CRUISE REPORT: CD151

1. SCIENTIFIC PERSONNEL

Eric Breuer	Scottish Association for Marine Science
Greg Cowie (PS)	University of Edinburgh
Andy Gooday	SOC – George Deacon Division
Rachel Jeffries	Liverpool University
Kate Larkin	SOC – George Deacon Division
Gareth Law	Univerisity of the Highlands and Islands
Steve Mowbray	University of Edinburgh
Oli Peppe	Scottish Association for Marine Science
Matthew Schwartz	University of Edinburgh
Tariq Masood Ali Khan	National Institute of Oceanography (Pakistan)
William Thompson	Scottish Association for Marine Science
Sandra Vandewiele	NIOO, the Netherlands
Christine Whitcraft	Scripps Institute of Oceanography
Clare Woulds	University of Edinburgh
R. Roberts	SOC - Ocean Engineering Division
W. Smith	SOC - Ocean Engineering Division
D. Comben	SOC – Ocean Engineering Division
D. Teare	SOC - Ocean Engineering Division
G. Knight	SOC - Ocean Engineering Division

2. SHIP'S PERSONNEL

P. Sarjeant	Master
P. Newton	Chief Officer
T. Owoso	2nd Officer
R. Clarke	3rd Officer
I. McGill	Chief Engineer
A. Greenhorn	2nd Engineer
K. Connor	3rd Engineer
D. Ardern	3rd Engineer
J. McIntyre	Electrical-Technical Officer
K. Luckhurst	Bosun
M Harrison	Bosun's mate
P. Allison	Seaman 1A
J. Dale	Seaman 1A
G. Crabb	Seaman 1A
I. Thomson	Seaman 1A
K. Pringle	Motorman
C. Perry	Ship's Catering Manager
P. Lynch	Chef
W. Isby	Assistant Chef
J. Osborn	Steward

3. ITINERARY

Sailed Port Sultan Qaboos, Muttrah, Muscat,Oman	17 September, 2003
Arrive Pakistan Margin work area	19 September, 2003
Departed Pakistan Margin work area	18 October, 2003
Docked in Port Sultan Qaboos, Muscat	20 October, 2003

4. OBJECTIVES

RRS Charles Darwin cruise 151 forms part of a larger programme of research (*Benthic processes in the Arabian Sea: mechanistic relationships between benthos, sediment biogeochemistry and organic matter cycling*), focusing on the benthic biogeochemistry of the Pakistan Margin, that includes four cruises in total (CD145,

CD146, CD150 and CD151). The research conducted over the four cruises is closely linked and is designed to provide a comprehensive assessment of benthic communities, sediment biogeochemistry and benthic system function at sites with contrasting redox conditions across the mid-slope oxygen minimum zone (OMZ) in monsoon vs. intermonsoon conditions of contrasting productivity. The primary objectives of the present cruise (monsoon conditions) are:

a) To complete characterisation of benthic communities under monsoon conditions at five sites spanning the mid-slope OMZ on the Pakistan margin, as commenced on CD150 (to provide cross-cruise replication and comparison to intermonsoon conditions as sampled on CD145 and CD146). This will entail use of a combination of coring devices (multi- and megacorers) and an Agassiz trawl.

b) Using the same coring techniques at the same stations to complete a parallel investigation of sediment geochemistry (solids and porewaters; organic, inorganic, nutrients, radiochemistry).

c) To complete characterisation of sediment microstructure, bioturbation and sediment mixing and accumulation rates via x-radiography, radiochemical analyses and particle tracer studies.

d) To further assess water-column and benthic boundary layer chemistry as commenced on CD150, using sensors and/or water samples collected by CTD and Benthic Boundary Layer Sampler (BBLS), respectively.

e) To assess the importance of chemosynthetic C sources in the OMZ via molecular and isotopic analyses and opportunistic sampling of bacterial mats.

f) To assess oxygen penetration depths and benthic consumption rates via shipboard and *in situ* microelectrode profiling and sediment incubation studies.

g) To determine benthic fluxes of nutrients, trace metals and dissolved organic matter using shipboard and *in situ* incubation studies maintained at ambient O_2 levels.

h) To complete assessment of benthic microbial process rates by aforementioned O_2 consumption studies combined with rate determinations of denitrification and Fe/Mn cycling via direct analysis, or modeling of porewater profiles and benthic fluxes.

i) To quantify benthic C cycling using added ^{13}C-enriched organic matter in shipboard and *in situ* incubation experiments, tracking the ^{13}C into overlying waters, sediments and fauna, and to assess meio- and macrofaunal tracer uptake and transformation via molecular-level ^{13}C tracking.

j) To assess short-term sediment mixing rates and size-selective particle mixing using shipboard incubation studies with added flourescently-labeled particles in different size ranges.

Greg Cowie

5. NARRATIVE

5.1. Diary (all times are GMT except where specified; Times for deployments are at commencement for landers, otherwise on reaching bottom).

Monday, September 15.
RRS Charles Darwin arrived Port Sultan Qaboos (a.m.). All CD150 scientific personnel departed vessel. PSO visited vessel for discussions with Captain, to check on airfreight arrival and on chemical and gas cylinder pick-up/delivery. Completed handover with Dr. Brian in the evening. All CD151 scientific party arrived Muscat (except NIO observer, Dr. Tariq Masood, due to arrive Sep. 16).

Tuesday, September 16.
Scientific party joined ship ca. 10 am (local). Unpacking and preparations of laboratories etc commenced. Diplomatic clearance from Pakistan in hand. All parties sign on with Master and attend vessel familiarisation and safey briefing. Gas cylinder pick-up/delivery completed and Dr. Matt Schwartz visits Sultan Qaboos University to pick up and weigh out chemicals kindly supplied by Dr. Salin Al Faidi and Mr. Bader at the Chemistry Department. Dr. Tariq Masood arrives ca. 19.00. Crane repairs commenced. Some delay (hours) may occur to planned departure on September 17 am.

Wednesday, September 17
Repaired crane parts delivered and tests carried out. Departed PSQ ca 07.00. Sun and calm seas. Unpacking and lab' and kit set-up continued. First planning meeting carried out at 13.00. PSO outlined cruise plan, teams and task assignments, plus schedule for meetings of sub-groups. Muster and safety drill at 12.15. Geochemical core processing meeting held in PSO's cabin at 14.45. Biological processing meeting held in PSO's cabin at 15.45. Draft plans and tasks assignments discussed and finalised.

Thursday, September 18.

Continued lab' and gear set-up. Shipboard incubation planning meeting held in PSO's cabin at 09.00. Draft plans and task assignments discussed. Sandra Vandewiele to obtain NIOO data from CD146 incubations. PSO to obtain ^{13}C slurry information from L. Levin. Planning meeting with Captain, bosun, engineers etc at 10.30. Lander buoyancy tests started in the afternoon, to ca. 2000m, followed by CTD cast for water collection and testing acoustic releases. CTD planning meeting at 15.30. General science meeting postponed to 04.00 on September 19. ETA for A140m station now estimated for afternoon of September 19.

Friday, September 19
Welding repairs to starboard gantry delayed arrival at station A140 to 17.15. **Station A140**. First deployment was a CTD cast (56101#1 at 18.16, 13 bottles) for bottom waters (for shipboard incubation reservoir and suspended solids), followed by megacorer deployment (56101#2, 11/12) at 19.15 for shipboard incubations and biological survey.

Saturday, September 20
Station A140. Lander deployment (56101#3, EO, moored) at 01.46 (very successful) followed by megacorer deployment (56101#4, 12 barrels, failed) at 02.34 and another (56501#5, 12/12) at 04.16. These were followed by a multicorer deployment (56101#6, 12 barrels, no trigger) at 6.31. Addition of broomsticks to feet of multicorer led to success with the next deployment (07.30, 56101#7, 12/12). A megacorer deployment (56101#8, 11/12) for shipboard incubations followed at 11.14, in turn followed by a CTD cast (56101#9, 13 bottle profile) at 12.45. Excellent curry dinner.

Sunday, September 21
Station A140. Megacorer deployment (56101#10, 11/12) at 05.02 followed by a multicorer deployment (56101#11, 8/9) at 09.16.. These were followed by four plankton tow deployments (56101#12-15) at 10.14-10.45, ELINOR recovery (56101#3, successful) at 13.18, and a successful BBLS deployment (56101#16, 4/5 bottles fired) at 16.03.

Monday, September 22
Station A140. ELINOR deployment (56101#18, EF, moored) at 01.44 (Note: sequence numbering error – skipped #17, bridge logs updated accordingly). Megacorer deployment (56101#19) at 05.44 (11/12 good cores, 1 misfire, 1 bubbled). Multicorer deployment (56101#20) at 09.37 (8/9) followed by a PROFILUR deployment (56101#21, moored) at 12.50.

Tuesday, September 23
Station A140. PROFILUR recovery at 05.00 followed by multicorer deployment (56101#22) at 06.03 (9/9 good cores), a megacorer deployment at (56101#23, 7/8, 1 bubbled) at 09.13, and a PROFILUR deployment (56101#24, moored) at 10.22. Agassiz trawl at ca. 135m at 11.25-12.03 (56101#25, small clean catch).

Wednesday, September 24
Station A140. ELINOR recovery (EF, 56101#18, successful) at 02.49, followed by a megacorer deployment (56101#26, 8/8) at 05.40, followed by a multicorer deployment (56101#27, 8/9) at 06.51. These were followed by a further megacorer deployment (56101#28, 7/8) at 09.19. Finally, ELINOR was deployed in moored EF13 mode at 12.38 (56101#29) and PROFILUR (56101#24, successful) was recovered at 13.22.

Thursday, September 25
Station A140. Shipboard activities (core and incubation sample processing).

Friday, September 26
Station A140. Megacorer deployment (56101#30, 7/8) at 06.21 followed by a CTD cast (56101#31,12 bottles fired at 6 depths) at 09.06.

Saturday, September 27
Station A140. ELINOR recovery (56101#29, successful) at 02.57. Transit to **Station A300**. CTD cast (56102#1, 13 bottles on bottom for incubations, 2 at surface) at 05.39. Megacorer deployment (56102#2, missing fate sheet) at 07.15. Transit to **Station A200**. Megacorer deployment (56103#3, 12 short cores all full of shells, rejected) at 08.51 followed by transit to **Station A250**. Megacorer deployments (56104#1,9/12, 2 bubbled) at 10.01 and (56014#2, 8/12, 2 broken barrels) at 11.07. Multicorer deployment (56104#3, 9/11) at 12.47. Transit to **Station A300**. ELINOR deployment (56105#1, moored EO) at 13.48 followed by a megacorer deployment (56105#2, 12/12, 3 bubbled) at 14.52.

Sunday, September 28
Station A300. Megacorer deployment (56105#3, failed) at 02.53 followed by two more with adjusted weights at 03.27 (56105#4, 7/12, 2 bubbled) and 04.45 (56105#5, 12/12). CTD cast (56105#6, 24 bottle profile) at 06.10 and multicorer deployment (56105#6, 8/10, 2 bubbled) at 08.15. Transit to **Station A400**. Seventeen megacorer deployments (56106#1-17) were carried out in search of bacterial mats between 10.52 on 28/9/03 and 0.18 on

29/9/03 at sites on a previous WASP track from CD150. No mats were recovered and all sediments were discarded.

Monday, September 29
Transit to Station A300. Megacorer deployments at 04.42 (56107#1, 9/12 cores, 5 bubbled) and 05.58 (56107#2, 10/11). Multicorer deployment (56107#3, 10/10, 2 bubbled) at 07.37. ELINOR deployment (56107#4, moored EF13 mode) at 12.39.

Tuesday, September 30
Station A300. Megacorer deployment (56107#5, 10/11, 1 bubbled) at 03.06 followed by a multicorer deployment (56107#6, 10/10, 4 bubbled) at 4.43 and a BBLS deployment (56107#7, successful) at 10.11. Master commences communications with Islamabad and Karachi re. request for clearance to visit more northerly site off Karachi where Schmaljohann and others previously reported widespread bacterial mats.

Wednesday, October 1
Station A300. Multicorer deployments at 04.59 (56107#8, 8/9, 1 bubbled) and 06.07 (56107#9, 6/6) followed by four plankton tows (56107#10-13, 0-40m) at 07.06-07.35. Transit to **Station A180**. Megacorer deployments at 09.41 (56108#1, no recovery) and 10.18 (56108#2, weights added, 8/12 short cores, shelly). Transit to **Station A220**. Megacorer deployment (56109#1, 12/12, short cores, sand/shells, mostly disturbed) at 11.08 followed by transit to **Station A250**. Multicorer deployment (56110#1, 8/8, 2 lost on deck) at 12.33. Transit to **Station A275**. Multicorer deployment (56111#1, 9/9, 4 bubbled) at 13.35 followed by a megacorer deployment (56111#2, 11/12, 1 bubbled) at 14.58. Transit to **Station A300**. Megacorer deployment (56112#1, 11/12, 2 bubbled) at 15.54.

Thursday, October 2
Station A300. 2 plankton tows (56112#2,3, 0-40m) at 06.10 and 06.25. ELINOR deployment (56112#4, moored EF mode) at 12.48 followed by transit to **Station A700**. Megacorer deployments at 15.17 (56113#1, 8/12) and 16.16 (56113#2, 10/12, 1 broken barrel, 2 bubbled) followed by 3 multicorer deployments (56113#3-5) at 17.49 9 (no fire), 18.53 (no fire) and 20.04 (9/9, 1 bubbled). Transit to **Station A850**.

Friday, October 3
Station A850. Megacorer deployment (56114#1, 8/12, 2 bubbled) at 05.15 followed by multicorer deployments at 07.19 (56114#2, overpenetrated) and 09.43 (56114#3, 9/9, 5 bubbled). PROFILUR deployment (56114#4) at 11.12 followed by a megacorer deployment (56114#5, 8/12) at 13.16 and transit to **Station A300**.

Saturday, October 4
Station A300. Megacorer deployment (56115#1, 8/12) at 06.17 followed by a multicorer deployment (56115#2, missing fate sheet) at 07.23. Transit to **Station A940**. CTD cast (56116#1, bottom water sampling) at 16.19. followed by and with a 24-bottle CTD cast for water-column profiling (55902#16) at 09.35, followed by a multicorer drop (55902#17, 10/12) at 11.03, a PROFILUR recovery at 13.27 (successful), a megacorer drop (55902#18, 10/12) at 14.51 and a moored PROFILUR deployment at 16.24 (55902#19).

Sunday, October 5
Station A940. ELINOR deployment (56116#2, moored EO) at 01.50. Megacorer deployments at 02.51 (56116#3, 7/8, 2 bubbled) and 05.53 (56116#4, 12/12, 2 bubbled). CTD cast 07.45 (56116#5, full 24-bottle water column profile). Megacorer deployment (56116#6, 12/12, 2 bubbled) at 10.09. Multicorer deployments at 12.07 (56116#7, 8/9, 3 bubbled) and 13.30 (56116#8, 8/9, 2 bubbled) followed by a PROFILUR deployment (56116#9, moored) at 14.53.

Monday, October 6
Station A940. Megacorer deployment (56116#10, 12/12 cores recovered, 1 bubbled) at 05.35 followed by a BBLS deployment (56116#11) at 7.38. These were followed by 5 plankton tows (56116#11-15, 0-40m vertical tows) at 09.08-10.06, a multicorer deployment (56116#16, 9/11) at 10.54. Transit to **Station C850** for an Agassiz trawl (56117#1, 889-955m) at 16.41-17.57. Transit to **Station A940**.

Tuesday, October 7
Station A940. ELINOR deployment (56118#1, EF mode, moored, successful) at 01.55 followed by a muliticorer deployment (56118#2, 9/9) at 03.02 and transit to **Station A1000**. Multicorer deployments at 04.49 (56119#1, 9/9, 3 bubbled) and 06.10 (56119#2, 9/9, 3 bubbled), followed by a megacorer deployment (56119#3, 12/12) at 07.50, a PROFILUR deployment (56119#4, successful) at 09.00, and transit to **Station A1100**. Megacorer deployment (56120#1, 11/12) at 10.17 followed by multicorer deployment (56120#2, 9/9) at 12.01 and transit to **Station A900**. Multicorer deployment (56121#1, 10/10, 2 bubbled) at 14.10 followed by megacorer deployment (56121#2, 9/12) at 15.25) and transit to Station A1000.

Wednesday, October 8
Station A1000. Recovery of PROFILUR (56119#4) at 04.02. Megacorer deployment at 05.28 (56122#1, 11/12 cores, 1 lost) followed by transit to **Station A800**, another megacorer deployment (56123#1, 7/12) at 07.48 and a multicorer deployment (56123#2, 10/10, l lost, 1 bubbled) at 09.23. Transit to **Station A850** followed by a megacocorer deployment (561241, 7/12) at 10.51 and a PROFILUR deployment (56124#2) at 12.19. Transit to **Station C1000**. Agassiz trawl (56126#1, ca. 980-990m) at 16.30-17.40. Transit to **Station A940**.

Thursday, October 9
Station A940. Recovery of ELINOR (56118#1, EF, successful) at 02.28. Transit to **Station A850**. Megacorer deployment (56127#1, 4/8) at 06.45 followed by transit to **Station A900**. Megacorer deployment (56128#1, 6/8, 1 bubbled) at 09.19 followed by transit to **Station A940**. Megacorer deployment (56129#1, 5/8) at 10.58 followed by PROFILUR recovery (56125#1, successful) at 12.29 and an ELINOR deployment (56129#2, moored EF13) at 13.44. After 10 days of contradictory indications, a shipping warning for CD in Ormara region off Karachi indicates that clearance has been granted. Master decides to proceed. Transit to bacterial mat hunting area off Karachi (ca. 16 hours).

Friday, October 10
Station BM1. After problems with the wire that cost 2.5 hours, a CTD cast was made (56130#1, 845m) at 08.38 for water-column profiling and bottom water sampling. Megacorer deployments at 10.47 (56130#2, 12/12, disturbed, 789m) and 12.16 (56130#3, 12/12, 759m, short cores), roughly at co-ordinates reported by Schmaljohann et el, 1997, with slight changes in location between sites. Orange/white bacterial mats were clearly observed with deployment 56130#3, overlying a subsurface black sulfidic horizon and a layer of highly consolidated clay. Moved station to assess extent of mats. Megacorer deployments at **Sites BM2** and **BM3** (56131#1 and 56132#1, 693 and 689m, 6/12 and 7/12) at 13.42 and 15.04. Site BM2 showed no mats, and a deeper black horizon (possible control site). Returned to the proximity of Site BM1. Megacorer deployments at Site BM4 (again with slight position shifts between deployments) were carried out at 16.29 (56133#1, 806m, none retained) and at 19.40 (56133#2, 845m, 11/12, 1 disturbed). A multicorer deployment (56133#3, 846m, 11/11) followed at 21.23 and then another megacorer deployment (56133#4, 845.8m, 11/12) at 22.58. Transit to control **Site BM5.**

Saturday, October 11
Site BM5 (control site). Megacorer deployment (56134#1, 697m, 11/12), at 0.28 followed by multicore deployments at 2.23 and 3.21 (56134#2,3, ca. 698m, both 11/11). Processed cores and commenced incubations. Transit to **Station A1850**.

Sunday, October 12
Site A1850. Recovery of ELINOR ((56129#2, EF13, water but no mud) at 02.16 followed by a CTD cast (56135#1, bottom water sampling, 14 bottles) at 09.15 and transit to **Station A940**. Megacorer deployment (56136#1, 4/4) at 15.47 and a multicorer deployement (56136#2, missing fate sheet) at 17.27 followed by a repeat ELINOR EF13 deployment (56135#3) at 21.58 and transit to **Station A1850**.

Monday, October 13
Station A1850. Megacorer deployments at 03.57 (56137#1, 12/12, 2 disturbed) and 06.21 (56137#2, 11/12) followed by multicorer deployments at 08.46 (56137#3, 11/12) and 10.50 (56137#4, 11/12), a PROFILUR deployment (56137#5) at 13.58 and a series of 6 plankton tows (56137#6-11, 0-40m) at 15.00-57. These were followed by a further megacorer deployment at 16.54 (56137#12, missing fate sheet).

Tuesday, October 14
Station A1850. Megacorer deployment (56137#13, 12/12) at 03.16 and a multicorer deployment (56137#14, 11/12, l barrel lost) at 06.18, followed by a BBLS deployment (56137#15, successful) at 09.10 and a PROFILUR deployment (56137#16) at 11.12. Transit to **Station D1700**. Agassiz trawl (56138#1, 1677-1712m) at 15.00-16.00. Transit to **Station A1200**.

Wednesday, October 15
Station A1200. Megacorer deployments (56139#1,2, 12/12 and 12/12, 1 disturbed) at 06.06 and 07.16 followed by transit to **Station A1850**. ELINOR deployment (56140#1, moored EO mode) at 11.50 followed by PROFILUR recovery (56137#16, failed) at 12.10, a megacorer deployment (56140#2, electrode profiling) at 14.18 and a multicorer deployment (56140#3, missing fate sheet) at 15.47 and transit to **Station A1200**.

Thursday, October 16
Station A1200. PROFILUR deployment (56141#1) at 01.22 followed by a megacorer deployment (56141#2, 8/10) at 02.00, two multicorer deployments (56141#3,4; 10/11 & 11/12) at 06.24 and 07.58 and a BBLS deployment (56141#5, successful) at 9.46. These were followed by 6 plankton tows (56141#6-11, 0-40m) at

11.07-11.48, a PROFILUR recovery (56141#1, successful) and a PROFILUR redeployment (56141#12) at 15.45.

Friday, October 17
Station A1200. PROFILUR recovery (56141#12, successful) at 03.47. Transit to **Station A1050**. Megacorer deployment (56142#1, missing details) at 06.42 and multicorer deployments (56142#2,3; 11/12 and 11/12, both with 1 disturbed core) at 8.28 and 9.51. Transit to **Station C1550.** Agassiz trawl (56143#1, 1520-1535.5m) at 14.28-15.38. Transit to **Station A1850**.

Saturday, October 18
Station A1850. Recovery of ELINOR (56140#1, no mud, stirrer stopped) at 0.17. Transit to Muscat. Continued core processing and analyses plus lab' cleanup and packing.

Sunday, October 19
Transit to Muscat and continued lab' cleanup and packing.

Monday, October 20
Arrived Muscat 08.00 (local) and commenced demobilisation.

Greg Cowie

5.2 Conclusions

The objectives of this cruise were diverse. In summary, these were both to complete biological and geochemical survey work that commenced during CD150 and to compare results for the monsoon/post-monsoon conditions experienced during CD150 and CD151 to similar intermonsoon data collected during CD145 and CD146. A further primary objective was to complete a programme of shipboard and *in situ* experimental studies to assess the nature and rates of benthic biogeochemical processes. A further objective was to attempt to collect surficial sediments with bacterial mats in order to characterise these mats and to assess the importance of chemosynthetic C inputs within the OMZ. At the same time, further sampling and profiling of the water column was also planned.

The replicated biological and geochemical survey work was completed at all 5 primary study sites previously visited during CD145 and CD146; namely at stations A140, A300, A940, A1200 and A1850, representing a wide spectrum of sediment characteristics, benthic communities and bottom water redox conditions. By using time made available during moored lander deployments, we were also able to complete unplanned biological and geochemical survey work at a number of sites, at roughly every 50m depth between 700 and 1200m, on a transect across the lower OMZ boundary. This work started during CD146 and was continued during CD150. Together with data from our primary sites, and from a similar set of cores collected at sites between 140 and 300m on the upper OMZ boundary, we have thus collected what represents an unprecedentedly detailed survey of any of the world's OMZ regions.

Most if not all of the technical problems encountered with the benthic lander and shipboard incubation rigs on CD146 were rectified before CD151 and with only a few exceptions, the full suite of 21 lander deployments conducted during CD151 was largely or completely successful. Notably, additional, unscheduled lander deployments and shipboard incubation studies were also conducted outside of those planned for 3 primary sites to be studied during CD151 (A140, A300, A940); namely at the 850m, 1000m, 1200m and 1850m sites.

Finally, after multiple unsuccessful attempts during CD145, CD146, CD150 and CD151 to recover cores with bacterial mats that were evident from WASP seafloor video footage, clearance was sought during CD151 from the Pakistani authorities to visit an additional, more northerly work area off Karachi, where previous German and Dutch cruises reported extensive bacterial mats. During a 48-our excursion we successfully recovered bacterial mats; cores were sectioned at high resolution for detailed biological and geochemical analyses, and comparative shipboard incubation studies were conducted in order to assess benthic fluxes of nutrients, gases, trace metals and dissolved organic matter, to be compared to similar data from sites without mats.

Addressing our specific objectives in turn:

a) Sampling for the characterisation of benthic communities under monsoon conditions at sites spanning the mid-slope OMZ on the Pakistan margin (A140, A300, A950, A1200 and A1850) was completed.

b) Replicate sampling for the characterisation of sediment porewater and solid-phase geochemistry was similarly completed.

c) Photography, x-radiography and shipboard gamma counting were conducted at all 5 sites, plus x-radiography for sediments recovered every ca. 50m from sites between 600 and 1100m depths. These, plus

additional radiochemical analyses to be conducted post-cruise, will provide unprecedented information on sediment microstructure and bioturbation, and on sediment mixing and accumulation rates.

d) CTD profiling and water-column sampling, along with BBLS deployments were successfully conducted at all 5 primary sites.

e) In pursuit of our objective to characterise bacterial mats and chemosynthetic processes in the Arabian Sea OMZ, mats were successfully sampled at a site at ca. 840m depth off Karachi after last-minute clearance was obtained from the Pakistani authorities. Micro-electrode O_2 profiles were obtained for recovered cores, and other cores were sectioned at high resolution for shipboard and post-cruise biological and geochemical analyses. Still others were used in unprecedented shipboard incubation studies.

f) Oxygen penetration depths and benthic consumption rates were successfully determined at all primary sites via shipboard and *in situ* microelectrode profiling and sediment incubation studies.

g) Sampling for determination of benthic fluxes of gases, nutrients, trace metals and dissolved organic matter was successfully conducted at 4 of our 5 primary sites (using shipboard and *in situ* incubation studies maintained at ambient O_2 levels) as well at two additional sites (A850 and A1000).

h) Benthic microbial process rates (commenced on CD145 and CD150 with sulfate reduction rate determinations) were assessed at all sites by aforementioned 0_2 consumption studies combined with rate determinations of denitrification and Fe/Mn cycling via direct analysis, or modeling of porewater profiles and benthic fluxes.

i) Sampling for the quantification of benthic C cycling was successfully conducted at 3 of the primary sites (A140, A300 and A940) using added ^{13}C-enriched organic matter in both shipboard and *in situ* incubation experiments (tracking the ^{13}C into overlying waters, sediments and fauna).

j) Short-term sediment mixing rates and size-selective particle mixing were successfully assessed using shipboard incubation studies with added flourescently-labeled particles.

In summary, the cruise was highly successful on essentially all fronts and the detailed sampling at OMZ boundary sites and of bacterial mats will provide important additional data sets beyond the biological and geochemical surveys and experimental work initially planned for the 5 primary study sites.

Greg Cowie

5.3 Acknowledgements

The series of cruises that CD151 completed, and the research project that was founded around them, were beset by a long series of obstacles. The project and cruise only survived thanks to the perseverance of all the scientists involved, but I am also especially indebted to Mike Webb at NERC, and to Andy Louch and Colin Day (and colleagues) at RSU and UKORS who have been consistently supportive and helpful throughout.

As was the case with CD146, the job of being PSO on CD151 was made easier not only by the huge efforts of the scientfic team, but also by the professionalism and persistently positive attitude of the crew, engineers, officers, and technicians - and I am grateful to all.

I am also indebted:

To all participants of CD145 and CD150, and especially to Brian Bett as PSO.

To everyone on board for putting up with the Bacterial Mat adventure.

To *Darryl*, Dave, Gareth, Kevin and Rhys for their excellent and varied technical help throughout the cruise.

To Clive, Peter, Geoff and Tulip, who once again managed not only to entertain us but to keep up an exceptional variety and quality of food throughout the cruise. Thanks in particular for an excellent BBQ.

Once again, to Willie and Oli for getting the BBLS and landers fully operational and then completing a grueling lander deployment schedule, and to Oli for agreeing to be seen helping with menial tasks like core processing.

To Rachel and Gareth for managing to survive back-to-back cruises and for maintaining amazingly positive attitudes throughout.

To Rachel for keeping us on track and up to speed with the organic geochemical sample processing, note taking, freeze drying etc (but not for the Justin Timberlake) and to Eric and Gareth for…well, everything.

To Sandra for tolerating lame humour and for the astronomic updates.

To Steve for finding a way to produce nutrient data despite having to survive in the Nut Hut on phenol fumes.

To Matt and Clare for somehow managing to keep up Edinburgh's end of the bargain.

To Tariq for his help on all fronts, and to Dr. Shahid Amjad and colleagues at NIO, Karachi for their assistance in securing clearance for the Bacterial Mat adventure in a new work area.

To Chris, Kate and Rachel for the 24/7 supply of mindless banter and to Andy for managing to filter them out.

To Kevin for being a superb bosun.

And, finally, to Peter Sarjeant, for all of his efforts throughout CD146 and CD151, from mob to demob, and especially for the hours spent on phone, e-mail and fax trying to get us clearance for the Bacterial Mat adventure.

Thank you all. **Greg**

6. SITE SELECTION AND EXPERIMENTAL DESIGNS

6.1 SITE SELECTION

The primary sites selected for study during CD150 and CD151 (see Fig. 1) were those previously visited during CD145 and CD146, namely at 140m (A140), 300m (A300), 940m (A940m), 1200m (A1200) and 1850m depths (A1850). This selection was founded on WASP footage and 10KHz echo-sounder, 3.5KHz and swath surveys conducted during CD145 and CD146. Primary criteria were contrasting depths, redox conditions and sediment types across the OMZ, but also suitability for trawling and benthic lander operations (hence a need to be removed from canyons, steep slopes or other major topographic features).Additional sites across the lower and upper OMZ boundaries were selected for coring during CD145 and CD146 (see Fig. 1), with the objective to obtain detailed and unprecedented geochemical and biological surveys at sites spanning observed gradients in bottom-water O_2 content. On CD146, mega- and multicores were collected at stations roughly every 50m depth between 700 and 1200m water-column depth. This work was continued on CD150 with replicate sampling at a 700m site, and was completed on CD151 with sampling at 800, 850, 900, 1000, 1050 and 1100m sites, in addition to the scheduled sampling at 940 and 1200m. Further unscheduled sampling was conducted at 200, 225, 250 and 275 m sites on the upper OMZ boundary. Finally, after some 50 unsuccessful attempts to recover mats

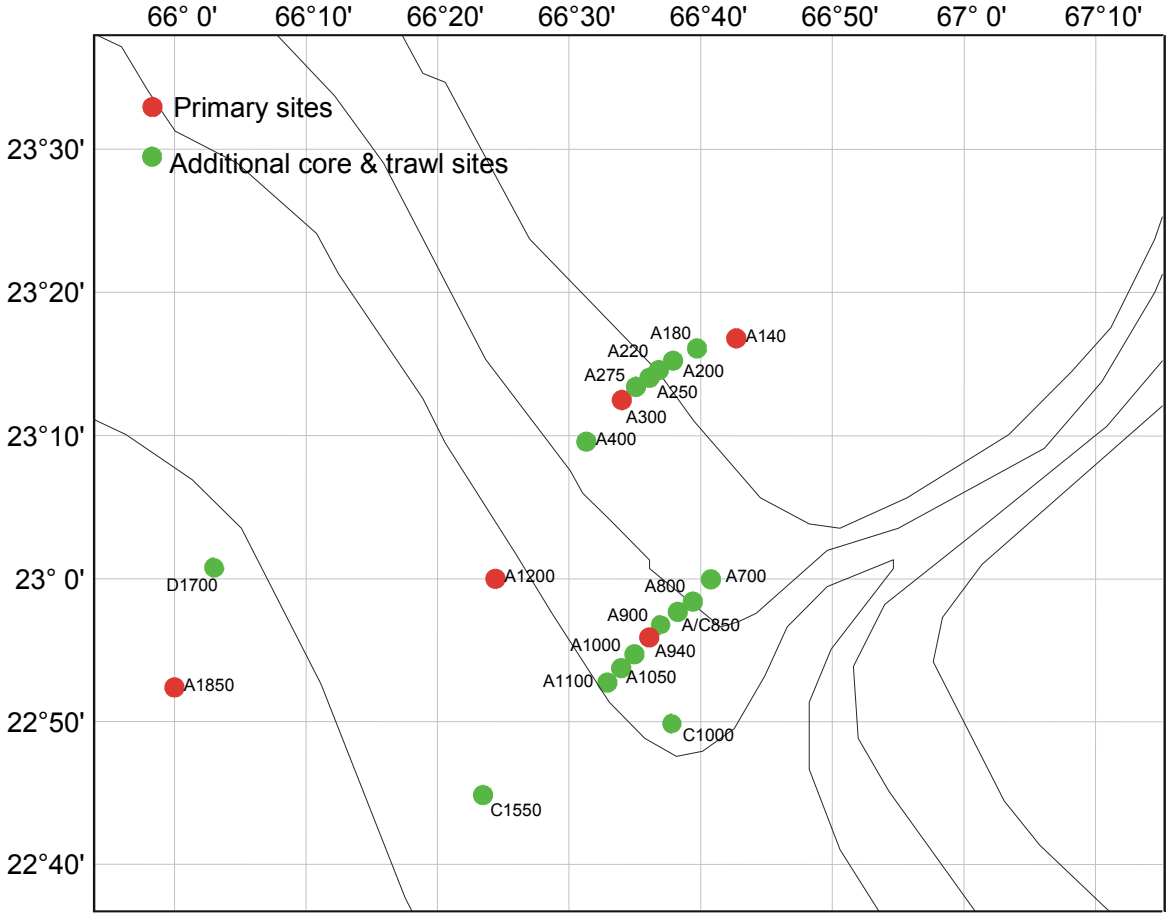


Figure 1. Indus margin work area study sites, including 5 primary sites where a full suite of survey and experimental work was conducted, plus additional sites where coring, CTD, trawling and incubation studies were conducted.

at various station depths on the Indus margin during CD146, CD150 and CD151, clearance was sought from Pakistani authorities during the course of CD151 to visit a more northerly work area off Karachi (see Chart 12.3, p121). The new work area was selected based on reports from previous Dutch and German cruises (e.g.

Schmaljohann et al. 1997) of widespread occurrence of seeps and mats of chemosynthetic *Beggiatoa* and *Thioploca* sp. During the ca. 16 hours on site, bacterial mats were recovered on only our second megacorer drop, and multiple deployments were then made for detailed core sectioning and shipboard incubation studies.

Greg Cowie

6.2 EXPERIMENTAL DESIGN

Designs of shipboard and *in situ* sediment incubation studies were as for CD146 (see CD146 cruise report).

In situ studies included; PROFILUR deployments for porewater O_2, pH and resistivitty profiling and ELINOR (chamber) deployments in 3 different modes:

a) Without O_2 regulation for determination of O_2 consumption and N_2 efflux (denitrifucation) rates. However, due to time constraints,
b) With Oe regulation for determination of DIC, DOC, TDN, nutrient and trace metal fluxes.
c) ^{13}C enrichment studies (with O_2 regulation and addition of ^{13}C-labelled diatoms).

Shipboard incubations were laboratory replicas of the 3 modes of ELINOR chamber deployments. Additional shipboard studies included incubations with added fluorescent particles in order to assess sediment mixing rates and size-selective ingestion/mixing (see CD146 cruise report).

The purpose of experiments carried out on CD151 was to provide a comparison during a monsoon season to results of the same studies conducted at the same sites during an intermonsoon (low-productivity) season (April-May, CD146). These were intended at a subset of 3 of our 5 primary sites. Stations A140, A300 and A950 were selected for the full suite of in situ and shipboard incubation studies based on the contrast in redox conditions and benthic communities these sites represent, and based on preliminary results from studies conducted during CD146. However, PROFILUR and selected ELINOR and shipboard incubations studies were also conducted at a number of other Indus margin sites, and comparative shipboard incubation studies were also conducted at our bacterial mat and control sites.

Table 1 shows a summary of shipboard incubation studies and lander deployments conducted during CD151.

	***In situ* studies**				**Shipboard studies**			
Site	**PROF**	**EO**	**EF**	**EF13**	**SO**	**SF**	**SF13**	**SB**
A140	2	1	1	1	4	2	2	2
A300		1	1	1	2	2	4	2
A850	1				2	2	2	
A940	2	1	1	2	2	2	2	2
A1000	1				2	2	2	
A1200	2				2	2	2	2
A1850	2	1			2	2	4	2
BM					2	2		
BMC					2	2		

PROF PROFILUR
EO ELINOR deployment without oxystat (O_2, N_2, DIC)
EF ELINOR deployment with oxystat (nutrients, trace metals, DOM)
EF13 ELINOR deployment with oxystat and ^{13}C-labelled diatom addition
SO shipboard incubations without oxystat (O_2, N_2, DIC)
SF shipboard incubations with oxystat (nutrients, trace metals, DOM)
SF13 shipboard incubations with oxystat and ^{13}C-labelled diatom addition (2 and 5-day incubations).
SB shipboard incubations with oxystat and addition of fluorescent beads
BM Bacterial mat site
BMC Bacterial mat control site

Further details of the shipboard incubation studies and lander deployments are provided in sections below.

Greg Cowie

7. SURVEY EQUIPMENT AND OPERATIONS

Operations were generally identical to those on CD146 and the reader is referred to the CD146 cruise report for general information. The exceptions were that there were fewer CTD deployments and no swath bathymetry of 3.5KHz survey work conducted during CD151.

Computing and data logging:
No particular problems were experienced with the ship's computer suite or data logging systems. Navigation data, surface sample data, meteorology 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 along with Surfmet data.

CTD operations:
With the exception of brake problems on the starboard CTD winch, 7 CTD deployments and a number of operational tests were conducted without problem over the course of CD151 (see Table 2). CTD data and operational records were backed-up to CD with copies supplied to the PSO. The benthic boundary layer sampler (BBLS), which had technical problems during CD150, was repaired by W. Thompson during CD151 and successfully deployed from the starboard gantry at a number of stations (see Table 2).

Station	CTD	notes	BBLS
A140	3	1 for profiling, 2 for bottom waters	✔
A300	2	1 profile, 1 bottom water	✔
A940	2	1 profile, 1 bottom water	✔
A1200			✔
A1850	1	Bottom waters	✔
BM site	1	Bottom waters	

Table 2: Summary of CTD and BBLS deployments during CD151.

Agassiz trawl operations:
To complete sampling for megafauna, the Agassiz trawl was deployed at 5 sites from the aft gantry, as per CD145, CD146 and CD150 (see Table 3).

Station	Notes
A140	ca. 132-134m
C850	ca. 889-955m
C1000	ca. 981-988m
D1700	ca 1677-1712m
C1550	ca. 1520-1536m

Table 3: Agassiz trawls conducted during CD151.

Plankton tows:
Vertical plankton tows (for isotopic, microscopic, geochemical and genetic charaacterisations) were conducted from the starboard gantry over the top 40m of the water column at a number of CD151 stations (see Table 4).

Station	Series #	Site	Date	Time	Latitude		Longitude	
			(03)	(utc)	DN	MN	DE	ME
56101	12	A140	21/09	10.14	23	16.900	66	42.000
56101	13	A140	21/09	10.20	23	16.900	66	42.000
56101	14	A140	21/09	10.30	23	16.900	66	41.900
56101	15	A140	21/09	10.45	23	16.900	66	41.800
56107	10	A300	01/10	7.06	23	12.410	66	33.950
56107	11	A300	01/10	7.15	23	12.400	66	33.990
56107	12	A300	01/10	7.25	23	12.450	66	34.330
56107	13	A300	01/10	7.35	23	12.370	66	34.049
56112	2	A300	02/10	06.10	23	12.560	66	33.980
56112	3	A300	02/10	6.25	23	12.560	66	33.980
56116	12	A940	06/10	9.08	22	53.530	66	36.650
56116	13	A940	06/10	9.20	22	53.530	66	36.650

Station	Series #	Site	Date	Time	Latitude		Longitude	
56116	14	A940	06/10	9.35	22	53.530	66	36.650
56116	15	A940	06/10	9.50	22	53.530	66	36.650
56116	16	A940	06/10	10.06	22	53.530	66	36.650
56137	6	A1850	13/10	14.41	22	52.380	65	59.950
56137	7	A1850	13/10	15.00	22	52.390	65	59.950
56137	8	A1850	13/10	15.10	22	52.430	65	59.960
56137	9	A1850	13/10	15.40	22	52.436	65	59.960
56137	10	A1850	13/10	15.50	22	52.313	65	59.970
56137	11	A1850	13/10	15.57	22	52.310	65	59.970
56141	6	A1200	16/10	11.07	22	59.980	66	24.423
56141	7	A1200	16/10	11.18	22	59.966	66	24.419
56141	8	A1200	16/10	11.26	22	59.936	66	24.401
56141	9	A1200	16/10	11.34	22	59.995	66	24.379
56141	10	A1200	16/10	11.42	22	59.964	66	24.363
56141	11	A1200	16/10	11.48	22	59.950	66	24.358

Table 4. Plankton tows conducted during CD151.

Multicorer operations: The SOC-GDD supplied SMBA-pattern multiple corer was used throughout the cruise and served as the primary coring device for meiofaunal sampling and for collecting sediments for a variety of geochemical analyses. It performed reliably at all sites. Modifications, in the form of reduced weights, broomsticks attached across the base, and a spacer added to the collar (see CD145 cruise report) were added for deployments at A300 and other sites with high-porosity sediments that caused difficulty in triggering the corer. A record of all 41 deployments is provided in Table 5.

Station	Series #	Site	Date (03)	Time (utc)	Lat. DN	Lat. MN	Long. DE	Long. ME	Depth (m)	Comment
56101	6	A140	20/09	6.31	23	16.760	66	42.660	133.5	no cores, did not fire, attached broomsticks
56101	7	A140	20/09	7.30	23	16.810	66	42.710	132.5	12/12
56101	20	A140	22/09	9.37	23	16.790	66	42.740	135	8/9 cores recovered
56101	22	A140	23/09	6.03	23	16.799	66	42.709	133	9/9 cores recovered
56101	27	A140	24/09	6.51	23	16.804	66	42.712	133	8/9 cores recovered
56104	3	A250	27/09	12.47	23	13.981	66	36.561	248.5	9/11 recovered
56105	7	A300	28/09	8.15	23	12.458	66	34.015	302.5	8/10 recovered, 2 bubbled
56107	3	A300	29/09	7.37	23	12.487	66	34.009	300	10/10 cores recovered, 2 bubbled
56107	8	A300	01/10	4.59	23	12.489	66	33.999	301	8/9, 1 bubbled
56107	9	A300	01/10	6.07	23	12.480	66	33.990	300	6/6 cores recovered
56110	1	A250	01/10	12.33	23	13.840	66	36.500	249.5	8/8 cores, 2 lost bottoms on deck
56111	1	A275	01/10	13.35	23	13.110	66	35.290	274	9/9, 4 bubbled/disturbed (laminated)
56113	3	A700	02/10	17.49	22	59.950	66	41.240	709.5	Did not fire
56113	4	A700	02/10	18.53	NA	NA	NA	NA	707.5	Did not fire
56113	5	A700	02/10	20.04	23	0.010	66	41.150	707.5	9/9, 1 bubbled, long cores, laminated
56114	2	A850	03/10	7.19	22	57.490	66	37.680	842.5	overpenetrated
56114	3	A850	03/10	9.43	22	57.490	66	37.700	843.5	9/9, 5 bubbled
56115	2	A300	04/10	7.23	23	12.480	66	33.980	299	(missing fate sheet)
56116	7	A940	05/10	12.07	22	53.460	66	36.500	948	8/9 cores recovered, 3 bubbled

Station	Series #	Site	Date (03)	Time (utc)	Lat. DN	Lat. MN	Long. DE	Long. ME	Depth (m)	Comment
56116	8	A940	05/10	13.30	22	53.450	66	36.540	947	8/9 cores recovered, 2 bubbled
56116	17	A940	06/10	10.54	22	53.570	66	36.640	941.5	9/11 cores recovered
56118	2	A940	7/10	3.02	22	53.511	66	36.703	942	9/9 cores recovered (acetylene block)
56119	1	A1000	7/10	4.49	22	54.610	66	34.965	999	9/9 cores recovered, 3 bubbled
56119	2	A1000	7/10	6.10	22	54.620	66	34.970	998	9/9 cores recovered, 3 bubbled
56120	2	A1100	7/10	12.01	22	52.750	66	32.090	1098.5	9/9 cores recovered
56021	1	A900	7/10	14.10	22	56.805	66	36.947	898	10/10 cores recovered, 2 bubbled
56123	2	A800	8/10	9.23	22	58.328	66	38.866	792.5	10/10 cores recovered, 1 lost, 1 bubbled
56133	3	BM4	10/10	21.23	24	49.267	65	54.248	846	Bacterial mats, 11/11
56134	2	BM5	11/10	2.23	24	50.118	65	54.715	698	BM Control, 11/11 cores recovered
56134	3	BM5	11/10	3.21	24	50.122	65	54.718	699	BM Control, 11/11 cores recovered
56136	2	A940	12/10	17.27	22	53.560	66	36.670	949	(missing fate sheet)
56137	3	A1850	13/10	8.46	22	52. 390	66	59.996	1853	11/12 cores recovered
56137	4	A1850	13/10	10.50	22	52. 396	66	59.990	1852	11/12 cores recovered
56137	14	A1850	14/10	6.18	22	52.389	66	0.005	1853	11/12 cores recovered (1 barrel lost)
56140	3	A1850	15/10	15.47	22	52.420	66	59.982	1843	(missing fate sheet)
56141	3	A1200	16/10	6.24	22	59.992	66	24.428	1191	10/11 cores recovered
56141	4	A1200	16/10	7.58	23	0.003	66	24.389	1193	11/12 cores recovered
56142	2	A1050	17/10	8.28	22	53.620	66	34.040	1044.5	11/12 cores recovered, 1 bubbled
56142	3	A1050	17/10	9.51	22	53.595	66	34.035	1046	11/12 cores recovered , 1 bubbled

Table 5: Multicorer deployments during CD151.

Megacorer deployments:
The SOC-GDD megacorer performed very well during the cruise: No modifications other than varying the ballast load and number of barrels deployed were required to recover good quality cores from all sites sampled. A total of 79 deployments were made during CD151, with details as outlined in Table 6.

Station	Se\ries #	Site	Date (03)	Time (utc)	Lat. DN	Lat. MN	Long. DE	Long. ME	Depth (m)	Comment
56101	2	A140	19/09	19.15	23	16.800	66	42.710	133	11/12 good cores
56101	4	A140	20/09	2.34	23	16.790	66	42.700	133	11/12, 4 bubbled
56101	5	A140	20/09	4.16	23	16.759	66	42.620	135.5	10/12, 2 bubbled
56101	8	A140	20/09	11.14	23	16.905	66	42.686	134	11/12, 1 bubbled
56101	10	A140	21/09	5.02	23	16.800	66	42.720	132	11/12 cores, some slumping
56101	19	A140	22/09	5.44	23	16.790	66	42.720	134	11/12 cores recovered, 1 bubbled
56101	23	A140	23/09	9.13	23	16.769	66	42.744	134	7/8 cores recovered
56101	26	A140	24/09	5.40	23	16.800	66	42.710	134	8/8 cores recovered
56101	28	A140	24/09	9.19	23	16.876	66	42.746	133	7/8 cores recovered
56101	30	A140	26/09	6.21	23	16.790	66	42.690	134.5	7/8 cores recovered
56102	2	A300	27/09	7.15	23	12.492	66	34.021	302	(missing fate sheet)
56103	1	A200	27/09	8.51	23	14.650	66	38.690	201.5	12 barrels, all shells, rejected
56104	1	A250	27/09	10.01	23	13.160	66	36.320	254	9/12 recovered, 2 bubbled
56104	2	A250	27/09	11.07	23	13.730	66	36.120	253.5	8/12 recovered, 2 broken barrels

Station	Se\ries #	Site	Date	Time	Lat.		Long.		Depth	Comment
			(03)	(utc)	DN	MN	DE	ME	(m)	
56105	2	A300	27/09	14.52	23	12.520	66	33.970	300.5	12/12 recovered, 3 bubbled
56105	3	A300	28/09	2.53	23	12.465	66	34.101	295	disturbed or did not fire
56105	4	A300	28/09	3.27	23	12.510	66	34.103	284	7/12 cores, 2 bubbled
56105	5	A300	28/09	4.45	23	12.490	66	34.010	285.4	11/12 recovered
56106	1	A400	28/09	10.52	23	9.550	66	31.040	408	bacterial mat hunting, failed
56106	2	A400	28/09	11.30	23	9.490	66	30.990	410	bacterial mat hunting, failed
56106	3	A400	28/09	12.18	23	9.470	66	30.970	410.5	bacterial mat hunting, failed
56106	4	A400	28/09	12.57	23	9.520	66	31.010	407.5	bacterial mat hunting, failed
56106	5	A400	28/09	13.40	23	9.530	66	31.020	407.5	bacterial mat hunting, failed
56106	6	A400	28/09	15.12	23	9.510	66	31.030	408	bacterial mat hunting, failed
56106	7	A400	28/09	16.06	23	9.490	66	31.010	411	bacterial mat hunting, failed
56106	8	A400	28/09	16.48	23	9.500	66	31.030	410	bacterial mat hunting, failed
56106	9	A400	28/09	17.23	23	9.510	66	31.040	410	bacterial mat hunting, failed
56106	10	A400	28/09	18.20	23	9.500	66	31.010	411.5	bacterial mat hunting, failed
56106	11	A400	28/09	19.32	23	9.503	66	30.999	411.5	bacterial mat hunting, failed
56106	12	A400	28/09	21.10	23	9.480	66	31.270	404	bacterial mat hunting, failed
56106	13	A400	28/09	22.12	23	9.460	66	31.130	408	bacterial mat hunting, failed
56106	14	A400	28/09	23.11	23	9.496	66	30.999	410	bacterial mat hunting, failed
56106	15	A400	29/09	0.04	23	9.419	66	31.075	410	bacterial mat hunting, failed
56106	16	A400	29/09	0.43	23	9.540	66	31.050	413	bacterial mat hunting, failed
56106	17	A400	29/09	1.18	23	9.548	66	31.029	409	bacterial mat hunting, failed
56107	1	A300	29/09	4.42	23	12.480	66	34.000	300.5	9/12 cores recovered, 5 bubbled
56107	2	A300	29/09	5.58	23	12.480	66	33.990	296.5	10/11 cores recovered
56107	5	A300	30/09	3.06	23	12.488	66	34.181	298	10/11 cores, 1 bubbled
56108	1	A180	01/10	9.41	23	15.110	66	39.310	184	0/12, no cores (sand/shells), weight added
56108	2	A180	01/10	10.18	23	15.230	66	39.370	180.5	8/12, 6 disturbed, more shells, short cores
56109	1	A220	01/10	11.08	23	14.390	66	37.830	232	short cores, mostly disturbed (sand/shells)
56111	2	A275	01/10	14.58	23	13.230	66	35.340	273	11/12, 1 bubbled
56112	1	A300	01/10	15.54	23	12.411	66	33.967	300	11/12, 2 bubbled
56113	1	A700	02/10	15.17	22	59.968	66	41.200	709	8/12 cores recovered
56113	2	A700	02.10	16.16	22	59.904	66	41.180	711	10/12, I broken barrel, 2 bubbled
56114	1	A850	03/10	5.15	22	57.460	66	31.700	845	8/12, 2 bubbled
56114	5	A850	03/10	13.16	22	57.491	66	37.620	845	8/12 cores recovered
56115	1	A300	04/10	6.17	23	12.500	66	33.990	300	8/12 cores recovered
56116	3	A940	05/10	2.51	22	53.524	66	36.657	942	7/8 cores recovered, 2 bubbled
56116	4	A940	05/10	5.53	22	53.530	66	36.630	943	12/12 cores recovered, 2 bubbled
56116	6	A940	05/10	10.09	22	53.520	66	36.640	943	(missing fate sheet)
56116	10	A940	06/10	5.35	22	53.499	66	36.663	943	12/12 cores recovered, 1 bubbled
56119	3	A1000	7/10	7.50	22	54.660	66	35.001	996	12/12 cores recovered
56120	1	A1100	7/10	10.17	22	52.770	66	33.010	1097	11/12 cores recovered
56021	2	A900	7/10	15.25	22	56.857	66	36.992	898	9/12 cores recovered
56122	1	A1000	8/10	5.28	22	54.674	66	35.005	996	11/12 cores recovered, 1 lost
56123	1	A800	8/10	7.48	22	58.346	66	38.916	791	7/12 cores recovered
56124	1	A850	8/10	10.51	22	57.517	66	37.634	842	7/12 cores recovered
56127	1	A850	9/10	6.45	22	57.511	66	37.720	841	4/8 cores recovered
56128	1	A900	9/10	9.19	22	56.719	66	36.785	900	6/8 cores recovered, 1 bubbled
56129	1	A940	9/10	10.58	22	53.506	66	36.626	946	5/8 cores recovered

Station	Se\ries #	Site	Date	Time	Lat.		Long.		Depth	Comment
			(03)	(utc)	DN	MN	DE	ME	(m)	
56130	2	BM1	10/10	10.47	24	49.968	65	54.193	789	12/12 cores recovered, short, disturbed,
56130	3	BM1	10/10	12.16	24	49.890	65	54.350	759	12/12 cores recovered, short, bacterial mats!
56131	1	BM2	10/10	13.43	24	50.120	65	54.700	693	6/12 cores, no mats, deep black band, control
56132	1	BM3	10/10	15.04	24	50.240	65	54.920	689	7/12 cores, none retained
56133	1	BM4	10/10	16.29	24	49.880	65	54.235	806	Bacterial mats, none retained (no fate sheet)
56133	2	BM4	10/10	19.40	24	49.870	65	54.238	845	Bacterial mats, 11/12, 1 disturbed
56133	4	BM4	10/10	22.58	24	49.870	65	54.235	845.8	Bacterial mats, 11/12 cores recovered
56134	1	BM5	11/10	0.28	24	50.114	65	54.721	696.8	BM Control, 11/12 cores recovered
56136	1	A940	12/10	15.47	22	53.560	66	36.680	940.5	4/4 cores recovered
56137	1	A1850	13/10	3.57	22	52.390	66	0.030	1853	12/12 cores recovered, 2 disturbed
56137	2	A1850	13/10	6.21	22	52.410	66	0.040	1853	11/12 cores recovered
56137	12	A1850	13/10	16.54	22	52.390	66	0.004	1852.5	(missing fate sheet)
56137	13	A1850	14/10	3.16	22	52.396	65	59.936	1853	12/12 cores recovered
56139	1	A1200	15/10	6.06	22	59.998	66	24.409	1192	12/12 cores recovered
56139	2	A1200	15/10	7.16	22	59.976	66	24.423	1193	12/12 cores recovered, 1 disturbed
56140	2	A1850	15/10	14.18	22	52.417	66	59.975	1859	electrode profiling
56141	2	A1200	16/10	2.00	23	0.000	66	24.416	1198	8/10 cores recovered
56142	1	A1050	17/10	6.42	22	53.604	66	34.029	1045.3	missing core details

Table 6. Details of megacorer deployments during CD151.

Greg Cowie

8. SAMPLING AND ANALYTICAL PROTOCOLS

8.1 Macrobenthos sampling

Macrobenthos sampling methods were as per those used in previous (see cruise reports for CD145 and CD146). Sampling for macrobenthos wasconducted as part of:

a) Survey sampling at main stations for SAMS (Gage/Lamont)
b) Fine-scale transition zone sampling (140-300 and 700-1100 m) for SIO (Levin)
c) Sampling of background macrobenthos for natural abundance isotope, amino acid and lipid analyses.
d) Sampling and sorting of macrofauna from ^{13}C shipboard and *in situ* incubation experiments
e) Sampling and sorting of macrofauna from bead incubation experiments.

Particular efforts were made during CD151 incubation studies to make quantitative determinations of total numbers of individuals of a given type within individual depth horizons. These were carried out in order to obtain total biomass values necessary for quantitative C tracking during the ^{13}C enrichment studies.

Greg Cowie (Christine Whitcraft)

8.2 Meiofauna sampling

As on previous cruises (CD145, CD146 and CD151) multicores were taken, sliced and preserved in 10% formalin for two main purposes: (i) faunal analysis focussed on the development of a proxy for bottom-water palaeo-oxygenation (Frans Jorissen; University of Angers, France) and (ii) a survey of meiofauna across the OMZ (Kate Larkin/Andy Gooday). Additional 0-1cm multicores and megacores slices were obtained from each site and frozen at –70°C to provide material for molecular studies on foraminifera. Meiofauna were also isolated and stored frozen for natural-abundance stable isotopic characterisation and for biochemical analyses. Finally, meiofauna were also collected from megacores and lander chamber subcores from ^{13}C enrichment studies, again with efforts made to make quantitative determinations of total numbers of live fauna within given depth horizons. See CD145 and CD146 cruise reports for all protocols and details.

Greg Cowie (Kate Larkin)

8.3 Marine geochemistry, radiochemistry and dissolved oxygen determinations (SAMS)

The SAMS geochemistry objectives for cruise 151 were per cruise 150 with respect to sediment geochemistry which were to obtain samples of solid phase and pore water to analyse for a range of constituents, organic (Edinburgh), inorganic and radiochemical. In addition to the above, we also utilized benthic *in situ* sampling platforms (see Lander section, O. Peppe), Winkler oxygen determinations and shipboard electrode profiling. These results will then be combined with the benthic results to ascertain the role of the benthos in the burial efficiency of carbon and the resultant impact on the biogeochemical cycling of trace elements in the oxygen minimum zone of the Arabian Sea off the Pakistan coast.

General aims:

1) The collection of a two Megacore barrels for porewater extraction. Barrel 1) Extract porewater and divide into appropriate vials for the following analyses: trace metal analysis, sulphide analysis and nutrient analysis. Barrel 2) Extract porewater and divide into appropriate vials for the following analyses: DOC analysis and disolved organic molecular analyses.
2) Collection of a mega core for radionuclides (^{210}*Pb,* ^{234}*Th)*.
3) Collection of a mega core for the analysis of solid phase metals
4) Upkeep and running of the gamma spectrometer for shipboard analysis of sediment for ^{234}Th.
5) Shipboard microelectrode profiling on a retrieved megacore and multi cores
6) Shipboard Winkler titration's for oxygen determination of:
   a) Megacore overlying water
   b) CTD bottom water
   c) CTD profile occasionally for calibration checks on CTD oxygen sensor
   d) Incubation checks
   e) Lander water bottles

Methodology for all sampling and shipboard radiochemical analyses was as per CD146 and CD150 (see reports) with the following exceptions;

Sediment oxygen profiling

In addition to the megacore we also this trip profiled multicores and turned over to Andy Gooday from SOC for benthic analyses.

Megacorer

The Megacorer performed very well during the cruise.No modifications other than varying the ballast load and number of tubes deployed were required to recover good quality cores from all sites sampled. Set up for RRS *Charles Darwin* cruise 151 were the same as 146 with the following stations added: Bacterial Mat Site - 1/2 ballast, 12 tubes of soft mud, core "slipping" technique was used for removal to alleviate bubbling problem.

Eric Breuer and Gareth Law

8.4 DIC, δ^{13}DIC and pH

Sampling for these parameters was conducted as described in reports for CD145, CD146 and CD150. These included sampling for porewaters for all 3 parameters, and samples from both shipboard and in situ incubations for DIC and δ^{13}DIC. Selected analyses were also conducted in order to assess pH changes during shipboard incubations. A Thermo Russell model RL 100 pH meter was used for all pH determinations during CD151.

Sandra Vandewiele

8.5 Solids and porewaters for organic geochemistry

Sampling, processing and storage of samples for biochemical, elemental and stable isotopic analyses at Edinburgh and/or Liverpool was essentially as per protocols carried out on CD145, CD146 and CD150 (see Cruise Reports) with the following exceptions.

Revised Protocols for CD 151

At each main station (A140, A300, A940, A1200, A1850) the following cores were sectioned: CLIP, CPIG, CARCH, 2 CBAC, 2 FISH/PLIP, DOC1 and a DOC2 core.

Protocol 1: Solid phase analysis of lipids (CLIP)

For details of this protocol see CD150 cruise report and the following amendments:
Amendment 1: A single multicore was taken at each site for lipids only.

Protocol 2: Solid phase analysis of pigments (CPIG)

For details of this protocol see CD145 cruise report and the following amendment:
Amendment 1: A single multicore was taken at each site for pigments only.

Protocol 3: Solid phase analysis Archive core (CARCH)

This multicore was treated the same way as the pigment core. However, the sediment was stored in plastic bags and frozen at -20˚C. One multicore was collected at each site.

Protocol 4: Solid phase analysis for microbial analyses (CBAC)
Two replicate multicores were taken per site. These cores were treated in the same way as the solid phase lipid core but the sediments were stored in plastic bags at -70˚C.

Protocol 5: FISH (fluorescence *in situ* hybridisation)
For microbial community analysis via flourescence *in situ* hybridisation (FISH), multicores were sectioned at 0-0.5, 0.5-1, 1-2, 2-3, 3-4 and 10-11 cm intervals and ca. 5 ml volumes transferred to plastic vials. To these were added 5ml of 0.2mm-filtered seawater and 1 ml of fresh 20% paraformaldehyde solution, and the vials were shaken. Samples were left at RT overnight and then transferred to a –20°C freezer.

Protocol 6: Pore water analysis for DOM and DFAA (DOC1)
For details of this protocol see CD150 cruise report, Section 8.3 of this report, and the following amendment:
Amendment 1: Sediment is frozen and then freeze-dried after sectioning in a glove bag porewater removal following centrifugation. It is then placed in sample bags for carbohydrate and amino acid analysis (ED) and jars for lipid analysis (LIV).

Protocol 7: DOC2
Additional megacores were sectioned (same intervals as DOC1) at all sites for additional porewaters. Sectioning was conducted without a glove bag, in the wet lab'. Porewaters were collected by centrifugation, as per DOC1.

Protocol 8: Collection of Megafauna from Agassiz Trawls for Lipid and SIA
For this protocol see CD 150 cruise report, there are no amendments.

Protocol 9: Sampling of water from the CTD and BBLS for lipid analysis.
For this protocol see CD 145 & 150 cruise report, there are no amendments.

NOTE: The same sets of cores were also collected and sectioned at all additional sites (i.e. sites between 140m and 300m depth, and between 800 and 1100m depths on the Indus Margin) although DOC1 cores were collected only at the A850 and A1000m sites.

Bacterial mat site core sectioning protocols
At the bacterial mat and control site the following multicores were sliced: CLIP, CPIG, CARCH1 and 2, CBAC and FISH/PLIP. The protocols followed were the same as for the main stations except that cores were sliced at the following intervals: 0.5 cm intervals to 5 cm, 1 cm intervals from 5-16 cm and 2 cm intervals from 16-20 cm. The DOC1 core was a megacore and was sliced at the usual intervals (0.5 cm to 2 cm, 1 cm to 10 cm and 2 cm to 18 cm).
In addition to these cores a second megacore was sliced from the bacterial mat site at the following intervals 0.5 cm to 18cm and then 5 cm was skipped where another 0.5 cm slice was taken. This core was sliced for CLIP, FISH/PLIP, CARCH and epifluorescent microscopy (EPFM). All these samples were taken in the usual way. For the EPFM samples 1 ml of sediment was placed in a scintillation vial and fixed with 2 % formalin. The formalin was neutralised with borax and 0.2 μm filtered sea water was used to bring the formalin to a 2 % solution.
Similarly a mulitcore from the control site was sectioned in the same way. However, owing to the smaller volume of sediment only CLIP and EPFM were samples on this core.

Rachel Jeffreys (Greg Cowie)

8.6 X-radiography
X-radiography was performed on subcores from megacores as described in the CD145 and CD146 cruise reports.

Greg Cowie (Christine Whitcraft)

8.7 Dissolved organic carbon and total dissolved nitrogen
Porewater, BBLS and both lander and shipboard incubation samples were collected for DOC and TDN analyses on return to SAMS. Sample collection and storage protocols were as described in CD145 and CD146 cruise reports. Sample inventories are as outlined in Sections 10.13 (BBLS), 10.25 (poreswaters), 10.32 (Elinor incubations) and 10.45 (shipboard incubations).

Greg Cowie

8.8 Water column chemistry and shipboard nutrient analyses
Samples from the Seabird CTD 24 bottle rosette were collected at stations A140, A300 and A940 using 10-litre bottles. Sample processing for pigment, CN and nutrient analyses was as described in cruise reports for CD150.

Shipboard nutrient analyses of porewater, CTD, BBLS and both shipboard and *in situ* incubation study samples were again conducted as described in the CD146 and CD150 cruise reports.

Periodic issues arose with valve timing, negatifve peaks and integration peculiarities, but all were resolved during the course of the cruise. Shortage of reagents required temporary storage and pooling of samples towards the end of the cruise. All analyses were successfully completed by cruise end.

Stephen Mowbray

8.9 Sedimentary denitrification rate determinations

The rate of denitrification in sediments at all 5 primary sites was assessed via two separate methods: 1) nitrogen ingrowth into lander and shipboard incubation chambers and 2) nitrous oxide ingrowth in parallel multicore incubations. Methods were as described in the CD146 cruise report.

All samples collected during CD151 will be analyzed on a GC-TCD system (forN_2/Ar) at Edinburgh or by GC-ECD (N_2O) at University of Newcastle-Upon-Tyne.

Matthew Schwartz

8.10 NIO (Pakistan) sampling

Five multicores samples were collected from the primary stations A140, A300, A950, A1200 and A1850. The top of the multicore samples were sliced at interval 0-5 cm and preserved in the plastic container by adding 10% formalin for further investigation/analysis at National Institute of Oceanography (NIO), Pakistan. One multicore sample was also collected at Bacterial Mat (BM) site. The core was sliced with intervals 0-1 cm, 1-5 cm and 5-10 cm and preserved in the 10% formalin for further analysis in Pakistan.

Arabian Sea shows marked variations in the circulation and water mass structure because it is land locked in the northern boundary and is under the influence of semi-annually varying winds. Changes in vertical and lateral fluxes of heat, salt and momentum affect the distributions of density dependent stratification and associated parameters such sound speed in the ocean. Hydrographic variations observed in the North Arabian Sea indicate spatial and seasonal variability in the thermohaline stratification and associated parameters. Therefore, a request has been made to provide the CTD data collected during the Charles Darwin cruises in the Arabian Sea during the year 2003. The vertical profiles of parameters observed at different stations will be helpful to study the variations in water mass structure and associated parameters and the extent of the spreading and mixing of high salinity Persian Gulf water in to North Arabian Sea. Similarly, the marine meteorological data recorded onboard in the marine observer log book during CD151 cruise will be useful while conducting air-sea interaction studies for the study area. 18

During working in the Pakistan Margin many land based birds and insects were observed onboard. A brief report was prepared with the help of other colleagues about this unusual event for publication in the Quarterly Journal of "The Marine Observer".

Tariq Masood Ali Khan

9. IN SITU AND SHIPBOARD EXPERIMENTAL EQUIPMENT AND PROTOCOLS

9.1 Benthic landers: *in situ* microelectrode profiling and sediment-water incubation studies

Introduction

The KC-Lander is a modular benthic lander system that can be used either autonomously or moored. SAMS have two systems that can be set up with any of four different instrument configurations. The two configurations used on CD151 were:

Profilur System designed to measure oxygen and pH and sulphide concentrations over the sediment-water interface at very fine resolution (~ 100 um) using micro-electrodes. On CD151 we were using oxygen and pH micro-electrodes only.

Elinor A chamber incubation system for measuring oxygen and nutrient fluxes over long deployments, using both mini-electrodes and a syringe sampling unit. The system is also designed to retrieving a small box core. Further developments have been made to the *Elinor* chamber at SAMS to enable oxygen levels in the chamber to be maintained close to those of the ambient water – an "oxystat" system.

The objectives of the cruise required the *Profilur* system to be deployed twice at each of the main CD146 sites across the OMZ and the *Elinor* system to be deployed three times at the three shallower sites, one deployment each of three different modes: a standard non-oxystated oxygen incubation; an oxystated incubation for nutrient fluxes; and an oxystated ^{13}C tracer incubation. If time allowed further deployments of Elinor would be made at the deeper stations. Unlike CD146 the landers were deployed using the moored mode at only the shallowest station (A140) and autonomous mode at all others.

A summary of the lander configuration and the deployment and recovery times and positions for each deployment is given in Table 1

Pre-cruise preparation
Substantial developments and modifications to both the lander platform and the instrumentation were required by this project. This work is detailed in a separate SAMS Marine Technology report, but a summary is included in the CD146 cruise report. However some work was carried out between CD146 and CD151, and this is summarised below:

- The Elinor chamber module was shipped back to UK and overhauled to rectify the problems experienced with the shovel hydraulics not working below 300m. A leaky bleed valve was identified and repaired. Further modifications were made to improve the bleeding / cocking system. However it wasn't possible to test the system in water deeper than 300m.
- A second camera system was built for the landers to enable a camera to be permanently fitted to the Profilur and Elinor.
- Two new Aanderaa oxygen optodes were purchased with a view to fitting them onto the Elinor system to compare with the electrode data.

Deck operations
Much the same procedures were used as for CD146 and a full description can be found in the CD146 cruise report. After the experience with mud types on CD146 we were confident enough to use autonomous mode at A300. However due to concern about the strength of currents at A140 (partly indicated by video footage during lander deployments) we continued to use moored mode at that site. All operations were made significantly easier during CD151 thanks to the near continuous calm weather. All autonomous recoveries were made using the starboard after crane with no problems. We continued to have problems with pellet lines catching on the masts or under the frame. It is thought that a swivel where the line attaches to the lander, or thicker line (14mm as opposed to 8mm?), might help. A special thanks must go to Kevin Luckhurst (Bosun) and his deck crew for their invaluable assistance during lander operations.

Equipment description and protocols
The equipment and protocols used are all described in the CD146 cruise report. Only minor changes were made during CD151.

Most notably oxygen electrode calibrations could not be performed in quite the same way as our stock of sodium dithionite, used for obtaining a zero calibration, was contaminated between the cruises and proved useless. As an alternative we obtained a "low oxgyen" calibration point by bubbling nitrogen through the calibration water for around 30 minutes (until a stable electrode signal was obtained). We then took 3 samples for winkler titrations, and used this as our second calibration point. The saturated calibration point was obtained, as before, by bubbing air through the water. This method was far from ideal, especially as there is some doubt about the accuracy of the winkler results at such low oxygen levels.

All deployments on both landers benefited from a camera system during this cruise, a second system having been built after the first proved so invaluable on CD151.

Elinor *system*
Elinor experimental modes
As in CD146 the *Elinor* system was used in three different modes (which are described in more detail in the CD146 cruise report:

Mode 1 (EO)	Non-oxystatted incubation for oxygen demand calculations and de-nitrification measurements.
Mode 2 (EF)	Oxystatted incubation for nutrient and trace metal fluxes.
Mode 3 (EF13)	Oxystated incubation with ^{13}C labelled slurry

Generic Elinor protocols
The only significant change to the Elinor system was the addition of an Aanderaa Oxygen optode (type 3830, with analogue adapter type 3966). This is a very new sensor, and one was fitted to the Elinor system to measure the external oxygen concentrations. Unfortunately it was not possible at this late stage to fit one to measure oxygen inside the chamber. The signal was recorded by the lander computer simultaneously with the standard ambient oxygen electrode. The sensor is factory calibrated and according to factory specs. requires no further calibration for a year. However a calibration of the analogue values was performed using the same procedures as for the oxygen electrodes. See Lander technical summary for further details.

^{13}C tracer experiments (EF13)
Different slurry for the ^{13}C tracer was used (see Schwartz shipboard incubation protocols) but otherwise the protocol was as for CD146.

9.2 Shipboard sediment incubation rig and protocols

Introduction

The shipboard megacore incubation rig was constructed and used as detailed in the CD 146 cruise report. Below are descriptions of changes made to the rig, followed by a summary of experiments conducted.

Incubation Rig And Oxystat System Changes

Summary Of Oxystat System Functioning

Figures 1-4 display oxygen % saturation measured by all electrodes during work at each of the four main stations. They will be referred to in the following text to illustrate certain points.

As described below, many of the difficulties experienced with the oxystat system during CD 146 were absent during CD 151, due to a number of changes instituted prior to, and during, CD151. In general, the system worked well, producing stable oxygen concentrations in monitored experiments as illustrated in figures 1 and 4 for the A140 and A1850 experiments respectively. The A1850 site provided the clearest example of core top oxygen being maintained over 5 days. The other main sites at which the system was used (A140, A300, A940, and A1200) had extremely low bottom water oxygen levels, far lower than those observed during CD 146. These cores were particularly vulnerable to oxygen contamination prior to incubation. The combination of low initial bottom water oxygen and very low sediment oxygen consumption rates meant that, at most stations during CD151, the main task of the oxystat system was in fact reducing core top oxygen to ambient levels. This is well displayed by channel 4 (an SF incubation) at the A300 site (Figure 2).

Oxystat Reservoir Gas Sparging

As in CD146, air and nitrogen generators were used to sparge the oxystat reservoir to the required oxygen saturation. In response to our suggestions following Cd146, the gas generators were fitted with step-down regulators. The installation of these regulators produced more constant flows, solving the previous problem of fluctuations of dissolved oxygen (DO) concentrations in the oxystat reservoir. The air generator, however, failed to produce sufficient back pressure to force any air through the sparging stones at a flow less than ~1 L/min. The failure to obtain lower air sparge rates meant that we could not obtain oxystat reservoir DO concentrations between 0% and 5%. The minimum air sparge rate was high enough that DO concentrations less than 5% were not attainable, regardless of nitrogen sparge rate. This was a non-trivial problem, as most CD151 sites were found to have extremely low DO concentrations (~2.5% saturation). Incubations at these sites tended to be oxystated with a reservoir oxygen saturation slightly higher than ambient (normally 5-10%).

Problems were also encountered in attempting to have air or nitrogen flow simultaneously through multiple sparging stones. The gas normally flowed through only one stone, presumably that which posed least resistance.

Low Oxygen Measurement / Calibration

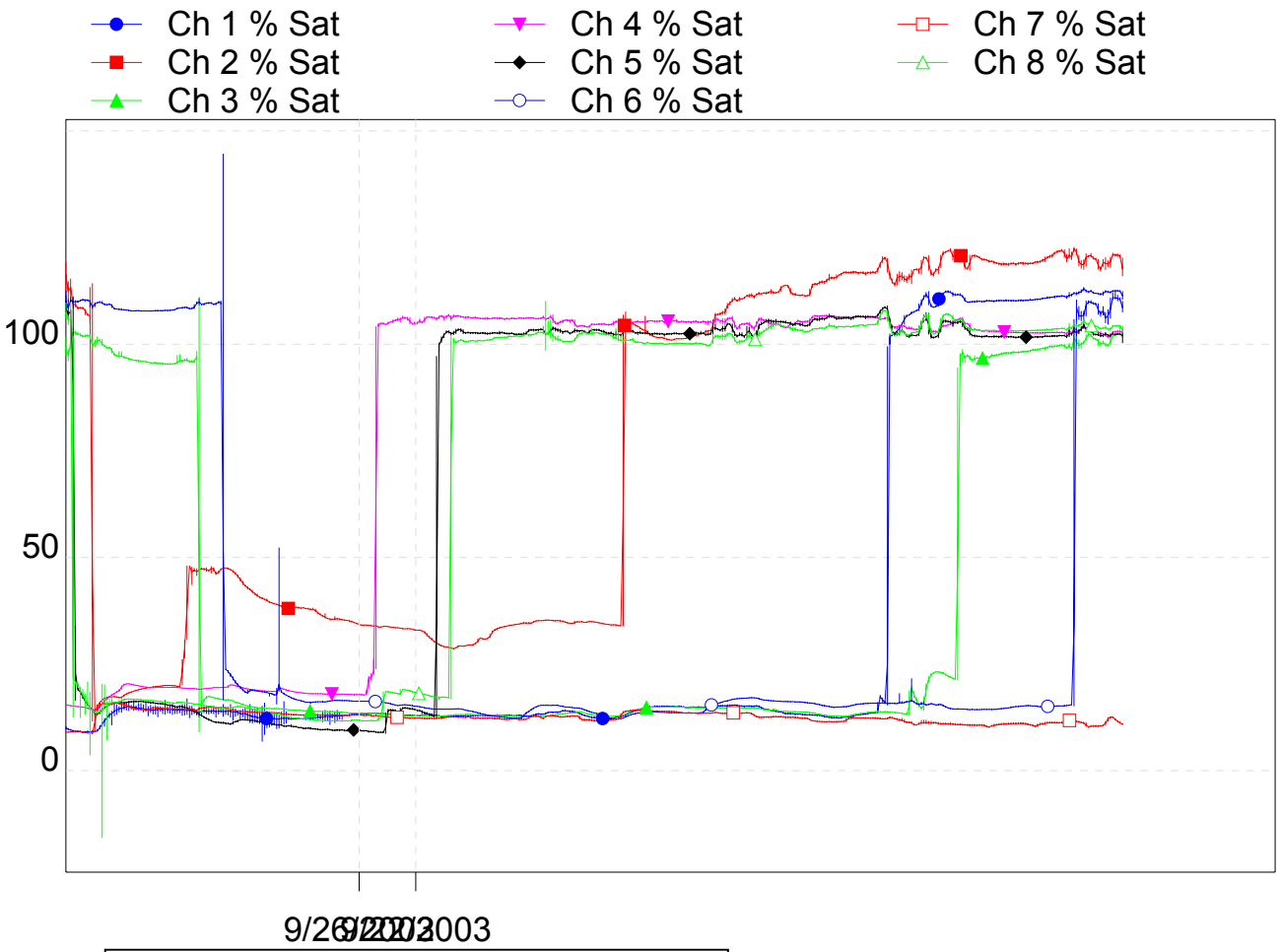
Oxygen electrode calibration was hampered by a lack of strong reducing agent for creating a 0% saturation calibrant. The low end calibrant was therefore created by sparging filtered seawater with nitrogen and quantifying its oxygen content by Winkler titration. Uncertainty in the Winkler method at low DO concentrations introduced a degree of uncertainty into the calibration, and thus into the electrode data. This uncertainty in the Winkler titration at low DO levels also introduced error into the determination of bottom water DO levels via analysis of bottom water from Niskin bottles or core tops. Inaccurate bottom water DO results would also affect shipboard incubations by providing an inaccurate target for the oxystat reservoir DO level.

Replacement Water

During CD 146, using replacement water during incubation sampling increased the core top oxygen levels. This was due to the fact that replacement water was not being sparged with gas to keep it at ambient bottom water DO levels. Prior to CD151, the oxystat reservoir was adapted such that the lid forms a gas tight seal and the oxystat reservoir exhaust was connected to a replacement water reservoir. This ensured that the replacement water reservoir was sparged with the same gas mix as the oxystat reservoir. This modification eliminated the problem of oxygen spikes from replacement water introduction (figures 1-4). Even with a constant low oxygen content, the introduction of replacement water into the oxygen consumption experiments (where dissolved oxygen levels are in flux) could contaminate the incubation. Therefore, sample volume was not replaced in these experiments, rather the volume of overlying water was reduced throughout the incubations by pushing the core top towards the sediment-water interface and eliminating any headspace introduced by removal of water during sampling.

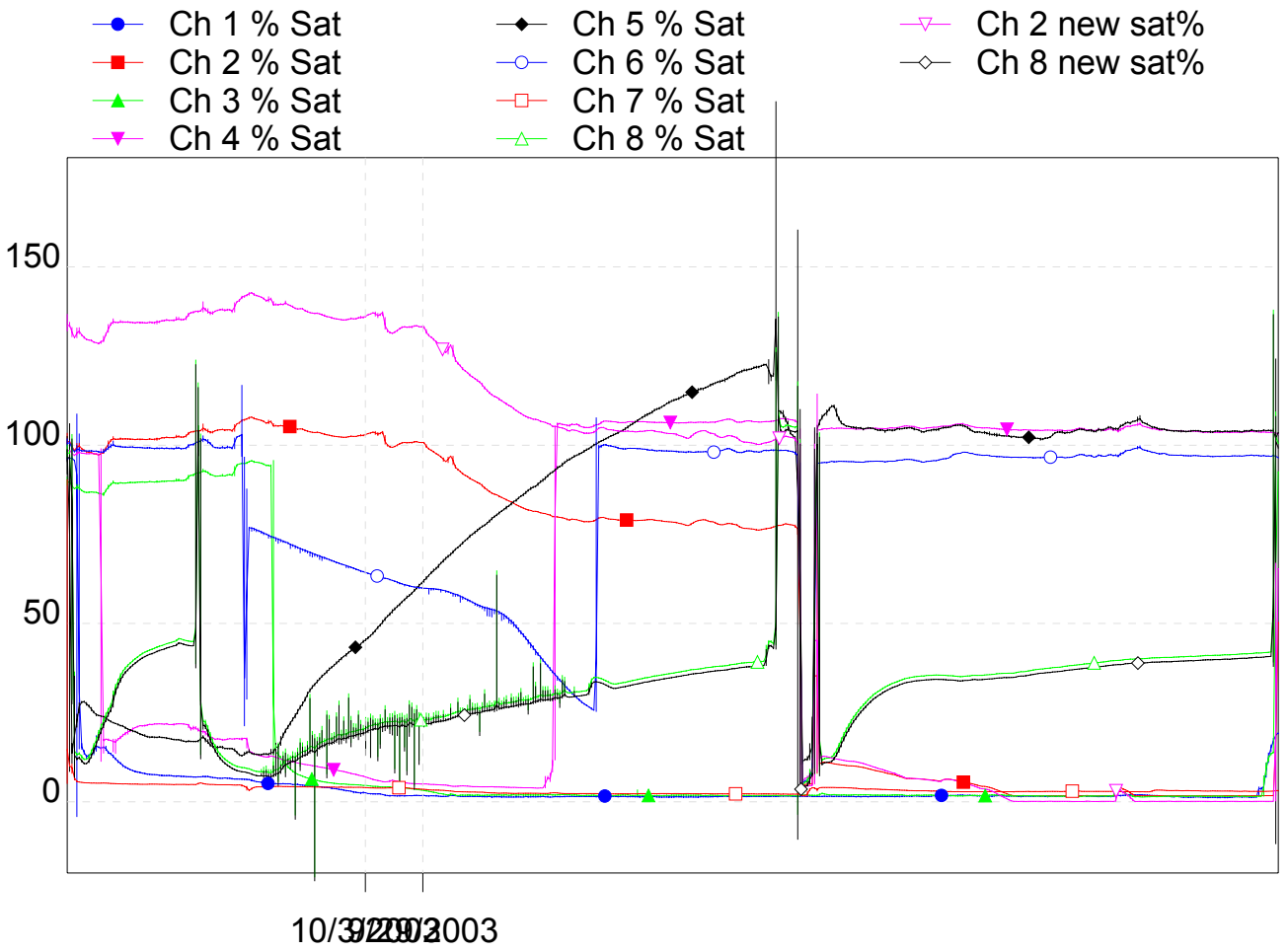
Porewater Squeezing

The problem of porewater squeezing was not encountered, as cores were not pushed up their tubes during incubation water sampling. For most experiments, this was rendered unnecessary by the use of replacement water (as described above). Oxygen consumption experiments did not use replacement water for fear that if used it would introduce unknown amounts of dissolved oxygen at each sampling point. During these experiments the removal of sample volume was compensated by downwards movement of the core top seal to the exclusion of all (temporarily-introduced) bubbles.



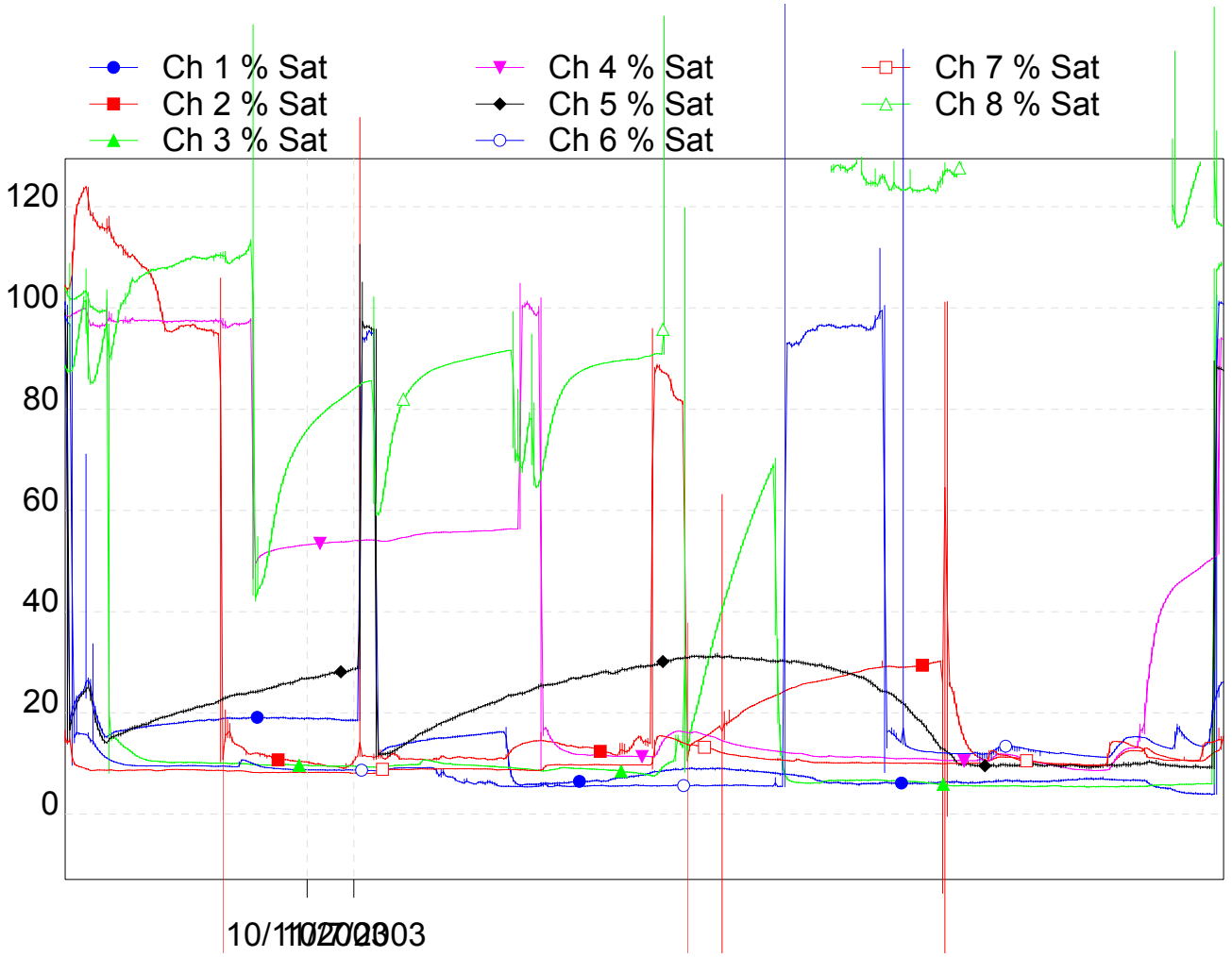
Ch. 1:
SF13-5(4)
20-25/09/03
Ch.2:
SOP
Ch. 3:
SF(10)
21-25/09/03
Ch. 4:
SF13-2(2)
20-22/09/03
Ch. 5:
SO(8)
20-22/09/03
Ch. 6:
SB (6)
21-26/09/03
Ch. 7:
Oxystat barrel
Ch. 8:
SO(7)
20-22/09/03

Figure 1. A140 Shipboard Incubation Oxygen Record.



Ch. 1:
SF13-5(4)
27/09-04/10/03
Ch.2:
SO v.2(8)
02-03/10/03
Ch. 3:
SF(10)
28/09-03/10/03
Ch. 4:
SF13-2(2)
27-30/09/03
Ch. 5:
SO(8)
28/09-01/10/03
Ch. 6:
SOP
28-30/09/03
Ch. 7:
Oxystat barrel
Ch. 8:
SO(7)
28/09-01/10/03
SO v.2(7)
02-03/10/03

Figure 2. A300 Shipboard Incubation Oxygen Record.



Ch. 1:
A940 SO(8)
05-07/10/03
A1000 SO(8)
07-/10/03
Ch.2:
Mat control
SF(4)
11-13/10/03
Ch. 3:
A940 SF(10)
5-9/10/03
Ch. 4:
A940 SOP
06-/10/03
Ch. 5:
A940 SO(7)
05-07/10/03
A1000 SO(7)
07-/10/03
Ch. 6:
A940 SF13-5(4)
05-10/10/03
Bacterial Mat
SF(6)
11-13/10/03
Ch. 7:
Oxystat barrel
Ch. 8:
A940 SOP+
06-/10/03

Figure 3. A940 Shipboard Incubation Oxygen Record.

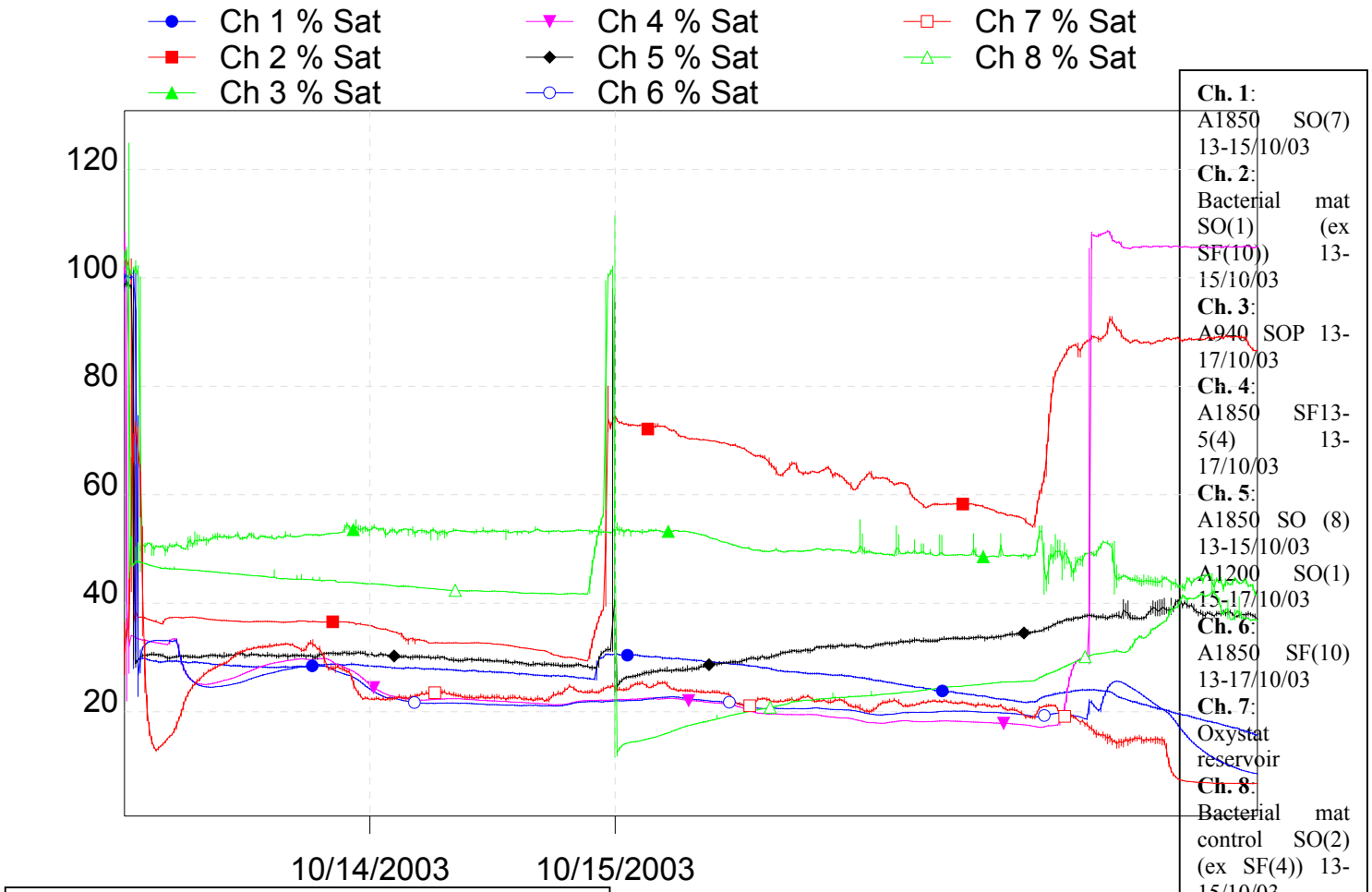


Figure 4. A1850 Shipboard Incubation Oxygen Record.

Seals
Sealing between Kynar and stopcocks on sampling lines was improved though the use of flexible silicone tubing as an intermediate. This reduced the previously experienced instance of bubbles entering samples during withdrawal. Reduced atmospheric contact should improve the quality of DIC and N_2/Ar samples.

Pump Failure
Failure of the oxystat pump (or, more frequently pump tubing) during CD 146 caused some incubations to tend towards anoxia until the pump tubing was repaired. During CD 151 the tension on each pump line was reduced to the minimum required for water to flow, placing less stress on the pump and reducing the occurrence of kinks. In addition, the sections of tubing running across the pump calliper were replaced after every five days of use (normally after every 1-2 stations). This prevented the tubing collapse that was a frequent problem during CD146. Two types of tubing were used, silicone and tygon. While the former was slightly more resilient, the latter was easier to prepare during replacement. No other differences were noted between the efficacy of the two types of tubing.

Core Top Oxygen Contamination
Core top oxygen contamination prior to core incubation was a particular problem during CD151 due to the reduced bottom water DO (as compared to CD 146 bottom water DO). This was minimised by exchanging core bottom (orange) bungs for incubation rig core bottom seals as soon as cores were removed from the corer. Cores were then immediately extruded to exclude any headspace. Orange bungs were then used to seal the core tops until incubation setup. Core top water was thus only exposed to the atmosphere for a matter of seconds. Although not completely eliminated, oxygen contamination of anoxic core tops was significantly reduced by these measures.

Exclusion Of Light
Light was excluded from incubation cores by wrapping core tubes in opaque black plastic sheeting, secured with Velcro. These "sleeves" (figure 5) proved easier to handle, and were more efficient, than the "wendy hut" of CD146.

Care Woulds and Matthew Schwartz

Figure 5. Incubation cores wrapped in black plastic.

10. PRELIMINARY OBSERVATIONS AND SAMPLE/DATA CATALOGUES

10.1 Water column chemistry

10.11 CTD Data

A total of 10 CTD casts were conducted at 6 stations over the course of CD151 (Table 1). Binned (1m) data are included in the appendices of the CD version of this report or can be obtained from the PSO. Note that data plotted below are for the first temperature and conductivity channels (not averages) and DO data are currently tabulated as mg/l concentrations rather than ml/l (to be addressed).

Station	Series #	Site	Date	Time	Lat.		Long.		Depth	Comment
			(03)	(utc)	DN	MN	DE	ME	(m)	
56101	1	A140	19/09	18.16	23	16.800	66	42.710	134	12 bottles fired at 129m
56101	9	A140	20/09	12.45	23	16.917	66	42.706	133	24 bottles, 5-131 m
56101	31	A140	26/09	9.06	23	16.720	66	42.560	136	12 bottles fired, 6 depths
56102	1	A300	27/09	5.39	23	12.470	66	34.030	301	15 bottles, 13 at bottom, 2 at surface
56105	6	A300	28/09	6.10	23	12.490	66	34.020	305	24 bottle sequence
56116	1	A940	04/10	16.19	22	53.490	66	36.630	948	Bottom water sampling
56116	5	A940	05/10	7.45	22	53.510	66	36.630	945	Water column profile
56130	1	BM1	10/10	8.38	24	49.870	65	54.245	845	Bacterial mat sampling area
56135	1	A1850	12/10	9.15	22	52.400	65	59.970	1852	Bottom water sampling, 14 bottles fired
56141	12	A1200	16/10	14.38	22	59.950	66	24.400	1205	13 bottles & profile, tests

Table 1. Summary of CTD casts during CD151.

Figures 1-3 show water-column profiles for the 6 sites (the 5 primary Indus margin study sites plus the Bacterial Mat site). Results are closely consistent with those obtained during CD150, indicating local variability in the upper water column structure but very consistent features below ca. 300m depth. As observed on CD150, there is also a clear shoaling of the upper OMZ boundary relative to profiles obtained during CD145 and CD146 (see cruise reports for CD145, CD146 and CD150).

CTD data from all 4 cruises will be processed at SOC/SAMS and made available to the project participants.

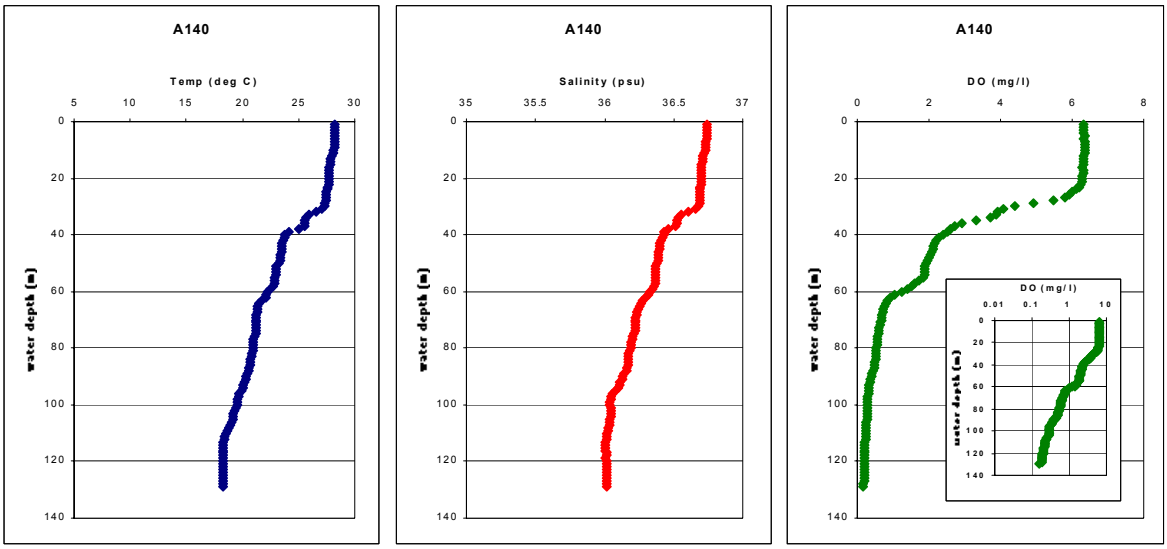


Figure 1: CTD data for station A140 (CTD cast 56101#1). Note DO values are in mg/l, to be checked, and temperature and salinity values are for 1st channels on the CTD. Inserts show DO data plotted on a logarithmic scale.

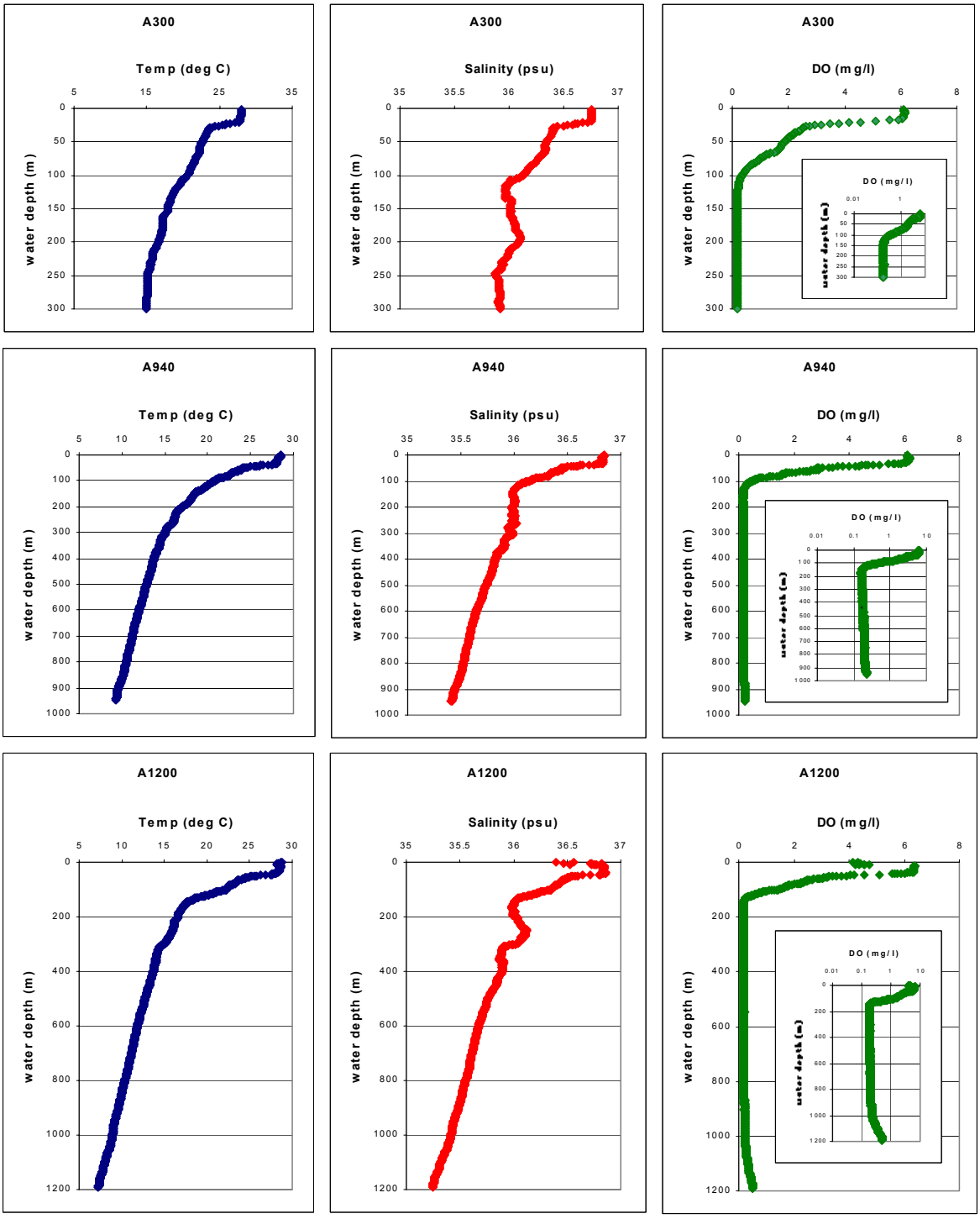


Figure 2. CTD profiles from Stations A300, A940 and A1200 (CTD casts 56102#1, 56116#1 and 56141#12, respectively).

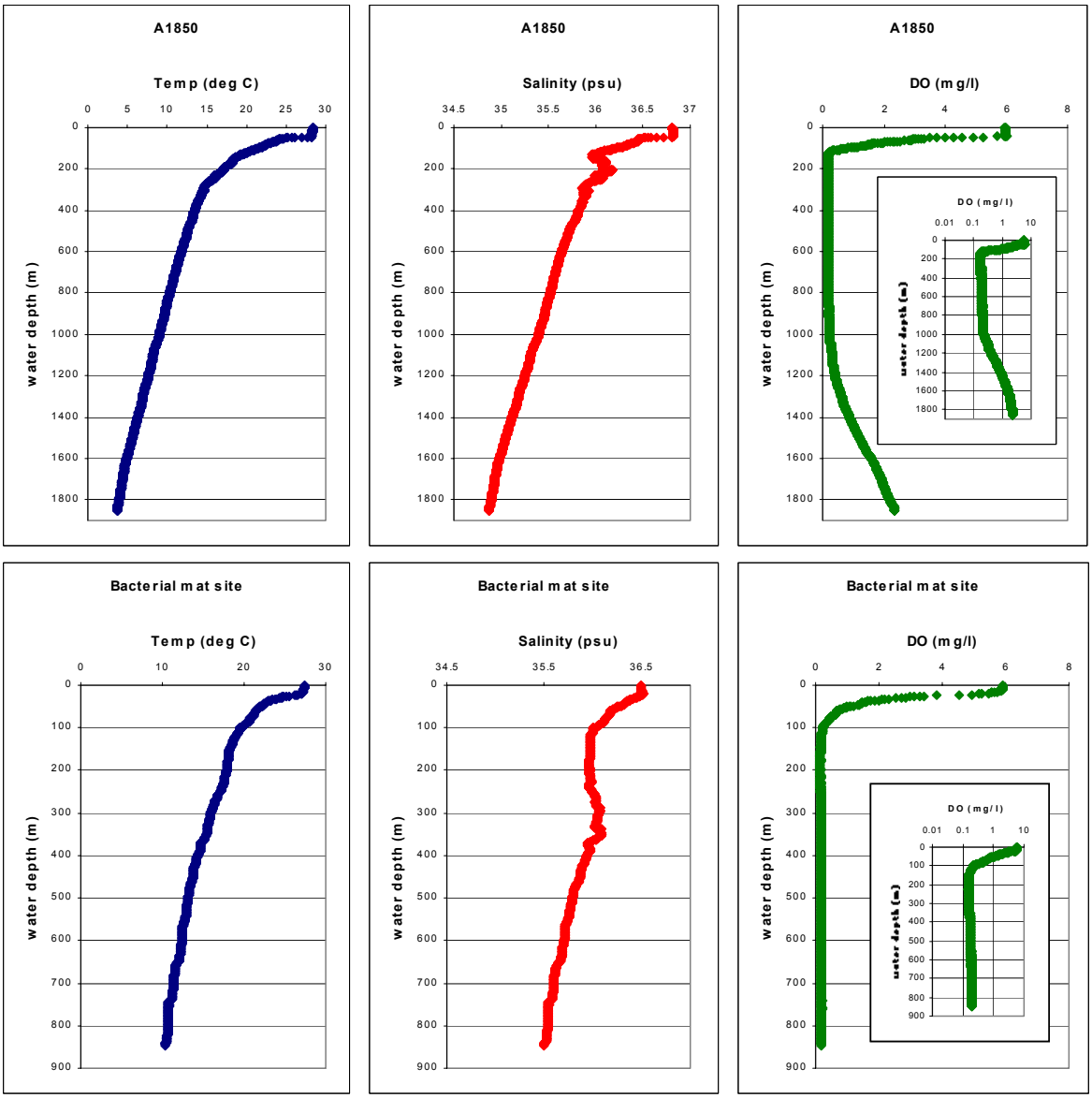


Figure 3: CTD profiles from stations A1850 and the Bacterial Mat site BM1 (casts 56135#1 and 56130#1, respectively).

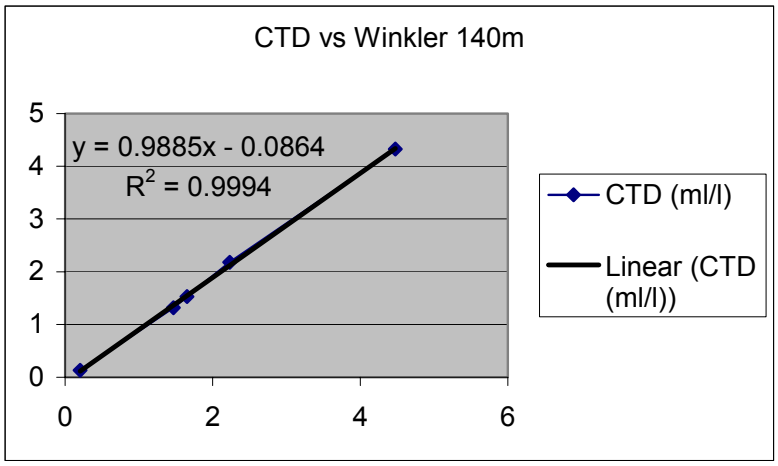
Greg Cowie (Dave Teare)

10.12 Winkler titration results

a) Station A140 oxygen comparisons between CTD sensor and Winkler titrations

Depth (m)	Winkler (ml/l)	CTD (ml/l)
10	4.475	4.33
25	2.233	2.18
35	1.653	1.53
60	1.469	1.32
120	0.204	0.129

Figure 1: Correlation between CTD sensor and Winkler titration O_2 data.



b) Bottom water oxygen concentrations

Bottom water oxygen concentrations were obtained from all sites cored by using either one of the following or a combination of the three: water collected from megacore overlying water, mini Niskin bottles attached to the landers and from normal Niskins attached to the CTD. The data from these determinations are presented in Table 1. Water column oxygen samples were also collected form the CTD to compare the Winkler method to the CTD sensor (Table 2, Fig. 1). While the correlation is very good, it is still evident that large variations occur between the sensor and Winklers at low levels of oxygen. The CTD sensor calibration is valid to 1 ml/l so values under this may be suspect. Sampling errors and artefacts occurring during sample recovery (temperature and pressure effects) and sample fixing (introduced oxygen) also have an impact on observed variations between lander electrodes and Niskins and CTD sensor and Niskins.

Table 1. Bottom water oxygen concentrations

Station	Core Top Oxygen (ml/L)	Lander BW Oxygen (ml/L)	CTD BW Oxygen (ml/L)
A140m	0.204	0.234	0.129
A300m	0.213	0.388	
A940m	0.634	0.383	
A1000m		0.211	
A1200m		0.641	
A1850		1.165	1.69

Eric Breuer and Gareth Law

10.13 Water-column nutrient data

Water-column nutrient data were collected shipboard from 24 –bottle casts at sites A140, A300 and A940. Preliminary data are presented in Figures 1-3. Note: Data are preliminary and final checking and corrections

remain to be carried out at SAMS. Fully processed data will be available to all project participants. Preliminary indications are that features are similar to those observed on CD150, most notably distinct nitrite maxima within the surficial 50m (nitrification) and again between ca. 150m and 700m, the latter (coupled with nitrate depletion) indicating more intensified and widespread dentitrification than during CD145 and CD146 (see cruise reports for CD145, CD146 and CD150).

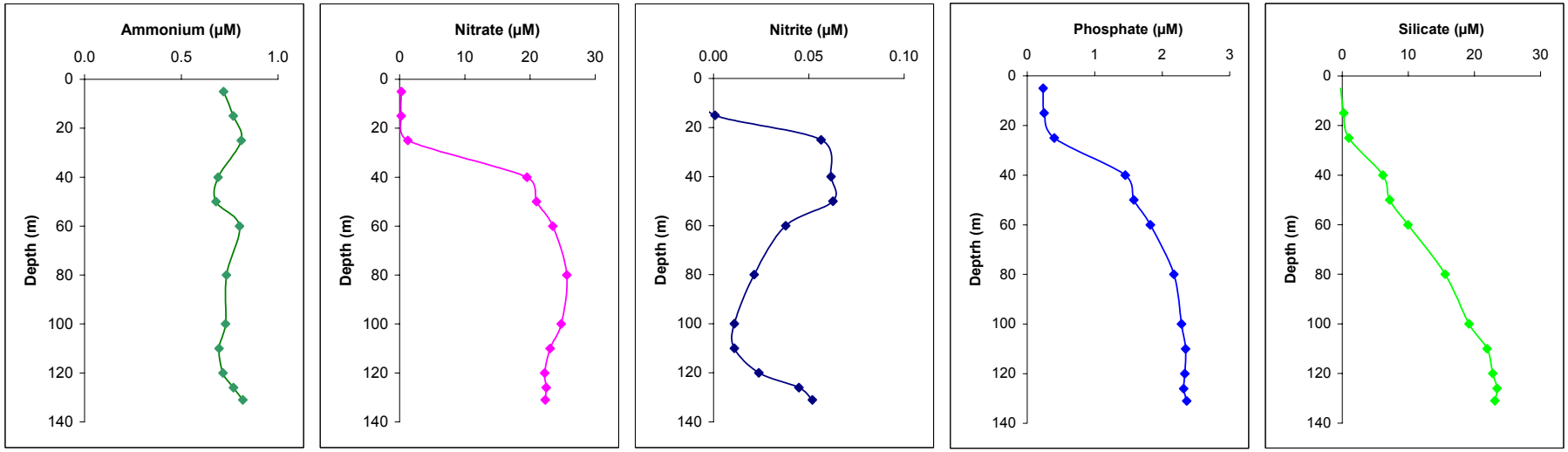


Figure 1. Water column nutrient data from station A140 (56101#9)

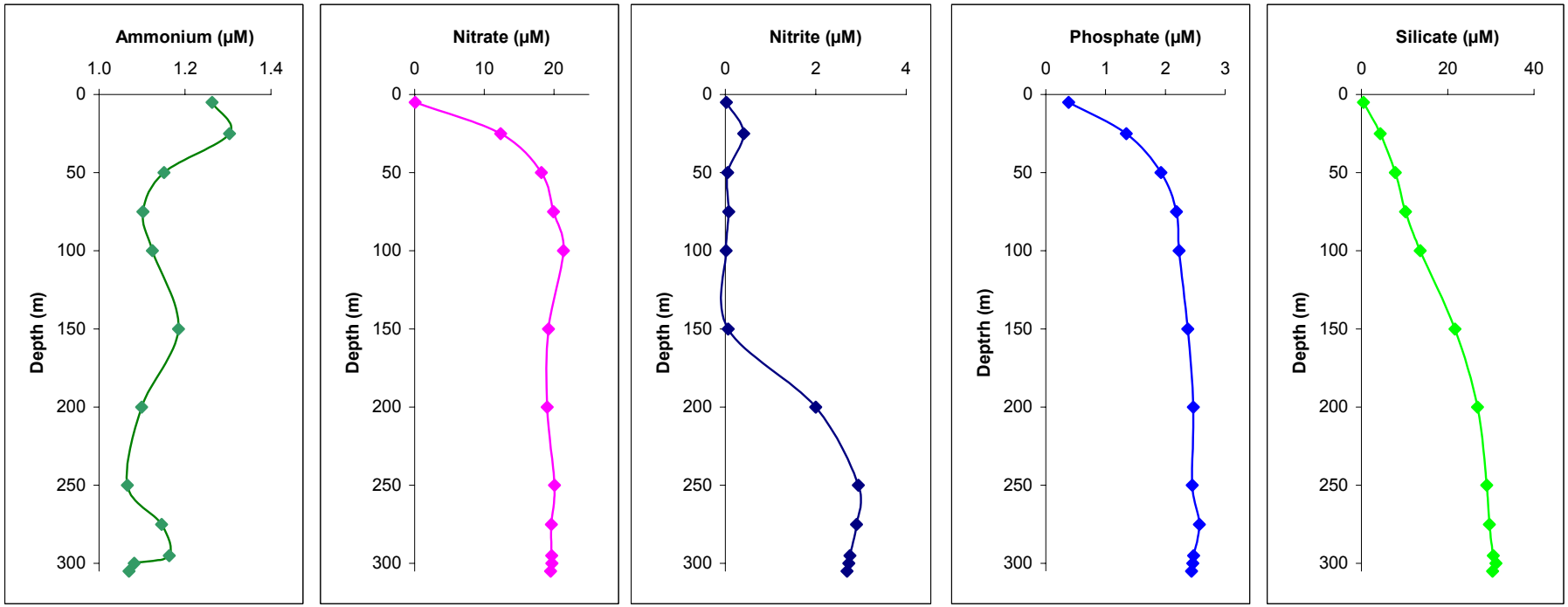


Figure 2. Water column nutrient data from site A300 (56105#5)

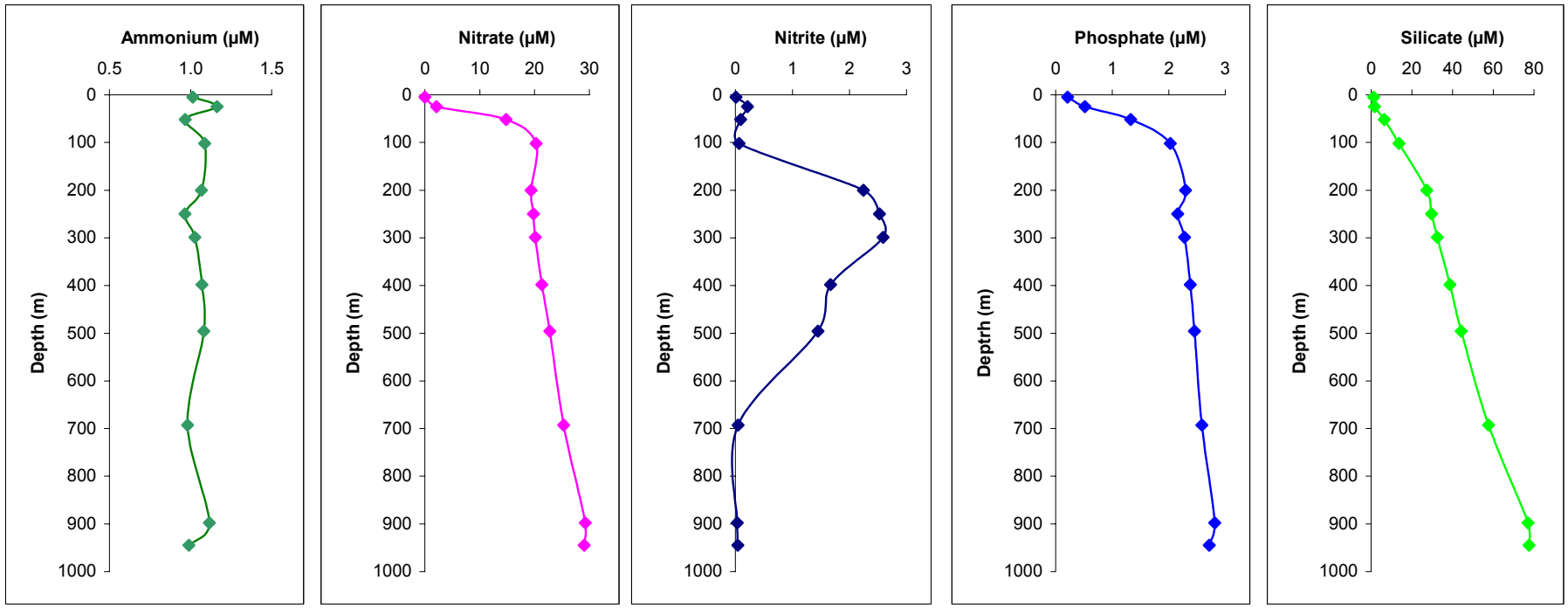


Figure 3: Water column nutrient data from site A940 (56116#5)

Table 1: Water sample collection from CD151 CTD casts

Site	Station #	Depth (m)	Type of Analyses
A140	56101#09	5	CN, PLFA, Chla, nutrients
		15	CN, PLFA, Chla, nutrients
		25	CN, PLFA, Chla, nutrients
		40	CN, PLFA, Chla, nutrients
		50	CN, PLFA, Chla, nutrients
		60	CN, PLFA, Chla, nutrients
		80	CN, PLFA, Chla, nutrients
		100	CN, PLFA, Chla, nutrients
		110	CN, PLFA, Chla, nutrients
		120	CN, PLFA, Chla, nutrients
		126	CN, PLFA, Chla, nutrients
		131	CN, PLFA, Chla, nutrients
A300	56105#06	5	CN, PLFA, Chla, nutrients
		25	CN, PLFA, Chla, nutrients
		50	CN, PLFA, Chla, nutrients
		75	CN, PLFA, Chla, nutrients
		100	CN, PLFA, Chla, nutrients
		150	CN, PLFA, Chla, nutrients
		200	CN, PLFA, Chla, nutrients
		250	CN, PLFA, Chla, nutrients
		275	CN, PLFA, Chla, nutrients
		295	CN, PLFA, Chla, nutrients
		300	CN, PLFA, Chla, nutrients
		305	CN, PLFA, Chla, nutrients
A940	56116#05	5	CN, PLFA, Chla, nutrients
		25	CN, PLFA, Chla, nutrients
		52	CN, PLFA, Chla, nutrients
		102	CN, PLFA, Chla, nutrients
		200	CN, PLFA, Chla, nutrients
		250	CN, PLFA, Chla, nutrients
		299	CN, PLFA, Chla, nutrients
		398	CN, PLFA, Chla, nutrients
		496	CN, PLFA, Chla, nutrients
		693	CN, PLFA, Chla, nutrients
		898	CN, PLFA, Chla, nutrients
		945	CN, PLFA, Chla, nutrients

CN	POC and TN, plus stable C&N isotopes on GFF filters (Edinburgh)
Chla	Chlorophyll a on GFF filters (Edinburgh)
PLFA	Lipid analyses on suspended solids (GFF filters, Liverpool)
Nutrienets	Dissolved nutrient analyses (shipboard)

Table 2: BBLS sampling during CD151

Station	Series #	Site	Date (03)	Analyses	Comment
56101	16	A140	21/09	DOC,TDN, nutrients, PLFA	Success with 4/5 bottles
56107	7	A300	30/09	DOC,TDN, nutrients, PLFA	Successful
56116	11	A940	06/10	DOC,TDN, nutrients, PLFA	Successful
56137	15	A1850	14/10	DOC,TDN, nutrients, PLFA	Successful
56141	5	A1200	16/10	DOC,TDN, nutrients, PLFA	Successful

BBLS nutrient data processing will be conducted at SAMS post-cruise, along with final processing and compilation of nutrient data from CTD water bottle samples.

Steve Mowbray (Greg Cowie)

10.14 Characterization of Plankton Community for Stable Isotope Analysis – Plankton as a food source

Plankton tows were conducted at main stations (140, 300, 940, 1200, and 1850m) to determine a natural isotope signature from the plankton community as a potential food source. A brief examination of the plankton caught showed ctenophores and calanoid copepods were dominant. An occasional small fish or polychaete was captured in the catch. See Table 1 for details.

Table 1: Plankton community samples and analysis fate

Date 2003	Station no	Tow depth	Fate	Person Receiving Sample
21-Sep	56101#12	40	ETOH - SIO	E. Geotze (SIO)
21-Sep	56101#13	10	Frozen -70 lipids	K. Larkin (SOC)
21-Sep	56101#14	10	Frozen -70 stable isotopes	L. Levin (SIO)
21-Sep	56101#15	10	Formalin	G. Cowie (Edinburgh)
1-Oct	56107#9	40	ETOH - SIO	E. Geotze
1-Oct	56107#10	40	Frozen -70 lipids	K. Larkin
1-Oct	56107#11	40	Frozen -70 stable isotopes	L. Levin
1-Oct	56107#12	40	Formalin	G. Cowie
2-Oct	56112#2	40	ETOH - SIO	E. Geotze
2-Oct	56112#3	40	Frozen -70 lipids	G. Cowie
6-Oct	56116#12	40	ETOH - SIO	E. Geotze
6-Oct	56116#13	40	Frozen -70 lipids	K. Larkin
6-Oct	56116#14	40	Frozen -70 stable isotopes	L. Levin
6-Oct	56116#15	40	Formalin	G. Cowie
6-Oct	56116#16	40	Frozen -70 stable isotopes	G. Cowie
16-Oct	56141#6	40	Frozen -70 lipids	G. Cowie
16-Oct	56141#7	40	Formalin	G. Cowie
16-Oct	56141#8	40	Frozen -70 lipids	K. Larkin
16-Oct	56141#9	40	ETOH - SIO	E. Geotze
16-Oct	56141#10	40	Frozen -70 stable isotopes	L. Levin
16-Oct	56141#11	40	Frozen -70 stable isotopes	L. Levin
13-Oct	56137#6	40	Frozen -70 stable isotopes	L. Levin
13-Oct	56136#7	40	Frozen -70 stable isotopes	L. Levin
13-Oct	56137#8	40	Frozen -70 lipids	K. Larkin
13-Oct	56136#9	40	ETOH - SIO	E. Geotze
13-Oct	56137#10	40	Frozen -70 lipids	G. Cowie
13-Oct	56136#11	40	Formalin	G. Cowie

Christine Whitcraft

10.2 Sediments.

10.21 Visual observations, photography, X-radiography

Twenty nine sediment slabs were examined from 17 different water depths. Depth-related trends are summarized below and in Figure Levin-1.

Fully bioturbated sediments with tube and burrow structures present are found early in the oxygen minimum zone at 140 m and once again, in the lower OMZ, from 1000 – 1200 m and below the OMZ (1850 m). Similar to the trends seen on CD146, irregular, disturbed laminations are present within the upper portion of the oxygen minimum zone (200, 250, 300 m), and uniform, unbroken, seasonal laminations (< 1 mm thick) are present at 600-800 m. In the lower portion of the OMZ (850-950 m) vertical burrows overlie laminations. A list of observations from x-radiographs is given below.

UPPER OMZ TRANSITION ZONE

A140

56101#5, MgC #4 (longest core)

Sediments relatively homogenous to 12 cm (depth of core)
Large horizontal burrow at 5.5 cm
Higher and lower density 'patches' (not laminae)

56101#23, MgC #1 (longest core)

Sediments homogeneous to at least 20 cm
Very fine burrows (< 0.25 mm) from 0 –3 cm
Outline of gastropoda shell at 12 cm

A250

5610431, MGC #7 (longest core)

Laminated sediments, finely
No burrows evident

A275

56111#2, MgC#1(longest core)

Laminated sediment, finely, to at least 20 cm
Laminations broken and wavy, with evidence of disturbance
Like 250m

OMZ CORE

A300

56107#2, MgC #6

Laminated sediments, to at least 12 cm.
Laminations broken and wavy, with evidence of disturbance
Surface sediments are finely laminated (< mm scale).

A700

56113#1, MgC#3

Laminated to 12.5 cm.
1 cm thick band at 3 cm
White clay lenses at 8cm, 15 cm
Wavy laminations, 1mm to 4 mm thick.
No biogenic features

LOWER OMZ TRANSITION ZONE

A800

56123#1, Mg C #1

Laminated to at least 14 cm
Laminae 1 mm thick
High density layer (clay?) 7 cm and 8 cm below surface

A850

56114#5, MgC#4

Laminated to 12.5 cm
Laminae 1 mm thick
High density layer 5.6 to 5.8 mm and 6.3 to 6.4 mm below surface
VERY faint vertical burrows: 1mm wide and 1 cm long

A900

56121 #2, MgC#7

Faint burrow network and mottling present to 5 cm, overlying laminations.

High density (clay?) lens present 5-6 cm
Two thin high density layers at 3 cm
Laminated deeper than 6 cm

A940

56116#4, MgC#8

Vertical burrows to 5.5 cm
High density (clay?) lens 4.5 to 5.5 cm, also burrowed through this layer
Different density layer at 11-15 cm

56116#6, MgC#10

High density sediment layer 4 to 5 cm
Vertical burrows to 5 cm
Few biogenic features below 6 cm

A1000

56119#3, MgC#8

Fine burrows at top of core (1-2 cm)
Rest of core homogenous in texture with some mottling
Density sediment change at 3 to 4 cm layer

56122#1, MgC#2

Fine burrows at top of core (1-2 cm)
Rest of core homogenous in texture with some mottling
Density sediment change at 3 to 4 cm layer

A1050

56142#1, MgC#2

Fluffy detrital layer in top 1 cm
High water content and burrowing in top 5 cm
Horizontal burrows or mottling in upper 4 cm. No features below.

A1100

56120#1, MgC#8

Fine-grained sediment (fecal pellets evident under microscope)
3 shrimp burrows evident on tope of core (shrimp observed on Lander video)
Fully bioturbated to 12 cm
No laminations (to 12 cm)

A1200

56139#2, MgC#5

Bioturbated at least to 20cm
Mottling of sediment throughout the core
Horizontal tube present at 10 cm
No density variation evident downcore

56139#1, MgC#11

Bioturabtion to at least 12cm
No density variation in lower layers (This density variation was observed in CD146)

BELOW OMZ

A1850

56137#1, MgC#3

Bioturbated at least to 20cm
Burrowing most evident in first 8 cm of core

56137#2, MgC#10

Bioturbated to at least 20 cm
Very similar to 56137#2, MgC#3

BACTERIAL MAT SITES

56133#1 (Bacterial mat)

From visual examination
Reddish fluffy layer at surface
Clay lens at 15 cm
11-15 cm black layer – perhaps pyrite?
Second reddish layer (1 cm) under the black layer
Solid clay under the second reddish layer

From xray -

Laminated sediments strarting at 0.5 cm (under mat) until 12 cm
Thin density change layer (1 cm thick) at 13 cm
3 cm thick black layer with thin different density layer beneath

56134#1, MgC# 4,5 (Bacterial mat control)

Clay layer lower down than in bacterial mat
Laminated down to at least 13 cm
Evenly spaced laminations
No obvious black layer

Table 1. Summary of x-radiographs taken on CD 151.

Date 2003	Station	Station no	Core no.	Exposure (sec)	Slab size	Comments
20-Sep	A140	56101#5	4	15	long, thin	
23-Sep	A140	56101#23	1	15	long, thin	
23-Sep	A140	56101#23	1	15	long, thin	
26-Sep	A140	56101#30	4	10	long, thin	under exposed
26-Sep	A140	56101#30	4	16.3	long, thin	over exposed
27-Sep	A250	56104#1	7	14	long, thin	
1-Oct	A275	56111#2	1	14	long, thin	
29-Sep	A300	56107#2	6	14	short	
2-Oct	A750	56113#1	3	6.3	short	
8-Oct	A800	56123#1	6	6.3	short	
3-Oct	A850	56114#5	4	6.3	very short	
7-Oct	A900	56121#2	7	8	very short	
5-Oct	A940	56116#4	8	6.3	short	
5-Oct	A940	56116#6	10	6.3	very short	
10-Oct	bac control	56134#1	4	8	short	
10-Oct	bac control	56134#1	4	14	short	
10-Oct	bac mat	56133#1	8	10	long, thin	
10-Oct	bac mat	56133#1	8	12	long, thin	
7-Oct	A1000	56119#3	8	6.3	long, thin	
8-Oct	A1000	56122#1	2	8	very short	
17-Oct	A1050	56142#1	3	8	short	
7-Oct	A1100	56120#1	8	8	long, thin	
15-Oct	A1200	56139#1	11	10	very short	
15-Oct	A1200	56139#2	5	10	long, thin	
13-Oct	A1850	56137#1	3	10	long, thin	under exposed
13-Oct	A1850	56137#2	10	10	short	under exposed
13-Oct	A1850	56137#1	3	14	long, thin	
13-Oct	A1850	56137#2	10	14	short	

Figure 1. Photographic X-Radiographic Images of Pakistan Margin Sediments CD151.

Bacterial mat

Photograph of slab

X-ray of slab

Bacterial mat control

Photograph of slab

Xray slab

Most x-radiographs from the Indus margin sites are closely similar to those from CD145 and CD46 (refer to cruise report for CD146. Requests for images can be made to L. Levin (Scripps Institute of Oceanography).

Christine Whitcraft

10.22 Faunal sampling

10.22.1 Metazoan macrobenthos:

A. Quantitative Macrobenthos Survey Sampling at Main Stations for Gage/Lamont (CSUR)

A total of 20 cores from 7 megacore drops were sectioned and preserved for SAMS survey work. Samples are logged in Table 1. At each station, one core was vertically sectioned (0-0.5, 0.5-1, 1-2, 2-3, 3-5, 5-10,10-20) and 3 cores were sectioned coarsely (0-10,10-20). All sections were preserved in formalin, without sieving due to lack of time. They include the following:

*140 m (4 cores: 1 drop)
* 300 m (4 cores: 1 drop)
* 940 m (4 cores: 1 drop)
*1200 m (4 cores: 2 drops)
*1850 m (4 cores: 2 drops)

A detailed sample list is provided in Table 1. A description of community composition is given in the section titled "Metazoan and Protozoan Assemblages on the Pakistan Margin".

Table 1: CSUR cores taken for Gage/Lamont, CD151

Date 2003	Water depth	Station no	Core no.	Vertical Fractions (0-1,1-2, 2-5, 5-10, 10-20)
20-Sep	A140	56101#2	9	0-0.5, 0.5-1,1-2, 2-3, 3-5,5-10,10-20
20-Sep	A140	56101#2	6	0-10, 10-20
20-Sep	A140	56101#2	10	0-10, 10-20
20-Sep	A140	56101#2	4	0-10, 10-20
29-Sep	A300	56107#2	9	0-0.5, 0.5-1,1-2, 2-3, 3-5,5-10,10-20
29-Sep	A300	56107#2	10	0-10, 10-20
29-Sep	A300	56107#2	11	0-10, 10-20
29-Sep	A300	56107#2	12	0-10, 10-20
	A940	56116#10	1	0-0.5, 0.5-1,1-2, 2-3, 3-5,5-10,10-20
	A940	56116#10	6	0-10, 10-20
	A940	56116#10	10	0-10, 10-20
	A940	56116#10	5	0-10, 10-20
15-Oct	A1200	56139#1	5	0-10, 10-20
15-Oct	A1200	56139#1	8	0-10, 10-20
15-Oct	A1200	56139#1	9	0-10, 10-20
15-Oct	A1200	56139#2	11	0-0.5, 0.5-1,1-2, 2-3, 3-5,5-10,10-20
13-Oct	A1850	56137#2	5	0-10, 10-20
13-Oct	A1850	56137#1	6	0-10, 10-20
13-Oct	A1850	56137#1	7	0-10, 10-20
13-Oct	A1850	56137#1	9	0-0.5, 0.5-1,1-2, 2-3, 3-5,5-10,10-20

B. Fine Scale Transition Zone Sampling of Macrobenthos. (CSIO)

Megacore samples were collected from the following depths across the lower portion of the oxygen minimum zone, where oxygen starts to increase (0.1 to 0.3 ml/l):, 700m, 800 m, 850 m, 900 m, 940 m, 1000 m, 1050 m and 1100 m. One or two cores were sectioned and preserved at each depth. One or two cores were also sorted live as time allowed, and finally, one or two cores were x-rayed to describe the sediment characteristics (see Section 10.21, Table 1). Faunal observations based on analysis of material sieved live and examined under the dissecting microscope are given in the section titled "Metazoan and Protozoan Assemblages on the Pakistan Margin". Lists of these samples are provided as a subset of the complete lists in Tables 2 and 3.

Table 2. List of macrobenthos samples collected for analysis at SIO
Samples were sectioned at 0-1,1-2, 2-5, 5-10, and 10-20 cm intervals.
Sections > 2 cm were sieved in a 300 μm mesh before preservation unless otherwise noted.

Date 2003	Station	Station no	Core no.	Comments
20-Sep	A140	56101#2	8	sieved 0-1, 2-5,5-10
20-Sep	A140	56101#4	3	sieved 2-5,5-10, 10-20, Gromids? In 10-20, lots of Scaphozoans
24-Sep	A140*	56101#26	7	sieved all fractions, sorted 0-1 live then preserved
1-Oct	A180	56108#2	3	short core, only 11 cm, very coarse sand
1-Oct	A220	56109#1	4	short core, only 10 cm, very coarse sand
27-Sep	A250	56104#2	10	Pelosina on top
27-Sep	A250	56104#2	11	Pelosina on top
2-Oct	A275	56111#1	7	sieved all fractions, sorted 0-10 live then preserved
29-Sep	A300	56107#1	12	
29-Sep	A300	56107#2	7	
4-Oct	A300*	56115#1	3	Eric took CHN sample from 0-1 cm
2-Oct	A700	56113#2	7	
8-Oct	A800	56123#1	8	
3-Oct	A850	56114#1	1	
3-Oct	A850	56114#5	6	

Date 2003	Station	Station no	Core no.	Comments
9-Oct	A850	56127#1	7	
7-Oct	A900	56121#2	9	
5-Oct	A940	56116#4	4	sieved 5-10, 10-20
12-Oct	A940*	56136#1	1	
10-Oct	bac control	56134#1	4	around x ray core
10-Oct	bac control	56134#1	5	
10-Oct	bac mat	56133#1	2	stopped at 15 due to clay lens
10-Oct	bac mat	56133#1	4	stopped at 15 due to clay lens
7-Oct	A1000	56119#3	9	
8-Oct	A1000	56122#1	12	
17-Oct	A1050	56142#1	2	
17-Oct	A1050	56142#1	2	
7-Oct	A1100	56120#1	3	
15-Oct	A1200	56139#1	6	
15-Oct	A1200*	56139#2	3	
13-Oct	A1850	56137#1	1	
13-Oct	A1850	56137#2	7	
15-Oct	A1850*	56140#2	1	burrow on top down to 2 cm, pseudofeces outside burrow

Table 3. Samples (all megacores) processed for live sorting of macrofauna for biochemical analyses. Samples were sectioned at 0-1,1-2, 2-5, 5-10, and 10-20 cm intervals and sieved on a 300 micron mesh.

Date 2003	station	Station no	Core no.	Comments
20-Sep	A140	56101#4	9	10-20 just looked with eye for big orgs
21-Sep	A140	56101#10	6	10-20 just looked with eye for big orgs
27-Sep	A250	56104#1	4	lots of fecal pellets in 0-1, 1-2
27-Sep	A250	56104#2	1	lots of fecal pellets in 0-1, 1-2
1-Oct	A275	56111#2	7	10-20 just looked with eye for big orgs
28-Sep	A300	56105#5	3	10-20 just looked with eye for big orgs
28-Sep	A300	56105#5	12	10-20 just looked with eye for big orgs
2-Oct	A750	56113#1	1	10-20 just looked with eye for big orgs
2-Oct	A750	56113#2	3	10-20 just looked with eye for big orgs
8-Oct	A800	56123#1	7	10-20 just looked with eye for big orgs
3-Oct	A850	56114#1	4	10-20 just looked with eye for big orgs
3-Oct	A850	56114#5	2	10-20 just looked with eye for big orgs, 3 pelosina removed (A. Gooday)
9-Oct	A850	56127#1	6	2 pelosina removed (A. Gooday)
7-Oct	A900	56121#2	11	3 Pelosina removed (A. Gooday), 3 shrimp burrows on surface
5-Oct	A940	56116#4	7	10-20 just looked with eye for big orgs
5-Oct	A940	56116#6	6	large worm on center of core
10-Oct	bac mat	56133#1	8	around x ray core
7-Oct	A1000	56119#3	10	3 Pelosina removed (A. Gooday)
8-Oct	A1000	56122#1	11	10-20 just looked with eye for big orgs
17-Oct	A1050	56142#1	1	10-20 just looked with eye for big orgs
7-Oct	A1100	56120#1	12	Sea pen preserved from top (P. Lamont)
15-Oct	A1200	56139#1	7	10-20 just looked with eye for big orgs
15-Oct	A1200	56139#1	1	10-20 just looked with eye for big orgs
15-Oct	A1200	56139#2	1	10-20 just looked with eye for big orgs
13-Oct	A1850	56137#1	2	burrows in 10-20, brown down to 5, gray down to 10, clay below that
13-Oct	A1850	56137#2	4	10-20 just looked with eye for big orgs
13-Oct	A1850	56137#2	5	10-20 just looked with eye for big orgs

C. Background Metazoan Macrofaunal Communities:
Characterization and Samples for Biogeochemical Analyses (CBIO).

A large number of megacore samples were sieved on a 300 μm mesh and macrofauna (>300μm) were sorted live under the dissecting microscope to (a) obtain background macrofauna for biogeochemical analyses, and (b) provide information about changing community composition across the oxygen minimum zone. Table 3 lists cores collected for this work. Faunal samples frozen for biogeochemical studies were collected from this sorting and listed in Appendix – Faunal logsheet. A total of 473 invertebrate samples, 13 bacteria samples and 12 plankton/phytoplankton samples were collected and frozen for isotopic analysis (See Table 4). Among the benthic invertebrates, there were 7 mixed meiofauna, and 3 nematode samples. Polychaetes were the dominant group (331 samples), followed by molluscs (69), crustaceans (31), echinoderms (16), cnidarians (13), Nemertea (6), Sipunculids (3), and Aplacophoran (3). These samples reflect the relative rate of encounter of different groups over the entire Pakistan margin, and indicate the clear dominance by polychaetes across all stations. The polychaete samples were dominated by

Table 4 – Preliminary summary of phyla collected and frozen for later analysis

Taxon	Number	Percentage
Aplacophoran	3	1
Bryozoa	1	0
Cnidaria	13	3
Crustacea	31	7
Echinodermata	16	3
Foraminifera	365	
Mollusca	69	15
Nemertea	6	1
Polychaetea	331	70
Sipunculida	3	1
W/O forams total	473	
TOTAL	**838**	

As opposed to CD146, the OMZ appears to have become slightly shallower, bringing the A140 station into the OMZ. The exact effect of this is not clear, although perhaps a small decrease in infaunal diversity occurred. Polychaetes are the dominant phylum, especially Cirratulids. Similar to CD146 results, macrofauna were rare to absent in the upper OMZ boundary cores (300 m-700 m), with only 1 Dorvellid? polychaete and 1 Cirratulid polychaete identified at 300m. Macrofauna appeared again at about 850 m with a very low diversity assemblage dominated by Pseudeurythoe polychaetes. This assemblage becomes moderately diverse and includes molluscs, echinoderms, cnidarians, crustaceans and other polychaetes by 940 m, although Pseudeurythoe polychaetes were still dominant. The 1200m sediments again contain large, deep burrows, and it is clear that several high biomass, bioturbating species are living deep in the sediment column. One large, currently unidentified, Sipunculid was found in such a large burrow at a depth of 31 cm. A single large, tube-building Onuphid polychaete was found in a multi core at this station but at a shallower depth of 1-2 cm. Otherwise, diversity and biomass of macrofaunal invertebrates in the upper 10 cm at this station was low. Below the OMZ, the better oxygenated 1850 m sediments also show low macrofaunal density, but higher diversity, with peracarid crustaceans, aplacophoran and bivalve molluscs and other groups becoming more common. Mudball-building cirratulid polychaetes were present still at the A1850 site although fewer were found than during CD146.

In a rapid examination, the bacterial mat site was dominated by the Pseudeurythoe polychaete, same species as observed at 940m site. No other macrofauna were found in the live sorting. The Pseudeurythoe were smaller and occurred in larger numbers (23 in 0-1 cm section of core) than at any other site examined on CD151. Burrows were evident in the upper 0-2 cm section of the cores. Pseudeurythoe were found wrapped up in white bacterial strands throughout the depth of the 10 cm sorted. At lower depths of 5-10 cm, black bacterial strands were also found. In addition to the organisms, both types of bacterial strands were frozen for natural isotope analysis.

10.22.2 Foraminiferal sampling

A large number of megacore samples were sieved on a 300-µm screen and sorted under a binocular microscope for benthic foraminifera in order to characterise faunal changes across the OMZ and to provide material for analyses of biochemistry and natural stable isotopes. Cores incubated the CT laboratory with ^{13}C-enriched diatoms (*Thallasiosira*) and subcores from parallel lander *in situ* incubations were sorted in a similar way. In most cases, the foraminifera were sorted to putative species. We attempted to remove only individuals that appeared to be live on the basis of their general appearance, test contents (e.g. pigmented protoplasm), or the fact that they were found in their life position. The thick-walled tests of some agglutinated taxa (e.g. *Cyclammina*) were broken open in order to determine whether or not they contained protoplasm. However, in the case of some species (particularly certain *Reophax* spp. and komokiaceans), it was difficult or impossible to determine the nature of the test contents. Our sorted material will therefore inevitably contain a mixture of live and dead individuals.

a) Foraminiferal assemblages

The main features of 'live' foraminiferal assemblages in core samples and sample residues from each sampling depth are summarised in Table 1. As during CD146, systematic observations were made on sieve fractions >300 µm at the main study sites (140, 300, 950, 1850 m) and opportunistic observations made at the other sites. Where possible, we photographed and collected larger foraminifera and gromiid-like protozoans visible on the surfaces of mega- and multicores.

Table 1. Observations on Foraminifera (>300-micron fraction)

Main sites in blue, bacterial mat and control sites in red, other sites in black.

Depth	Dominant foraminifera species
A140	0-1-cm. Calcareous species dominant. *Uvigerina* sp. most abundant.
	Other species include *Globobulimina* sp., *Lenticulina* spp., *Cancris* sp., *Brizalina* sp., *Quinquiioculina* sp.; occasional
	allogromiids (several species). Slender white *Bathysiphon*protrude from core surfaces. *Pelosina* present on core surfaces
	but less common than during CD146.
180m	Coarse shelly sediment with surface *Pelosina*
230m	Coarse shelly sediments with abundant *Pelosina*(up to 30 or more on a single megacore)
250m	*Pelosina* common. Very long, tubular monothalamous foraminifera on core surfaces. Small, gromiid-like species, sausage-
	like 'saccamminids' present in residues. Also Lenticulina, Globobulimina,
275m	Long muddy cores with occasional *Pelosina.* No sausage-shaped saccamminids and only rare 'casperamminids'
A300	0-1cm. Calcareous species dominant. Assemblage fairly diverse; *Uvigerina* sp. again dominant and *Globobulimina, Cassidulina, Brizalina, Cancris* also present
	Pelosina uncommon on core surfaces
	Agglutinated species are more abundant and diverse than at 140m; including two *Reophax* spp., slender white *Bathysiphon, Cribrostomides* and *Ammodiscus*.
	Monothalamous forms diverse and include many of those seen during CD146: e.g. 'casperamminids', sausage-shaped saccamminids, *Nemogullmia*,
693m:control site	*Reophax* sp. (same species that occurs at 300m) common on sediment surface. Diverse assemblage of monothalamous species includes
	sausage-like saccamminids, casperamminids, *Nemogullmia*-like allogromiids
700m	0-10cm. *Pelosina* fairly common on core surfaces; *Globobulimina* sp. dominates residues. Monothalamous species include
	Casperammina sp and brown sausage-shaped saccamminids.

Depth	Dominant foraminifera species
759m:bacterial mat	surface layer: *Globobulimina* sp. very abundant; ocassional monothalamous species (casperamminids) also present. No other foraminiferal species observed
806m:bacterial mat	other live species. Some monothalamous including *Casperammina* sp.
800m	0-2 cm. *Pelosina* fairly uncommon; 0ne megacore with 6 specimens of a different *Pelsosina* sp.,
	Globobulimina spp. and *Bulimina* spp. dominate the calcareous species.
	monothalamous species include 'casperamminids', white and brown allogromiids, white sausages-like saccamminids.
850m	0-10cm. *Globobulimina* spp. (3 species), *Chilostomella* sp. and *Cribostomoides* sp.
900m	0-5cm. *Chilostomella* sp. and *Globobulimina* sp. Common; *Bulimina* sp.also present. Monothalamous species uncommon but include
	some species present in OMZ core.
A940	0-10cm. Agglutinated foraminifera fairly diverse, including 4 *Reophax* spp., *Cribrostomoides* sp., *Karerriella* sp., *Ammodiscus* sp. ;
	Chilostomella sp. dominant calcareous species (increasing numbers with depth);*Globobulimina* sp., *Cancris* sp. also present
	Monothalamous taxa uncommon
1000m	0-2cm. *Pelosina* fairly uncommon (<1 per core) and upright, unbranched agglutinated tube also visible on core surfaces.
	Brown, grape-shaped allogromiids and small Bathysiphon sp. attached to *Pelosina* and other vertical structures.
	Lenticulina sp., *Chilostomella* sp. , *Bulimina* sp., *Globobulimina* sp. *a, Cyclammina* sp. and a brown lattice-like 'pseudokomokiacean' present in residues
1050m	A different *Pelosina* species occasionally present on core surfaces
A1200	0-2cm. *Reophax* spp. abundant and diverse (6-7 species); other agglutinated include *Bathysiphon* sp., a silver *Hyperammina* sp. and
	Ammobaculitesbaculusalsus. Live calcareous foraminifera rare; include *Globobulimina* sp., *Melonis* sp., *Hyalina baltica.,Bulimina aculeata, Chilostomella sp.*
	Monothalamous taxa include *Nodellum* sp. and a few allogromiids. Occasional large gromiids/allogromiids on core surfaces.
A1850	0-2cm . 'Typical' deep-sea assemblage dominated by *Rhizammina* sp., komokiaceans and chain-like forms. Multilocular agglutinated taxa (*Resphax, Cyclammina,*
	Cribrostomoides', Eggerella, Nodosium) diverse but often dead. Robust *Bathysiphon, H yperammina* and *Rhabdammina* spp.
	and occasional xenophyophore fragments also occur. Live calcareous foraminifera (*Bulimina aculeata* and *Hoeglundina* sp.) usually rare
	Monothalamous include C*rithionina* sp., *Nodellum* sp., yellow saccaminids. Most megacorer deployments yielded 1-2 *Gromia sphaerica.*

In general, the foraminifera present were similar to those observed on CD146. Calcareous foraminifera, mainly *Uvigerina* sp., dominated at 140 m and 300 m. A diversity of agglutinated taxa (particularly *Reophax* spp.), together with the infaunal calcareous genera *Chilostomella* and *Globobulimina,* were present at deeper stations (950 m, 1200 m), and komokiaceans and other typical deep-sea taxa were abundant at the deepest site (1850 m). Sausage-shaped saccamminids and allogromiids were again a significant feature of assemblages in the OMZ core (300-900 m). However, during the present cruise we also made a number of new observations which can be summarised as follows.

1) Compared with CD146, *Uvigerina* sp. was relatively more abundant at the140-m site and relatively less abundant at the 300-m site. This difference may reflect the upward shift of the upper OMZ boundary noted elsewhere in this cruise report.

2) *Pelosina* was less common at 140 m and 300 m than it was during CD146. However, it was very abundant on the surfaces of cores collected at 230 m and to a lesser extent at 250 m depth. These cores consisted of coarse, shelly sediments and came from just below the shelf break.
3) A distinctive new species of *Pelosina*, characterised by long, delicate, tapered test branches, was observed at 1000m.
4) Long, sausage-shaped saccamminids were present at 250 m, shallower than the shallowest record (300 m) of these forms on CD146.
5) Clear faunal differences were evident between the 'bacterial mat' site (Stations 56130, 56133) and the control site (Stations 56131, 56134). In particular, the mat samples were overwhelmingly dominated by a *Globobulimina* species while the control site yielded abundant *Reophax* sp. (probably the same species that occurs at the main 300-m site) together with sausage-shaped monothalamous forms.

More detailed studies of faunal trends in relation to the OMZ will be conducted using multicores collected during the present and preceding cruises (CD150, 151) (Table 2). These cores were sliced into 0.5-cm layers to a depth of 2 cm and thereafter in 1-cm thick layers to 10-cm depth. The sediment slices were fixed in buffered 10% formalin.

Table 2. Multicores for foraminiferal faunal analyses.

Station/series	Water depth (m)	Core number	Interval sliced (cm)
56101#27	133	4	0-10
56104#3	248	43	0-10
56105#7	302	5	0-7
56110#1	249	1	0-10
56110#1	249	9	0-10
56111#1	275	3	0-10
56111#1	275	5	0-10
56115#2	299	11	0-8
56119#1	999	11	0-10
56119#1	999	8	0-10
56120#1	1097	11	0-10
56121#1	898	10	0-10
56121#1	898	11	0-10
56123#2	792	11	0-10
56114#3	843	1	0-10
56114#3	843	3	0-10
56133#3	846	7	0-10
56133#3	846	8	0-10
56134#3	845	10	0-10
56134#3	845	11	0-10
56136#2	940	1	0-10
56137#	1853	3	0-10
56140#3	1843	1	0-10
56141#3	1991	1	0-10
56142#2	1044	10	0-10
56142#2	1044	9	0-10

b) Biogeochemical analyses

Foraminifera for lipid, carbohydrate and amino acid analyses were sorted from 17 megacores (CBIO samples; Table 3), sliced as follows: 0-1, 1-2, 2-5, 5-10 cm. An additional 13 cores were sliced in the same intervals and frozen at -70°C and will be sorted later (Table 4).

Table 3. Megacores sorted for foraminiferal biochemical analyses (>300-micron fraction)

Station/series	Depth	Core number	Intervals sorted
56101#10	132m	12	0-1
56101#4	133m	6	0-1
56105#5	A300	12	0-1

Station/series	Depth	Core number	Intervals sorted
56105#5	A300	3	0-1
56131#1	693m:control site		surface
56113#1	700m	1	0-10
56130#3	759m:bacterial mat		surface
56133#1	806m:bacterial mat	8	surface
56123#7	800m	7	0-2
56127#1	850m	6	0-10
56121#2	900m	11	0-5
56116#4	A940	7	0-10
56122#1	1000m	11	0-2
56139#2	A1200	1	0-5
56139#1	A1200	1	0-5
56137#2	A1850	4	0-2
56137#1	A1850	2	0-2

Table 4. Megacores used for natural abundance faunal biochemistry

Cores were taken to replicate of those taken on CD150.
All cores sliced and frozen at -70C

Station/series	Depth (m)	Core number	Core interval (cm)	Comments
56101#2	133	5	0-10	
56101#5	137	6	0-10	
56104#2	253	12	0-10	
56105#4	280	4	0-10	
56116#6	940	5	0-10	
56130#3	759	9	0-1	core top from extra bacterial mat site
56130#3	759	8	0-1	core top from extra bacterial mat site
56131#1	693	4	0-0.5	core top from control site
56133#1	806	7	0-5	bacterial mat site
56133#2	845	11	0-5	bacterial mat site
56134#1	697	6	0-5	control site
56137#1	1850	10	0-10	
56139#2	1200	10	0-10	

c) ^{13}C enrichment experiments: shipboard and in situ incubations

In situ lander incubation were conducted successfully at 140, 300, 940 m and shipboard incubations at 140, 300, 940, 1200 and 850 m. A total of 15 megacores and 6 lander core (half slices) was recovered (Table 5). The cores were sliced into the following layers: 0-0.5, 0.5-1.0, 1.0-1.5, 1.5-2.0, 2-3, 3-4, 4-5, 5-7, 7-10 cm and sorted for foraminifera, in addition to metazoans, down to 1cm depth. Unsorted slices and finer fractions (<300μm) were frozen for later analysis. As on CD 146, a bright green protoplasmic colouration indicated that a number of species, notably *Uvigerina* sp. but also *Cassidulina* sp. and *Cancris* sp., had taken up the labeled algae.

Table 5. Samples incubated with ^{13}C-enriched algae and sorted for sorted macrofaunal metazoans and foraminifera

Date 2003	Station	Station/series	Core type	Core no.	Time series
22-Sep	A140	56101#4	Megacore	6	SF13-T2A
22-Sep	A140	56101#10	Megacore	6	SF13-T2B
24-Sep	A140	56101#28	Megacore	3	SF13-T0
25-Sep	A140	56101#2	Megacore	2	SF13-T5B
25-Sep	A140	56101#2	Megacore	3	SF13-T5A
27-Sep	A140	56101#29	Lander	n/a	EF13-A
27-Sep	A140	56101#29	Lander	n/a	EF13-B
27-Sep	A140	56101#29	Lander	n/a	*bulk sediment
30-Sep	A300	56105#3	Megacore	5	SF13-T2A
30-Sep	A300	56105#3	Megacore	5	SF13-T2B
2-Oct	A300	56107#4	Lander	n/a	EF13-A
2-Oct	A300	56107#4	Lander	n/a	EF13-B
3-Oct	A300	56112#1	Megacore	9	SF13-T0
4-Oct	A300	56102#2	Megacore	unknown	SF13-T5A
4-Oct	A300	56102#2	Megacore	unknown	SF13-T5B
6-Oct	A940	56116#2	Lander	n/a	*bulk sediment
10-Oct	A940	56116#3	Megacore	12	SF13-T5A
10-Oct	A940	56116#3	Megacore	12	SF13-T5B
14-Oct	A940	56136#1	Megacore	unknown	SF13-T0
15-Oct	A940	56136#3	Lander	n/a	EF13-A
15-Oct	A940	56136#3	Lander	n/a	EF13-B
17-Oct	A1850	56137#2	Megacore	unknown	SF13-T5A
17-Oct	A1850	56137#2	Megacore	unknown	SF13-T5B

* Only sorted for metazoan macrofauna

Kate Larkin and Andy Gooday

10.22.3 Megabenthos (Agassiz trawls)

For details of the deployment of the Agassiz trawl see CD150 cruise report.
For details of the methods of sample preservation see CD150 cruise report.

The Agassiz trawls carried out on CD151 were typically characterised by muddy hauls with small sample volumes.

Station 56101#25; Site A140; Depth: 134-136.5 m
A medium sized haul from the upper boundary of the OMZ. This catch was dominated by molluscs including a second specimen of *Tibia* sp. previously found on CD150. Present were hermit crabs, solitary scleractinian polyps, infaunal actinaria, *Astropecten* sp., a few small fish, prawns and small crabs.

Station 56117#01; Site 900; Depth: 889-955 ucm
A very large muddy haul from the core of the OMZ. Present were 3 gastropods, and many *Pseudeurythoe* sp., unfortunately these were small than 2mm and so were not retained on the sieve. There were also numerous fish vertebrae. No megafaunal sample was collected here.

Station 56126#01; Site C1000; Depth: 981.5-987.5 ucm
Once again this was a large muddy haul. The catch was small and dominated by the holothurian *Psolus* sp., pennatulids, sorberaceans, sponges and two species of ophiuroid.

Station 56138#01; Site D1700; Depth: 1676-1712 ucm
This large muddy haul also produced a small catch. However, this catch was more diverse than the catch at C1000. Present were several species of fish including, macruids and notocanths. The crustacea present included, *Polycheles* sp., *Munida scrobina*, *Glyphocrangon* sp., *Thalassina* sp. amphipods and isopods. There were also two species of ophiuroid present, some scaphopods, and a clam. A few *Hyalinoecia* sp. (quill worms) were also present.

Station 56143#01; Site C1500; Depth: 1520-1535 ucm
This site produced a smaller haul. The sample volume was also small but diverse. Present were several crustaceans including natant crustaceans, isopods, mysids, *Thalassina* sp. and *Munida scrobina*. There were two specimens of the holothurian *Molpadia* sp. present. Also present was the 'round' ophiuroid species. There were also several sipunculid worms present, a sponge, tunicate, two gromiids, the actinarian *Actinoscyphia* sp. and a few polychaetes.

Rachel Jeffreys

10.23 Porewater pH and sample collection for NIOO

For pH measurements, the Thermo Russell, model RL 100 pH meter was used.

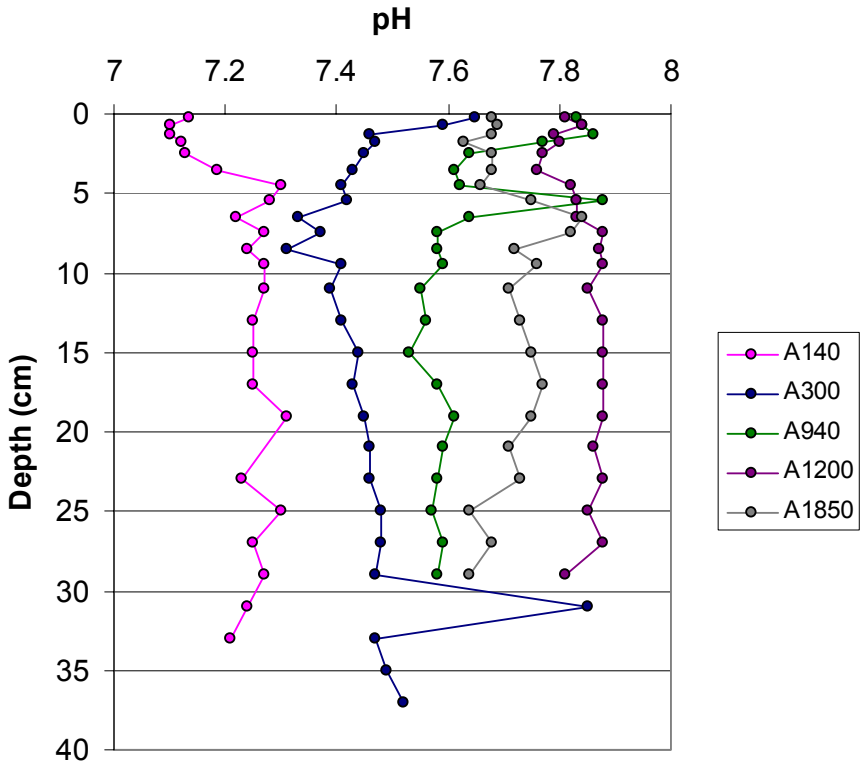
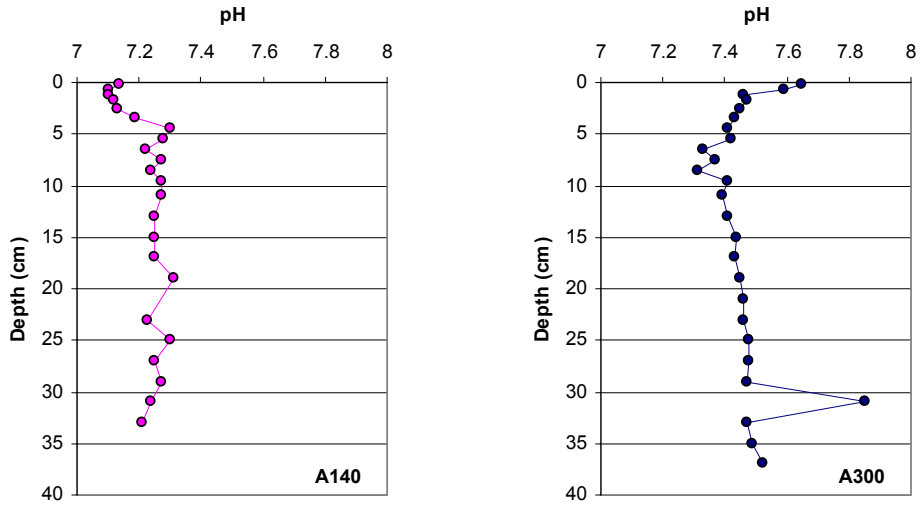


Fig. 1: pH values of the 5 main stations



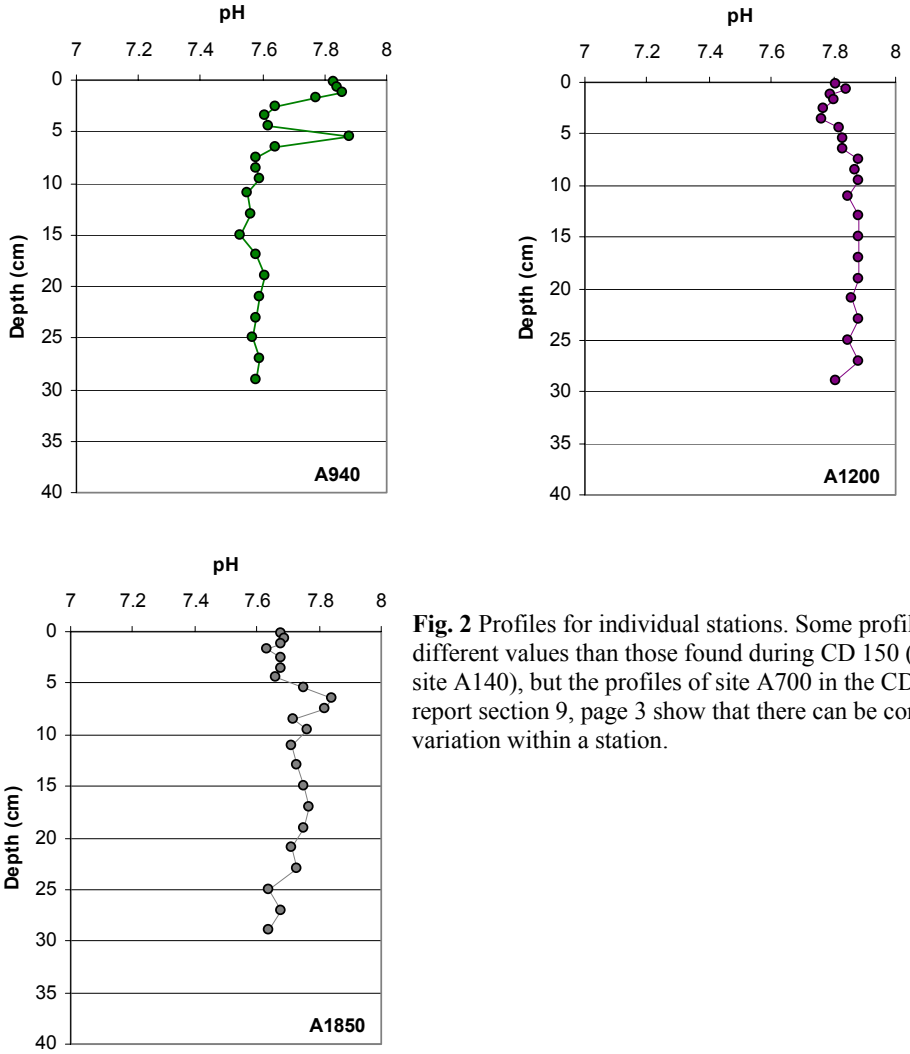


Fig. 2 Profiles for individual stations. Some profiles show different values than those found during CD 150 (for example at site A140), but the profiles of site A700 in the CD 150 cruise report section 9, page 3 show that there can be considerable variation within a station.

Table 1. Porewater pH results

Depth	A140	A300	A940	A1200	A1850
0.25	7.135	7.65	7.83	7.81	7.68
0.75	7.1	7.59	7.84	7.84	7.69
1.25	7.1	7.46	7.86	7.79	7.68
1.75	7.12	7.47	7.77	7.8	7.63
2.5	7.13	7.45	7.64	7.77	7.68
3.5	7.185	7.43	7.61	7.76	7.68
4.5	7.3	7.41	7.62	7.82	7.66
5.5	7.28	7.42	7.88	7.83	7.75
6.5	7.22	7.33	7.64	7.83	7.84
7.5	7.27	7.37	7.58	7.88	7.82
8.5	7.24	7.31	7.58	7.87	7.72
9.5	7.27	7.41	7.59	7.88	7.76
11	7.27	7.39	7.55	7.85	7.71
13	7.25	7.41	7.56	7.88	7.73
15	7.25	7.44	7.53	7.88	7.75
17	7.25	7.43	7.58	7.88	7.77

Depth	A140	A300	A940	A1200	A1850
19	7.31	7.45	7.61	7.88	7.75
21	-	7.46	7.59	7.86	7.71
23	7.23	7.46	7.58	7.88	7.73
25	7.3	7.48	7.57	7.85	7.64
27	7.25	7.48	7.59	7.88	7.68
29	7.27	7.47	7.58	7.81	7.64
31	7.24	7.85			
33	7.21	7.47			
35		7.49			
37		7.52			

As stated in the CD 150 cruise report, two different pH meters were used for the measurements of the porewater pH. To see if there is a difference in the results of both meters, the pH of six depth intervals at the A300 site were measured with both meters. The measurements with the Russell meter appeared to be systematically higher than the ones with the Hanna meter.

Table 2. Comparison of pH results from 2 different meters.

Depth (cm)	Russell	Hanna	delta
0.25	7.65	7.54	0.11
0.75	7.59	7.45	0.14
1.25	7.46	7.34	0.12
1.75	7.47	7.34	0.13
2.5	7.45	7.37	0.08
3.5	7.43	7.33	0.1
		average	**0.11**
		stdev	**0.02**

NIOO sample catalogue

a) *EHAA and density separation*

In order to analyse the enzymatically hydrolyzable amino acids (EHAA) in the sediments of the visited sites, several multicores were collected. These cores were sliced in 0.5 cm intervals until 3 cm, 1 cm intervals until 10 cm and 2 cm intervals until the bottom of the core. The EHAA analysis itself will be performed at the NIOO (Yerseke, the Netherlands).

The sediment of several megacores was collected in order to perform a density separation (in the Netherlands), with the exception of station 56101#11, where the 0-1 cm and 1-2 cm sediment slice of a multicore was used. From station 56101#19 onwards, two slices were collected per core: 0-1 cm and 9-10 cm. For some stations, a vertical profile was made using a 1 cm interval until 2 cm and a 2 cm interval until 10 cm.

EHAA

Site	Station	Core	Processed length(cm)	Gear	Preservation state
A140	56101#7	V	26	Multicore	Frozen
A140	56101#11	IV	24	Multicore	Frozen
A140	56101#20	I	26	Multicore	Frozen
A300	56107#8	VIII	40	Multicore	Frozen
A300	56107#9	I	46	Multicore	Frozen
A250	56110#1	VIII	10	Multicore	Frozen
A275	56111#1	VI		Multicore	Frozen
A700	56113#5	III	42	Multicore	Frozen
A850	56114#3	V	42	Multicore	Frozen
A940	56116#7	IX	30	Multicore	Frozen
A940	56116#8	XI	32	Multicore	Frozen

Site	Station	Core	Processed length(cm)	Gear	Preservation state
A1000	56119#1	IV	30	Multicore	Frozen
A1100	56120#2	VI	28	Multicore	Frozen
A900	56121#1	VIII	46	Multicore	Frozen
A800	56123#2	IX	46	Multicore	Frozen
BM800	56133#2	III	26	Multicore	Frozen
BM800	56133#3	VI	24	Multicore	Frozen
BMcontrol	56134#3	V	32	Multicore	Frozen
A1850	56137#4	V	24	Multicore	Frozen
A1850	56137#3	IX	24	Multicore	Frozen
A1200	56141#3	II	28	Multicore	Frozen
A1200	56141#4	V	26	Multicore	Frozen
A1050	56142#2	VII	24	Multicore	Frozen

Density separation

Site	Station	Core	Analysis	Gear	Preservation state
A140	56101#11	V	density	Multicore	Frozen
A140	56101#19	IV, VI, VIII, XI	density	Megacore	Frozen
A140	56101#23	III, IV, IX, XII	density	Megacore	Frozen
A300	56105#2	I, VI, IX, X	density	Megacore	Frozen
A300	56105#5	I, IV, X, XI	density	Megacore	Frozen
A700	56113#1	II, VIII, IX, X	density	Megacore	Frozen
A700	56113#2	I, IX, X, XI	density	Megacore	Frozen
A850	56114#5	I, X, XI, XII	density	Megacore	Frozen
A940	56116#4	III, V, VI, XI	density	Megacore	Frozen
A940	56116#6	II, III, IX, XI	density	Megacore	Frozen
A1000	56119#3	I, II	density	Megacore	Frozen
A1100	56120#1	IV, V	density	Megacore	Frozen
A900	56121#2	VI, VIII	density	Megacore	Frozen
A800	56123#1	I, XI	density	Megacore	Frozen
A1050	56142#1		density	Megacore	Frozen

Density separation, vertical profile

Site	Station	Core	Analysis	Gear	Preservation state
A300	56115#1	X, XII	vertical profile	Megacore	Frozen
A1850	56137#12	I, III	Vertical profile	Megacore	Frozen
A1850	56137#13	X, XI	Vertical profile	Megacore	Frozen
A1200	56139#1	II, III	Vertical profile	Megacore	Frozen
A1200	56139#2	X, XI	Vertical profile	Megacore	Frozen
BM800	56133#2	I, II	Vertical profile	Megacore	Frozen

Samples were also collected for δ^{13}DIC analyses, for porewaters (at the same sites as pH analyses were conducted) and from all shipboard and in situ ^{13}C enrichment studies, following protocols previously described in CD145 and CD146 cruise reports. These will be returned to the NIOO for analysis by Henrik Andersson.

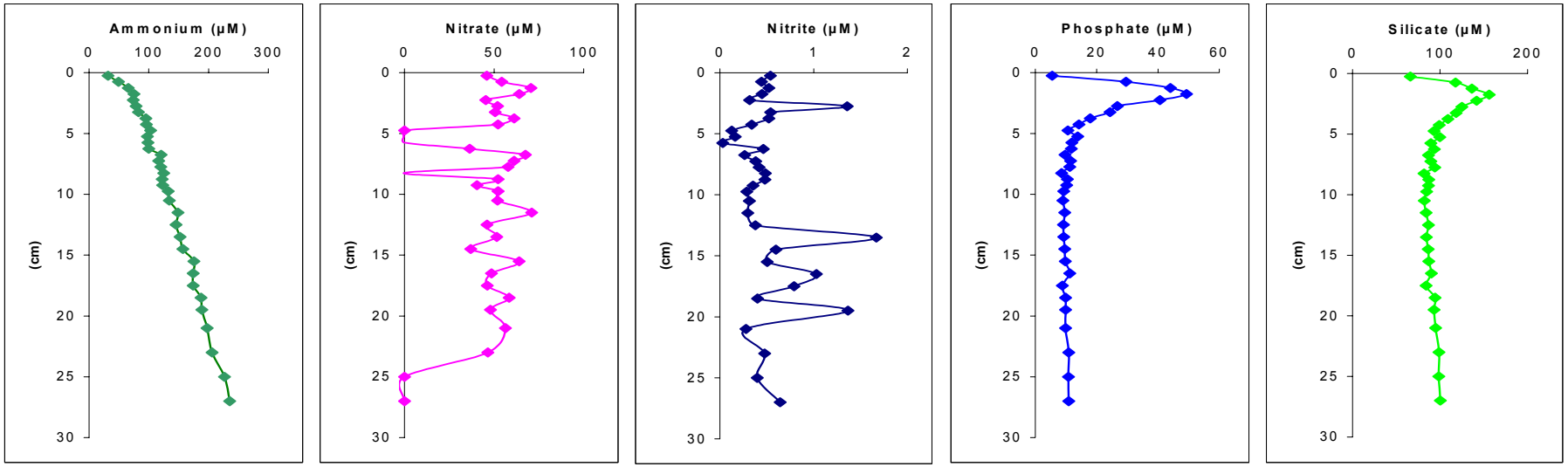
Sandra Vandewiele

10.24 Porewater nutrient profiles

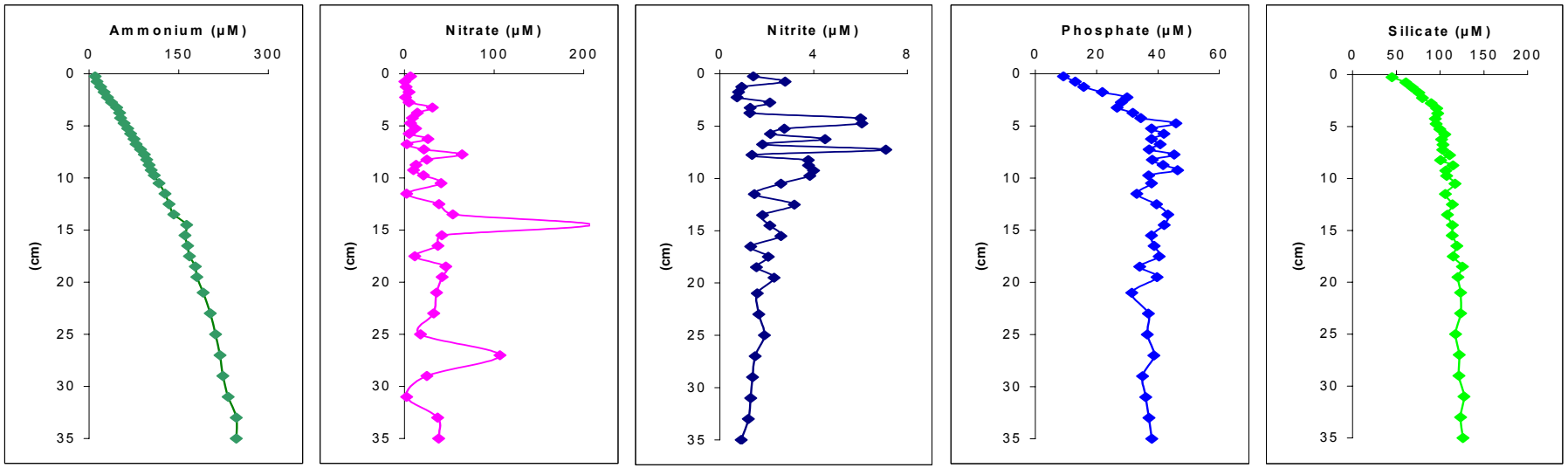
Plotted in the following figures are draft porewater nutrient profiles as they were processed on the ship. Nitrite, and especially nitrate data for some cores appear to be erroneous and need to be checked. In some cases, samples will be reanalysed on return of frozen porewater samples to SAMS.

Steve Mowbray (Greg Cowie)

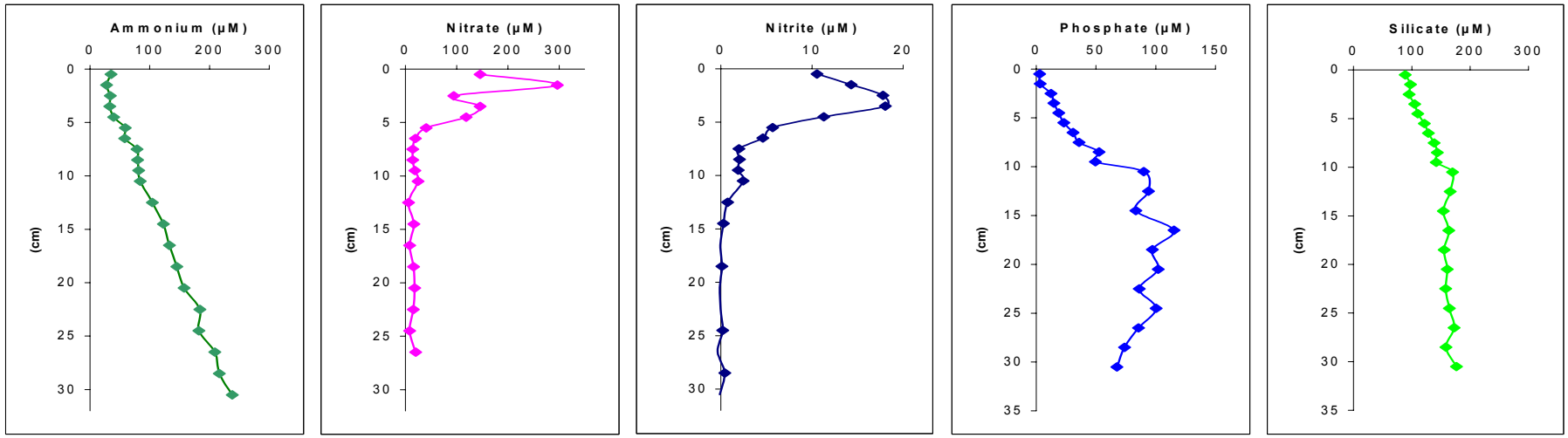
A140


Ammonium (µM)
0 100 200 300
Nitrate (µM)
0 50 100
Nitrite (µM)
0 1 2
Phosphate (µM)
0 20 40 60
Silicate (µM)
0 100 200
(cm)
0 5 10 15 20 25 30

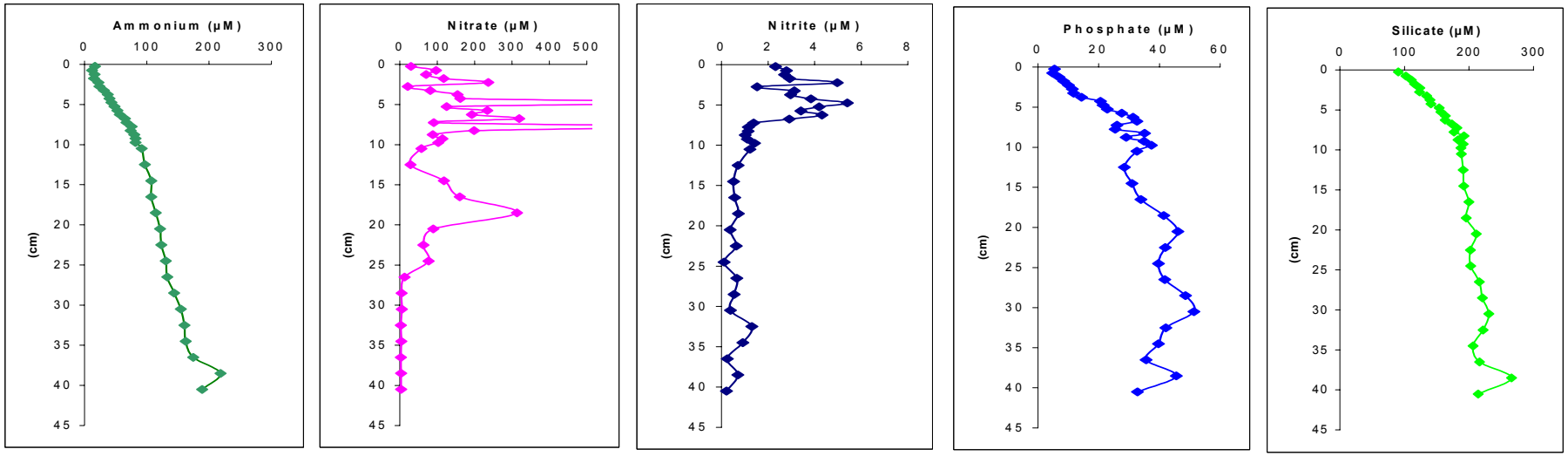
A300


Ammonium (µM)
0 150 300
Nitrate (µM)
0 100 200
Nitrite (µM)
0 4 8
Phosphate (µM)
0 20 40 60
Silicate (µM)
0 50 100 150 200
(cm)
0 5 10 15 20 25 30 35

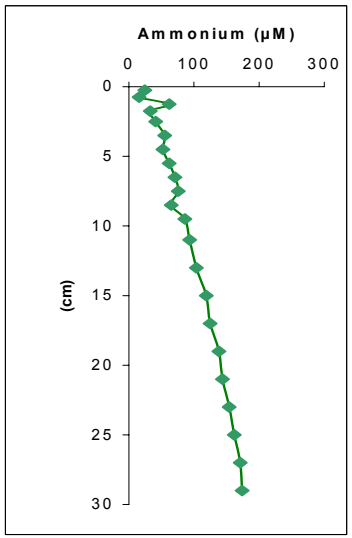
A850

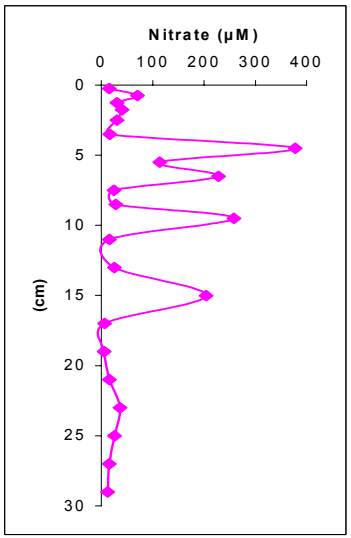

Ammonium (µM)
0 100 200 300
Nitrate (µM)
0 100 200 300
Nitrite (µM)
0 10 20
Phosphate (µM)
0 50 100 150
Silicate (µM)
0 100 200 300
(cm)
0 5 10 15 20 25 30 35

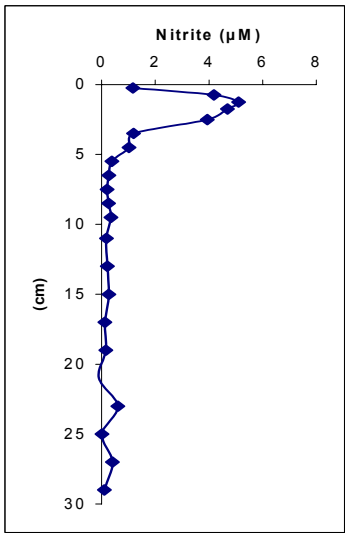
A940

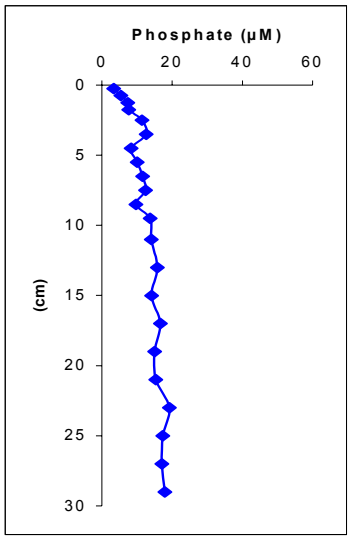

Ammonium (µM)
0 100 200 300
Nitrate (µM)
0 100 200 300 400 500
Nitrite (µM)
0 2 4 6 8
Phosphate (µM)
0 20 40 60
Silicate (µM)
0 100 200 300
(cm)
0 5 10 15 20 25 30 35 40 45

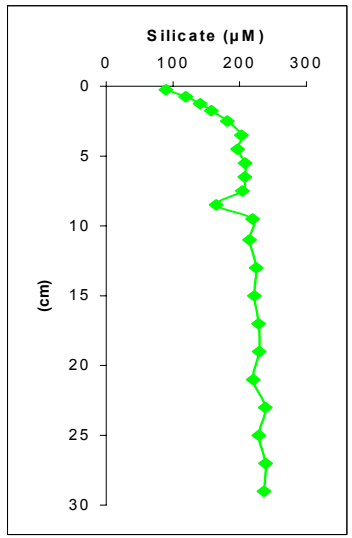
A1000


Ammonium (µM)
0 100 200 300
0 5 10 15 20 25 30
(cm)

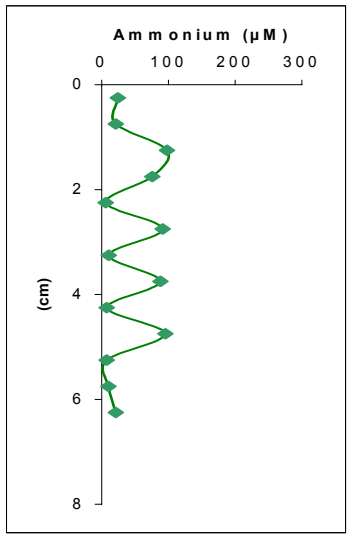

Nitrate (µM)
0 100 200 300 400
0 5 10 15 20 25 30
(cm)

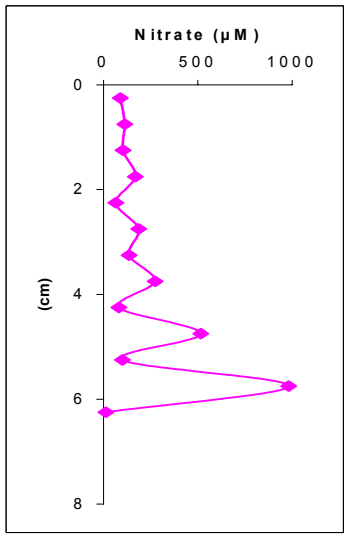

Nitrite (µM)
0 2 4 6 8
0 5 10 15 20 25 30
(cm)

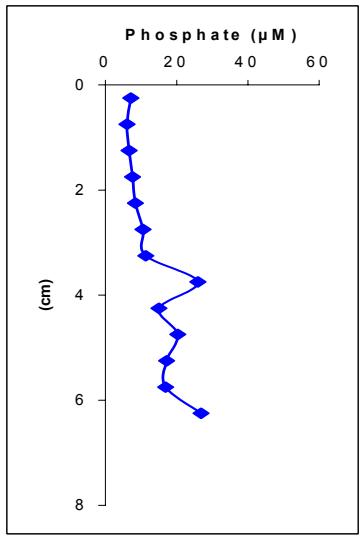

Phosphate (µM)
0 20 40 60
0 5 10 15 20 25 30
(cm)

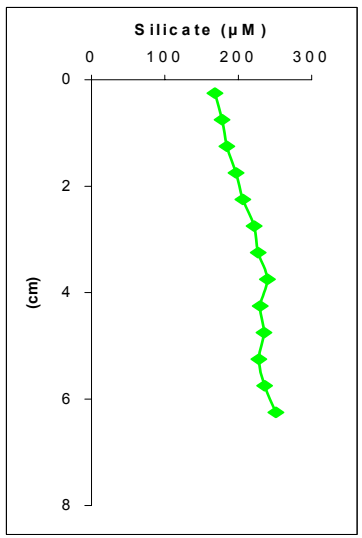

Silicate (µM)
0 100 200 300
0 5 10 15 20 25 30
(cm)

A1850


Ammonium (µM)
0 100 200 300
0 2 4 6 8
(cm)


Nitrate (µM)
0 500 1000
0 2 4 6 8
(cm)


Phosphate (µM)
0 20 40 60
0 2 4 6 8
(cm)


Silicate (µM)
0 100 200 300
0 2 4 6 8
(cm)

10.25 Marine Geochemistry core and sampling inventory (SAMS)

A. Geochemical Core Processing Inventory A140

Protocol: **T-metal PW**
Drop: 56101/5 **Core:** 3 **Date:** 20/09/03
Locality: 23° 16.75 N / 66° 42.62 E
Initial length: 40cm
Processed length: 40cm
pH: 7.65 **Temp:** 21.2°C
Remarks/Core description: Noticeable burrows in the upper 3.5cm. Light brown 1cm surface layer with a transition to slightly darker sediment thereafter, which remained homogeneous to depth.

Protocol: **Trace metal solid**
Drop: 56101/5 **Core:** 2 **Date:** 20/09/03
Locality: 23° 16.75 N / 66° 42.62 E
Initial length: 40cm
Processed length: 38cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per T-M description except for a large shell and fragments evident in the 5-5.5cm horizon.

Protocol: **RN**
Drop: 56101/5 **Core:** 5 **Date:** 20/09/03
Locality: 23° 16.75 N / 66° 42.62 E
Initial length: 40cm
Processed length:
pH: N/A **Temp:** N/A
Remarks/Core description: As per T-M description

Protocol: **DIC**
Drop: 56101/5 **Core:** 11 **Date:** 20/09/03
Locality: 23° 16.75 N / 66° 42.62 E
Initial length: 41.5cm
Processed length: 38cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per T-M core description except: Worm burrow and worm evident at the 30-34cm horizon.

Protocol: **DOC**
Drop: 56101/10 **Core:** 5 **Date:** 21/09/03
Locality: 23°16.80 / 66°42.72
Initial length: 40cm
Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: Basic appearance as per the earlier 140m cores except for a large worm at the 4-5cm interval and a large spine (Echinoderm?) at 7-8cm. Also evident: black streaking at the 8-9cm interval.

Protocol: **ELINOR A140 T-metal**
Drop: 56101/18 **Core:** 1 of 1 **Date:** 22/09/03
Locality: 23°17.20 / 66°42.42
Initial length: 15cm
Processed length: 14cm
pH: 7.56 **Temp:** 23°C
Remarks/Core description: This core was left in the CT lab for approx 5 hours prior to processing. Core demonstrated a similar colour profile as other 140m cores.

Protocol: **Oxygen Profile (Mega)**
Drop: 56101/26 **Core:** 7 **Date:** 24/09/03
Locality: 23°16.80 / 66°42.72

Initial length: 40cm
Processed length: C.O. SCRIPPS
pH: N/A **Temp:** N/A
Remarks/Core description: Oxygen profiles carried out on the above core to determine Oxygen penetration depth in surface sediment. Core then passed onto Biologists for subsequent sectioning. Core showed evidence of 3 burrows in surface 3cm.

Protocol: **Oxygen Profile (Multi)**
Drop: 56101/27 **Core:** 4 **Date:** 24/09/03
Locality: 23°16.80 / 66°42.71
Initial length: 40cm
Processed length: C/O SOC
pH: N/A **Temp:** N/A
Remarks/Core description: Multi Core profile taken by SOC.

B. Geochemical Core Inventory A300

Protocol: **T-metal**
Drop: 56107/5 **Core:** 1 **Date:** 30/09/03
Locality: 23° 12.51 N / 66° 34.08 E
Initial length: 36cm
Processed length: 34cm
pH: 7.4 **Temp:** 12°C
Remarks/Core description: 0.5-1.0 section showed a strong Fe/Mn banded layer approximately 4mm in length. Evidence of some bacterial spores in a 1cm 'fluff' layer on the core surface. No strong evidence to suggest bioturbation. After the initial Fe/Mn the core showed an Olive drab colour to depth.

Protocol: **T-metal solid**
Drop: 56107/5 **Core:** 2 **Date:** 30/09/03
Locality: 23° 12.51 N / 66° 34.08 E
Initial length: 40cm
Processed length: 40cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per T-metal pore water core.

Protocol: **RN**
Drop: 56107/5 **Core:** 3 **Date:** 30/09/03
Locality: 23° 12.51 N / 66° 34.08 E
Initial length: 40cm
Processed length: 40cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per T-metal pore water core.

Protocol: **DIC**
Drop: 56105/5 **Core:** 1 **Date:** 28/09/03
Locality: 23° 12.49 N / 66° 34.01 E
Initial length: 40cm
Processed length: 38cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per T-metal pore water core.

Protocol: **DOC**
Drop: 56107/1 **Core:** 3 **Date:** 29/09/03
Locality: 23° 12.48 N / 66° 34.00 E
Initial length: 36cm
Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: Evidence of a small bacterial mat on the surface of the core with a strong surface Fe/Mn layer also evident. Directly below the bacterial strands, many small fish bones where found in the 0.5-

1.0cm layer. From 1.5-2.0cm a very evident black coloured layer was evident although no noticeable smell of Hydrogen Sulphide was evident. Below 3cm the core was exactly as all other 300m site cores.

Protocol: **Oxygen profile (Mega)**
Drop: 56115/1 **Core:** 3 **Date:** 4/10/03
Locality: 23° 12.50 N / 66° 33.99 E
Initial length: 40cm
Processed length: C/O SCRIPPS
pH: N/A **Temp:** N/A
Remarks/Core description: As per T-metal pore water core.

Protocol: **Oxygen profile (Multi)**
Drop: 56115/2 **Core:** 11 **Date:** 4/10/03
Locality: 23° 12.48 N / 66° 33.98 E
Initial length: 40cm
Processed length: C/O SOC
pH: N/A **Temp:** N/A
Remarks/Core description: As per T-metal pore water core.

Protocol: **Elinor T-metals**
Drop: 56112/4 **Core:** 1 of 1 **Date:** 2/10/03
Locality: 23° 12.80 N / 66° 33.42 E
Initial length: 18cm
Processed length: 14cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per T-metal pore water core.

C. Geochemical Core Inventory A900

Protocol: **T-metal solid phase**
Drop: 56121/2 Core: 2 Date: 7/10/03
Locality: 22° 56.86 N / 66° 39.99 E
Initial length: 35cm
Processed length: 30cm
pH: N/A **Temp**: N/A
Remarks/Core description: Core slightly disturbed on transfer (bubbled). Core showed a 1cm brown coloured fluff layer. There after a 4cm thick olive drab layer extended to 5cm where it was interrupted by a 5mm thick light clay band. Thereafter the olive drab sediment extended to 10cm upon which the sediment type changed to homogeneous, olive drab silt/clay.

Protocol: **RN**
Drop: 56121/2 **Core:** 4 **Date:** 7/10/03
Locality: 22° 56.86 N / 66° 39.99 E
Initial length: 35cm
Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: This core should be used for both RN and TM analysis due to the disturbance caused to Core number 2 due to bubbling. Core description as per core 2, drop 56121/2.

D. Geochemical Core Inventory A940

Protocol: **T-metal**
Drop: 56116/4 **Core:** 10 **Date:** 5/10/03
Locality: 22° 53.53 N / 66° 36.65 E
Initial length: 38cm
Processed length: 36cm
pH: 7.52 **Temp:** 16°C
Remarks/Core description: This core showed a slightly bioturbated surface layer with numerous epi-fauna present and a number of evident shells. The upper 1cm was light brown in colour and (possibly redox zone?) After 1cm a transition to a olive drab coloured sediment occurs which is interrupted at 5cm by a 5mm thick clay

band. After the clay band the olive drab sediment extends to 10cm thereafter we see a transition to darker green sediment which is consistent to depth.

Protocol: **T-Metal solid**
Drop: 56116/2 **Core:** 1 **Date:** 5/10/03
Locality: 22° 53.46 N / 66° 36.50 E
Initial length: 38cm
Processed length: 36cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per the trace metal pore water core except that the 5-5.5cm clay band had a slightly orange colour on its upper surface.

Protocol: **Radio Nuclide**
Drop: 56116/2 **Core:** 12 **Date:** 5/10/03
Locality: 22° 53.46 N / 66° 36.50 E
Initial length: 38cm
Processed length: 36cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per the trace metal pore water core except that the 5-5.5cm clay band had a slightly orange colour on its upper surface.

Protocol: **DOC**
Drop: 56116/3 **Core:** 7 **Date:** 5/10/03
Locality: 22° 53.53 N / 66° 36.65 E
Initial length: 38cm
Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per the trace metal pore water core.

Protocol: **DIC**
Drop: 56116/10 **Core:** 11 **Date:** 6/10/03
Locality: 22° 53.49 N / 66° 36.66 E
Initial length: 38cm
Processed length: 36cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per the trace metal pore water core.

Protocol: **ELINOR T-metals**
Drop: 56118/1 **Core:** 1 of 1 **Date:** 7/10/03
Locality: 22° 53.23 N / 66° 37.01 E
Initial length: 18cm
Processed length: 14cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per the trace metal pore water core, although there was a small slump on the core surface.

Protocol: **Oxygen profile (mega)**
Drop: 56136/1 **Core:** 1 **Date:** 12/10/03
Locality: 22° 53.63 N / 66° 36.69 E
Initial length: N/A
Processed length: C/O SCRIPPS
pH: N/A **Temp:** N/A
Remarks/Core description: As per the trace metal pore water core.

Protocol: **Oxygen profile (multi)**
Drop: 56136/2 **Core:** 1 **Date:** 12/10/03
Locality: 22° 53.56 N / 66° 36.67 E
Initial length: N/A
Processed length: C/O SOC
pH: N/A **Temp:** N/A

Remarks/Core description: As per the trace metal pore water core.

E. Geochemical Core Inventory A1000

Protocol: **T-metal solid phase**
Drop: 56122/1 **Core:** 8 **Date:** 8/10/03
Locality: 22° 54.62 N / 66° 35.02 E
Initial length: 35cm
Processed length: 30cm
pH: 7.24 **Temp:** 13.2°C
Remarks/Core description: The core showed a homogeneous olive drab colour from surface to depth except for a small light brown fluff layer evident at the top of the core. There was no evident bioturbation.

Protocol: **RN**
Drop: 56122/1 **Core:** 10 **Date:** 8/10/03
Locality: 22° 54.62 N / 66° 35.02 E
Initial length: 35cm
Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: The core showed a homogeneous olive drab colour from surface to depth except for a small light brown fluff layer evident at the top of the core. There was evident bioturbation in the upper 1.5cm of the core.

Protocol: **DOC**
Drop: 56122/1 **Core:** 10 **Date:** 8/10/03
Locality: 22° 54.62 N / 66° 35.02 E
Initial length: 38cm
Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per the trace metal solid phase core.

F. Geochemical Core Inventory A1050

Protocol: **T-metal solid phase**
Drop: 56142/1 **Core:** 2 **Date:** 17/10/03
Locality: 22° 53.62 N / 66° 34.04 E
Initial length: 35cm
Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: The core showed a homogeneous olive drab colour from surface to depth except for a small light brown redox layer evident at the top of the core. There was evidence of burrowing a number of worms present in the core.

Protocol: **RN**
Drop: 56142/1 **Core:** 3 **Date:** 17/10/03
Locality: 22° 53.62 N / 66° 34.04 E
Initial length: 35cm
Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per the trace metal solid phase core.

G. Geochemical Core Inventory A1100

Protocol: **T-metal solid phase**
Drop: 56120/1 **Core:** 2 **Date:** 7/10/03
Locality: 22° 52.77 N / 66° 33.01 E
Initial length: 35cm
Processed length: 30cm
pH: N/A **Temp:** N/A

Remarks/Core description: The core showed a homogeneous olive drab colour from surface to depth. Large burrows were evident and a great deal of surface topography was evident (2-3cm high mounds). A number of small brittle stars were evident.

Protocol: **RN**
Drop: 56120/1 **Core:** 9 **Date:** 7/10/03
Locality: 22° 52.77 N / 66° 33.01 E
Initial length: 35cm
Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: The core showed a homogeneous olive drab colour from surface to depth. Large burrows were evident and a great deal of surface topography was evident (2-3cm high mounds).

H. Geochemical Core Inventory A850

Protocol: **T-metal solid phase**
Drop: 56114/1 **Core:** 11 **Date:** 03/10/03
Locality: 22° 57.46 N / 66° 37.70 E
Initial length: 42cm
Processed length: 30cm
pH: 7.52 **Temp:** 16°C
Remarks/Core description: This core showed a strongly bioturbated surface with abundant megafauna. The core was topped with a 2-3mm fluff layer of light brown colour. A 5cm thick light brown/Olive drab layer underlay the fluff section. Ay 5cm a 5mm light coloured clay layer was evident which gave way to homogenous olive drab sediment which stayed consistent with depth.

Protocol: **RN**
Drop: 56114/1 **Core:** 2 **Date:** 03/10/03
Locality: 22° 57.46 N / 66° 37.70 E
Initial length: 45cm
Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per trace metal core.

Protocol: **DOC**
Drop: 56114/1 **Core:** 12 **Date:** 03/10/03
Locality: 22° 57.46 N / 66° 37.70 E
Initial length: 43cm
Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per trace metal core.

Protocol: **Oxygen profile (mega)**
Drop: 56114/1 **Core:** 3 **Date:** 03/10/03
Locality: 22° 57.46 N / 66° 37.70 E
Initial length: 45cm
Processed length: C/O SCRIPPS
pH: N/A **Temp:** N/A
Remarks/Core description: As per trace metal core.

I. Geochemical Core Processing Inventory A1200m

Protocol: **T-metal pore water**
Drop: 56141/2 **Core:** 11 **Date:** 16/10/03
Locality: 23° 00.00 N / 66° 24.41 E
Initial length: 33cm
Processed length: 30cm
pH: 7.25 **Temp:** 14.9°C (processed at 3-4°C)

Remarks/Core description: Homogenous sediment throughout the length of the core of olive drab colour. Sediment type became clay like at depth (20cm). No evidence of bioturbation on surface but slight bioturbation witnessed at 2-5cm.

Protocol: **T-metal solid**
Drop: 56141/2 **Core:** 2 **Date:** 16/10/03
Locality: 23° 00.00 N / 66° 24.41 E
Initial length: 33cm
Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per TM pore water core.

Protocol: **RN**
Drop: 56141/2 **Core:** 3 **Date:** 16/10/03
Locality: 23° 00.00 N / 66° 24.41 E
Initial length: 32cm
Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per TM pore water core.

Protocol: **DOC**
Drop: 56141/2 **Core:** 1 **Date:** 16/10/03
Locality: 23° 00.00 N / 66° 24.41 E
Initial length: 33cm
Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per TM pore water core.

Protocol: **DIC**
Drop: 56141/1 **Core:** 10 **Date:** 16/10/03
Locality: 23° 00.00 N / 66° 24.41 E
Initial length: 33cm
Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per TM pore water core. Please note that core sat for 5hrs before processing commenced.

Protocol: **Oxygen profile (mega)**
Drop: 56139/2 **Core:** 3 **Date:** 15/10/03
Locality: 23° 59.97 N / 66° 24.42 E
Initial length: N/A
Processed length: C/O SCRIPPS
pH: N/A **Temp:** N/A
Remarks/Core description: As per TM pore water core except evidence of extreme surface burrowing through which a profile was taken.

Protocol: **Oxygen profile (multi)**
Drop: 56141/3 **Core:** 1 **Date:** 15/10/03
Locality: 22° 59.99 N / 66° 24.42 E
Initial length: N/A
Processed length: C/O SOC
pH: N/A **Temp:** N/A
Remarks/Core description: As per TM pore water core.

J. Geochemical Core Processing Inventory A1850m

Protocol: **T-metal pore water**
Drop: 56137/13 **Core:** 1 **Date:** 14/10/03

Locality: 22° 52.39 N / 65° 59.93 E
Initial length: 35cm
Processed length: 32cm
pH: 7.60 **Temp:** 9.5°C (processed at 3-4°C)
Remarks/Core description: Light brown surface redox/organic rich layer underlain by consolidated olive drab clay which remains homogeneous to depth. Some evidence of burrows on the surface with smearing evident down to 5cm.

Protocol: **T-metal solid phase**
Drop: 56137/13 **Core:** 3 **Date:** 14/10/03
Locality: 22° 52.39 N / 65° 59.93 E
Initial length: 36cm
Processed length: 34cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per TM pore water core.

Protocol: **RN**
Drop: 56137/13 **Core:** 2 **Date:** 14/10/03
Locality: 22° 52.39 N / 65° 59.93 E
Initial length: 36cm
Processed length: 34cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per TM pore water core.

Protocol: **DOC**
Drop: 56137/13 **Core:** 5 **Date:** 14/10/03
Locality: 22° 52.39 N / 65° 59.93 E
Initial length: 34cm
Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per TM pore water core but with barrel smearing evident to 6cm.

Protocol: **DIC**
Drop: 56137/1 **Core:** 12 **Date:** 13/10/2003
Locality: 22° 52.39N / 66° 00.03E
Initial length: 39cm
Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per TM pore water core.

Protocol: **Oxygen profile (mega)**
Drop: 56140/2 **Core:** 1 **Date:** 15/10/2003
Locality: 22° 52.31N / 66° 00.07E
Initial length: N/A
Processed length: C/O SCRIPPS
pH: N/A **Temp:** N/A
Remarks/Core description: As per TM pore water core.

Protocol: **Oxygen profile (multi)**
Drop: 56140/3 **Core:** 1 **Date:** 15/10/2003
Locality: 22° 52.42N / 66° 59.98E
Initial length: N/A
Processed length: C/O SOC
pH: N/A **Temp:** N/A
Remarks/Core description: As per TM pore water core.

K. Geochemical Core Processing Inventory Bacterial Mat site

Protocol: **T-metal pore water**
Drop: 56133/1 **Core:** 9 **Date:** 10/10/03

Locality: 24° 49.88 N / 65° 54.24 E
Initial length: 34cm
Processed length: 20cm
pH: 7.29 **Temp:** 15.7°C (processed at 9°C)
Remarks/Core description: Evident bacterial spores and mats of orange and white colouration on the surface of the core extending down through the first 1cm. This was underlain by a 9cm thick light brown sediment with high water content. From 10-14cm an evident redox horizon (sulphate reduction) was found which was underlain by extremely consolidated olive drab clay which terminated the core. Oxygen profiles were taken from this core prior to sectioning.

Protocol: **T-metal solid**
Drop: 56133/1 **Core:** 8 **Date:** 10/10/03
Locality: 24° 49.88 N / 65° 54.24 E
Initial length: 34cm
Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per TM pore water core.

Protocol: **RN**
Drop: 56133/1 **Core:** 7 **Date:** 10/10/03
Locality: 24° 49.88 N / 65° 54.24 E
Initial length: 34cm
Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per TM pore water core.

Protocol: **DOC**
Drop: 56133/1 **Core:** 1 **Date:** 10/10/03
Locality: 24° 49.88 N / 65° 54.24 E
Initial length: 34cm
Processed length: 18cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per TM pore water core.

L. Geochemical Core Processing Inventory BM Control

Protocol: **T-metal pore water**
Drop: 56134/1 **Core:** 7 **Date:** 10/10/03
Locality: 24° 50.14 N / 65° 54.72 E
Initial length: 40cm
Processed length: 20cm
pH: 7.42 **Temp:** 10.7°C (processed at 9°C)
Remarks/Core description: This core showed and absence of 'bacterial mat material,' showing a 1cm light brown aerated surface underlain by a homogeneous olive drab clay extending to 35cm upon which transition to a sulphate reducing redox horizon was evident which terminated the core.
Oxygen profiles were taken from this core prior to sectioning.

Protocol: **T-metal solids**
Drop: 56134/1 **Core:** 8 **Date:** 11/10/03
Locality: 24° 50.14 N / 65° 54.72 E
Initial length: 40cm
Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per TM pore water core.

Protocol: **RN**
Drop: 56134/1 **Core:** 11 **Date:** 11/10/03
Locality: 24° 50.14 N / 65° 54.72 E
Initial length: 40cm

Processed length: 30cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per TM pore water core.

Protocol: **DOC**
Drop: 56134/1 **Core:** 12 **Date:** 11/10/03
Locality: 24° 50.14 N / 65° 54.72 E
Initial length: 40cm
Processed length: 18cm
pH: N/A **Temp:** N/A
Remarks/Core description: As per TM pore water core.

Please note that no DIC cores were processed at either ABM or ABMC station due to time limitations.

Eric Breuer and Gareth Law

10.26 Organic geochemical core processing inventory (Liverpool-Edinburgh)

Site	Station #	Core #	Coring Depth (cm)	Gear	Type of Analysis	Preservation State	Affiliation
A140	56101#07	6	30	MC	CARCH	Frozen @ -20	ED
A140	56101#07	7	26	MC	CLIP	Frozen @ -20	LIV
A140	56101#07	8	30	MC	CPIG	Frozen @ -20	ED
A140	56101#11	8	32	MC	CBAC	Frozen @ -70	ED
A140	56101#20	5	30	MC	CBAC	Frozen @ -70	ED
A140	56101#22	9	11	MC	FISH & PLIP	Formalin & frozen @ -70	ED
A140	56101#28	IV	34	Mega	DOC 2 (pore water DOC & DFAA only)	Frozen @ -20	SAMS & ED
A140	56101#10	V	30	Mega	DOC, DFAA, (solids=LIP & AA)	Pore water frozen @ -20, solids freeze-dried	SAMS, ED & LIV
A140	56101#27	8	11	MC	FISH & PLIP	Formalin & frozen @ -70	ED
A250	56104#03	9	18	MC	CBAC	Frozen @ -70	ED
A250	56104#02	III	30	Mega	DOC 2	Frozen @ -20	ED
A250	56104#01	VI	30	Mega	DOC, DFAA, (solids=LIP & AA)	Frozen @ -20	SAMS, ED & LIV
A250	56110#01	4	30	MC	CARCH	Frozen @ -20	ED
A250	56110#01	3	30	MC	CLIP	Frozen @ -20	LIV
A250	56110#01	5	11	MC	FISH/PLIP	Formalin & frozen @ -70	ED
A250	56110#01	11	30	MC	CPIG	Frozen @ -20	ED
A275	56111#01	8	30	MC	CLIP	Frozen @ -20	LIV
A275	56111#01	11	30	MC	CPIG	Frozen @ -20	ED
A275	56111#01	4	30	MC	CARCH	Frozen @ -20	ED
A275	56111#01	10	11	MC	FISH/PLIP	Formalin & frozen @ -70	ED
A275	56111#02	VIII	30	Mega	DOC 2	Frozen @ -20	ED
A300	56105#07	12	30	MC	CLIP	Frozen @ -20	LIV
A300	56105#07	1	30	MC	CBAC	Frozen @ -70	ED
A300	56105#07	4	11	MC	FISH/PLIP	Formalin & frozen @ -70	ED
A300	56105#07	6	30	MC	CARCH	Frozen @ -20	ED
A300	56107#03	3	11	MC	FISH/PLIP	Formalin & frozen @ -70	ED
A300	56107#03	1	30	MC	CBAC	Frozen @ -70	ED
A300	56107#01	III	30	Mega	DOC, DFAA, (solids=LIP & AA)	Frozen @ -20	SAMS, ED & LIV
A300	56107#05	XI	30	Mega	DOC 2	Frozen @ -20	ED
A300	56107#06	5	30	MC	CPIG	Frozen @ -20	ED
A700	56113#02	XII	30	Mega	DOC2	Frozen @ -20	ED
A700	56113#05	8	30	MC	CPIG	Frozen @ -20	ED

Site	Station #	Core #	Coring Depth (cm)	Gear	Type of Analysis	Preservation State	Affiliation
A700	56113#05	9	11	MC	FISH/PLIP	Formalin & frozen @ -70	ED
A700	56113#05	10	30	MC	CARCH	Frozen @ -20	ED
A700	56113#05	11	30	MC	CLIP	Frozen @ -20	LIV
A700	56113#05	5	30	MC	CBAC	Frozen @ -70	ED
A800	56123#02	1	30	MC	CARCH	Frozen @ -20	ED
A800	56123#02	3	30	MC	CLIP	Frozen @ -20	LIV
A800	56123#02	7	30	MC	CPIG	Frozen @ -20	ED
A800	56123#02	8	30	MC	CBAC	Frozen @ -70	ED
A800	56123#02	6	11	MC	FISH/PLIP	Formalin & frozen @ -70	ED
A800	56123#01	IV	30	Mega	DOC/DFAA	Frozen @ -20	ED
A800	56123#01	IX	30	Mega	DOC/NUTS	Frozen @ -20	ED
A850	56114#03	10	30	MC	CLIP	Frozen @ -20	LIV
A850	56114#03	8	30	MC	CPIG	Frozen @ -20	ED
A850	56114#03	6	30	MC	CBAC	Frozen @ -70	ED
A850	56114#03	4	30	MC	CARCH	Frozen @ -20	ED
A850	56114#03	11	11	MC	FISH/PLIP	Formalin & frozen @ -70	ED
A850	56114#01	XII	30	Mega	DOC, DFAA, (solids=LIP & AA)	Frozen @ -20	SAMS, ED & LIV
A850	56114#05	III	30	Mega	DOC 2	Frozen @ -20	ED
A900	56121#01	3	30	MC	CARCH	Frozen @ -20	ED
A900	56121#01	4	30	MC	CBAC	Frozen @ -70	ED
A900	56121#01	5	30	MC	CLIP	Frozen @ -20	LIV
A900	56121#01	6	30	MC	CPIG	Frozen @ -20	ED
A900	56121#01	7	11	MC	FISH/PLIP	Formalin & frozen @ -70	ED
A900	56128#01	VII	30	Mega	DOC/NUTS	Frozen @ -20	ED
A900	56128#01	VI	30	Mega	DOC/DFAA	Frozen @ -20	ED
A940	56116#03	VII	30	Mega	DOC, DFAA, (solids=LIP & AA)	Frozen @ -20	SAMS, ED & LIV
A940	56116#07	4	30	MC	CBAC	Frozen @ -70	ED
A940	56116#07	5	30	MC	CARCH	Frozen @ -20	ED
A940	56116#08	3	30	MC	CLIP	Frozen @ -20	LIV
A940	56116#08	4	30	MC	CPIG	Frozen @ -20	ED
A940	56116#08	8	11	MC	FISH/PLIP	Formalin & frozen @ -70	ED
A940	56116#10	XII	30	MC	DOC 2	Frozen @ -20	ED
A940	56116#07	4	30	MC	CBAC	Frozen @ -70	ED
A940	56116#07	5	11	MC	FISH/PLIP	Formalin & frozen @ -70	ED
A1000	56119#01	5	11	MC	FISH/PLIP	Formalin & frozen @ -70	ED
A1000	56119#01	10	30	MC	CBAC	Frozen @ -70	ED
A1000	56119#02	2	30	MC	CLIP	Frozen @ -20	LIV
A1000	56119#02	1	30	MC	CARCH	Frozen @ -20	ED
A1000	56119#02	9	28	MC	CPIG	Frozen @ -20	ED
A1000	56119#03	VI	30	Mega	DOC 2	Frozen @ -20	ED
A1000	56119#03	VII	30	Mega	DOC 2	Frozen @ -20	ED
A1000	56122#01	X	30	Mega	DOC, DFAA, (solids=LIP & AA)	Frozen @ -20	SAMS, ED & LIV
A1050	56142#02	1	26	MC	CLIP	Frozen @ -20	LIV
A1050	56142#02	2	26	MC	CPIG	Frozen @ -20	ED
A1050	56142#02	4	26	MC	CBAC	Frozen @ -70	ED
A1050	56142#02	6	26	MC	CARCH	Frozen @ -20	ED
A1050	56142#02	3	11	MC	FISH/PLIP	Formalin & frozen @ -70	ED
A1050	56142#02	?	24	MC	DOC/DFAA	Frozen @ -20	ED

Site	Station #	Core #	Coring Depth (cm)	Gear	Type of Analysis	Preservation State	Affiliation
A1050	56142#02	?	24	MC	DOC/DFAA	Frozen @ -20	ED
A1050	56142#01	?	28	Mega	DOC/NUTS	Frozen @ -20	ED
A1100	56120#01	VI	30	Mega	DOC 2	Frozen @ -20	ED
A1100	56120#01	X	30	Mega	DOC 2	Frozen @ -20	ED
A1100	56120#02	3	30	MC	CLIP	Frozen @ -20	LIV
A1100	56120#02	4	30	MC	CPIG	Frozen @ -20	ED
A1100	56120#02	5	30	MC	CBAC	Frozen @ -70	ED
A1100	56120#02	1	30	MC	CARCH	Frozen @ -20	ED
A1100	56120#02	8	11	MC	FISH/PLIP	Formalin & frozen @ -70	ED
A1200	56141#03	2	30	MC	CLIP	Frozen @ -20	LIV
A1200	56141#03	4	30	MC	CBAC	Frozen @ -70	ED
A1200	56141#03	6	11	MC	FISH/PLIP	Formalin & frozen @ -70	ED
A1200	56141#04	11	30	MC	CARCH	Frozen @ -20	ED
A1200	56141#04	10	30	MC	CBAC	Frozen @ -70	ED
A1200	56141#04	1	11	MC	FISH/PLIP	Formalin & frozen @ -70	ED
A1200	56141#04	3	30	MC	CPIG	Frozen @ -20	ED
A1200	56141#02	I	30	Mega	DOC, DFAA, (solids=LIP & AA)	Frozen @ -20	SAMS, ED & LIV
A1200	56139#01	IV	30	Mega	DOC 2	Frozen @ -20	ED
A1850	56137#03	8	11	MC	FISH/PLIP	Formalin & frozen @ -70	ED
A1850	56137#03	5	28	MC	CBAC	Frozen @ -70	ED
A1850	56137#03	1	26	MC	CARCH	Frozen @ -20	ED
A1850	56137#04	2	11	MC	FISH/PLIP	Formalin & frozen @ -70	ED
A1850	56137#04	6	26	MC	CBAC	Frozen @ -70	ED
A1850	56137#04	11	26	MC	CLIP	Frozen @ -20	LIV
A1850	56137#04	9	26	MC	CPIG	Frozen @ -20	ED
A1850	56137#13	V	30	Mega	DOC, DFAA, (solids=LIP & AA)	Frozen @ -20	SAMS, ED & LIV
A1850	56137#13	XII	30	Mega	DOC 2	Frozen @ -20	ED
Bac. Mat	56133#03	4	20	MC	CBAC	Frozen @ -70	ED
Bac. Mat	56133#03	1	20	MC	CARCH	Frozen @ -20	ED
Bac. Mat	56133#03	9	20	MC	CLIP	Frozen @ -20	LIV
Bac. Mat	56133#03	5	20	MC	CPIG	Frozen @ -20	ED
Bac. Mat	56133#03	10	20	MC	FISH/PLIP	Formalin & frozen @ -70	ED
Bac. Mat	56133#03	2	20	MC	CARCH 2	Frozen @ -20	ED
Control site	56134#03	1	20	MC	CLIP	Frozen @ -20	LIV
Control site	56134#03	2	20	MC	CARCH	Frozen @ -20	ED
Control site	56134#03	3	20	MC	CARCH 2	Frozen @ -20	ED
Control site	56134#03	4	20	MC	CPIG	Frozen @ -20	ED
Control site	56134#03	7	20	MC	CBAC	Frozen @ -70	ED
Control site	56134#03	8	20	MC	FISH/PLIP	Formalin & frozen @ -70	ED

Site	Station #	Core #	Coring Depth (cm)	Gear	Type of Analysis	Preservation State	Affiliation
Bac. Mat	56133#04	III	24.5	Mega	CLIP, EPFM, FISH/PLIP, Spare	Frozen @ -20, fixed in 2% formalin, frozen @-70 and fixed in formalin, frozen @-20.	LIV and ED
Control site	56134#03	9	5	MC	CLIP and EPFM	Frozen @ -20, fixed in 2% formalin	LIV
Bac. Mat	56133#01	2	18	Mega	DOC, DFAA, (solids=LIP & AA)	Frozen @ -20	SAMS, ED & LIV
Contol site	56134#01	1	18	Mega	DOC, DFAA, (solids=LIP & AA)	Frozen @ -20	SAMS, ED & LIV

Rachel Jeffreys

10.27 Shipboard radiochemistry

Shipboard gamma counting for ^{234}Th and ^{210}Pb decay was monitored for the 0-0.5, 0.5-1, 1-1.5 and 1.5-2 cm intervals for sediments from sites A140, A300, A250, A900, A1000, and the Bacterial Mat site by procedures specified in the CD145 and CD146 cruise reports and on cores identified in the SAMS core inventory (Section 10.25, this report). Samples from sites A1200 and A1850 were returned for immediate analysis at SAMS. Preliminary indications are that ^{234}Th activities were generally higher than those observed in corresponding sites on CD145 and CD146, suggesting recent deposition of detritus during the intervening monsoon period.

Gareth Law

10.28 Sedimentary denitrification (acetylene block method)

Acetylene block incubations were performed at the five main stations (A140, A300, A940, A1200, and A850). The protocol and equipment used were described in the CD 146 Cruise Report. Two problems were encountered with the multicore barrels used in these incubations (see below); however, modifications were made and satisfactory samples were collected from most incubations. Arrangements have been made to analyse these samples at Newcastle University in early 2004.

A140: One of the three multicores used for acetylene block incubations was damaged and could not be repaired prior to A140 sampling. Therefore, the time series and whole core incubations were not performed on the same day; the time series incubation was performed on 23 September 2003, while the whole core incubation was performed the subsequent day. The whole core incubation was not agitated prior to T_{final} sampling; this means that the final sampling point will likely not include the sediment denitrification input of N_2O. Therefore, the whole core denitrification rate will underrepresent the actual denitrification in the sediment plus water column.

A300: The damaged multicore tube was repaired prior to A300 sampling and both acetylene block incubations were performed on 1 October 2003. A small crack in the multicore used for the whole core incubation may have allowed some N_2O to escape the incubation barrel during the incubation period. Though the core was agitated prior to T_{final} sampling, the final value may underrepresent the actual N_2O flux from sediments during the incubation. Also, due to short water columns in all A300 multicore barrels, the replacement reservoir was replenished with 50 mL of acetylene-sparged filtered seawater at 1500h (after the four-hour sampling point in the time series incubation)

A940: Acetylene block incubations were performed normally at this station on 7 October 2003.

A1850: Due to a loose core ring, one acetylene-block multicore was lost during coring at A1850 on 14 October 2003. Therefore, an empty multicore barrel was filled with bottom water and amended with a 10% addition of acetylene-sparged seawater; this barrel was used as a replacement reservoir for the time series incubation. Incubation sampling was performed normally except that the replacement reservoir water was sampled during the incubation to allow calculation of any dilution/enrichment effect to the time series incubation.

A1200: Incubations were performed on 16 October 2003 following the same protocol as that used at A1850 except that a 1 L bottle of acetylene-sparged seawater was sued as the time series replacement reservoir. As at A1850, this replacement reservoir was sampled (at the four-hour sampling point) to allow calculation of any dilution/enrichment effect to the time series incubation.

Matthew Schwartz

10.3 Lander deployments
10.31 Summary and logs

Profilur

Oxygen micro-electrode profiles

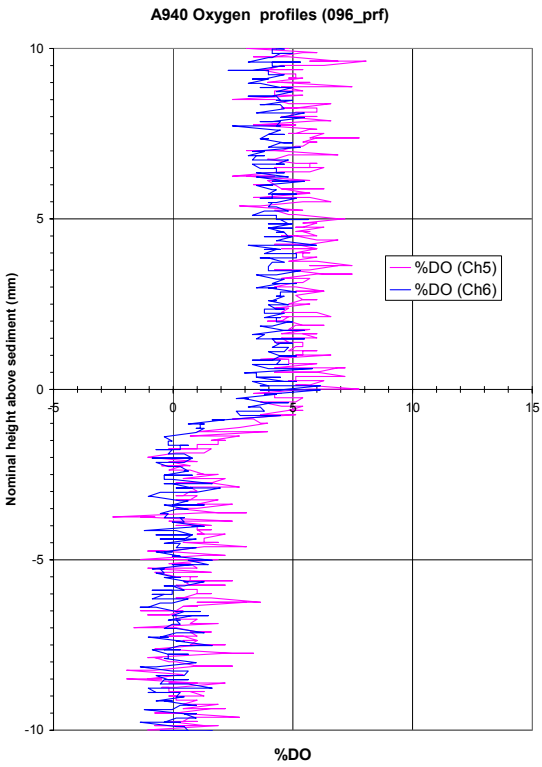
The Profilur was deployed twice at all the main sites with the exception of A300, where no deployments were made as we knew there to be no detectable oxygen there (from CD146 profiles). Good data was obtained from all but one of these deployments (at A1850). In addition to these major sites, deployments were also made at A850 and A1000. Some of the profiles obtained at each station are shown in the graphs below to give an idea of depth of oxgyen penetration into the sediment (except for sites showing no oxygen change across the sediment water interface), together with some profiles from CD146 for comparison. The %DO values are calculated from the lander water bottle winkler titrations and CTD measured bottom temperature and salinity, and the values must be treated with caution (see Breuer's winkler section of this report). The major difference from CD146 is that at A140 there is no discernible change in oxygen level across the sediment water interface. This is also true for the A850 site (at which no lander deployments were made on CD146), and by inference the A300 site (which showed no change on CD146).

pH and Resistivity

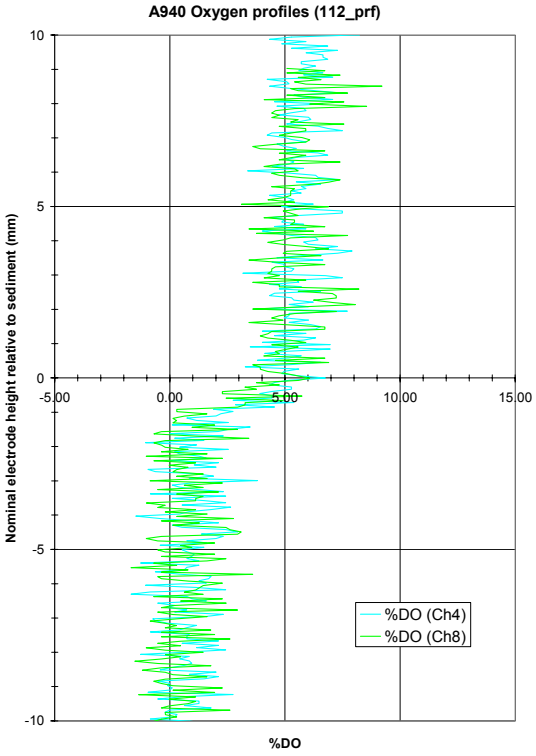
At the time of writing the pH data have not been analysed. However pH readings appeared to be stable and reliable (as on CD146) and in general seem to show a very slight decrease in pH as the electrode enters the sediment.

The resistivity probe worked reliably throughout, except once at A1850, when it failed due to dirt on the probe from previous deployments. On occasions the probe was used successfully to detect the sediment in order to shorten the length of deployment.

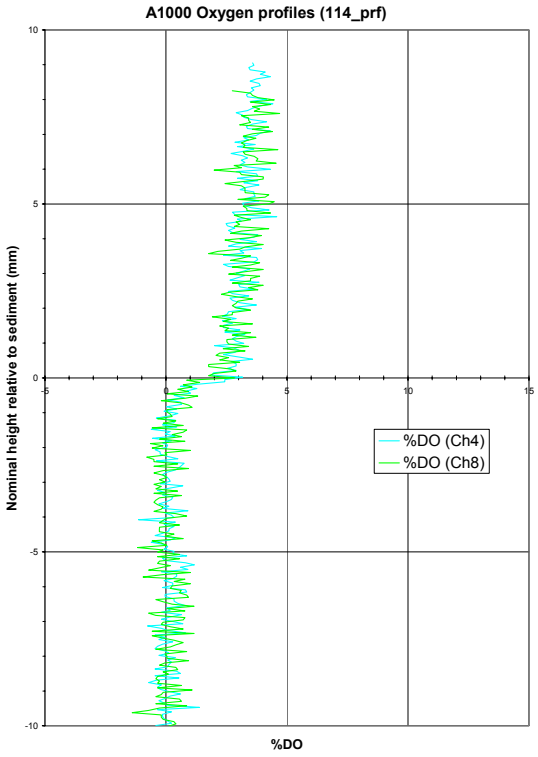
PTO



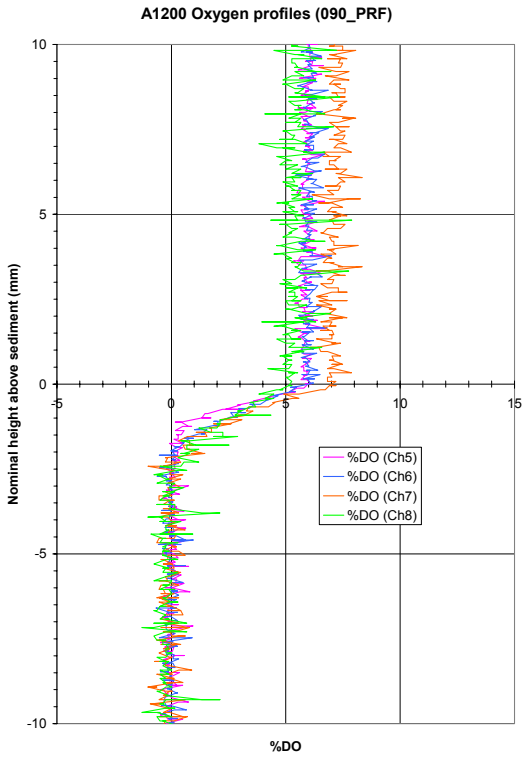
CD146



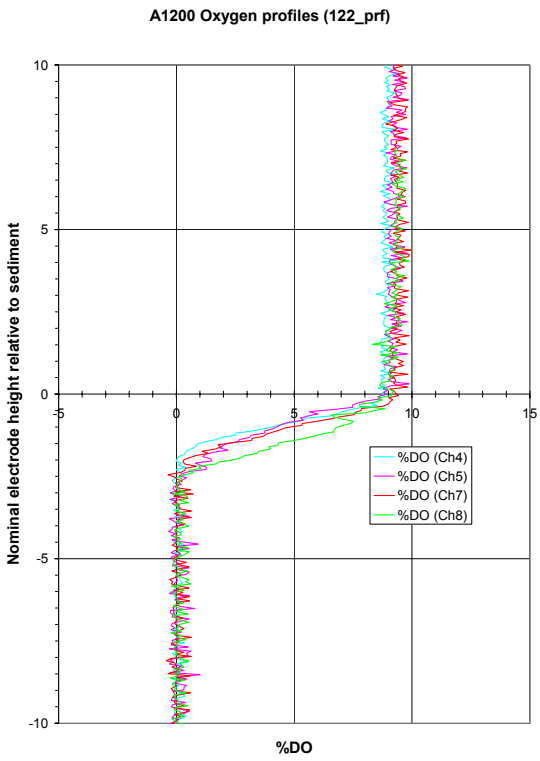
CD151



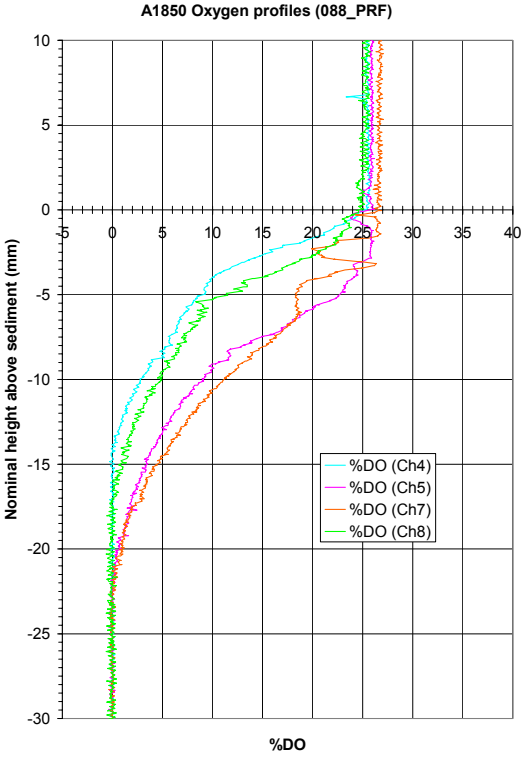
CD151



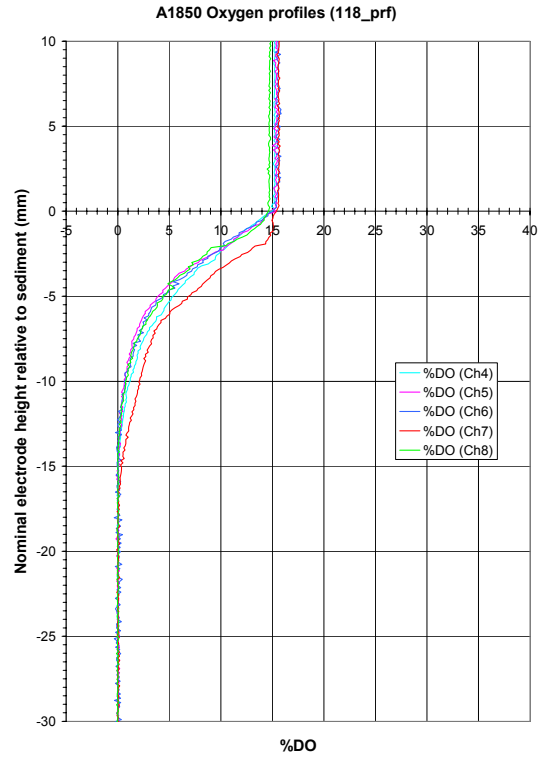
CD146



CD151



CD146



CD151

Elinor

In stark contrast to CD146 the *Elinor* deployments on CD151 were largely successful, with reliable lid closure, water samples and sediment retrieval. The cores retrieved at A140 (in moored mode) were less good because of the chamber going into the sediment at an angle. This meant that there was often a gap between one or two of the chamber walls and the sediment. On one occasion this led to wash out of the overlying water. The only site at which we didn't get a core retrieved was A1850. Some of the nutrient data shows verifiable trends (see Mowbray nutrient data section). Oxygen levels at A140 and A300 were below the detectable limits of the electrodes (certainly < 1 uM) and no trends were seen. Data from the oxygen optode also showed levels of oxygen well below the specifications of the sensor (resolution 1 μM). During all deployments at A940 the oxygen electrodes show a decrease in oxgyen in the first stage of the incubation, after which the level bottomed out, presumably once the oxygen had decreased to zero? This proves that the oxystat system is not capable of operating with such a low gradient in oxygen concentration across the membrane. Oxygen consumption figures have not yet been worked out from this data. At A1850 a single 2.5 day oxygen incubation (EO) was performed. Unfortunately the stirrer cut out early on in the deployment. However a small linear decrease in oxygen inside the chamber can be seen. At this stage it is not known how much effect the lack of stirring will have caused.

Bottom temperature
Temperature loggers were fitted to the landers as in CD146 and mean, min and max bottom temperatures are given in Table 2. There is significant variation in temperatures over the course of deployments, especially at A140 and A300. A brief inspection of the oxygen and temperature data for an *Elinor* deployment at A140 shows close correlation between the temperature and the ambient oxygen signal.

Technical summary
In stark contrast with CD146, this cruise was blessed with relatively few technical failures. What follows are a few notes on the various troubles experienced.

Profilur

The major problem experienced was with the calibration procedures and measurement of extremely low levels of oxygen. These are discussed in calibration procedures above and in Breuer's winkler section of this report. It should be noted that at these low oxygen values the noise level on the electrode amplifiers becomes significant, and could probably be improved.

The pressure housing end cap which showed signs of leaking during CD146 and was shipped back to Denmark for inspection was returned after remachining and with different size of o-rings for the electrode connectors. The system was pressure tested on the CTD at 940m a couple of times and showed no signs of leaking. However this end cap wasn't actually used during the cruise.

Problems were continued to be experienced with the Interocean release system fitted to the *Profilur*. When tested at A300, the motor was found to turn the release bolt, but not quite far enough, thus the ballast wasn't released, and had to be recovered by using the main Oceano release. This test was repeated a couple of times with the same results. It may be that the paraffin oil used to refill the motor housing after it leaked on CD146 is too viscous (although the system was used successfully after the refilling at A940 on CD146). The batteries in the Interocean deck unit were replaced after failure on CD146.

Elinor

Water sampler
New springs were brought out to replace those not replaced during CD146, and consistently good water samples were obtained on every deployment (largely >50ml, always >40ml). We continued to use new syringes for each deployment, and grease the plungers with silicone grease.

Lid closure
No problems were experienced with lid closure on this cruise, the lid being fitted with an extra 0.5kg weight at the front.

Mud retrieval
The chamber system was overhauled and modified back in the UK between CD146 and CD151, and proved significantly improved with reliable sedediment retrieval at all of the main CD151 sites (A140, A300 and A940). However on the one deployment at A1850 mud wasn't recovered, and camera footage shows the shovel still not closing until well after the lander left the bottom. The problem is certainly not due to air in the system as throughout the cruise the system was carefully bled and checked for air. Thus the problem must be something to do with pressure or temperature on the hydraulic system, and needs further investigation. Note that the problem is not due to mud type, as at A1850 the shovel didn't even close as far as the sediment surface before stopping.

On one deployment a broken burnwire prevented the shovel from firing (hence the A940 EF13 deployment was repeated). It is thought that there was a tiny nick in the insulation and the wire had been gradually corroding there throughout the cruise. It is essential that burnwires should be inspected carefully before every deployment (despite this being very time consuming) and the resistance from end to end monitored – it should not rise above about 100 ohms. In future it would also be good to make some "spools" for the burnwires – the current system of coiling them in plastic pots can lead to tangles.

Electrodes and sensors

Two changes were made to the sensor fit on CD151. The pH electrode was changed to the type with no pre-amplifier (as the oxgyen electrodes were on CD146) which seemed to work well, at least initially. However after the first six deployments the pH system stopped giving reliable results, and it didn't appear to be specific to pH electrodes or reference (both were changed several times), or to any obvious electronic failure. This problem was not rectified, and deployments at A940 and A1850 were without pH data.

An Aanderaa optode was fitted (see Elinor protocols) to measure ambient oxgygen. Two sensors were purchased which arrived the week before departing the UK, and so there was no opportunity to gain experience with them prior to the cruise. The sensors proved easy to interface to the Elinor electronics, giving an analogue output (special option) between 0 –5 V which was fed directly into one of the analogue channels on the lander controller. A special port had to be made in order to fit an extra bulkhead connector to the lander pressure housing - many thanks to Dan Comben for this. Unfortunately the oxygen levels at most sites were so low as to be below the official specifications of the sensor. However a non-zero signal was obtained at A140 and A940 (and possibly at A300 – it was difficult to tell because of our inability to obtain a zero oxgygen calibration solution), and it may be that the sensor does give valid values below the official specification. When asked, the manufacturers were very uncertain as to the actual performance of the sensor at very low oxygen levels, and admitted they did not really know the actual minimum oxgygen level that could be measured reliably. This data will be looked at, and post cruise calibrations performed

Other problems

On the last Elinor deployment the stirrer motor stopped after approx 2 hours for no apparent reason. Both the counter data and the camera footage confirm this (and so it is not just a counter failure). The system was tested again on deck after the deployment and worked fine for > 3 hours. Also on this deployment the Novatech Xenon flasher beacon (which was actually needed due to the pre-dawn recovery) proved faulty. On examination afterwards the beacon could only be made to work by increasing the intensity setting to maximum, and even then it missed some flashes. It is not known why this failed, having been working fine throughout the cruise.

Oli Peppe

PTO

Table 1: Deployment summary

Deployment #	**102_eli**	**103_eli**	**104_prf**	**105_prf**	**106_eli**	**107_eli**	**108_eli**	**109_eli**	**110_prf**	**111_eli**
Site	A140	A140	A140	A140	A140	A300	A300	A300	A850	A940
SOC series #	56101#3	56101#18	56101#21	56101#24	56101#29	56105#10	56107#4	56112#4	56114#4	56116#2
Configuration	*Elinor* (EO), moored	*Elinor* (EF), moored	*Profilur,* moored	*Profilur*, moored	*Elinor* (EF13), moored	*Elinor* (EO), autonomous	*Elinor* (EF13), autonomous	*Elinor* (EF), autonomous	*Profilur*, autonomous	*Elinor* (EO), autonomous
Comments on data & samples obtained	Good mud & water samples. O2 data very low	Good mud and water samples (gap at front of chamber)	Data OK, but no discernible profiles	As 104_prf	Gap in core at front and right. Otherwise OK	Good very deep core.	All good.	All good	Good – but no discernible change in O2	All good. Definite decrease in O2.
Deployment date	20/09/03	22/09/03	22/09/03	23/09/03	24/09/03	27/09/03	29/09/03	02/10/03	03/10/03	05/10/03
Deployment time (UTC)	0138	0131	1241	1012	1228	1334	1229	1239	1108	0131
Deployment position	23°17.127'N 66°42.481'E	23°17.200'N 66°42.472'E	23°17.385'N 66°42.038'E	23°17.391'N 66°42.165'E	23°17.136'N 66°42.538'E	23°12.77'N 66°33.30'E	23°12.866'N 66°33.318'E	23°12.803'N 66°33.429'E	22°56.978'N 66°37.991'E	23°53.199'N 66°37.011'E
Deployment Water depth	134m	136m	134m	133m	133m	306m	305m	301m	843m	938m
Mooring line length (m)	220	220	225	225	220	n/a	n/a	n/a	n/a	n/a
Recovery date	21/09/03	24/09/03	23/09/03	24/09/03	27/09/03	29/09/03	02/10/03	04/10/03	04/10/03	06/10/03
Recovery time	1324	0300	0510	1330	0306	0308	0222	1242	0322	1323
Time on bottom (hrs)	35.3	49.6	14.8	27.0	63.0	37.0	61.4	47.5	15.6	35.0
Weight on descent (kg)	145	145	100	100	140	51	55	42	43	50
Weight on ascent (kg)	n/a	n/a	n/a	n/a	n/a	-107	-107	-107	-78	-107
Descent speed (m/min)	n/a	n/a	n/a	n/a	n/a	60	61	60	60	62
Ascent speed (m/min)	n/a	n/a	n/a	n/a	n/a	77	n/k	75	56	n/k
Est. height of sediment above lander feet (mm)	15	5	45	30	25	95	130	85	80	55
Est. max. penetration of O2 electrodes or chamber into sediment (mm)	195	190	80	45	210	275	260	205	85	240

Note: *Dep. time:* time system reset prior to deployment
D*ep. pos.:* position of ship when lander released, or mooring released
Rec. time: time lander completely in-board

Deployment #	**112_prf**	**113_eli**	**114_prf**	**115_prf**	**116_eli**	**117_eli**	**118_prf**	**119_prf**	**120_eli**	**121_prf**
Site	A940	A940	A1000	A940	A940	A940	A1850	A1850	A1850	A1200
SOC series #	56116#9	56118#1	56119#4	56125#1	56129#02	56136#3	56137#5	56137#16	56140#1	56141#1
Configuration	*Profilur,* autonomous	*Elinor* (EF), autonomous	*Profilur*, autonomous	*Profilur,* autonomous	*Elinor* (EF13), autonomous	*Elinor* (EF13), autonomous	*Profilur*, autonomous	*Profilur,* autonomous	*Elinor* (EO), autonomous	*Profilur,* autonomous
Comments on data & samples obtained	Good profiles (very slight)	All good	Good O2 profiles	Good O2 profiles	No mud (broken burnwire)	All good	Good O2 profiles	No profiles – res. probe failure	No mud. Stirrer failed	Good O2 profiles
Deployment date	05/10/03	07/10/03	07/10/03	08/10/03	09/10/03	12/10/03	13/10/03	14/10/03	15/10/03	16/10/03
Deployment time (UTC)	1432	0135	0857	1215	1325	2154	1322	1107	1141	0108
Deployment position	22°52.890'N 66°37.160'E	22°53.237'N 66°37.005'E	22°54.998'N 65°35.107'E	22°52.923'N 66°37.191'E	22°53.254'N 66°37.005'E	22°53.238'N 66°37.007'E	22°51.067'N 65°59.916'E	22°51.107'N 66°59.912'E	22°51.797'N 66°00.023'E	22°59.784'N 66°24.786'E
Deployment Water depth	940m	938m	994m	938	937	937	1864	1863	1857	1182
Mooring line length (m)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Recovery date	06/10/03	09/10/03	08/10/03	09/10/03	12/10/03	10/05/03	14/10/03	15/10/03	18/10/03	16/10/03
Recovery time	0437	0327	0433	1309	0249	0317	0448	1300	0118	1240
Time on bottom (hrs)	13.3	48.6	17.7	23.9	60.5	52.5	14.2	24.4	59.9	10.5
Weight on descent (kg)	44	50	44	44	50	50	44	44	64	44
Weight on ascent (kg)	-103	-107	-103	55	58	-107	-103	-103	-107	-103
Descent speed (m/min)	55	55	n/k	55	44	55	55	53	58	50
Ascent speed (m/min)	73	78	77	n/k	78	72	75	n/k	n/k	74
Est. height of sediment above lander feet (mm)	50	55	26	62	n/k	55	n/k	n/k	30	20
Est. max. penetration of electrodes or chamber into sediment (mm)	85	250	90	90	n/k	245	-100	n/k	215	75

Note: *Dep. time:* time system reset prior to deployment
D*ep. pos.:* position of ship when lander released, or mooring released
Rec. time: time lander completely in-board

Deployment #	**122_prf**									
Site	A1200									
SOC series #	56141#13									
Configuration	*Profilur*, autonomous									
Comments on data & samples obtained	Good O2 profiles									
Deployment date	16/10/03									
Deployment time (UTC)	1541									
Deployment position	22°59.776'N 66°24.758'E									
Deployment Water depth	1184m									
Mooring line length (m)	n/a									
Recovery date	17/10/03									
Recovery time	0420									
Time on bottom (hrs)	11.7									
Weight on descent (kg)	44									
Weight on ascent (kg)	-103									
Descent speed (m/min)	54									
Ascent speed (m/min)	74									
Est. height of sediment above lander feet (mm)	55									
Est. max. penetration of electrodes or chamber into sediment (mm)	80									

Note: *Dep. time:* time system reset prior to deployment
D*ep. pos.:* position of ship when lander released, or mooring released
Rec. time: time lander completely in-board

Table 2 – Summary of bottom temperature records from lander deployments (~0.5m above bottom)

Deployment #	Station	Max temp (C)	Min temp (C)	Mean temp (C)
102_eli	A140	18.20	18.13	18.17
103_eli	A140	18.26	18.22	18.24
104_prf	A140	18.27	18.22	18.23
105_prf	A140	18.27	18.24	18.25
106_eli	A140	18.43	18.27	18.32
107_eli	A300	15.07	14.51	14.87
108_eli	A300	15.35	14.84	15.03
109_eli	A300	15.85	15.10	15.37
110_prf	A850	9.85	9.68	9.71
111_eli	A940	9.42	9.25	9.31
112_prf	A940	9.40	9.19	9.32
113_eli	A940	9.54	9.19	9.35
114_prf	A1000	9.16	8.66	8.97
115_prf	A940	9.46	9.17	9.33
116_eli	A940	9.51	9.14	9.30
117_eli	A940	9.30	8.98	9.09
118_prf	A1850	3.55	3.52	3.53
119_prf	A1850	3.52	3.47	3.48
120_eli	A1850	3.51	3.37	3.45
121_prf	A1200	7.34	7.28	7.31
122_prf	A1200	7.31	7.20	7.26

Oli Peppe

10.32 Elinor event logs.

Lander deployment no.	**102_ELI**
Station	**A140**
SOC No.	**56101 #3**
Elinor Mode	**EO**

Event	Date / time (UTC)	Time from incubation start (hrs)	Comments
Lid closed	20/09/03 05:11	0.0	Assumed lid closure (no camera picture)
Stirrer start	20/09/03 05:11	0.0	
Oxystat pump on	n/a	n/a	
Oxystat pump off	n/a	n/a	
Stirrer off	21/09/03 12:01	30.8	
Shovel & water bottles fired	21/09/03 12:01	30.8	Good core retrieved (some "cracking") Estimated overlying water vol: 12.9l

Water samples

Syringe port	Date / time (UTC)	Time from incubation start (hrs)	Vial / Tube Nos.	Sample Vol (ml)	Water sample analytes / Comments
#01	20/09/03 05:11	0.0	A02	42	DO
#02	20/09/03 05:11	0.0	A03	0	DO
#03	20/09/03 20:27	15.3	A08	37	DO (+ 6ml air)
#04	20/09/03 20:27	15.3	A04	42	DO
#05	21/09/03 11:33	30.4	#06	50	N2 (+ 5ml air)
#06	21/09/03 11:40	30.5	n/a	n/a	KBr inject (53 ml 0.1M KBr)
#07	21/09/03 11:50	30.7	n/a	56	KBr sample
#08	21/09/03 11:33	30.4	B05	56	DO
#09	21/09/03 11:33	30.4	A06	49	DO
#10	21/09/03 11:33	30.4	B04	40	DO
#11	20/09/03 05:11	0.0	A05	50	DO
#12	20/09/03 05:11	0.0	#03	54	N2
#13	20/09/03 20:27	15.3	B25	53	DO (+ 1ml air)
#14	20/09/03 20:27	15.3	#04	48	N2
#15	21/09/03 11:33	30.4	#05	49	N2

Lander deployment no.	**103_ELI**
Station	**A140**
SOC No.	**56101 #18**
Elinor Mode	**EF**

Event	Date / time (UTC)	Time from incubation start (hrs)	Comments
Lid closed	22/09/03 05:12	0.0	
Stirrer start	22/09/03 05:10	0.0	
Oxystat pump on	22/09/03 05:25	0.3	
Oxystat pump off	24/09/03 01:09	44.0	
Stirrer off	24/09/03 01:09	44.0	
Shovel & water bottles fired	24/09/03 01:09	44.0	Shovel fully closed by 01:50. Core OK - gap at front. 1 subcore taken for TM analysis (Breuer) Estimated overlying water vol: 19.9l

Water samples

Syringe port	Date / time (UTC)	Time from incubation start (hrs)	Vial / Tube Nos.	Sample Vol (ml)	Water sample analytes / Comments
#01	22/09/03 05:10	0.0	2B		TM
#02	22/09/03 05:10	0.0	1B3Y		TM
#03	22/09/03 20:30	15.3	1B4Y		TM
#04	24/09/03 00:42	43.5	5B		TM
#05	24/09/03 00:42	43.5	1B		TM
#06	24/09/03 00:49	43.7	n/a		KBr inject (53 ml 0.1M KBr)
#07	24/09/03 00:59	43.8	n/a		KBr sample
#08	23/09/03 10:36	29.4	3B		TM
#09	23/09/03 10:36	29.4	4B		TM
#10	23/09/03 10:36	29.4	#06		Nutrients
#11	22/09/03 05:10	0.0	#03		Nutrients
#12	22/09/03 05:10	0.0	#05		Nutrients
#13	22/09/03 20:30	15.3	#01		Nutrients
#14	24/09/03 00:42	43.5	#02		Nutrients
#15	24/09/03 00:42	43.5	#04		Nutrients

Lander deployment no.	**107_ELI**
Station	**A300**
SOC No.	**56105 #01**
Elinor Mode	**EO**

Event	Date / time (UTC)	Time from incubation start (hrs)	Comments
Lid closed	27/09/03 17:09	0.0	
Stirrer start	27/09/03 17:07	0.0	
Oxystat pump on	n/a	n/a	
Oxystat pump off	n/a	n/a	
Stirrer off	29/09/03 01:57	32.8	
Shovel & water bottles fired	29/09/03 01:57	32.8	Excellent, deep core. Some sediment in water bottles Estimated overlying water vol: 5.5l

Water samples

Syringe port	Date / time (UTC)	Time from incubation start (hrs)	Vial / Tube Nos.	Sample Vol (ml)	Water sample analytes / Comments
#01	27/09/03 17:07	0.0	B04	55	DO
#02	27/09/03 17:07	0.0	B25	54	DO
#03	28/09/03 09:23	16.3	B05	53	DO
#04	28/09/03 09:23	16.3	B29	56	DO
#05	29/09/03 01:30	32.4	#06	54	N2
#06	29/09/03 01:37	32.5	n/a	n/a	KBr Inject 53ml 0.1M KBr (possibly fired at #07 time?)
#07	29/09/03 01:47	32.7	n/a	0	KBr sample (didn't trigger)
#08	29/09/03 01:30	32.4	A02	56	DO (possibly fired at #09 time?)
#09	29/09/03 01:30	32.4	A03	56	DO (possibly fired at #10 time?)
#10	29/09/03 01:30	32.4	A08	54	DO (possibly fired at #06 time?)
#11	27/09/03 17:07	0.0	A06	51	DO
#12	27/09/03 17:07	0.0	#05	56	N2
#13	28/09/03 09:23	16.3	A05	51	DO
#14	28/09/03 09:23	16.3	#03	56	N2
#15	29/09/03 01:30	32.4	#04	54	N2

Lander deployment no.	**106_ELI**
Station	**A140**
SOC No.	**56101#29**
Elinor Mode	**EF13**

Event	Date / time (UTC)	Time from incubation start (hrs)	Comments
Lid closed	24/09/03 16:08	0.0	
Stirrer start	24/09/03 16:57	0.8	(Some stirring during slurry addition, prior to settling)
Oxystat pump on	24/09/03 16:57	0.8	
Oxystat pump off	27/09/03 01:06	57.0	
Stirrer off	27/09/03 01:06	57.0	
Shovel & water bottles fired	27/09/03 01:06	57.0	Core OK, lost overlying water - slumped at front. 2 subcores taken for 13C analysis Estimated overlying water vol: 15.6l

Water samples

Syringe port	Date / time (UTC)	Time from incubation start (hrs)	Vial / Tube Nos.	Sample Vol (ml)	Water sample analytes / Comments
#01	24/09/03 16:11	0.1	n/a	n/a	Slurry inject (350mg slurry mixed 2:1 with kaolinite ballast) Slurry gone from tube by 17:18 (t=1.2)
#02	24/09/03 17:17	1.2	#01	42	Nutrients
#03	25/09/03 11:24	19.3	#10	41	Nutrients
#04	26/09/03 05:31	37.4	#06	44	Nutrients
#05	27/09/03 00:39	56.5	#09	51	Nutrients
#06	27/09/03 00:45	56.7	n/a	n/a	KBr inject (53 ml of 0.1M KBr)
#07	27/09/03 00:55	56.8	n/a	55	KBr sample
#08	24/09/03 16:06	0.0	#07	40	Nutrients
#09	27/09/03 00:39	56.5	#03	55	Nutrients
#10	27/09/03 00:39	56.5	#12	42	Nutrients
#11	24/09/03 16:06	0.0	#02	43	Nutrients
#12	24/09/03 17:17	1.2	#04	44	Nutrients
#13	25/09/03 11:24	19.3	#08	49	Nutrients
#14	26/09/03 05:31	37.4	#11	47	Nutrients
#15	26/09/03 05:31	37.4	#05	50	Nutrients

Lander deployment no.	**108_ELI**
Station	**A300**
SOC No.	**56107 #04**
Elinor Mode	**EF13**

Event	Date / time (UTC)	Time from incubation start (hrs)	Comments
Lid closed	29/09/03 16:09	0.0	
Stirrer start	29/09/03 16:58	0.9	(Some stirring during slurry addition, prior to settling)
Oxystat pump on	29/09/03 16:58	0.9	
Oxystat pump off	02/10/03 01:06	57.0	
Stirrer off	02/10/03 01:06	57.0	
Shovel & water bottles fired	02/10/03 01:06	57.0	Excellent core. 2 subcores taken for 13C analysis Estimated overlying water vol: 7.0l

Water samples

Syringe port	Date / time (UTC)	Time from incubation start (hrs)	Vial / Tube Nos.	Sample Vol (ml)	Water sample analytes / Comments
#01	29/09/03 16:12	0.1	n/a	n/a	Slurry inject (350mg slurry mixed 2:1 with kaolinite ballast) All slurry in by 16:17. None left in tube.
#02	29/09/03 17:18	1.2	#07	45	Nutrients
#03	30/09/03 11:24	19.3	#10	43	Nutrients
#04	01/10/03 05:31	37.4	#09	45	Nutrients
#05	02/10/03 00:39	56.5	#06	55	Nutrients
#06	02/10/03 00:46	56.7	n/a	n/a	KBr inject (53 ml of 0.1M KBr)
#07	02/10/03 00:56	56.8	n/a	56	KBr sample
#08	29/09/03 16:07	0.0	#01	56	Nutrients
#09	02/10/03 00:39	56.5	#03	54	Nutrients
#10	02/10/03 00:39	56.5	#02	49	Nutrients
#11	29/09/03 16:07	0.0	#04	48	Nutrients
#12	29/09/03 17:18	1.2	#08	51	Nutrients
#13	30/09/03 11:24	19.3	#12	49	Nutrients
#14	01/10/03 05:31	37.4	#11	54	Nutrients
#15	01/10/03 05:31	37.4	#05	51	Nutrients

Lander deployment no.	**109_ELI**
Station	**A300**
SOC No.	**56112 #04**
Elinor Mode	**EF**

Event	Date / time (UTC)	Time from incubation start (hrs)	Comments
Lid closed	02/10/03 16:19	0.0	
Stirrer start	02/10/03 16:17	0.0	
Oxystat pump on	02/10/03 16:27	0.2	
Oxystat pump off	04/10/03 11:11	42.9	
Stirrer off	04/10/03 11:11	42.9	
Shovel & water bottles fired	04/10/03 11:11	42.9	Good core. One subcore taken for TMs (Breuer) Estimated overlying water vol: 10.3

Water samples

Syringe port	Date / time (UTC)	Time from incubation start (hrs)	Vial / Tube Nos.	Sample Vol (ml)	Water sample analytes / Comments
#01	02/10/03 16:17	0.0	1B4Y	50	TM
#02	02/10/03 16:17	0.0	3B	43	TM
#03	03/10/03 06:32	14.3	1B2Y	55	TM
#04	04/10/03 10:44	42.4	5B	56	TM
#05	04/10/03 10:44	42.4	1B	55	TM
#06	04/10/03 10:50	42.6	n/a	n/a	KBr inject (53 ml 0.1M KBr)
#07	04/10/03 11:01	42.7	n/a	53	KBr sample (+ 3ml air)
#08	03/10/03 20:38	28.4	2B	47	TM
#09	03/10/03 20:38	28.4	4B	49	TM
#10	03/10/03 20:38	28.4	#06	49	Nutrients
#11	02/10/03 16:17	0.0	#05	56	Nutrients
#12	02/10/03 16:17	0.0	#03	51	Nutrients
#13	03/10/03 06:32	14.3	#02	56	Nutrients
#14	04/10/03 10:44	42.4	#01	56	Nutrients
#15	04/10/03 10:44	42.4	#04	56	Nutrients

Lander deployment no. **111_eli**
Station **A940**
SOC No. **56116 #2**
Elinor Mode **EO**

Event	Date / time (UTC)	Time from incubation start (hrs)	Comments
Lid closed	05/10/03 05:15	0.2	Lid largely closed by 05:07. Fully closed by 05:15
Stirrer start	05/10/03 05:04	0.0	
Oxystat pump on	n/a	n/a	
Oxystat pump off	n/a	n/a	
Stirrer off	06/10/03 11:55	30.8	
Shovel & water bottles fired	06/10/03 11:55	30.8	Good core retrieved Estimated overlying water vol: 8 - 10l (core not measured)

Water samples

Syringe port	Date / time (UTC)	Time from incubation start (hrs)	Vial / Tube Nos.	Sample Vol (ml)	Water sample analytes / Comments
#01	05/10/03 05:04	0.0	A05	53	DO
#02	05/10/03 05:04	0.0	B25	56	DO
#03	05/10/03 20:20	15.3	B05	56	DO
#04	05/10/03 20:20	15.3	B04	54	DO
#05	06/10/03 11:27	30.4	#01	56	N2
#06	06/10/03 11:34	30.5	n/a	n/a	KBr Inject (53 ml 0.1M KBr)
#07	06/10/03 11:44	30.7	n/a	56	KBr sample
#08	06/10/03 11:27	30.4	A06	56	DO
#09	06/10/03 11:27	30.4	A03	51	DO
#10	06/10/03 11:27	30.4	A02	52	DO
#11	05/10/03 05:04	0.0	A08	53	DO
#12	05/10/03 05:04	0.0	#06	53	N2
#13	05/10/03 20:20	15.3	B29	56	DO
#14	05/10/03 20:20	15.3	#03	56	N2
#15	06/10/03 11:27	30.4	#04	56	N2

Lander deployment no. **113_ELI**
Station **A940**
SOC No. **56118 #1**
Elinor Mode **EF**

Event	Date / time (UTC)	Time from incubation start (hrs)	Comments
Lid closed	07/10/03 05:16	0.0	
Stirrer start	07/10/03 05:14	0.0	Some sticking in stirrer early on (11-12 RPM)
Oxystat pump on	07/10/03 05:24	0.2	
Oxystat pump off	09/10/03 01:08	43.9	
Stirrer off	09/10/03 01:08	43.9	
Shovel & water bottles fired	09/10/03 01:08	43.9	Good core. One subcore taken for TMs (Breuer) Estimated overlying water vol: 8.7 l

Water samples

Syringe port	Date / time (UTC)	Time from incubation start (hrs)	Vial / Tube Nos.	Sample Vol (ml)	Water sample analytes / Comments
#01	07/10/03 05:14	0.0	#04	51	Nutrients
#02	07/10/03 05:14	0.0	#02	56	Nutrients
#03	07/10/03 20:29	15.3	#06	54	Nutrients
#04	09/10/03 00:41	43.5	#01	53	Nutrients
#05	09/10/03 00:41	43.5	#05	56	Nutrients
#06	09/10/03 00:48	43.6	n/a	n/a	KBr inject (53ml 0.1M KBr)
#07	09/10/03 00:58	43.7	n/a	56	KBr sample
#08	08/10/03 10:35	29.4	1B2Y	57	TM
#09	08/10/03 10:35	29.4	5B	56	TM
#10	08/10/03 10:35	29.4	#03	47	Nutrients
#11	07/10/03 05:14	0.0	4B	56	TM
#12	07/10/03 05:14	0.0	2B	54	TM
#13	07/10/03 20:29	15.3	1B	55	TM
#14	09/10/03 00:41	43.5	1B3Y	56	TM
#15	09/10/03 00:41	43.5	3B	57	TM

Lander deployment no. **116_ELI**
Station **A940**
SOC No. **56129 #02**
Elinor Mode **EF13**

Event	Date / time (UTC)	Time from incubation start (hrs)	Comments
Lid closed	09/10/03 17:02	0.0	Estimate - no camera picture
Stirrer start	09/10/03 17:57	0.9	(Some stirring during slurry addition, prior to settling)
Oxystat pump on	09/10/03 17:57	0.9	
Oxystat pump off	12/10/03 01:06	56.1	
Stirrer off	12/10/03 01:06	56.1	
Shovel & water bottles fired			not fired (broken burnwire)
			Estimated overlying water vol: n/k (no mud or picture)

Water samples

Syringe port	Date / time (UTC)	Time from incubation start (hrs)	Vial / Tube Nos.	Sample Vol (ml)	Water sample analytes / Comments
#01	09/10/03 17:08	0.1	n/a	n/a	Slurry inject (253mg slurry mixed 2:1 with kaolinite ballast) No slurry in tube on recovery.
#02	09/10/03 18:18	1.3	#02	54	Nutrients
#03	10/10/03 12:24	19.4	#01	56	Nutrients
#04	11/10/03 06:31	37.5	#03	55	Nutrients
#05	12/10/03 00:38	55.6	#09	56	Nutrients
#06	12/10/03 00:45	55.7	n/a	n/a	KBr inject (53 ml of 0.1M KBr)
#07	12/10/03 00:55	55.9	n/a	56	KBr sample
#08	09/10/03 17:02	0.0	#12	56	Nutrients
#09	12/10/03 00:38	55.6	#08	54	Nutrients
#10	12/10/03 00:38	55.6	#07	49	Nutrients
#11	09/10/03 17:02	0.0	#04	48	Nutrients
#12	09/10/03 18:18	1.3	#11	51	Nutrients
#13	10/10/03 12:24	19.4	#10	56	Nutrients
#14	11/10/03 06:31	37.5	#06	56	Nutrients
#15	11/10/03 06:31	37.5	#05	50	Nutrients

Lander deployment no. **117_ELI**
Station **A940**
SOC No. **56136 #03**
Elinor Mode **EF13**

Event	Date / time (UTC)	Time from incubation start (hrs)	Comments
Lid closed	13/10/03 01:33	0.0	
Stirrer start	13/10/03 02:27	0.9	(Some stirring during slurry addition, prior to settling)
Oxystat pump on	13/10/03 02:27	0.9	
Oxystat pump off	15/10/03 01:32	48.0	
Stirrer off	15/10/03 01:32	48.0	
Shovel & water bottles fired	15/10/03 01:32	48.0	Good core. 2 subcores taken for 13C analysis. Estimated overlying water vol: 9.4l

Water samples

Syringe port	Date / time (UTC)	Time from incubation start (hrs)	Vial / Tube Nos.	Sample Vol (ml)	Water sample analytes / Comments
#01	13/10/03 01:37	0.1	n/a	n/a	Slurry inject (250mg slurry mixed 2:1 with kaolinite ballast) Significant amount of slurry left in injection tube
#02	13/10/03 02:48	1.3	#07	52	Nutrients
#03	13/10/03 18:53	17.4	#10	56	Nutrients
#04	14/10/03 10:59	33.5	#01	56	Nutrients
#05	15/10/03 01:05	47.6	#09	56	Nutrients
#06	15/10/03 01:12	47.7	n/a	n/a	KBr inject (53 ml of 0.1M KBr)
#07	15/10/03 01:22	47.8	n/a	54	KBr sample
#08	13/10/03 01:32	0.0	#02	47	Nutrients
#09	15/10/03 01:05	47.6	#12	56	Nutrients
#10	15/10/03 01:05	47.6	#05	55	Nutrients
#11	13/10/03 01:32	0.0	#03	50	Nutrients
#12	13/10/03 02:48	1.3	#06	56	Nutrients
#13	13/10/03 18:53	17.4	#04	56	Nutrients
#14	14/10/03 10:59	33.5	#11	56	Nutrients (bottom tube came off during coil removal)
#15	14/10/03 10:59	33.5	#08	56	Nutrients

Lander deployment no.	**120_eli**
Station	**A1850**
SOC No.	**56140#1**
Elinor Mode	**EO**

Event	Date / time (UTC)	Time from incubation start (hrs)	Comments
Lid closed	15/10/03 15:17	0.0	
Stirrer start	15/10/03 15:14	0.0	
Oxystat pump on	n/a	n/a	
Oxystat pump off	n/a	n/a	
Stirrer off	15/10/03 17:05	1.9	Cut out for no apparent reason…
Shovel & water bottles fired	17/10/03 22:13	55.0	
			Estimated overlying water vol: 11 - 12l

Water samples

Syringe port	Date / time (UTC)	Time from incubation start (hrs)	Vial / Tube Nos.	Sample Vol (ml)	Water sample analytes / Comments
#01	15/10/03 15:14	0.0	B04	55	DO
#02	15/10/03 15:14	0.0	B05	48	DO
#03	16/10/03 09:31	18.3	A06	56	DO
#04	16/10/03 09:31	18.3	A08	56	DO
#05	16/10/03 09:31	18.3	A03	55	DO
#06	17/10/03 21:52	54.6	n/a	n/a	KBr Inject (53 ml 0.1M KBr)
#07	17/10/03 22:02	54.8	n/a	55	KBr sample
#08	15/10/03 15:14	0.0	#01	56	Nutrients
#09	15/10/03 15:14	0.0	#06	56	Nutrients
#10	15/10/03 15:14	0.0	B29	54	DO
#11	16/10/03 09:31	18.3	#05	52	Nutrients
#12	17/10/03 03:39	36.4	#03	56	Nutrients
#13	17/10/03 03:39	36.4	#04	56	Nutrients
#14	17/10/03 21:46	54.5	#02	54	Nutrients
#15	17/10/03 21:46	54.5	#07	56	Nutrients

Oli Peppe

10.4 Shipboard incubations summary

10.41 Summary of experiments

Below is a summary of the experiments conducted, followed by some initial observations and details of new experiments. Experimental protocols are as given in the cruise report for CD 146. As a key to Table1. the aims of the different experiments are now briefly described.

- Benthic flux incubations (SF) utilise the oxystat system and overlying waters are periodically sampled for DIC, δ^{13}C DIC, nutrients, trace metals and DOC.
- SF13-2 and SF13-5 are two and five day duration, respectively, benthic flux incubations. These differ from the standard benthic flux incubations because ^{13}C labelled algae are injected at the beginning of each incubation. These are not sampled for trace metals and experiments terminate with core sectioning and the separation and preservation of sediment, fauna, and porewaters.
- Oxygen consumption experiments (SO) measure decreases in dissolved oxygen in sealed cores (no oxystat) and water is sampled for N_2/Ar, DIC, δ^{13}C DIC and nutrients.
- Bead incubations (SB) start with the introduction of fluorescent tracer beads and finish with core sectioning. The oxystat system is employed and water samples are not taken.
- SOP experiments are discussed below.

Experiment	SF	SF13-2	SF13-5	SB	SO	SOP
A140	x	x	x	x	X	x
A300	x	x	x		X	x
A940	x		x	x	X	x
A1200					X	
A1850	x		x		X	
A850					x	
A1000					x (failed)	
Bacterial Mat	x				x*	
Bacterial Mat Control	x				x*	

Table 1. A summary of all shipboard incubation experiments conducted during CD 151.
* = Core incubated as SF, then disconnected from oxystat and continued as SO.

Oxygen Consumption

As during CD 146, problems were encountered conducting oxygen consumption (SO) incubations at sites with low bottom water DO. As discussed above, core top water became quickly oxygen-contaminated before incubations started, an effect which was minimised, but which still produced perturbed starting conditions, possibly affecting any subsequently observed consumption rate. Efforts were made to return core top oxygen to ambient levels prior to beginning incubation using the oxystat system. This seemed to be effective, but took up to 24 hours, delaying the start of other experiments. Furthermore, in some case, the core top DO increased after being isolated from the oxystat system. Core top water was also sparged with nitrogen and then helium to alleviate initial oxygen contamination. This proved to be a faster acting solution.

Even having returned dissolved oxygen to ambient levels, however, SO incubations continued to be problematic. In most cases oxygen electrode data showed an increase, not consumption, in dissolved oxygen for a period up to 48 hours despite the incubation being a sealed system (see SO channels in figures 2, 3 and 4). This tendency for oxygen to increase perhaps explains the unusually long time taken to reduce oxygen levels with the oxystat system (in all low oxygen site incubations), and brings into question the integrity of the core top seals under such a steep oxygen gradient (atmosphere on one side, anoxic water on the other). The alternative explanation is that oxygen producing chemoautotrophs are present; however the problem was so widespread that this seems unlikely.

Perturbed Oxygen Consumption (SOP) Experiments

During CD 146, cores with oxygen-contaminated overlying water were observed to consume oxygen only after a period of up to 48 hours, during which core top DO stabilised at a level significantly higher than that of local bottom water. Stabilisation often involved an initial gradual increase in core top oxygen levels, despite the fact that the core in question was a sealed system. This pattern was not observed during *in situ* experiments and was, therefore, thought to be a sampling artefact. Furthermore, such behaviour suggests that any oxygen consumption rate subsequently observed may be altered from that which would be observed *in situ*, (i.e., that in fact the system alters as a result of perturbation and thereafter behaves differently).

the following hypothesis was formulated after reviewing the DO data from CD146. During the 24-48 hour (or longer) stabilisation period, the sediment microbial community is exposed to suddenly increased quantities of oxygen (i.e., DO contamination). The dominant microbial community at the time of sampling will be that best suited to the *in situ* low oxygen levels. However, in sediments underlying an OMZ (the extent and intensity of which varies with season) minority communities of microorganisms, capable of utilising and thriving in higher DO conditions, will be present. We proposed that following the upward perturbation of core top DO, the dominant microbial community is unable to function efficiently and their oxygen consumption is too slow to be observed (or to overcome leakage problems in the incubation system). However, minority groups flourish and reproduce until, after 24-48 hours, they become dominant. When the new, oxygen-tolerant community becomes sufficiently numerous, the signal of their new oxygen demand is observed and, if left long enough, they can reduce the DO levels to near zero.

A perturbed oxygen consumption (SO-perturbed, or SOP) incubation was devised to test this hypothesis. Cores from low oxygen sites were deliberately contaminated with oxygen (passively or actively) before being sealed and incubated in the same manner as standard SO cores. After the stabilisation period was complete (or after 48 hours, whichever was the shorter), the cores were sectioned (resolution: 0.5cm to 1cm depth, 1cm to 4cm depth, then a single 9-10cm section) and preserved in paraformaldehyde and frozen, awaiting fluorescent *in situ* hybridisation (FISH) analysis. This will produce a signature of the dominant microbial community after stabilisation.

For comparison, "fresh" samples (straight from the seafloor) were also sectioned for FISH analyses, as were standard SO cores (which, as described above, had been forced to start at close to in situ DO levels), so that microbial changes during those experiments may also be assessed.

Finally it was intended to carry out extended SOP incubations (SOP+). These would be perturbed, then allowed to stabilise and subsequently consume all available oxygen and stabilise at a new low level. These would also be subjected to FISH analysis to ascertain whether the original low oxygen microbial community would be re-established.

Background samples were taken from all stations and preserved for FISH analysis. Where reasonably successful oxygen consumption experiments were completed, these were also preserved. A limited number of SOP and SOP+ experiments were conducted, as dictated by the availability of oxygen electrodes. These experiments were hampered by the fact that they begin with a sampling artefact that is hard to standardise, and proceed through a poorly understood and little observed pattern. Further processing of oxygen electrode data followed by initial FISH analysis are required to gauge their success.

Matt Schwartz and Clare Woulds

10.42 Nutrient analyses from incubation studies: preliminary observations

Water samples collected from all shipboard and *in situ* lander incubations were analysed for nutrient (ammonium, nitrate, nitrite, phosphate, and silicate) concentrations. Nutrient data must be corrected for changing incubation volume and the introduction of replacement water during shipboard incubation sampling. The results summarised below were not corrected for these factors, but should represent the general nutrient trends observed during these incubations.

The principal conclusions from these preliminary results are encouraging: 1) nutrient trends in shipboard incubations closely follow those in the related shipboard incubations and 2) replicate shipboard incubations (i.e., paired incubations undergoing the same treatment) yield similar nutrient trend results. The relation between lander and shipboard incubation nutrient trends is illustrated by comparing the preliminary results from the A140 EO, SO(7), and SO(8) incubations as well as the A140 EF, SF(9), and SF(10) incubations (below). Preliminary results from paired shipboard incubations [e.g., SO(7) and SO(8) or SF(9) and SF(10)] are also shown below.

The similar nutrient trends from lander and shipboard incubations suggests that experimental artifacts have been minimized in the core sampling and incubation setup for the shipboard incubations. Similar nutrient trends in replicate shipboard incubations [e.g., SF(9) and SF(10)] provides confidence that incubation setup and sampling parameters have been standardized.

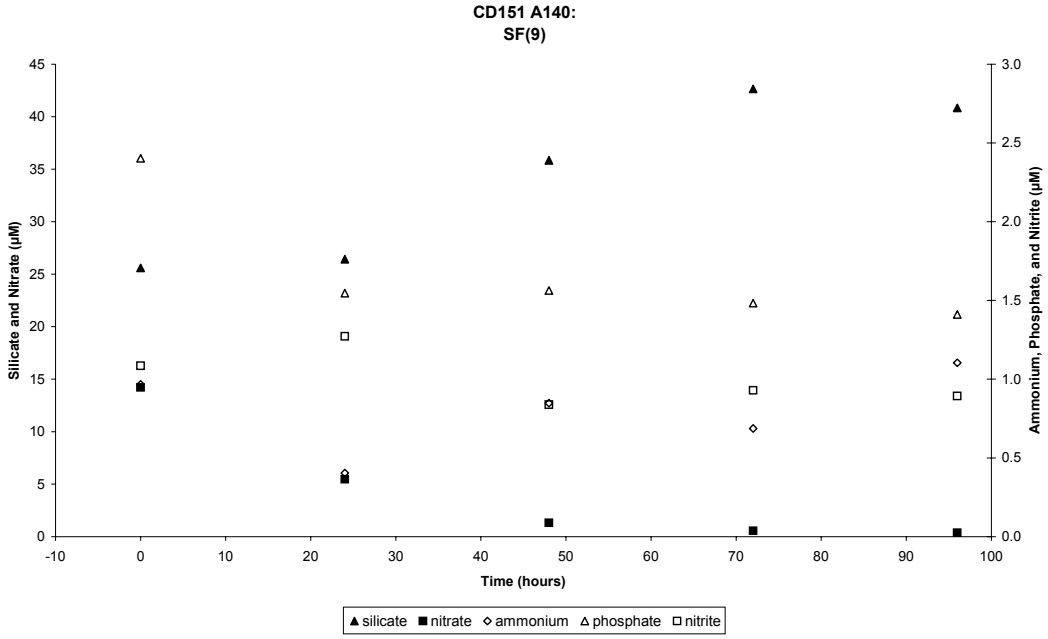
a) A140 Summary

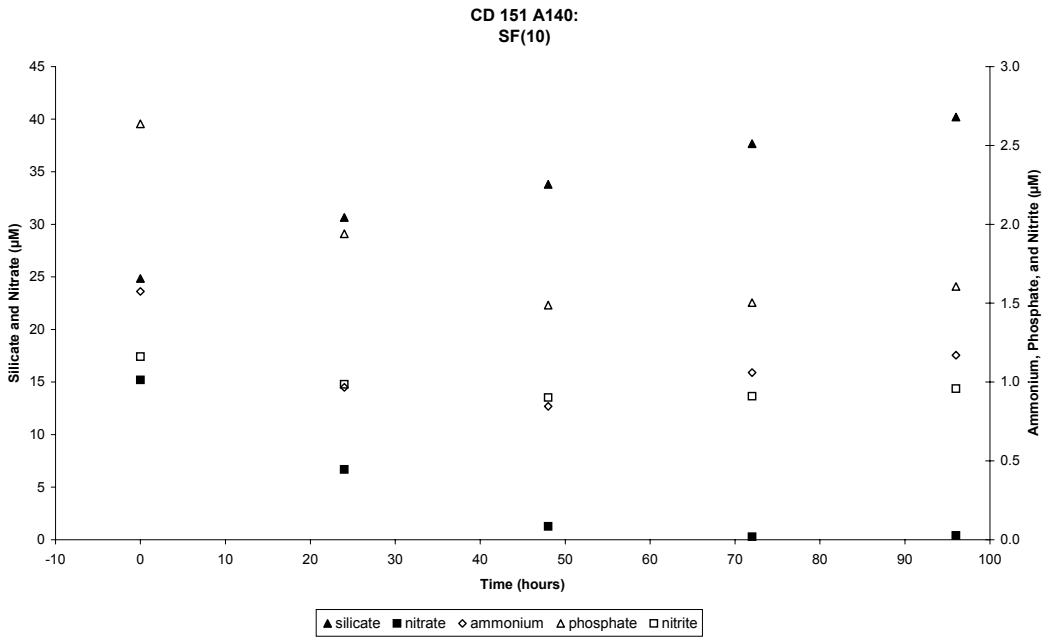
The results from the 140m station are presented to compare shipboard incubations with *in situ* lander incubations for both oxygen consumption (SO and EO) and "oxystatted" (SF and EF) experiments.

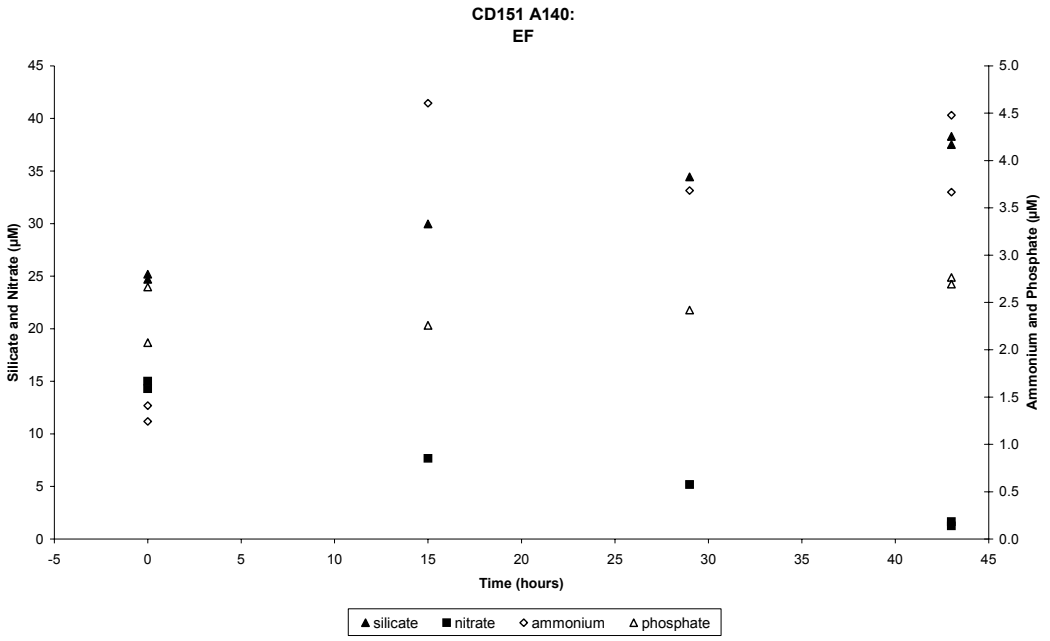
Nitrate concentrations decreased in all incubations at the 140m station. In both shipboard oxygen consumption incubations [SO(7) and SO(8)], nitrate decreased 60-80% during a 24-hour period. A similar decrease occurred in the associated *in situ* lander incubation (EO). Initial nitrate was effectively exhausted during the first 72 hours of the 96-hour long shipboard benthic flux incubations [SF(9) and SF(10)], duplicating the trend observed in the related lander incubation (EF).

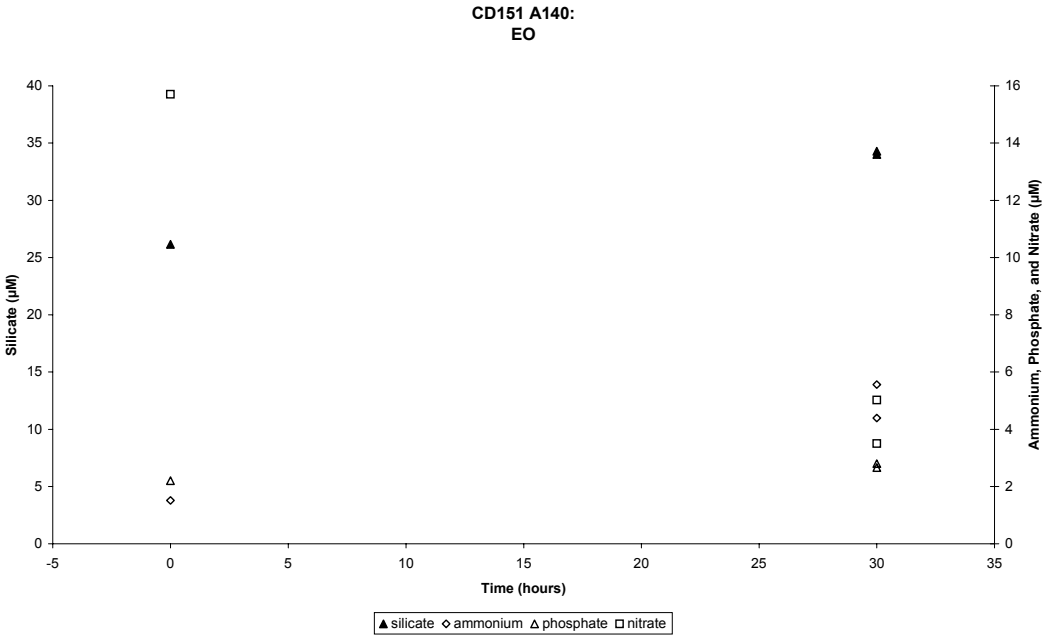
Ammonium was generally low (<2 µM) and relatively constant in all incubations at the 140m station. The lander benthic flux incubation (EF) showed higher concentrations than in other incubations (up to 4.5 µM), but no consistent trend was evident.

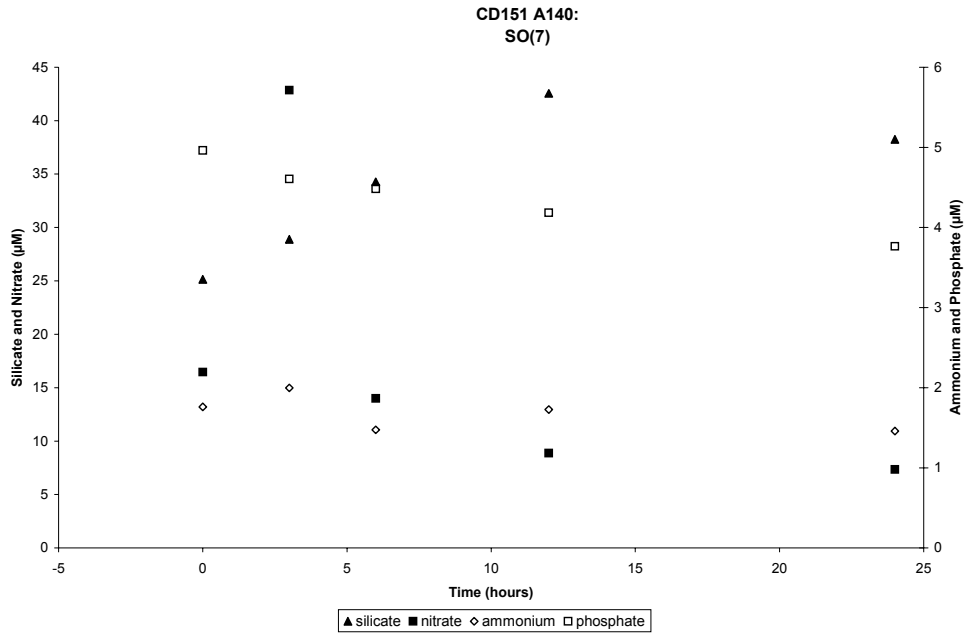
In all experiments at the 140m station, silicate increased during the course of the incubation. For example, silicate concentrations in both shipboard oxygen consumption incubations increased from 25 µM to 40 µM over the 24-hour incubation. This increase is likely from the dissolution of natural and experimental silica in the enclosed incubation chamber (e.g., silicate tests/frustules, sand particles, glass sampling hooks, and replacement water carboy).

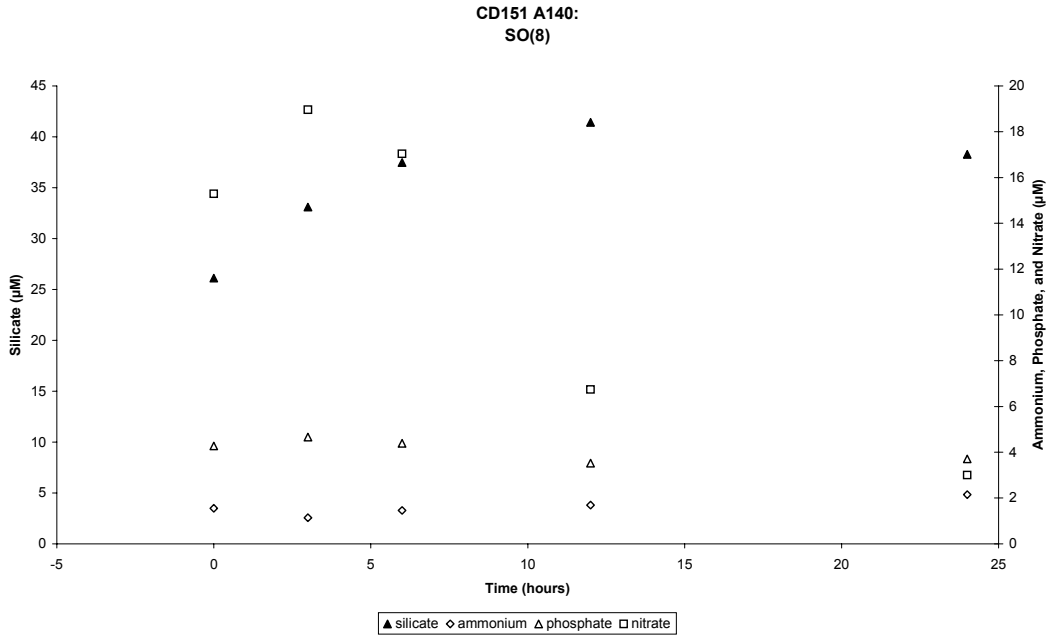





CD151 A140:
EF
Silicate and Nitrate (µM)
Ammonium and Phosphate (µM)
Time (hours)
silicate
nitrate
ammonium
phosphate

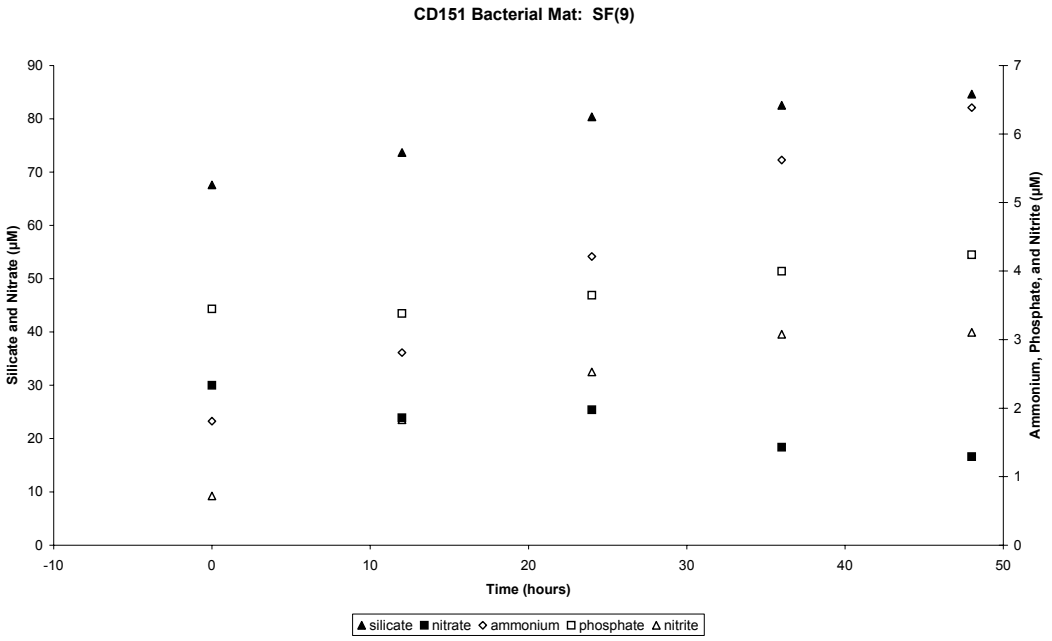

CD151 A140:
EO
Silicate (µM)
Ammonium, Phosphate, and Nitrate (µM)
Time (hours)
silicate
ammonium
phosphate
nitrate

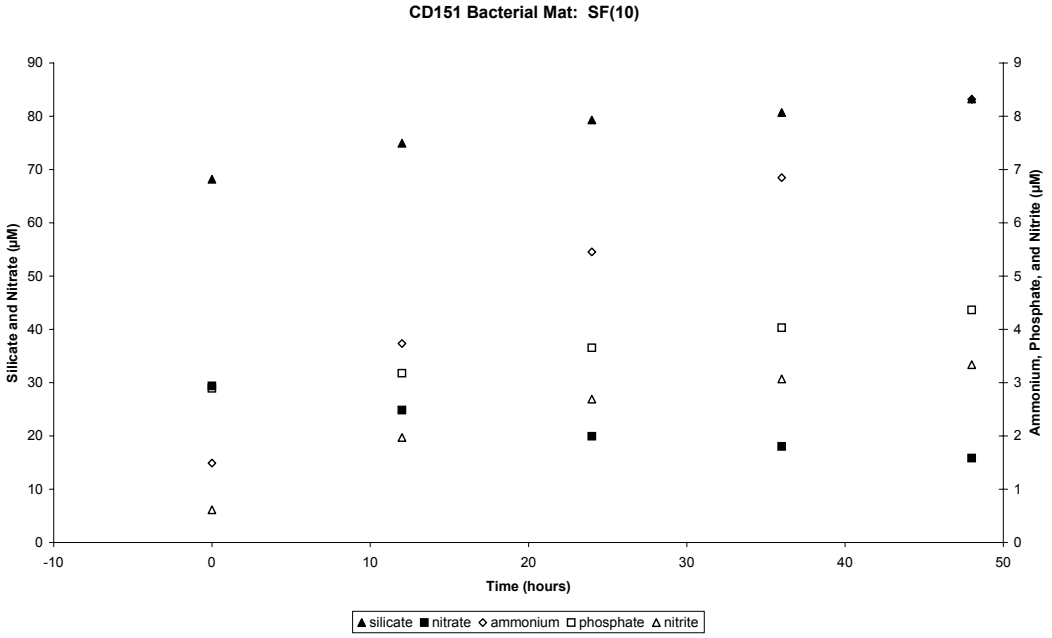

CD151 A140:
SO(7)
Silicate and Nitrate (µM)
Ammonium and Phosphate (µM)
Time (hours)
▲silicate ■nitrate ◇ammonium □phosphate

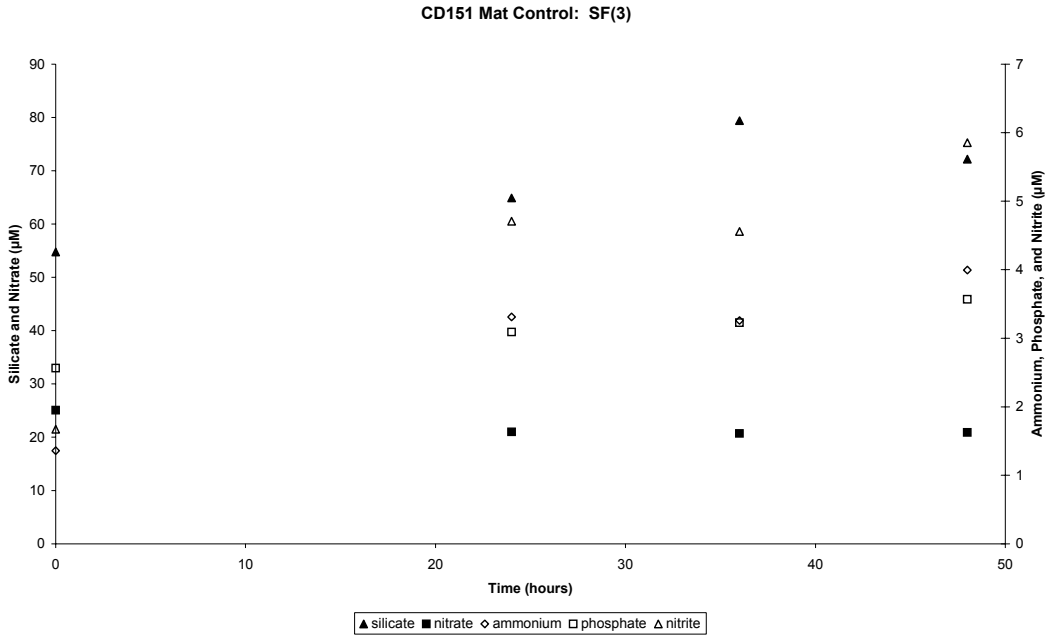

CD151 A140:
SO(8)
Silicate (µM)
Ammonium, Phosphate, and Nitrate (µM)
Time (hours)
▲silicate ◇ammonium △phosphate □nitrate

b) Bacterial Mat and Mat Control Summary

The preliminary trends from the bacterial mat and mat control shipboard incubations (below) suggest interesting nitrogen dynamics at the bacterial mat sites. Ammonium and nitrite concentrations increased by more than 70% and more than 75%, respectively, while nitrate decreased by approximately 50% in the bacterial mat incubations [i.e., SF(9) and SF(10)]. In the mat control incubations [SF(3) and SF(4), below)], the trend in nitrite concentrations is similar to that observed in the bacterial mat incubations, but ammonium levels increase less than in the bacterial mat incubations and nitrate concentrations remain relatively stable. These results indicate that the nitrate consumption rate is greater in the bacterial mat incubations than in the mat control incubations. The similar nitrite profiles in the bacterial mat and mat control incubations suggest that the nitrogen transformation processes (e.g., nitrification, denitrification) are complex and should be more closely evaluated in conjunction with ancillary data collected during CD151 (e.g., N_2/Ar ratios, DOM, and DIC).







Matt Schwartz and Clare Woulds

10.43 Bead incubation studies – preliminary observations

Experiment Summary

Shipboard incubations of cores treated with fluorescent beads were conducted as described in the cruise report for CD 146. Briefly, a mixture of three colours of beads, each colour having a certain mean grainsize, was added to each of a pair of cores, which were then incubated for roughly three days. The aim of this incubation is to investigate size selectivity of particle ingestion and mixing by the macrofaunal community. At the end of the experiment the cores are sectioned, one of each pair being split in half for visual investigation of the macrofauna. A small number of changes were made to the bead incubation protocol. Firstly it was found that the grainsize distributions of the previously used beads were unsatisfactory. Beads were re-sieved in preparation for CD 151. Secondly, bead experiments were allowed to run for as long at each station as the rest of the program permitted, rather than being terminated after exactly three days. It is thought that longer experiments will be more informative. Lastly a split sectioning ring (shown in figure 1) was used to facilitate sectioning two halves of the same core at different intervals (the half used for macrofaunal study is sectioned on a coarser resolution to avoid damage to animals). Sections taken for bead analysis were as follows; 0.5cm sections to 2cm depth, then 1cm sections to 10cm depth. The biological half core was sectioned as follows; 0-0.5cm, 0.5-1cm, 1-2cm, 2-5cm, 5-10cm.

Figure 5. Split sectioning ring.

Fluorescent bead experiments were conducted at two of the main three stations, A140 and A940. Time zero control cores were also processed at these two stations so that the downward movement of beads due to falling down burrows and smearing may be assessed. The A300 site was considered too anoxic and laminated to make the use of bead tracer worthwhile.

Preliminary Observations-Whole Core

In advance of bead counting analyses the results of these incubations may only be assessed by visual observation.

Of the two sites at which bead incubations were carried out downward movement of beads could only be observed at A940. Figure 2 shows the appearance

of an A140 bead core at the end of the experiment. All visible beads are still at the surface despite the presence of a polychaete in a burrow. Comparison with the appearance of a time zero control core from the A940 site (figure 3) further supports the lack of visible bead movement.

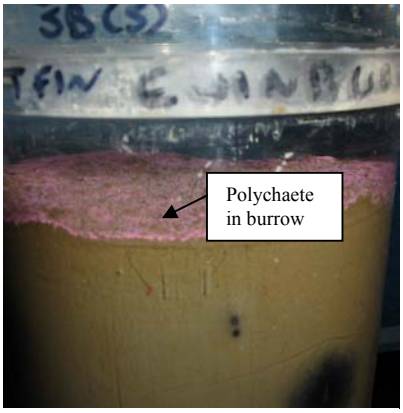


Figure 6. A140 SB(5) T final.

Figure 3. A940 time zero control.

Figure 4. A940 SB(5) T final.

Figure 5. A940 SB(6) Tfinal.

Figures 4 and 5 in contrast show the appearance of an A940 site bead incubation core after a 72 hour experiment. At this station the initial even distribution of tracer across the core top is disrupted as beads are subducted or covered by faecal pellets produced by head-down feeders. Examination of core sides reveals beads inside polychaete burrows, most probably a result of them having fallen down open holes (this feature is also observed in time zero control cores from the same site, figure 3). Figure 4 however shows positive evidence of tracer ingestion and mixing in the form of a faecal pellect composed of beads.

It is hoped that bead counting analysis of sediment samples will supplement these initial observations.

Clare Woulds

Protocols for Processing Macrofauna from Bead Incubation Cores

From one half of one bead incubation core at each station, sediments were obtained to provide information about macrofaunal composition and use of beads. Core sediments were sectioned at 0-0.5, 0.5-1, 1-2, 2-5, 5-10 cm intervals. After sectioning, all sediments were sieved on a 300-micron mesh, and the retained sediments and fauna were put in the refrigerator until they could be sorted for animals. Sorting was done on a dissecting microscope at 12x magnification. Observations were made of bead incorporation into biological structures (e.g., tubes and sheaths) and animal guts. When possible, evidence of animal use or ingestion of beads was photographed (Fig. 1).

BEAD CORE OBSERVATIONS – CD 151

Summary:
There was little evidence of bead ingestion at either station (A140 or A940) though a few beads were found in a thyrasirid (Fig. 1a) and in the fecal pellet of a Ampharetid both at 940 m (Fig. 1b). Beads were found incorporated into tube exteriors (Fig. 1a), tube linings, and mucous sheaths (Fig. 1c) at both stations.

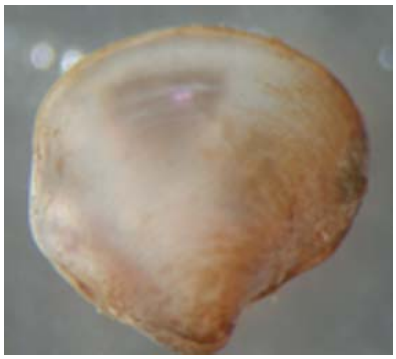
STATION A140 SB5 56101#10, MgC 3
(112h incubation)

0-0.5 cm: Pink, yellow and purple beads were agglutinated to tubes (Fig 1e)
0.5-1 cm: No evidence of bead incorporation into biogenic structures
1-2 cm: Cirratulids present and abundant, Ampharetids (yellow organ) but no evidence of bead incorporation. In fact, fewer beads were observed in the sample as a whole.
2-5 cm: No beads observed
5-10 cm Cursory look but no beads observed

STATION A940 SB5 56116#10, MgC#9
(72 h incubation)

0-0.5 cm: Thyrasirid bivalve with pink bead inside, 1 Thyrasirid without bead, 1 Ampharetid with yellow and pink beads in fecal pellet, 2 Macrochaetae with beads on anterior, (Fig 1a, 1c, 1b) Tubes and worm bits lso have beads incorporated (Fig 1d)1-2 cm: 2 black tentacled cirratulid anteriors, no beads
0.5-1 cm: Edwardsiidae anemone (Fig 1d) with beads coating exterior, tubes (hard and fluffy) with yellow bead attached
1-2 cm: no beads visible. 1 Macrochaetae, 6 Pseudeurythoe
2-5 cm: 2 fecal pellet-like objects with beads, 6 Pseudeurythoe with no evidence of bead uptake or use
5-10 cm: no whole animals

Figure 1

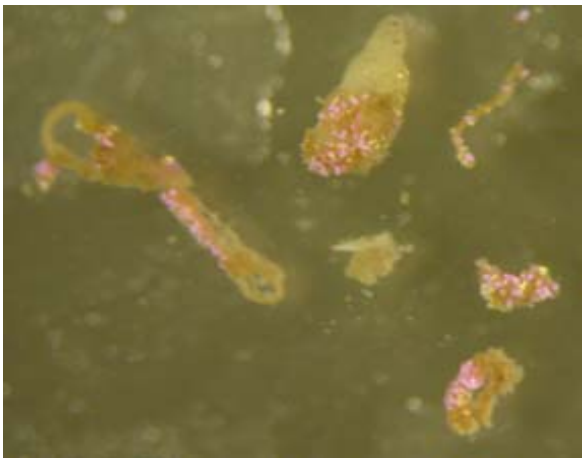


a) 940m Thyrasirid with beads

b. 940 m. Ampharetidae with yellow and pink beads in fecal pellet

c) 940 m. Pink and yellow beads on anterior of macrochaetae

d. 940 m Yellow beads attached Edwardsiidae anemone



e) 140m Incorporation of beads into tubes etc

Christine Whitcraft

10.44 Use of ^{13}C-labeled algae in incubations

The following table summarises the use of ^{13}C algae in all shipboard and *in situ* incubations during CD151. All algae were combined with kaolinite powder to form a slurry that was approximately 1/3 kaolinite/algae (v/v), wetted with milli-Q, frozen, and then freeze-dried prior to re-suspension and application to the pertinent incubation.

CD151 ^{13}C Algae Use Summary

Source	Aliquot ID	mass (mg)	% carbon	carbon mass (mg)	Incubation		
					Station	ID	Dates
Dave Pond (BAS)	34	50.4	14	7.06	A140	SF13-2(2)	20-22/09/2003
Dave Pond (BAS)	33	50.2	14	7.03	A140	SF13-2(1)	20-22/09/2003
Dave Pond (BAS)	32	49.1	14	6.87	A140	SF13-5(4)	20-25/09/2003
Dave Pond (BAS)	31	49.7	14	6.96	A140	SF13-5(3)	20-25/09/2003
Dave Pond (BAS)	30-24	349.1	14	48.87	A140	EF13	25-27/09/2003
Dave Pond (BAS)	23	50.9	14	7.13	A300	SF13-5(3)	27/09-04/10/2003
Dave Pond (BAS)	22	50.4	14	7.06	A300	SF23-5(4)	27/09-04/10/2003
Dave Pond (BAS)	21	49.4	14	6.92	A300	SF13-2(1)	27-30/09/2003
Dave Pond (BAS)	20	49.3	14	6.90	A140	T0	24/09/2003
Dave Pond (BAS)	19	50.2	14	7.03	***A300?***	***T0?***	***3/10/2003?***
Dave Pond (BAS)	18	50.7	14	7.10	A300	SF13-2(2)	27-30/09/2003
Dave Pond (BAS)	17	49.6	14	6.94		geochemistry	post-cruise
Dave Pond (BAS)	16-10	349.3	14	48.90	A300	EF13	30/09-2/10/2003
Dave Pond (BAS)	9	50.2	14	7.03		geochemistry	post-cruise
Dave Pond (BAS)	8	50.1	14	7.01	***A940?***	***T0?***	***14/10/2003?***
Dave Pond (BAS)	7-3	252.8	14	35.39	A940	EF13	13-15/10/2003
Dave Pond (BAS)	2	50.9	14	7.13	A940	SF13-5(4)	05-10/10/2003
Dave Pond (BAS)	1	50.5	14	7.07	A940	SF13-5(3)	05-10/10/2003
NIOO	FT1-5	250.2	26.3767	65.99	A940b	EF13	13-15/10/2003
NIOO	FT6	49.5	26.3767	13.06		geochemistry	post-cruise
NIOO	FT100_1	49.7	27.8867	13.86	A1850	SF13-5	13-17/10/2003
NIOO	FT100_2	49.7	27.8867	13.86	A1850	SF13-5	13-17/10/2003
NIOO	FT100_3	50.2	27.8867	14.00		geochemistry	post-cruise

Matt Schwartz and Clare Woulds

10.45 Fate of shipboard incubation water amples

Note, all times are in ship time, which is GMT plus 4.

Station	Depth	Inc. Type	Barrel #	Timepoint (h) Intended	Timepoint (h) Actual	Sampling Date and Time	Analyte DIC	DIC-13	Nut	DOC	TM	N2/Ar	pH	total vol. (ml)	Notes
56101	140	SO	7	T0	0.0	9/20/03 23:45	211	476, 483	SI 8	n	n	101	n	81	
56101	140	SO	7	T3	7.4	9/21/03 7:10	213	747, 762	SI 10	n	n	103	n	79	
56101	140	SO	7	T6	14.7	9/21/03 14:30	220	749, 776	SI 16	n	n	106	8.05	76.2	pH @ 1520h
56101	140	SO	7	T12	31.4	9/22/03 7:10	224	468, 484	SI 22	n	n	107	7.65	83.3	used 13C HgCl2 pipettor MCS
56101	140	SO	7	T24	35.6	9/22/03 11:20	232	460, 734	SI 27	n	n	109	7.64	81.2	inject 1ml 10M KBr @1130h, collect 20ml KBr sample @ 1355h.
56101	140	SO	8	T0	0.0	9/20/03 23:55	210	457, 477	SI 7	n	n	102	n	76.3	
56101	140	SO	8	T3	7.5	9/21/03 7:25	215	752, 760	SI 11	n	n	104	n	75.4	
56101	140	SO	8	T6	14.8	9/21/03 14:45	225	753, 754	SI 17	n	n	105	8.05	77.3	pH @1520h
56101	140	SO	8	T12	31.6	9/22/03 7:30	227	495, 761	SI 23	n	n	108	7.62	82.3	used 13C HgCl2 pipettor MCS
56101	140	SO	8	T24	35.8	9/22/03 11:45	233	485, 756	SI 28	n	n	110	n	82.6	inject 1ml 10M KBr @1150h, collect 20ml KBr sample @ 1350h.
56101	140	SF	9	T0	0.0	9/21/03 11:00	216	456	SI 12	y	n	n	7.84	98	DIC-13 gets 100 ul HgCl2
56101	140	SF	9	NA	3.0	9/21/03 13:58	n	n	n	n	y	n	n	24	pH only
56101	140	SF	9	T24	28.4	9/22/03 15:25	234	489	SI 29	y	y	n	7.94	95	DIC and DIC-13 get 125 ul HgCl2; nutrients not filtered
56101	140	SF	9	T48	51.1	9/23/03 14:05	238	441	SI 35	y	y	n	8.16	98	DIC and DIC-13 get 100 ul HgCl2

Note, all times are in ship time, which is GMT plus 4.

Station	Depth	Inc. Type	Barrel #	Timepoint (h) Intended	Timepoint (h) Actual	Sampling Date and Time	Analyte DIC	DIC-13	Nut	DOC	TM	N2/Ar	pH	total vol. (ml)	Notes
56101	140	SF	9	T72	77.6	9/24/03 16:35	244	732	SI 39	y	y	n	8.23	96	DIC and DIC-13 get 100 ul HgCl2
56101	140	SF	9	T96	96.1	9/25/03 11:05	248	498	SI 43	y	y	n	8.24	98	inject 10 mL 1 M KBr at 1120h; collect 20 mL KBr sample at 1330h
56101	140	SF	10	T0	0.0	9/21/03 11:20	107	480	SI 13	y	n	n	7.82	99	DIC-13 gets 100 ul HgCl2
56101	140	SF	10	NA	2.7	9/21/03 14:00	n	n	n	n	y	n	n	24	pH only
56101	140	SF	10	T24	28.6	9/22/03 15:55	230	444	SI 30	y	y	n	7.99	95	DIC and DIC-13 get 125 ul HgCl2; nutrients not filtered
56101	140	SF	10	T48	50.9	9/23/03 14:15	239	490	SI 36	y	y	n	8.22	96	DIC and DIC-13 get 100 ul HgCl2
56101	140	SF	10	T72	77.7	9/24/03 17:00	245	481	SI 40	y	y	n	8.22	96	DIC and DIC-13 get 100 ul HgCl2
56101	140	SF	10	T96	96.2	9/25/03 11:30	249	742	SI 44	y	y	n	8.29	98	inject 10 mL 1 M KBr at 1140h; collect 20 mL KBr sample at 1330h
56101	140	SF13-5	3	T0	0.0	9/20/03 11:21	204	795	SI 1	y	n	n	n	77	
56101	140	SF13-5	3	T24	27.7	9/21/03 15:00	221	454	SI 18	y	n	n	n	69	
56101	140	SF13-5	3	T48	53.7	9/22/03 17:05	235	492	SI 31	y	n	n	n	71	
56101	140	SF13-5	3	T72	72.5	9/23/03 11:50	273	790	SI 33	y	n	n	n	68	
56101	140	SF13-5	3	T96	99.1	9/24/03 14:30	242	475	SI 37	y	n	n	n	72	
56101	140	SF13-5	3	T120	115.9	9/25/03 7:15	247	471	SI 42	y	n	n	n	70	inject 10 mL 1 M KBr at 0720h
56101	140	SF13-5	4	T0	0.0	9/20/03	205	796	SI 2	y	n	n	n	68	

Note, all times are in ship time, which is GMT plus 4.

Station	Depth	Inc. Type	Barrel #	Timepoint (h) Intended	Timepoint (h) Actual	Sampling Date and Time	Analyte DIC	DIC-13	Nut	DOC	TM	N2/Ar	pH	total vol. (ml)	Notes
						11:37									
56101	140	SF13-5	4	T24	27.6	9/21/03 15:15	222	755	SI 19	y	n	n	n	64	
56101	140	SF13-5	4	T48	53.6	9/22/03 17:15	236	464	SI 32	y	n	n	n	68	
56101	140	SF13-5	4	T72	72.3	9/23/03 11:55	241	727	SI 34	y	n	n	n	68	
56101	140	SF13-5	4	T96	99.0	9/24/03 14:40	243	743	SI 38	y	n	n	n	69	
56101	140	SF13-5	4	T120	115.8	9/25/03 7:25	246	478	SI 41	y	n	n	n	74	inject 10 mL 1 M KBr at 0750h
56101	140	SF13-2	1	T0	0.0	9/20/03 12:59	206	763	SI 3	y	n	n	n	66	add 20 ul HgCl2 to DIC-13; add 100 ul HgCl2 to DIC
56101	140	SF13-2	2	T12	10.3	9/20/03 23:15	208	469	SI 5	y	n	n	n	72	
56101	140	SF13-2	3	T24	25.1	9/21/03 14:05	218	453	SI 14	y	n	n	n	67	
56101	140	SF13-2	4	T36	32.0	9/21/03 21:00	223	726	SI 20	y	n	n	n	63	
56101	140	SF13-2	5	T48	44.0	9/22/03 9:00	229	766	SI 25	y	n	n	n	69	inject 10 mL 1M KBr at 0915h; 20 mL KBr collected at 0950h
56101	140	SF13-2	1	T0	0.0	9/20/03 12:47	207	461	SI 4	y	n	n	n	71	
56101	140	SF13-2	2	T12	10.6	9/20/03 23:25	209	487	SI 6	y	n	n	n	70	
56101	140	SF13-2	3	T24	25.5	9/21/03 14:15	219	741	SI 15	y	n	n	n	63	
56101	140	SF13-2	4	T36	32.4	9/21/03 21:10	226	745	SI 21	y	n	n	n	67?	
56101	140	SF13-2	5	T48	44.4	9/22/03	231	482	SI 26	y	n	n	n	74	inject 10 mL 1M KBr at

Note, all times are in ship time, which is GMT plus 4.

Station	Depth	Inc. Type	Barrel #	Timepoint (h) Intended	Timepoint (h) Actual	Sampling Date and Time	Analyte DIC	DIC-13	Nut	DOC	TM	N2/Ar	pH	total vol. (ml)	Notes
						9:10									0915h; 20 mL KBr sample collected at 0950h
NA	140	Replacement		A		9/20/03 23:25	212	499	SI 9	A	y?	n	n		
NA	140	Oxystat				9/21/03 0:08	214	459	n	n	n	n	n		
NA	140	Replacement		B		9/22/03 7:00	228	758	SI 24	B	y?	n	n		
NA	140	Oxystat				9/23/03	240	470	n	n	n	n	n	n	
NA	140	Replacement		C		9/26/03 15:50	250	497	SI 45	C	y?	n	n		
56102	300	SF13-5	3	T0	165.7	9/27/03 21:25	253	777	SI47	y	n	n	n	70	
56102	300	SF13-5	3	T24	199.8	9/29/03 7:35	270	739	SI 58	y	n	n	n	78	
56102	300	SF13-5	3	T48	226.2	9/30/03 10:00	273	902	SI 69	y	n	n	n	66	
56102	300	SF13-5	3	T72	256.4	10/1/03 16:10	282	913	SI 76	y	n	n	n	73	
56102	300	SF13-5	3	T96	284.6	10/2/03 20:24	289	919	SI 83	y	n	n	n	68	
56102	300	SF13-5	3	T120	320.6	10/4/03 8:20	296	980	SI 89	y	n	n	n	65	10ml 1M KBr injected 0820, sampled 0915
56102	300	SF13-5	4	T0	158.2	9/27/03 21:35	254	473	SI 46	y	n	n	n	85	
56102	300	SF13-5	4	T24	192.3	9/29/03 7:45	269	496	SI 59	y	n	n	n	62	65ml removed (+replaced) by mistake 92/09/03, 1120h
56102	300	SF13-5	4	T48	218.7	9/30/03 10:10	275	903	SI 70	y	n	n	n	66	
56102	300	SF13-5	4	T72	248.7	10/1/03 16:10	283	914	SI 77	y	n	n	n	74	

Note, all times are in ship time, which is GMT plus 4.

Station	Depth	Inc. Type	Barrel #	Timepoint (h) Intended	Timepoint (h) Actual	Sampling Date and Time	Analyte DIC	DIC-13	Nut	DOC	TM	N2/Ar	pH	total vol. (ml)	Notes
56102	300	SF13-5	4	T96	277.8	10/2/03 21:15	288	929	SI 84	y	n	n	n	74	
56102	300	SF13-5	4	T120	313.1	10/4/03 8:30	297	960	SI 90	y	n	n	n	66	10ml 1M KBr injected 0830, sampled 0915
56105	300	SF	9	T0	148.6	9/28/03 20:00	257	442	SI 52	y	y	n	8.06	87	
56105	300	SF	9	T24	171.8	9/29/03 19:15	263	474	SI 65	y	y	n	8.08	93	
56105	300	SF	9	T48	195.8	9/30/03 19:10	278	999	SI 72	y	y	n	8.1	95	
56105	300	SF	9	T72	221.9	10/1/03 21:20	291	916	SI 78	y	y	n	8.32	98	
56105	300	SF	9	T96	261.4	10/3/03 12:50	293	938	SI 87	y	y	n	8.08	96	10ml 1M KBr injected @1250. 20ml KBr sample collected 1415.
56105	300	SF	10	T0	174.2	9/28/03 20:15	258	500	SI 53	y	y	n	8.06	92	
56105	300	SF	10	T24	197.5	9/29/03 19:30	262	901	SI 66	y	y	n	8.15	94	
56105	300	SF	10	T48	221.5	9/30/03 19:30	278	990	SI 73	y	y	n	8.08	94	
56105	300	SF	10	T72	247.5	10/1/03 21:30	290	917	SI 79	y	y	n	8.41	100	
56105	300	SF	10	T96	287.3	10/3/03 13:15	294	939	SI 88	y	y	n	8.16	98	10ml 1M KBr injected @1315. 20ml KBr sample collected 1415.
56112	300	SO (V2)	8	T0	290.5	10/2/03 13:50	286	930	SI 81	n	n	y	8.05	64.2	
56112	300	SO (V2)	8	T3	296.2	10/2/03 19:30	287	922	SI 82	n	n	y	8	67.2	
56112	300	SO (V2)	8	T6	310.1	10/3/03	292	989	SI 85	n	n	y	7.84	65.4	

Note, all times are in ship time, which is GMT plus 4.

Station	Depth	Inc. Type	Barrel #	Timepoint (h) Intended	Timepoint (h) Actual	Sampling Date and Time	Analyte DIC	DIC-13	Nut	DOC	TM	N2/Ar	pH	total vol. (ml)	Notes
						9:25									
56112	300	SO (V2)	8	T12	314.2	10/3/03 13:30	295	949	SI 86	n	n	y	7.89	67.2	10ml 1M KBr injected 1330. 20ml KBr sample taken 1415
56105	300	SF13-2	1	T0	79.5	9/27/03 22:00	251	451	SI 48	y	n	n	n	72	
56105	300	SF13-2	1	T12	92.1	9/28/03 10:35	255	462	SI 50	y	n	n	n	74	
56105	300	SF13-2	1	T24	100.5	9/28/03 19:00	271	463	SI 54	y	n	n	n	63	
56105	300	SF13-2	1	T36	116.8	9/29/03 11:15	267	767	SI 60	y	n	n	n	64	
56105	300	SF13-2	1	T48	137.8	9/30/03 8:15	272	920	SI 67	y	n	n	n	67	8ml KBr injected 0820, collected 20ml KBr sample 0845, note, stirrer off poss for whole incubation and KBr
56105	300	SF13-2	2	T0	106.2	9/27/03 22:05	252	788	SI 49	y	n	n	n	66	
56105	300	SF13-2	2	T12	118.8	9/28/03 10:45	256	491	SI 51	y	n	n	n	69	
56105	300	SF13-2	2	T24	127.2	9/28/03 19:10	261	486	SI 55	y	n	n	n	66	
56105	300	SF13-2	2	T36	143.6	9/29/03 11:30	268	769	SI 61	y	n	n	n	65	
56105	300	SF13-2	2	T48	164.5	9/30/03 8:25	274	910	SI 68	y	n	n	n	69	10ml KBr injected 0825, collected 20ml KBr sample 0905
56105	300	SO	7	T0	174.4	9/28/03 20:30	259	488, 494	SI 56	n	n	y	n	77.3	100 ul HgCl2 for DIC & DIC13, 50ul for N2/Ar
56105	300	SO	7	T3	192.7	9/29/03 14:45	265	455, 457	SI 63	n	n	y	n	83.4	
56105	300	SO	7	T6	216.2	9/30/03	276	905, 906	SI 71	n	n	y	7.85	87.2	

Note, all times are in ship time, which is GMT plus 4.

Station	Depth	Inc. Type	Barrel #	Timepoint (h) Intended	Timepoint (h) Actual	Sampling Date and Time	Analyte DIC	DIC-13	Nut	DOC	TM	N2/Ar	pH	total vol. (ml)	Notes
						14:20									
56105	300	SO	7	T12	240.2	10/1/03 14:15	280	904, 909	SI 74	n	n	y	7.71	76.6	Injected 10ml 1M KBr 1415. Did not push down core top after final sample (replaced). Collect KBr and winkler sample 1515.
56105	300	SO	8	T0	189.3	9/28/03 20:45	260	472, 443	SI 57	n	n	y	n	83.6	
56105	300	SO	8	T3	207.6	9/29/03 15:00	264	493, 452	SI 64	n	n	y	n	80.4	
56105	300	SO	8	T6	231.2	9/30/03 14:35	277	907, 908	SI 72	n	n	y	7.94	114.6	
56105	300	SO	8	T12	255.1	10/1/03 14:30	281	912, 911	SI 75	n	n	y	7.82	78.6	Injected 10ml 1M KBr 1430. Did not push down core top after final sample (replaced). Collect KBr sample 1515.
NA	A300	Replacement		A		9/29/03 19:30		266	458	SI 62	A	y?	n	8.24	
NA	A300	Replacement		B		10/1/03 17:00		285	915	SI 80	B	y?	n	8.3	
NA	A300	Oxystat				10/1/03 17:00	284	918	n	n	n	n	n		
NA	A300	Oxystat				10/4/03 8:45	298	940	n	n	n	n	n		
NA	A300	Replacement				10/4/03 8:45		299	959	n	C	y?	n	8.57	
56134	mat control	SF	3	T0	0.0	10/11/03 13:45	331	941	SI 121	y	y	n	7.87	94	
56134	mat control	SF	3	T24	23.7	10/12/03 13:25	336	928	SI 130	y	y	n	8.26	99	
56134	mat control	SF	3	T36	30.4	10/12/03 20:10	346	964	SI 136	y	y	n	8.44	105	

Note, all times are in ship time, which is GMT plus 4.

Station	Depth	Inc. Type	Barrel #	Timepoint (h) Intended	Timepoint (h) Actual	Sampling Date and Time	Analyte DIC	DIC-13	Nut	DOC	TM	N2/Ar	pH	total vol. (ml)	Notes
56134	mat control	SF	3	T48	43.4	10/13/03 9:10	351	923	SI 140	y	y	n	8.43	96	
56134	mat control	SF	4	T0	0.0	10/11/03 13:55	332	942	SI 122	y	y	n	7.89	104	
56134	mat control	SF	4	T24	23.7	10/12/03 13:35	337	953	SI 131	y	y	n	8.26	98	
56134	mat control	SF	4	T36	30.8	10/12/03 20:40	347	965	SI 137	y	y	n	8.32	97	
56134	mat control	SF	4	T48	43.8	10/13/03 9:40	352	934	SI 141	y	y	n	8.55	97	becomes mat control SO(2) at 13 October 03 1420h
56134	mat control	SO	2	T0	0.0	10/13/03 20:00	n	n	SI 153	n	n	y	n	14.3	formerly mat control SF(4): 56134 #1 core 9
56134	mat control	SO	2	T12	12.8	10/14/03 8:50	n	n	SI 156	n	n	y	8.27	18.6	formerly mat control SF(4): 56134 #1 core 10
56134	mat control	SO	2	T24	23.2	10/14/03 19:10	n	n	SI 164	n	n	y	8.26	19.6	formerly mat control SF(4): 56134 #1 core 11
56134	mat control	SO	2	T36	41.4	10/15/03 13:25	n	n	SI 168	n	n	y	8.35	21.5	formerly mat control SF(4): 56134 #1 core 12
NA	940	replacement reservoir	A	A		10/5/03 19:40	306	926	SI 97	y	n	n	8.12		
NA	940	replacement reservoir	B	B		10/11/03 13:45	333	969	SI 123	y	y	n	8.66		
NA	940	oxystat reservoir				10/12/03 20:50	348	921	n	n	n	n	n		
NA	940	12C syringe 01 blank				10/13/03 9:30	n	n	SI 142	n	n	n	n		sampled 13 October 03
NA	940	12C syringe 02 blank				10/14/03 9:30	n	n	SI 143	n	n	n	n		sampled 12 October 03
NA	940	replacement syringe blank				10/15/03 9:30	n	n	SI 144	n	n	n	n		sampled 12
NA	940	13C syringe 01 blank				10/16/03	n	n	SI 145	n	n	n	n		sampled 12 October 03

Note, all times are in ship time, which is GMT plus 4.

Station	Depth	Inc. Type	Barrel #	Timepoint (h) Intended	Timepoint (h) Actual	Sampling Date and Time	Analyte DIC	DIC-13	Nut	DOC	TM	N2/Ar	pH	total vol. (ml)	Notes
								9:30							
NA	940	13C syringe 02 blank						10/17/03 9:30	n		n	SI 146	n	n	n n sampled 12 October 03
56116	940	SF13-5	3	T0	0.0	10/5/03 13:55	300	997	SI 91	y	n	n	n	60	
56116	940	SF13-5	3	T24	24.3	10/6/03 14:15	307	978	SI 98	y	n	n	n	65	
56116	940	SF13-5	3	T48	47.7	10/7/03 13:35	311	986	SI 102	y	n	n	n	67	
56116	940	SF13-5	3	T96	72.1	10/8/03 14:00	315	935	SI 106	y	n	n	n	68	
56116	940	SF13-5	3	T120	113.3	10/10/03 7:10	325	945	SI 115	y	n	n	n	65	KBr injected at 0715h (10 ml 1 M); KBr sampled at 0800h
56116	940	SF13-5	4	T0	0.0	10/5/03 14:05	301	988	SI 92	y	n	n	n	65	
56116	940	SF13-5	4	T24	24.4	10/6/03 14:30	308	979	SI 99	y	n	n	n	61	
56116	940	SF13-5	4	T48	47.8	10/7/03 13:50	312	998	SI 103	y	n	n	n	70	
56116	940	SF13-5	4	T96	74.4	10/8/03 16:30	316	925	SI 107	y	n	n	n	70	
56116	940	SF13-5	4	T120	113.3	10/10/03 7:20	326	982	SI 116	y	n	n	n	67	KBr injected at 0725h (10 ml 1 M); KBr sampled at 0800h
56124	850	SF	1	T0	0.0	10/8/03 17:20	318	975	SI 108	y	n	n	7.93	65	
56124	850	SF	1	T24	24.3	10/9/03 17:35	323	973	SI 114	y	n	n	8.30	86	
56124	850	SF	1	T48	46.8	10/10/03 16:05	327	993	SI 117	y	n	n	8.39	68	
56124	850	SF	1	T72	72.1	10/11/03 17:25	339	984	SI 127	y	n	n	8.43	66	

Note, all times are in ship time, which is GMT plus 4.

Station	Depth	Inc. Type	Barrel #	Timepoint (h) Intended	Timepoint (h) Actual	Sampling Date and Time	Analyte DIC	DIC-13	Nut	DOC	TM	N2/Ar	pH	total vol. (ml)	Notes
56124	850	SF	1	T96	98.4	10/12/03 19:41	344	937	SI 134	y	n	n	8.43	70	10 mL 1 M KBr at 1940h
56124	850	SF	2	T0	0.0	10/8/03 17:30	317	985	SI 109	y	n	n	7.97	67	
56124	850	SF	2	T24	24.3	10/9/03 17:45	324	983	SI 115	y	n	n	8.28	69	
56124	850	SF	2	T48	46.8	10/10/03 16:15	228	994	SI 118	y	n	n	8.44	68	
56124	850	SF	2	T72	71.8	10/11/03 17:15	338	985	SI 126	y	n	n	8.42	73	
56124	850	SF	2	T96	98.3	10/12/03 19:50	345	947	SI 135	y	n	n	8.43	68	inject 10 mL 1M KBr at 1950h
56116	940	SO	7	T0	0.0	10/5/03 17:00	302	958	SI 93	n	n	y?	7.22	67.6	incubation terminated due to lack of oxygen consumption
56116	940	SO	8	T0	0.0	10/5/03 17:10	303	970	SI 94	n	n	y?	7.19	67.6	incubation terminated due to lack of oxygen consumption
56116	940	SF	9	T0	0.0	10/5/03 19:25	304	927	SI 95	y	y	n	7.92	101	
56116	940	SF	10	T24	24.8	10/6/03 20:15	310	948	SI 100	y	y	n	8.10	88	
56116	940	SF	10	T48	48.9	10/7/03 20:20	313	977	SI 104	y	y	n	8.27	95	
56116	940	SF	10	T72	72.0	10/8/03 19:25	319	967	SI 110	y	y	n	8.38	92	
56116	940	SF	10	T96	91.2	10/9/03 14:40	321	966	SI 112	y	y	n	8.37	91	inject 10 mL 1 M KBr at 1440h
56116	940	SF	10	T0	0.0	10/5/03 19:35	305	936	SI 96	y	y	n	7.95	86	
56116	940	SF	10	T24	24.8	10/6/03 20:25	309	950	SI 101	y	y	n	8.12	89	
56116	940	SF	10	T48	49.0	10/7/03	314	996	SI 105	y	y	n	8.35	94	

Note, all times are in ship time, which is GMT plus 4.

Station	Depth	Inc. Type	Barrel #	Timepoint (h) Intended	Timepoint (h) Actual	Sampling Date and Time	Analyte DIC	DIC-13	Nut	DOC	TM	N2/Ar	pH	total vol. (ml)	Notes
						20:35									
56116	940	SF	10	T72	72.1	10/8/03 19:40	320	976	SI 111	y	y	n	8.43	95	
56116	940	SF	10	T96	91.3	10/9/03 14:50	322	965	SI 113	y	y	n	8.39	102	
56133	bacterial mat	SF	9	T0	0.0	10/11/03 3:05	329	992	SI 119	y	n	n	7.98	71	no trace metal sample
56133	bacterial mat	SF	9	T12	13.3	10/11/03 16:20	334	987	SI 124	y	y	n	8.01	95	
56133	bacterial mat	SF	9	T24	27.6	10/12/03 6:40	340	951	SI 128	y	y	n	8.25	93	
56133	bacterial mat	SF	9	T36	38.8	10/12/03 17:50	342	957	SI 132	y	y	n	8.32	92	
56133	bacterial mat	SF	9	T48	46.3	10/13/03 1:25	349	924	SI 138	y	y	n	8.39	97	
56133	bacterial mat	SF	10	T0	0.0	10/11/03 3:15	330	952	SI 120	y	n	n	8.00	66	
56133	bacterial mat	SF	10	T12	13.3	10/11/03 16:35	335	968	SI 125	y	y	n	8.18	96	no trace metal sample
56133	bacterial mat	SF	10	T24	27.6	10/12/03 6:50	341	991	SI 129	y	y	n	8.28	97	
56133	bacterial mat	SF	10	T36	38.2	10/12/03 17:26	343	954	SI 133	y	y	n	8.32	94	
56133	bacterial mat	SF	10	T48	46.6	10/13/03 1:50	350	962	SI 139	y	y	n	8.45	94	becomes bacterial mat SO(1) at 13 October 03 1420h
56133	bacterial mat	SO	1	T0	0.0	10/13/03 19:45	n	n	SI 154	n	n	y	n	17	formerly bacterial mat SF(10): 56133 #2 core 8
56133	bacterial mat	SO	1	T12	13.1	10/14/03 8:50	n	n	SI 155	n	n	y	8.28	18	formerly bacterial mat SF(10): 56133 #2 core 8
56133	bacteri	SO	1	T24	23.4	10/14/03	n	n	SI 163	n	n	y	8.25	20	formerly bacterial mat

Note, all times are in ship time, which is GMT plus 4.

Station	Depth	Inc. Type	Barrel #	Timepoint (h) Intended	Timepoint (h) Actual	Sampling Date and Time	Analyte DIC	DIC-13	Nut	DOC	TM	N2/Ar	pH	total vol. (ml)	Notes
	al mat					19:10									SF(10): 56133 #2 core 8
56133	bacterial mat	SO	1	T36	41.7	10/15/03 13:25	n	n	SI 167	n	n	y	8.38	20.2	formerly bacterial mat SF(10): 56133 #2 core 8
56136	1850	SF	9	T0	0.0	10/13/03 20:25	355	956	SI 149	y	y	n	n	99	
56136	1850	SF	9	T24	21.2	10/14/03 17:40	363	933	SI 161	y	y	n	8.06	94	
56136	1850	SF	9	T48	47.1	10/15/03 19:30	372	804	SI 174	y	y	n	8.28	100	
56136	1850	SF	9	T72	72.0	10/16/03 20:25	382	815	SI 184	y	y	n	n	91	
56136	1850	SF	9	T96	89.4	10/17/03 13:50	390	824	SI 192	y	y	n	8.34	92	inject 10 mL 1M KBr at 1400h
56136	1850	SF	10	T0	0.0	10/13/03 20:30	356	961	SI 150	y	y	n	n	93	
56136	1850	SF	10	T24	21.3	10/14/03 17:50	364	944	SI 162	y	y	n	8.11	96	
56136	1850	SF	10	T48	47.2	10/15/03 19:40	373	805	SI 175	y	y	n	8.33	94	
56136	1850	SF	10	T72	72.1	10/16/03 20:35	383	816	SI 185	y	y	n	n	96	
56136	1850	SF	10	T96	89.7	10/17/03 14:10	391	832	SI 191	y	y	n	8.37	97	inject 10 mL 1M KBr at 1410h
NA	1850	replacement reservoir	A			10/15/03 13:45	367	803	SI 169	y	y	n	8.35	NA	
NA	1850	replacement reservoir	B			10/17/03 14:30	387	851	SI 190	y	y	n	n	NA	
NA	1850	oxystat reservoir				10/17/03 9:05	386	841	n	n	n	n	n	NA	
NA	1850	milli-Q blank				10/17/03 9:15	n	n	n	n	y	n	n	NA	

Note, all times are in ship time, which is GMT plus 4.

Station	Depth	Inc. Type	Barrel #	Timepoint (h) Intended	Timepoint (h) Actual	Sampling Date and Time	Analyte DIC	DIC-13	Nut	DOC	TM	N2/Ar	pH	total vol. (ml)	Notes
56136	1850	SO	7	T0	0.0	10/13/03 20:10	359	972	SI 151	n	n	y	n	59	
56136	1850	SO	7	T12	14.5	10/14/03 10:40	358	971	SI 157	n	n	y	7.69	67	
56136	1850	SO	7	T24	23.3	10/14/03 19:30	365	801	SI 165	n	n	y	7.70	68.4	
56136	1850	SO	7	T36	41.9	10/15/03 14:05	368	821	SI 170	n	n	y	7.78	67.4	inject 10 mL 1M KBr at 1405h; 1450h sample KBr
56136	1850	SO	8	T0	0.0	10/13/03 20:15	360	963	SI 152	n	n	y	n	63.5	
56136	1850	SO	8	T12	14.6	10/14/03 10:50	357	931	SI 158	n	n	y	7.72	67	
56136	1850	SO	8	T24	23.4	10/14/03 19:40	366	802	SI 166	n	n	y	7.72	67.4	
56136	1850	SO	8	T36	42.0	10/15/03 14:15	369	831	SI 171	n	n	y	7.87	68.3	
56136	1850	SF13-5	3	T0	0.0	10/13/03 20:45	353	932	SI 148	y	n	n	n	64	
56136	1850	SF13-5	3	T24	19.2	10/14/03 16:00	361	981	SI 159	y	n	n	n	70	
56136	1850	SF13-5	3	T48	47.2	10/15/03 19:55	374	806	SI 176	y	n	n	n	74	
56136	1850	SF13-5	3	T72	68.1	10/16/03 16:50	378	813	SI 180	y	n	n	n	74	
56136	1850	SF13-5	3	T96	86.3	10/17/03 11:00	388	819	SI 188	y	n	n	n	71	
56136	1850	SF13-5	4	T0	0.0	10/13/03 20:50	354	974	SI 147	y	n	n	n	77	
56136	1850	SF13-5	4	T24	19.3	10/14/03 16:05	362	946	SI 160	y	n	n	n	69	
56136	1850	SF13-5	4	T48	47.2	10/15/03	375	807	SI 177	y	n	n	n	65	

Note, all times are in ship time, which is GMT plus 4.

Station	Depth	Inc. Type	Barrel #	Timepoint (h) Intended	Timepoint (h) Actual	Sampling Date and Time	Analyte DIC	DIC-13	Nut	DOC	TM	N2/Ar	pH	total vol. (ml)	Notes
						20:00									
56136	1850	SF13-5	4	T72	68.2	10/16/03 17:00	379	814	SI 181	y	n	n	n	68	
56136	1850	SF13-5	4	T96	86.7	10/17/03 11:30	389	820	SI 189	y	n	n	n	67	
56139	1200	SO	1	T0	0.0	10/15/03 16:25	370	812	SI 172	n	n	y	7.81	67.6	
56139	1200	SO	1	T12	16.7	10/16/03 9:05	376	809	SI 178	n	n	y	7.73	69.6	
56139	1200	SO	1	T24	24.9	10/16/03 17:20	380	811	SI 182	n	n	y	7.73	65.2	
56139	1200	SO	1	T36	40.5	10/17/03 8:55	384	817	SI 186	n	n	y	7.84	68.2	
56139	1200	SO	1	T48	48.2	10/17/03 16:40	392	833	SI 193	n	n	y	7.71	67.2	no KBr
56139	1200	SO	2	T0	0.0	10/15/03 16:35	371	822	SI 173	n	n	y	7.87	67.3	
56139	1200	SO	2	T12	16.7	10/16/03 9:15	377	808	SI 179	n	n	y	7.78	67.3	
56139	1200	SO	2	T24	24.9	10/16/03 17:30	381	823	SI 183	n	n	y	7.81	66.3	
56139	1200	SO	2	T36	40.6	10/17/03 9:10	385	818	SI 187	n	n	y	7.82	68.7	
56139	1200	SO	2	T48	48.3	10/17/03 16:50	393	842	SI 194	n	n	y	7.73	70.8	no KBr

Matt Schwartz and Clare Woulds

11. CD151 Station List

Station	Series #	Site	Gear	Gear #	Start Date (03)	Time (utc)	Latitude DN	MN	Longitude DE	ME	Depth (m)	End Date (03)	Time (utc)	Depth (m)	Comment
56101	1	A140	CTD	1	19/09	18.16	23	16.800	66	42.710	134				12 bottles fired at 129m
56101	2	A140	MEGA	1	19/09	19.15	23	16.800	66	42.710	133				11/12 good cores
56101	3	A140	EO	1	20/09	1.46	23	17.127	66	42.481	134	21/09	13.18		Moored, successful deployment
56101	4	A140	MEGA	2	20/09	2.34	23	16.790	66	42.700	133				11/12, 4 bubbled
56101	5	A140	MEGA	3	20/09	4.16	23	16.759	66	42.620	135.5				10/12, 2 bubbled
56101	6	A140	MC	1	20/09	6.31	23	16.760	66	42.660	133.5				no cores, did not fire, attached broomsticks
56101	7	A140	MC	2	20/09	7.30	23	16.810	66	42.710	132.5				12/12
56101	8	A140	MEGA	4	20/09	11.14	23	16.905	66	42.686	134				11/12, 1 bubbled
56101	9	A140	CTD	2	20/09	12.45	23	16.917	66	42.706	133				24 bottles, 5-131 m
56101	10	A140	MEGA	5	21/09	5.02	23	16.800	66	42.720	132				11/12 cores, some slumping
56101	11	A140	MC	3	21/09	9.16	23	16.770	66	42.710	131				8/10 ok cores
56101	12	A140	PTOW	1	21/09	10.14	23	16.900	66	42.000					40m vertical tow, preserved for SIO
56101	13	A140	PTOW	2	21/09	10.20	23	16.900	66	42.000					10m vertical tow, frozen for SOC
56101	14	A140	PTOW	3	21/09	10.30	23	16.900	66	41.900					10m vertical tow, frozen for SIO
56101	15	A140	PTOW	4	21/09	10.45	23	16.900	66	41.800					10m vertical tow, formalin, for Edinburgh
56101	16	A140	BBLS	1	21/09	16.03	23	16.820	66	42.640	134				Success with 4/5 bottles
56101	17	A140	numbering error, did not happen												
56101	18	A140	EF	1	22/09	1.44	23	17.200	66	42.472	136	24/09	2.49		Successful deployment (water and mud)
56101	19	A140	MEGA	6	22/09	5.44	23	16.790	66	42.720	134				11/12 cores recovered, 1 bubbled
56101	20	A140	MC	4	22/09	9.37	23	16.790	66	42.740	135				8/9 cores recovered
56101	21	A140	PROF	1	22/09	12.50	23	17.385	66	42.036	134	23/09	5.00		Successful deployment (water and mud)
56101	22	A140	MC	5	23/09	6.03	23	16.799	66	42.709	133				9/9 cores recovered
56101	23	A140	MEGA	7	23/09	9.13	23	16.769	66	42.744	134				7/8 cores recovered
56101	24	A140	PROF	2	23/09	10.22	23	17.391	66	42.165	133	24/09	13.22		Successful deployment
56101	25	A140	TRAWL	1	23/09	11.25	23	16.320	66	44.370	132	23/09	12.03	134	Small, clean catch, 134-136.5m
56101	26	A140	MEGA	8	24/09	5.40	23	16.800	66	42.710	134				8/8 cores recovered
56101	27	A140	MC	6	24/09	6.51	23	16.804	66	42.712	133				8/9 cores recovered
56101	28	A140	MEGA	9	24/09	9.19	23	16.876	66	42.746	133				7/8 cores recovered

Station	Series #	Site	Gear	Gear #	Start Date (03)	Time (utc)	Latitude DN	MN	Longitude DE	ME	Depth (m)	End Date (03)	Time (utc)	Depth (m)	Comment
56101	29	A140	EF13	1	24/09	12.38	23	17.136	66	42.538	133	27/09	2.57		Successful except for some sediment disturbance
56101	30	A140	MEGA	10	26/09	6.21	23	16.790	66	42.690	134.5				7/8 cores recovered
56101	31	A140	CTD	3	26/09	9.06	23	16.720	66	42.560	136				12 bottles fired, 6 depths
56102	1	A300	CTD	4	27/09	5.39	23	12.470	66	34.030	301				15 bottles, 13 at bottom, 2 at surface
56102	2	A300	MEGA	11	27/09	7.15	23	12.492	66	34.021	302				(missing fate sheet)
56103	1	A200	MEGA	12	27/09	8.51	23	14.650	66	38.690	201.5				12 barrels, all shells, rejected
56104	1	A250	MEGA	13	27/09	10.01	23	13.160	66	36.320	254				9/12 recovered, 2 bubbled
56104	2	A250	MEGA	14	27/09	11.07	23	13.730	66	36.120	253.5				8/12 recovered, 2 broken barrels
56104	3	A250	MC	7	27/09	12.47	23	13.981	66	36.561	248.5				9/11 recovered
56105	1	A300	EO	2	27/09	13.48	23	12.767	66	33.235	306	29/09	2.50		Successful
56105	2	A300	MEGA	15	27/09	14.52	23	12.520	66	33.970	300.5				12/12 recovered, 3 bubbled
56105	3	A300	MEGA	16	28/09	2.53	23	12.465	66	34.101	295				disturbed or did not fire
56105	4	A300	MEGA	17	28/09	3.27	23	12.510	66	34.103	284				7/12 cores, 2 bubbled
56105	5	A300	MEGA	18	28/09	4.45	23	12.490	66	34.010	285.4				11/12 recovered
56105	6	A300	CTD	5	28/09	6.10	23	12.490	66	34.020	305				24 bottle sequence
56105	7	A300	MC	8	28/09	8.15	23	12.458	66	34.015	302.5				8/10 recovered, 2 bubbled
56106	1	A400	MEGA	19	28/09	10.52	23	9.550	66	31.040	408				bacterial mat hunting, failed
56106	2	A400	MEGA	20	28/09	11.30	23	9.490	66	30.990	410				bacterial mat hunting, failed
56106	3	A400	MEGA	21	28/09	12.18	23	9.470	66	30.970	410.5				bacterial mat hunting, failed
56106	4	A400	MEGA	22	28/09	12.57	23	9.520	66	31.010	407.5				bacterial mat hunting, failed
56106	5	A400	MEGA	23	28/09	13.40	23	9.530	66	31.020	407.5				bacterial mat hunting, failed
56106	6	A400	MEGA	24	28/09	15.12	23	9.510	66	31.030	408				bacterial mat hunting, failed
56106	7	A400	MEGA	25	28/09	16.06	23	9.490	66	31.010	411				bacterial mat hunting, failed
56106	8	A400	MEGA	26	28/09	16.48	23	9.500	66	31.030	410				bacterial mat hunting, failed
56106	9	A400	MEGA	27	28/09	17.23	23	9.510	66	31.040	410				bacterial mat hunting, failed
56106	10	A400	MEGA	28	28/09	18.20	23	9.500	66	31.010	411.5				bacterial mat hunting, failed
56106	11	A400	MEGA	29	28/09	19.32	23	9.503	66	30.999	411.5				bacterial mat hunting, failed
56106	12	A400	MEGA	30	28/09	21.10	23	9.480	66	31.270	404				bacterial mat hunting, failed
56106	13	A400	MEGA	31	28/09	22.12	23	9.460	66	31.130	408				bacterial mat hunting, failed
56106	14	A400	MEGA	32	28/09	23.11	23	9.496	66	30.999	410				bacterial mat hunting, failed

Station	Series #	Site	Gear	Gear #	Start Date (03)	Time (utc)	Latitude DN	MN	Longitude DE	ME	Depth (m)	End Date (03)	Time (utc)	Depth (m)	Comment
56106	15	A400	MEGA	33	29/09	0.04	23	9.419	66	31.075	410				bacterial mat hunting, failed
56106	16	A400	MEGA	34	29/09	0.43	23	9.540	66	31.050	413				bacterial mat hunting, failed
56106	17	A400	MEGA	35	29/09	1.18	23	9.548	66	31.029	409				bacterial mat hunting, failed
56107	1	A300	MEGA	36	29/09	4.42	23	12.480	66	34.000	300.5				9/12 cores recovered, 5 bubbled
56107	2	A300	MEGA	37	29/09	5.58	23	12.480	66	33.990	296.5				10/11 cores recovered
56107	3	A300	MC	9	29/09	7.37	23	12.487	66	34.009	300				10/10 cores recovered, 2 bubbled
56107	4	A300	EF13	2	29/09	12.39	23	12.866	66	33.318	305	02/10	2.01		Successful, water and mud
56107	5	A300	MEGA	38	30/09	3.06	23	12.488	66	34.181	298				10/11 cores, 1 bubbled
56107	6	A300	MC	10	30/09	4.43	23	12.480	66	34.010	298				10/10, 4 bubbled
56107	7	A300	BBLS	2	30/09	10.11	23	12.498	66	34.016	306				Successful
56107	8	A300	MC	11	01/10	4.59	23	12.489	66	33.999	301				8/9, 1 bubbled
56107	9	A300	MC	12	01/10	6.07	23	12.480	66	33.990	300				6/6 cores recovered
56107	10	A300	PTOW	5	01/10	7.06	23	12.410	66	33.950					40m vertical tow
56107	11	A300	PTOW	6	01/10	7.15	23	12.400	66	33.990					40m vertical tow
56107	12	A300	PTOW	7	01/10	7.25	23	12.450	66	34.330					40m vertical tow
56107	13	A300	PTOW	8	01/10	7.35	23	12.370	66	34.049					40m vertical tow
56108	1	A180	MEGA	39	01/10	9.41	23	15.110	66	39.310	184				0/12, no cores (sand/shells), weight added
56108	2	A180	MEGA	40	01/10	10.18	23	15.230	66	39.370	180.5				8/12, 6 disturbed, more shells, short cores
56109	1	A220	MEGA	41	01/10	11.08	23	14.390	66	37.830	232				short cores, mostly disturbed (sand/shells)
56110	1	A250	MC	13	01/10	12.33	23	13.840	66	36.500	249.5				8/8 cores, 2 lost bottoms on deck
56111	1	A275	MC	14	01/10	13.35	23	13.110	66	35.290	274				9/9, 4 bubbled/disturbed (laminated)
56111	2	A275	MEGA	42	01/10	14.58	23	13.230	66	35.340	273				11/12, 1 bubbled
56112	1	A300	MEGA	43	01/10	15.54	23	12.411	66	33.967	300				11/12, 2 bubbled
56112	2	A300	PTOW	9	02/10	06.10	23	12.560	66	33.980					40m vertical tow
56112	3	A300	PTOW	10	02/10	6.25	23	12.560	66	33.980					40m vertical tow
56112	4	A300	EF	2	02/10	12.48	23	12.808	66	33.429	301	04/10	12.15		Successful, water and mud
56113	1	A700	MEGA	44	02/10	15.17	22	59.968	66	41.200	709				8/12 cores recovered
56113	2	A700	MEGA	45	02.10	16.16	22	59.904	66	41.180	711				10/12, I broken barrel, 2 bubbled
56113	3	A700	MC	15	02/10	17.49	22	59.950	66	41.240	709.5				Did not fire
56113	4	A700	MC	16	02/10	18.53	NA	NA	NA	NA	707.5				Did not fire

Station	Series #	Site	Gear	Gear #	Start Date (03)	Time (utc)	Latitude DN	MN	Longitude DE	ME	Depth (m)	End Date (03)	Time (utc)	Depth (m)	Comment
56113	5	A700	MC	17	02/10	20.04	23	0.010	66	41.150	707.5				9/9, 1 bubbled, long cores, laminated
56114	1	A850	MEGA	46	03/10	5.15	22	57.460	66	31.700	845				8/12, 2 bubbled
56114	2	A850	MC	18	03/10	7.19	22	57.490	66	37.680	842.5				overpenetrated
56114	3	A850	MC	19	03/10	9.43	22	57.490	66	37.700	843.5				9/9, 5 bubbled
56114	4	A850	PROF	3	03/10	11.12	22	56.978	66	37.991	843	04/10	2.49		Successful, no obvious O2 profile
56114	5	A850	MEGA	47	03/10	13.16	22	57.491	66	37.620	845				8/12 cores recovered
56115	1	A300	MEGA	48	04/10	6.17	23	12.500	66	33.990	300				8/12 cores recovered
56115	2	A300	MC	20	04/10	7.23	23	12.480	66	33.980	299				(missing fate sheet)
56116	1	A940	CTD	6	04/10	16.19	22	53.490	66	36.630	948				Bottom water sampling
56116	2	A940	EO	3	05/10	1.50	22	53.199	66	37.011	938	06/10	12.52		Successful, including mud
56116	3	A940	MEGA	49	05/10	2.51	22	53.524	66	36.657	942				7/8 cores recovered, 2 bubbled
56116	4	A940	MEGA	50	05/10	5.53	22	53.530	66	36.630	943				12/12 cores recovered, 2 bubbled
56116	5	A940	CTD	7	05/10	7.45	22	53.510	66	36.630	945				Water column profile
56116	6	A940	MEGA	51	05/10	10.09	22	53.520	66	36.640	943				(missing fate sheet)
56116	7	A940	MC	21	05/10	12.07	22	53.460	66	36.500	948				8/9 cores recovered, 3 bubbled
56116	8	A940	MC	22	05/10	13.30	22	53.450	66	36.540	947				8/9 cores recovered, 2 bubbled
56116	9	A940	PROF	4	05/10	14.53	22	52.890	66	37.160	940	06/10	4.08		Good profiles
56116	10	A940	MEGA	52	06/10	5.35	22	53.499	66	36.663	943				12/12 cores recovered, 1 bubbled
56116	11	A940	BBLS	3	06/10	7.38	22	53.510	66	36..65	942.5				Successful
56116	12	A940	PTOW	11	06/10	9.08	22	53.530	66	36.650					Vertical tow, top 40m
56116	13	A940	PTOW	12	06/10	9.20	22	53.530	66	36.650					Vertical tow, top 40m
56116	14	A940	PTOW	13	06/10	9.35	22	53.530	66	36.650					Vertical tow, top 40m
56116	15	A940	PTOW	14	06/10	9.50	22	53.530	66	36.650					Vertical tow, top 40m
56116	16	A940	PTOW	15	06/10	10.06	22	53.530	66	36.650					Vertical tow, top 40m
56116	17	A940	MC	23	06/10	10.54	22	53.570	66	36.640	941.5				9/11 cores recovered
56117	1	C850	TRAWL	2	6/10	16.41	22	56.230	66	37.150	889	06/10	17.57	955	large muddy catch with all sorts (including Sir Andy's bamboo samurai sword)
56118	1	A940	EF	3	7/10	1.55	22	53.237	66	37.005	938	9/10	2.28		Successful, mud and water
56118	2	A940	MC	24	7/10	3.02	22	53.511	66	36.703	942				9/9 cores recovered (acetylene block)
56119	1	A1000	MC	25	7/10	4.49	22	54.610	66	34.965	999				9/9 cores recovered, 3 bubbled
56119	2	A1000	MC	26	7/10	6.10	22	54.620	66	34.970	998				9/9 cores recovered, 3 bubbled

Station	Series #	Site	Gear	Gear #	Start Date (03)	Time (utc)	Latitude DN	MN	Longitude DE	ME	Depth (m)	End Date (03)	Time (utc)	Depth (m)	Comment
56119	3	A1000	MEGA	53	7/10	7.50	22	54.660	66	35.001	996				12/12 cores recovered
56119	4	A1000	PROF	5	7/10	9.00	22	54.998	66	35.107	994	8/10	4.02		Successful profiling
56120	1	A1100	MEGA	54	7/10	10.17	22	52.770	66	33.010	1097				11/12 cores recovered
56120	2	A1100	MC	27	7/10	12.01	22	52.750	66	32.090	1098.5				9/9 cores recovered
56021	1	A900	MC	28	7/10	14.10	22	56.805	66	36.947	898				10/10 cores recovered, 2 bubbled
56021	2	A900	MEGA	55	7/10	15.25	22	56.857	66	36.992	898				9/12 cores recovered
56122	1	A1000	MEGA	56	8/10	5.28	22	54.674	66	35.005	996				11/12 cores recovered, 1 lost
56123	1	A800	MEGA	57	8/10	7.48	22	58.346	66	38.916	791				7/12 cores recovered
56123	2	A800	MC	29	8/10	9.23	22	58.328	66	38.866	792.5				10/10 cores recovered, 1 lost, 1 bubbled
56124	1	A850	MEGA	58	8/10	10.51	22	57.517	66	37.634	842				7/12 cores recovered
56125	1	A940	PROF	6	8/10	12.19	22	52.923	66	37.191	938	9/10	12.29		Successful profiling
56126	1	C1000	TRAWL	3	8/10	16.30	22	51.020	66	37.290	981.5	8/10	17.40	987.5	very muddy, small catch
56127	1	A850	MEGA	59	9/10	6.45	22	57.511	66	37.720	841				4/8 cores recovered
56128	1	A900	MEGA	60	9/10	9.19	22	56.719	66	36.785	900				6/8 cores recovered, 1 bubbled
56129	1	A940	MEGA	61	9/10	10.58	22	53.506	66	36.626	946				5/8 cores recovered
56129	2	A940	EF13	3	9/10	13.44	22	53.254	66	37.005	937	12/10	2.16		Water but no mud (burn wire on shovel)
56130	1	BM1	CTD	8	10/10	8.38	24	49.870	65	54.245	845				Bacterial mat sampling area
56130	2	BM1	MEGA	62	10/10	10.47	24	49.968	65	54.193	789				12/12 cores recovered, short, disturbed, weird!
56130	3	BM1	MEGA	63	10/10	12.16	24	49.890	65	54.350	759				12/12 cores recovered, short, bacterial mats!
56131	1	BM2	MEGA	64	10/10	13.43	24	50.120	65	54.700	693				6/12 cores, no mats, deep black band, control
56132	1	BM3	MEGA	65	10/10	15.04	24	50.240	65	54.920	689				7/12 cores, none retained
56133	1	BM4	MEGA	66	10/10	16.29	24	49.880	65	54.235	806				Bacterial mats, none retained (no fate sheet)
56133	2	BM4	MEGA	67	10/10	19.40	24	49.870	65	54.238	845				Bacterial mats, 11/12, 1 disturbed
56133	3	BM4	MC	30	10/10	21.23	24	49.267	65	54.248	846				Bacterial mats, 11/11
56133	4	BM4	MEGA	68	10/10	22.58	24	49.870	65	54.235	845.8				Bacterial mats, 11/12 cores recovered
56134	1	BM5	MEGA	69	11/10	0.28	24	50.114	65	54.721	696.8				BM Control, 11/12 cores recovered
56134	2	BM5	MC	31	11/10	2.23	24	50.118	65	54.715	698				BM Control, 11/11 cores recovered
56134	3	BM5	MC	32	11/10	3.21	24	50.122	65	54.718	699				BM Control, 11/11 cores recovered
56135	1	A1850	CTD	9	12/10	9.15	22	52.400	65	59.970	1852				Bottom water sampling, 14 bottles fired
56136	1	A940	MEGA	70	12/10	15.47	22	53.560	66	36.680	940.5				4/4 cores recovered

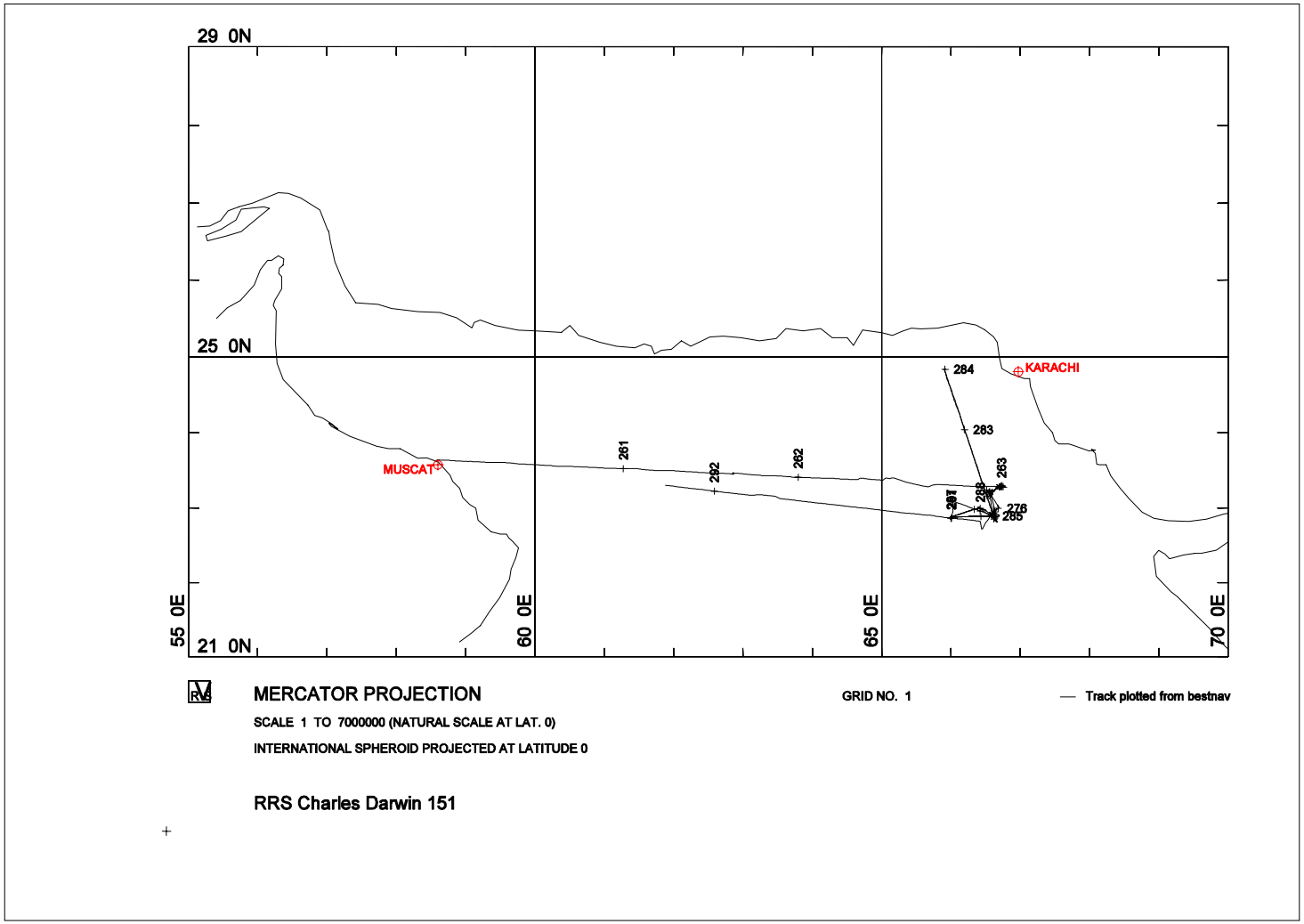
Station	Series #	Site	Gear	Gear #	Start Date (03)	Time (utc)	Latitude DN	MN	Longitude DE	ME	Depth (m)	End Date (03)	Time (utc)	Depth (m)	Comment
56136	2	A940	MC	33	12/10	17.27	22	53.560	66	36.670	949				(missing fate sheet)
56136	3	A940	EF13	4	12/10	21.58	22	53.238	66	37.007	937	15/10	2.47		Success, mud and water!
56137	1	A1850	MEGA	71	13/10	3.57	22	52.390	66	0.030	1853				12/12 cores recovered, 2 disturbed
56137	2	A1850	MEGA	72	13/10	6.21	22	52.410	66	0.040	1853				11/12 cores recovered
56137	3	A1850	MC	34	13/10	8.46	22	52. 390	66	59.996	1853				11/12 cores recovered
56137	4	A1850	MC	35	13/10	10.50	22	52. 396	66	59.990	1852				11/12 cores recovered
56137	5	A1850	PROF	7	13/10	13.58	22	51.067	65	59.916	1864	14/10	4.07		Successful profiling
56137	6	A1850	PTOW	11	13/10	14.41	22	52.380	65	59.950					Vertical tow, top 40m
56137	7	A1850	PTOW	12	13/10	15.00	22	52.390	65	59.950					Vertical tow, top 40m
56137	8	A1850	PTOW	13	13/10	15.10	22	52.430	65	59.960					Vertical tow, top 40m
56137	9	A1850	PTOW	14	13/10	15.40	22	52.436	65	59.960					Vertical tow, top 40m
56137	10	A1850	PTOW	15	13/10	15.50	22	52.313	65	59.970					Vertical tow, top 40m
56137	11	A1850	PTOW	16	13/10	15.57	22	52.310	65	59.970					Vertical tow, top 40m
56137	12	A1850	MEGA	73	13/10	16.54	22	52.390	66	0.004	1852.5				(missing fate sheet)
56137	13	A1850	MEGA	74	14/10	3.16	22	52.396	65	59.936	1853				12/12 cores recovered
56137	14	A1850	MC	36	14/10	6.18	22	52.389	66	0.005	1853				11/12 cores recovered (1 barrel lost)
56137	15	A1850	BBLS	4	14/10	9.10	22	52.390	65	59.970	1861				Successful
56137	16	A1850	PROF	8	14/10	11.12	22	51.107	65	59.912	1863	15/10	12.10		Failed profiles.
56138	1	D1700	TRAWL	4	14/10	15.00	23	0.810	66	1.480	1712	14/10	16.00	1677	lots of mud, not many critters
56139	1	A1200	MEGA	75	15/10	6.06	22	59.998	66	24.409	1192				12/12 cores recovered
56139	2	A1200	MEGA	76	15/10	7.16	22	59.976	66	24.423	1193				12/12 cores recovered, 1 disturbed
56140	1	A1850	EO	4	15/10	11.50	22	51.797	66	0.023	1857	18/10	0.17		No mud, stirrer stopped mid-deployment
56140	2	A1850	MEGA	77	15/10	14.18	22	52.417	66	59.975	1859				electrode profiling
56140	3	A1850	MC	37	15/10	15.47	22	52.420	66	59.982	1843				(missing fate sheet)
56141	1	A1200	PROF	9	16/10	1.22	22	59.784	66	24.786	1182	16/10	12.05		Successful profiles
56141	2	A1200	MEGA	78	16/10	2.00	23	0.000	66	24.416	1198				8/10 cores recovered
56141	3	A1200	MC	38	16/10	6.24	22	59.992	66	24.428	1191				10/11 cores recovered
56141	4	A1200	MC	39	16/10	7.58	23	0.003	66	24.389	1193				11/12 cores recovered
56141	5	A1200	BBLS	5	16/10	9.46	22	59.932	66	24.404	1193				Successful
56141	6	A1200	PTOW	17	16/10	11.07	22	59.980	66	24.423					Vertical tow, top 40m

Station	Series #	Site	Gear	Gear #	Start Date (03)	Time (utc)	Latitude DN	MN	Longitude DE	ME	Depth (m)	End Date (03)	Time (utc)	Depth (m)	Comment
56141	7	A1200	PTOW	18	16/10	11.18	22	59.966	66	24.419					Vertical tow, top 40m
56141	8	A1200	PTOW	19	16/10	11.26	22	59.936	66	24.401					Vertical tow, top 40m
56141	9	A1200	PTOW	20	16/10	11.34	22	59.995	66	24.379					Vertical tow, top 40m
56141	10	A1200	PTOW	21	16/10	11.42	22	59.964	66	24.363					Vertical tow, top 40m
56141	11	A1200	PTOW	22	16/10	11.48	22	59.950	66	24.358					Vertical tow, top 40m
56141	12	A1200	CTD	10	16/10	14.38	22	59.950	66	24.400	1205				13 bottles & profile, tests
56141	13	A1200	PROF	10	16/10	15.45	22	59.776	66	24.758	1184	17/10	3.47		Successful profiles
56142	1	A1050	MEGA	79	17/10	6.42	22	53.604	66	34.029	1045.3				missing core details
56142	2	A1050	MC	40	17/10	8.28	22	53.620	66	34.040	1044.5				11/12 cores recovered, 1 bubbled
56142	3	A1050	MC	41	17/10	9.51	22	53.595	66	34.035	1046				11/12 cores recovered , 1 bubbled
56143	1	C1550	TRAWL	5	17/10	14.28	22	45.580	66	25.900	1520	17/10	15.38	1535.5	Successful

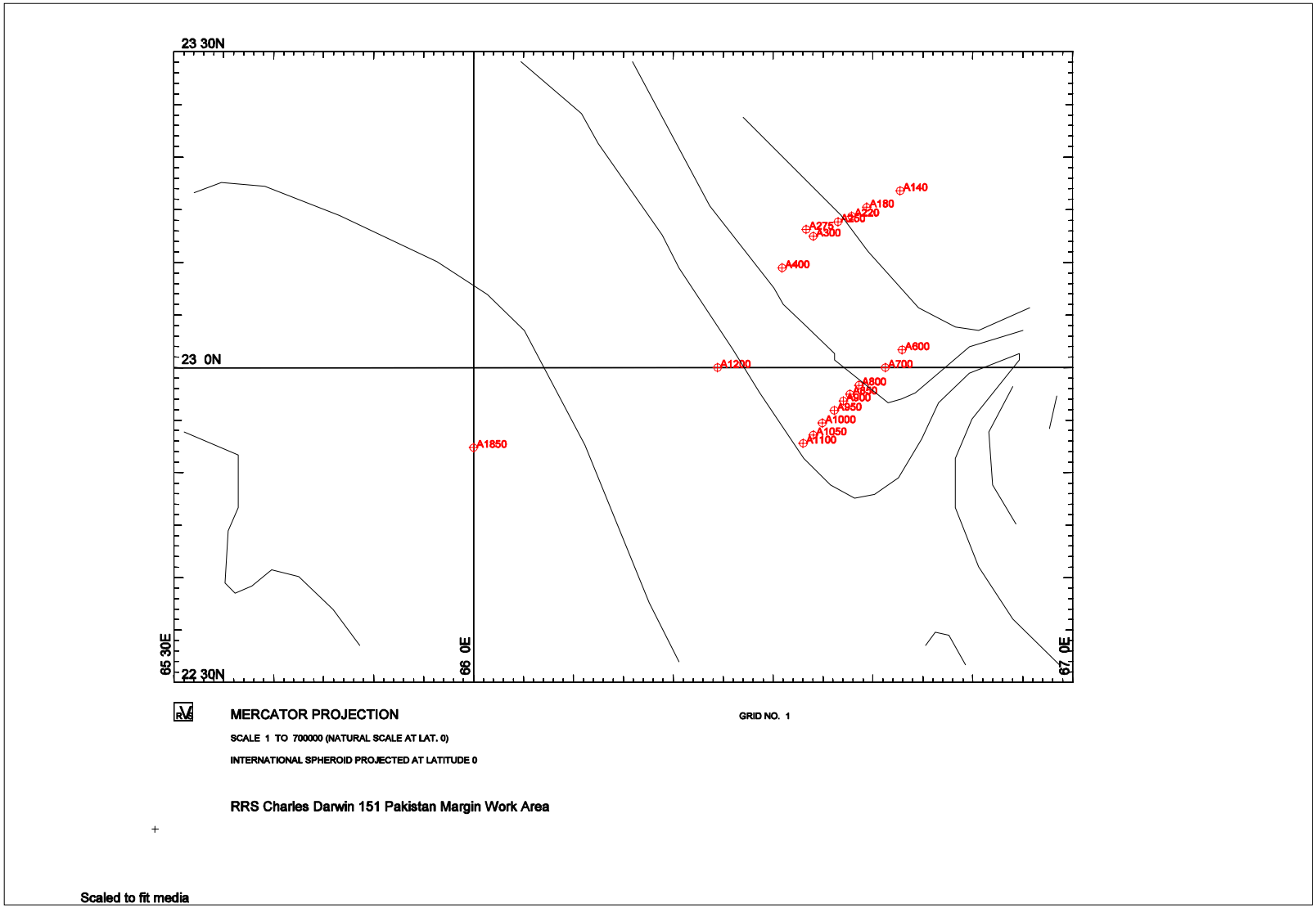
Greg Cowie

12. Charts

12.1 Full cruise track



12.2. Main Indus margin work area (note that depth contours are approximations only)



12.3. Bacterial mat sampling area (off Karachi, depth contours are approximations)