SAMS – Northern Seas programme
RRS James Clark Ross 15th June > 10th July 2003
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## Acknowledgements

It gives me great pleasure to thank Chris Elliott, the officers and crew of the James Clark Ross for all their help and support which made JCR75 such an enjoyable and productive cruise.

I would also like to thank the following people for their support , Chris Hindley, John Pye and Nick Cox (BAS); The Kings Bay Company in Ny Alesund; Colin Day and Ian Waddington (UKORS); Nigel Fannin and Dave Smith (BGS); Mike Webb (NERC) and John Humphery (POL).

Finally I would like to thank the UK Hydrographic Office for providing the XBTs for the cruise.

## Index

**Cruise Objectives for JCR75**

The cruise work will directly address the following SAMS Northern Seas programme elements:

Theme A, Question 4

- *How does bioturbation vary in response to environmental forcing and what are the consequences for redistribution of anthropogenic contaminants?*
- *How does the anthropogenic burden change along a northern transect of 4 stations (67 to 81 N)?*

Theme A, Question 5

- *To deliver an understanding of the effect of abrupt climate change and land use on fjordic/sea loch systems, which link the marine and terrestrial environments at high latitudes in Northwest Europe.*

Theme B, Question 2

- *To what extent does benthic faunal composition and size structure determine processes of carbon dynamics ?*
- *Can we link changes in regional patterns in sediment biogeochemistry with disparate patterns in benthic distributions?*

Bioturbation processes form the interface between seabed biology and geochemistry. The 'environmental forcing' referred to in the programme is likely to vary both with depth (eg. fjordic-shelf-slope-abyss) and latitude (north-south gradients in intensity and interannual variability of pulsed OM input). Bioturbation therefore provides a crossover between the two main themes of the Northern Seas programme.

Work to be carried out from JCR should be seen as an essential supplement to the Wyville-Thomson work carried out on D257. To test the reality or otherwise of benthic biogeochemical 'provinces' we require comparable data from a range of sites in the water masses north and south of the WT Ridge (differences between our WTN and WTS stations does not in itself amount to a demonstration of 'provinces'). The WTS results can be put alongside existing data from previous studies in the Atlantic water mass (BENBO, SES), but at present we need more stations north of the ridge to compare with WTN.

Proposed study sites for JCR : Norwegian - Barents Sea continental margin

- Continental margin Norway - Barents Sea - Svalbard - Yermak Plateau, approx. N-S course without major undersea geographic barriers. Benthic faunal distribution therefore determined by gradients in seabed environmental conditions without confounding by biogeographic factors.
- This line also forms the approx. course of the northern 'conveyor' carrying contaminants from W. Europe to the arctic.
- Overall northwards trend in OM supply to the benthos will be one of increasingly pulsed flux and greater inter-annual variation in the timing and total supply of OM derived from water column primary production.

- Local factors superimposed on overall northwards trend, ie. winter 'outbursts' of fine-grained material off Barents Sea shelf, relative contributions of ice algae and phytoplankton on Yermak Plateau

- Data from series of sites along this N-S margin will therefore show how benthic community varies (biomass, bioturbator community structure) in response to forcing factor of OM supply, and consequences of this for sediment mixing rate, biogeochemical process rates and sediment contaminant distribution.

Four stations will form the northern transect. If time constraints or ice thickness prevents work at the Yermak Plateau, the remaining ice-free sites will still provide us with a 3-station northward transect.

1. Voring Plateau: High Priority Site: (Gravity coring Site) Nyk Drift, this site is similar in supply to other 3 northern transect sites. Alternative site: Central Plateau: Purely pelagic OM supply, no advection off shelf. Much published information on nature and distribution of benthic fauna, will facilitate interpretation of our samples. Few data on biogeochemical process rates.
2. Bear Island Fan: Not far from Voring, but receives advected material off Barents Sea shelf as well as pelagic OM flux.
3. Margin W. of Svalbard, no ice cover: No ice algae, but will receive pelagic OM and northwardly-advected material from West Spitzbergen Current (WSC)
4. Western margin of Yermak Plateau: Within influence of WSC, with additional contribution from ice algae.

Proposed study sites for JCR : Svalbard margin out from Kongsfjord

This is intended to tie in with April 2002 LSF work (post-bloom data from Kongsfjord stations). The transect will consist of four main stations, nb there are 5 main stations however the 1400m station will be completed during the execution of the northern transect.
The transect will continue out from fjord in a series of stations across the shelf (where soft sediments exist) and down continental slope. This will allow changes in benthic community and biogeochemistry to be recorded along a depth/OM supply gradient not confounded by other factors. This bathymetric transect will intersect with the N-S margin transect proposed above.

Proposed main sampling sites Kongsfjord Transect

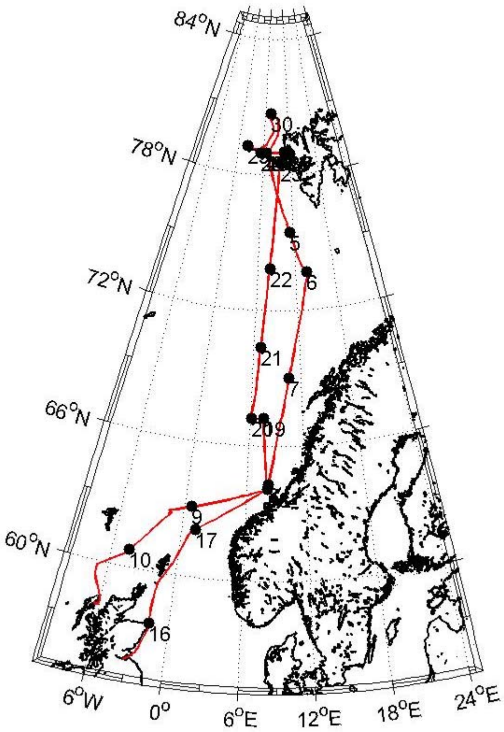
1. The inner station occupied by the lander April 2002 (station 22 141m depth N79° 0.33′ E11° 54.20′ )
2. Mooring station April 2002 (200m depth N79 03.25' E011 17.96 )
3. Station outwith fjord approximately 800 m?
4. Station 1400 m this is the same station as northern transect (count only once)
5. Fram Strait, station as far west as possible in time constraints (no further than 0°)

An array of equipment will be used during the cruise, these include CTD and a water bottle rossette, SAMS landers, BGS gravity corer, SMBA multi and mega corers, NIOZ box corer and POL bedhop camera. At the main sites all major equipment and techniques will be deployed. In addition to these main sites CTD and coring deployments may take place at intervening sites. A variety of underway measurements will be made whilst the ship is underway:- TOPAS, Multibeam, ADCP, XBT, meteorological and sea-surface measurements. There will also be mooring activity in the Kongsfjord and the Sula Ridge. A more detailed description of the Cruise objectives is given in appendix A.

**PERSONNEL**

| | | |
|---|---|---|
| ELLIOTT | Christopher | Master |
| | | |
| PATERSON | Robert C | Ch/Off |
| COOLING | Kim | 2/Off |
| GOLDING | Michael | 3/Off |
| SUMMERS | John W | Dk/Off |
| WADDICOR | Charles A | R/Off |
| CUTTING | David J | C/Eng |
| KERSWELL | William R | 2/Eng |
| ARMOUR | Gerard J | 3/Eng |
| EADIE | Steven J | 4/Eng |
| WRIGHT | Simon A | D/Eng |
| THOMAS | Norman E | Elect |
| OLLEY | Kenneth R | Cat/O |
| STEWART | George M | Bosun |
| WILLIAMS | David O | Bos/Mate |
| McGOWAN | John J M | Sea 1 |
| BAKER | James A | Sea 1 |
| BLABY | Marc A | Sea 1 |
| JENKINS | Derek G | Sea 1 |
| REES | David | Sea 1 |
| SMITH | Sydney F | M/Man |
| ROBINSHAW | Mark A | M/Man |
| TURNER | Richard J | Ch Cook |
| BALDWIN-WHITE | Lawrence | 2nd Cook |
| PRATLEY | Clifford R | S/Stwd |
| LEE | Derek W | Stwd |
| WESTON | Kenneth | Stwd |
| NEWALL | James | Stwd |
| | | |
| SHIMMIELD | Graham B | PSO |
| | | |
| HORTOP | Sarah E | Doctor |
| COOPER | Patrick J | E/Eng |
| HINDLEY | Christopher | Logistics |
| ROBST | Jeremy | IT |
| WILLIS | Douglas | IT |
| BARR | Robert B | Lander |
| BLACK | Kenneth | Chemist |
| BREUER | Eric R | Geochemist |
| COTTIER | Finlo R | Physicist |
| DARROCH | Louise J | Chemist |
| DEAN | Rebecca | Geochemist |
| DERRICK | John D | Geologist |
| EVANS | Claire | Chemist |
| EZZI | Ivan | H&S/Nutrients |
| GRIFFITHS | Colin R | Logistics/Physicist |
| GUNN | Caroline N | Ice |
| HARVEY | Stewart M | Chemist |
| HOWE | John A | Geologist |
| HUGHES | Claire | Chemist |

| | | |
|---|---|---|
| HUGHES | David J | Biologist |
| JOHNSON | Martin T | Chemist |
| KADNER | Susanne | Chemist |
| LAMONT | Peter | Biologist |
| LARSEN | Mona | Biologist |
| MORETON | Steven | Geologist |
| MORRI | Clara | Geologist |
| PEPPE | Oliver C | Lander |
| PROVOST | Paul G | Coring/Physicist |
| ROBERTS | John M | Biologist |




**JCR75 Cruise Track 15/6 > 10/7 2003**

## Narrative

15th June — Departed Leith docks at 13.00Z, via locks, into the Firth of Forth. Most scientific personnel boarded on the 14th. A fine reception was held for friends and colleagues of the British Geological Survey and SAMS on the night of the 14th, with thanks due to the catering staff of the JCR. The waters of the Firth allowed for final stowage and equipment tie-down. A comprehensive and clear safety briefing was given by the First Officer at 16.00Z. Course was set NW along the Fife and Aberdeen-shire coast. Weather partly overcast, with bright spells; little sea – very pleasant.

16th June — Underway for the Sula Ridge, Norway. Off the Fair Isle (59° 30.726'N 01° 25.746'W), the first shakedown CTD and bottle cast was made at 08.42Z. Water depth was only 95 m. A slack loop on the CTD wire required stoppering and re-tensioning. Water sampling protocol successfully completed. Underway at 09.41Z. The PSO delivered a general introduction to the scientific party, officers and crew, followed by some recent underwater video of the Sula Ridge.

17th June — At 08.42Z the first CTD (59°30.726'N 01° 25.747'W) for water samples was performed, to full depth (95.6 m). Making good speed with little deterioration in the weather to the Sula Ridge (64° 05.03'N 08° 02.34'E) we arrived at 18.55Z and commenced a TOPAS survey. After some initial familiarisation with the Swath/TOPAS, a very successful survey of the Sula Ridge was completed by 21.00Z. The survey data revealed the sediment drape feature (64° 05.023'N 08° 02.260'E) on the north west flank of the ridge which was our target for sediment coring and the photolander deployment. A CTD (JCR75/5: 21.22Z) drop with oxygen sensor attached was performed, followed by two box cores (JCR75/6 and /7). The former suffered from washout due to cobbles jamming the spades, but the second was successful. Unfortunately, the deployment was marred by a finger injury to Paul Provost; an accident form and recommendations for changes in procedure has been lodged. At 00.03Z the photolander mooring deployment commenced with release at 00.53 (64° 05.055'N 08° 02.209'E). All acoustic communication with the release functioned perfectly. Immediately after release course was made for the Voring Plateau. Throughout the Sula Ridge activity the weather remained clement and shipboard operations were carried out smoothly.

18th June — En route for the Voring Plateau a CTD/bottle cast was performed at 08.38Z (65° 30.04'N 07° 46.36'E). Interference between the EM 500 and the EM120 results in very spurious depth information. A strong recommendation is made to switch off the EM120 on station. At 17.33Z a swath/Topas survey commenced centered on station VP1. Following this 2 hour successful survey a CTD and gravity core were deployed. This first use of the BGS gravity corer was a complete success with excellent operational and handling procedures by John Derrick, BGS. After completion of sampling, we conducted a depth test on the buoyancy sphere integrity and acoustic release mechanisms for the landers (23.28Z). Unfortunately the acoustic testing was not successful, and on recovery, one release and the deck unit were found to be malfunctioning. Course was set for VP2, 2.5 hours transit to the west of VP1.

19th June — On arrival at VP2 (67° 13.03'N 6° 05.95'E) another swath/Topas survey was run. At 05.40Z a second acoustic release was attached to the CTD to test operation at depth. The release was attached to one side of the CTD frame, rather than underneath which would prevent good acoustic reception due to shielding. This imbalance in the CTD and possible resulting rotation through the water column, was implicated in the birdcaging of the CTD conducting cable a few meters above the package. Re-termination was required, and successfully completed. During this operation the NIOZ box corer was deployed, unfortunately resulting in sediment overpenetration, requiring a second deployment. The cause of the overpenetration was linked to the false bottom depth recording of the EM500 system which appears to be consistently recording depths of 30-50m too deep. All subsequent coring deployments will be using a pinger set at 50m above the corer.

After a successful box core, the lander in profiling mode, was made ready and successfully deployed at 67$^c$ 13.21'N 06$^o$ 05.30'E in 1440 m of water. Control systems included one acoustic modem with a back-up burn wire release. The experiment was timed for 12.30 hours duration. Thereafter a successful series of multi-coring, bed hop camera and mega corer, with one gravity core, were completed. A couple of times, minor winch alarms were noted (too fast a descent for the multi core, and the veer counter not responding). Sea state was good to moderate.

20$^{th}$ June — Just after midnight (00.25Z), with good daylight, and moderate sea state (force 4), the acoustic release was triggered and the lander surfaced 25 minutes later off the starboard bow. The excellent navigation and dynamic positioning capability of the *JCR*, led to a successful recovery with only minor damage to the lander beacon mast. Excellent seamanship skills were demonstrated in this procedure. Once on deck and secure, the ship was repositioned for a final megacore and bed hop camera transect. Processing of the lander data revealed a complete success with 4 electrodes reporting excellent *in situ* sediment oxygen profiles. At 04.15Z, course was set due north for Svalbard. During passage, a CTD was conducted at 08.30Z to 1000 m water depth, and XBT profiles at one hour intervals. By 14.00Z the weather had deteriorated somewhat, necessitating a decrease in speed to 9 knts. For the remainder of the day, underway sampling and hourly XBTs were carried out during the northerly passage.

21$^{st}$ June — With improving weather, later becoming cloudless skies, the underway speed quickly picked up again reaching 12.5-13.0 knts. Watchkeeping was now in full swing, with hourly XBT releases. A CTD with full bottle cast was deployed at 08.30Z (71$^o$ 58.25'N 07$^o$ 21.02'). Due to the fair weather, and suitable depth, a lander buoyancy test in 2984 m of water was carried out successfully. Around 17.00Z a very large school (200+) of White-beaked Dolphins was sighted. The midnight position was 73$^o$ 52.917'N, 0$^o$ 55.033'E.

22$^{nd}$ June — Continued underway to Kongsfjord, Svalbard at 12.5 knts. XBTs continue to monitor the changing water masses every hour, now recording sub-zero water temperature at only 500 m water depth. A more detailed CTD profile was conducted at 08.30Z at 75$^o$ 34.41'N 08$^o$ 32.51'E down to 1000 m depth.

23$^{rd}$ June — At 05.34Z Station 2 in the outer Kongsfjord (79$^o$ 03.26N 11$^o$ 18.01E) commenced with an acoustic interrogation of the mooring array deployed in April from the RV *Lance*. A signal was returned to our relief, indicating that the array was upright and some 400 m distant. The station sampling began with a box core which revealed a pebble-rich sea floor overlying dark, anoxic stiff mud with a substantial epifauna and infauna. Although recognising that a lander "Profileur" deployment would risk the fragile electrodes, it was decided to take the risk and launch in tethered mode in a water depth of 240 m. After launching, and repositioning, the water column was studied using two CTD drops, before returning to benthic sampling with the bed hop camera and the box core. After box coring repeatedly revealed the pebble aggregate surface layer, there was considerable concern over the possibility of coring with the multi- and megacorer. In the event, the former proved remarkably successful, although the megacorer failed to penetrate. The gravity corer was deployed at 12.32Z and recovered an excellent 3 m core followed by another bed hop camera transect. At 15.45Z we commenced the recovery of the mooring array, following an acoustically-triggered release, and good seamanship to recover the pellet line. The recovery went exceptionally smoothly with a full suite of instruments intact and in very good condition (little fouling). The sediment trap had performed excellently with a full carousel of sampling bottles recovered. Whilst waiting for the lander sample time to expire (12 hours is required), an attempt was made to deploy the underwater video camera in 230 m. Unfortunately, there appeared to be a power failure to the TV lights, and the exercise was aborted. At 19.35Z the lander was recovered using the tethered pickup. As feared, all electrodes had been damaged although readings had been taken up to the point of failure. After securing sampling gear, a swath/TOPAS track was laid out to undertake a complete survey of the Kongsfjord up to the Kongsbreen glacier front at 100 m depth. On a still evening, the JCR cruised up the fjord amidst spectacular mountain scenery with small drifting bergs to complete the first leg of the survey, Overnight the remainder of the fjord was covered producing an excellent bathymetric and sediment thickness map.

24$^{th}$ June The early morning continued the swath mapping, with arrival on the Ny Alesund pier at 09.20Z to allow a short visit and walk ashore for the ship's party. Chris Hindley and Doug Willis departed for Cambridge via air to Longyearbyen and on to Tromso and Oslo. We were met on the pier by Nick Cox (the Harland Hut base commander) and some of his colleagues. After a short tour of the ship and planning for the Reception on the 2$^{nd}$ July, the pier was left at 12.30Z for Station 1 (78° 57.47N 11° 54.84E, 355 m depth). The initial CTD and box core was followed by an autonomous mode lander drop in Profileur mode. Subsequently, the sediment coring sequence of box, multi, gravity and mega coring was undertaken.

25$^{th}$ June Dawn does not exist so far north at this time of year, but the early hours revealed a spectacularly crisp polar day, with small amount of orographic cloud to the north and east, and a clearing front to the south. At 3.30Z the lander was "pinged" to release ballast and surface – nothing happened. It quickly became apparent that the very soft mud characterising the sediment of the basin at KF1 has enveloped the base of the lander and was not about to release its prize. Following a planning meeting on the bridge, the Captain's plan was put into action – a bridle attached to 400 m wires fore and aft, dragged slowly across the lander site with the JCR in dynamic position mode. Rigging the appropriate wires and clump chain weights was a significant task, but everyone felt a purpose behind the operation. Dragging began mid-morning, and the skill and perseverance of the Captain and crew was rewarded with a welcome sight of the lander at the surface around 08.00Z. The relief was palpable. Another couple of hours was required to retrieve and stow the cable gear, and on recovery of the lander, it was found to be completely undamaged. A great success! The only disappointment was that the sediment had indeed been too soft and that the profiler unit had penetrated too quickly and been unable to recover any suitable data. At 11.10Z we were underway, bound for the Fram Strait and the deeper sampling of the Kongsfjord transect.

Swath and TOPAS was run as we moved out of outer Kongsfjord to the north of Prins Karls Forland. By 17.30Z we were on station over a small contourite mound on the flank of the margin slope (KF4, 1200 m, 78° 59.99N 06° 59.97E) running CTDs and the first couple of box cores. These revealed a significant dilemma;

very soft sediment with the corer overpenetrating. I moved the ship a few km to the southwest off the mound and into slightly deeper water of 1385 m depth. Here the sediment was marginally firmer, and with some lander modification (decreased ballast and increased buoyancy) I took the decision to deploy at 23.40Z (78 ° 57.99N 06 ° 43.03E). By this stage the sea state had dropped to an almost unbelievable degree – virtually as flat as a millpond with only the slightest ripple, although under a rather heavy, leaden sky. Hard to believe we were out in the Fram Strait!

26th June Coring operations, with reduced weights, began at 00.56Z, 800 m to the NNW of the lander site (78 ° 58.40N 06 ° 42.49E). After successfully completing triplicate sets of box and multi cores, we returned to the contourite mound to deploy the gravity core, preceded by a multicore to retrieve an intact sediment water interface. Back at the second ("B") site, mega coring and a bedhop camera preceded the recovery of the lander.

At 16.14Z the release was fired on the lander, closely followed by the second backup. Unfortunately, the instrument package refused to budge and a rapid meeting on the bridge concluded that the soft sediment was indeed holding on to our instruments. Unlike the station 1 in the Kongsfjord, the 1400 m of the Fram Strait was an altogether different proposition and rather different tactics were called for. A single 500 m of trawl wire was attached to a clump chain weight at either end, with one end fixed to the main trawl warp over the rear A-frame. A course was designed to "sweep" the trawl wire over the lander position, releasing it from the mud.

27th June Slow dragging of the wire had failed to produce any effect on the recalcitrant instrument package, so that by 03:00Z the attempt was halted and another approach adopted. The lander position was refixed with range finding based on the pinger signal direction as the JCR sailed a 90° box around the estimated position. This revealed a small drift of the lander during deployment and a seabed location slightly to the northwest of the release point. Another dragging operation was devised and implemented, using a more acute angle of pull, followed by encircling the postion. The latter approach was borne of frustration at the lack of success, but at 10.40Z, after 18 hours, I finally called off the search and we departed for Station 5. This was a bitter decision, rather more because of the impact on our science, rather than the financial aspects of the loss (it is insured!). It had been a tiring and frustrating experience, with our interpretation of the lack of success hinging on the bottom wire flying over the lander as the wire moved upslope.

At 14.33Z we reached station 5 (78° 56.87N 05° 17.35'E) in 2,500 m of water. Sampling began with the now familiar sequence of CTD and water bottles, box, multi, gravity and mega coring with a bed hop camera. The sampling went smoothly.

28th June During the box core, there was a minor hitch on the traction winch with one of the governors. Simon Wright diagnosed the fault and swiftly attended to the situation with minimal down time. The station was completed exactly on time at 17:30Z, and we set off further west to complete a hydrographic survey search for warm core eddies above the Molloy Deep using XBTs. The evening started to brighten considerably from the north west, coinciding with our arrival at the pack ice margin (79° 14.52N 02° 15.0E; 23.22Z).

29th June In the early hours of the day, in full bright sunshine, the ship's company was treated to spectacular pack ice formation and the intensity of the polar light. We watched, mesmerised, as the JCR pushed west a little further, before setting a reciprocal course to lead us out of the pack by 03.00Z. It had been a fantastic introduction to polar sea ice for most of the scientific party. Course was then set NNE for the Yermak Plateau and the most northerly station of the cruise. XBTs continued to be launched.

By the early evening the fog has begun to roll out across the cold waters of the ice front. After clear water on a northeast heading we once more encountered the edge of the pack. Keeping the ice to port we advanced north up an open lead to record the farthest north position for the ship (although this was slightly bettered during a bed-hop camera survey as the ice moved to 80° 45.37'N). At 20:07Z station 1 on the Yermak Plateau commenced with a CTD deployment (80° 41.36'N 07° 25.55'W).

30th June YP1 continued through the grey light of the marginal ice zone. Continuing advance of the pack from the south west progressively pushed us further north, recording the highest latitude at 08:10Z. At 10:00Z the station was complete after a full set of cores and excellent sediment recovery. By now the combination of scientists and crew was working very well indeed and turnaround between gear deployments was efficient maximising down time. Course was set for station 4 in a southerly direction, again launching XBTs at one hour intervals to investigate the thermal structure of the upper water column. Station 4 was to be re-occupied to attempt a second lander recovery operation.

At 22:09Z Station 4 was reached an an initial multi-core deployment performed in order to recover cores for shipboard microelectrode and oxygen incubation studies. The lander recovery commenced with 3 locations and a pinger ranging on the lander position to refine the coordinates. When corrected for the speed of sound in these waters, a precise fix was obtained northeast of the launch site, consistent with the residual current in the Fram Strait. Simultaneous swath mapping revealed the likelihood that the lander was sitting in a break in slope at 1380 m water depth. It seemed that fate had intervened to locate the instrument in the protective crook of a soft sediment embrace on the flanks of the Svalbard margin. The sea state could not have been better with a virtual calm, albeit under overcast skies.

1st July For the second attempt, our strategy was to encircle the lander with 500 m of trawl wire, and weighted coring warp, producing a 360° laying of cable on the bottom, overlapping at the tag end. The lander hopefully would lie at the centre of the 500 m radius. At 1:40Z cable laying began and the noose tightened with a pull to the ESE. By 07:30Z optimism had evaporated into the grey mists of the arctic morning and we called off the attempt. It was clear to me that the physical location of the lander was now a very difficult proposition for any shipboard attempt at recovery. In order to prevent the loss impacting heavily on the science programme, it was important to move on and regain the sampling momentum. Accordingly, course was set due east for the outer channel of the Kongsfjord at the top of the continental slope (Station 3).

At 13:15Z after considerable swath and Topas mapping to elucidate softer sediment in the former glacial channel, Station 3 commenced with a CTD in 330 m of water (79° 01.41'N 10° 41.50'E). The sediment proved to be very fine grained and soft, requiring two attempts with the NIOZ box corer due to overpenetration. Throughout the evening coring continued in very calm seas. The station was completed successfully just after midnight, with a full sample set and bottom camera work.

2nd July By this stage of the cruise, the preparation for the Reception in Ny Alesund to mark the 10th anniversary of NERC's presence was in full swing. Three visitors (the NERC Chairman, Richard Hardman, the Head of Science Programmes, David Brown, and the Head of Administration at BAS, John Pye) were due to arrive on board at breakfast for a short introduction to active marine science. A reception for the Ny Alesund scientific community was arranged for the evening. In the event, fog bound delays to the VIPs travel arrangements in Oslo caused a reshuffle of the programme. Accordingly, we deployed the "Elinor" lander at Station 1 (03:20Z; 78° 57.46'N 11° 54.99'E) for a 36-hour experiment together with a gravity core, and then continued our swath survey of the Kongsfjord to include the northern branch of the Krossfjord and a CTD station. Unfortunately, the day was overcast and the mountains clad by a firm cloud base at less than 300 m height. Nevertheless, the spectacular fjord scenery and the steep flanks of the Krossfjord were obvious. We retraced our track once the Lilliehookbreen glacier seracs were in sight at the head of the fjord. By 11:45Z we were alongside the pier at Ny Alesund.

Shore leave was granted to all personnel, allowing time for souvenirs to be purchased, and the sights of Ny Alesund to be explored. Nick Cox provided considerable help and the facilities of the NERC hut for some equipment testing. However, the highlight before the Reception, was the world's most northerly football match on the 2nd July 2002, played between the Ny Alesund select team and the scientists and crew of the JCR. Unfortunately, the pitch was a little uneven, the opposition rather too skilled, and the bloody knees of the JCR XI saw a 3-0 defeat! Later the Master and NERC VIPs hosted 58 guests on the bridge of the JCR for an excellent reception. A short speech was given by David Brown thanking the scientific community and the Kings Bay Company for their assistance in hosting NERC's presence for the past 10 years. The party lasted well into the small hours!

3rd July At 7:30Z we departed the Ny Alesund facility for the last time, and headed a short distance for Station 1. Three multicore drops were made for oxygen incubation work, followed by transit to Station 2 and the deployment of the mooring rig (13:33Z; 79° 03.44'N 11° 16.87'E; 205 m depth). Over the previous days a vain attempt had been made to elucidate a variety of problems plaguing the two fluorimeter data loggers (ESM-1s; WS Instruments). In the end it was decided not to re-deploy these instruments which was a significant blow to the overall objectives of the mooring. Nevertheless the remaining instrument packages will provide some of the highest oceanographic detail for a northern fjord. Upon successful deployment, we retraced our course (continuing to map the Kongsfjord with swath and Topas) to Station 1 and completed a successful recovery of the "Elinor" lander. By 17:30Z we were once more able to head west for a final attempt at lander recovery at Station 4. At 22.02Z we arrived on station to commence a grappling operation commencing with a ranging of the lander from a northern position.

4th July To attempt the 3rd recovery operation it was decided to try grappling using a towing bar and four grapples. The located lander position was repeatedly raked 100 m either side and from three different directions, unfortunately without success. At 03.55Z the attempt was officially declared over and the position logged. I am grateful to the immense effort made by the Master and the officers and crew in trying to retrieve this equipment and it certainly was not for lack of trying. Course was set south for the Bear Island Fan site. Weather conditions continued to be very favourable for science allowing good speed to be made. A short CTD deployment was undertaken at 07:40Z.

5th July — Under very good conditions for transit, we made rapid progress to a point southwest of Bear Island (73° 39.62'N 13° 47.10'E) where a full station sampling suite commenced with a CTD at 10.50Z following a swath/Topas survey. The first box cores overpenetrated in soft mud, but this was cured by reducing the weight and setting the travel distance at a lower increment. Sea conditions continued to remain calm as we completed the station on time with a mega core at 00:18Z. The station had been completely successful in reaching the sampling objectives set.

6th July — After midnight, course was set for the Sula Ridge. No early morning CTD was taken. By midday, we crossed into the warmer waters of the Norwegian Current. A noticeable change occurred to the air temperature, although skies remained overcast, but brightening towards evening. Swath surveying continued along the line of passage, and all the accumulated backlog of sediment cores was sieved and sectioned. The end-of-cruise entertainment began with a Quiz Night for all JR75 members.

7th July — At 09:03Z a CTD was deployed for water samples at 67°13.03N 09°28.08W. Skies had begun to clear revealing a splendid day with good seas. All the sample backlog was processed and stowed away. Swath surveying continued, leading to the second entertainment night of a darts match between scientists and crew.

8th July — The Sula Ridge was reached just as the sun dipped below the horizon for the briefest of Arctic nights (64°05.25N 08°02.61E; 01:08). Recovery of the photolander commenced with range finding and a diagnostic check. The releases were fired and 8 minutes later the entire package surfaced through a glass-like sea into a spectacular dawn sunrise. The subsequent recovery was completed professionally and without incident. On deck it was clear that the instrument package was performing correctly, with its timed flashguns continuing to activate. Within half an hour the hard disc had been removed and downloaded to reveal a very good set of time lapse digital sea bed images, reflecting the heterogenous nature of the seafloor. These images revealed large, rounded glacial dropstones, one of which lay directly in the line of the flashgun causing a degree of bounce-back and flare.

After completing the lander recovery, we moved to box coring the sediment apron adjacent to the reef in the vicinity of the lander position (64° 05.02N 08° 02.24E). The first core retrieved a large dropstone which deformed the bucket; similar damage and no samples occurred at the second attempt. The final event at the Sula Ridge was a couple of bed-hop camera transects, before departing for the Faroe-Shetland Channel. That evening, the scientists and officers gathered to mutually thank each other and to celebrate with an evening meal, the PSO's open house, and a truly spectacular concert from three of the scientific party (Black, Howe and Griffiths).

9th July — En route to the Faroe-Shetland Channel and a swath/Topas survey of the mud diapers at 62° 47.7N, 01°28.3W commissioned by the DTI via Geotek. The survey consisted of three lines forming a triangle. At the completion of the third line, the main power supply board for the Topas system expired. Without knowing the cause of this fault, it was decided to shut down the system rather than attempt a repair.

At 10:30Z a CTD was deployed for water samples at 62°38.84N 01°19.38W . The remaining XBT's were fired through the day along the axis of the Faeroe Shetland Channel.

10th July At 02:25Z the final CTD cast was deployed at 62°38.84N 01°19.38W, A further 8 XBTs were fired during the early morning. The last XBT was fired at 0902Z. A course was now set for Stornoway. It was a fine evening as we entered the Minch, the James Clark Ross docked in Stornoway at 2103Z.

**JCR75 Station Log**

| Date | Time | Lat | Long | Event | Depth | I/W | Bottom | O/W | Stn | Activity | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 16/06/02 | 0842 | N59 30.73 | W01 25.75 | #1 | 95.6 | | 0921 | 0938 | SD | CTD001 | Shake down |
| 16/06/02 | 1437 | N60 25.05 | W00 27.03 | #2 | 90 | | | | | XBT001 | TOPAS XBT |
| 17/06/02 | 0835 | N63 05.84 | E04 35.90 | #3 | 875 | 0842 | 0906 | 0933 | UEA1 | CTD002 | 0930 Dip |
| 17/06/02 | 1855 | N64 03.95 | E07 56.88 | #4 | 256 | 1855 | | | | XBT002 | TOPAS XBT |
| 17/06/02 | 2122 | N64 05.19 | E08 02.20 | #5 | 285 | 2121 | 2136 | 2200 | SULA | CTD003 | O2 added |
| 17/06/02 | 2241 | N64 05.02 | E08 02.26 | #6 | 285 | 2242 | 2251 | 2257 | SULA | NIOZ001 | No Core |
| 17/06/02 | 2305 | N64 05.02 | E08 02.26 | #7 | 285 | 2307 | 2318 | 2225 | SULA | NIOZ002 | Good Core |
| 18/06/02 | 0003 | N64 05.01 | E08 02.21 | #8 | 286 | 0005 | 0046 | | SULA | LANDER | DEPLOYED |
| 18/06/02 | 0838 | N65 30.04 | E07 46.36 | #9 | 380 | 0845 | 0900 | 0921 | UEA2 | CTD004 | |
| 18/06/02 | 1733 | N67 08.51 | E07 29.71 | #10 | 1287 | 1733 | | | | XBT003 | TOPAS |
| 18/06/02 | 1940 | N67 11.03 | E07 29.89 | #11 | 1565 | 1943 | 2020 | 2056 | VP1 | CTD005 | |
| 18/06/02 | 2136 | N67 11.52 | E07 29.42 | #12 | 1358 | 2137 | 2202 | 2230 | VP1 | GC001 | GRAVITY |
| 18/06/02 | 2328 | N67 15.19 | E07 28.61 | #13 | 1510 | | 0020 | | | BUOYAN | CY TEST |
| 19/06/02 | 0540 | N67 13.03 | E06 05.95 | #14 | 1437 | 0540 | 0615 | | VP2 | CTD006 | RELEASE |
| 19/06/02 | 0700 | N67 13.12 | E06 05.91 | #15 | 1438 | 0700 | | | VP2 | CTD007 | ABORT |
| 19/06/02 | 0802 | N67 13.02 | E06 05.79 | #16 | 1437 | 0803 | 0830 | 0900 | VP2 | NIOZ003 | |
| 19/06/02 | 0916 | N67 13.02 | E06 05.70 | #17 | 1435 | 0916 | 0944 | 1012 | VP2 | NIOZ004 | |
| 19/06/02 | 1116 | N67 13.21 | E06 05.30 | #18 | 1440 | 1116 | 1141 | | VP2 | PROFILE | LANDER |
| 19/06/02 | 1212 | N67 13.04 | E06 06.15 | #19 | 1436 | 1212 | - | 1327 | VP2 | CTD008 | Profile |
| 19/06/02 | 1349 | N67 13.01 | E06 06.06 | #20 | 1436 | 1349 | 1423 | 1523 | VP2 | Bedhop01 | OK |
| 19/06/02 | 1540 | N67 12.85 | E06 05.54 | #21 | 1385 | 1545 | 1615 | 1645 | VP2 | NIOZ005 | Good core |
| 19/06/02 | 1725 | N67 12.86 | E06 05.53 | #22 | 1434? | 1726 | 1753 | 1819 | VP2 | MultiC001 | Good cores |
| 19/06/02 | 1835 | N67 12.86 | E06 05.53 | #23 | 1433? | 1837 | 1900 | 1928 | VP2 | MultiC002 | Good cores |
| 19/06/02 | 1940 | N67 12.85 | E06 05.54 | #24 | 1433 | 1943 | 2014 | 2042 | VP2 | MultiC003 | |
| 19/06/02 | 2120 | N67 12.80 | E06 06.23 | #25 | 1406 | 2120 | 2143 | 2212 | VP2 | GC002 | |
| 19/06/02 | 2233 | N67 12.81 | E06 06.25 | #26 | 1385 | 2233 | 2259 | 0026 | VP2 | MegaC001 | |
| 20/06/02 | 0025 | | | #27 | 1440 | | | 0105 | VP2 | Profilur | Recovery |
| 20/06/02 | 0128 | N67 13.11 | E05 05.15 | #28 | 1390 | 0129 | 0152 | | VP2 | MegaC002 | |
| 20/06/02 | 0303 | N67 13.09 | E05 05.13 | #29 | | 0307 | 0335 | 0440 | VP2 | BH002 | |
| 20/06/02 | 0700 | N67 36.49 | E06 12.97 | #30 | 1565 | 0702 | 0707 | | XBT | XBT004 | |
| 20/06/02 | 0759 | | | #31 | | 0801 | 0809 | | XBT | XBT005 | |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| 20/06/02 | 0830 | N67 54.74 | E06 21.22 | #32 | 1323 | 0840 | 0904 | 0936 | UEA3 | CTD009 | 1000m cast |
| 20/06/02 | 0954 | N67 56.99 | E06 22.99 | #33 | 1374 | 0957 | 1006 | | XBT | XBT006 | |
| 20/06/02 | 1056 | N68 08.89 | E06 26.16 | #34 | 1726 | 1101 | 1103 | | XBT | XBT007 | |
| 20/06/02 | 1156 | N68 20.39 | E06 30.39 | #35 | 2334 | | | | XBT | XBT008 | |
| 20/06/02 | 1205 | N68 21.96 | E06 31.02 | #36 | 2389 | 1212 | 1214 | | XBT | XBT009 | |
| 20/06/02 | 1303 | N68 32.94 | E06 32.70 | #37 | 2515 | 1308 | | | XBT | XBT010 | |
| 20/06/02 | 1404 | N68 43.22 | E06 34.55 | #38 | 3000 | 1411 | 1415 | | XBT | XBT011 | |
| 20/06/02 | 1453 | N68 50.48 | E06 35.74 | #39 | 3145 | | | | XBT | XBT012 | |
| 20/06/02 | 1457 | N68 51.02 | E06 35.81 | #40 | 3153 | 1459 | | | XBT | XBT013 | |
| 20/06/02 | 1600 | N68 59.67 | E06 37.47 | #41 | 3668 | 1604 | 1608 | | XBT | XBT014 | |
| 20/06/02 | 1700 | N69 08.51 | E06 39.18 | #42 | 3184 | 1701 | 1705 | | XBT | XBT015 | |
| 20/06/02 | 1800 | N69 19.00 | E06 40.89 | #43 | 3220 | 1805 | 1809 | | XBT | XBT016 | |
| 20/06/02 | 1855 | N69 27.54 | E06 43.45 | #44 | 3209 | 1853 | 1858 | | XBT | XBT017 | |
| 20/06/02 | 2058 | N69 39.33 | E06 45.01 | #45 | 3201 | 2058 | 2107 | | XBT | XBT018 | |
| 20/06/02 | 2055 | N69 49.39 | E06 45.52 | #46 | 3175 | 2213 | | | XBT | XBT019 | |
| 20/06/02 | 2159 | N70 02.11 | E06 48.60 | #47 | 3151 | 2210 | 2216 | | XBT | XBT020 | |
| 20/06/02 | 2258 | N70 11.60 | E06 51.40 | #48 | 3101 | 2302 | 2307 | | XBT | XBT021 | Good |
| 21/06/02 | 0010 | N70 24.80 | E06 55.67 | #49 | 3064 | 0015 | | | XBT | XBT022 | FAIL |
| 21/06/02 | 0024 | N70 27.29 | E06 55.91 | #50 | 3058 | 0028 | | | XBT | XBT023 | Good |
| 21/06/02 | 0112 | N70 36.64 | E06 58.03 | #51 | 3047 | 0118 | 0122 | | XBT | XBT024 | Good |
| 21/06/02 | 0225 | N70 50.37 | E07 02.40 | #52 | 3030 | 0230 | 0233 | | XBT | XBT025 | Good |
| 21/06/02 | 0255 | N70 56.42 | E07 03.28 | #53 | 3046 | 0255 | Abort | | XBT | XBT026 | FAIL |
| 21/06/02 | 0310 | N70 58.61 | E07 03.74 | #54 | 3050 | 0312 | 0317 | | XBT | XBT027 | Good |
| 21/06/02 | 0400 | N71 07.88 | E07 06.62 | #55 | 2977 | 0401 | 0405 | | XBT | XBT028 | Good |
| 21/06/02 | 0500 | N71 18.73 | E07 10.29 | #56 | 2942 | 0500 | 0503 | | XBT | XBT029 | Good |
| 21/06/02 | 0600 | N71 29.90 | E07 13.48 | #57 | 2919 | 0600 | 0603 | | XBT | XBT031 | Good |
| 21/06/02 | 0700 | N71 42.26 | E07 17.15 | #58 | 2831 | 0704 | 0708 | | XBT | XBT032 | |
| 21/06/02 | 0800 | N71 53.14 | E07 20.31 | #59 | 2780 | 0805 | 0811 | | XBT | XBT033 | |
| 21/06/02 | 0830 | N71 58.25 | E07 21.02 | #60 | 2757 | 0858 | 0932 | | CTD | CTD010 | |
| 21/06/02 | 0951 | N72 00.77 | E07 21.65 | #61 | 2746 | 0952 | | | XBT | XBT034 | Noisy |
| 21/06/02 | 0955 | N72 01.54 | E07 21.91 | #62 | 2743 | 0956 | 1001 | | XBT | XBT035 | |
| 21/06/02 | 1101 | N72 13.40 | E07 26.15 | #63 | 2672 | 1103 | | | XBT | XBT036 | |
| 21/06/02 | 1107 | N72 14.59 | E07 26.64 | #64 | 2656 | 1108 | 1113 | | XBT | XBT037 | |
| 21/06/02 | 1204 | N72 25.90 | E07 30.30 | #65 | 2585 | 1205 | 1206 | | XBT | XBT038 | |
| 21/06/02 | 1306 | N72 38.40 | E07 33.70 | #66 | 2534 | | | | XBT | XBT039 | |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| 21/06/02 | 1404 | N72 50.10 | E07 36.20 | #67 | 2479 | | | | XBT | XBT040 | |
| 21/06/02 | 1500 | N72 02.70 | E07 41.60 | #68 | 2430 | 1504 | 1508 | | XBT | XBT041 | |
| 21/06/02 | 1600 | N72 13.40 | E07 42.80 | #69 | 2473 | 1601 | 1604 | | XBT | XBT042 | |
| 21/06/02 | 1700 | N73 25.77 | E07 42.37 | #70 | 2984 | 1726 | 1921 | | TEST | LANDER | |
| 21/06/02 | 1946 | N73 25.77 | E07 42.37 | #71 | 3212 | 1948 | 2031 | 2148 | TEST | LANDER | |
| 21/06/02 | 2206 | N73 29.30 | E07 44.37 | #72 | 2773 | 2214 | 2217 | | XBT | XBT043 | |
| 21/06/02 | 2303 | N73 40.36 | E07 49.29 | #73 | 2240 | 2309 | 2312 | | XBT | XBT044 | |
| 22/06/02 | 0003 | N73 52.92 | E07 55.03 | #74 | 2223 | 0010 | 0013 | | XBT | XBT045 | |
| 22/06/02 | 0112 | N74 05.96 | E08 00.06 | #75 | 2443 | 0116 | 0120 | | XBT | XBT046 | |
| 22/06/02 | 0208 | N74 16.62 | E08 04.59 | #76 | 2360 | 0212 | 0215 | | XBT | XBT047 | |
| 22/06/02 | 0309 | N74 29.60 | E08 09.68 | #77 | 2660 | 0311 | 0317 | | XBT | XBT048 | |
| 22/06/02 | 0409 | N74 41.98 | E08 14.66 | #78 | 2558 | 0415 | 0421 | | XBT | XBT049 | |
| 22/06/02 | 0511 | N74 54.75 | E08 19.22 | #79 | 3471 | 0516 | 0521 | | XBT | XBT050 | |
| 22/06/02 | 0616 | N75 08.34 | E08 23.73 | #80 | 2638 | 0620 | 0626 | | XBT | XBT051 | |
| 22/06/02 | 0715 | N75 20.55 | E08 28.11 | #81 | 2686 | 0719 | 0725 | | XBT | XBT052 | |
| 22/06/02 | 0800 | N75 30.54 | E08 32.13 | #82 | 2580 | 0806 | 0810 | | XBT | XBT053 | |
| 22/06/02 | 0830 | N75 34.41 | E08 32.35 | #83 | 2557 | 0834 | 0858 | | CTD | CTD011 | To 1000m |
| 22/06/02 | 1000 | N75 39.43 | E08 34.36 | #84 | 2386 | 1002 | 1005 | | XBT | XBT054 | |
| 22/06/02 | 1100 | N75 41.40 | E08 39.81 | #85 | 2369 | 1102 | - | | XBT | XBT055 | Broke off |
| 22/06/02 | 1110 | N75 53.01 | E08 40.43 | #86 | 2369 | 1110 | 1114 | | XBT | XBT056 | |
| 22/06/02 | 1200 | N75 03.42 | E08 44.03 | #87 | 2300 | 1203 | 1206 | | XBT | XBT057 | |
| 22/06/02 | 1304 | N75 15.76 | E08 49.12 | #88 | 2250 | 1308 | 1311 | | XBT | XBT058 | |
| 22/06/02 | 1402 | N75 27.31 | E08 52.35 | #89 | 2214 | 1404 | 1407 | | XBT | XBT059 | |
| 22/06/02 | 1500 | N75 39.12 | E08 58.40 | #90 | 2264 | 1500 | 1504 | | XBT | XBT060 | FAILURE |
| 22/06/02 | 1505 | N75 40.87 | E08 59.16 | #91 | 2264 | 1508 | 1511 | | XBT | XBT061 | |
| 22/06/02 | 1605 | N75 52.46 | E08 03.82 | #92 | 2237 | 1605 | 1608 | | XBT | XBT062 | |
| 22/06/02 | 1700 | N77 04.00 | E08 08.38 | #93 | 2202 | 1700 | 1703 | | XBT | XBT063 | |
| 22/06/02 | 1910 | N77 30.90 | E09 19.62 | #94 | 1904 | 1910 | 1916 | | XBT | XBT064 | Wrong setup |
| 22/06/02 | 2019 | N77 45.23 | E09 25.65 | #95 | 1276 | 2020 | 2027 | | XBT | XBT065 | |
| 22/06/02 | 2102 | N77 55.16 | E09 29.44 | #96 | - | 2104 | 2108 | | XBT | XBT066 | |
| 22/06/02 | 2207 | N78 08.56 | E09 36.03 | #97 | - | 2205 | 2212 | | XBT | XBT067 | |
| 23/06/02 | 0230 | - | - | #98 | 246 | 0230 | - | | XBT | XBT068 | Topas X |
| 23/06/02 | 0235 | N78 59.78 | E10 43.33 | #99 | 250 | 0235 | 0237 | | XBT | XBT069 | Topas |
| 23/06/02 | 0534 | N79 03.26 | E11 18.01 | | 241 | 0534 | - | 0540 | KF2 | Acoustics | Mooring |
| 23/06/02 | 0542 | N79 03.25 | E11 17.97 | #100 | 240 | 0543 | 0551 | 0559 | KF2 | NBC | Good |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| 23/06/02 | 0620 | N79 03.25 | E11 17.97 | #101 | 240 | 0621 | 0633 | | KF2 | lander | Moored |
| 23/06/02 | 0640 | N79 03.25 | E11 17.97 | #102 | 240 | 0645 | 0651 | 0658 | KF2 | CTD012 | Bottom |
| 23/06/02 | 0710 | N79 03.25 | E11 17.97 | #103 | 240 | 0714 | 0728 | 0748 | KF2 | CTD013 | Profile |
| 23/06/02 | 0809 | N79 03.56 | E11 18.28 | #104 | 218 | 0809 | - | 0908 | KF2 | BedHop | BH003 |
| 23/06/02 | 0929 | N79 03.35 | E11 18.08 | #105 | 244 | 0931 | 0938 | 0944 | KF2 | NBC | OK |
| 23/06/02 | 1005 | N79 03.34 | E11 18.01 | #106 | 244 | 1006 | 1011 | 1017 | KF2 | NBC | OK |
| 23/06/02 | 1048 | N79 03.34 | E11 18.08 | #107 | 244 | 1050 | 1057 | 1106 | KF2 | MultiC | 6 good |
| 23/06/02 | 1116 | N79 03.34 | E11 18.08 | #108 | 231 | 1116 | 1122 | 1130 | KF2 | MultiC | 8 good |
| 23/06/02 | 1141 | N79 03.30 | E11 18.08 | #109 | 231 | 1141 | 1146 | 1154 | KF2 | MultiC | |
| 23/06/02 | 1232 | N79 03.03 | E11 21.54 | #110 | 307 | - | 1239 | - | KF2 | GC003 | #GC064 |
| 23/06/02 | 1323 | N79 03.33 | E11 17.68 | #111 | 222 | 1322 | 1328 | 1336 | KF2 | MegaC | X |
| 23/06/02 | 1342 | N79 03.33 | E11 17.66 | #112 | 230 | 1344 | 1349 | 1401 | KF2 | MegaC | X |
| 23/06/02 | 1442 | N79 03.57 | E11 18.56 | #113 | 212 | 1443 | 1447 | 1538 | KF2 | Bedhop | |
| 23/06/02 | 1545 | N79 03.47 | E11 18.86 | #114 | | | | | KF2 | Mooring | Recovery |
| 23/06/02 | | | | #115 | | | | | KF2 | Video | Problems |
| 23/06/02 | 1900 | N79 03.41 | E11 17.79 | #116 | 250 | | | 1935 | KF2 | Lander | Recovery |
| 24/06/02 | 1300 | N78 57.46 | E11 54.49 | #117 | 355 | 1305 | 1314 | 1321 | KF1 | CTD014 | Bottom |
| 24/06/02 | 1330 | N78 57.46 | E11 54.49 | #118 | 355 | 1334 | 1349 | 1406 | KF1 | CTD015 | Profile |
| 24/06/02 | 1424 | N78 57.46 | E11 54.48 | #119 | 355 | 1425 | 1433 | 1441 | KF1 | NBC | Good |
| 24/06/02 | 1515 | N78 57.47 | E11 53.95 | #120 | 354 | 1517 | | | KF1 | Lander | Free Fall |
| 24/06/02 | 1550 | N78 57.46 | E11 54.53 | #121 | 355 | 1551 | 1559 | 1607 | KF1 | NBC | Good |
| 24/06/02 | 1625 | N78 57.46 | E11 54.53 | #123 | 355 | 1625 | 1632 | 1643 | KF1 | NBC | Good |
| 24/06/02 | 1710 | N78 57.46 | E11 54.48 | #124a | 355 | 1710 | 1727 | 1801 | KF1 | BHC | bedhop |
| 24/06/02 | 1900 | N78 57.46 | E11 54.48 | #124b | 355 | 1901 | 1911 | | KF1 | MC | 8/8 FULL |
| 24/06/02 | 1937 | N78 57.46 | E11 54.49 | #125 | 355 | 1937 | 1944 | 1955 | KF1 | MC | 7/8 FULL |
| 24/06/02 | 2007 | N78 57.46 | E11 54.49 | #126 | 355 | 2008 | 2015 | 2026 | KF1 | MC | BIT BENT |
| 24/06/02 | 2035 | N78 57.46 | E11 54.49 | #127 | 355 | 2036 | 2043 | 2052 | KF1 | GC | GC#065 |
| 24/06/02 | 2110 | N78 57.46 | E11 54.49 | #128 | 355 | 2111 | 2118 | 2129 | KF1 | MegaC | 2 lost |
| 24/06/02 | 2205 | N78 57.46 | E11 54.49 | #129 | 355 | 2207 | 2214 | 2225 | KF1 | MegaC | 2 of 3 |
| 24/06/02 | 2242 | N78 57.46 | E11 54.49 | #130 | 355 | 2243 | 2251 | 2302 | KF1 | MegaC | 3 of 3 |
| 25/06/02 | 0005 | N78 57.46 | E11 54.50 | #131 | 355 | 0005 | 0009 | 0017 | KF1 | SAMS BC | |
| 25/06/02 | 0105 | N78 57.48 | E11 54.49 | #132 | 355 | 0105 | 0112 | 0210 | KF1 | BHC | bedhop |
| 25/06/02 | 0105 | N78 57.48 | E11 53.84 | #133 | 359 | 0330 | | | KF1 | LANDER | Recovery |
| | | | | | | | | 1019 | KF1 | LANDER | onboard |
| 25/06/02 | 1450 | N78 58.89 | E07 53.71 | #134 | 1105 | 1451 | 1454 | | XBT | XBT070 | Topas |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| 25/06/02 | 1730 | N79 00.00 | E06 59.98 | #135 | 1215 | 1735 | 1800 | 1822 | KF4A | CTD016 | BOTTOM |
| 25/06/02 | 1833 | N79 00.16 | E06 59.57 | #136 | 1220 | 1836 | 1909 | 1949 | KF4A | CTD017 | Profile |
| 25/06/02 | 2011 | N79 00.00 | E06 59.98 | #137 | 1246 | 2015 | 2038 | 2102 | KF4A | NIOZ | muddy |
| 25/06/02 | | N78 57.99 | E06 43.02 | #138 | 1381 | | | 2259 | KF4B | NIOZ | |
| 25/06/02 | 2340 | N78 57.99 | E06 43.03 | #139 | 1381 | 2340 | 0013 | - | KF4B | LANDER | DEPLOYED |
| 26/06/02 | 0056 | N78 58.38 | E06 42.49 | #140 | 1385 | 0052 | 0121 | 0155 | KF4B | NIOZ | |
| 26/06/02 | 0210 | N78 58.40 | E06 42.49 | #141 | 1385 | 0210 | 0240 | 0308 | KF4B | NIOZ | |
| 26/06/02 | 0331 | N78 58.40 | E06 42.47 | #142 | 1385 | 0331 | 0400 | - | KF4B | MultiC | |
| 26/06/02 | 0456 | N78 58.40 | E06 42.47 | #143 | 1385 | 0456 | 0526 | 0550 | KF4B | MultiC | |
| 26/06/02 | 0605 | N78 58.42 | E06 42.46 | #144 | 1385 | 0606 | 0631 | - | KF4B | MultiC | |
| 26/06/02 | 0730 | N78 58.42 | E06 42.46 | #145 | 1385 | 0735 | 0755 | 0818 | KF4B | MultiC | |
| 26/06/02 | 0901 | N79 00.00 | E06 56.81 | #146 | 1226 | 0904 | 0930 | 0957 | KF4A | MultiC | Geology Site |
| 26/06/02 | 1003 | N79 00.01 | E06 56.84 | #147 | 1226 | 1007 | 1031 | 1054 | KF4A | GC066 | 1226 w/o |
| 26/06/02 | 1155 | N78 58.43 | E06 42.66 | #148 | 1352 | 1156 | 1221 | - | KF4B | MegaC | 1335 w/o |
| 26/06/02 | 1323 | N78 58.40 | E06 42.73 | #149 | 1381 | - | 1323 | | KF4B | MegaC | |
| 26/06/02 | 1415 | N78 58.40 | E06 42.77 | #150 | 1380 | 1417 | 1442 | | KF4B | BHC | |
| 26/06/02 | 1612 | N78 57.82 | E06 43.68 | #151 | 1422 | | | | KF4B | Lander | recovery |
| 27/06/02 | 1433 | N78 56.90 | E05 17.35 | #152 | 2500 | 1433 | 1516 | 1559 | KF5 | CTD018 | BOTTOM |
| 27/06/02 | 1610 | N78 56.87 | E05 17.31 | #153 | 2500 | 1614 | 1704 | 1802 | KF5 | CTD019 | PROFILE |
| 27/06/02 | 1810 | N78 56.87 | E05 17.31 | #154 | 2500 | 1810 | 1855 | 2044 | KF5 | BHC | bedhop |
| 27/06/02 | 2120 | N78 56.85 | E05 17.32 | #155 | 2498 | 2121 | 2205 | 2247 | KF5 | NIOZ | MUD |
| 27/06/02 | 2311 | N78 56.85 | E05 17.31 | #156 | 2498 | 2312 | 2351 | 0152 | KF5 | NIOZ | PROBLEMS |
| 28/06/02 | 0230 | N78 56.85 | E05 17.31 | #157 | 2465 | 0232 | 0319 | 0357 | KF5 | MultiC | W/o 2465 |
| 28/06/02 | 0420 | N78 56.85 | E05 17.31 | #158 | 2465 | 0424 | 0500 | 0540 | KF5 | MultiC | |
| 28/06/02 | 0555 | N78 56.85 | E05 17.31 | #159 | 2465 | 0556 | 0630 | 0711 | KF5 | MultiC | |
| 28/06/02 | 0725 | N78 56.85 | E05 17.31 | #160 | 2465 | 0728 | 0805 | 0840 | KF5 | MultiC | |
| 28/06/02 | 0925 | N78 56.74 | E05 13.59 | #161 | 2500 | 0926 | | 1115 | KF5A | GC | |
| 28/06/02 | 1130 | N78 56.90 | E05 17.83 | #162 | 2632? | 1130 | 1216 | 1255 | KF5 | Mega | 2467 W/O |
| 28/06/02 | 1313 | N78 56.86 | E05 17.47 | #163 | ? | 1313 | 1350 | - | KF5 | Mega | 2463 W/O |
| 28/06/02 | 1505 | N78 56.89 | E05 16.60 | #164 | 2500? | 1506 | 1551 | - | KF5 | BHC | |
| 28/06/02 | 2237 | N79 15.00 | E02 30.00 | #165 | 4444 | 2237 | - | - | HS | XBT071 | |
| 28/06/02 | 2322 | N79 14.52 | E02 15.00 | #166 | 4142 | 2322 | - | - | HS | XBT072 | Heavy ice |
| 29/06/02 | 0003 | N79 15.00 | E02 09.30 | #167 | 4270 | 0003 | | | HS | XBT072 | |
| 29/06/02 | 0034 | N79 17.00 | E02 21.30 | #168 | 3585 | 0034 | | | HS | XBT073 | |
| 29/06/02 | 0056 | N79 15.71 | E02 29.31 | #169 | 3930 | 0056 | | | HS | XBT074 | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 29/06/02 | 0118 | N79 13.78 | E02 40.19 | #170 | 4980 | 0118 | | | HS | XBT075 | |
| 29/06/02 | 0127 | N79 13.00 | E02 45.30 | #171 | 5163 | 0127 | | | HS | XBT076 | |
| 29/06/02 | 0137 | N79 12.28 | E02 50.50 | #172 | 5462 | 0137 | | | HS | XBT077 | |
| 29/06/02 | 0145 | N79 11.57 | E02 55.00 | #173 | 5323 | 0145 | | | HS | XBT078 | |
| 29/06/02 | 0157 | N79 10.87 | E03 00.00 | #174 | 5329 | 0157 | | | HS | XBT079 | |
| 29/06/02 | 0221 | N79 09.90 | E03 06.30 | #175 | 5314 | 0221 | | | HS | XBT080 | |
| 29/06/02 | 0230 | N79 10.21 | E03 11.76 | #176 | 5172 | 0230 | | | HS | XBT081 | |
| 29/06/02 | 0237 | N79 10.43 | E03 15.44 | #177 | 5049 | 0237 | | | HS | XBT082 | |
| 29/06/02 | 0246 | N79 10.68 | E03 12.00 | #178 | 5054 | 0246 | | | HS | XBT084 | 83? |
| 29/06/02 | 0257 | N79 10.35 | E03 24.75 | #179 | 5068 | 0257 | | | HS | XBT085 | |
| 29/06/02 | 0307 | N79 10.00 | E03 30.00 | #180 | 4753 | 0307 | | | HS | XBT086 | |
| 29/06/02 | 0318 | N79 09.75 | E03 35.00 | #181 | 3791 | 0318 | | | HS | XBT087 | |
| 29/06/02 | 0417 | N79 06.44 | E03 36.81 | #182 | 3323 | 0417 | | | HS | XBT088 | |
| 29/06/02 | 0830 | N79 19.27 | E06 37.22 | #183 | 1568 | 0834 | | | UEA | CTD020 | |
| 29/06/02 | 1909 | N80 41.36 | E07 25.55 | #184 | 867 | 1920 | 1941 | 1956 | YP1 | CTD021 | NORTH |
| 29/06/02 | 2007 | N80 41.36 | E07 25.53 | #185 | 888 | 2008 | 2030 | 2107 | YP1 | CTD022 | |
| 29/06/02 | 2125 | N80 41.36 | E07 25.64 | #186 | 886 | 2127 | 2143 | 2240 | YP1 | BH | |
| 29/06/02 | 2320 | N80 43.65 | E07 24.66 | #187 | 892 | 2320 | 2345 | 2358 | YP1a | NIOZ | ICE |
| 30/06/02 | 0025 | N80 43.64 | E07 24.60 | #188 | | 0025 | 0043 | | YP1a | NIOZ | |
| 30/06/02 | 0120 | N80 43.76 | E07 25.72 | #189 | 898 | 0120 | 0139 | 0157 | YP1a | NIOZ | |
| 30/06/02 | 0252 | N80 45.02 | E07 38.72 | #190 | 922 | 0252 | 0309 | 0331 | YP1b | MultiC | ICE |
| 30/06/02 | 0343 | N80 45.02 | E07 38.74 | #191 | | 0343 | 0400 | 0418 | YP1b | MultiC | |
| 30/06/02 | 0429 | N80 45.02 | E07 38.74 | #192 | | 0429 | 0446 | 0507 | YP1b | MultiC | |
| 30/06/02 | 0521 | N80 45.00 | E07 38.72 | #193 | 961 | 0521 | 0538 | 0556 | YP1b | GC | |
| 30/06/02 | 0600 | N80 45.00 | E07 38.72 | #194 | | 0600 | 0629 | 0650 | YP1b | MegaC | |
| 30/06/02 | 0700 | N80 45.00 | E07 38.72 | #195 | | 0700 | 0718 | 0735 | YP1b | MegaC | |
| 30/06/02 | 0810 | N80 45.37 | E07 40.73 | #196 | 966 | 0812 | 0830 | | YP1b | BH | |
| 30/06/02 | 1000 | N80 44.59 | E07 59.71 | #197 | 951 | 1005 | | | XBT | XBT089 | FAIL |
| 30/06/02 | 1005 | N80 43.39 | E07 59.68 | #198 | 946 | 1007 | | | XBT | XBT090 | FAIL |
| 30/06/02 | 1013 | N80 42.90 | E07 59.44 | #199 | 930 | 1013 | | | XBT | XBT091 | |
| 30/06/02 | 1105 | N80 37.40 | E08 32.25 | #200 | 849 | 1105 | | | XBT | XBT092 | |
| 30/06/02 | 1110 | N80 36.97 | E08 35.27 | #201 | 881 | 1110 | | | XBT | XBT093 | |
| 30/06/02 | 1210 | N80 28.91 | E09 09.82 | #202 | 927 | 1210 | | | XBT | XBT094 | |
| 30/06/02 | 1300 | N80 20.26 | E09 27.50 | #203 | 620 | 1303 | | | XBT | XBT095 | |
| 30/06/02 | 1403 | N80 09.87 | E09 28.41 | #204 | 552 | 1411 | | | XBT | XBT096 | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30/06/02 | 1500 | N80 00.68 | E09 27.50 | #205 | 488 | 1501 | | | XBT | XBT097 | |
| 30/06/02 | 1600 | N79 52.29 | E09 20.89 | #206 | 458 | 1601 | | | XBT | XBT098 | X |
| 30/06/02 | 1605 | N79 51.96 | E09 20.61 | #207 | 458 | 1605 | | | XBT | XBT099 | |
| 30/06/02 | 1655 | N79 43.76 | E09 11.33 | #208 | 404 | 1658 | | | XBT | XBT100 | |
| 30/06/02 | 1805 | N79 33.98 | E08 40.78 | #209 | 405 | 1805 | | | XBT | XBT101 | |
| 30/06/02 | 1900 | N79 25.36 | E08 14.93 | #210 | 285 | 1802 | | | XBT | XBT102 | |
| 30/06/02 | 2004 | N79 15.86 | E07 45.83 | #211 | 884 | 2005 | | | XBT | XBT103 | |
| 30/06/02 | 2209 | N78 58.33 | E06 58.33 | #212 | 1326 | 2215 | | | KF4 | MultiC | |
| 30/06/02 | 2316 | N78 56.24 | E06 42.23 | #213 | 1380 | 2316 | 0023 | 0053 | | Survey | |
| 30/06/02 | 0140 | N78 58.08 | E06 42.91 | #214 | 1380 | | | 0731 | | Dragging | |
| 01/07/02 | 1315 | N79 01.41 | E10 41.50 | #215 | 327 | 1317 | 1328 | 1335 | KF3b | CTD023 | |
| 01/07/02 | 1348 | N79 01.33 | E10 41.52 | #216 | 333 | 1349 | 1424 | 1426 | KF3b | CTD024/5 | |
| 01/07/02 | 1435 | N79 01.33 | E10 41.52 | #217 | 331 | 1435 | 1445 | 1523 | KF3b | BHC | BHC(914) |
| 01/07/02 | 1606 | N79 01.34 | E10 41.73 | #218 | 343 | 1606 | 1616 | 1624 | KF3b | NIOZ | |
| 01/07/02 | 1635 | N79 01.34 | E10 41.68 | #219 | 343 | 1637 | 1646 | 1656 | KF3b | NIOZ | |
| 01/07/02 | 1712 | N79 01.34 | E10 41.65 | #220 | 342 | 1714 | 1722 | 1731 | KF3b | NIOZ | |
| 01/07/02 | 1755 | N79 01.34 | E10 41.63 | #221 | 342 | 1755 | 1806 | | KF3b | NIOZ | |
| 01/07/02 | 1845 | N79 01.34 | E10 41.62 | #222 | 342 | 1848 | 1857 | | KF3b | MultiC | |
| 01/07/02 | 1915 | | | #223 | 342 | | 1934 | | KF3b | MultiC | |
| 01/07/02 | 1950 | | | #224 | 342 | | 2006 | 2018 | KF3b | MultiC | |
| 01/07/02 | 2024 | N79 01.33 | E10 41.63 | #225 | 342 | 2025 | 2028 | 2035 | KF3b | GC | GC072 |
| 01/07/02 | 2056 | N79 01.33 | E10 41.63 | #226 | 342 | 2056 | 2100 | 2108 | KF3b | GC | GC073 |
| 01/07/02 | 2120 | N79 01.34 | E10 41.61 | #227 | 325 | 2120 | 2129 | 2139 | KF3b | MegaC | |
| 01/07/02 | 2146 | N79 01.33 | E10 41.61 | #228 | 343 | 2146 | 2156 | | KF3b | MegaC | |
| 01/07/02 | 2222 | N79 01.33 | E10 41.62 | #229 | 343 | 2222 | 2230 | 2242 | KF3b | MegaC | |
| 01/07/02 | 2309 | N79 01.33 | E10 41.61 | #230 | 333 | 2309 | 2319 | 0034 | KF3b | BHC | Bedhop |
| 02/07/02 | 0320 | N78 57.46 | E11 54.99 | #231 | 365 | 0322 | 0340 | | KF1 | LANDER | Moored |
| 02/07/02 | 0610 | N78 59.36 | E11 46.03 | #232 | 379 | 0615 | 0630 | 0640 | KF1b | GC | GC074 |
| | | | | #233 | | | | | | | |
| 02/07/02 | 0712 | N79 10.52 | E11 46.67 | #234 | 350 | 0711 | 0724 | 0750 | KF1 | CTD026 | |
| 03/07/02 | 0758 | N78 57.38 | E11 54.57 | #235 | 366 | 0802 | 0810 | 0820 | KF1 | MultiC | |
| 03/07/02 | 0827 | N78 57.41 | E11 54.46 | #236 | 366 | 0828 | 0836 | | KF1 | MultiC | |
| 03/07/02 | | | | #237 | | | 0906 | | KF1 | MultiC | |
| 03/07/02 | 1025 | N79 03.30 | E11 17.75 | #238 | 235 | 1030 | 1045 | 1102 | KF2 | CTD027 | |
| 03/07/02 | 1333 | N79 03.44 | E11 16.87 | #239 | 205 | | | | KF2 | Mooring | Deployed |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 03/07/02 | 1634 | N78 57.52 | E11 55.27 | #240 | 362 | | | 1704 | KF1 | Elinor | Recovery |
| 03/07/02 | 2202 | | | #242 | | | | 0355 | KF4 | 3rd attempt | Lander |
| 04/07/02 | 0732 | N78 17.84 | E07 37.55 | #243 | 2725 | 0740 | 0834 | 0930 | UEA | CTD028 | |
| 05/07/02 | 0735 | N73 57.76 | E13 03.42 | #244 | 1877 | 0738 | | | XBT | XBT105 | Topas XBT |
| 05/07/02 | 1050 | N73 39.62 | E13 47.10 | #245 | 1462 | 1109 | 1138 | 1204 | BIF | CTD029 | Bottom |
| 05/07/02 | 1216 | N73 39.67 | E13 47.21 | #246 | 1446 | 1219 | 1253 | 1331 | BIF | CTD030 | Profile |
| 05/07/02 | 1341 | N73 39.71 | E13 47.26 | #247 | 1445 | 1341 | 1408 | 1513 | BIF | BHC | |
| 05/07/02 | 1539 | N73 39.64 | E13 46.83 | #248 | 1445 | 1541 | 1609 | 1635 | BIF | NIOZ(1) | |
| 05/07/02 | 1652 | N73 39.61 | E13 46.93 | #249 | 1445 | 1655 | 1716 | 1740 | BIF | NIOZ(2) | extra weight |
| 05/07/02 | 1755 | N73 39.61 | E13 46.96 | #250 | 1440 | 1757 | 1819 | 1841 | BIF | NIOZ(3) | |
| 05/07/02 | 1910 | N73 39.61 | E13 46.97 | #251 | 1440 | 1910 | 1933 | | BIF | MultiC | |
| 05/07/02 | 2013 | N73 39.61 | E13 47.00 | #252 | 1440 | 2013 | 2036 | | BIF | MultiC | |
| 05/07/02 | 2114 | N73 39.61 | E13 47.00 | #253 | 1440 | 2114 | 2136 | | BIF | MultiC | |
| 05/07/02 | 2209 | N73 39.59 | E13 46.99 | #254 | 1440 | 2209 | 2218 | 2244 | BIF | GC | GC076 |
| 05/07/02 | 2257 | N73 39.59 | E13 46.95 | #255 | 1440 | 2257 | 2319 | 2346 | BIF | MegaC | |
| 05/07/02 | 2358 | N73 39.59 | E13 46.96 | #256 | 1440 | 2359 | 0018 | | BIF | MegaC | |
| 07/07/02 | 0903 | N67 13.03 | E09 28.08 | #257 | 399 | 0906 | 0920 | 0939 | UEA | CTD031 | |
| 08/07/02 | 0113 | N64 05.25 | E08 02.61 | #258 | 286 | | | 0148 | SULA | Photo | recovery |
| 08/07/02 | 0212 | N64 05.02 | E08 02.24 | #259 | 285 | 0212 | 0219 | 0228 | SULA | NIOZ | ROCK |
| 08/07/02 | 0238 | N64 05.02 | E08 02.24 | #260 | 285 | 0238 | 0245 | 0255 | SULA | NIOZ | WATER |
| 08/07/02 | 0326 | N64 05.02 | E08 02.24 | #261 | 285 | 0326 | 0334 | 0430 | SULA | BEDHOP | |
| 08/07/02 | 0509 | N64 04.80 | E08 01.89 | #262 | 250 | 0509 | 0524 | 0620 | SULA | BEDHOP | |
| 08/07/02 | 1150 | N63 45.71 | E05 36.56 | #263 | 450 | 1155 | | | XBT | XBT106 | |
| 08/07/02 | 1203 | N63 45.71 | E05 34.52 | #264 | 519 | 1213 | 1231 | 1251 | UEA | CTD032 | |
| 09/07/02 | 1036 | N62 38.84 | W01 19.38 | #265 | 1645 | 1039 | 1118 | | FSC(N) | CTD033 | |
| 09/07/02 | 1438 | N62 17.18 | W01 59.60 | #266 | 1731 | 1438 | | | XBT | XBT107 | |
| 09/07/02 | 1839 | N61 40.65 | W02 59.76 | #267 | 1515 | 1839 | | | XBT | XBT108 | |
| 09/07/02 | 2028 | N61 22.15 | W03 29.57 | #268 | 1236 | 2028 | | | XBT | XBT109 | |
| 09/07/02 | 2219 | N61 43.58 | W03 59.73 | #269 | 1153 | 2219 | | | XBT | XBT110 | |
| 09/07/02 | 2321 | N60 53.32 | W04 15.28 | #270 | 1129 | 2321 | | | XBT | XBT111 | |
| 10/07/02 | 0016 | N60 44.26 | W04 29.63 | #271 | 1110 | 0016 | | | XBT | XBT112 | |
| 10/07/02 | 0115 | N60 34.71 | W04 45.05 | #272 | 1072 | 0115 | | | XBT | XBT113 | |
| 10/07/02 | 0225 | N60 25.00 | W05 00.00 | #273 | 930 | 0226 | | | FSC(S) | CTD034 | Pump? |
| 10/07/02 | 0420 | N60 20.04 | W05 16.84 | #274 | 1025 | 0420 | | | XBT | XBT114 | |
| 10/07/02 | 0458 | N60 16.00 | W05 30.10 | #275 | 1101 | 0458 | | | XBT | XBT115 | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/07/02 | 0539 | N60 11.75 | W05 44.79 | #276 | 1163 | 0539 | | | XBT | XBT116 | |
| 10/07/02 | 0620 | N60 07.42 | W05 59.76 | #277 | 1145 | 0620 | | | XBT | XBT117 | |
| 10/07/02 | 0704 | N60 02.93 | W06 15.05 | #278 | 1032 | 0704 | | | XBT | XBT118 | |
| 10/07/02 | 0749 | N59 58.37 | W06 30.15 | #279 | ~375 | 0744 | | | XBT | XBT119 | |
| 10/07/02 | 0832 | N59 53.81 | W06 45.20 | #280 | 770 | 0832 | | | XBT | XBT120 | |
| 10/07/02 | 0902 | N59 50.52 | W06 55.41 | #281 | 1000 | 0902 | | | XBT | XBT121 | |

## Physical measurements
## Colin Griffiths, Finlo Cottier & Paul Provost

## Mooring Activity

During JCR75 the Kongsfjord mooring was serviced. The mooring was recovered on the 23rd June 2002 at 15:45Z. The mooring was recovered in excellent condition. The sediment trap collected 18 samples, the interval for collection was 3.5 days. A full description of the deployment of this mooring from the Lance is given in Appendix B, this includes full details of the instrument setup for this mooring. All the physical instruments were successfully downloaded, rebatteried and prepared for redeployment. It soon became clear that there were problems with the ESM1 loggers. Both units had stopped prior to recovery, one instrument had only just stopped whilst the other unit had failed in early May. The instruments were downloaded, rebatteried and then setup to perform post deployment calibrations. Both units were to fail soon after. A great deal of time was spent trying to debug these instruments. The mooring deployment was delayed in the hope that the problems could be solved. It soon became obvious that there was to be no quick fix and eventually it was decided to redeploy without the ESM1 loggers and to return the instruments to UKORS as soon as we returned to the UK. The mooring was deployed in 205m water on the 3/7/02 at 1333Z. As an afternote to the mooring activity aboard JCR75, the mooring was successfully recovered from the Haakon Mosby in September 2002. All instruments recorded full data sets and it is our intention to redeploy the mooring in April 2003 from the Jan Mayen. The plan is to maintain the mooring at ~6 month intervals until eventual recovery from the Discovery in September 2003.

Sediment trap samples from the Kongsfjord Mooring

## CTD

The BAS SeaBird (SBE) 9/11+ CTD was used for station-based profiling of the water column on JR75. The BAS SBE 9/11+ system consists of twin pumped temperature and conductivity sensors and a pressure transducer connected to a SBE 32 twelve-position carousel water sampler, with each position having a 10 litre Niskin bottle fitted. For the first three casts an altimeter, a transmissometer, a fluorometer and a photosynthetically active radiation (PAR) sensor were also mounted to the system. Details of the sensor types, serial numbers and calibration dates are given in Table 1. The BAS SBE35 deep ocean standards thermometer was not available on JR75. The raw binary data are logged to the CTD PC, a Viglen Genie 4Dx266 attached to the SBE deck unit. Data were logged using the SeaBird seasave module from the Seasoft version 4.226 set of utilities. Seasoft runs under DOS and has been configured to be accessed using a menu by typing "ctdmenu" at the DOS prompt; this menu system prompts for resetting of the PC clock, an essential step to ensure correct time-stamping of the CTD data. Calibration data are entered using the utility seacon. Sampling rate for JCR75 was set to 24 Hz, the maximum permitted with the system.

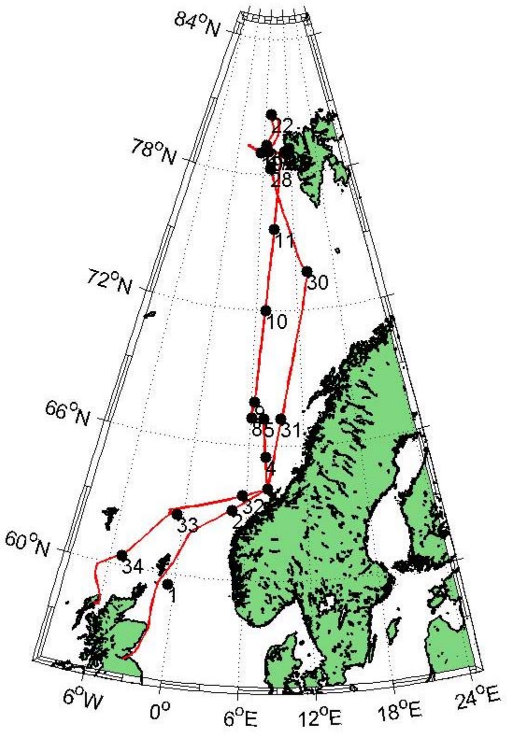
The CTD package was deployed from the midships gantry and hauled/veered on the CTD/hydro winch. The BAS swivel was not used, since the package was sufficiently compact that rotation was not deemed a likely problem. The general procedure was to power up the deck unit prior to deployment and commence logging, then lower the package to about 5 metres depth, where it was left to soak for ~5 minutes. The pumps are saltwater activated after 60 seconds using a conductivity switch, and so do not operate until the CTD is in the water. With the word display on the deck unit set to "E", the least significant digit on the display denotes pumps active (1) or pumps inactive (0). The soaking ensures the pumps are running when the cast starts and that the CTD system has had some time to adjust to the water temperature from the atmospheric temperature. After soaking the CTD was brought to the surface, the winch wireout zeroed, and the CTD lowered to about 10 metres above the seabed using the altimeter to judge the approach.

Whilst steaming daily CTD's were performed usually at 08:30Z, profiles were obtained to a maximum of 1000m with a full set of bottles fired on the upcast. Bottles were typically fired at 1000m, 500m, 250m, 100m, 50m, 40m, 30m, 20m, 10m, 5m & 2m. Special attention was given to the Chlorophyll maximum. Whilst on station, 2 CTD casts were performed, the first with the sole intention of the collection of bottom water for incubation experiments. All bottles would be fired near the bottom. The second cast was used to derive the CTD profile and collect water throughout the water column.

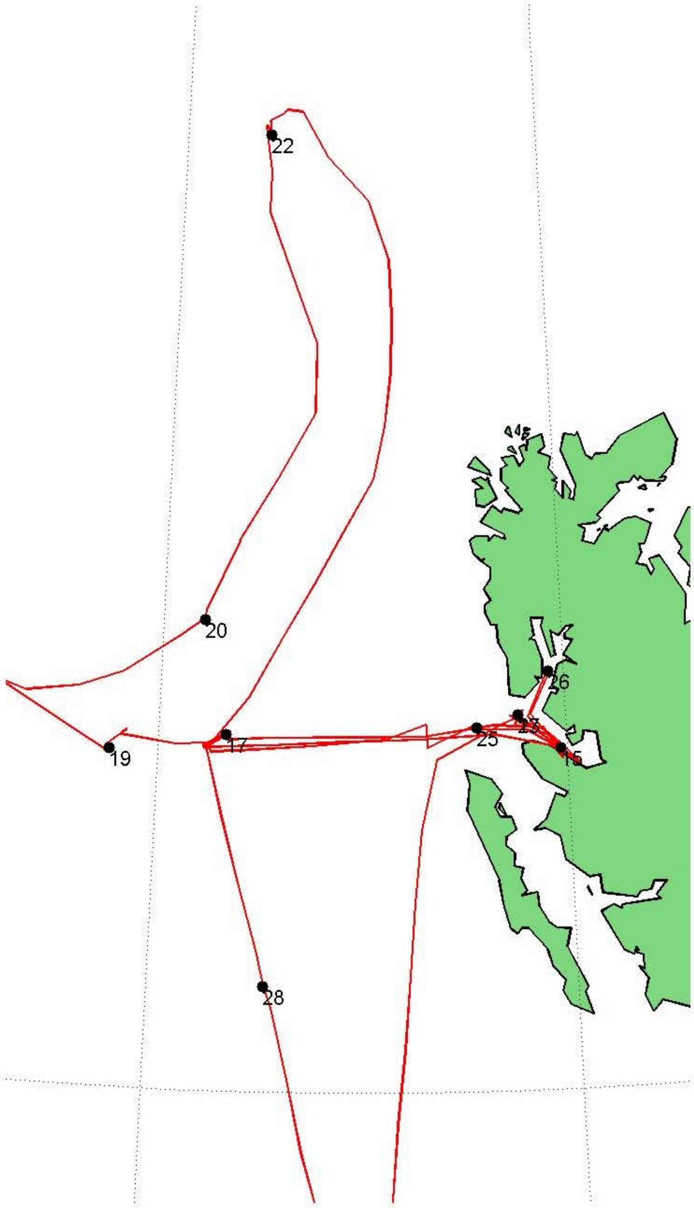
Duplicate salinity samples were usually drawn from the bottom bottle, samples were analysed back at SAMS using a Guildline 8400B. Processing of the CTD data was performed using the routines supplied by SeaBird. A batch files was written using the DOS based version 4.244 routines. The following set of routines were run to produce a bottle file and a downcast profile of 1m depth averaged values:-

DATCNV
ROSSUM
DATCNV
ALIGNCTD
CELLTM
FILTER
LOOPEDIT
DERIVE
BINAVG
DERIVE
ASCIIOUT

The system performed very well, there were slight problems with the SAMS oxygen sensor, the surface values on the downcast took a while to settle despite a 5 minute soak. The surface oxygen values in the top 10m should be treated with caution. There were also concerns on the upcast, the return cast being quite different to the downcast. On return to SAMS the O2 sensor was tested in Loch Etive in the deep hole at RE5. A calibration was derived for the downcast of the JCR75 using Winkler results from both the JCR and Etive cruises. An offset was applied to the Salinity to both sensors on the BAS CTD. No calibration was possible for the temperature sensors, both sensors were in excellent agreement with each other.
The fluorometer will be calibrated once the Chlorophyll samples are worked up.



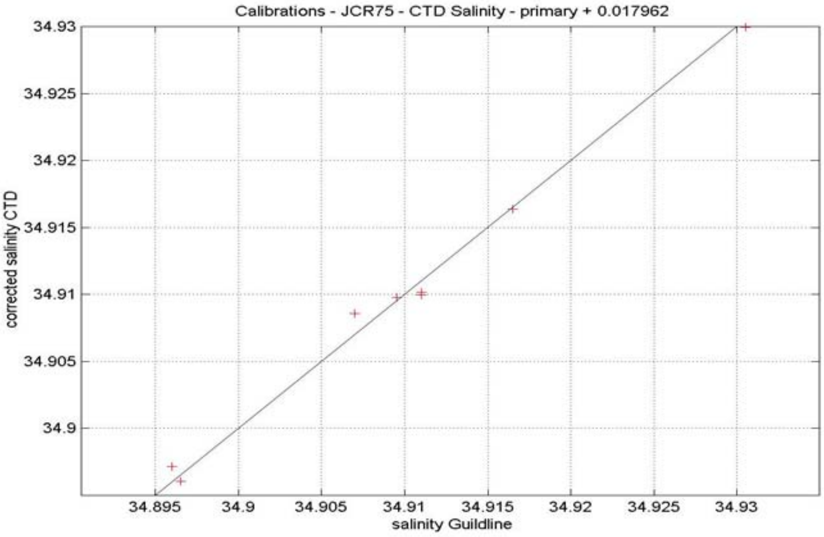

Position of CTD casts during JCR75.



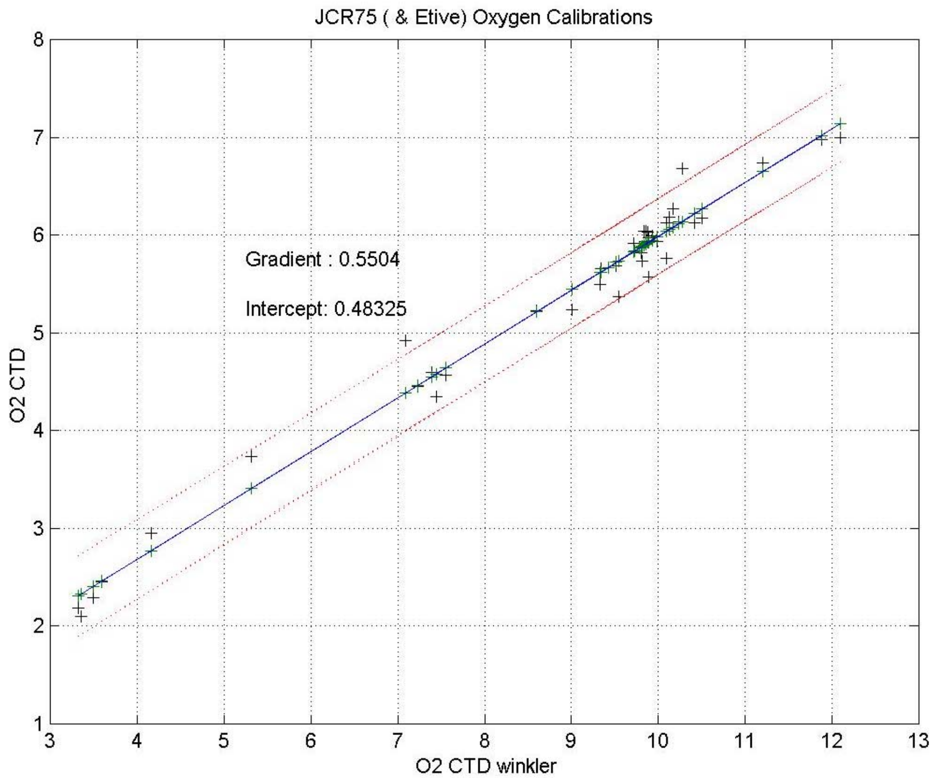

CTD casts around Spitzbergen

Table 1.

| Instrument | Type | Serial Number | Calibration Date |
|---|---|---|---|
| Underwater Unit | SBE 9 plus | 09P15759-0480 | - |
| Deck Unit | SBE 11 plus | 11P15759-0458 | - |
| Primary Temperature | SBE 3 plus | 03P2709 | 12-Sep-00 |
| Primary Conductivity | SBE 4C | 42255 | 13-Sep-00 |
| Secondary Temperature | SBE 3 plus | 03P2705 | 02-Jul-01 |
| Secondary Conductivity | SBE 4C | 42222 | 13-Sep-00 |
| Pressure Transducer | Series 410K-105 Digiquartz pressure transducer. | 67241 | 30-Jun-00 |
| Altimeter | Tritech | 2130.26993 | - |
| Pylon | SBE 32 | 90194U 3220391-0128 | |
| Niskin Bottles | Ocean Test Equipment | | - |
| Primary Pump | SBE 5 T | 51813 | |
| Secondary Pump | SBE 5 T | 51807 | |
| Fluorometer | Chelsea Mk III Aquatracka | 88216 | 11-Jun-01 |
| Transmissometer | Wet Labs C-Star | CST-396DR | 05-Jul-01 |
| PAR sensor | Biospherical Inc., QCD905L | 7235 | 18-Jun-01 |
| Oxygen sensor | SBE13 | 130256 | 15-Oct-02 |




CTD salinity calibrations




Oxygen calibrations

CTD cast information for JCR75

| Date | Time Z | Lat | Long | Event | Depth | I/W | O/B | O/W | Stn | Activity | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 16/06/02 | 0842 | N59 30.73 | W01 25.75 | #1 | 95.6 | | 0921 | 0938 | SD | CTD001 | Shake down |
| 17/06/02 | 0835 | N63 05.84 | E04 35.90 | #3 | 875 | 0842 | 0906 | 0933 | UEA1 | CTD002 | 0930 Dip |
| 17/06/02 | 2122 | N64 05.19 | E08 02.20 | #5 | 285 | 2121 | 2136 | 2200 | SULA | CTD003 | O2 added |
| 18/06/02 | 0838 | N65 30.04 | E07 46.36 | #9 | 380 | 0845 | 0900 | 0921 | UEA2 | CTD004 | Profile |
| 18/06/02 | 1940 | N67 11.03 | E07 29.89 | #11 | 1565 | 1943 | 2020 | 2056 | VP1 | CTD005 | Profile |
| 19/06/02 | 0540 | N67 13.03 | E06 05.95 | #14 | 1437 | 0540 | 0615 | 0650 | VP2 | CTD006 | Release |
| 19/06/02 | 0700 | N67 13.12 | E06 05.91 | #15 | 1438 | 0700 | - | - | VP2 | CTD007 | Problems |
| 19/06/02 | 1212 | N67 13.04 | E06 06.14 | #19 | 1436 | 1212 | - | 1327 | VP2 | CTD008 | Profile |
| 20/06/02 | 0830 | N67 54.74 | E06 21.22 | #32 | 1323 | 0840 | 0904 | 0936 | UEA3 | CTD009 | 1000m |
| 21/06/02 | 0830 | N71 58.25 | E07 21.02 | #60 | 2757 | 0858 | 0932 | 0928 | UEA4 | CTD010 | 1000m |
| 22/06/02 | 0830 | N75 34.41 | E08 32.35 | #83 | 2557 | 0834 | 0858 | 0928 | UEA5 | CTD011 | 1000m |
| 23/06/02 | 0640 | N79 03.25 | E11 17.97 | #102 | 240 | 0645 | 0651 | 0658 | KF2 | CTD012 | Bottom |
| 23/06/02 | 0710 | N79 03.25 | E11 17.97 | #103 | 240 | 0714 | 0728 | 0748 | KF2 | CTD013 | Profile |
| 24/06/02 | 1300 | N78 57.46 | E11 54.49 | #117 | 355 | 1305 | 1314 | 1321 | KF1 | CTD014 | Bottom |
| 24/06/02 | 1330 | N78 57.46 | E11 54.49 | #118 | 355 | 1334 | 1349 | 1406 | KF1 | CTD015 | Profile |
| 25/06/02 | 1730 | N79 00.00 | E06 59.98 | #135 | 1215 | 1735 | 1800 | 1822 | KF4A | CTD016 | Bottom |
| 25/06/02 | 1833 | N79 00.16 | E06 59.57 | #136 | 1220 | 1836 | 1909 | 1949 | KF4A | CTD017 | Profile |
| 27/6/02 | 1433 | N78 56.90 | E05 17.35 | #152 | 2500 | 1433 | 1516 | 1559 | KF5 | CTD018 | Bottom |
| 27/6/02 | 1610 | N78 56.87 | E05 17.31 | #153 | 2500 | 1614 | 1704 | 1802 | KF5 | CTD019 | Profile |
| 29/06/02 | 0830 | N79 19.27 | E06 37.22 | #183 | 1568 | 0834 | 0908 | 0948 | UEA6 | CTD020 | Profile |
| 29/06/02 | 1909 | N80 41.36 | E07 25.55 | #184 | 867 | 1920 | 1941 | 1956 | YP1 | CTD021 | Bottom |
| 29/06/02 | 2007 | N80 41.36 | E07 25.53 | #185 | 888 | 2008 | 2030 | 2107 | YP1 | CTD022 | Profile |
| 01/07/02 | 1315 | N79 01.41 | E10 41.50 | #215 | 327 | 1317 | 1328 | 1335 | KF3b | CTD023 | Bottom |
| 01/07/02 | 1348 | N79 01.33 | E10 41.52 | #216 | 333 | 1349 | 1424 | 1426 | KF3b | CTD024/5 | Profile |
| 02/07/02 | 0712 | N79 10.52 | E11 46.67 | #234 | 350 | 0711 | 0724 | 0750 | XF1 | CTD026 | Profile |
| 03/07/02 | 1025 | N79 03.30 | E11 17.75 | #235 | 235 | 1030 | 1045 | 1102 | KF2 | CTD027 | Profile |
| 04/07/02 | 0732 | N78 17.84 | E07 37.55 | #243 | 2725 | 0740 | 0834 | 0930 | UEA7 | CTD028 | Profile |
| 05/07/02 | 1050 | N73 39.62 | E13 47.10 | #245 | 1462 | 1109 | 1138 | 1204 | BIF | CTD029 | Bottom |
| 05/07/02 | 1216 | N73 39.67 | E13 47.21 | #246 | 1446 | 1219 | 1253 | 1331 | BIF | CTD030 | Profile |
| 07/07/02 | 0903 | N67 13.03 | E09 28.08 | #257 | 399 | 0906 | 0920 | 0939 | UEA8 | CTD031 | Profile |
| 08/07/02 | 1203 | N63 45.71 | E05 34.52 | #264 | 519 | 1213 | 1231 | 1251 | UEA9 | CTD032 | Profile |
| 09/07/02 | 1036 | N62 38.84 | W01 19.38 | #265 | 1645 | 1039 | 1118 | 1158 | FSC(N) | CTD033 | Profile |
| 10/07/02 | 0225 | N60 25.00 | W05 00.00 | #273 | 930 | 0226 | 0251 | 0324 | FSC(S) | CTD034 | Profile |

## Expendable Bathythermographs (XBTs)

During JR75, a number of XBT drops were made from RRS *James Clark Ross*. The drops included the following transects:

- Northward transect from Voring Plateau to Kongsfjord
- Survey of surface waters around the ice edge west of the Molly Deep
- Southward transect from Yermack Plateau to Kongsfjord
- Transect along the axis of the Faroe-Shetland Channel
- Individual drops for speed of sound data for the TOPAS/Swath system.

In all, 120 drops were made; full details are listed in the table.

Sippican T5 probes were used, having been provided by the UK Hydrographic Office. All data are to be returned to UKHO at the end of the cruise. A fixed launcher was used, sited on the port quarter and few problems were experienced other than premature failure of the wire as the sea state increased to moderate/rough. Data were logged by a Viglen IBM-type 486 PC running the Sippican WinMk12 software. After a successful drop, data were transferred to local PCs for processing using a MATLAB script developed onboard to read the *.edf files generated by the system.

<u>Voring Plateau to Kongsfjord</u>

This transect began at 0700Z on 20/06/02 at position N67 36.5 E006 13.0 and finished at 2200Z on 22/06/02 at position N78 08.6 E09 36.0. The transect was 600nm (700km) in water depths typically around 3000m. A total of 55 XBTs were launched in this time at hourly intervals with 85% success rate - most failures being through excessively noisy signals.

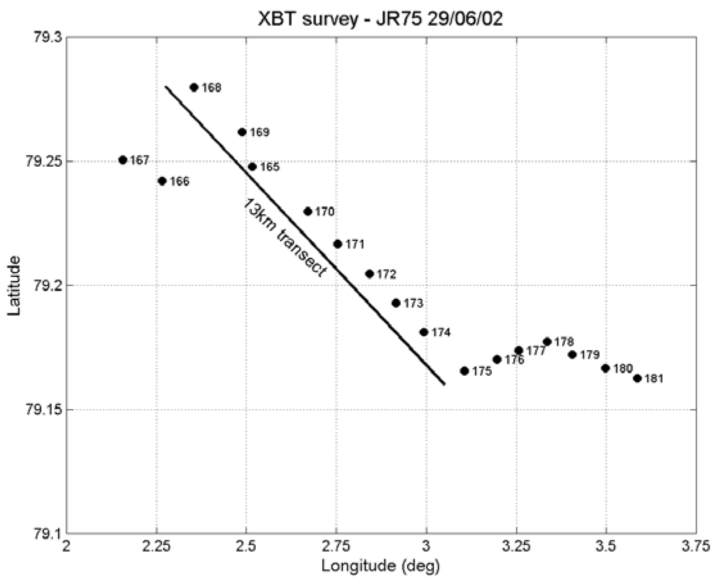
| Date | Time(Z) | Lat (N) | Lon (E) | Event | XBT | Depth (m) |
|---|---|---|---|---|---|---|
| 20/6 | 0659 | 67 36.5 | 06 13.0 | #30 | 004 | 1565 |
| 20/6 | 0759 | 67 49.4 | 06 18.2 | #31 | 005 | |
| 20/6 | 0954 | 67 57.0 | 06 23.0 | #33 | 006 | 1374 |
| 20/6 | 1056 | 68 08.9 | 06 26.2 | #34 | 007 | 1726 |
| 20/6 | 1156 | 68 20.4 | 06 30.4 | #35 | 008 | 2334 |
| 20/6 | 1206 | 68 22.0 | 06 31.0 | #36 | 009 | 2389 |
| 20/6 | 1303 | 68 32.9 | 06 32.7 | #37 | 010 | 2515 |
| 20/6 | 1404 | 68 43.2 | 06 34.6 | #38 | 011 | 3003 |
| 20/6 | 1453 | 68 50.5 | 06 35.7 | #39 | 012 | 3145 |
| 20/6 | 1457 | 68 51.0 | 06 35.8 | #40 | 013 | 3153 |
| 20/6 | 1600 | 68 59.7 | 06 37.5 | #41 | 014 | 3068 |
| 20/6 | 1700 | 69 08.5 | 06 39.2 | #42 | 015 | 3187 |
| 20/6 | 1800 | 69 19.0 | 06 40.9 | #43 | 016 | 3220 |
| 20/6 | 1900 | 69 27.5 | 06 43.5 | #44 | 017 | 3209 |
| 20/6 | 1958 | 69 39.3 | 06 45.0 | #45 | 018 | 3201 |
| 20/6 | 2055 | 69 49.4 | 06 45.5 | #46 | 019 | 3175 |
| 20/6 | 2159 | 70 02.1 | 06 48.6 | #47 | 020 | 3151 |
| 21/6 | 2258 | 70 11.6 | 06 51.4 | #48 | 021 | 3101 |
| 21/6 | 0010 | 70 24.8 | 06 55.7 | #49 | 022 | 3064 |
| 21/6 | 0026 | 70.27.3 | 06 55.9 | #50 | 023 | 3058 |
| 21/6 | 0112 | 70 36.6 | 06 58.0 | #51 | 024 | 3047 |
| 21/6 | 0225 | 70 50.4 | 07 02.4 | #52 | 025 | 3030 |
| 21/6 | 0300 | 70 56.4 | 07 03.3 | #53 | 026 | 3046 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 21/6 | 0310 | 70 58.6 | 07 03.7 | #54 | 027 | 3050 |
| 21/6 | 0400 | 71 70.9 | 07 6.62 | #55 | 028 | 2977 |
| 21/6 | 0500 | 71 18.7 | 07 10.3 | #56 | 029 | 2942 |
| 21/6 | XBT never launched or logged | | | | 030 | - |
| 21/6 | 0600 | 71 29.9 | 07 13.5 | #57 | 031 | 2919 |
| 21/6 | 0700 | 71 42.3 | 07 17.2 | #58 | 032 | 2831 |
| 21/6 | 0800 | 71 53.1 | 07 20.3 | #59 | 033 | 2780 |
| 21/6 | 0951 | 72 00.8 | 07 61.7 | #61 | 034 | 2746 |
| 21/6 | 0955 | 72 01.6 | 07 21.9 | #62 | 035 | 2743 |
| 21/6 | 1101 | 72 13.4 | 07 26.2 | #63 | 036 | 2672 |
| 21/6 | 1107 | 72 14.6 | 07 26.6 | #64 | 037 | 2656 |
| 21/6 | 1204 | 72 25.9 | 07 30.3 | #65 | 038 | 2585 |
| 21/6 | 1306 | 72 38.4 | 07 33.7 | #66 | 039 | 2534 |
| 21/6 | 1404 | 72 50.1 | 07 36.2 | #67 | 040 | 2479 |
| 21/6 | 1500 | 72 02.7 | 07 41.6 | #68 | 041 | 2430 |
| 21/6 | 1600 | 72 13.4 | 07 42.8 | #69 | 042 | 2473 |
| 21/6 | 2206 | 73 29.3 | 07 44.4 | #72 | 043 | 2773 |
| 21/6 | 2303 | 73 40.4 | 07 49.3 | #73 | 044 | 2240 |
| 22/6 | 0003 | 73 52.9 | 07 55.0 | #74 | 045 | 2223 |
| 22/6 | 0112 | 74 05.9 | 08 00.1 | #75 | 046 | 2443 |
| 22/6 | 0208 | 74 17.6 | 08 04.6 | #76 | 047 | 2360 |
| 22/6 | 0309 | 74 29.6 | 08 09.7 | #77 | 048 | 2660 |
| 22/6 | 0409 | 74 42.0 | 08 14.7 | #78 | 049 | 2558 |
| 22/6 | 0511 | 74 54.8 | 08 19.2 | #79 | 050 | 3471 |
| 22/6 | 0616 | 75 08.3 | 08 23.7 | #80 | 051 | 2638 |
| 22/6 | 0715 | 75 20.6 | 08 28.1 | #81 | 052 | 2686 |
| 22/6 | 0800 | 75 30.5 | 08 32.1 | #82 | 053 | 2580 |
| 22/6 | 1000 | 75 39.4 | 08 34.4 | #84 | 054 | 2386 |
| 22/6 | 1100 | 75 41.4 | 08 39.8 | #85 | 055 | 2369 |
| 22/6 | 1110 | 75 53.0 | 08 40.4 | #86 | 056 | 2369 |
| 22/6 | 1200 | 75 03.4 | 08 44.0 | #87 | 057 | 2300 |
| 22/6 | 1304 | 76 15.8 | 08 49.1 | #88 | 058 | 2250 |
| 22/6 | 1402 | 76 27.3 | 08 52.6 | #89 | 059 | 2214 |
| 22/6 | 1500 | 75 39.1 | 08 58.4 | #90 | 060 | 2264 |
| 22/6 | 1505 | 75 40.9 | 08 59.2 | #91 | 061 | 2264 |
| 22/6 | 1605 | 75 52.5 | 08 03.8 | #92 | 062 | 2237 |
| 22/6 | 1700 | 77 04.0 | 08 08.4 | #93 | 063 | 2202 |
| 22/6 | 1910 | 77 30.9 | 09 19.6 | #94 | 064 | 1904 |
| 22/6 | 2019 | 77 45.2 | 09 25.6 | #95 | 065 | 1276 |
| 22/6 | 2102 | 77 55.2 | 09 29.4 | #96 | 066 | - |
| 22/6 | 2207 | 78 08.6 | 09 36.0 | #97 | 067 | - |

<u>Ice Edge survey at Molloy Deep</u>

Warm water eddies are reported to be a persistent feature in the marginal ice zone west of the Molloy Deep. To investigate these observations of warm water lenses in this area, we planned an extensive XBT survey comprising two 30nm legs. However, ice conditions were such that the survey was limited to a much smaller area centred around N79.2 E003.0 during which 17 successful drops were made. The longest continuous transect ran NW/SE and was 11nm in length. During this time, ice obsevations were also made from the bridge. In the transect, three lenses of water of 4°C were detected at depths ranging from 20 - 100m. These results will be further worked up with Prof P. Wadhams of the Scott Polar Research Institute.

| Date | Time(Z) | Lat (N) | Lon (E) | Event | XBT | Depth (m) |
|---|---|---|---|---|---|---|
| 28/6 | 2238 | 79 15.0 | 02 30.0 | #165 | 071 | 4444 |
| 28/6 | 2322 | 79 14.5 | 02 15.0 | #166 | 072 | 4142 |
| 29/6 | 0003 | 79 15.0 | 02 09.3 | #167 | 073 | 4270 |
| 29/6 | 0034 | 79 17.0 | 02 21.3 | #168 | 074 | 3585 |
| 29/6 | 0056 | 79 15.7 | 02 29.3 | #169 | 075 | 3930 |
| 29/6 | 0118 | 79 13.8 | 02 40.2 | #170 | 076 | 4980 |
| 29/6 | 0127 | 79 13.0 | 02 45.3 | #171 | 077 | 5263 |
| 29/6 | 0137 | 79 12.3 | 02 50.5 | #172 | 078 | 5462 |
| 29/6 | 0145 | 79 11.6 | 02 55.0 | #173 | 079 | 5323 |
| 29/6 | 0157 | 79 10.9 | 03 00.0 | #174 | 080 | 5329 |
| 29/6 | 0221 | 79 09.9 | 03 06.3 | #175 | 081 | 5314 |
| 29/6 | 0230 | 79 10.2 | 03 11.8 | #176 | 082 | 5172 |
| 29/6 | 0237 | 79 10.4 | 03 15.4 | #177 | 083 | 5049 |
| 29/6 | 0246 | 79 10.7 | 03 20.0 | #178 | 084 | 5054 |
| 29/6 | 0257 | 7910.4 | 03 24.7 | #179 | 085 | 5068 |
| 29/6 | 0307 | 79 10.0 | 03 30.0 | #180 | 086 | 4753 |
| 29/6 | 0318 | 79 09.7 | 03 35.0 | #181 | 087 | 3791 |
| 29/6 | 0417 | 79 06.4 | 03 36.8 | #182 | 088 | 3323 |




<u>Yermak Plateau to Kongsfjord</u>

A total of 11 XBTs were launched on the transit from the Yermak Plateau station heading south to Kongsfjord. The line began at 1000Z on 30/06/02 at N80 44.4 E007 59.8 and ended at 2100Z on 30/06/02 at N79 06.3 E007 18.7. This transect extends the northward transect from the Voring Plateau to Kongsfjord up to the ice edge to the north of Svalbard.

| Date | Time(Z) | Lat (N) | Lon (E) | Event | XBT | Depth (m) |
|---|---|---|---|---|---|---|
| 30/6 | 1000 | 80 44.4 | 07 59.8 | #197 | 089 | 951 |
| 30/6 | 1005 | 80 43.4 | 07 59.7 | #198 | 090 | 946 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 30/6 | 1013 | 80 42.9 | 07 59.4 | #199 | 091 | 930 |
| 30/6 | 1105 | 80 37.4 | 08 32.2 | #200 | 092 | 849 |
| 30/6 | 1110 | 80 37.0 | 08 35.3 | #201 | 093 | 881 |
| 30/6 | 1210 | 80 28.9 | 09 09.8 | #202 | 094 | 927 |
| 30/6 | 1303 | 80 20.3 | 09 27.5 | #203 | 095 | 620 |
| 30/6 | 1401 | 80 09.9 | 09 28.4 | #204 | 096 | 552 |
| 30/6 | 1500 | 80 00.7 | 09 27.5 | #205 | 097 | 488 |
| 30/6 | 1600 | 79 52.3 | 09 20.9 | #206 | 098 | 463 |
| 30/6 | 1605 | 79 52.0 | 09 20.6 | #207 | 099 | 463 |
| 30/6 | 1655 | 79 43.8 | 09 11.3 | #208 | 100 | 404 |
| 30/6 | 1805 | 79 33.9 | 08 40.7 | #209 | 101 | 405 |
| 30/6 | 1900 | 79 25.3 | 08 14.8 | #210 | 102 | 285 |
| 30/6 | 2000 | 79 15.7 | 07 45.5 | #211 | 103 | 884 |
| 30/6 | 2100 | 79 06.3 | 07 18.7 | #212 | 104 | 1286 |

Faroe-Shetland Channel

An opportunistic survey of the channel was made with the remaining XBTs.

## Meteorological Sensors

A suite of measurements were recorded during the cruise. The data was time stamped by the ships clock and recorded on the ships computing system.

Details of the suite of instruments used are listed below.

| Instrument | Make | Location |
|---|---|---|
| Digital Barometer | Vaisala PTB210 Classe B | Logger rack |
| Digital Barometer | Vaisala PTB210 Classe B | Logger rack |
| Air humidity and temperature | Rotronic MP103A-CG030-W4W | Foremast |
| Air humidity and temperature | Rotronic MP103A-CG030-W4W | Foremast |
| TIR sensor (pyranometer) | Kipp & Zonen SP LITE | Foremast |
| TIR sensor (pyranometer) | Kipp & Zonen SP LITE | Foremast |
| PAR sensor | Kipp & Zonen Quantum PAR LITE | Foremast |
| PAR sensor | Kipp & Zonen Quantum PAR LITE | Foremast |
| Ultrasonic Anemometer | Solent Meteorological | Foremast |

## Navigational Data

Instruments used were the Trimble 4000 GPS receiver, the Sperry Mk 37 Model D Gyrocompass, the Ashtech ADU-2 GPS receiver and the GLONASS GPS (Ashtech GG24) receiver. Data from the Chernikeeff Aquaprobe Mk V Electromagnetic log and the Sperry SRD 421 Doppler log were not routinely logged; the latter of these was operational only briefly during the cruise. In addition to these instruments, a Racal Satcom received GPS SV range correction data via INMARSAT B: this was passed to the Trimble and other GPS receivers to allow them to operate in differential mode (DGPS). The Trimble 4000 in differential mode was the primary source of positional information on JCR75. The data stream from the gyrocompass constitutes the most continuous information available on ship's heading. It is involved in processing data from meteorological instrumentation (so as to derive information on true wind velocity), and in processing the Acoustic Doppler Current Profiler (ADCP) data. It is also drawn into the bestnav stream (see below) to derive positional information by dead reckoning during periods of no GPS data coverage. The ship's gyrocompass is subject to an inherent error and can oscillate for several minutes after a turn. Consequently, the Ashtec ADU-2 is used to correct errors in the gyrocompass heading prior to input of the data to the ADCP processing.
The Ashtech GG24 receiver works by accepting data from both American GPS and the Russian GLONASS satellites. This increases accessibility to satellite fixes, and hence should provide more accurate navigation data than standard GPS coverage allows. Bestnav is a processed data stream, which contains 30 second interval position data. It uses the best available data source: GPS when available, dead reckoning from the ship's gyrocompass and speed otherwise.

## Vessel-Mounted Acoustic Doppler Current Profiler (VMADCP)

The acoustic Doppler current profiler (ADCP) on the RRS *James Clark Ross* is an RD Instruments 153.6 kHz unit sited in a sea chest that is recessed within the hull to afford protection from sea ice. The fluid in the sea chest is a mixture of 90% deionised water and 10% ethylene glycol, and is closed to the sea by a 33 mm thick window of Low Density PolyEthylene (LDPE). The orientation of the transducer head is offset by approximately 45¤ to the fore-aft direction.

For cruise JR75 the VMADCP was configured to record data in 64 x 8 m bins, in ensembles of 2 minute duration. The 'blank beyond transmit' was set to 4 m such that the centre depth of the first bin was 14 m, given the approximate transducer depth of 6 m. The system uses 17.07 firmware and version 2.48 of RDI Data Acquisition Software (DAS) run on a Viglen IBM-type 286 PC. A log was maintained of the drift of the pc clock relative to the ships clock. The two minute ensembles of data are passed via a printer buffer directly to the Level C. Data can be recovered from the PC PINGDATA files in the instance of any problems with the ship's Level C system.

## Oceanographic Sensors

The underway measurements consisted of a SBE 45 thermosalinograph (Ser No. 4524698-0016) and a fluorometer connected to the ship's non-toxic pumped seawater supply. Calibration samples were taken for both Chl and salinity.

## Simrad EA500 Bathymetric Echo Sounder

The Simrad EA500 echo sounder was run continually during the cruise. It soon became clear that there was interference with the swath/TOPAS systems. This problem is still being investigated and any data from this system must be treated with caution.

## Acoustic Seabed Mapping and Gravity Core Sampling

John A. Howe, Steve Moreton, Clara Morri and John Derrick

Scottish Association for Marine Science
NERC Radiocarbon Laboratory
British Geological Survey

Objectives

This project aims to examine the signal of climatic amelioration from high-lataitude marine sediments using sediment texture and geochemistry. Utilising the high sedimentation rates of the Polar North Atlantic (3-100 cm/ky) climatic events can be detected at a high temporal resolution allowing the timing and onset of events such as deglaciation and its relationship to sediment supply and productivity to be examined.
A 6 m-long gravity corer is used to obtained sediment records spanning that least the last glacial-interglacial cycle. Sampling stations range from deep-water sites of current-influenced sedimentation on the Western Svalbard Margin and Fram Strait to the shallower shelfal sites such Kongsfjord, Spitsbergen and the Yermak Plateau. Core site selection involved a short acoustic survey (TOPAS and EM120 Multibeam) to identify key areas of current influenced sedimentation. Post-cruise analysis will entail sediment texture (laser Particle Size Analysis), microfaunal and geochemical (organic and inorganic) analysis.

JR75 Gravity Core Stations

Core samples were obtained at all stations using the 6 m British Geological Survey (BGS) gravity corer (see Table 1). The corer uses a 1000 kg weight and a 6 m long, 10 cm diameter steel barrel, within which is a polycarbonate liner. The corer is deployed from the port aft area of the ship using a launching/recovery trough. The BGS 3 tonne 'free-fall' winch operated using a 5000 m plastic-coated Kevlar rope. This controls the rate of descent at about 60m/min until 30m above the seabed, where the corer was stabilised before being run in at about 20m/min. Once inboard the barrel was unbolted from the head and carried, with the aid of the Effer crane to the bench. The core cutter and catcher were removed and the polycarbonate liner pushed out of the barrel with the aid of hydraulic ram. The core was then measured and sliced on deck into 1m sections. Following sectioning, the complete core was passed through a Bartington MS2 magnetic susceptibility loop in the ships' wet lab prior to splitting. Splitting was achieved on deck using a router and cheese wire. Once split the cores were logged, and digitally photographed.

Sample recovery varied to between 3.10-3.80m, depending on the sediment type. Some core compaction is possible at the softer sediment sites (e.g. Kongsfjord). Loss of the core top was also noted, but after comparision with the multicore and box core samples, this was reduced to <10cm by running in at lower speeds (<20m/min). Initially, two core catchers were used, to prevent core catcher inversion in stiffer sediments (e.g. Voring Plateau), but this was found to be inhibiting the length of the core obtained in softer sediments, (e.g. Svalbard margin) and a single core catcher was found to provide longer cores.

Table 1 Gravity & Multicore Samples

| Date & Time Recov. | Event Number & SAMS Core Number | Position | Water Depth | Total Depth | General Area | Sediment Type | Comment |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 18/6/02<br>22:30 hrs | 12 GC062 | 67 11.52<br>07 29.42 | 1358 | 3.10m<br>+ CC | Nyk Drift / Norwegian Margin | Silty-clays and stiff grey clays | Contourite |
| 20/6/02<br>22:15 hrs | 25 GC063 | 67 12.80<br>06 06.24 | 1406 | 3.27m<br>+ CC | Central Voring Plateau | Silty-clays and stiff grey clays | |
| 23/6/02<br>12:32 hrs | 110 GC064 | 79 03.03<br>11 21.54 | 307 | 3.28m<br>+ CC | Kongsfjord, Svalbard Station 2 | Homog., greeny-grey silt | Full of worm tubes |
| 24/6/02<br>20:45 hrs | 127 GC065 | 78 57.46<br>11 54.49 | 355 | 3.34m<br>+CC | Kongsfjord off Ny Alesund, Station 1 | Homog., brown / black silts | |
| 26/6/02<br>09:30 hrs | 146 MC066<br>(3 cores) | 79 00.00<br>06 56.81 | 1226 | 0.25m<br>0.31m<br>0.34m | Svalbard Margin Drift Station 4 | Homog., greeny-grey muds | |
| 26/6/02<br>10:31 hrs | 147 GC067 | 79 00.01<br>06 56.84 | 1226 | 3.80m<br>+ CC | Svalbard Margin Drift Station 4 | Homog., greeny-grey muds | |
| 28/6/02<br>10:50 hrs | 161 GC068 | 78 56.74<br>05 13.59 | 2527 | 2.89m<br>+ CC | Svalbard Margin Station 5 | Grey-brown muds/sand | Turbidite |
| 30/6/02<br>04:46 hrs | 192<br>MC069<br>(2 cores) | 80 45.01<br>07 38.74 | 961 | 0.34m | Yermak Plateau | | |
| 30/6/02<br>05:21 hrs | 193 GC070 | 80 45.00<br>07 38.72 | 961 | 3.39m<br>+ CC | Yermak Plateau | Homog., Grey-brown muds | |
| 1/7/02<br>18:57 hrs | 224 MC071<br>(2 cores) | 79 01.33<br>10 41.63 | 342 | 0.25m<br>0.35m | Kongsfjord, Svalbard Station 3 | | |
| 1/7/02<br>20:24 hrs | 225<br>GC072 | 79 01.33<br>10 41.63 | 342 | 2.60m | Kongsfjord, Svalbard Station 3 | | Core Unsplit |
| 1/7/02<br>20:56 hrs | 226 GC073 | 79 01.33<br>10 41.63 | 342 | 2.80m | Kongsfjord, Svalbard Station 3 | Homog., gas-rich black muds | |
| 2/67/02<br>04:27 hrs | 232 GC074 | 78 59.36<br>11 46.03 | 379 | 3.48m | Kongsfjord, Ny Alesund | Greeny-black muds & sands | Turbidite |
| 5/7/02<br>19:33 hrs | 251<br>MC075<br>(2 cores) | 73 39.61<br>13 46.97 | 1440 | 0.25m<br>0.25m | Bear Island Fan | | |
| 5/7/02<br>22:18 hrs | 254 GC076 | 73 39.51<br>13 44.99 | 1440 | 3.17m<br>+CC | Bear Island Fan | Homog., brown-grey muds | Mud clasts |

Multicore and box core sub-sampling for radiocarbon dating.

Obtaining undisturbed samples of surface-water interface is vital for determining the radiocarbon age of the sediment surface. That age is then used to calculate both the local marine reservoir correction that needs to be applied to core and the sedimentation rates. The shock wave caused by the narrow diameter and relative high entry speed (approximately $1m^{-s}$) of gravity corer frequently disturbs the unconsolidated surface sediment. Therefore, multicores and/or sub-samples of box cores were obtained from most sites where gravity cores were taken. The large cross section area of the box corer (0.5 x 0.5 m) and the slower entry speed of the hydraulically-damped multi corer are both more likely to preserve undisturbed core top sediments.

Two methods of box core sub-sampling were used. Initially 38mm x 25mm box-section electrical cable conduit was pressed into the cleaned face of the box core. A cheese wire was run along the open face of the conduit to cut the sediment. The sediment filled conduit was then eased out of the box core, the lid snapped back on and the ends capped. This method worked reasonably well and did not introduce any compaction of the sediment but it did interrupt the processing of the box core for biological specimens and it proved difficult to produce a water-tight seal at the core top to retain the wettest surface sediment. After JR75 event number 156 (see table 2) off-cuts of gravity core tube liners were inserted vertically into the box core and capped once the surrounding sediment had been excavated and processed. This latter method was less disruptive to the box coring programme and although there was some compaction of the sediment it was found that it could be minimised by fitting the core liner with a plunger (made on board by J. Derrick, BGS), which was withdraw at the same rate as the tubing was inserted into the sediment.

Two different methodologies were also employed for extruding the multicore samples. Following common practice, multicores from JR75 event numbers 23, 107, and 125 were extruded and sliced at one centimetre intervals and the slices bagged and labelled individually. However, multicores from JR75 event numbers 126 onwards (see table xx.xx) were extruded whole into off-cuts of gravity core tube liner which had been cut in half lengthways. Electrical tape was used to seal the open ends of the tube liner and the core was wrapped in clingflim before being sealed in lay-flat polythene tube. The advantage of this second methodology was that the core can be split and described at a later date which will allow the multicore and gravity core samples to be correlated.

It is hoped that funding will be granted to allow 3 AMS $^{14}C$ dating projects to be carried out on the cores.

1) Dating the onset and duration of climatic changes identified in the gravity core samples.
2) Dating the uppermost preserved sediment in adjacent gravity cores, box cores and multicores in order to assess the amount of sediment loss by the three different coring techniques. The results of this study will assist in the strategic planning of coring programmes on future cruises.
3) High-resolution (centimetre scale) dating of paired carbonate and bulk organic carbon samples from box core material to investigate the depth of active mixed layer and the carbon flux in the high Arctic.

Table 2. Multicore and box core samples taken to augment gravity core record.

| JR75 Event Number | Box/Multi core | Equivalent Gravity core | Latitude | Longitude | Depth (m) | Comments |
|---|---|---|---|---|---|---|
| 12 | - | GC062 | | | 1358 | No other deployments |
| 21 | Box core (NBC 868) | GC063 | N67 12.85 | E06 05.54 | 1385 | |
| 23 | Multicore | GC063 | N67 12.86 | E06 05.53 | 1433 | |
| 106 | Box core (NBC 878) | GC064 | N79 03.34 | E11 18.01 | 244 | |
| 107 | Multicore | GC064 | N79 03.34 | E11 18.08 | 244 | |
| 125 | Multicore | GC065 | N78 57.46 | E11 54.49 | 355 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 146 | Multicore (MC066) | GC067 | N79 00.01 | E06 56.81 | 1226 | |
| 156 | Box core (NBC 899) | GC068 | N78 56.85 | E05 17.31 | 2465 | |
| 158 | Multicore | GC068 | N78 56.85 | E05 17.31 | 2465 | |
| 188 | Box core (NBC 907) | GC070 | N80 43.64 | E07 24.60 | 961? | |
| 192 | Multicore (MC069) | GC070 | N80 45.02 | E07 38.74 | 961? | |
| 219 | Box core (NBC 915) | GC072 | N79 01.34 | E10 41.68 | 343 | |
| 222 | Multicore (MC071) | GC072 | N79 01.34 | E10 41.62 | 342 | |
| | - | GC074 | | | | No other deployments |
| 249 | Box core (NBC925) | GC076 | N73 39.61 | E13 46.96 | 1445 | |
| 251 | Multicore (MC075) | GC076 | N73 39.61 | E13 46.97 | 1440 | |

<u>Acoustic Seabed Mapping</u>

Seabed mapping was achieved using the RRS James Clark Ross EM120 multibeam system, running in parallel with the TOPAS sub-bottom profiling system (Table 3). These two systems provide detailed data of the seabed morphology (EM120 Multibeam) and the sediment geometry and acoustic character (TOPAS). Both systems were operated continuously throughout the cruise, with surveys conducted both underway and detailed surveying of each station prior to sampling. Overall, although both systems worked well during the cruise, there are a number of issues that need to be addressed, notably those concerning the stability of the software (see section below).

<u>Sub-Bottom Profiling using TOPAS</u>

An updated version of TOPAS was supplied by BAS for the cruise, version 2.1.2, this was found to work very well using the settings stated below, as outlined in BAS Cruise Report JR71:

Sampling rates of 10kHz, trace length 400ms, file size 10MB. Swell OFF, dereverb OFF and stacking OFF.

In deep-water (>1000m). Chirp source, 15 ms pulse length, 1.5-5kHz, level 85%; bandpass filter settings 1400-1600/4900-5100 Hz. Manual triggering, generally 2000 msec. Gain 20-25 dB depending on water depth, seabed type and weather. Processing: filter ON, deconv ON (1pmm), TVG ON, scale 3000%.

In shallow-water (<1000m). Burst source, period 2, level 100%, secondary frequency 2800 Hz. SSU triggering, ping interval set to 0. Gain 10-20 dB depending on water depth, seabed type and weather. Processing: filter ON, AVC ON, scale 2000%.

EPC Chart recorder settings; TOPAS on channel A, 0.5 second sweep, 0 delay, threshold about 1/3 turn clockwise from minimum, trigger level 0, gain 10 (max), sweep direction left to right, print polarity +/- (centre setting). Takeup was left ON, scale lines ON, mark/annotate OFF, chart drive internal (centre setting), 100 LPI, contrast centre setting.

<u>EM120 Multibeam seabed mapping</u>

The EM120 multibeam system performed, on the whole, very well throughout the cruise. Seabed bathymetric maps could be produced within 20 minutes of a survey ending in some cases, this was especially important when the bridge needed core positions and sampling stations as soon as possible after a survey. Only in rougher weather and whilst turning did the system perform less well with drop-outs and spurious depth readings commonly encountered. The system also repeatedly crashed when a new survey was being prepared requiring start-up of the Operator Interface again and resetting of the bridge display. Sound velocity profiles were commonly loaded into the EM120 on average once every three days or prior to a new survey in a new area (e.g. Kongsfjord). The sound velocity profiles were gathered from the SAMS XBT sampling rather than using the EM120 sound velocity probe.

Transfer of XBT profiles into EM120

Copy **.edf file onto floppy** and insert into the EM120 machine
Login as **xbt** with pswd **simrad0**
Type: **eject floppy**
Type: **volcheck**
Type: **cp /floppy/floppy0/T*_*****.EDF .** (note space after full stop!)
Type: **eject floppy**
Stop logging and select **AML calc format profile**
Type: **java xbt T*_*****.EDF>/dev/term/b**
(A window should pop up on the EM120 machine)
Select options->show profile
File save as
Close
Enter new profile name and load up the current sound profile into the main MBES window.
Return to logging.

Cleaning EM120 data

On Neptune unit – click middle mouse button
Select **CHECK/REPLY DATA** (this brings up *Raw2Sur* dialogue box)

- **SURVEY -** select required survey from drop down box
- select **ALL LINES or SOME LINES**
- (if SOME LINES option selected select required lines from drop down box by holding down SHIFT key and clicking left mouse button.)
- What to do with the data? – choose **CONVERT DIRECTLY**.
- Raw data – leave as **EMX**
- **TO SURVEY** – use same name as survey name (can give file new name if required)
- **INITIATED FROM**? – select **UTM** from the list
- Leave everything else and click OK.

*Raw2Surv* info dialogue box will appear and scroll through lots of "warning check sum error messages". Wait for data to finish processed. Click OK.
Cancel *Raw2Sur* dialogue box.

Click middle mouse button
Select NEPTUNE
From the list choose survey name given in the previous operation (above). *Neptune Survey Control* window appears.

**PROCESSING** – select **DEPTH CORRECTION** – select **SETUP RULES**

- click OK to warning dialogue box
- click **NEW** at the bottom of the window to create a new rule or click **SELECT** to select a pre-existing rule. Give a new rule a name in the **COMMENT** box at the top of the window.
- **REMOVE BEAMS** – set maximum acceptable depth which is known from the survey. All other spurious data (eg bad data generated when the ship turns during a survey) will then be removed)
- click **ACCEPT**

- click **OK**

**DISPLAYS - CREATE GRID** – input grid size for interpolated data (the lower the value the higher the resolution of the processed data but the less the likelihood that gaps in the swath data will be filled in).

- Dialogue boxes will appear then disappear automatically when processing complete.

**DISPLAYS** – **GRID DISPLAY**. Grid display window appears.

- **VIEW** – select **ANNOTATE COLOUR** from the drop down list. Set background colour to white and grid lines to black.
- select **SHOW/HIDE**. From the options available go to **GRID CELL** and select **AS GRID**.
- select **LAT/LONG** – choose middle option
- to change from contour map to 3D sun illuminated representation select **GRID CELL – SUN ILLUMINATION**
- select **SHADING PARAMETERS** – monkey about with the various options until you have something that makes everyone go "Wow!".

Converting surveys into postscript files

To convert a survey into a postscript file, enter Neptune bring up the survey, then file-plot-convert to UTM – postscript level 2 – postscript file a4 (making sure you have selected file and NOT command).
Bring up a terminal on the workstation.

Floppy disk in
Type: **eject floppy**
Type: **volcheck**
Type: **cd /data2/em120/proc/JR75_****** (filename)**
Type: **ls -1 ******.ps**
Type: **compress <*****.ps> ******.ps.Z**
Type: **cp *****.ps.Z /floppy/floppy0**
Type: **eject floppy**
Your survey is then saved onto disk as a postscript file.

<u>EM120 & Topas software</u>

The user interface provided with both the EM120 and Neptune systems was far from intuitive. The overall stability of the software is also an issue that needs to be addressed.
*EM120.* Once the survey is started the EM120 seems to be fairly trouble free, providing that the minimum amount of changes are made. The main problems appear to be related to random mouse clicks, which may be made in an attempt to pan or zoom or reposition in the survey window. One such attempt caused the software to crash mid survey resulting in error messages and an inability to regain the Bridge display, without exiting the User interface and completely restarting the program. This meant that the bridge was without an echo sounder in relatively shallow water and unable to accurately gauge the beam coverage from the previous line.
*TOPAS.* The TOPAS system seems to be relatively stable. One problem that was encountered early on in the cruise was caused by the clock ceasing to work, which meant that data was also not recording. **The day before surveying ended (08:50 hrs 9/7/02), the TOPAS system underwent a complete breakdown. This was caused by the failure of the +50 volts power supply. No spares were carried onboard. Had this failure occurred earlier in the cruise it would have produced serious problems for core site selection and surveying.**
*Neptune – Swath Bathymetry Processing.* Once the data had been processed using Neptune, any misfortunate software failures were usually caused by the size of the survey and the size of the grid. An error message indicating that an environment variable (LAUNCHPAD_ADDR) can be ignored. The problem may be resolved by either increasing the size of the grid to display (i.e. 50m:50m) or by selecting only a certain number of lines for grid generation.

Table 3 JR75 EM120 Multibeam and Topas Survey Lines

| Area | Date | Start time | End time | EM120 File Name | Topas File Name | Water Depth | Topas System | Sampling |
|---|---|---|---|---|---|---|---|---|
| NE Shetland Shelf 61N- | 16/6/02 - 17/6/02 | 19:54 | 17:30 | JR75 | 0206101332.raw to 02061707054.raw (incl) | 170-860 | Burst Chirp Ricker | - |
| Sula Ridge | 17/6/02 | 17:30 | 19:05 | JR75_Sula_Prep | 020617170553.raw | 227-251 | Burst Chirp Ricker | - |
| Sula Ridge Survey | 17/6/02 | 18:55 | 21:05 | JR75_Sula | 020617191529.raw | 274-313 | Burst | Lander & Box Core |
| Norwegian Margin | 18/6/02 | 00:57 | 17:27 | JR75_Underway2 | 020618005932.raw & 020618172643.raw | 280-1260 | Burst Chirp | - |
| Voring Plateau 1 | 18/6/02 | 17:49 | 19:36 | JR75_Voring1 | 020618174946.raw | 1321-1329 | Chirp | Gravity Core GC062 |
| Voring | 19/6/02 | 03:10 | 04:20 | JR75_Underway2 | 020619030749.raw | 1331 | Chirp | |
| Voring Plateau 2 | 19/6/02 | 04:20 | 05:24 | JR75_Voring2 | 020619041830.raw | 1398-1400 | Chirp | Gravity Core GC063 |
| Norwegian Margin | 20/6/02-21/6/02 | 04:46 | 17:08 | JR75_Underway3 | 020620044049.raw | 1395-3212 | Chirp | Lander Testing |
| Norwegian Basin-Greenland Sea | 21/6/02-22/6/02 | 21:53 | 10:15 | JR75_Underway5 | 020621215320.raw | 3077-2397 | Chirp | - |
| Bear Island - Svalbard | 22/6/02-23/6/02 | 11:38 | 02:48 | JR75_Underway6 | No data recorded | 2310-333 | Chirp Burst | - |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Kongsfjord Station 2 | 23/6/02 | 03:10 | 05:04 | JR75_Kongsfjord_st2 | 020623031121.raw | 307 | Burst | Gravity Core GC064 |
| Kongsfjord Survey into Ny Alesund | 23/6/02-24/6/02 & 25/6/02 | 19:51<br>10:24 | 09:04<br>11:45 | JR75_Kongsfjord | 020623195016.raw | 350-50 | Burst | - |
| Western Svalbard Margin | 25/6/02 | 11:45 | | JR75_underway6 | 020625102019.raw | 200-1500 | Burst Chirp | |
| Western Svalbard Margin Station 4 | 25/6/02 - 26/6/02 | 11:23 | 17:33 | JR75_Svalbard_stn4 | 020626112325.raw | 1100-1300 | Chirp | Multicore MC066<br>Gravity Core GC067 |
| Western Svalbard Margin | 27/6/02 | 10:24 | 12:00 | JR75_Underway7 | 020627102329.raw | 1300-2000 | Chirp | |
| Western Svalbard Margin Station 5 | 27/6/02 | 12:00 | 14:27 | JR75_Svalbardmargin_stn5 | 020627115450.raw | 2000-2500 | Chirp | Gravity core GC068 |
| Molloy Deep / Fram Strait | 28/6/02 | 18:38 | 09:19 | JR75_FramStrait | 020628184103.raw | 2500-5300 | Chirp | Hydrog. Survey |
| Northwest Svalbard Margin | 29/6/02 | 10:09 | 17:39 | JR75_Underway8 | 020629100939.raw | 1137-750 | Chirp Burst | |
| Yermak Plateau | 29/6/02 | 17:40 | 19:09 | JR75_Yermak_stn1 | 020629173946.raw | 750-950 | Burst | Multicore MC069 & Gravity core GC070 |
| Yermak-Svalbard | 30/6/02 | 09:44 | 21:10 | JR75_underway9 | 020630094223.raw | 200-1300 | Burst Chirp | |
| Western Svalbard | 30/6/02 | 21:15 | 01:34 | JR75_Lostlander_stn4 | 020701080114.raw | 1000-1500 | Chirp | Attempt for Lander recovery |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Margin | | | | | | | | |
| Western Svalbard Shelf | 1/7/02 | 08:05 | 10:06 | JR75_Underway10 | 020701080114.raw | 200-300 | Burst | |
| Western Svalbard | 1/7/02 | 10:07 | 13:21 | JR75_Svalbardshelf_stn3 | 020701100514.raw | 200-350 | Burst | Gravity cores GC072 GC073 |
| Kongsfjord, Svalbard | 1/7/02 | 01:15 | 03:09 | JR75_Kongsfjord | 020702005720.raw | 50-400 | Burst | Gravity core GC074 |
| Kongsfjord / Krossfjord | 2/7/02 | 05:01 | | JR75_Kongsfjord | 020702045328.raw | 50-400 | Burst | |
| Kongsfjord - Western Svalbard Margin | 3/7/02 | 17:47 | 22:00 | JR75_underway11 | 020703174629.raw | 300-1300 | Burst Chirp | Attempt for Lander recovery |
| Western Svalbard Margin - Bear Island | 4/7/02 5/7/02 | 04:07 | 08:30 | JR75_underway11 | 020704040657.raw 020704094433.raw | 1300-2700 | Chirp | |
| Bear Island Fan | 5/7/02 | 08:37 | 11:04 | JR75_BearIsland | 020705083602.raw | 1400-1500 | Chirp | Mulitcore MC075 Gravity core GC076 |
| Bear Island - N. Norway Margin | 6/7/02 - 7/7/02 | 01:06 | 06:47 | JR75_underway12 | 020706010544.raw 020706120455.raw 020706145202.raw | 2000-300 | Chirp Burst | |
| Norwegian Margin | 7/7/02 8/7/02 | 06:48 | 01:03 | JR75_underway13 | 020707064738.raw 020707094403.raw | 300 | Burst | Lander recovery Sula Ridge |
| Norwegian Margin | 8/7/02 | 06:37 | | JR75_underway14 | 020708063644.raw | 300 | Burst | |
| Faeroe-Shetland Channel (Dti Survey) | 9/702 | 04:45 | 09:08 | JR75_FaeroeShetlandChannel | 020709044717.raw 020709065525.raw | 1300 | Chirp | Complete Topas power failure 08:50 hrs END of Topas Surveying |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Faeroe Shetland Channel – Wyville Thomson Ridge | 9/7/02 10/7/02 | 12:20 | 09:27 | JR75_FSCWTR | _ | 1300 | _ | _ |

## Coring report
## Paul G. Provost

Coring apparatus

NIOZ Box Core (UKORS & SAMS)
Core size 500x500x550mm (L,W,D)
The box core was used to collect undisturbed samples for biological analysis. Sub samples were also collected from the box core in order to quantify the disturbance of the sediment surface caused by the 'bow wave' effect.

Barnett & Watson Multi corer
Core size 59x400mm (LxØ), 8 out of a possible 12 cores were set up for this cruise.
The multi corer was used to collect undisturbed samples for chemical, physical and biological analyses.

SAMS Modified Mega corer
Core size 110x800mm (LxØ), initially 4 cores were set up for this cruise.
The mega corer was used to collect undisturbed samples for chemical and physical analyses. The design of the mega corer is unique and incorporates the frame and firing head mechanism of the Barnett & Watson Multi corer. Up to four coring heads each containing one mega core can be fitted in this design. The firing mechanism is unique to this system. The traditional mega corer design could not be incorporated into this because of patent restrictions.

The relatively shallow cores collected using the multi and mega corers created an overlap of undisturbed sediment profiles in the top 20cm of the surface sediment that the BGS gravity corer was unable to provide due to the disturbance caused on penetration.

It has been suggested, but not quantified that the nature of action of the box core sample collection creates sufficient turbulence of the sediment-seawater interface that very fine floc material and biota can be lost from the sample. The damped action of the multi and mega corer on sediment penetration is thought not to have this effect. Hence samples that required an undisturbed sediment interface were collected using the multi and mega corer.

Method

Box corer deployment

The box corer was deployed from the vessel using the starboard midships gantry. The veer (drop) speed was up to 75 m/min to approximately 40m above seabed. The winch was stopped for approximately 30 seconds for wire to settle and then dropped at 20-30 m/min into seabed. In very soft sediments, the box corer was landed to the seabed at 10 m/min to minimise frame penetration into the sediment. Once the corer was landed onto the seabed, 5m of additional wire was paid out, and then the wire was immediately hauled to complete the mechanical action of the corer. The haul (recovery) speed was up to 75m/min.

Multi and mega corer deployment

The Multi and Mega corer was deployed from the vessel using the starboard midships gantry. The veer (drop) speed was up to 75 m/min to approximately 40m above seabed. The winch was stopped for approximately 30 seconds for wire to settle and then dropped at 20-30 m/min into seabed. In very soft sediments, the corer was landed to the seabed at 10 m/min to minimise frame penetration into the sediment. Once the corer had landed onto the seabed, 10-15m of additional wire was paid out (depending on sea conditions) and the corer was allowed to rest on the seabed for 2 minutes to allow the hydraulic firing action of the corer to complete. The wire was then hauled to recover the corer. Therefore in total the corer sat for approximately 3 minutes on the seabed. The haul (recovery) speed was up to 75m/min.

Results

Box coring

30 box core deployments were made during the cruise. Of these only one failed to collect any sample (water only) and 2 further deployments collected samples that were incomplete due to rocks trapped in the spade seal. A list of box coring deployments during the cruise is described in Table 1.

Multi coring

31 multi core deployments were made during the cruise. The corer was set up to collect from only 8 of the maximum of 12 core tube positions – this allowed for redundancy of spare parts and requirements of the sampling. Every drop was successful, although on some drops less than 8 acceptable cores were collected. A list of multi coring deployments during the cruise is described in Table 2.

Mega coring

18 mega core deployments were made during the cruise. The corer was initially set up to collect from the maximum of 4 core tube positions (one made to an earlier design and three to a later design). Early on in the cruise it became apparent that the later design of the mega core heads was more successful and as a result only these were set up during the later stages. Despite this, the mega corer deployments were only sporadically successful. The success of the mega core collection would be increased if noted improvements to the firing mechanism are made and a more rigid material is used for the core tubes. A list of mega coring deployments during the cruise is described in Table 3.

## Geochemistry
## Eric Breuer and Rebecca Dean

Objectives
The following questions are the basis of our cruise effort for JCR 75:
Theme A, Question 4 *How does bioturbation vary in response to environmental forcing and what are the consequences for redistribution of anthropogenic contaminants?*
Theme B, Question 2. *To what extent do benthic faunal composition and size structure determine processes of carbon dynamics and biogeochemical provinces at the benthic boundary?*

As part of SAMS Northern Seas overall objective this first Arctic cruise will provide invaluable data on contaminant transport, sediment digenesis, sedimentation rate, and latitudinal changes in bioturbation behaviour and lay the foundation for future research.

Methodology

*Sediment geochemistry*
Megacores (111 cm diameter) were collected with little to no disturbance to the sediment water interface by using a modified version of the Barnett Watson multicorer. This modification was to place four "megacore" heads onto the multicorer. Megacores were obtained from all sites for metal analyses except KF2 where a multicorer (5cm diameter) was used. Megacores for Radionuclide/Organic Matter analyses were obtained from all sites except KF2 and BIF where multicores were substituted. The substitution of megacores for multicores at these sites was due to megacorer failure. Three cores were needed at each site, 1 for metal analyses, 1 for organic matter analysis and 1 for radionuclides ($^{210}Pb$, $^{234}Th$) and chlorophyll. Once collected, cores were sectioned at 0.5cm intervals to a depth of 10cm, 1cm intervals to 20cm depth then 2cm slices until the bottom of the core. For dissolved and solid phase metal, sample slicing and centrifugation was performed under $N_2$-atmosphere (to prevent oxidation and precipitation of dissolved metals).

*Oxygen profiling*
In conjunction with the in-situ profiling system (see Oli's report) a shipboard system for the measurement of oxygen microprofiles was used. Micro-electrodes with a sensing tip diameter of < 10 μm and 90% response time of 1s were used to measure oxygen concentrations in the sediment at a vertical resolution of between 50 - 250 μm. The electrodes were inserted into collected multi cores as soon as possible after collection. All stations except VP2 have shipboard oxygen profiles.

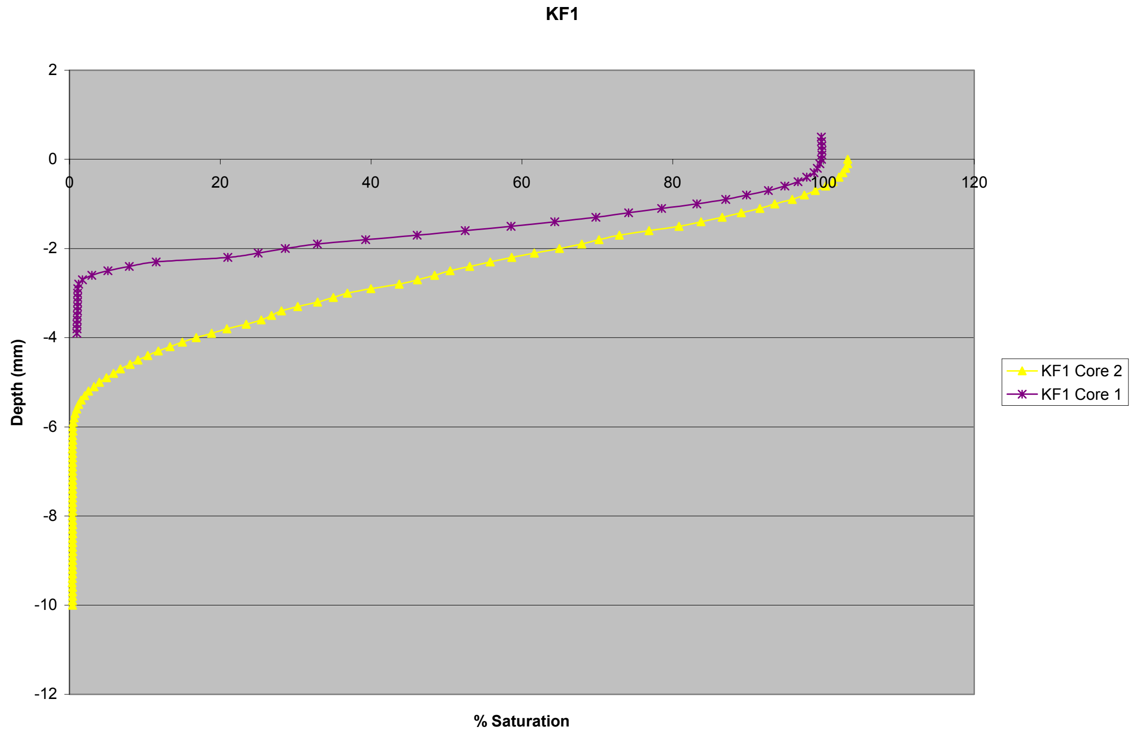
Sample stations and deployed

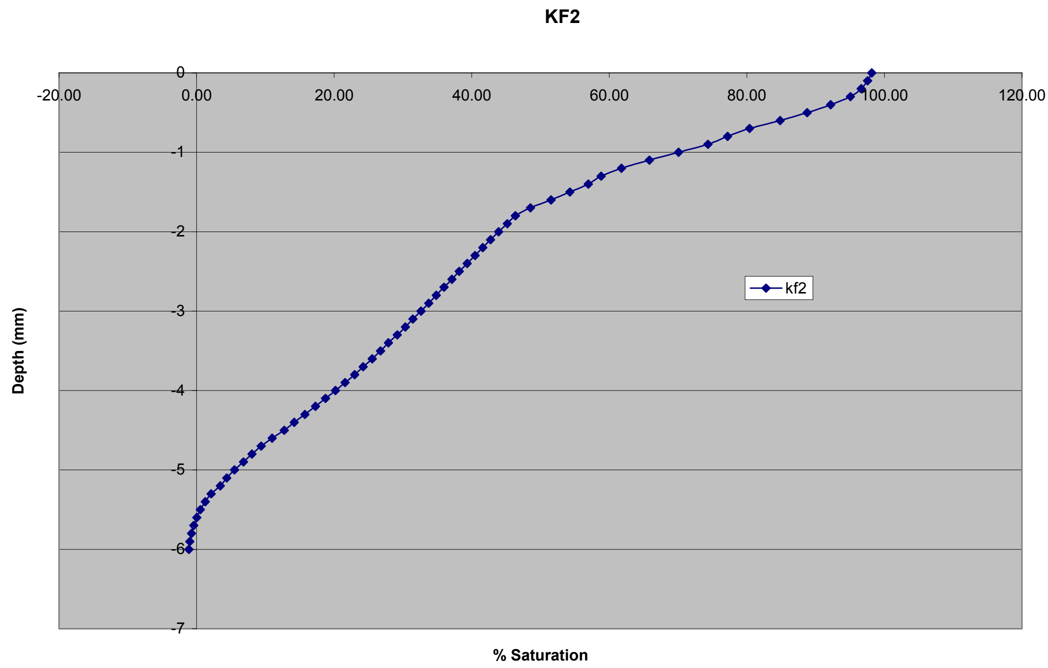
| Station/sampling | Date | Lat/Long | Event (#) | Depth |
|---|---|---|---|---|
| Voring Plateau (VP2) | 19/06/02 | N67 12.81/ E06 06.25 | Megacore (26) | 1385 |
| Kongsfjord (KF2) | 23/06/02 | N79 03.33/ E11 17.68 | Multicore (109)/ Shipboard oxygen profile | 222 |
| Kongsfjord (KF1) | 24/06/02 | N78 57.46/ E11 54.49 | Megacore (129)/ Shipboard oxygen profile | 355 |
| Kongsfjord (KF4B) | 26/06/02 | N78 58.43/ E06 42.66 | Megacore/ Shipboard oxygen profile | 1335 |
| Kongsfjord (KF5) | 28/06/02 | N78 56.90/ E05 17.83 | Megacore (162)/ Shipboard oxygen profile | 2467 |
| Yermak Plateau (YP1B) | 30/06/02 | N80 45.00/ E07 38.72 | Megacore (194)/ Shipboard oxygen | 922 |

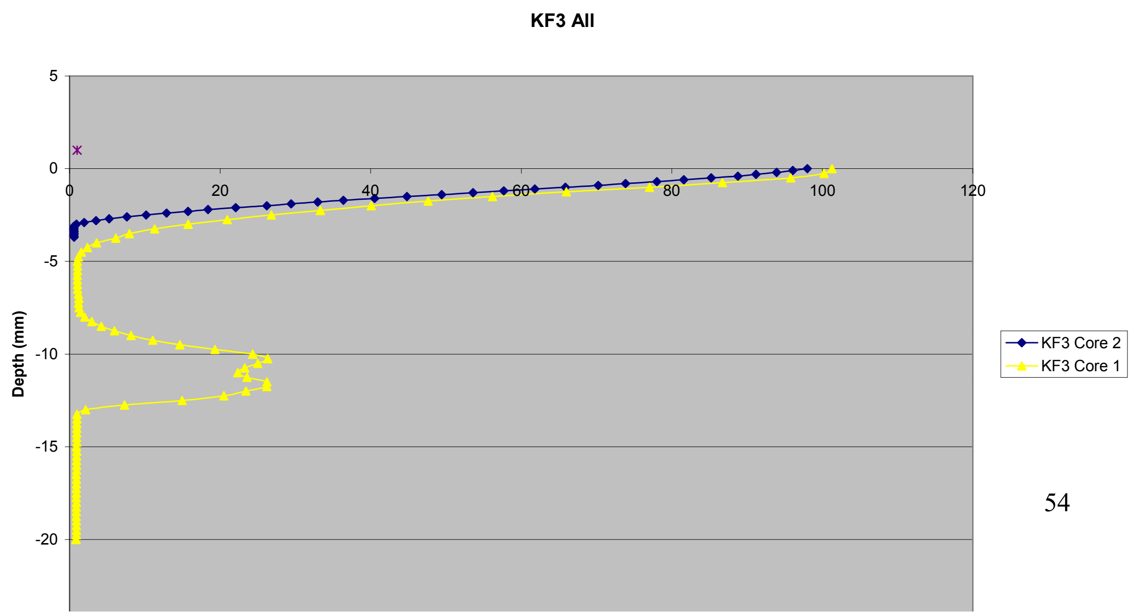
| | | | | |
|---|---|---|---|---|
| | | | profile | |
| Kongsfjord (KF3b) | 01/07/02 | N 70 01.33/ E01 41.61 | Megacore (228)/ Shipboard oxygen profile | 343 |
| Bear Island Fan (1400m) | 05/07/02 | N73 39.59/ E13 46.95 | Megacore (#255)/multicorer (253) Shipboard oxygen profile | 1440 |

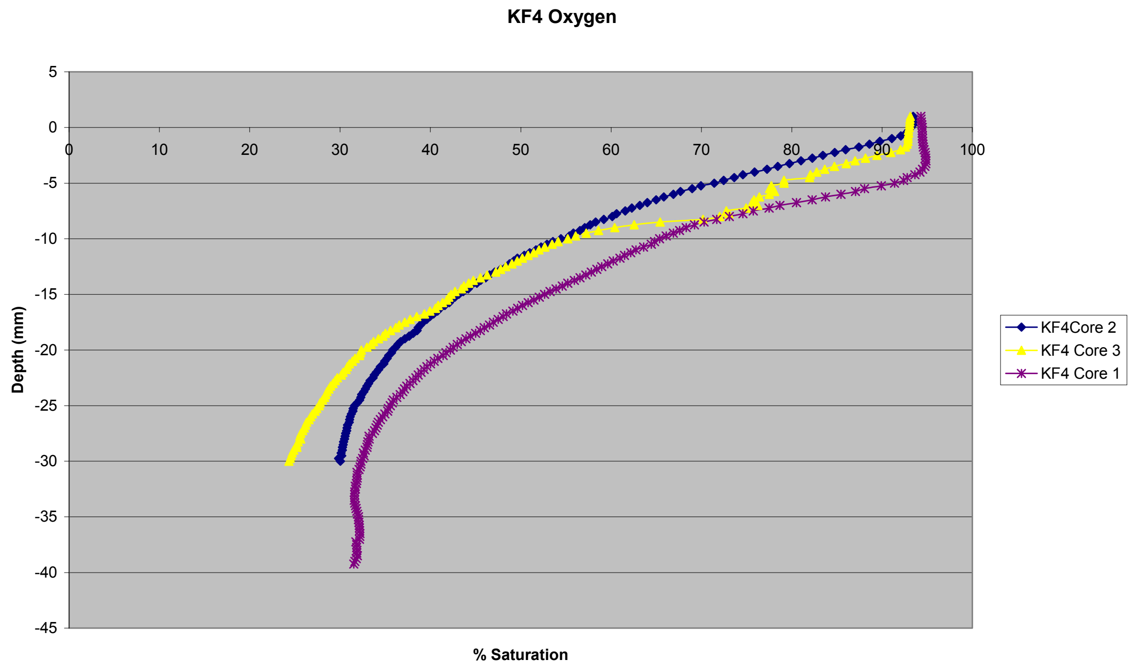
Initial results.
Figures 1 through 7 show shipboard oxygen profiles for all stations with the exception of VP2. This is initial data that still needs to be processed with the calibration data and bottom water oxygen concentrations determined by micro-winkler titration's. The data presented on the graphs are from 3 different cores (when possible) taken from three separate drops of the muti-corer. Initial interpretation of the results indicates the expected trend seen in oxygen organic matter relationships. The shallower sites KF2, KF1 and KF3b will have expected higher inputs of fresh organic matter fuelling microbial process that will rapidly consume oxygen (Figures 1-3). Figure 1 profiles are indicative of the heterogeneity seen in shallow water with patchy distribution of organic matter and high rates of bioturbation. Data from the deeper sites indicates much deeper penetration of oxygen as a likely consequence of less organic matter reaching the seabed due to water column recycling.

<u>Future activity</u>
The solid phase sediment data will be used to characterise sediment type and identify major changes in type along both the latitudinal and longitudinal gradients.
The solid phase and pore water analysis of sediment cores in conjunction with oxygen data, radionuclide data and organic data will be used to determine the biogeochemical processes that are dominating the system under study and investigate the role of carbon (quantity and type) and benthic biota with respect to changing environments. This will be done for both the latitudinal gradient (change in supply but constant depth) and longitudinal gradient (change in depth and water masses). The redistribution of pollutants will also be investigated on both transects.
This data will be intimately linked with the biological data and flux data and will be modelled with respect to the benthic/geochemical system.
The radionuclide and chlorophyll data will provide rates of mixing on different scales, Th-234 and chlorophyll days to months and Pb-210 years. The Th-234 and chlorophyll will be targeted to the fjordic sediments where we might expect a higher concentration of biota and hence mixing.


KF1
Depth (mm)
% Saturation
KF1 Core 2
KF1 Core 1


KF2
Depth (mm)
% Saturation
kf2


KF3 All
Depth (mm)
KF3 Core 2
KF3 Core 1


KF4 Oxygen
Depth (mm)
% Saturation
KF4Core 2
KF4 Core 3
KF4 Core 1
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
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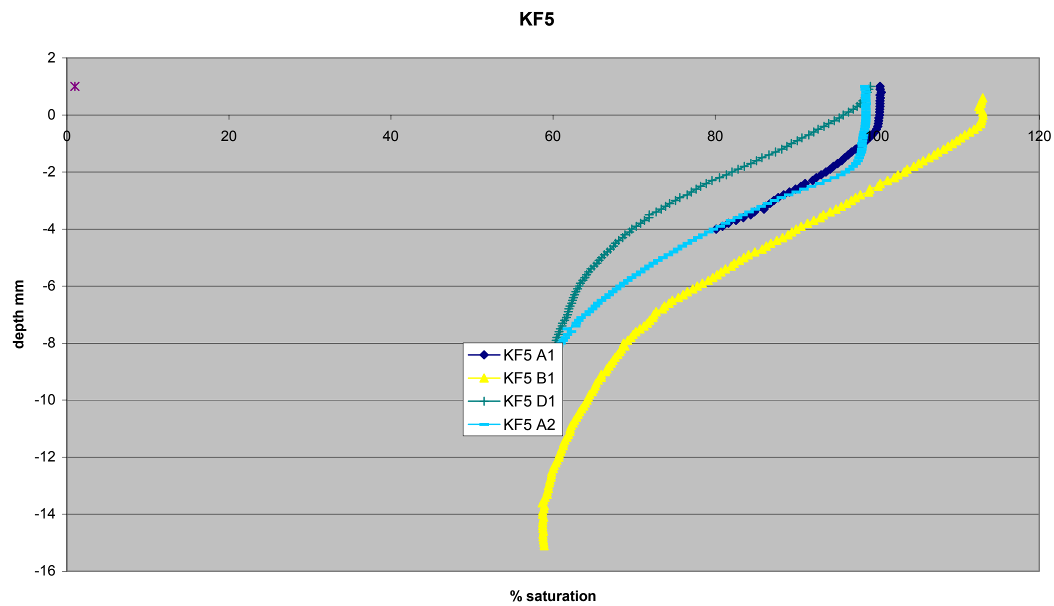
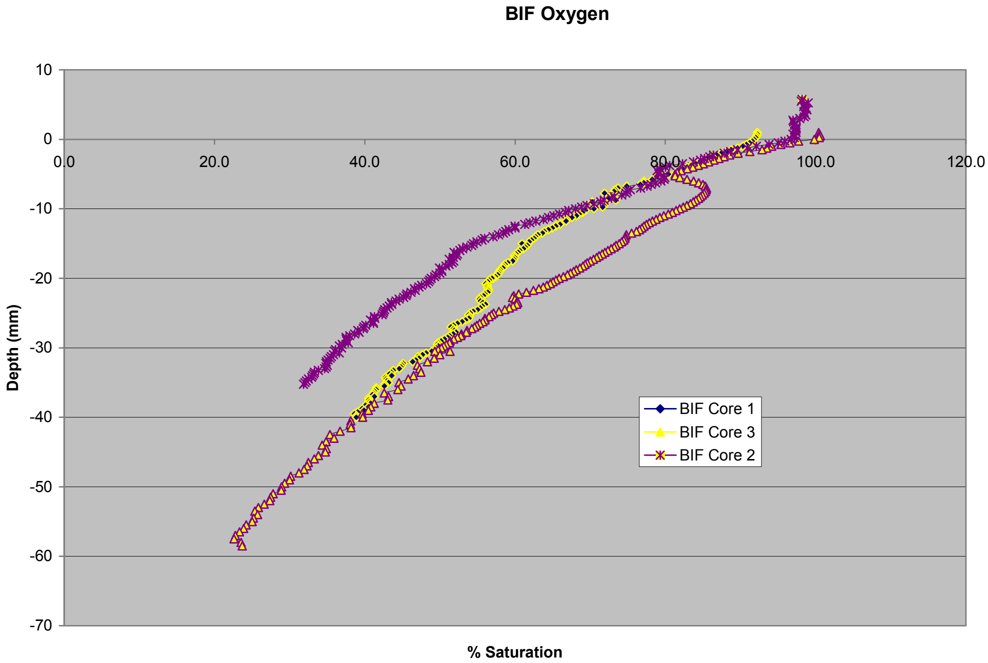
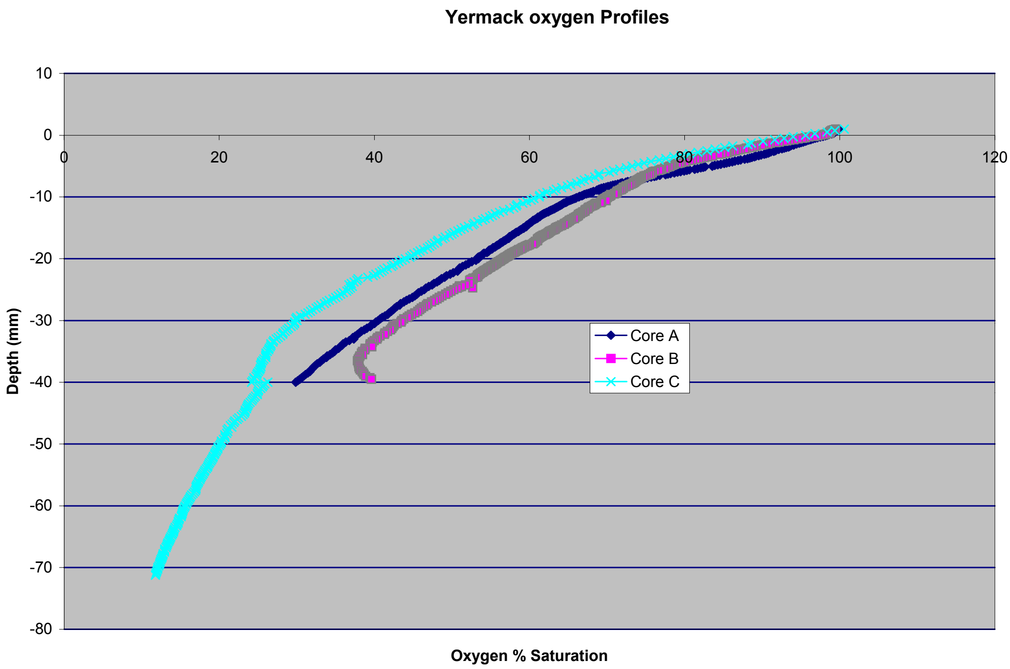
60
70
80
90
100


KF5
depth mm
% saturation
KF5 A1
KF5 B1
KF5 D1
KF5 A2
2
0
-2
-4
-6
-8
-10
-12
-14
-16
0
20
40
60
80
100
120


BIF Oxygen
10
0
-10
-20
-30
-40
-50
-60
-70
0.0
20.0
40.0
60.0
80.0
100.0
120.0
Depth (mm)
% Saturation
BIF Core 1
BIF Core 3
BIF Core 2


Yermack oxygen Profiles
10
0
-10
-20
-30
-40
-50
-60
-70
-80
0
20
40
60
80
100
120
Depth (mm)
Oxygen % Saturation
Core A
Core B
Core C

# KC-Lander Operations on RRS James Clark Ross – JR75

**Oli Peppe, Bruce Barr, Eric Breuer**

## 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 JR75 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 JR75 we were using oxygen 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 capable of 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 at each of the main study sites, using moored mode at the shallowest station (~ 200m) and autonomous mode at all others. The *Elinor* system was to be tested in its oxystat mode at one deep water (1400m) station as part of ongoing preparation for the Arabian Sea programme. In addition the cruise was to be used to train new personnel in the operation of the lander.

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

Early deployments in firm sediment types proved successful, but major problems were experienced with the softer muds encountered in the Kongsfjorden region, and this resulted in one of the landers being twice. Grappling proved successful the first time (in 350m) but unfortunately not the second time (in 1380m).

## Pre-cruise preparation

Much of the work before this cruise was combined with ongoing preparations for the Arabian Sea programme (currently scheduled for 2003). A brief summary of the work relevant to JR75 is given below:

- A new buoyancy frame was made and tested to a modified design allowing twin Oceano acoustic releases (Type AR / RT 661) to be fitted.
- New control software was implemented, in collaboration with Unisense, to remove bugs and improve functionality.
- A prototype of the oxystat system for *Elinor* was made so that the effect of pressure on membrane permeability could be assessed.
- The *Elinor* shovel system and syringe sampler were overhauled, including the strengthening of the shovel closure by inclusion of a spacer to pretension the spring.
- New parts to complete the second autonomous system were ordered or made and then fitted.
- All buoyancy and recovery aids and instrument housings were serviced.

## Pre-deployment tests

### Buoyancy tests

Due to a lack of deep water early in the cruise buoyancy testing was performed in two stages. An initial test was done on one of the buoyancy frames to 1500m, just before reaching the Voring Plateau station. This test was performed lowering the full lander frame (with no instrumentation attached) over the stern using the coring wire. With a net wet weight of around 110kg the frame would sink at no more than 35 m/min or so so the test was very slow. A fairly heavy swell almost certainly contributed to this. All buoyancy remained intact. On the way North to Svalbard we stopped in over 3000m water and tested both buoyancy frames and the spare spheres. This time the frames were lowered on their own from the starboard gantry (no instrumentation frame attached), with a 500kg clump of chain below at a speed of 70 m/min. All buoyancy remained intact.

Acoustic release tests

All acoustic releases were tested during the buoyancy tests, having first been tested on deck. The InterOcean release failed, and was found to have a broken connector pin on recovery. Oceano release S/N AR690 appeared not to be responding, but had in fact executed the release command correctly. All other releases functioned correctly. Problems were experienced with the new SAMS Oceano TT301 deck unit, later reckoned to be due to moisture in the transducer connector.

*Profilur* deployments

Deployment Plan

The aim was to deploy the *Profilur* system at each of the major stations along the 1400m South – North transect (Voring Plateau, Bear Island Fan, Kongsfjord, and Yermack Plateau) and at each station along the East – West Kongsfjord transect. The results would give a measure of the oxygen penetration depth and diffusive boundary layer thickness for each station, and be compared with results from ship-based measurements on retrieved cores. At all sites only oxygen micro-electrodes would be fitted, as little or no sulphide was expected, and ongoing problems with the pH electrodes precluded their use.

Details of Deployments

Deployment 062_PRF – Voring Plateau, 19/06/02 – 20/06/02, 1440m

Because of the failure of the InterOcean release during the first buoyancy test, and the inability of fitting two Oceano type releases to the old (tested) buoyancy frame, the lander was configured with one Oceano release and a burnwire as back-up ballast release. The system was fitted with 5 oxygen micro-electrodes, and the profile set-up is shown in *Fig 1* . These profile settings were a compromise between maximum measuring resolution and the time available for the deployment (only about 13 hours).

The lander was deployed using the starboard deck crane over the aft starboard side. Whilst this ensured the clearest path across deck, deploying so close to the stern significantly increased the swell hitting the lander (and therefore electrodes) during deployment and wherever possible the lander should be dropped from as close to midships as possible. It is also important to pass the trigger line for the release hook over the shackle to ensure a good upward pull.

Recovery was complicated by the fact that the pellet float became caught up under the buoyancy frame. It is presumed this happened because the lander was slightly more buoyant than usual (~95kg cf 75kg) and rose faster than the pellet sphere. (The pellet sphere was seen to be clear of the frame as the lander sank.)

4 good profiles were obtained (*Fig 2* ), with one electrode broken sometime before profiling started.

130mm initial step

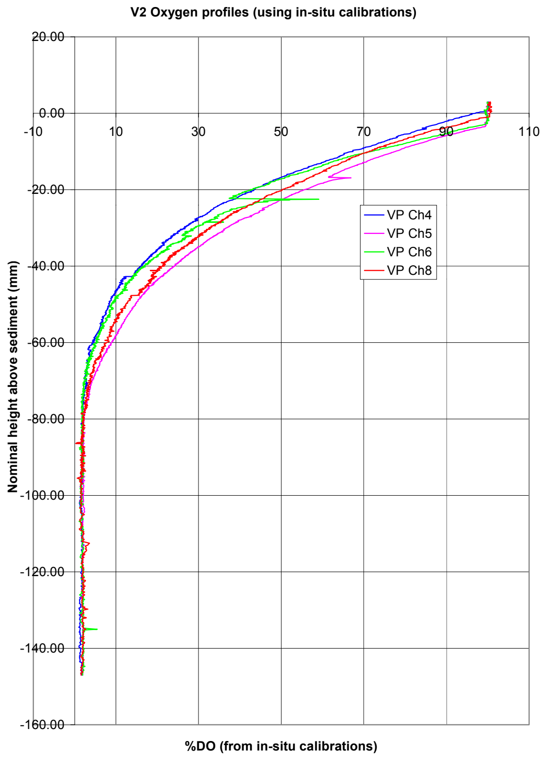
30mm at 100um

20mm at 50um Level of leg plates

50mm at 100um

50mm at 250um

*Fig 1 – Profile settings*



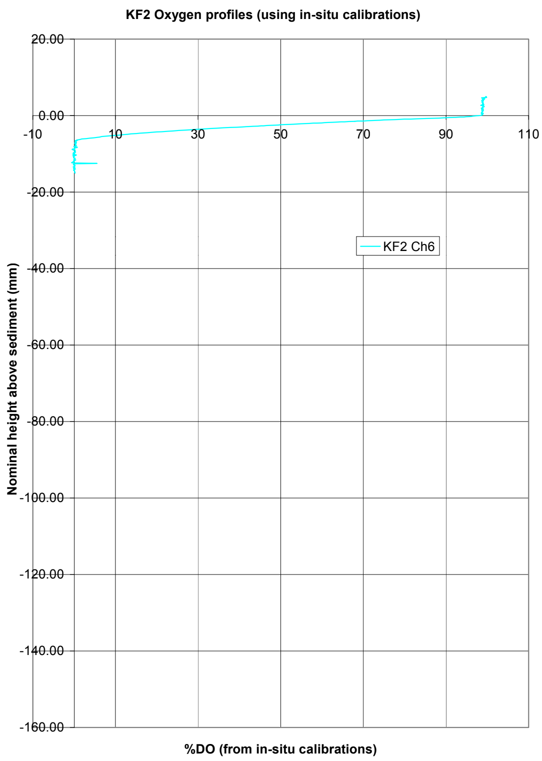




*Fig 2 – Oxygen profiles from the Voring Plateau and Kongsfjorden Station 2*

Deployment 063_PRF – Kongsfjord 2, 23/06/02, 245m

This deployment was made in moored configuration, using 265m of rope – a combination of 12mm Seasteel and 6mm polyester multibraid – and two surface marker floats (this length of rope was subsequently found give only just sufficient slack for recovery, given the long lead to the deck winch.

The first box core from the site showed the sediment to be covered in large pebbles (*Fig 3* ) and it was acknowledged that the chances of getting electrodes back intact were slim! The electrode configuration and profiling protocol were the same as used in 062_PRF.

Not surprisingly on recovery all electrodes were broken (*Fig 4*) but fortunately one electrode survived long enough to get a complete profile (*Fig 2* ) The water-bottle burnwire had not fired, and there were signs of some form of weed(?) covering the nick. The burnwire firing time had been increased to 15 mins (from normal 5 mins) to allow for the cold water temperatures.

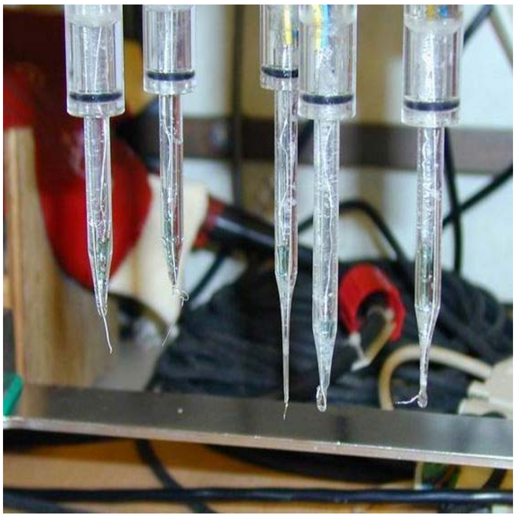


*Fig 3 – Box core surface from KF2* *Fig 4 – Electrodes after profiling at KF2!*

Deployment 064_PRF – Kongsfjord 1, 24/06/02 – 25/06/02, 350m

Set-up identical to 062_PRF. The first box core showed mud to be fairly soft at this site, but at that stage this was not reckoned to be a problem. However we did maintain the net ascent buoyancy at 95kg, rather than reducing it to the normal 75kg as originally planned to try and avoid the problem experienced with pellet float during 062_PRF recovery.

However when we came to drop the ballast, the acoustics confirmed release, but the lander did not lift off from the sea-bed (as indicated by ranges and pinger trace). A trawl line was set up using the length of the ship to create a loop (*Fig 5 a.*) and the ship was moved sideways over the lander position using DP and thrusters. Just as we reckoned we must have missed it, it lifted off from the seabed and was recovered shortly afterwards with no sign of damage. The whole recovery operation took just under 7 hours.

Because of the depth the lander had sunk in, estimated to be between 10 and 18 cm above the leg plates, no profiles were obtained and 3 electrodes were broken. In hindsight, given the low tidal regime in Kongsfjorden and the extremely calm weather it would have been possible to moor the system in this water depth and this should undoubtedly be considered when operating in soft muds and relatively shallow waters.

Once again the burnwire had not fired, despite tests before the deployment in the cold room. A similar brown "fluff" to that observed after 063_PRF was covering the nick, under which the metal seemed completely uncorroded.

Deployment 065_PRF – Kongsfjorden 4, 25/06/02 - ?, 1380m

Because of the unreliability of the burnwire, the buoyancy frame was changed for the new one which fits two Oceano acoustic releases, thus avoiding the need for a burnwire back-up.

The mud type at this station was again very soft, though it was thought there might be a slightly stiffer layer at a shallower depth. We decided to add an extra buoyancy sphere

(maintaining the net ascent buoyancy around 100kg), lower the legs of the lander to lift the instrumentation and ballast weights higher above the sediment, and reduce the descent weight and therefore the descent speed (see
*Table 1*). However once again, and not entirely unexpectedly, the lander failed to lift off from the seabed when the acoustic releases were triggered. Over the next week or so three different methods of recovery were attempted and the lander position accurately surveyed. These recovery operations are described in more detail in Section 0.

Unfortunately none were successful, and the lander remains on the seabed. There is a possibility of assistance from the R/V Polarstern with the Victor ROV as they will be in the area in August.

Deployment 066_ELI – Kongsfjorden 1, 02/07/02 – 03/07/02, 350m

This deployment of the *Elinor* system had originally been designed as a test of the new oxystat system in deep water. However given the problems with the *Profilur* sticking in soft mud at the intended Kongsfjorden 4 station (1400m) this clearly couldn't go ahead. So instead we made a moored deployment at Kongsfjorden 1. We used 425m of rope – a combination of 12mm Seasteel, 6mm polyester multibraid, and 18mm polypropylene.

Because of the continuing problems we were having with burnwires, we sent the system down with the chamber lid closed, as the deployment would be completely wasted if the burnwire failed and the lid stayed open throughout. Also at the last minute the hydraulic switch for the shovel system developed a fault, and so the shovel was disabled. Lengths of 3x2 wood were lashed across the legs of the lander to create a makeshift platform to prevent the chamber sinking too far into the soft mud, and the leg height was set so that the shallow part of the chamber was actually 50mm higher than the leg plates. In hindsight this probably left too little sediment above the bottom of the chamber walls to form an effective seal.

The oxygen concentrations in the chamber were monitored at 5 minute intervals by a mini-electrode, and water samples (duplicated) were taken at 5 discrete intervals. Another mini-electrode measured the ambient oxygen concentration. Sodium bromide was injected at the end of the deployment, and a water sample taken shortly afterwards, to measure the volume of water enclosed by the chamber, and therefore the height of the sediment.

On recovery of the system, the chamber electrode was broken (it is not known how this happened), and significant electrode drift is seen in the external electrode signal. The water sampler had only taken about half the samples (the syringes appeared to be stuck – perhaps due to cold temperatures?). In short the data confirms little about the operation of the oxystat system. On a positive note all 3 burnwires had fired, however this doesn't explain the problems being experienced on earlier deployments of the *Profilur*.

<u>Lander recovery methods</u>

Four different methods were used to try recovering the lander. The first, successful, was only suitable for the shallow station. The other three were used at Kongsfjorden 4, in around 1400m of water.

1. 150m of wire stretched the length of the ship with a 500kg chain clump and 500m of wire up to the ship at either end. The wire was then dragged sideways along the bed. (*Fig 5 (a)*.)
2. 500m of heavy wire with a 500kg chain clump at either end laid in a straight line and then pulled with the coring wire in an arc across the lander position. This was attempted twice, using different orientations of the bottom line, and different angles of pull. (*Fig 5 (b)*.)
3. A circle of coring wire, radius 100m, laid around the lander position and then pulled tight. (*Fig 5 (c)*.)
4. A 2.5m wide grapple system with 3 grappling hooks on 5m tails weighted with 500kg chain clump, towed backwards and forwards just off the seabed.

Good weather conditions throughout meant that the ship was able to manoeuvre using DP. A 10kHz pinger was placed on the wire to monitor the height of the gear relative to the seabed. At close ranges to the lander both the 10kHz wire pinger and the12kHz lander pinger could be tracked using the PES on 10kHz. At greater distances (~ 1km or more) the PES had to be switched into 12kHz mode to see the lander pinger.

In order to increase our chances, a detailed swath map was made of the area, and the lander position surveyed acoustically in two ways:

1. By timing the point of closest approach using the trace of the lander pinger on the PES screen as the ship steamed a box around the estimated position
2. By triangulation using acoustic ranges from 3 points roughly 1km away from the lander. After the raw ranges given by the TT301 deck unit were adjusted to allow for the speed of sound in water in this region (1465 m/s from CTD) the horizontal range was calculated using the depth of lander, depth of transducer and Pythagoras.

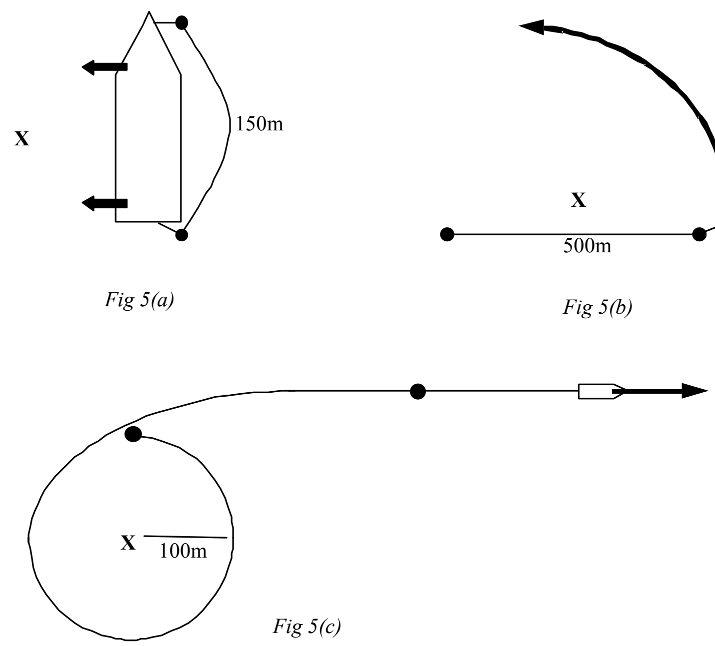



*Fig 5 – Schematics of the different methods used to try and recover the lander from soft mud.*

Future plans

As a result of the problems experienced in the soft muds found at most sites during this cruise, we will be considering means of improving the lander design for use in soft mud such as:

- Inflatable lift bag to provide emergency buoyancy
- Expendable "pancake" feet
- Spool of Kevlar rope with releasable float to send up surface line.
- Means of slowing rate of descent without reducing the hold down weight.

Oxygen micro-electrode calibration procedures

An in-situ two point calibration was used. Water bottles on the lander were used to take samples of the overlying water to give the oxygen concentration using winkler titration. The zero oxygen point was taken from the asymptote of the electrode signal. As a back-up lab oxygen calibrations were done before each deployment, in the cold room (around –1C) after the system had been left to stabilise for 2 hours or more The signal from electrodes in oxygenated seawater was recorded. Then sodium-dithionite was added to remove all oxygen and the signal was again recorded. No magnetic stirrer was used as the heat given off by it was warming up the calibration water!

*Table 1: Deployment summary*

| **Deployment #** | **062_PRF** | **063_PRF** | **064_PRF** | **065_PRF** | **066_ELI** |
|---|---|---|---|---|---|
| **Site** | Voring Plateau (VP2) | Kongsfjorden (KF2) | Kongsfjorden (KF1) | Kongsfjorden (KF4B) | Kongsfjorden (KF1) |
| **JR75 Event number of deployment / recovery** | #18 / #27 | #101 / #116 | #120 / #133 | #139 / not recovered | #231 / #240 |
| **Configuration** | Profilur, autonomous | Profilur, moored | Profilur, autonomous | Profilur, autonomous | Elinor Oxystat, moored |
| **Deployment date** | 19/06/02 | 23/06/02 | 24/06/02 | 25/06/02 | 02/07/02 |
| **Deployment time** | 1113Z | 0616Z | 1508Z | 2340Z | 0319Z |
| **Deployment position** | 67° 13.21'N 06° 05.30'E | 79° 03.26'N 11° 17.96'E | 78° 57.47'N 11° 53.94'E | 78° 57.98'N 06° 43.04'E | 78° 57.46'N 11° 55.07'E |
| **Deployment Water depth (m)** | 1439 | 245 | 354 | 1380 | 355 |
| **Recovery date** | 20/06/02 | 23/06/02 | 25/06/02 | Not recovered | 03/07/02 |
| **Recovery time** | 0105Z | 1935Z | 1020Z | n/a | 1700Z |
| **Recovery position** | as deployment | as deployment | 78° 57.48'N 11° 53.84'E | Best estimate pos. on seabed 78° 58.06'N 06° 42.81'E | as deployment |
| **Time on bottom (hrs)** | 12.8 | 12.8 | 17.7 | n/k | 36.9 |
| **Weight on descent (kg)** | 50 | n/a | 48 | ~30 | n/a |
| **Weight on ascent (kg)** | -95 | n/a | -95 | -100 | n/a |
| **Descent speed (m/min)** | 60 | n/a | n/k | 53 | n/a |
| **Ascent speed (m/min)** | 68 | n/a | ~70 | n/k | n/a |
| **Estimated max. penetration of electrodes or chamber into sediment (mm)** | 145 | 15 (before all electrodes broken) | 180 (missed interface) | n/k | n/k (bromide sample still to be processed) |

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

## Benthic biology

Objectives

*SAMS Northern Seas Programme*

Benthic biological work carried out as part of the SAMS Northern Seas Programme focused on bioturbation – the disturbance of marine sediments by animal activity – with the aim of determining how this important process varies over large-scale gradients in latitude and organic matter input in the northern North Atlantic. The aim was therefore not to comprehensively sample the entire benthic community at any of the cruise stations, but to quantify and characterize those elements of the biota (the macro- and mega-infauna) whose feeding and burrowing activities are the major contributing factors to particle and solute transport in marine sediments. Biological data will be used together with the results of geochemical analyses to provide an integrated assessment of the effects and significance of bioturbation at the study sites.

Specific objectives of biological sampling were:

- To determine the absolute abundance, biomass and depth distribution of benthic macro-infauna (defined here as animals retained on 250 μm sieve mesh) in the sediments at each study site.
- To determine the relative abundance of benthic mega-infauna at the study sites, and as far as possible to identify the taxa present, using seabed photography (and any fortuitous captures of these animals in boxcores). Mega-infauna are here defined as burrowing animals large enough to make traces (Lebensspuren) on the sediment surface visible in seabed photographs.
- To characterize the modes of bioturbation occurring at each site from functional group classification of fauna sampled directly (by coring) or indirectly (by seabed photography), and by observation of sub-surface biogenic structures present in boxcores.

*Atlantic Coral Ecosystem Study (ACES)*

Additional work was also conducted at the Sula Ridge off the Norwegian coast, as a contribution to the EU-funded ACES programme. This consisted of deployment of the SAMS Photolander adjacent to a reef of the cold-water corals, dominated by *Lophelia pertusa,* supplemented by additional seabed photography. The objectives and results of this work are summarized in a separate section.

Methodology

Benthic samples were collected using both types of sediment corer available on the cruise (NIOZ boxcorer and SAMS multi/megacorer). Seabed photographs were taken using the Proudman Oceanographic Laboratory (POL) 'Bedhop' camera. For all three gear types the JCR proved to be an excellent platform and all deployments were performed smoothly and efficiently.

*NIOZ boxcorer*

This was used with a 50 x 50 cm square box, with weighting and penetration limiter adjusted according to sediment type. After appropriate adjustments, excellent cores (ie. with undisturbed surface and overlying water retained) were obtained at all sampling stations. Two or three boxcores were taken at each station. Recovered boxcores were treated as follows:

- Core surface was sketched and photographed, conspicuous epifauna removed and fixed in formalin.
- After siphoning of the overlying water and removal of the box front panel, the core was carefully excavated by trowel. Notes were made and photographs taken of sediment stratification and any visible biogenic structures (burrows etc) encountered.
- The uppermost 10 cm of sediment from each core was retained, sieved through 500 and 250 μm mesh, and residues fixed in formalin.

- A subsample of the sediment below 10 cm depth was sieved on a coarse mesh (2 mm) to extract any larger animals. At most stations the cohesive nature of the deeper sediment made it impractical to sieve the entire box in the available time, and most was discarded after visual examination. The removal of sediment in small amounts using a trowel meant that any deeply-buried mega-infauna were very unlikely to have been missed.
- At each station a subcore (10 cm diameter) was taken from a boxcore for X-ray analysis of relict biogenic structures.

*SAMS Multi/megacorer*
Available time did not generally allow for dedicated corer drops for biological sampling, but at each station, 'spare' cores remaining from geochemical sampling drops were retained. Multicores used for oxygen flux measurements were also obtained after completion of incubations and used to provide additional biological data. Biota were extracted from these hydraulically-damped cores to give more detailed information on depth distribution and as a check on the sampling efficiency of the NIOZ boxcorer. Non-incubated cores were vertically sectioned at intervals of 0-2 cm, 2-5, 5-10, and then at 5 cm intervals to the base of the core. For incubated cores, only the uppermost 10 cm of sediment was preserved, as upward movement of infauna is to be expected under the conditions of oxygen stress generated by the experimental procedure.

*POL Bedhop camera*
The bedhop camera was deployed twice at each station where time was available. The camera was loaded with 35 mm colour transparency film, allowing a maximum of 25 exposures per deployment. Deployments were made with the ship moving on a set course at a speed of 0.5 kt. The time of each seabed contact was recorded, allowing an exact reference to the ship's positioning for each photograph. Owing to time constraints and the absence of proper darkroom facilities on board, no attempt was made to process the films on the ship. However, in every case the film had advanced through the camera correctly and neither the camera nor the flash gave any problems during setup of the system.  It is anticipated that excellent seabed photographs should be obtained after onshore film processing.

**Sample details**
The table below briefly summarizes the biological samples collected during the cruise. The third column gives the sample number assigned in the SAMS Deep-Sea Benthic Group (DSBG) collection.
BHC = Bedhop camera; MC = Multicorer; MGC = Megacorer;  NBC = NIOZ boxcorer

| Station | Cruise Event | SAMS DSBG Sample No. | Nature of sample |
|---|---|---|---|
| Voring Plateau | 16 | NBC 866 | Top 10 cm + X-ray subcore |
| Voring Plateau | 20 | BHC 867 | 25 seabed photos |
| Voring Plateau | 21 | NBC 868 | Top 10 cm of boxcore |
| Voring Plateau | 22 | MC 869 | 7 x multicores |
| Voring Plateau | 23 | MC 870 | 8 x multicores |
| Voring Plateau | 24 | MC 871 | 6 x multicores |
| Voring Plateau | 26 | MGC 872 | 1 x megacore |
| Voring Plateau | 28 | MGC 873 | 1 x megacore.<br>Core slices photographed for burrow counts |

| | | | |
|---|---|---|---|
| Voring Plateau | 29 | BHC 874 | 25 seabed photos |
| Kongsfjord S2 | 100 | NBC 875 | Top 10 cm + large fauna from > 10 cm |
| Kongsfjord S2 | 104 | BHC 876 | 25 seabed photos |
| Kongsfjord S2 | 105 | NBC 877 | Top 10 cm + large fauna from > 10 cm, + vertical section for X-ray |
| Kongsfjord S2 | 106 | NBC 878 | Top 10 cm + large fauna from > 10 cm. |
| Kongsfjord S2 | 113 | BHC 879 | 25 seabed photos |
| Kongsfjord S2 | 107-109 | MC 880 | 6 non-incubated multicores + 6 used for oxygen incubation |
| Kongsfjord S1 | 119 | NBC 881 | Top 10 cm of boxcore |
| Kongsfjord S1 | 121 | NBC 882 | Top 10 cm of boxcore + X-ray subcore |
| Kongsfjord S1 | 123 | NBC 883 | Core surface badly disturbed. Trowelled-through for large fauna, but no sample retained |
| Kongsfjord S1 | 124 | MC 885 | 4 x non-incubated multicores + 2 used for oxygen incubation |
| Kongsfjord S1 | 124a | BHC 884 | 25 seabed photos |
| Kongsfjord S1 | 125 | MC 886 | 4 x non-incubated multicores + 2 used for oxygen incubation |
| Kongsfjord S1 | 126 | MC 887 | 3 x non-incubated multicores + 2 used for oxygen incubation |
| Kongsfjord S1 | 128 | MGC 888 | 1 x megacore |
| Kongsfjord S1 | 132 | BHC 889 | 25 seabed photos |
| Kongsfjord S4 | 138 | NBC 890 | Top 10 cm of boxcore |
| Kongsfjord S4 | 140 | NBC 891 | Top 10 cm of boxcore + X-ray subcore |
| Kongsfjord S4 | 141 | NBC 892 | Top 10 cm of boxcore |
| Kongsfjord S4 | 142-146 | MC 893 | 3 x non-incubated multicores + 2 used for oxygen incubation |
| Kongsfjord S4 | 142-146 | MC 894 | 3 x non-incubated multicores + 2 used for oxygen incubation |
| Kongsfjord S4 | 142-146 | MC 895 | 4 x non-incubated multicores + 2 used for oxygen incubation |
| Kongsfjord S4 | 149 | MGC 895.1 | 1 x megacore |
| Kongsfjord S4 | 150 | BHC 896 | 25 seabed photos |
| Kongsfjord S5 | 154 | BHC 897 | 25 seabed photos |
| Kongsfjord S5 | 155 | NBC 898 | Top 10 cm of boxcore |
| Kongsfjord S5 | 156 | NBC 899 | Top 10 cm of boxcore + X-ray subcore |
| Kongsfjord S5 | 157 | NBC 900 | Top 10 cm of boxcore |
| Kongsfjord S5 | 158 | MC 901 | 3 x non-incubated multicores + 2 used for oxygen incubation |
| Kongsfjord S5 | 159 | MC 902 | 6 x non-incubated multicores + 2 used for oxygen incubation |
| Kongsfjord S5 | 160 | MC 903 | 3 x non-incubated multicores + 2 used for oxygen incubation |
| Kongsfjord S5 | 164 | BHC 904 | 25 seabed photos |
| Yermak Plat. | 186 | BHC 905 | 25 seabed photos |
| Yermak Plat. | 187 | NBC 906 | Top 10 cm of boxcore |
| Yermak Plat. | 188 | NBC 907 | Top 10 cm of boxcore + X-ray subcore |
| Yermak Plat. | 189 | NBC 908 | Top 10 cm of boxcore |
| Yermak Plat. | 190 | MC 909 | 5 x non-incubated multicores + 2 used for oxygen incubation |

| | | | |
|---|---|---|---|
| Yermak Plat. | 191 | MC 910 | 5 x non-incubated multicores + 2 used for oxygen incubation |
| Yermak Plat. | 192 | MC 911 | 5 x non-incubated multicores + 2 used for oxygen incubation |
| Yermak Plat. | 194 | MGC 912 | 1 x megacore |
| Yermak Plat. | 196 | BHC 913 | 25 seabed photos |
| Kongsfjord S3 | 217 | BHC 914 | 25 seabed photos |
| Kongsfjord S3 | 219 | NBC 915 | Top 10 cm + large fauna from > 10 cm, + X-ray subcore |
| Kongsfjord S3 | 220 | NBC 916 | Top 10 cm + large fauna from > 10 cm. |
| Kongsfjord S3 | 221 | NBC 917 | Top 10 cm + large fauna from > 10 cm. |
| Kongsfjord S3 | 222 | MC 918 | 2 x multicores used for oxygen incubation |
| Kongsfjord S3 | 223 | MC 919 | 2 x multicores used for oxygen incubation |
| Kongsfjord S3 | 224 | MC 920 | 2 x multicores used for oxygen incubation |
| Kongsfjord S3 | 229 | MGC 921 | 1 x megacore |
| Kongsfjord S3 | 230 | BHC 922 | 25 seabed photos |
| Bear Isl. Fan | 247 | BHC 923 | 25 seabed photos |
| Bear Isl. Fan | 248 | NBC 924 | Top 10 cm of boxcore |
| Bear Isl. Fan | 249 | NBC 925 | Top 10 cm of boxcore + X-ray subcore |
| Bear Isl. Fan | 250 | NBC 926 | Top 10 cm of boxcore |
| Bear Isl. Fan | 251 | MC 927 | 2 x non-incubated multicores + 2 used for oxygen incubation |
| Bear Isl. Fan | 252 | MC 928 | 3 x non-incubated multicores + 2 used for oxygen incubation |
| Bear Isl. Fan | 253 | MC 929 | 3 x non-incubated multicores + 2 used for oxygen incubation |

**Sample summary**

| Station | NIOZ boxcores | Multicores | Megacores | Seabed photos taken |
|---|---|---|---|---|
| Voring Plateau | 2 | 21 | 2 | 50 |
| Bear Island Fan | 3 | 14 | - | 25 |
| Kongsfjord Station 1 | 3 | 17 | 1 | 50 |
| Kongsfjord Station 2 | 3 | 12 | - | 50 |
| Kongsfjord Station 3 | 3 | 6 | 1 | 50 |
| Kongsfjord Station 4 | 3 | 16 | 1 | 25 |
| Kongsfjord Station 5 | 3 | 18 | - | 50 |
| Yermak Plateau | 3 | 21 | 1 | 50 |

**<u>Preliminary observations from boxcores</u>**

**Voring Plateau (1400 m)**
Boxcores consisted of a soft brown mud layer approx. 10 cm deep overlying a much drier, crumbly brown layer from 10-14 cm, below which softer brown sediment continued to approx. 27 cm. The deepest layer sampled comprised a soft grey mud. There were no conspicuous biogenic features at the core surface, but within the sediment clear evidence was found of two distinct burrow types described by German and Norwegian workers from stations on the Voring Plateau. The sediment of both boxcores taken on JR 75 was deeply

penetrated by high densities of very fine (approx. 1 mm diameter) vertical 'capillary' burrows constructed by the sipunculan *Golfingia* (subgenus *Nephasoma*) sp. These burrows extended the full depth of the cores (> 30 cm). In one boxcore was found the anterior end of an enteropneust worm *Stereobalanus canadensis* and a small section of its burrow. This biogenic feature occurred in the upper 10 cm of the sediment.

**Bear Island Fan (1440 m)**
Boxcore surfaces from this station showed high densities of polychaete tube endings with attached flocculent material. Mobile epifauna included tiny brittlestars and a small (approx. 1.5 cm long) holothurian. The sediment was brown to approx. 25 cm depth, grey below this. One large infilled horizontal burrow was found and photographed at 10-12 cm depth. High densities of much smaller horizontal burrows and some extremely fine vertical burrows were also noted.

**Kongsfjord Station 1 (350 m)**
The recovered sediment was an extremely soft brown mud without stones but with a thick greenish flocculent layer covering the surface. The surface and upper 10 cm of sediment was penetrated by abundant polychaete tube endings, of which the long black tubes of *Spiochaetopterus typicus* were immediately recognizeable. The occurrence of large sipunculan worms at the station was demonstrated by two specimens found in the sediment adhering to the outside of the core boxes, but none were found within the cores themselves.

**Kongsfjord Station 2 (240 m)**
The surfaces of all three boxcores taken here showed almost 100% coverage of small pebbles, among which several species of brittlestar and other epifauna were found. The stones overlay a sticky blackish mud streaked with pale brown mottlings where oxic sediment penetrated the deeper material. This conspicuous pattern is probably attributable to bioturbation by large sipunculan worms (some individuals > 10 cm long) which occurred at high density (provisional estimate 80 $m^{-2}$). The sipunculans found in situ occupied vertical or oblique blind-ending burrows which penetrated the sediment to 18-20 cm. Large polychaete worms, including a huge specimen of the Family Flabelligeridae were also found amongst or just below the superficial stone layer. The abundance of large macro-infauna suggests that geochemical parameters of the sediments at this station will be strongly influenced by bioturbation.

**Kongsfjord Station 3 (330 m)**
The sediment at this station appeared to be an organically-enriched fine mud with a thick blackish floc covering the surface. Tubes of the polychaete *Spiochaetopterus typicus* were abundant, and large maldanid polychaetes were also noted amongst the sieved fauna. It is likely that macrofaunal biomass and bioturbation intensity will prove to be high at this station.

**Kongsfjord Station 4 (1400 m)**
Several brittlestars were present on the surface of each boxcore collected at Station 4. Amphipods, bivalves and other smaller epifauna were also noted. The sediment was pale brown from the surface to approx. 5 cm depth, grey below this, and very soft throughout. No large burrow structures were observed during excavation, but networks of very fine 'capillary' burrows similar to those seen at the Voring Plateau station were seen in the grey sediment below 10 cm depth. Detailed examination of the sieved biota should reveal whether the organisms responsible are the same at both sites.

A large, complete specimen of the deep-sea pennatulacean (sea pen) *Umbellula* sp. was brought to the surface on the chain used in attempts to recover the KC Lander, and fragments of other individuals were recovered later. This sea pen may therefore be expected to be visible on seabed photos from the station.

**Kongsfjord Station 5 (2500 m)**
Boxcore surfaces at Station 5 were largely featureless, with little evidence of biological activity. The sediment was a uniform cohesive brown from the surface to approx. 32 cm

depth, with a well-marked darker brown clay extending for 2 cm below this. The deepest sediment present in the cores was grey. Excavation revealed little biogenic structure and very few organisms were visible in the sieve residues. This station may therefore prove to show the lowest bioturbation intensity of those sampled.

**Yermak Plateau (880 m)**

Biomass appeared to be high at this station, with boxcore surfaces showing numerous polychaete tube endings and small epifauna. Excavation also revealed much evidence of biological activity, suggesting high levels of bioturbation. Large animals found during excavation included echiuran worms (present in two out of three boxcores taken) and a very large (approx. 25 cm long) capitellid polychaete. Maldanid polychaetes could be clearly seen extending below 10 cm depth in the sediment. A horizontal burrow compatible in size with the echiurans was found at approx. 8 cm sediment depth in one core. Faecal pellets present in this burrow were sampled. Fine 'capillary' burrows similar to those seen at the Voring Plateau were also present down to at least 28 cm sediment depth.

**Planned future activity**

The task ahead is to process the collected material, extract the desired information on faunal composition and activity, and integrate these data with the results of sediment geochemical analyses. It is a measure of the success of JR75 that such a large volume of biological samples was collected. The major types of data to be extracted from the benthic and photographic samples are as follows:

- **Benthic samples:** Total abundance and biomass of macro-infauna. Identification of taxa to lowest level necessary for assignment to bioturbator functional group. X-ray analysis of sediment subcores.
- **Seabed photographs:** Quantification and categorization of mega-infaunal surface traces (Lebensspuren). Identification of conspicuous epifauna.

**Acknowledgments**

Many members of the scientific party and ship's company provided help with the biological sampling at various times, and their assistance is gratefully acknowledged. Special thanks go to Caroline Gunn (Scott Polar Research Institute) for her generous efforts in the onerous task of sediment sieving.

David J. Hughes
Peter A. Lamont
J. Murray Roberts

## Sula Ridge Station Report. JR75, 17 June 2002

**Objectives**

- Conduct multibeam and TOPAS survey over photo lander deployment site of July 2001.
- Perform CTD.
- Collect box core sample from this site.
- Deploy photo lander next to the Sula Ridge reef.
- Recover photo lander.
- Collect second box core sample.
- Bed-hop photograph the lander site.
- Bed-hop photograph the upper portion of the Sula Ridge.

Following a four-day deployment by the Sula Ridge in 2001, the photo lander was deployed for a twenty-day period between 18 June and 8 July. The lander forms a tripod frame designed to stand on relatively flat, coral rubble areas to the side of the Sula Ridge. To locate a suitable deployment site, the area around last year's site was surveyed (see survey report) and the initial, unprocessed survey results revealed the same seabed features that had guided the first deployment (multibeam survey, Norwegian Geological Survey / IMR). Having completed the survey, a box core was taken. The first core had failed to seal correctly and dumped on deck, the corer redeployed and a second good core was recovered. When dissected, this core contained a single echiuran worm (probably *Bonellia* sp.). The feeding activity of these active bioturbators was a notable feature of the photographs from the first photo lander deployment by the Sula Ridge. The remaining top 10cm of the core were sieved (500 and 250µm) and preserved for macrofaunal analysis.

The lander frame was initially lifted overboard and into the water, then stopped off to allow the buoyancy sphere to be attached. The lander and buoyancy were then lowered to within 15m of the bottom. This height was confirmed by tracking the lander acoustic release pinger on the waterfall display. The gear was then released by acoustic release. After checking acoustic release diagnostics indicating that the lander frame was vertical, it was left until recovery scheduled for Monday 8 July.

<u>Photo lander equipment list, data gathering devices only</u>

- Benthos digital stills time-lapse camera (1 picture/60 minutes).
- Mk 5 'bathysnap' time-lapse film camera (1 picture/18 minutes).
- Camel Camera Alive time-lapse film camera (1 picture/120 minutes).
- Transmissometer, light-scattering sensor and fluorometer controlled by UMI data logger (1 minute burst sampling every 20 minutes).
- S4 recording current meter (1 minute burst sampling every 10 minutes).
- Minilogger temperature recorder (set to record every 10 minutes).

On returning to the photo lander station at 0100 on 8 July, both ranges and diagnostics to the lander releases were checked. These gave ranges of 610m and a vertical diagnostic. The lander was released at 0113 and immediately decreasing range values indicated that it had left the seabed. At 0119 the lander buoyancy was on the surface and grappled at 0132. The buoyancy sphere was on deck at 0140 on the lander was on deck at 0148, 35 minutes after it had been released from the seabed. Once on deck the system was visually inspected, any corrosion was noted and photographed and the film cameras and instruments were checked.

The box core was then deployed at the lander station. The first core hit a large dropstone (40cm diameter). This and some surrounding sediment were recovered but the box was damaged and the core partially washed out. The core was dumped on deck and the sediment retained. Encrusting sponges were sampled from the dropstone. A second core was attempted but after this also failed the decision was made to begin bed-hop photography.

The bed-hop camera was deployed on the lander site to characterise this reef zone. The ship made 0.5kt NE during the deployment. Following this, a second bed-hop deployment was made along a transect on one of the ridge features identified during the multibeam survey. This 620m long transect was from 64° 04.796N 08° 01.892E to 64° 04.952 08° 02.562E.

Activity summary from log

| Date/Time | Lat Lon | Event | Depth | I/W | Bottom | O/W | Stn | Activity | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 17/06/02 2122 | N64 05.19 E08 02.20 | #5 | 285 | 2121 | 2136 | 2200 | SULA | CTD003 | SULA CTD + Oxy |
| 17/06/02 2241 | N64 05.02 E08 02.26 | #6 | 285 | 2242 | 2251 | 2257 | SULA | NIOZ001 | No Core |
| 17/06/02 2305 | N64 05.02 E08 02.26 | #7 | 285 | 2307 | 2318 | 2225 | SULA | NIOZ002 | Good Core |
| 18/06/02 0003 | N64 05.005 E08 02.209 | #8 | 285 | 0005 | 0046 | | SULA | LANDER | DEPLOYED |
| 08/07/02 0113 | N64 05.25 E08 02.61 | #258 | 286 | | | 0148 | SULA | LANDER | RECOVERY |
| 08/07/02 0212 | N64 05.02 E08 02.24 | #259 | 285 | 0212 | 0219 | 0228 | SULA | NIOZ | ROCK |
| 08/07/02 0238 | N64 05.02 E08 02.24 | #260 | 285 | 0238 | 0245 | 0255 | SULA | NIOZ | WATER |
| 08/07/02 0326 | N64 05.02 E08 02.24 | #261 | 285 | 0326 | 0334 | 0430 | SULA | BEDHOP | |
| 08/07/02 0326 | N64 05.02 E08 02.24 | #262 | 250 | 0509 | 0524 | 0620 | SULA | BEDHOP | |

Samples and data collected

- Multibeam and TOPAS survey, see survey report images.
- CTD data, JR75 event #5.
- Box core, JR75 event #6, portion of unsealed core retained intact, encrusting sponges on dropstone sampled (SAMS No. NBC 864).
- Box core, JR75 event #7, core dissected sieved and preserved (SAMS No. NBC 865)

**Photo Lander recovery (JR75 event #258)**

- 414 photos from Benthos camera (resolution good enough to make out *Bonellia* proboscis).
- Full set of readings from optical instruments.
- Current meter, speed (max 25cm/s) was recorded, but direction was faulty.
- Minilogger showed temperatures between 7.5 and 8.5°C with three interesting 'events'.
- Box core, JR75 event #259, encrusting sponge samples from dropstone.
- Bed-hop camera, JR75 event #261, lander site.
- Bed-hop camera JR75 event #262, upper portion of ridge adjacent to lander site.

Work planned on return

- Unload and process film from the other two lander cameras.
- Correct current meter speeds to 0.5m (height of optical instruments).
- Calibrate optical instruments with locally collected sediment.
- Correct optical instrument outputs using this calibration.
- Estimate levels of near bed resuspension.
- Analyse photographs and attempt to relate megafaunal activity seen with near-bed current and resuspension estimates.

Acknowledgements
All the objectives listed above were achieved during JR75 giving a very promising data set. Thanks are due to the captain and crew of the James Clark Ross especially for their efficient deployment and recovery of the Photo Lander.

## Chemistry

**Personnel involved:** Ivan Ezzi, Kenny Black, Caroline Gunn

Activities:

Dissolved inorganic nutrients
Particulate organic carbon
Chlorophyll
Oxygen
Microbial samples

Objectives:

Dissolved inorganic nutrients (DIN)
Water samples were taken from all CTD bottles at each of the survey stations as part of the water column characterisation. Samples were taken in triplicate for onboard analysis for nitrate, phosphate, ammonia and silicate.
Equivalent analysis was carried out on sediment core pore water provided by Eric Breuer and overlying water from incubated sediment cores provided by Martyn Harvey.
Underway samples were taken from the ship's non-toxic supply at approximately six hour intervals for the major part of the cruise.

Particulate organic carbon (POC) and chlorophyll (CHL)
Water samples from the same CTD bottles as above were filtered onto glass fibre filters and stored in the –80 freezer for analysis at Dunstaffnage. Chlorophyll data will also be used for calibration of the fluorometer attached to the CTD.

Oxygen
Water samples were removed from CTD bottles as detailed in table for titration onboard. This data will be used to calibrate the SAMS oxygen sensor attached to the CTD.

Microbial samples ( Ray Leakey)
Samples were collected in surface waters from CTD bottles for analysis at Dunstaffnage of microplankton, nanoplankton and bacterioplankton. The samples were preserved in both lugol's iodine and gluteraldehyde.

Oxygen determinations from CTD bottles on JCR75
Kenny Black

In order to calibrate the SAMS Seabird oxygen probe that was fitted to the BAS CTD system after CTD3, water samples were taken and determined by the Winkler method. Typically, 3 samples from 2 depths were taken. The selection of depths was made on the basis of the temperature and salinity profile generated by each cast, as the oxygen sensor output was not displayed. In general, depths were chosen in separate water masses avoiding the interface regions where possible.

Samples were analysed by a derivation of the Winkler method using an auto-titrator (ABU9 Autoburette, Radiometer, Copenhagen) as described in the SAMS Standard Operating Procedure (Brand and Dixon). Results were calculated using the spreadsheet created for the purpose under this SOP. The thiosulphate secondary standard was calibrated against an iodate primary standard on 3 occasions during the cruise in each case giving similar results (0.230M).

Results are given in the table as the mean of n determinations. Standard deviations are given where n is greater than 2. Where n=2 plus/minus errors are given.

Table Winkler method oxygen determinations carried out on JCR75 showing CTD cast number, sample depth, number of replicates (n), mean oxygen concentration (mg/l) and standard deviation (or ± error where n=2)

| Cast | Depth | n | Mean (mg/l) | SD |
|---|---|---|---|---|
| **CTD1** | 90 | 5 | 8.951 | 0.021 |
| | 2 | 5 | 9.582 | 0.082 |
| **CTD2** | 600 | 1 | 9.696 | |
| | 250 | 3 | 8.980 | 0.015 |
| | 10 | 2 | 9.841 | 0.003 |
| **CTD3** | 200 | 2 | 8.785 | 0.109 |
| | 40 | 3 | 9.702 | 0.010 |
| | 10 | 3 | 11.574 | 0.047 |
| **CTD4** | 200 | 3 | 9.012 | 0.044 |
| | 10 | 3 | 9.542 | 0.004 |
| **CTD5** | 1000 | 3 | 9.814 | 0.069 |
| | 200 | 3 | 9.335 | 0.011 |
| **CTD8** | 1000 | 3 | 9.811 | 0.007 |
| | 300 | 3 | 9.518 | 0.006 |
| **CTD9** | 1000 | 3 | 9.727 | 0.121 |
| | 200 | 3 | 9.427 | 0.065 |
| **CTD10** | 1000 | 3 | 9.647 | 0.298 |
| | 250 | 3 | 9.981 | 0.106 |
| **CTD11** | 1000 | 3 | 10.091 | 0.020 |
| | 250 | 2 | 10.172 | 0.025 |
| **CTD13** | 220 | 3 | 10.419 | 0.003 |
| | 10 | 3 | 12.098 | 0.009 |
| **CTD15** | 354 | 3 | 10.510 | 0.008 |
| | 50 | 3 | 11.879 | 0.124 |
| **CTD17** | 1232 | 3 | 9.799 | 0.051 |
| | 250 | 3 | 10.237 | 0.160 |
| **CTD19** | 2527 | 3 | 9.858 | 0.045 |
| | 103 | 3 | 10.127 | 0.127 |
| **CTD20** | 1360 | 2 | 10.047 | 0.019 |
| | 100 | 3 | 9.927 | 0.010 |
| **CTD22** | 853 | 3 | 9.891 | 0.060 |
| | 100 | 2 | 9.995 | 0.076 |
| **CTD24/25** | 300 | 3 | 10.272 | 0.136 |
| | 50 | 3 | 11.203 | 0.050 |
| **CTD30** | 1459 | 3 | 9.712 | 0.023 |
| | 50 | 3 | 9.337 | 0.012 |
| **CTD33** | 1220 | 3 | 9.774 | 0.008 |
| | 40 | 3 | 8.929 | 0.052 |
| **CTD34** | 882 | 3 | 9.789 | 0.006 |
| | 102 | 3 | 8.544 | 0.017 |

## Sediment oxygen and nutrient fluxes – Martyn Harvey

Objectives
1. To obtain a suite of measurements of the sediment oxygen demand and sediment nutrient fluxes across a latitudinal transect, whilst maintaining an approximately equal water depth at each station (as far as is possible).
2. To obtain the same measurements across a longitudinal transect, from inner fjordic (Kongsfjord) to oceanic sediments.

Methodology
The multicorer was used to collect sediment cores at each station, as shown in the table below (extracted from JR75 station log):

| Date | Lat | Long | Event | Depth | Stn | Deployment |
|---|---|---|---|---|---|---|
| 19/06/02 | N67 12.86 | E06 05.53 | #22 | 1434? | VP2 | 1 |
| 19/06/02 | N67 12.86 | E06 05.53 | #23 | 1433? | VP2 | 2 |
| 19/06/02 | N67 12.85 | E06 05.54 | #24 | 1433 | VP2 | 3 |
| 23/06/02 | N79 03.34 | E11 18.08 | #107 | 244 | KF2 | 1 |
| 23/06/02 | N79 03.34 | E11 18.08 | #108 | 231 | KF2 | 2 |
| 23/06/02 | N79 03.30 | E11 18.08 | #109 | 231 | KF2 | 3 |
| 24/06/02 | N78 57.46 | E11 54.48 | #124 | 355 | KF1 | 1 |
| 24/06/02 | N78 57.46 | E11 54.49 | #125 | 355 | KF1 | 2 |
| 24/06/02 | N78 57.46 | E11 54.49 | #126 | 355 | KF1 | 3 |
| 26/06/02 | N78 58.40 | E06 42.47 | #142 | 1385 | KF4B | 1 |
| 26/06/02 | N78 58.40 | E06 42.47 | #143 | 1385 | KF4B | 2 |
| 26/06/02 | N78 58.42 | E06 42.46 | #144 | 1385 | KF4B | 3 |
| 26/06/02 | N78 58.42 | E06 42.46 | #145 | 1385 | KF4B | 4 |
| 28/06/02 | N78 56.85 | E05 17.31 | #157 | 2465 | KF5 | 1 |
| 28/06/02 | N78 56.85 | E05 17.31 | #158 | 2465 | KF5 | 2 |
| 28/06/02 | N78 56.85 | E05 17.31 | #159 | 2465 | KF5 | 3 |
| 28/06/02 | N78 56.85 | E05 17.31 | #160 | 2465 | KF5 | 4 |
| 30/06/02 | N80 45.02 | E07 38.72 | #190 | 922 | YP1b | 1 |
| 30/06/02 | N80 45.02 | E07 38.74 | #191 | nr | YP1b | 2 |
| 30/06/02 | N80 45.02 | E07 38.74 | #192 | nr | YP1b | 3 |
| 01/07/02 | N79 01.34 | E10 41.62 | #222 | 342 | KF3b | 1 |
| 01/07/02 | nr | nr | #223 | nr | KF3b | 2 |
| 01/07/02 | nr | nr | #224 | nr | KF3b | 3 |
| 03/07/02 | N78 57.38 | E11 54.57 | #235 | 366 | KF1 | 1 |
| 03/07/02 | N78 57.41 | E11 54.46 | #236 | 366 | KF1 | 2 |
| 03/07/02 | nr | nr | #237 | nr | KF1 | 3 |
| 05/07/02 | N73 39.61 | E13 46.97 | #251 | 1440 | BIF | 1 |
| 05/07/02 | N73 39.61 | E13 47.00 | #252 | 1440 | BIF | 2 |
| 05/07/02 | nr | nr | #253 | 1440 | BIF | 3 |

Two cores from each of three deployments of the multicorer (ie six in total) from each station were used to measure the sediment oxygen demand and the flux of nutrients (nitrate, phosphate, silicate and ammonium) across the sediment/water interface.
After collection, the cores were placed in a tank of seawater obtained from approximately 5m above the seabed at the same site, and maintained at the bottom water temperature in the ship's constant temperature room. 10ml samples were taken from this in syringes, and fixed for Winkler titration to determine their dissolved oxygen content.
The cores were sealed with submersible stirrers and incubated for approximately 24 hours (measured exactly). Samples of the water overlying the cores were taken and fixed. The difference in the dissolved oxygen content of the samples taken at the start and the end of the incubation was used to determine the sediment oxygen demand.

After the 24 hour incubation and removal of the water samples, the overlying water was aerated and the cores incubated for a further 24 hours. After this time water samples were removed, filtered through GF/F filters and refrigerated until analysis to determine the concentration of dissolved nutrients. Similar samples taken from the water in the tank at the start of the incubation provide time zero values, and thus the sediment nutrient fluxes could be determined.
Once the incubations were completed the cores were sliced and preserved for subsequent faunal analysis.

Results
The oxygen flux values obtained are presented in the table below. The nutrient flux values will not be obtained until final calibrations and corrections have been applied after the return to DML.

| Station | **Approx. depth (m)** | **Sediment Oxygen Demand (mmol $m^{-2}$ $d^{-1}$)** |
|---|---|---|
| VP2 | 1430 | 4.64 ± 1.65 |
| BIF | 1440 | 3.92 ± 0.59 |
| YP1b | 920 | 2.92 ± 0.88 |
| KF1 | 370 | 14.47 ± 3.42 |
| KF2 | 240 | 11.26 ± 2.45 |
| KF3b | 340 | 14.55 ± 3.59 |
| KF4b | 1390 | 4.25 ± 0.91 |
| KF5 | 2470 | 3.23 ± 0.90 |

Sediment oxygen demand values are mean ± s.d. (n = 6, 2 cores from each of 3 deployments of the multicorer)

# How Do Marine Viruses Influence the Production of Dimethyl Sulphide?

**Claire Evans - UEA**

## Introduction

The majority of biogenic sulphur released to the atmosphere is in the form of dimethyl sulphide (DMS). DMS is believed to have significance to atmospheric chemistry and forming cloud condensation nuclei thus potentially influencing global climate. Most DMS is produced from its cellular precursor dimethylsulponiopropionate (DMSP) found in certain species of marine phytoplankton. DMSP is enzymatically cleaved to DMS and acrylic acid via a group of izozymes generically termed DMSP lyases, which are ubiquitous among the marine microbial community. Viruses are believed to influence the S cycle primarily by lysing the phytoplankton releasing their DMSP and if present DMSP lyase. DMS may be produced directly as a result of cleavage by the hosts enzymes or indirectly by other microbes present Viruses may also influence the cycling of DMSP and related compounds by infecting other microbes involved in S cycling.

## Objectives

The aim was to increase understanding of the role of marine viruses in DMS production via a programme of monitoring relevant parameters and experiments on the natural assemblage. Attempts were also made to isolate viruses and hosts for culture and further experimental work in the lab.

## Methodology

Parameters measured/samples collected

- Concentration of DMS and DMSP in the particulate and dissolved phase.
- Concentration of viruses and bacteria.
- Activity of DMSP lyase
- Collection of samples for detection of specific viruses infectious to DMSP containing phytoplankton, free and associated with the host.

Depth profiles were made as often as time and schedule permitted. Samples for concentration of S compounds, viruses and bacteria were taken in duplicate at 6 depths, usually from surface to 100 m. All other samples were taken from the chlorophyll maximum.

<u>Analysis of DMS, DMSPp and DMSPd</u>

Analysis of DMS and related compounds was via a triple purge and cryotrap system in combination with Shimadzu GC-14B gas chromatograph and a flame photometric detector. Data was collected and analysed on a reporting integrator, Shimadzu C-R5A. The system was calibrated using a DMSP solution of known concentration cleaved to DMS by 10 M NaOH (Fig 1).

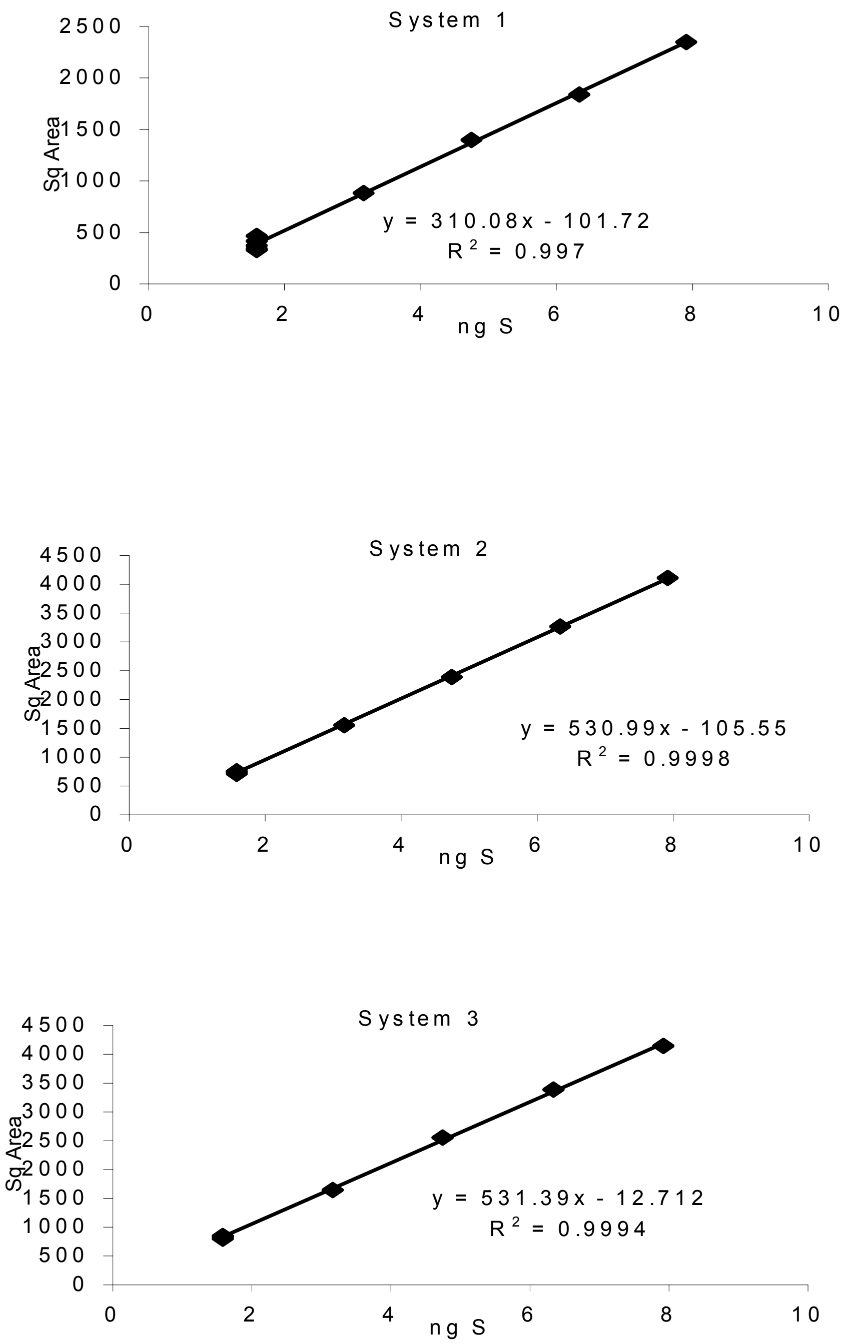



Figure 1. Calibration curves for the triple purge and trap systems.

All samples for DMS were analysed as soon as possible. Samples for DMSPp and DMSPd were preserved for later analysis.

Concentration of Viruses and Bacteria

Samples were preserved in 10% glutaraldehyde and snap frozen for later analysis in the lab by flow cytometry. Viral and bacterial enumeration will be performed on each sample at the same time. Sample will be defrosted at room temperature, diluted 10 fold in TE buffer and heated at 65 °C for 15 min in the dark in the presence of SYBR Green I (Molecular Probes). Samples will then be analysed at medium flow rate. Green fluorescence and side scatter will be used to define the viral and bacterial populations.

Activity of DMSP lyase

Activity of DMSP lyase will be determined using a headspace analysis of DMS production. Cells were first harvested by filtration under low light condition and at ambient temperature using 0.2 μm polycarbonate membrane filters under a vacuum of <100 mm Hg. Samples were then snap frozen and stored at - 80 °C for analysis back at the lab. Samples will be defrosted in the presence of Bis-tris propane buffer pH 8.2 and sonicated to release the DMSP lyase. The resultant extract will be placed in a gas tight vial and 50 $mm^3$ volumes of headspace periodically withdrawn through a septa using a gas tight syringe to test for the concentration of DMS. DMSP is will be added to the vials and DMS production monitored allowing the calculation of the enzymes activity. DMS concentration will be measured by direct injection on to the GC column and detection by flame photometric detector (instrument set up as detailed above). In order that any losses due to freezing be accounted for duplicate test samples were taken of which one will be stored to be analysed in the lab whilst the other was analysed on ship.

Detection of Viruses Infectious to DMSP Containing Phytoplankton

Two litters of seawater were filtered under low light condition and at ambient temperature using 0.45 μm Supor membrane filters under a vacuum of <100 mm Hg. The filters were snap frozen for later analysis in the lab. The resultant filtrate was concentrated by a VivaFlow 200 system (Viva Science) to approximately 30 ml. At a later date these samples will be used to look for the presence of specific viruses using oligonuceotide probes.

**Results**

| Date | Time | Event | Lat | Long |
|---|---|---|---|---|
| 19/06/2002 | 12:12 | 19 | 67° 13.04 | 06° 06.14 |
| 20/06/2002 | 08:30 | 32 | 67° 54.74 | 06° 21.22 |
| 21/06/2002 | 08:36 | 60 | 71° 58.83 | 07° 21.06 |
| 22/06/2002 | 08:30 | 83 | 75° 34.41 | 08° 32.51 |
| 23/06/2002 | 07:10 | 104 | | |
| 24/06/2002 | 13:30 | 118 | 78° 57.46 | 11° 54.49 |
| 25/06/2002 | 18:33 | 136 | 79° 00.16 | 06° 59.57 |
| 27/06/2002 | 16:10 | 153 | 78° 56.87 | 05° 17.31 |
| 29/06/2002 | 08:30 | 183 | 79° 19.27 | 06° 37.22 |
| 29/06/2002 | 20:07 | 185 | 80° 41.36 | 07° 25.53 |
| 01/07/2002 | 13:48 | 216 | 79° 01.33 | 10° 41.52 |
| 02/07/2002 | 07:09 | 234 | 79° 10.52 | 11° 46.67 |
| 03/07/2002 | 10:25 | 238 | 79° 03.30 | 11° 17.75 |
| 04/07/2002 | 07:32 | 184 | 78° 17.84 | 07° 37.55 |
| 05/07/2002 | 12:16 | 246 | 73° 39.67 | 13° 47.21 |
| 07/07/2002 | 09:03 | 257 | 67° 13.04 | 09° 28.08 |
| 08/07/2002 | 12:10 | 264 | 68° 45.67 | 05° 34.52 |

Table 1 Details of the CTDs sampled

DMS was present in highest concentrations in the surface waters decreasing with depth. Concentrations varied from around 2 nM to 16 nM Figure 2.

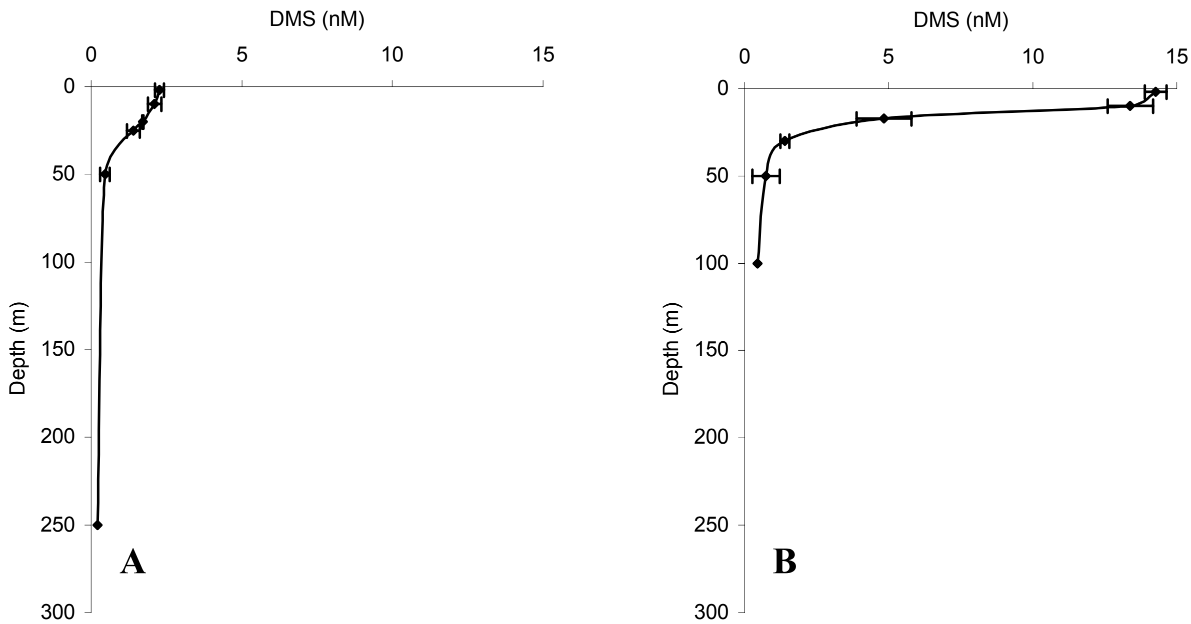



Figure 1 Depth profiles of DMS concentration taken on (a) 21-06-02 and (b) 05-07-02. Preliminary data confirms the presence of DMS in the water column. Full interpretation of the data remains impossible until the analysis of all the samples taken.

**Acknowledgements**

I would like to thank; all those involved in the organisation of this cruise. The UEA crew. Claire Hughes and Suza Kadner for their help with bacterial production measurements and Louise Darroch for advice on sulphur analysis. All those involved with the CTD operation. Simon for his assistance with incubator tanks and onboard seawater supply. Michael Steinke for lending me his equipment. And all the scientists, officers and crew. Special thanks to Graham Shimmield and Colin Griffiths.

# Halocarbon Measurements

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Halogenated organic compounds are known to be an important source of halogens (chloride, bromide and iodide) to the atmosphere. Measurements of the halogenated organic compounds listed in table 1 were made during JCR75 using a purge-and-trap preparation system and Hewlett Packard gas chromatograph - mass spectrometer (GC-MS). The aim of these studies was to gain some understanding of the processes controlling the production of halocarbons in seawater.

Table 1 - Halocarbons analysed by GC-MS during JCR75

| Compound | Molecular Formula |
|---|---|
| Methyl chlroide | $CH_3Cl$ |
| Methyl bromide | $CH_3Br$ |
| Methyl iodide | $CH_3I$ |
| Bromoethane | $CH_3CH_2Br$ |
| Iodoethane | $CH_3CH_2I$ |
| Carbon tetrachloride | $CCl_4$ |
| 1-iodopropane | $CH_3CH_2CH_2I$ |
| Dibromomethane | $CH_2Br_2$ |
| 2-iodopropane | $CH_3CHICH_3$ |
| Chloroiodomethane | $CH_2ClI$ |
| Dibromochloromethane | $CHBr_2Cl$ |
| Tetrachloroethylene | $CH_2Cl_4$ |
| Bromoiodomethane | $CH_2BrI$ |
| Bromoform | $CHBr_3$ |
| Diiodomethane | $CH_2I_2$ |

**Sample Details**

During JCR75, samples were taken for halocarbon analysis from the non-toxic seawater supply for underway sampling, CTD casts for depth profiles in interesting areas and various experiments were set up to investigate the source/ fate of halocarbons in the marine environment.

**Underway Sampling**

Table 2 gives the position, date and time at which samples were taken from the non-toxic supply for underway sampling. Samples were analysed in duplicate from each of these stations. Figures 1 and 2 show the distribution of two halocarbons, iodoethane ($C_2H_5I$, a) and dibromomethane ($CH_2Br_2$, b) along the JCR75 cruise track. Peaks in concentration of both iodoethane and dibromomethane, together with a suite of other halocarbons, were measured in Kongsfjord.

Table 2 - JCR75 underway halocarbon sampling stations.

| Date | Time | Position |
|---|---|---|
| 18-Jun | 1300 | 67o15.9'N, 03o31.5'E |
| 18-Jun | 2000 | 67o11.0'N, 07o30.0'E |
| 19-Jun | 1000 | 67o13.13'N, 06o05.97'E |
| 20-Jun | 1000 | 67o54.75'N, 06o21.35'E |
| 20-Jun | 1727 | 70o23.00'N, 10o48.08'E |
| 21-Jun | 0100 | 70o21.33'N, 06o54.20'E |
| 21-Jun | 1100 | 71o29.56'N, 07o13.56'E |
| 21-Jun | 1700 | 73o25.40'N, 07o42.27'E |
| 22-Jun | 1000 | 75o34.41'N, 08o32.51'E |
| 22-Jun | 1700 | 76o49.84'N, 09o02.49'E |
| 22-Jun | 2240 | 78o03.29'N, 09o33.66'E |
| 23-Jun | 0920 | 79o03.42'N, 011o17.85'E |
| 23-Jun | 1345 | 79o03.03'N, 011o21.54'E |
| 24-Jun | 1640 | 78o57.47'N, 011o53.98'E |
| 25-Jun | 1400 | 79o00.12'N, 010o10.36'E |
| 25-Jun | 1945 | 79o0.158'N, 06o59.61'E |
| 26-Jun | 1540 | 78o 58.41'N, 06o42.73'E |
| 27-Jun | 1447 | 78o56.87'N, 05o17.36'E |
| 28-Jun | 1530 | 78o58.86'N, 05o17.47'E |
| 28-Jun | 1900 | 78o58.85'N, 04o54.42'E |
| 28-Jun | 2230 | 79o11.86'N, 02o57.19'E |
| 29-Jun | 1340 | 79o50.56'N, 08o02.73'E |
| 1-Jul | 1345 | 79o01.31'N, 10o34.88'E |
| 1-Jul | 1630 | 79o01.33'N, 10o41.53'E |
| 3-Jul | 1138 | 78o58.63'N, 11o46.45'E |
| 4-Jul | 0835 | 78o17.80'N, 07o38.35'E |
| 4-Jul | 1700 | 77o01.30'N, 09o17.08'E |
| 4-Jul | 2400 | 75o48.98'N, 10o54.38'E |
| 5-Jul | 1053 | 73o38.53'N, 13o50.50'E |
| 5-Jul | 2252 | 73o39.59'N, 13o47.00'E |
| 6-Jul | 1130 | 71o46.62'N, 12o24.14'E |
| 6-Jul | 1930 | 70o08.22'N, 011o13.50'E |
| 8-Jul | 0900 | 63o59.45'N, 07o20.65'E |
| 8-Jul | 1340 | 63o46.16'N, 05o34.51'E |

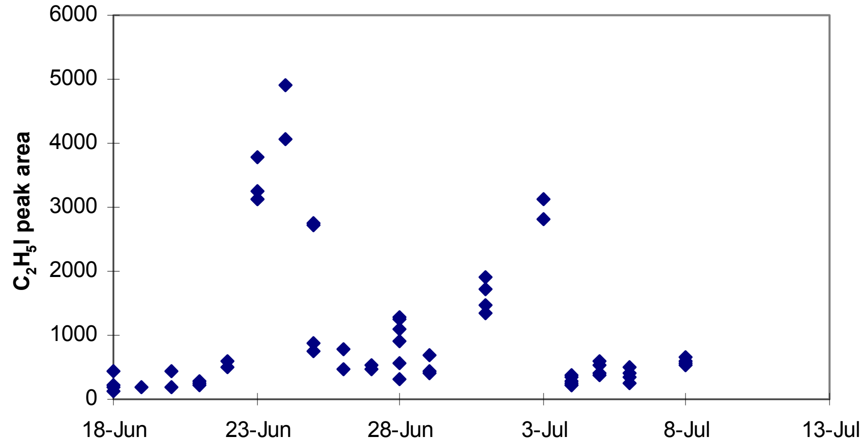


Figure 1. Distribution of iodoethane along the JCR75 cruise track.

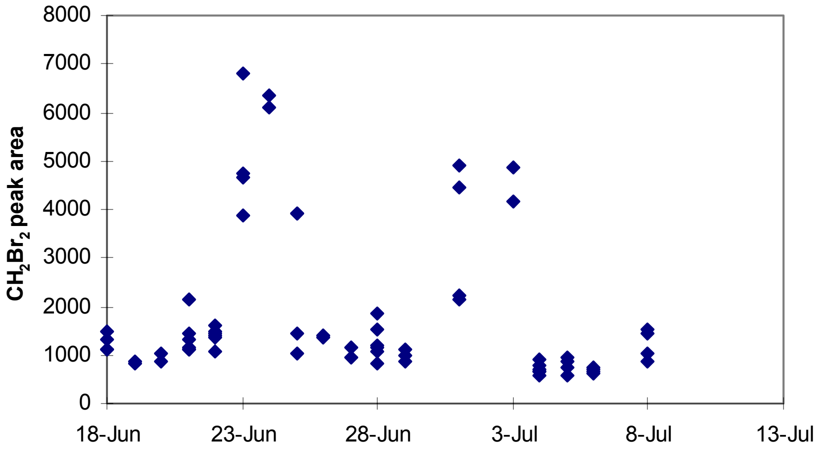


Figure 2. Distribution of dibromomethane along the JCR75 cruise track.

**Depth Profiles**

Halocarbon depth profiles were measured at 7 stations during JCR75, the details of which are presented in table 3.

Table 3 - JCR75 halocarbon depth profile stations

| Date | Event | CTD | Coordinates |
|---|---|---|---|
| 24 June | 118 | 015 | 78o57N, 11o54E |
| 25 June | 136 | 017 | Station KF4 |
| 27 June | 153 | 019 | 78o57N, 05o17E |
| | | | Station KF5 |
| 29 June | 183 | 020 | 80o41N, 07o26E |
| | | | Station YP1 |
| 1 July | 216 | 024/5 | 79o01N, 10o42E |
| | | | Station KF3B |
| 3 July | | 027 | 78o58'N, 11o46'E |
| 4 July | 184 | 028 | 78o18N, 07o34E |

In general, higher concentrations of halocarbons were encountered in the upper ocean. In Kongsfjord, however, higher concentrations of some compounds were measured at depth. Figures 3 a and b are depth profiles of two compounds, methyl iodide ($CH_3I$)and bromoform ($CHBr_3$), measured in Kongsfjord.

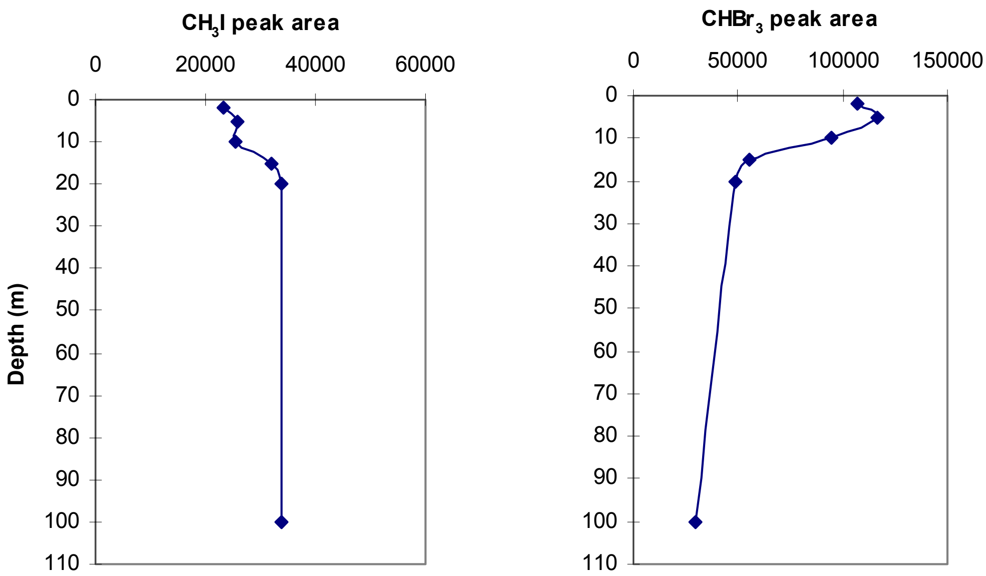


Figure 3. Depth profiles of methyl iodide (a) and bromoform (b) measured in Kongsfjord (CTD cast 015, event 118) during JCR75.

**Experiments**

A series of experiments were carried out during JCR75 to investigate the source/s of the halocarbons being measured in seawater. All experiments were centered around incubations carried out in glass syringes held in an on-deck tank supplied with running seawater. One positive results came from the incubation of "marine snow' collected from the top of a box core in Kongsfjord. During this incubation, high rates of methyl iodide, 2-iodopropane, 1-iodopropane and iodoethane production were observed. This result, together with those collected from other experiments, will be used to further our investigations in to the sources of halocarbons in the marine environment.

**Acknowledgements**
I would like to thank the following people for their help before and during JCR75 - Gill Malin, Sussanne Kadner, Louise Darroch, Claire Evans, Martin Johnson, Gareth Lee, Colin Griffiths and Graham Shimmield.

## Dimethyl sulphoxide (DMSO) in seawater

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### Introduction

Dimethylsulphoxide (DMSO) is an oxidized form of the climatically active trace gas dimethyl sulphide (DMS). It is a stable and ubiquitous compound, which is generally found in higher concentrations than DMS in seawater. DMSO is thought to be formed from DMS through abiotic photo- and bacterial-oxidation of DMS. Marine bacterial isolates have also been found that can reduce DMSO to DMS. Recently, DMSO has been measured in unicellular algae and it has been suggested that phytoplankton are a direct source of DMSO in seawater.

### Aims

The aim of this research was to compare the distribution of dissolved DMSO in seawater (DMSOd) and intracellular DMSO (DMSOp) within the water column and with changes in phytoplankton communities, using a new method to determine DMSOp. We also aimed to establish how significant DMSOp is in the oceans and as a likely source of DMSOd.

### Methods

Filtered seawater samples were (Millipore AP25 depth filters) initially pre-purged of any ambient DMS using nitrogen gas. An aliquot of this sample was then used to determine DMSO dissolved (DMSOd) using the enzyme DMSO reductase method developed by Hatton *et al*. (1994). The process was initiated by light acting on ethylenediamintetraacetic acid to form radicals, which reduce flavin mononucleotide (FMN). FMN then acts as an electron donor to DMSO reductase, catalyzing the reduction of DMSO to DMS. The evolved DMS was pre-concentrated using a purge-and-cryotrap system, similar to that described by Turner *et al*. (1990). The trapped DMS was injected onto a Chromosil 330 packed column and analysed by a Varian 3300 gas chromatograph fitted with a flame photometric detector. Filters including cells were then placed in an alkaline buffer for several hours to degrade cells and release any intracellular DMSO. Samples were then neutralized and analysed as DMSOd as above. DMSOp was found to be removed from cells in the dark so CTD sample bottles were stored in a flow-through seawater incubator in natural sunlight before analysis. No significant changes in DMSOp concentration were observed during storage

### Sample Details

DMSOd and DMSOp were sampled from CTD casts as follows

| Date | Event# | CTD# | Coordinates | Comments |
|---|---|---|---|---|
| 17.6 | 003 | 002 | ? | DMSOd, DMSPp. 2,5,10,20,40,50,200 m |
| 18.6 | 009 | 004 | 65°30N 07°46E | DMSOd. 2,5,10,20,40,100,200,370m |
| 20.6 | 032 | 009 | 67°55N 06°2E | DMSOd. 2,10,20,25,50,100,30,1000m |
| 21.6 | 060 | 010 | 71°58N 07°21E | DMSOd, 2,10,20,25,50,250 m |
| 22.6 | 083 | 011 | 75°34N 08°33E | Photochemistry experiment |
| 23.6 | 104 | 013 | KF2 | DMSOd. 2,5,10,20,40,100 m |
| 24.6 | 118 | 015 | 78°57N 11°54E | DMSOd. 2,5,10,15,20,100m<br>Size fraction of DMSOp and DMSPp.<br>Fractions, <2, 2-5, 5-20, >20µm |
| 25.6 | 136 | 017 | Station KF4 | DMSOd, DMSOp at 2,5,20,50,165,250 m |

| | | | | |
|---|---|---|---|---|
| 26.6 | | | 78°58N 06°43E | Photochemistry experiment |
| 27.6 | 153 | 019 | 78° 57N 05°17E Station KF5 | DMSOd, DMSOp at 2,10,20,45,100,500,1500,2400m |
| 29.6 | 183 | 020 | 79°19N 06°37E | DMSOd, DMSOp at 2,5,10,20,30,100,500,1360m |
| 29.6 | 185 | 022 | Station YP1 80°41N 07°26E | DMSOd, DMSOp at 2,5,15,30,50,100m |
| 1.7 | 216 | 024/025 | Station KF3B 79°01N 10°42E | DMSOd, DMSOp at 2,5,10,20,50,100m |
| 2.7 | 234 | 026 | 79°11N 11°47E | DMSOd, DMSOp at 2,5,10,40,60,100m Production of DMS and DMSOd from marine snow incubation |
| 4.7 | 184 | 028 | 78°18N 07°34E | DMSOp, DMSOd at 2,5,10,15,50,100m |
| 5.7 | 246 | 030 | 73°40N 13°47E | DMSOd, DMSOp at 2,5,10,17,30,100m Photochemistry experiment |
| 7.7 | 257 | 031 | 67°13N 09°28E | DMSOp, DMSOd at 2,10,20,30,60,100m |
| 8.7 | 264 | 032 | 68°46N 05°35E | DMSOp, DMSOd at 2,5,20,25,30,100m |

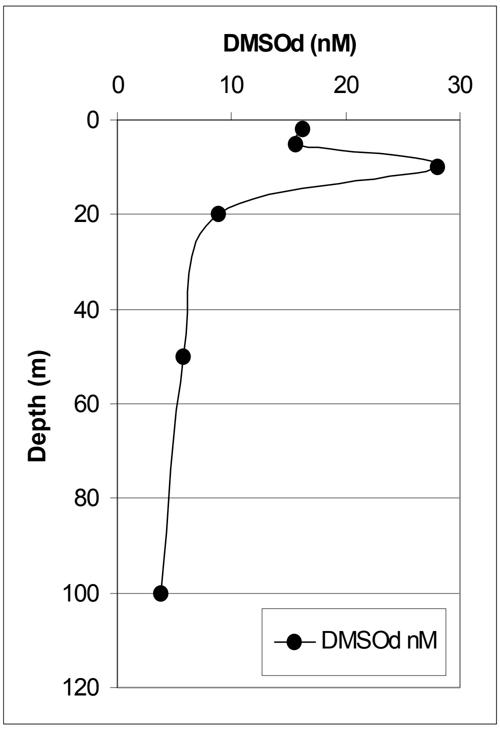
Experiments were also set up to investigate the production of DMSO in seawater from alternative pathways to phytoplankton release. We investigated the photo-oxidation of DMS to DMSO. We also analysed DMSOp in different size fractions of cells from seawater and the formation of DMS and DMSO from marine snow

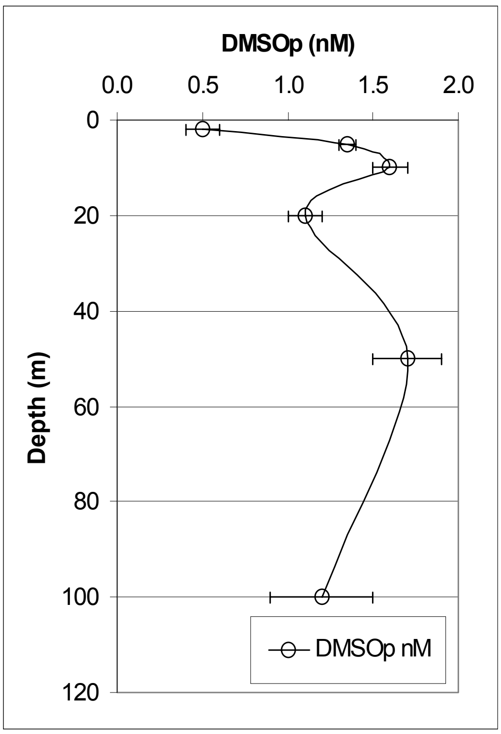
Measured parameters

DMSO was determined using a GC calibrated with alkaline-hydrolysed dimethyl-sulphoniopropionate (DMSP). DMSOd were measured as single replicates while duplicate samples were taken for DMSOp. DMSO reductase activity was checked using a DMSO standard.

Initial results

Below are profiles of DMSOd and DMSOp from station KF3B (79°01N 10°42E) on 1.7.02, where the phytoplankton biomass (chlorophyll fluorescence) was ~ 1.6ug/L. Although DMSOd concentrations were high, reaching 28 nM at 10m depth, DMSOp concentrations were much lower ranging from 0.5 – 1.6 nM DMSO. DMSOd was generally found in much higher concentrations (0.5 – 60 nM) than DMSOp throughout the cruise (0-2 nM)



Future Research

Some samples for DMSOp will be analysed at UEA following the cruise. DMSOp and DMSOd will then be compared with levels of DMS and DMSP (Claire Evans, UEA) and phytoplankton chlorophyll data (Stuart Gibb, UHI). Changes in DMSOp will also be compared to other parameters such as light, temperature and salinity.

# JCR 75 – ACRYLIC ACID MEASUREMENTS IN SEAWATER

SUSANNE KADNER / UEA

## INTRODUCTION

Acrylic acid in the marine environment is assumed to originate mainly from the algal osmolyte Dimethylsulphoniopropionate (DMSP). The cleavage of DMSP is initiated through grazing, viral attack, lysis and/or senescence during which the enzyme DMSP-lyase is activated. This enzyme is responsible for the cleavage of DMSP in its end-products Dimethylsulphide (DMS), a sulphur gas with climate active properties, and acrylic acid.

The fate of acrylic acid is fairly unknown and many suggestions have been made about its possible roles in the marine food web. During this cruise, depth profiles showing its distribution throughout the water-column have been made.

## METHODS

Acrylic acid in seawater is measured with an HPLC by direct injection of the samples. Immediately after collection, the seawater samples are acidified to pH1with 10M $H_3PO_4$. This allows the samples to be stored for at least 1 week and also inactivates the enzyme DMSP-lyase. Hereby, accidental rupture of the cells during filtration which would activate the enzyme will not alter the concentrations of acrylic acid in the dissolved phase. The samples are then filtered under a gentle vacuum (10 cm Hg) through a 0.2µm polycarbonate filter and collected for analysis.

The samples are analysed with an AGILENT 1100 HPLC system. The eluent is pre-mixed Milli-Q water with 0.05% $H_3PO_4$ (v/v) and pumped at a 1ml/min flow rate. The thermostat in the column compartment is set to heat the eluent to 40°C. The samples in the autosampler are kept at a constant temperature at 10°C until analysis. The detection wavelength was set to 205nm with a bandwidth of 10nm and the slit width opened to 16nm. The injection volume is 100µl. This gives a detection limit of 10nM or 1pmole in a 100µl injection.

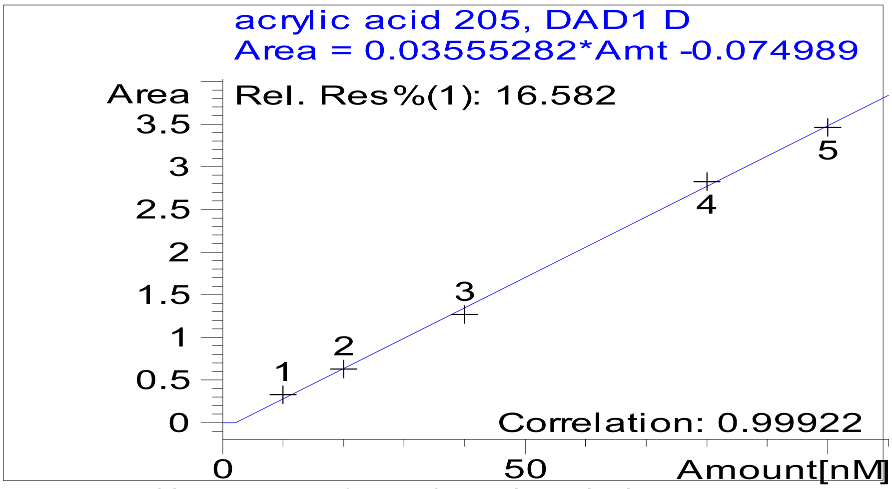


Fig. 1 Calibration curve for acrylic acid standards (10-100nM) in seawater

The instrument is calibrated by injecting different volumes of a 1µM acrylic acid (SIGMA Chemicals) standard, made up in 0.2µm filtered seawater. The calibration curve for a 10-100nM concentration range can be seen in Figure 1.

**ACRYLIC ACID DEPTH PROFILES**

Depth profiles were taken throughout the course of the cruise of which the profiles between the 21/6 and the 1/7 were analysed. As expected, most profiles show higher acrylic acid concentrations at the surface and the chlorophyll maximum (Table 1, Fig 2a and b). As a comparison, interesting profiles were obtained in the Kongsfjord (Table 1, Fig. 3a and b) which exhibit lower acrylic acid concentrations at the surface and increases over depth. These results will have to be interpreted in conjunction with the data obtained for DMS, DMSPd, DMSPp and the pigment analysis.

| Activity | date | Latitude | Longitude | Event |
|---|---|---|---|---|
| CTD 010 | 21/06/02 | N71 58.25 | E07 21.02 | #60 |
| CTD 011 | 22/06/02 | N75 34.41 | E08 32.35 | #83 |
| CTD 013 | 23/06/02 | N79 03.25 | E11 17.97 | #102 |
| CTD 015 | 24/06/02 | N78 57.48 | E11 54.49 | #118 |

Table 1 CTD cast information

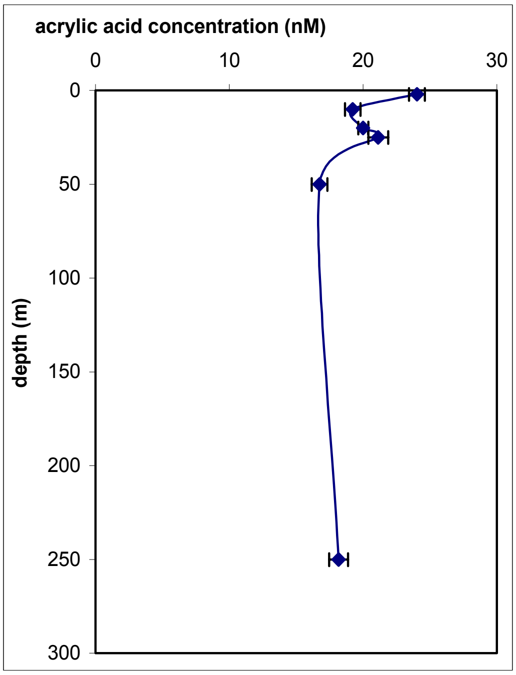



Fig 2a Depth profile for CTD 010
(N71 58.25 / E07 21.02)

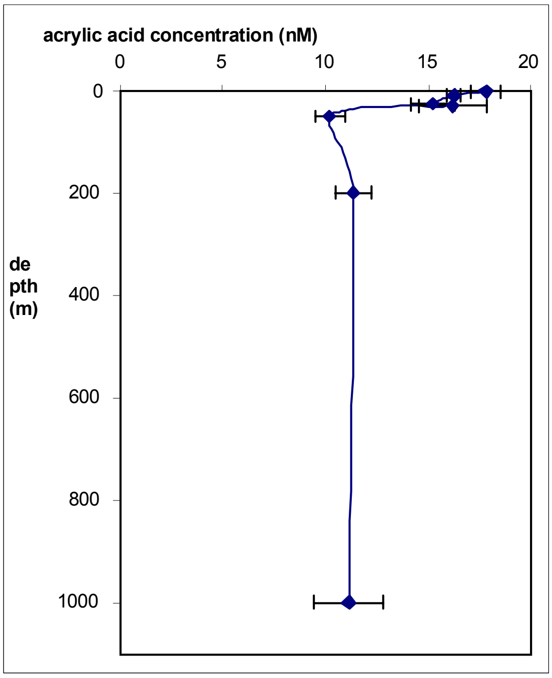



Fig. 2b Depth profile for CTD 011
(N75 34.41 / E 08 32..35)

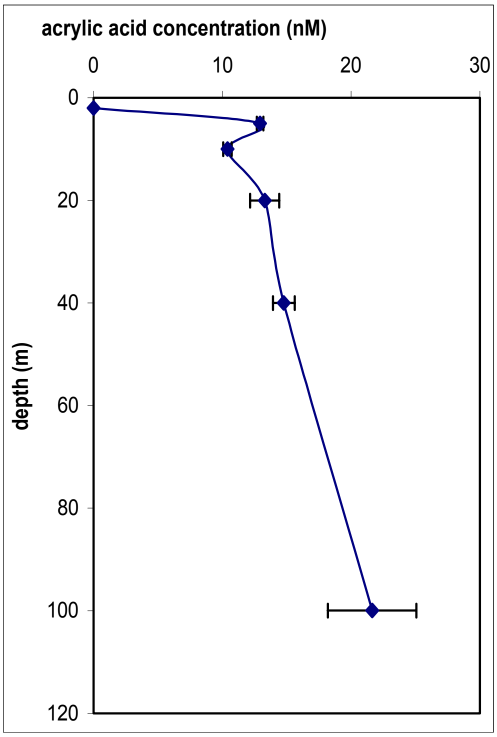



Fig. 3a Depth profile for CTD013
(N79 03.25 / E1 17.97)

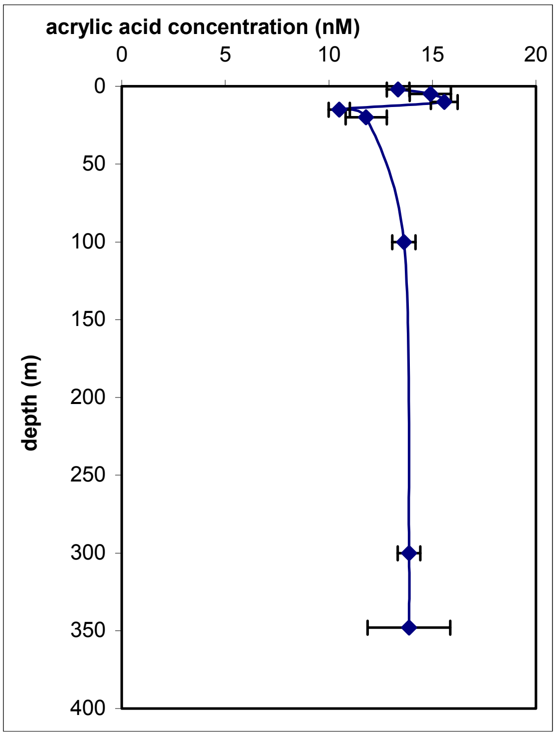



Fig. 3b Depth profile for CTD015
(N78 57.48 / E 11 54.49)

**ACKNOWLEDGEMENTS**

Greatest thanks to Graham Shimmield for giving us all the opportunity to come on this cruise and to obtain a complete data set covering all the parameters important for our research at UEA. Many thanks also to the officers, Simon Wright and everyone in the crew of the RRS *James Clark Ross* for their help and support throughout the cruise. And last but not least a great thank you to everyone onboard the JCR75 who made this cruise a very enjoyable experience.

## JCR 75 Seawater Ammonium / Atmospheric Ammonia measurement – Martin Johnson, UEA Norwich.

Seawater ammonium concentrations and atmospheric ammonia concentrations were measured in order to calculate the air-sea flux of ammonia. CTD ammonium profiles were also measured. This work is funded by the NERC thematic research programme, Global Nitrogen Enrichment and, as such, all data will be made available through the NERC data centre at CEH Monks Wood, Cambridgeshire.

Methods

OPA fluorimetry as outlined by Holmes *et al* (1999), was used for the analysis of seawater samples and for the assay of ammonia in the atmospheric samples. The method has been developed slightly from the Holmes method in that a smaller ratio of reagent to sample is used, reducing the baseline fluorescence and therefore the detection limit. The detection limit of the method on this cruise was approximately 10 nmol $L^{-1}$.

Measurement of atmospheric ammonia was achieved using filter packs – 1 PTFE filter (to catch particulate matter) and two acid coated filters to collect ammonia, in line, with air pulled through them by an air pump. Duplicate filter packs were run simultaneously, with a third set deployed without any air passing through them as a blank. The blanks, as normal with this method, were pretty high, but preparation in a glove box under nitrogen, and repeated washing of the filters with milliQ water before applying the acid reduced the blank to about 20% of the sample + blank value for an 8 hour sampling period at an atmospheric ammonia concentration of 5 nmol $m^{-3}$. The atmospheric sampling equipment was mounted at the front of the monkey island. Sampling was only conducted when the wind was blowing at greater than 10 knotts (remarkably infrequently on this cruise!) and the ship was into the wind (to prevent contamination from the funnel). Getting a power supply to the equipment was no problem – the long outdoor extension lead with waterproof sockets that was brought was adequate.

Sampling Details

*Table 1: CTD Sampling*

| *Event #* | **CTD #** | **Lat N** | **Long W** | **Date** | **Time** |
|---|---|---|---|---|---|
| #001 | 1 | 59°30.73 | 01°25.75 | 16/6/02 | 0842 |
| #005 | 3 | 59°30.73 | 01°25.75 | 17/6/02 | 2122 |
| #009 | 4 | 65°30.04 | 07°46.36 | 18/6/02 | 0838 |
| #019 | 8 | 67°13.04 | 06°06.14 | 19/06/02 | 1212 |
| #032 | 9 | 67°54.74 | 06°21.22 | 20/06/02 | 0830 |
| #060 | 10 | 71°58.23 | 07°21.06 | 21/6/02 | 0836 |
| #083 | 11 | 75°34.41 | 08°32.51 | 22/6/02 | 0830 |
| #104 | 13 | | | 23/06/02 | 0710 |
| #118 | 15 | 78°57.46 | 11°54.49 | 24/6/02 | 1330 |
| #136 | 17 | 79°00.16 | 06°59.57 | 25/6/02 | 1833 |
| #183 | 20 | 79°19.27 | 06°37.22 | 29/6/02 | 0830 |
| #185 | 22 | 80°41.36 | 07°25.53 | 29/6/02 | 2007 |
| #246 | 30 | 73°39.67 | 13°47.21 | 05/07/02 | 1216 |

*Table 2 – Underway seawater ammonium samples (from NTS)*

| **Sample No.** | **Date** | **Time** |
|---|---|---|
| nts1 | 19/06/2002 | 19:55 |
| nts2 | 21/06/2002 | 00:00 |
| nts3 | 22/06/2002 | 15:30 |
| nts4 | 23/06/2002 | 10:30 |

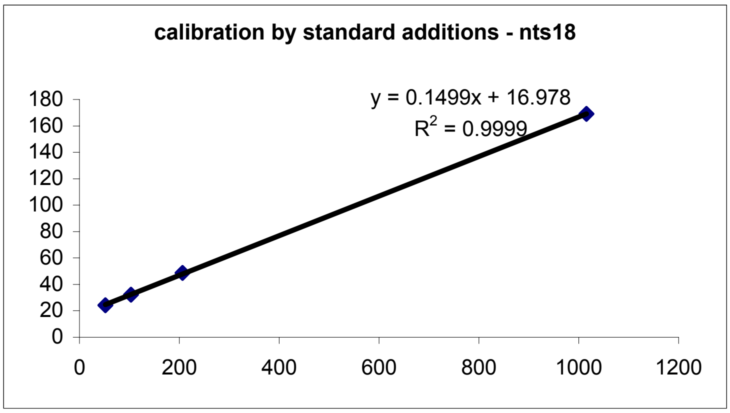
| | | |
|---|---|---|
| nts5 | 23/06/2002 | 14:05 |
| nts6 | 23/06/2002 | 17:05 |
| nts7 | 23/06/2002 | 21:10 |
| nts8 | 24/06/2002 | 03:30 |
| nts9 | 26/06/2002 | 12:45 |
| nts10 | 26/06/2002 | 21:25 |
| nts11 | 27/06/2002 | 06:55 |
| nts12 | 27/06/2002 | 17:00 |
| nts13 | 27/06/2002 | 21:30 |
| nts14 | 28/06/2002 | 00:30 |
| nts15 | 28/06/2002 | 19:40 |
| nts16 | 30/06/2002 | 12:50 |
| nts17 | 30/06/2002 | 19:30 |
| nts18 | 04/07/2002 | 04:45 |
| nts19 | 04/07/2002 | 11:21 |
| nts20 | 04/07/2002 | 13:15 |
| nts21 | 04/07/2002 | 22:20 |
| nts22 | 05/07/2002 | 09:20 |
| nts23 | 06/07/2002 | 01:24 |

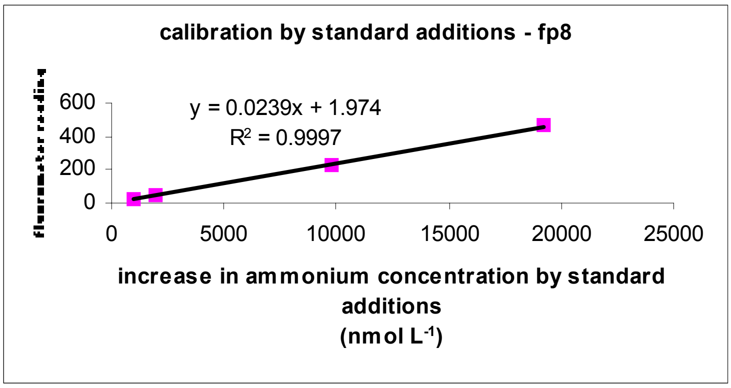
*Table 3 Atmospheric Samples*

| Sample No. | Start Date / Time | Finish Date / Time |
|---|---|---|
| fp1 | 19/06/2002 11:02:00 | 19/06/2002 21:00:00 |
| fp2 | 19/06/2002 21:00:00 | 20/06/2002 11:40:00 |
| fp3 | 20/06/2002 11:40:00 | 21/06/2002 00:30:00 |
| fp4 | 21/06/2002 00:30:00 | 21/06/2002 10:15:00 |
| fp6 | 23/06/2002 11:25:00 | 23/06/2002 22:00:00 |
| fp7 | 25/06/2002 17:50:00 | 26/06/2002 18:00:00 |
| fp8 | 27/06/2002 19:45:00 | 28/06/2002 01:20:00 |
| fp9 | 28/06/2002 01:20:00 | 30/06/2002 03:15:00 |
| fp10 | 30/06/2002 13:30:00 | 30/06/2002 21:20:00 |
| fp11 | 04/07/2002 05:40:00 | 04/07/2002 13:40:00 |
| fp12 | 04/07/2002 16:10:00 | 05/07/2002 00:05:00 |
| fp13 | 05/07/2002 00:25:00 | 05/07/2002 09:45:00 |

Calibration

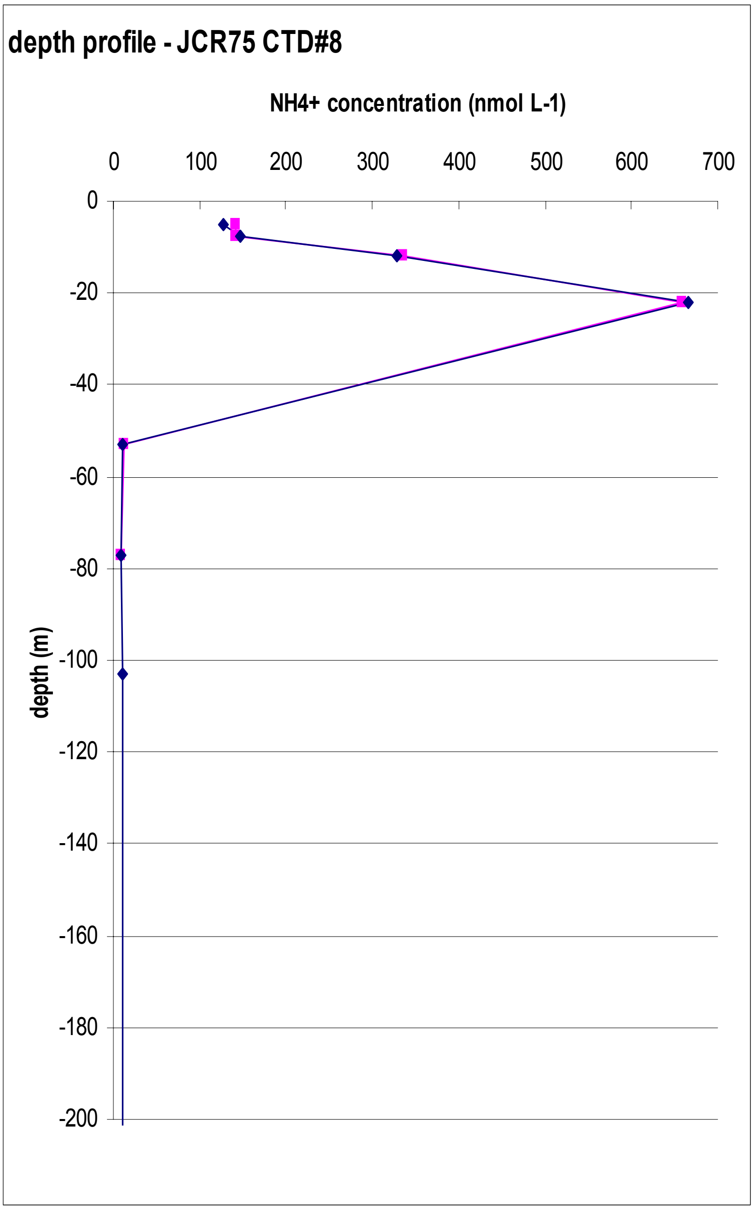
All samples (seawater and atmospheric) were run with a set of standard additions for calibration. The response of the calibration curve was markedly different for milliQ (used for atmospheric samples) and seawater, due to the matrix effect. The advantage of standard additions for this fluorescence ammonium method is that samples to not have to be analysed within the time window of maximum fluorescence – the standard additions will loose their fluorescence at a rate proportional to the samples, so analysis can be done up to 3 days after sampling (although normally samples were run less than 24 hours after sampling). The calibrations below show 1 milliQ calibration and 1 seawater calibration.

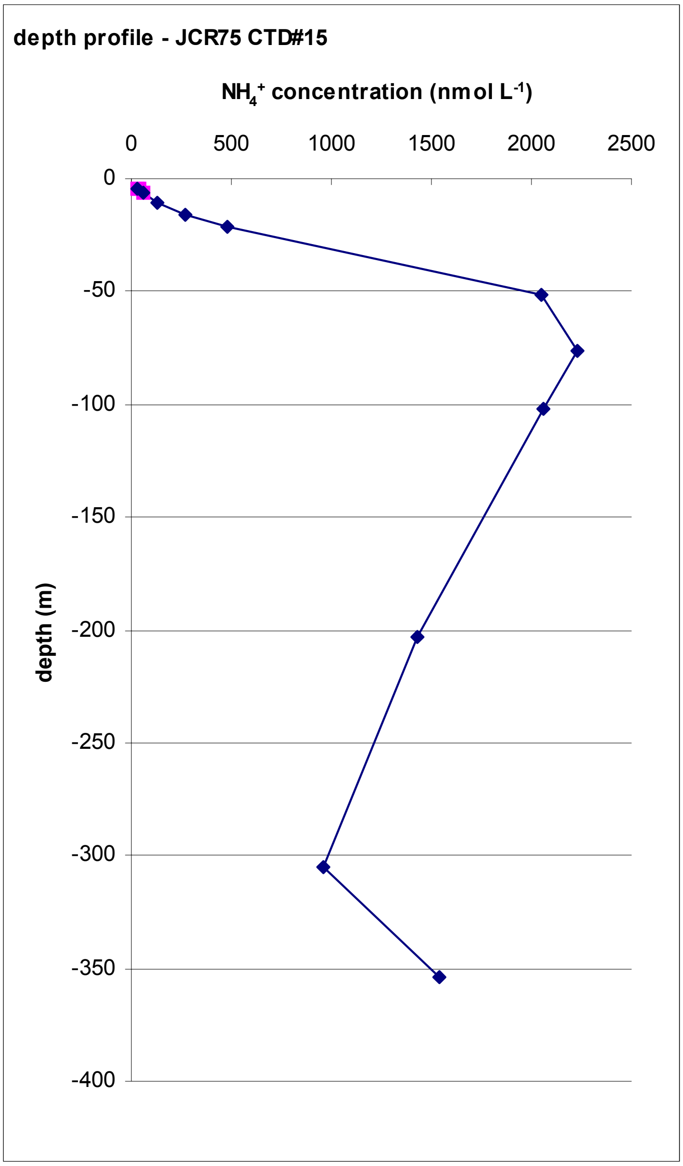



Depth Profiles

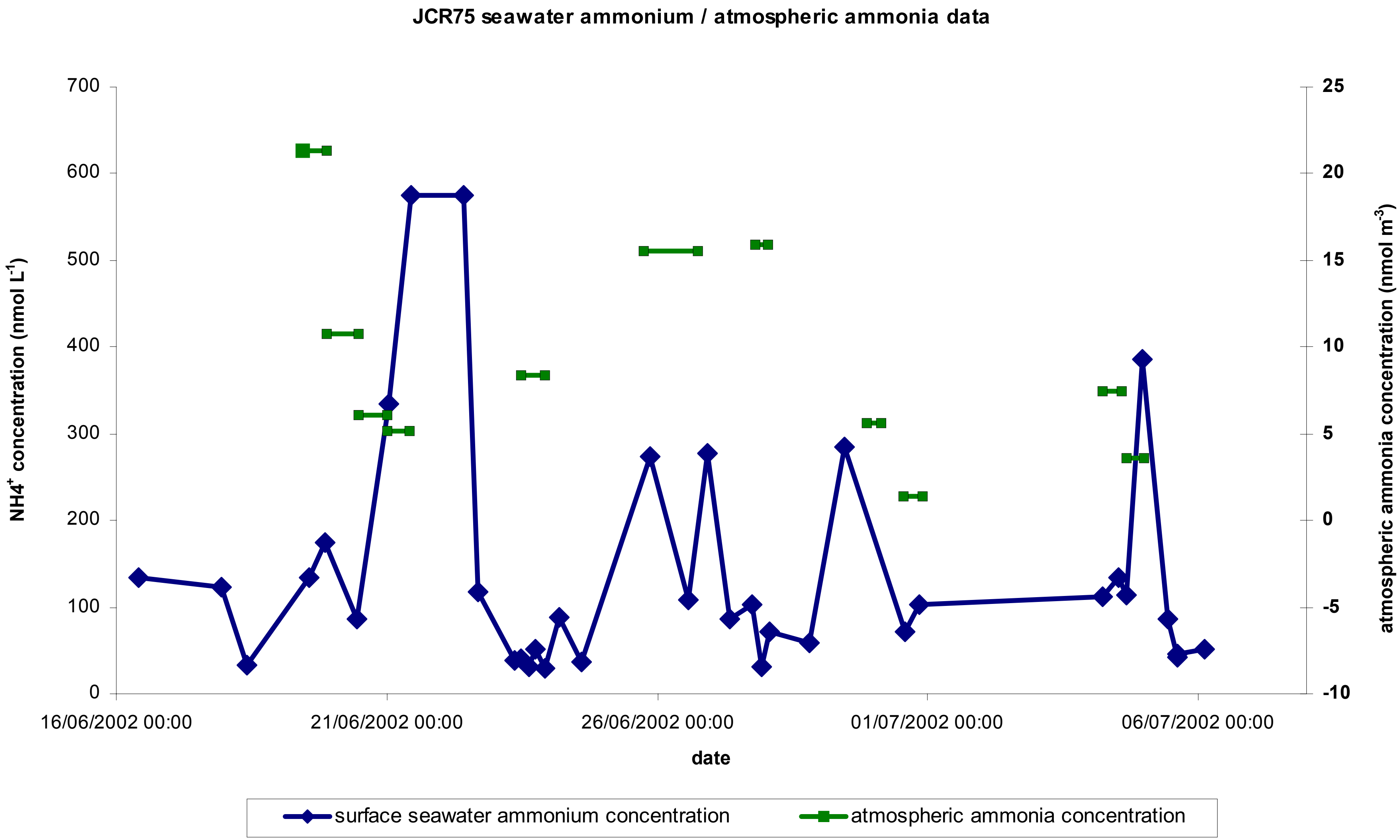
Depth profiles from selected CTDs are presented below. Magenta points show replicates sampled separately from Niskin bottles. Replication was excellent, and comparison with auto-analyser ammonium concentrations was good (not shown here).




Underway and Atmospheric Sampling

Data from underway and atmospheric samples is shown below. It was surprising to see atmospheric concentrations as high as 15nmol $m^{-3}$ as far north as Svalbard. The atmospheric data is preliminary – errors have not been included.


JCR75 seawater ammonium / atmospheric ammonia data
700
600
500
400
300
200
100
0
NH4+ concentration (nmol L-1)
25
20
15
10
5
0
-5
-10
atmospheric ammonia concentration (nmol m-3)
16/06/2002 00:00
21/06/2002 00:00
26/06/2002 00:00
01/07/2002 00:00
06/07/2002 00:00
date
surface seawater ammonium concentration
atmospheric ammonia concentration

Acknowledgements

Many thanks to the Officers and Crew for all their help, particularly Simon Wright, Deck Engineer and Norman Thomas, Electrical Engineer who made sampling on the monkey island possible. Also John Derrick, without whom the atmospheric work would have ground to a halt in the second week of the cruise, when the vacuum pump I was using broke down. Thank you also to all at DML for being so welcoming and helpful and for providing such an enjoyable cruise!

# THE NORTHERN SEAS PROGRAMME 2002

## JCR CRUISE (JUNE 14TH JULY 11TH)

## Leith, Edinburgh to Yermak Plateau, Arctic

## SAMS Northern Seas JCR cruise 2002: Scientific rationale and proposed sampling sites

### 1. Relevance to SAMS Northern Seas programme

The cruise work will directly address the following programme elements:

Theme A, Question 4

- *How does bioturbation vary in response to environmental forcing and what are the consequences for redistribution of anthropogenic contaminants?*
- *How does the anthropogenic burden change along a northern transect of 4 stations (67 to 81 N)?*

Theme A, Question 5

- *To deliver an understanding of the effect of abrupt climate change and land use on fjordic/sea loch systems, which link the marine and terrestrial environments at high latitudes in Northwest Europe.*

Theme B, Question 2

- *To what extent does benthic faunal composition and size structure determine processes of carbon dynamics ?*
- *Can we link changes in regional patterns in sediment biogeochemistry with disparate patterns in benthic distributions?*

Bioturbation processes form the interface between seabed biology and geochemistry. The 'environmental forcing' referred to in the programme is likely to vary both with depth (eg. fjordic-shelf-slope-abyss) and latitude (north-south gradients in intensity and interannual variability of pulsed OM input). Bioturbation therefore provides a crossover between the two main themes of the Northern Seas programme.

Work to be carried out from JCR should be seen as an essential supplement to the Wyville-Thomson work carried out on D257. To test the reality or otherwise of benthic biogeochemical 'provinces' we require comparable data from a range of sites in the water masses north and south of the WT Ridge (differences between our WTN and WTS stations does not in itself amount to a demonstration of 'provinces'). The WTS results can be put alongside existing data from previous studies in the Atlantic water mass (BENBO, SES), but at present we need more stations north of the ridge to compare with WTN.

### 2. Proposed study sites for JCR : Norwegian - Barents Sea continental margin

- Continental margin Norway - Barents Sea - Svalbard - Yermak Plateau, approx. N-S course without major undersea geographic barriers. Benthic faunal distribution therefore determined by gradients in seabed environmental conditions without confounding by biogeographic factors.

- This line also forms the approx. course of the northern 'conveyor' carrying contaminants from W. Europe to the arctic.
- Overall northwards trend in OM supply to the benthos will be one of increasingly pulsed flux and greater inter-annual variation in the timing and total supply of OM derived from water column primary production.

- Local factors superimposed on overall northwards trend, ie. winter 'outbursts' of fine-grained material off Barents Sea shelf, relative contributions of ice algae and phytoplankton on Yermak Plateau

- Data from series of sites along this N-S margin will therefore show how benthic community varies (biomass, bioturbator community structure) in response to forcing factor of OM supply, and consequences of this for sediment mixing rate, biogeochemical process rates and sediment contaminant distribution.

At **MAIN** sites all major equipment and techniques will be deployed. In addition to these main sites CTD and coring deployments may take place at intervening sites.

### 2.1 Deployment of Photo Lander

In addition to the transect sites the SAMS Coral Lander will be deployed at the Sula Ridge at the start of the cruise and will be recovered on the return journey. The co-ordinate and depth of the station are as follows:

- 280m depth
- 64 05.0340N 08 02.3374E

Before deployment a quick multibeam (+TOPAS) survey will be run over the deployment site to ascertain site conditions as the lander is designed to sit on flat seabed beside the reefs, not in amongst the live coral areas. Estimated time of the survey is 1 to 2 hours but this requires finalising with the ship's personnel.

On the return leg a sediment sample will be collected from the lander position, a box core would be ideal. If time permits a sample of live coral should be obtained from the reef area.

### 2.2 Proposed main sampling sites Northern Transect

Sampling all at depth similar to top of Voring Plateau, ie. ~ 1400 m

1. **Voring Plateau: High Priority Site:** (Gravity coring Site) Nyk Drift, this site is similar supply to other 3 northern transect sites. **Alternative site:** Central Plateau: Purely pelagic OM supply, no advection off shelf. Much published information on nature and distribution of benthic fauna, will facilitate interpretation of our samples. Few data on biogeochemical process rates.
2. **Bear Island Fan:** Not far from Voring, but receives advected material off Barents Sea shelf as well as pelagic OM flux.

3. **Margin W. of Svalbard, no ice cover:** No ice algae, but will receive pelagic OM and northwardly-advected material from West Spitzbergen Current (WSC)
4. **Western margin of Yermak Plateau:** Within influence of WSC, with additional contribution from ice algae.

These four stations will form the northern transect. If time constraints or ice thickness prevents work at the Yermak Plateau, the remaining ice-free sites will still provide us with a 3-station northward transect.

### 2.3 Additional Deployment Northern Transect, Kongsfjord (1400m)

There will be a trial of the Elinor chamber at the Kongsfjorden 1400m station. The deployment duration will hopefully be 2-3 days.

## 3. Proposed study sites for JCR : Svalbard margin out from Kongsfjord

This is intended to tie in with April 2002 LSF work (post-bloom data from Kongsfjord stations). The transect will consist of four main stations, nb there are 5 main stations however the 1400m station will be completed during the execution of the northern transect.
The transect will continue out from fjord in a series of stations across the shelf (where soft sediments exist) and down continental slope. This will allow changes in benthic community and biogeochemistry to be recorded along a depth/OM supply gradient not confounded by other factors.
This bathymetric transect will intersect with the N-S margin transect proposed above.

### 3.1 Proposed main sampling sites Kongsfjord Transect

1. The inner station occupied by the lander April 2002 (station 22 141m depth N79° 0.33′ E11° 54.20′ )
2. Mooring station April 2002 (200m depth N79 03.25’ E011 17.96 )
3. Station outwith fjord approximately 800 m?
4. Station 1400 m this is the same station as northern transect (count only once)
5. Fram Strait, station as far west as possible in time constraints (no further than 0°)

### 3.2 Proposed additional coring sampling sites Kongsfjord

Coring sites LSF April 2002:
Megacore and box core

| Station | Gear | Longitude | Latitude | Depth |
|---|---|---|---|---|
| 52 (Fjord) | Sholkovitz (S1) | N 79 02 | E 11 24.6 | 260 m |
| KB3 (Fjord) | Sholkovitz (S1) | N 78 57.5 | E 11 56.7 | 347 m |

Deep Hole (Molloy Deep): In addition to the above stations a limited amount of coring will take place at the deep hole 5500m if time permits.

## 4. Summary of main stations and equipment to be deployed

| Station/sampling | **Lander (profiler)** | **Oxygen Incubations** | **Nutrient Incubations** | **CTD** |
|---|---|---|---|---|
| Voring Plateau (1400m) | Yes (auto) | Yes | Yes | Yes (2drops) |
| Bear Island Fan (1400m) | Yes (auto) | Yes | Yes | Yes (2drops) |
| Off Kongsfjord (1400m) | Yes (auto)/**Elinor trial** | Yes | Yes | Yes (2drops) |
| Yermak Plateau (1400m) | No (ice?) | Yes | Yes | Yes (2drops) |
| Kongsfjord (141m) | Yes (moored) | Yes | (to be decided) | Yes (2drops) |
| Kongsfjord (200m) | Yes moored) | Yes | Yes | Yes (2drops) |
| Kongsfjord (1200 m) | Yes (auto) | Yes | (to be decided) | Yes (2drops) |
| Fram Strait (3000m) | Yes (auto) | Yes | (to be decided) | Yes (2drops) |

| Station/sampling | **Multicorer** | **Megacorer** | **Box corer** |
|---|---|---|---|
| Voring Plateau (1400m) | Yes (3 drops) | Yes (min 3 drops) | Yes (min 2 drops) |
| Bear Island Fan (1400m) | Yes (3 drops) | Yes (min 3 drops) | Yes (min 2 drops) |
| Off Kongsfjord (1400m) | Yes (3 drops) | Yes (min 3 drops) | Yes (min 2 drops) |
| Yermak Plateau (1400m) | Yes (3 drops) | Yes (min 3 drops) | Yes (min 2 drops) |
| Kongsfjord (200m) | Yes (3 drops) | Yes (min 3 drops) | Yes (min 2 drops) |
| Kongsfjord (350m) | Yes (3 drops) | Yes (min 3 drops) | Yes (min 2 drops) |
| Kongsfjord (1200 m) | Yes (3 drops) | Yes (min 3 drops) | Yes (min 2 drops) |
| Fram Strait (3000m) | Yes (3 drops) | Yes (min 3 drops) | Yes (min 2 drops) |

| Station/sampling | **Bedhop Camera** | **Gravity corer** |
|---|---|---|
| Voring Plateau (1400m) | Yes (min 2 drops) | **For details see below** |
| Bear Island Fan (1400m) | Yes (min 2 drops) | |
| Off Kongsfjord (1400m) | Yes (min 2 drops) | |
| Yermak Plateau (1400m) | Yes (min 2 drops) | |
| Kongsfjord (200m) | Yes (min 2 drops) | |
| Kongsfjord (350m) | Yes (min 2 drops) | |
| Kongsfjord (1200 m) | Yes (min 2 drops) | |
| Fram Strait (3000m) | Yes (min 2 drops) | |

In addition to the above sampling higher resolution longitudinal sampling will be undertaken using the mega corer and box core. This will provide samples for benthic biomass and sediment cores for solid phase geochemistry.

Also limited sampling of the Molloy Deep.

## 5. Geochemical and benthic sampling to be carried out at each selected station

### 5.1 Benthic sampling requirements at each main station

- **Seabed photos: Minimum 2 drops of bedhop camera** (= 50 photos) More if time allows. Will process colour slide film from each station on board ship to give on-the-spot information on seabed type.
- **Boxcoring: Minimum 2 good ones per station** More if time allows. Will be subcored for X-ray analysis (working with John Howe), dissected for burrow features, burrow contents/animal gut contents sampled for geochemistry if any found. Sediments will be sieved for larger fauna (> 500 µm in fine sediments, coarser sieve necessary if material is sandier)
- **Megacoring** Will be used as standard sampler for sediment macrofauna **8 cores per station** (as used in AFEN protocols), but do not have to come from 8 separate drops. Cores will be sieved on 250 and 500 µm. Some depth-sliced for data on vertical distribution. If megacorer fails, boxcores will be sub cored for sieving on 250µm, and back-up with multicores as done on D257.

### 5.2 Geochemistry sampling requirements at each main station

The solid phase and pore water analysis of sediment cores in conjunction with the lander data, radionuclide data and organic data will be used to determine the biogeochemical processes that are dominating the system under study and investigate the role of carbon (quantity and type) and benthic biota with respect to changing environments. This will be done for both the latitudinal gradient (change in supply but constant depth) and longitudinal gradient (change in depth and water masses). The redistribution of pollutants will also be investigated on both transects.
This data will be intimately linked with the biological data and flux data and will be modelled with respect to the benthic/geochemical system.

Geochemistry sampling will involve

- **Lander deployment:** in profiler mode and possibly Elinor mode (off Kongsfjord, 1400m ),
- **Incubations:** $O_2$ and nutrient fluxes from incubated cores.
- **Radionuclide**: One sediment core will be collected from each station for down core Pb-210, Th-234 (only at fjordic sites) and Cs-137 (all stations)(sliced and stored at 4$^{o}$C). The radionuclide and chlorophyll data will provide rates of mixing on different scales, Th-234 and chlorophyll days to months and Pb-210 years. The Th-234 and Chlorophyll will be targeted to the fjordic sediments where we might expect a higher concentration of biota and hence mixing.
- **Trace metals and particle size**: One sediment core will be collected at each station for trace metal analysis and PSA. (sliced and stored at 4$^{o}$C). The solid phase sediment data will be used to characterise sediment type and identify major changes in type along both the latitudinal and longitudinal gradients.

- **OM and stable isotopes**. 2 sediment cores (if possible) will be taken at each station sliced and kept frozen. These cores will be used for Chlorophyll and stable carbon isotope analysis.
- **Pore water extraction**: Pore water extraction will be performed on one core at all of the main sites (or as many as possible).

From each main station geochemical analysis will require a total of **5 mega core** this could be reduced to 4 if organic analysis can be performed on another core ie solid phase.

| Analysis | Pore water extraction | Solid phase | Radionuclide | Chlorophyll | Organic analysis |
|---|---|---|---|---|---|
| Megacore | 1 | 1 | 1 | 1 | 1 |

Each core will be sectioned as follows;
- 0.5cm increments to 10cm depth,
- 1 cm increments to 20cm depth
- and thereafter 2cm to bottom of the core.

**The samples will be bagged and kept at a max of $4^oC$ or in the case of the organic samples frozen.**
As stated above, from further stations in Kongsfjord or on the shelf (deep hole) we will require 2 megacores per station for solid phase analysis, and radionuclide analysis

### 5.3 Shipboard Analysis

- Shipboard analysis of porewater nutrients will be required. A maximum of 50 samples at 8 stations will be required = 400 analysis.
- Nutrient analysis of CTD water will also be required at each main station.

## 6. JCR75 – Gravity Coring Programme

### 6.1 Rationale

The timing and effects of deglaciation in high latitude deep-water environments and its impact on bottom current circulation. Regions of high sedimentation rates in the Polar North Atlantic will be targeted (3-100 cm/ky) allowing abrupt climatic events to be detected at a high temporal resolution allowing the timing and onset of deglaciation and its relationship to sediment supply and productivity to be examined.

### 6.2 Methods

A 6 m-long (BGS) gravity corer will be used to obtained sediment records spanning the last glacial-interglacial cycle. Sampling stations are selected from sites of current-influenced sedimentation on the Voring Plateau, Western Svalbard Margin and Fram Strait and the Yermak Plateau. Core site selection will be based on a short (< 3hrs) acoustic survey (Topas and Multi-Beam) to identify key areas of current influenced sedimentation. The study targets key regions of oceanic circulation as well as complementing the interdisciplinary SAMS sampling stations. Cores will be split digitally photographed and logged onboard RRS James Clark Ross.

### 6.3 Sampling Stations (All Sites 6 m core with exception of Konsfjord 3m).

| Station | | Priority | Approx. Location | Water Depth | Acoustic Survey | Depositional environment | Science Target |
|---|---|---|---|---|---|---|---|
| Voring Plateau | 1 | High | 67N 7.5E | 1000-1400 | Topas (nearby Nyk slide) | Nyk Drift, extreme sedimentation rates (1.2m per 1000 year) | Atlantic Surface & Intermediate water flow? |
| Voring Plateau | 2 | Med. | 65.5N 5E | 1400-1500 | Topas | General SAMS | Atlantic Surface & Intermediate water flow? |
| Outer Voring Plateau | 3 | High | 68N 2E | 2000-2500 | Topas | Contouritic | NSDW flow |
| Bear Island Fan | 4 | Low | tbc | 1400-1500 | Topas | Downslope sediment fluxes<br>General SAMS | LGM-Holocene sediment transport, Trough Mouth Fan |
| Kongsfjord | 5 | High | tbc | <350 | Topas + Multibeam | General SAMS | Fjordic Proxy |
| Kongsfjord | 6 | High | tbc | <350 | Topas + Multibeam | General SAMS | Fjordic Proxy |
| Kongsfjord | 7 | High | tbc | <350 | Topas + Multibeam | General SAMS | Fjordic Proxy |
| W. Svalbard Margin | 8 | Med | 79N 8E | 1400 | Topas | General SAMS | Konsfjord Trough Mouth Fan & alongslope currents |
| W. Svalbard Margin | 9 | Med | 79N 6E | 2000 | Topas | Contouritic | Konsfjord Trough Mouth Fan & alongslope currents |
| Fram Strait | 10 | High | 79N 3E | 2000-3000 | Topas | Contouritic | Bottom water flow influence of Molloy Deep Eddy |
| Fram Strait | 1 | High | 79N 0E | 2000- | Topas | Contouritic- | Molloy - SW |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | | | 3000 | | hemipelagic | Hovgaard Fracture Zone - Bottom water flow influence of Molloy Deep Eddy |
| Fram Strait | 12 | High | 79N 0E | 3000-5669 (Molloy Deep) | Topas | Contouritic-hemipelagic | Molloy - SW Hovgaard Fracture Zone - Bottom water flow influence of Molloy Deep Eddy |
| Yermak Plateau | 13 | Low | 81N 3E | 1000-1500 | Topas | Contouritic - glaciomarine | Arctic deep water flow. Seasonal ice, productivity |
| Yermak Plateau | 14 | Med | 81N 3E | 1500-2000 | Topas | Contouritic - glaciomarine | Arctic deep water flow. Seasonal ice, productivity |
| Yermak Plateau / Lena Trough | 15 | Med | 81N 0E | 2000-2500 | Topas | Contouritic - glaciomarine | Arctic deep water flow. Seasonal ice, productivity |

Station Times (based on 3 hours MAX survey* using Topas and winch speed of 40m/min)

* No account of slow surveying for ice conditions

| **Station** | **Water Depth** | **Estimated Time on Station (Survey+Wire Time)** | **Problems & Comments** |
|---|---|---|---|
| 1. Voring Plateau | 1400 | 4 hrs 10 mins | Care surveying as slides on both side of drift. |
| 2. Voring Plateau | 1500 | 4 hrs 15 mins | Unknown sediment type |
| 3. Outer Voring Plateau | 2500 | 5 hrs 10 mins | Unknown sediment type |
| 4. Bear Island Fan | 1500 | 4 hrs 15 mins | Possible coarser seds. Debris flows and Turbidites common. |
| 5. Konsfjord | 350 | 3 hrs 9 mins | Need 3 m barrel for all fjord sites: Diamict common!<br>ONE Topas & Multibeam survey could identify all three core sites in Konsfjord |
| 6. Konsfjord | 350 | 3 hrs 9 mins | ONE Topas & Multibeam survey could identify all three core sites in Konsfjord |
| 7. Konsfjord | 350 | 3 hrs 9 mins | ONE Topas & Multibeam survey could identify all three core sites in Konsfjord |

| | | | |
|---|---|---|---|
| 8. W. Svalbard Margin | 1400 | 4 hrs 10 mins | Unknown sediment types poss diamict in shallow water |
| 9. W. Svalbard Margin | 2000 | 4 hrs 30 mins | Contouritc + Ice Rafted Debris |
| 10. Fram Strait | 3000 | 5 hrs 50 mins | Contouritc + Ice Rafted Debris |
| 11. Fram Strait | 3000 | 5 hrs 50 mins | Contouritc + Ice Rafted Debris |
| 12. Fram Strait | 5669** | 8 hrs | Contouritc + Ice Rafted Debris |
| 13. Yermak Plateau | 1500 | 4 hrs 15 mins | Contouritc + Ice Rafted Debris + Diamict! |
| 14. Yermak Plateau | 2000 | 4 hrs 30 mins | Contouritc + Ice Rafted Debris + Diamict! |
| 15. Yermak Plateau | 2500 | 5 hrs 10 mins | Contouritc + Ice Rafted Debris |

Total MAX Time Surveying and Gravity Coring: <u>69 hrs 53 minutes (approx. 3 days)</u>
** Assumes sampling Molloy Deep alternative sites may be found in depths < 3000 m

## 7. Marine Physics: proposed physical oceanographic support to projects

Each SAMS project have requirements for water column properties. This will be via a planned program of CTD stations with water samples from strategic depths. Vessel mounted ADCP will be logging continuously throughout the cruise. In addition to data collected about water movement which has been requested by certain projects (sediments, benthic, ...) and a proposed survey of entrance of Kongsfjord, backscatter data will be of value to biological programmes (Mike Burrows).

[It may be possible to provide support to organisations or groups on other vessels in the Arctic to fill gaps in their own surveys or time-series. This is **<u>very low priority</u>** and only feasible if stations lay on our intended cruise track. Though this is not part of the SAMS core program there may be mutual and future benefits.]

### 7.1 Vessel mounted ADCP survey of Kongsfjord and beyond the shelf break.

- An ADCP survey of Kongsfjord will contribute to the physics element of Theme A and give a baseline for other activities within the fjord.
- The survey will take place in the vicinity of the mooring position and conceivably be attempted whilst the mooring is being turned around There is an opportunity to observe T/S and flow characteristics along the shelf edge and in the deep-water exit from Kongsfjord on the planned transect into the Fram Strait.

### 7.2 Potential mooring/survey work in conjunction with Norsk Polar Institut (NPI)

NPI are undertaking a program of physical observations of Kongsfjord as part of OAERRE (although this is not within our own OAERRE commitments). We will be able to contribute to this in collaboration with Harald Svendsen as part of Theme A. Using an ADCP we can get good tidal information and make observations of the changes in baroclinic flow through the fjord as the system changes from stable stratification to one influenced by convection through cooling and salt injection. At high latitudes internal tides are not expected to exist; we hope to investigate this.

Two possibilities include

1. revisiting NPI hydrographic stations and
2. servicing and possible redeployment of the moored instruments that were deployed in April as part of the LSF work. These moorings may be recovered by JCR or alternatively in September with *Hakon Mossby* (needs confirmation). Each recovery and deployment require **0.5 days ship time** with a 1 day interval for instrument turn around.

### 7.3 Primary Measurements*:*

- CTD and VM-ADCP
- Moored 300 kHz ADCP and T/S loggers

### 7.4 Onboard facilities/personnel:

- 150 kHz ADCP with data logging and 1 Hz ship's navigation data.
- Technician/scientist to operate and download the ADCP data.

### 7.5 Collection of water samples for $\delta^{18}O$ measurements

Water samples from CTD casts will be taken for $\delta^{18}O$ analysis. This will be used to trace water of fjordic origin up the coast to the Yermak Plateau. The data will be of use in interpretating the geochemical data with respect to sources. It has also been found to be useful in determining the contribution of sea ice melt to water in the Fram Strait.

## 8. Order of priorities

After considering the scientific objectives of the cruise and the feedback from SAMS Programme Advisory Board the following order of priorities have been assigned;

1. The 4 stations of the Northern Transect are of highest priority although it is understood that the ice conditions at the Yermak plateau will have to be assessed during the cruise.
2. It is important that deployment of all equipment and recovery of the necessary samples at each main station is complete. It is more important that fewer stations are completed than all stations are visited but not completed. Answering the scientific questions requires benthic, geochemical and physical data.
3. The highest priority for the Kongsfjord transect are the 2 stations occupied April this year and the Fram strait stations.

# 9. External and internal requests for sample collection and measurements

## 9.1 Surface Sediment sites requested by Prof. McCave

Prof. McCave is interested in obtaining surface sea-bed samples, (top 1 cm preferably) from Bear Island Fan, Fram Strait and by Jan Mayen.

Depths and Locations

| | | | |
|---|---|---|---|
| UW/BI-CM2 | 1712 m | 73° 43.9'N | 13° 05.4'E |
| UW/BI-CM3 | 1686 m | 73° 49.6'N | 13° 27.3'E |
| Berg/FS-1 | 1094 m | 78° 58.7'N | 05° 16.1'W |
| Berg/FS-1B | 1043 m | 78° 58.6'N | 05° 18.9'W |
| Berg/FS-3 | 2539 m | 78° 54.9'N | 03° 17.7'W |
| Berg/FS-4 | 2345 m | 78° 39.4'N | 04° 05.7'E |
| Berg/FS-7B | 979 m | 78° 50.3'N | 08° 04.2'E |
| Berg/FS-9B | 2572 m | 79° 01.0'N | 00° 55.0'W |
| Berg/107 | 2045 m | 71° 12.0'N | 07° 44.0'W |
| WHOI/FS-1 | 2527 m | 78° 52.0'N | 01° 22.0'E |
| WHOI/FS-2 | 2430 m | 79° 00.0'N | 04° 55.0'E |

## 9.2 Underway sampling UAE/THURSO

**Stuart Gibb Thurso:**
Collection of samples from both CTD and underway (ideally every 2 hours) for chemotaxomomic pigments inclusing CHLa. These will be collected by Mona Larsen of the ERI for analysis back in the lab.

UAE

**Louise Darroch** PhD project on *Dimethylsulphoxide: Origin, Fate And Cycling In Marine Waters.*
(Supervisors Malin & Liss,UEA. External Supervisor Angela Hatton, DML).
DMSO is the oxidation product of dimethylsulphide (DMS). Louise is using the GC - DMSO reductase linked method for the analysis of DMSO in seawater, natural particulates and culture samples/expts. During JCR75 she will focus on the distribution of particulate DMSO. Louise would be interested to analyse any deep water, near sediment water, marine snow or coral samples that are collected by other participants. If time permits some incubation experiments to determine

whether artificially induced oxidative stress enhances DMS/DMSO production by phytoplankton and to look at DMS photoxidation may be done. Louise was on a cruise onboard Discovery in the North Sea in 1999 (prior to her PhD) and has also worked at the Bergen Mesocosm facility.

**Claire Evans** PhD project on *How do viruses influence the production of DMS?* (Supervisors Malin & Liss, UEA. CASE with Willie Wilson, MBA).
To date Claire's project has focused on laboratory studies of cultures of *Emiliania huxleyi* and its specific viral pathogens. During JCR75 she will analyse some of the DMS related compounds with Louise, and look at DMSP lyase activity by GC. Areas that might support populations of *Ehux* or *Phaeocystis* would be of particular interest. Claire will also collect samples for viral and bacterial enumeration by AFC, analysis of particulate phase viral DNA and isolation of *Ehux* viruses. If time permits she will also conduct some incubation expts. Previously Claire has worked onboard the MBA's Squilla during an Ehux bloom off Plymouth, and she worked with us on a Bergen Mesocosm study while studying for her MSc. This is her 1st major offshore research cruise.

**Susanne Kadner** PhD project on *Acrylic acid: the forgotten part of the DMS story* (Supervisors Malin & Liss, UEA. External Supervisor Stuart Gibb, ERI).
Acrylic acid (AA) + DMS = DMSP the recognised precursor of DMS, the idea here is to investigate the biogeochemical cycle of DMS from the AA viewpoint. Very few previous studies have had this focus and many assumptions have been made as to the origin and fate of acrylic acid. Where such studies have been done the detection limit for AA has been rather poor. Susa has developed an HPLC method which allows analysis of dissolved AA with direct injection of seawater with a detection limit of approx 10nM – far more sensitive than anything else reported in the literature. The JCR75 cruise will allow the 1st at-sea trial of this method and further development of a method for analysis of particulate AA.. AA will be analysed in surface and profile samples. Bacterial enumeration data will be obtained using onshore DAPI counting of filters prepared at sea (as a back up to AFC counts mentioned above) and bacterial activity will be monitored using a tritiated Leucine incorporation method. Some experiments will also be done to determine directly whether bacterial activity is affected by AA and to assess the turnover time of AA in whole seawater and the bacterial fraction. This is Susa's 1st research cruise.

**Claire Hughes** PhD project on *Biological Mechanisms for the production of organo-halogen gases*
(Supervisors Malin and Liss, UEA. CASE with Phil Nightingale, PML).
Claire is using a Hewlett Packard (now Agilent) GC – MS system for this project which focuses on volatile low molecular weight iodinated compounds and their production by seaweeds and phytoplankton. During JCR75 she will look at production/turnover of volatile halocarbon compounds in incubations of concentrates of seawater prepared using the non-toxic supply. The aim being to follow up some interesting data collected on a previous cruise. Bacterial counts will be done via DAPI stained filters and bacterial activity will be monitored using a tritiated Leucine incorporation method. Samples will be taken for HPLC analysis of pigments indicative of phytoplankton degradation by e.g. zooplankton grazing. Surface and profile samples will also be analysed as time permits. It would be of interest to analyse any marine snow, sedimenting diatom mat or coral samples

collected during the cruise. Claire sailed with PML onboard Discovery earlier this year and on a research cruise in the Atlantic whilst doing her MSc at Dalhousie.

**Martin Johnson** PhD project on *The Air-Sea flux of Ammonia.*
(Supervisors Liss & Jickells, UEA. External Supervisor Stuart Gibb, ERI).
The aim of Martin's project is to quantify the air-sea exchange of ammonia. This is important as a significant exchange process in euphotic zone N budget and an important influence on atmospheric aerosol composition and hence climate. To quantify the air-sea flux of ammonia seawater and atmospheric ammonia concentrations are measured, as well as meteorological parameters (especially wind speed) that affect the rate of transfer. Surface seawater and profile samples will be analysed onboard for ammonium concentration using the OPA fluorometry method and pH. Together these allow calculation of ammonia concentrations. Ammonia concentrations are also measured in the atmosphere, requiring that the ship be heading into the wind for periods of several hours to collect enough sample and to avoid ship derived contamination. For this we are developing a rotating annular denuder sampling method which should give an atmospheric ammonia concentration for every 1-2 hours of sampling. With the water and atmospheric ammonia concentrations measured, the direction and rate of ammonia transfer between the atmosphere and the ocean can be determined. During his PhD studies Martin has already taken part in research cruises in the Atlantic and North Sea.

**Sample coordination for UEA projects**
As far as possible routine CTD and non-toxic system sampling will be coordinated so that the whole group samples the same water, to enable direct comparison of data. This is particularly important for the DMS related projects (Darroch, Evans and Kadner).

**Link to other data to be collected on JCR75**
Beyond the possibility of opportunistic joint experiments, wherever possible we would like to maximise the possibility of interpreting UEA data with reference to data collected by other JCR75 participants. As with other NERC cruises our data will be available to others for the same purpose. Where possible e.g. profile samples, non-toxic supply samples it would be most ideal to coordinate the timing of sampling with others. We haven't a complete view of what will be done during the cruise but examples of the sort of data that would be of interest are as follows:

- Standard fluorometric chlorophyll data
- HPLC pigments
- Nutrient data
- Primary production
- Phytoplankton speciation and count data ~ + any general information that becomes available during the cruise due to visual observation, satellite imagery, that might be relevant to taking survey samples and setting up experiments etc.
- Microzooplankton Grazing
- Zooplankton speciation and count data
- DOC
- Met data
- Light data

### 9.3 Microbial Samples (SAMS)

Samples to be collected by Ivan Ezzi

The objective is to collect samples for analysis of microplankton, nanoplankton and bacterioplankton. It is not intended to obtain a full and complete data set for a paper but rather to collect occasional samples in support of other work (e.g. Stuart Gibbs phytoplankton HPLC analysis) and to give some preliminary data on microbes from the Svalbard area.

Up to 40 samples can be taken during the cruise. The positions of sampling have not been decided but will be surface waters from different stations along interesting transects (e.g. Kongsfjord to open ocean, or north sea to arctic).

Sampling involves gently decanting water from Niskin bottle into bottles containing preservative. Two types of sample:
1. 200 ml into amber glass bottle containing 2 ml lugol's iodine
2. 100 ml into amber plastic bottle containing 4 ml glutaraldehyde.

The preservatives will already be in the bottles. The bottles should be filled in a fume hood/cupboard. The bottles should be stored in their plastic storage boxes, preferably in the cool room.

### 9.3 TOPAZ, Northern Triangle

A high resolution survey (using Topaz) of a representative selection of diapers ( Northern Triangle, north of Shetland (1000 to 2400m) will be carried out for GEOTEC (AREA C). This will take place on the return leg of the cruise.
Below is an image of the mud diapirs north of Shetland.Objective is to obtain a TOPAZ (hull-mounted profiler on JCR) profile (or a few profiles) crossing the diapirs. A top to bottom profile across the image shown will take 1 hour at 8 kt, so this profile and maybe one or two at right angles to this could be obtained in < 4 hours.

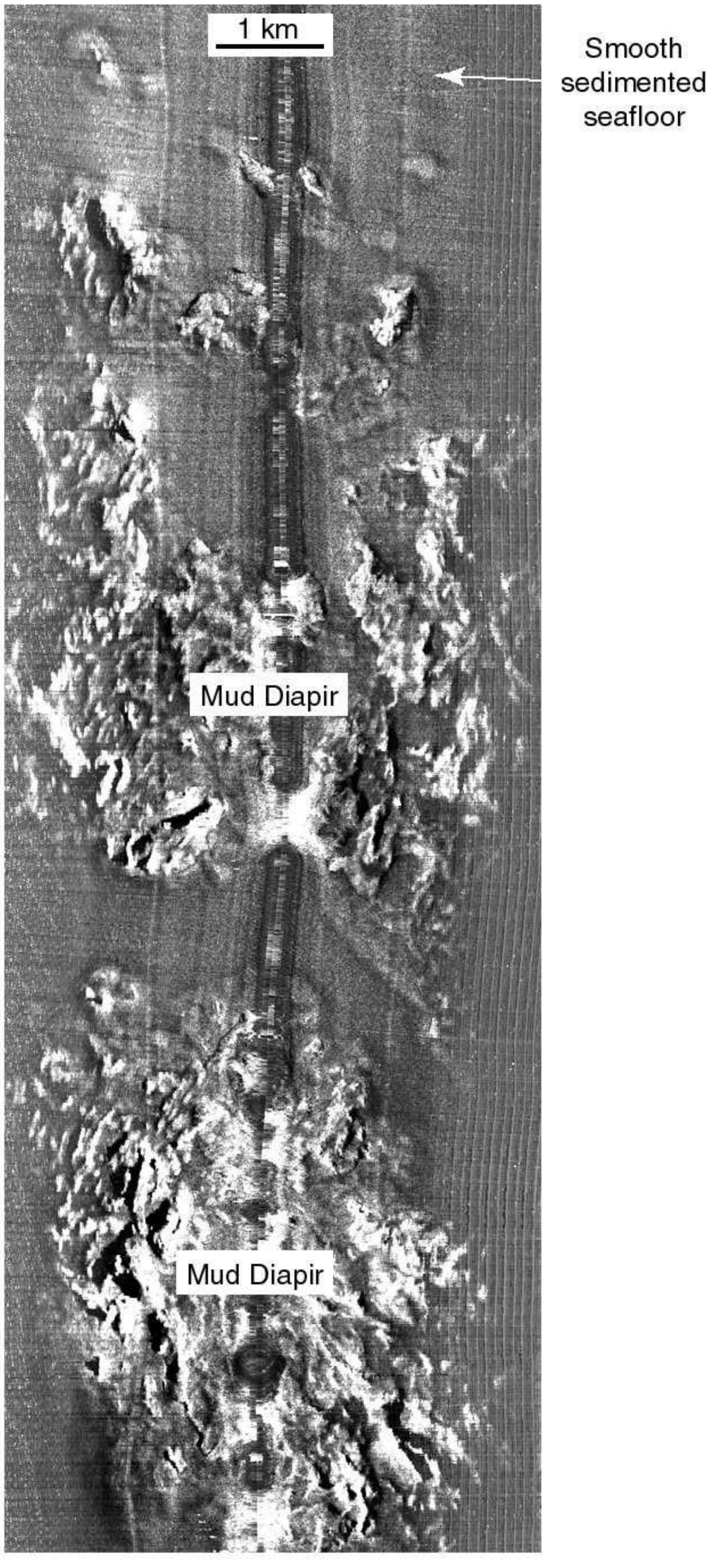
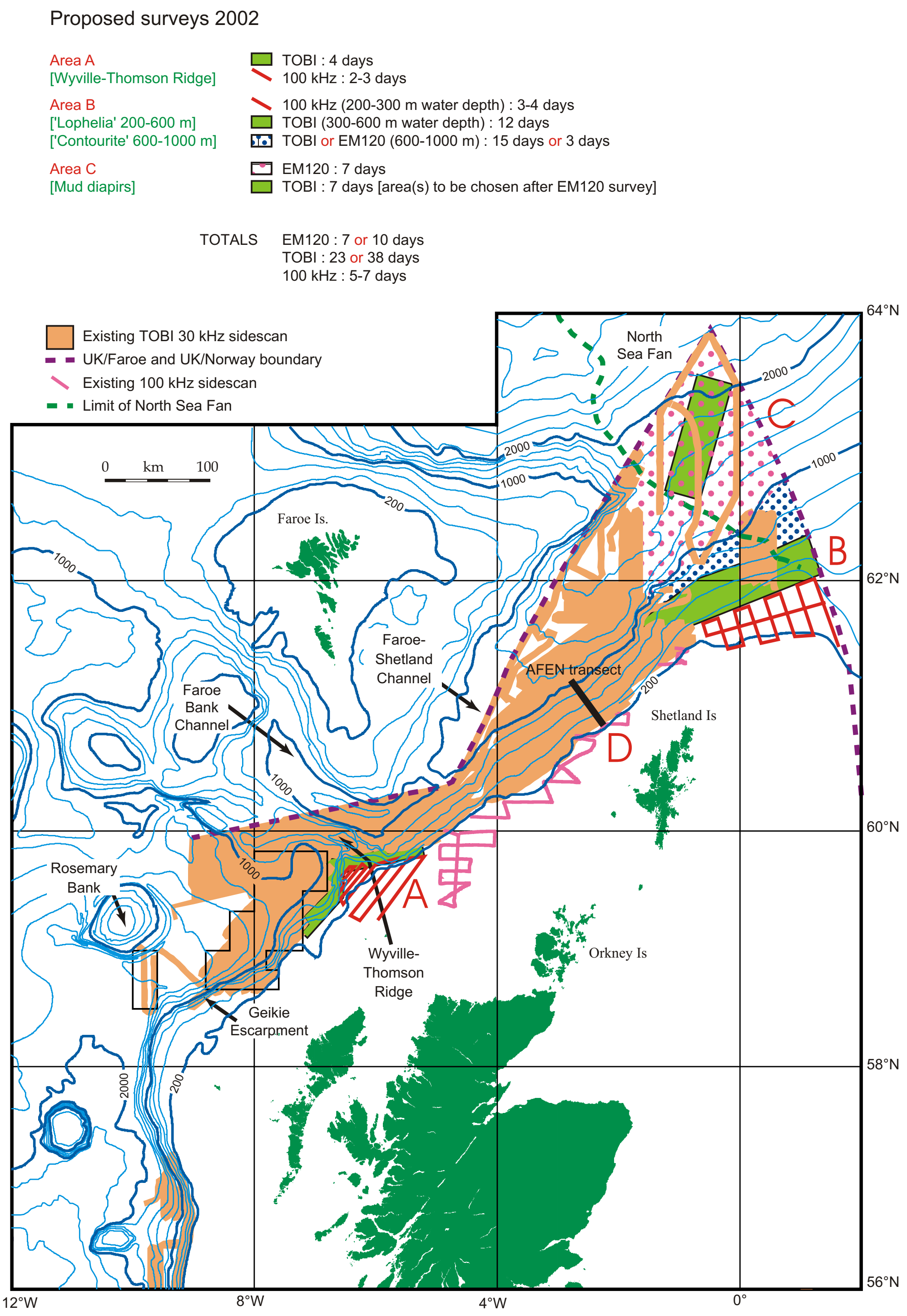



Fig. 16. TOBI image showing two mud diapirs, shown as rough high backscatter targets (white). These contrast strongly with the smooth moderate backscatter background seafloor (uniform grey). See figure 2 for location.




## 9.5 Surface sediment from box cores

Collection of surface samples from boxcores for Prof. Amann, at main stations with depths greater than 1000m. These samples will be used for microbiological analysis.

## 9.6 Surface sediment multicore for Foraminifera analysis

A 1cm section from a multicore tube at each of the stations will be collected and preserved in formalin and Rose Bengal. These samples will be added to the foram database.

# 10. Further information supplied

## 10.1 Benthic environments around Svalbard

Information supplied by Thomas Soltwedel

You might know that in summer 1999, we established a deep-sea long-term station (AWI-"Hausgarten") to the West off Svalbard to carry out multidisciplinary work to assess seasonal and interannual variabilities in various parameters. This "station" consists of a central experimental field at 2500m water depth at about **79°04'N, 4°10'E** and a depth transect of 9 stations (500m steps) crossing that area.
There are several moorings in that region: if you intend to work in that area, please ask for exact positions of the moorings to avoid any "accidents".
The shallowest sampling site along the transect is at approx. 1250m on a plateau off Kongsfjord (79°08'N, 6°05'E); the deepest site lies in the central Molloy Deep at about 5500m (79°12'N, 2°34'E). Originally we planned to extend this transect to a **500m site, however, for very coarse sediments (with pebbles and stones!)** in front of the fjord there was no
chance to get sediment samples further to the East. At deeper sampling sites you will find "normal" fine-grained deep-sea sediments.
Observations with the French Remotely Operated Vehicle "Victor 6000" in summer 1999 at **2500m showed single larger drop stones or even small patches of larger drop stones - this, however, is probably typical for the whole region. To hit such aggregations is just bad luck.** By now, we successfully deployed our chamber lander twice at the central "Hausgarten" site at 2500m, and once in the central Molloy Deep at 5500m. This summer, we plan to carry out 3-4 deployments with the lander at 1500m, 2500m and 3500m along the transect. Polarstern will be at "Hausgarten" in the first week of August - is there a chance to meet RRS James Clarke Ross?
Back in 1997, we carried out an extensive sediment sampling programme (no lander work!) along two transects crossing the Yermak Plateau and another two (shorter) transects at the northern Svalbard continental margin. You will find all the station data we achieved in the paper Soltwedel et al. (2000) in Deep-Sea Research 47: 1761-1785.
Next year, we will have "Victor 6000" back on Polarstern. Starting beginning of June it is planned to work in the Porcupine Seabight and to the West off Ireland, than heading to the North for "Hausgarten" and finally working at the Hakon Mosby Mud Vulcano. There will be an international scientific party on board (France, UK, Ireland, Belgium, Netherlands, Germany) carrying out various scientific work (including work with the ROV, multicorer/box corer sampling, lander deployments etc.). There is still some space/time available for additional work. What about to extend the group by a (another) Scottish team ? (It would be
interesting to compare results from both of our chamber landers !) If you are interested to participate, please let me know.

Benthic work at "Hausgarten" by now encompasses mainly a number of biological parameters:

- sediment-bound pigments (to estimate the input of particulate organic matter from primary production)
- particulate proteins (indicating living + dead biomass)
- phospholipids (indicating cell wall material; living biomass)
- exo-enzymatic activity (esterase turnover)
- bacterial numbers/biomasses
- meiofauna abundances/composition/size spectra (nematode taxonomy)

Next year co-operation with Russian colleagues will allow the spectrum to macrofauna investigations to expand. This year we plan to run the OFOS system ("Ocean Floor Observation System"; photo/video cameras at a deep-sea cable) to assess large-scale mega/epifauna distribution patterns along the "Hausgarten" transect.
Carbon turnover rates were assessed using a free-falling grab-respirometers and (from this year additionally) with a free-falling micro-profiling unit. Near-bottom currents will be assessed in high resolution using a new designed device (see http://www.awi-bremerhaven.de/Research/ProjectGroups/DeepSea/ocean.html).
A sedimentologist joining the group will care for sediment properties (water content/porosity, grain sizes, terrigenous vs. marine input, etc).

### 10.2 Established sites with in-situ equipment

In addition, we have a mooring with sediment traps out there continuously recording the sedimentation of particulate matter since 2000.

- The mooring is anchored at **79°01,7'N/4°20,9'E**.
- experimental areas at **79°03,8'N/4°11,5'E** (metal frame with hard substrates --> colonisation experiment; small cages at the seafloor --> exclusion experiment) and
- **78°36,5'N/5°04,4'E** (mimic experiments;  disturbance experiment).

There may still be other moorings from an EU project (VEINS) out there – to check please contact Dr. Ursula Schauer (uschauer@awi-bremerhaven.de).
As you see from the list of biological parameters, there is (by now) no-one working on the larger bioturbating infauna in that region. Again: next year we will have the ROV VICTOR 6000 on board Polarstern. I guess a tool like VICTOR, allowing a targeted sampling of biogenic structures at the deep seafloor, should be perfect to carry out your kind of investigations. If you are interested in participating the cruise next year, we need your reaction till mid of June at latest.

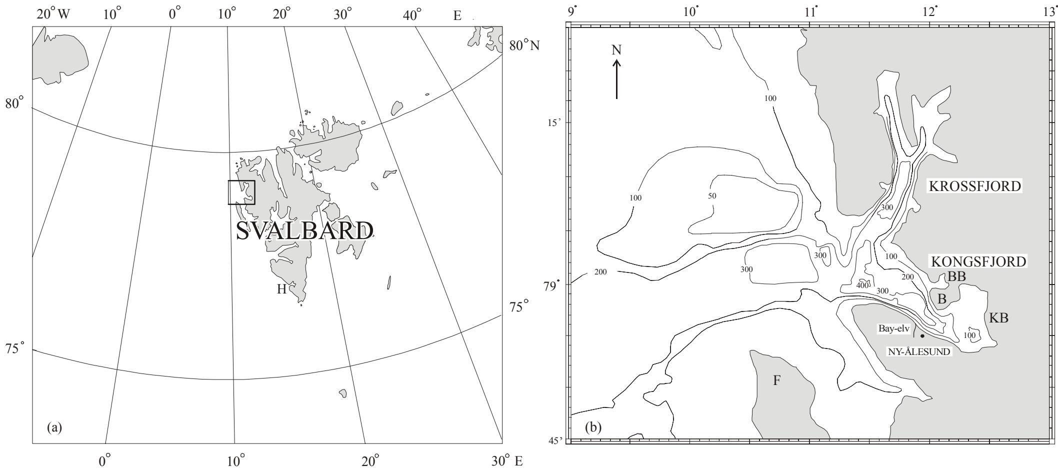
## 10.3 Kongsfjorden-Krossfjorden and adjacent shelf area

H. Svendsen, V. Tverberg, S. Falk-Petersen, S. Kwasniewski*, T. Pearson
Norwegian Polar Institute.
* Institute of Oceanology, Poland.

### 1. Physics

### ***Topography***

Other than Forlandet, a large island which covers almost the whole stretch of coast between Isfjorden and Kongsfjorden, the rest of the west coast of Spitsbergen is unsheltered with no skerries, Fig. 1a.




(a) (b)

*Figure 1* Map of a) Svalbard and b)Kongsfjorden-Krossfjorden and adjacent shelf area.

The exchange between the fjords and the adjacent water at the wide shelf therefore takes place unobstructed. The shelf area off the mouth of the branched fjord system, formed by Kongsfjorden and Krossfjorden, is about 50 km wide. The near zone to the common mouth area of the fjord system is characterized by a deep trench, Kongsfjordrenna, which reaches its deepest part, about 300 m, just outside the mouth, Fig. 1b.
Ny-Ålesund is situated at the narrowest part (4 km) of the Kongsfjorden facing the peninsula Blomstrandhalvøyen (B) which separates the glacier Blomstrandbreen (BB) in two parts. A girdle of small islets and skerries cover the inner part of Kongsfjorden where also the large tidewater glacier Kongsbreen (KB) meets the fjord.

The Krossfjord branches into two arms in the inner part. At the head of the western arm there is a large glacier, Lillehøøkbreen. The eastern arm of the fjord has four small fjord arms each with a glacier at the head. Data for the fjords are listed below.

## Dimensions of the fjords

| Length (km) | Max. depth (m) | Name | Max. width (km) |
|---|---|---|---|
| 24 | 400 | Kongsfjorden | 8 |
| 30 | 300 | Krossfjorden | 6 |

## *Climate and meteorology*

Svalbard has a warmer climate than other Arctic areas at the same latitude. This is related to a net northward transport of heat by air and ocean currents through the Fram Strait. Central in this connection is the West-Spitsbergen Current; a branch of the North Atlantic current carrying relatively warm and saline water (> 35 psu) along the shelf slope.

Due to the exchange of air masses through the Fram Strait, the area is a convergent area for warm and cold air masses and the weather is usually unstable and stormy, especially in wintertime. The frequent passing of atmospheric lows raises the average air temperature. However, dramatic changes in temperature may take place in the front zone and temperature differences of more than 30 $^{o}$C in a few hours have been observed. The coldest period is February - March and the warmest period is July-August, Fig. 2.

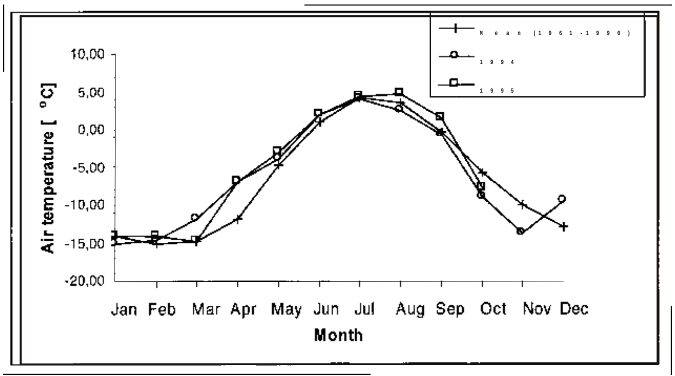



*Figure 2* Monthly mean values of air temperature in Ny-Ålesund, 1994 and 1995.

When air masses are passing over cold land they are cooled, stabilized, and channeled along valleys, fjords and other depressions. The wind may therefore experience large local differences in both direction and strength. Prevailing down-fjord winds are dominating in wintertime, while in the summer the wind conditions are more variable.

## *Freshwater runoff*

The water vapor content of the air masses passing West-Spitsbergen is small, and the precipitation rate is low, Fig 3. The main source of freshwater from the drainage area to the fjords are melt water from glaciers,

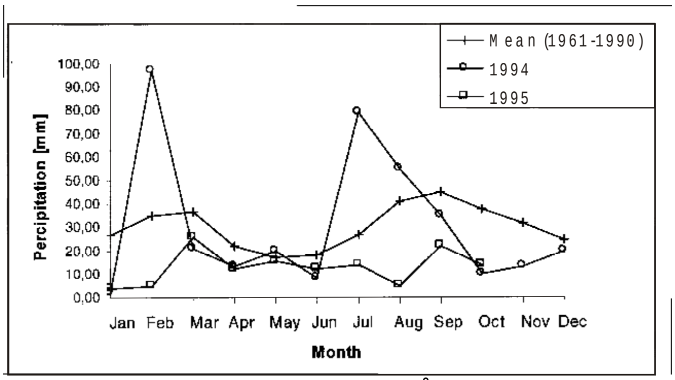



*Figure 3* Monthly mean values of precipitation in Ny-Ålesund, 1994 and 1995

surface or sub-surface discharge, calving and water supplied from melting of snow stored elsewhere (Liestøl ,1988). At present the glacier Kongsfjordbreen is calving most frequently (Lefauconnier *et al.*,1994). Calving from Lillehøøkbreen (in the left fjord arm at the head of Krossfjorden) is believed to take place relatively frequently (Den Norske Los, 1992).

The glaciers in Svalbard are so-called "sub-polar" glaciers which means they produce freshwater the whole year (Liestøl,1988). An estimation of the freshwater supply in other fjord areas in Svalbard indicates however that the supply is small between November and May and increases gradually to a maximum during the summer (Weslawski *et al.*,1994). There are reasons to assume that this runoff pattern also is representative for the Kongsfjorden-Krossfjorden system since the climate characteristics are similar.

## *The tide*

The tide appears as a progressive semi-diurnal wave propagating north-northeastward towards the shallow areas of Svalbard and appears as a progressive Kelvin wave propagating northward along the coast of West-Spitsbergen see e.g. Kowalik and Proshutinsky (1995), Kasajima and Svendsen 2001. The amplitude of the tide is small, with a sea-surface elevation about 0.5 m in the open sea. Passing the wide common mouth of Kongsfjorden-Krossfjorden the Kelvin wave turns into the fjord (see e.g. Svendsen 1995). It is expected that a part of the tidal energy is reflected at the head of the fjord and the rest is dissipated and/or propagates counter clockwise in the wide part of the fjord system.

The net transport related to the tide is small and is negligible in the upper layer where the circulation driven by the local wind and freshwater supply are far more important.

## *The upper layer*

The following description of the physics of the fjord system is based on results from two short field experiments, one week in September 1994 and August 1995 respectively, and numerical simulations with the Princeton Ocean Model (Blumberg and Mellor 1987) carried out by Geophysical Institute, University of Bergen. Since the tide is weak in the fjord the simulations are done without tide. For details about the field experiments and simulations see Ingvaldsen *et al*. 2001. The measurements used to describe the physics of the intermediate and deep layer are placed to our disposal by Institute of Oceanology, Poland.

Three scenarios are simulated. Characteristics for the scenarios are a) Freshwater-driven. b) Freshwater-and wind (down-fjord)-driven. c) Freshwater- and wind (up-fjord)-driven. It is important to keep in mind that the effects of at least three governing forces (wind, freshwater supply and tide) are simultaneously present in the fjord system, i.e. none of the simulated scenarios are expected to exist isolated in the natural fjord system. It is expected that both the baroclinic and barotropic tidal velocity components in this wide fjord system without a sill are negligible compared to the components related to the two other main forces. This fact makes it easier to select situations from the field experiments which are suitable for comparison with the simulated scenarios. However, one has to keep in mind the "memory" of the fjord system, i.e. the inertia of the system. Based on an analysis of observed surface layer response to a varying wind field, Svendsen (1981) found that more than 10% of the current in 2 m depth was related to the wind action with a lag of 6 hours. Furthermore, remote forcing of the coastal waters outside the fjord system might in periods dominate the local fjord dynamics as shown by e.g. Svendsen 1977, Proehl and Rattray 1994, Stigebrandt 1990, Asplin *et al*. 1999.

*"Freshwater-driven":*

As sub-surface supply of freshwater from the glaciers takes place the whole year there will always be a fresh water driven current component in the fjord system. All the field observations and also the simulations without wind show, however, the same main feature; a down-fjord flow in a wedge on the right hand side of the fjords, except in the bay outside

Blomstrandhalvøyen where the flow at times is displaced offshore (from the fjord side), Fig. 4 a.

(a) (b)

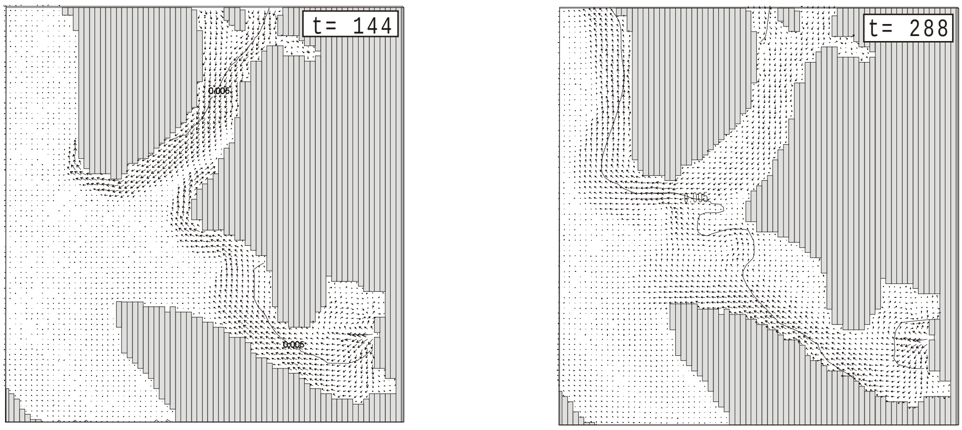
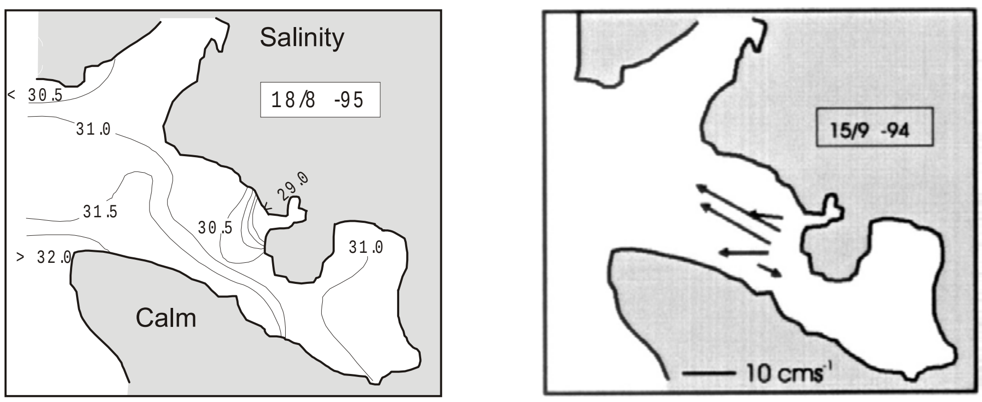



Figure 4 Current velocity in the surface layer after a) 144h and b) 288h simulation time with freshwater supply.

The baroclinic Rossby radius of deformation is usually less than the width of the fjord. A rough two-layer approach based on the observed vertical density distribution gives a radius less than 4 km. The Rossby radius is therefore less than the minimum width of the whole fjord system, and thus the rotation of the earth is the main explanation of the marked deflection of the flow. The flow in Kongsfjorden around Blomstrandhalvøyen and in the transition between Kongsfjorden and Krossfjorden describe a "semi-circle" movement, where the Coriolis acceleration acts in the direction of a "centripetal acceleration". It is, however, likely that also the aggregate effect of friction, topography of the fjord sides and pressure gradients may have an effect in this connection. Due to friction a horizontal velocity shear appears along the "fjord wall", and the resulting negative relative vorticity (down-fjord flow) causes a deflection towards the fjord side.




(a) (b)

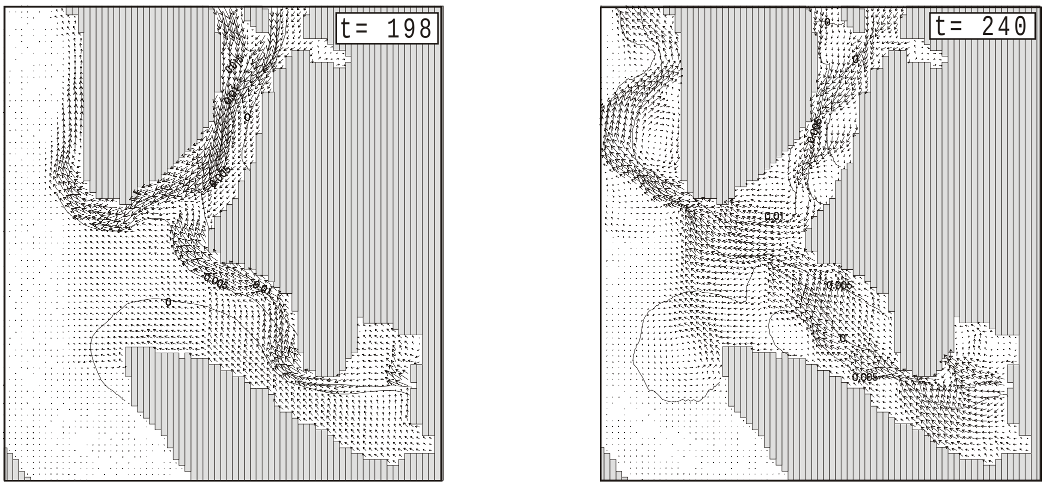
*Figure 5* Mapped salinity distribution (a) in the surface layer of the fjord system and surface velocity (b) observed with drifting drogues. Both the salinity and current are observed during calm conditions.

On 18 August 1995 it was almost calm in Kongsfjorden. The mapped surface salinity distribution these days, Figure 5a, reflects mainly the effect of the freshwater driven component. The saline and cold (not shown) water in the inner part has probably two reasons; entrainment of salt water to ascent freshwater from below the glacier and the fjords "memory" of the wind-driven up-welling the day before. The low saline water in the lagoon outside Blomstrandhalvøyen is related to discharge from the lagoon glacier. The observed current on 15 September 1994, Figure 5 b, is assumed to be representative for the surface layer flow during calm conditions.

It is expected that the marked turn of the flow towards the right hand side of the fjord, which is illustrated in the simulation shown in Fig. 4a, only exists in relatively short periods. Stacking up of water in the bight entering Blomstrandhalvøyen builds up a cross-fjord pressure gradient which displaces the flow towards the left hand side of the fjord, Figure 5b.

Model runs with large and small freshwater supplies gave less surface layer salinities than observed. The differences may be related to the fact that field data reflect also the effect of wind mixing and sub-surface supply of freshwater, while the model is run only with freshwater as the driving force. Another reason could be that the freshwater supply is underestimated.

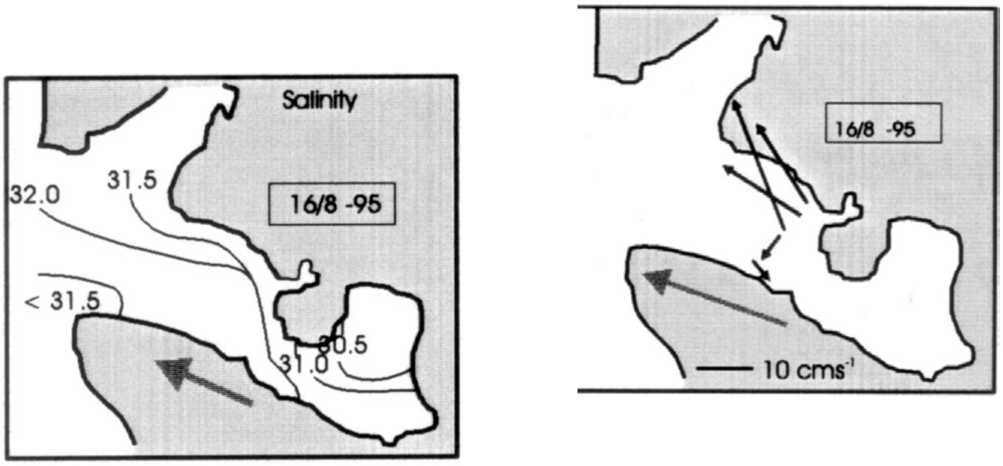
<u>*Freshwater- and wind (down-fjord)-driven:*</u>
Such conditions were present in Kongsfjord on August 16, 1995, Figure 7. The surface layer salinity reflects a down-fjord flow along the northern side of the fjord, Figures 7a, which is in accordance with the findings by Cushman-Roisin *et al.* (1994) who studied the effect of rotational dynamics on fjord circulation. They found a deep brackish layer on the right hand side (looking in the direction of the current) and an out-cropping of the interface on the left hand side. Indeed rotational dynamics is important in the broad fjord Kongsfjorden.




(a) (b)

Figure 6 Current velocity in the surface layer after a) 198h and b) 240h simulation time with freshwater supply and down-fjord wind.

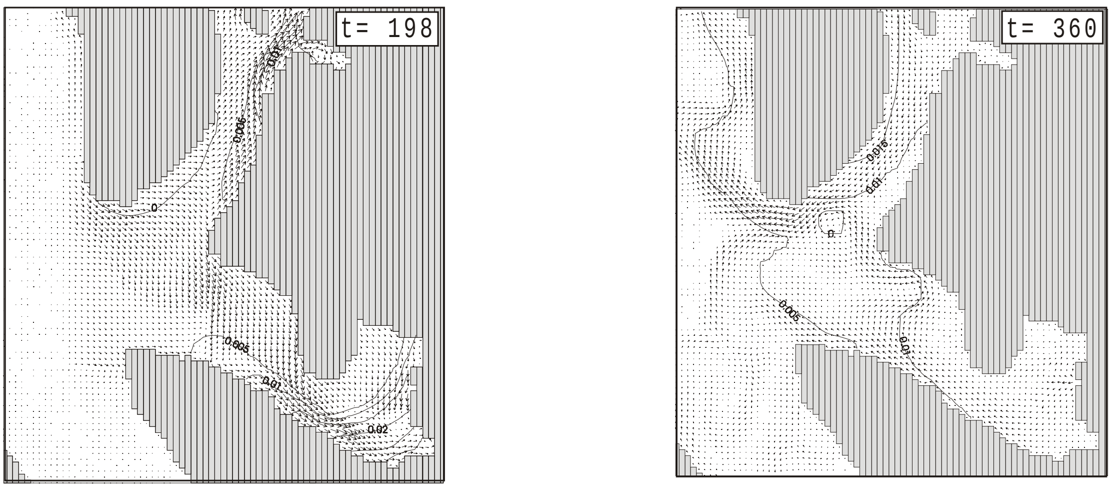
The wind field has a marked intensification effect on the flow in both fjordarms. Figure 6a show the current pattern 6 hours after the initiation of the wind (i.e. after 198 hours of simulation). The strong Ekman transport towards the fjord side increases the water level more than is "consumed" by thegeostrophic field resulting in a broadening of the flow caused by the "excess" cross-fjord pressure gradient. The drifting drogue experiment shown in Fig 7b represents probably an "intensification period".




(a) (b)

*Figure 7* Mapped salinity distribution (a) in the surface layer of the fjord system and surface velocity (b) observed with drifting drogues. Both the salinity and current are observed during down-fjord wind.

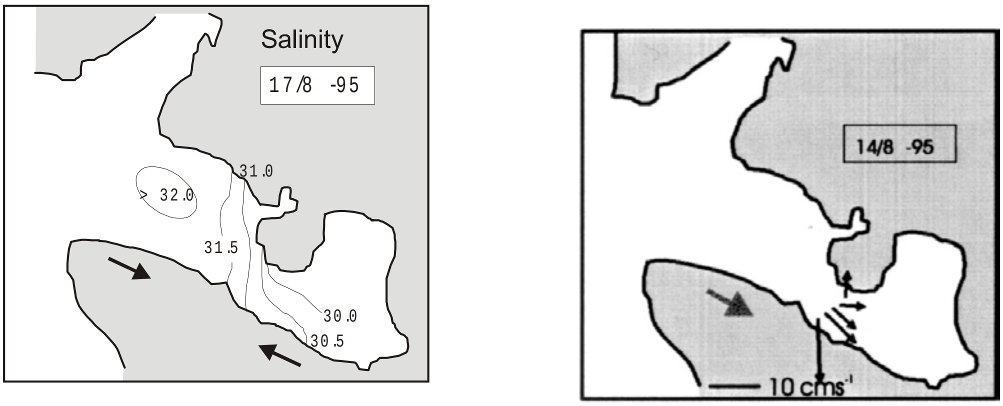
*Freshwater-and wind (up-fjord)-driven:*
Such conditions did not appear during any of the surface layer mappings. However, on 17 August 1995, the conditions were close with the exception of the down-fjord wind in the inner part of the fjord. The effect of the up-fjord wind is mainly the stacking up of water which is reflected in the salinity distribution which indicates a cross-fjord front at the Blomstrandhalvøyen, Fig. 9a.




(a) (b)

Figure 8 Current velocity in the surface layer after a) 198h and b) 360h simulation time with freshwater supply and up-fjord wind.

The drifting drogue experiment carried out during up-fjord wind in the Kongsfjord shows, as expected, an up-fjord current, Fig. 9b, being strongest along the left hand side of the fjord, in accordance with the simulations, Figure 8. At the headland of the Blomstrandhalvøyen, the current direction is down-fjord




(a) (b)

*Figure 9* Mapped salinity distribution (a) in the surface layer of the fjord system and surface velocity (b) observed with drifting drogues. Both the salinity and current are observed during up-fjord wind in the main part of the fjord.

in the experiment but it is up-fjord in the simulations, a difference which may be due to differences between the wind field used in the simulations and the existing wind conditions during the field experiment.

After some time a down-fjord pressure gradient builds up due to stacking up of water in the inner part of the fjord and the current is turned down-fjord, Figure 8b.

## ***The intermediate and deep layer***

Because of the strong pycnocline a circulation in the deep layers could be to some extent independent from the upper layer flow. Moreover, the remote forcing by the coastal wind and tide produce a vertical displacement of the density field outside the fjord and in this way generate a Kelvin wave travelling around the fjord coast to the right (see e.g. Svendsen 1995). An example of such disturbance can be observed in the ADCP measured sections across the fjord, Figure 10, as an up-fjord flow at the southern coast with a width of ca 4 km, thus comparable to the local Rossby radius. The opposite, down-fjord current along the northern side of fjord results in the bidirectional flow scheme in the outer basin. Maximum velocities measured in the deep layers are not higher than 8-10 cm/s.

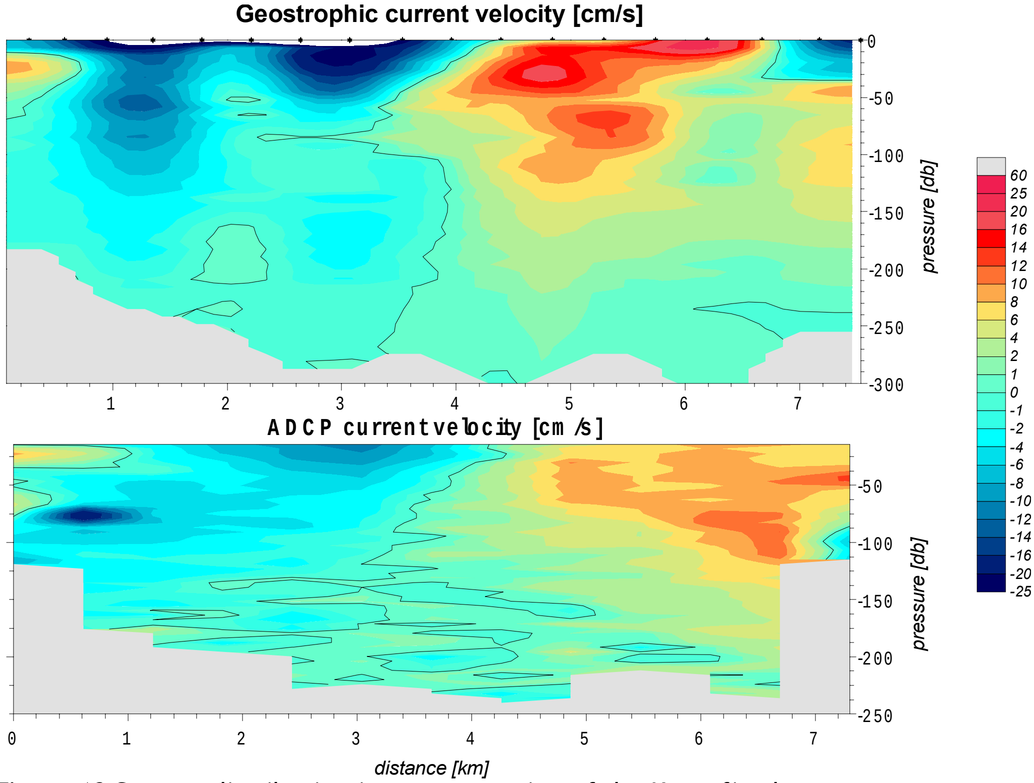
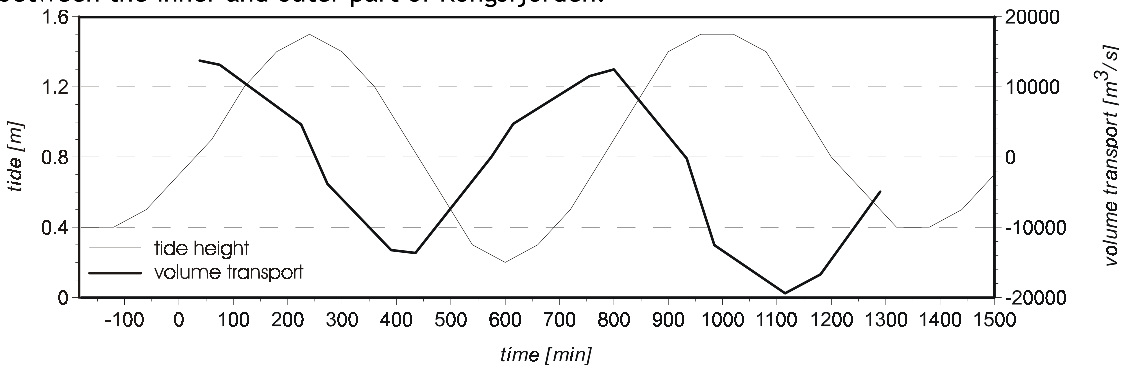



*Figure 10* Current distribution in a cross section of the Kongsfjord

In the inner basin the Kelvin wave entering at the southern coast forces an outflow along the northern side. ADCP sections repeated continuously in the constriction between the inner and outer basin during 24 hours confirmed this layout of currents. Intensities of opposite flows were highly variable with maximum velocities exceeding 10 cm/s in the intermediate layer. The width of the dominating stream changed periodically and an up-fjord flow in the southern part of the constriction was less stable compared to a down-fjord outflow along the northern coast. But two-directional flow was maintained during almost the entire period. Net volume transport across the whole section in the layer below 20 m, thus excluding the surface flow, was revealed to be closely correlated with the tide (Figure 11).

*Figure 11* Time series of tidal height and net volume transport across the constriction between the inner and outer part of Kongsfjorden.




Water exchange with the coastal area is a very complex process, driven by different mechanisms and only qualitative estimations are possible on the basis of current data. Few ADCP sections across the Kongsfjorden outlet reveal an up-fjord directed flow at the southern side with maximum velocities of about 6 - 8 cm/s found within the layer occupied by the Atlantic origin water. There is no shallow sill at the fjord entrance, so this dense water of open sea origin could be transported directly into the deep layers in Kongsfjorden. Hypothetical rate of the fjord water advection towards the coastal area was estimated at *ca* 5 cm/s on the basis of seaward displacement of the fjord origin intrusion observed in 1999. In that case water mass originating from Kongsfjorden was found in the intermediate layer between 50 and 110 m at a distance of about 15 km from the fjord outlet. Most frequently an outflow of the fjord water was found at the northern coast but the cold water of local origin transported by down-fjord current was also observed in a central part of the outlet.

Volume and properties of the Atlantic water supplied to Kongsfjorden are influenced not only by a coastal situation (wind and tide) but also, in a more general way, they are related to the West Spitsbergen Current year-to-year variability. A great amount of the Atlantic Water with high temperatures, carried on by the WSC in summer 1999, was reflected in Kongsfjorden, where the whole volume of the outer basin below the depth of 120 m was filled up with the Atlantic origin water.

## ***Concluding remarks on physics***

It is shown that rotational dynamics have a considerable influence on the circulation pattern in the fjord system. Down-fjord flows take place along the right hand sides of the fjords except off the Blomstrand-halvøyen lagoon where a pressure gradient forces the flow off shore. In central and outer parts of the fjord system, the flow seems to be limited to the upper 2-3 m. After a period with up-fjord wind (stacking up of water) the down-fjord flow of "released" water may be considerably deeper. The velocity of the brackish water core varies between 5-20 cm $s^{-1}$ in periods without wind. In addition, the model simulations show just minor changes to the main structure of the circulation with increased runoff.

As the freshwater is supplied to the fjords from glaciers, the supply occurs in the form of events rather than as a steady trickle of water. This is also evident from the field data. Together with the fact that lasting calm winds for longer periods are rare events in the fjord system, it is likely that steady flow conditions seldom (if ever) appear in the fjords.

The qualitative agreement between the simulated and observed circulation pattern indicates that the sub-surface discharge may not have any particular influence on the circulation pattern in the central and outer part of the fjord system. This is because the freshwater is supplied to the surface in the model while it is expected that some part of the natural freshwater supply to the fjord system takes place as sub-surface discharge.

The simulated interactions between the fjord arms are, among others, reflected in the flow around the tip of the Kongsfjorden, continuing along the east side of the Krossfjorden. The simulations also show that in the common fjord mouth area, the circulation is dominated by an anticyclonic eddy. It is likely that this circulation pattern is present most of the year. However, more comprehensive field experiments will be necessary to give definitive explanations to these phenomena.

The main part of the exchange of the intermediate and deep water masses in the fjords is associated with non-local forcing resulting in a displacement of the vertical density field at the coast.

The results from this investigation support the strong three-dimensional dynamics which were found in both simulations and field experiments of the sub-arctic fjords, Porsangerfjord, Altafjord and Malangen (Svendsen, 1991, Cushman-Roisin *et al*. 1994, Asplin, 1994, Svendsen 1995, Leth 1995). Obviously, the classic assumption that the circulation in fjords is governed by a hydraulic control in the mouth is not present in broad fjords ie broader than the baroclinic Rossby radius of deformation.

Further investigations of broad fjords procure, in addition to 3-D simulations, a comprehensive field program based on time series of current and hydrography in selected sections across the fjords and across the adjacent shelf including the shelf slope.

## 2. Biology

### *2.1 Zooplankton community*

Zooplankton in Kongsfjorden is composed of representatives of most of the major marine zooplankton groups (Table 1) with the highest number of species/genera identified among Copepoda (20), followed by Amphipoda (4) and Euphausiacea (4).

Table 1. Major zooplankton taxa in Kongsfjorden

| Taxon | No. species/genera identified |
|---|---|
| Hydrozoa | 2 |
| Ctenophora | 2 |
| Gastropoda | 2 |
| Polychaeta | 1 |
| Copepoda | 20 |
| Euphausiacea | 4 |
| Decapoda | 1 |
| Mysidaea | 2 |
| Cumacea | 1 |
| Amphipoda | 4 |
| Appendicularia | 2 |
| Chaetognatha | 2 |

The presence of *Calanus finmarchicus* and *Metridia lucens* is indicative of the Atlantic bio-geographic province while *Calanus glacialis* and *Limacina helicina* inhabit the Arctic bio-geographic province. This suggests that the zooplankton in Kongsfjorden is shaped by water masses of different origin. The West Spitsbergen Current transports water of Atlantic origin while the Sørkapp Current transports a mixture of Arctic and Atlantic water masses.

On the regional basis the most important zooplankton components in terms of numbers in Kongsfjorden in July 1997 were Copepods, principally *Oithona similis*, *Calanus finmarchicus*, *Calanus glacialis* and *Pseudocalanus* spp. (Table 2). They were accompanied by some non-copepod taxa such as Bivalvia veliger, *Limacina helicina* juvenile or *Fritillaria borealis*.

Table 2. The most numerous zooplankton taxa in Kongsfjorden on regional basis

| Taxa | Relative abundance July 1997 |
|---|---|
| *Calanus finmarchicus* | 23 |
| *Calanus glacialis* | 6 |
| *Calanus hyperboreus* | 1 |
| *Pseudocalanus spp.* | 13 |
| *Microcalanus spp.* | 4 |
| *Metridia longa* | 7 |
| *Bradyidius similis/Neoscolecithrix farrani* | 1 |
| *Oithona similis* | 29 |
| *Oncaea borealis* | 2 |
| *Copepoda nauplii* | 10 |
| Bivalvia veliger | + |

| | |
|---|---|
| *Limacina helicina* | + |
| *Fritillaria borealis* | 2 |

Abundance of zooplankton in Kongsfjorden differed clearly between the outer and innerepart of the fjord as well as between years and months. In July 1997 the abundance of zooplankton in the outer basin was higher than in the inner basin, Figure 12. The number of *C. finmarchicus* varied between 59535 and 30388 ind m$^{-2}$ on the outer stations and between 41775 and 18648 ind m$^{-2}$ on the inner stations.

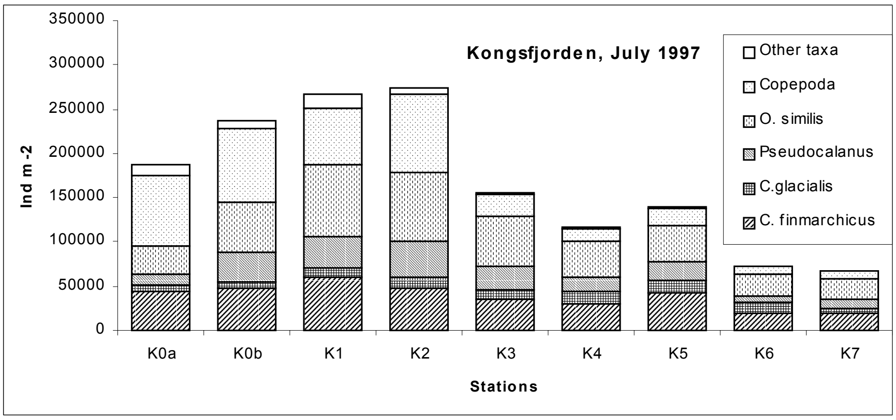



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Figure 12. Integrated abundance of zooplankton (ind m$^{-2}$) in Kongsfjorden in July 1997.

The larger zooplankton forms as the euphausiids (*Thysanoessa inermis, T.raschii and T. longicaudata*), the amphipods (*Themisto libellula, T.abysorum*), the pteropods (*Limacina helicina, Clione limacina*), and the ctenophores (*Mertensia ovum, Beroe cucumis*) can also be prominent members of the zooplankton communities . Weslawski found large abundances of *L. helicina* (1000 ind. m$^{-3}$) and euphausiids (600 ind. m$^{-3}$) at intermediate depths in the inner part of the fjords in 1996 using a net with 2 mm mesh size.

## *2.2 Benthic communities*

### Environmental factors influencing the benthos

The glacial complex debouching into the head of the Kongsfjord imposes sharp gradients in temperature, salinity, sedimentation rates and turbidity, all of which influence the distribution of benthic species throughout the fjord. The euphotic zone declines from about 20 m in width at the fjord mouth to less than 0.5 m at the glacier face. Particle concentrations reach 500 mg/dm$^3$ in the inner basin compared with less than 15 mg/dm$^3$ in the outer fjord and ice cover during 5-7 months of the year in the inner fjord further reduces light penetration. Sinking brine during winter freezing may produce cold and hypersaline conditions in bottom depressions in the inner basin, but in general, bottom salinities remain relatively high and stable throughout the fjord.

Physical disturbance of the sediments caused by extensive ploughing by calving icebergs is also a stress on benthos in the shallow inner basin but has little influence on the sediments of the deeper central and outer areas. However, in general the most influential factors affecting the distribution of benthos are sedimentation rates and turbidity.

Drop stones are common throughout the fjord and provide a substrate for the development of islands of hard ground communities in sedimentary areas. Hard substrates are found in the shallower areas on the slopes. These may be more subject to fluctuating salinities and temperatures than the deeper sedimentary areas but are also influenced by turbidity and sedimentation effects.

The different communities are:

**1.** Sublittoral macrophytes on stony grounds in the euphotic zone

Stones and boulders on bedrock or sedimentary substrates may cover extensive areas of both level bottoms and slope areas in various parts of the fjord at depths of between 2 and 30 m. Such areas are dominated by brown macroalgae (20 species), with *Laminaria saccharina* predominating in the outer and central areas of the fjord and *L. solidungula* in the inner basin and transitional zone between the inner and central basins. Some 10 species of red algae, typified by *Phycodrys rubens,* are also common in these areas. Many invertebrates are found within the kelp stands, notably the amphipod *Ischyrocerus anguipes* and the echinoid *Strongylocentrotus droebachiensis.* Some 50 species of epiphytic fauna are found on the macrophytes, including the gastropod *Margarites helicinus*, the hydromedusae *Lucernaria* and *Haliclystus* and many bryozoans. Both sessile and motile species are present and the dominant trophic modes represented are suspension feeding and carnivory. Species numbers vary up to 150, faunal densities average about 2-3000 $m^{-2}$ and biomass varies between 0.2-20 kg wet weight (ww) $m^{-2}$.

## 2. Intertidal stony substrates.

Dense accumulations of pebbles, stones and boulders on bedrock or sediments occur in all areas of the fjord exposed to strong hydrodynamic activity. Such areas are subject to wave action, drying, freezing and ice scouring. Surfaces are frequently overgrown by microphytobenthic films and typically have accumulations of detritus between the stones. Dominant fauna include Harpecticoid copepods, large Lumbricillid oligochaetes, the amphipods *Gammarus setosus* and *G. oceanicus* and the snailfish *Liparis* sp. Species numbers are usually fewer than 20 $m^{-2}$, densities range up to a few hundred and biomass may reach a few g ww $m^{-2}$.

## 3. Intertidal soft substrates.

These consist of fine mud to medium sand sediments, typically flat and of restricted area, occurring in sheltered localities near fresh water outflows. They are subject to freshwater washout, wave action, sediment displacement and freezing. Typical macrofaunal species include the amphipod *Onisimus littoralis* and the bivalve *Thyasira* spp. Species number usually less that 20, with densities up to 300 $m^{-2}$ and biomass up to 10 g ww $m^{-2}$. An abundant meiofauna dominated by Nematoda is also present.

## 4. Intertidal rock substrates

Stony flat or sloping bedrock occurs in all areas of the fjord exposed to strong hydrodynamic activity. Such areas are subject to wave action, drying, freezing and ice scouring. Surfaces are usually overgrown by macroalgae dominated in the central and inner areas by *Fucus disticus* and *Pilayella littoralis* and in the exposed outer areas by *Chordaria flagelliformis*. The cirripede *Semibalanus balanoides* and the gastropd *Littorina saxatilis* occur in sheltered places. Detritivorous and omnivorous gammarid and caprellid amphipods predominate. Fewer than 50 species occur, densities up to a few hundred individuals per $m^2$ and biomass up to 1 kg $m^{-2}$.

## 5. Subtidal rock without kelp.

In steep, often vertical, slope areas. Ledges and cavities in such areas in the inner basin are often covered with fine sediment. In outer areas exposed to strong currents and, therefore, lower sedimentation rates, encrusting algae cover most of the surface and may extend to 50 m depth in some places. There a dense cover of sessile ascidians, anthozoans, chitons, bivalves and bryozoans occurs, together with occasional red algae. The presence of numerous megafaunal species may produce very high biomass levels of several kg $m^{-2}$.

## 6. Subtidal gravel substrates.

This occurs in patches throughout the fjord usually on flat or slightly sloping substrates. Encrusting algae do not occur but at depths below 20 m a fine sediment film may cover the gravel. Ophiurid echinoderms and detritivorous amphipods dominate the fauna.

## 7. Soft sediment substrates in the inner basin.

The sea floor of the inner basin of the Kongsfjord is composed of a poorly consolidated soft mud deposited from the outflow of the adjacent Kongsbreen glacier. The fauna is characterised by the protobranch molluscs *Portlandia arctica, Yoldiella lenticulata* and *Y. fraterna*. the lucinid bivalve *Thyasira dunbari,* the polychaete *Chone paucibranchiata* and a suite of tanaid crustaceans dominated by *Sphyrapus anomalus*. All of these are mobile surface feeding species of small body size. Throughout the basin cirratulid polychaetes, principally *Chaetozone setosa* are also abundant. There is a high degree of similarity in the species composition of samples taken throughout the basin although patterns of dominance are disturbed near the glacial fronts. Eighty five macrofaunal species have been recorded from this area; densities vary from 210-620 individuals $m^{-2}$ and biomass from 1.2-4.2 g $m^{-2}$.

## 8. Soft sediments in the central and outer areas of the fjord.

The outer basin of the Kongsfjord is also of soft mud becoming slightly sandier towards the open sea. In general, sediments are far better consolidated than in the inner fjord. The fauna is characterised by the large tube-dwelling polychaetes *Maldane sarsi, Laonice cirrata* and *Spiochaetopterus typicus*. The smaller tubiculous polychaete *Prionospio cirrata*, the mobile polychaete *Lumbineris mixochaeta* and the suspension feeding bivalve *Bathyarca glacialis* are also typical. Changing patterns in the identity of the dominants define three faunal zones, a transitory zone to the west of Lovenoyane and Blomstrandoya (c.120 m), a deep zone (depths 250-400 m) and an outer zone close to the open sea. Two hundred and ten macrofaunal species have been recorded from these areas; densities vary between 230-500 individuals $m^{-2}$ and biomass between 1- 15.5 g $m^{-2}$.

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## Appendix B - JCR75 Cruise Report
## RV LANCE - LSF April 2002 - Mooring report

A single point sub surface mooring was deployed from RV Lance on 16th April 2002 at 1825Z. Final position N79 03.25' E011 17.96 in 200m water.
The mooring was placed off the main axis of the Fjord, this area is trawled for prawns during the summer. The mooring has no surface pellets because of the ice, the sub surface sphere is 15m below the surface.

The mooring has a number of objectives:-

To measure the onset of the Spring bloom

To collect this material as it sinks

To study the incursion of Atlantic water

To measure the currents and temperature through the water column
(Do internal waves exist?)

To study the vertical migration of Zooplankton (If any?)

The first deployment attempt on 14th April 2002 was aborted due to the weather. There was a high chance of the instruments being damaged. The first attempt had been by S/S first, on consultation with the Captain and the PS it was decided to opt for an anchor first deployment. This is the usual technique employed by the Lance from the Std foredeck using the main winch and one of the cargo cranes. The mooring is stopped off using a hook attached to the Std rail. My only concern was the size of the deck block.

By the evening of the 16th April conditions had improved considerably, there was no ice and the deployment went smoothly with the exception of the occasional shackle jamming in the block, these were eased through using a crowbar. There was no problem with loose turns on the drum but one loop had dug in to the layer below, no major problems though.

The S/S sphere had an Argos beacon attached s/n 098/24333. The S/S sphere was moored at a depth of ~15m. A 10m pickup line was attached with 2 orange pellets attached. This sphere has no top pickup point so line attached to the link below the sphere. Wire used was 3 core plastic coated wires supplied by SOC, SWL 1T. One 10m section of 14mm 6x19FC was used directly below the chain under the sub-surface sphere, SWL 2T. Two BOSS 5T swivels were used, one below the S/S, one above the A/R.

10 VEMCO temperature miniloggers were distributed through the mooring at depths of 17m, 21m, 41m, 53m, 56.5m, 81.5m, 106.5m, 137m, 139.5m, 159.5m, Ser No's 4793, 3956, 5230, 8545(T+P), 5231, 8947, 8953, 9046(T+P), 8962 & 4792. All loggers were started in delay mode, start time
23:00Z 14/4/2002, all 12 bit loggers on 12 minute sampling enabling 90 days of data. The 8 bit loggers 4793,4792,9046 & 8545 were on 16 minute sampling enabling 89 days of data to be recorded. Loggers were attached to the mooring line via a single cable tie and electrical tape.

An 300KHz ADCP was deployed at a depth of 137m, set for 30 x 4m bins, interval 4 minutes, 33 pings per ensemble (error 0.5 cm/s), batteries good for 72 days (398.6Wh@0.0degC) . Clock set @ 020414171112Z and instrument
powered up @ 17:19Z 14/4/2002. Unit beeping away happily.

1 McLeans 21 bottle sediment trap was deployed at a depth of 52m, the schedule was set to line up the first bottle @ 00:00Z Thursday 18$^{th}$ April 2002, the interval was set to 3.5 days. Bottles were filled to the top with filtered sea water with 5 ppt extra salt and 2% w/v formadehyde which was buffered with sodium tetraborate. Volume of bottles was 520ml. Status message received from unit following setup was:-

15 April 2002 09:15:17 Vb 19 1 deg C aligned

Care was taken to ensure bottles did not freeze whilst unit was on deck prior to deployment. Event 22 i.e. all bottles full is timed for Sunday 30$^{th}$ June 2002 @12:00Z, we are due to pick up mooring on the 20/21$^{st}$ June on our way into Ny Alesund first time round.

2 SeaBird Microcats 37IM were deployed at 31m and 189m, Ser Nos 1124 and 1125 respectively. Both units were rebatteried prior to deployment. Unit 1124 had a 197m pressure sensor and unit 1125 was rated to 335m. Units will sample every 4 minutes, start up time 20:52Z 14/4/2002 & 20:40Z 14/4/2002 for units 1124 and 1125 respectively.

2 WS ESM1 loggers with SeaPoint fluorometers were deployed at depths of 17m and 55m respectively, Ser Nos 2338/2352 and 2341/2354 respectively. Four units were available but there was concern over 2 of the battery packs supplied. Units were set to burst every 6 secs for 3 minutes every hour. SeaPoint Fluorometers were set with 3X gain, this is software controlled. These units also record temperature and pressure.

Units were setup using the ESM software with the file LSF12002.ESM which contained the following script:-

```
set|1
set|11
wai|100
dev|Ch0
dev|Ch7
dev|Ch5
bur|600|30
wai|100
rst|1
rst|11
```

this script was then run every hour using

```
exe|0|3600|0
```

Unit 2341/2354 was powered up at 13:58:10Z 14/4/2002, light on @ 59:50Z, light off 02:52Z. Unit 2338/2352 first sample was centred on 14:00Z 16/4/2002. Both units were logging prior to deployment for the mooring. CTD's were deployed alongside the mooring to enable the calibration of the fluorometers. Paul Tett will supply calibrations at a later time. Loggers were attached to ½" L/L galvanised chain below the S/S and below the sediment trap.

An Acoustic Release was deployed at 190m depth, unit used was an OCEANO RT661 B1S, Ser No 226. Unit fitted with a full set of Lithium batteries. Unit had been fully tested from RV Calanus down to 200m prior to shipment to Tromso. Lab test was performed aboard RV Lance prior to deployment ON/OFF/RELEASE. Quick ON/OFF test was performed after deployment. TT301 set to MODE B, Window command B271(Wait 15s,Active 60s), ON B272, OFF B273, RELEASE 1 B274(W), DIAGNOSTIC B275(W), PINGER B294 (W).

Colin R. Griffiths 20/4/2002