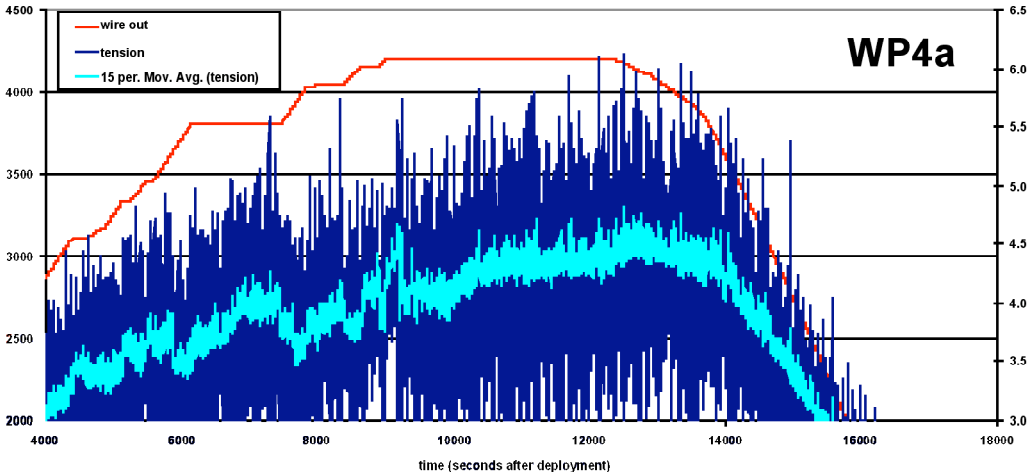
Appendix 2

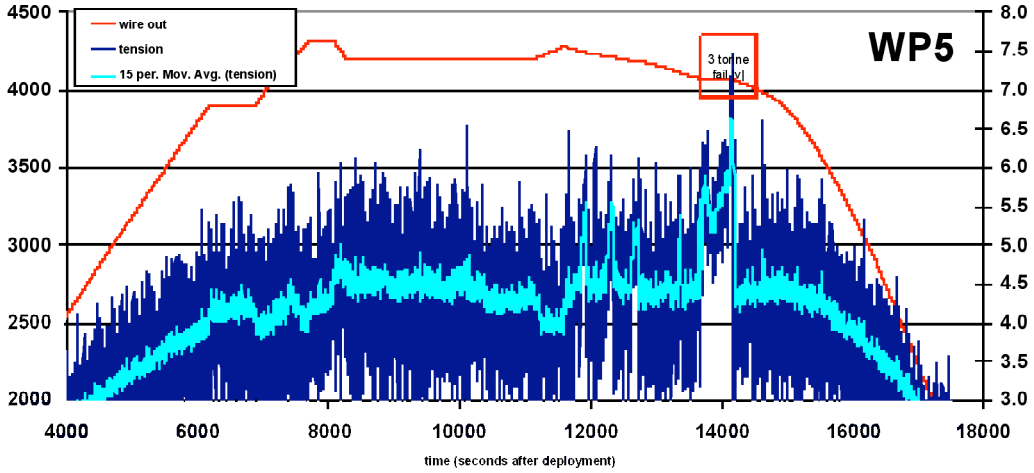
Plots of wire-out, wire tension and time for each dredge station. Peak loads are likely times of sampling. Weak-link breakage is indicated by red box. Time is time since deployment (see appendix).

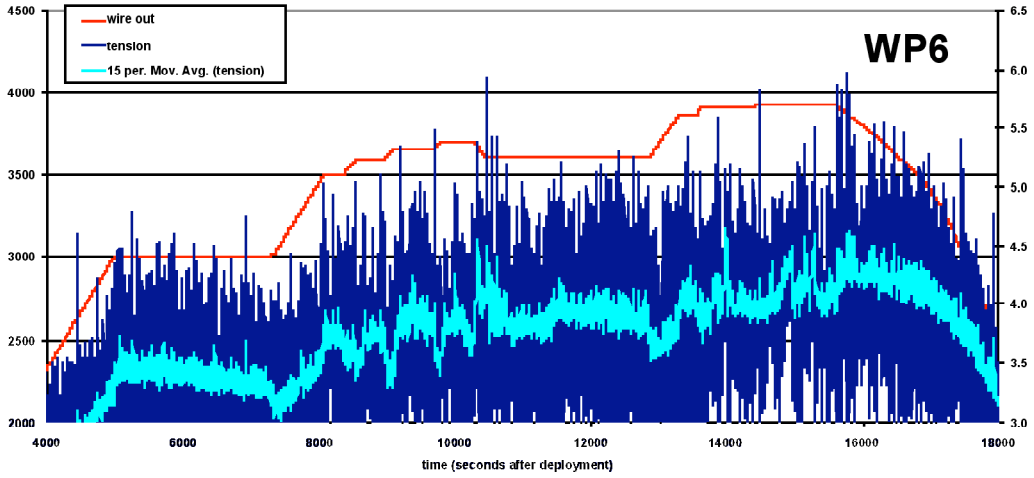


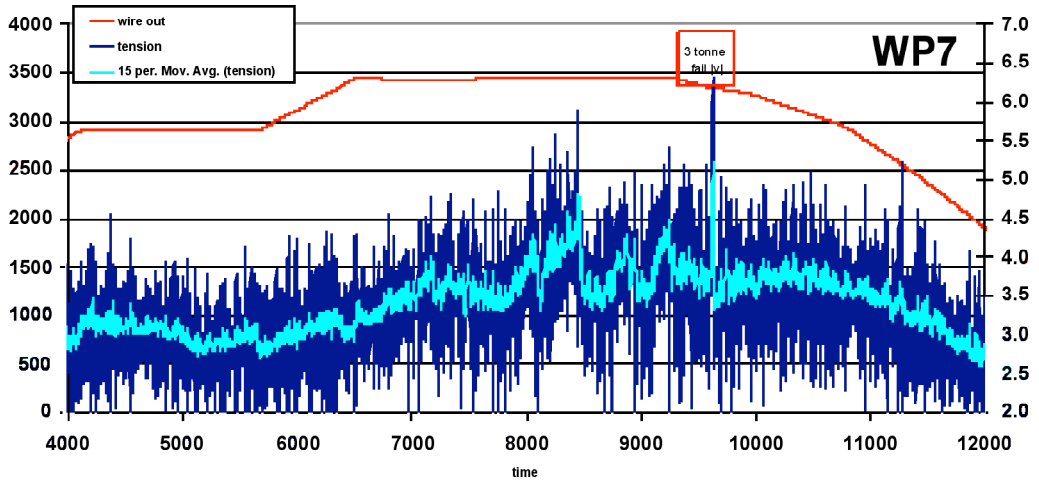


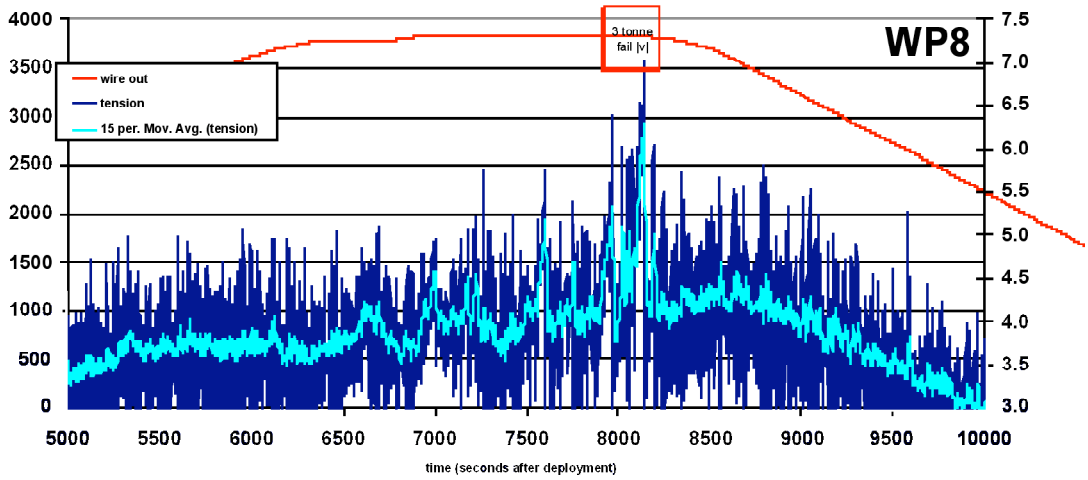


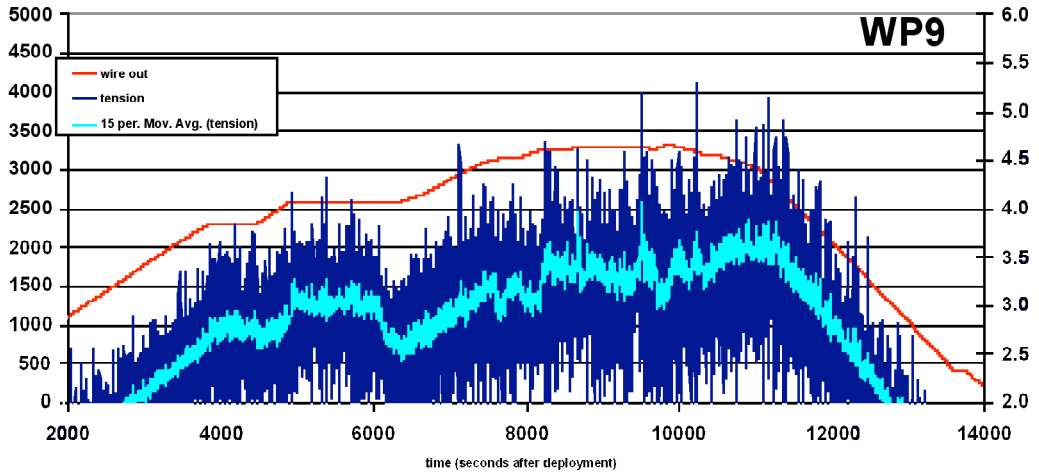

wire out
tension
15 per. Mov. Avg. (tension)
WP4a
4500
4000
3500
3000
2500
2000
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
4000
6000
8000
10000
12000
14000
16000
18000
time (seconds after deployment)

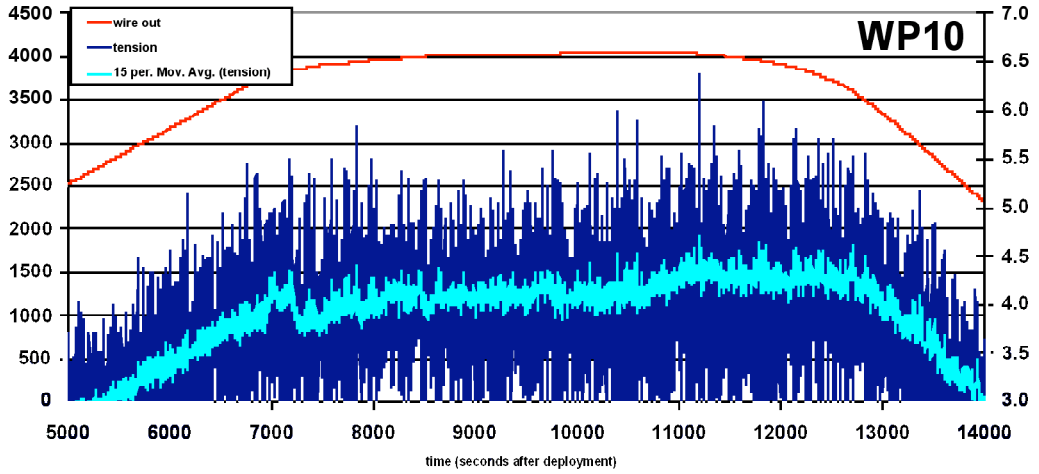

wire out
tension
15 per. Mov. Avg. (tension)
WP5
3 tonne fail-y
4500
4000
3500
3000
2500
2000
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
4000
6000
8000
10000
12000
14000
16000
18000
time (seconds after deployment)

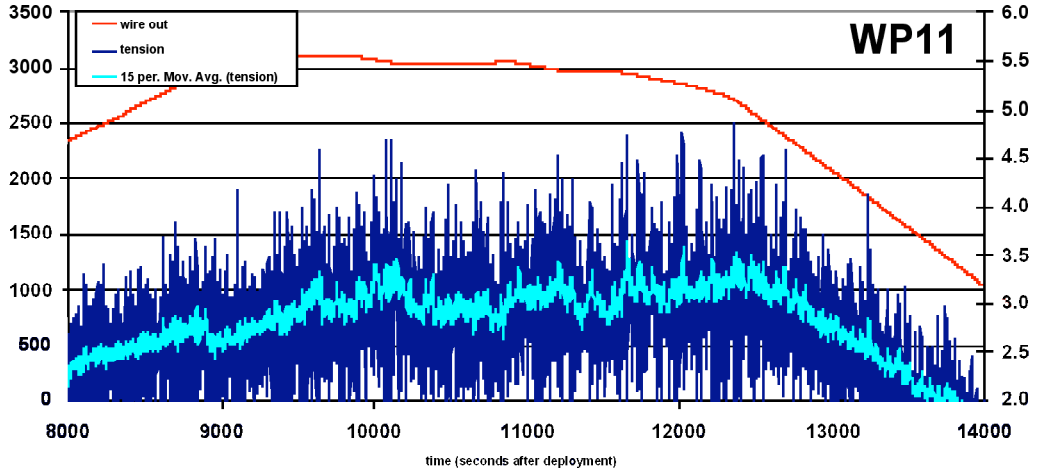

wire out
tension
15 per. Mov. Avg. (tension)
WP6
4500
4000
3500
3000
2500
2000
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
4000
6000
8000
10000
12000
14000
16000
18000
time (seconds after deployment)

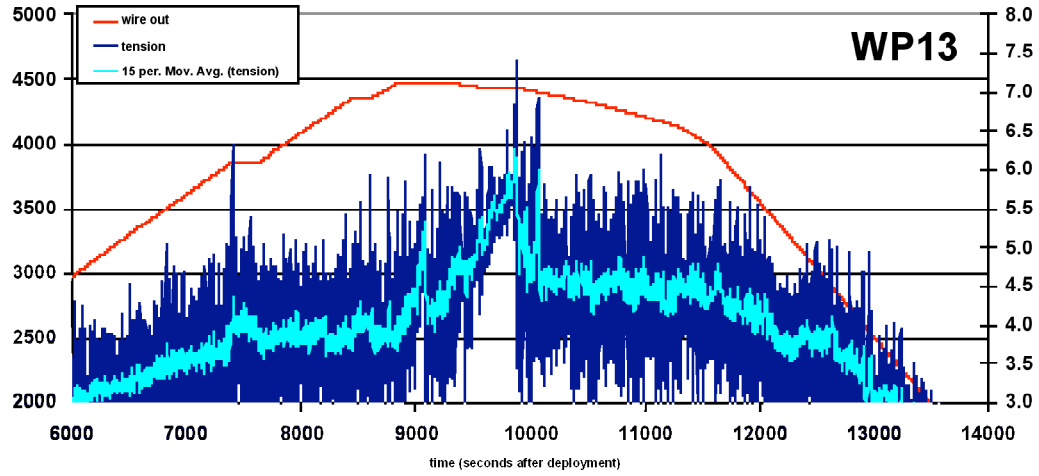

WP7
wire out
tension
15 per. Mov. Avg. (tension)
3 tonne fail |v|
time

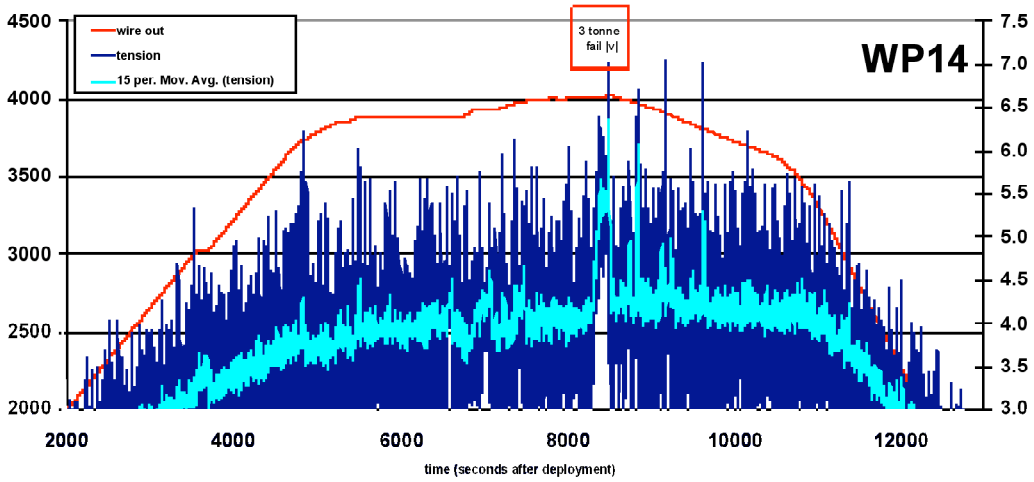

WP8
wire out
tension
15 per. Mov. Avg. (tension)
3 tonne fail |v|
time (seconds after deployment)

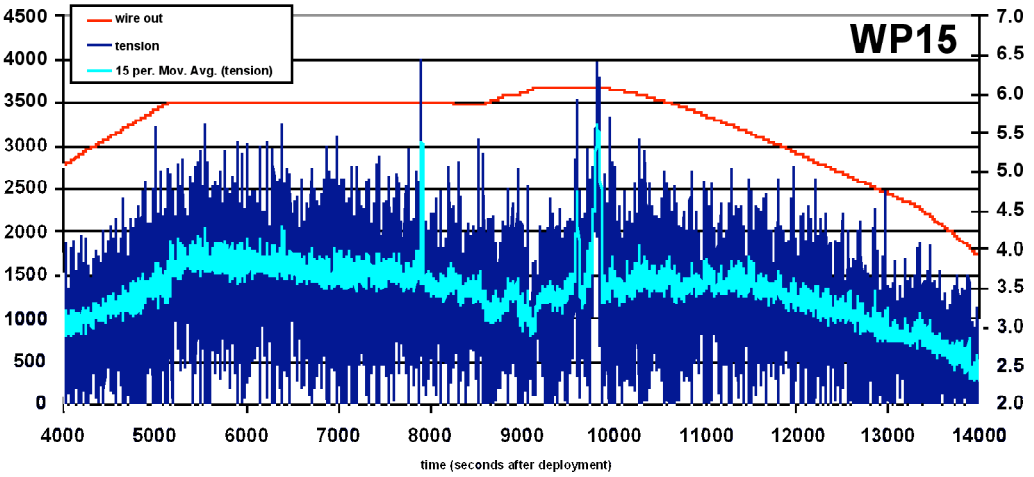

WP9
wire out
tension
15 per. Mov. Avg. (tension)
time (seconds after deployment)

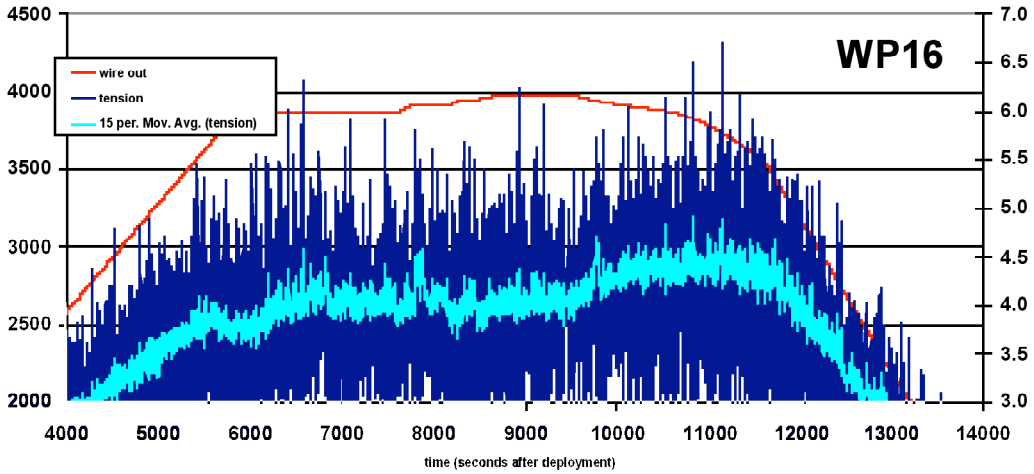

WP10
wire out
tension
15 per. Mov. Avg. (tension)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
time (seconds after deployment)

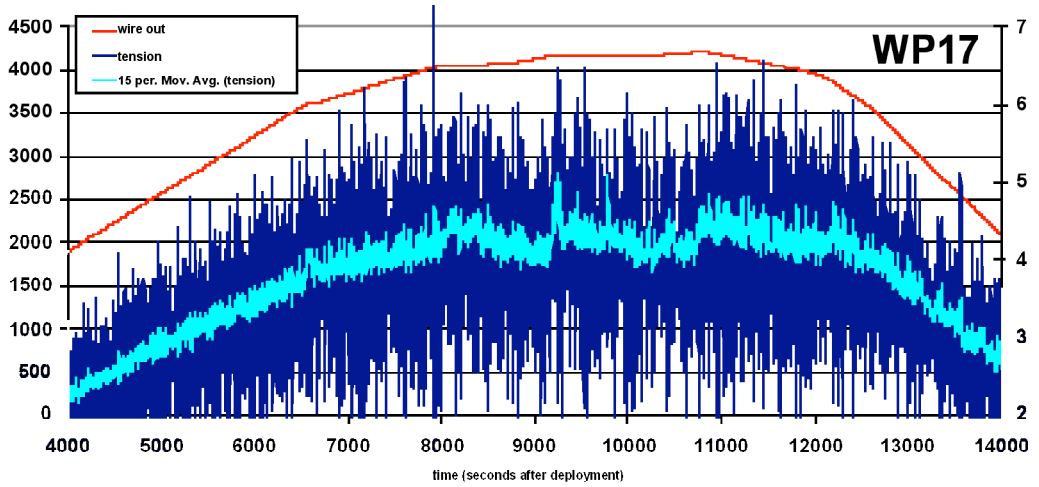

WP11
wire out
tension
15 per. Mov. Avg. (tension)
3500
3000
2500
2000
1500
1000
500
0
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
8000
9000
10000
11000
12000
13000
14000
time (seconds after deployment)

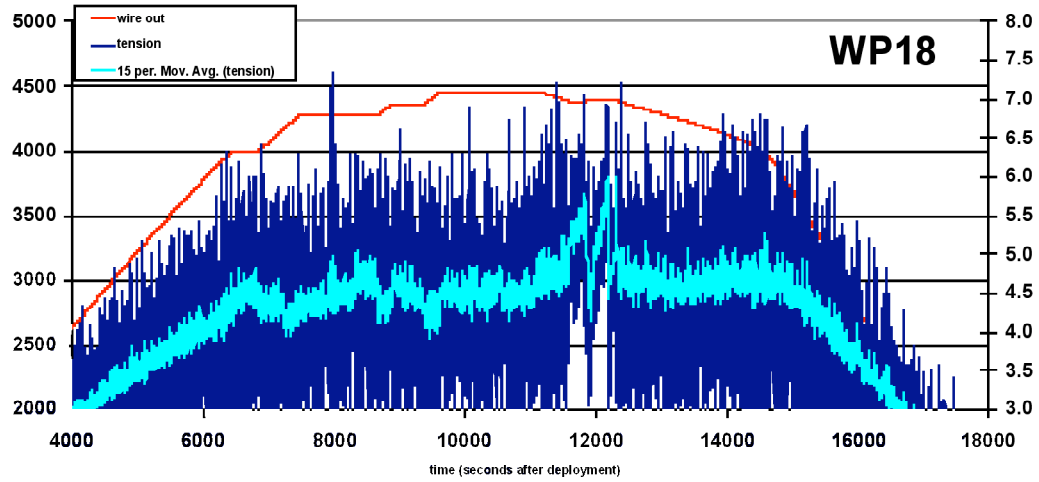

WP13
wire out
tension
15 per. Mov. Avg. (tension)
5000
4500
4000
3500
3000
2500
2000
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
6000
7000
8000
9000
10000
11000
12000
13000
14000
time (seconds after deployment)

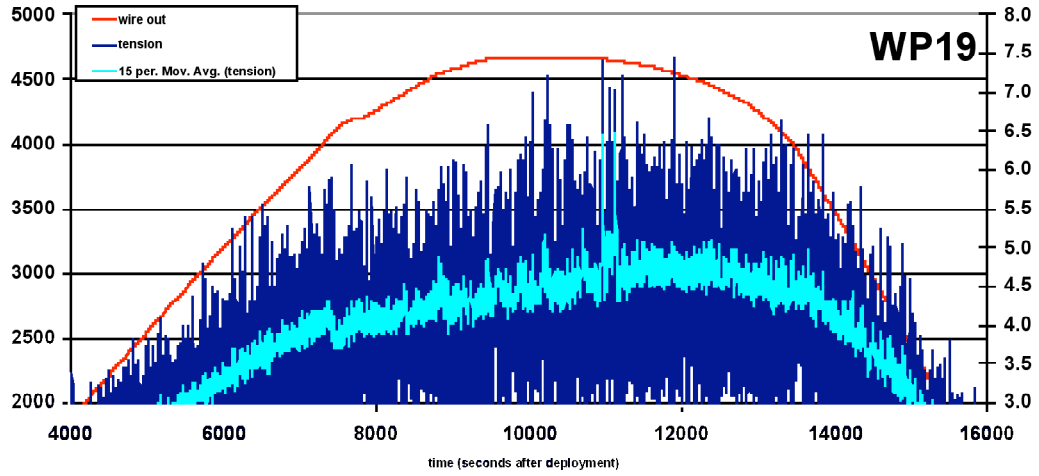

wire out
tension
15 per. Mov. Avg. (tension)
3 tonne fail |v|
WP14
4500
4000
3500
3000
2500
2000
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2000
4000
6000
8000
10000
12000
time (seconds after deployment)


wire out
tension
15 per. Mov. Avg. (tension)
WP15
4500
4000
3500
3000
2500
2000
1500
1000
500
0
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
time (seconds after deployment)


wire out
tension
15 per. Mov. Avg. (tension)
WP16
4500
4000
3500
3000
2500
2000
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
time (seconds after deployment)


wire out
tension
15 per. Mov. Avg. (tension)
WP17
4500
4000
3500
3000
2500
2000
1500
1000
500
0
7
6
5
4
3
2
4000 5000 6000 7000 8000 9000 10000 11000 12000 13000 14000
time (seconds after deployment)


wire out
tension
15 per. Mov. Avg. (tension)
WP18
5000
4500
4000
3500
3000
2500
2000
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
4000 6000 8000 10000 12000 14000 16000 18000
time (seconds after deployment)


wire out
tension
15 per. Mov. Avg. (tension)
WP19
5000
4500
4000
3500
3000
2500
2000
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
4000 6000 8000 10000 12000 14000 16000
time (seconds after deployment)

Appedix 3: Day Log

Way Point	Date	Time GMT	Latitude			Longitude			Depth(m)	Wire out(m)	Layback(m)	CTD	Dredge	Comments	Speed Made Good	Course Made Good
0	18/7/03	12:50	4	32	-4.5333 S	55	27	55.4500	20			n	n	**Note: All latitudes are South**	10.7	316.00
0	18/7/03	13:30	4	26	-4.4333 S	55	28	55.4667	20			n	n	Deployed 3.5kHz fish - not working	2.6	133.00
0	18/7/03	14:00	4	25	-4.4167 S	55	28	55.4667	20			n	n		9.7	14.00
0	18/7/03	14:30	4	21	-4.3500 S	55	29	55.4833	20			n	n		9.6	8.00
0	18/7/03	15:00	4	15	-4.2500 S	55	30	55.5000	20			n	n		10.5	9.00
0	18/7/03	15:30	4	10	-4.1667 S	55	31	55.5167	20			n	n		10.4	15.00
0	18/7/03	16:00	4	3	-4.0500 S	55	32	55.5333	20			n	n		10.3	11.00
0	18/7/03	16:30	3	59	-3.9833 S	55	33	55.5500	20			n	n		11.1	9.00
0	18/7/03	17:00	3	54	-3.9000 S	55	34	55.5667	49.5			n	n		10.4	10.00
0	18/7/03	17:24			0.0000 S							n	n	3.5kHz re-started - occasional problems		
0	18/7/03	17:30	3	48	-3.8000 S	55	35	55.5833	64			n	n		11.2	7.00
0	18/7/03	18:00	3	43	-3.7167 S	55	36	55.6000	468			n	n		10.9	15.00
0	18/7/03	18:30	3	39	-3.6500 S	55	30	55.5000	2251			n	n		11.2	43.00
0	18/7/03	19:00	3	34	-3.5667 S	55	42	55.7000	2946			n	n		10	50.00
0	18/7/03	19:30	3	31	-3.5167 S	55	45	55.7500	3170			n	n		10.9	54.00
0	18/7/03	20:00	3	28	-3.4667 S	55	49	55.8167	3338			n	n		10.4	45.00
0	18/7/03	20:30	3	24	-3.4067 S	55	53	55.8783	3500			n	n		10.3	41.00
0	18/7/03	21:00	3	20	-3.3400 S	55	57	55.9417	3670			n	n		10.2	48.00
0	18/7/03	21:30	3	17	-3.2817 S	56	0.2	56.0033	3774			n	n		10.3	39.00
0	18/7/03	22:00	3	13	-3.2150 S	56	3.9	56.0650	3904			n	n		11.5	55.00
0	18/7/03	22:30	3	89	-4.4817 S	56	7.6	56.1267	3942			n	n		10.2	41.00
0	18/7/03	23:00	3	5.1	-3.0847 S	56	11	56.1900	3725			n	n		9.7	48.00
1	18/7/03	23:30	3	5.3	-3.0883 S	56	16	56.2583	3309			n	n		8.2	110.00
1	19/7/03	0:00	3	7.3	-3.1217 S	56	20	56.3250	4106			n	n		9.1	114.00
1	19/7/03	0:28	3	9	-3.1500 S	56	23	56.3833	4129			n	n		7.2	113.00
1	19/7/03	0:59	3	10	-3.1667 S	56	27	56.4500	4148			n	n		6.9	114.00
1	19/7/03	1:29	3	12	-3.2000 S	56	31	56.5167	4157			n	n		7.3	110.00
1	19/7/03	1:59	3	14	-3.2333 S	56	35	56.5833	4000						7.7	113.00
2	19/7/03	2:23	3	15	-3.2500 S	56	37	56.6167	4021			n	y	dredge out, holding station.	0.7	135.00
2	19/7/03	2:27	3	15	-3.2500 S	56	37	56.6167	4042			n	y	dredge overboard, no CTD	0.7	110.00
2	19/7/03	2:40	3	16	-3.2583 S	56	37	56.6233	4010			n	y	pinger on @ 150m above dredge. MAPR on 1m above. Current 2 kts.	0.3	150.00
2	19/7/03	2:57	3	15	-3.2500 S	56	37	56.6167	3281			n	y	? Erratic fish, use simrad instead. Reeling out dredge.	0.7	112.00
2	19/7/03	3:29	3	16	-3.2667 S	56	37	56.6167	4021			n	y	Still reeling out dredge.	0.3	161.00
2	19/7/03	4:00	3	16	-3.2667 S	56	38	56.6317	3807					Still reeling out dredge.	0.4	136.00
2	19/7/03	4:30	3	16	-3.2667 S	56	38	56.6333	3766	4200	1859.4	n	y	Still reeling out dredge. 4:43 Dredge on bottom	0.7	218.00
2	19/7/03	5:00	3	17	-3.2833 S	56	39	56.6450	3700	4225	2039.8	n	y		1.2	159.00
2	19/7/03	5:30	3	18	-3.2933 S	56	39	56.6483	3867	4150	1506.3	n	y	Hauling	1.6	264.00
2	19/7/03	5:45	3	18	-3.2967 S	56	39	56.6467	3853	4080	1341.9	n	y	Dredge off bottom		
2	19/7/03	6:00	3	18	-3.3000 S	56	38	56.6333	3934			n	y	Dredge coming up	2.4	180.00
2	19/7/03	6:30	3	19	-3.3183 S	56	39	56.6467	4020			n	y	Dredge coming up	2.1	198.00
2	19/7/03	7:00	3	20	-3.3300 S	56	39	56.6483	4042			n	y	Dredge stopped @250m. Dredge coming up	1	246.00
2	19/7/03	7:30	3	21	-3.3467 S	56	40	56.6617	4039			n	y	Dredge up & on deck	8.4	147.00
3	19/7/03	8:00	3	23	-3.3900 S	56	41	56.6900	3978			n	y		1.6	139.00
3	19/7/03	8:30	3	23	-3.3900 S	56	41	56.6900	3978			n	y		3.3	67.00
3	19/7/03	9:00	S DOWN			S	56		3953	1620		n	y	dredge out	gps down.	
3	19/7/03	9:10	3	24	-3.4017 S	56	42	56.6950	3946			n	y	gps back, still lowering dredge.	0.7	164.00
3	19/7/03	9:30	3	24	-3.4050 S	56	42	56.6983	3957	2660		n	y	09:50 gps down again.	2.4	variable 175
3	19/7/03	10:00	3	25	-3.4083 S	56	42	56.6950	3936	3760		n	y	gps ok. 4150m paid out, dredge on bottom.	2.8	variable 220
3	19/7/03	10:30	3	25	-3.4133 S	56	41	56.6900	3874	4165	1529.5	n	y	dragging dredge.	1.7	variable 200
3	19/7/03	10:53	3	25	-3.4183 S	56	41	56.6850	3639			n	y	hauling off bottom.	1.8	282.00
3	19/7/03	11:00	3	25	-3.4200 S	56	41	56.6833	3543			n	y	hauling dredge.	0.9	256.00
3	19/7/03	11:30	3	26	-3.4250 S	56	41	56.6750	3457	2942		n	y	hauling dredge.	0.9	215.00
3	19/7/03	11:59	3	26	-3.4333 S	56	40	56.6667	3529	1278		n	y	hauling dredge.	0.7	112.00

3	19/7/03	12:29	3	26	-3.4333	S	56	41	56.6833	3601	n	n	dredge is up, fire drill.	0.7	105.00
3	19/7/03	13:01	3	27	-3.4500	S	56	41	56.6833	3602	n	n	dredge up, foraminiferal ooze. No useful lithological samples.	0.7	131.00
3	19/7/03	13:30	3	27	-3.4500	S	56	41	56.6833	3690	y	n	deploying CTD to 1000m. Only 600m allowed, since load cell not working.	0.3	159.00
3	19/7/03	13:35	3	27	-3.4567	S	56	42	56.7000	3892	y	n	CTD deployed to 600m.	0.5	105.00
3	19/7/03	13:59	3	27	-3.4500	S	56	42	56.7000	3701	y	n	CTD on way up.		
3	19/7/03	14:29	3	27	-3.4500	S	56	42	56.7000	3799	y	n	CTD on board.	0.3	137.00
3	19/7/03	14:59	3	27	-3.4500	S	56	43	56.7167	3884	y	n	100ml approx conc HCl to each Niskin to clean. Ship stopped.	1.7	135.00
3	19/7/03	15:13	3	27	-3.4500	S	56	44	56.7333	3847	n	n	Set off again.	10.4	28.00
3	19/7/03	15:30	3	25	-3.4167	S	56	45	56.7500	3952	n	n	Steaming.	9.4	42.00
	19/7/03	15:58	3	21	-3.3500	S	56	47	56.7833	4041	n	n		9.7	31.00
	19/7/03	16:30	3	16	-3.2667	S	56	49	56.8167	4111	n	n		10.4	25.00
	19/7/03	17:00	3	11	-3.1833	S	56	51	56.8500	4201	n	n		9.4	25.00
	19/7/03	17:30	3	7	-3.1167	S	56	54	56.9000	4239	n	n			
	19/7/03	18:00	3	3	-3.0500	S	56	56	56.9333	4266	n	n		9.6	33.00
	19/7/03	18:30	2	58	-2.9667	S	56	58	56.9667	4283	n	n		9.7	27.00
	19/7/03	19:00	2	54	-2.9000	S	57	0	57.0000	4299	n	n		10	25.00
	19/7/03	20:00	2	45	-2.7500	S	57	5	57.0833	4350	n	n		10	21.00
	19/7/03	21:00	2	36	-2.6000	S	57	9	57.1500	4362	n	n		10.9	26.00
	19/7/03	22:00	2	27	-2.4500	S	57	14	57.2333	4370	n	n		9.5	24.00
	19/7/03	23:00	2	18	-2.3000	S	57	18	57.3000	4363	n	n		10.1	24.00
	20/7/03	0:00	2	9	-2.1500	S	57	23	57.3833	4383	n	n		9.9	33.00
	20/7/03	1:00	2	0	-2.0000	S	57	27	57.4500	4409	n	n		10	28.00
	20/7/03	2:00	1	52	-1.8667	S	57	32	57.5333	4220	n	n		10.1	30.00
	20/7/03	3:00	1	43	-1.7167	S	57	37	57.6167	4467	n	n		10.3	28.00
	20/7/03	4:00	1	35	-1.5833	S	57	42	57.7000	4480	n	n		9.4	36.00
	20/7/03	5:00	1	26	-1.4333	S	57	46	57.7667	4494	n	n		9.8	26.00
	20/7/03	6:00	1	18	-1.3000	S	57	51	57.8500	4518	n	n		10.1	25.00
	20/7/03	7:00	1	9	-1.1500	S	57	55	57.9167	4531	n	n		9.5	21.00
	20/7/03	8:00	1	1	-1.0167	S	58	0	58.0000	4545	n	n	new sound-velocity profile - line30	10.4	22.00
	20/7/03	9:00	0	52	-0.8667	S	58	4	58.0667	4502	n	n		10.2	25.00
	20/7/03	10:00	0	43	-0.7167	S	58	9	58.1500	4595	n	n		9.3	27.00
	20/7/03	11:00	0	37	-0.6167	S	58	13	58.2167	4592	n	n	manouvres svp calibration	8.2	39.00
	20/7/03	12:00	0	42	-0.7000	S	58	8	58.1333	4603	n	n	manouvres plot at 12:30	8.3	218.00
	20/7/03	13:00	0	37	-0.6167	S	58	12	58.2000	4592	n	n		8.8	24.00
	20/7/03	14:00	0	30	-0.5000	S	58	16	58.2667	4459	n	n		8.3	26.00
	20/7/03	15:00	0	24	-0.4000	S	58	19	58.3167	4693	n	n	plot at 14:30	7.9	30.00
	20/7/03	16:00	0	23	-0.3833	S	58	19	58.3167	4698	n	n	started annotating 3.5kHz plot every 2hrs	7.8	204.00
	20/7/03	17:00	0	21	-0.3500	S	58	19	58.3167	4693	n	n		9.7	299.00
	20/7/03	18:00	0	14	-0.2333	S	58	23	58.3833	4698	n	n		8.2	45.00
	20/7/03	19:00	0	6.8	-0.1133	S	58	28	58.4733	4703	n	n	3.5 khz ok finished simrad calibration, logging line	9.5	40.00
	20/7/03	20:00	0	0.7	0.0117	N	58	32	58.5400	4703	n	n	**all lats north**	8.8	26.00
	20/7/03	21:00	0	7	0.1167	N	58	36	58.6000	4706	n	n	10KHz EA500 giving dodgy readings	10	29.00
	20/7/03	22:00	0	15	0.2500	N	58	40	58.6667	4737	n	n		9.5	37.00
	20/7/03	23:00	0	23	0.3833	N	58	44	58.7333	4612	n	n		9	26.00
	21/7/03	0:00	0	31	0.5167	N	58	48	58.8000	4711	n	n		8.5	29.00
	21/7/03	1:00	0	39	0.6500	N	58	52	58.8667	4711	n	n		8.3	26.00
	21/7/03	2:00	0	47	0.7833	N	58	56	58.9333	4160	n	n		8.3	28.00
	21/7/03	3:00	0	53	0.8833	N	58	0	58.0000	4604	n	n		8	27.00
	21/7/03	4:00	1	2	1.0333	N	59	4	59.0667	4344	n	n		8.3	18.00
	21/7/03	5:00	1	9	1.1500	N	59	8	59.1333	4462	n	n	plot line advanced 4:30	7.9	7.00
	21/7/03	6:00	1	15	1.2500	N	59	11	59.1833	4558	n	n	xbt deployed 06:24	5.2	42.00
	21/7/03	7:00	1	22	1.3667	N	59	14	59.2333	4706	n	n	3.5 khz not working again	8	36.00
	21/7/03	8:00	1	29	1.4833	N	59	18	59.3000	4421	n	n		8.2	20.00
	21/7/03	9:00	1	37	1.6167	N	59	23	59.3833	4749	n	n		8	26.00
	21/7/03	10:00	1	43	1.7167	N	59	26	59.4333	4090	n	n		8	23.00
	21/7/03	11:00	1	50	1.8333	N	59	30	59.5000	4322	n	n	3.5 khz not good	8	47.00
	21/7/03	12:00	1	57	1.9500	N	59	33	59.5500	4744	n	n	ea500 not good, 3.5khz reading for depth	8	23.00

	21/7/03	13:00	2 5	2.0833	N	59 37	59.6167	4535			n	n	rebooted 3.5khz	7.4	21.50
	21/7/03	14:00	2 12	2.2000	N	59 41	59.6833	4198			n	n	rebooted 3.5khz twice	7.8	25.40
	21/7/03	15:00	2 20	2.3333	N	59 45	59.7500	5255			n	n		8.2	24.20
	21/7/03	15:33		0.0000	N		0.0000				n	n	3.5khz stopped logging - system error		
	21/7/03	16:00	2 27	2.4500	N	59 49	59.8167	4137			n	n		8.2	24.10
	21/7/03	17:00	2 34	2.5667	N	59 52	59.8667	4290			n	n		8.2	22.00
	21/7/03	18:00	2 42	2.7000	N	60 56	60.9333	4137			n	n		8.4	31.00
	21/7/03	19:00	2 50	2.8333	N	60 0	60.0000	3771			n	n		9.1	25.00
	21/7/03	20:00	2 57	2.9500	N	60 4	60.0667	3860			n	n		8.8	18.00
	21/7/03	21:00	3 6	3.1000	N	60 9	60.1500	3705			n	n		9.1	16.00
	21/7/03	22:00	3 13	3.2167	N	60 13	60.2167	3821			n	n		8.8	17.00
	21/7/03	23:00	3 21	3.3500	N	60 17	60.2833	4043			n	n		8.9	22.00
	22/7/03	0:00	3 29	3.4833	N	60 21	60.3500	4568			n	n		9.6	25.00
	22/7/03	1:00	3 37	3.6167	N	60 25	60.4167	4059			n	n		9.7	20.00
	22/7/03	2:00	3 45	3.7500	N	60 29	60.4833	4097			n	n		9.2	16.90
	22/7/03	3:00	3 53	3.8833	N	60 33	60.5500	3993			n	n		9.3	20.30
	22/7/03	4:00	4 3	4.0500	N	60 38	60.6333	4226			n	n		9.2	26.20
	22/7/03	5:00	4 12	4.2000	N	60 43	60.7167	4131			n	n	plot line advanced 5:30	9	25.80
	22/7/03	6:00	4 20	4.3333	N	60 48	60.8000	4109			n	n		9	21.60
	22/7/03	7:00	4 28	4.4667	N	60 52	60.8667	3642			n	n		9.4	23.10
	22/7/03	8:00	4 36	4.6000	N	60 56	60.9333	3391			n	n		8.8	22.70
	22/7/03	9:00	4 45	4.7500	N	61 0	61.0000	3207			n	n		9.2	25.90
	22/7/03	10:00	4 53	4.8833	N	61 5	61.0833	3504			n	n		9.1	28.20
	22/7/03	11:00	5 0	5.0000	N	61 8	61.1333	3665			n	n		8.7	27.90
	22/7/03	12:00	5 9	5.1500	N	61 13	61.2167	3172			n	n		9.4	36.00
	22/7/03	13:00	5 18	5.3000	N	61 18	61.3000	2814			n	n		9.1	27.40
	22/7/03	14:00	5 25	5.4167	N	61 22	61.3667	2881			n	n		9	25.70
	22/7/03	15:00	5 34	5.5667	N	61 26	61.4333	2058			n	n		9	22.80
WP4	22/7/03	16:00	5 41	5.6833	N	61 30	61.5000	3922			n	n		8.9	26.20
	22/7/03	16:30	5 45	5.7500	N	61 31	61.5167	3134			n	n	Processed grid at 16:50	7.2	308.50
	22/7/03	17:00	5 45	5.7500	N	61 28	61.4667	3116			n	y	New log directory: carlsberg_ridge, line#1	5.8	214.70
	22/7/03	17:18	5 43	5.7167	N	61 27	61.4500	3642			n	y	Dredge in water		
	22/7/03	17:38	5 43	5.7167	N	61 27	61.4500				n	y	MAPR attached, EA500 set to pinger mode		
	22/7/03	18:00	5 43	5.7167	N	61 27	61.4500	4062			n	y	Dredge reeling out		
	22/7/03	18:30	5 42	5.7000	N	61 27	61.4500	3835			n	y	Dredge reeling out	0	230.90
	22/7/03	19:00	5 42	5.7000	N	61 27	61.4500	3804	2235		n	y	Dredge reeling out	0.3	247.00
	22/7/03	19:30	5 42	5.7000	N	61 27	61.4500	3947	3561		n	y	Dredge reeling out	0.3	254.40
	22/7/03	19:46	5 42	5.6930	N	61 27	61.4533	4093	4010		n	y	dredge on bottom	0.2	267.00
	22/7/03	20:00	5 41	5.6833	N	61 27	61.4500	4088	4065		n	y	dredge on bottom	0	256.10
	22/7/03	20:19	5 41	5.6872	N	61 27	61.4520	4113	4109		n	y	dredge off bottom hauling in	0	226.00
	22/7/03	20:30	5 41	5.6833	N	61 27	61.4510	3828	3459		n	y	hauling dredge.	0	253.00
	22/7/03	21:05	5 40	5.6733	N	61 27	61.4477	3509	1310		n	y	hauling dredge.	0.3	248.00
	22/7/03	21:30	5 40	5.6667	N	61 27	61.4458	2993	235		n	y	hauling dredge.	0	263.00
	22/7/03	21:39		0.0000	N						n	y	pinger and mapr removed	0	259.00
	22/7/03	21:44		0.0000	N						n	n	dredge on deck		
	22/7/03	22:00	5 39	5.6500	N	61 26	61.4383	2643			n	n		0	259.00
	22/7/03	22:30	5 42	5.6928	N	61 27	61.4550	4068			n	n		8.3	17.00
	22/7/03	23:00	5 45	5.7518	N	61 29	61.4750	3136			n	n		5.6	327.00
WP4a	22/7/03	23:08	5 45	5.7518	N	61 28	61.4727	3107	0		n	n		0	251.90
	22/7/03	23:30	5 45	5.7490	N	61 28	61.4725	3164	263		n	y	pinger mapr attached dredge in water	0	252.00
	23/7/03	0:00	5 45	5.7425	N	61 28	61.4707		1423		n	y	Dredge in water	0	
	23/7/03	0:30	5 44	5.7370	N	61 28	61.4667		2773		n	y	Dredge in water	0	244.00
	23/7/03	0:40			N				3100		n	y	plot line advanced every hour on the half hour		
	23/7/03	1:00	5 44	5.7317	N	61 28	61.4650	3646	3341		n	y		0	
	23/7/03	1:12	5 44	5.7283	N	61 28	61.4633	3725	3800	751.2	n	y	dredge down reading from ping bottom of valley	0	239.00
	23/7/03	1:20	5 44	5.7267	N	61 28	61.4633	3918	3801		n	y	steaming through valley at 0.5/1 knott to hill 1 mile away	0.7	
	23/7/03	1:35	5 43	5.7217	N	61 28	61.4617	4153	3951		n	y		0.9	235.00

	23/7/03	1:40	5	43	5.7200	N	61	28	61.4617	4120	4024		n	y	0	240.00
	23/7/03	1:50	5	43	5.7183	N	61	28	61.4617	4196	4150		n	y	0.3	241.90
	23/7/03	2:00	5	43	5.7150	N	61	28	61.4617	4050	4191	1078.0	n	y	0.2	243.00
	23/7/03	2:10	5	43	5.7133	N	61	28	61.4617	3998	4190	1253.8	n	y	0	244.00
	23/7/03	2:20	5	43	5.7117	N	61	28	61.4600	3931	4190	1450.3	n	y	0	249.00
	23/7/03	2:30	5	43	5.7113	N	61	28	61.4588	3850	4191	1655.9	n	y	0.4	246.00
	23/7/03	2:40	5	43	5.7083	N	61	28	61.4583	3840	4191	1679.0	n	y	0	237.00
	23/7/03	2:50	5	42	5.7080	N	61	28	61.4585	3872	4191	1603.8	n	y	dredging on bottom	0	242.00
	23/7/03	2:56	5	42	5.7075	N	61	27	61.4580	3760	4181	1828.4	n	y	hauling up dredge	0	241.00
	23/7/03	3:04	5	42	5.7050	N	61	27	61.4578	3800	4099	1536.8	n	y	hauling up dredge	0	239.70
	23/7/03	3:15	5	42	5.7030	N	61	27	61.4577	3819	3879	679.6	n	y	hauling up dredge	0	238.00
	23/7/03	3:45	5	42	5.6967	N	61	27	61.4558	3941	2616		n	y	hauling up dredge	0	241.00
	23/7/03	4:00	5	42	5.6933	N	61	27	61.4543	3915	1611		n	y	hauling up dredge	0.1	249.00
	23/7/03	4:30	5	41	5.6883	N	61	27	61.4500	3830			n	y	dredge up rocks split into D1 (pillow) and D2	0	254.40
	23/7/03	5:25	5	44	5.7333	N	61	28	61.4667	3433			n	n		0	234.10
	23/7/03	5:36	5	44	5.7333	N	61	28	61.4667	3656			n	n		0	218.00
	23/7/03	6:00	5	43	5.7167	N	61	28	61.4667	3657			y	n	ctd in water	0.6	246.00
	23/7/03	6:30	5	43	5.7167	N	61	28	61.4667	4170			y	n	testing ctd, new svp into em12	0	254.00
	23/7/03	7:00	5	43	5.7167	N	61	28	61.4667	4014			y	n	ctd going down	3.2	309.00
	23/7/03	7:30	5	42	5.7063	N	61	28	61.4717	3945			y	n	ctd going down	0	242.00
	23/7/03	8:00	5	42	5.7017	N	61	28	61.4717	3862			y	n	ctd going down (2754m)	0	247.00
	23/7/03	8:10	5	43	5.7145	N	61	28	61.4717				y	n	firing niskins and bringing CTD up		
	23/7/03	8:33	5	42	5.7013	N	61	28	61.4717	3720			y	n	CTD coming up	0	262.00
WP4a	23/7/03	9:00	5	42	5.6947	N	61	28	61.4667	3764			y	n	CTD coming up	0	260.00
	23/7/03	9:30	5	42	5.6945	N	61	28	61.4633	3923			y	n	CTD coming up	0	251.00
	23/7/03	9:51	5												CTD stopped, then re-started. Near surface		
	23/7/03	10:00	5	41	5.6907	N	61	28	61.4640	4064			y	n	CTD onboard	0	249.00
	23/7/03	10:40	5	44	5.7302	N	61	25	61.4198	4742			n	n	Heading to wp5	7	318.00
	23/7/03	11:00	5	46	5.7613	N	61	24	61.3935	4369			n	n	Heading to wp5	7	315.00
	23/7/03	12:00	5	51	5.8467	N	61	19	61.3150	3778			n	n		5.9	313.00
	23/7/03	13:00	5	56	5.9317	N	61	14	61.2300	3223			n	n		6.7	297.00
WP5	23/7/03	13:35	5	54	5.8992	N	61	13	61.2233	3552			n	y	Dredge going down	0.3	270.00
	23/7/03	14:11	5	54	5.8977	N	61	13	61.2183	4114	1367		n	y	Dredge reeling out	0.1	267.00
	23/7/03	14:22	5	54	5.8968	N	61	13	61.2150	4146	1850		n	y		0.6	267.00
	23/7/03	14:35	5	54	5.8960	N	61	13	61.2117	4184	2318		n	y		0.1	267.00
	23/7/03	14:45	5	54	5.8953	N	61	13	61.2100	4129	2699		n	y		0.1	264.00
	23/7/03	14:53	5	54	5.8947	N	61	13	61.2100	4136	2973		n	y		0.3	265.00
	23/7/03	15:10	5	54	5.8917	N	61	12	61.2067	4146	3614		n	y		0.7	273.00
	23/7/03	15:20	5	54	5.8917	N	61	12	61.2050	4177	3900		n	y	Dredge at 3900m, pinger about 500m from bottom	0.6	272.00
	23/7/03	15:41	5	54	5.8917	N	61	12	61.1983	3999	4262	1474.0	n	y	Fine tuning position, reeling out more	0.3	275.00
	23/7/03	15:46	5	54	5.8917	N	61	12	61.1983	3999	4316	1623.5	n	y		0.3	268.00
	23/7/03	15:54	5	54	5.8917	N	61	12	61.1983	4003	4200	1271.2	n	y	Dredge back down in correct place	0.3	266.00
	23/7/03	15:58	5	53	5.8912	N	61	12	61.1968	3954	4200	1416.3	n	y		0.8	259.00
	23/7/03	16:40	5	53	5.8900	N	61	11	61.1835	3864	4210	1671.4	n	y	Letting out dregde	0.1	275.50
	23/7/03	16:50	5				61			3773	4257	1971.4	n	y	Dredge probably been on bottom for 20mins, pinger hit floor, no echo		
	23/7/03	16:54	5	53	5.8910	N	61	11	61.1825	3861	4236	1742.5	n	y	Dredge on bottom	0.3	276.00
	23/7/03	17:05	5	53	5.8915	N	61	11	61.1817	3824	4189	1710.2	n	y		0.3	274.00
	23/7/03	17:30	5	54	5.8927	N	61	11	61.1797	3841	4073	1355.0	n	y		0.1	286.00
	23/7/03	17:32	5	54	5.8927	N	61	11	61.1797		4056	4056.0	n	y	Dredge bag strangled and off bottom		
	23/7/03	17:45	5				61					0.0	n	y	Coming up		
	23/7/03	18:00	5	54	5.8935	N	61	11	61.1763	3843	3282	#NUM!	n	y		0.3	272.00
	23/7/03	18:30	5	54	5.8942	N	61	10	61.1737	3828	1605	#NUM!	n	y		0.3	275.00
	23/7/03	19:00	5	54	5.8947	N	61	10	61.1722			0.0	n	y	Pinger and MAPR up		
	23/7/03	19:05										0.0	n	n	Pinger and MAPR retrieved		
	23/7/03	19:20										0.0	n	n	Dredge on surface		
	23/7/03	19:29	5	54	5.8927	N	61	10	61.1700			0.0	n	n	dredge on deck		
	23/7/03	20:00	5	54	5.9067	N	61	8.6	61.1433	3691		#NUM!	n	n	On way to WP6	5.6	300.00

	23/7/03	20:45	5 57	5.9517	N	61 4.3	61.0717			0.0	n	n	On way to WP6	6.1	288.00
	23/7/03	21:29	5 59	5.9767	N	60 60	60.9933	3335		#NUM!	n	n	On way to WP6	6.1	292.00
	23/7/03	22:00	5 60	5.9933	N	60 57	60.9417	3480		#NUM!	n	n	On way to WP6		
WP6	23/7/03	22:37	6 2.3	6.0383	N	60 53	60.8883	3713		#NUM!	n	n	Passed WP6, turning on to it	8.4	290.00
	23/7/03	23:09	6 3.1	6.0520	N	60 57	60.9533	3442		#NUM!	n	n	On WP6 in 5 min	10.1	72.00
	23/7/03	23:25								0.0	n	y	Launch dredge, MAPR 33 attached + pinger		
	23/7/03	23:30	6 3	6.0500	N	60 58	60.9683			0.0	n	y	Dredge down and running out cable	1.1	284.00
	24/7/03	0:06	6 2.9	6.0483	N	60 58	60.9633	3230	1308	#NUM!	n	y	Running cable out	1.1	234.00
	24/7/03	0:13	6 2.9	6.0483	N	60 58	60.9617	3269	1598	#NUM!	n	y	Running cable out	0.6	298.00
	24/7/03	0:34	6 2.9	6.0483	N	60 58	60.9600	3264	2465	#NUM!	n	y	Running cable out to about 3000m. Then drag to target	0.8	275.00
	24/7/03	0:47	6 2.8	6.0467	N	60 58	60.9583	3416	2959	#NUM!	n	y	Going to travel about 2miles to target (30mins)	0.9	292.00
	24/7/03	1:01	6 2.8	6.0467	N	60 57	60.9550	3481	3001	#NUM!	n	y	Travelling to target	1.2	285.00
	24/7/03	1:25	6 2.8	6.0467	N	60 57	60.9450	3532	3025	#NUM!	n	y	Travelling to target; holding at 1knot. Taking dredge to surface floor	1.7	314.00
	24/7/03	1:35	6 2.8	6.0467	N	60 57	60.9433	3432	3357	#NUM!	n	y	Taking dredge out further, slowly	0.7	292.00
	24/7/03	1:40	6 2.8	6.0460	N	60 57	60.9433	3440	3500	645.3	n	y	Cable out to 3500 and stop	0.9	320.00
	24/7/03	1:45	6 2.7	6.0452	N	60 57	60.9417	3581	3560	#NUM!	n	y	Reeling out more to 3600, slowed to 0.7 k	0.3	305.00
	24/7/03	2:00	6 2.7	6.0447	N	60 56	60.9408	3661	3660	#NUM!	n	y	Paid out to 3600	0.4	344.00
	24/7/03	2:11	6 2.7	6.0447	N	60 56	60.9392	3648	3701	624.1	n	y	Paid out to 3701; in valley	0.1	variable
	24/7/03	2:20	6 2.7	6.0447	N	60 56	60.9388	3644	3603	#NUM!	n	y	Reeling back a little before next hill; then accelerate to 1.5kts	0.9	variable
	24/7/03	2:40	6 2.6	6.0440	N	60 56	60.9315		3603	3603.0	n	y	Moving toward target	1.1	232.00
	24/7/03	3:00	6 2.6	6.0437	N	60 56	60.9250		3604	3604.0	n	y		1	254.00
	24/7/03	3:01	6 2.6	6.0435	N	60 55	60.9245	3645	3668	410.1	n	y	reeling to the bottom back to .5 knots	0.5	176.00
	24/7/03	3:11	6 2.6	6.0433	N	60 55	60.9240		3918	3918.0	n	y	looking for the bottom	0.5	variable
	24/7/03	3:20	6 2.6	6.0440	N	60 55	60.9230	3578	3919	1598.9	n	y	pinger at about 110m off sea floor	0.9	343.00
	24/7/03	3:40	6 2.7	6.0448	N	60 55	60.9215		3920	3920.0	n	y	biting up to 5 tonnes max ~5.8t	0.8	variable
	24/7/03	3:45	6 2.7	6.0450	N	60 55	60.9207		3909	3909.0	n	y	slow heave up	0.4	variable
	24/7/03	4:00	6 2.7	6.0450	N	60 55	60.9200	3502	3675	1114.3	n	y	bringing dredge up	1.6	356.00
	24/7/03	4:30	6 2.7	6.0450	N	60 55	60.9183				n	y	reeling dredge in	1.2	163.00
	24/7/03	5:00	6 2.6	6.0433	N	60 55	60.9133	3674			n	y	bringing dredge up	0.5	178.00
	24/7/03	5:15											pinger and mapr removed		
	24/7/03	5:26	6 2.5	6.0423	N	60 55	60.9150	3521			n	n	dredge on deck	1.1	131.00
	24/7/03	6:00	6 4.7	6.0775	N	60 52	60.8717	3761			n	n	on way to wp7	8.2	299.00
	24/7/03	6:35	6 7.3	6.1208	N	60 48	60.8000	4209			n	n		8.1	312.00
	24/7/03	7:00	6 9	6.1497	N	60 47	60.7783	4489			n	n	course alteration 15.cw	7.2	300.00
	24/7/03	7:35	6 13	6.2103	N	60 45	60.7417	3810			n	n		8.6	330.00
	24/7/03	8:00	6 15	6.2497	N	60 43	60.7100	3610			n	n		7.1	289.00
	24/7/03	8:30	6 17	6.2800	N	60 40	60.6633	3463			n	n	on way to wp7	7.2	290.00
	24/7/03	9:00	6 18	6.2948	N	60 38	60.6250	3344			n	n		6.8	285.00
	24/7/03	9:30	6 18	6.3067	N	60 34	60.5733	2969			n	n		7	287.00
	24/7/03	10:00	6 20	6.3377	N	60 32	60.5350	2871			n	n		7.7	344.00
	24/7/03	10:30	6 23	6.3890	N	60 34	60.5733	2556			n	n		9.6	99.00
WP 7	24/7/03	11:00	6 22	6.3605	N	60 36	60.6067	2667			n	n	start preparation of dredge	4.8	191.00
	24/7/03	11:25			N						n	y	MAPR attached, EA500 set to pinger mode	0.7	265.00
	24/7/03	11:30	6 21	6.3452	N	60 36	60.6020	2966	430		n	y	dredge in water and reeling out	0.1	235.00
	24/7/03	12:00	6 21	6.3440	N	60 46	60.7650	3090	1461		n	y	Reeling out	0.7	301.00
	24/7/03	12:30	6 21	6.3423	N	60 35	60.5900	3003	2624		n	y	not logging on plot for technical reason	1.4	286.00
	24/7/03	12:43	6 20	6.3415	N	60 35	60.5850	2941	2900		n	y	stopped reeling out cable, at 2900. Steaming to target.	1.9	264.00
	24/7/03	13:00	6 20	6.3405	N	60 35	60.5783	2926	2900		n	y	travelling to target.	0.8	265.00
	24/7/03	13:10	6 20	6.3398	N	60 35	60.5767	2932	3136	1112.6	n	y	reeling out a little more cable.	0.7	249.00
	24/7/03	13:20	6 20	6.3402	N	60 35	60.5760	2941	3436	1776.7	n	y	stopped reeling out cable, at 3436, then pulled up 10m.	0.4	252.00
	24/7/03	13:35	6 20	6.3403	N	60 34	60.5747	2947	3436	1766.7	n	y	back to 3436	0.3	218.00
	24/7/03	13:45	6 20	6.3400	N	60 34	60.5733	2931	3436	1793.1	n	y	small bites from 4-5T	0.1	298.00
	24/7/03	14:00	6 20	6.3400	N	60 34	60.5717				n	y	further small bites up to 5.4	0.4	305.00
	24/7/03	14:05	6 20	6.3398	N	60 34	60.5712	2981	3426	1688.5	n	y	reeling dredge back in. *got a 6.5T on the way up at 3334m, seabed rising.	0.5	227.00
	24/7/03	14:25	6 20	6.3387	N	60 34	60.5683	2951	3082	889.0	n	y	reeling up faster, ping just off bottom. Plot on again.	0.3	257.00
	24/7/03	15:00	6 20	6.3373	N	60 34	60.5627	2941	1400		n	y	Dredge is on way to surface	0.8	283.00
	24/7/03	15:33	6 20	6.3330	N	60 33	60.5567	2904	157		n	y	Dredge on deck		

	24/7/03	16:00	6	20	6.3275	N	60	33	60.5483	2884			n	y	Dredge on deck, samples retrieved	1.9	224.00
	24/7/03	16:40	6	21	6.3467	N	60	31	60.5217	2962			n	n	On way to WP8	8.4	335.00
	24/7/03	17:00	6	23	6.3850	N	60	30	60.4917	3088			n	n		8.1	324.00
	24/7/03	17:34	6	26	6.4367	N	60	27	60.4500	3439			n	n	10 degree turn to port - following axial volcanic ridge towards wp8	9	300.00
	24/7/03	18:01	6	28	6.4667	N	60	24	60.4000	3695			n	n		6.4	300.00
	24/7/03	18:40	6	31	6.5167	N	60	21	60.3500	3539			n	n		7.7	326.00
	24/7/03	19:00	6	33	6.5500	N	60	20	60.3333	3602			n	n		7.8	325.00
	24/7/03	19:30	6	36	6.6000	N	60	18	60.3000	3554			n	n		5.5	310.00
	24/7/03	20:00	6	34	6.5667	N	60	17	60.2833	3300			n	n		9.6	136.00
	24/7/03	20:30	6	35	6.5767	N	60	21	60.3433	3671			n	n	wind 250 degress	8.8	20.00
WP8	24/7/03	21:00	6	36	6.6040	N	60	21	60.3450	3613			n	y	dredge deployed	0.2	185.00
	24/7/03	21:30	6	36	6.6038	N	60	21	60.3417	3627	1078		n	y	dredge out	0.8	314.00
	24/7/03	22:07	6	36	6.6027	N	60	20	60.3342	3567	2641		n	y	dredge out	1.5	246.00
	24/7/03	22:30	6	36	6.6010	N	60	20	60.3270		3493	3493.0	n	y	dredge out	1.2	218.00
	24/7/03	22:40				N				3446	3780	1553.5	n	y	dredge on bottom		
	24/7/03	23:00	6	36	6.5998	N	60	19	60.3208	3405	3820	1731.6	n	y	dredge on bottom	1.9	136.00
	24/7/03	23:13	6	36	6.5998	N	60	19	60.3183	3409	3850	1789.2	n	y	dredge off bottom after bite	1	206.00
	24/7/03	23:15	6		6.0000	N	60		60.0000	3412	3813	1702.1	n	y	weak link gone		
	24/7/03	23:00	6	36	6.5983	N	60	19	60.3158	3475	3300		n	y	hauling dredge.	1.8	279.00
	25/7/03	0:08	6	36	6.5950	N	60	18	60.3050	3692	855		n	y	dredge coming up	0.9	203.00
	25/7/03	0:56	6	36	6.5950	N	60	18	60.2967	3708			n	y	dredge in with 1/4 tonne of rock	1.2	300.00
	25/7/03	1:24	6	37	6.6233	N	60	16	60.2708	3709			n	n	all rocks tagged and bagged	7.3	317.00
	25/7/03	2:00	6	39	6.6513	N	60	14	60.2267	3551			n	n	on way to WP9	4.9	307.00
	25/7/03	2:36	6	42	6.6960	N	60	10	60.1702				n	n		7.1	344.00
	25/7/03	3:05	6	45	6.7515	N	60	8.8	60.1463	3763			n	n		6.8	341.00
	25/7/03	4:00	6	51	6.8563	N	60	6.1	60.1020	3325			n	n		7.1	344.00
	25/7/03	4:30	6	55	6.9160	N	60	4.4	60.0730	3409			n	n		6.7	318.00
	25/7/03	5:00	6	57	6.9530	N	60	1.8	60.0298	3309			n	n		6.9	309.00
	25/7/03	5:30	6	59	6.9873	N	59	59	59.9823	3147			n	n		8.6	318.00
	25/7/03	6:00	7	2.1	7.0347	N	59	57	59.9527	2776			n	n		7.2	324.00
	25/7/03	6:33	7	2.6	7.0432	N	59	54	59.9065	3037			n	n	turning to wp9	4.8	265.00
WP9	25/7/03	7:00	7	2.6	7.0433	N	59	57	59.9525	2599			n	n	stopped, preparing to dredge	2.3	238.00
	25/7/03	7:30	7	2.5	7.0415	N	59	57	59.9508	2664			n	y	mapr and pinger attached	1	203.00
	25/7/03	7:30	7	2.5	7.0415	N	59	52	59.8675	2704			n	y	dredge in water	0.5	300.00
	25/7/03	8:00	7	2.5	7.0413	N	59	60	59.9983	2665			n	y	dredge reeling out	1.5	45.00
	25/7/03	8:30	7	2.3	7.0388	N	59	57	59.9437	2783	2300		n	y	dredge reeling out	2	5.00
	25/7/03	9:00	7	2.3	7.0383	N	59	56	59.9322	2815	2598		n	y	dredge reeling out	0.2	260.00
	25/7/03	9:30	7	2.3	7.0382	N	59	55	59.9223	2879	3017	902.0	n	y	Dredge reeling out. Bottom trace indistinct	0.8	255.00
	25/7/03	9:45	7	2.3	7.0377	N	59	55	59.9180	2906	3250	1455.2	n	y	Dredge on bottom? Bottom trace indistinct	1.2	160.00
	25/7/03	10:00	7	2.2	7.0372	N	59	55	59.9157	2950	3290	1456.6	n	y	Dredge on bottom? Bottom trace indistinct	1.6	190.00
	25/7/03	10:14									3317	3317.0	n	y	Ping on bottom; trace weakened		
	25/7/03										3287	3287.0	n	y	Ping off bottom		
	25/7/03	10:23	7	2.2	7.0362	N	59	55	59.9107	2929	3186	1253.6	n	y	No big bites, but dredge on bottom for 40 min; now hauling	0.9	244.00
	25/7/03	10:30	7	2.2	7.0360	N	59	55	59.9095	2929	3096	1003.1	n	y	hauling dredge.	0.8	259.00
	25/7/03	11:00	7	1.9	7.0318	N	59	54	59.9013	2756	1207		n	y	hauling dredge.	2.2	305.00
	25/7/03	11:30	7	1.6	7.0273	N	59	57	59.9550		67		n	y	taking off pinger	0.1	286.00
	25/7/03	12:00	7	1.5	7.0250	N	59	54	59.8917	2647			n	y	dredge up, steaming to next wp, stopped.	0	168.00
	25/7/03	13:45	7	5.9	7.0983	N	59	47	59.7867	3323			n	n	interesting sulphurous rocks in dredge, may do a ctd	5.2	274.00
	25/7/03	14:15	7	6.2	7.1025	N	59	45	59.7533	3349			n	n	too rough for ctd, on to next wp	4.8	267.00
	25/7/03	15:00	7	8.4	7.1407	N	59	41	59.6823	3596			n	n		8.2	278.00
	25/7/03	15:30	7	9.8	7.1640	N	59	38	59.6400	3730			n	n	steaming to wp10	4.2	311.00
	25/7/03	16:00	7	12	7.2002	N	59	36	59.5993	3841			n	n		8.5	330.00
	25/7/03	16:39	7	17	7.2913	N	59	34	59.5660	4072			n	n		8.3	334.00
	25/7/03	17:05	7	21	7.3512	N	59	34	59.5625	4720			n	n		9.6	19.00
	25/7/03	17:35	7	25	7.4218	N	59	35	59.5892	4130			n	n		8.7	29.00
	25/7/03	18:03	7	29	7.4863	N	59	37	59.6142	3620			n	n		9.2	19.00
	25/7/03	18:42	7	31	7.5150	N	59	39	59.6488	3556			n	n		8.6	153.00

	25/7/03	19:06	7	29	7.4860	N	59	39	59.6537	3737		n	n	2	347.00
	25/7/03	19:30	7	29	7.4905	N	59	39	59.6480	3527		n	n	4.9	123.00
	25/7/03	20:00	7	29	7.4888	N	59	39	59.6433	3509		n	y	1.9	342.00
	25/7/03	20:30	7	29	7.4895	N	59	38	59.6355	3716	526	n	y	1.9	165.00
	25/7/03	21:00	7	29	7.4858	N	59	38	59.6300	3786	1578	n	y	1.5	273.00
	25/7/03	21:30	7	29	7.4828	N	59	38	59.6258	3807	2800	n	y	2	255.00
	25/7/03	22:00	7	29	7.4817	N	59	37	59.6198	3753	3842	n	y	1.1	257.00
	25/7/03	22:30	7	29	7.4810	N	59	37	59.6127	3749	4016	n	y	0.8	202.00
	25/7/03	23:00	7	29	7.4795	N	59	36	59.6070	3600	4045	n	y	2.1	233.00
	25/7/03	23:30	7	29	7.4773	N	59	36	59.5967	3723	3663	n	y	0.6	261.00
	26/7/03	0:00	7	29	7.4763	N	59	35	59.5902	3659	1821	n	y	2	273.00
	26/7/03	0:30	7	28	7.4733	N	59	35	59.5783			n	y	0	variable
	26/7/03	1:00	7	28	7.4733	N	59	35	59.5783	3808		n	y	0	182.00
	26/7/03	1:14	7	28	7.4717	N	59	35	59.5767	3875		n	n	1	variable
	26/7/03	2:12	7	33	7.5533	N	59	39	59.6533	4227		n	n	8.2	29.00
	26/7/03	2:30	7	36	7.5917	N	59	40	59.6700	4429		n	n	8.4	29.00
	26/7/03	3:00	7	40	7.6618	N	59	40	59.6632	3916		n	n	6.5	334.00
	26/7/03	4:00	7	45	7.7508	N	59	36	59.5983	3400		n	n	3.8	282.00
	26/7/03	4:30	7	46	7.7745	N	59	33	59.5563			n	n	5.6	310.00
	26/7/03	5:00	7	48	7.7985	N	59	31	59.5125	2995		n	n	6.9	295.00
	26/7/03	5:30	7	50	7.8268	N	59	29	59.4757	2634		n	n	5.5	314.00
	26/7/03	6:00	7	52	7.8615	N	59	26	59.4402	2382		n	n	8.2	325.00
	26/7/03	6:35	7	52	7.8742	N	59	28	59.4615	2366		n	n	7.6	80.00
WP11	26/7/03	7:00	7	52	7.8725	N	59	29	59.4788	2358		n	n	1	257.00
	26/7/03	7:15	7	52	7.8745	N	59	29	59.4775	2352		n	y	0.9	267.00
	26/7/03	7:30	7	52	7.8738	N	59	29	59.4757	2359		n	y	0.3	241.00
	26/7/03	8:00	7	52	7.8718	N	59	28	59.4723	2360		n	y	0.9	200.00
	26/7/03	8:30	7	52	7.8718	N	59	28	59.4633	2507	1648	n	y	1.2	297.00
	26/7/03	9:00	7	52	7.8702	N	59	27	59.4533	2545	1648	n	y	3.1	267.00
	26/7/03	9:30	7	52	7.8677	N	59	26	59.4350	2512	2495	n	y	1.9	252.00
	26/7/03	9:45	7	52	7.8670	N	59	26	59.4300	2511	3069	n	y	1.5	252.00
On way to 12	26/7/03	10:00	7	52	7.8677	N	59	26	59.4283	2495		n	y	0.6	274.00
	26/7/03	10:30	7	52	7.8688	N	59	25	59.4200	2520		n	y	2.7	341.00
	26/7/03	10:43	7	gps down		N	59			2513		n	y		
	26/7/03	11:00	7	52	7.8680	N	59	25	59.4120	2531		n	y	0.9	316.00
	26/7/03	11:36	7	52	7.8697	N	59	24	59.4058	2501		n	n	1.9	332.00
	26/7/03	12:00	7		7.0000	N	59					n	n		
	26/7/03	12:20	7	53	7.8780	N	59	23	59.3850	2513		n	n	7.8	308.00
	26/7/03	12:56	7	56	7.9392	N	59	24	59.3943	2768		n	n	9.2	42.00
	26/7/03	13:58	7	53	7.8840	N	59	30	59.5067	2817		n	n	7	169.00
	26/7/03	14:59	7	48	7.7982	N	59	35	59.5767	3132		n	n	4.7	215.00
	26/7/03	16:00	7	45	7.7483	N	59	31	59.5200	2399		n	n	4.8	293.00
	26/7/03	16:30	7	46	7.7633	N	59	28	59.4687	2516		n	n	3.8	293.00
	26/7/03	17:00	7	47	7.7833	N	59	24	59.4000	2466		n	n	4	293.00
	26/7/03	17:38	7	50	7.8268	N	59	22	59.3622	2594		n	n	6.2	309.60
	26/7/03	18:00	7	51	7.8560	N	59	20	59.3337	2957		n	n	5.5	312.90
	26/7/03	18:30	7	54	7.9023	N	59	17	59.2893	3083		n	n	5.9	313.00
	26/7/03	19:00	7	57	7.9502	N	59	15	59.2445	3275		n	n	4.8	315.00
	26/7/03	20:00	8	0.9	8.0153	N	59	11	59.1827	3995		n	n	4.6	313.00
	26/7/03	20:30	8	1.4	8.0228	N	59	8.5	59.1420	4180		n	n		
	26/7/03	21:00	8	1.3	8.0217	N	59	6.1	59.1018	3890		n	n	6.8	282.00
	26/7/03	22:00	8	1.3	8.0215	N	59	1.9	59.0317	3700		n	n	6.2	261.00
	26/7/03	22:30	8	1.3	8.0217	N	58	59	58.9872	3578		n	n	6.7	259.00
	26/7/03	23:00	8	1.6	8.0273	N	58	57	58.9493	3527		n	n	6	271.00
	26/7/03	23:35	8	3.3	8.0543	N	58	54	58.8958	3861		n	n	6.7	302.00
n way to wp	27/7/03	0:00	8	4.1	8.0688	N	58	52	58.8700	3631		n	n	3.4	284.00
	27/7/03	1:09	8	7	8.1170	N	58	46	58.7733	3642		n	n	3.7	281.00

dredge in water 20:03	
dredge in water	
dredge in water	
pinger @150m from bottom	
50m off bottom?	
dredge coming up	
dredge coming up	
dredge coming up	
dredge almost up	
dredge up, no rocks apparent. Bucket of sand.	
setting off to wp11	
sailing to wp11	
sailing to wp11	
sailing to wp11	
6:50 at WP11	
Dredge in water, MAPR and pinger being attached	
Dredge reeling out	
Dredge reeling out	
Dredge on deck	
Change of course for swathing	
steaming to wp12	
Change of course	
wp 12 aborted, prob just mud. Heading to wp13	

	27/7/03	1:40	8	8.7	8.1445	N	58	44	58.7250	3818		n	n	we are going to do a turn @wp13 due to poor bathymetry	5.3	290.00
	27/7/03	2:00	8	9.6	8.1602	N	58	40	58.6600	3889		n	n	now turning	7	330.00
wp13	27/7/03	2:25	8	11	8.1883	N	58	44	58.7300	3582		n	y	preparing to dredge at wp13	7.1	80.00
	27/7/03	3:17	8	12	8.2063	N	58	46	58.7583	3902		n	y	dredge away with mapr, ping (@300m instead of 150m) and net @200m	1	253.00
	27/7/03	3:50	8	12	8.2020	N	58	45	58.7500	3734	1456	n	y	Dredge going down	1.2	212.00
	27/7/03	4:00	8	12	8.1993	N	58	45	58.7460	3819	2022	n	y	4:05 stopped @2152 (wire out)	2.8	312.00
	27/7/03	4:30	8	12	8.1960	N	58	44	58.7393	3862	2152	n	y	4:36 reeling out again	1.3	283.00
	27/7/03	5:00	8	12	8.1933	N	58	44	58.7302	3842	3068	n	y	reeling out	2	239.00
	27/7/03	5:05	8	12	8.1925	N	58	44	58.7278	3800		n	y	close to bottom, pinger trace ok, bottom echo lost	2.1	291.00
	27/7/03	5:31	8	11	8.1905	N	58	43	58.7205	3642	4142	n	y	on bottom, no bottom echo	1	348.00
	27/7/03	5:50	8								4498	n	y	pinger lost! Average tension 4.2T	1.2	250.00
	27/7/03	6:00	8								4426	n	y	dredge stuck	1.5	
	27/7/03	6:02	8								4426	n	y	weakest link failed @ 7.2T, average tension 4.2		
	27/7/03	6:21	8	13	8.2093	N	58	43	58.7138	4043	4198	n	y	dredge off bottom	3.5	248.00
	27/7/03	6:30	8	13	8.2122	N	58	43	58.7088	4001	3755	n	y	reeling in	2	326.00
	27/7/03	7:15	8	13	8.2137	N	58	40	58.6713	3651	930	n	y	reeling in	4.2	260.00
	27/7/03	7:30	8	13	8.2128	N	58	40	58.6613	3684	400	n	y	reeling in; plot updated	1.5	247.00
	27/7/03	7:40	8											mapr & pinger retrieved; mapr seen some seafloor		
	27/7/03	8:00	8	13	8.2135	N	58	39	58.6487	3806		n	n	dredge recovered, samples in bag & pipe		
on to wp14	27/7/03	8:38	8	13	8.2180	N	58	38	58.6400	3732		n	n	on way to wp14	0.8	270.00
	27/7/03	9:30	8	14	8.2250	N	58	37	58.6215	3559		n	n		2.4	267.00
	27/7/03	10:00	8	16	8.2583	N	58	35	58.5910	3397		n	n		7.7	1.00
	27/7/03	10:30	8	19	8.3247	N	58	35	58.5913	3779		n	n		5.2	307.00
	27/7/03	11:00	8	20	8.3367	N	58	33	58.5550	3692		n	n		5.2	283.00
wp14	27/7/03	12:30	8	22	8.3600	N	58	29	58.4783	3091		n	n	at wp14	0.1	332.00
	27/7/03	13:27	8	25	8.4117	N	58	28	58.4733	3456		n	n	container ship changed course around us, now in a squall	8.1	347.00
	27/7/03	13:55	8	24	8.4033	N	58	32	58.5400	3206		n	y	getting into position at wp14	7.7	129.00
	27/7/03	15:02	8	23	8.3783	N	58	34	58.5715	3583	751	n	y	dredge is away and reeling out, mapr, ping and net device attached	0.9	277.00
	27/7/03	15:30	8	23	8.3792	N	58	34	58.5648	3701	1809	n	y	Pinger @1500m	0.5	247.00
	27/7/03	15:44	8	23	8.3778	N	58	34	58.5622		2302	n	y	Pinger @2000m	1	variable
	27/7/03	16:00	8	23	8.3787	N	58	33	58.5580	3641	3026	n	y		1	193.00
	27/7/03	16:30	8	23	8.3792	N	58	33	58.5512	3658	3846	n	y			
	27/7/03	16:34									3876	n	y	Dredge on bottom	1.2	115.00
	27/7/03	16:59								3600	3924	n	y	Downward slope, let out wire		
	27/7/03	17:05								3606	3978	n	y	Downward slope, let out wire		
	27/7/03	17:30	8	23	8.3815	N	58	32	58.5390	3534	3971	n	y	plot updated	2.1	194.00
	27/7/03	18:00	8	23	8.3823	N	58	32	58.5310	3450	3583	n	y	still dredging	1.6	292.00
	27/7/03	18:04	8	23	8.3828	N	58	32	58.5297		3362	n	y	dredge coming up	2.4	355.00
	27/7/03	18:30	8	23	8.3833	N	58	31	58.5232	3525	1779	n	y	Reeling in	2.1	265.00
	27/7/03	19:00	8	23	8.3818	N	58	31	58.5163	3587	291	n	y	Pinger and MAPR being retrieved	2.5	318.00
	27/7/03	19:20	8											Dredge up		
	27/7/03	19:30	8	23	8.3827	N	58	30	58.5077	3699				Dredge on deck. Nothing in pipe, some in net/bag	3	258.00
to WP15	27/7/03	20:00	8	23	8.3812	N	58	30	58.4927	3603		n	n	On way to WP15	6.1	281.00
	27/7/03	20:30	8	25	8.4092	N	58	26	58.4367	3431		n	n	On way to WP15	5.2	282.00
	27/7/03	21:05	8	26	8.4300	N	58	24	58.3933	3631		n	n	On way to WP15	4.6	298.00
	27/7/03	21:44	8	27	8.4578	N	58	21	58.3550	3560		n	n	On way to WP15	7.4	325.00
	27/7/03	22:00	8	30	8.5070	N	58	22	58.3590	3738		n	n	SIMRAD problem; data not updating - no depth info	8.5	325.00
	27/7/03	22:30	8	34	8.5587	N	58	22	58.3660	no data		n	n	SIMRAD problem;Tim and Geir in Plot….	7.4	325.00
	27/7/03	22:40										n	n	SIMRAD back; Original WP15 way off position.		
	27/7/03	23:00	8	37	8.6112	N	58	22	58.3650	3747		n	n	Mapping target area	7.6	333.00
	27/7/03	23:30	8	40	8.6633	N	58	22	58.3733	3529		n	n	course alteration to 090, for 5m, then 180 for 5m. Box	6.2	85.00
	28/7/03	0:00	8	40	8.6622	N	58	27	58.4485	3938		n	n		6.8	99.00
	28/7/03	0:40	8	37	8.6218	N	58	27	58.4488	3948		n	n		5.2	275.00
	28/7/03	1:00	8	39	8.6422	N	58	25	58.4183	4117		n	n		6.4	305.00
	28/7/03	2:00	8	46	8.7697	N	58	24	58.4003	3801		n	n		8.8	358.00
	28/7/03	2:56	8	53	8.8767	N	58	21	58.3567	4832		n	n		6.2	309.00
	28/7/03	4:00	8	57	8.9498	N	58	16	58.2700	3408		n	n		4.7	315.00

	28/7/03	4:30	8	59	8.9868	N	58	15	58.2498	2845		n	n	9.1	13.00
	28/7/03	5:00	9	2.8	9.0460	N	58	17	58.2807	2498		n	n	05:13 plot updated	7.8	23.00
	28/7/03	5:30	9	5.9	9.0985	N	58	17	58.2915	3277		n	n		8	3.00
	28/7/03	6:00	9	7.9	9.1323	N	58	18	58.2962	3628		n	n		5.3	331.00
	28/7/03	6:30	9	8.9	9.1480	N	58	16	58.2652	3648		n	n		4.5	294.00
	28/7/03	7:00	9	10	9.1747	N	58	15	58.2452	3826		n	n		6.6	17.00
	28/7/03	7:30	9	11	9.1817	N	58	14	58.2377	3624		n	n	plot updated	4.9	227.00
	28/7/03	8:00	9	8.9	9.1483	N	58	16	58.2607	3729		n	n		8.2	115.00
	28/7/03	8:46	9	6.4	9.1062	N	58	21	58.3470	3878		n	n	plot updated	3.1	276.00
	28/7/03	9:00	9	6.3	9.1048	N	58	21	58.3453	3944		n	n	GPS DOWN	1.2	11.00
WP15	28/7/03	9:46	9	5.4	9.0893	N	58	19	58.3212	3875		n	y	GPS DOWN pinger & mapr in water @290m	2.1	214.00
	28/7/03	10:00	9	5.2	9.0863	N	58	19	58.3168	3892	753	n	y	Veering dregde @40m/min	2.1	287.00
	28/7/03	10:30	9	4.9	9.0822	N	58	19	58.3085	3706	1901	n	y	Veering dregde @40m/min	3.7	231.00
	28/7/03	11:00	9	4.5	9.0752	N	58	18	58.2998	3193	3323	n	y	Veering dregde @40m/min	1.3	258.00
	28/7/03	11:30	9	4.2	9.0697	N	58	18	58.2920	2813	3501	n	y	Veering dregde @40m/min. Bagless dredge sinking fast with no p/o	2.3	298.00
	28/7/03	12:03	9	3.8	9.0627	N	58	17	58.2822	2731	3489	n	y	Dredging	0.3	257.00
	28/7/03	12:38	9	3.4	9.0560	N	58	16	58.2737	2538	3572	n	y	Reeling back in	1.1	208.00
	28/7/03	13:00	9	3.1	9.0510	N	58	16	58.2667	3304	2973	n	y	Reeling back in	1.9	233.00
	28/7/03	13:30	9	2.8	9.0465	N	58	16	58.2607	2981	2230	n	y	Reeling back in	1.3	228.00
	28/7/03	13:50	9	2.5	9.0410	N	58	15	58.2550	2211	1172	n	y	Reeling back in	0.5	184.00
	28/7/03	15:31	9	3.7	9.0618	N	58	15	58.2488	2051		n	n	Dredge been back on board for some time. On way to wp16	9.5	12.00
WP16	28/7/03	16:30	9	9.4	9.1570	N	58	17	58.2900	3877		n	n		2	126.00
	28/7/03	17:07	9	9.2	9.1540	N	58	17	58.2820	3645		n	y	Pinger & MAPR attached (300m). Dredge reeling out	1.3	143.00
	28/7/03	17:30	9	9.3	9.1545	N	58	17	58.2780	3627		n	y	Dredge reeling out	2	357.00
	28/7/03	18:00	9	9.3	9.1548	N	58	16	58.2732	3620	2129	n	y	Dredge reeling out	1.8	301.00
	28/7/03	18:30	9	9.4	9.1565	N	58	16	58.2685	3673	3333	n	y	Dredge 400m off bottom	1.5	236.00
	28/7/03	18:34									3300	n	y			
	28/7/03	18:40									3700	n	y	Dredge on bottom		
	28/7/03	18:47	9	9.5	9.1582	N	58	16	58.2657	3725	3851	n	y	Dredge on bottom	2.2	357.00
	28/7/03	19:00										n	y	New survey line #106		
	28/7/03	19:13	9	9.5	9.1585	N	58	16	58.2607	3784	3865	n	y	Letting wire out - on downward slope	1.3	331.00
	28/7/03	19:17	9	9.5	9.1587	N	58	16	58.2600	3779	3918	n	y		1.3	326.00
	28/7/03	19:30	9	9.6	9.1600	N	58	16	58.2583	3755	3971	n	y	plot updated	1	285.00
	28/7/03	19:48										n	y	Bite 5.5 tonnes		
	28/7/03	19:58										n	y	Dredge off bottom		
	28/7/03	20:00	9	9.7	9.1623	N	58	15	58.2533	3893	3884	n	y	hauling	0.8	224.00
	28/7/03	20:30	9	9.3	9.1555	N	58	15	58.2443	3926	3139	n	y	hauling	1.1	194.00
	28/7/03	21:00	9	8.4	9.1397	N	58	14	58.2333	3663	1066	n	y	hauling	3	161.00
	28/7/03	21:30	9	7.5	9.1255	N	58	13	58.2133	3136		n	n	dredge recovered, moving on to next wp, pipe empty	3.1	292.00
	28/7/03	22:16	9	7.2	9.1195	N	58	11	58.1858	2884		n	n	on to wp17	6.2	311.00
	28/7/03	22:30	9	8.2	9.1368	N	58	10	58.1662	3296		n	n	mapr	6.2	309.00
	28/7/03	23:00	9	10	9.1677	N	58	8.1	58.1357	3716		n	n	on to wp17	5.1	323.00
	28/7/03	23:30	9	11	9.1898	N	58	5.7	58.0945	3870		n	n	on to wp17	3.3	303.00
	29/7/03	0:30	9	15	9.2493	N	58	3.1	58.0512	3967		n	n	on to wp17	8.3	33.00
	29/7/03	1:08	9	20	9.3300	N	58	3.5	58.0583	4162		n	n	on to wp17	8.8	333.00
	29/7/03	2:02	9	28	9.4622	N	58	4.4	58.0725	4384		n	n	on to wp17	9.5	4.00
	29/7/03	3:00	9	36	9.5993	N	58	5.3	58.0887	4230		n	n	on to wp17	8.9	356.00
	29/7/03	4:00	9	39	9.6508	N	58	1	58.0167	4135		n	n		6.1	304.00
	29/7/03	4:30	9	41	9.6832	N	57	59	57.9883	4100		n	n		6.8	12.00
	29/7/03	5:00	9	45	9.7527	N	57	60	57.9982	3484		n	n	plot updated	6.2	7.00
WP17	29/7/03	5:36	9	45	9.7453	N	58	1.6	58.0263	3378		n	n	Dredge just gone in water	7	123.00
	29/7/03	6:00	9	44	9.7362	N	58	1.8	58.0293	3760		n	y	mapr & pinger attached @300m	1.3	219.00
	29/7/03	6:20										n	y	Dredge reeling out		
	29/7/03	6:30	9	44	9.7333	N	58	1.6	58.0268	3430		n	y	Dredge reeling out	1.1	245.00
	29/7/03	7:00	9	44	9.7323	N	58	1.5	58.0253	3565	1625	n	y	Dredge reeling out	1.7	196.00
	29/7/03	7:24	9	44	9.7313	N	58	###	58.0013	3904	2625	n	y	100 off bottom, gps down	1.5	26.00
	29/7/03	7:51								3746	3630	n	y	450 off bottom		

29/7/03	7:57							3630	3747	n	y	300m off bottom			
29/7/03	8:00							3624	3908	n	y	gps down	1		
29/7/03	8:30							3874	4132	n	y	08:33 dredge on bottom, cable 4178	1		
29/7/03	8:40	9	42	9.6995	N	58	0.8	58.0125	3908	4179	n	y	gps back, dredge on bottom again, good bite @ 9:41	2.3	161.00
29/7/03	9:00	9	42	9.6932	N	58	0.7	58.0110	4031	4220	n	y	on bottom? Bottom trace indistinct	2.2	190.00
29/7/03	9:05	9	42	9.6918	N	58	0.6	58.0107	3953	4102	n	y	hauling dredge.	2.5	232.00
29/7/03	9:30	9							3928	3378	n	y	hauling dredge. Gps down		
29/7/03	10:00	9							4092	1509	n	y	hauling dredge. Gps down		
29/7/03	11:23	9	39	9.6455	N	57	59	57.9825	3484		n	n	gps down, dredge recovered @10:30, on way to next wp18	1.7	269.00
29/7/03	11:33	9	39	9.6517	N	57	58	57.9713	3033		n	n	gps back, on way to wp18	9.1	349.00
29/7/03	12:00	9	41	9.6813	N	57	58	57.9683	4260		n	n	on way to wp18	4.8	265.00
29/7/03	12:31	9	42	9.6943	N	57	56	57.9338	3835		n	n	change course, not going as far as wp18	6.7	305.00
29/7/03	13:00	9	42	9.7062	N	57	55	57.9108	3744		n	n		4.9	322.00
29/7/03	14:00	9	45	9.7520	N	57	51	57.8512	4283		n	n	hove to, to fix pump	0	204.00
29/7/03	15:00	9	47	9.7750	N	57	51	57.8450	3895		n	n	manoevering into posn	7.3	17.00
29/7/03	15:30	9	49	9.8202	N	57	54	57.9040	4069		n	n	manoevering into posn	6.4	44.00
29/7/03	16:00	9	50	9.8405	N	57	55	57.9237	3478		n	n		3	141.00
29/7/03	16:30	9	49	9.8142	N	57	55	57.9242	3638		n	n		2.8	207.00
29/7/03	17:06	9	48	9.8013	N	57	55	57.9100	3795		n	n		5	195.00
29/7/03	18:00	9	48	9.7935	N	57	53	57.8780	3938		n	n		3.9	261.00
29/7/03	18:30	9	47	9.7888	N	57	51	57.8570	3888		n	n		2.7	240.00
29/7/03	19:00	9	47	9.7843	N	57	50	57.8360	3898		n	n		3	318.00
29/7/03	19:30	9	47	9.7817	N	57	49	57.8168	3938		n	n		2.5	267.00
29/7/03	20:00	9	47	9.7817	N	57	48	57.8057	3960		n	n		1	258.00
29/7/03	20:39	9	47	9.7800	N	57	47	57.7833	3893		n	n		1.1	272.00
29/7/03	21:00	9	47	9.7800	N	57	46	57.7742	3661		n	n		3.7	164.00
29/7/03	22:00	9	46	9.7740	N	57	45	57.7448	3674		n	n	no progress	1.8	339.00
29/7/03	23:09	9	49	9.8168	N	57	45	57.7502	4202		n	n		9.4	34.00
30/7/03	0:00	9	53	9.8817	N	57	48	57.7998	4204		n	n	hove to, to fix down eqpt on deck	2.9	252.00
30/7/03	0:30	9	52	9.8717	N	57	47	57.7858	4131		n	n		4.5	217.00
30/7/03	1:00	9	52	9.8652	N	57	46	57.7703	3956		n	n		2.9	244.00
30/7/03	2:00	9	50	9.8403	N	57	44	57.7277	4250		n	n		3.3	250.00
30/7/03	3:00	9	50	9.8395	N	57	41	57.6858	3625		n	n		2.9	249.00
30/7/03	4:00	9	51	9.8507	N	57	38	57.6350	3558		n	n		3.1	282.00
30/7/03	4:30	9	52	9.8615	N	57	36	57.5967	3588		n	n		4	281.00
30/7/03	5:00	9	52	9.8678	N	57	34	57.5727	4094		n	n		4.6	294.00
30/7/03	5:30	9	53	9.8847	N	57	34	57.5675	3940		n	n		6.4	330.00
30/7/03	6:00	9	54	9.8932	N	57	33	57.5503	4106		n	n		4.2	210.00
30/7/03	6:30	9	53	9.8813	N	57	32	57.5265	4611		n	n	plot updated	1.4	110.00
30/7/03	7:02	9	52	9.8708	N	57	30	57.4922	3748		n	n		6.3	263.00
30/7/03	7:30	9	52	9.8595	N	57	27	57.4582	3882		n	n		5.1	264.00
30/7/03	8:00	9	51	9.8497	N	57	26	57.4267	3800		n	n	em12 quality poor due to force8. On way to wp19	4.5	252.00
30/7/03	8:30	9	51	9.8435	N	57	24	57.3983	4059		n	n		2.5	268.00
30/7/03	9:00	9	50	9.8405	N	57	22	57.3600			n	n	GPS DOWN		
30/7/03	9:30	9	50	9.8393	N	57	20	57.3283	4190		n	n		3.9	287.00
30/7/03	10:00	9	50	9.8387	N	57	18	57.3007	4482		n	n		2.5	300.00
30/7/03	10:30	9	50	9.8400	N	57	15	57.2578	4485		n	n		4.5	282.00
30/7/03	11:00	9	51	9.8417	N	57	14	57.2270	4121		n	n		5.2	279.00
30/7/03	11:30	9	51	9.8417	N	57	12	57.2012	4111		n	n		2.2	276.00
30/7/03	12:00	9	51	9.8442	N	57	11	57.1767	3856		n	n		3.1	279.00
30/7/03	12:30	9	51	9.8483	N	57	8.6	57.1440	4067		n	n		2.5	273.00
30/7/03	13:00	9	51	9.8453	N	57	7.5	57.1247	3860		n	n		3	240.00
30/7/03	14:00	9	52	9.8690	N	57	4	57.0663	3855		n	n		4.3	270.00
30/7/03	15:00	9	54	9.9060	N	57	0.3	57.0045	3681		n	n		6.2	330.00
30/7/03	16:00	10	0.9	10.0143	N	57	2.8	57.0458	3429		n	n		8.8	32.00
30/7/03	17:00	10	1	10.0165	N	57	4.5	57.0743	2683		n	n		4.8	166.00
30/7/03	17:38	9	59	9.9875	N	57	4.1	57.0678	3067		n	n		6.3	171.00

	30/7/03	18:00	9	58	9.9680	N	57	4.3	57.0712	3598		n	n	plot updated	6.6	109.00
WP19	30/7/03	18:36	9	58	9.9710	N	57	6.2	57.1027	2664		n	n		1.8	299.00
	30/7/03	18:45	9	58	9.9713	N	57	6	57.1005	2665		n	y	Dredge in water		
	30/7/03	19:00	9	58	9.9707	N	57	5.9	57.0977	2728		n	y	Pinger & MAPR attached (300m)	0.9	233.00
	30/7/03	19:30	9	58	9.9707	N	57	5.2	57.0873	3076		n			0.3	207.00
	30/7/03	20:00	9	58	9.9668	N	57	4.9	57.0813	3522		n		reeling out	1.4	250.00
	30/7/03	20:30	9	58	9.9617	N	57	4	57.0672	3701	2602	n	y		1.4	243.00
	30/7/03	21:05	9	57	9.9560	N	57	3.8	57.0630	4898	4171	n	y		1.4	213.00
	30/7/03	21:30	9	57	9.9523	N	57	3.3	57.0553	3932	4588	n	y		2.4	310.00
	30/7/03	22:00	9	57	9.9472	N	56	2.8	56.0467	4016	4653	n	y	first good bite dredge on bottom	3.3	235.00
	30/7/03	22:30	9	57	9.9422	N	56	2.2	56.0360	4230	4391	n	y	hauling 3 good bites	2.4	148.00
	30/7/03	23:00	9	56	9.9357	N	56	1.9	56.0317	4238	2170	n	y	hauling	1.1	149.00
	30/7/03	23:30	9	56	9.9300	N	56	0.8	56.0132	4334	804	n	y	hauling	1.3	233.00
	31/7/03	0:07	9	56	9.9272	N	56	0.1	56.0022	4347		n	n	dredge on deck	0.7	312.00
	31/7/03	0:10	9	53	9.8823	N	56	58	56.9717	3653		n	n	on way to wp 18	3.5	229.00
	31/7/03	2:14	9	49	9.8197	N	56	56	56.9350	3615		n	n		4.5	230.00
	31/7/03	3:00	9	49	9.8160	N	56	59	56.9810	3159		n	n	tacking to avoid waves	8.1	80.00
	31/7/03	3:55	9	52	9.8650	N	57	7.3	57.1218	3874		n			9.2	95.00
	31/7/03	4:30	9	52	9.8747	N	57	13	57.2172	3847		n		plot updated	9.1	80.00
	31/7/03	5:00	9	54	9.8955	N	57	18	57.2932	4480		n			9.6	72.00
	31/7/03	5:35	9	55	9.9177	N	57	23	57.3825	4626		n			9.4	89.00
	31/7/03	6:07	9	56	9.9383	N	57	28	57.4672	4113		n			10.5	88.00
	31/7/03	7:00	9	58	9.9747	N	57	36	57.6000	3671		n			9.9	83.00
	31/7/03	8:00	9	60	9.9972	N	57	44	57.7290	2566		n			2.9	166.00
	31/7/03	8:30	9	58	9.9733	N	57	43	57.7163	3411		n			2.7	217.00
	31/7/03	9:00	9	58	9.9620	N	57	42	57.7043	3950		n			1.5	189.00
	31/7/03	9:41	9	57	9.9457	N	57	41	57.6807	4181		n			1.7	242.00
	31/7/03	10:00	9	56	9.9398	N	57	40	57.6657	3938		n			3.3	272.00
	31/7/03	10:30	9	56	9.9322	N	57	39	57.6483	3956		n			4.9	241.00
	31/7/03	11:00	9	55	9.9230	N	57	38	57.6400	4134		n		on dredge site course alteration @ bridge request	1.9	179.00
	31/7/03	11:10			0.0000	N	57		57.0000			n	Y	dredge in water	1.7	127.00
	31/7/03	11:30	9	55	9.9163	N	57	38	57.6378	4297	715	n	Y	veering dredge at 40m/m	1.1	162.00
	31/7/03	12:00	9	55	9.9095	N	57	38	57.6332	4148	1732	n	Y		0.2	209.00
	31/7/03	12:30	9	54	9.9033	N	57	38	57.6307	4048	2871	n	Y	Dredge going down	1.7	198.00
	31/7/03	13:00	9	54	9.9005	N	57	38	57.6273	4033	3922	n	Y		0.2	243.00
	31/7/03	13:30	9	54	9.8947	N	57	37	57.6227	3982	4276	n	Y		1.2	230.00
	31/7/03	14:20	9	53	9.8867	N	57	37	57.6177	4032	4450	n	Y		0.3	234.00
	31/7/03	14:33	9	53	9.8847	N	57	37	57.6220	4100	4400	n	Y	beginning to haul	1.1	320.00
	31/7/03	15:00	9	53	9.8783	N	57	37	57.6148	4056	4190	n	Y	hauling in	0.5	243.00
	31/7/03	16:00	9	52	9.8698	N	57	36	57.6038	3910	1767	n	Y	Hauling in	1.4	249.00
	31/7/03				0.0000	N			0.0000			n	Y			
	31/7/03				0.0000				0.0000				Y			
	31/7/03				0.0000				0.0000							
					0.0000				0.0000							
					0.0000				0.0000							

Appedix 4: Sample Log

sample	start Lat	start Lor	end Lat	end Lon	srt dept	end dept	wt. (kg)	ha	sa	ba	ph	DESCRIPTION
WP2/D1.1	-3.267	56.633	3.297	56.647	3766	3853	25	v	y		y	10-30cm pieces of altd. pillow and green alt. glassy rims (<15mm thick). Olivine (iddingsite) (<1mm, <2%), Plag. (<2mm, <2%), +/- cpx (<1mm, <0.5%).
WP2/D1.2							25		y			Same as WP3/D1.1 but as 30cm x 20cm sheetflow with altered green glassy rim.
WP2/D1.3							25	v	y			Altered green glassy fragments forming breccia with calcariuos matrix.
WP2/D1.4							3			y		Altered basalt as D1.1 and D1.3, but with cauliform manganese crust <8mm thick
WP3/D1.1	-3.408	56.695	-3.433	56.683	3936	3529	0.01			y	y	Small fragments of altered basalt from pipe dredge - probably left over from WP2/D
WP3/D1.2							20			y		Pipe dredge full of calcarious ooze
WP4A/D1	5.728	61.463	5.707	62.458	3725	3760	5	y		y	y	1 piece , 10cm diameter, glassy rimmed plag phyric pillow
WP4A/D1g								y				<5g variably altered glasss from rim of WP4A/D1
WP4A/D3								n		y		4 pieces, 10cm diameter, variably altered non-glassy, plag.phyric basalt massive flow.
WP5D2	5.891	61.183	5.893	61.180	3861		1.25			y	y	Glassy and slightly altered basalt, plagioclase phyric. Calcarious sediment.
WP5/D1							0.75	y				Assorted glassy fragments - best examples picked from D2
WP5/Bio										y		Small (5mm) gastropod, preserved in formalin.
WP5/D3							1.25			y		Altered basalt; grey some glass rims; some Mn coating
WP5/D4							0.2			y		125ml plastic bottle of light brown fine mud collected from pipe dredge. This is the mud from which much basalt glass was sieved
WP6/D1	6.044	60.925	6.045	60.921			0.2	y		y	y	Fresh glass sheet flow fragments, 10-15mm thick.
WP6/D2							0.2	y		y		Assorted glass fragments from the pipe dredge
WP6/D3							1.5	n		y		glassy rimmed sheet flow, 10-20mm thick, 2 pieces
WP6/D4							2			y		grey altered pillow basalt, some glassy rims. 4 pieces.
WP6/D5							1			y		grey limnite stained pillow basalt, som efresh glass. 3 pieces
WP6/D7							50					Mn-coated pillow lavas, fresh glass rims 5-10mm thick, sopme plagioclase (<2mm, <0.5%). 4 pieces inc. one of 30kg.
	6.340	60.577	6.337	60.563	2932	1400						
WP7/Dsed							200	y				Calc sediment
WP7/D1							2	y		y		Aphyric basaltic glass
WP7/D2							5	y		y		Aphyric glassy rimmed fresh sheet flow and small pillow fragments - fresh
WP7/D3							8	y		y		Scouriaceous basalt fresh
WP7/D4							10	y		y		Oxidised grey scouria basalt
	6.600	60.318	6.601	60.327	3493	3409						
WP8/D1g							200	y		y		glass subsample of D1
WP8/D1								y		y		Aphyric grey basalt pillows with glassy rims. Some with outter glass rind. 30x30cm max, 5x5cm min, about 50 pieces
WP8/D2								y		y		Aphyric grey sheet flow fragments with glassy rims. Some with outter glass rind. 5x15cm max, 5x5cm min
WP8/D3								n		y		Aphyric glass pieces from dredge
WP9/D1	7.038	59.922	7.036	59.911	2906	2929		y	y	y	y	Black fine grained possible chimney with 0.5mmnradial crystals of white anhydrate. There are rounded manganese nodules. Approx 300g
WP9/D1g												
WP9/D2										y		Partially altered aphyric basalt. No glass. Approx 1.7kg
WP9/D2g												
WP9/D3										y		laminer sheet flow basalt with glassy top. Glass has cooling structure. Basalt bottom. Aphanitic. Vesicular.
WP9/D3g												aphyric
WP9/D4										y		Green altered basalt. Some iron staining, fine grained some black manganese on surface. No glass. Chloride stained. Approx 5kg
WP9/D4g												
WP9/D5										y		Iron stained basalt with semi vitreous band at top.Aphanitic. Approx 400g of pillow larvae.
WP9/D5g												
WP9/D6										y		Oxidised granules - red and orange. Fine grained
WP9/D6g												
WP10/D1	7.293	59.386	7.284	59.347	3509	3808		y	n	n	n	white sludgey mud with calcerious hard bits possibly forams
WP11/D1	7.524	59.287	7.522	59.247	2358	2768		y	y	n	y	Obsidian glass 100g
WP11/D2								y		y	y	sheet flow basalt with vitreous crust
WP11/D3										y	y	pillow lava, delicate, hand sized chunks
WP11/D4										y	y	manganese crust, black some grains 300g
WP11/D5								y		n	y	Black aphyric aphanitic basalt with ropey morphology 200g
WP12												No dredge, No samples
WP13/D1	8.206	58.758			3902			y		y	y	Glassy basalt fragments (<3cm), frequent plag crystals, Mn stained, some evidence of flow striations, fresh glass when broken.
WP13/D1g								y		y	y	Small glassy basalt chips (<1cm), as above. Not alpha-glass, but not bad.

WP13/D2				y		y	y	As D1, but obvious flow striations (fast flow), plag fragments, stained Mn, pieces up to 7x7cm. Glassy margins
WP13/D3				y	y		y	Large block (20x15cm), multi-layered flow, 4-5 internal rinds. Iindividual flows roughly sub-sampled (A (bottom) to D(top)); Mn crusting, Fe staining.
WP13/D4					y		y	Large block 20x20cm, layered flow, glassy rind, dark grey basalt
WP13/D5						y	y	3 altered basalt fragments, greenish, Fe-stained.
WP14/D1	8.378	58.572	3583	y	n	n	y	100g of altered basalt fragments, max 2x3cm. Stained, crusted fine-grained. Green-white-brown
WP14/D2				y	n	n	y	Dolerite. Single dyke piece ~12x3cm, weathered surface, some crusting. Several smaller pieces.
WP14/D3				y	n	n	y	200g small fragments of pillow basalt, some glassy. Some Mn stained.
WP14/D3g				y	n	n	y	Subsample of above; the most glassy pieces ~ 50g of 1cm chips.
								NB: The total recovery of the dredge has been bagged and put in the hand-specimen tin.
WP15/D1				y		yy	y	serpentinite breccia 6kg
WP15/D2				y		y	y	dunite with secondary amphibole 1kg
WP15/D3				y		y	y	sheared feti olivine gabbro (mylonitic, high temp, plag augens in ol cpx, cpx, matrix, abundant magnetite grains
WP15/D4				y			y	sheared dunite 50g
WP15/D5				y		y	y	hatrzburgite, 1kg 3 pieces
WP15/D6				y			y	gabbro harzburgite 200g
WP15/D7				y		y	y	talcbrucite serpentinised, hartzburgite, phacoids, 5-90cm, 4 pieces, 2kg
WP15/D8				y			y	green serpentinite minerals, 15g.
WP15/D9				y		yy\	y	sheared serpentinised hartzburgite and dunite on phacoids 10-30 cm, 20kg
WP15/D10				y		yy\	y	fresh dunite 10-30cm, 25kg
WP15/D11						y	y	assorted smalls 5kg
WP15/D12						y		sediment
WP16/D1				y		y	y	aphyric micro-vesicular olivine phyric, mafic lava, fist sized piece, weathered
WP16/D2				y		y	y	dunite, weathered
WP16/D3				y		y	y	sheared serpentinite
WP16/D4				y			y	serpentinite with gabbroic vein
WP17/D1				y	sa\	y	y	Olivine, plag rich basalt. Big Plag crstals <9mm, 5%, micro-vesicular. Olivine 3mm, with chromespinnel. Very dark matrix, mafic. No glass. 2Kg
WP17/D2				y	sa\	n	y	Basalt glass, Mn coated
WP17/D3				y	sa\	n	y	fresher (than d2) basalt glass, Mn coated
WP18/D1				y		n	y	Glass, aphyric, fresh glass. 400gr
WP18/D2				y		y	y	Plag, pillow, glassy rim, micro-vesicular. 30kg
WP18/D3				y		n	y	Glassy, aphyric, sheet flow, 5cm thick. 200gr
WP18/D4				y		y	y	Altered, pillow interior. 5kg
WP19/ D1				y		y	y	sheet flow, basalt, aphyric striated glass surface
WP19/ D2				y		y	y	assorted glass fragments from pipe dredge 1bag of fine other of coarse.
WP19/ D3				y		y	y	aphyric pillows with glass on margins Fe staining.
WP19/ D4				y		y	y	Older basalts some glass flow banding 5 small pieces
WP19/ D5				y		y	y	Mn stained blocks older than the rest? Small plag phenocrysts
WP19/ D6				y		y	y	4pieces *2 dolerite polygonal columns (dyke) and 2 pillows with glass rims

Appendix 5

Geotectonic History of the Carlsberg Ridge

The Carlsberg Ridge exhibits the topographic, gravitational and magnetic expression typical of a slow spreading ridge. There are two episodes of spreading in the Arabian Sea. Spreading episodes may indicate a progressive opening of the Arabian Sea from south to north. Volcanism in the vicinity of the Carlsberg Ridge has occurred since the Cretaceous.

The Carlsberg Ridge is an extensional mid-oceanic ridge located in the Arabian Sea between India and Northern Africa. Spreading began in the Tertiary when the spreading center between Madagascar and India jumped northward to form the Carlsberg Ridge.

Several geophysical surveys have been performed on various segments of the ridge. Seismic, gravitational, magnetic and bathymetric data have been collected from various localities along the ridge.

The Carlsberg Ridge, with its rough topography, expresses the typical morphology of a slow-spreading ridge. The axis of the Carlsberg Ridge is N57W according to bathymetric data. Depth to the ridge varies from 1700-4400m. Gravity data show this trend as a gravity low. The topography of the ridge has small scale undulations along the axis. This is indicative of slow spreading and possibly of greater lithospheric strength.

A rift valley is located in the center of the ridge along its entire length. It is demarcated by a steep gradient and rugged topography. Magnetics represent the rift valley as a broad magnetic low. Along the axis of the rift, depths range from 3250-4400m. The rift valley is wide and relatively smooth in the northwest, it narrows in the middle and shallows toward the southeast. Bathymetric data also shows a well defined median valley.

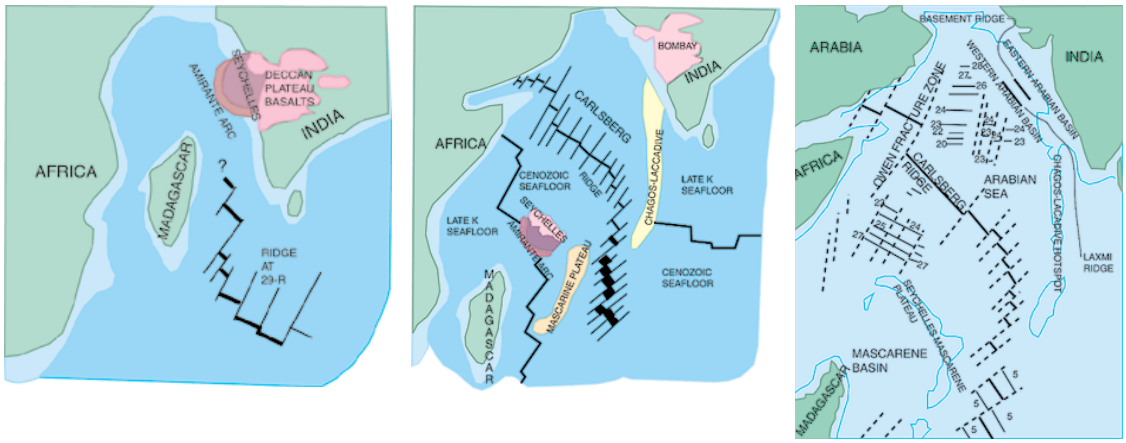
There are two episodes of spreading history in the Arabian Sea. These phases are determined using spreading rates and magnetic anomalies. The older phase began when the spreading center between Madagascar and India jumped northward to form the Carlsberg Ridge. This phase occurs between A27 and A21 and is dated in the early Tertiary. The spreading rate during this time ranged between 2.8 and 9.2cm/yr depending upon time and locality.

The older spreading phase ceased or became very slow after A22. This waning may correspond with progressive collision of India and Eurasia, closure of the Neotethys, and major reorganization of spreading geometries in the Indian Ocean. A21 (50Ma in the early Eocene) marks the end of the older phase of spreading in the Arabian Sea and the initiation of a magnetic quiet zone. This zone terminates against a lineation (A11) parallel to the present day spreading axis. Spreading rates between A21 and A11 were about 0.7cm/yr.

The second spreading phase in its present geometry began just before A11 (32Ma, Late Oligocene) and is still active. The current spreading rate is about 1.2cm/yr with spreading orientation in a NE-SW direction. This may indicate a progressive opening of the Arabian Sea from south to north.

The Carlsberg Ridge and Chagos-Laccadive hotspot track formed relatively simultaneously with the Deccan Plateau. Southward migration of the Chagos-Laccadive hotspot (relative to a fixed Indian Plate) began ~65Ma in the early Paleocene. Initiation of spreading on the Carlsberg Ridge also began at this time (chron 29-R). Isotopic dating shows main phase Deccan volcanism began ~66Ma with a localized phase of volcanism occurring in the northwest ~64Ma. This age coincides with the emplacement of the first oceanic crust in the Arabian Sea.

As spreading along the Carlsberg Ridge continued, the Seychelles Islands (preCambrian granite) and the Amirante Ridge (Cretaceous-aged sea floor) were separated from the Indian Mainland. and the Arabian Sea opened from the southwest to the northeast. The Amirante Ridge and the Seychelles have moved approximately 600km from India during the past 65 million years. (Figure below after Alt, Sears and Hyndman, 1988, Terrestrial Maria: the origins of large basalt plateaus, hotspot tracks, and spreading ridges, The Journal of Geology, v.96, p.647-659).


AFRICA
MADAGASCAR
SEYCHELLES
AMIRANTE ARC
DECCAN PLATEAU BASALTS
INDIA
?
RIDGE AT 29-R
BOMBAY
INDIA
CARLSBERG RIDGE
CHAGOS-LACCADIVE
AFRICA
CENOZOIC SEAFLOOR
LATE K SEAFLOOR
SEYCHELLES
AMIRANTE ARC
MASCARENE PLATEAU
LATE K SEAFLOOR
CENOZOIC SEAFLOOR
MADAGASCAR
BASEMENT RIDGE
ARABIA
INDIA
WESTERN INDIAN BASIN
EASTERN ARABIAN BASIN
OWEN FRACTURE ZONE
CARLSBERG RIDGE
ARABIAN SEA
CHAGOS LACCADIVE HOTSPOT
LAXMI RIDGE
SEYCHELLES-MASCARENE PLATEAU
MASCARENE BASIN
MADAGASCAR