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RRS *CHARLES DARWIN* CRUISE 145
12 MAR - 09 APR 2003

Benthic ecology and biogeochemistry
of the Pakistan Margin

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2004

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ABSTRACT

RRS *Charles Darwin* cruise 145 forms part of a larger programme of research ("Benthic processes in the Arabian Sea: interrelationships between benthos, sediment, biogeochemistry and organic matter cycling", NER/A/S/2000/01280), focusing on the benthic biogeochemistry of the Pakistan Margin, that includes four cruises in total (CD145, 146, 150 and 151). The primary objectives of the present cruise were: a) to establish a series of some five sites on a transect spanning the Arabian Sea oxygen minimum zone as it impinges on the seabed at the Pakistan Margin; b) to assess the chemical oceanography of the water column overlying these sites, through CTD sensor profiles and chemical determinations on water bottle samples from both the CTD and BBLS; c) to provide a general characterization of the seabed in the area of these sites using acoustic remote sensing (EM12 and 3.5 kHz) and seabed imagery (WASP); d) to initiate a programme of detailed seabed sampling at these sites to determine a suite of biological, chemical and biogeochemical parameters using a range of coring devices (multicorer, Megacorer, box corer); and e) to assess and sample the megabenthos of these sites by the combined use of trawling (Agassiz trawl) and seabed photography (WASP).

Despite being beset by a number of difficulties, this was a very successful cruise that very largely achieved its planned objectives: 1) A series of five sites on a transect spanning the Arabian Sea oxygen minimum zone were established in the Pakistan Margin work area, with a sixth deep-water site also successfully studied; 2) CTD sensor profiles and chemical determinations on water bottle samples from both the CTD and BBLS were successfully undertaken at all six sites; 3) A substantial tranche of EM12 swath bathymetric mapping, and supporting 3.5 kHz seabed profiling, was achieved in the Pakistan Margin work area; 4) An extensive coring programme, delivering a wealth of samples, was successfully carried out at all six sites.; and 5) Good quality seabed imagery was obtained with the WASP system at all six primary sites and a further six additional sites. Supporting work with the trawl was also undertaken at five of the six study depths and additional depths in the lower boundary of the oxygen minimum zone where rapid changes in the composition of the megabenthic fauna appears to occur. In summary, this cruise laid a firm foundation on which forthcoming cruises (see CD146, 150 and 151) will build.

KEYWORDS

210Pb, Agassiz trawl. Arabian Sea, bathymetry, benthic boundary layer sampler, benthic communities, benthos, biochemistry, biogeochemistry, box corer, *Charles Darwin*, continental slope, cruise 145, CTD, foraminifera, geochemistry, Indian Ocean, Indus Margin, megabenthos, megacorer, meiobenthos, multiple corer, organic matter, oxygen minimum zone, Pakistan Margin, protozoa, seabed, sulphate reduction, X-radiography

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2. SHIP'S PERSONNEL

Peter Sarjeant	Master
Phil Gauld	Chief Officer
Andy Cope	Second Officer
Titus Owoso	Extra Second Officer
Jet Jethwa	Chief Engineer
Alex Greenhorn	Second Engineer
Glen Collard	Third Engineer
Keith Conner	Third Engineer
Dennis Jakobaufderstroht	Electrical-Technical Officer
Mick Drayton	Bosun
Greg Lewis	Bosun's Mate
Phil Allison	Seaman
Stu Cook	Seaman
Garry Crabb	Seaman
Bob Johnston	Seaman
Iain Thomson	Seaman
Keith Pringle	Motorman
Clive Perry	Ship's Catering Manager
John Haughton	Chef
Tulip Haughton	Assistant Chef
Jeff Orsborn	Steward

3. ITINERARY

Sailed Muscat, Oman	12 March 2003
Arrive Pakistan Margin work area	*14 March*
Depart Pakistan Margin work area	*15 March*
Arrive BIGSET NAST site	*16 March*
Depart BIGSET NAST site	*18 March*
Return to Pakistan Margin work area	*20 March*
Depart Pakistan Margin work area	*1 April*
CTD deployment at A2750 site	*1 April*
WASP deployment at BIGSET NAST site	*2 April*
Docked Port Victoria, Mahe, Seychelles	9 April 2003

4. OBJECTIVES

RRS *Charles Darwin* cruise 145 forms part of a larger programme of research (*"Benthic processes in the Arabian Sea: interrelationships between benthos, sediment, biogeochemistry and organic matter cycling"*, NER/A/S/2000/01280), focusing on the benthic biogeochemistry of the Pakistan Margin, that includes four cruises in total (CD145, 146, 150 and 151). The primary objectives of the present cruise are:

a) to establish a series of some five sites on a transect spanning the Arabian Sea oxygen minimum zone[1] as it impinges on the seabed at the Pakistan Margin.

b) to assess the chemical oceanography of the water column overlying these sites, through CTD sensor profiles and chemical determinations on water bottle samples from both the CTD[2] and BBLS[3].

c) to provide a general characterization of the seabed in the area of these sites using acoustic remote sensing (EM12[4] and 3.5 kHz[5]) and seabed imagery (WASP[6]).

d) to initiate a programme of detailed seabed sampling at these sites to determine a suite of biological, chemical and biogeochemical parameters using a range of coring devices (multicorer, Megacorer, box corer).

e) to assess and sample the megabenthos of these sites by the combined use of trawling (Agassiz trawl) and seabed photography (WASP).

[1] An oxygen depleted (<0.5 ml/l) water layer
[2] Conductivity Temperature Depth probe
[3] Benthic Boundary Layer Sampler
[4] Hull mounded 12 kHz swath bathymetry system
[5] 3.5 kHz surface towed seabed profiling system
[6] SOC Wide-Angle Seabed Photography vehicle

5. NARRATIVE

5.1. Diary (see figure 1 and chart 1)

Monday 10 March.

PSO joins the vessel, several scientists already working-by the ship. The vast majority of on loading of equipment having already taken place.

Tuesday 11 March.

Stowing and installing of equipment continues, remainder of scientific party arrives and all of the scientific party signs on. Scientific party attends vessel familiarisation and safety briefing given by the Captain.

Advised Pakistani observer will not be joining the vessel (his permission to travel having not been received from the appropriate Pakistani authorities), and that diplomatic clearance to work in Pakistani waters has not yet been received.

Sailing planned for 08:00 (local – all narrative times will be given in ship's local time – UTC+4), with intention to recover Bathysnap deployed during CD143, then to proceed to work area, awaiting diplomatic clearance.

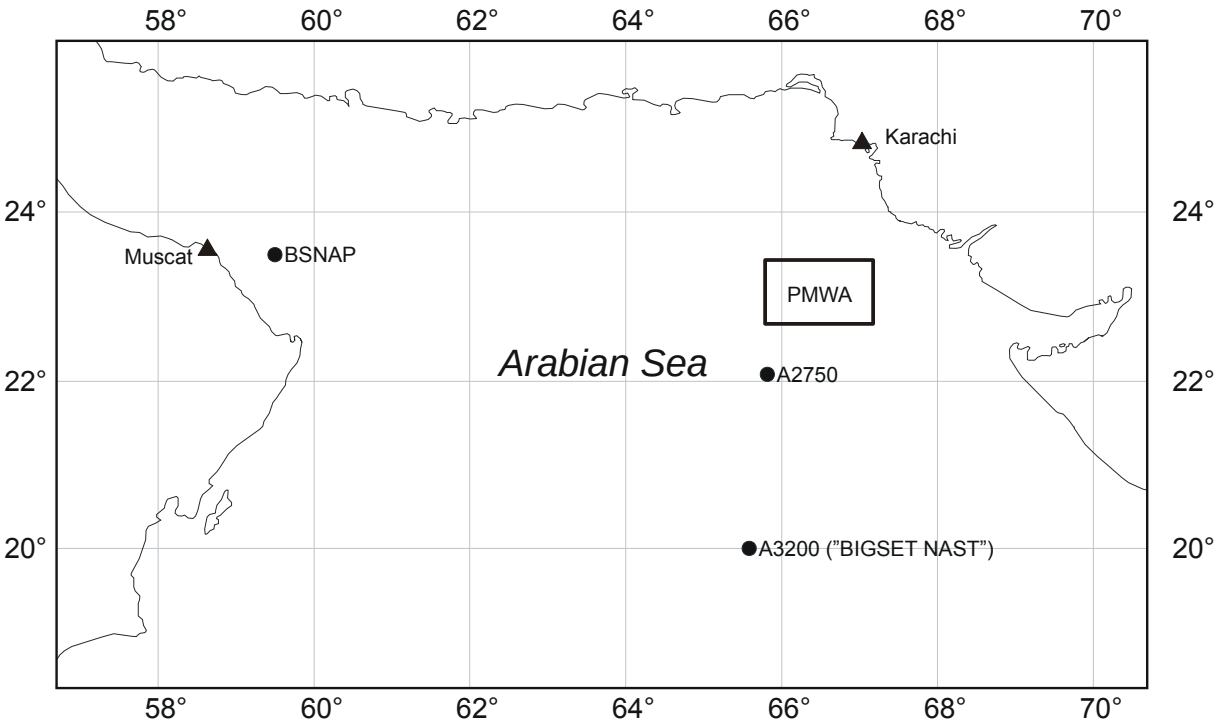

Figure 1. General location of operations (BSNAP – Bathysnap mooring recovery site; PMWA – Pakistan Margin working area; A2750 and A3200 – additional work sites).

Wednesday 12 March.

Sailed Muscat c. 08:30. PES fish deployed c. 13:00. At c. 14:00 begin calibration runs of ship's EM log. Bathysnap released at c. 15:00. Emergency muster and boat drill held at 16:15. Bathysnap sited at the surface at c. 16:30, well streamed at surface, grappled first time and recovery completed to Dan Buoy removal, at which point a hydraulic hose to the deck winch burst. Recovery re-commenced using the A-frame pedestal capstan. Mooring all recovered intact without further incident.

General science meeting held in the evening. Still no diplomatic clearance; proceeding to Pakistan Margin regardless.

Thursday 13 March.

Continuing towards the Pakistan Margin work area. By-gear detailed science meetings begin (Mega-, Multi- and Box core). Science-Shipside liaison meeting held to consider safety and operational matters. Still no diplomatic clearance; continuing towards work area.

PES recovered as an indication that we are "not working".

Friday 14 March.

At c. 06:00 enter the work area and begin a simple hull-mounted, single beam echo-sound survey of the work area – still no diplomatic clearance. Continue with detailed science planning meetings (Agassiz, CTD and Benthic Boundary layer Sampler. Bar committee meeting held. Further science meeting on issues related to the need for temperature-controlled workspaces. Initial training with, and deck trials of, the Megacorer carried out.

Singe beam echo sounding continues, in the hope of possible diplomatic clearance tomorrow.

Saturday 15 March.

Continuing single-beam echo-sound survey, awaiting news on diplomatic clearance. Captain in direct contact with "our man in Islamabad". Clearance not forthcoming – possibly Monday? Meeting of science party to discuss what to do in the meantime. Suggested, and accepted, that we leave for a high seas site to begin some work. A sensible choice of site being the BIGSET[7] programme NAST site (this being only 20 nm more distant than the closest possible high seas location). Complete final echo-sounding line at c. 16:30 and make for the NAST location.

Sunday 16 March.

Proceeding towards BIGSET NAST site. Arrive NAST c. 08:00. CTD+SVP deployed as stn[8]

[7] BIGSET – Biogeochemical transports of energy and matter in the deep sea – see Pfannkuche & Lochte (2000), The biogeochemistry of the deep Arabian Sea: overview, *Deep-Sea Research* II, 47, 2615-2628.

[8] Station number – the station numbering adopted for this cruise follows the long standing (ex-"*Discovery Investigations*", National Institute of Oceanography, Institute of Oceanographic Sciences, Institute of Oceanographic Sciences Deacon Laboratory) scheme operated by the George Deacon Division of the Southampton Oceanography Centre; the cruise number is 558, the first station 55801 and the first deployment

55801#1 for full depth cast. All 24fired, but nine were found to have misfired and the SVP to have failed on recovery. The PES fish was deployed during this deployment to check bottom approach prior to altimeter lock-on (c. 50mab).

Mega12 deployed as stn 55801#2, returning 10/12 short cores, only four of which were successfully removed from the corer. A Mega08 redeployed as stn 55801#3 it returns 8/8 good cores.

Box core deployed as stn 55801#4, it returns a fair core that is sampled for macrobenthos and x-ray slab cores.

Steam for a trawl start position, where the Agassiz trawl is shot as stn 55801#5.

Monday 17 March.

Recover Agassiz trawl (stn 55801#5), it returns a fair catch, with *Zoroaster* and *Benthodytes* among the dominant larger megabenthos.

Relocate on central NAST position and deploy Mega08 as stn 55801#6, it returns 8/8 good cores.

Move off 1nm from the central NAST position and deploy the BBLS as stn 55801#7. It triggers midwater (c. 2000m) and the deployment is aborted. On recovery the trigger pads are fitted with four Day grab weights and the BBLS is redeployed as stn 55801#8. On this occasion it triggers as expected at the seabed. The lower bottle is rather cloudy and the top bottle not fully closed at recovery.

Return to central NAST position and deploy multicore as stn 55801#9, it returns 10/12 short cores (15-19cm). Multicore redeployed (with some new bungies on) as stn 55801#10. It returns 12/12 cores, but again they are short.

Relocate to CTD site, c. 1nm off the central location, and deploy CTD as stn 55801#11, but the deployment is aborted almost immediately with an electrical problem. Wait for re-termination of the electrical connector. Redeploy the CTD as stn 55801#12 but this time experience problems with major “juddering” on the winch and abort the deployment.

Tuesday 18 March.

Move off from the central NAST site and deploy the Agassiz trawl as stn55801#13. It returns a small catch very similar to that of the previous trawl.

Some maintenance carried out on the starboard gantry before we switch back to coring. Deploy Mega08 as stn 55801#14, it returns 8/8 cores of 34-37cm (bar one that had slumped).

Deploy multicore as stn 55801#15, it returns 11/12 short cores.

Begin period of trials on the CTD winch. After much inspection, calls to shoreside and trial use with test weight, the CTD is finally deployed as stn 55801#16 for a cast to c. 2500m, all

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at that station 55801#1, the latter part being referred to as the series number. The station number increments by one each time the vessel relocates to another nominal site (regardless of whether the site has been visited before) and the series number increments by one for each deployment made at a particular station.

bottles fired correctly.

This completed operations at the NAST site and course was set for the northern-most high seas location in the Indian Ocean to await developments on diplomatic clearance.

Wednesday 19 March.

Making for northern location.

At c. 11:00, fax from British High Commission suggests that we have diplomatic clearance for Pakistani waters. This is further confirmed by telephone call, and course is set for the Pakistan Margin transect. At c. 19:00 EM12 swath system is activated and the 3.5 kHz deployed with the intention to make an initial assessment of the vicinity of the proposed 2100m site as we pass through *en route* to working initially at the 1200m site ("A1200"; see figures 2 and 3). On approach to "2100m" area reduce speed to 8 knots for run through and on up to 1200m.

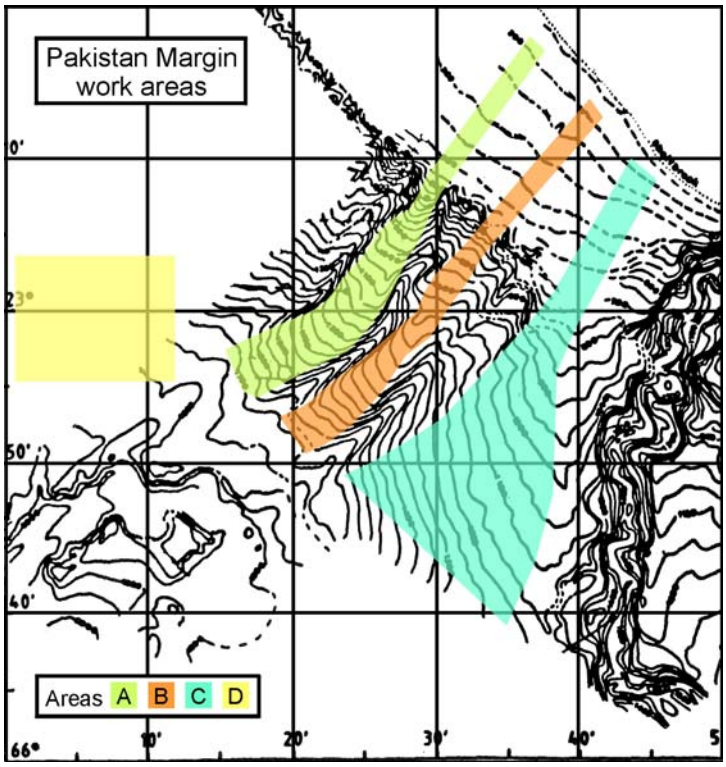

Figure 2. Work area and site naming convention – initial examination of the Hydrosweep swath mapping available from the FS Sonne cruise (the base map shown here) indicated the presence of three main downslope channels in the central region of the study area, with "The Swatch" / Indus Canyon bounding the area to the east. These features naturally divide the region in to three areas: A, B and C. Additionally, work was also carried out in the previously un-mapped area D. Work sites were named by area and approximate depth, e.g. C1100 – in area C at c. 1,100m. Note that for simplicity all primary coring sites are named "A" regardless of their location, i.e. A1850 falls in area D and site A3200 lies some 150nm south of the mapped area shown above (see figure 1 for location).

Thursday 20 March.

Continuing run in to the 1200m site. At c. 06:30 deploy the CTD at site A1200 as stn 55802#1 for a full depth cast. Operations then continue with a deployment of the BBLS as stn 55802#2, but is quickly halted as the CTD cable is drawn into the block by the main coring cable being used for the BBLS. CTD cable chopped off and the BBLS deployment continues. The BBLS deployment continues; it triggers at the seabed (with just two weights on this time); it returns with the top bottle not closed, the bottom bottle cloudy and the middle bottle having rather warm water – i.e. having flushed during ascent.

Deploy Mega12 as stn 55802#3, it returns 12/12 good cores with fine flocculent top over soft uniform brown mud.

Deploy MC as stn 55802#4, it returns 12/12 good cores, c. 30cm, of uniform soft brown mud. Redeploy MC as stn 55802#5, it returns an identical set of 12/12 good cores of c. 30cm uniform soft brown mud.

Deploy box core as stn 55802#6, it returns a fair core, though somewhat full.

Deploy Mega12 as stn 55802#7, it returns 12/12 good cores.

At c. 20:30 begin another tranche of swath survey in the 1200 to 300m zone – four lines of swath and 3.5 kHz run for the overnight stint.

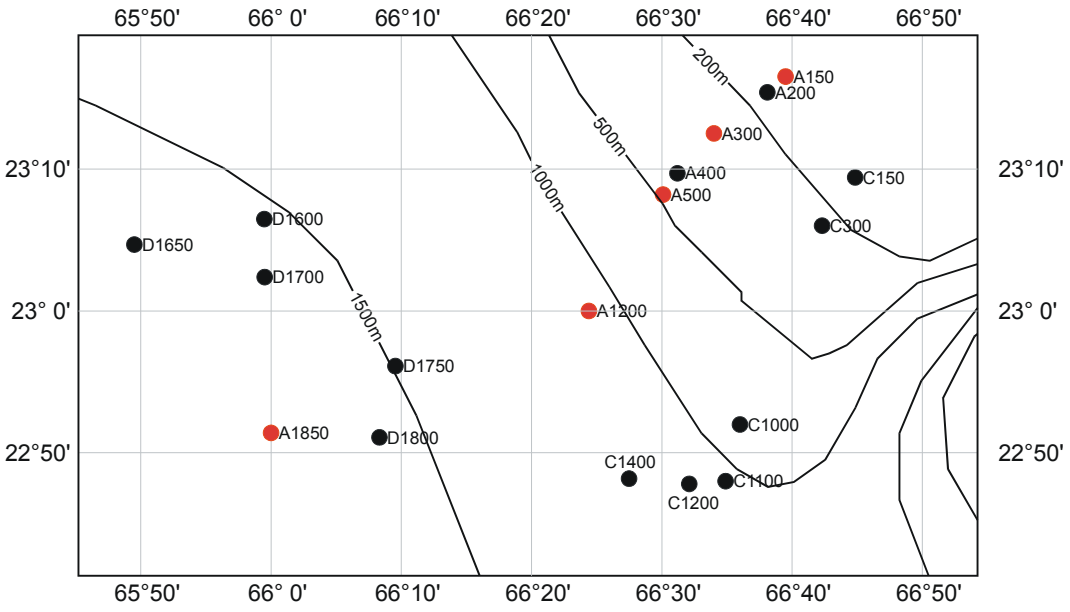

Figure 3. Sites in the Pakistan Margin working area, primary coring sites are indicated in red, other WASP and trawl sites are indicated in black (GEBCO[9] bathymetric contours).

Friday 21 March.

Complete the swath work and relocate to the A300 site. Deploy the CTD as stn 558031#1. Followed by a BBLS deployment, stn 55803#2, which returns a good set of water samples –

[9] 1997 Edition of the IOC/IHO General Bathymetric Chart of the Oceans

although the top bottle is still not closing.

Deploy the box core as stn 55803#3, it returns overfull, with mud to the very top of the box and the core is discarded. Use of the corer suspended for modifications – but the column weights cannot be removed, the head is seized on! Make and tap new holes for the penetration limiter to be fitted as low as possible on the column.

Deploy MC as stn 55803#4, it returns 12/12 good cores, c. 46-50cm but still with clear top water. Redeploy MC as 55803#5, again it returns 12/12 long cores (43-48cm) – core profiles are finely banded – varved.

Deploy Mega12 (with top weights and eight inner weights removed), it returns 10/12 good cores, again showing fine banding below a 2cm unconsolidated layer.

An emergency muster is held at c. 16:00. At around 17:00 begin an echo-sounding run along the approximate location of the 300m contour and back along the 150m contour.

Make for site C300 and deploy Agassiz trawl as stn 55804#1 for a short tow (30mins) that returns a minimal catch of natants only. Relocate to start position for a second attempt, as stn 55804#2, at site C300.

Saturday 22 March.

Recover trawl (stn 55804#2), it comes with a bag of mud and yields only a few natants and some fish vertebrae!

Relocate to site A150 and deploy Agassiz trawl as stn 55805#1. Net comes fast, and eventually comes free. The trawl returns with the frame badly distorted and the badly torn. Some catch is retained, having lots of shelly debris and a variety of crabs and fish.

Continue with further echo sounding in the "C" area before making back towards site A300.

At site A300 deploy Mega12 as stn 55806#1, it returns 12/12 good cores. Redeploy Mega12 as stn 55806#2, it returns 11/12 good cores – one of which is lost on deck.

Deploy MC as stn 55806#3, it returns with 12/12 good cores.

Deploy BC as stn 55806#3, it returns a fair, if rather full core.

Attempt to relocate to an A150 site, but end up deploying Mega08 at about 250m in error as stn 55808#1. It returns 8/8 good cores of very soft mud that are surface picked for *Pelosina* only and then discarded.

Relocate to site A150 and deploy Mega08 as stn 55808#1, it returns 8/8 good cores (29-32cm) of muddy sand over shelly debris.

Deploy MC as stn 55808#2, it returns 12/12 good cores (c. 30cm) of the same muddy sand over shell debris. Redeploy MC as stn 55808#3 for an identical result to #2.

Begin a swath survey down the "B" axis, and then head to the west looking for a deep site location.

Sunday 23 March.

Complete the swath work and return to site A150. Deploy CTD as stn 55809#1. There are some problems with the cable metering (tension readout), but continue with the deployment as this seems to be a simple electrical problem at the instrumented sheave. The problem is further investigated at recovery of the CTD.

Deploy the BBLS as stn 55809#2. A successful drop, although the top bottle does not close again.

Deploy the BC as stn 55809#3, it returns a short core that does not hold the top water and is discarded. Move the penetration limiters to the top of the column and try again as stn 55809#4, it returns a nice core.

Deploy Mega08 (with all weights on) as stn 55809#5, it returns 8/8 cores, though three have a cloudy layer at the sediment-water interface.

Deploy MC as stn 55809#6, it returns 12/12 good cores of muddy sand.

Deploy BC as stn 55809#7, it returns a fair core with plenty of *Pelosina* on top.

Make for the start of a slope break swath survey to investigate a possible new site at c. 500m. Complete the swath survey and relocate to the prospective new "A500" site for a trial drop of the Megacorer as stn 55810#1. It returns 7/8 rather full (50+cm) cores of very soft mud.

Recommence swath of alongslope area and then head out in to area "C" towards the 1200m contour to seek a trawl site.

Monday 24 March.

Locate a suitable trawl track and deploy the Agassiz trawl as stn 55811#1, it returns a good and varied catch, including lots and lots of gromiids.

Make for site A150.

At site A150, deploy Mega08 as stn 55812#1, it returns 7/8 good cores (34-40cm, some fractures). Redeploy Mega08 as stn 55812#2, it returns 8/8 good cores of 38-40cm.

Make for site A300.

At site A300 deploy Mega08 (less top weights and eight inner weights) as stn 55813#1, it returns 8/8 good cores, 44cm of very soft finely banded (varved) mud.

Relocate to site A500.

Deploy the BC as stn 55814#1 (with penetration limiters set to lowest position on the column), it returns overfull and the core is discarded. The corer is redeployed as stn 55814#2 and hauled immediately on touch down, but again it returns full to the brim – the core is processed for bulk fauna.

Deploy MC as stn 55814#3, it returns 0/12 – not fired, but having been well in to the bottom – assume insufficient resistance against the head to fire it. Add a short plank under the head in an attempt to increase resistance on sediment penetration. Redeploy MC as stn 55814#4, again it returns unfired despite having been in the bottom. The firing mechanism tested twice

on deck – it is working well. Remove all the lead from the damper assembly and redeploy the MC as stn 55814#5 – but again it does not fire!

Give the MC a break and deploy Mega08 (less top weights and eight inner weights) as stn 55814#6, it returns 6/8 long (47-53cm) cores (two units not triggered), 3cm of unconsolidated material over very sloppy mud.

Make for a swath start position to run out into the deeper waters to the southwest.

Tuesday 25 March.

Complete the swath work and deploy the Agassiz trawl as stn 55815#1 at site "D1800". The trawl returns a major protozoan "fest" – *Gromia spherical*, carrot-shaped gromiids, other gromiids, *Bathysiphon*, saccamminids and tubular forams that infest the net. Otherwise, the catch has quill worms and natants.

Make back towards the A500 site, filling in a swath gap *en route*.

At site A500, deploy CTD as stn 55816#1 for a full depth cast – all bottles fired.

A meeting of the ship's safety committee is held, with the PSO (Brian Bett) and TLO (Gareth Knight) in attendance as co-opted members. There are no major issues raised concerning the present cruise, though suggestions are made concerning the storage of hazardous chemicals in warmer weather for future cruises (i.e. CD150 & 151).

At site A599, deploy the BBLS as stn 55816#2, it fires at the bottom and returns with all bottles closed and containing clear water for the first time.

Deploy Mega12 (no weights on) as stn 55816#3, it returns 8/12 good cores (39-44cm), with two units not triggered.

Deploy the MC as stn 55816#4 – all column weights off and the trigger collar connected to the frame by seizing wire with just a little slack – yet again it returns not triggered! Try again, stn 55816#5, with the trigger collar wired tight to the frame – but still it does not fire. And once again deploy MC as 55816#6; trigger collar wired tight to the frame and pairs of "broomsticks" lashed between the four shorter inter-leg spans. This time it fires! Returning 12/12 good cores – although one is lost on deck. Redeploy MC, stn 55816#7 with the trigger wire not so tight – but it fails to fire.

Make for a swath run start position to locate an 1100m-trawl site in the "C" area.

Wednesday 26 March.

Having found a suitable location, deploy Agassiz trawl (C1100) as stn 55817#1, returning an "ophiuroid-turf" style catch, having at least five species of ophiuroids, with fish, worm tubes, natants, squats, *Actinoscyphia*?, other actiniarians and pennatulids.

Run swath back towards site A500, along the 1000m contour of the "C" area.

At site A500, deploy Mega12 as stn 55818#1, it returns 6/12 good cores, six units not triggered. Redeploy Mega12 as stn 55818#2, it returns 8/12 good cores (4 units not fired).

Then we were back to trying the MC in this soft stuff. Deploy the MC as stn 55818#3 (with broomsticks and the collar wired up) – but it fails to fire again. Try again as stn 55818#4 with the trigger collar wired up an inch. It fires and returns 12/12 good cores (30-49cm). Try again as stn 55818#5 with the same set up, but it doesn't fire. And try again with two extra broomsticks attached – but still it doesn't fire!

At site A500 deploy WASP as stn 55818#7 for a 30min run – it is sometimes difficult to hold near bottom - ? a current running. Video appears to show relatively long wavelength (1-2m), low amplitude mud ripples / waves.

Relocate to site A1200 and deploy WASP as stn 55819#1 for a 30min run, a very steady tow – video shows well burrowed seabed.

Deploy Mega12 as stn 55819#2, it returns 11/12 good cores 36-40cm (one no fire).

Relocate to site C1200 and deploy Mega12 as stn 55820#1 looking for gromiids. It returns 11/12 good cores, 36-40cm, and is surface picked for forams (saccamminids).

Deploy WASP as stn 55820#2 for a 60min run, a good tow, video showed well burrowed seabed, somewhat different to that of site A1200.

Thursday 27 March.

Make a short swath run along the 1400m contour in "C" area to locate trawl site C1400.

Having seen suitable ground, deploy Agassiz trawl at site C1400 as stn 55821#1, it returns a good catch, several species of fish, natants, large *Actinoscyphia*, echinothurids, squat lobsters and quill worms.

Relocate to site A1200 and deploy Mega12 as stn 55822#1, it returns 12/12 good cores (36-38cm) with some gromiids.

Deploy MC as stn 5822#2, it returns 12/12 good cores of 30cm.

Relocate to site A500 to have another go at multicoring this site – with a couple of pads attached below the head to try to increase resistance. Deploy MC as stn 55823#1, it returns not fired yet again. Wire up trigger collar by an inch and try again as stn 55823#2 – it doesn't fire. Remove the wooden pads and try again, as stn 55823#3, with the head wired up tight, but it still doesn't fire!

Relocate to site A150. Deploy WASP for 30mins as stn 55824#1. A very steady tow with camera data requests throughout, video shows plenty of fish and suggests there may be some resuspension of sediments.

At site A150 deploy Mega06 as stn 55824#2 with a tube drilled for pore water sampling in an attempt to get a better sample from this site – earlier attempts proved less than satisfactory as pore waters tended to drain through the coarser sediment. Deployment returned 6/6 good cores of the usual muddy sand with shelly debris below.

Relocate to site A300 and deploy WASP for a 30min run, as stn 55825#1. Again a very steady tow (reference trace rather intermittent towards end of run). Video shows some bacterial mats, and some jelly / faecal boluses rolling over the seabed.

Move out in to the deeper "D" area in search of a deep site with the swath and 3.5 kHz running – there do appear to be some channels out here and possibly some variation in seabed type - ? overbank deposits.

Friday 28 March.

Complete the swath work and relocate to the centre position of the D1800 trawl (stn 55815#1) and deploy WASP, as stn 55826#1, for a 60min run; a steady tow with the reference trace faint again.

Reposition to the centre of D1800 again and deploy Mega12 as stn 55826#2 in search of gromiids etc. It returns 8/12 good cores, but no obvious signs of gromiids.

Relocate to new "A1850" site and deploy CTD for full depth cast as stn 55827#1.

Then deploy BBLS as stn 55827#2, it fires successfully at the seabed and returns with all bottles closed, though the bottom bottle is cloudy.

At c. 18:00 receive word that the NERC Executive Council have decided, in light of the Gulf War II, that the cruise will terminate in the Seychelles and not Muscat as originally planned.

Deploy Mega12 as stn 55827#3, it returns 12/12 good cores (33-36cm) with flocculent tops, 1cm of brown mud over lighter clay. Redeploy Mega12 as stn 55827#4, again it returns 12/12 good cores essentially identical to those of #3.

Break off operations at A1850 and make for the "C" area for further WASP work.

Saturday 29 March.

In area "C", deploy WASP as stn 55828#1 for a 30min run at site C1000; recover WASP and relocate to site "C1100".

Deploy WASP as stn 55829#1 at site C1100 for a 30min run at the seabed.

Recover WASP and make back towards site A1850 to resume the coring programme.

At site A1850 deploy Mega12 as stn 55830#1, it returns 12/12 good cores, 33-38cm.

Deploy MC as stn 55830#2 (back to all weights on and no broomsticks), it returns 11/12 good cores (24-28cm). Redeploy MC as stn 55830#3, it returns 12/12 good cores. And again redeploy the MC as stn 55830#4, it returns 11/12 good cores.

Deploy BC as stn 55830#5, it returns a fair if short core (limiters at mid point on column) which drains through a burrow (possibly a sipunculid – 2 specimens recovered from that area of the core) and so is only processed to provide specimen material.

Deploy WASP as stn 55830#6 for a one hour run at the seabed.

Recover WASP and make for our final line of swath survey for this cruise.

Sunday 30 March.

Complete last swath line and make for an "A400" site to do a WASP run.

At A400, deploy WASP as stn 55831#1. The Mk7 camera fails to run at the seabed, the run is aborted, and WASP recovered for inspection. The Mk7 indicates film jam when commanded to shoot; this is cleared by a forced motor wind, the camera is then test run on the bench and a trial start up on deck completes as normal.

Meanwhile, relocate to site A150 and deploy Mega08 as stn 55832#1, it returns 8/8 good cores.

Relocate to an "A200" site and deploy WASP as stn 55833#1 for a 30min run.

Relocate to an "A400" site and deploy WASP as stn 55834#1 for another 30min run.

Relocate to site A500 and deploy CTD for a full depth cast as stn 55835#1.

Deploy the BBLS as stn 55835#2, it fires at the seabed and returns with all bottles closed and just a little sediment in the bottom bottle.

Then deploy Mega08 as stn 55835#3, it returns 10/12 good cores (two no fires), 39-47cm). Redeploy Mega12 as stn 55835#4, it returns 7/12 good cores (five no fires), 39-44cm. Redeploy Mega12 once again as stn 55835#5, it returns 5/12 good cores.

Relocate to site A1200 and deploy Mega08 as stn 55836#1, it returns 7/8 good cores (one no fire).

Make for the "D" area.

Monday 31 March.

Make a short echo-sounding run to investigate a trawling track.

Deploy Agassiz trawl at site D1750 as stn 55837#1, it returns a good catch, including a one specimen of the much hoped for *Benthothuria ?cristatus*, various gromiids (in fact another gromiid fest), plenty of forams / "foram turf", natants and *Munidopsis*.

Relocate to site A1850 and deploy Mega12 as stn 55838#1, it returns 12/12 good cores, 31-37cm – one with what appears to be *Benthothuria* pooh on it.

Deploy box core as stn 55838#2. At recovery the corer is pulled up into the roller, parting the corer's activating warp (recorded tension 4.3 tonnes) dropping the corer back in to the sea as a total loss.

Make to the north echo sounding for the 1700 and 1600m contours.

At the 1600m contour, deploy WASP (site D1600) as stn 55839#1 for a 30min run at the seabed.

Return to the 1700m contour and deploy WASP (site D1700) for another 30min run as stn 55840#1.

Undertake some further echo-sounding to locate a last trawl location. Deploy Agassiz trawl (site D1650) as stn 55841#1.

Tuesday 1 April.

Recover the trawl (stn 55841#1). A smallish catch with lots of foram turf, at least three species of gromiids, including lots of "sausages", natants, *Munida*, a fair sized rattail and other fish, plus one ophiuroid.

At c. 03:30 set off for a new CTD site "A2750".

Arrive at A2750 at c. 09:30 and deploy CTD as stn 55842#1 for a full depth cast.

At c. 13:30 make for the BIGSET NAST site (A3200).

Wednesday 2 April.

En route for BIGSET NAST site (A3200).

At c. 02:30 arrive at site A3200 and deploy WASP for a 60min run at the seabed as stn 55843#1.

Recover WASP and set course for the Seychelles at c. 07:00.

At c. 16:00 an emergency muster is held, with safety training / briefing for the scientific party.

Continuing on passage to the Seychelles.

Thursday 3 April.

Continuing *en route* to the Seychelles; progress not yet sufficient to add any further deployments.

At c. 15:30, with the vessel only making some 8 knots, recover both the 3.5 and 10 kHz fish to see if we can improve our passage speed.

Friday 4 April. - Continuing *en route* to the Seychelles.

Saturday 5 April. - Continuing *en route* to the Seychelles. A barbeque night.

Sunday 6 April. - Continuing *en route* to the Seychelles.

Monday 7 April. - Continuing *en route* to the Seychelles. We cross the line.

Tuesday 8 April. - Continuing *en route* to the Seychelles.

Wednesday 9 April. - Dock Port Victoria, Mahe, Seychelles c. 09:00.

Brian Bett

5.2 Conclusions

Despite being beset by a number of difficulties (see narrative), this has been a very successful cruise that has very largely achieved its planned objectives:

1. A series of five sites on a transect spanning the Arabian Sea oxygen minimum zone were established in the Pakistan Margin work area, with a sixth deep-water site also successfully studied.
2. CTD sensor profiles and chemical determinations on water bottle samples from both the CTD and BBLS were successfully undertaken at all six sites.
3. A substantial tranche of EM12 swath bathymetric mapping, and supporting 3.5 kHz seabed profiling, was achieved in the Pakistan Margin work area, although this was undertaken in an opportunistic fashion to catch up on lost time (some further swath work would be useful in the area).
4. An extensive coring programme, delivering a wealth of samples, was successfully carried out at all six sites. Although some sites proved to be un-core-able (box core at A500) or practically un-core-able (multicore at A500) with some gears the Megacorer was always effective.
5. Good quality seabed imagery was obtained with the WASP system at all six primary sites ("A" sites) and a further six additional sites. Supporting work with the trawl was also undertaken at five of the six study depths (only the 500m depth was not fished – video from this depth shows practically no megafauna to be present) and additional depths in the lower boundary of the oxygen minimum zone where rapid changes in the composition of the megabenthic fauna appears to occur.

In summary, this cruise has laid a firm foundation on which the larger research programme, *"Benthic processes in the Arabian Sea: interrelationships between benthos, sediment, biogeochemistry and organic matter cycling"* (NER/A/S/2000/01280), and its forthcoming cruises (CD146, 150 and 151) can build.

It is a little early in the programme for scientific conclusions – with a great deal of labour intensive work in shore-side laboratories still to come. From a biologist's immediate perspective, it appears that the Pakistan Margin is comparatively poor in its benthic fauna, and will certainly make a contrast with previous Arabian Sea oxygen minimum zone studies on the Oman Margin (e.g. Gage – RRS *Discovery* 211; Jacobs – RRS *Charles Darwin* 143).

Brian Bett

5.3 Acknowledgements

An unusual cruise! Cast adrift to the High Seas with no diplomatic clearance to work in any bathyal oxygen minimum zone. And the late opportunity to take a sunshine tour to the Seychelles. Well there is a war on you know!

But we got there (in the end) – to the work site (eventually) – to the Seychelles (eventually) – and through the programme.

For the latter I am indebted:

To the "old hands", from whom I may have picked up one or two PSO-ing tips, to Tony Rice and other good PSOs I have had the pleasure to sail with – applying a North Atlantic "safety factor" to a glass calm Arabian Sea might have seemed like folly, but (as ever) turned out to be our savior.

To Dave Billett my "night dog" for the finest example of (near) single-handed overnight science yet seen.

To the girls coring team, whose muscles surely grew by the day.

To the macrofauna men, who sieved for Scotland (despite being English, Irish and Cypriot).

To the Water Boys, who analysed by day and by night.

And to the Mechanical Men … can they fix it, yes they can!

And so to those who kept us working, alive, afloat, illuminated, fed, watered and entertained – my thanks as ever. Keep the kippers flowing, the lights on (despite our best attempts otherwise), us in order on deck, and on track and on station.

And do not forget the unsung heroes and heroines ashore, who served us so well.

And to my Captain, thanks for going the several extra miles (in all senses of the phrase) – very much appreciated.

So what have we learned – expect the worst and hope for the best (it usually works out in the end),

safe trips home all, BB.

PS. Hope that chesty cough clears up Iain

PPS. Never did like that box corer anyway (ask anyone) Garry

PPPS. Hi Keith, the motorman never gets a mention does he, thanks.

6. SURVEY DESIGN

Initial cruise planning called for the location of a series of sampling sites at c. 150, 300, 900, 1200 and 2100m depths on the Pakistan Margin a little way NW of the Indus Canyon / "The Swatch". This transect of sites to follow the line of a previous investigation by FS *Sonne*. On arrival at the work area there was no diplomatic clearance to begin scientific operations (see narrative account above). Consequently, initial investigation of the area was limited to "casual" inspection via the hull mounted 10 kHz echo sounder. This early work confirmed the location matched with the earlier FS *Sonne* observations, i.e. there was no gross navigational offset, and that the slope was relatively complex (see below). With distinctly uneven terrain at 2000-1800m – later confirmed (see further below) to be part of a large meandering channel system. A three-part slope with two notable breaks in slope – at c. 1100m and c. 400m.

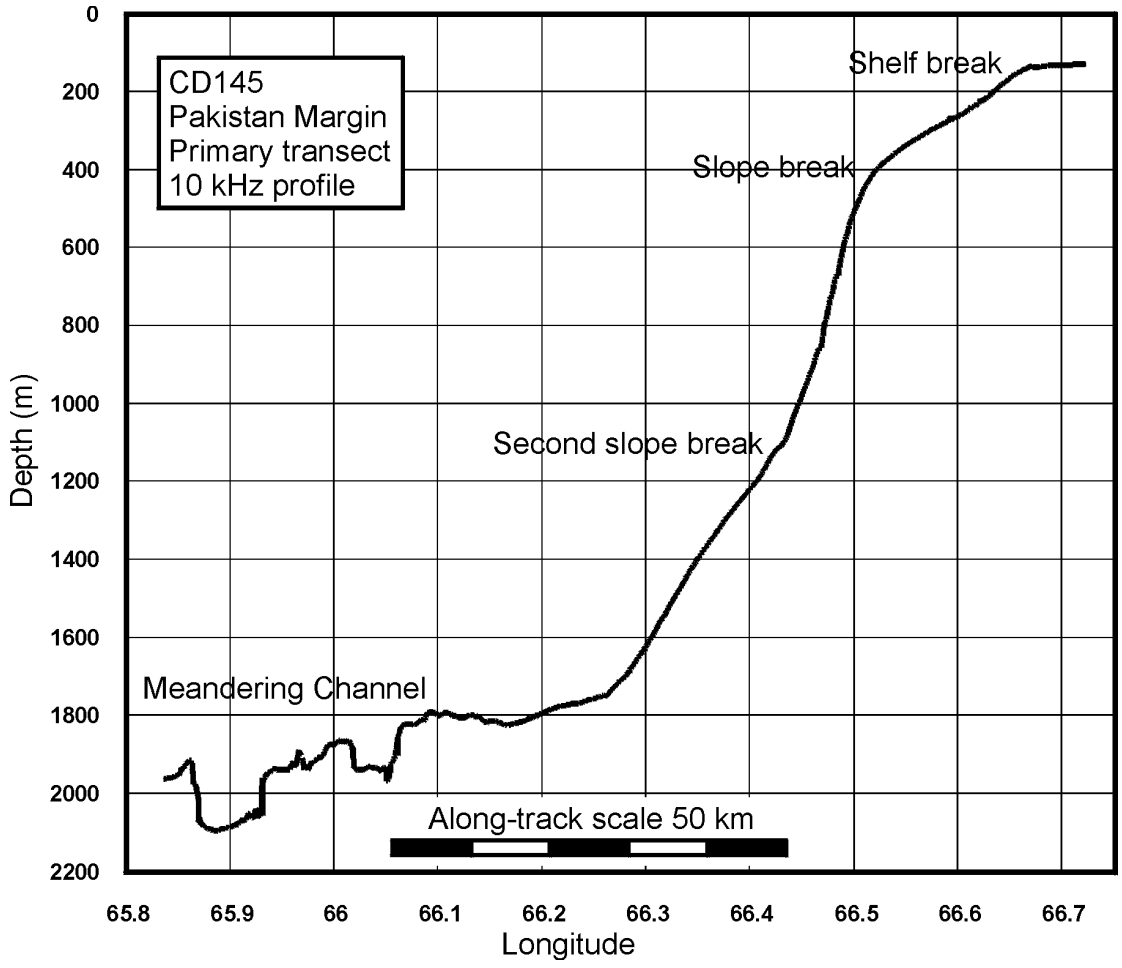

Figure 4. Single-beam echo-sounding line along the axis of the primary transect.

Having no diplomatic clearance, and there being no immediate prospect of clearance being forthcoming, RRS *Charles Darwin* left the work area headed for international waters. The nearest safe point of international water being some 140nm distant. Rather than begin work "at any point in the ocean", course was shaped for the "BIGSET NAST" site only 20nm more distant. BIGSET was a major German-led Arabian Sea campaign focused on biogeochemistry

(see Pfannkuche & Lochte, 2000, The biogeochemistry of the deep Arabian Sea: overview, *Deep-Sea Research* II, 47, 2615-2628. The BIGSET NAST site was designated site A3200 for the purposes of the present cruise (A – primary sampling site, approximate depth 3,200m).

With the eventual delivery of diplomatic clearance to work in Pakistani waters, RRS *Charles Darwin* returned to the Pakistan Margin work area. The 12kHz swath bathymetry system was activated for the approach to the work area (see below), note that the swath was run uncalibrated, i.e. without a local sound velocity profile, consequently the depths derived do not match those of subsequent swath operations. This initial swath line revealed a large, multi-level, sinuous channel that runs to the base of the slope in the work area – the northern wall of this channel is evident on the FS *Sonne* Hydrosweep bathymetry, but is incorrectly identified as a lower slope scarp. The swath survey also revealed that the FS *Sonne* 2,111m coring site was located closely adjacent to this channel and was therefore discounted as a suitable location for the present study. The lower slope leading up from this channel was relatively "smooth" with little topography (see below) such that a "safe" 1,200m work site (A1200) could be located in this area.

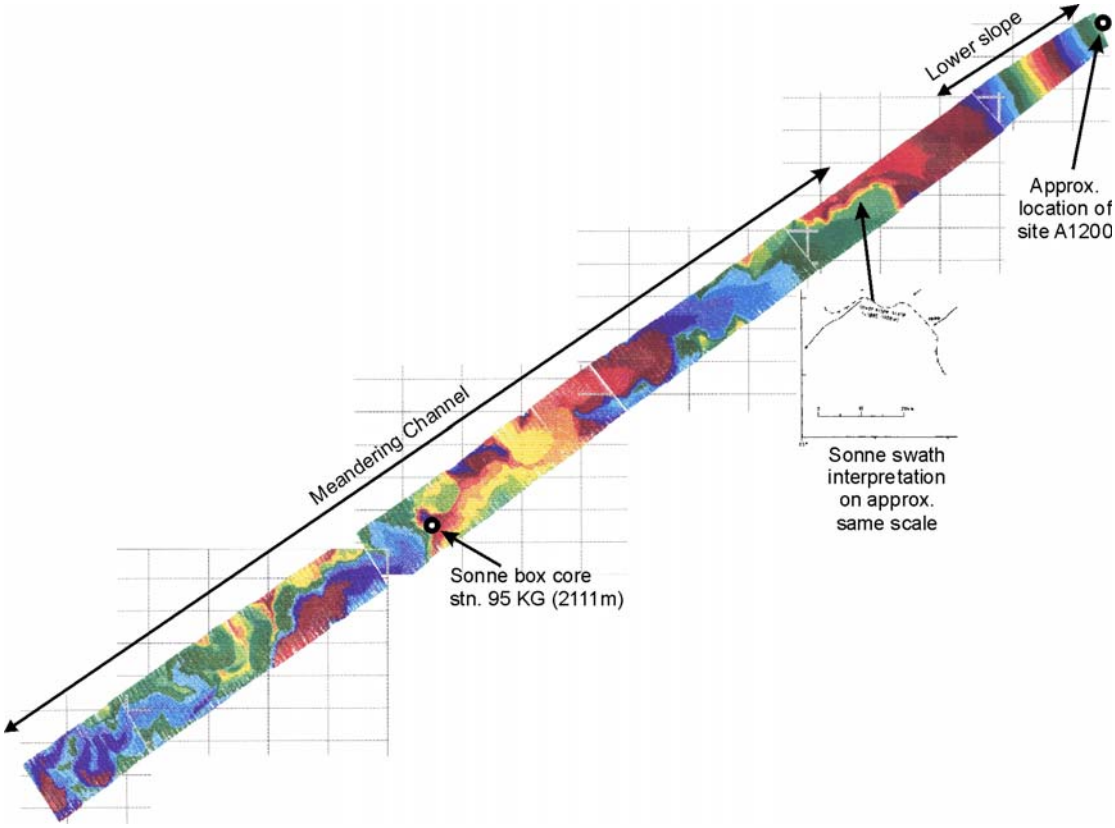

Figure 5. First swath bathymetry line run on the approach to the work area.

The original cruise plan called for a 2-3 day period of swath operations to characterise the area with additional observations from the WASP camera system. However, having lost a week of on-site time as a result of the delay in receiving diplomatic clearance the sampling programme was initiated immediately at the A1200 site and at two sites on the "simple" upper

slope region (A300 and A150) – though note that some small gullies and channels extend on to this upper part of the slope (see full swath chart further below). Swath operations were run on an opportunistic *ad hoc*, mostly overnight, basis and WASP work reserved for the latter part of the cruise.

The original cruise plan called for a sampling site at c. 900m, consequently the first calibrated (with sound velocity data calculated from CTD stn 55802#1) swath lines were run around the primary transect axis between sites A1200 and A300 (see below). This proved to be a region of very complex topography.

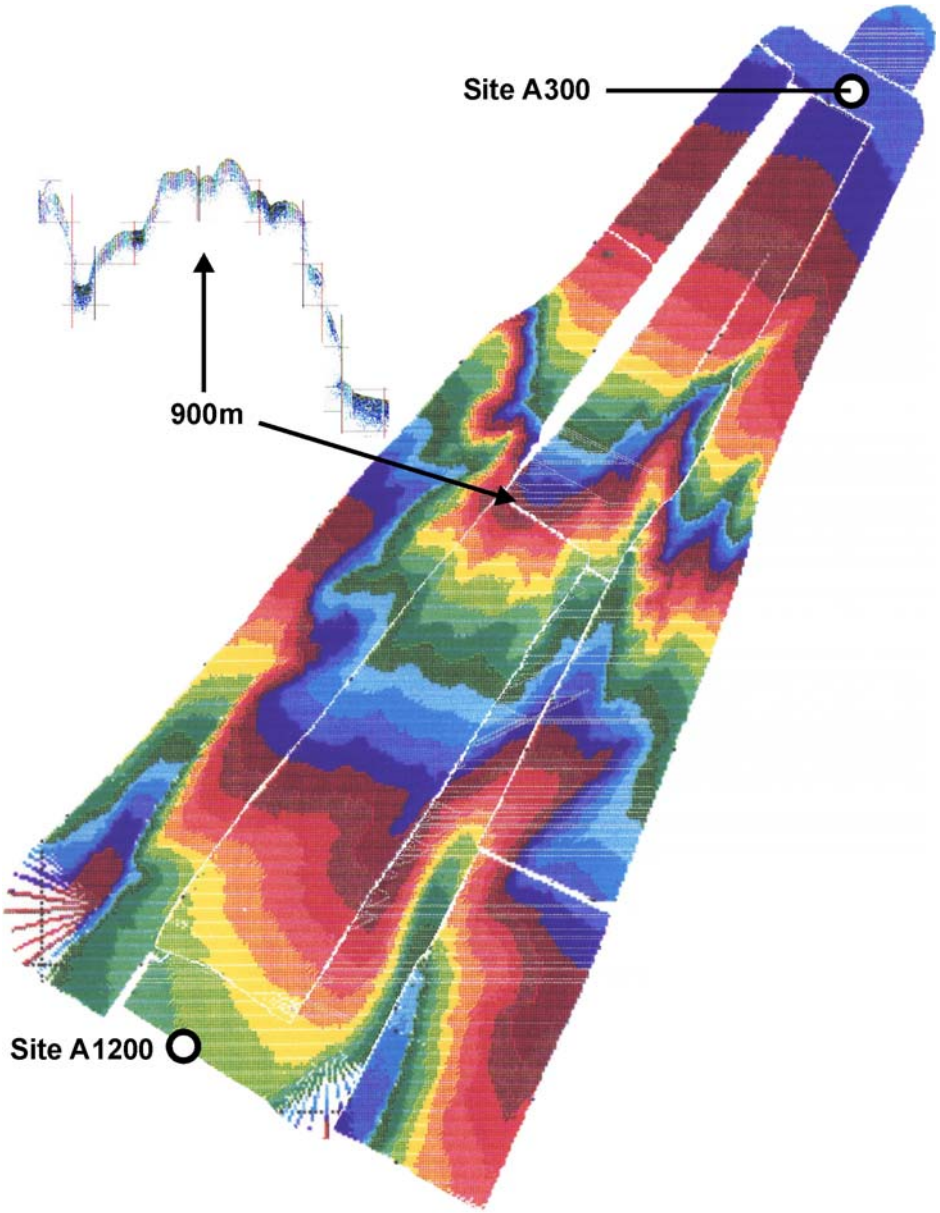

Figure 6. Early swath bathymetry lines run between sites A1200 and A300, with inset showing along-slope 10kHz echo-sounder profile.

The mid-slope region (between the first and second slope breaks, see above), c. 500-1,000m, is heavily and very frequently incised by gullies / canyons / channels (see above and below).

The slope break region was further studied, for c. 10nm either side of the primary transect axis with an along-slope swath survey (see below). This revealed no significant change in topography. Given the need to locate a "reasonably"-sized homogeneous area, out-with the influence of any potentially active downslope transport features, no work site was located in this depth band. A study site, A500, was located at c. 500m, the deepest "smooth" contour available.

Attention then focused on locating a "deep" site, planned for c. 2100m, the original FS *Sonne* site already having been discounted (see above). Swath lines were run out to the west of the main transect axis, beyond the area investigated by FS *Sonne*. Although this is a relatively "open" area with a comparatively gentle slope, it is certainly not a simple slope (see main swath chart below). In areas the contours are somewhat convoluted, there are certainly some small channels (though these are not always obvious on the swath) and 3.5kHz profiling indicates distinct variations in seabed fabric (possibly overbank deposits?). The data require closer scrutiny than is possible here. A deep site (A1850) was located in this region in an area where the 3.5kHz returns suggested "normal" thick, uniformly layered sediments.

Some additional swath lines were run to the east of the main transect axis while checking the "safety" of proposed trawl tracks in that area. It is possible that a mid- slope-depth sampling site will be found in that area with additional swath coverage, although the area is rapidly "narrowed" by the proximity of the Indus Canyon.

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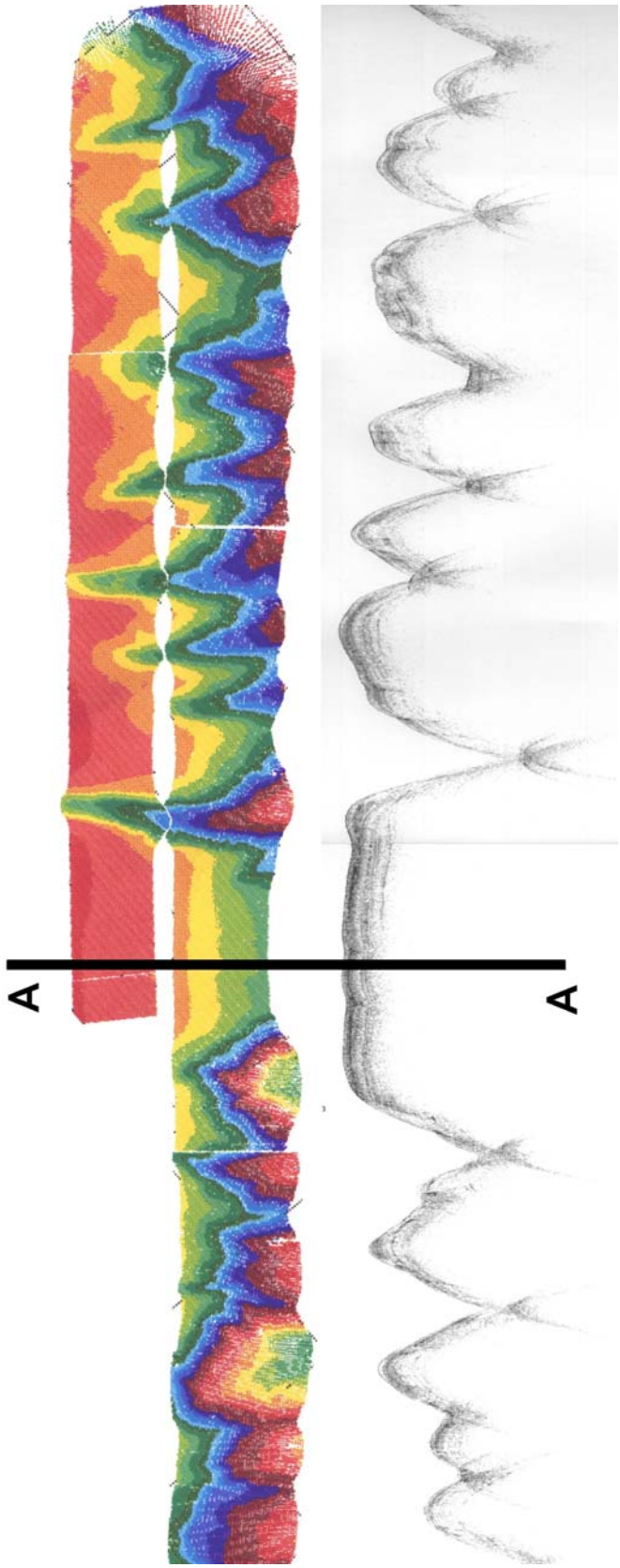


Figure 7. Swath bathymetry lines run along the slope break, with (approximately) matching 3.5kHz profile.

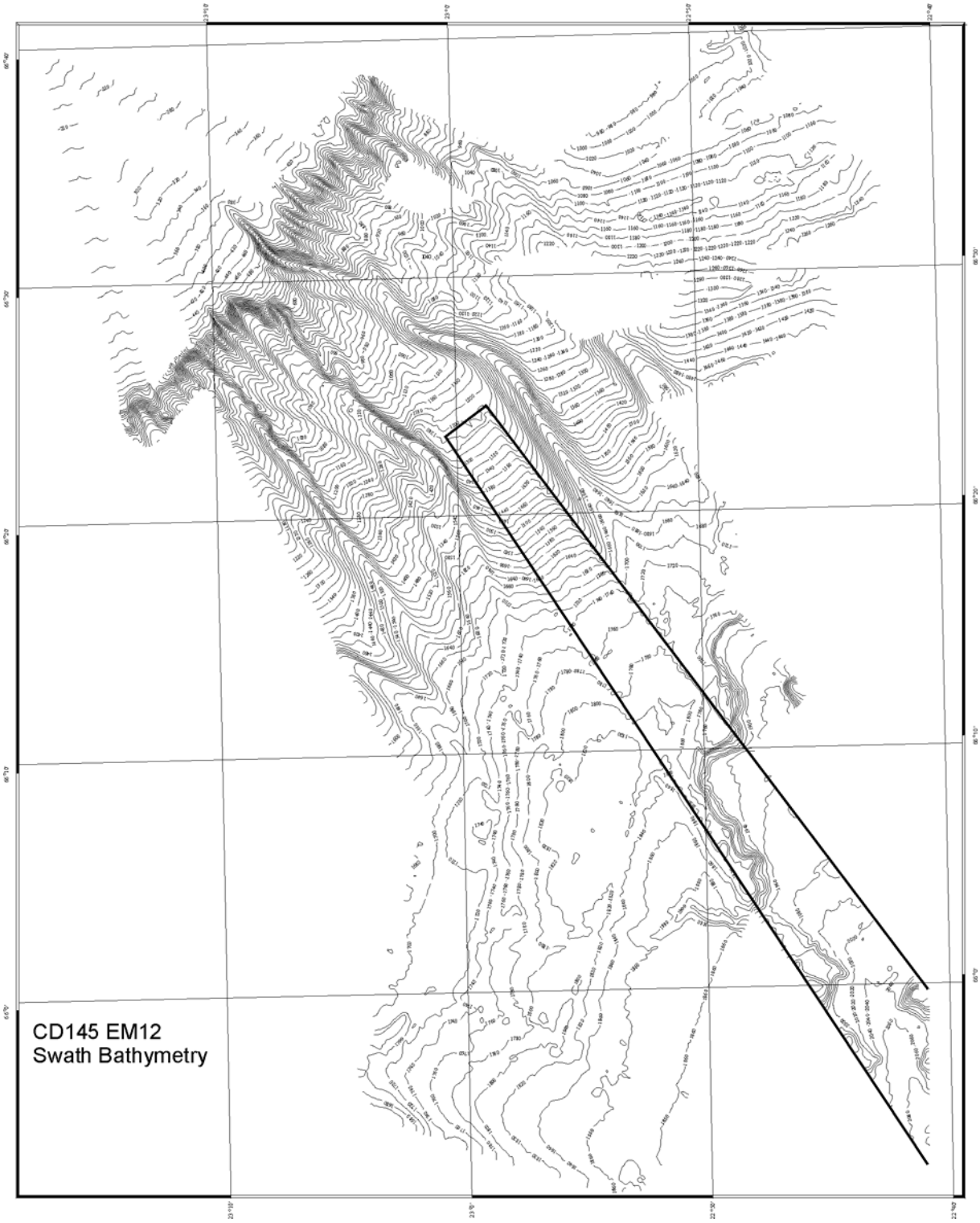


Figure 8. RRS Charles Darwin *cruise 145 EM12 swath bathymetry, note the outlined area contains "qualitative" data with obvious edge effect artifacts where it joins the calibrated data beyond.*

7. SAMPLING PROTOCOLS

7.1. Protocols in macrobenthos sampling

The sampling work breaks into two main components: that for assembling a quantitative sample set for macrobenthos community analysis along the "A" transect, and examination of washed samples on board for isolation of macrobenthic organisms for biochemical analysis and for preliminary identification of candidate organisms for use in incubations during RRS *Charles Darwin* cruise 146.

For quantitative sampling, samples were obtained using the Megacorer and Mk 2 pattern USNEL box corer. The aim was to obtain a sample set along the "A" transect yielding sufficient fauna for statistical analysis of community composition and variability.

Using the Megacorer the aim was to obtain a minimum of two cores per deployment from a minimum of 4 separate deployments at each of the 6 stations worked during the cruise (including "BIGSET NAST" / A3200). The within-Megacorer duplication and the between Megacorer replication was in order to analyse trends in scales of spatial variability. Down-core pattern was addressed by fine-slicing at least one core per deployment at intervals of 0-0.5, 0.5-1.0, 1.0-2.0, 2-3, 3-5, 5-10 and 10-20cm. In the very soft sediment at site A500, the finest slicing near the surface proved impracticable and the first two slices were combined. The remaining cores from each deployment were sliced into two layers, 0-10 and 10-20 cm. Each slice was treated with 10% seawater formalin and stored on deck for 2-3 days before washing using filtered seawater through a 300μm sieve. The washings were stored in 10% formalin solution together with a label written on masking tape within sealed plastic bags. These were stored in labelled 1-litre plastic tubs, one for each core, for onwards shipping to the UK after RRS *Charles Darwin* cruise 146.

Box corer samples for quantitative analysis were treated as follows: The supernatant water was carefully siphoned off and a digital photograph taken of the sediment surface. Any visible structures or organisms were noted and their position mapped on a sketch. Some gromiid protozoans were removed at this stage for detailed study. Two slab cores were inserted at this stage for on-board X-ray analysis by Angelos Hannides. Provided the sediment was firm enough so that it was unlikely to collapse unsupported by the sides of the box, the removable front of the box was removed and the top-most 2 cm, followed by 2-5, 5-10 and finally 10-20cm layers of sediment removed using a builders trowel. This worked well for cores from the A150 and A300 sites, but not from the softer-sediment ones, particularly those from A500, and the NAST (A3200) site, from which the sediment was towelled out with the removable side in place. From other depths, the surface 5 cm of the box core was trowel-sliced and the sediment washed in order to isolate community dominants for biogeochemical analysis and for identification for potential use in incubations during RRS *Charles Darwin* cruise 146. The detailed protocols are provided below:

MACROBIOSURVEY - Box corer (SBC)
One deployment per station CD145 (5 stations)

1) Notes are made of any surface features and a photograph taken.
2) Surface water is drained off through a 250-micron sieve
3) Subcoring, e.g. three X-ray slabs, is carried out at this stage.
4) Box front is removed, photographed and the depth of the mixed layer noted.
5) Core sliced at 2, 3, 5, 5, 5 cm or just 2, 3 cm if time is limited. Sediment placed into 20l buckets with cooled, filtered seawater or formalin depending on fate of material.
6) X-ray slabs released when appropriate.
7) Sieving of bucket contents later when time permits on 300 micron. Samples used for sourcing additional example fauna types for RRS *Charles Darwin* cruise 146 reference collection.

Objective: comparison with Megacore / earlier Oman Margin samples, and also source of additional specimen material

MACROBIOSURVEY - Megacorer (MGC)

CD145 minimum four replicates (deployments) per station
CD146 two replicates per station

1) Temporary (elasticated) labels are applied to the cores as they are released from the corer. Label:[Discovery number] [Core number (position clockwise from marker)]
2) Successful cores stored temporarily in cold room in hold – or whatever arrangement exists.
3) Labels on masking tape (alcohol proof pen, tape doubled back to stick to itself):
   Label: Darwin 145 [Discovery number]
   MGC [SAMS number] [sediment horizon][sieve][date]
   [core No. in array]
4) One core from each deployment sliced a.s.a.p. on deck at 0.5, 0.5, 1, 1, 2, 5, 5, 5. First five horizons placed into polythene zip-lock bags and formalin added (4% formaldehyde, 10% formalin, borax buffer added to concentrate, 100 micron filtered seawater). Zip lock bags placed in 1-litre tubs.
   Tub label & internal label (masking tape):
   As 3) above
   Polybag labels, alcohol proof pens:
   [Discovery number]
   [sediment horizon]
   5 cm slices placed in 1.0 L pots with buffered formalin (not in zip-lock polybag).
   Tub & internal Label on masking tape:
   As 3) above

Objective: downcore community pattern

5) Remaining (minimum two, and preferably four) cores for taxonomic/community structure are cut at 10 cm (0 – 10 cm) and 10 cm (10 – 20 cm) and placed in 2.5 l pots with formalin with internal and external labels as 2) above. This sediment is sieved later (minimum two days) and transferred to 0.5 l pots for storage (10% buffered formalin) and later processing in the UK.

Objective: community biomass and structure.

The above protocol was amended slightly and the intervals for downcore slicing changed to 0.5,0.5,1,1,2,5,10 cm. Also, it was found quicker to dispense core slices directly into plastic pots instead of zip lock bags. Plastic labels were attached to Megacore tubes on removal from the corer. These recorded the station number and the core position on the array. Core positions were marked on the corer using small plastic tags attached with cable ties. Uppercase Roman numerals were adopted for the I to XII core positions to avoid confusion with other label numbers. Where additional cores were taken and sliced at 0-10 and 10-20 cm the number per deployment varied (see section 10.1.). It was not found practical, due to pressure of time, to downcore fine-slice soon after recovery and sometimes cores were fine-sliced some hours after landing. A 1200 m core was fine sliced <?> days after recovery to see if there are detectable differences.

MACROORGCHEM All gears
MEIOORGCHEM All gears

All cruises: survey (natural), incubated and lander
CD145 - cores per station (replicates): survey 3
CD146 - cores per station (replicates): survey 2, incubated 2, lander 10 (5 with and 5 without tracer)

1) Megacore/multicore sediment (survey - whole slices; incubated / lander - half slices) in plastic petri dishes are retrieved from temporary storage at ambient temperature and examined under stereo binocular microscope placed on foil-covered benches.
2) Macrofauna are sorted first using alcohol-cleaned instruments and 25 micron-filtered, cooled seawater. 24-well microculture plates may be found useful to sort specimens into. Taxa can be separated into different wells. In general, reference specimen fauna should be placed in 7 ml vials with full label and an assigned putative species number. Post sorting, these vials are changed to 10% seawater formalin (made with 25 micron, filtered seawater). These reference specimens should match the specimens for freeze-drying placed in numbered vials with foil caps. There should be 3000 glass vials of three types all pre-numbered, pre-combusted and fitted with foil caps. The aim is to assemble >0.001g of freeze-dried biomass per vial, of identified fauna or fauna identifiable via the reference collection. Priority should aim first at single species, amalgamating with successively inclusive taxa to achieve a minimum biomass. NOTE that there will be two numbers applying to the record – the vial number and the ‘species’ number. The ‘species’ number may also represent a genus or family.
3) Selected specimens are rinsed in distilled fresh water to remove salts and placed in the numbered vials with as little liquid as possible.
4) A record entry is made in the **vial sample record sheet** (an Excel file printout) for each vial number listing fauna and station details as appropriate.
5) Filled vials are frozen in a deep-freeze
6) Deep-frozen vials are then freeze-dried to dry the contents.

7) Vials are returned to temporary storage in deep-freeze then transported via hand luggage back to the UK at the end of the cruise.
8) Sediment sorted for macrofauna is passed on for meiofauna sorting by Ludox method – **MEIOORGCHEM LUDOX** (Gooday / Larkin)

Protocol in practice on CD145:
The appropriate sections of the above were attempted on CD145, but fresh material sorting time was limited by the logistics of core processing for preserved samples. A collection of common/typical macrofauna specimens was assembled but the sparse fauna meant that duplicate specimens to those in vials were not available in every case.

The need to process cores meant interruptions of the sorting work and that reduced sorting efficiency. All those people theoretically involved in sorting were busy with core processing and much less sorting was attempted than had been hoped. However, if the fauna had been more numerous and comparable to the Oman Margin, then the effort invested might have produced the output that was anticipated at the planning stage.

Fresh specimens were placed in vials in a –70°C freezer for freeze drying and subsequent later analysis or in formalin for the reference collection and their record entered on the vial record spreadsheet. However, the frozen samples tended to be small and it is unlikely that the biomass of many of the macrofauna in vials will be sufficient for anything other than lipid analysis that requires the minimum dry weight of the several analyses to be attempted. It was found that polychaetes and crustaceans remained alive even after several days at ambient temperature in sliced sediment while awaiting sieving.

Reference collection material was preserved in 10% buffered seawater formalin in numbered screw top vials with white tops. The vial number, scratched on in diamond pencil, was taken as the putative species number where appropriate (i.e. where a single animal was present). A separate species number, as had been planned in the protocol above, was deemed unnecessary.

Captive sieving:
Sieving of fresh material was carried out in the ship's wet lab using a closed system with a limited amount of cooled, seawater filtered through a 25-micron mesh. This process worked well and both macro and meiofauna could be separated from the same sample. Care was taken to make sure the buckets for this work were very clearly marked and not used for formalin at any time.

It is important that such buckets should not be nested (stacked inside each other) when empty as ship's grease and other contaminants can be introduced to the insides of clean buckets. In addition, a new SAMS stainless steel 300-micron sieve was used exclusively for fresh material and never with formalin samples.

Enough cooled seawater was placed in the bottom of a clean bucket to come up to within a centimetre of the top of the 300 micron sieve. The sediment was introduced a portion at a

time and the sieve raised up and down to irrigate the sample from below until the majority of small mud particles were removed. This was continued until the entire sample had been washed as far as possible. The sievings were returned to the ambient temperature and the seawater in the bucket then passed through a 45-micron sieve to retain meiofauna.

In practice, it was not possible to sort for meiofauna onboard ship. This was partly because the meiofauna was also very sparse and would have required a significant amount of time to extract. Ludox extraction was tried (see report by Kate Larkin).

At some sites, e.g. A1200, the samples were dominated by faecal pellets that remained intact with the gentle washing but continually broke up leaving the water cloudy for examination. It was found that once a petridish full had been prepared for microscope analysis the overlying depth could be reduced and clarity established by pipetting off while watching the pipette opening for anything being sucked up. This left the settled sediment sufficiently clear, with its thin layer of overlying water, to examine for macrofauna and thus the sample could be sorted without preliminary excessive washing. Sometimes cool packs were used as a stage to keep the sediment portion from warming too much. Another approach was to use a small petri dish so that the portion examined was also small and only on the microscope stage for a short time. The fluctuations in temperature due to this procedure did not seem to adversely affect the viability of the polychaetes and crustaceans encountered. Two video sequences of polychaetes swimming were taken from such an A1200 site sample without the use of cool bags.

Digital photography:
This was the first cruise where we had digital photomicroscopy available with the various group's digital cameras. This medium was ideal for recording macrofauna and many vial contents were photographed before freezing. The reference collection was also photographed and should be available as a guide for the next group on CD146 as the ship's colour laser printer is excellent at image reproduction.

The ship's winch caused image-disturbing vibration at the microscope bench reducing photographic quality at times. Future microscope work on CD150 might be better sited on the port bench of the main lab, which is more remote from the vibration source.

John Gage, Peter Lamont

7.2. Particle Size Analysis (PSA)

Below is an additional protocol suggested for CD146-151; proposed by John Howe / John Gage, SAMS.

1. Extrude multicore in 1cm slices OR subcore a Megacore using a suitable narrow bore plastic tube and extrude and section as for multicore. No advice given as to maximum depth, but suggest go down to 20 cm, as this is the max depth of benthic faunal sampling on CD145.

(BB – subcoring a Megacore is liable to introduce core compaction artefact – suggest complete 1cm Megacore slices are used.)

2. For storage, transfer slices to labelled plastic bags and seal and store at a cool temperature (4-5°C).
3. Suggest samples from each transect station are packed together in a plastic tub.
4. At end of cruise please pack and label the samples so that they eventually arrive c/o John Gage at SAMS, Dunstaffnage Marine Laboratory, Oban, Scotland PA37 1QA UK.

John Gage

7.3. Marine Geochemistry

General aims:

a) The collection of a single Megacore sample for porewater extraction at each station. Extract porewater and divide into appropriate vials for the following analyses: trace metal analysis, sulphide analysis and nutrient analysis.
b) Collection of a mega core for radionuclide analysis
c) Collection of a mega core for the analysis of trace metals
d) Upkeep and running of the gamma spectrometer.
Shipboard analysis of gut material and sediment for ^{234}Th. Extraction of gut material is the responsibility of Angelos Hannides.

NB – no changes needed to be made to the proceeding protocols during the cruise

Standard Operating Procedure - Sediment Pore Water Extraction for metals and nutrients

People required: TWO
Corer – Megacore
Sample resolution: 0-10 = 0.5cm
10-20 = 1cm
20-40 = 2cm = total 40 samples

The most ***undisturbed*** core should be used for pore water extraction. Mark each core tube with electrical tape and marker e.g. station number and type of analysis (PW, RN etc)

FIRST STEP

1. Check equipment (see attached) is prepared before the cores are collected to speed up core processing e.g. all bags are labelled correctly for station, tubes are numbered 1-40.
2. Set up one large glove bag on to the tabletop, attaching nitrogen gas line. Seal gas line.
3. Position all the large glove bag equipment (see list) neatly and so that it can all be reached using the gloves. Take the centrifuge tops OFF. Fill with nitrogen and purge the bag until all O_2 has gone (use judgement but N.B. nitrogen quantity is limited!)
4. Make sure the core extruder "lego" pieces and jack are ready by the table.
5. For each core, measure the length of sediment, describe it and photograph it when possible.

6. Once an undisturbed core has been obtained, carefully siphon off overlying water until ~5 inches remains. Insert the core into the table hole up into the glove bag and replace the top bung. Then remove the bottom bung and replace with the extruder. Add lego pieces and position the jack. Remove the top bung and jack up the extruder until the water level is close to the top.
7. Wearing cloth glove bag gloves directly on your skin put arms into glove bag and put on disposable gloves over the bag material.
8. Using the large syringe, remove the overlying water taking care not to disturb the sediment surface and syringe through the brown and blue filter, filling the 30ml bottle (which contains 300 µl of HNO_3). Remove the rest of the water and discard.
9. NOW THE SEDIMENT SLICING. 0.5 cm slices to start with. Place 0.5 cm ring over core. Get 2nd person to carefully jack up the core until the surface is in alignment with the top of the ring.
10. Slice the sediment and ***slide*** the slice back off the core. Using the spatula, fill the no.1 centrifuge tube (approx 70%). The remaining sediment, place in the first sample bag and seal.
11. Place all used equipment in plastic bag, wash down gloves and wipe off.
12. Repeat this process down the core at the above resolution. Your final sample will be 40cm if the core is long enough. When the sediment is drier, use a second centrifuge tube to obtain enough porewater for analysis.
13. Make notes of sediment change at different depths and anything else to comment upon e.g. large shell at 17cm etc.
14. Upon completion, remove all equipment, wash off mud and soak in de-ionised water for proceeding core. Throw away glove bag unless in good, clean condition (yeah?).
15. Check all bags are well sealed and place in large plastic bag, label and store in cold store (~4°C).

Tips: when filling the centrifuge tubes, knock tube on table to get sediment to drop down.
When you are approximately half way through slicing, remove the full centrifuge tubes and get second person to start centrifuging (see below).

SECOND STEP

Keep samples chilled whenever possible.

1. Centrifuge the samples for c. 20 minutes at 3000 rpm. Place tubes of a similar weight opposite each other in the rotor otherwise the centrifuge will lose balance and stop.
2. Clean tubes of lose mud.
3. Label vials if necessary with station number, date and depth.
4. Place all equipment on list into small glove bag including the centrifuged samples. Connect nitrogen, fill and purge as before.
5. Place the pipette tip onto the end of the syringe and syringe up as much water from the centrifuge tube as possible.
6. Remove pipette tip and replace with filters. Only one end should fit – the brown is 5µm so should be first on to the syringe.

7. Syringe the water through the filters with care into the number corresponding 8ml, 3.5ml and 2ml bottles. Fill the nutrient bottle (2ml) first where c. 1.2ml is required. Put ~ 3ml into the 8ml metals bottle and ~2.5 ml in the 3.5 ml sulphide vial.
8. The 8ml bottles should be labelled but check and adjust if necessary.
9. Place the 8ml bottles in a small Tupperware container and refrigerate.
10. The 2ml: Out of glove bag take 1ml from tube and dilute up to 10ml with de-ionised water in designated nutrient analysis tubes. Give to Tim Brand.
11. Place the 3.5 ml vials for sulphide/sulphate in cold store to ship back to Edinburgh.
12. Use small glove bag as many times as is possible.

Tips: it may be easier to write the depth and their corresponding number down on paper to prevent confusion e.g. 0-0.5 = 1, 0.5-1 = 2, 1-1.5 = 3 etc.

Sulphide Preparation

1. Locate zinc acetate powder bags.
2. Pour one bag into a 500ml beaker and add ~300ml de-ionised water. Stir well until dissolved.
3. Transfer solution to a 500ml volumetric flask. Make up to mark and stir.
4. Add 1ml to each 3.5 ml vial and label.

Standard Operating Procedure - Sediment Slicing for Solid Phase Analysis

CORING: 1st DROP – 3 CORES (PW's, solid RN, solid Metals)
There needs to be at least 24 hrs between drops 1 & 2.

People required: TWO
Corer – Megacore
Sample resolution: 0-10 = 0.5cm
10-20 = 1cm
20-40 = 2cm = total 40 samples
One core will be sliced for metals (+XRF) and one for radionuclide analysis (RN) using the same slicing method but varying post slicing treatment.

Slicing.

1. Ideally all cores should be undisturbed. Place cores in the core stand. Label core with electrical tape stating station and type of analysis: RN or Metals (M). Cores should be stored in the cold room but can be sliced on deck.
2. Measure length of sediment, write core description (see sediment description sheet) and photograph if have access to digital camera.
3. Equipment needed: slice, rings (0.5, 1 and 2 cm), sealable and labelled bags, extruder, extension poles and notebook.
4. Remove the top bung and siphon off some water. Replace bung firmly.
5. Remove bottom bung and immediately replace with the extruder. Add extensions when necessary.

6. One person hold the core steady and move up when necessary while other person slices:
7. Place ring over core surface and push up extruder until sediment surface reaches the top of the ring. Slide the slicer between the core tube and ring and slide back off. Place this sediment in the bag and seal well. Clean rings and slices in between each sample using ordinary water. Continue slicing at the above resolution until end of core.
8. Place all sample bags for Metals core in a large plastic bag, label and store in cold room.
9. Place all samples for RN's in a large plastic bag, label and freeze.
10. At the end of each cruise, these samples need to be sent to SAMS in cold container.
11. Clean off equipment and store in geochem box.

Standard Operating Procedure - Shipboard Radionuclide Analysis

Gamma Spectrometer Preparation.

1. Top up the dewar with liquid nitrogen every other day (see PV30 protocol and risk assessment).
2. Before placing a sample on the detector ensure clingfilm is surrounding detector head, check it is undamaged and protecting the detector. Seawater will destroy detector.
3. Place sample holder very carefully over detector head.
4. When sample is in place, please secure lid with appropriate device.
5. **CHECK ENERGY CALIBRATION EVERY DAY WITH EU-152 SOURCE. IF ENERGY OK NO NEED TO RECALIBRATE**

Sediment Sampling and analysis

1. Section core as described in solid phase sampling protocol. (0.5cm to 10cm, 1cm to 20cm and 2cm thereafter).
2. Place maximum amount of sample in gamma pot and place on cap. Cover pot with parafilm before placing cap on. Seal round cap with duck tape or insulating tape to ensure seal.
3. Measure depth of sediment in gamma pot to the nearest mm and record.
4. Place gamma pot in sample holder (Check clingfilm is around detector).
5. Start count. Record cruise number station number and depth in Gamma Analysis log sheet for cruise.
6. Stop count when has been counting for 2 hours or in low activity samples when a minimum of a 1000 NET area counts has been achieved.
   Use common sense here. If the sample is very active and you have a few thousand counts in a relatively short time then stop count and start another sample.
   If sample has very low activity then stop after 2hrs if other samples need counting.
   The sediment samples will probably need longer than 2 hrs, which is fine providing there are no gut samples waiting for analysis (count each sediment sample for a maximum of 6hrs).
7. Stop count and store use the following naming system:
   Cruise number, station number, depth i.e. CD145STNXXX01
8. Record stop time and date, real time and spectra file name in gamma log sheet.

9. Each day back up files on floppy or CD - ensure a different folder for each day.
10. Remove sample and freeze to prevent moisture loss.
11. These samples should be returned to UK after the cruise in the cold container and places in a freezer or cold store at DML.

NB: Count gut samples before sediment samples, and stop counting sediment samples from previous station when samples from next station are available.

Gut Sampling and analysis

1. Angelos will prepare gut samples for analysis. It is important that these samples are not contaminated with sediment from outside the gut.
2. Place maximum amount of sample in gamma pot and place on cap. Seal round cap with duck tape or insulating tape to ensure seal.
3. Measure depth of sample in gamma pot to the nearest mm and record. If there is very little sample try and disperse evenly over bottom of pot. Take digital photograph of sample distribution to help recalibrate if necessary.
4. Place gamma pot in sample holder (Check clingfilm is around the detector).
5. Start count. Record cruise number station number and depth in Gamma Analysis log sheet for cruise.
6. Stop count when it has been counting for 2 hours or in low activity samples when a minimum of a 1000 NET area counts has been achieved.
   Use common sense here. If the sample is very active and you have a few thousand counts in a relatively short time then stop count and start another sample.
   If sample has very low activity i.e. sediments then stop after 6hrs unless there are no samples waiting for counting. In this situation leave the sample counting until another one is ready.
7. Stop count and store use the following naming system
   Cruise number, station number, depth i.e. CD145STNXXXB??
8. Record stop time and date, real time and spectra file name in gamma log sheet. Also record description of benthos and where found in core (Angelos)
9. As above each day back up files on floppy or CD - ensure a different folder for each day.
12. Remove sample and freeze to prevent moisture loss.
13. These samples should be returned to UK after the cruise in the cold container and place in a freezer or cold store at DML.

NB: Count gut samples before sediment samples, and stop counting sediment samples from previous station when samples from next station are available.

Terrie Sawyer

7.4. Sulphate reduction

Initial protocols for sulphate reduction measurements on RRS *Charles Darwin* cruises 145 and 150

1. Preparation of working solutions
Stock ^{35}S-sulphate solution is kept in the fridge in the radiation container. Aliquots of this are transferred by syringe to 1.5ml vials and diluted with distilled water such that 5µl of the resulting working solution contains approximately 74kBq (2µCi) activity. The vials are sealed and refrigerated until use. An approximately 10% zinc acetate solution is also required. 100ml of the dry chemical weighs c. 90g. This is made up to 900ml in a 1-litre Schott bottle with distilled water.

2. Collection of samples
The Megacorer or multicorer is used to collect the samples. Core tubes have been predrilled with a series of holes down the tubes at 1cm intervals. Strips of parcel tape are wrapped round the tubes to seal these holes. Four cores are collected, one from each of three separate deployments of the corer and a fourth from any deployment. The cores are placed in the Constant Temperature Room (previously set to bottom seawater temperature) as soon as possible after collection and kept there until further processing.

3. Core processing
After siphoning off most of the overlying water the sealing tape around the core tubes is removed from the holes with a scalpel and 3ml plastic syringes (from which the luer ends have been removed) are inserted. Subcores are thus taken at 1cm intervals downcore. The syringes filled with sediment are removed, sealed with rubber 'Subaseals' and placed promptly in an anaerobic jar. An 'Anaerogen' sachet is added to remove oxygen, and the jars are sealed and kept in the CT room until further processing. The syringes are individually numbered and a record should be made of the core and downcore depth of each subcore.

4. Injection of radiolabel
The anaerobic jars are transferred to the radiation container and the subcores removed from them. 5µl of the working labelled sulphate solution is injected into each subcore through the rubber seal, using a 10µl Hamilton syringe. The needle is inserted as far as possible into the subcore and as the plunger is depressed it is pulled backwards, thus distributing the radiolabel as evenly as possible along the centreline of the subcore. After injection the subcores from the cores taken from the three separate corer deployments are returned to their anaerobic jars and an 'Anaerogen' sachet added. The jars are sealed and returned to the CT room. The injected samples from the fourth core are transferred promptly into 20ml vials containing 10ml of an approximately 10% zinc acetate solution. This both fixes any sulphide present and halts further sulphate reducing activity. The vials are sealed and thoroughly mixed on a vortex mixer. These samples will provide blank values.

5. Incubation
The anaerobic jars are kept in the CT room for 24 hours. After this time they are returned to the radiation container and opened. The subcores are transferred into 20ml vials containing 10ml of an approximately 10% zinc acetate solution, sealed and mixed in the same manner as the blanks.

6. Sample storage and further treatment
The 20ml vials are refrigerated. At the earliest opportunity (presumably the end of the second cruises CD146 and CD151) they should be returned to the UK under refrigeration. Further processing (distillation to remove sulphide, scintillation counting) and calculation of the sulphate reduction rate will be carried out at DML.

Notes:
1. Whilst the ^{35}S unsealed source is being handled as both stock and working solutions (i.e. during dilution, injection and transfer of sediment subcores into vials) appropriate precautions will be taken: work to be done in the radiation container using secondary containment (spill tray) and 'benchkote'; vials to be secured in holders to prevent tipping over; lab coat and latex gloves to be worn.
2. The working area, hands and clothing should be monitored after handling the radiochemical solution.
3. The concentration of ^{35}S above which notification is required is 100kBq/g. The specific activity of the injected subcores will be approximately 16.5kBq/g, and that of the samples after transfer to the zinc acetate solution will be 5.1kBq/g. These will therefore be exempt from applicable transport regulations and thus for return to the UK are effectively not radioactive (i.e. do not require to be labelled externally or be accompanied by any relevant documentation).
4. In order to calculate the sediment sulphate reduction rate it is also necessary to know the porewater sulphate concentration and sediment porosity at each depth interval. It is my understanding that these measurements will be provided by the Edinburgh group.

Modifications to the sulphate reduction protocol adopted on RRS *Charles Darwin* cruise 145

1. Preparation of working solutions
The activity of the radiolabelled working solution was changed from that specified in the protocol. A lower activity was used because it was decided to return the samples to the UK immediately after the cruise rather than leave them to the end of CD146. Consequently they could be analysed more quickly and so needed a lower activity. The solutions were made up so that the activity of 5µl working solution contained (on 01/04/2003) 25.188kBq 35S.

2. Collection of samples
The Megacorer was able to collect cores that were longer than those obtained from the multicorer and therefore it was used exclusively. Once it became apparent that six stations would be worked instead of the five originally planned for, the degree of replication was reduced from three cores to two, and no further blanks were taken.

3. Core processing - No modifications.

4. Injection of radiolabel - No modifications.

5. Incubation - No modifications.

6. Sample storage and further treatment
The 20ml vials will be returned to the UK immediately after the cruise. The contents of each vial (3ml sediment plus 10ml zinc acetate solution) weigh in excess of 13g, so their specific activity is <2kBq/g. The limit of activity for ^{35}S, below which materials are exempted from any requirement for classification as a radioactive material is 100kBq/g. Thus the samples are effectively non-radioactive and can be transported without additional supporting documents.

Martyn Harvey

7.5. DIC13, DIC and pH

1 - Core slicing in N_2 glove bag 1

Required in glove bag 1: Numbered centrifuge tubes in stands
Box of centrifuge tube lids
Syringe and container for overlying water
Box of tissues
Disposable gloves
SAMS slicers, spatulas, core rings
Rubbish bag

(N.B. You need approx 1 tube per 0.5cm, 2 tubes per 1cm, and 3 tubes per 2cm slice)

Procedure: Siphon off some overlying water, leaving around 5cm.
Transfer core bung to plunger.
Put core into table and make hole in glove bag for tube.
Seal bag and purge with N_2, directing gas into tubes.
Purge bag, then refill.
Syringe off remaining overlying water.
Slice core using different slice, ring and spatula for each slice.

2 - Centrifuging

Wipe tubes before putting into centrifuge.
Centrifuge at 3000, for 15 mins.

(N.B. Do tubes for pH first)

3 - pH in N_2 glove bag 2

Required in glove bag 2: pH electrode,
buffer solutions
temp probe,
paper and pencil
milli-q rinse bottle and waste container
Disposable gloves
Pipette and tips

Procedure: Pipette off 1ml solution into 2ml vials
Calibrate pH electrode
Record pH

4 - DIC in N_2 glove bag 2

First dispense 50uL HgCl2 into 6ml vials

Required in glove bag: glass syringes and pieces of tubing
0.2um filters
long needles
numbered 6ml vials (with teflon tape round top) and caps
DIC vial rack
centrifuge tubes

Procedure: Refill glove bag, purge and refill
Draw out pore water using syringe with tubing attached.
Filter thro needle to base of vial.
Overfill, drop cap onto meniscus and screw down tightly.
Remove remaining tubes for dic13 in fume cupboard.

5 – DIC DIC13 in fume cupboard

Required in fume cupboard: small plastic tubes for end of syringes
Glass syringes
0.2um filters
Long needles
Mercuric chloride solution
Hamilton syringe
Henrik's 2ml vials, caps and capper
DIC 6ml vials, tops wrapped in teflon tape.
DIC vial rack
DIC13 vial rack.

Procedure: Take out the porewater using syringe and tube.
Dispense thro filter and needle into the bottom of vial.
Allow to run over top and leave meniscus.
Add 10 or 50uL MgCl2 to bottom of sample.
Cap and crimp, or screw cap.
Label with station and depth.
Store in cold store upside down.

Heather Johnstone

7.6. Biochemistry: lipids, amino acids, carbohydrates and stable isotopes

Core processing

On initial sorting of the 0-0.5 cm sediment layer from the A3200 site, it was clear that the quantities of organisms present were too low to provide sufficient biomass for all the biochemical analyses. Therefore, the protocol was revised such that two cores rather than one were taken from each of three deployments at each site. This retained true replication across three deployments, with the duplicate cores providing more biomass for the biochemical analyses.

In total 36 cores were collected for biochemical analysis over the six sites. Any surface organisms were extracted prior to slicing and were either frozen for lipid, amino acid, carbohydrate or stable isotope work, or preserved in formalin for identification purposes.

The depth to which the cores were sliced was also revised so that only the top 10cm was taken. This was taken to be a more realistic cut-off depth for fauna living within the sediment, as below this depth the very few organisms present would provide sufficient biomass for any biochemical analysis. The slicing intervals taken were 0-0.5, 0.5-1, 1-1.5, 1.5-2 and then in 1cm intervals down to 10cm.

Slices were placed in Aluminium foil covered Petri dishes, or wrapped directly in Aluminium foil that had been muffle furnaced. Both methods were to avoid contact with plastics that might add contaminants to the lipid biomarkers study material. The foil-covered samples were then placed in labelled plastic bags and stored in the cold core store (4ºC) if awaiting processing, or directly frozen at -70ºC.

Ludox method: for extraction of meiofauna

Megacore slices were sieved on a 300µm sieve, retaining the filtrate in a bucket and the >300µm residue carefully transferred into a Petri dish and sorted for macrofauna. The filtrate (<300 µm) was then sieved on a 45µm sieve and then washed with freshwater. The 45-300µm fraction (i.e. the residue retained on the 45µm sieve) was then transferred into two centrifuge tubes, with a minimal amount of freshwater. Ludox solution was then added in equal quantities to the two centrifuge tubes. (Note the original protocol was revised so that the addition of a spatula of kaolin was disregarded, this relates to the type of centrifuge available, the head of which is fixed at a set angle and therefore the formation of a true kaolin ‘plug’ between the extracted material and the sediment pellet was ineffective). The tubes were then

vortex mixed at maximum speed for 30 seconds followed by slow mixing for 4 minutes and then centrifuged for 10 minutes at 2500 rpm. The material extracted by the Ludox method was poured onto a 45um sieve and washed through with freshwater and then sorted under a binocular microscope to the lowest taxonomic level possible. The residue of the Ludox-ed material was then sorted through in order to check the efficiency of Ludox extraction.

The Ludox method was tested on the 45-300μm fraction of the 0-0.5cm slice from site A3200 (55801#02, core 1). The supernatant of extracted organisms following Ludox centrifugation yielded many Foraminifera such as *Hoeglundina* sp. *Trochammina* sp. *Lagenammina* sp. *Bulimmina* sp. and *Hyperammina* sp. However, on sorting through the residue pellet, many larger calcareous Foraminifera such as *Lagenid* sp. and metazoans such as nematodes were found that had not been extracted using the Ludox method. Ludox centrifugation was therefore found to be inefficient in extracting a sufficiently representative sample of meiofauna from the sediments and it was therefore decided not to use the Ludox method again and to concentrate on direct sorting of the 45-300μm fraction.

Proposed revision to protocol for biochemical work for CD146

As three true replicates have already been collected from each site, providing a large amount of sediment for obtaining bulk meiofauna and macrofauna for biochemical analyses, the revised protocol for CD146 is to take one Megacore from each of two deployments (12 cores in total) and then in order to maximise the biomass but still retain replication, to homogenise the two replicates together back in the UK and to use a sample splitter to obtain the equivalent of two separate Megacores that are more representative of the area sampled. Sediments will be taken and stored as per CD145.

Kate Larkin

7.7. Meiobenthos

The protocol used for collection of multicores for the analysis of meiofaunal Foraminifera on CD145 was to take three multicores from separate deployments at each site. One core was sliced down to 10cm in intervals 0-0.5, 0.5-1 and then in 1cm intervals to 10cm and two cores were sliced to 5cm in the same intervals. This produced 3 true replicates for the top 5cm of sediment. Core slices were washed into a 500ml bottle using a funnel and seawater. Care was taken to wash all sediment into the bottle. 10% formalin was then added to all bottles, and the bottles stored in wooden boxes.

Proposed protocol for taking faunal samples on CD146

On CD146, two cores will be taken from two separate deployments with one core sliced to 10cm and one core sliced to 5cm in 0.5 cm to 1cm and thereafter in cm intervals to 10cm. The slices will be stored in 500ml bottles in formalin in the core store on board which will be set to 6ºC. These two cores will enable comparison with the three cores taken during CD145, giving a total of five replicates of the top 5cm and two replicates of the top 5-10cm of sediment over the two cruises.

Kate Larkin

7.8. X-radiography

Because of the inherent risks associated with the use of X-rays, the application of the method is specific to every vessel. Therefore, in addition to sampling and X-raying procedure descriptions, I include a complete account of safety precautions as they were developed on the RRS *Charles Darwin* during this cruise.

Sampling procedure

Two thick slab cores were used to sample box cores, whereas thin slab cores were used to sample Megacores. Typically one box core and one Megacore were sampled per site, yielding at least two thick slab X-rays and two thin slab X-rays per site. Sampling was photographed and on one occasion filmed (Hannides, Lamont). X-raying and development procedures are described below. The sediment of all slab cores was subsequently sieved through 300μm mesh sieve or, in some thin slab core cases, through a 250μm sieve, and the samples fixed for macrofaunal composition analysis. Preliminary observations on X-ray negatives were made using the light table in the plot. Notes were made throughout these stages and can be found in another section of this document, along with recommendations for technical settings for X-raying sediment at specific stations.

X-raying and film development procedure

X-raying and development of film took place in the darkroom of the vessel.

1) Prepare and attach lead labels to slab core(s). Include station number, gear and date.
2) Strap slab(s) onto base.
3) Prepare machine:
- Plug in machine
- Plug in remote control pedal
- Plug light box into machine and centre the beam on slabs
- Set Ma/KVF at 15/70.
4) Notify bridge (phone number 01) and engineers in control room (phone number 02).
5) Place signs on doors and turn darkroom-in-use light on.
6) Turn lights off and red light on.
7) Take film and place behind slabs.
8) Set line at 3rd notch or centre on green diamond.
9) X-ray at desired time.
10) Remove film and place in developer bath.
11) Proceed with development and further exposures. Development is carried out as follows:
- D-19 developer 5 min
- Stopbath 1 min
- Fixer 5 min
- Running water 1+ min
- Water tub 5 min
- Hang to dry
12) Turn machine power off.
13) Notify bridge of termination of X-raying.
14) Remove caution signs.

Summary of safety precautions

1) Try to X-ray between 8:00 and 17:00, avoiding the morning break (approx. 10:00-10:30), lunch break (11:30-12:30) and the afternoon break (14:30-15:00). Weekends are also "sensitive" times, especially after lunch.
2) In addition to the X-ray risk assessment form, separate forms for the chemicals involved in development have been produced and copies distributed as required.
3) Access to the darkroom is restricted to everyone without the operator's consent. A note from the Master to the effect has been posted on the darkroom door.
4) Within the darkroom:

- a note cautions that the chemicals kept in the closed tubs covered in plastic bags are irritants to the skin and eyes. This is accompanied by a recommendation that in case of a flood the operator must be notified immediately.
- the X-ray machine, which is securely tied on the bench top, is not plugged in. The power cord and the remote control pedal are stored away in the machine case. This ensures that the machine is not readily usable.

5) Before every exposure or set of exposures, the bridge is notified with an estimate of the duration of the procedure (phone number 01). If permission to proceed is obtained, the engine control room is also notified (phone number 02). In turn, "Caution – X-rays" signs are placed on the door of the darkroom and the door opening to the alleyway. Finally, the red sign warning of the darkroom being in use is turned on. As soon as the X-raying is completed bridge and control room are notified and the "caution" signs are removed.

Angelos Hannides

7.9. Sediment collection for ^{210}Pb profiles

Sediments were collected from two cores, in most cases adjacent to one another, from each multicore drop. Each core was sliced in 1-cm intervals down to 7 cm and in 2-cm intervals down to 15 cm. An outer rind of approximately 5 mm was removed from each slice to exclude smearing effects during sampling. Sediment from intervals of equal depth from the two cores from each sample was mixed to yield enough sediment for subsequent analysis. At one site, A500, the multicore failed to fire 11 out of 13 times. Precautionary single Megacores were collected from an equal number of drops (samples) and sliced in a similar manner. All samples are stored at above-freezing temperature.

Angelos Hannides

7.10. Megafaunal gut contents collection for ^{234}Th analysis

At five stations, megafaunal individuals were collected, either intentionally with an Agassiz trawl or opportunistically found in box cores and Megacores, and their gut contents extracted with dissection tools for ^{234}Th. Gut contents were placed in a ^{234}Th jar (small) and handed over to T. Swayer (SAMS), for ship-board ^{234}Th analysis. The remainder of the individuals dissected were returned to D. Billett (Agassiz trawl) and R. Jeffreys (other gear) for other observations and analyses.

Angelos Hannides

7.11. Biochemistry

Solid phase analysis of lipids, amino acids and carbohydrates

Two cores must be obtained at each station from different deployments to ensure true replication. Note both of these will be sliced for lipids, amino acids and carbohydrates. The core can be either a Mega- or a multi-core.

1. Make a note of the site, station number, date, depth, time, core number and to what depth the core was sliced.
2. Label up enough plastic bags (provided by Edinburgh) for the amino acid analysis. For the lipids, label up four foil covered Petri dishes for the first four slices and then glass jars for the remaining slices (provided by Liverpool).
3. Slice the core at the following intervals, 0.5 cm down to 2cm, 1cm down to 10cm and 2cm thereafter. Using a spatula, please make sure to trim off the edges of each slice of the core to minimise the concentration of plasticizers in the sample.
4. During slicing rinse the plastic ring, slicer and spatula in seawater and then the spatula and slicer only in DCM in the separate bucket provided for this purpose. Please wear a pair of yellow marigold gloves or something similar when slicing the core for your own protection.
5. Place the half of each of the top four core slices in the relevant foil covered Petri dishes and half of each of the remaining core slices in the relevant glass jars with foil covered lids for the lipid samples. For amino acids place half of each core slice in the relevant plastic bag.
6. Once the core has been sliced freeze all the samples at -20˚C, then freeze dry and store at -20˚C. The foil covered Petri dishes should be stored at -20˚C and transported back to the UK under dry ice. The freeze-dried sediments in the glass jars and plastic bags will be transported back to the U.K. in the refrigerated container.

Solid phase analysis of lipids and pigments

Two cores must be obtained at each station from different deployments to ensure true replication. Note one of these will be sliced for pigments only and the other for lipids and pigments. The core can be either a Mega- or a multi-core.

1. Make a note of the site, station number, date, depth, time, core number and to what depth the core was sliced.
2. Label up enough scintillation vials and ensure that the Teflon liners and caps for the vials are to hand, along with a tweezers, this is for the pigment work (provided by Edinburgh). For the lipid core label up four foil covered Petri dishes for the first four slices and then glass jars for the remaining slices (provided by Liverpool).
3. Slice the core at the following intervals, 0.5 cm down to 2cm, 1cm down to 10cm and 2cm thereafter. Using a spatula, please make sure to trim off the edges of each slice of the core to minimise the concentration of plasticizers in the sample.
4. During slicing rinse the plastic ring, slicer and spatula in seawater and then the spatula and slicer only in DCM in the separate bucket provided for this purpose. The DCM need only be used when slicing the lipid/pigment core. Please wear a pair of yellow marigold gloves or something similar when slicing the core for your own protection.
5. Place the half of each of the top four core slices in the relevant foil covered Petri dishes and half of each of the remaining core slices in the relevant glass jars with foil covered lids for the lipid samples. For the pigments place half of each core slice into the scintillation vials but remember to leave an air pocket for expansion of the sediment upon freezing, cap with Teflon lined caps.
6. Once the core has been sliced freeze the pigment vials in a clearly labelled bag at -70˚C and the lipid jars at -20˚C. Once the lipid samples are frozen the jars only can be freeze-dried and then stored at -20˚C in cardboard boxes. The foil covered Petri dishes should be stored at -20˚C and transported back to the UK under dry ice.

<u>Pore water analysis for DOM and DFAA</u>

1. Ensure that a Megacore is taken from the same deployment as the core to be analysed for trace metals.
2. Ensure that a yellow cap and not a rubber bung is placed on the top of the core and store in the CT lab until the core can be processed.
3. Because it will be a while before a glove bag becomes free in which to carry out slicing it is advisable to take a sample of the overlying waters for DOM as soon as it reaches the CT lab and then again immediately before it is processed.
4. Once a glove bag station has become available you will need to set up the glove bag with everything needed for processing the core. This includes: 60 centrifuge tubes in racks labelled 1-60, the caps for these tubes should be in a separate container, 60 Teflon liners for the tube caps and forceps, enough slicers to slice the entire core, i.e. 1 per slice, enough spatulas, i.e. one per slice, enough rings i.e. one per slice, a container of tissues, an ice cream tub of Milli-Q water, a rubbish bag and four pairs of surgical gloves.
5. Next, place an extruder in the base of your core and several ‘lego’ pieces, then place the core and extruder on “Jack”. Make an incision in the shape of a cross in the glove bag for the core to go through. This should already exist as the glove bag will likely have been used previously for TM processing. Push the core up into the glove bag through the cross until the ring of the core is flush with the table. Now place the plastic strip around the neck of the core and secure the core in place with the clip lock. Siphon off the overlying water leaving about 2-3 cm of water on the top of the core.

Close the glove bag with the seal and fill with N_2. At this stage take the N_2 tap and flush the N_2 into each centrifuge tube. When the bag is full purge and refill, then tape along the seal. The tap is there to control the amount of N_2 in the bag. You are now ready to start processing your core.

6. To get into the glove bag put on the cotton gloves, surgical gloves and then put your hands in the glove bag. Now take another pair of surgical gloves and put them on. Jack up the core until it is at 0.5 cm, measure with the appropriate sized ring i.e. 0.5 cm, 1 cm, 2cm. Slice with a slicer and use the spatula to place the sediment in the centrifuge tube, please note you may need more than one tube per slice (up to 4). Place a Teflon liner in the cap and cap the tube. You can now place the ring, spatula and slicer in the rubbish bag, do this at the end of each slice. Remember to wipe you hands with some tissues before beginning each slice and change surgical gloves in the glove bag at least every 10 cm.
7. The core should be sliced as follows: in 0.5 cm intervals down to 2cm, 1 cm intervals down to 10 cm and in 2 cm intervals down to 30 cm.
8. Once you have finished slicing centrifuge at 3000 rpm for 15 mins note you should only place about 6 tubes in per run, make sure the centrifuge is balanced.
9. You are now ready to begin filtering, please ensure that you wear powder-free surgical gloves or polyethylene gloves for the whole procedure. Label up the appropriate vials, i.e. 5 ml ampoules for DOM and 5ml vials (Ed) for the DFAA fraction. The filtering can be done in the fume hood.
10. Prepare two glass ampoules with foil caps per slice and place in the wooden rack. To each ampoule add 15 microlitres of 85% orthophosphoric acid using the auto dispenser ensure that foil caps are replaced onto the vials after adding the acid.
11. Place 3-4 cm of silicone tubing onto disposable 5 ml polyethylene syringes.
12. Draw up sample into syringe, take off the silicone tubing and set aside for reuse, attach a 13mm GFF filter unit, discard 3-4 drops into waste then fill the glass ampoule to 0.5 cm below the neck, replace foil cap. Take off filter unit and set aside for reuse.
13. Reattach the silicone tubing draw a second aliquot of pore water into the syringe (using multiple centrifuge tubes if required) remove silicone tube reattach filter unit. Dispense the DFAA this time using 5ml vials and cap with Teflon lined caps, only 1 aliquot is needed here. If enough pore water remains then repeat step 12, to fill or part fill a second DOM vial.
14. Discard syringe, GFF filter unit after each slice and place the silicone tubing into the little wash beaker for washing and reuse.

Only gentle pressure should be applied when the filter unit is attached. If the filter is blocked (i.e. there is strong resistance against the plunger) or ruptured (i.e. cloudy solution breaking through) then replace the filter unit remembering to drip the first few drops to waste. It may be necessary to use several filter units for particularly turbid pore water.

Cleaning: Please note it is important to wash all slicers, spatulas, rings, tubs, tube lids, centrifuge tubes and Teflon liners and the rubbish bag in seawater and then in Milli-Q. Muffle the centrifuge tubes in the oven at 400˚C for 4 hours. Dry everything else in the drying oven overnight and rinse the Teflon liners in DCM.

Collection of Megafauna from Agassiz Trawls for Lipid and SIA

1. If organisms are small enough take the whole organism, wrap it in foil and place it in a clearly labelled (cruise number, site number, station number, specimen name, individual number) zip-lock bag.
2. If the organism is too large then dissect with the clean dissection kit provided on a foiled lined dissection tray. Once a piece of tissue has been dissected, ensure that this is not the gonad or guts, then once again wrap in foil and place in a zip-lock bag.
3. Please make sure that there are at least 5 of the same species taken to ensure good replication. At the same time also ensure that there is one of each species preserved in formalin for later species identification.
4. If there are any interesting large echinoderms or crustaceans, place in a Teflon bag.
5. All organisms should be frozen immediately at -70˚C.
6. After use the dissection kit should be cleaned in Decon 90 for ~ 4 hours and then wrapped in clean foil and dried for ~ 4 hours in the drying oven at 60˚C.

The organisms are being taken for lipid and stable isotope analysis. However, if there is a particularly abundant species take enough whole specimens i.e. around 15, so that pigment analysis can be done on the gut contents as well.

Laboratory Equipment Used

Muffle Furnace: Supplied by Edinburgh. Temperature set at 400˚C.

Points to note: a) Make others aware when it is switched on.
b) Let the oven cool down before removing contents.
c) Use glove and tongs to remove hot items.

Drying Ovens: Supplied by Edinburgh. Temperature variable/adjustable.

Take note of the points for the muffle furnace.

Freeze- Driers: Supplied by Liverpool and Edinburgh.

Both come with operating instructions and are straightforward to use. Please make sure that there is sufficient oil in the vacuum pumps before running. Also note that there is no oil mist filter on the Edinburgh pump and so the oil mist is collected in a drum attached by a tube at the exhaust valve. There is also a second tube attached for oil mist to be carried outside away from the working laboratory. Both freeze-driers worked well on CD 145.

Eppendorf, 5416 Centrifuge: Supplied by Edinburgh.

This was self-explanatory and worked well during the cruise. It is important to keep the centrifuge clean, in order for it to balance and prevent the breakage of the glass tubes. The optimum setting for the glass tubes in this centrifuge was at 3000 rpm for 15 minutes.

Rachel Jeffreys

7.12. Water column chemistry

Phytoplankton photosynthetic pigments and degradation products.

Objective: Identification and quantification of algal pigments from within the photic zone and to examine their subsequent degradation stages within the water column down to the sediment surface.

Method

Samples were collected from the Seabird CTD 24 bottle rosette using the 10l Seabird bottles. The samples were initially collected in 5l polythene bottles and then transferred to polycarbonate bottles for use on the SAMS vacuum water filtration rig. The rig uses the ship's compressed air via a pneumatically operated Seimens venturi pump to provide the vacuum. Samples were filtered through 25mm dia. Whatman GF/F filters and the filters stored frozen in 15ml polypropylene vials.

Water column particulate organic carbon and nitrogen.

Objective: Quantification of the POC and PON from the water column and examination of the stable isotopic signature (δC^{13} and δN^{15}) to determine organic carbon provenance and nitrogen cycling

Method

Samples were collected from the Seabird CTD rosette using 10l Seabird bottles. The samples were initially collected in 5l polythene bottles and then transferred to polycarbonate bottles for use on the SAMS vacuum water filtration rig. Samples were filtered through pre-ignited 25mm dia. Whatman GF/F filters and the filters stored frozen in pre-ignited 2ml glass vials.

Water column total dissolved nitrogen (TDN) δN^{15}

Objective: Evaluation of nitrogen cycling within the water column by stable isotopic analysis of the dissolved nitrogen component. This will compliment the stable isotopic data obtained from the particulate fraction

Method

Samples were collected from the Seabird CTD rosette using 10l Seabird bottles. The samples were initially collected in 5l polythene bottles and then transferred to polycarbonate bottles for use on the SAMS vacuum water filtration rig. Samples were filtered through pre-ignited 25mm dia. Whatman GF/F filters. The filtrate was collected in acid-washed 500ml polythene bottles. The filtrates were then spiked with 500µl of conc. hydrochloric acid for preservation. The filters were used for the POC/N analysis described above.

Water column particulate and dissolved manganese and iron analysis

Objective: Iron and manganese are intimately linked to benthic carbon cycling in sub and anoxic conditions. Both are used as terminal electron acceptors by bacteria and undergo reduction to soluble reduced species (Fe^{2+}, Mn^{2+}) from particulate oxidised forms (Fe^{3+}, Mn^{4+}). The soluble reduced forms diffuse from the sediment surface and oxidise within the water column. The presence of an OMZ may dramatically slow the water column oxidation step. Using published rate equations and by including the water column oxidation concentration, it is possible to calculate the oxidation rate of both iron and manganese.

Method

Samples were collected from the Seabird CTD rosette using 10l Seabird bottles. The samples were initially collected in 5l polythene bottles and then transferred to polycarbonate bottles for use on the SAMS vacuum water filtration rig. Samples were filtered through 25mm dia. Whatman nucleopore 0.4µm filters. The filter was stored in 10ml polypropylene vials and filtrate was collected in acid washed 25ml polypropylene bottles. The filtrates were then spiked with 25µl nitric acid.

Water column dissolved nutrients (ammonium, phosphate, silicate, nitrate and nitrite)

Objective: Dissolved water column nutrients play a large role in phytoplankton production and biomass. They are actively sequestered in the photic zone and released in deep waters from the remineralisation of the phytodetritus.

Method

Samples were collected from the Seabird CTD rosette using 10l Seabird bottles. The samples were initially collected in 5l polythene bottles and then transferred to polycarbonate bottles for use on the SAMS vacuum water filtration rig. Samples were filtered through 25mm dia. Whatman GF/F filters (filters used for pigment analysis described above) and the filtrate initially collected in 250ml polythene bottles. The dissolved nutrients were analysed on a Lachate model flow injection autoanalyser. The instrument uses flow injection modifications of classic colorimetric methods. Ammonium, phosphate, silicate and nitrate were analysed on all samples collected. By removal of the cadmium-copper reduction column in the nitrate line some samples (see below for details) were also analysed for nitrite. All samples were analysed in triplicate.

Operational considerations

The ammonium concentration in the water column is very low and there is a large negative blank effect due to the refractive properties of the saltwater sample in the deionised water carrier stream. The salinity effect is normally corrected by running nutrient poor seawater or artificial seawater blanks as part of the standard calibration. The artificial seawater compound was found to be contaminated with ammonium and so blank correction will be carried out at SAMS.

Tim Brand

7.13. Sediment column chemistry

Pore water nutrients

Objective: Sediment porewater nutrient profiles reflect degree of organic and siliceous (diatom frustules) matter remineralisation within the sediment column. Nitrate and nitrite are used as terminal electron acceptors (oxidising agents) in the absence of oxygen by bacteria and their profiles reflect the redox conditions of the sediment.

Method
Porewaters were collected from centrifuge sediment slices at ambient sea floor temperature and under nitrogen. See Sawyer (this report) for full protocol. Pore water volume was normally between 1 and 2mls. This was split in to two volumes and diluted to between 100 and 200 times to yield approximately two 8ml volumes. The first volume was used for NH_4, PO_4, SiO_3 and NO_3 analysis and the second volume was used for NO_2 analysis.

Tim Brand

7.14. Dissolved organic carbon and total dissolved nitrogen

Relatively rapid and precise techniques are available for the determination of DOC and total dissolved nitrogen (TDN). Most commonly used for this purpose is high temperature catalytic oxidation (HTCO). Such techniques involve the direct injection of acidified and decarbonised seawater onto a platinised alumina catalyst, at high temperatures (680 - 900°C), under an atmosphere of oxygen or high purity air. Quantitative production of CO_2 gas allows DOC concentrations to be determined using a CO_2-specific infrared gas analyser (IRGA). In this work these measurements are made using a *Shimadzu TOC 5000A* analyser. Incorporation of a *LiCor 6252*, solid-state IRGA, and a PC-based analog-digital conversion and integration system (*hplc Technology*) allows high precision measurements to be made. Addition of a nitrogen-specific chemiluminescence detector (*Sievers 280i*), in series with the IRGA, provides a method for simultaneous measurement of TDN. Combustion of nitrogenous compounds under an oxygen atmosphere at 680°C (in the *TOC 5000A* furnace) leads to quantitative production of the nitric oxide (NO) radical. Subsequent reaction with ozone produces excited nitrogen dioxide (NO_2) species, which emit quantifiable light energy upon decay to their ground state. Using total combined inorganic N-based nutrient data, the TDN concentrations will be used to derive DON, complementary to HTCO-DOC measurements.

A number of faults were encountered with various components of the analytical system:

(i) The *LiCor* detector developed an intermittent fault resulting in the loss of signal. This was identified as a problem with an inductor (L3) on the main power board (Terry Edwards, UKORS), and was temporarily rectified through manual tapping at the recurrence of the fault.

(ii) The *hplc Technology* integration software was installed on two unrelated PCs. On neither system would the software allow the reprocessing of the raw data; persistently crashing the program at all attempts. This has prevented the reprocessing of any data on board, such that any results are of a highly preliminary nature.

(iii) The *LiCor* detector developed a permanent error after the sampling programme had been completed and the porewaters had been analysed. This was identified as a fault with the flow cell, requiring attention from the manufacturer. In light of this difficulty, the analytical system was reconfigured so that analysis could be performed with the Shimadzu infrared detector and the chemiluminescence detector. The intention was to produce TDN data

onboard with a view to analysing archived samples back at SAMS when the equipment returns around December 2003. [Note, under circumstances of very calm seas, and without winches working, it may be possible to obtain useful DOC data. Such conditions were encountered on passage, so the Shimadzu IRGA was connected to the *hplc Technology* analog-digital converter in order to produce raw data that may be usefully reprocessed when the solution to (ii) above has been implemented.

Axel Miller

8. SURVEY EQUIPMENT

8.1. Computing and data logging

No particular problems were experienced with the ship's computer suite or data logging systems. Navigation data, surface sample data, metrology data and winch data were all logged to the onboard computing system. Processed navigation, salinity, corrected bathymetry and processed wind speed data were also produced. These data were backed-up to a data CD.

The 3.5kHz record was also logged and the data backed-up to CDs (3).

Data from the EM12 swath bathymetry system were logged too *.all files. These files contain backscatter, bathymetry and navigation data. A survey map of the work area was produced using the Simrad Neptune package for initial editing of returns and then girded data produced with Roxar Cfloor software. A 100m grid of the whole work area was produced. Raw and processed EM12 data were backed-up to CDs (1 of each).

Gareth Knight

8.2. Acoustic systems

3.5 kHz seabed profiler

The profiler was not operated continuous during the cruise; its use was restricted to the periods of swath bathymetry operation, when the ship's speed was limited to 8 knots. The system appeared to work well and a good paper record was obtained. However, the clock on the PC running the system did not hold time, consequently the time-marks on the printed record may be "wrong" or drift. Any use of the live printed record should be checked against the 10 kHz profile and / or the logged 3.5 kHz dataset.

10 kHz echo sounder

The Simrad EA500 was run more-or-less continuously throughout the cruise, and no problems noted with the basic system. System time drifted marginally and was reset occasionally, although it was seldom out by more than a few seconds. For reference during CD146 *et al*., transducer depths were set as follows:

4.5m when operating through the hull and 10m when operating through the fish.

A more-or-less continuous printed record was maintained in addition to the centrally logged depth data. The EA500 was also used to monitor acoustic telemetry for much of the cruise – the Waterfall display system being apparently inoperative (but see further below) - successfully monitoring the CTD pinger, trawl pinger (though seabed returns were not detected during fishing phases), BBLS pinger and WASP telemetry. The beam steering unit was activated during one or two of the trawls, but appeared to be ineffective, and frequently reset its self or "flicked" between settings – a problem that has been seen before. The single element of the 10 kHz fish was also used during the recovery of Bathysnap (stn 55792#1) and appeared to operate well with the SOC-GDD MORS deck unit, command transmissions were evidently effective and the vast majority of "ranging", "received" and "executed" returns were detected.

Waterfall display system

The Waterfall display system was apparently ineffective for most of the cruise, this despite much "fiddling" and swapping around of UKORS and SOC-GDD components. The problem was eventually traced to the fact that the 10 kHz output card had been removed from the Simrad main unit! It would have been nice to be forewarned about this withdrawal of, what has become, a "standard feature". The Waterfall worked well once this card had been reinstalled!

Simrad EM 12 swath bathymetry

The system appeared to work well throughout the cruise. Screen dumps from the quality control unit were made regularly during swath operations. All data (backscatter, bathymetry and navigation) were centrally logged. Note the initial swath run was carried out without a "local" sound velocity profile – edge effect artefacts are obvious on the swath chart where these data meet the later, calibrated, data.

Brian Bett

8.3. Mechanical handling

CTD deployments

Nine deployments to a maximum depth of 3226m (wire out) were carried out using the starboard gantry and CTD winch. During the 2nd deployment the winch speed was found to be "pulsing" when attempting to lower the CTD into the water. Cleaning and adjusting the hydraulic counterbalance valve on the winch motor rectified the fault. The winch monitoring system wire tension readout became unstable during the 5th deployment giving a wildly fluctuating reading. As all CTD deployments on the cruise were relatively shallow and the sea state calm, the resultant induced wire tensions were known to be well within operational limits of the wire and therefore subsequent deployments were carried out with this fault present. Investigation into the fault during the cruise indicates that the load cell has an

intermittent break in its internal circuitry. The load cell will be replaced during the next recertification period.

BBLS, multicore, Megacore, WASP and Box Core deployments

A total of 98 deployments were carried out using the trawl warp over the starboard gantry with a maximum wire out of 3227 metres. No problems were encountered during deployments except during the recovery of the box core when the corer appeared to come into contact with the gantry roller / sheave causing the corer pennant to part and the box core being lost (see also report below). The loss of the box corer is not considered to be due to a fault in either the winch or gantry.

Agassiz Trawl Deployments

Trawl deployments were carried out using the trawl warp over the aft gantry. No problems were encountered during deployments. A total of 11 deployments were carried out with a maximum wire out of 4800 metres. One Agassiz trawl frame was distorted beyond repair during the cruise when it became snagged on the bottom.

Box corer

The softness of the sediment at some sites meant that the sample box was overfilling. Drilling and tapping additional holes in the column to enable the column stop bars to be moved to reduce the travel of the sample box overcame this. It would have been useful to reduce the weight of the corer by removing lead ballast from the column. It was found that this was not practical as to remove the weights would mean removing the trigger head. Modification to allow easier removal of weights and have adjustable column stops in a replacement corer would be desirable.

Rhys Roberts, Alan Sherring

8.4. Laboratory facilities

Liquid Nitrogen Generator

Although problems were encountered with the LN_2 generator during the cruise, the system maintained a supply of LN_2 throughout the cruise. The siting of the system in the airgun annex is not ideal and problems with cutting out on high temperature at times were experienced. The level indicator gauge stopped working a few days into the cruise. E-mail correspondence with the manufacturer seems to suggest there is an ice blockage in the high pressure gauge connection pipe inside the dewar. The only way to cure this is to empty the dewar and let it thaw out for a couple of days. The continuous requirement for LN_2 during the cruise did not allow for the dewar to be thawed out therefore the gauge was disconnected. The

level was physically checked every few days and the system was started / shutdown manually as required.

Clean Chemistry Container Laboratory

No problems were reported during the cruise except the icing up of the air conditioning unit on one occasion.

Radio Nuclide Container Laboratory

The fire alarm system backup batteries were replaced during the cruise.

Millipore Water Purifiers

Two RO12 systems were used during the cruise. One in the chemistry container lab. and one in the Ship's wet lab. The system in the container lab had been shut down for a period and was restarted with a new RO membrane and filter packs. The prefilter was replaced midway through the cruise. The system in the wet lab had a new prefilter fitted at the start of the cruise and required no further maintenance.

Flake Ice Maker Machine

The Ice Maker was installed in the wet lab and worked without problems during the cruise.

Sensair 20 Fume Cupboard

The fume cupboard was installed in the main lab and worked satisfactorily apart from frequent low airflow alarms while the unit stabilised after start up. This is thought to be due to the proximity of the deck head to the cupboard exhaust grill airflow causing backpressure.

Rhys Roberts, Alan Sherring

8.5. CTD

As used during the cruise, the CTD consisted of the following apparatus:

- 24 way frame, holding 24 10 litre externally sprung sample bottles
- GO 1016 rosette
- Seabird 911+ CTD with 2 pumped TC pairs
- SBE 43 Dissolved oxygen sensor
- Seatech LBSS
- Chelsea Alphatracka 25cm transmissometer
- Chelsea Aquatracka 3 fluorometer

A total of 11 CTD casts were carried out, two of which (55801#11 and #12) were abandoned due to data communication failure. Slight data spiking problems occurred on some casts some of which were assigned to a failed O-ring on the LBSS and some of which on 55842#1 are under investigation. The successful casts were:

Site	Station	Comment
A150	55809#1	Full depth cast
A300	55803#1	Full depth cast
A500	55816#1	Full depth cast
A500	55835#1	Full depth cast
A1200	55802#1	Full depth cast
A1850	55827#1	Full depth cast
A2750	55842#1	Full depth cast
A3200	55801#1	Full depth cast
A3200	55801#16	2500m cast

Sample Bottle Operation

The first cast, 55801#1, suffered multiple misfires due to lanyard routing problems. As new lanyards had been fitted prior to the dip, in retrospect it would have been a good idea to test fire all the bottles shallow and restart the cast rather than carry out a full deep cast. This problem was rectified and did not re occur. The GO 1016 rosette performed without fault

Temperature / Conductivity Pairs

Salinity comparisons based on samples analysed on a Guildline Portasal showed the primary TC pair to be typically within 0.001 PSU. The secondary TC pair were typically within 0.015PSU, although this offset was fairly constant.

Dissolved Oxygen

Checked against lab titrated samples. The sensor was shown to be performing well.

Fluorometer

Performed as expected, no problems recorded.

LBSS

The original LBSS 338 was used and was very noisy. A damaged O-ring was replaced; this did not totally cure the problem. The LBSS was then sealed to the high gain cable, which also did not cure the problem. The LBSS was replaced after 55801#16, as was the cable. A low gain cable had to be used. LBSS 339 performed well after this.

Transmissometer

From the first cast, the transmissometer voltage exhibited a step change in the top few hundred meters that has been difficult to explain. The transmissometer was changed after 55803#1 with no effect and the whole cable and digitisation circuit systematically checked. The effect continued to happen. There appears to be no correlation between other parameters, including backscatter, density, fluorescence and salinity that were the likely suspects. The possibility that it is a natural effect has not been ruled out.

Terry Edwards

8.6. Benthic Boundary Layer Sampler

A benthic boundary layer sampler (BBLS) has been designed at SAMS (Willie Thomson); the frame built at the University of Edinburgh (Jim Smith) and the sampling bottles at SAMS (Drew Connelly). The BBLS frame accommodates 1.5 litre capacity PVC/Perspex sampling bottles, aligned horizontally at variable intervals between 0.16 and 2.12 metres (to the centre of each bottle) from the bottom plate of the frame. A mechanical trigger (vertical movement of bottom plate) fires the closing mechanism (spring-taught pistons) of all bottles simultaneously upon impact with the bottom, whilst a magnetic switch changes the frequency of the pinger used to monitor deployments.

Bottles were situated at 0.16, 0.55, 1.01, 1.56 and 2.12 metres (to the centre of each bottle) above the base. The uppermost bottle was a ‘prototype’ and was subject to a number of design problems. The bottle closing mechanism failed to fire on several occasions, but this was resolved through a re-engineering of the metal closing plate mechanism. There was also no drain vent in this prototype bottle, so the stopper had to be rapidly opened and closed in order to withdraw water. The bottle at 1.01 metres consistently leaked from the rear piston, and on one occasion was shown – through inorganic nutrient analysis - to have back-flushed during ascent through the water column.

The BBLS was deployed from the core warp (19mm wire rope). This relatively heavy wire, compared to the sampling device, has previously been shown to provide greater control for ‘light equipment’, reducing “kiting” and increasing the likelihood of the gear landing squarely on the seabed (Bett, *pers. comm.*). During the first deployment a descent rate of 10-15 m/min

was used over the first 200 m, with 25-30 m/min thereafter. Around 2000 m, the BBLS closing mechanism fired and the rig had to be returned to the surface for re-cocking. To prevent the upward force of the water firing the mechanism before the gear is bottomed, a lead weight (4-5 kg) was bolted to each side of the footplate. Although the mechanism did not fire on the subsequent cast the lead weights were removed during shallow casts, particularly where sediments were believed to be of a soft, muddy nature.

Because of the nature of the frame (vertical tower, with small, narrow footprint) it is important to halt the descent as soon as the firing mechanism has been triggered. The failure to do so will result in the frame (including fired bottles) falling over. This happened on one occasion, but the result was limited to a muddying of the BBLS frame; all samples appeared to remain un-compromised (as shown from inorganic nutrient analysis). The precaution against this result is to halt the descent immediately upon impact. This can be difficult due to the nature of the change in frequency of the pinger signal, requiring 1.5-2.5 seconds for confirmation. A change to a 3 or 4 Hz ping upon impact may lessen the likelihood of this toppling effect. (Monitoring of BBLS operation was carried out using the SIMRAD EA500, the display of which is a little slow to update – use of a "Waterfall" display system would make quick detection of firing more likely, BB)

On a number of occasions the bottom bottle returned cloudy brown water, indicating the inclusion of some resuspended sediment or material from right at the fluid sediment-water interface. In an attempt to lessen the former effect, the decent rate was lessened from around 25-30 m/min to 5 m/min as the BBSL approached the bottom, thus creating less of a bow wave effect. The latter effect was more difficult to compensate for, as the sensitivity of the trigger plate may be too coarse for very soft, fluid sediments. On several occasions the BBLS returned with clear, colourless water, indicating that there had been no inclusion of bottom particulates.

Two immediate modifications to the system that would facilitate greater ease of preparation are:

(i) a handle on the sliding angle plate, for greater control during cocking of the firing mechanism; and
(ii) the removal of the upper portion of the polypropylene fin, to allow unhindered access to the upper most bottle on the frame.

In the longer term it will also be necessary to devise a holding rack for location on the deck and a means of transport around the deck.

Axel Miller

8.7. Multiple corer

A SOC-GDD supplied SMBA-pattern[10] multiple corer was used throughout the cruise. The corer generally performed well, however, it proved extremely difficult to operate successfully at site A500 (see below).

Site	Station	Comment	Core lengths
A150	55808#2	12/12 good cores	30cm
A150	55808#3	12/12 good cores	30cm
A150	55809#6	12/12 good cores	22-30cm
A300	55803#4	12/12 good cores	46-50cm
A300	55803#5	12/12 good cores	na
A300	55806#3	12/12 good cores	41-48cm
A500	55814#3	0/12, not fired	na
A500	55814#4	0/12, not fired	na
A500	55814#5	0/12, not fired	na
A500	55816#4	0/12, not fired	na
A500	55816#5	0/12, not fired	na
A500	55816#6	10/12 good cores	na
A500	55816#7	0/12, not fired	na
A500	55818#3	0/12, not fired	na
A500	55818#4	12/12 good cores	30-49cm
A500	55818#5	0/12, not fired	na
A500	55818#6	0/12, not fired	na
A500	55823#1	0/12, not fired	na
A500	55823#2	0/12, not fired	na
A500	55823#3	0/12, not fired	na
A1200	55802#4	12/12 good cores	26-31cm
A1200	55802#5	12/12 good cores	30cm
A1200	55822#2	12/12 good cores	30cm
A1850	55830#2	11/12 good cores	24-28cm
A1850	55830#3	12/12 good cores	24-27cm
A1850	55830#4	12/12 good cores	26-30cm
A3200	55801#9	10/12 short cores.	15-19cm
A3200	55801#10	12/12 short cores.	16-18cm
A3200	55801#15	11/12 short cores.	13-20cm

[10] Barnett, P.R.O., Watson J. and Connelly, D., 1984. The multiple corer for taking virtually undisturbed samples from shelf, bathyal and abyssal sediments. *Oceanol Acta*, **7**, 399-408.

The extremely soft sediments of site A500 appear to offer insufficient resistance to the penetration of the coring head. Consequently, the central axis of the damper column does not move relative to the head and the triggering collar is not brought in contact with the firing mechanisms. Numerous modifications and "fixes" were attempted: removal of all column leads, addition of "broomsticks" between the feet, addition of a small plank or pads below the coring head, and (in varying degrees of tightness) the wiring of the trigger collar directly to the frame. None of these modifications guaranteed success. The best advice that can be offered for subsequent coring at this site is: removal of all column leads, the fitting of "broomsticks" or similar between the feet, and the tight wiring of the trigger collar to the frame – such that the collar is held up by approximately one inch (see below).

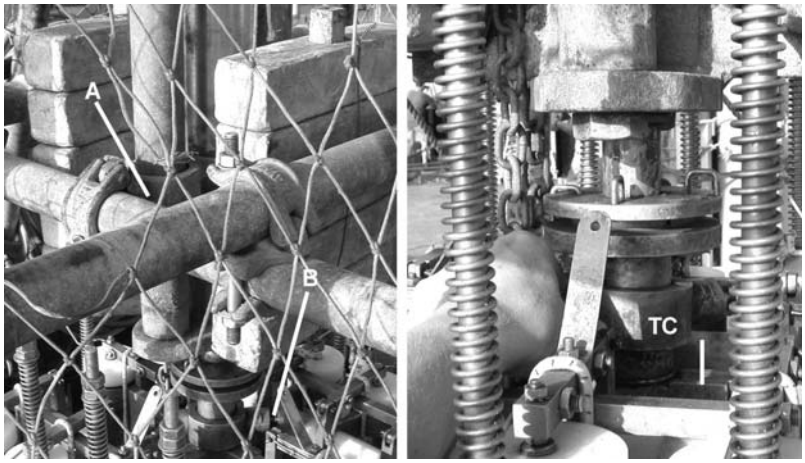


Figure 9. Hints on rigging the multicore for operation at site A500. The trigger collar (TC) should be held up an inch (see right) and seizing wire run from point A on the frame to point B on the trigger collar mechanism (see left) – this repeated on both side to give an even pull up on the collar (note that A and B as illustrated are on opposite sides).

No other particular operational difficulties were experienced with the multicorer during the cruise. It is, however, worth noting that the multicorer occupies most of the available deck space below the starboard gantry, it is therefore **most important that no personnel are positioned inboard of the corer during launch and recovery** (until the corer is swung out board and lowered to allow removal of the "pin").

Brian Bett

8.8. Megacorer

The SOC-GDD Megacorer performed very well during the cruise:

Site	Station 558	Depth (m)	Cores	Comments
A150	08#1	161	8/8	29-32cm, muddy sand over shelly debris.
	09#5	153	8/8	34-39cm, 3 somewhat disturbed, sandy mud with numerous *Pelosina*.
	12#1	150	7/8	some fractures, 34-40cm.
	12#2	151	8/8	38-40cm.
	24#2	155	6/6	muddy sand with some shelly debris below (extra drop carried out to try pore water sampling via ports drilled in core tube).
	32#1	152	8/8	c. 39cm.
A300	03#6	311	10/12	39-43cm, 2cm unconsolidated material over finely banded mud. All top weights and 8 inner weights removed for this deployment.
	06#1	299	12/12	41-42cm
	06#2	309	10/12	one no fire, on lost on deck, 38-43cm.
	13#1	308	8/8	44cm, soft finely banded mud.
A500	10#1	499	7/8	rather full, 50+cm, was with full ballast load.
	14#6	492	6/8	2 not fired, 3cm unconsolidated layer over very soft, finely banded mud.
	16#3	502	8/12	(4 not fired), 39-44cm.
	18#1	500	6/12	6 not fired, 42-45cm, one subsequently lost on deck.
	18#2	495	8/12	4 no fires, 40-43cm.
	35#3	502	10/12	(2 no fires), 39-47-cm.
	35#4	497	7/12	(5 no fires), 39-44cm.
	35#5	499	5/12	41-45cm.
A1200	02#3	1200	12/12	37-40cm, uniform brown mud, with some large burrows.
	02#7	1200	12/12	37-39cm.
	19#2	1197	11/12	1 no fire, 36-40cm.
	22#1	1200	12/12	36-38cm, some gromiids.
	36#1	1214	7/8	(1 no fire).

A1850	27#3	1870	12/12	33-36cm, 1-1.5cm brown layer over lighter clay.
	27#4	1867	12/12	36-40cm, 1-1.5cm of brown mud over lighter clay.
	30#1	1874	12/12	33-38cm, flocculent layer, 1cm brown mud over lighter clay below.
	38#1	1871	12/12	31-37cm, a little flocc over 3-4cm of brown mud over lighter clay. One of the cores having what appears to be holothurian (*Benthothuria*) pooh.
A3200	01#2	3189	10/12	short cores 9-12cm, 2 cloudy, 2 drained through burrows and two bubbled on deck; 6 cm of soft brown mud over light grey clay. Four short cores retained.
	01#3	3190	8/8	Reduced to 8 tubes and somewhat increased wait time following the poor first drop. 34-39cm, with 8cm soft dark brown mud over light grey clay, several burrows apparent.
	01#6	3191	8/8.	33-40cm, some with (natural) sloped surfaces. Usual darker brown soft mud over light grey clay.
	01#14	3191	7/8.	34-37cm; one slumped 18cm, with c. 9cm of soft brown mud over light grey clay.
-	07#1	258	8/8	Oops wrong depth ! very soft mud, surface picked for *Pelosina* then discarded.
C1200	20#1	1170	11/12	1 no fire. Looking for gromiids previously trawled at this location; but with no great success, surface picked for forams (saccamminids).
D1800	26#2	1833	8/12	2 not fired, 2 slumped, surface flocculent layer, 1cm of brown mud over lighter clay.

No modifications other than varying the ballast load and number of tubes deployed were required to recover good quality cores from all sites sampled.

Recommended set up for RRS *Charles Darwin* cruise 146 operations:

Site A150 – *full ballast, 8 or less tubes – beware shelly base layer in cores and resultant tendency of the cores to fracture – use of core "slipping" technique for removal may alleviate fracturing.*

Site A300 – *partial ballast (top weight and eight inner weights removed), 8-12 tubes – very soft mud, bottom bungs must be held in at all times! – beware tendency of cores to bubble - – use of core "slipping" technique for removal may alleviate bubbling problem.*

Site A500 – *no ballast (all weights removed), 12 tubes (some units may not trigger in this soft stuff, this is normal, though do check units move freely on the pins if you get repeated failures of a particular unit) – ultra soft mud, bottom bungs must be held in at all times! – beware tendency of cores to bubble – use of core "slipping" technique for removal may alleviate bubbling problem.*

Site A1200-A3200 (and all sites >1,200m) – *full ballast, 8-12 tubes – should all be straightforward to core.*

As with the multicorer it is **most important that no personnel are positioned inboard of the corer during launch and recovery**, therefore ensure that the head locking latch is turned to face either fore or aft at deployment / recovery.

Brian Bett

8.9. Box corer

A SOC-UKORS supplied, modified USNEL Mk2 spade box corer[11] was used throughout the cruise until its ultimate complete loss (see below). The corer was rigged and deployed in the conventional manner throughout. As supplied the corer had penetration limiters (stops on the central column) fitted at the top of the column, which could also be repositioned to the mid-point of the column. During the cruise a third position was drilled and taped on the column to enable the limiters to be fitted as low as possible (i.e. immediately above the trigger lever.

This corer worked well in the calm sea conditions, although the "sloppy" sediment encountered at site A500 led to over-penetration. Here the recovered box filled with sediment up to the maximum possible extent, even when the box corer's column limiters were adjusted to minimise penetration. Unfortunately it was found to be impossible to remove any of the lead ballasting that had been placed within the column (the head piece of the corer was seized and had sheared off bolts). It might have been useful if this ballasting consisted of pellets that could be removed through the inspection plate, although admittedly this is rather small for doing this. The solid lead plates were impossible to remove from the corer while on cruise.

The box corer was lost on deployment 55838#2 at site A1850. This meant that a series of box corer samples from this site was not achieved. A report of this incident was prepared immediately following the event and is added below:

[11] Hessler, R.R. and Jumars, P.A., 1974. Abyssal community analysis from replicate box cores in the central North Pacific. *Deep-Sea Res*, **21**, 185-209.

Loss of the "Yellow Box Corer", during RRS *Charles Darwin* cruise 145, Monday 31 March 2001

The UKORS "Yellow box corer" (SMBA-pattern / USNEL Mk2 spade box corer) was lost during recovery from a deployment at site A1850 (station number 55838#2). The corer was deployed at 05:50z 31-III-03 and bottomed at 06:48z at position 22° 50.56′ N 065° 59.67′ E. The team assembled for recovery to deck consisted of:

Garry Crabb	Seaman	winch and gantry control
Stuart Cook	Seaman	steadying
Brian Bett	Principal Scientist	steadying
John Gage	Scientist	steadying

The corer was brought to the surface and closer to the side of the ship in the normal manner of recovery. With Cook, Bett and Gage steadying, the corer was then raised further to clear the rail. The corer continued to rise, at which point Cook, Bett and Gage realised the potential danger and quickly evacuated the rail (Cook and Bett going forward and inboard, Gage going aft). A few seconds later, the activating warp of the corer parted and the corer dropped in to the sea without contacting the vessel. There were no injuries to the personnel involved. Having cleared the vicinity of the rail, I (Bett) did not have sight of the activating warp parting, and only saw the corer fall back in to the sea. From my observations of the incident, subsequent inspection of the main warp pennant, the remaining activating warp and the winch dynamometer record, I would suggest the following: "The corer was brought up to such a height that it came in contact with the gantry roller. Hauling in continued, rapidly increasing the load on the corer's activating warp until it parted at a maximum-recorded tension of c. 4.3 tonnes."

John Gage, Peter Lamont, Brian Bett

8.10. WASP

The SOC-GDD WASP (Wide-Angle Seabed Photography) system was used throughout the cruise in its standard configuration without any need for modifications or repairs etc. Briefly, WASP is a self-contained, off-bottom, towed camera vehicle that provides still and video footage of the seabed, and is capable of operation to 6,000m water depth on a simple mechanical cable (i.e. conducting or fibre-optic cable not required). As deployed during CD145, WASP is fitted with: OSIL Mk7 (stills) camera, OSIL 1200J flash gun, SOC OceanCam6000V (digital video) camera, 2 x 250W DSPL video lamps, 3 x DSPL 24V batteries, Simrad Mesotech 200kHz altimeter, and a SOC-OED acoustic telemetry system (10kHz). Data from the altimeter is telemetered to a shipborne display enabling the operator to make fine adjustments of the amount of cable deployed with the aim of keeping the vehicle at c. 3m above the seabed. The still and video cameras are both automatically activated by the altimeter when the range to the seabed is <10m. For all deployments made during CD145, the

still camera was loaded with 30m of Kodak Vision 250D and the video camera loaded with a 65 minute MiniDV tape.

Despite being overseas in transit or storage since autumn 2002, the WASP system was fully function from the outset and performed almost flawlessly for the duration of the cruise, making 15 deployments:

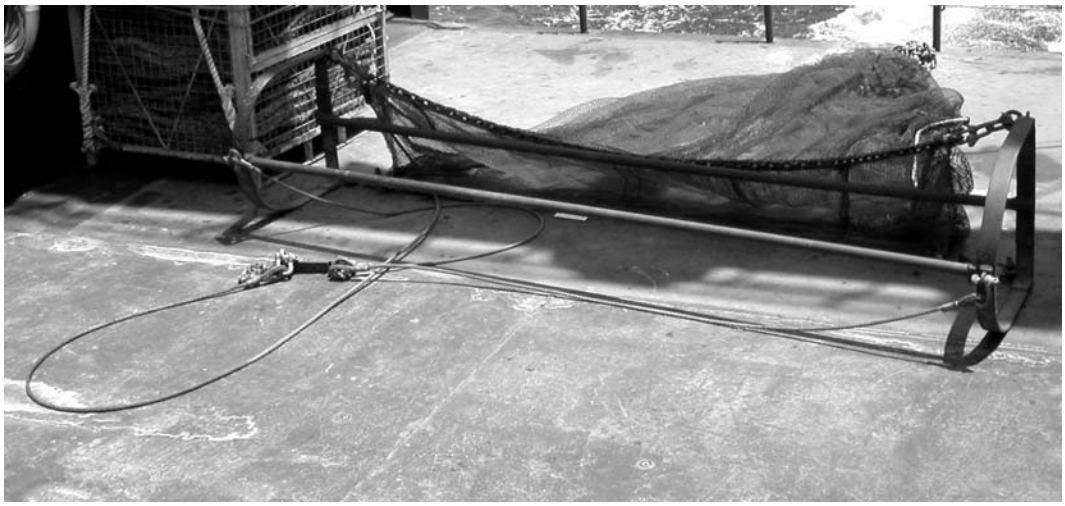
Site	Station	Depth	Comment
A150	55824#1	150-157m	Good tow
A200	55833#1	187-187m	Good tow
A300	55825#1	307-304m	Good tow
A400	55834#1	405-426m	Good tow
A400	55831#1	395-407m	Aborted tow
A500	55818#7	563-608m	Good tow
A1200	55819#1	1203-1222m	Good tow
A1850	55830#6	1867-1874m	Good tow
A3200	55843#1	3190-3191m	Good tow
C1000	55828#1	1018-1034m	Good tow
C1100	55829#1	1098-1100m	Good tow
C1200	55820#2	1165-1187m	Good tow
D1600	55839#1	1625-1640m	Good tow
D1700	55840#1	1705-1710m	Good tow
D1800	55826#1	1836-1806m	Good tow

The first deployment at site A400 was aborted shortly after arrival at the seabed when the telemetry indicated the still camera was not running. This proved to be a simple film jam that was ready cleared, the vehicle redeployed and the tow successfully completed. The only other point of note relates to the lack of a Waterfall display system for the majority of the cruise (see acoustics section), this necessitated the use of the Simrad EA500 screen as a display. This proved to be no inconvenience – other than perhaps cricking the neck looking sideways at the screen – and indeed was a bonus in that active echo sounding could be run simultaneously without interference to the WASP "traces".

Brian Bett

8.11. Agassiz trawl

UKORS supplied Agassiz trawl frames and nets were used



Eleven Agassiz Trawls were made between 150 and 3200m water depth:

Station	Depth (m)
55801#5	3162-3178
55801#13	3157-3175
55804#1	321-341
55804#2	299-327
55805#1	161-182
55811#1	1174-1177
55815#1	1799-1852
55817#1	1089-1103
55821#1	1405-1407
55837#1	1791-1814
55841#1	1620-1660

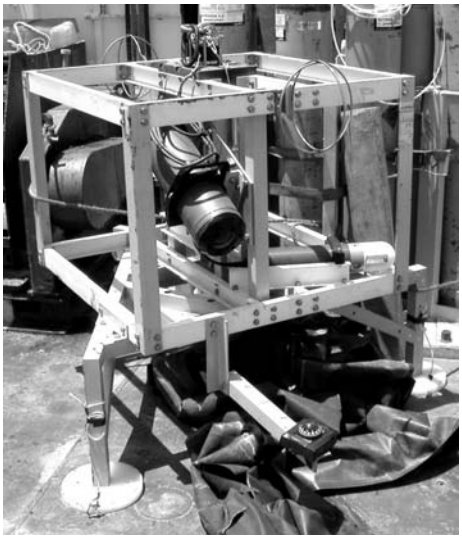
All samples were collected without difficulty apart from one, at 160m depth, which caught fast on the seabed while the net was being recovered. The frame was badly bent and the net was torn. However, even in this case, a sample was retrieved. A second frame and net were used for subsequent hauls. Fishing was generally undertaken at a scope of c. 1.3 and a speed

of c. 1.5 knots. A 10 kHz pinger was used for all hauls, positioned mushroom down 100m up the wire; pinger bottom echo traces were not generally detectable during the fishing phase.

Dave Billett, Brian Bett

8.12. Bathysnap

The first deployment of the new generation "Bathysnap" (free-fall time-lapse photography) system – incorporating the new SOC OceanCam6000S stills camera and the new "Roughsnap" frame – was undertaken at the end of RRS *Charles Darwin* cruise 143. The camera was deployed off the Oman Margin at c. 3,300m at a position on the track between Muscat and the Pakistan Margin work area.



The mooring was successfully recovered during the present cruise – the final stage of the recovery being somewhat unconventional in the use of the A-frame pedestal capstan, a hose to the deck winch having burst mid-way through the recovery. Mooring, frame and all instrumentation all appear to be intact and in good order following this c. 80-day deployment.

Brian Bett

9. PRELIMINARY OBSERVATIONS

9.1. Foraminifera

Pelosina

The macrofaunal foraminiferan *Pelosina* sp. (>300 μm) was found living on the surface of sediments at sites A150, A300, A500 and A1200 (see below), and was most abundant at the A150 site, decreasing in abundance with depth. It was not observed on cores from sites A1850 or A3200.

Where possible the total number of *Pelosina* sp. specimens present on core tops was recorded. Specimens of *Pelosina* sp. were then carefully picked out using floppy forceps, carefully washed on a 45um sieve to clean sediment from the specimens, and then frozen at -70°C for biochemical work (lipids, amino acids, carbohydrates, stable isotopes), preserved in formalin for identification, or stored in gluteraldehyde 3% for ultrastructural work using TEM.

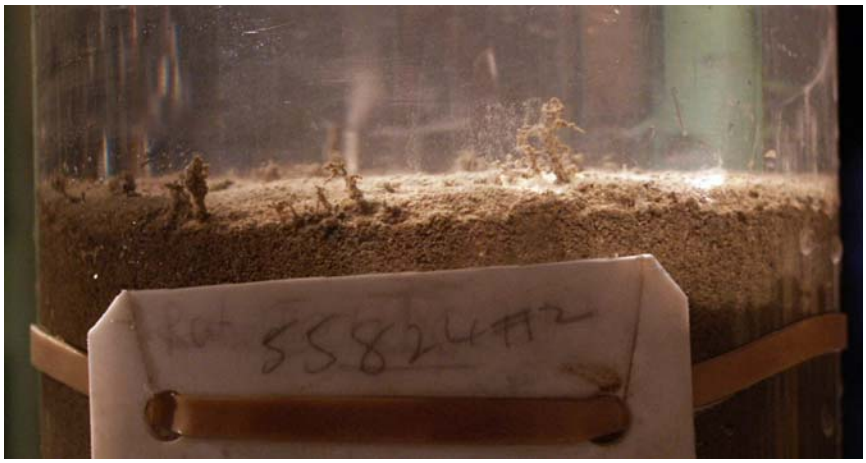


Figure 10. Pelosina sp. visible on the surface of a Megacore from site A150.

Table: Pelosina sp. specimens collected from core tops (MC-multicore, MGC-Megacore, BC-box core) at sites A150 A300, A500 and A1200.

Site	Depth (m)	Station 558	Gear	No. cores	*Pelosina* sp.	10% formalin	Frozen
A150	151	12#2	MGC	8	30		30
	153	09#1	MGC	2	28		28
	153	09#5	MGC	1	10		10
	156	09#6	MC	2	10		10
	155	09#7	BC	1	100		20
	161	08#1	MGC	2	29		29
A300	299	06#1	MGC	1	Many small		Many small

	311	03#6	MGC	1	1		1
	315	03#7	BC	1	1		1
A500	492	14#6	MGC	1	4	2	2
A1200	1170	20#1	MGC	7	Many small		Many small

Macrofaunal Foraminifera

A150: *Globobulumina* sp. were sorted from 0-5 cm slice (>300 µm) of Megacore 55824#02.

A300: Foraminiferans in the >500µm fraction from the top 5cm of the box core 55806#04 included *Lenticulina* sp. and *Reophax* sp.

A500: *Globobulumina* sp. were sorted from the >500µm fraction from the top 2cm of the box core 55814#02.

A1200: None sorted

A1850: Macrofaunal foraminiferans from the >500µm fraction of the uppermost 2cm of sediment from box core 55830#05 included *Reophax* sp. *Bathysiphon* sp. *Rhizammina* sp. and *Lana* sp. Of particular interest was the fact that *Rhizammina* sp. and *Lana* sp. were found in close association with *Thioploca* sp., a filamentous bacteria. However, a Megacore from the same site (55826#02) contained a different taxonomic composition including the macrofaunal foraminiferans (>300µm) Saccamminid sp., *Reophax* sp., *Hormosina* sp., and tube fragments.

A3200: Macrofaunal foraminiferans sorted from the >300µm fraction of the 0-0.5cm slice of Megacore 55801#02 were *Cribostomoides* sp., *Lana* sp., and komokiacean-like chains. On sorting the top 10cm of the >300µm fraction of the Megacore 55801#04, many fragments of a xenophyophore were found.

Box cores and trawls were found to be effective for obtaining bulk macrofaunal Foraminifera for biochemical analyses, although such equipment does not provide quantitative data such as the abundance of a particular organism over a specific surface area.

The trawl samples from 1791-1814m (55837#1) and 1620-1660m (55841#1) were particularly diverse in their macrofaunal foraminiferal composition, including *Triloculina* sp., spherical Saccamminids, brown Miliolids, *Bathysiphon* sp. and *Reophax* sp. *Triloculina* sp. (see below)

Bathysiphon sp. and *Reophax* sp. appeared in high abundances from 1800m up to 1650m. Dark Miliolids and spherical Saccamminids were most abundant at the deeper site of 1800m and decreased in abundance with decreasing water depth.

Figure 11. Protozoa caught by the Agassiz Trawl between 1791-1814 m. Left to right: sausage shaped Gromiid, carrot shaped Gromiid, dark grape Gromiid, small spherical Gromiid, Reophax sp. Agglutinated tube, Triloculina sp., brown Miliolid and Saccamminid.

Meiofauna

It was found that it was not realistic to sort through all meiofaunal fractions of cores given the time constraints on board and the time spent core processing. Most of the sediment cores collected for extraction of fauna for biochemical analysis were therefore frozen directly at -70ºC. From the sediment slices that were sorted, the Foraminifera were picked out under a binocular microscope and sorted to the lowest taxonomic level possible and subsequently frozen at -70ºC in separate small vials for biochemical analysis (lipids, amino acids, carbohydrates, stable isotopes).

Meiofaunal Foraminifera were found to be using larger protozoans as a substrate. For instance, a dark, elongate saccamminid and domed Foraminifera were found attached to the surface of a spherical gromiid at a depth of 1850m (55827#03).

A3200: The meiofaunal Foraminifera (45-300µm) picked from the 0-0.5cm sediment slice of Megacore 1 (55801#02) at A3200m included *Hoeglundina* sp., *Trochammina* sp., *Lagenammina* sp., *Bulimina* sp. and *Hyperammina* sp. The taxonomic composition of the foraminiferal meiobenthos within the 0.5-1cm sediment slice was slightly less diverse and was dominated by 'spheres' and *Rhizammina* sp., also including *Lenticulina* sp., and tubular agglutinated Foraminifera.

Kate Larkin

9.2. Gromiids – "Giant Protozoans"

During RRS *Charles Darwin* cruise 143 on the Oman Margin of the Arabian Sea, in December 2002, high numbers of large (>300 μm) gromiids (Protozoan of the order Filosea) were observed on the surface of Megacore samples. During the present cruise to the Pakistan Margin of the Arabian Sea, the aim was to survey this area in order to compare it with the Oman Margin.

Gromiids were visible on the surface of multicore, Megacore and Box Core deployments between 1200 and 1850 m depth (see Table below). A number of different morphotypes were also collected with the Agassiz Trawl. Protozoans have primarily been collected using either the multicore or the Megacorer, but larger protozoans (>300 μm) were retained by the Agassiz Trawl and this proved to be an effective method to collect bulk material in relatively good condition. However, the Megacorer is the most suitable equipment for quantitative work - the surface area of a multicore is generally not sufficient for the study of these large protozoa.

Table: Gromiids visible on the surface of multicores (MC) and Megacores (MGC) and collected by the Agassiz Trawl (AT).

Depth (m)	1174-1177	1200	1201	1620-1660	1791-1814	1799-1852	1833	1870	1867	1874
Station 558	11#1	02#7	02#4	41#1	37#1	15#1	26#2	27#3	27#4	30#2
Gear	AT	MGC	MC	AT	AT	AT	MGC	MGC	MGC	MC
Number of cores	na	1	1	na	na	na	8	1	4	2
Spherical	Many	2	1	Many	Many	Many	1			
Sausage				Many	Many	Many				
Carrot				Many	Many	Many				
Dark grape				Many	Many	Many				
Pale grape				Many	Many	Many				
Gromiia sphaerica				Many	Many	Many				
Spherical with dome shaped attached forams								1	3	2

At site A1200, 1 small (500 mm) spherical gromiid, similar to *Gromiia sphaerica* was found on the surface of 1/12 multicore tubes at 1/3 deployments. Two were found on the surface of 1/12 Megacore at 1/3 deployments. These gromiids were sampled in large numbers by the Agassiz Trawl at this depth.

The deployments of the Agassiz Trawl between 1600 and 1850 m collected large numbers of gromiids of different morphotypes (see below): sausage, carrot, dark grape, light grape and spherical. The abundances of the different morphotypes varied with depth. Dark and pale grapes were the most abundant at 1620-1660 m (55841#1). Sausage shaped gromiids were the most abundant at 1791-1814 m (55837#1). Spherical shaped gromiids were the most abundant at the deeper station 1799-1852 m (55815#1).

Figure 12. Gromiid morphotypes caught by the Agassiz Trawl between 1620-1660m depth (55841#1).

All the material collected by Agassiz Trawl was preserved in 10% formalin for taxonomic work, in 3% gluteraldehyde for ultrastuctural work (transmitted electron microscope), in ethanol (molecular grade) for molecular genetic studies or frozen at -70˚C for lipid, stable isotope, amino acid and carbohydrate analysis.

Ana da Silva

9.3. Macrobenthos

Overall, macrofaunal densities appear impoverished compared to those observed off Oman (RRS *Discovery* cruise 211, Oct/Nov 1994). Although it was possible to sample the sediment at site A150, just above the OMZ, where oxygen is still >2.5 ml/l, and the fauna here appears well developed and diverse. The sediment here was a sandy, somewhat shelly, silt. In contrast that at A300 (oxygen about 0.1 ml/l) appears poor with the main faunal constituent appearing to be arborescent foraminiferans, especially *Pelosina* sp., attached to the sediment surface.

The sediment is a sandy mud. At A500 the fauna inhabiting the very soft muddy sediment (orange-coloured layer about 1-2 mm below the sediment surface, overlying a 2 mm brown layer) appears even sparser, with the main constituent of an entire washed box core being the shelled Foraminferan *Globobulimina* sp. About three or four species of nematodes were present. Deeper, at A1200 oxygen is increasing but still <0.4 ml/l, and the soft muddy ooze is strongly pelletised at the surface with a variety of soft-bodied, but few agglutinated, foraminiferans becoming common. Polychaete worms, including Sphaerodoridae and Apsistobranchidae spp., were noted in the top-most layer of sediment. At A1850 m the macrofauna has become comparatively well developed with polychaetes becoming quite common, while tanaid and amphipod peracarids were noted. Molluscs included a small bivalve with a black coating on its shell. Agglutinated foraminiferans, such as *Bathysiphon*, *Lana* and *Reofax* were present. Very few nematodes were noted from this depth. The muddy ooze was less soft here than at A1200 and had a conspicuous brown-coloured softer layer about 8-10 cm thick overlying grey clay. Finally at A3200 ("BIGSET NAST" site) the fauna in the clay-like ooze becomes very sparse, with little more than foraminiferans noted in microscopic examination of freshly washed sediment. The impoverished biomass appeared in stark contrast to a well-developed phytoplankton bloom (*Noctiluca*) noted at the sea surface.

John Gage, Peter Lamont

9.4. Geochemistry

Pore waters

There was plenty of SAMS equipment to fulfil the protocols and all the equipment worked well. It was not possible for 2 people to be working on the same core due to lack of personnel. This extended the time it took to process the entire core but it was possible to do it alone. Due to the extended time it took to process the core, when working alone it is necessary to obtain the core at the beginning of the shift (or close to) in order to have approx 10 hrs for processing. The total volume of pore water required for the 3 types of analysis was high; 1.5ml nutrients, ≅3 ml for metals and ≅ 2.5 ml sulphides. Due to the amount of pore water retained in the filters and the type of sediment, it was not always possible to obtain enough for all three analyses. This was particularly the case for sites A3200 and A1850, where the sediment was a dense clay. Site A150 was problematic in terms of extracting pore water in a down core profile. This sediment was very sandy and there was a visible downward migration of water, which leaked from the bottom of the core. This will have a large impact on data interpretation of the porewater profiles. Secondly, very little pore water was initially obtained, followed by unsuccessful centrifugation as the porewater was re-absorbed to the sediment when removed from the centrifuge. A different technique for porewater removal needs to be developed when sampling from sandy sediment. One idea is to extract the porewater immediately from the core using syringes that penetrate the core through pre-cut holes in the core tube at the resolution required. Further trials will be required to perfect such a technique.

The nutrient pore waters were analysed onboard. See Tim Brands report for data and interpretation.

Gamma Spectrometry

The gamma spectrometer has functioned well onboard and has only needed re-filling with approx. 5 litres of liquid nitrogen every 2-3 days. Samples were counted for c. 10+ hours to obtain enough counts for ^{234}Th. This was far longer than initially anticipated. There was a lack of fauna in the trawls and cores for gut extraction and gamma counting. Therefore CD145 was not successful in obtaining a sufficient amount of faunal samples for ^{234}Th data. The guts that were obtained were very small hence all samples failed in producing enough counts for the gamma counter for ^{234}Th analysis. ^{234}Th was present in all the surface core samples (0.25 cm) from each site other than the two deep sites (A1850 and A3200). It does not appear at any greater depth in the core other than at site A150 (see below). The core from site A1850 contained a sipunculid worm that had produced a very visible burrow (at edge of Perspex tube) down to a depth of 3.5 cm. The worm was removed, guts extracted and subsequently gamma counted to compare with the sediment it was living in. Unfortunately, not enough counts were obtained from the guts so no comparison was made. The highest amount of ^{234}Th was found in the sediment from site A150. This was not expected due to the sediment being predominantly sand; radionuclides are generally associated with finer material. It could be that sediment type is not the major determinant of higher Th in this core, but a result of the shallower depth i.e. more fresh "phytodetritus" reaching the sediment surface in shallower waters.

Terrie Sawyer

9.5. Sulphate reduction

The shipboard part of sediment sulphate reduction rate determination comprises three stages, sample collection, sample preparation and incubation. Sample collection used the Megacorer exclusively, since this was able to collect longer cores that the multicorer. After the cores were collected and stored at the seabed temperature (obtained from the CTD temperature profile) in the ship's constant temperature room the samples were prepared by taking subcores and storing them in an oxygen free atmosphere. The incubations were started by injection of the radiolabel into each subcore. This operation was carried out in the radiation container after which they were returned to the CT room for a period of 24 hours. At the end of this period they were mixed into a 10% zinc acetate solution that both halts any further bacterial activity and fixes the sulphide products as insoluble zinc sulphide. In this form the samples are suitable for transport back to the UK for subsequent treatment. During all of these operations no problems were encountered. The facilities provided on the ship were entirely suitable, with the possible exception of the CT room's minimum operating temperature of 4°C, given that the bottom seawater temperature at the NAST site was less than 2°C. At all other sites the temperature was easily achieved and maintained.

Broadly speaking three different sediment types were encountered. At A150 it was a waterlogged sand, at A300, A500 and A1200 it was a very soft greenish brown mud, and at the deeper sites below the OMZ, A1850 and NAST, it comprised a more consolidated clay. At none of the sites was there any visual evidence of sulphide formation, which was particularly surprising in the case of the three stations within the OMZ. There are a number of reasons why this is the case. Sulphate reduction might not be occurring at these sites, this in itself would be surprising, given that the absence of oxygen would normally imply that alternative electron acceptors were being used in the breakdown of organic matter. Since sulphate is expected to be in abundant supply, this would be expected to play the major role. The sediments themselves may be organic limited, but enhanced levels of dissolved organic carbon in the sediments compared with the overlying water column (Axel Miller pers. comm.) suggest this is not the case. Alternatively the sediments may be iron limited and thus the characteristic formation of iron sulphide species is not occurring. This could be due either to there being intrinsically low in iron, or to the preferential binding of available iron to other anions, e.g. carbonate. The pH of all the sediments sampled lies between 7.2 and 8.0 (Heather Johnstone, pers. comm.) and this slightly basic composition might account for a different anion binding potential. The future analyses of samples and data should elucidate which of these geochemical processes is occurring in the sediments at the sampling sites.

Martyn Harvey

9.6. Porewater pH

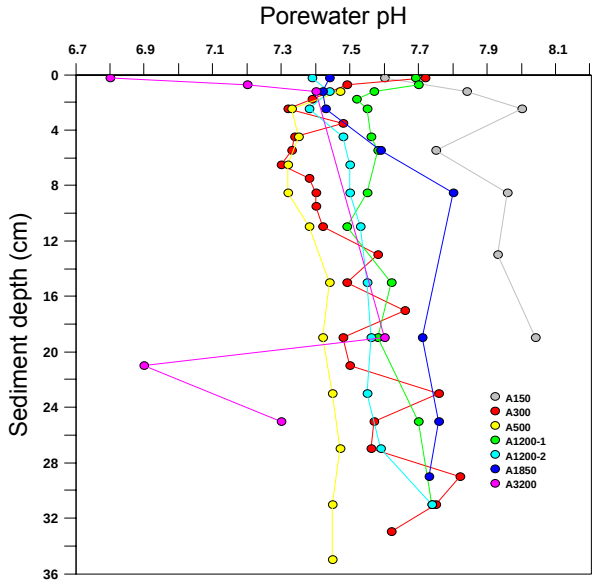


Figure 13. Sediment porewater pH determinations – all the sites had alkaline porewaters at all depths measured (data as given in section 10.x.)

Heather Johnstone

9.7. Preliminary analysis notes for X-radiography

Site	Station Gear and core type	Sampling notes	C	Xr	E	X-ray notes	Sieving (µm)	Preliminary analysis notes
A150	55809#04 BC, TC	Box core surface contained over 160 Foraminifera; contains shell-rich and fairly coarse sediment. Slab cores A and B taken over burrows.	A A B	13 14 15	24 30 30	Perhaps a slight improvement in details with greater exposure. However, better detail with thin slab cores.	300	Core A: 2 short (1.2 and 0.9 cm) open burrows 0.3 cm in diameter. Also, 1 longer (4.6 cm) and thinner (0.1 cm) with a possible second opening (#13). Lower layer of shelly material underlies finer-grained surface layer, 1.5 cm deep. Core B: 1 wide (0.5 cm) open burrow extends down to 2.8 cm. Surface layer is 0.5 cm deep.
	55809#05 MG, TN	Core IX – 3 slabs. Sediment fairly coarse and shell-rich.	All	16	16.3	Better detail than with the thick slab cores, maybe due to less shell material to penetrate through.	300	Fine-grained surface layer 1.5-4 cm deep. 2 thin (0.1-0.2 cm) J-shaped tubes extend down to 4-6 cm in the sediment, even beneath the interface between surface layer and shell-rich lower layer. In one case (middle plate), burrow extends down to 5.2 cm and 2.5 cm across. In the second (right plate), 3.8 cm deep and 2.7 cm across.
A300	55803#07 BC, TC	Sampled with 2 thick slab cores at the core center in a T-shape: Core A horizontal and Core B being the stem. There appears to be a sub-surface (0.5 cm) red-brown layer 0.5-1 cm thick.	A B	10 12	24 24	-	300	Core A: Laminations come out beautifully. Dark and light bands alternate on a large scale (3 cm) with light bands consisting of much finer laminations (0.5-1 mm). No burrows visible. Surface layer, 0.7-1 cm thick, is also distinguishable from deeper layers. Core B: in general, as in A. Possibly a horizontal or U-shaped closed burrow 2.2 cm beneath the surface and 5.6 cm across.
	55806#02 MG, TN	Core II – 3 slabs. Sediment very sloppy. Thin slabs do not hold as well as thick ones in this sediment.	All	11	16.3	Due to fluidity of sediment these cores are quite distorted near the core walls. Thick cores preferable at this depth?.	300	Dark X-ray. Laminations heavily distorted; a sampling artefact.
A500	55814#02 BC, TC	Partly full (preceded by unsuccessful attempt at box coring); some original surface left as indicated by *Pelosina* on the surface. Slab core A over *Pelosina* and slab core B over balls of mud.	A B	18 19	26.3 26.3	Good detail: laminations evident as in 300 m X-rays, and also sediment balls at surface for Core B.	300	Core A: Laminations visible as in A300. Periods appear to have smaller length scales (1.5-2 cm) than at 300 m. Finer scale laminations, 1 mm, are also present. No structures evident. Core B: As in A, laminations are also visible but not as distinct. Certain sediment balls 0.6-1.1 cm across show up at the sediment surface on the right of the plate. No other structures are visible.

A1200	55802#03 MG, TN	Core VII – 2 slabs.	All All	05 06	12 14	-	300	Very dark X-rays. Left plate: Cuts through U-shaped burrow, 6.8 cm deep and at least 6.5 cm across. Right plate: Thick (0.5 cm) burrow visible 2 cm across.
	55802#06 BC, TC	Sampled with 2 thick slab cores at the center, named A and B.	A B A A	07 08 09 17	20 20 16.3 30	Fracture in core A may be artificial. Very few details can be seen. Apparently, the few features that are present are big, because they appear blurred. No improvement in detail with increased exposure. It may be very compact sediment, then. Core A 30 s exposure shot at a later date (3/23/03)	*300*	Very compact sediment. Core A: V-fracture at surface is not a burrow but probably a sampling artefact. Core B: Hardly any structures visible.
	55822#01 MG, TN	Core III – 3 slabs (photograph taken). Compact sediment cylinders on a small mound at one side of the core surface.	All All	20 21	16.3 20	Not a visible improvement in details with greater exposure. Great detail at the surface layer. Much better than thick cores.	250	3 sediment layers are visible: (a) 0.4-1.3 cm thick flocculent/gelatinous layer; (b) 2.5-3 cm thick surface layer infused with numerous very fine burrows; (c) deeper, very compact layer. One horizontal burrow, 0.7 cm in diameter, permeates all three plates. Buried burrow fragments are visible through the core. Cross section of sediment cylinders clearly visible on left plate.
A1850	55827#04 MG, TN	Core II – 2 slab cores. Flocculent layer present, underlain by a surface brown layer. Deeper sediment is greyish-beige and quite well consolidated. *Gromia sphaerica* present in one of the cores (photograph taken).	All All	22 23	16.3 20	Some improvement in details with greater exposure. Deeper sediment layer too dense for any details to show, as in the case of 1200 m slab cores earlier in the cruise.	300	Flocculent layer barely visible here. A fairly thick surface layer, 4.5-6 cm, infused with numerous fine burrows, is underlain by a more compact lower sediment layer. Fragments of burrow linings present at various depths. *Gromia sphaerica* appears at the surface on the very left of the left plate, 0.5 cm in diameter.
	55830#05 BC, TC	Shallow box core. A number of tubes protruding over an uneven surface; the brown surface layer seen in Megacores is present. Box core sampled with 2 thick slab cores for X-rays directly adjacent to one another: Core A, which includes a protruding tube, and Core B.	A B	24 25	30 30	A fair amount of detail considering the consolidation of deeper sediment. Tubes show fairly clearly.	300	Core A: Surface layer, 2.5-4 cm deep, is fairly visible but not as clear as on thin plates. A few tubes with lining present are visible, 0.3 cm in diameter and 4.7 cm deep, while one of them protrudes 0.6 cm above the sediment surface. Core B: Surface layer, 4-5 cm deep, is infused with numerous fine burrows. Fragments of tubes with tube linings are also visible.
A3200	55801#04 BC, TC	A mound feature was sampled with two thick slab cores: core C – central and core D – distant.	All All	01 02	18 14	Conducted in complete darkness to assess feasibility of using film in this packaging. Not much detail evident; slabs too thick for this very compact sediment.	300	Core C: Fine burrows faintly visible at surface layer, down to 3 cm. One burrow, 2 mm in diameter, goes down to 5.8 cm. Sediment ball visible on the surface. Core D: Not much is visible. On 18 s exposure, a burrow 3 mm in diameter with two openings is visible on the mound.
	55801#06 MG, TN	Core VII – 2 slabs.	All All	03 04	8 12	Water appears as white. Still, various structures are evident in thin slabs when seen in diffuse light.	250	A surface layer 1-3 cm deep overlays a deeper layer. Right plate shows an open burrow 0.8 cm deep. Nearby, a compact sphere is visible, which upon examination was shown to be a sediment ball.

(C-core, Xr-x-ray, E-exposure, BC-box core, MG-Megacore, TC-thick slab cores, TN-thin slab cores)

Angelos Hannides

9.8. Observations from multicores for sedimentary ^{210}Pb analysis

Site	Station 558	Gear	Core	Notes
A150	08#02	MC	X XI	Core X had 15 *Pelosina* (Foraminifera). Fairly shell-rich material. Core XI had 6 *Pelosina* (Foraminifera). Shell-rich material. At 13-14 cm an aggregation of shells is encountered.
	08#03	MC	VIII IX	Both cores had fairly coarse material. Core VII had 4 *Pelosina* (Foraminifera). Very shell-rich material.
	09#06	MC	IX X	Both cores had fairly coarse and very shell-rich material. Core IX had 7 *Pelosina* (Foraminifera). A decapod crustacean 3 cm long was found at the 1-2 cm interval. R. Jeffreys froze the sample for isotope analysis. 2 amphipods were found at a depth of 3-4 cm. Core X had 6 Foraminifera.
A300	03#04	MC	IV V	Core IV included two burrows followed down to 6 cm where they merged. A third burrow was followed down to 9 cm. Sub-surface red-brown layer seen in box core also evident in multicore.
	03#05	MC	V IX	Retrieved cores VII and VIII not found, but V and IX are also suitable although not adjacent. Small burrows present. Sub-surface red-brown layer seen in box core also evident in multicore.
	06#03	MC	IX X	Sub-surface red-brown layer seen in box core also evident in multicore.
A500	14#06	MGC	I	Eleven no-fires of the multicore at this site: 55814#03-05, 55816#04-05 & #07, 55818#03 & #05, 55823#01-03. Failure due to very fluid sediment. Necessitated the use of Megacore.
	16#03	MGC	VI	
	16#06	MC	VIII IX	
	18#04	MC	I III	
A1200	02#04	MC	II III	Core III included a burrow (diameter ~ 4 mm) down to 6 cm
	02#05	MC	IV V	Burrows were followed down core V, and merged at a depth of 7-7.5 cm to form a horizontal cavity.
	22#02	MC	IX X	-
A1850	30#02	MC	IX X	Flocculent layer and surface brown layer present. Burrows seen down to 6 cm.
	30#03	MC	I II	Flocculent layer and surface brown layer present. Burrows seen down to 5-6 cm.
	30#04	MC	VII VIII	Flocculent layer and surface brown layer present. Burrows seen down to 5-7 cm.
A3200	01#09	MC	II IV	Core II only down to 13 cm.
	01#10	MC	III IV	-
	01#15	MC	IX XI	Core IX only down to 13 cm.

(MC-multicore, MGC-Megacore)

Angelos Hannides

9.9. Biochemistry

Site A150

This site is in the upper boundary of the OMZ and the sediments here were characterised by a muddy sand over shelly debris. Pore water processing for DOM was not done at this site because of the rapid draining of overlying seawater and pore waters through the cores. Many of the Megacores at this site had the macrofaunal foram *Pelosina arborescens* present on the surface layer. The trawl at this depth consisted of several species of fish, two different species of bivalve, spider crabs, swimming crabs, decapod shrimps and *Astropectin* sp.

Site A300

The top 2-3 cm of these sediments were unconsolidated and overlay brown consolidated sediments. Some fine banding was also seen within these cores. These sediments yielded ~ 10 ml of pore waters. The trawl at this depth was poor and consisted mainly of decapod shrimps. A possible reason for the lack of epifauna at this site could be a result of the unconsolidated surficial sediments.

Site A500

The sediments at this site, well within the OMZ, were brown/green in colour and extremely 'gloopy'. These sediments yielded ~ 10 ml of pore waters.

Site A1200

The 1200m site was situated in the lower boundary of the OMZ. The sediments here were typified by uniform brown cores with some large burrows. Pore waters within the sediments here were ~ 7 ml. The trawl at this depth was excellent. There were numerous species collected and there was plenty of biomass. Therefore, I would make the assumption that this was owing to an abundance of. The sediments could be organically rich and an excellent food source. The trawl consisted of crinoids, elasmobranchs, several species of ophiuroids, several species of Actiniaria, Pennatulacea, Porifera, flat fish, eels, spider crabs, polychaete worms and opistobranchs. A second trawl at this depth (1089-1103 m) contained a mass of three different species of ophiuroids. Several of each species were taken for lipid and pigment work on their gut contents to elucidate what specific molecular fraction of organic matter they are feeding on and if they are feeding selectively. Squat lobsters were also abundant at this depth.

Site A1850

This site was situated essentially below the OMZ. The sediments here were characterised by a 1-1.5 cm surface layer of orange/brown flocculent material over light grey clays. There was ~ 5 ml of pore water obtained from these sediments. The trawls in this depth range were characterised by a mass of protozoans that are described in reports by Larkin and Da Silva. In

terms of metazoan megafauna no specimens were collected at this depth. A similar trawl was obtained at 1750 m but here a large *Benthothuria* sp. (holothurian) was collected as well; such holothurians had been observed using the WASP. A Megacore at this site also yielded some *Benthothuria* sp. faeces (see below), this material did not appear to be particularly 'fresh' but a sample was taken for pigment and lipid analysis.

Figure 14. Holothurian faeces found in a Megacore at site A1850.

Several *Golfingia* sp. (sipunculid worms, see below) were found in box core and Megacore samples at this depth. These could be of significance to the tracer experiments on CD146 as they are infaunal surface deposit feeders, and so could be responsible for non-local vertical transport of surficial sediments. They are also of a suitable biomass for all the planned geochemical analysis i.e. lipids, stable isotopes, amino acids, carbohydrates. In addition to these analyses, ^{234}Th and pigments could be carried out on the guts of these specimens. The guts of these sipunculids are easily dissected and can be split into fore and hindgut making them valuable for the bead experiments.

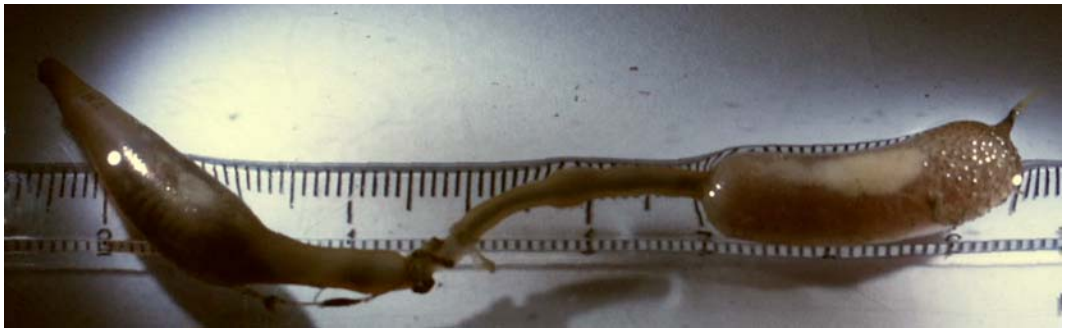


Figure 15. Golfingia sp. (sipunculid worm) found at 1850 m in a box core.

Figure16. Sipunculid worm in its burrow; Megacore from site A1850.

Site A3200

This site was situated well below the oxygen minimum zone (OMZ) and the sediments here consisted of ~ 6 cm of soft brown mud overlying light clays. The sediments here could be typified as foraminiferal ooze. There was very little pore water in these sediments ~ 2-3 ml. The trawls obtained at this depth were generally 'poor catches' consisting of two species of asteroids, two species of ophiuroids, decapod shrimps, mysids, spider crabs, eels, one species of holothurian (*Benthodytes* sp.), scaphopods, and *Limopsidae* bivalves. At this depth we were sampling in the abyss - here the food supply to the benthos is limited to the flux of particulate organic material from the surface waters in the form of the spring bloom and possibly also to large nekton falls and carcasses. This limited food supply has constraints on the benthic biomass.

Rachel Jeffreys

9.10. Water column chemistry

Water column nutrient data was achieved from seven CTD sites along the "A" transect (A150, A300, A500, A1200, A1850, A2750) and including the BIGSET NAST site, A3200.Temperature and salinity data from the Seabird CTD reveal a warm saline layer of water approximately 180m deep sitting on cooler, fresher water below. The upper warm layer is fully oxygenated and has relatively low nutrient concentrations (PO_4, <0.5 SiO_3 <2.0 and

NO_3 <1.0 µM). The water below this is has a very low oxygen concentration (<1mg/l) and relatively high nutrients (PO_4, >2 SiO_3 >10 and NO_3 >10 µM). The boundary between the two water masses is quite distinct giving steep concentration gradients for nutrients and oxygen. Phosphate and nitrate increase in concentration to approximately 3 and 40µM respectively at 1500m and then appear to decrease slightly in concentration below this depth. Silicate increases to 150µM at 2500m. Nitrite was measured at sites A1200, A1850 and A2750 and on a high-resolution study of the bottom water at site A500. It shows a concentration peak at the chlorophyll-maxima depth (0.5mM), decreases to zero between 50 and 250m and then increases to approximately 1µM at between 500 and 600m. It then decreases to zero below this depth. The oxygen begins to increase in concentration below 1000m and reaches 60% of surface values at 3km. The gradient increase in oxygen concentration in the bottom waters is far shallower than the decrease seen in the upper waters.

Water column nutrient profiles are shown in the figures below; the results have not been salinity-effect blank corrected.

Tim Brand

9.11. Sediment pore water chemistry

Pore water was collected from cores from all six coring sites and analysed for ammonium, phosphate, silicate, nitrate and nitrite. There were problems with porewater collection (Sawyer, this report) at site A150. With the exception of site A3200, ammonium shows a steady rise in concentration with depth, reaching a maximum of 200µM. This concentration is reached at depth of 25cm at station A500 and 15cm at station A300. Phosphate shows an increase in concentration with depth at all stations but the rate of increase increases towards the shallower sites. Silicate shows an initial increase in concentration with depth at all sites and reaches a maximum concentration of 300µM at site A3200. Nitrate show a very irregular profile at all sites, but indicates towards a decrease in concentration with depth. Nitrite is present in the highest concentration at sites A1850 and A1200 (25 and 5µM respectively) as a subsurface peak. It appears to be in background concentrations at the other sites and was not measured at site A3200.

Sediment porewater profiles are shown in the figures below; the results have not been salinity-effect blank corrected.

Tim Brand

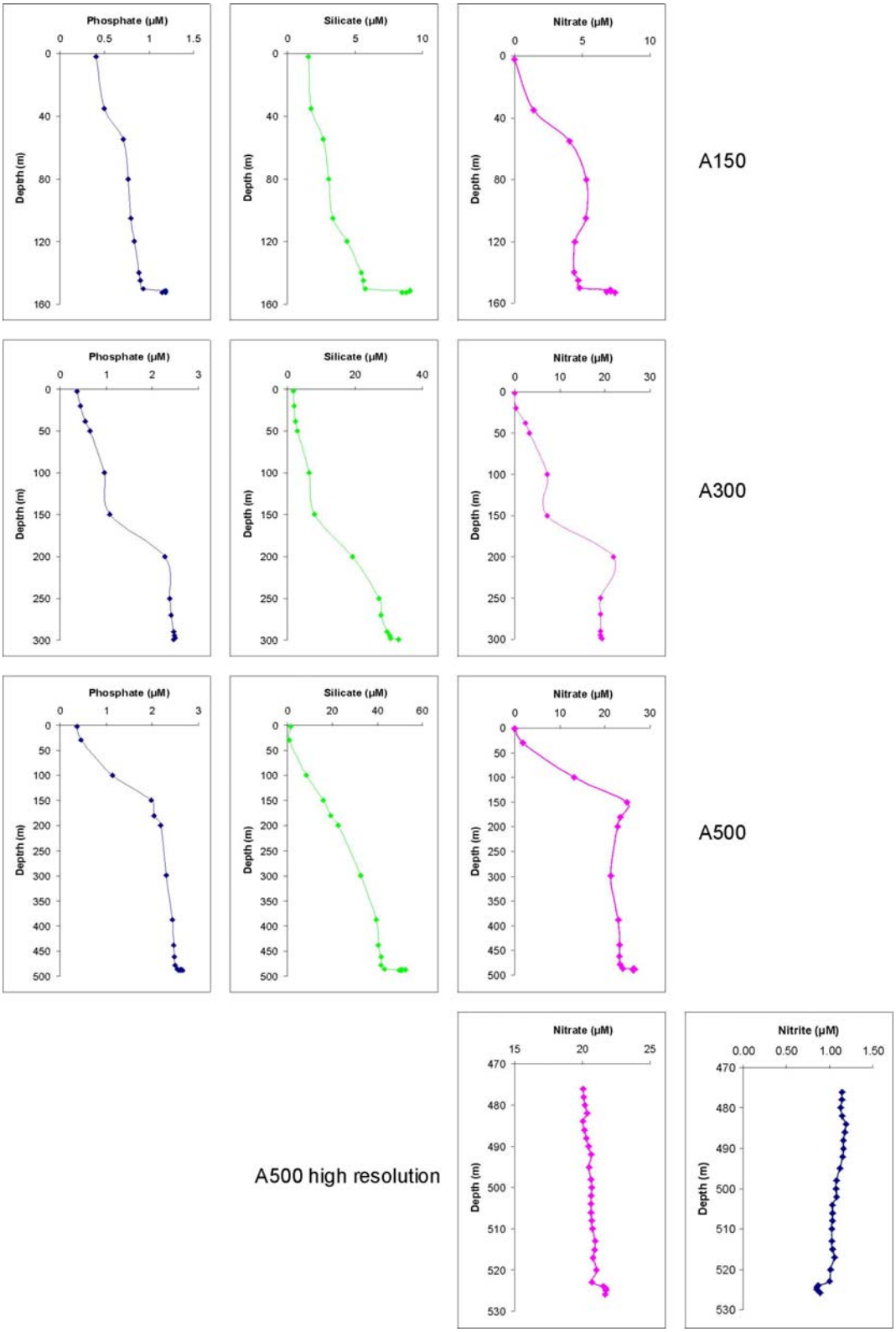


Figure 17. Water column nutrient profiles, Tim Brand

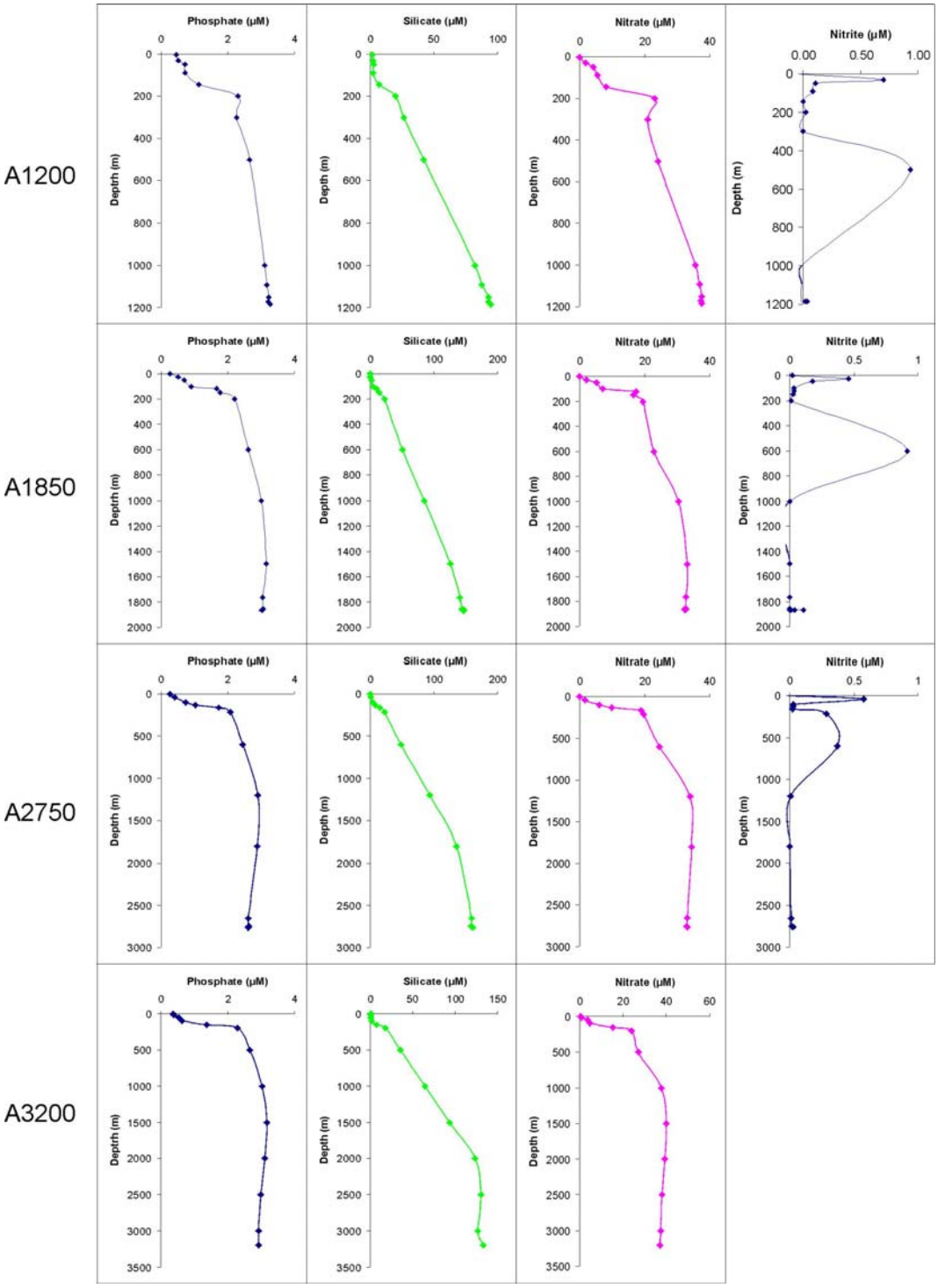


Figure 18. Water column nutrient profiles, Tim Brand

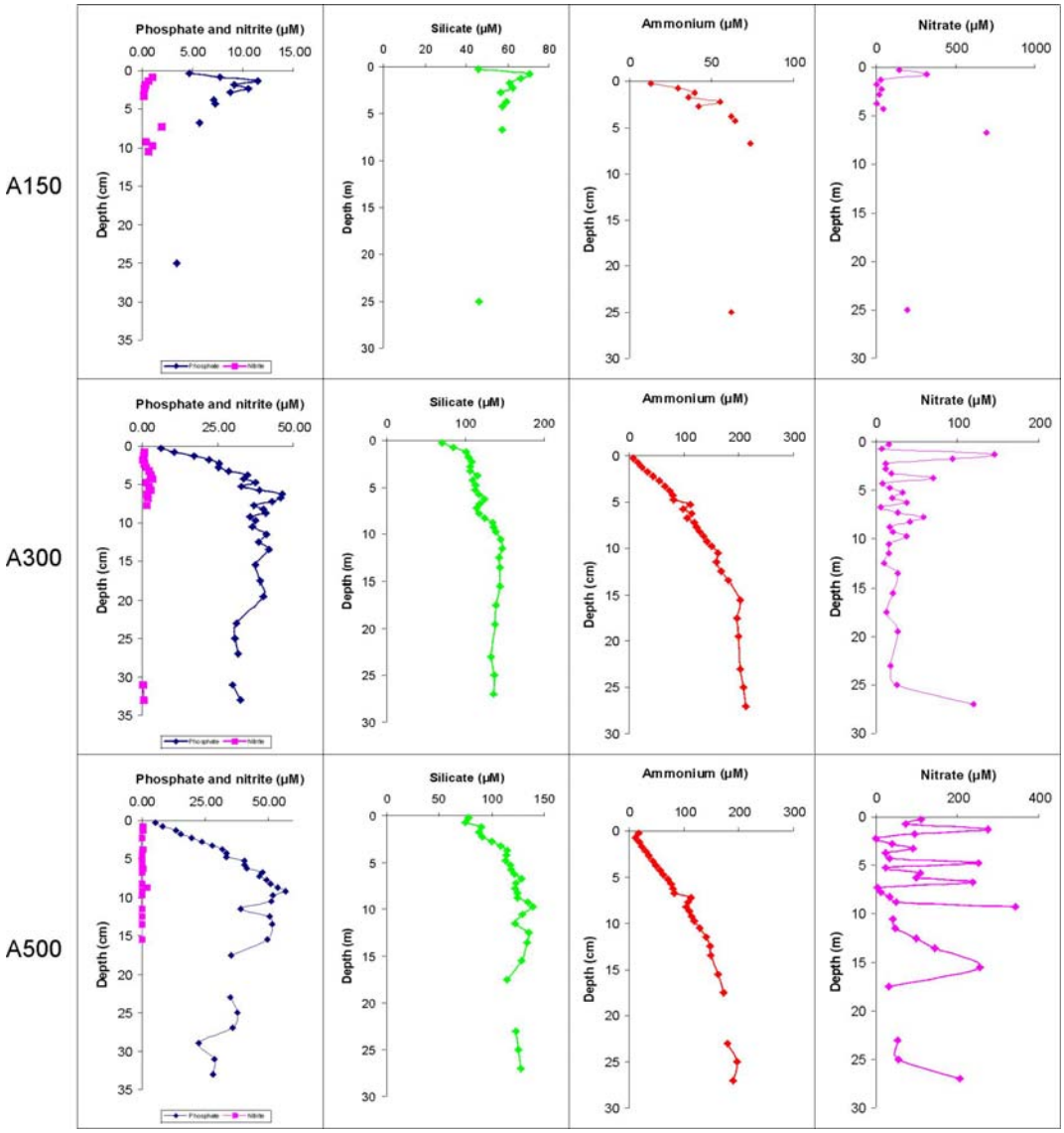


Figure 19. Water column nutrient profiles, Tim Brand

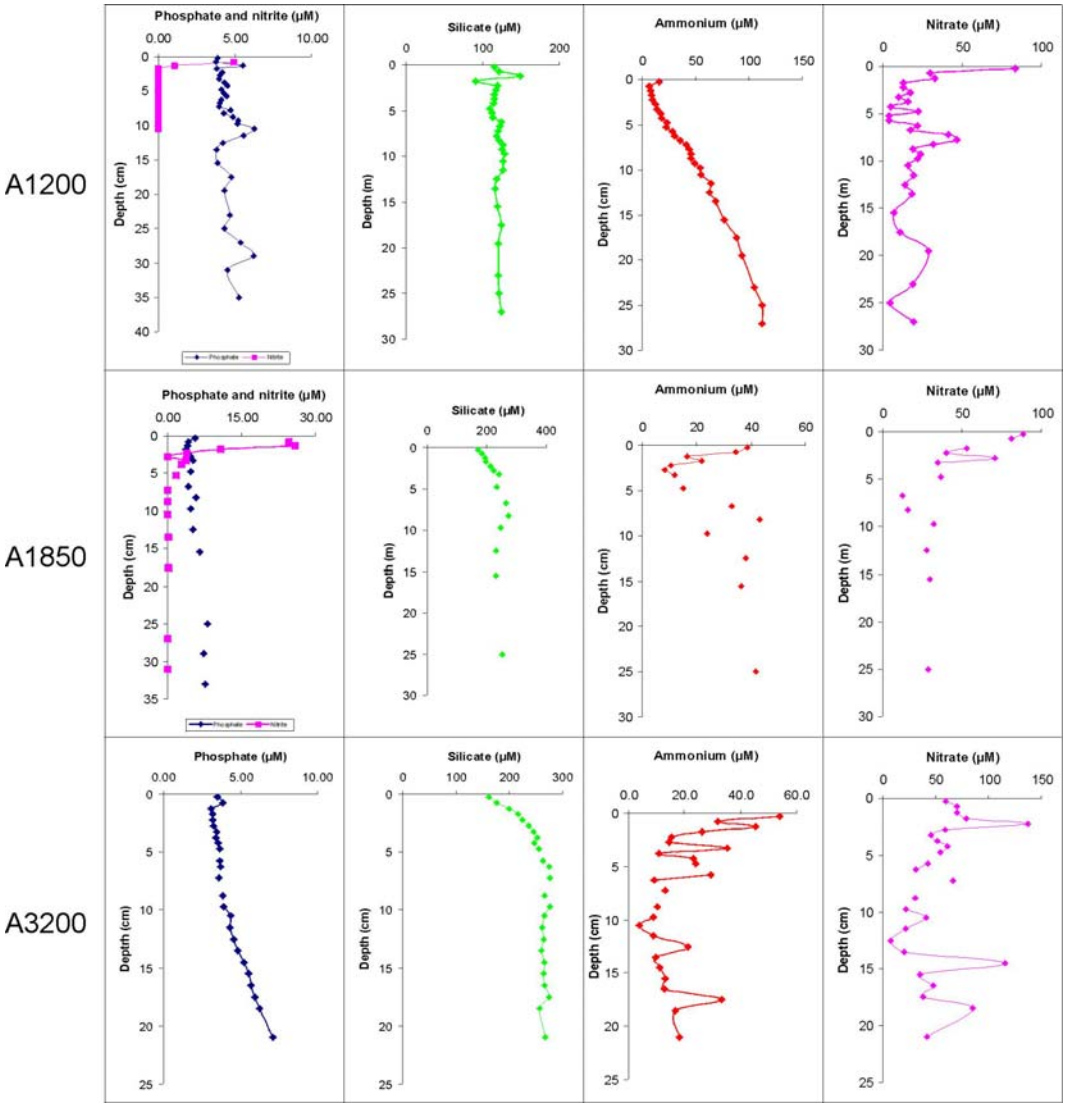


Figure 20. Water column nutrient profiles, Tim Brand

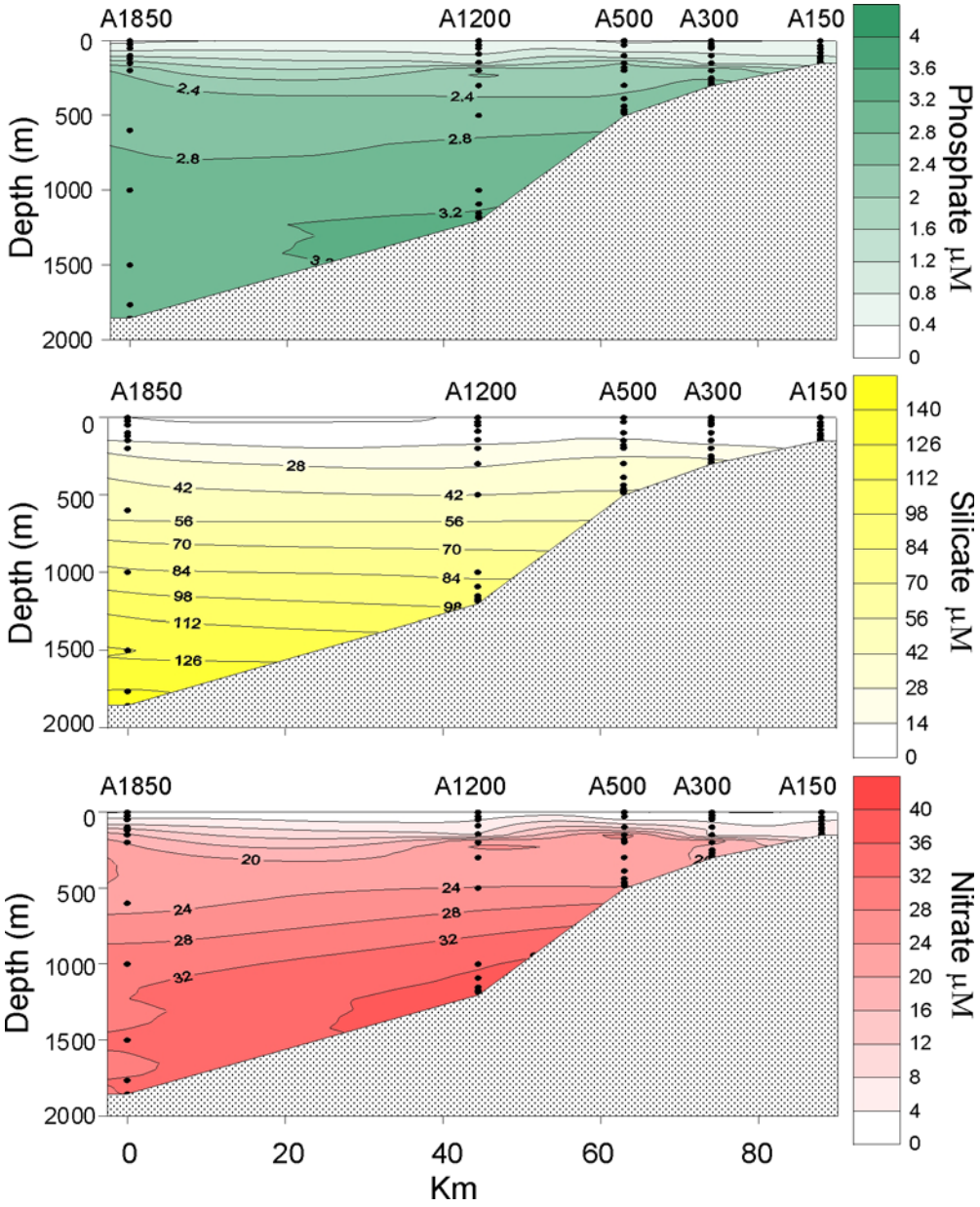


Figure 21. Contour plots of water column nutrients, Tim Brand

9.12. Dissolved organic carbon and total dissolved nitrogen

Sampling Efficiency

At Site 150 the sediments are described as 'very sandy mud over shelly debris'. As a result, as soon as the bottom bung was removed from a Megacore, overlying and porewater proceeded to drain through the entire core. A simple kinetic experiment showed that water drained through the core, over the full surface area, at a rate of 12-13 mm per hour. Clearly there can be little confidence in the veracity of porewaters collected at high resolution (0.5, 1.0 and 2.0 cm slices down-core) under these circumstances. As the hydrodynamics of water particle transport through the heterogeneous core media are known to be complex (Huettel and Webster, 2001), but in this case uncharacterised, it would not be possible to verify the provenance of any sample. On this basis, it was decided not to attempt extraction of porewaters through slicing at this site.

Prior to a return visit to Site A150 some consideration was given to obtaining representative samples of porewater. Following the design of the sulphate reduction core tubes (Martyn Harvey, SAMS) an attempt was made to produce a similar system to accommodate the 5ml syringes necessary to obtain an appropriate volume of porewater for DOM analysis. A series of holes were drilled into a core tube (Alan Sherring, UKORS) to enable 1cm resolution sampling down-core. These were sealed with parcel tape (*NB* potential for DOM contamination from sealing gum) prior to deployment, ready for piercing with scalpel immediately prior to sampling by syringe.

A complete core was recovered. Water drained through the core, even with the bottom bung in place. When the first incision into the sealing tape was made (0-1cm depth) water-sediment 'slurry' poured out, losing the whole of that layer (what would have been the 0-1cm 'slice'). Subsequent 'water-logged' layers also drained from the core tube when an incision was made. In deeper surface layers (4-5cm to 6-7 cm) it was possible to extract ~5ml of sediment-water mixture into the syringe, resulting in a 'porewater' sample of ~2-3ml. Deeper still, there was difficulty in obtaining water or sediments, from the layers.

The decision was made to abandon DOM porewater sampling at this site. Prior to CD150 attempts will be made to identify or develop a method for reliably sampling sediments of high permeability.

Preliminary Observations

As detailed above, the inability to reprocess the raw data on board has prevented the production of DOC or DON data of absolute quantitative value.

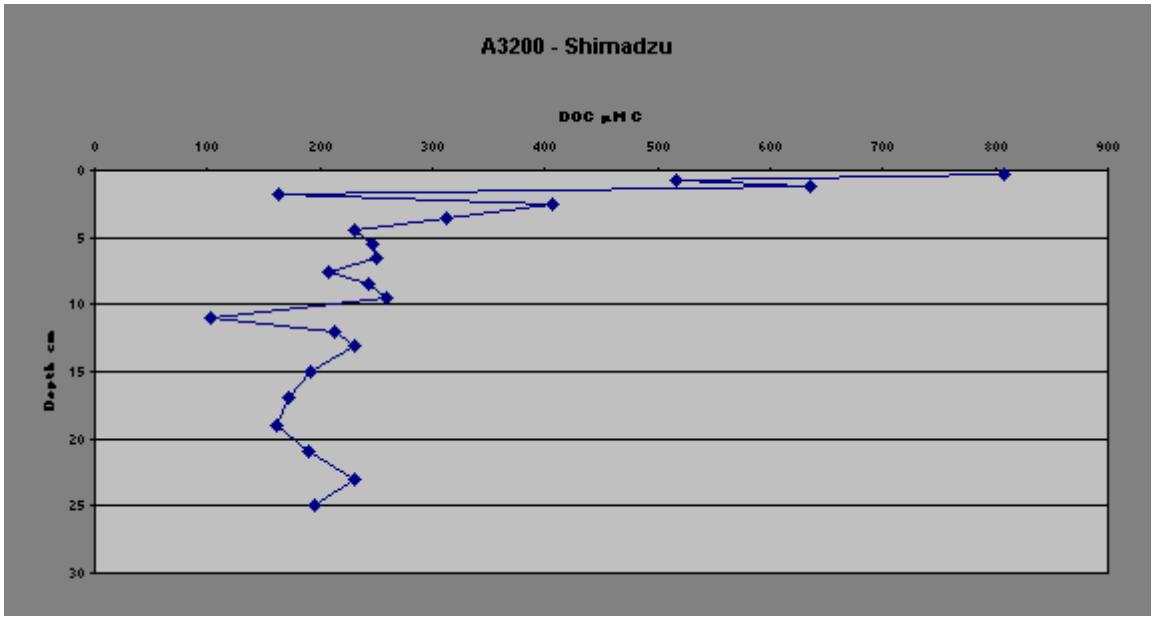
Using raw data from the Shimadzu TOC-5000A IRGA, however, it has been possible to produce preliminary profiles of the porewater DOC from all stations where samples were collected (see below).

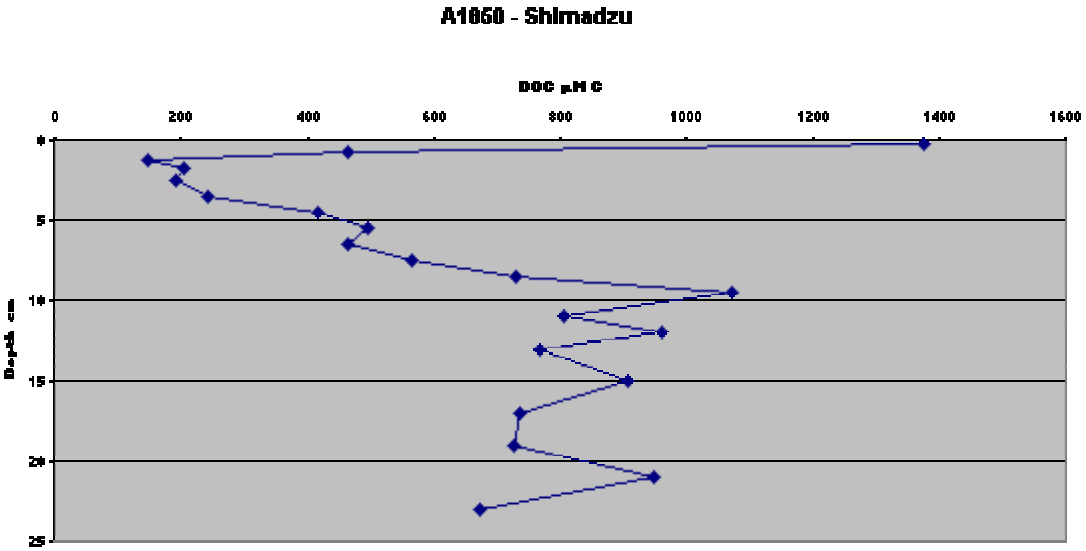
From these profiles it appears that the deep-water Sites A3200 and A1850 are distinct from the shallower A1200, A500 and A300 sites. Deep sites show organic enrichment in upper surface sediments, up to an order of magnitude greater than typical water column DOC concentrations. [Similar distinction can be made from the ammonium profiles produced by Tim Brand (SAMS) elsewhere in this report.] Fine-scale variability in the down-core distributions may well be the result of epifaunal activity, rather than sharp distinction in the degree of microbiological turnover of DOM.

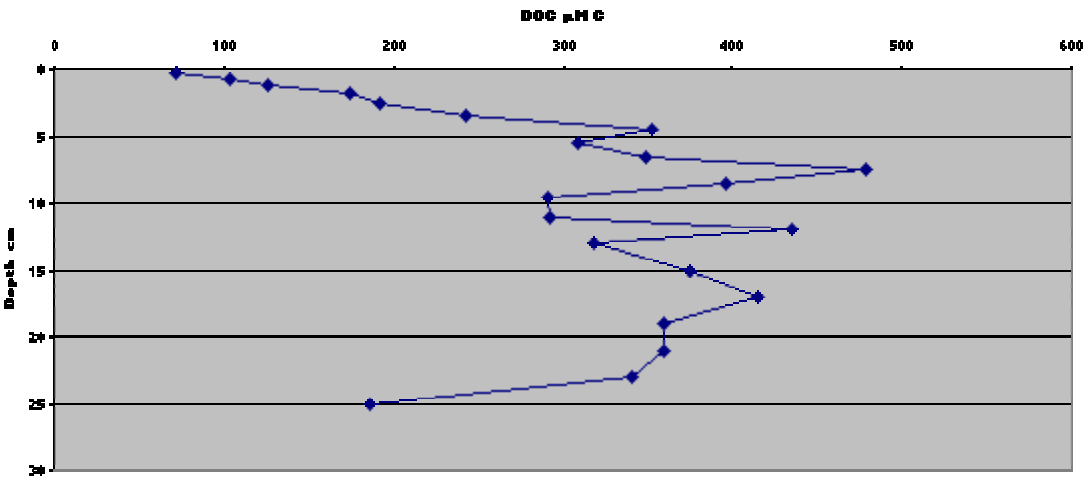
BBLS samples (data not shown) were observed to produce DOC/TDN concentrations in excess of typical water column values. This illustrates the largely diffusive flux of diagenetically reworked particulate organic matter into the waters of the benthic boundary layer. Combined with bottom water CTD profiling, these data will be used to determine the potential impact of sediment-water DOM flux to the biogeochemistry of oceanic bottom waters.

Axel Miller

Figure 22. Preliminary porewater DOC profiles: raw data from Shimadzu TOC 5000A, Axel Miller







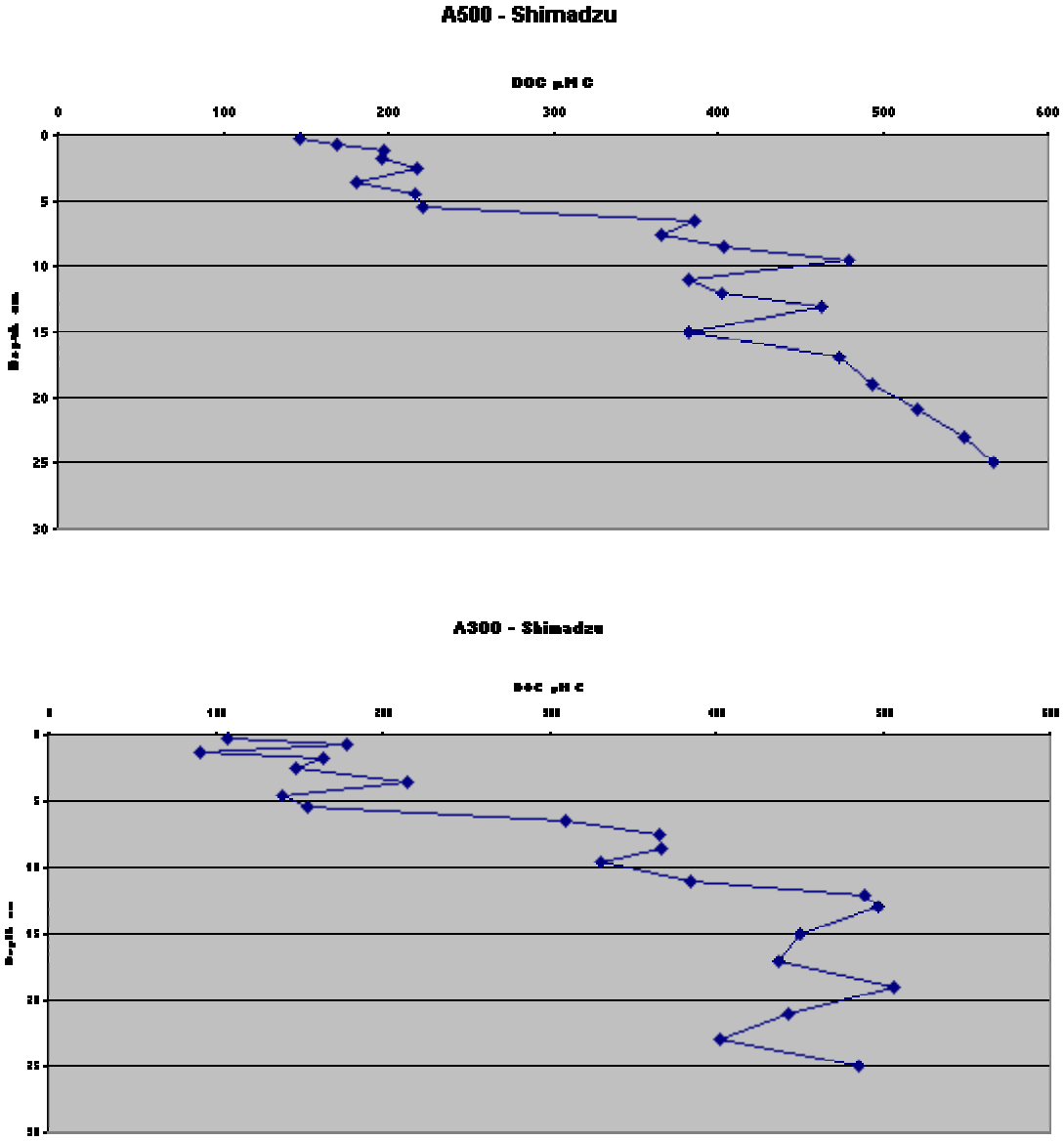


Figure 22-ctd. Preliminary porewater DOC profiles: raw data from Shimadzu TOC 5000A, Axel Miller

9.13. Megabenthos / Agassiz Trawl

Eleven Agassiz Trawls were made between 150 and 3200m water depth (see below). Samples were taken primarily to identify fauna observed in photographic images of the seafloor and for studies of trophic relationships. For the latter task tissue samples or whole animals were taken from a wide variety of fauna and frozen for lipid and carbon/nitrogen isotopic analyses, while gut contents were taken for chlorophyll and carotenoid pigment biomarker studies. In addition, samples were taken to study downslope zonation of the fauna in relation to the Oxygen Minimum Zone (OMZ) and for combined molecular / morphological taxonomic research.

The catches from the trawl were generally rather small. This mirrored video observations of the seafloor that also indicated that the megafauna on the Pakistan Margin was generally sparse, apart from localities at the base of the OMZ. Here dense collections of ophiuroids and other fauna occurred. Of particular note in the trawl samples was the prevalence of giant protozoans at depths greater than 1100m. A wide variety of gromiids (jellyballs) and foraminiferans were collected. Of note also was the collection of only the third known specimen of the large holothurian (sea cucumber) *Benthothuria cristatus*.

All samples were collected without difficulty apart from one, at 160m depth, which caught fast on the seabed while the net was being recovered. The frame was badly bent and the net was torn. However, even in this case, a sample was retrieved.

Table: Agassiz trawls undertaken during RRS Charles Darwin *cruise 145*

Station	Date	Depth (m)
55801#5	16:03:03	3162-3178
55801#13	18:03:03	3157-3175
55804#1	21:03:03	321-341
55804#2	21:03:03	299-327
55805#1	21:03:03	161-182
55811#1	23:03:03	1174-1177
55815#1	24:03:03	1799-1852
55817#1	25:03:03	1089-1103
55821#1	28:03:03	1405-1407
55837#1	30:03:03	1791-1814
55841#1	31:03:03	1620-1660

Stations 55801#5 and 55801#13

Two trawls were conducted on the abyssal plain (c. 3200m) close to the location sampled by a previous German expedition to the Arabian Sea (BIGSET). Varied catches were obtained by the two trawls and were dominated by bivalves (principally *Limopsis* sp.) and scaphopods. The samples were also notable for the holothurian *Benthodytes typica*, the asteroid *Zoroaster*

sp. (a long-armed form similar to *Z. longicauda*), ophiuroids, sponges, gastropods, a cephalopod, an echiuran, the crustaceans *Plesiopenaeus* sp. and *Munidopsis* sp. The catch also contained some large tube protozoans, *Bathysiphon* sp., up to 5cm in length. A few fish were also sampled.

Stations 55804#1 and 55804#2

Two small and disappointing catches were obtained at c. 300m in the upper part of the OMZ. The samples were dominated by a few different natant crustaceans. The paucity of mega-epifauna in this area was subsequently confirmed by photographic images of the area.

Station 55805#1

Although the net caught on the seabed while hauling the net at the end of the tow, deforming the frame of the Agassiz Trawl and ripping a large hole in the net, a fairly large muddy catch with many dead bivalve and a few gastropod shells was obtained. Mixed in with the dead shells were a number of live bivalves (2 species, of which one belonged to the family Astartidae). Fish were common. The catch also contained a few small asteroids (probably *Astropecten* sp.), swimming crabs, sand crabs, hermit crabs, natant decapods and a squat lobster, probably *Munida scrobina*.

Station 55811#1

A muddy sample was collected at about 1100m close to the base of the OMZ. The sample was washed using a hose at the stern rail before it was brought inboard. The sample was varied and was notable for a large number of worm tubes, large orange ophiuroids and green/blue-stalked crinoids about 10cm in length. Of greatest note, however, was the prevalence of a pea-sized gromiid protozoan that occurred in large numbers. The catch was also notable for a number of different actiniarians, including a small form of the Venus Flytrap-shaped genus *Actinoscyphia*, pennatulids, zoanthids encrusting sponge spicules, sponges, natant crustaceans and fish.

Station 55815#1

This sample from c. 1800m on the lower slope was also very poor for large metazoan epifauna, but contained a surprising variety and number of large protozoans, including several types of gromiid, milliolid, saccamminids, rheophaxes and specimens of the foraminiferan genera *Bathysiphon*, *Triloculina* and *Ammodiscus*. The few mega-epifauna that occurred were dominated by natant decapods and quill worms. All these fauna were caught up in an amorphous like, yet fibrous, fluffy material which formed a mat on the net and which was wrapped around everything else. It was believed that this material was of protozoan origin, but its precise nature will have to be determined in the laboratory.

Station 55817#1

A sample taken at c. 1000m at the base of the OMZ contained many ophiuroids, generally of a small size. There were at least five different species. The catch was also notable for worm tubes, various actiniarians, including the small form of *Actinoscyphia*, pennatulids, various crustaceans including *Munida scrobina* and natant decapods, a collection of midwater and demersal fish, and a couple of cephalopods.

Station 55821#1

Although the inner lining of the net was torn along a seam, resulting in some of the catch escaping into the outer lining, a varied sample was obtained at this station (c. 1400m). There was a varied fish sample. Invertebrates were dominated by a large form of the actiniarian *Actinoscyphia*, natant crustaceans, the squat lobster *Munida scrobina*, and echinothuriid sea urchins. Also of note were quill worms and two irregular sea urchins.

Station 55837#1

This second trawl at c. 1800m also produced a large and varied catch of large protozoans, including several different types of gromiids, foraminiferans, such as saccamminids, rheophaxes, milliolids, *Bathysiphon* and *Triloculina* and various tubes and nondescript material that made a mat on the surface of the net. There were also a few crustaceans, notably a specimen of *Munidopsis* sp. Of particular interest, however, was the third specimen ever to be sampled of *Benthothuria cristatus* - last seen in the late 1890s! *B. cristatus* was only known from one specimen collected in the Bay of Bengal, but another species *B. distortus*, similar to *B. cristatus*, had been collected during the same expedition in the Arabian Sea at a locality further south off the coast of India. *B. distortus* was characterised by some curious shield-shaped deposits, described as "escutcheons", which had puzzled holothurian biologists for some time. These were apparent on the ventral surface of the specimen collected at Stn 55837#1, but turned out to be the tests of pelagic pteropods that were abundant on the sediment surface. It appears, therefore, that *B. cristatus* is widely spread, at least in the northern Indian Ocean. The specimen of *B. cristatus*, however, had suffered considerable damage in the trawl and looked little like the images of the species captured on the photographic transect at the same depth.

Station 55841#1

Apart from a varied fish catch, including one large rattail, this catch was rather disappointing, apart from its varied catch of gromiids and other large protozoans. The catch was notable for an ophiuroid, several natant crustaceans and the squat lobster *Munida scrobina*.

David Billett, Ana Aranda da Silva, John Gage, Rachel Jeffreys, Kate Larkin

9.14. CTD profiles

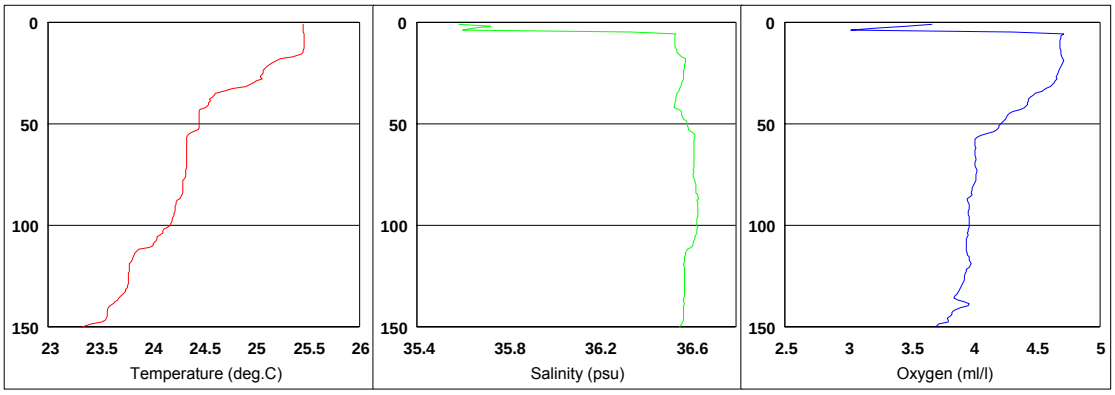


Figure 23. Site A150 CTD profiles, Brian Bett

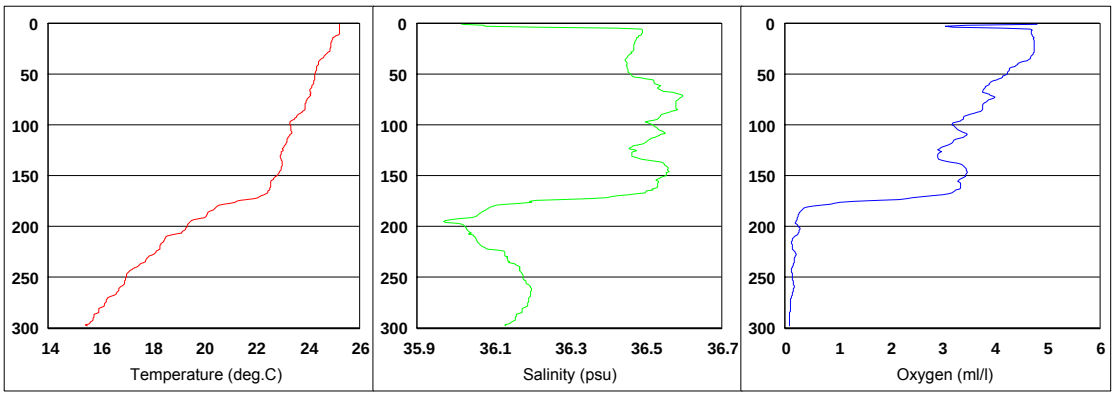


Figure 24. Site A300 CTD profiles, Brian Bett

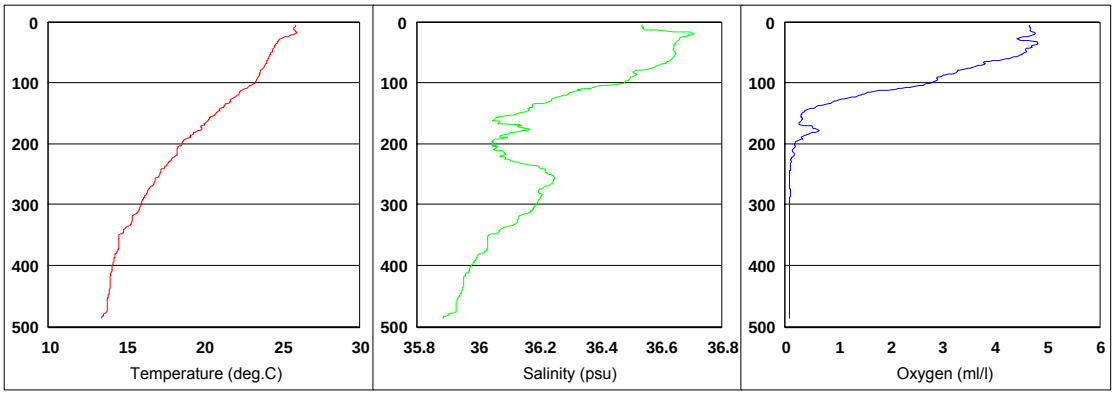


Figure 25. Site A500 CTD profiles, Brian Bett

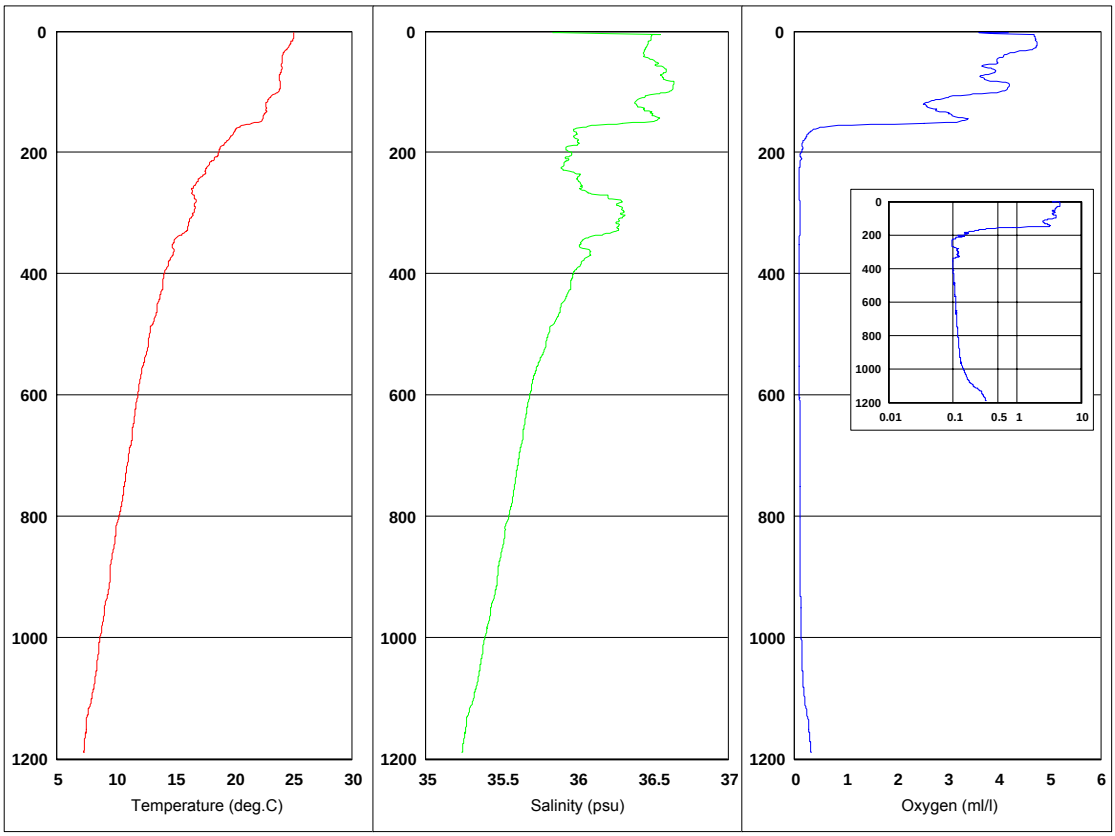


Figure 26. Site A1200 CTD profiles, Brian Bett

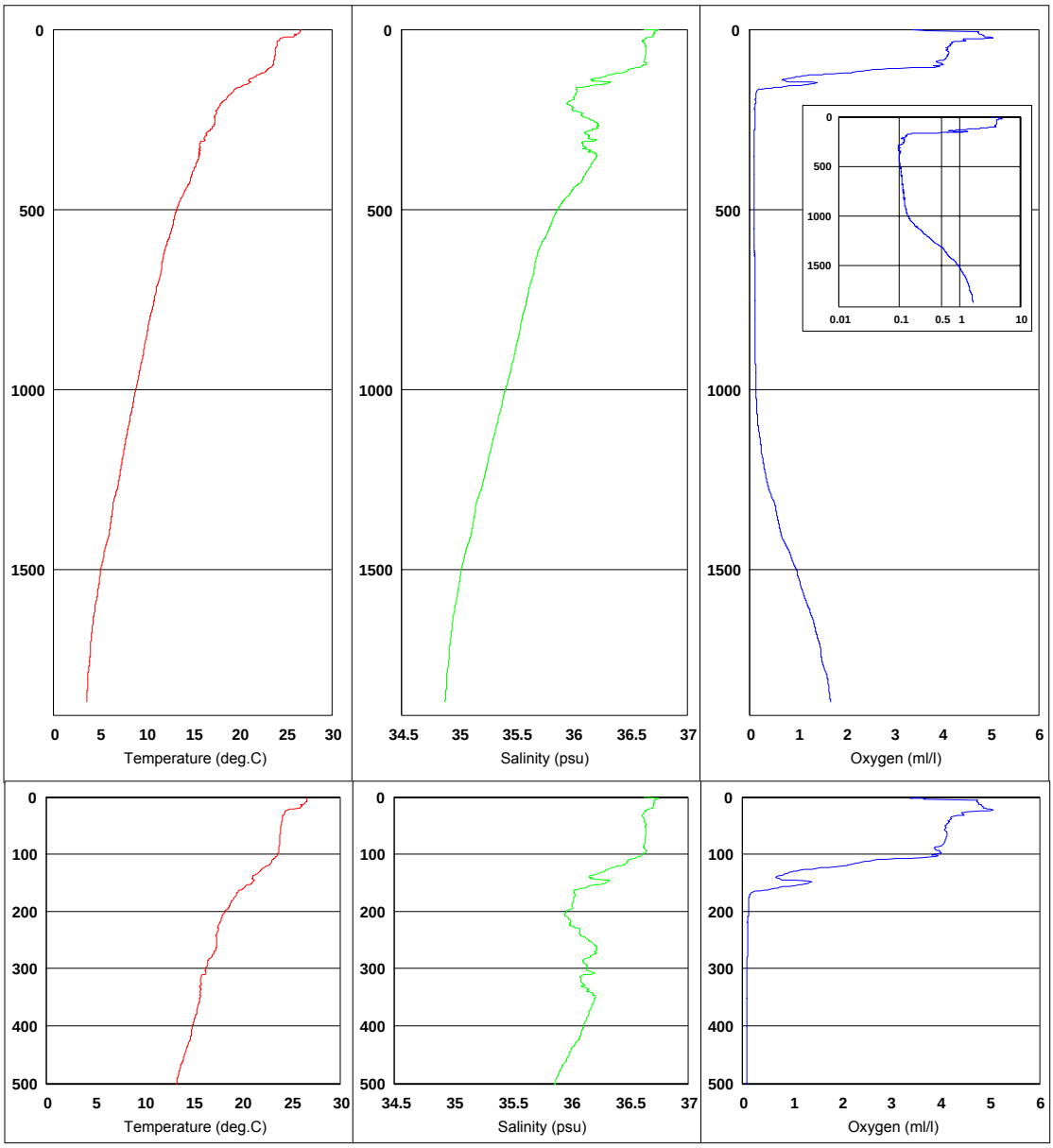


Figure 27. Site A1850 CTD profiles, Brian Bett

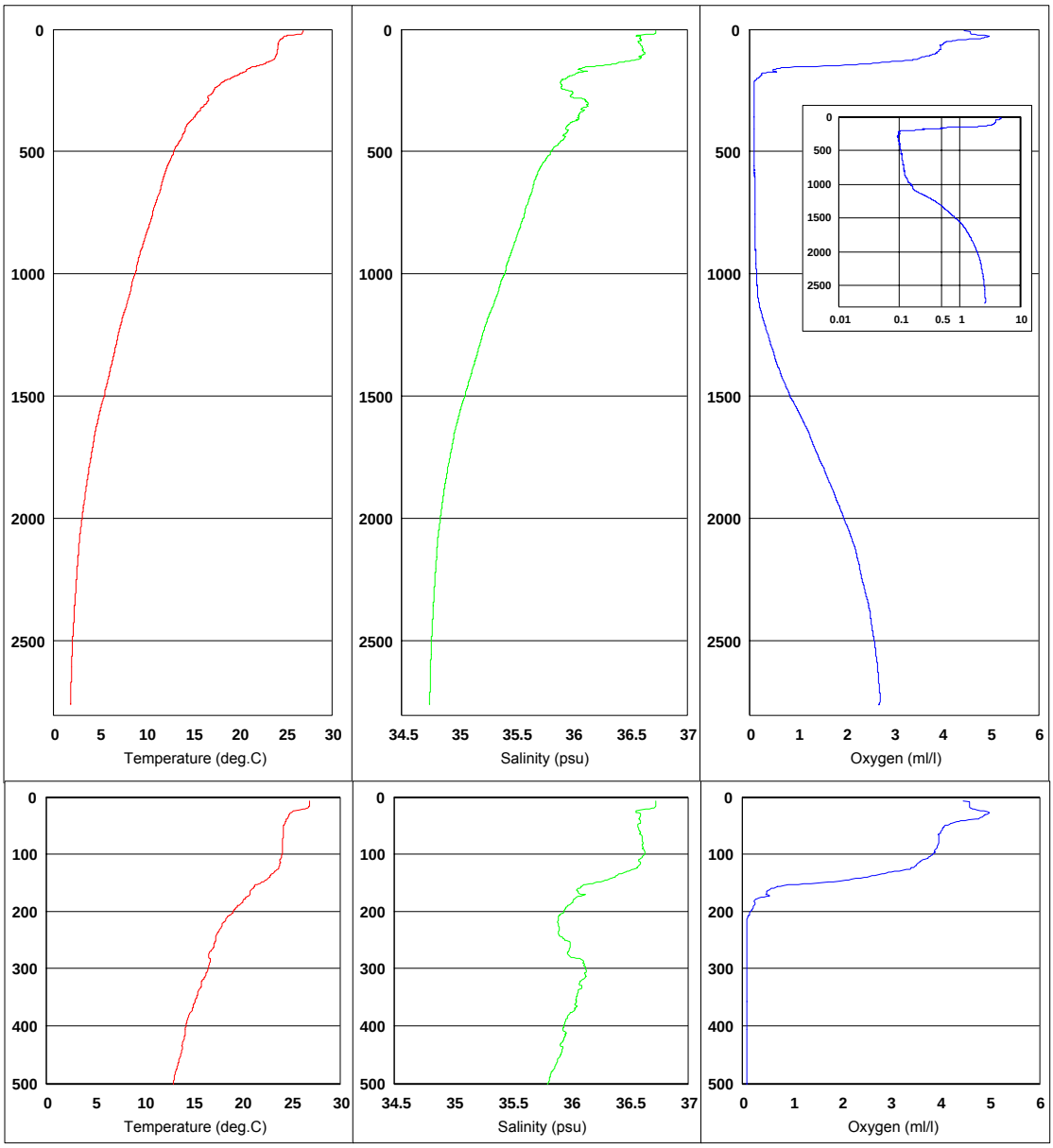


Figure 28. Site A2750 CTD profiles, Brian Bett

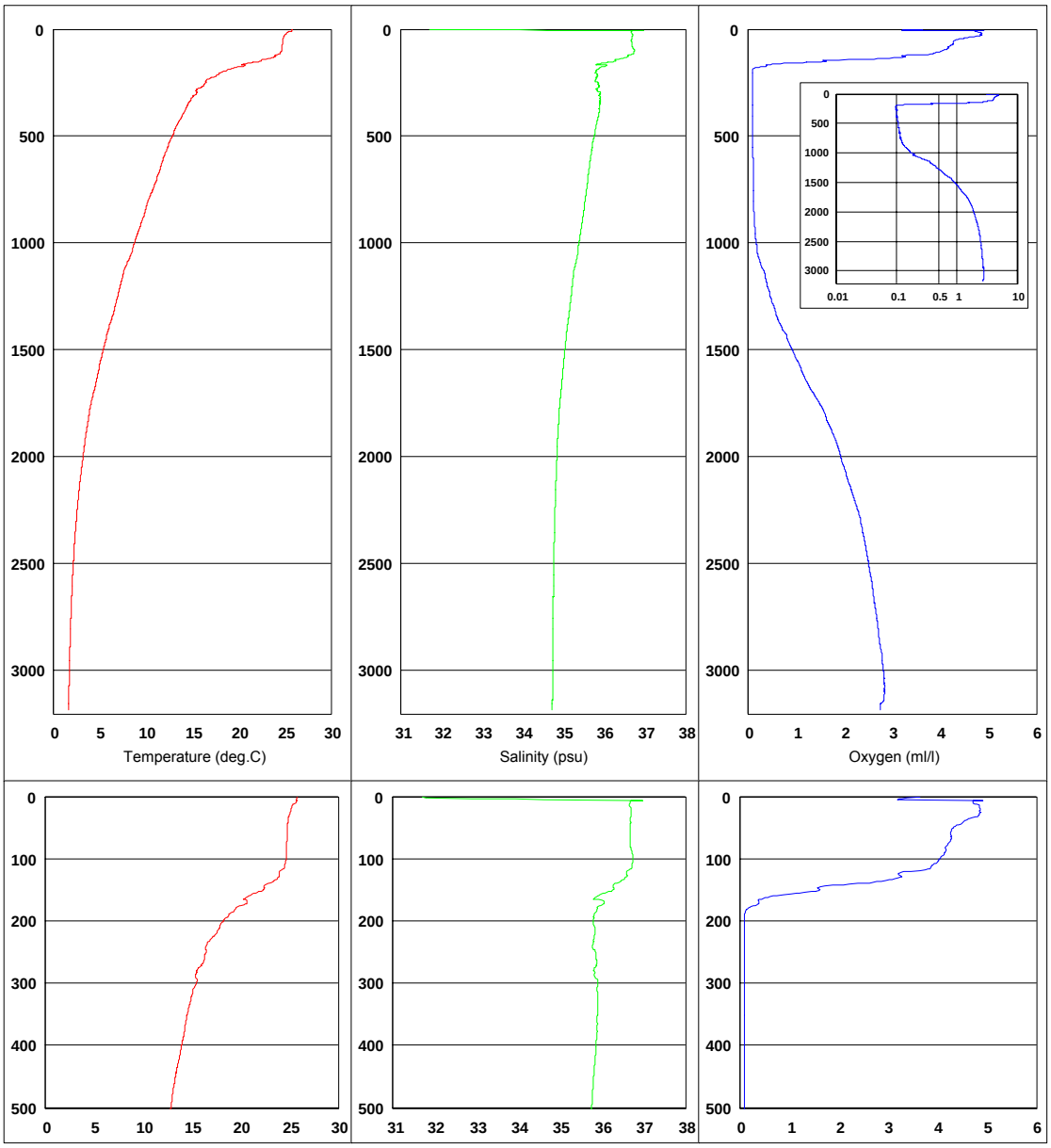


Figure 29. Site A3200 CTD profiles, Brian Bett

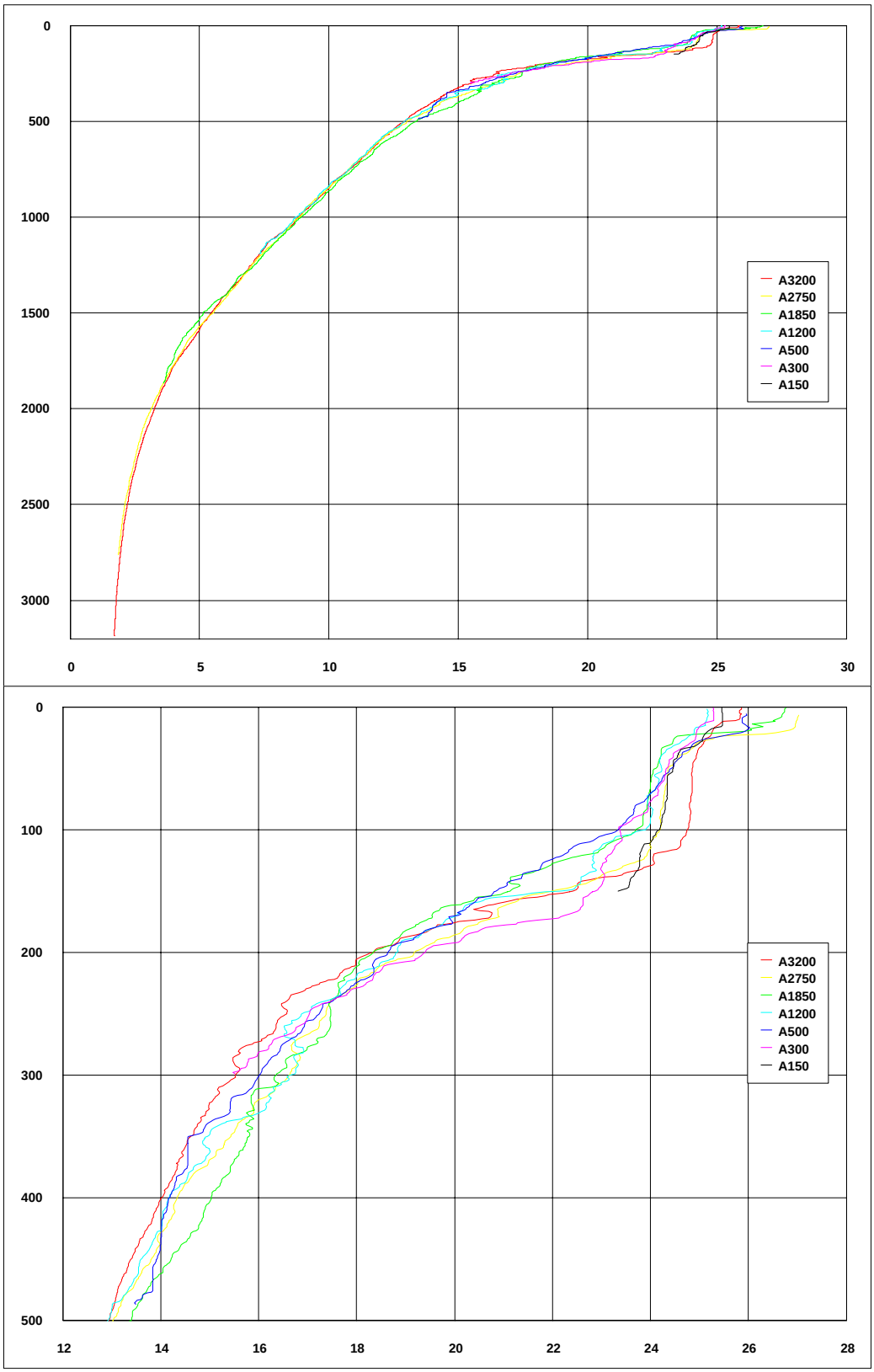


Figure 30. Co-plotted temperature (deg.C) profiles, Brian Bett

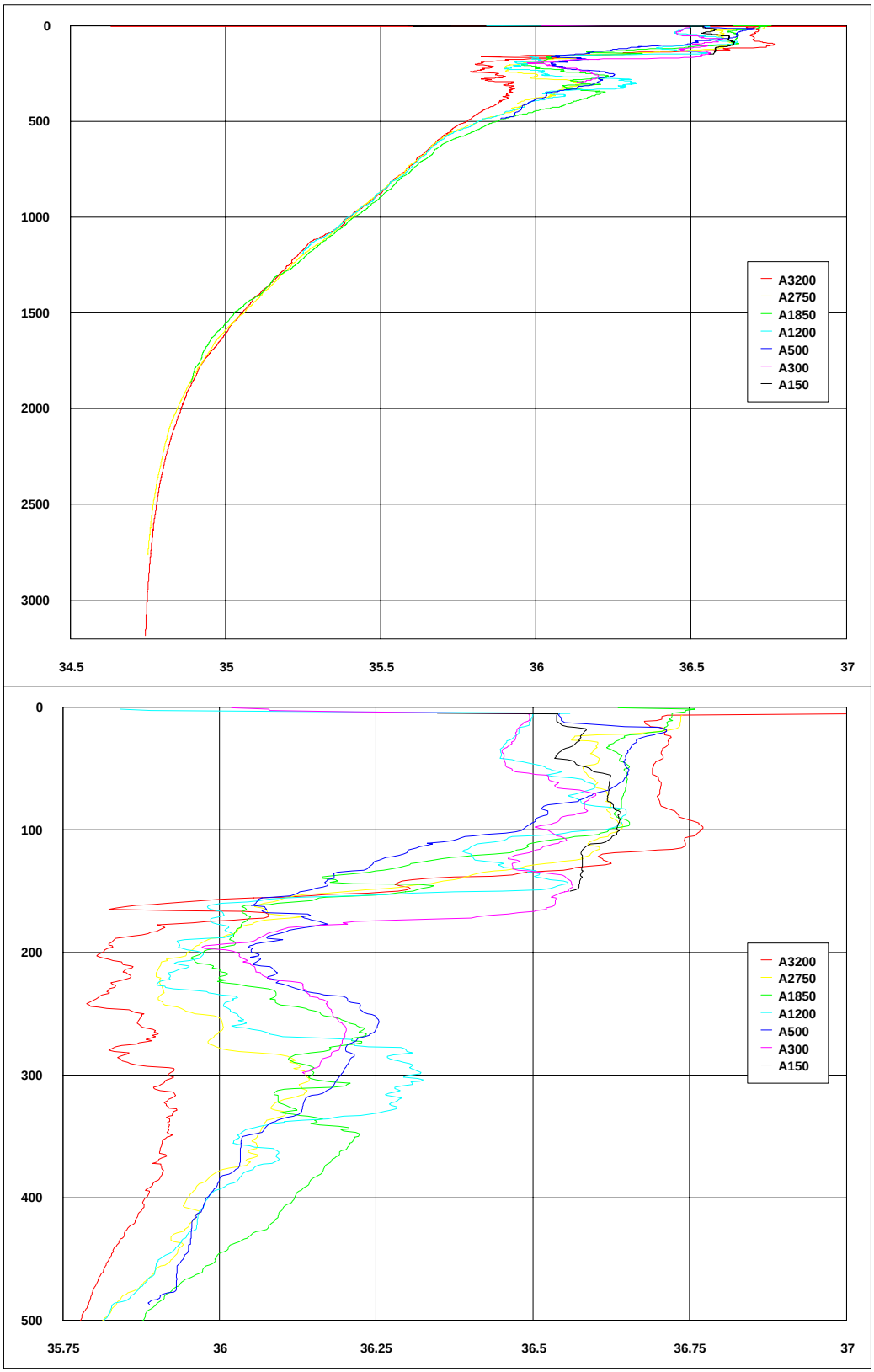


Figure 31. Co-plotted salinity (psu) profiles, Brian Bett

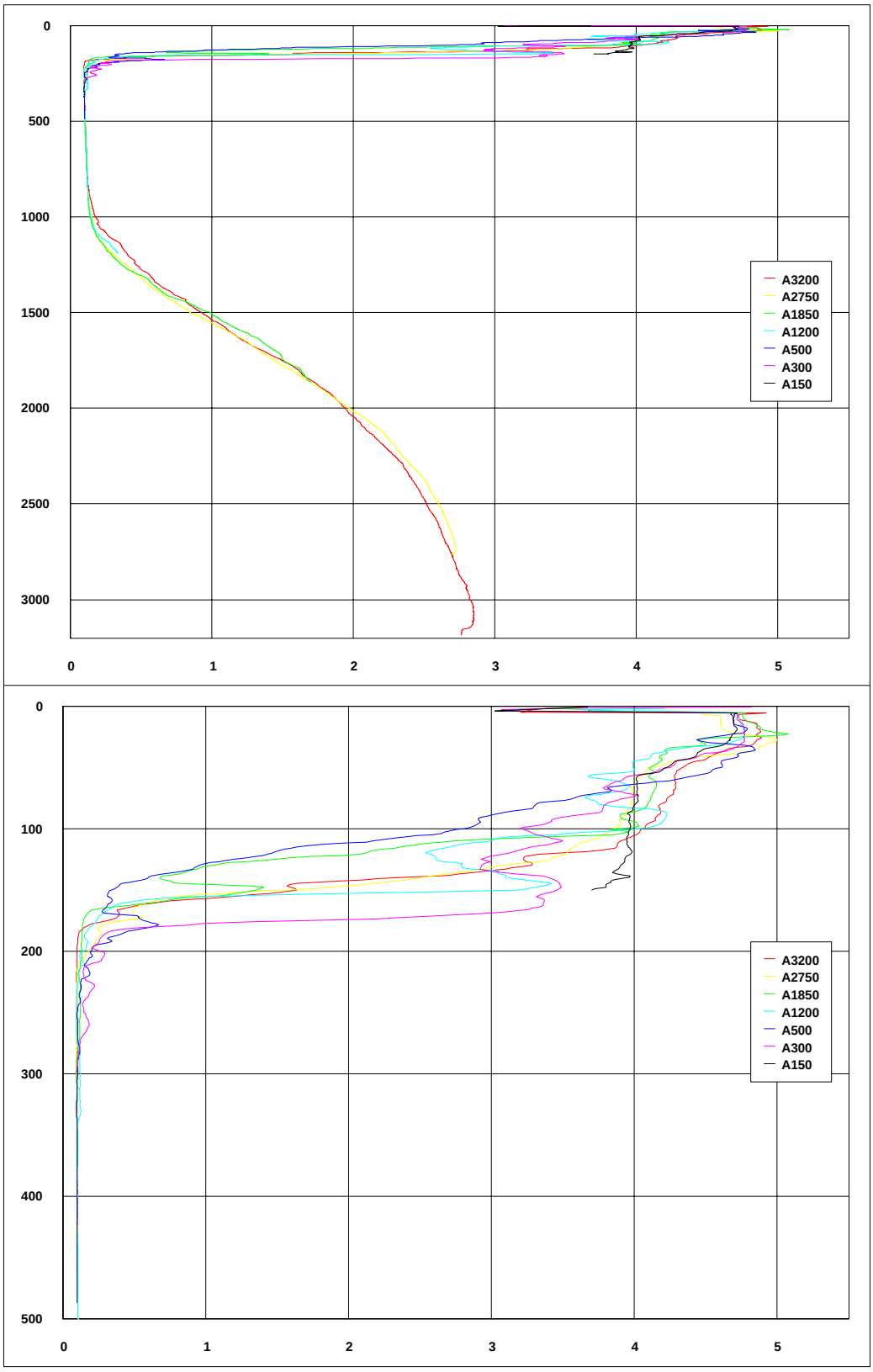


Figure 32. Co-plotted oxygen (ml/l) profiles, Brian Bett

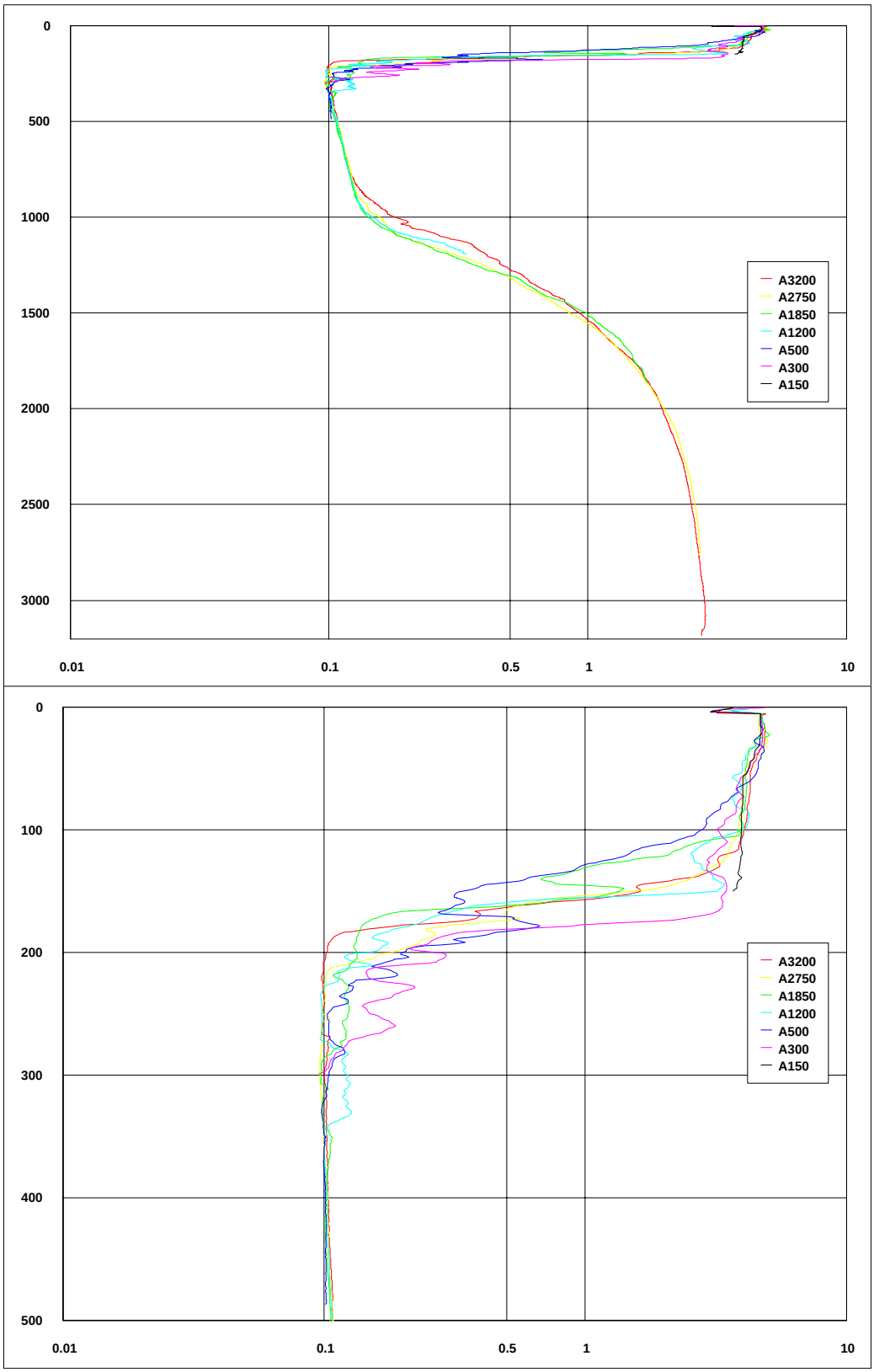


Figure 33. Co-plotted oxygen (log scale ml/l) profiles, Brian Bett

9.15 Winkler titration results

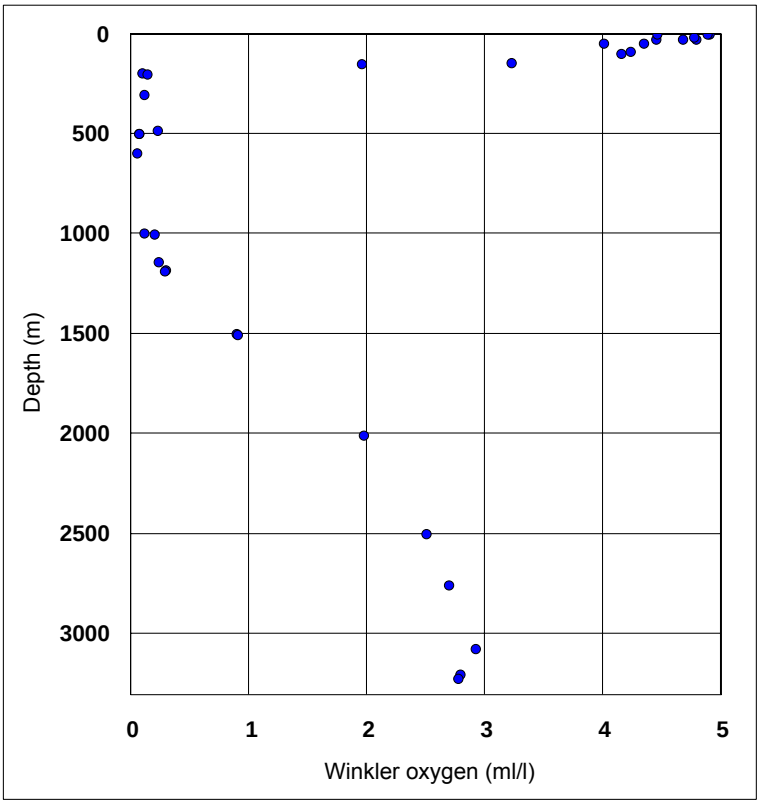


Figure 34. Composite water column oxygen profile from Winkler data, Dave Billett, Brian Bett.

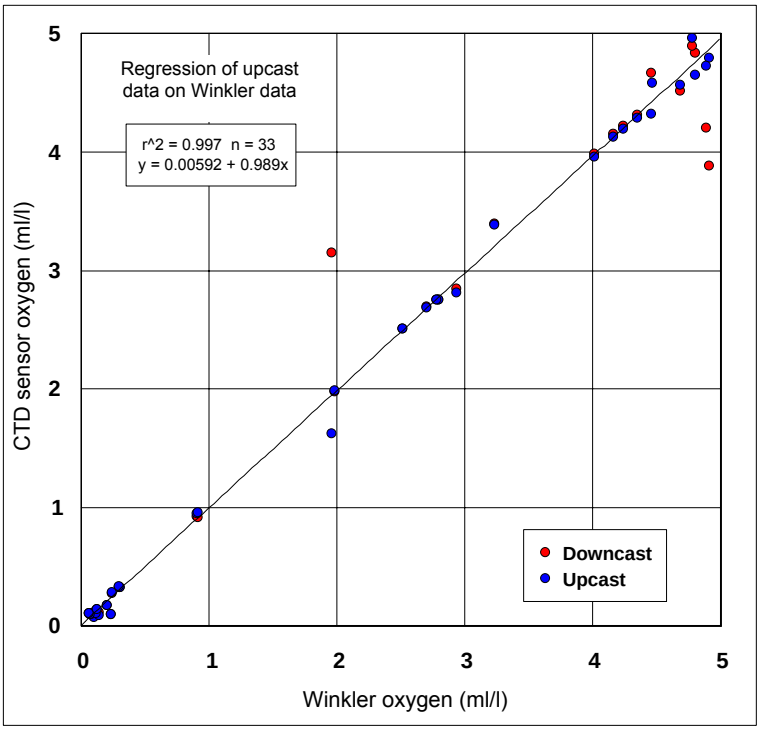


Figure 35. Calibration of CTD oxygen sensor on Winkler data, Dave Billett, Brian Bett.

9.16. WASP observations

Rather limited time was available to watch the video footage obtained with the WASP system, the following notes are therefore rather "cursory":

A150 (stn 55824#1) Sandy seabed, possibly some turbidity, fish quite numerous, crabs (as per trawl) ?holothurian observed.

A200 (stn 55833#1) Rather featureless seabed, shelly (pteropod) fragments, plenty of fish, natants and crabs again.

A300 (stn 55825#1) Jelly / faecal "blobs" rolling across seabed (some current running), seabed lineations – ripples?, bacterial mats (white and orange), fish and natants observed.

A400 (stn 55834#1) Rippled seabed, natants, squid and fish present, small bacterial mats (white and orange).

A500 (stn 55818#7) Rippled / lineated seabed (mini-mud waves), shelly (pteropod) fragments in troughs, fish present.

C1000 (stn 55828#1) Not many burrows, dead jellyfish at seabed, fish, crinoids, holothurians, ?*Pelagothuria*, sponges(?), asteroids, ?*Enypniates*, ?*Galatheathuria*, ophiuroids.

C1100 (stn 55829#1) Small burrows very numerous (very different from C1000), very numerous brittle stars, natants, amphipods, natants, swimming holothurian?, *Actinoscyphia*, crinoids, ?*Munida* and fish.

C1200 (stn 55820#2) Fish (various species), *Actinoscyphia*, squat lobsters / burrows, asteroids, natants, *Plesiopenaeus*, crinoids, ?holothurian, lots of ophiuroids, ?sponge.

A1200 (stn 55819#1) Many burrows, fish, crinoids, actiniarians, *Plesiopenaeus*, gorgonian, large ophiuroid, *Actinoscyphia*.

D1600 (stn 55839#1) not reviewed.

D1700 (stn 55840#1) not reviewed.

D1800 (stn 55826#1) Plenty of large burrows, faecal cast common (? *Benthothuria*), sipunculid-type spoke burrows, fish, natants, amphipods, large crustacean (!) in burrow, *Zoroaster*, *Benthothuria*, xenophyophore (?), ?*Munidopsis*, very large echiuran-type spoke burrows.

A1850 (stn 55830#6) not reviewed (comparable with D1800).

A3200 (stn 55843#1) not reviewed (well-burrowed, sparse holothurians and asteroids).

VHS copies of the WASP video footage were left aboard for CD146 participants to examine.

Brian Bett

10. SAMPLE AND DATA CATALOGUE

10.1. Macrobenthos

SAMS No.	Station No.	Gear	Depth (m)	Notes
934	55801#02	MGC	3200	short core, poorly sliced @ 0.5,0.5,1,1,2,5,10
935	55801#03	MGC	3200	longer core, good slicing @ 0.5,0.5,1,1,2,5,10
936	55801#04	SBC	3200	reasonable box, some disturbance, approx @ 2,3,5,10; 2 X-ray subcores
937	55801#06	MGC	3200	VI @surface, 1,1,1,2,5; one core @10,10 cm
938	55801#14	MGC	3200	I@0.5,0.5,1,1,2,5,5,5; IV,XII,VII. @10,10
939	55802#03	MGC	1200	V@0.5,0.5,1,2,6,10; III@c10,10 (tube stuck)
940	55802#06	SBC	1200	2 X-ray subcores; Trowel sliced approx @ 2,3,5,>10
941	55802#07	MGC	1200	VI 2 gromiids -Xana de Silva,8,10; V 0.5,0.5,1,1,2,5,10;X,VI,I,IX,II,IV,XII@10,10
942	55803#06	MGC	300	XI,III,XII @ 2x10 cm; III @0.5,0.5,1,1,2,5,10
943	55803#07	SBC	300	V. full core, mound in corner; Some *Pelosina* removed by Kate Larkin
944	55806#01	MGC	300	VII@1,1,1,2,5,10; X@0.5,0.5,1,1,2,5,10
945	55806#02	MGC	300	VI@10,10(bubbled); XI@0.5,0.5,1,1,2,5,10
946	55806#04	SBC	300	for fresh fauna; 0-2 removed@ 500 micron; >10 on 1 mm; sorted fauna to vials
947	55808#01	MGC	150	XII@2x10: X@0.5,0.5,1,1,2,5,10
948	55809#04	SBC	150	Good core, burrows and c165 *Pelosina* many in lines (see photos)
949	55809#05	MGC	150	IV@ 10, 10 cm
950	55809#07	SBC	150	c188 *Pelosina* (some picked) + burrows; sorted fauna to vials
951	55810#01	MGC	500	VI@ 10, 10cm
952	55812#01	MGC	150	III@0.5,0.5,1,1,2,5,10
953	55812#02	MGC	150	X@ 0.5,0.5,1,1,2,5,10; III@ 10, 10cm
954	55813#01	MGC	300	VI@ 0.5,0.5,1,1,2,5,10; VII, IX, I,X @ 10, 10cm.
955	55814#01	SBC	500	for fresh fauna; box v. full; nematodes & *Globobulumina*
956	55814#06	MGC	500	VI @ 10, 10; photographed surface
957	55816#03	MGC	500	XI@ 0.5,0.5,1,1,2,5,10 oblique surface
958	55818#02	MGC	500	II@0.5,0.5,1,1,2,5,10 bubbled on extruding; II, VII, VI, XII @ 10, 10.cm.
959	55819#02	MGC	1200	IX @ 05.,05.,1,1,2,5,10; II,III,IV,V,VII, XII @ 10, 10 cm.
960	55820#01	MGC	1200	Trawl site; polychaete from core III retained in vial 2356 as specimen
961	55822#01	MGC	1200	IV @ 05.,0.5,1,1,2,5,10; V, VII, IX, XII @ 10, 10; XII & V sieved fresh
962	55824#02	MGC	150	X @ 05.,0.5,1,1,2,5,10; IV, VI, VII @ 10, 10 cm.
963	55827#03	MGC	1800	IV @ 0.5,0.5,1,1,2,5,10; I, II, V, X, XI @ 10, 10 cm.
964	55827#04	MGC	1800	X @ 0.5,0.5,1,1,2,5,10; III, VI, VII, XI (poor surface), XII @ 10, 10 cm.
965	55830#01	MGC	1850	XII @ 0.5,0.5,1,1,2,5,10; V, VII, XI @ 10, 10 cm.
966	55830#05	SBC	1850	over full, sieved for fauna for reference collection; 2 X-ray cores
967	55832#01	MGC	150	I, III, IV, VI, @ 10, 10; VII as sediment sample
968	55835#03	MGC	500	VI @ 0.5,0.5,1,1,2,5,10; IV, VIII, IX, XI @ 10, 10 cm.
969	55835#04	MGC	500	VIII @ 0.5,0.5,1,1,2,5,10; VI, V (?), VIII (?), XII @ 10 ,10 - some label muddle
970	55835#05	MGC	500	IX, @ 1,1,1,2,5,10; V, VII, VIII @ 10, 10 cm.
971	55836#01	MGC	1200	III @ 0.5,0.5,1,1,2,5,10; X @ 10, 10; 4 more cores combined across horizons for fresh sorting
972	55838#01	MGC	1850	VI @ 0.5,0.5,1,1,2,5,10; V, VI, VII, VIII, IX @ 10, 10 cm.

Macrobenthos sample catalogue (SAMS No. – Scottish Association for Marine Science sample numbering scheme; SBC – spade box corer; MGC – Megacorer; I-XII – core position on Megacorer, numbering is anti-clockwise when viewed from above).

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10.2. Geochemistry core Information

ID	Site:	Station no.	Core length (cm)	Analysis & comments
145A3200	A3200	55801#3	35	Pw:metals, nutrients, sulphides. Very dry core
145A3200	A3200	55801#3	37	Radio nuclides
145A3200	A3200	55801#3	34	Spare/metals
145A1200	A1200	55802#3	40	Pw:metals, nutrients, sulphides
145A1200	A1200	55802#3	40	Radio nuc's
145A1200	A1200	55802#3	40	Spare
145A300	A300	55803#1	Top 5cm	Dave Green
145A300	A300	55806#1	41	Pw:metals, nutrients, sulphides
145A300	A300	55806#1	42	Radio nuc's
145A300	A300	55806#1	41	Spare
145A150	A150	55808#1	Top 5cm	D.Green
145A150	A150	55812#1	34	Pw:metals, nutrients, sulphides
145A150	A150	55812#1	36	Radio nuc's
145A150	A150	55812#1	34	Spare
145A500	A500	55818#1	43	Pw:metals, nutrients, sulphides
145A500	A500	55818#1	43	Radio nuc's
145A500	A500	55818#1	40	Spare
145A500	A500	55818#2	40	D. Green top 5 cm only
145A1850	A1850	55830#1	33	Pw:metals, nutrients, sulphides
145A1850	A1850	55830#1	33	Radio nuc's
145A1850	A1850	55830#1	34	Spare

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10.3. Gamma Analysis

Date core taken	Site & Station No.	Sample type	Sample depth in pot	Start date & time	Stop date & time	Real time	Net area counts Th-234	Net area counts Pb-210	Sample description and spectra file name
16-03	A3200 55801#3	Sed 0.25cm	9mm	22.30 16-03	0800 17-03	33929	115	728	145A3200-0.25
17-03	A3200 55801#5	Gut 1	7mm	0854 17-03	1430 1703	20002.4	130	72.8	145A3200-1
17-03	A3200 55801#5	Gut 2	5mm	14.30 17-03	2030 17-03	21343.4	110	0	145A3200-2
17-03	A3200 55801#5	Gut 3	4mm	2100 17-03	08.30 18-03	40972.4	130	129	145A3200-3
18-03	A3200 55801#3	Sed 0.75cm	14.5mm	13.48 18-03	10.50 19-03	75743.2	0	1620	145A3200-0.75
19-02	A3200 55801#3	Sed 1.25	15mm	11.15 19-03	2100 19-03	34916.7	0	605	145A3200-1.25
20-03	A1200 55802#3	Sed 0.25	16mm	13.55 21-03	0800 22-03	65327	1100	1050	145A1200-0.25
20-03	A1200 55802#3	Sed 0.75	12mm	0810 22-03	0900 23-03	89285.6	0	1390	145A1200-0.75
22-03	A300 55806#1	Sed 0.25	12mm	0930 23-03	1540 24-03	108705.5	1900	858	145A300-0.25
23-03	A150 55809#7	Guts sipunculid	3mm	1545 24-03	0830 25-03	60135.4	0	0	145A150-1 box core
25-03	A300 55806#1	Sed 0.75	16mm	10.30 25-03	0730 26-03	75685.5	0	766	145A300-0.75
25-03	A150 55812#02	Guts P1 Petinamid	1-2mm	0740 26-03	2040 26-03	46694	0	0	145A150-P1
24-03	A150 55808#1	Sed 0.25	18mm	2045 26-03	10.25 27-03	48841.8	1230	290	145A150-0.25
24-03	A150 55808#1	Sed 0.75	16mm 3mm h20	10.50 27-03	0930 28-03	81757	1050	597	145A150-0.75
24-03	A150 55808#1	Sed 1.25	21mm 3mm h20	0940 28-03	0835 29-03	82367.7	443	481	145A150-1.25
26-03	A500 55818#1	Sed 0.25	13mm 4mmH20	0840 29-03	0930 30-03	88830.6	1840	1570	145A500-0.25
26-03	A500 55818#1	Sed 0.75	17mm	2000 30-03	0840 31-03	44457	0	659	145A500-0.75
29-03	A1850 55830#5	Guts S2F	tiny	1115 03-04	0840 04-04	77409.8	0	0	145A1850-S2F
29-03	A1850 55830#5	Guts S2H	tiny	1615 01-04	0900 02-04	60368	0	0	145A1850-S2H
30-03	A1850 55830#1	Gut S3 Out of RN	tiny	0845 31-03	1930 31-03	38709.5	0	0	145A1850-S3
29-03	A1850 55830#1	Sed 0.25	10mm 2mm h20	1945 31-03	1611 01-04	73643.8	0	1780	145A1850-0.25
29-03	A1850 55830#1	Sed 0.75	16mm 2mm	0910 02-04	0940 03-03	88202.4	92.7	1730	145A1850-0.75
29-03	A1850 55830#1	Sed 1.25		0845 04-04					
29-03	A1850 55830#1	Sed 1.75							

All sediment samples put in large pots (75ml), all gut samples put in small pots.

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10.4. Porewater samples

Station		55801#3			55830#1			55802#3			558186#1			55806#1			55812#1		
Site		A3200			A1850			A1200			A500			A300			A150		
ID no.	Depth	N	M	S	N	M	S	N	M	S	N	M	S	N	M	S	N	M	S
1	0.25																		
2	0.75																		
3	1.25																		
4	1.75																		4
5	2.25																		4
6	2.75																		
7	3.25																		
8	3.75			5															8
9	4.25			5															8
10	4.75			5															
11	5.25																		
12	5.75			5														12	
13	6.25			6														12	
14	6.75			6														14	
15	7.25			6														14	
16	7.75			6														16	
17	8.25			6														16	
18	8.75			7	20	20													
19	9.25			7	20	20													
20	9.75			7	20	20													
21	10.5			8															
22	11.5			8														22	
23	12.5			8														22	
24	13.5			8															
25	14.5			9															
26	15.5			9														26	
27	16.5			9														26	
28	17.5			9														28	
29	18.5																	28	
30	19.5																		
31	21																		
32	23																		
33	25	25	28	9															
34	27																11	25	5
35	29				18	23	8												
36	31																		
37	33													36	36	35			
38	35																		
39	37							33	38	30	38	38	38						
40	39																		

(N - nutrients, M - metals, S - sulphides: Yellow – complete sample, Blue – combined sample, Red – no sample)

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10.5. Sulphate reduction samples

Date 2003	Site	Station 558	Deployment	Core #	Depth (cm)	Syringe # + vial #	Jar #	Inj start time	Inj end time	Inc start time date	Inc end time date	Inc temp (°C)	Type	Dilution #
16/03	NAST	01#3	1	1	0-1	1	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	1-2	2	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	2-3	3	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	3-4	4	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	4-5	5	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	5-6	6	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	6-7	7	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	7-8	8	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	8-9	9	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	9-10	10	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	10-11	11	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	11-12	12	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	12-13	13	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	13-14	14	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	14-15	15	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	15-16	16	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	16-17	17	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	17-18	18	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	18-19	19	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	19-20	20	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	20-21	21	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	21-22	22	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	22-23	23	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	23-24	24	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	24-25	25	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	25-26	26	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	26-27	27	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	27-28	28	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	28-29	29	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	29-30	30	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	30-31	31	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	31-32	32	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#3	1	1	32-33	33	1	1312	1332	1322 19/3	1322 20/3	4	S	103/1A
16/03	NAST	01#6	2	2	0-1	34	2	1344	1400	1352 19/3	1352 20/3	4	S	103/1A
16/03	NAST	01#6	2	2	1-2	35	2	1344	1400	1352 19/3	1352 20/3	4	S	103/1A
16/03	NAST	01#6	2	2	2-3	36	2	1344	1400	1352 19/3	1352 20/3	4	S	103/1A
16/03	NAST	01#6	2	2	3-4	37	2	1344	1400	1352 19/3	1352 20/3	4	S	103/1A
16/03	NAST	01#6	2	2	4-5	38	2	1344	1400	1352 19/3	1352 20/3	4	S	103/1A
16/03	NAST	01#6	2	2	5-6	39	2	1344	1400	1352 19/3	1352 20/3	4	S	103/1A
16/03	NAST	01#6	2	2	6-7	40	2	1344	1400	1352 19/3	1352 20/3	4	S	103/1A
16/03	NAST	01#6	2	2	7-8	41	2	1344	1400	1352 19/3	1352 20/3	4	S	103/1A
16/03	NAST	01#6	2	2	8-9	42	2	1344	1400	1352 19/3	1352 20/3	4	S	103/1A
16/03	NAST	01#6	2	2	9-10	43	2	1344	1400	1352 19/3	1352 20/3	4	S	103/1A
16/03	NAST	01#6	2	2	10-11	44	2	1344	1400	1352 19/3	1352 20/3	4	S	103/1A

16/03	NAST	01#6	2	2	11-12	45	2	1344	1400	1352	19/3	1352	20/3	4	S	103/1A
16/03	NAST	01#6	2	2	12-13	46	2	1344	1400	1352	19/3	1352	20/3	4	S	103/1A
16/03	NAST	01#6	2	2	13-14	47	2	1344	1400	1352	19/3	1352	20/3	4	S	103/1A
16/03	NAST	01#6	2	2	14-15	48	2	1344	1400	1352	19/3	1352	20/3	4	S	103/1A
16/03	NAST	01#6	2	2	15-16	49	2	1344	1400	1352	19/3	1352	20/3	4	S	103/1A
16/03	NAST	01#6	2	2	16-17	50	2	1344	1400	1352	19/3	1352	20/3	4	S	103/1A
16/03	NAST	01#6	2	2	17-18	51	2	1344	1400	1352	19/3	1352	20/3	4	S	103/1A
16/03	NAST	01#6	2	2	18-19	52	2	1344	1400	1352	19/3	1352	20/3	4	S	103/1A
16/03	NAST	01#6	2	2	19-20	53	2	1344	1400	1352	19/3	1352	20/3	4	S	103/1A
16/03	NAST	01#6	2	2	20-21	54	2	1344	1400	1352	19/3	1352	20/3	4	S	103/1A
16/03	NAST	01#6	2	2	21-22	55	2	1344	1400	1352	19/3	1352	20/3	4	S	103/1A
16/03	NAST	01#6	2	2	22-23	56	2	1344	1400	1352	19/3	1352	20/3	4	S	103/1A
16/03	NAST	01#6	2	2	23-24	57	2	1344	1400	1352	19/3	1352	20/3	4	S	103/1A
16/03	NAST	01#6	2	2	24-25	58	2	1344	1400	1352	19/3	1352	20/3	4	S	103/1A
16/03	NAST	01#6	2	2	25-26	59	2	1344	1400	1352	19/3	1352	20/3	4	S	103/1A
16/03	NAST	01#6	2	2	26-27	60	2	1344	1400	1352	19/3	1352	20/3	4	S	103/1A
18/03	NAST	01#14	3	3	0-2	61	3	1408	1416	1412	19/3	1412	20/3	4	S	103/1A
18/03	NAST	01#14	3	3	2-4	62	3	1408	1416	1412	19/3	1412	20/3	4	S	103/1A
18/03	NAST	01#14	3	3	4-6	63	3	1408	1416	1412	19/3	1412	20/3	4	S	103/1A
18/03	NAST	01#14	3	3	6-8	64	3	1408	1416	1412	19/3	1412	20/3	4	S	103/1A
18/03	NAST	01#14	3	3	8-10	65	3	1408	1416	1412	19/3	1412	20/3	4	S	103/1A
18/03	NAST	01#14	3	3	10-12	66	3	1408	1416	1412	19/3	1412	20/3	4	S	103/1A
18/03	NAST	01#14	3	3	12-14	67	3	1408	1416	1412	19/3	1412	20/3	4	S	103/1A
18/03	NAST	01#14	3	3	14-16	68	3	1408	1416	1412	19/3	1412	20/3	4	S	103/1A
18/03	NAST	01#14	3	3	16-18	69	3	1408	1416	1412	19/3	1412	20/3	4	S	103/1A
18/03	NAST	01#14	3	3	18-20	70	3	1408	1416	1412	19/3	1412	20/3	4	S	103/1A
18/03	NAST	01#14	3	3	20-22	71	3	1408	1416	1412	19/3	1412	20/3	4	S	103/1A
18/03	NAST	01#14	3	3	22-24	72	3	1408	1416	1412	19/3	1412	20/3	4	S	103/1A
18/03	NAST	01#14	3	3	24-26	73	3	1408	1416	1412	19/3	1412	20/3	4	S	103/1A
18/03	NAST	01#14	3	3	26-28	74	3	1408	1416	1412	19/3	1412	20/3	4	S	103/1A
18/03	NAST	01#14	3	3	28-30	75	3	1408	1416	1412	19/3	1412	20/3	4	S	103/1A
18/03	NAST	01#14	3	3	30-32	76	3	1408	1416	1412	19/3	1412	20/3	4	S	103/1A
18/03	NAST	01#14	3	4	0-1	77	no jar	1430	1438	1434	19/3	1434	19/3	-	B	103/1A
18/03	NAST	01#14	3	4	2-3	78	no jar	1430	1438	1434	19/3	1434	19/3	-	B	103/1A
18/03	NAST	01#14	3	4	4-5	79	no jar	1430	1438	1434	19/3	1434	19/3	-	B	103/1A
18/03	NAST	01#14	3	4	6-7	80	no jar	1430	1438	1434	19/3	1434	19/3	-	B	103/1A
18/03	NAST	01#14	3	4	8-9	81	no jar	1430	1438	1434	19/3	1434	19/3	-	B	103/1A
18/03	NAST	01#14	3	4	10-11	82	no jar	1430	1438	1434	19/3	1434	19/3	-	B	103/1A
18/03	NAST	01#14	3	4	12-13	83	no jar	1430	1438	1434	19/3	1434	19/3	-	B	103/1A
18/03	NAST	01#14	3	4	14-15	84	no jar	1430	1438	1434	19/3	1434	19/3	-	B	103/1A
18/03	NAST	01#14	3	4	16-17	85	no jar	1430	1438	1434	19/3	1434	19/3	-	B	103/1A
18/03	NAST	01#14	3	4	18-19	86	no jar	1430	1438	1434	19/3	1434	19/3	-	B	103/1A
18/03	NAST	01#14	3	4	20-21	87	no jar	1430	1438	1434	19/3	1434	19/3	-	B	103/1A
18/03	NAST	01#14	3	4	22-23	88	no jar	1430	1438	1434	19/3	1434	19/3	-	B	103/1A
18/03	NAST	01#14	3	4	24-25	89	no jar	1430	1438	1434	19/3	1434	19/3	-	B	103/1A
18/03	NAST	01#14	3	4	26-27	90	no jar	1430	1438	1434	19/3	1434	19/3	-	B	103/1A
18/03	NAST	01#14	3	4	28-29	91	no jar	1430	1438	1434	19/3	1434	19/3	-	B	103/1A
18/03	NAST	01#14	3	4	30-31	92	no jar	1430	1438	1434	19/3	1434	19/3	-	B	103/1A
18/03	NAST	01#14	3	4	32-33	93	no jar	1430	1438	1434	19/3	1434	19/3	-	B	103/1A
20/03	A1200	02#3	4	5	0-1	94	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A

20/03	A1200	02#3	4	5	1-2	95	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	2-3	96	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	3-4	97	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	4-5	98	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	5-6	99	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	6-7	100	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	7-8	101	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	8-9	102	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	9-10	103	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	10-11	104	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	11-12	105	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	12-13	106	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	13-14	107	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	14-15	108	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	15-16	109	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	16-17	110	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	17-18	111	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	18-19	112	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	19-20	113	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	20-21	114	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	21-22	115	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	22-23	116	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	23-24	117	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	24-25	118	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	25-26	119	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	26-27	120	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	27-28	121	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	28-29	122	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	29-30	123	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	31-32	124	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	32-33	125	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	33-34	126	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	5	34-35	127	1	1020	1038	1029	21/3	1029	22/3	8	S	103/1A
20/03	A1200	02#3	4	6	0-1	128	no jar	1844	1858	1851	20/3	1851	20/3	-	B	103/1A
20/03	A1200	02#3	4	6	2-3	129	no jar	1844	1858	1851	20/3	1851	20/3	-	B	103/1A
20/03	A1200	02#3	4	6	4-5	130	no jar	1844	1858	1851	20/3	1851	20/3	-	B	103/1A
20/03	A1200	02#3	4	6	6-7	131	no jar	1844	1858	1851	20/3	1851	20/3	-	B	103/1A
20/03	A1200	02#3	4	6	8-9	132	no jar	1844	1858	1851	20/3	1851	20/3	-	B	103/1A
20/03	A1200	02#3	4	6	10-11	133	no jar	1844	1858	1851	20/3	1851	20/3	-	B	103/1A
20/03	A1200	02#3	4	6	12-13	134	no jar	1844	1858	1851	20/3	1851	20/3	-	B	103/1A
20/03	A1200	02#3	4	6	14-15	135	no jar	1844	1858	1851	20/3	1851	20/3	-	B	103/1A
20/03	A1200	02#3	4	6	16-17	136	no jar	1844	1858	1851	20/3	1851	20/3	-	B	103/1A
20/03	A1200	02#3	4	6	18-19	137	no jar	1844	1858	1851	20/3	1851	20/3	-	B	103/1A
20/03	A1200	02#3	4	6	20-21	138	no jar	1844	1858	1851	20/3	1851	20/3	-	B	103/1A
20/03	A1200	02#3	4	6	22-23	139	no jar	1844	1858	1851	20/3	1851	20/3	-	B	103/1A
20/03	A1200	02#3	4	6	24-25	140	no jar	1844	1858	1851	20/3	1851	20/3	-	B	103/1A
20/03	A1200	02#3	4	6	26-27	141	no jar	1844	1858	1851	20/3	1851	20/3	-	B	103/1A
20/03	A1200	02#3	4	6	28-29	142	no jar	1844	1858	1851	20/3	1851	20/3	-	B	103/1A
20/03	A1200	02#3	4	6	30-31	143	no jar	1844	1858	1851	20/3	1851	20/3	-	B	103/1A
20/03	A1200	02#3	4	6	32-33	144	no jar	1844	1858	1851	20/3	1851	20/3	-	B	103/1A

20/03	A1200	02#7	5	7	0-1	145	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	1-2	146	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	2-3	147	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	3-4	148	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	4-5	149	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	5-6	150	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	6-7	151	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	7-8	152	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	8-9	153	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	9-10	154	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	10-11	155	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	11-12	156	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	12-13	157	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	13-14	158	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	14-15	159	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	15-16	160	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	16-17	161	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	17-18	162	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	18-19	163	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	19-20	164	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	20-21	165	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	21-22	166	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	22-23	167	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	23-24	168	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	24-25	169	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	25-26	170	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	26-27	171	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	27-28	172	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	28-29	173	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	29-30	174	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	31-32	175	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	32-33	176	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
20/03	A1200	02#7	5	7	33-34	177	2	1046	1102	1054 21/3	1054 22/3	8	S	103/1B
22/03	A300	06#1	6	8	0-1	178	1	0840	0858	0849 23/3	0849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	1-2	179	1	0840	0858	0849 23/3	0849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	2-3	180	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	3-4	181	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	4-5	182	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	5-6	183	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	6-7	184	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	7-8	185	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	8-9	186	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	9-10	187	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	10-11	188	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	11-12	189	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	12-13	190	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	13-14	191	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	14-15	192	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	15-16	193	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	16-17	194	1	0840	0858	849 23/3	849 24/3	15	S	103/1B

22/03	A300	06#1	6	8	17-18	195	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	18-19	196	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	19-20	197	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	20-21	198	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	21-22	199	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	22-23	200	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	23-24	201	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	24-25	202	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	25-26	203	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	26-27	204	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	27-28	205	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	28-29	206	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	29-30	207	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	31-32	208	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	32-33	209	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	33-34	210	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	34-36	211	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	36-38	212	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	8	38-40	213	1	0840	0858	849 23/3	849 24/3	15	S	103/1B
22/03	A300	06#1	6	9	0-1	214	no jar	1530	1540	1535 22/3	1535 22/3	-	B	103/1B
22/03	A300	06#1	6	9	2-3	215	no jar	1530	1540	1535 22/3	1535 22/3	-	B	103/1B
22/03	A300	06#1	6	9	4-5	216	no jar	1530	1540	1535 22/3	1535 22/3	-	B	103/1B
22/03	A300	06#1	6	9	6-7	217	no jar	1530	1540	1535 22/3	1535 22/3	-	B	103/1B
22/03	A300	06#1	6	9	8-9	218	no jar	1530	1540	1535 22/3	1535 22/3	-	B	103/1B
22/03	A300	06#1	6	9	10-11	219	no jar	1530	1540	1535 22/3	1535 22/3	-	B	103/1B
22/03	A300	06#1	6	9	12-13	220	no jar	1530	1540	1535 22/3	1535 22/3	-	B	103/1B
22/03	A300	06#1	6	9	14-15	221	no jar	1530	1540	1535 22/3	1535 22/3	-	B	103/1B
22/03	A300	06#1	6	9	16-17	222	no jar	1530	1540	1535 22/3	1535 22/3	-	B	103/1B
22/03	A300	06#1	6	9	18-19	223	no jar	1530	1540	1535 22/3	1535 22/3	-	B	103/1B
22/03	A300	06#1	6	9	20-21	224	no jar	1530	1540	1535 22/3	1535 22/3	-	B	103/1B
22/03	A300	06#1	6	9	22-23	225	no jar	1530	1540	1535 22/3	1535 22/3	-	B	103/1B
22/03	A300	06#1	6	9	24-25	226	no jar	1530	1540	1535 22/3	1535 22/3	-	B	103/1B
22/03	A300	06#1	6	9	26-27	227	no jar	1530	1540	1535 22/3	1535 22/3	-	B	103/1B
22/03	A300	06#1	6	9	28-29	228	no jar	1530	1540	1535 22/3	1535 22/3	-	B	103/1B
22/03	A300	06#1	6	9	30-31	229	no jar	1530	1540	1535 22/3	1535 22/3	-	B	103/1B
22/03	A300	06#1	6	9	32-33	230	no jar	1530	1540	1535 22/3	1535 22/3	-	B	103/1B
22/03	A300	06#1	6	9	34-35	231	no jar	1530	1540	1535 22/3	1535 22/3	-	B	103/1B
22/03	A300	06#2	7	10	0-1	232	2	0902	0916	0909 23/3	0909 24/3	15	S	103/1B
22/03	A300	06#2	7	10	1-2	233	2	0902	0916	0909 23/3	0909 24/3	15	S	103/1B
22/03	A300	06#2	7	10	2-3	234	2	0902	0916	0909 23/3	0909 24/3	15	S	103/1B
22/03	A300	06#2	7	10	3-4	235	2	0902	0916	0909 23/3	0909 24/3	15	S	103/1B
22/03	A300	06#2	7	10	4-5	236	2	0902	0916	0909 23/3	0909 24/3	15	S	103/1B
22/03	A300	06#2	7	10	5-6	237	2	0902	0916	0909 23/3	0909 24/3	15	S	103/1B
22/03	A300	06#2	7	10	6-7	238	2	0902	0916	0909 23/3	0909 24/3	15	S	103/1B
22/03	A300	06#2	7	10	7-8	239	2	0902	0916	0909 23/3	0909 24/3	15	S	103/1B
22/03	A300	06#2	7	10	8-9	240	2	0902	0916	0909 23/3	0909 24/3	15	S	103/1B
22/03	A300	06#2	7	10	9-10	241	2	0902	0916	0909 23/3	0909 24/3	15	S	103/1B
22/03	A300	06#2	7	10	10-11	242	2	0902	0916	0909 23/3	0909 24/3	15	S	103/1B
22/03	A300	06#2	7	10	11-12	243	2	0902	0916	0909 23/3	0909 24/3	15	S	103/1B
22/03	A300	06#2	7	10	12-13	244	2	0902	0916	0909 23/3	0909 24/3	15	S	103/1B

22/03	A300	06#2	7	10	13-14	245	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A300	06#2	7	10	14-15	246	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A300	06#2	7	10	15-16	247	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A300	06#2	7	10	16-17	248	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A300	06#2	7	10	17-18	249	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A300	06#2	7	10	18-19	250	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A300	06#2	7	10	19-20	251	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A300	06#2	7	10	20-21	252	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A300	06#2	7	10	21-22	253	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A300	06#2	7	10	22-23	254	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A300	06#2	7	10	23-24	255	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A300	06#2	7	10	24-25	256	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A300	06#2	7	10	25-26	257	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A300	06#2	7	10	26-27	258	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A300	06#2	7	10	27-28	259	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A300	06#2	7	10	28-29	260	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A300	06#2	7	10	29-30	261	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A300	06#2	7	10	31-32	262	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A300	06#2	7	10	32-33	263	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A300	06#2	7	10	33-34	264	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A300	06#2	7	10	34-35	265	2	0902	0916	0909	23/3	0909	24/3	15	S	103/1B
22/03	A150	08#1	8	11	0-1	266	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	1-2	267	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	2-3	268	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	3-4	269	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	4-5	270	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	5-6	271	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	6-7	272	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	7-8	273	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	8-9	274	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	9-10	275	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	10-11	276	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	11-12	277	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	12-13	278	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	13-14	279	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	14-15	280	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	15-16	281	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	16-17	282	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	17-18	283	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	18-19	284	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	19-20	285	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	20-21	286	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	21-22	287	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	22-23	288	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	23-24	289	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	24-25	290	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#1	8	11	25-26	291	3	0928	0940	0934	24/3	0934	25/3	23	S	103/1C
22/03	A150	08#2	9	12	0-1	292	4	0952	1006	0959	24/3	0959	25/3	23	S	103/1C
22/03	A150	08#2	9	12	1-2	293	4	0952	1006	0959	24/3	0959	25/3	23	S	103/1C
22/03	A150	08#2	9	12	2-3	294	4	0952	1006	0959	24/3	0959	25/3	23	S	103/1C

22/03	A150	08#2	9	12	3-4	295	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	4-5	296	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	5-6	297	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	6-7	298	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	7-8	299	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	8-9	300	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	9-10	301	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	10-11	302	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	11-12	303	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	12-13	304	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	13-14	305	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	14-15	306	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	15-16	307	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	16-17	308	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	17-18	309	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	18-19	310	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	19-20	311	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	20-21	312	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	21-22	313	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	22-23	314	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	23-24	315	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	24-25	316	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	25-26	317	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	26-27	318	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	27-28	319	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	28-29	320	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	29-30	321	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
22/03	A150	08#2	9	12	31-32	322	4	0952	1006	0959 24/3	0959 25/3	23	S	103/1C
26/03	A500	16#3	11	16	0-1	323	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	1-2	324	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	2-3	325	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	3-4	326	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	4-5	327	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	5-6	328	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	6-7	329	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	7-8	330	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	8-9	331	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	9-10	332	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	10-11	333	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	11-12	334	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	12-13	335	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	13-14	336	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	14-15	337	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	15-16	338	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	16-17	339	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	17-18	340	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	18-19	341	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	19-20	342	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	20-21	343	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C
26/03	A500	16#3	11	16	21-22	344	1	1238	1300	1249 26/3	1249 27/3	13	S	103/1C

26/03	A500	16#3	11	16	22-23	345	1	1238	1300	1249	26/3	1249	27/3	13	S	103/1C
26/03	A500	16#3	11	16	23-24	346	1	1238	1300	1249	26/3	1249	27/3	13	S	103/1C
26/03	A500	16#3	11	16	24-25	347	1	1238	1300	1249	26/3	1249	27/3	13	S	103/1C
26/03	A500	16#3	11	16	25-26	348	1	1238	1300	1249	26/3	1249	27/3	13	S	103/1C
26/03	A500	16#3	11	16	26-27	349	1	1238	1300	1249	26/3	1249	27/3	13	S	103/1C
26/03	A500	16#3	11	16	27-28	350	1	1238	1300	1249	26/3	1249	27/3	13	S	103/1C
26/03	A500	16#3	11	16	28-29	351	1	1238	1300	1249	26/3	1249	27/3	13	S	103/1C
26/03	A500	16#3	11	16	29-30	352	1	1238	1300	1249	26/3	1249	27/3	13	S	103/1C
26/03	A500	16#3	11	16	30-31	353	1	1238	1300	1249	26/3	1249	27/3	13	S	103/1C
26/03	A500	16#3	11	16	31-32	354	1	1238	1300	1249	26/3	1249	27/3	13	S	103/1C
26/03	A500	16#3	11	16	32-33	355	1	1238	1300	1249	26/3	1249	27/3	13	S	103/1C
26/03	A500	16#3	11	16	33-34	356	1	1238	1300	1249	26/3	1249	27/3	13	S	103/1C
26/03	A500	16#3	11	16	34-35	357	1	1238	1300	1249	26/3	1249	27/3	13	S	103/1C
26/03	A500	16#3	11	16	35-36	358	1	1238	1300	1249	26/3	1249	27/3	13	S	103/1C
26/03	A500	16#3	11	16	36-37	359	1	1238	1300	1249	26/3	1249	27/3	13	S	103/1C
26/03	A500	16#3	11	16	37-38	360	1	1238	1300	1249	26/3	1249	27/3	13	S	103/1C
26/03	A500	16#3	11	16	38-39	361	1	1238	1300	1249	26/3	1249	27/3	13	S	103/1C
26/03	A500	16#3	11	16	39-40	362	1	1238	1300	1249	26/3	1249	27/3	13	S	103/1C
25/03	A500	16#1	10	15	0-1	363	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	1-2	364	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	2-3	365	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	3-4	366	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	4-5	367	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	5-6	368	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	6-7	369	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	7-8	370	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	8-9	371	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	9-10	372	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	10-11	373	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	11-12	374	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	12-13	375	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	13-14	376	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	14-15	377	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	15-16	378	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	16-17	379	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	17-18	380	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	18-19	381	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	19-20	382	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	20-21	383	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	21-22	384	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	22-23	385	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	23-24	386	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	24-25	387	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	25-26	388	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	26-27	389	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	27-28	390	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	28-29	391	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	29-30	392	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	30-31	393	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	31-32	394	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C

25/03	A500	16#1	10	15	32-33	395	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	33-34	396	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	34-35	397	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	35-36	398	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
25/03	A500	16#1	10	15	36-37	399	2	1318	1334	1326	26/3	1326	27/3	13	S	103/1C
28/03	A1850	27#3	11	18	0-1	400	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	1-2	401	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	2-3	402	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	3-4	403	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	4-5	404	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	5-6	405	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	6-7	406	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	7-8	407	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	8-9	408	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	9-10	409	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	10-11	410	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	11-12	411	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	12-13	412	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	13-14	413	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	14-15	414	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	15-16	415	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	16-17	416	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	17-18	417	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	18-19	418	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	19-20	419	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	20-21	420	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	21-22	421	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	22-23	422	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	23-24	423	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	24-25	424	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	25-26	425	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	26-27	426	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	27-28	427	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	28-29	428	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	29-30	429	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	30-31	430	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#3	11	18	31-32	431	1	0922	0940	0931	30/3	0931	31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	0-1	432	2	0948	1004	0956	30/3	0956	31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	1-2	433	2	0948	1004	0956	30/3	0956	31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	2-3	434	2	0948	1004	0956	30/3	0956	31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	3-4	435	2	0948	1004	0956	30/3	0956	31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	4-5	436	2	0948	1004	0956	30/3	0956	31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	5-6	437	2	0948	1004	0956	30/3	0956	31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	6-7	438	2	0948	1004	0956	30/3	0956	31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	7-8	439	2	0948	1004	0956	30/3	0956	31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	8-9	440	2	0948	1004	0956	30/3	0956	31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	9-10	441	2	0948	1004	0956	30/3	0956	31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	10-11	442	2	0948	1004	0956	30/3	0956	31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	11-12	443	2	0948	1004	0956	30/3	0956	31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	12-13	444	2	0948	1004	0956	30/3	0956	31/3	4	S	103/1B+C

28/03	A1850	27#4	12	20	13-14	445	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	14-15	446	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	15-16	447	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	16-17	448	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	17-18	449	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	18-19	450	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	19-20	451	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	20-21	452	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	21-22	453	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	22-23	454	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	23-24	455	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	24-25	456	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	25-26	457	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	26-27	458	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	27-28	459	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	28-29	460	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	29-30	461	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	30-31	462	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	31-32	463	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	33-34	464	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C
28/03	A1850	27#4	12	20	34-35	465	2	0948	1004	0956 30/3	0956 31/3	4	S	103/1B+C

(Incubation time = 24 hours, activity per syringe on 1/4/03 = 25.188 kBq, all samples taken by Megacorer, S – sample, B – blank)

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10.6. pH Measurements, DIC 13 and DIC samples

Site	Station	pH measurement		Samples retained on board	
	Core No.	pH	depth	DIC 13	DIC
A3200	55801#6 lll,	6.80	0-0.5	0-0.5	0-0.5
“BIGSET	3.8°C	7.20	0.5-1	0.5-1	0.5-1
NAST”		7.40	1-1.5	1-1.5	1-7
		7.60	18-20	1.5-2	
		6.90	20-22	2-3	
		7.30	26-30	3-4	
				4-5	
				12-14	
				14-16 (2)	
				16-18	
				18-20	
				20-22	
				22-26	
				26-30	
A1200	55802#3 VII	7.69	0.5-1	0.5-1	0-0.5
	8°C	7.70	1-1.5	3-4	0.5-1
		7.57	1.5-2	5-6	1-1.5
		7.52	2-3	10-12	1.5-3
		7.55	3-4	12-14	3-5
		7.56	5-6	14-16	5-14
		7.58	6-7	16-18	14-24
		7.55	9-10	20-22	24-34
		7.49	12-14	22-24	
		7.62	16-18	24-26	
		7.58	20-22		
		7.70	26-28		
		7.74	32-34		
A300	55806#01	7.72	0-0.5	0-0.5	0-0.5
	14°C	7.49	0.5-1	0.5-1	0.5-1
		7.39	1.5-2	1-1.5	1-1.5
		7.32	2-3	1.5-2	1.5-2
		7.48	3-4	2-3 (2)	2-3
		7.34	4-5	3-4	3-4 (2)
		7.33	5-6	4-5	4-5
		7.30	6-7	5-6 (2)	5-6
		7.38	7-8	6-7	6-7
		7.40	8-9	7-8	7-8
		7.40	9-10	8-9	8-9
		7.42	10-12	9-10	9-10
		7.58	12-14	10-12	10-12
		7.49	14-16	12-14	12-14
		7.66	16-18	14-16	14-16
		7.48	18-20	16-18	16-18
		7.50	20-22	18-20	18-20
		7.76	22-24	20-22	20-22
		7.57	24-26	22-24 (2)	22-24
		7.56	26-28	24-26	24-26
		7.82	28-30	26-28	26-28
		7.75	30-32	28-30	28-30
				32-34	32-34
					34-36
A150	55812#1 VII	7.60	0-0.5	0-0.5	0-4
	22°C	7.84	1-1.5	4-6	8-12
		8.00	2-3	6-8	16-20
		7.75	5-6	10-14	20-24
		7.96	8-9	12-16	24-32
		7.93	12-14	18-20	
		8.04	18-20	22-24	

A500	55818#2 III			0-0.5	0-0.5
	18°C	7.47	1-1.5	4-6	0.5-1
		7.33	2-3	6-8	1-1.5
		7.35	4-5	10-14	1.5-2
		7.32	6-7	12-14	2-3
		7.32	8-9	14-16	3-4
		7.38	10-12	16-18	4-5
		7.44	14-16	18-20	5-6
		7.42	18-20	20-22	6-7
		7.45	22-24	22-24	7-8
		7.47	26-28	24-26	8-9
		7.45	30-32	26-28	9-10
				28-30	10-12
				30-32	12-14
				32-34	14-16
				34-36	16-18
					18-20
					20-22
					22-24
					24-26
					26-28
					28-30
					30-32
					32-34
A1850	55830#01 I	7.44	0-0.5	0-0.5	0-1
	3.3°C	7.42	1-1.5	0.5-1	0.5-1
		7.43	2-3	1-1.5	1-1.5
		7.59	5-6	1.5-2	1.5-3
		7.80	8-9	3-4	3-4
		7.71	18-20	10-14	4-9
		7.76	24-26	22-26	14-24
		7.73	28-30	26-30	
A1200 (2)	55836#1 XII	7.39	0-0.5	0-1	0-0.5
	8°C	7.44	1-1.5	2-3	0.5-1
		7.38	2-3	3-4	1-1.5
		7.48	4-5	4-5	1-2
		7.50	6-7	5-6	2-4
		7.50	8-9	6-8	4-5
		7.53	10-12	8-9	4-6
		7.55	14-16	10-12	6-8
		7.56	18-20	12-14	8-12
		7.55	22-24	16-18	20-24
		7.59	26-28	18-22	
		7.74	30-32	24-26	
				28-32	

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10.7. Foram' geochemistry cores

A150	55812#2 XI	Sliced at cm resolution and refrigerated
A300	55806#1	
A500	55814#6 VI	
A1200	55822#1 I	
A1850	55827#8 XII	
A3200	55801#3 VII	

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10.8. Core sample material for biochemistry, faunistics and paleoceanography

BC-biochemistry (SOC, Liverpool, Edinburgh), G-genetics (SOC), F-Foraminifera (SOC), P-paleoceanography (SOC-Kiel), F:G-gromiids (SOC), NIO- material collected for National Institute of Oceanography, Pakistan

Site	Station	MC	MGC	Preservation
A150	55808#1		7 BC (0-10 cm)	Frozen
	55808#2	2 F (0-10 cm)		10% Formalin
		3 G (0-1 cm)		Frozen
	55808#3	1 NIO (0-2 cm)		10% Formalin
		3 G (0-1 cm)		Frozen
		10 F (0-5 cm)		10% Formalin
		11 P (0-10 cm)		10% Formalin
	55809#5		1 BC (0-10 cm)	Frozen
			6 BC (0-10 cm)	Frozen
	55809#6	11 F (0-5 cm)		10% Formalin
	55812#1		1 BC (0-10 cm)	Frozen
			9 BC (0-10 cm)	Frozen
	55812#2		1 BC (0-10 cm)	Frozen
			6 BC (0-10 cm)	Frozen
A300	55803#4	2 F (0-10 cm)		10% Formalin
		3 G (0-1 cm)		Frozen
	55803#5	5 F (0-5 cm)		10% Formalin
		9 P (0-10 cm)		10% Formalin
	55803#6		6 BC (0-10 cm)	Frozen
	55806#1		2 BC (0-10 cm)	Frozen
			6 BC (0-10 cm)	Frozen
	55806#3	5 F (0-10 cm)		10% Formalin
		1 NIO (0-2 cm)		10% Formalin
	55813#1		4 BC (0-10 cm)	Frozen
			12 BC (0-10 cm)	Frozen
A500	55810#1		1 BC (0-10 cm)	Frozen
			9 BC (0-10 cm)	Frozen
	55814#6		3 BC (0-10 cm)	Frozen
			4 BC (0-10 cm)	Frozen
	55816#3		8 BC (0-10 cm)	Frozen
			9 BC (0-10 cm)	Frozen
	55816#6	5 G (0-1 cm)		Frozen
		10 NIO (0-2 cm)		10% Formalin
		11 F (0-5 cm)		10% Formalin
	55818#4	11 P (0-10 cm)		10% Formalin
		10 F (0-5 cm)		10% Formalin
	55835#3	3 F (0-5 cm)		10% Formalin

A1200	55802#3		6 BC (0-10 cm)	Frozen
			? G (0-1 cm)	Frozen
	55802#4	4 F (0-10 cm)		10% Formalin
		5 P (0-10 cm)		10% Formalin
	55802#5	1 F (0-5 cm)		10% Formalin
	55802#7		7 BC (0-10 cm)	Frozen
			8 BC (0-10 cm)	Frozen
	55819#2		1 BC (0-10 cm)	Frozen
			10 BC (0-10 cm)	Frozen
	55822#1		1 BC (0-10 cm)	Frozen
			11 BC (0-10 cm)	Frozen
	55822#2	4 F (0-5 cm)		10% Formalin
		5 NIO (0-2 cm)		10% Formalin
		7 G (0-1 cm)		Frozen
C1800	55826#2		2 F: G (0-2 cm)	10% Formalin
			3 F: G (0-2 cm)	10% Formalin
			6 F: G (0-2 cm)	10% Formalin
			7 F: G (0-2 cm)	10% Formalin
			8 F: G (0-2 cm)	10% Formalin
			9 F: G (0-2 cm)	10% Formalin
			10 F: G (0-2 cm)	10% Formalin
			12 F: G (0-2 cm)	10% Formalin
A1850	55827#3		6 BC (0-10 cm)	Frozen
			7 BC (0-10 cm)	Frozen
	55827#4		5 BC (0-10 cm)	Frozen
			9 BC (0-10 cm)	Frozen
	55830#1		5 BC (0-10 cm)	Frozen
			9 BC (0-10 cm)	Frozen
	55830#2	7 G (0-1 cm)		Frozen
		8 NIO (0-2 cm)		10% Formalin
		11 F (0-10 cm)		10% Formalin
	55830#3	4 F (0-5 cm)		10% Formalin
		5 P (0-10 cm)		10% Formalin
	55830#4	11 F (0-5 cm)		10% Formalin
A3200	55801#2		1 BC (0-7 cm)	Frozen
	55801#3		1 BC (0-19 cm)	Frozen
	55801#6		1 BC (0-20 cm)	Frozen
	55801#9	3 G (0-1 cm)		Frozen
		7 P (0-10 cm)		10% Formalin
		9 F (0-19 cm)		10% Formalin
	55801#10	10 F (0-5 cm)		10% Formalin
		11 G (0-1 cm)		Frozen
	55801#14		10 BC (0-10 cm)	Frozen
	55801#15	3 F (0-10 cm)		10% Formalin
		5 G (0-1 cm)		Frozen
		12 G (0-1 cm)		

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10.9. Protozoan specimen material

10% Formalin preserved material

Site	Station	Gear	Container	Contents
A150	55812#2	MGC	vial	1 Pelosina like Foram
A250	55807#1	MGC	60 ml	6 *Pelosina* sp.
A300	55806#2	MGC	60 ml	Mudball
	55806#4	BC	vial	3 *Lenticulina* sp.
	55806#7	MGC	vial	3 *Pelosina*
A500	55814#6	MGC	vial	2 *Pelosina*
C1200	55801#5	AT	60 ml	Bathysiphons
A1200	55802#7	MGC	60 ml	1 Gromiid
			vial	1 Gromiid
	55820#1	MGC	vial	1 Saccamminid
			vial	1 Saccamminid
			vial	1 Saccamminid
C1200	55811#1	AT	500 ml	Gromiids
D1650	55841#1	AT	60 ml	10 Light grapes
			5 l	Gromiid catch
D1800	55815#1	AT	5 l	Gromiid catch
			1100 ml	Tubes
			60 ml	Tube fragments
			60 ml	44 Saccamminids
			60 ml	Tube fragments
			60 ml	10 Sausages Gromiids
			60 ml	6 Hormosina
			60 ml	42 *Gromiia sphaerica*
			60 ml	26 Gromiids
			60 ml	Saccamminids
			60 ml	Milliolids
			60 ml	*Hormosina* sp.
			vial	3 *Ammodiscus* sp.
			vial	10 Milliolids
			vial	5 *Triloculina* sp.
D1750	55837#1	AT	5 l	Gromiid catch
			60 ml	Fluff
A1850	55826#2	MGC	8 x 500 ml	8 x 0-2 cm
			60 ml	> 300
			vial	1 Gromiid
			vial	1 Saccamminid
	55827#3	MGC	60 ml	1 Gromiid
	55827#4	MGC	60 ml	1 Gromiid + l Saccamminid attached
			60 ml	1 Gromiid + l Saccamminid
			60 ml	Astrorhizid
	55830#2	MGC	60 ml	1 Gromiid
	55830#1	MGC	60 ml	1 Gromiid
A3200	55801#14	MGC	60 ml	Xenophyophores

3% Gluteraldehyde preserved material

Site	Station	Gear	Container	Contents
A250	55807#1	MGC	vial	1 Pelosina
A300	55806#4	BC	vial	3 Lenticulina
A1200	55802#4	MC	vial	1 Gromiid
	55802#7	MGC	vial	1 Gromiid
C1200	55811#1	AT	vial	1 Gromiid
			vial	1 Gromiid
			vial	1 Gromiid
			vial	1 Gromiid
			vial	1 Gromiid
			vial	1 Gromiid
A1200	55820#1	MGC	vial	1 Saccamminid
			vial	1 Saccamminid
D1650	55841#1	AT	vial	1 pale grape Gromiid
D1800	55815#1	AT	vial	1 Sausage
			vial	1 Sausage
			vial	1 Grape
			vial	1 *Gromiia sphaerica*
			vial	1 Saccamminid
			vial	1 Saccamminid
			vial	1 Saccamminid
			vial	1 *Ammodiscus* sp.
			vial	1 *Triloculina* sp.
			vial	1 Milliolid sp.
D1750	55837#1	AT	vial	1 Sausage Gromiid
			vial	1 Sausage Gromiid
			vial	1 Sausage Gromiid
			vial	1 Dark grape Gromiid
			vial	1 Dark grape Gromiid
			vial	1 Dark grape Gromiid
			vial	1 Dark grape Gromiid
			vial	1 Saccamminid
			vial	1 Saccamminid
A1850	55827#4	MGC	vial	1 Gromiid

Ethanol preserved material

Site	Station	Gear	Container	Contents
D1750	55837#1	AT	60 ml	10 Dark grape Gromiid
			60 ml	10 Sausage Gromiid
			60 ml	1 0 Saccamminids
			60 ml	10 *Triloculina* sp.
			60 ml	6 *Hormosina* sp.
			60 ml	Fluff
D1800	55815#1	AT	60 ml	Gromiids

Ana da Silva

10.10. X-ray, ^{234}Th and ^{210}Pb studies

Site	Station 558	Gear	PB	XR	MF	GC
A150	08#02	MC	Y			
	08#03	MC	Y			
	09#04	BC		Y	Y	
	09#05	MG		Y	Y	
	09#06	MC	Y			
	09#07	BC				Y
	12#02	MG				Y
A300	03#04	MC	Y			
	03#05	MC	Y			
	03#07	BC		Y	Y	
	06#02	MG		Y	Y	
	06#03	MC	Y			
A500	14#02	BC		Y	Y	
	14#06	MG	Y			
	16#03	MG	Y			
	16#06	MC	Y			
	18#04	MC	Y			
A1200	02#03	MG		Y	Y	
	02#04	MC	Y			
	02#05	MC	Y			
	02#06	BC		Y	Y	
	22#01	MG		Y	Y	
	22#02	MC	Y			
A1850	27#04	MG		Y	Y	
	30#01	MG				Y
	30#02	MC	Y			
	30#03	MC	Y			
	30#04	MC	Y			
	30#05	BC		Y	Y	Y
A3200	01#04	BC		Y	Y	
	01#05	AT				Y
	01#06	MG		Y	Y	
	01#09	MC	Y			
	01#10	MC	Y			
	01#15	MC	Y			

(BC-box core, AT-Agassiz trawl, MG-Megacore, MC-multicore, XR-X-ray cores, MF-macrofauna, GC-megafaunal gut contents for ^{234}Th, PB-^{210}Pb profiles)

Notes: Where X-ray cores were obtained from a box core, this involved two thick slab cores (12.3 x 2.6 cm), whereas when a Megacore was sampled for X-raying this was done with 2-3 thin slab cores (6.9 x 0.9 cm). The sediment of all slab cores was subsequently sieved through 300 μm mesh sieve or, in some thin slab core cases, through a 250 μm sieve, and the samples fixed for macrofaunal composition analysis. At five sites, megafaunal individuals were collected, either intentionally with an Agassiz trawl or opportunistically found in box cores and Megacores, and their gut contents extracted for ^{234}Th analysis. All samples correspond to one individual except from the Agassiz trawl at site A3200 that corresponds to three. Where sediments for ^{210}Pb profiles were collected with a multicore, this typically means that two cores were collected from that sample and sliced. Sediment from intervals of equal depth from the two cores from each sample was mixed to yield enough sediment for subsequent analysis. In the case of site A500m, multicoring success was not assured so samples were also obtained from one Megacore in each of two drops.

Angelos Hannides

10.11. Biochemistry

Station 558	Analysis	Fraction	Preservation	Fate
01#03	DFAA	Pore water	Frozen	E'burgh
01#05	SI & Lips	Megafauna	Frozen	L'pool
01#06	AA, Ch & Lips	Solid phase	Freeze-dried	E'burgh & L'pool
01#08	Lips	Bacterial lipids	Frozen	L'pool
01#09	Pigs & Lips	Solid phase	Frozen/Freeze-dried	E'burgh & L'pool
01#13	SI & Lips	Megafauna	Frozen	L'pool
01#14	AA, Ch & Lips	Solid phase	Freeze-dried	E'burgh & L'pool
02#02	Lips	Bacterial lipids	Frozen	L'pool
02#03	DFAA	Pore water	Frozen	E'burgh
02#04	AA, Ch & Lips	Solid phase	Freeze-dried	E'burgh & L'pool
02#05	AA, Ch & Lips	Solid phase	Freeze-dried	E'burgh & L'pool
03#02	Lips	Bacterial lipids	Frozen	L'pool
03#04	AA, Ch & Lips	Solid phase	Freeze-dried	E'burgh & L'pool
03#05	Pigs & Lips	Solid phase	Frozen/Freeze-dried	E'burgh & L'pool
03#06	AA, Ch & Lips	Solid phase	Freeze-dried	E'burgh & L'pool
04#01	SI & Lips	Megafauna	Frozen	L'pool
05#01	SI & Lips	Megafauna	Frozen	L'pool
06#01	DFAA	Pore water	Frozen	E'burgh
06#02	Pigs	Solid phase	Frozen	E'burgh
08#01	Pigs	Solid phase	Frozen	E'burgh
08#03	Pigs & Lips	Solid phase	Frozen/Freeze-dried	E'burgh/L'pool
09#01	Lips	Bacterial lipids	Frozen	L'pool
09#05	AA, Ch & Lips	Solid phase	Freeze-dried	E'burgh/L'pool
09#06	AA, Ch & Lips	Solid phase	Freeze-dried	E'burgh/L'pool
11#01	SI & Lips	Megafauna	Frozen	L'pool
13#01	Pigs	Solid phase	Frozen	E'burgh
14#06	Pigs & Lips	Solid phase	Frozen/Freeze-dried	E'burgh/L'pool
15#01	SI	Megafauna (forams)	Frozen	L'pool
16#02	Lips	Bacterial lipids	Frozen	L'pool
16#03	Pigs	Solid phase	Frozen	E'burgh
16#07	AA, Ch & Lips	Solid phase	Freeze-dried	E'burgh/L'pool
17#01	SI & Lips	Megafauna	Frozen	L'pool
18#01	DFAA	Pore water	Frozen	E'burgh
18#02	AA, Ch & Lips	Solid phase	Freeze-dried	E'burgh/L'pool
21#01	SI & Lips	Megafauna	Frozen	L'pool
22#01	Pigs & Lips	Solid phase	Frozen/Freeze-dried	E'burgh/L'pool
22#02	Pigs	Solid phase	Frozen	E'burgh
27#02	Lips	Bacterial lipids	Frozen	L'pool
27#03	AA, Ch & Lips	Solid phase	Freeze-dried	E'burgh/L'pool
27#04	AA, Ch & Lips	Solid phase	Freeze-dried	E'burgh/L'pool
30#01	DFAA	Pore water	Frozen	E'burgh
30#02	Pigs	Solid phase	Frozen	E'burgh
30#03	Pigs & Lips	Solid phase	Frozen/Freeze-dried	E'burgh/L'pool
35#02	Lips	Bacterial lipids	Frozen	L'pool
37#01	SI, AA & Ch	Megafauna (forams)	Frozen	L'pool/E'burgh
38#01	Lips & Pigs	Holothurian faeces	Frozen	L'pool
41#01	SI, AA & Ch	Megafauna (forams)	Frozen	L'pool/E'burgh

Rachel Jeffreys

10.12. Water column chemistry

Site	Station number	Gear	Depths sampled	Analysis
A3200	55801#1	CTD	3078	Nuts, Chl.A, POC/N, Diss.N, Mn
'NAST'			3224	Nuts, Chl.A, POC/N, Diss.N, Mn
A3200	55801#16	CTD	2	Nuts, Chl.A, POC/N, Diss.N, Mn
'NAST'			20	Nuts, Chl.A, POC/N, Diss.N, Mn
			50	Nuts, Chl.A, POC/N, Diss.N, Mn
			100	Nuts, Chl.A, POC/N, Diss.N, Mn
			150	Nuts, Chl.A, POC/N, Diss.N, Mn
			200	Nuts, Chl.A, POC/N, Diss.N, Mn
			500	Nuts, Chl.A, POC/N, Diss.N, Mn
			1002	Nuts, Chl.A, POC/N, Diss.N, Mn
			1505	Nuts, Chl.A, POC/N, Diss.N, Mn
			2009	Nuts, Chl.A, POC/N, Diss.N, Mn
			2509	Nuts, Chl.A, POC/N, Diss.N, Mn
A3200	55801#8	BBLS	0.165mab	Nuts, POC/N, Bacterial lipids
'NAST'			0.165mab	Nuts, POC/N, Bacterial lipids
			0.165mab	Nuts, POC/N, Bacterial lipids
			0.165mab	Nuts, POC/N, Bacterial lipids
A1200	5802#1	CTD	2	Nuts, Chl.A, POC/N, Diss.N, Mn
			30	Nuts, Chl.A, POC/N, Diss.N, Mn
			50	Nuts, Chl.A, POC/N, Diss.N, Mn
			90	Nuts, Chl.A, POC/N, Diss.N, Mn
			450	Nuts, Chl.A, POC/N, Diss.N, Mn
			200	Nuts, Chl.A, POC/N, Diss.N, Mn
			300	Nuts, Chl.A, POC/N, Diss.N, Mn
			500	Nuts, Chl.A, POC/N, Diss.N, Mn
			100	Nuts, Chl.A, POC/N, Diss.N, Mn
			1092	Nuts, Chl.A, POC/N, Diss.N, Mn
			1152	Nuts, Chl.A, POC/N, Diss.N, Mn
			1172	Nuts, Chl.A, POC/N, Diss.N, Mn
			1184	Nuts, Chl.A, POC/N, Diss.N, Mn
A1200	55802#2	BBLS	0.165mab	Nuts, Bacterial lipids
			0.555mab	Nuts, POC/N, Bacterial lipids
			1.01mab	No sample taken
			1.560mab	Nuts, POC/N, Bacterial lipids
			2.12mab	No sample
A300	55803#1	CTD	2	Nuts, Chl.A, POC/N, Diss.N, Mn
			20	Nuts, Chl.A, POC/N, Diss.N, Mn
			38	Nuts, Chl.A, POC/N, Diss.N, Mn
			50	Nuts, Chl.A, POC/N, Diss.N, Mn
			100	Nuts, Chl.A, POC/N, Diss.N, Mn
			150	Nuts, Chl.A, POC/N, Diss.N, Mn
			200	Nuts, Chl.A, POC/N, Diss.N, Mn
			250	Nuts, Chl.A, POC/N, Diss.N, Mn
			270	Nuts, Chl.A, POC/N, Diss.N, Mn
			290	Nuts, Chl.A, POC/N, Diss.N, Mn
			295	Nuts, Chl.A, POC/N, Diss.N, Mn
			298	Nuts, Chl.A, POC/N, Diss.N, Mn
A300	55803#2	BBLS	0.165mab	Nuts, Bacterial lipids
			0.555mab	Nuts, POC/N, Bacterial lipids
			1.01mab	Nuts, POC/N, Bacterial lipids
			1.560mab	Nuts, POC/N, Bacterial lipids
			2.12mab	No sample
A150	55809#1	CTD	5	Nuts, Chl.A, POC/N, Diss.N, Mn
			35	Nuts, Chl.A, POC/N, Diss.N, Mn
			55	Nuts, Chl.A, POC/N, Diss.N, Mn
			80	Nuts, Chl.A, POC/N, Diss.N, Mn
			105	Nuts, Chl.A, POC/N, Diss.N, Mn
			120	Nuts, Chl.A, POC/N, Diss.N, Mn
			140	Nuts, Chl.A, POC/N, Diss.N, Mn
			145	Nuts, Chl.A, POC/N, Diss.N, Mn
			150	Nuts, Chl.A, POC/N, Diss.N, Mn
A150	55809#2	BBLS	0.165mab	Nuts, Bacterial lipids
			0.555mab	Nuts, Bacterial lipids
			1.010mab	Nuts, Bacterial lipids
			1.560mab	Nuts, Bacterial lipids
			2.120mab	No sample
A500	55816#1	CTD	2	Nuts, Chl.A, POC/N, Diss.N, Mn
			30	Nuts, Chl.A, POC/N, Diss.N, Mn

			100	Nuts, Chl.A, POC/N, Diss.N, Mn
			150	Nuts, Chl.A, POC/N, Diss.N, Mn
			180	Nuts, Chl.A, POC/N, Diss.N, Mn
			199	Nuts, Chl.A, POC/N, Diss.N, Mn
			299	Nuts, Chl.A, POC/N, Diss.N, Mn
			388	Nuts, Chl.A, POC/N, Diss.N, Mn
			438	Nuts, Chl.A, POC/N, Diss.N, Mn
			462	Nuts, Chl.A, POC/N, Diss.N, Mn
			478	Nuts, Chl.A, POC/N, Diss.N, Mn
			486	Nuts, Chl.A, POC/N, Diss.N, Mn
A500	55816#2	BBLS	0.165mab	Nuts, POC/N, Bacterial lipids
			0.555mab	Nuts, POC/N, Bacterial lipids
			1.01mab	Nuts, POC/N, Bacterial lipids
			1.560mab	Nuts, POC/N, Bacterial lipids
			2.12mab	Nuts, POC/N, Bacterial lipids
A1850	55827#1	CTD	2	Nuts, Chl.A, POC/N, Diss.N, Mn
			25	Nuts, Chl.A, POC/N, Diss.N, Mn
			500	Nuts, Chl.A, POC/N, Diss.N, Mn
			100	Nuts, Chl.A, POC/N, Diss.N, Mn
			120	Nuts, Chl.A, POC/N, Diss.N, Mn
			150	Nuts, Chl.A, POC/N, Diss.N, Mn
			200	Nuts, Chl.A, POC/N, Diss.N, Mn
			600	Nuts, Chl.A, POC/N, Diss.N, Mn
			1000	Nuts, Chl.A, POC/N, Diss.N, Mn
			1500	Nuts, Chl.A, POC/N, Diss.N, Mn
			1765	Nuts, Chl.A, POC/N, Diss.N, Mn
			1856	Nuts, Chl.A, POC/N, Diss.N, Mn
			1864	Nuts, Chl.A, POC/N, Diss.N, Mn
A1850	55827#2	BBLS	0.165mab	Nuts, Bacterial lipids
			0.555mab	Nuts, POC/N, Bacterial lipids
			1.01mab	Nuts, POC/N, Bacterial lipids
			1.560mab	Nuts, POC/N, Bacterial lipids
			2.12mab	Nuts, POC/N, Bacterial lipids
A500	55835#1	CTD	476	Nuts, Chl.A, POC/N, Diss.N, Mn
			478	Nuts, Chl.A, POC/N, Diss.N, Mn
			480	Nuts, Chl.A, POC/N, Diss.N, Mn
			482	Nuts, Chl.A, POC/N, Diss.N, Mn
			484	Nuts, Chl.A, POC/N, Diss.N, Mn
			486	Nuts, Chl.A, POC/N, Diss.N, Mn
			488	Nuts, Chl.A, POC/N, Diss.N, Mn
			490	Nuts, Chl.A, POC/N, Diss.N, Mn
			492	Nuts, Chl.A, POC/N, Diss.N, Mn
			495	Nuts, Chl.A, POC/N, Diss.N, Mn
			498	Nuts, Chl.A, POC/N, Diss.N, Mn
			500	Nuts, Chl.A, POC/N, Diss.N, Mn
			502	Nuts, Chl.A, POC/N, Diss.N, Mn
			504	Nuts, Chl.A, POC/N, Diss.N, Mn
			506	Nuts, Chl.A, POC/N, Diss.N, Mn
			508	Nuts, Chl.A, POC/N, Diss.N, Mn
			510	Nuts, Chl.A, POC/N, Diss.N, Mn
			513	Nuts, Chl.A, POC/N, Diss.N, Mn
			515	Nuts, Chl.A, POC/N, Diss.N, Mn
			517	Nuts, Chl.A, POC/N, Diss.N, Mn
			520	Nuts, Chl.A, POC/N, Diss.N, Mn
			523	Nuts, Chl.A, POC/N, Diss.N, Mn
			520	Nuts, Chl.A, POC/N, Diss.N, Mn
A500	55835#2	BBLS	0.165mab	Nuts, Bacterial lipids
			0.555mab	Nuts, Bacterial lipids
			1.01mab	Nuts, Bacterial lipids
			1.560mab	Nuts, Bacterial lipids
			2.12mab	Nuts, Bacterial lipids
A2750	55842#1	CTD	2	Nuts, Chl.A, POC/N, Diss.N, Mn
			40	Nuts, Chl.A, POC/N, Diss.N, Mn
			100	Nuts, Chl.A, POC/N, Diss.N, Mn
			130	Nuts, Chl.A, POC/N, Diss.N, Mn
			160	Nuts, Chl.A, POC/N, Diss.N, Mn
			215	Nuts, Chl.A, POC/N, Diss.N, Mn
			600	Nuts, Chl.A, POC/N, Diss.N, Mn
			1200	Nuts, Chl.A, POC/N, Diss.N, Mn
			1800	Nuts, Chl.A, POC/N, Diss.N, Mn
			2655	Nuts, Chl.A, POC/N, Diss.N, Mn
			2750	Nuts, Chl.A, POC/N, Diss.N, Mn
			2759	Nuts, Chl.A, POC/N, Diss.N, Mn

Key: *BBLS* *Benthic boundary layer sampler*
Nuts *Nutrients*
Chl A *Chlorophyll, other pigments and degradation products*
POC/N *Particulate organic carbon and nitrogen including stable isotopes δC^{15} and δN^{15}*
Diss N *Dissolved nitrogen δN^{15}*
Mn *Dissolved and particulate manganese*
mab *Meters above bottom*

Tim Brand

10.13. Dissolved organic carbon and total dissolved nitrogen

Site	Station	Type of samples	Status of Analysis
A3200	55801# 01	CTD	Completed
	55801# 03	Megacore	Completed
	55801# 08	BBLS	Completed
	55801# 16	CTD (2500m)	Completed
A1200	55802# 01	CTD	Completed *
	55802# 02	BBLS	Completed *
	55802# 03	Megacore	Completed
A300	55803# 01	CTD	Completed *
	55803# 02	BBLS	Completed *
	55806# 01	Megacore	Completed
A150	55809# 01	CTD	Completed
	55809# 02	BBLS	Completed
	55812# 02	Megacore	No samples recovered
A500	55816# 01	CTD	Completed *
	55816# 02	BBLS	Completed *
	55818# 01	Megacore	Completed
	55835# 01	CTD +	
	55835# 02	BBLS	
A1850	55827# 01	CTD	Completed *
	55827# 02	BBLS	Completed *
	55830# 01	Megacore	Completed
A2750	55842# 01	CTD	

* *indicates samples analysed or part-analysed <u>without</u> the LiCor infrared gas analyser in series.*
\+ *high resolution sampling – 24 bottles at 2-3 m intervals above the sediment-water interface.*

i) Aliquots of samples from all CTD and BBLS deployments, and from sediment porewaters at all sites apart from A3200 have been archived for transportation back to SAMS.

ii) CTD samples collected with the assistance of Terry Edwards (UKORS). Samples drawn directly from the 10l, external steel spring, Niskin bottles, using 20ml glass luer-lock syringes. The raw water was then expelled through 25mm polypropylene syringe filter holders, with silicone gasket (Sartorius), supporting 25mm GF/F filters (Whatmnan) into ashed 10ml glass ampoules containing 30µl 85% orthophosphoric acid.

iii) BBLS samples collected with the assistance of Tim Brand (SAMS). Samples drawn directly from the 1.5l BBLS bottles as described in ii above.

iv) Megacores sliced under N_2 in a glove bag (see Rachel Jeffreys, this report). Samples drawn directly from the centrifuge tubes using disposable 5ml polypropylene syringes with a 2-3cm length of cleaned silicone tubing attached. The raw water was then expelled through disposable polypropylene syringe filter units containing 13mm GF/F filters (Whatmnan) into ashed 5ml glass ampoules containing 15µl 85% orthophosphoric acid.

Axel Miller

10.14. Trawl catch samples

Station	Catch	Material preserved separately
55801#5	Asteroidea / Ophiuroidea (5l)	Zoroaster tube feet (6) - ethanol - Billett
	Holothuriodea (5l)	Benthodytes muscle (5) - ethanol - Billlett
	General catch and fish (5l)	Bathysiphon (1) - formalin - da Silva
		Asteroid (pink) sp.A (2) - frozen - Jeffreys
		Ophiuroid (salmon) sp.A (1) - frozen - Jeffreys
		Mysid sp.A (1) - frozen - Jeffreys
		Decapod sp.A (1) - frozen - Jeffreys
		Plesiopenaeus sp (1) - frozen - Jeffreys
		Zoroaster sp. (4) - frozen - Jeffreys
		Ophiomusium (2) - frozen - Jeffreys
		Limnopsis (8) - frozen - Jeffreys
		Munidopsis sp. (1) - frozen - Jeffreys
		Benthodytes sp. (5) - frozen - Jeffreys
		Scaphopoda (5) - frozen - Jeffreys
		Synaphobranchid tissue - frozen - Jeffreys
		Fish sp.A tissue - frozen - Jeffreys
55801#13	General catch (5l)	Scaphopoda (5) - frozen - Jeffreys
	Holothuriodea (5l)	Sipunculid (1) - frozen - Jeffreys
		Benthodytes sp. (5) - frozen - Jeffreys
		Zoroaster sp. (1) - frozen - Jeffreys
		Plesiopenaeus sp (2) - frozen - Jeffreys
		Ophiomusium ? lymani (1) - frozen - Jeffreys
		Asteroid sp. (pink) (1) - frozen - Jeffreys
55804#1	Whole catch (5l)	?
55804#2	Whole catch (5l)	"prawn sp." (5) - frozen - Jeffreys
55805#1	Bivalves, gastropds etc (8 x 5l)	Fish sp.1 (5)- frozen Jeffreys
	Fish (5l)	Flatfish sp.1 (5)- frozen Jeffreys
	General catch (5l)	Fish sp.2 (3)- frozen Jeffreys
		Bivalve sp.1 (cockle) (2)- frozen Jeffreys
		Bivalve sp.2 (clam) (5)- frozen Jeffreys
		Astropectin sp. (5)- frozen Jeffreys
		Spider crab sp.1 (5)- frozen Jeffreys
		Swimmer crab sp.1 (4)- frozen Jeffreys
		"fairy shrimps" (5)- frozen Jeffreys
55811#1	General catch (mainly large fauna) (5l)	Ophiuroidea (5) - ethanol - Billett
	General catch (mainly gromiids) (5l)	Crinoidea (5) - ethanol - Billett
	General catch (mainly worm tubes) (5l)	Elasmobranch tissue (1) - frozen - Jeffreys
	Fish (5l)	Ophiuroidea (orange) (5) - frozen - Jeffreys
		Actiniaria Actinoscyphia (3) - frozen - Jeffreys
		Actiniaria (pink) (2) - frozen - Jeffreys
		Actiniaria (?Actinauge bit) - frozen - Jeffreys
		Opisthobranchs (3) - frozen - Jeffreys
		Pennatulacea (2) - frozen - Jeffreys
		Sponge (part 1) - frozen - Jeffreys
		Eel (part) - frozen - Jeffreys
		"flatfish" (part) - frozen - Jeffreys
		worm tubes (6) - frozen - Jeffreys

		Gromiids - frozen - da Silva
		Gromiids - gluteraldehyde - da Silva
		Gromiids - ethanol - da Silva
		Gromiids - -70C - Larkin
		Gromiids - -70C - da Silva
		Gromiids - -70C - Jeffreys
		Gromiids - formalin - da Silva
55815#1	General catch (5l)	Gromiids (2) - frozen - Jeffreys
	Bulk forams (5l)	Miliolids (2) - frozen - Jeffreys
		Saccamminids (2) - frozen - Jeffreys
		Triloculina (2) - frozen - Jeffreys
		Protozoa misc. - gluteraldehyde - da Silva
		Protozoa misc. - -70C - Larkin
		Protozoa misc. - frozen - Woulds
		Protozoa misc. - formalin - da Silva
55817#1	Ophiuroidea and general catch (3 x 5l)	Pennatulacea (5) - frozen - Jeffreys
	Actinaria, Pennatulacea, Cephalopoda, ophiuroid (5l)	Actiniaria (Actinoscyphia ?) (5) - frozen - Jeffreys
	Fish (5l)	Actiniaria (Actinauge ?) (5) - frozen - Jeffreys
	Crustacea (5l)	Squat lobsters (10) - frozen - Jeffreys
		Natants (7) - frozen - Jeffreys
		Hexagonal ophiuroids (15) - frozen - Jeffreys
		"grotty" ophiuroids (7) - frozen - Jeffreys
		Rounded ophiouroids (15) - frozen - Jeffreys
		Fish tissue (various) - frozen - Jeffreys
		Cephalopod tissue (2) - frozen - Jeffreys
55821#1	Fish (5l)	Actinoscyphia - ethanol - Billett
	General catch (5l)	squat lobster - ethanol - Billett
	Actiniaria (Actinoscyphia) (5l)	Echinothuriid - ethanol - Billett
		Echinothuriid (5) - frozen - Jeffreys
		squat lobsters (10) - frozen - Jeffreys
		Actinoscyphia (5) - frozen - Jeffreys
		Quill worms (5 pieces) - frozen - Jeffreys
		Fish pieces - frozen - Jeffreys
55837#1	Benthothuria cristatus (5l)	B. cristatus (10 from 1 spec) - ethanol - Billett
	Megafauna (5l)	Protozoa misc - ethanol - da Silva
	Bulk protozoa	Protozoa misc - TEM - da Silva
		"fluff" - formalin - da Silva
		Protozoa misc - -70C - Larkin
		Gromiids - -70C - Jeffreys
		Gromiids - aas CHO - Woulds
55841#1	General catch (incl. fish) (5l)	Gromiids - gluteraldehyde - da Silva
	Bulk protozoa	Gromiids - -70C - Larkin
		Gromiids - -70C - Jeffreys
		2 x Gromiids - -70C - Woulds

Brian Bett, David Billett, Ana Aranda da Silva,
John Gage, Rachel Jeffreys, Kate Larkin

10.15. WASP Materials

Site	Station	MiniDV	Vision
A150	55824#1	30mins	7m
A200	55833#1	30mins	7m
A300	55825#1	30mins	7m
A400	55831#1	7mins	na
A400	55834#1	30mins	7m
A500	55818#7	30mins	7m
A1200	55819#1	30mins	7m
A1850	55830#6	60mins	15m
A3200	55843#1	60mins	15m
C1000	55828#1	30mins	7m
C1100	55829#1	30mins	7m
C1200	55820#2	60mins	15m
D1600	55839#1	30mins	7m
D1700	55840#1	30mins	7m
D1800	55826#1	60mins	15m

WASP footage retained: MiniDV – digital video, Vision – KODAK Vision 250D colour negative.

Brian Bett

10.16. 10kHz records

At cruise end, the printed record (colour injet, fanfold paper) from the EA500 consisted of:

	Start	End
"Roll" 1	16:30 13/03/03	08:50 19/03/03
"Roll" 2	09:00 19/03/03	17:10 22/03/03
"Roll" 3	17:20 22/03/03	13:30 24/03/03
"Roll" 4	13:40 24/03/03	17:10 29/03/03
"Roll" 5	17:50 29/03/03	03:20 06/04/03

All depth data (corrected) centrally logged and available on cruise CD.

Brian Bett

10.17. 3.5kHz records

At cruise end, there were six rolls of 3.5kHz grayscale paper record retained – as noted above, the time marks may be unreliable in parts therefore these should be cross-referenced with the 10kHz record or the centrally logged returns consulted (three data CDs held by the Principal Scientist).

Brian Bett

10.18. EM12 swath records

At cruise end, there were six rolls (fanfold paper) of screen dumps from the quality control unit, and four rolls of grayscale paper record output of backscatter. All raw data (bathymetry, backscatter and navigation) was logged centrally and is retained on a data CD by the Principal Scientist. Swath processing results (girded data and contour plots) are also retained on a separate data CD by the Principal Scientist.

Brian Bett

11. STATION LIST

Station list abbreviations and notes

Station	Unique deployment identification number
Site	Site name
Gear	Equipment used (see listing below)
Start	Start of sampling operation
Date	Date of operation
03	2003
Time	Time of operation
(utc)	utc / Greenwich meantime
Position	Ship's position (or estimated net position for trawls)
DN	Degrees north
MN	Minutes north
DE	Degrees east
ME	Minutes east
Depth	Depth of sampling operation
(m)	Metres (corrected)
End	End of sampling operation
Sounding	Mean sounding during sampling operations
Comment	Results etc.

Gear abbreviations and acronyms

AT	Agassiz trawl
BBLS	Benthic boundary layer sampler (water bottles)
BC	Box corer
BSNAP	Bathysnap - time-lapse seabed camera
CTD	Conductivity, temperature, depth probe (with oxygen, fluorescence, transmission) and water bottles
MC	Multiple corer
MEGAxx	Megacorer (xx core tubes deployed)
WASP	Wide-angle Seabed Photography system (video and still photography)

Station	Site	Gear	Start Date 03	Time (utc)	Position DN	MN	DE	ME	Depth (m)	End Date 03	Time (utc)	Position DN	MN	DE	ME	Depth (m)	Sounding (m)	Comment
55792#1	Sch2	BSNAP	19/12	12:38	23	29.98	59	30	3308	12/03	11:04	23	29.98	59	30	3308	3308	Successful recovery
55801#1	A3200	CTD	16/03	04:20	20	0.02	65	34.97	0	16/03	08:45	20	0.02	65	34.93	3189	3190	Full depth cast
55801#2	A3200	MEGA12	16/03	10:48	20	0.04	65	34.84	3189								3189	10/12 short cores
55801#3	A3200	MEGA08	16/03	13:20	19	59.97	65	35.04	3190								3190	8/8 good cores
55801#4	A3200	BC	16/03	16:19	19	59.96	65	35	3190								3190	Fair core.
55801#5	A3200	AT	16/03	22:00	20	1.17	65	42.06	3162	16/03	23:31	20	0.76	65	39.6	3171	3163	Fair catch, c. 5.6km run.
55801#6	A3200	MEGA08	17/03	03:03	20	0.05	65	34.95	3191								3191	8/8 good cores.
55801#7	A3200	BBLS	17/03	05:52	20	1.11	65	34.94	2020								2020	Fired midwater - aborted.
55801#8	A3200	BBLS	17/03	08:30	20	1.29	65	35.16	3188								3188	Successful deployment.
55801#9	A3200	MC	17/03	11:50	19	59.83	65	35.26	3189								3189	10/12 short cores.
55801#10	A3200	MC	17/03	14:41	20	0	65	35.04	3190								3190	12/12 short cores.
55801#11	A3200	CTD	17/03	17:06	20	0	65	35.42	3189								3189	Aborted.
55801#12	A3200	CTD	17/03	19:16	20	1.06	65	35.1	3190								3190	Aborted (again).
55801#13	A3200	AT	18/03	00:49	20	1.29	65	43.1	3157	18/03	02:10	20	0.62	65	40.28	3175	3166	Fair catch, 5.2km run
55801#14	A3200	MEGA08	18/03	06:18	19	59.83	65	34.5	3191								3191	7/8 good cores.
55801#15	A3200	MC	18/03	09:09	20	0.14	65	34.84	3189								3189	11/12 short cores.
55801#16	A3200	CTD	18/03	17:13	20	1.29	65	34.74	0	18/03	19:28	20	1.38	65	34.34	2539	3190	2500m cast.
55802#1	A1200	CTD	20/03	02:22	23	0	66	24.45	0	20/03	04:31	23	0.14	66	24.46	1189	1197	Full depth cast
55802#2	A1200	BBLS	20/03	06:54	23	0.04	66	24.35	1203								1203	Fired at seabed
55802#3	A1200	MEGA12	20/03	08:29	22	59.97	66	24.47	1200								1200	12/12 good cores
55802#4	A1200	MC	20/03	10:08	22	59.99	66	24.44	1201								1201	12/12 good cores
55802#5	A1200	MC	20/03	11:40	22	59.99	66	24.31	1202								1202	12/12 good cores
55802#6	A1200	BC	20/03	13:51	22	59.58	66	24.44	1200								1200	Fair core
55802#7	A1200	MEGA12	20/03	15:31	22	59.97	66	24.45	1200								1200	12/12 good cores
55803#1	A300	CTD	21/03	03:14	23	12.54	66	34.07	0	21/03	04:15	23	12.38	66	34.02	298	307	Full depth cast
55803#2	A300	BBLS	21/03	05:48	23	12.5	66	34.14	305								305	Fired at seabed
55803#3	A300	BC	21/03	06:43	23	12.45	66	34.2	305								305	Overfull - discarded
55803#4	A300	MC	21/03	08:08	23	12.57	66	33.99	306								306	12/12 good cores
55803#5	A300	MC	21/03	09:10	23	12.53	66	34.07	306								306	12/12 good cores

			Start								End							
Station	Site	Gear	Date	Time	Position				Depth	Date	Time	Position				Depth	Sound	Comment
			03	(utc)	DN	MN	DE	ME	(m)	03	(utc)	DN	MN	DE	ME	(m)	ing (m)	
55803#6	A300	MEGA12	21/03	10:27	23	12.25	66	33.98	311								311	10/12 good cores
55803#7	A300	BC	21/03	11:40	23	12.12	66	33.69	315								315	Fair core
55804#1	C300	AT	21/03	17:57	23	5.9	66	42.58	321	21/03	18:33	23	5.66	66	41.67	341	331	Very modest catch
55804#2	C300	AT	21/03	19:45	23	6.32	66	43.25	299	21/03	20:50	23	6.16	66	41.7	327	313	Very poor catch
55805#1	C150	AT	21/03	22:29	23	9.42	66	44.88	159	22/03	00:33	23	9.41	66	44.79	182	170	Frame and net damaged
55806#1	A300	MEGA12	22/03	05:34	23	12.74	66	34.07	299								299	12/12 good cores
55806#2	A300	MEGA12	22/03	06:29	23	12.26	66	34.69	309								309	10/12 good cores
55806#3	A300	MC	22/03	07:36	23	12.44	66	33.98	307								307	12/12 good cores
55806#4	A300	BC	22/03	08:55	23	12.43	66	34.28	305								305	Fair core
55807#1	none	MEGA08	22/03	10:26	23	16.32	66	34	258								258	8/8 good cores
55808#1	A150	MEGA08	22/03	11:30	23	16.3	66	39.24	161								161	8/8 good cores
55808#2	A150	MC	22/03	12:38	23	16.54	66	39.48	153								153	12/12 good cores
55808#3	A150	MC	22/03	13:25	23	16.57	66	39.41	149								149	12/12 good cores
55809#1	A150	CTD	23/03	03:47	23	16.5	66	39.48	0	23/03	04:31	23	16.48	66	39.31	150	153	Full depth cast
55809#2	A150	BBLS	23/03	05:45	23	16.33	66	39.57	160								160	Fired at seabed
55809#3	A150	BC	23/03	06:31	23	16.61	66	39.59	150								150	Short core, discarded
55809#4	A150	BC	23/03	06:59	23	16.46	66	39.56	153								153	Fair core
55809#5	A150	MEGA08	23/03	07:31	23	16.57	66	39.4	153								153	8/8 good cores
55809#6	A150	MC	23/03	08:19	23	16.38	66	39.49	156								156	12/12 good cores
55809#7	A150	BC	23/03	09:21	23	16.48	66	39.48	155								155	Fair core
55810#1	A500	MEGA08	23/03	15:26	23	8.21	66	30.15	499								499	7/8 good cores
55811#1	C1200	AT	23/03	21:21	22	47.42	66	32.15	1174	23/03	22:30	22	48.13	66	31.97	1177	1176	Good catch
55812#1	A150	MEGA08	24/03	03:11	23	16.58	66	39.47	150								150	7/8 good cores
55812#2	A150	MEGA08	24/03	04:02	23	16.64	66	39.43	151								151	8/8 good cores
55813#1	A300	MEGA08	24/03	05:55	23	12.57	66	33.77	308								308	8/8 good cores
55814#1	A500	BC	24/03	07:35	23	8.22	66	30	505								505	Overfull-discarded
55814#2	A500	BC	24/03	08:24	23	8.28	66	29.97	496								496	Overfull
55814#3	A500	MC	24/03	09:40	23	8.26	66	29.82	508								508	0/12, not fired
55814#4	A500	MC	24/03	10:33	23	8.5	66	30.16	483								483	0/12, not fired

			Start								End							
Station	Site	Gear	Date	Time	Position				Depth	Date	Time	Position				Depth	Sound	Comment
			03	(utc)	DN	MN	DE	ME	(m)	03	(utc)	DN	MN	DE	ME	(m)	ing (m)	
55814#5	A500	MC	24/03	11:38	23	8.34	66	30.06	495								495	0/12, not fired
55814#6	A500	MEGA08	24/03	12:43	23	8.35	66	30.16	492								492	6/8 good cores
55815#1	D1800	AT	24/03	23:52	22	51.6	66	6.92	1799	25/03	00:50	22	50.81	66	9.4	1852	1826	Good catch
55816#1	A500	CTD	25/03	06:31	23	8.31	66	30.78	0	25/03	07:41	23	8.25	66	29.85	486	492	Full depth cast
55816#2	A500	BBLS	25/03	09:47	23	8.32	66	29.64	497								497	Fired at seabed
55816#3	A500	MEGA12	25/03	11:17	23	8.06	66	30.28	502								502	8/12 good cores
55816#4	A500	MC	25/03	12:33	23	8.39	66	30	493								493	0/12, not fired
55816#5	A500	MC	25/03	13:23	23	8.27	66	30.1	498								498	0/12, not fired
55816#6	A500	MC	25/03	14:44	23	8.22	66	30.21	492								492	10/12 good cores
55816#7	A500	MC	25/03	15:56	23	8.16	66	30.17	499								499	0/12, not fired
55817#1	C1100	AT	25/03	21:26	22	47.12	66	35.14	1089	25/03	22:30	22	48.74	66	34.59	1103	1096	Good catch
55818#1	A500	MEGA12	26/03	03:27	23	8.24	66	30.12	500								500	6/12 good cores
55818#2	A500	MEGA12	26/03	04:32	23	8.3	66	30.11	495								495	8/12 good cores
55818#3	A500	MC	26/03	05:53	23	8.18	66	29.97	506								506	0/12, not fired
55818#4	A500	MC	26/03	06:37	23	8.36	66	30	512								512	12/12 good cores
55818#5	A500	MC	26/03	07:48	23	8.2	66	30.04	504								504	0/12, not fired
55818#6	A500	MC	26/03	08:40	23	8.08	66	29.8	518								518	0/12, not fired
55818#7	A500	WASP	26/03	09:52	23	7.99	66	29.22	563	26/03	10:24	23	7.93	66	28.95	608	586	Good tow
55819#1	A1200	WASP	26/03	12:34	23	0.04	66	23.99	1203	26/03	13:11	22	59.97	66	23.9	1222	1212	Good tow
55819#2	A1200	MEGA12	26/03	15:07	22	59.95	66	24.44	1197								1197	11/12 good cores
55820#1	C1200	MEGA12	26/03	17:58	22	47.88	66	32.19	1170								1170	11/12 good cores
55820#2	C1200	WASP	26/03	19:43	22	47.82	66	32.11	1165	26/03	20:52	22	48.16	66	31.66	1187	1176	Good tow
55821#1	C1400	AT	27/03	00:10	22	47.45	66	27.77	1405	27/03	01:10	22	48.89	66	27.21	1407	1406	Good catch
55822#1	A1200	MEGA12	27/03	04:16	22	59.97	66	24.44	1200								1200	12/12 good cores
55822#2	A1200	MC	27/03	06:07	23	0	66	24.38	1200								1200	12/12 good cores
55823#1	A500	MC	27/03	08:12	23	8.33	66	30.18	487								487	0/12, not fired
55823#2	A500	MC	27/03	09:00	23	8.48	66	29.94	491								491	0/12, not fired
55823#3	A500	MC	27/03	09:51	23	8.45	66	30.08	484								484	0/12, not fired
55824#1	A150	WASP	27/03	12:12	23	16.44	66	39.31	150	27/03	12:45	23	16.36	66	39.52	157	154	Good tow

Station	Site	Gear	Start Date 03	Time (utc)	Position DN	MN	DE	ME	Depth (m)	End Date 03	Time (utc)	Position DN	MN	DE	ME	Depth (m)	Sounding (m)	Comment
55824#2	A150	MEGA06	27/03	13:20	23	16.46	66	39.46	155								155	6/6 good cores
55825#1	A300	WASP	27/03	14:46	23	12.49	66	30.02	307	27/03	15:21	23	12.55	66	34.2	304	306	Good tow
55826#1	D1800	WASP	28/03	01:13	22	51.11	66	8.26	1836	28/03	02:21	22	50.57	66	8.36	1806	1821	Good tow
55826#2	D1800	MEGA12	28/03	04:54	22	51.08	66	8.32	1833								1833	8/12 good cores
55827#1	A1850	CTD	28/03	07:10	22	51.34	65	59.89	0	28/03	09:43	22	51.21	65	59.78	1664	1869	Full depth cast
55827#2	A1850	BBLS	28/03	13:06	22	51.37	66	0.02	1870								1870	Fired at seabed
55827#3	A1850	MEGA12	28/03	15:40	22	51.35	66	0.09	1870								1870	12/12 good cores
55827#4	A1850	MEGA12	28/03	17:46	22	51.5	66	0.1	1867								1867	12/12 good cores
55828#1	C1000	WASP	28/03	23:09	22	51.26	66	35.85	1018	28/03	23:44	22	50.95	66	35.73	1034	1026	Good tow
55829#1	C1100	WASP	29/03	01:30	22	48.02	66	34.9	1098	29/03	02:07	22	47.76	66	34.92	1100	1099	Good tow
55830#1	A1850	MEGA12	29/03	07:26	22	50.84	65	59.72	1874								1874	12/12 good cores
55830#2	A1850	MC	29/03	09:41	22	50.77	65	59.56	1874								1874	11/12 good cores
55830#3	A1850	MC	29/03	11:34	22	51.32	66	0.01	1870								1870	12/12 good cores
55830#4	A1850	MC	29/03	13:25	22	51.4	65	59.95	1870								1870	12/12 good cores
55830#5	A1850	BC	29/03	15:35	22	51.36	66	0.07	1870								1870	Fair core
55830#6	A1850	WASP	29/03	17:48	22	51.23	65	59.75	1867	29/03	18:57	22	50.92	65	59.7	1874	1870	Good tow
55831#1	A400	WASP	30/03	01:24	23	9.72	66	31.3	395	30/03	01:41	23	9.61	66	31.23	407	401	Aborted tow
55832#1	A150	MEGA08	30/03	03:41	23	16.52	66	39.5	152								152	8/8 good cores
55833#1	A200	WASP	30/03	04:46	23	15.46	66	38.08	187	30/03	05:17	23	15.23	66	37.91	187	187	Good tow
55834#1	A400	WASP	30/03	06:48	23	9.55	66	31.14	405	30/03	07:19	23	9.38	66	30.77	426	412	Good tow
55835#1	A500	CTD	30/03	08:17	23	8.08	66	30	0	30/03	09:30	23	7.46	66	29.54	527	535	Full depth cast
55835#2	A500	BBLS	30/03	11:39	23	8.38	66	29.62	497								497	Fired at seabed
55835#3	A500	MEGA12	30/03	12:56	23	8.17	66	30.1	502								502	10/12 good cores
55835#4	A500	MEGA12	30/03	13:55	23	8.23	66	30.16	497								497	7/12 good cores
55835#5	A500	MEGA12	30/03	14:55	23	8.23	66	30.12	499								499	5/12 good cores
55836#1	A1200	MEGA08	30/03	17:04	22	59.89	66	24.12	1214								1214	7/8 good cores
55837#1	D1750	AT	30/03	22:28	22	57.21	66	9.51	1791	30/03	23:45	22	55.01	66	9.59	1814	1802	Fair catch
55838#1	A1850	MEGA12	31/03	04:07	22	51.31	66	0.03	1871								1871	12/12 good cores
55838#2	A1850	BC	31/03	06:48	22	50.56	65	59.67	1877								1877	Corer lost!

Station	Site	Gear	Start Date 03	Start Time (utc)	Start Position DN	Start Position MN	Start Position DE	Start Position ME	Start Depth (m)	End Date 03	End Time (utc)	End Position DN	End Position MN	End Position DE	End Position ME	End Depth (m)	Sounding (m)	Comment
55839#1	D1600	WASP	31/03	12:34	23	5.96	65	59.52	1625	31/03	13:06	23	5.73	65	59.48	1640	1632	Good tow
55840#1	D1700	WASP	31/03	15:12	23	2.25	65	59.48	1705	31/03	15:49	23	1.94	65	59.45	1710	1708	Good tow
55841#1	D1650	AT	31/03	20:05	23	4.49	65	50.54	1620	31/03	21:15	23	4.86	65	48.49	1660	1640	Smallish catch
55842#1	A2750	CTD	01/04	05:46	22	5.1	65	49.02	0	01/04	08:46	22	4.58	65	48.59	2759	2769	Full depth cast
55843#1	A3200	WASP	02/04	00:15	19	59.71	65	34.95	3190	02/04	01:25	19	59.17	65	34.87	3191	3190	Good tow

12. CHARTS

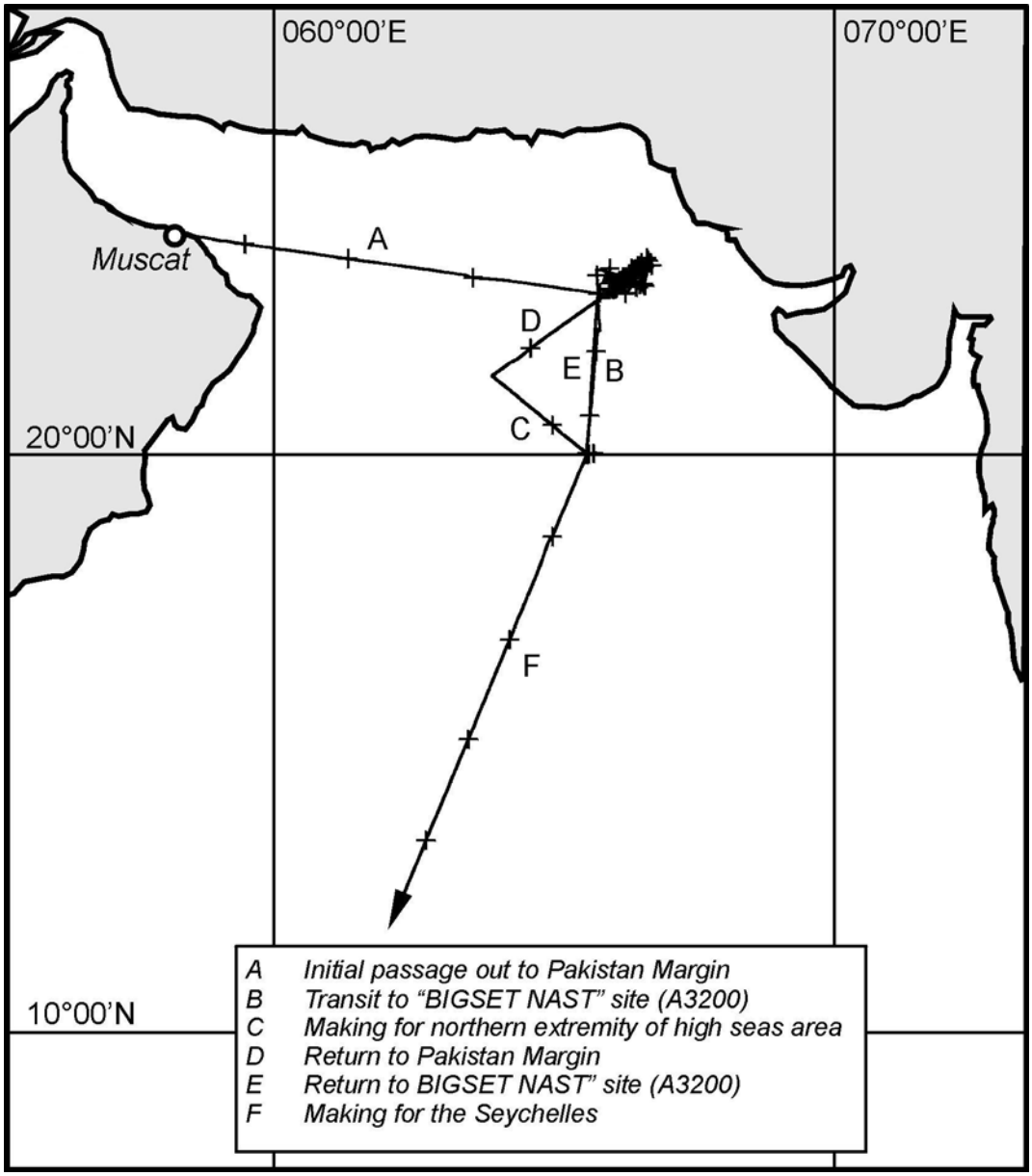


Chart 1. Track chart RRS Charles Darwin *cruise 145 (see Narrative for further details).*

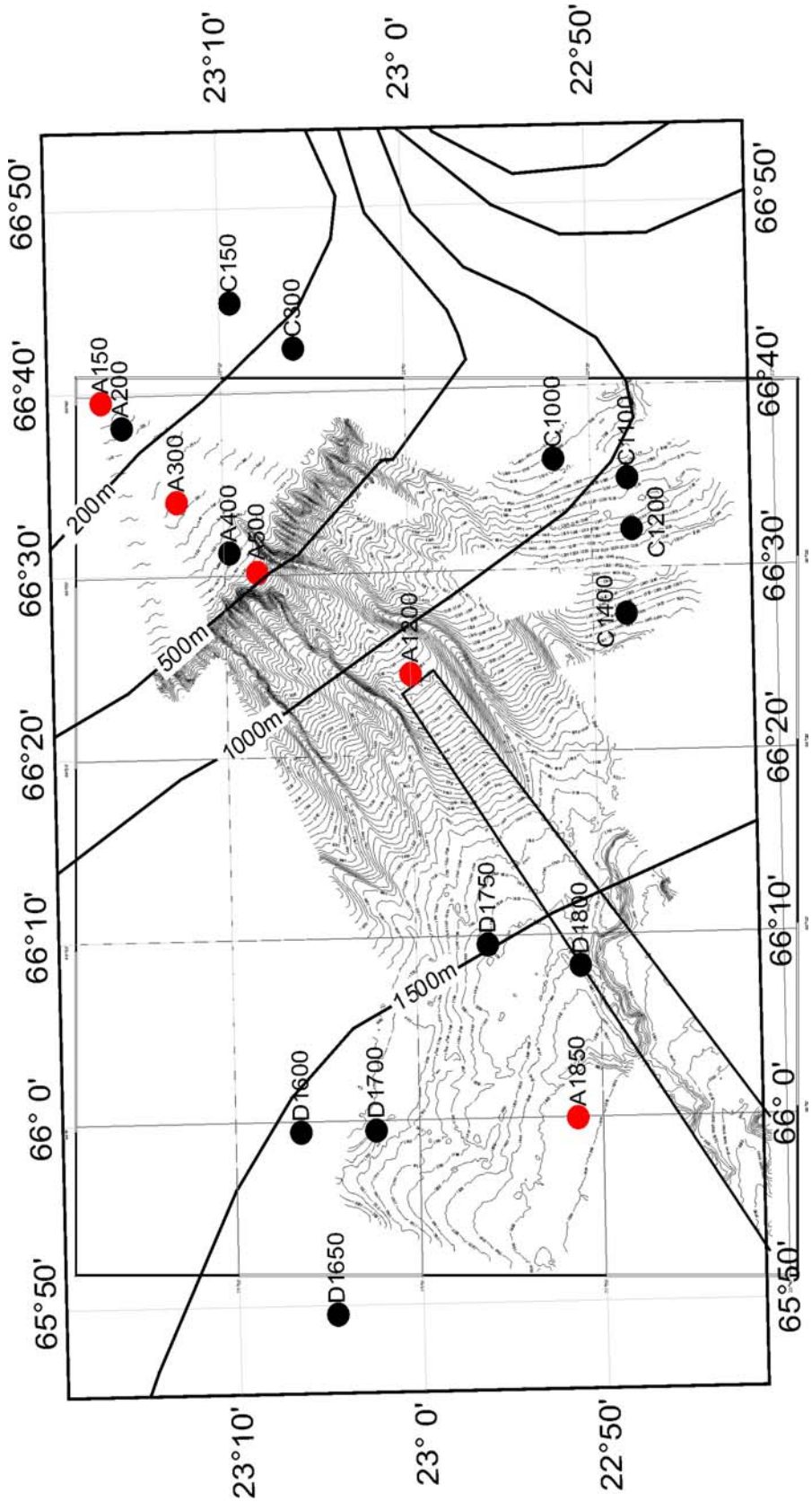
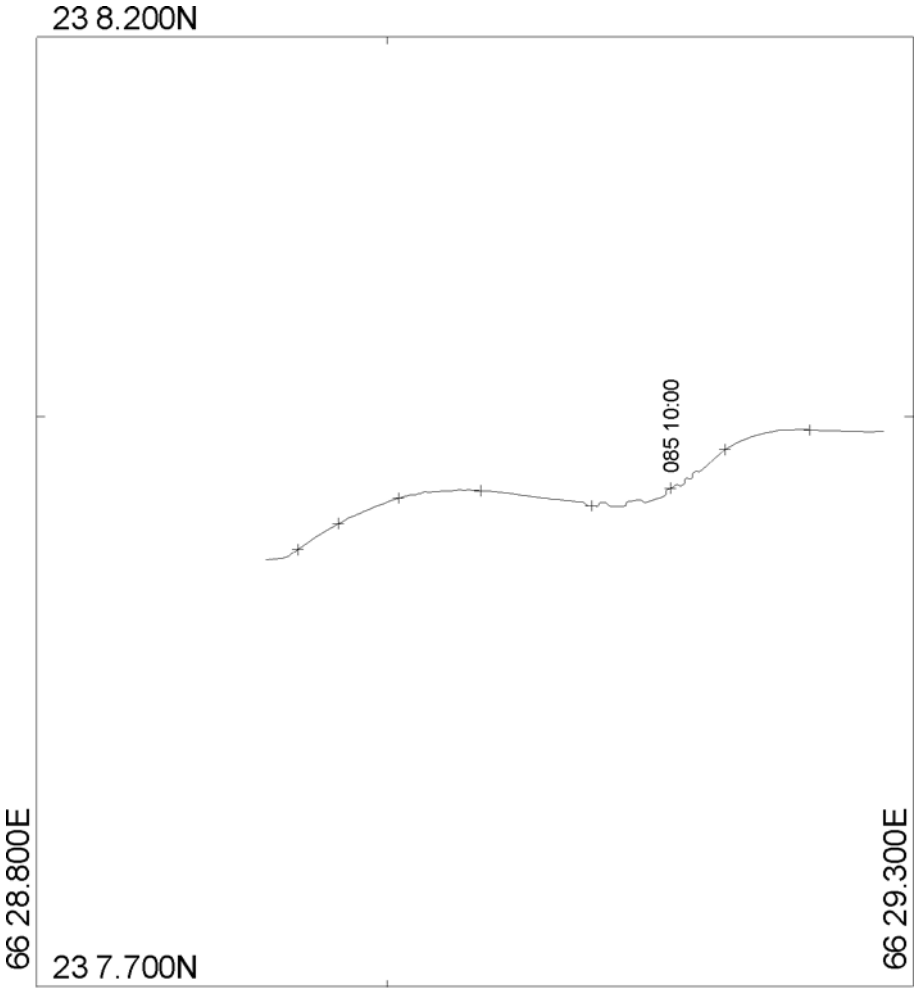


Chart 2. RRS Charles Darwin *cruise 145 – sites overlaid on swath chart.*

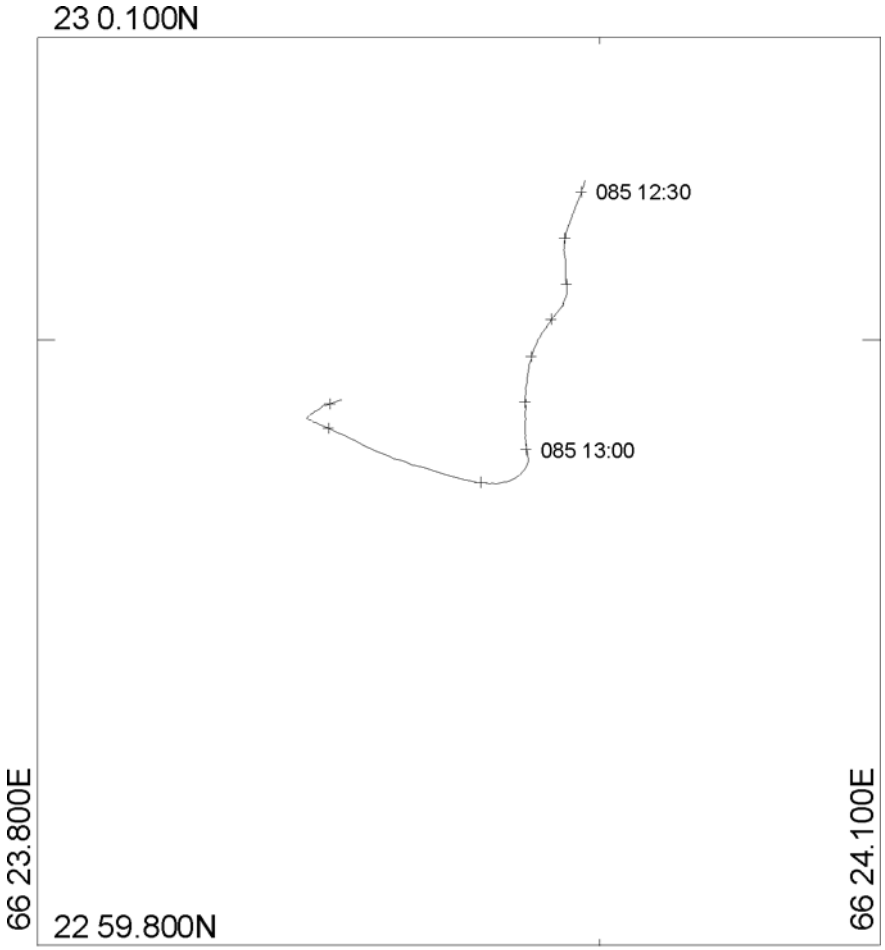


MERCATOR PROJECTION

SCALE 1 TO 8000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 23

WASP 55818#7

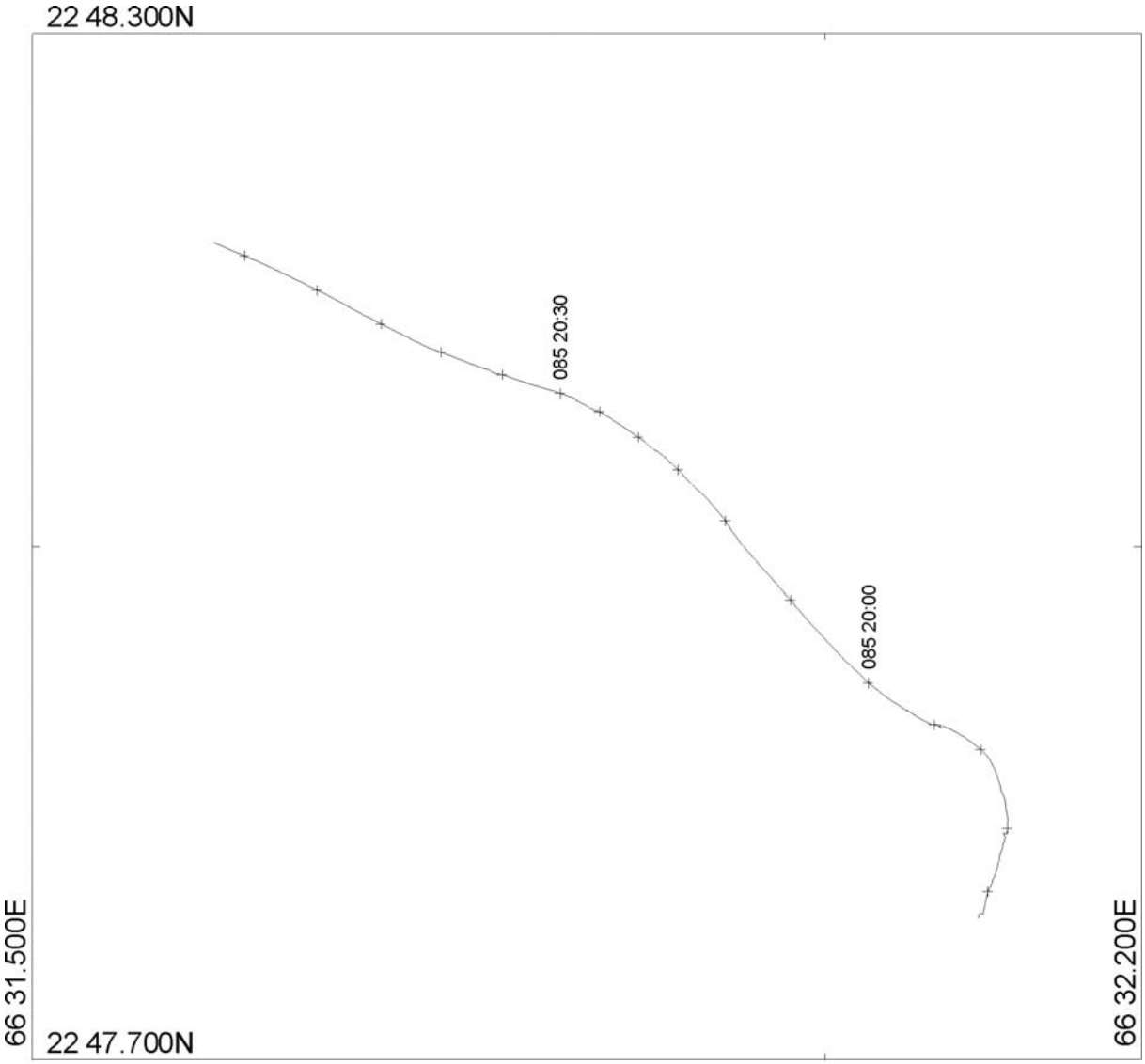


MERCATOR PROJECTION

SCALE 1 TO 5000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 23

WASP 55819#1

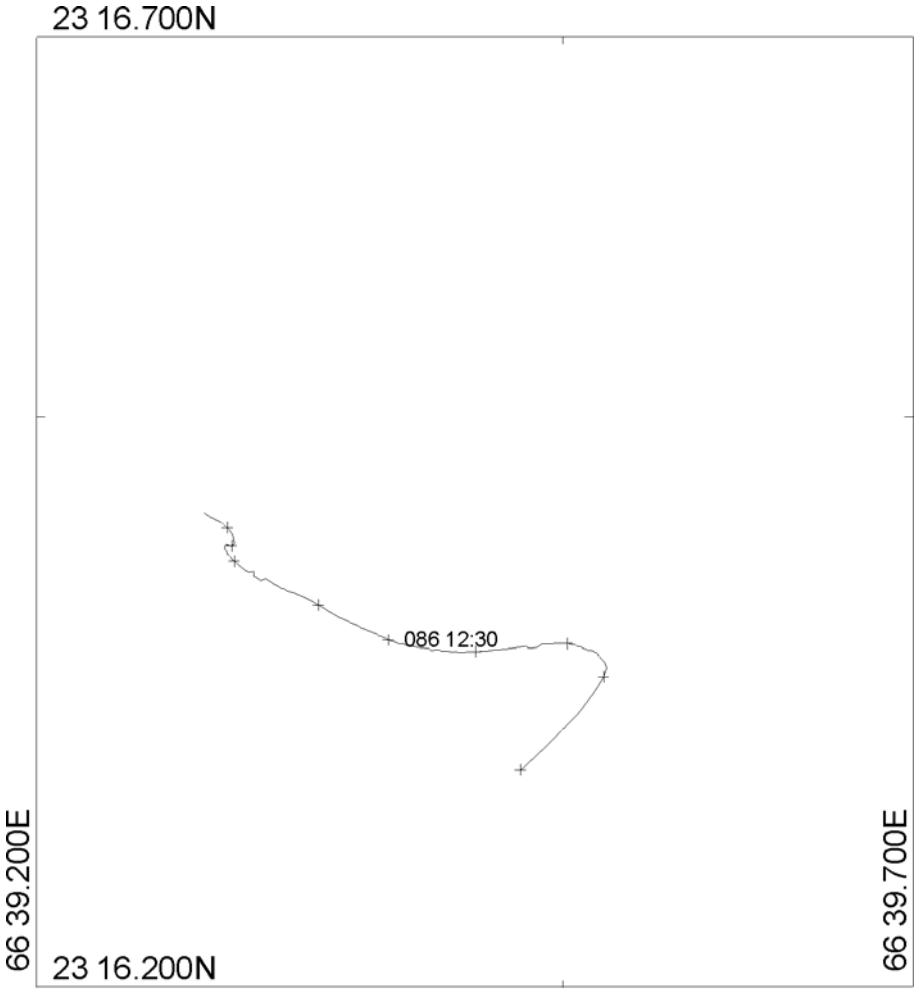


MERCATOR PROJECTION

SCALE 1 TO 8000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 23

WASP 55820#2

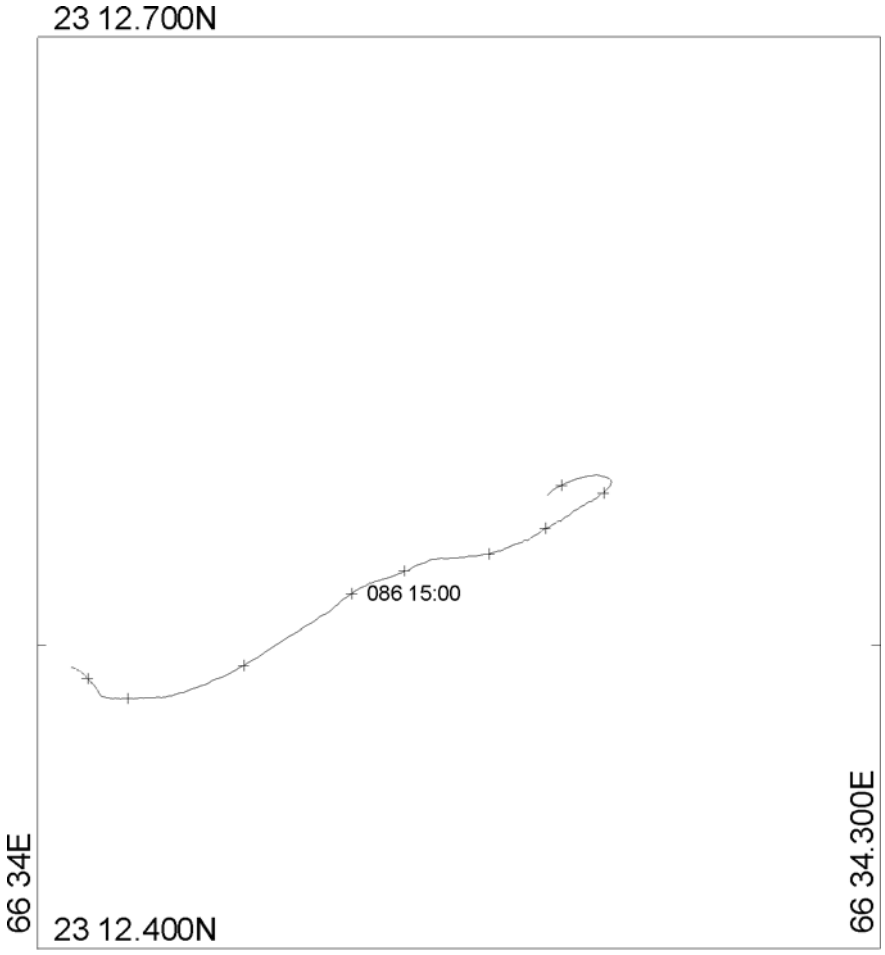


MERCATOR PROJECTION

SCALE 1 TO 8000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 23

WASP 55824#1

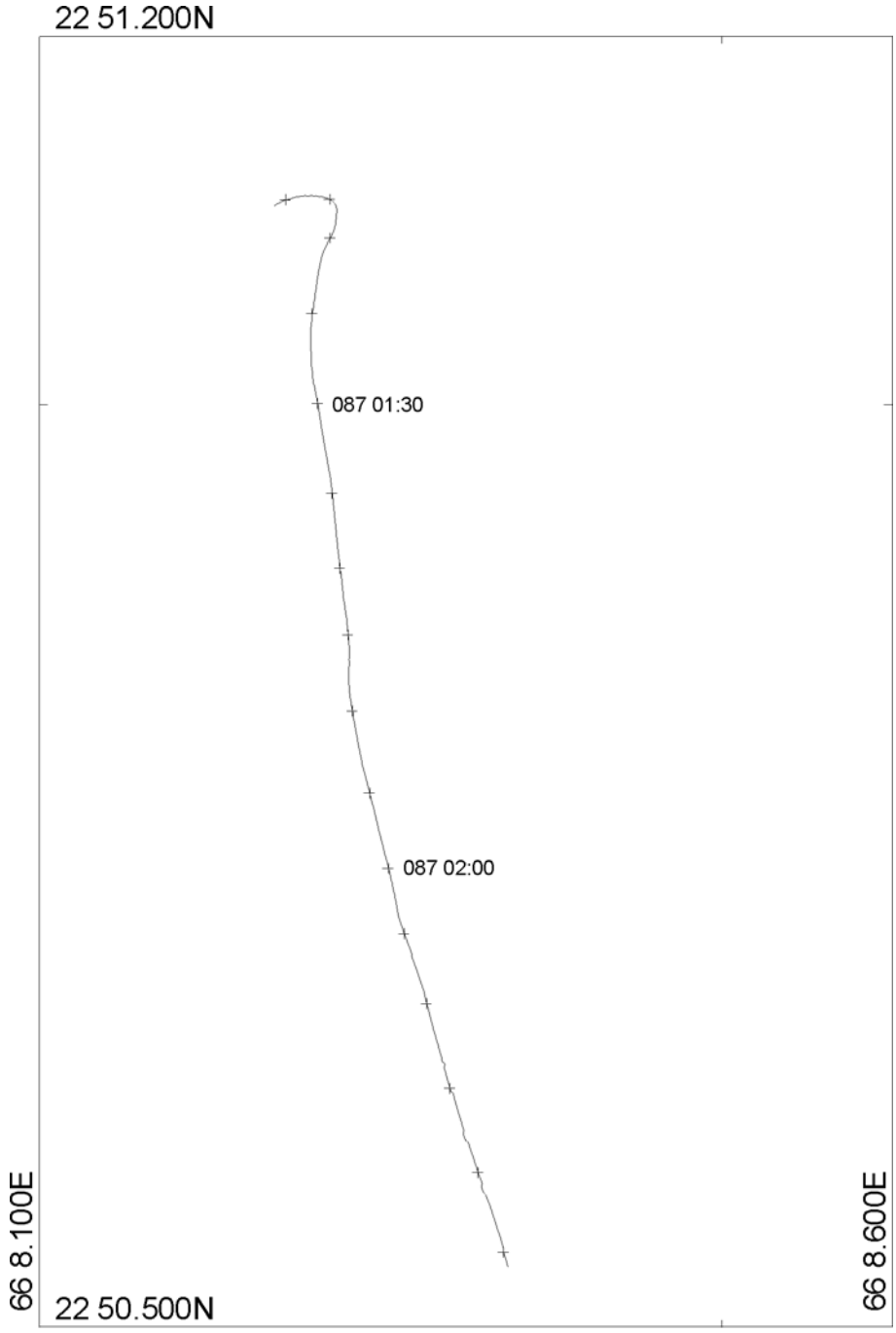


MERCATOR PROJECTION

SCALE 1 TO 5000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 23

WASP 55825#1

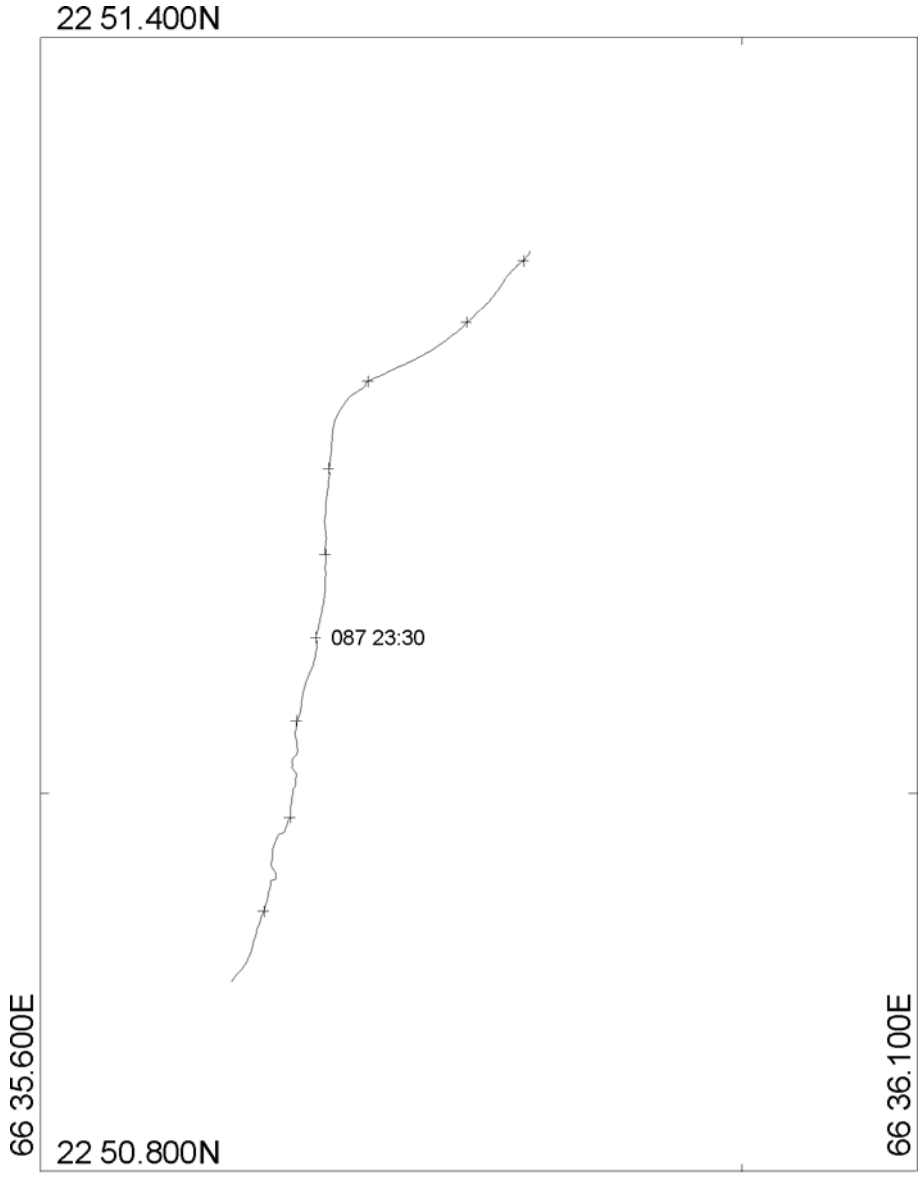


MERCATOR PROJECTION

SCALE 1 TO 8000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 23

WASP 55826#1

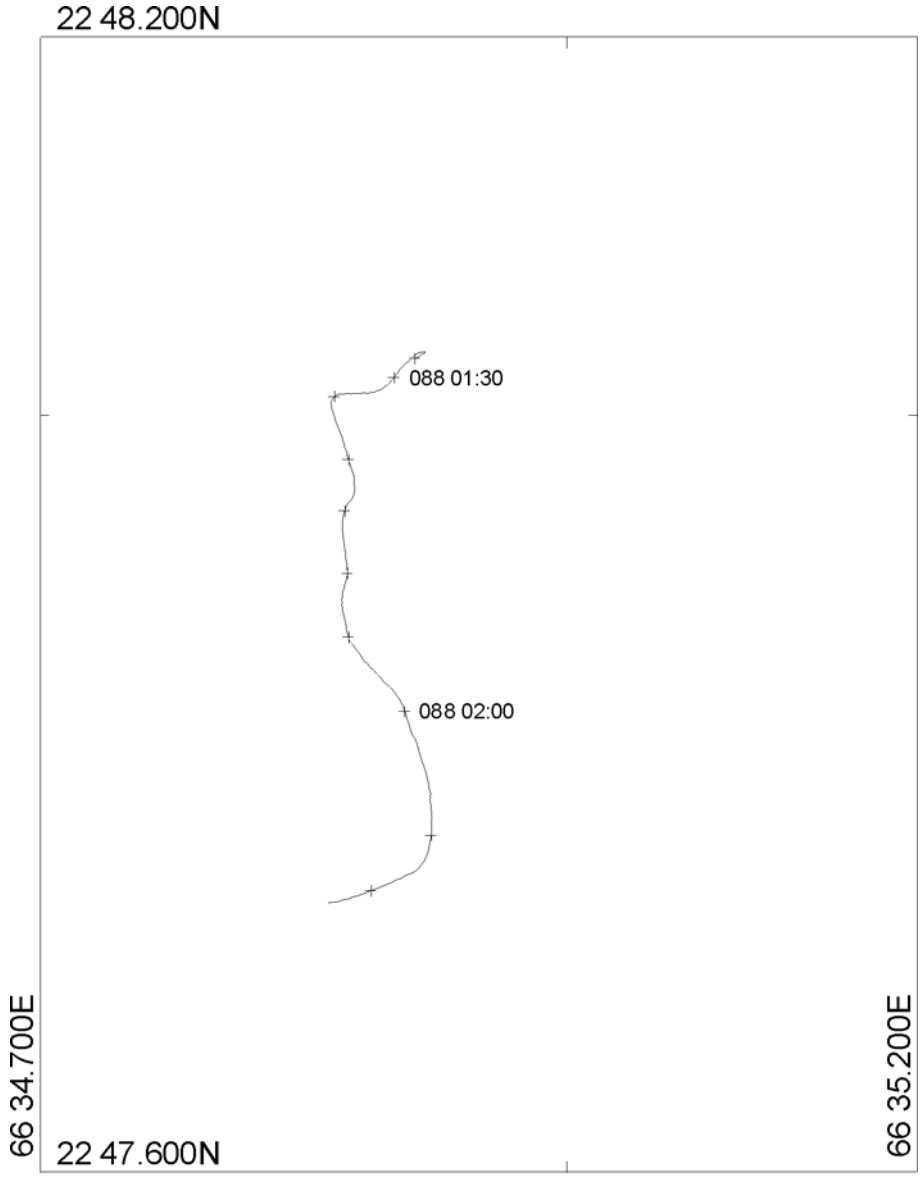


MERCATOR PROJECTION

SCALE 1 TO 8000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 23

WASP 55828#1

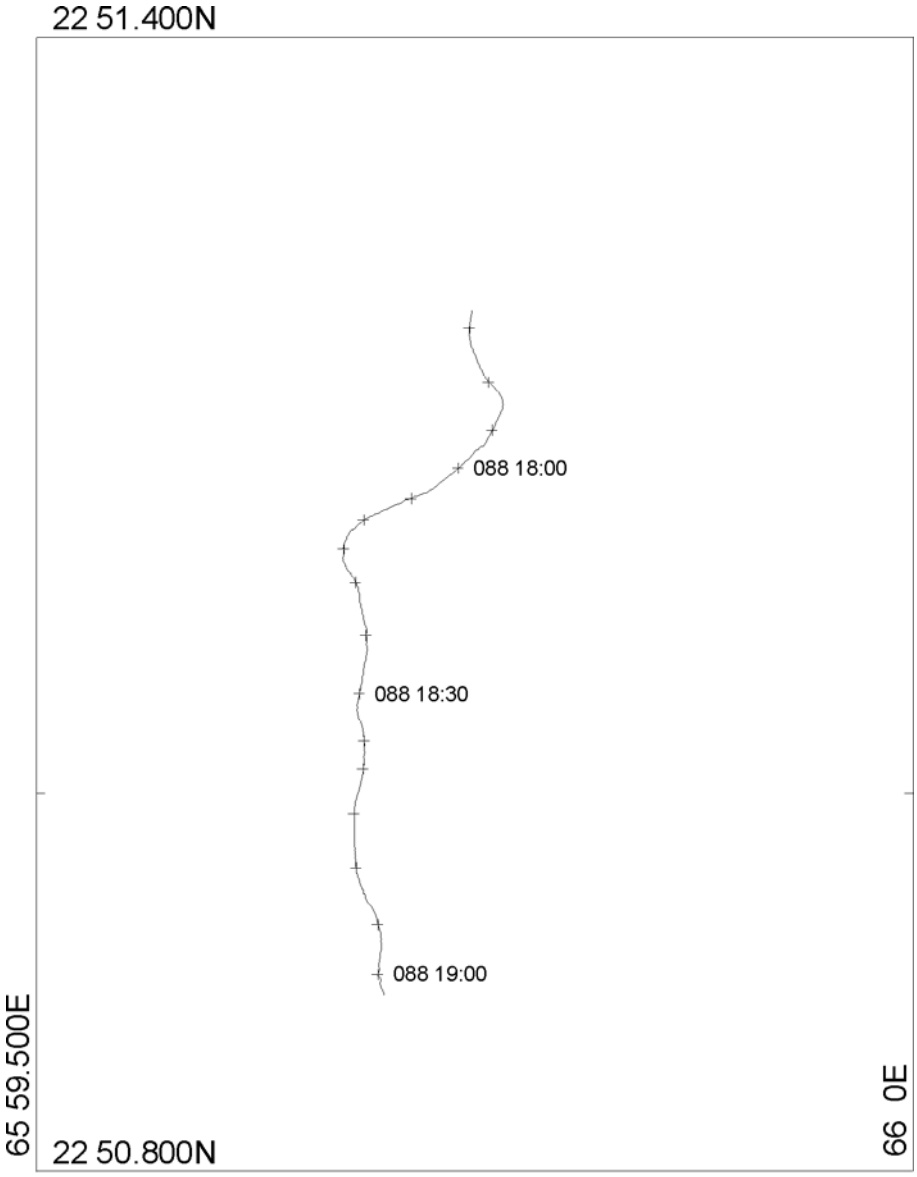


MERCATOR PROJECTION

SCALE 1 TO 8000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 23

WASP 55829#1

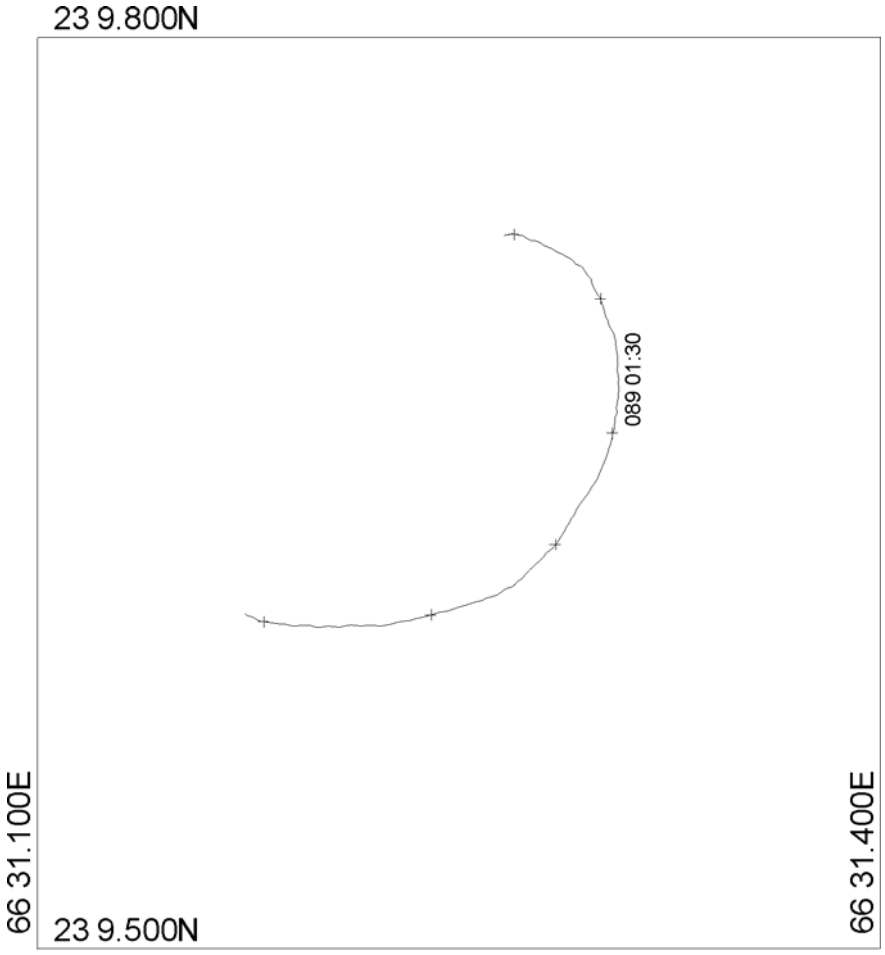


MERCATOR PROJECTION

SCALE 1 TO 8000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 23

WASP 55830#6



MERCATOR PROJECTION

SCALE 1 TO 5000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 23

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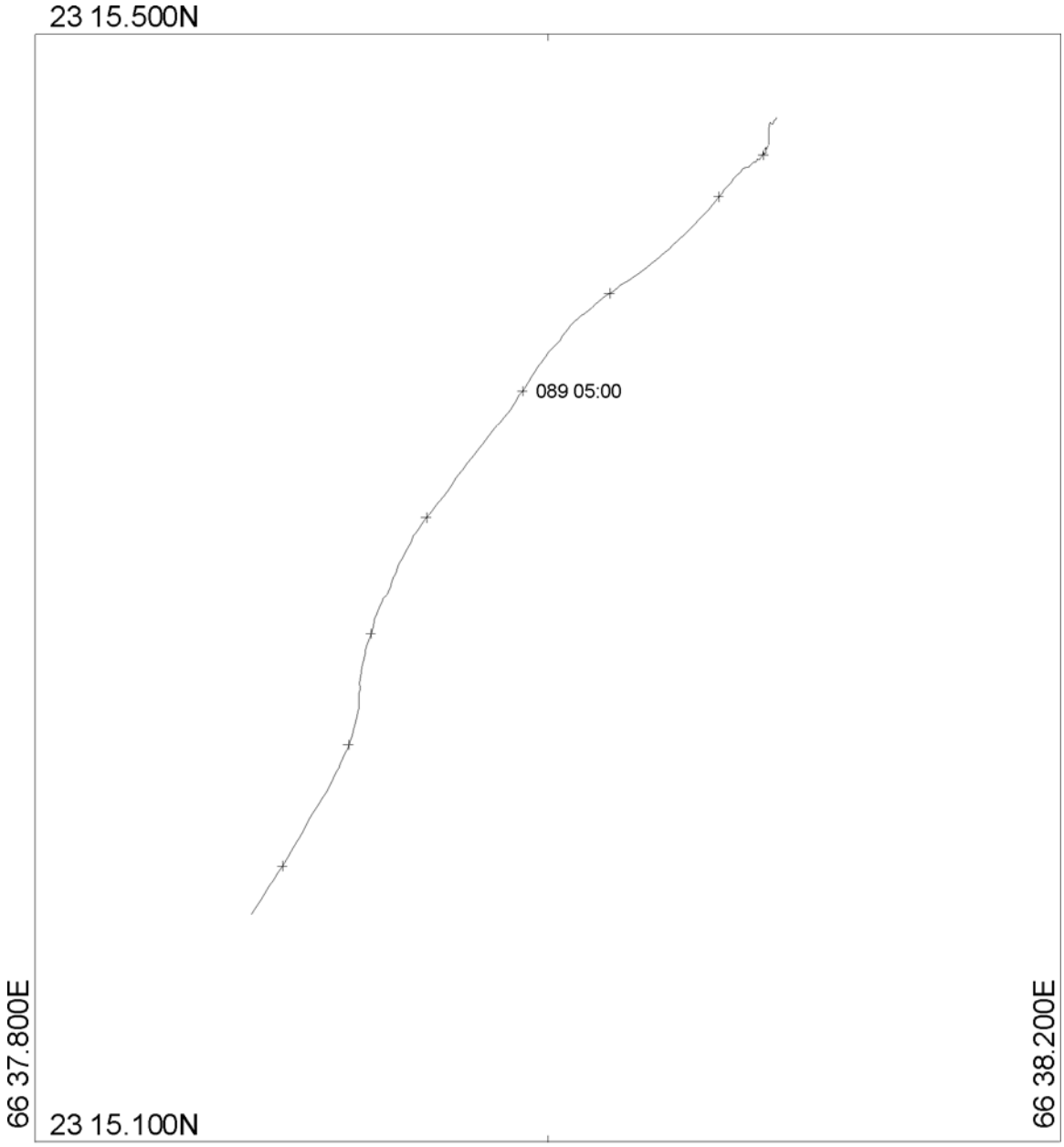
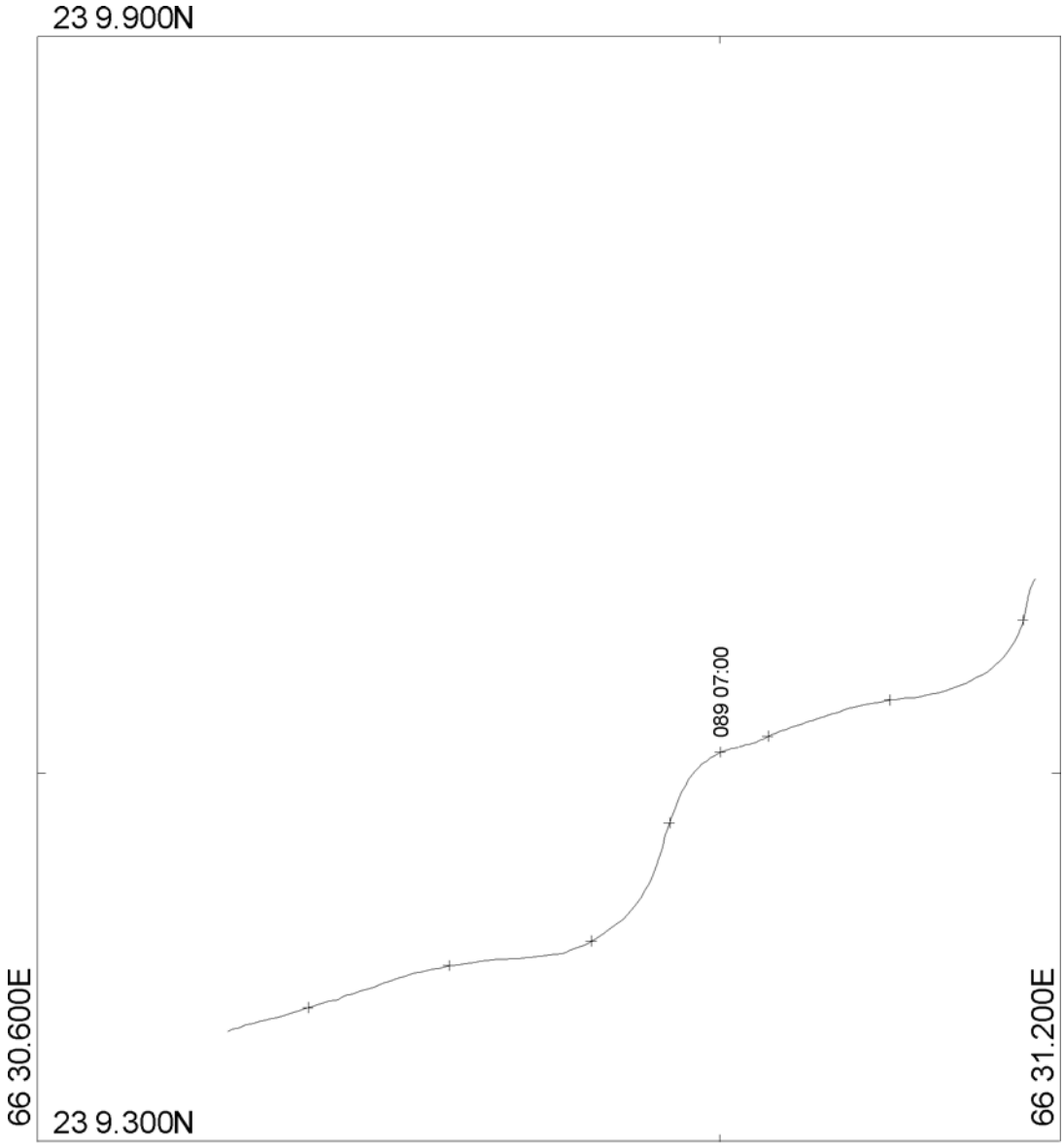


MERCATOR PROJECTION

SCALE 1 TO 5000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 23

WASP 55833#1



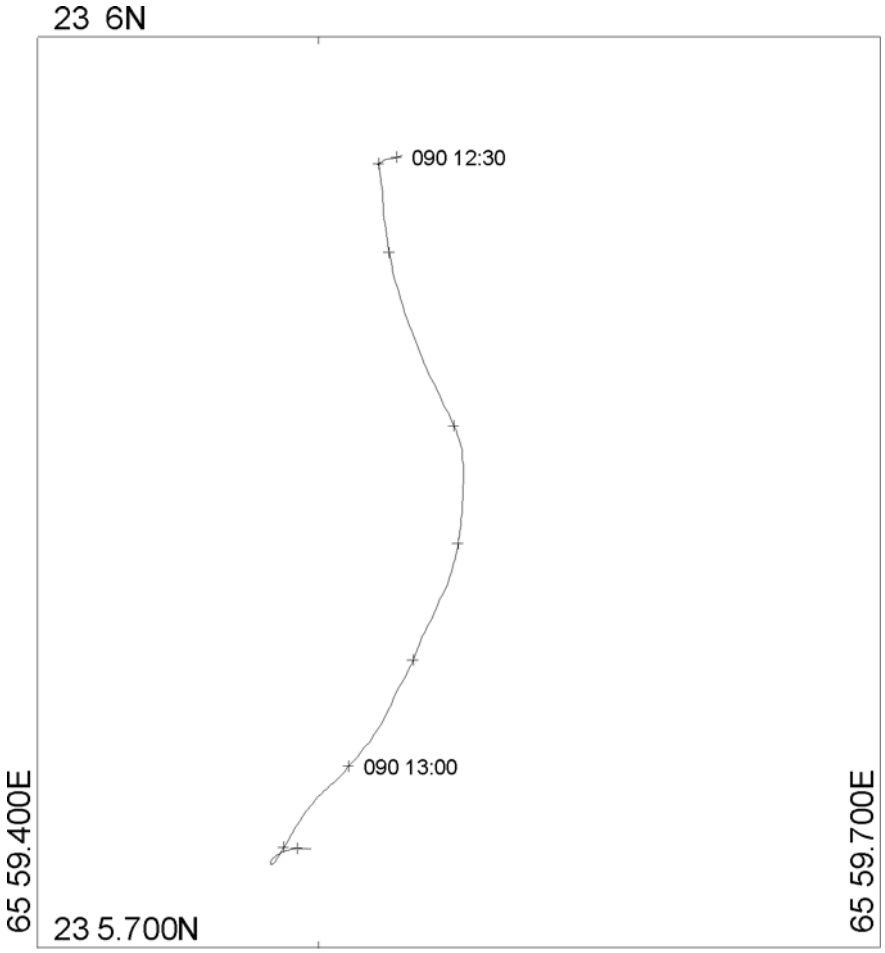
RVS

MERCATOR PROJECTION

SCALE 1 TO 8000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 23

WASP 55834#1

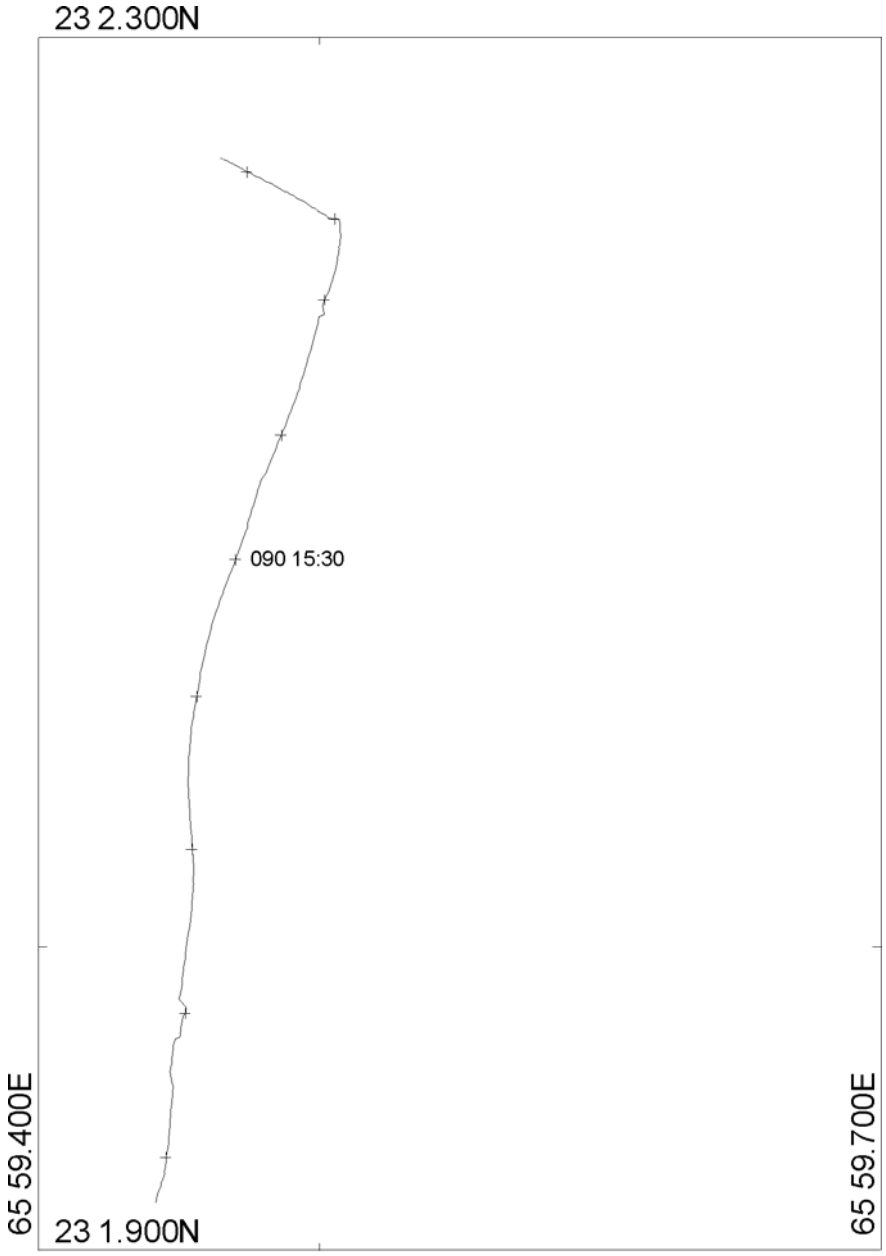


MERCATOR PROJECTION

SCALE 1 TO 5000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 23

WASP 55839#1

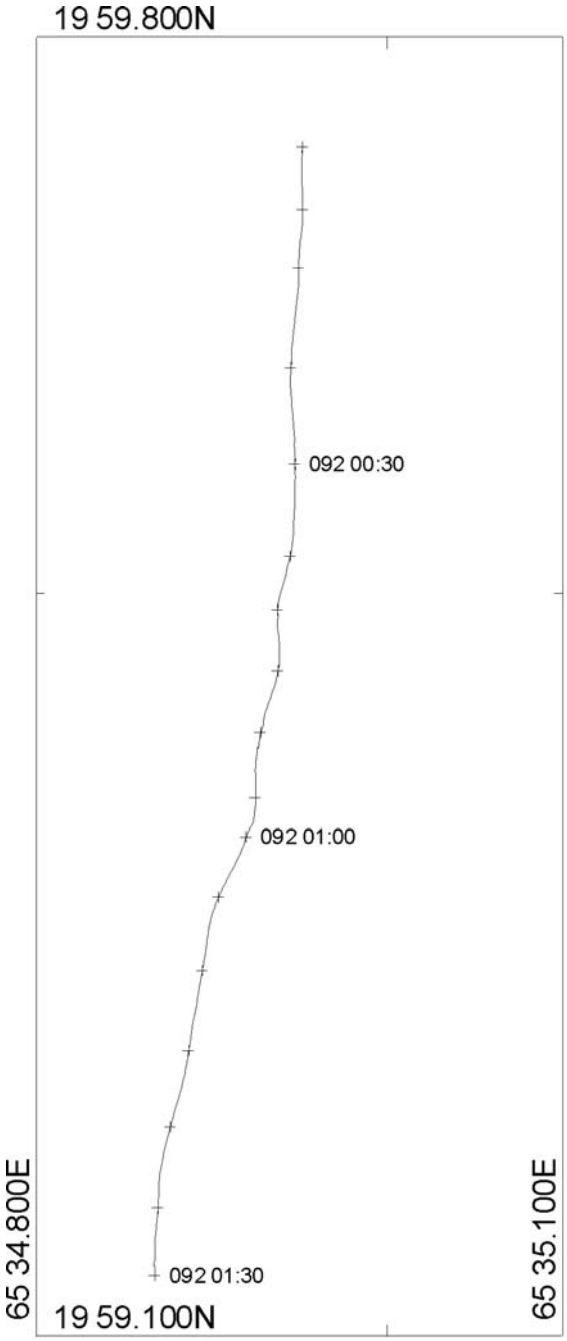


MERCATOR PROJECTION

SCALE 1 TO 5000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 23

WASP 55840#1



MERCATOR PROJECTION

SCALE 1 TO 8000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 23

WASP 55843#1

13. The End – the ode.

CD145 crossing the Arabian Sea,
the 'BIGARSE' cruise of 2003,

With manic skippers Andy, Terrie and Glyn,
and Axel glued to binoculars, ever searching for 'that fin'

'Right'…that'll be Rachel…. 'I'm off to the gym'
And Terry at the bow replying 'one beer is a sin'
Rachel keeps calm as the freeze drier explodes
The reason for this… 'nobody knows!'

A quick scan of the main lab catches Heather in her box,
And in strolls the Captain, proudly wearing 'those socks'!

Titus announces there'll soon be X-raying again,
and we all picture Angelos working in his 'den'.

Peter and John fill us with awe,
As drop after drop, they reach for those cores.

Watch out, there's the crew, covered in grease,
And lets not forget D.I.Y experts Alan and grandpa Rhys

Hang on a minute, there's Kate, the lemsip 'junkie'
And sidekick Xana, dancing to music that's funky!

As nighttime falls, Phil is seen on deck with his bait,
And e-mail hero Gareth does the honours at half past eight.

There are ping-pong antics from chief engineer Jet,
and Tim answering 'trivial' questions that none of us get!

Morning rises again, and the smiling members of the galley
make sure we eat well and keep up our ice cream tally!

Hark, the sound of sweet music…it must be operatic Dave,
And our in-house thespian Martyn….. that night in the bar was a fave.

But amongst the mayhem, cool-headed Brian runs the show
Battling behind the scenes to keep us all in the know.
For it's off to the Seychelles and back home for many,
But the ship carries on, the veterans are ready!

So cheers to birthdays, to sunsets and beer,
To cold rooms (?!), core stores and box core gear (!)
To equator crossings and trivial pursuit,
To lemon tart with toffee sauce and dwindling supplies of fruit!

Kate and Xana