Cruise JR211 of RRS James Clark Ross

Leg 1: 23rd August - 1st September 2008,
Longyearbyen to Longyearbyen, Svalbard

Leg 2: 2nd September - 24th September 2008,
Longyearbyen, Svalbard to Immingham, UK

Scientific Party	
Alfred Aquilina (Leg 2)	Earth Sciences, University of Bristol
Christian Berndt (Leg 2)	IFM-Geomar, Kiel, Germany
Clara Bolton	National Oceanography Centre Southampton
Alan Burchell	Earth Sciences, University of Durham
Anne Chabert	National Oceanography Centre Southampton
Anya Crocker	National Oceanography Centre Southampton
Rebecca Fisher (Leg 1)	Geology, Royal Holloway University of London
Darryl Green	National Oceanography Centre Southampton
Veit Hühnerbach	National Oceanography Centre Southampton
Rachael James (Leg 2)	National Oceanography Centre Southampton
Mathias Lanoiselle	Geology, Royal Holloway University of London
Tim Minshull	National Oceanography Centre Southampton
Anne Osborne	Earth Sciences, University of Bristol
Heiko Pälike	National Oceanography Centre Southampton
Alex Piotrowski (Leg 2)	Earth Sciences, University of Cambridge
Eelco Rohling (Leg 2)	National Oceanography Centre Southampton
Kate Thatcher	Earth Sciences, University of Birmingham
Graham Westbrook, PSO	Earth Sciences, University of Birmingham

Technical Support	
Allan Davies (Leg 2)	NMF - SS, NOC Southampton
Julian Klepacki	British Antarctic Survey
Pete Lens	British Antarctic Survey
Duncan Matthews (Leg 1)	NMF - SS, NOC Southampton
Ian Rouse (Leg 1)	NMF - SS, NOC Southampton
Andy Tait	British Antarctic Survey
Per Trinhammer (Leg 2)	University of Aarhus, Denmark
Jim Wherry (Leg 1)	NMF - SS, NOC Southampton
Darren Young (Leg 2)	NMF - SS, NOC Southampton

Ship's Company

Graham Chapman,	Master
Robert Patterson,	Chief Officer
Douglas Leask,	2nd Officer
Simon Evans,	3rd Officer
John Summers,	Deck Officer
Charles Waddicor,	ETO (Comms)
David Cutting,	Chief Engineer
Glynn Collard,	2nd Engineer
James Ditchfield,	3rd Engineer
Steven Eadie,	4th Engineer
Simon Wright,	Deck Engineer
Nicholas Dunbar,	ETO (Eng)
James Gibson,	Purser
George Stewart,	Bosun
Marc Blaby,	Bosun's Mate
Derek Jenkins,	SG1
Lester Jolly,	SG1
Andrew Campbell,	SG1
Brian Conteh,	SG3
Mark Robinshaw,	MG1
Carl Moore,	MG1
Keith Walker,	Cook
Glen Ballard,	2nd Cook
Kenneth Weston,	Steward
James Newall,	Steward
Derek Lee,	Steward
Roy Turney,	Steward (Leg 1)

Doctor

Petra Schmitt	(Leg 1)

Contents

List of Figures

1 Introduction

The cruise, which was part of the International Polar Year programme, investigated evidence for the existence of methane hydrate in the sediment of the continental margin of northwestern Svalbard, and evidence for the escape of methane gas released by the hydrate into the water column during the period following the last glaciation to the present day (approximately 15,000 years). It used geophysical and geological techniques to detect methane hydrate beneath the seabed, discovered and sampled features through which methane escapes to the seafloor, and measured methane concentration in the water column and the atmosphere. The seabed was imaged and mapped using multibeam sonar (Simrad EM120), Simrad EK60 echo sounder, TOBI deep-towed sidescan sonar (30 kHz), and Widescan sidescan sonar (100 and 325 kHz). The sedimentary layers and geological structures beneath the seabed were imaged with the 7kHz profiler in TOBI, a TOPAS sub-bottom acoustic profiler and multichannel seismic reflection (96 channels with 6.25-metre group spacing) using two GI guns in true GI mode 45/105 cu. in. More accurate information on seismic velocity was obtained by deploying ocean-bottom seismometers on the seabed time. Samples of sediment, two of them containing hydrate, were taken, using piston corer, gravity corer and box corer. Water chemistry was measured from samples taken with bottles attached to ctds and continuously from the ship using the uncontaminated seawater supply. Air samples were taken.

2 Brief cruise narrative

All times are UTC. Julian day numbers are shown in square brackets.

23rd August [236]: RRS James Clark Ross sailed from Longyearbyen, Spitsbergen, in the afternoon of the to commence the first leg of the cruise. The first leg was devoted a reconnaissance with EM120 multibeam bathymetric echo-sounder, TOBI side-scan sonar and sub-bottom profiler, TOPAS sub-bottom profiler, EK60 multi-frequency sonar for features in the water column, ctd casts with water sampling, twice-daily air sampling and continuous of air and water, using a equilibrator, to provide methane concentration in the air and in the water over half-hourly periods. At 1800 calibration of the EM120 multibeam sonar commenced at the mouth of Isfiord, followed at 2154 by CTD cast 1 to give a depth profile of sound velocity. Multibeam bathymetric surveying commenced at 2257. TOBI was deployed at 2341.

24th August [237]: Surveying with TOPAS and EK60 commenced at 0614. Later in morning the acoustic signature of a bubble plume was identified in the EK60 record in water of about 370 m depth.

25th August [238]: TOBI was recovered at 1259, prior to the proceeding to a reference site for water-column physical properties and water chemistry, SW of the Molloy fracture zone (active transform fault), where CTD cast 2 was taken. On the approach to this site, at 72° 48'N, 61° 02'E, sea ice was encountered, which necessitated a southward diversion along the edge of the ice to reach the site. At 2329, CTD 3 was taken at the site of a large pockmark at about 900 m depth.

26th August [239]: Surveying with EM120, TOPAS and EK60 continued until 0239, when TOBI was redeployed to continue surveying the upper slope edge, in concert with the hull-mounted sonars.

27th August [240]: At 1203, TOBI was recovered at the northernmost extent of the survey area. Surveying with EM120, TOPAS and EK60 continued, but at 1612 the track was deviated to avoid sea ice.

28th August [241]: Continued surveying with EM120, TOPAS and EK60.

29th August [242]: Continued surveying with EM120, TOPAS and EK60. At 1310, a failure of the logging system for the EM 120 required a section of track to be repeated.

30th August [243]: CTD 4 was taken at 1524 in an area where there was much acoustic scattering in the water column shown by the EK60. At 1939 redeployment of TOBI commenced, to give a wider swath of coverage along the southward track, but a problem with TOBI's umbilical required the umbilical to be changed. This was followed by two problems with the electrical termination of the main tow-cable. The TOBI run eventually commenced at 0530 on 31st August [244].

31st August [244]: TOBI was run between 0530 and 1821. Continued surveying with EM120, TOPAS and EK60.

1st September [245]: CTD 5 was taken at 0251, close to the position of CTD 3. A pressure test was conducted on the OBSs at 0412. Between about 1000 and about 2200, many plumes of bubbles were detected by the EK60 along lines run parallel to contours in water depths between 300 and 400 m. CTD 6, at 1337, and CTD 7, at

1830, were taken in water depths of 386 and 377 m, respectively, to sample the water affected by the plumes. Ship approaching anchorage in Longyearbyen at 2345.

2nd September [246]: In Longyearbyen. TOBI team (Ian Rouse, Duncan Matthews and Jim Wherry) and Rebecca Fisher disembarked. Alfred Aquilina, Christian Berndt, Rachael, Alex Piotrowski, Eelco Rohling, Allan Davies, Per Trinhammer and Darren Young joined for coring and for seismic work. In harbour, TOBI equipment was put in the hold and the coring system was rigged. The ship left Longyearbyen at 1330 for the 2nd leg of the cruise, which would undertake coring (both for the geochemistry related to methane and hydrate content and for paleoceanography), seismic reflection profiling and experiments with ocean-bottom seismic recorders (OBS), and high-resolution side-scan sonar surveys. Acquisition of data commenced at 2003, surveying the southernmost part of the area with EM120, TOPAS and EK60.

3rd September [247]: Continued surveying with EM120, TOPAS and EK60. This was the only work that could be conducted, because of bad weather. Data quality, especially for the EM120, was of variable quality.

4th September [248]: Most of the day was occupied with coring the sites of the bubble plumes and some comparison sites on the upper slope [BC1, BC2, BC3, GC4, GC5, BC6, PC7, BC8 and GC9]. Surveying with EM120, TOPAS and EK60 recommenced at 2245.

5th September [249]: Deployment of the seismic reflection system began at 0144. After some initial problems, the first seismic line began at 0717. Marine mammal observation commenced prior to the air guns being fired and continued throughout seismic operations. Between 2010 and 2104, seismic profiling was suspended to repair a bird (streamer depth controller).

6th September [250]: Continued seismic reflection, lines 3 to 8, together with EM120, TOPAS and EK60.

7th September [251]: Continued seismic reflection, lines 9 to 11, together with EM120, TOPAS and EK60.

8th September [252]: Continued seismic reflection, line 12, together with EM120, TOPAS and EK60, until 0059. The first seismic experiment with OBS commenced with the deployment of four OBS between 0504 and 0542. The shot lines, 13, 14, 15 and 16, were run between 0701 and 2104. OBS 1, 2 and 3 were recovered between 2233 and 2343.

9th September [253]: Retrieved OBS 4 at 0023. Two lines were run between 0121 and 0753 with the Widescan side-scan sonar, operating at 100 kHz, in the southern area where plumes of bubbles had been detected with the EK60, to detect plumes in the water column. Box core 10 and piston core 11 were taken, further down slope in the southern area for palaeoceanography at 0722 and 0937. Gravity cores 12, 13 and 14 were taken in the northern area between 1623 and 2231, following surveying with EM120, TOPAS and EK60 on track north.

10th September [254]: Gravity cores 15 and 16 were taken at 0208 and 0357, respectively. Two lines were run between 0558 and 1133 with the Widescan side-scan sonar, operating at 100 kHz and 325 kHz, on the shelf edge in the north, across mounds where abundant acoustic signals in the water column had been detected with the EK60. Between 1301 and 1733, box cores 17 to 21 and gravity core 22 were taken in shallow water in the northern area, some on targets identified with the side-scan sonar. Seismic reflection line 17 was commenced at 2248.

11th September [255] – 13th September [257]: Seismic reflection line 17 to 27, together with EM120, TOPAS and EK60, were run during this period. During line 17 across the Vesnaser Ridge, a bubble plume from a large pockmark was detected with the EK60. Sea ice to the northwest restricted the area that could be surveyed. The sea ice was first encountered in the late evening of the 11th. Increasingly bad weather limited the choice of courses that could run effectively and made turns more complicated. At 2118 on the 13th, deployment of six OBS for the 2nd OBS experiment commenced.

14th September [258]: The 2nd OBS experiment began at 0212, shooting lines 28 to 31.

15th September [259]: The OBS experiment was completed and the OBS retrieved at 0555. CTD cast 8 was made at 0707 and gravity core 23 was taken at 0857, both at the site of gravity core 12. Seismic reflection line 32 was run between 0956 and 2027, connecting the northern group of seismic lines to the southern group. At 2344, a detailed survey of part of the pockmark on the Vesnaser Ridge, from which a bubble plume was detected on seismic line 17, was begun with EM120, TOPAS and EK60 at slow speed (1-2 knots) with the ship using dynamic positioning. The bubble plume was no longer active, but the probable site of the vent was located with TOPAS.

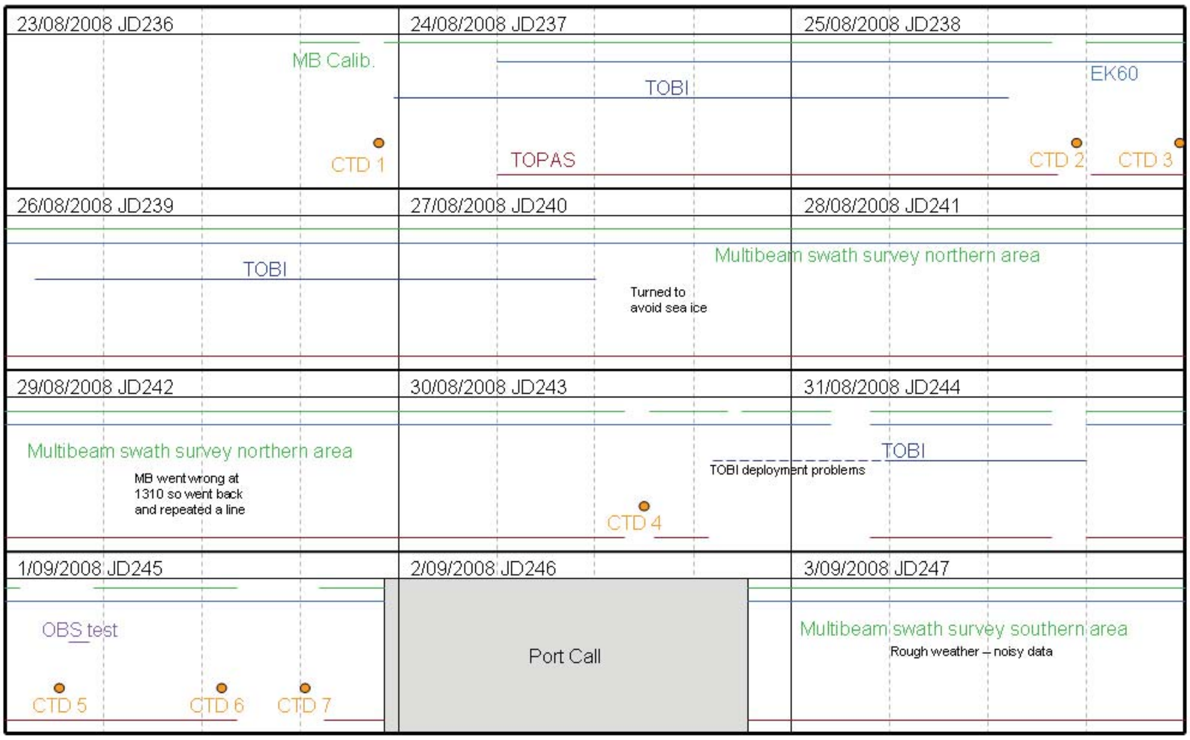
16th September [260]: Plume site survey completed at 0330, and was followed by CTD cast 9, box core 24 and gravity cores 25 and 26 at the plume site. Both gravity cores 25 and 26 retrieved hydrate. At 1317 the first of two gravity cores 27 and 28 was taken at a palaeoceanography site. Coring was completed at 1555,and at 1923 the first of 3 OBS for the third OBS experiment close to the shelf edge in the southern area was deployed, Shooting for the OBS experiment began at 2052.

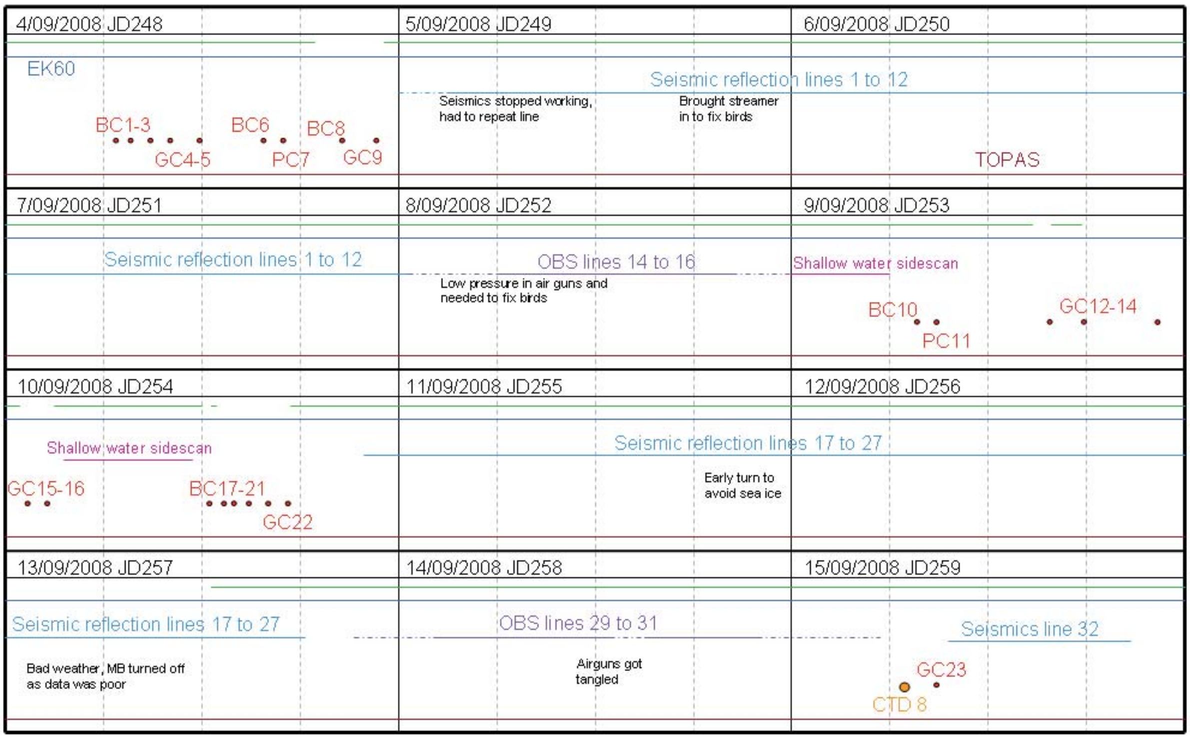
17th September [261]: The OBS experiment was completed with retrieval of the last OBS at 0615. At 0728, a Widescan survey was run at 100 kHz and then 325 kHz along the sites of plumes at the shelf edge in the southern area. The survey successfully imaged plumes in the water and possibly two of the vents in the seabed. This was followed at 1530 by continued surveying of the plume area with EK60 until 1823 and then by an extended period of sampling the water column and seabed at plume sites with CTD and box core. CTDs 10, 11 and 12 were made at 1904, 1926 and 1955. Box cores 29 and 30 were taken at 2108 and 2138.

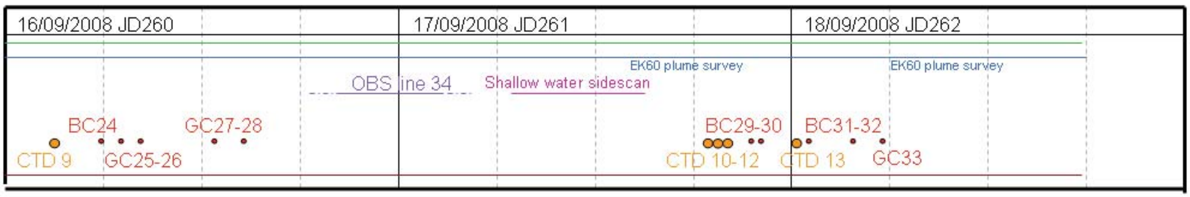
18th September [262]: CTD 13 was made at 0010, and box core 31 was taken at 0108. The ship then moved further down slope to sample another pockmark that seismic reflection profile 1 showed to be underlain by what was possibly an active chimney in the locality where cores had been taken earlier. Box core 32, taken at 0434, showed no sign of hydrate. Gravity core 33, taken at 0554, closer to the centre of the pockmark, recovered hydrate. From 0836 until 1126, further lines were run across the northern part of the plume are at a spacing that was a little less than width of the sonar beam at the seabed. Surveying with EM120, TOPAS and EK60 continued on the line southward until 1805, when the acquisition of data finished.

From the evening of 18th September until 24th September the ship was on passage to Immingham, UK, where she docked in the forenoon.

3 Brief log


23/08/2008 JD236
24/08/2008 JD237
25/08/2008 JD238
MB Calib.
TOBI
EK60
CTD 1
TOPAS
CTD 2
CTD 3
26/08/2008 JD239
27/08/2008 JD240
28/08/2008 JD241
TOBI
Multibeam swath survey northern area
Turned to
avoid sea ice
29/08/2008 JD242
30/08/2008 JD243
31/08/2008 JD244
Multibeam swath survey northern area
MB went wrong at
1310 so went back
and repeated a line
TOBI
TOBI deployment problems
CTD 4
1/09/2008 JD245
2/09/2008 JD246
3/09/2008 JD247
OBS test
Port Call
Multibeam swath survey southern area
Rough weather – noisy data
CTD 5
CTD 6
CTD 7


4/09/2008 JD248
5/09/2008 JD249
6/09/2008 JD250
EK60
Seismic reflection lines 1 to 12
Seismics stopped working, had to repeat line
Brought streamer in to fix birds
BC1-3
BC6
BC8
GC4-5
PC7
GC9
TOPAS
7/09/2008 JD251
8/09/2008 JD252
9/09/2008 JD253
Seismic reflection lines 1 to 12
OBS lines 14 to 16
Shallow water sidescan
Low pressure in air guns and needed to fix birds
BC10
PC11
GC12-14
10/09/2008 JD254
11/09/2008 JD255
12/09/2008 JD256
Shallow water sidescan
Seismic reflection lines 17 to 27
GC15-16
BC17-21
GC22
Early turn to avoid sea ice
13/09/2008 JD257
14/09/2008 JD258
15/09/2008 JD259
Seismic reflection lines 17 to 27
OBS lines 29 to 31
Seismics line 32
Bad weather, MB turned off as data was poor
Airguns got tangled
GC23
CTD 8


16/09/2008 JD260
17/09/2008 JD261
18/09/2008 JD262
EK60 plume survey
EK60 plume survey
OBS line 34
Shallow water sidescan
BC24
GC27-28
CTD 9
GC25-26
BC29-30
CTD 10-12
BC31-32
CTD 13
GC33

4 Ocean Bottom Seismometers

Ocean bottom seismometers (OBSs) were supplied by the UK Ocean Bottom Instrumentation Consortium (OBIC). The OBSs were equipped with a 3-component, gimballed 4.5 Hz geophone package and a broadband hydrophone. The geophone package was installed inside the instrument frame, 10-20 cm above the seabed, and coupled to the seabed through the anchor weight, which was a 40 kg iron grid. Further details of the specification may be found at www.obs.ac.uk. OBS internal clocks were synchronised with GPS shortly before deployment and their offset from GPS time measured shortly after recovery.

The cruise made use of a new set of data-loggers purchased from Scripps Institution of Oceanography, termed “4x4s” because in principle they can record four channels at 4 kHz. During JR211, the loggers were operated at 1 kHz sample rate. Some of these loggers had been used with a 250 Hz sample rate during a cruise off Sumatra in May 2008, but their performance at 1 kHz (an other sample rates) was poorly known. Also, fully functional software to convert the data to SEGY was not available. Therefore, during the first few days of the cruise, an exhaustive series of tests was conducted to characterise the performance of the loggers. These tests involved recording a GPS clock signal at either one-second or one-minute intervals on one or more logger channels, for periods of at least 12 hours and up to 3 days, and displaying the resulting data in Promax. The tests showed that data could be recovered with consistent and reliable timing. The logger internal clocks drifted by a few milliseconds per day at room temperature, and the logger delay was measured to be 36 ms at 1 kHz sample rate. The SEGY conversion software was then adapted to correct for this delay, so that the 1-minute clock pulse had a zero-crossing at zero time (to the nearest sample) at the start of recording in the resulting SEGY file.

The OBS experiments were designed to recover P and S wave velocities to depths of a few hundred metres below the seabed at representative locations along and across the margin, and if possible, information about anisotropic wave propagation in these sediments. Three experiments were conducted, with OBSs deployed in a total of 5 representative areas, and 2-3 OBSs deployed at 200 m spacing in each area (Appendix J, Table 1). The shot pattern involved shots along an existing multichannel reflection profile, shots along a perpendicular profile, and a two circles around each group of OBSs with radii adjusted to optimise the configuration for determining anisotropy. The guns were fired at 5 s intervals, and simultaneous reflection data were acquired for lines where none existed previously. Two additional lines were shot through the area of the first deployment to give additional redundancy; this redundancy was fortuitous because there were failures of the reflection recording system during two of the lines through this area.

In case of unanticipated problems with the new loggers when operating on the ocean floor, an additional instrument was deployed at the first site that used older “LC2000” loggers. These loggers can only record a total of 1000 samples per second, or 250 Hz on 4 channels. Since at 250 Hz sample rate, frequencies above about 110 Hz are lost, and the GI-gun source had much of its energy above 110 Hz, a new configuration was designed involving the use of two loggers, each recording two channels at 500 Hz. One of these loggers was connected to the hydrophone and vertical geophone channel, and the other to the two horizontal geophones. The hybrid instrument involved two logger tube in two frame units, two buoyancy units, and an 80 kg anchor weight comprising two 40 kg anchors welded together. The resulting instrument was a little heavier in water than the standard OBS configuration. Geophone data quality from this instrument (deployed at site 4) appeared slightly better than that from adjacent OBSs. Therefore to test whether the heavier anchor was providing better seabed coupling, a double anchor was used also at site 8. However, there was no obvious difference in data quality between this instrument and the adjacent one deployed with a single anchor at site 7.

Data from the experiment were converted into SEGY in two ways. Firstly, a series of "QC" SEGY files were created that consist of 5 s records starting on the exact second at 5 s intervals from when the logger started recording to when it stopped. These files include the time the logger was on board before deployment and periods on the seabed before shooting started. Secondly, a series of SEGY files were created with 5 s records starting at the exact shot times (50 ms after the exact second); these files only contain data from times when the guns were being fired.

The final SEGY files for the hybrid 500 Hz instrument were corrected for an assumed linear clock drift. However, at present the SEGY conversion software for the new loggers does not allow correction for instrument clock drift. With one exception, the observed clock offsets on recovery were small (maximum value 4.3 ms and mostly less than 2 ms; Appendix J, Table 2). The one exception is the OBS that was deployed at site 7; here, there was a 5-hour clock offset on recovery. Further examination of the data suggested that the clock jumped backwards by 5 hours early in its recording period, while it was still on board. Direct wave arrival times in the data suggest that there was no anomalous clock behaviour during the shooting, so it should be possible to calculate and correct the clock jump.

Following each experiment, the "QC" files were inspected to assess the data quality. All instruments appear to have recorded correctly on all four channels. Hydrophone records in all cases have a smooth spectrum with a peak below 5 Hz corresponding to ocean wave noise; this noise is readily removed by bandpass filtering and there is little signal at these frequencies. At the shallower sites (sites 1-4 and 9-13), the hydrophone is unfortunately saturated at traveltimes less than about 400 ms, and subsurface reflectors cannot be resolved at offsets of less than a few hundred metres. The logger itself is not saturated (data values do not reach the maximum allowed), so the saturation is intrinsic to the hydrophone.

The geophone records are of variable quality, with noise levels varying significantly with deployment depth. The geophone spectra are strongly peaked, with peaks commonly occurring at about 10 Hz and 110-120 Hz. Instruments deployed at the deeper sites (1-6) have relatively low noise levels and appear to show well-resolved P and S reflections at short offsets, as well as refracted arrivals at longer offsets. At the shallower sites (7-13) there is strong low-frequency noise that is stronger than the signal up to frequencies of 30-40 Hz. These are sites where the seabed as imaged in the TOPAS data is significantly harder, and where ice-rafted debris may be widespread. There appears to be some dependence of these noise levels on weather conditions, with significant variation within the period of a deployment. The five instruments placed in 300 m water depth have the highest noise levels; here it may prove difficult to pick subsurface reflectors, but clear refracted arrivals are observed.

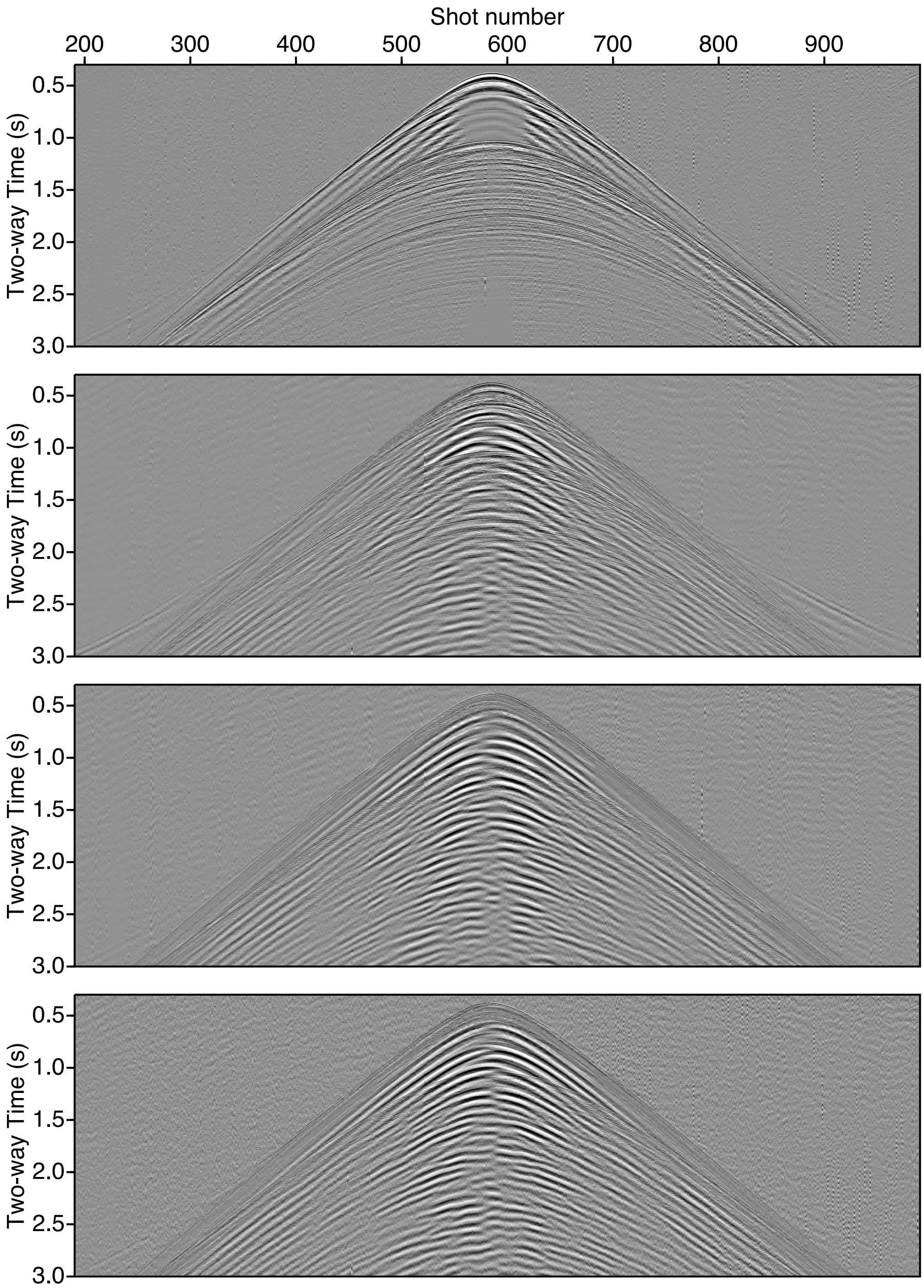


Figure 1: OBS data from site 3. An Ormsby bandpass filter has been applied with corner frequencies of 5, 10, 250 and 300 Hz. From top to bottom are shown the hydrophone, the vertical geophone, and the two horizontal geophones. The maximum offset shown is about 5 km. The hydrophone is saturated at the closest ranges. The vertical geophone shows a series of clear P wave reflections following the direct arrival and strong refracted arrivals at longer ranges. The geophone components all show a series of strong low-frequency reflections that are probably mode-converted S waves.

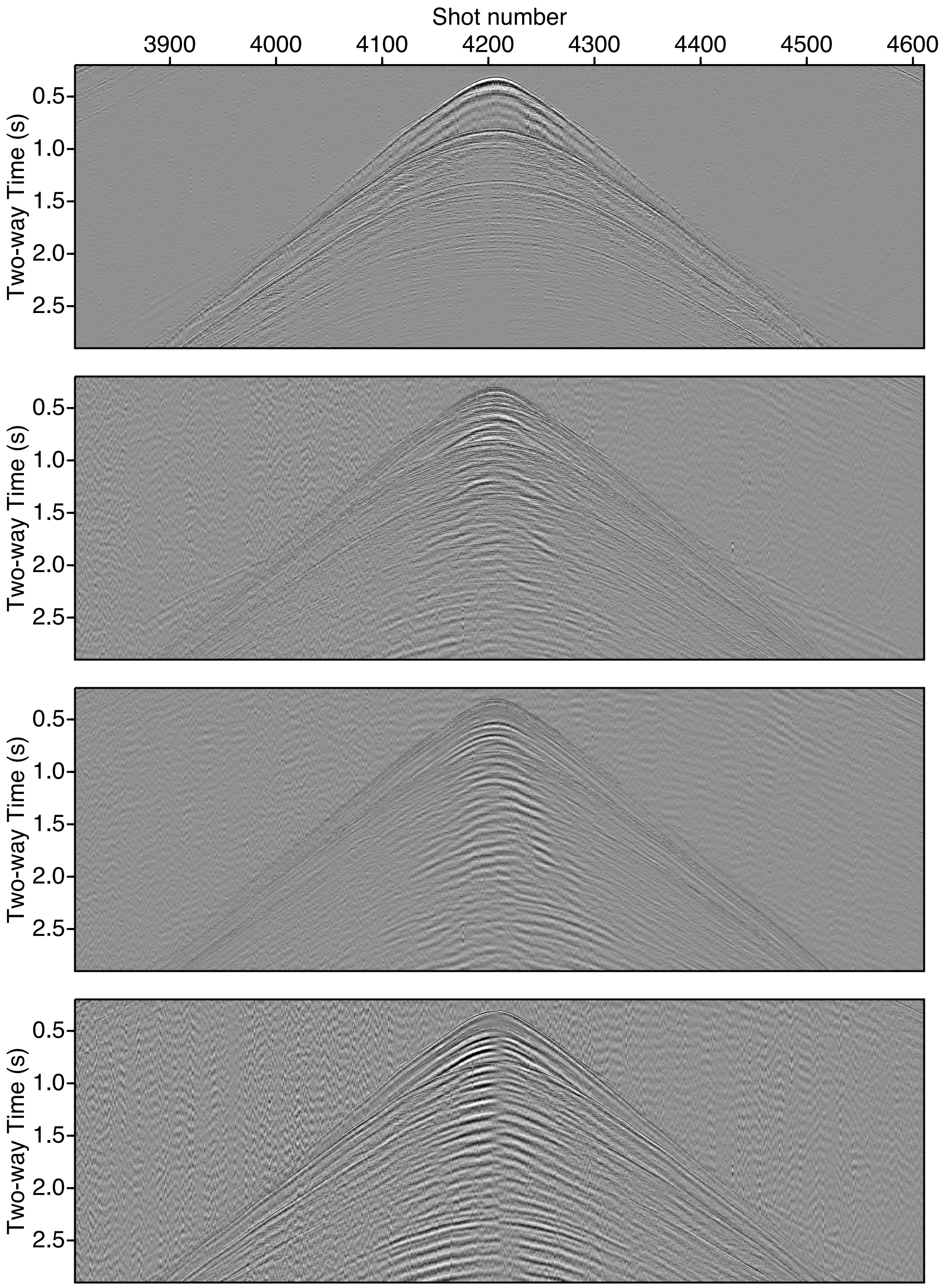


Figure 2: OBS data from site 12. Display parameters are as for Fig. 1. The hydrophone is again saturated at short ranges. The data exhibit similar characteristics to those seen in Fig. 1 but all components are considerably more noisy. The presence of coherent, source-generated noise is also more evident.

5 Multi-channel reflection seismic data acquisition and processing

Overview

During JR211 we collected some 1250 km of multi-channel seismic reflection data (see Appendix B). The first aim was to map the distribution of bottom simulating reflectors (BSR) as a proxy for the occurrence of marine gas hydrates and to derive constraints on the pressure and temperature conditions on the Svalbard margin. The second goal was to find out whether sub-surface sediment mobilization structures exist that would provide clues on past and present gas migration pathways. NMFD supplied a new GI gun array and a new Avalon gun controller for this survey. Initially it was planned to use a new Spanish digital streamer to record the seismic signal. However, this streamer was lost in Antarctica about 6 months before JR211 and a substitute had to be found on short notice. Luckily enough, the University of Århus was able to jump into the breach and provided excellent service on short notice.

Equipment

Gun controller

The electronic control system is enclosed in a single 19inch X 22U racking system with interfacing to the airguns via two separately mounted "break-out" boxes. This provides portability combined with minimum set up and dismantlement time. Individual components within the racking comprise: A Source Controller; a Source Interface Unit; a standard PC; a keyboard; a monitor and an optional second GPS time and frequency reference unit. The Source Controller and Source Interface Unit is a bespoke RSS2 system provided by Avalon Sciences Ltd of Somerset UK; the PC, keyboard and monitor are generic rack mountable units and the optional second GPS time and frequency reference unit is a GPStarplus 565 provided by Zyfer Inc. Of Anaheim USA. External to the racking is a Garmin GPS antenna providing a time input for the RSS2 system plus a second antenna providing position and time information for the optional Zyfer clock. These antennas were mounted on an external rail of the vessel. Connections to the air guns were via two break-out boxes, one in the main laboratory and one on deck. The two airguns were GI 210 type provided by Sercel Marine Sources Division of Toulon France. The guns were operated and maintained by a separate group of technicians and are the subject of a separate report. All of the above is part of the National Marine Equipment Pool and is maintained by staff at the National Oceanography Centre, Southampton. Outputs of hydrophone trigger pulses were also provided to equipment owned by other institutions, namely Aarhus University of Denmark who provided the hydrophone streamer and Geometrics monitoring system, and Durham University for their Ocean Bottom Seismometer's.

Configuration and technical details: The RSS2 Source Controller Unit can control up to 32 guns, however only one Source Interface Unit was used on this occasion which has provisions for 4 firing circuits.(Further firing circuits can be provided by

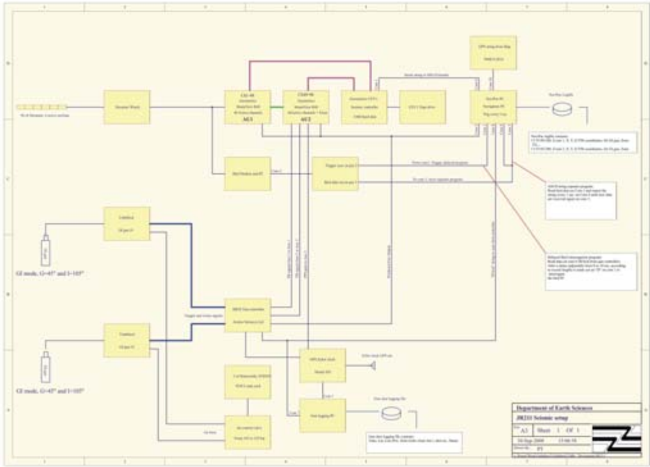


Figure 3: Setup of the seismic acquisition system.

connecting further SIU's in series up to a maximum of 8 units.) Only 2 guns were used so the remaining firing circuits were disabled. The software running on the dedicated PC provides ready means of manipulating the various parameters appertaining to each firing circuit. Timing for each firing pulse is normally provided by the SCU's in built GPS time stamp unit which is accurate to within 10?s. However on this occasion the Zyfer clock was used to provide an external time stamp which is accurate to within 0.3?s. A firing interval of 5 seconds was used throughout the cruise. The actual firing pulse of the Generator Gun solenoid occurred 50ms after the time stamp (this being the default value which was not altered), and the Injector Gun solenoid pulse occurred a further 37ms later as this was the delay recommended by Sercel. The SCU has options to synchronise the gun firing pulses at various points on the waveform output from the gun hydrophones and it was found that aligning the guns at the peak value produced the most consistent results so this was chosen for the remainder of the cruise after the initial experimental runs. It was found that the guns would fall into alignment typically within the first ten shots. The SCU automatically keeps the guns aligned within the threshold set and no further operator intervention was needed. Trigger pulse signals were also provided to the OBS logger and to the Aurhus University Geometrics system (together with a fixed 1 pulse per second) for their use. Logging of the hydrophone channels and firing sensors is done by the SCU and was recorded on the PC in SEGY format, also a .CSV text file is produced giving shot time information. At the start of the cruise it was discovered that the scientists required position data to be recorded along with the shot time details, however this information is not available from the RSS2 in its current form. With invaluable help from the on board computer technician a program was written to extract position data from the Zyfer clock and record this together with the firing time on a separate desk top PC. It should be remembered that the position recorded was that of the Zyfer antenna, not that of the air guns themselves. (See recommendations for future cruises).

Statistics: Seven separate deployments took place throughout the cruise with a total firing time logged at 198 hours, 18 minutes and 35 seconds. The actual firing time would probably be nearer 200 hours to allow for firing before and after logging. The position data was logged for a total of 110 hours 30 minutes and 10 seconds. During these periods a total of 134,590 and 75,237 shots respectively were recorded. The longest single uninterrupted deployment was for 70 hours and 34 minutes. A total of 2.356Gbytes of data was logged by the RSS2 PC and 4.101Mbytes of data was logged by the separate position logger. Further details are found in the Excel spreadsheet JR211 firing summary.xls

Conclusions and recommendations: This was the first opportunity to test the firing system in a real life situation as it had been purchased immediately prior to the cruise following the trial of a prototype version on the RRS James Cook earlier in the year. The general feeling was that the system performed very well with no obvious failures. Once the system had been set up very little user involvement was required other than to keep a watching brief. A few minor additions to the interfacing facilities will make installing and removing the system even easier on future cruises. A potentially awkward situation involving the lack of position logging was solved with the assistance of the on board computer technician however it is felt that had the appropriate Platform Systems Group technician been invited to the pre cruise planning meetings this problem would not have arisen. An enhancement for the future is to modify the RSS2 unit to provide a position output (it already has the information displayed on its LCD screen but it's not accessible programmatically) which could then be logged by the rack mounted PC rather than using a separate desktop PC. This would be a great improvement and lead to a true 'one box' solution, making transfer from ship to ship very simple.

Airguns

Description and configuration: Two Sercel GI Guns 210 cubic Inch (Generator105/ Injector105) - M 9/16 JIC (Part NB 603-100) were bought specifically for this cruise, and used for all shot firing. Both guns were configured in true GI mode with volume reducer (Part NB 615-045) fitted to the Generator chamber (reducing volume of generator to 45 cu. in. The discharge ports were also swapped out from the as supplied medium sized ports to the smaller port units. These changes altered the GI gun from Harmonic mode to true GI. Both guns had their own GI GUN TB Hydrophone Assemblies (603TBK) fitted, with the phones directly in front of one of the discharge ports. Both guns were both 150 cu. In (Generator 45/ Injector105 total volume. Both Guns were hung on their own single hanger towing frames and towed with individual umbilical's. The umbilicals were made up of a long slender net which contained the air hose, two solenoid cables plus the hydrophone cable. The towing strain cable was fed through loops on the outside of the umbilical nets. The Umbilical's were 210ft long as supplied and recommended by the manufacturer. The guns were towed at 30 meters (direct line of sight distance) from the stern of the ship to the floats above the gun hangers The Guns were towed at a depth of approximately 3 meters for the duration of the cruise The Guns were fired at 5 second intervals at 2000psi for the duration of the cruise

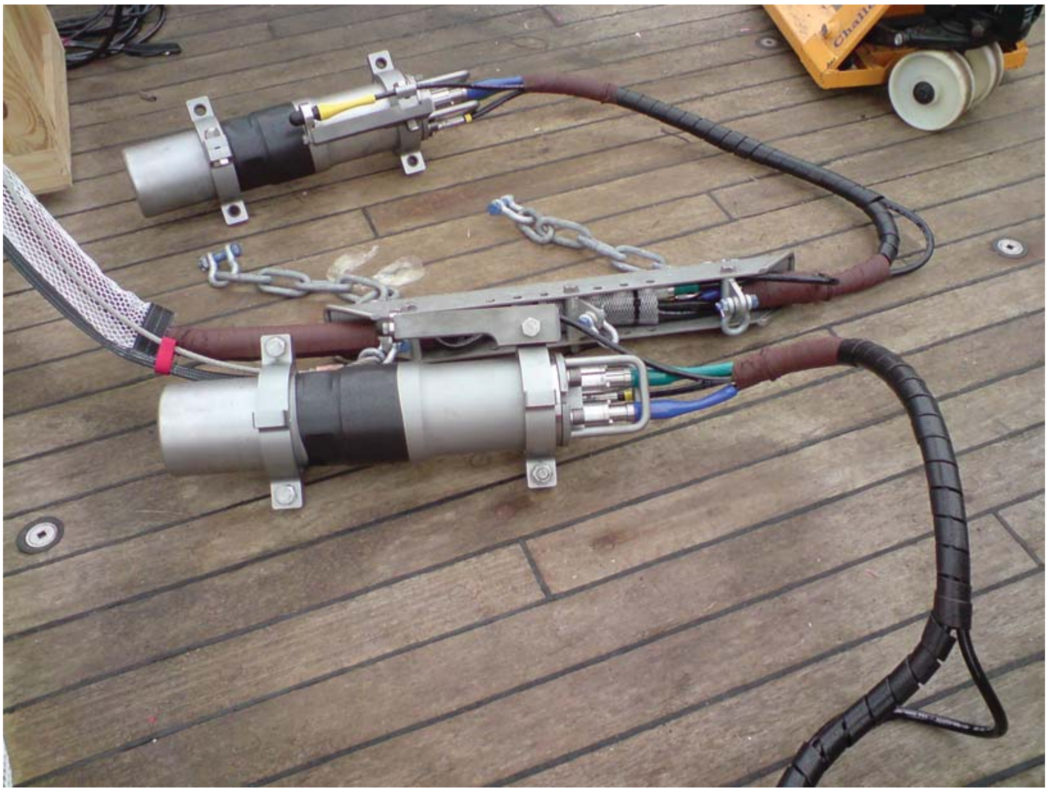


Figure 4: The new GI gun array on deck.

Conclusions and recommendations The GI Guns were brand new at the start of the cruise and on completion of the seismic work had fired a total of 209,827 without a fault. The first deployment of the guns did not go well, with the Port gun towing to close to the streamer and almost touching it. It appeared that the sausage floats which were hung directly above the airgun hangers (front of the float net shackled to the front of the hanger and the same for the aft ends of the hanger and float net) were accentuating the problem, because they were towing outwards separating the guns out to around 5-6 metres, when they were secured to the deck at 3m separation. The wash from the vessels props was also adding to the problem. It was decided to deploy both guns on the same side of the ships wash (Starboard). The floats were also secured to the gun hangers by their aft end only. The Guns were deployed in this way for the duration of the cruise and towed well. When carrying out very tight circle surveys over the Ocean Bottom Seismometers the floats crossed over and occasionally tangled up, but would untangle once the turn was complete and we straightened up. The umbilical nets became tangled around the gun hangers several times, due to the net being free to move down the stain towing cables. This was stopped by securing off the nets as well as the strain cables. The strain cables were secured to the deck with an eye bolt and bulldog grips. When the guns were stripped on completion of the cruise seismic work, it was found that one of the small discharge port rings had a small crack in it. This will be returned to Sercel for their comment. The Generator solenoid 'O' ring on Gun 1 (stbd) was damaged, and slight water ingress and tracking was found on the pins.

Compressors

During the JR211 we used the James Clark Ross in-build compressors. During several of the seismic work periods there was a loss of system pressure to well below the 2000psi which was being maintained normally. It was traced to the pressure reducing/maintaining valve sticking. Several times, one of the two on line compressors would shut down on high temperature. This was traced to a sticking/damaged unloader valve. Down time was minimal. The electronic control system is enclosed in a single 19inch X 22U racking system with interfacing to the airguns via two separately mounted "break-out" boxes. This provides portability combined with minimum set up and dismantlement time. Individual components within the racking comprise: A Source Controller; a Source Interface Unit; a standard PC; a keyboard; a monitor and an optional second GPS time and frequency reference unit. The Source Controller and Source Interface Unit is a bespoke RSS2 system provided by Avalon Sciences Ltd of Somerset UK; the PC, keyboard and monitor are generic rack mountable units and the optional second GPS time and frequency reference unit is a GPStarplus 565 provided by Zyfer Inc. of Anaheim USA. External to the racking is a Garmin GPS antenna providing a time input for the RSS2 system plus a second antenna providing position and time information for the optional Zyfer clock. These antennas were mounted on an external rail of the vessel. Connections to the air guns were via two break-out boxes, one in the main laboratory and one on deck. The two airguns were GI 210 type provided by Sercel Marine Sources Division of Toulon France. The guns were operated and maintained by a separate group of technicians and are the subject of a separate report. All of the above is part of the National Marine Equipment Pool and is maintained by staff at the National Oceanography Centre, Southampton. Outputs of hydrophone trigger pulses were also provided to equipment owned by other institutions, namely Aarhus University of Denmark who provided the hydrophone streamer and Geometrics monitoring system, and Durham University for their Ocean Bottom Seismometer.

Receivers

96 Ch. HydroScience streamers, consisting of 6 active sections and with total active length of 593.75 meter, one 50 m stretch section and 50 m tow cable :

Active section specifications:

- 3,125 m group length
- 7 x Benthos RDA hydrophones in each group
- 6,25 meter channel interval, centre to centre
- DigiCourse comm. coil at the rear end of each section

50 meter stretch section:

- DigiCourse comm. coil in front and rear end

Comment We had to pay out an additional 10 m tow cable to keep the streamer depth at 3 meter in the front part of the active streamer section. On several of the lines, especial east/west and west/east lines the front part of the streamer had problems to stay in 3 meter, and often went down to 4-7 meters. Furthermore, there was a tendency that the changing in streamer depth showed an oscillating behaviour especially when wind and swell were high. Possible explanations may include water density changes and changes in current direction.

Birds (DigiCourse 5010)

Five birds control the streamer depth. They are mounted at different distances along the streamer (see "Marine Survey Logfile-JR211-xx"). Each bird controls the depth of the streamer by means of a depth transducer, and adjusts the wings up and down to reach a certain depth (pressure). The lifting weight of each bird is 15 kg at 5 kts. After sending the desired depth to the bird, the bird is self-contained and will operate independently.

Figure 5: The guns are towed on two fenders on the starboard inside of the A-Frame. The towing point for the streamer is a fairlead on the port side just outside the A-Frame.

Comment Bird 1 and 2 had difficulties to stay at desired depth on several lines, see above. The two birds were opened to check if there should be any bad connections, but there was no evidence of malfunction. Also a test was carried out, with positive result for each bird.

Streamer winch

This is a hydradraulic winch which is placed in a 10" container, with remote control. The winch has following specifications:

- Powered from 3x380V, 50/60 Hz, 32 A
- Drum size, inner diameter 1.3 m, outer diameter 2.1 m, and width 1.2 m
- Break 2.0 ton, pulling force 1.0 ton
- Weight: 5 ton

Bird interface

Interface unit for Birdcontrol (type DigiCourse Modem, Model 272), used to communicate between Bird PC and the birds attached to the Streamer.

Figure 6: Århus' multi-channel seismic streamer during a former deployment.

Bird PC

This PC is used to download data to each bird. Once the bird operates it transmits back the actual fin angle and depth. The log in the Bird PC is set to send a serial string every time it gets an interrogation from the NaviPac PC. The format that is send out is DigiCourse (see page 70 in "DigiSCAN 293A PC Edition Operator's Manual" for detailed format specification). With diagnostics in the bird PC, the battery status of each bird can be checked. This was done every 2nd day.

Comment During JR211 an external gun controller triggered the acquisition, unlike on previous surveys. This created the problem that the bird interrogation occurred during the data acquisition and induced additional noise into the seismic record. NaviPac interrogates with its own time every 10 s and the timing for the shooting was controlled by another clock which makes both systems drift with respect to each other. As the interrogation makes a noise burst in the record, we tried to aim it to take place between shots. The noise burst looks like five spikes on almost all channels from ch no. 48 to ch 96 (Fig. 7)

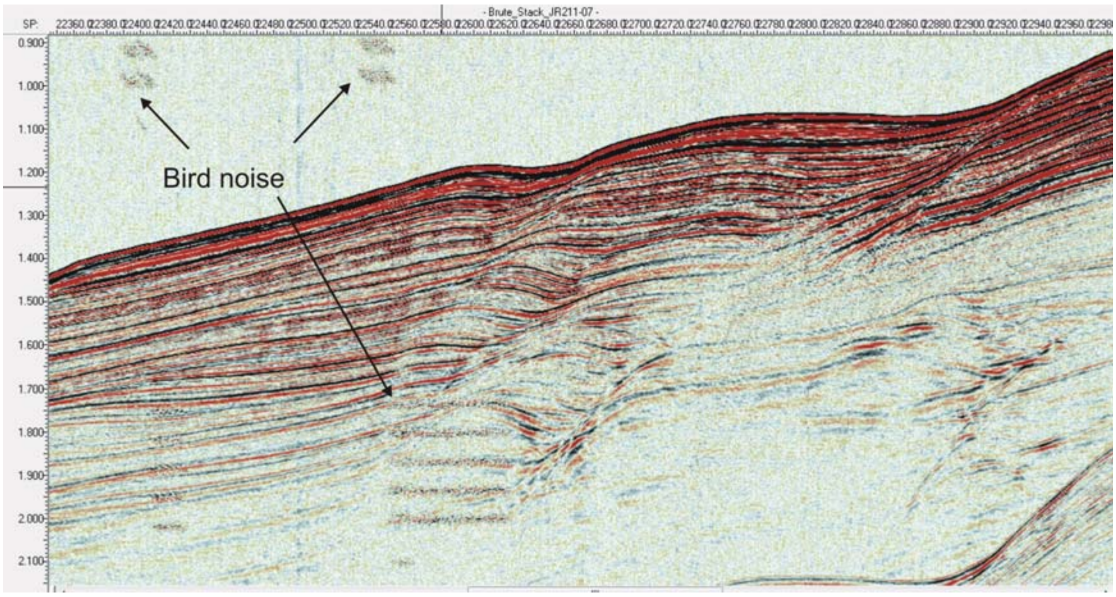


Figure 7: Illustration of noise due to bird data transmission. This affected lines JR211-1 through JR211-16.

With help from Julian Klepacki, BAS, a software program to control the interrogation of the bird pc was developed. The program uses the fired pulse from the gun controller, delays it by 4.2 sec (record length is 4 sec) and then sends the interrogation command to the bird PC. This application was added from line JR211-17 and ensured that no transmission noise interfered with the data during the rest of the survey.

Geometrics R48

One 48 channel and one 60 channel acquisition unit acted as slaves for CNT-1, on which all recording parameters were set up. The two units have an 18 bit Sigma-Delta, 4 bit IFP A/D converter, and each unit sends data set to the CNT-1, via the 100Mbit net card. Each acquisition unit gets its own trigger, from the gun controller.

CNT-1

The CNT-1 is the recording unit, a Centrino 1 Ghz PC, with two network cards (100Mbit) - one for each acquisition unit - and a fast wide SCSI interface to the LTO-2 tape deck. Within the program CNT-1, Line name, Tape no. and acquisition parameters were set up. The following settings were used on for lines, except Line JR211-14A for which the record length was set to 3000 ms.

- Sample interval : 1 ms
- Record length : 4000 ms
- Delay : 0 ms
- Low cut filter : 10 Hz, slope 24 db/oct.
- High cut filter : 300 Hz (anti-alias filter set automatically corresponding to half the sample interval)
- Data format : SEG-D 8058

During the survey the program generates a log file.

The first line is the reading from the serial input from NaviPac (not all charters in the string are readable in the log file, but all data are sent to the SEG-D header).

The format of the string is: Time HH:MM:SS (UTC), Event no, X pos, Y pos (UTM Zone 32, WGS 84, GI Gun Position), Lat, Lon, (Gi gun pos), Bird data <CR> <LF>

During data acquisition several windows were displayed on the PC:

- The shot gather window is displayed, with varying display settings changed as appropriated on the fly.
- The gather file window that produces an on-line brute stack with limited processing facilities like AGC, HP and LP filters and velocities tables. The “Brute stack” is saved in a local format; this file was transferred to SEG-Y format after EOL and imported in our Kingdom suite notebook and printed out on the “Stack Printer”. It was also imported directly into the KingdomSuite project svalbard2 to facilitate further survey planning.
- The noise window shows all 96 channel noise values in μbar, as a “snapshot”, recorded and calculated between shots.
- The trigger window shows the time interval between shots and the energy of a specified hydrophone (in our case ch 1).

- The Aux gather window is displaying the tree Aux channels, Aux 1 = gun time break from Gun 1, Aux 2 = gun time break from Gun 2 and AUX 3 = the PPS pulse from Zyfer clock.

The shooting is triggered by the gun controller RSS2. It is sending out a trigger every 5 s to the two acquisition units. The fired pulse used is the time when the guns fire. The NaviPac program is trigged from the gun controller and generates an event on its own system. In addition NaviPac sends out a string to the CNT-1. The string contains time, event, position (UTM and Geographical Lat/Lon position of the gi gun) and bird data. These data are stored in the SEG-D external header on tape.

Comments On the first line (JR211-01) the CNT-1 program version 4.509 (8 May 2008) was used. This version turned out to have some timing problems; even though it had been tested extensively before surveying started. The program was uninstalled and the old version 4.32 (10 May 2005) was installed instead. This program was running during the rest of the survey. From time to time there have been some missed shots (and even a restart of the program has been necessary) due to problems with the external USB hard disk, LTO-2 tape deck and sync error to the two acquisitions units. A summary of lost files can be found in the document sync_error_JR211.xls in the folder Geometrics.

LTO-2 Tape deck

Data is recorded on one LTO-2 tape deck - and on an external USB Hard Disk.

Stack Printer

The stack printer, an Epson 4400 colour printer is used to print out the Brute stack from the KingdomSuite PC.

NaviPac PC

NaviPac is a navigation and datalogging program, that runs on a computer, with Win2K. To provide enough input/outputs it is extended with “digiboard” that adds 8 extra serial ports. The GPS information is acquired from the ships local network. The ships GPS is send out as an NMEA GGA string every 1 s to the NaviPac navigation PC. There are two offsets with the ship’s GPS as reference: GI-gun and streamer Ch1. These offset are stored in the navipac log files. The GI-gun offset is stored in the custom log file, and it is used in the serial string send to the CNT-1 computer. Furthermore, the programs also imports and stores the bird data. By the Helmsman’s display the logging of each line is controlled by starting and stopping individually sail lines. The seismic recording unit generates several log files in the folder seismic

`Line Overview-log\_JR211.xls:`

This file contains 6 sheets (Page 1 to 6) with information written down during the survey. SOL and EOL etc. The next sheet is the NaviPac log files, with information about collation between line names and log files in the NaviPac system, and event numbers in the NaviPac system. Next sheet is the Tape Inventory log with information about tape numbers and file no of SOL and EOL of each line. The last two sheets were used to print labels to the LTO-2 tapes.

Folder: `Geometrics`

A log file generated by the CNT-1 program during survey. There is one log file for each line, below is an excerpt from file JR211-06:

```
Beginning New Line - Line 6, Starting File Number is 18569
09:23:31.239,18535,521054.30,8705541.31, 078$^\circ$25. - Received at
09:24:58.54 for File 18569
ALARM: Trigger time threshold exceeded.  09:25:05
File   18569 09:25:00.39 09/06/2008 1604 Kbytes SAVED to TAPE Lbl 102 Scid 3
```

The first line tells this is the start of new line etc , the 2nd line is the serial string from NaviPac. It contains time, event no., X, Y coordinates for the GI-gun. The rest of the sting is not logged - but it is retained in the SEG-D header, and includes the bird data. Third line is an alarm - as there have been more than 5 s since the last shot (break because of new line), and fourth line is information about the file no. on the tape deck, reel no. and file size. The geometrics folder also contains sync_error_JR211.xls that is an overview of missing shots due to occasionally timing problems with the two acquisitions units.

Folder: `NaviPac` In subfolders, named by the date of the day, ex. 080908 there are three log files, General log, Survey log and Custom log. All files can be opened by notepad or a similar program. General log contains general information, ellipsoid, projection, datum, off sets and data for each "instrument" for each event. etc . Survey log contains more or less the same as above - but can be used to import data to "NaviEdit" that is a post processing software tool from same company as NaviPac. Custom log contains information about SOL and time, GI-gun position and filtered vessel position for each event. In the NaviPac folder is a file called "events_JR211.log", this file contains limited information for each event, but cover the whole survey.

Folder: `Marine Survey General info` For each line there is a word file with an overview of offset, date, gun setting etc.

Seismic processing

The seismic data were processed in two ways during the cruise. Brute stacks were produced directly by the seismic recording system and were available at the end of each line for further planning. The brute stack processing is piece of the proprietary Geometrics seismic recording software and detailed parameters are not known. The data are found in the Svalbard2 KingdomSuite project under the brutestack sub-survey.

In addition to this rough initial processing we have begun proper processing of the data during the cruise. We established a seismic processing flow in ProMAX that included geometry load and binning with 3-m spacing, time variant frequency filters, amplitude correction, velocity analysis, normal move-out correction, and post-stack time migration with water velocity. Furthermore, we tested dip-move out corrections, various deconvolutions and other migrations, but the best imaging results were obtained with the relatively simple flow shown in Figure 6. Upto the end of the cruise 10 out of 33 seismic lines were processed in this way and four vintages of the data (stack, stack with agc, migration, and migration with agc) were loaded into KingdomSuite. Before the data could be processed in ProMAX the navigation data had to be extracted from the seismic log files using gawk (see README file in the nav_files directory for details), and it has to be ensured that only complete shots are used. This is most easily achieved by checking the log file for SYNC errors, and excluding those shots during the SEG-D file load in the first ProMAX flow. Care has to be taken that navigation for these shots is also commented out during the source location load in the 2D marine geometry spread sheet.

We determined the seismic velocities through semblance analysis of super gathers (Figure 7). This was done after the resorting to CDP numbers and loading the geometry information derived in the binning process to the trace headers.

In order to suppress the seafloor multiples we picked a bottom mute that kills the horizontal part of the multiple in the NMO corrected CDP gathers. At this stage also the time gates for the time-variant frequency filter and a NMO stretch suppressing top mute were picked (Figure 8). The processing resulted in high-quality seismic images for the upper 400 ms of below the sea bed (Fig. 9). The close bin spacing of 3 m allows the identification of small disturbances such as faults and even erratics in some instances. The processing results are stored in the directory seismic/promax-out.

```
FLOW - 01_segd_read  Mon Sep  8 01:33:14 2008
  Output - jr211-4 Add 230304 Over 0
 SEG-D Input

FLOW - 10_sort   Mon Sep  8 01:38:31 2008
  Output - jr211-4-sort Add 230304 Over 0
 Trace Header Math
  Select mode                                  Fixed equation mode
    DEFINE trace header equation(s)
    cdp=ffid;source=ffid;sin=ffid;station=ffid
 Extract Database Files
  Is this a 3D survey?                         No
  Data type                                    MARINE
  Source index method                          FFID
  Mode of operation                            OVERWRITE
  Pre-geometry extraction?                     No

FLOW - 30_resort     Fri Sep 12 03:20:57 2008
  Output - jr211-4-cdpsort Add 230208 Over 0
 Database/Header Transfer
  Direction of transfer                        Load TO trace header FROM database
  First header entry                           CDP bin number
  Second header entry                          X coordinate of CDP
  Third header entry                           Y coordinate of CDP
  Fourth header entry                          Source X coordinate
  Fifth header entry                           Source Y coordinate
  Sixth header entry                           Receiver X coordinate
  Seventh header entry                         Receiver Y coordinate
  Eighth header entry                          Signed source-receiver offset
 Trace Header Math
  Select mode                                  Fixed equation mode
    DEFINE trace header equation(s)
    aoffset = sqrt ( (sou_x - rec_x)**2 + (sou_y - rec_y)**2)

FLOW - 80-nmo-stack  Fri Sep 19 08:27:13 2008
  Output - jr211-stack-no-dmo Add 9995 Over 0
 True Amplitude Recovery
    Time-Power constant                        2.
  APPLY or REMOVE amplitude corrections?       Apply
  Maximum application TIME                     0.
  Normalization source                         Calculate
  Normalization reference TIME                 0.
 Bandpass Filter
  TYPE of filter                               Time and Space-Variant Filter
  Type of filter specification                 Ormsby bandpass
  PHASE of filter                              Minimum
    Percent additive noise factor              1.
  Apply a notch filter?                        No
  Space-variant filter parameters
```

```
1:0:25-35-250-300,35-50-130-180/
  Get time gates from the DATABASE?              Yes
    SELECT time gate parameter file              freq-filter-gates
 Normal Moveout Correction
  Direction for NMO application                  FORWARD
    Stretch mute percentage                      30.
    Apply any remaining static during            Yes
  NMO?
    Disable check for previously applied         No
  NMO?
  Apply partial NMO?                             No
  Long offset correction?                        NONE
  Get velocities from the database?              Yes
    SELECT Velocity parameter file               jr211-4-velana
 Trace Muting
  Re-apply previous mutes                        No
  Mute time reference                            Time 0
  TYPE of mute                                   Top
    Starting ramp                                30.
    SELECT mute parameter file                   nmo-top
 Ensemble Stack/Combine
  Type of operation                              Stack Only
    How are trace headers determined?            Average
    Secondary key bin size                       100.
  Maximum traces per output ensemble             1
  Select PRIMARY Trace Order Header Word         CDP bin number
  Average the X and Y coordinates of             No
  primary key?
  Select SECONDARY Trace Order Header            Signed source-receiver offset
  Word
  Output trace secondary key order               Ascending
  Suppress FOLD normalization?                   No

FLOW - 99-header-math    Fri Sep 19 08:37:59 2008
  Output - jr211-4-stack-w-hdr Add 9995 Over 0
 Trace Header Math
  Select mode                                    Fixed equation mode
    DEFINE trace header equation(s)
    Line = 1
```

```
FLOW - 100-migration     Fri Sep 19 08:39:46 2008
  Output - jr211-4-mig Add 9995 Over 0
 Memory Stolt F-K Migration
  Maximum frequency  to migrate (in Hz)         220.
  RMS velocities for migration
    1:0-1500/
  Number of traces to smooth velocity           0
  field over
  Percent velocity scale factor                 100.
  Stolt stretch factor                          0.6
  Re-apply trace mutes?                         Yes
  Re-kill dead traces?                          Yes
```

Figure 6: ProMAX processing flow.

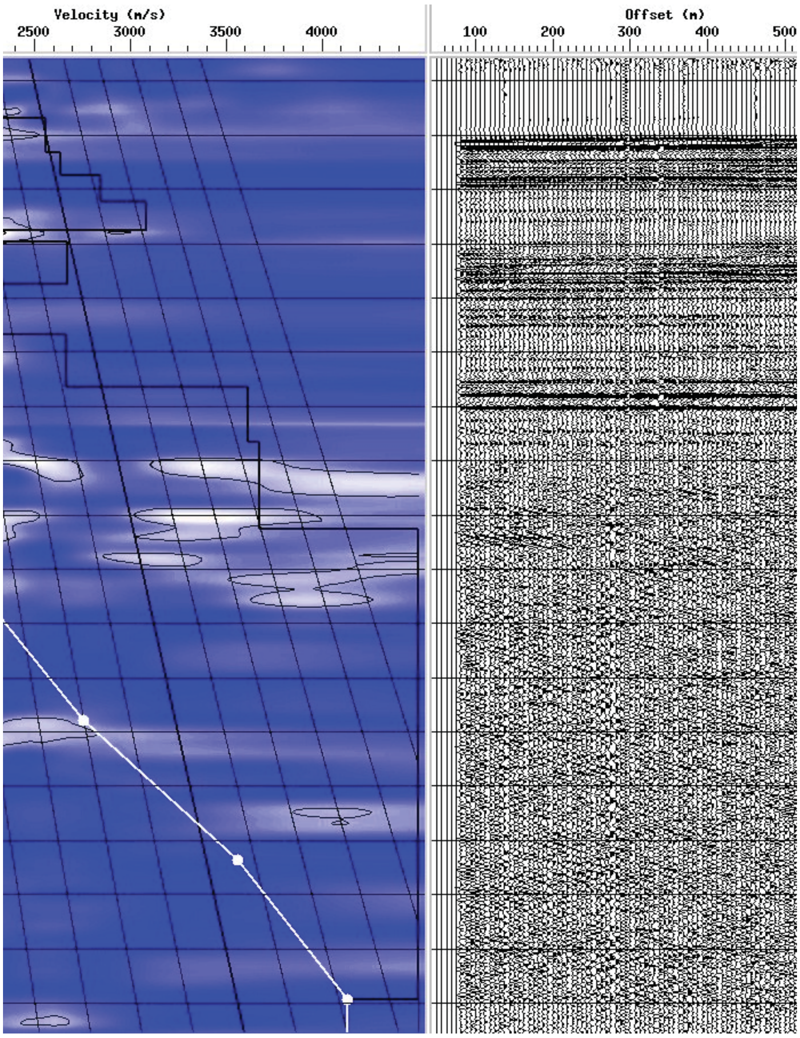


Figure 7: Semblance velocity analysis (left), nmo corrected gather (centre) and test stack (right). Note the clear low-velocity zone visible at BSR depth (black line in left panel indicating interval velocities).

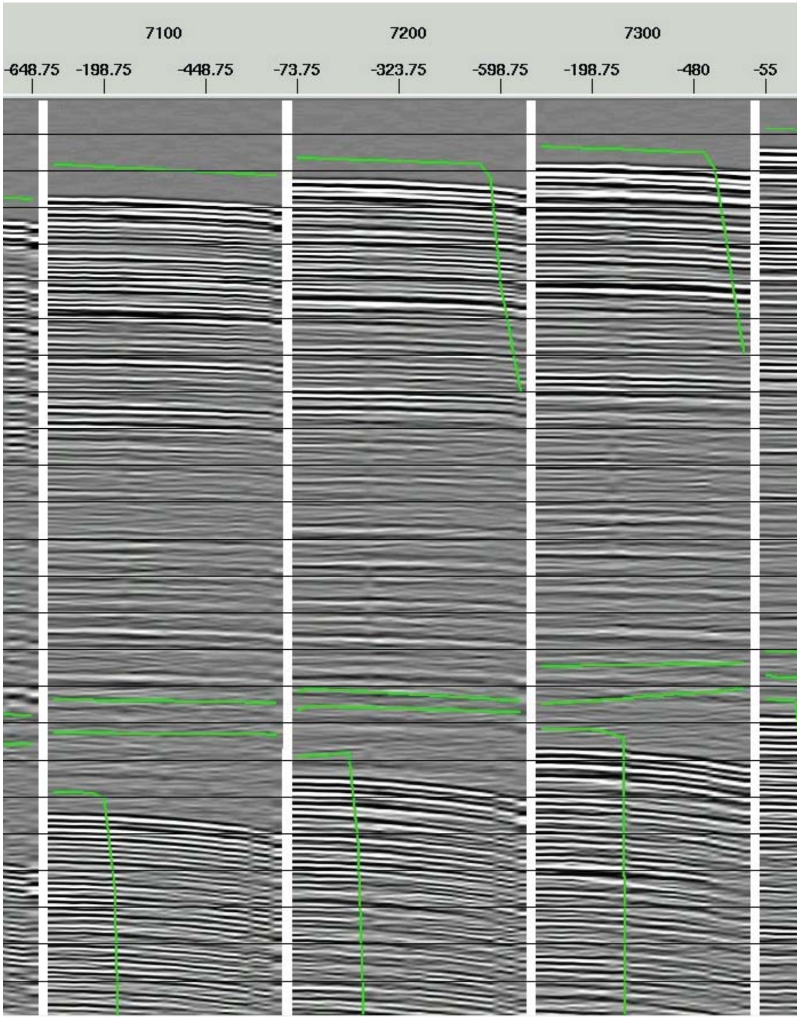


Figure 8: Top mute, time gates, and bottom mute picking before NMO. Note that the top of the upper time gate window has to be picked at time zero and the bottom of the lower time gate has to be picked at time 4000 in order for the ProMAX flow to run.

Processing Recommendations

Wave noise is only a problem for two lines acquired during marginal weather conditions. These have not been processed yet, but it seems likely that the noise can be suppressed by deleting individual channels, because for each shot only a few channels were affected by breaking waves. Velocity analysis showed that low velocity zones exist in some places where gas is present in the sediments. Clearly in these areas the migration results can be improved by a more sophisticated velocity analysis and perhaps prestack depth migration.

The present processing flow aims at a balanced resolution/penetration ratio. We conducted some tests stacking only near offset channels 5 through 10 and suppressing the low frequencies in the seismic source signal. The result is a somewhat noisier image that has a considerably higher resolution (Fig. 10). It may therefore be more suitable for investigation of the shallow subsurface than the data processed with the standard flow. It also seems worthwhile to bin the data on a larger bin spacing and to use lower frequencies to achieve a greater penetration than the present maximum of 800 ms observed at present. Such processing would, however, also require multiple suppression processes such as Radon filtering.

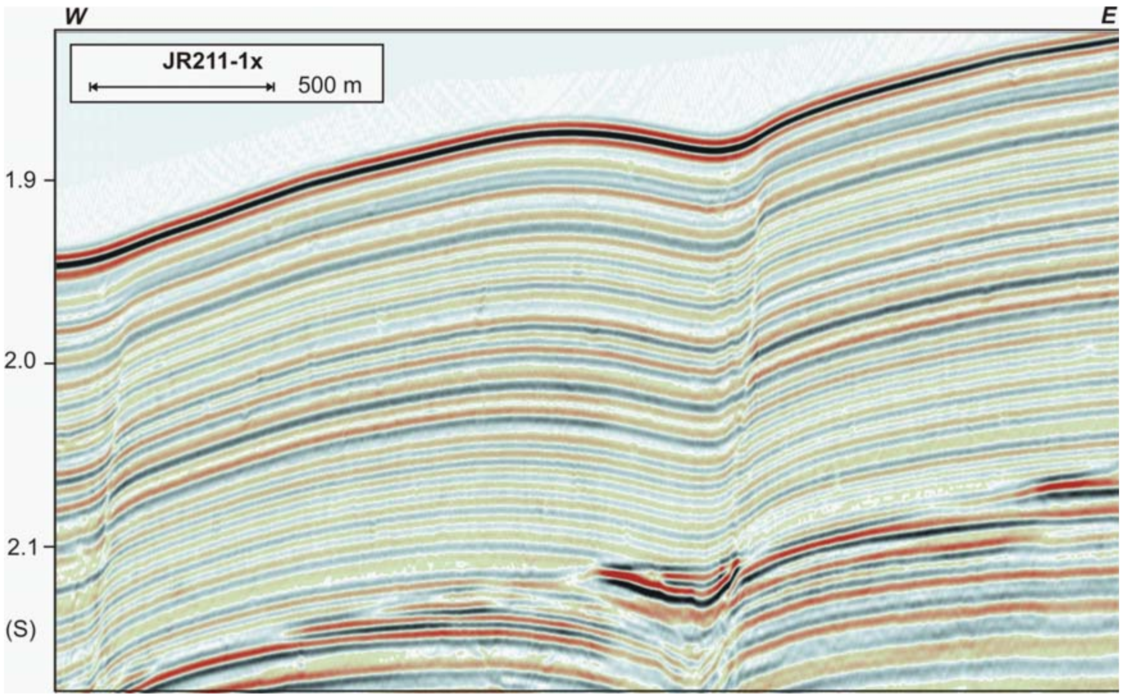


Figure 9: Detail of JR211-1x showing the high quality of the reflection seismic data. At this location the base of the gas hydrate stability zone is characterized by abrupt termination of high amplitude reflections caused by free gas. Also note the two normal faults and the small scale disturbances around 2.0 s travel time which are real events.

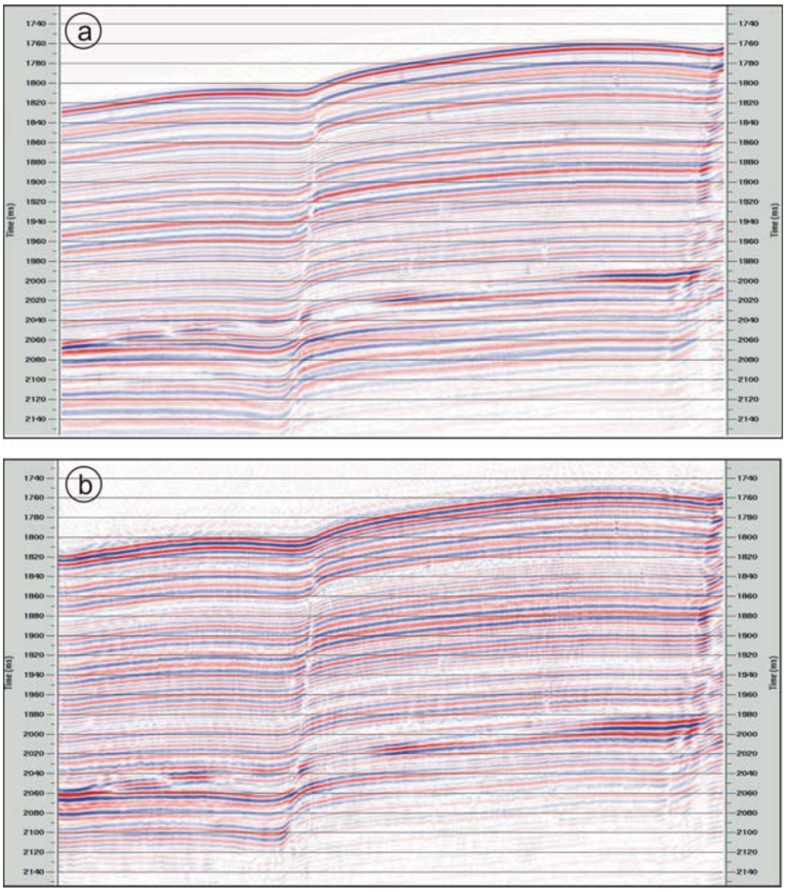


Figure 10: Comparison of data processed using the standard flow (a) and data processed for higher resolution (b). Whereas (a) uses the entire offset (channel 1 through 96) and a frequency with the highest power (25-35-180-220 Hz), for (b) only 6 channels (5 through 10) and high frequencies were used (50-75-300-350 Hz). Otherwise the processing is the same (nmo, stacking, time migration).

6 TOBI

System Description

TOBI - Towed Ocean Bottom Instrument - is the National Oceanography Centre, Southampton's deep towed vehicle. It is capable of operating in 6000m of water. The maximum water depth encountered during the TOBI surveys during this cruise was around 1000m.

Although TOBI is primarily a sidescan sonar vehicle a number of other instruments are fitted to make use of the stable platform TOBI provides. For this cruise the instrument complement was:

1. 30kHz sidescan sonar with swath bathymetry capability (Built by IOSDL/NOCS)
2. 8kHz chirp profiler sonar (Built by IOSDL/NOC)
3. Three-axis fluxgate magnetometer. (Ultra Electronics Magnetics Division MB5L)
4. CTD (Falmouth Scientific Instruments Micro-CTD)
5. Pitch & Roll sensor (G + G Technics ag SSY0091)
6. Gyrocompass (S.G.Brown SGB 1000U)
7. Light backscattering sensor (Seapoint Turbidity Meter)

A fuller specification of the TOBI instrumentation is given in tobispec.doc.

The TOBI system uses a two-bodied tow system to provide a highly stable platform for the on-board sonars. The vehicle weighs 2.5 tonnes in air but is made neutrally buoyant in water by using syntactic foam blocks. A neutrally buoyant umbilical connects the vehicle to the 600kg depressor weight. This in turn is connected the main armoured coaxial tow cable. All signals and power pass through this single conductor.

Mobilisation

The NOCS TOBI system was transported to the RRS James Clark Ross in Portland. All equipment was loaded there and left to be set up on arrival at Longyearbyen.

Both umbilical and launch winches were mounted on the aft deck for a stern deployment position. The deck electronics systems were set up in UIC room. 8' x 4' x 18mm plywood sheets were cut to extend the bench space available and make an 'L' shaped installation. The electronics racks plus the TOBI replay system were mounted on these. Further sheets were used to fill in the aft area to make a useful space for the high frequency sidescan deck unit and TOBI image processing computer. The TOBI data replay computer was set up in the Main laboratory. The GPS receiving aerial was mounted on a pole on the port side of the deck outside the UIC to give navigation and time inputs to the logging system.

TOBI Deployments

TOBI was launched and recovered three times during the cruise. The times are listed below along with relevant comments:

Deployment	Start time/day	End time/day	Comments
1	23:57/236	14:30/238	
2	02:15/239	12:28/240	
3	19:30/243	21:00/244	Problem with umbilical necessitated change of umbilical followed by two problems with electrical termination of the main tow cable. The run eventually commenced at 05:09/244. Due to non-coax umbilical there was more noise on the sidescan record during this run.

The M-O disks used and their relevant numbers, files and times are listed in JR211 Westbrook MO record.doc.

The RRS James Clark Ross is equipped with a high stern mounted hydraulic 'A' frame with a secondary independently operated extension that allows TOBI to be deployed and recovered in an in-line position. This gives reasonable control of the vehicle during these operations, especially as the weather was good throughout. The extension with a secondary block was used for launch and recovery of the vehicle. The main sheave on the 'A' frame was used for towing during the survey.

No problems were encountered during any of the launch or recovery operations, which is a very great credit to the deck crews involved.

TOBI Watch keeping

TOBI watch keeping was split into three, four-hour watches repeating every 12 hours. Watch keepers kept the TOBI vehicle flying at a height of ideally 300 to 400m above the seabed by varying wire out and/or ship speed. Ship speed was usually kept at 2.5knts over the ground with fine adjustments carried out by using the winch. As well as flying the vehicle and monitoring the instruments watch keepers also kept track of disk changes and course alterations. Due to the shallow water on most of the TOBI runs there was little requirement for winch operations.

The bathymetry charts of the work area were found to be quite accurate which helped immensely when flying the vehicle. The ship's EM120 multibeam sonar, TOPAS profiler and EK500 echo-sounder monitors mounted in the laboratory gave the watch keepers read outs of water depth and bathymetry.

Instrument Performance

Vehicle

The vehicle performance was excellent for the first two runs. The third run was delayed due to an intermittent open circuit on the main power cable. This was thought most likely to be a fault in the umbilical so the vehicle was recovered and the umbilical changed for the spare non-coax unit. When the vehicle was deployed with this cable again there was again an open circuit. This was traced to the electrical termination of the main cable. With the vehicle still deployed the termination was remade and tested. It again failed so had to be remade again. Finally the depressor was launched some 9.5 hours after ithe vehicle was first put into the water. Due to the construction of the replacement umbilical - it is designed for the next generation TOBI which will have fibre-optic communications - there was an increase in noise interference on the sidescan and swath records. Clearly a coax cable is needed for this analogue system to work correctly.

Profiler

During the first two runs the profiler gave strong returns from the seafloor but little or no detail in the penetration. For the final run the front end gain was reduced by 16dB and the output of the vehicle correlator reduced to prevent clipping by the signal limiting circuitry. These changes gave a far better signal for the final run but unfortunately the run did not go over any ground with significant sedimentation. The reason why the gains were so high was that previously the profiler array had been compromised by some dead elements which reduced the performance. With a new set of elements the performance had been restored but the extra gain introduced to compensate had not been taken out. For future cruises the profiler will be logged separately using a CODA Octopus 360 system.

Sidescan

Due to the shallow water depth of the TOBI runs and a strong temperature inversion near the water surface the sidescan could not give its full 6km swath width. Artefacts from the temperature inversion limited the range to about half of maximum. Features within this range were imaged clearly. The final run with the non-coax cable introduced noise into the record as well although this only affected the same areas as the artefacts did.

Magnetometer

The unit worked well throughout the cruise. An incorrect reading of the x value was observed in the logged data every 12 seconds, which may be explained by the asynchronous nature of the A/D converter for the unit leading to readings during a sonar transmission.

Gyro

The gyro gave very stable, reliable data throughout. The unit took up to 6 hours to stabilise due to the latitude location of the cruise.

CTD

The CTD worked well throughout the cruise with only 3 reboots required.

Pitch/Roll

This unit performed admirably for the whole cruise.

Seapoint Turbidity Sensor

The unit performed well throughout both deployments. Interference from the sonar transmission signals necessitated taking the reading 2 seconds after the transmit pulse. This then gave clean data.

Swath bathymetry

From the results of this cruise it could be seen that there is a good 1.5km range for the starboard swath with approximately 1km for the port side. The port side seemed to suffer from periods where the far range was washed out by a strong, non-acoustic signal. The port side seemed to have a poorer beam pattern also. These observations will be investigated at NOCS.

Deck Unit

The system proved very reliable in operation throughout the cruise. A voltage of 340V was used to power the vehicle with a current of approximately 700 - 800mA.

Data Recording and Display

Data from the TOBI vehicle is recorded onto 1.2Gbyte magneto-optical (M-O) disks. One side of each disk gives approximately 16 hours 9 minutes of recording time. All data from the vehicle is recorded along with the ship position taken from the GPS receiver. Data was recorded using TOBI programme LOG.

As well as recording sidescan and digital telemetry data LOG displays real-time slant range corrected sidescan and logging system data, and outputs the sidescan to a Raytheon TDU850 thermal recorder. The Seapoint turbidity sensor signal was printed onto the Raytheon recorder alongside the sidescan image.

PROFDISP displays the chirp profiler signals and outputs them to a Raytheon TDU850.

DIGIO9 displays the real-time telemetry from the vehicle - magnetometer, CTD, pitch and roll, Seapoint - plus derived data such as sound speed, heading, depth, vertical rate and salinity.

LOG, PROFDISP and DIGIO9 are all run on separate computers, each having its own dedicated interface systems.

Data recorded on the M-O disks were copied onto CD-ROMs for archive and for importation into the on board image processing system.

The gyro in the vehicle had been removed for repair prior to this cruise. In remounting the unit the offset in the reading was changed from -10.1 degrees to +10.1 degrees. This was corrected easily in DIGIO9 - the data display programme - and was also corrected on the CD-ROMs by running programme DAYFIX - which added 20.2 degrees to the raw reading - prior to copying onto CD-ROM.

Summary

Although compromised by the environment it was working in, the system performed well overall with some good sidescan imagery especially of iceberg scours. The work done on the profiler will greatly benefit future cruises.

IPR, DLRM, JW 31/08/08

TOBI technical reference: 'TOBI, a vehicle for deep ocean survey', C. Flewellen, N. Millard and I. Rouse, Electronics and Communication Engineering Journal April 1993. e-mail: ianr@noc.soton.ac.uk url: http://www.noc.soton.ac.uk

TOBI Image Processing

Onboard processing equipment during this cruise consisted of a standard PC laptop with a virtual Linux partition and a total of 90 Gigabyte of disk space. Final maps containing side-scan sonar imagery were plotted on an A0 plotter. All data were also archived onto an external 250 Gigabyte hard disk and CD-ROM.

The ship's navigation was recorded online on a UNIX server of the ship. The data were transferred on a daily basis and then tested for time-continuity and abnormal speed values. No gaps in the navigation data file occurred. The GPS coverage and position quality was good; DOB between 1.0 and 1.8. Good navigation data is essential for processing, because the vehicle position and hence the sidescan image position is calculated from it.

The winch data (wireout) were recorded analogue and stored in a separate file. The TOBI imagery was downloaded from the CD-ROMs using a subsample and average factor of 8. This gave a pixel resolution of 6 metres and an almost 3-fold improvement of the signal-to-noise ratio.

The survey consisted of three runs. These were split into 13 blocks (processed at 78 degrees standard latitude) to facilitate processing. The approximate size of the blocks was approximately 0.25 by 0.75 degrees for most areas. After each survey run was completed, the imagery was processed using the PRISM (v4.0) and ERDAS Imagine (v9.1) software suites to produce geographically registered imagery which could then be composed onto a series of mapsheets. These were produced at a scale of 1:35000, and printed on the A0 plotter. The digital version of the imagery was also made available for the onboard Geographical Information System (GIS) of the area.

The processing of TOBI imagery has two main phases: Pre-processing and Mosaicing. The pre-processing stage involves correcting of the side-scan sonar characteristics, removal of sonar specific-artefacts and geographical registration of each individual ping. This processing stage is solely composed of PRISM programs and runs from a graphical user interface. The PRISM software uses a modular approach to 'correct' the imagery, which is predefined by the user in a 'commands.cfg' file. For this data it was defined as:

```
suppress_tobi -i %1 -o %0
tobtvg -i %1 -o %0 -a
mrgnav_inertia -i %1 -o %0 -t -u 234 -n navfile.veh_nav
tobtvg -i %1 -o %0 -h -l 50 # use track heading
tobslr -i %1 -o %0 -r 6.0 , res
edge16 -i %1 -o %0 -m
drpout -i %1 -o %0 -u -f -p -k 201
drpout -i %1 -o %0 -u -f -p -k 51
shade_tobi -i %1 -o %0 -t1,4095
```

To explain this in sonar terms (in order):

- Removal of any surface reflection (i.e. from vehicle to the sea surface and back) - generally only a problem in shallower water depths, where a bright stripe or line is seen semi-parallel to the ship's track. Removal is only done when the imagery is unambiguous, whether the line is true artefact and not an actual seafloor feature. The result can sometimes be seen on the final imagery as a faint dark line.

- Smoothing of the altitude of the vehicle above the seafloor. The altimeter sometimes cannot locate the seafloor, possibly due to very soft sediment thus reducing the return profiler signal. Smoothing is done by a median filter of the given values, comparing this with the first return seen on the port and starboard sides, and applying a maximum threshold for altitude change if first return and altitude value differ. Generally first return values are used, as these values will be used in the slant-range correction too.

- Merging of ship navigation and cable data with the imagery and calculation of the TOBI position using an inertial navigation algorithm. The 'navfile.veh_nav' file contains ship position and cable values and an umbilical length of 160metres (first two runs) and 200 metres (third run) plus an additional 34 metre for the distance between the GPS receiver and the approximate point where the cable enters the water. The cable values in the TOBI cable file are used. Various assumptions are applied: the cable is assumed to be straight, the cable value is assumed to be correct, and zero cable is set when the depressor enters the water.

- Replaces the TOBI compass heading with track heading. A smoothing filter of 50 pings is applied. The heading values are used in the geographic registration process to angle each ping relative to the TOBI position.

- Slant-range correction assuming a flat bottom. This is a simple Pythagoras calculation assuming that the seafloor is horizontal across-track and sound velocity is 1500ms-1. Each pixel is 8ms and generally equates to 6 metre resolution; any pixel gaps on the output file are filled by pixel replication.

- Median filter to remove any high or bright speckle noise. A threshold is defined for the maximum deviation for adjoining pixels over a small area above which the pixel is replaced by a median value.

- Dropout removal for large imagery dropouts. When the vehicle yaws excessively, it is possible for the 'transmit' and 'receive' phase of each ping to be angled apart. If this exceeds the beam sensitivity value (0.8°) little or no signal is received, creating a dark line on the imagery. The program detects the dropout lines and interpolates new pixel values. If more than 7 dropouts are present concurrently (28 seconds) no interpolation is done.

- More dropout removal but for smaller, partial line dropouts. If more than 7 partial dropouts are present concurrently (28 seconds) no interpolation is done.

- Across-track equalisation of illumination on an equal range basis. This assumes that the backscatter from a particular range should average a given amount for each piece of data. The near-range pixels and far-range pixels are generally darker than mid-range pixels. This is due to the transducer's beam pattern and differences in seafloor backscatter response in terms of angle of incidence. The result of this is to amplify the near and far-range pixels by about 1.5 and reduce the mid-range pixels by 0.8.

Once these calculations have been applied to a piece of data the individual pings are placed on a geographic map. To emulate beamspreading the pixels are smeared over a small angle (0.8°) if no other data is present in those pixels. As survey tracks are designed to overlap the imagery at far-range, any overlapping data pieces are placed on separate layers of the same map. This allows user intervention to define the join where one piece touches the other. If small pixel gaps are visible between the geographically mosaiced pings, these are filled with an interpolated value plus a random amount of noise (but having the same variance as the surrounding data pixels).

The second phase (of mosaicing) allows the user to view all the 'layers' of data for an area. The software used is a commercial package named ERDAS Imagine (v9.1). Within this software the different layers can be displayed in different colours to distinguish the layers with data that will overlap data from another layer. In order to merge the different layers and their data together, polygons (Areas of Interest -or AOI) are drawn by the user to define the join lines between layers and then applied to create a single layer final image map. This procedure can also be used to remove shadow zones and areas of no data. The program that merges all data within selected AOIs into the final single layer image is called 'addstencil'. Several of these final images can then be mosaiced together into a big image from which maps can be created in different projections and spheroids, including scales, co-ordinates and text. Also annotation such as ship's track, vehicle track and dates and times can be added to the map. The map can then be plotted on the A0 plotter and/or converted into other format e.g. TIFF, JPEG, generic postscript etc. to be used for further analysis on PC, Macintosh or UNIX workstations.

Preliminary results

The TOBI data has partly been affected by water column heterogeneities (salinity and temperature differences) in the shallow waters of the survey area. This results in limited seabed coverage as some of the sound sent out is reflected off that water layer boundary rather than scattered back to the vehicle from the seabed. Nevertheless, some morphological features can be identified from the seabed: a slope failure deposit in the southern part of the area, pockmarks and big gullies in the northern section. Iceberg plough marks (IPMs) are found all along the shelfbreak, in particular in the far northeast of the survey area. Some IPMs are up to 100m wide and 1-2km long; they occur in water depths between 400-500m. The pockmarks appear as dark (low backscatter) circular spots of about 100-200m in diameter. These were found on two E-W running tracks downslope from the shelf, at around 78°45' N and 78°55'N. They clearly correspond to and area of bottom simulating reflectors (BSR). The gullies in the northern part of the survey area are several kilometres long and cross the TOBI records mainly from NE-SW.

7 CTD Hydrocasts

Thirteen vertical CTD hydrocasts were undertaken throughout the cruise, using a Sea-Bird SBE Model 11 system comprising conductivity, temperature, pressure and oxygen sensors, a transmissometer, 24-bottle rosette and a transponder for ultra-short baseline relative position determination. The conductivity sensors were calibrated onboard against conductivity of seawater sampled at various depths and determined using a Guildline autosalinometer that was calibrated against IAPSO standard seawater. One bottle (#14) failed to seal throughout and was not sampled.

Sub-samples of the 168 seawater samples obtained were taken for pCH4, pO2, carbon and oxygen isotopic compositions and nutrient assays. Duplicate sub-samples were taken for pCH4 to allow both onboard and onshore determinations to be made. pO2 was also determined onboard, using the Winkler method. Isotope measurements will be carried out at RHUL and NOC and nutrient assays will be completed at NOC.

8 Geochemistry coring

Introduction

Measurements of the chemical composition of sediment porefluids can be used to provide information as to (i) chemical reactions occurring in sediments, including diagenetic (redox) processes, (ii) advection and diffusion of chemical species both within sediments and across the seawater-sediment interface and (iii) the origin of those species. Thus, in areas for which there is evidence for active or recently active venting of methane, porefluid chemistry will provide information about the source, and fate, of methane gas above the hydrate stability zone. Such information is crucial for gas hydrate modelling.

Sampling

A total of 15 box cores, 6 gravity cores and 1 piston core were attempted at locations for which evidence was found for active or recently active venting of methane at the seafloor. Our strategy was first to take a box core (i) to assess whether the seafloor substrate was suitable for piston or gravity coring and (ii) to provide an undisturbed sample of the uppermost part of the sediment column. If the box core returned material that was suited to gravity or piston coring, a gravity/piston core was then taken.

Box cores were sampled by extrusion at intervals of 3-5cm. Gravity/ piston cores were split into sections of 50cm in length, and then split using a circular saw. Samples were taken at intervals from one half of the core; the other half of the core was preserved as an 'archive half'. Sediment samples were squeezed in a glove bag maintained under a nitrogen atmosphere to extract their porefluid.

Analyses

Analyses of headspace methane concentration, [Cl-], [SO42-], [Br-] and the nutrient elements were made on-board where possible. All alkalinity measurements were made on-board immediately after sampling. Samples have been collected for isotopes (C, O), cations, H2S and hydrocarbons C1-C6, for analysis back at NOCS.

Preliminary observations on geochemical analyses

Analyses of headspace methane concentration, alkalinity and the anions [Cl-], [SO42-] and [Br-] is now complete although final calibrations will need to be performed back in the laboratory. Unsurprisingly, cores 3, 4, 24, 26, 32 and 33 show highly elevated levels of methane while concentrations of SO42- fall to zero within a few cm of the seawater-sediment interface. Concentrations of Cl- are lower than that of contemporary seawater in several cores, which may be indicative of dissociation of gas hydrate.

Comments on the coring system

The box core provided an intact sample of the seawater-sediment interface in areas that were minimally affected by glacial deposits; it failed to close on several occasions if large rocks were present, as may be expected.

The piston core was used on only one occasion for geochemistry sampling. Although more than 9m of sediment was cored, the middle section of the core liner got stuck and we were unable to retrieve an intact record. Further attempts to utilise this system for palaeoceanographic studies produced only short (3m or so) cores, so the decision was made to stick to the gravity coring system. This was generally reliable, even in areas where the sediment surface was somewhat pebbly.

9 Sediment Coring

Coring during JR211 was performed with a standard large-bucket box corer, and a 6.5cm diameter piston/gravity corer. A limited number (nine) of 3 meter core barrels was available, which necessitated a conservative approach to piston/gravity coring.

We expected sediments with occasionally large ice-rafted rocks, especially close to the islands, as well as a variety of coarse gravely beds. We therefore opted for initial box coring to assess the nature of the sediment at each site prior to any piston/gravity coring. In practice, large rocks, measuring up to 25x15x10 cm, were encountered in box cores from even the deepest sites considered (∼1300 m). Consequently, the decision whether or not to deploy the piston/gravity corer was based on a qualitative assessment of the box core sediments in terms of general grain size and the abundance of (very) large clasts. Although qualitative, this procedure worked well, and only two slightly overambitious piston/gravity coring attempts resulted in a (∼ 30°) bent barrel. Especially at vent sites as identified from seismic, TOPAS, and EK60 surveys, the box corer occasionally failed to trigger, indicating that the bucket did not sink below the base frame into the sediment. This agrees with the survey data for these sites, which generally suggested a very hard (rocky) sea floor. In these cases, no piston/gravity corer was deployed. In none of the cases where a piston/gravity corers was deployed did the corer significantly over-penetrate. Hence, we are satisfied that the piston/gravity core material recovered represents the maximum possible with the available equipment.

Coverage of the outside of the core barrel with sediment suggests that, in all cases where it was deployed, the piston/gravity corer penetrated more than twice as deep as the length of sediment recovered. We consider the outside sediment cover on the corer to be accurately indicative of the total penetration, since the sediment was very sticky, and hard to remove even with a pressure hose. Two hypotheses were developed on board about the discrepancy between the corer's penetration and the length of the sediment sequence recovered:

1. The high friction within the narrow 6.5 cm barrel caused strong compaction of the sediment while the corer was penetrating. This hypothesis is supported by observations of similar rates of compaction (up to 60%) seen during insertion of core-liner tubes into box core sediments. This hypothesis would suggest that a sediment sequence may have been sampled by the piston/gravity cores that corresponds in original length to the corer's penetration depth (outside sediment coverage), but that it is represented in compressed form within the core barrel.

2. The high friction within the narrow 6.5 cm barrel caused the corer to penetrate and sample normally, until a 'plug' had formed within the barrel, which due to friction stopped riding up within the barrel. The corer would then have penetrated further into the seabed like a 'solid nail'. This hypothesis is supported by the fact that 60% compaction would be anomalously high, and that no pore fluid expulsion seemed to happen when sub-sampling the box cores. This hypothesis would imply that the piston/gravity cores sampled only the upper few metres of the sediment sequences.

The corer was used only a few times in piston-coring mode. This technique was abandoned, because it resulted in imploded core liners, which were impossible to extract in tact. The under-pressure that caused the liner implosions likely resulted from downward displacement of the sediment surface inside the liner as the corer penetrated into the sediment (either due to compaction of the sediment within the liner, or due to a lack of further sediment penetration into the liner, see above hypotheses), while the piston was held at the position of the original sediment surface. We tried a normally rigged piston and a more loosely fitting piston. In both cases, the liner imploded. Hereafter, we deployed the corer only in its simpler form, as gravity corer. In an attempt to optimise penetration, the flow valve at the top of the core barrel was removed. We are not sure if this made any significant difference.

Most of the objectives for coring during JR211 may have (just) been met: (a) We recovered cores from deeper waters that according to published sedimentation rates may just reach down into the Last Glacial Maximum. Unfortunately, we targeted to recover this in all cores, at least in 3 from the South and 3 from the North, and we may in reality have recovered it only from the deep sites in the North and - possibly -the South. It remains to be seen if this will suffice for a comprehensive palaeoceanographic interpretation of past hydrate activity. (b) We recovered a few cores with active methane hydrates for geochemical pore-fluid analyses. Again, only a few (2 in particular) were recovered, and it remains to be seen if significant regional interpretations will be possible from such a small number of sites. We completely missed our third objective, namely (c) to calibrate the geophysical information of subsurface acoustic sediment characteristics, because the recovered depth of sediment was too small to allow even the shallowest acoustically transparent layer to be penetrated.

Cores were taken for two disciplines of study: (1) geochemistry, and (2) palaeoceanography. Cores for geochemistry were sampled in 50 cm sections, then opened and analysed on board. Analytical details are provided in the geochemical section of the cruise report. Cores for palaeoceanographic studies were sampled in 150 cm sections, labelled, capped, and archived in tact at 4°C, for opening, logging, and further study in Southampton. Core catcher samples were retained for all cores, and will be specifically used for initial dating of the deepest level of penetration.

Overall, we note that much time was lost on making the best of a rather outdated 6.5 cm coring system in a difficult setting. This cannot be the most efficient use of NERC's shiptime. The more modern NIOZ coring system was not available because it was being used on another cruise. NERC might consider investment in a second NIOZ-type coring system, because that would - even on a relatively short term - represent a more efficient use of funds than the current waste of precious shiptime.

10 Air and water sampling and the equilibrator system

Collection of Air Samples

Spot samples of ambient air were collected throughout the cruise and the return to the UK. Sampling was at 12 hour intervals (usually at 08:00 and 20:00 GMT) from 23rd August to 23rd September 2008. The collection site was on the Navigation Bridge deck. The side of the ship was chosen depending on the relative wind direction so that collection of the sample was always upwind of any emissions from the ship. Additional air samples were collected at the CTD and core sites. Air was pumped into 5L Tedlar air bags (SKC Ltd.) using a small battery operated diaphragm pump.

In additional to the ambient air samples, a few samples of air were collected close to the funnel of the ship so that the isotopic composition of methane in the ship emissions can be determined which will help identify whether there has been any contamination of any of the ambient air samples by the ship.

Also, samples of gas released from the cores were collected when the cores were under an inert atmosphere (N2). Two samples of hydrate have been put in vials, each one connected to another one full of water with a double needle so that gas emission of the hydrates were injected in the second vials, taking place of the water. Then the gas samples were sealed and frozen.

The air (or gas) samples will be returned to the Atmospheric Monitoring and Stable Isotope Laboratory at Royal Holloway for analysis of methane mixing ratio by GC-FID (Gas Chromatography - Flame Ionisation Detector) and the stable carbon isotopic composition of methane (δ^{13}C) using a continuous flow GC-IRMS (Gas Chromatography - Isotope Ratio Mass Spectrometry) system. The results will be compared with measurements of air samples collected daily throughout the duration of the cruise at the Zeppelin Station in Ny-Ålesund, Spitsbergen.

Water Sampling

Seawater samples was collected from the Niskin bottles in the following order:

1. Water samples for oxygen (Darryl Green, NOC)
2. 240 mL glass bottles for onboard methane concentration analysis. The bottles were overfilled by 2 times their volume and then filled to the top and capped with a screw cap containing a silicone/rubber septum, ensuring that there was no headspace. The water was kept in a fridge at 4^{o}C until onboard analysis.
3. 1.8 mL glass vials for water δ^{18}O analysis. The vials were overfilled by at least ten times their volume and then filled to the top and capped with a snap-on cap containing a rubber septum ensuring that there was no headspace. The vials were kept in a fridge at 4^{o}C and sent to Royal Holloway for isotopic analysis after the cruise.
4. Nutrient samples (Darryl Green, NOC)

5. 2 litre and 1 litre multilayer bags for storage of the water for analysis of methane concentrations and $\delta^{13}C$. The bags were filled either using a diaphragm pump connected between the Niskin bottle and the inlet of the bag or by directly connecting tubing from the Niskin bottle to the bag. Once filled any bubbles of air that had entered the bag as it was filled were squeezed out before the bags were capped. The water samples were poisoned by injecting saturated mercuric chloride into the bags. 200μL of saturated HgCl solution was used per litre of seawater. The bags will be sent to Royal Holloway for methane concentration and isotopic analysis after the cruise.

Seawater Headspace Analysis

Methane concentration in the seawater transferred into 240 mL bottles from the Niskin bottles at each CTD site was measured on board the ship using a headspace technique.

The bottles were inverted and 24 mL of N2 (Air Products, BIP Plus) was injected into the bottles through the septum. An open ended needle was injected into the septum at the same time and seawater displaced by the injected nitrogen, so that there was a 24mL headspace of nitrogen in the bottles (10% of the volume of the bottles). The septa were covered with silicone sealant to ensure that the septa were still leaktight. The bottles were shaken on an orbital shaker for at least 2 hours, during which time the water temperature increased to room temperature and the seawater and headspace equilibrated. 250 μL of the headspace were removed using a syringe and injected into a GC-FID (HP 6850, supplied by NOC) for methane concentration analysis. The samples were each analysed three or four times. Concentrations were calculated based on peaks heights and calibrated using a working standard supplied by Scientific and Technical Gases (1.9 ppmv CH4) which was analysed regularly throughout each set of analyses. The working standard will be measured against NOAA air standards at Royal Holloway after the cruise to check the calibration and ensure that all data is on the NOAA-04 scale.

Methane and Carbon Dioxide Equilibrator

An automated equilibrator and GC (supplied by NOC) were set up in the main laboratory to measure the flux of methane and carbon dioxide between the sea surface and air.

The equilibrator is of the design described by Rehder and Suess, 2001. Seawater pumped to the main laboratory from the ship's non-toxic surface water supply flowed continuously through the equilibrator vessel at 3 L min-1. The seawater entered the vessel from the top through a 45 cm glass column. The volume of the equilibration vessel is approximately 2 litres. Air recirculated through the vessel using a pump via a back pressure regulator; the air entered the equilibration vessel at the base and was dispersed into bubbles through a coarse glass frit to ensure a large surface area for the equilibration. A vent ensured equilibration at ambient pressure. This vent was closed only when a sample was pumped from the equilibrator to the GC to avoid pumping ambient air to the GC at this time. The temperature in the equilibration vessel was logged at ten minute intervals.

The GC-FID (HP 7890) measures methane and carbon dioxide mixing ratios. Carbon dioxide is measured by conversion of carbon dioxide to methane in a methaniser. The air was dried by flowing through a Sicapent drier before entering the GC. The input to the GC is selected using an automated 6 way valve. The GC was set up to analyse a working standard, outside air, equilibrated air and finally outside air again every half hour. Thus air from the equilibrator was analysed at half hourly intervals and ambient outside air was analysed at 15 minute intervals. The ambient outside air was pumped along $\frac{1}{4}$" tubing from an inlet above the ship's bridge. The working standard (1.9 ppmv CH4, 320 ppmv CO2) from Scientific and Technical Gases Ltd.) will be calibrated against NOAA cylinders at Royal Holloway after the cruise to ensure all data is on the NOAA scale.

References

Rehder, G. and E. Suess, 'Methane and pCO2 in the Kuroshio and the South China Sea during maximum summer surface temperatures', Marine Chemistry, 75, 89-108, 2001.

11 Simrad EK60 hydroacoustic surveying

Overview

During cruise JR211 we undertook a continuous survey of water column acoustic backscatter properties using the RRS James Clark Ross shipboard hull mounted Simrad fisheries EK60 system. The immediate aim was to map, if possible, the occurrence of gas bubbles in the water column, as had been achieved previously in similar studies (e.g., Sauter et al., 2006). The EK60 system is generally designed, and primarily used, for fisheries research, in which case the acoustic reflective properties of fish and zooplankton are imaged, specifically the occurrence of fish buoyancy air bladders. It was unknown prior to the cruise whether the RRS James Clark Ross EK60 system would be suitable for the stated purpose under survey conditions (water depth, bubble size), and what type of result one might expect for active plumes.

Equipment

The James Clark Ross is equipped with a split-beam, multi-frequency transducer system that operates at 38kHz, 120 kHz and 200 kHz. The system is potentially affected by turbulent flow and bubbles around the hull, as well as noise during dynamic positioning bow thruster operations. However, these effects appeared to be negligible during operations, apart from a few occasions during rough sea states in combination with a ship's heading against the predominant current direction from south to north (the West-Svalbard current, up to 1 knots). The split beam transducers are located within the transducer space in the hull, transceivers (GPTs) are located in the gravimeter room. Two user workstations are located in the Underway Instrument Control room (UIC), and are isolated from general computer network. Bottom detection, echo integration and target strength algorithms are all implemented in software, with separate computation within each transceiver channel. The system is able to record, as part of the data stream, navigation and motion information from the ship's systems. Apart from the initial day of the cruise, during JR211 the data stream was supplemented with Seatex/Seapath200 GGA NMEA GPS location datagrams. In principle, and desirable for future cruises, additional attitude, and gyro orientation data would be useful (see processing and recommendations). The system requires calibration, ideally for each cruise. The last calibration, using copper spheres as reflective acoustic target, was apparently performed during JR210. The latest paper record of calibration results found in the shipboard manuals dated 3 Sept 2002, performed by a Bjorn Ford. Consultation with the ship's deck engineer (Simon xxx) indicated that the 38kHz transducer is mounted between ship frames 81 and 82, ca. 79.8m centrally ahead of the aft (taken from file "gps antenna locations (new).gif", prepared by Pete Lens, April 2007. The 120kHz and 200 kHz transducers are mounted between frames xx and xx, ca. xx.xm centrally ahead of the aft. The Seatex/SeaPath200 GPS location is 11m aft from frame 66, near frame 50, putting the 38kHz transducer offset approximately 22.05m ahead of the used GPS navigation point. Apart from the stern-most frames, ship frames are 70cm long.

Data logging

The data output from the EK60 is logged primarily in two types of "raw" data files, which were archived during and after the cruise as part of the standard data collection protocol on the read-only "legdata" drive. The .raw files record data and transceiver settings for all three frequencies in a single file in the form of "datagrammes". The binary format is fully open and documented, and can be found at
http://www.simrad.com/www/01/nokbg0397.nsf/AllWeb/
62D6EBE0D8EEB97CC125718E004B41C7?OpenDocument The .raw file contains, for each trace or ping, the full record of received acoustic power, as well as the alongship and athwartship directional information obtained through the split beam set up. In all cases, positive degree angles correspond to the starboard side for athwartship, and foreward for alongship directional information. In principle, all data can be fully reconstructed from these raw files, which also contain the navigational data stream. There is also an additional, much smaller, ".out" binary file, which records the calculated bottom detection depth, absorption coefficients, and total reflection, for each data point and frequency. For each "line", there is one ".out" file, and one or more ".raw" files, which get generated as soon as a file reaches about 250MB in size. Additional calibration and metadata (selected sound velocity, pulse lengths and recording intervals etc., are also logged in the raw files. "Lines" are changed manually by the operator, by clicking on a non-intuitive, and rather small, display of the line number in the bottom status bar of the EK60 software. The system is only recording when the line number is displayed in red, and incremented by clicking the line number once to switch off logging, and again to reengage it. In addition, a ring-buffer of display screenshots is saved if the correct and writeable location is set in the preferences (here "legwork/EK60/history"). If this directory is set, up to 400 .bmp format screenshots are saved, each one approximately recording 30 minutes of recordings as a digital paper trail. Once GPS data are supplied, the system was set to place GPS location marks on top of the screenshot, which in a few cases led to short plume data being hidden. In addition, a short vertical tick mark is added for each minute of time. The continuous loop is full after about 4-5 days, after which the system starts to overwrite existing files, starting with the oldest. We routinely collated the existing .bmp files as PDF binders in separate files, and then collated all data for the entire cruise in a single PDF file (1089 pages, "legwork/EK60/JR211_EK60_HistoryToEOL.pdf"). An example of the actual operator screen, as well as the recorded "screenshot" is shown in Fig. 11.

Operations, Configurations and technical details

Appendix 20 lists the main configuration details of the EK60 system, as used during JR211. Calibration data are stored within the .raw files, and were obtained during the most recent calibration. The most pertinent ones are the along and athwartship beam angles for the three different frequencies and transducers. These are of the order of 7 degrees in each direction, resulting in a typical footprint of 2xsin(7)x1000m $\sim$250m for 1000m water depth, and $\sim$75m for 300m water depth. Of the three different frequencies available, the 38kHz proved the most useful, as the returned signal stood out above the noise down to water depths exceeding 1500m, whereas the 120kHz channel only resolved features down to approximately 350m, and the 200kHz one only for the top 50-80m below sea surface. The pulse length of the emitted signal was set to 4.096 milliseconds for the 38kHz transducer, and the assumed sound velocity was 1470m/s, as determined during the first CTD (CTD-1) experiment. During cruise JR211 a large number of different active acoustic instruments were used (TOPAS depth profiler, EM120 multibeam swath, EK60 "fishfinder", EA600 depth sounder, 3.5 kHz subbottom profiler), which required some experimentation to obtain the optimum triggering sequence. For most of the survey, data acquisition rate was controlled by the EM120 instrument, resulting at a typical ping rate for the EK60 of 4-5 seconds, at a typical survey speed of 5 knots during multi-channel seismic operations, and 2.5 knots during TOBI and side-scan towing experiments, resulting in a typical EK60 horizontal ping rate of 1/12m at 5 knots. Although the EK60/ER60 data acquisition software does have the ability to auto-range according to the detected bottom depth, during cruise JR211 this task was conducted manually, and independently for each frequency channel. This setting determines the number of data traces recorded, with typical sample numbers per ping of 600-800 (38kHz), and 2000-3000 (120; 200kHz). Data inventory The complete data set is available through binary ".raw" and ".out" data files in "legdata/ek60". Recorded data files are listed in Appendix N, with line start positions, times and ping numbers in Appendix O, available both as .xls and .pdf files. Digital "screenshots" of the processing screen are collated in the 1089 page file "legwork/EK60/JR211_EK60_HistoryToEOL.pdf". A subset of data for the 38kHz channel was processed for true bubble position in UTM zone 32X coordinates, and are placed as gzipped text files under "legwork/EK60/rotated_data"

Methods of data visualization

For a quick reconnaissance, the screenshot .pdf file should be adequate, with the caveat that if the seafloor is plotted close to the top of the screens, some occurrences of features might be hidden underneath the GPS location labels. The raw data (both integrated reflection amplitude, as well as alongship and athwartship directional information) can be read and visualised using the software "Echoview" (Myriax, http://www.echoview.com/). A trial version of this software was installed on the EK60 processing unit, but times out after approximately 10 minutes of use, and disabled export and printing functions. There is apparently a free reduced feature application from the same company called "Echolog". A copy of the trial version of Echoview used during JR211 for mapping of plume features by Kate Thatcher has been placed on "legwork/EK60/Echoview_trial_software/EchoviewSetup.exe" (Windows XP). The true value of the EK60 system with a split-beam setup is that it allows the extraction of directional information for each acoustic return through the recording of alongship and athwartship directional angles as well as the returned power. This type of data is not sufficiently visualized in the basic processing software, but a limited view can be obtained through "anglogrammes" that display the direction for each return, and available in the EchoView software. It is important to extract and use the directional data, as on a pure amplitude waterfall display, the transducer will "see" acoustic returns ahead and behind the ship's true position, as well as sideways (see "Processing").

Processing

Beyond the automatic processing steps that are built into the EK60 software such as algorithmic bottom detection, little processing of data is done within the shipboard's software. Instead, it is possible to extract the raw data from the .raw and .out files, using a set of Matlab scripts developed by Rick Towler (NOAA Alaska Fisheries Science Center), and available from (http://www.imr.no/om_hi/organisasjonen/forskningsgrupper/observasjonsmetodikk/prosjekter/echolab/matlab_code , and directly from http://www.imr.no/__data/page/6882/EchoLab_readEKRaw_ver1_0.zip) This software was adapted by H. Pälike to run on Octave (a Matlab clone, http://www.gnu.org/software/octave/), and subsequently (postcruise) substituted by much faster custom C-language code. These tools allowed the extraction of all directional angle information for each sample of each ping, which was then used to calculate the spatial source for each return with respect to the ship's position, as well as in absolute terms. This approach produces true three-dimensional representations of acoustic returns within the EK60 transducer footprint, which was then visualized in three dimension using the software "Datatank" (http://www.visualdatatools.com/DataTank.html). The main procedure to convert the recorded range data into positions consists of the following steps:

1. Conversion of the ship's position information from WGS-84 longitude and latitude to UTM coordinates in meters (x coordinate as Easting, y coordinate as Northing). The chosen UTM zone for JR211 was 32X, although this does not affect the actual conversion. Range information was used as z-coordinate, with positive depth values.

2. Each ping UTM coordinate was then rotated using the following rotation matrices:

$$R_x = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & cos(\phi) & -sin(\phi) & 0 \\ 0 & sin(\phi) & cos(\phi) & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}, R_y = \begin{pmatrix} cos(\psi) & 0 & -sin(\psi) & 0 \\ 0 & 1 & 0 & 0 \\ sin(\psi) & 0 & cos(\psi) & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}, R_z = \begin{pmatrix} cos(\gamma) & -sin(\gamma) & 0 & 0 \\ sin(\gamma) & cos(\gamma) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}, \quad (1)$$

   where ϕ is the alongship angle (positive for fore), ψ is the athwartship angle (positive for starboard), and γ is the ship's bearing.

3. Using x,y,z,0 vectors, the bearing corrected offset from the GPS position to the 38kHz transducer is given by

$$rotated\_offset = \begin{pmatrix} 0 \\ 22.05cm \\ 0 \\ 0 \end{pmatrix} .R_z \quad (2)$$

4. The corrected position of the acoustic return is given by

$$new\_position = \begin{pmatrix} UTMx \\ UTMy \\ depth \\ 0 \end{pmatrix} .R_x R_y R_z \quad (3)$$

   6) And the final position is then obtained by adding the GPS - transducer offset:

$$final\_position \begin{pmatrix} UTMx \\ UTMy \\ depth \\ 0 \end{pmatrix} = new\_position \begin{pmatrix} UTMx \\ UTMy \\ depth \\ 0 \end{pmatrix} + rotated\_offset \begin{pmatrix} offsetX \\ offsetY \\ 0 \\ 0 \end{pmatrix} \quad (4)$$

For performance reason, these steps were performed with a custom written software making use of parallel (vector) processing units, resulting in a processing time of a few seconds for the rotation of each line with several thousand pings. A small number of lines was processed in such a manner, and the resulting text files with (UTMx. UTMy, -depth, acoustic power, seafloor depth) records were generated and are placed on /legwork/EK60/rotated_data as gzipped ASCII text files, clipped to acoustic returns between -90 and -50 dB. This will need to be done for all lines post-cruise, using the ship's gyro bearing rather than GPS calculated bearings to avoid artifacts during slow ship speeds.

Preliminary indications from data

1) Main occurrence of plume type features during JR211

Towards the end of the expedition, Kate Thatcher undertook a visual examination of recorded data in EchoView to map and locate the large number of apparent plume structures observed during the cruise. These results are summarized in Appendix P, and shown in map view in Figure 15. In total, apparently close to 200 plumes were mapped and identified, with over 390 individual entries (some plumes will have been logged more than once, due to the close spacing of survey lines in some areas). A full quantitative evaluation will have to await further shore-based analysis, using the fully 3D migrated data set from all survey lines. Figure 15 shows that the majority of observed plume type features occur within the 150-400m bathymetric range (near the current gas-hydrate stability zone), particularly in the SE part of the survey area, in fairly concentrated "plume fields". Additionally, isolated plumes were found in deep waters above pock-mark bathymetric features, for example on top of the Vestnesa ridge in ca. 1200m water depth. Most observed plumes are well imaged to about 100-150m above sea-floor, however there are examples where the apparent plume reaches to within 100m or closer of the sea-surface (e.g., near CTD-10), or rise more than 400m up in the water column (again, on the Vestnesa ridge, see "Plume geometry"). Within the concentrated plume fields, strong activity was observed during several return visits, separated by up to 2.5 weeks. We did find at least three examples where plume activity had ceased upon a return visit. This includes the plume type feature above the Vestnesa ridge. All observed plume structures showed an offset of the upper part of the plume type structures towards the North, which we interpret to be caused by the West Svalbard Current system, which extends at least down to 700m water depth in this area, with a current speed of 0.5-1 knots (Cokelet et al., 2008).

2) Rising velocity of bubbles

During stationary periods of the survey, primarily during CTD cast operations, the ship was DP positioned above or close to apparent plume features. This allowed a preliminary determination of vertical bubble rise velocity, because at most sites where the ship was stationary, we observed a pulsing type behaviour in the strength of the acoustic returns. Vertical rising velocities were determined crudely by measuring the time one such pulse takes to rise a certain vertical distance. Example calculations from EK60 line 40 (during CTD-7) give a rise velocity of between 20 m/4 minutes

(8cm/s) to 40 m/7 minutes (10 cm/s). At the location of CTD-10 (line 78), a velocity of 25 cm/s was estimated (Figure 16). The first two estimates are compatible with bubble sizes between 2mm and 1cm (REF).

3) 3D-migration of EK60 combined directional and amplitude data

Our 3D migration of the EK60 data allowed a preliminary visualization of one of the most concentrated plume fields in the SE of the area (see Figure 14), as shown in Figure 17. There, an extremely dense survey was conducted, such that the ship track was close enough together to provide overlapping EK60 footprints over the plume area. In one particular example, close to the CTD10-12 survey area, acoustic backscattering of a strong plume type feature almost reaches the sea-surface from a depth of about 350m. Another spectacular example is provided by the pockmark flare on Vestnesa ridge (discovered by Anya Crocker). This is an example of a plume that became inactive over a 5 day period. 3D migration allows the detailed mapping of where the plume base eminates from with respect to the sea-floor bathymetry. Eventually it will be possible to add the TOPAS subbottom profiler data to the view. Figure 18 shows the traditional EK60 processing software view of the plume (amplitude only), whereas Figure 19 shows the 3D migrated data together with EM120 multibeam data.

Recommendations:

It would be useful to feed the gyro bearing data into the EK60 system as additional NMEA datagrammes, and also attitude data (heave,pitch,roll). This would ease processing. Initially a cable was missing for the GPS feed from the SCS logger. This must be carefully checked at the beginning of each cruise. The operator should be reminded when and if the system is recording.

References

Sauter, E.J., et al., 2006, Methane discharge from a deep-sea submarine mud volcano into the upper water column by gas hydrate-coated methane bubbles, Earth Planet. Sci. Letters 243, 354 - 365, doi:10.1016/j.epsl.2006.01.041.

Cokelet, E.D., Tervalon, N., Bellingham, J.G., 2008, Hydrography of the West Spitsbergen Current, Svalbard Branch: Autumn 2001, Journal of Geophys. Res. 113, C01006, doi:10.1029/2007JC004150.

Missing references for bubble size calibration, Tromsoe and NHS multibeam data for FigEK60-3.

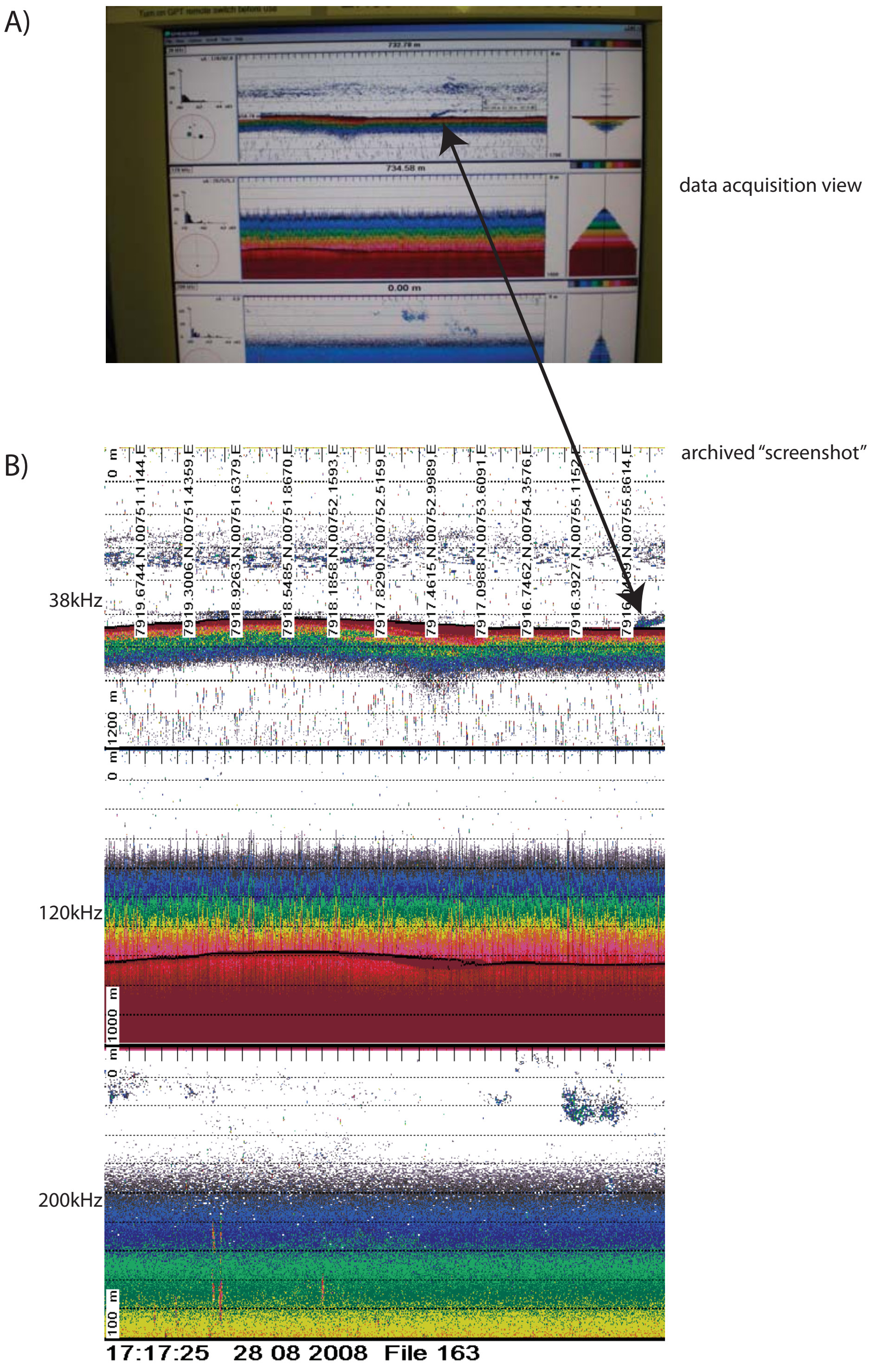


Figure 11: Illustration of screen display and digital "hardcopy" for EK60 data.

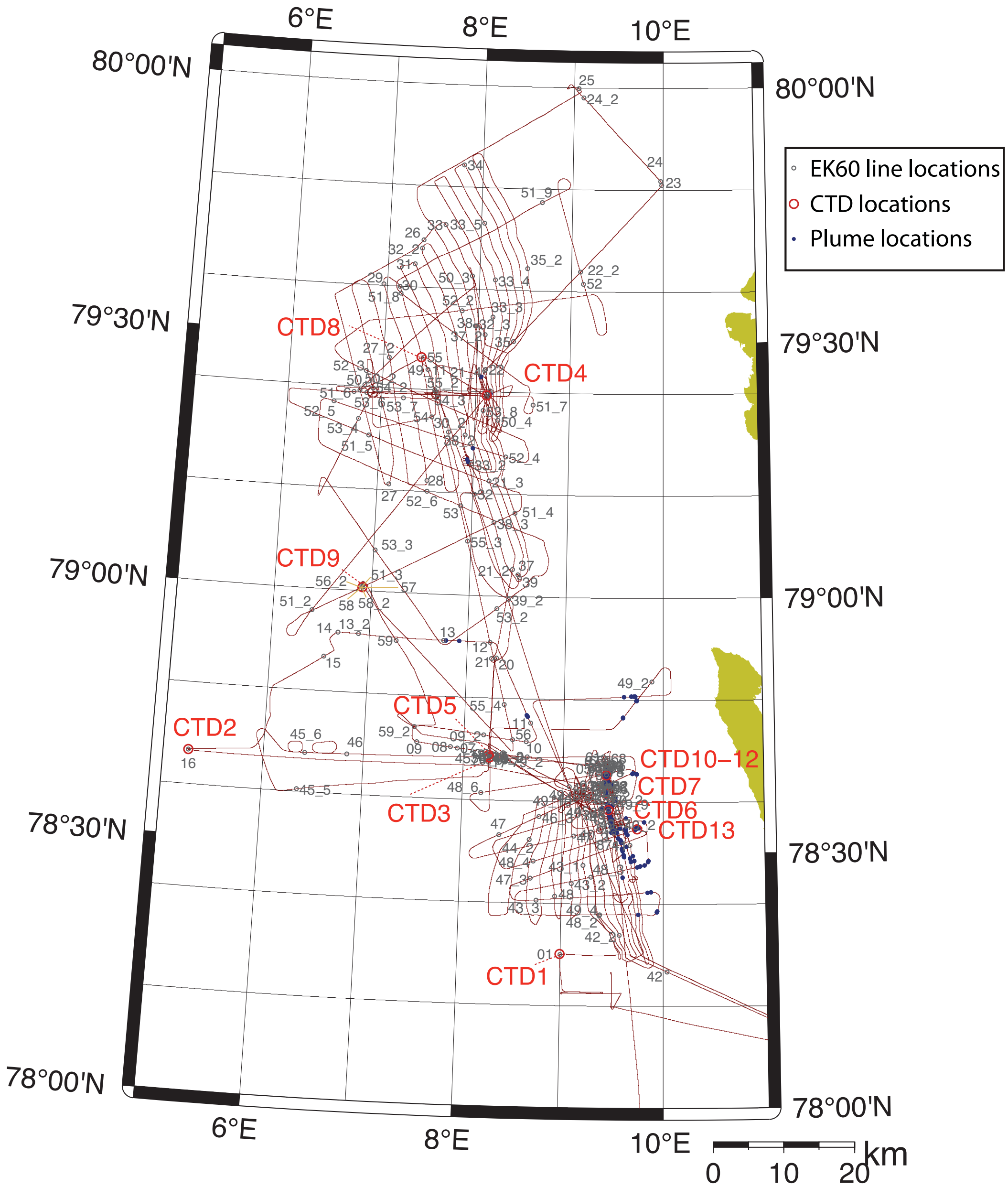


Figure 12: Survey line from JR211, and start position of EK60 lines (Appendicies N, O). Also marked are CTD stations, and mapped plume locations (Appendix P).

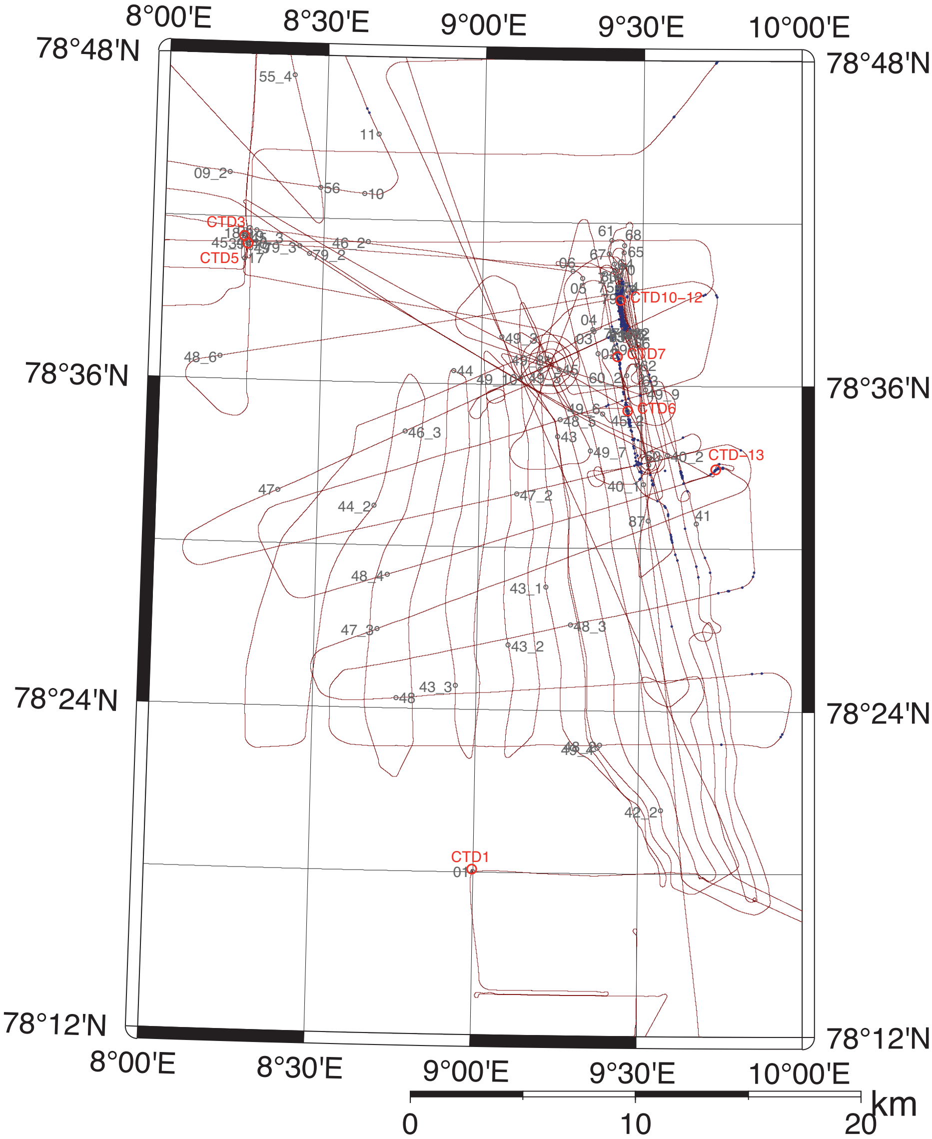


Figure 13: As Figure 12, but a close up of the SE survey area.

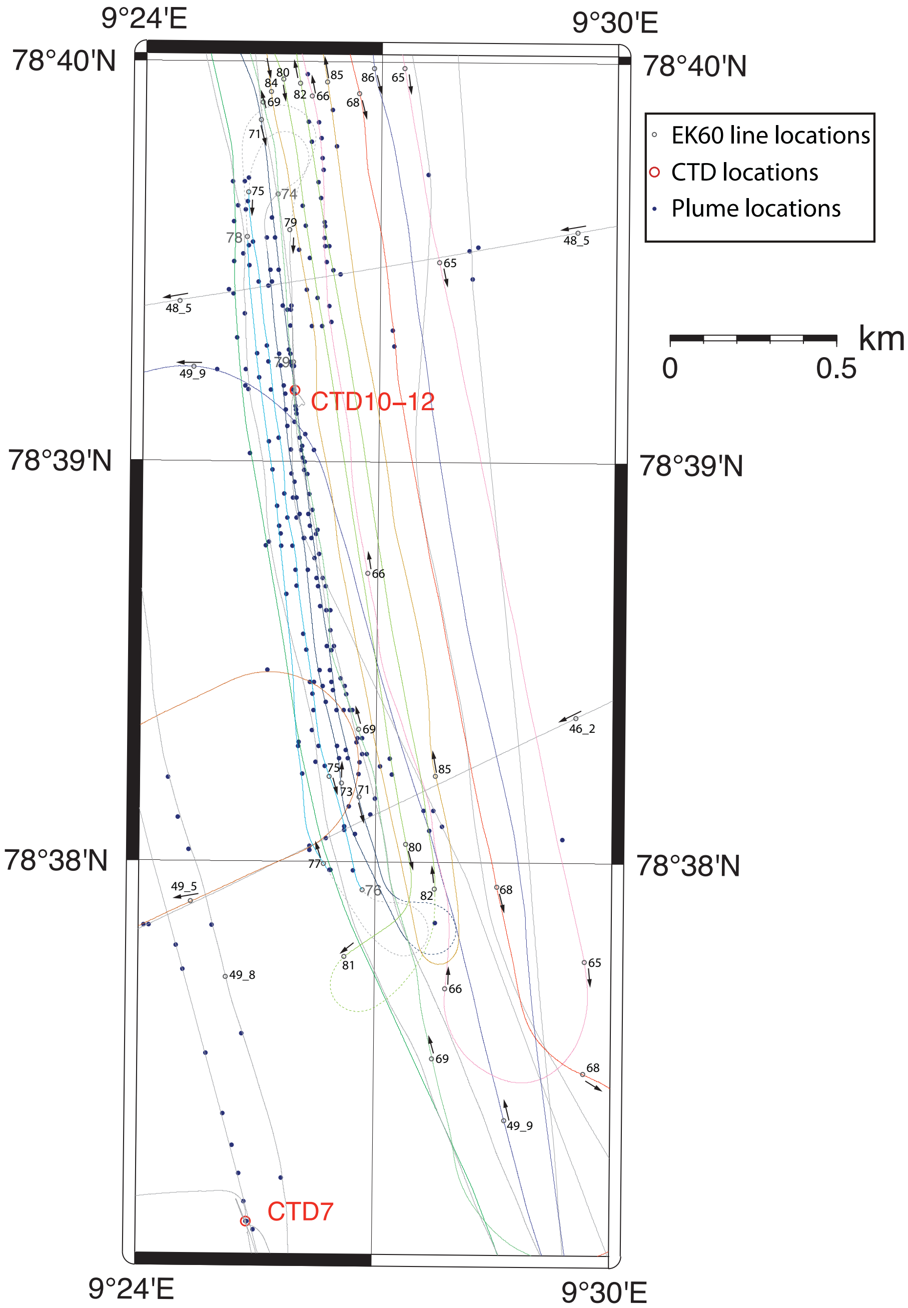


Figure 14: As Figure 13, but a close up of the detailed plume field survey.

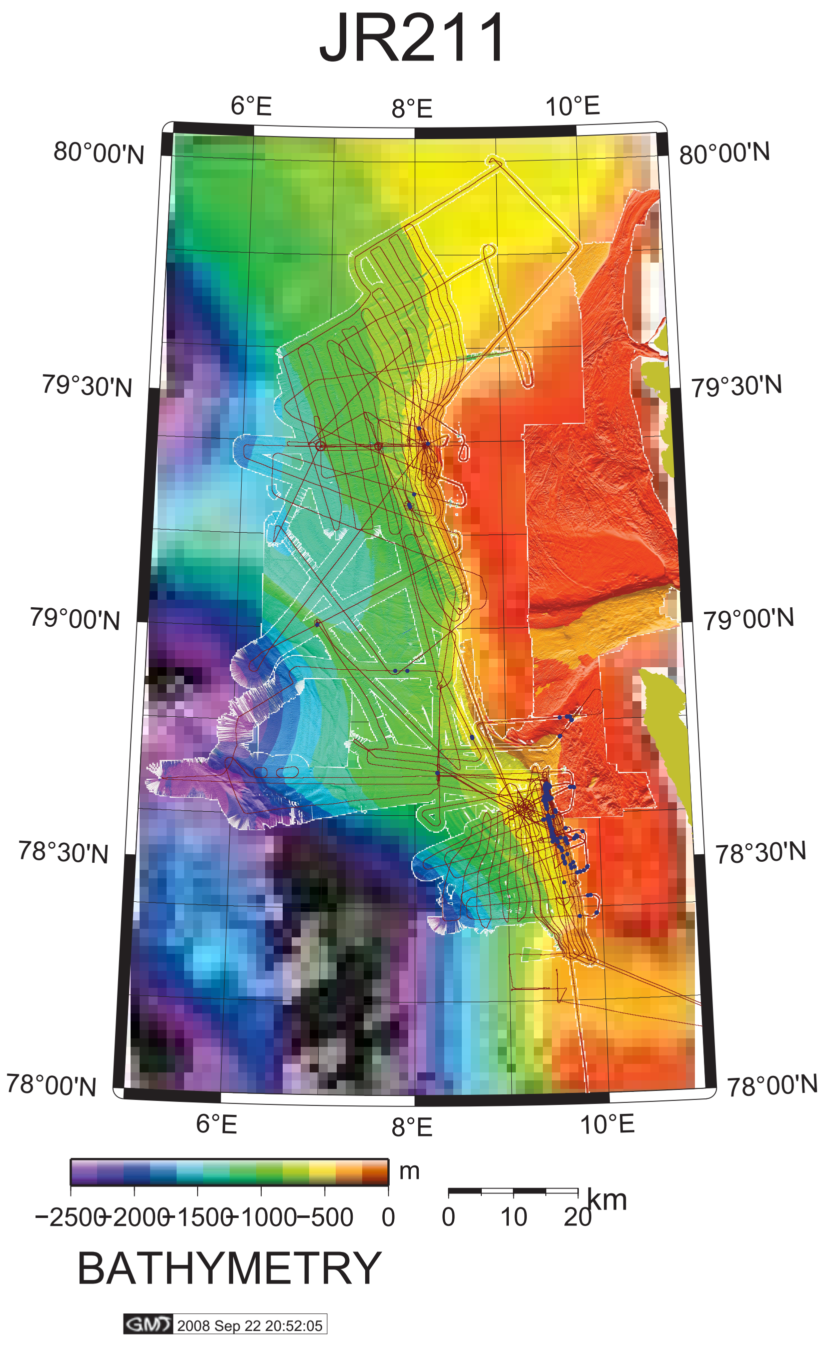


Figure 15: Bathymetric chart of the survey area, combined from 1) high-resolution data from the Norwegian Hydrographic survey (to the East), 2) multibeam data from Tromsø University (REF, Mienert et al.???), and a sparsely MB-system processed version of our new survey data, with location of plume observations superimposed (blue filled circles).

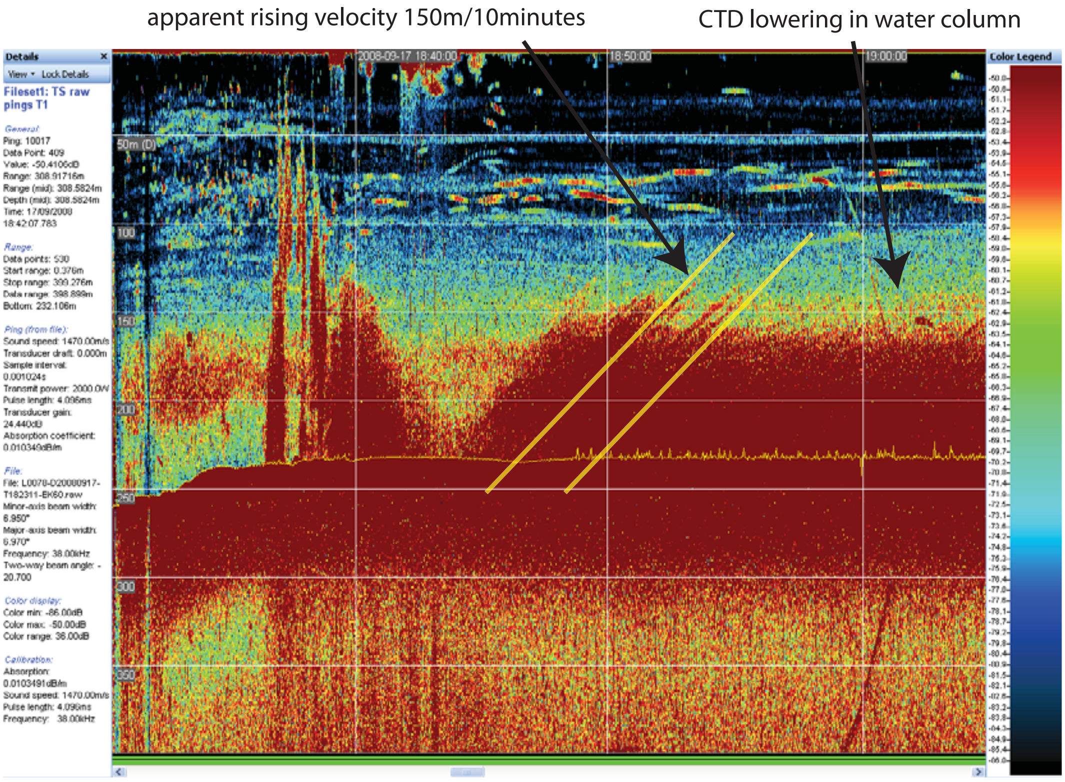


Figure 16: Example of pulsing plume field underneath stationary ship during CTD survey, allowing determination of bubble rising velocity.

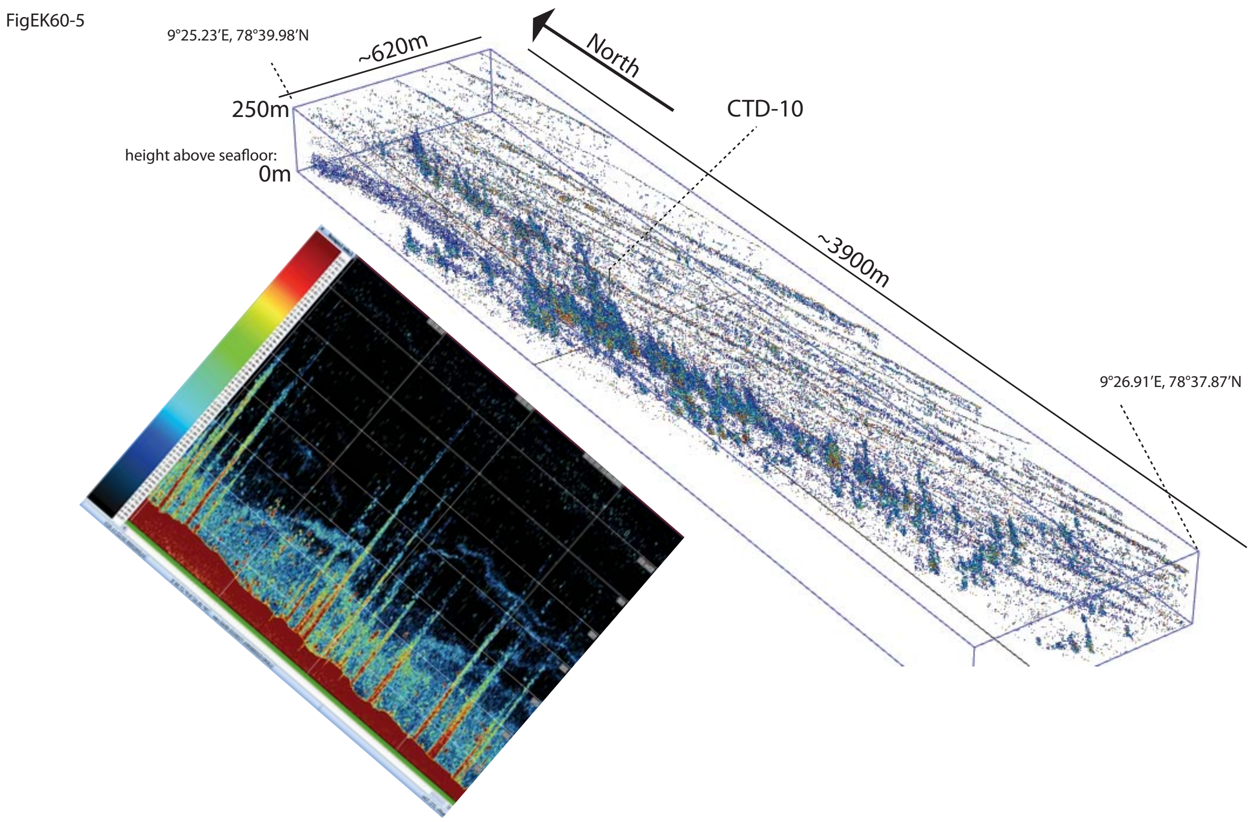


Figure 17: 3D visualization from dense Plume field survey, using 3D migrated EK60 38kHz data. Within our visualization software, the field of view can be freely rotated in all directions.

Plume structure observed above 10-20m deep, 200m wide pockmark on Vestnesa Ridge on Julian Day 255 (2008/09/11). This plume had switched off upon a return only 5 days later. Plume rises to 800m waterdepth.

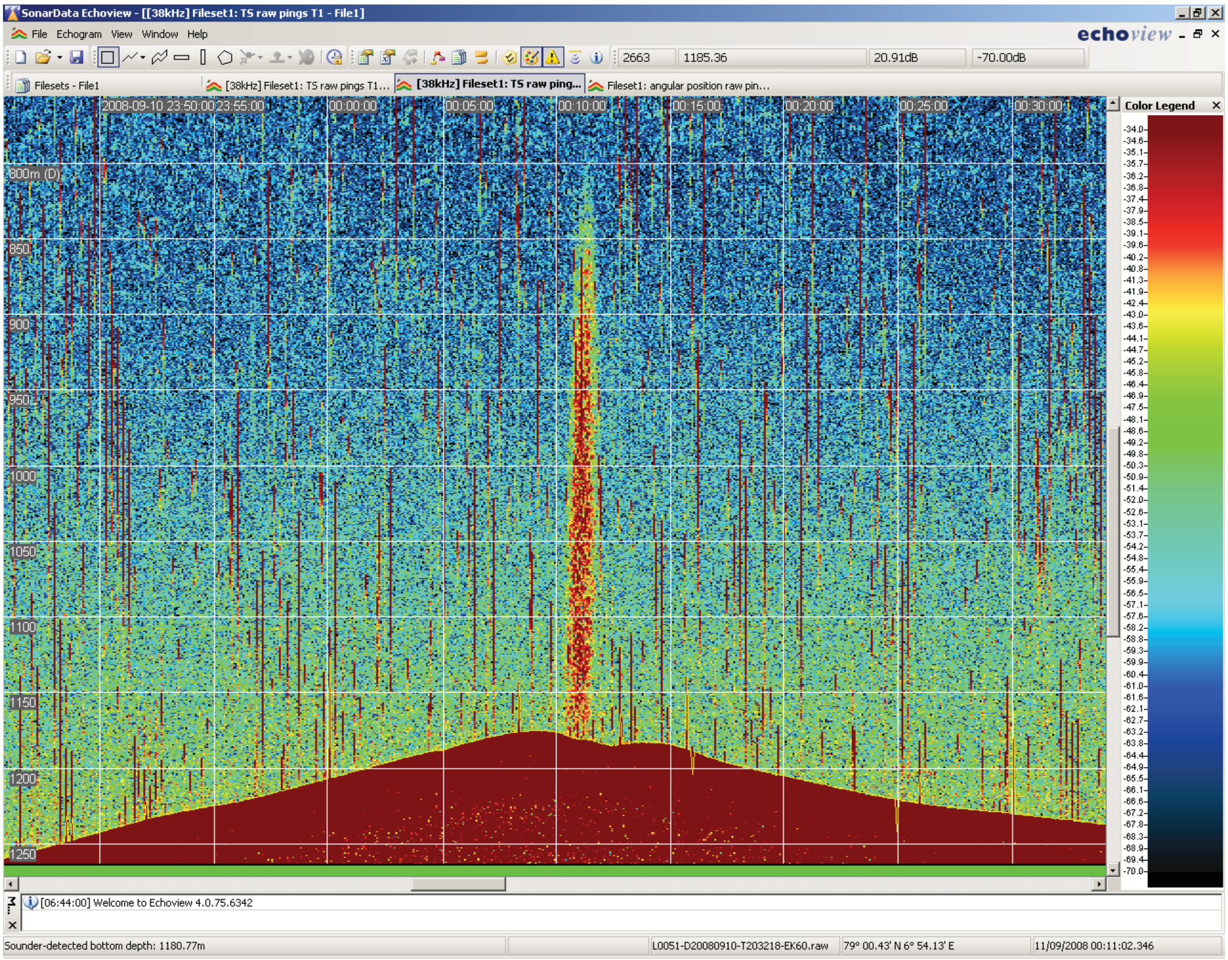
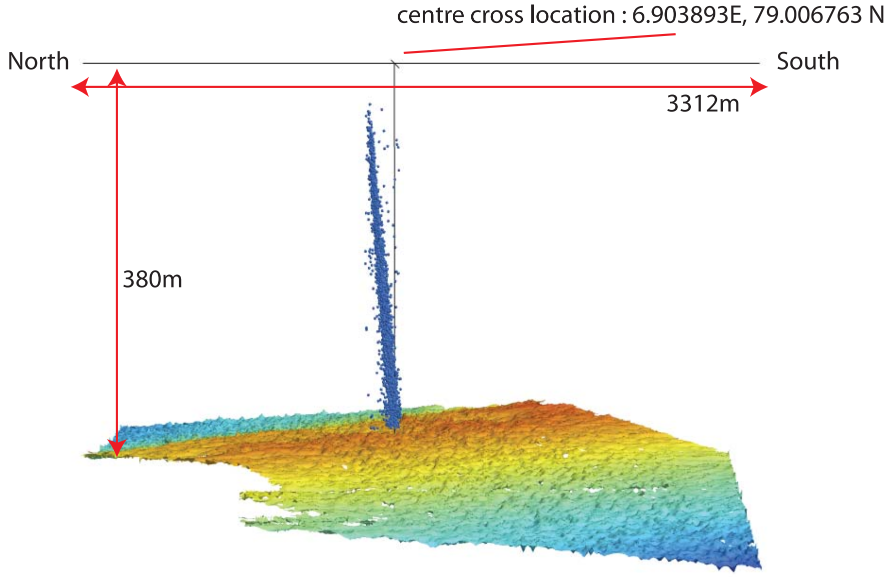


Figure 18: Intermittent plume above Vestnesa ridge pockmark.

A) Horizontal view from W to E of Vestnesa plume in 3D, plotted on top of EM120 bathymetry. The cross hair is centred at the upcurrent (S) side of the base of the plume, and from a sea-floor depth of 1180m to 800m. Slope between "flare" and vertical is 19 degrees.



B) Oblique view of 3D plume visualization.

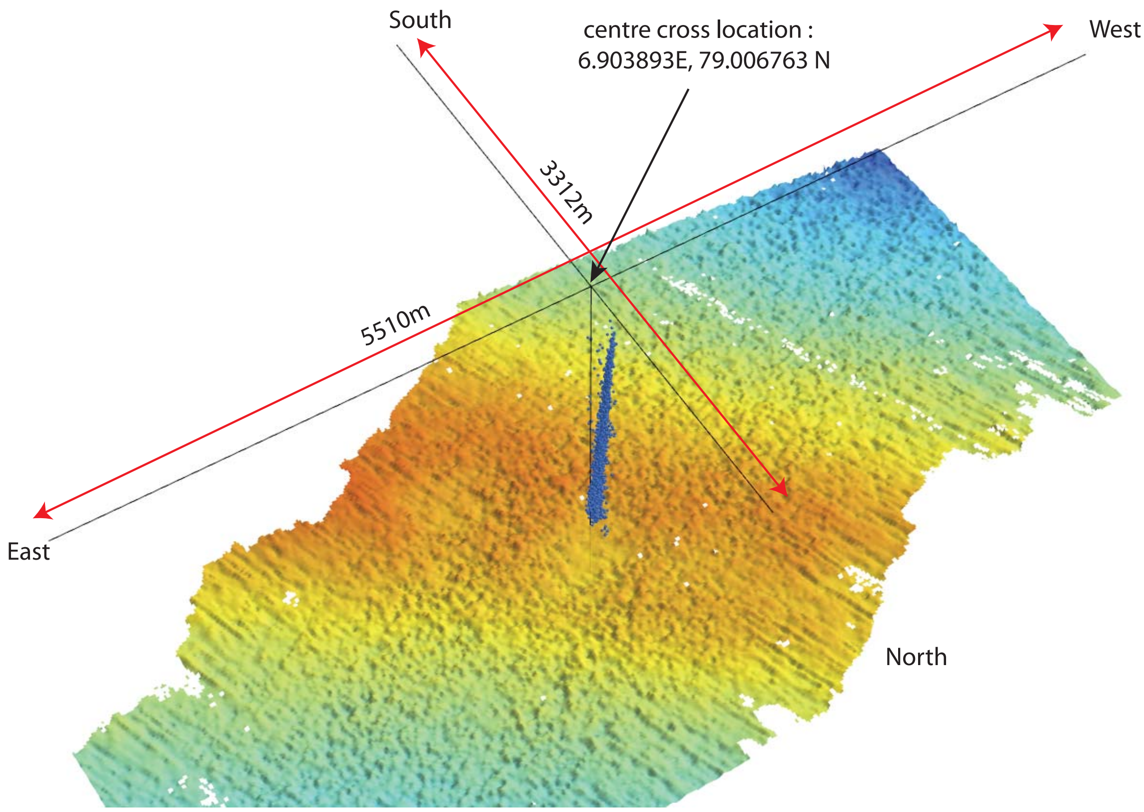


Figure 19: 3D version of EK60-6.

Table EK60-1

Setting	Transducer **38kHz**	**120kHz**	**200kHz**
Serial numbers of transducers	GPT 38 kHz 009072033fa5 1 ES38 GPT 120 kHz 00907203422d 1 ES120-7 GPT 200 kHz 009072033f91 1 ES200-7		
Beamwidth alongship [deg]	6.95	7.39	6.66
Beamwidth athwartship [deg]	6.97	7.36	6.83
Absorption coefficient	0.010349	0.03017	0.043266
Angle offset athwartship [deg]	0.00	-0.20	-0.11
Angle offset alongship [deg]	-0.17	-0.07	-0.22
Angle sensitivity athwartship	22	21	23
Angle sensitivity alongship	22	21	23
Equivalent beam angle [dB]	-20.70	-20.70	-19.60
Gain [dB]	24.44	22.31	23.79
Gain table	24.00	22.80	24.80
	24.36	24.22	26.10
	24.16	25.35	20.00
	25.50	25.40	26.30
	24.44	22.31	23.79
Pulse length [ms]	0.004096	0.001024	0.001024
Available Pulse length table [s]	0.000256	0.000064	0.000064
	0.000512	0.000128	0.000128
	0.001024	0.000256	0.000256
	0.002048	0.000512	0.000512
	0.004096	0.001024	0.001024
Sa correction table [dB]	0.00	0.00	0.00
(for avail. pulse lenghts)	-0.84	0.04	0.00
	-0.74	-0.45	1.50
	0.00	0.00	0.00
	-0.33	-0.41	-0.32
Sample interval [s]	0.001024	0.000256	0.000256
Sound velocity [m/s]	1470	1470	1470
Transducer depth [m]	0	0	0
Transmit power [W]	2000	1000	400

Figure 20: Detailed calibration and sample acquisition details for the 38kHz, 120kHz and 200kHz transducer channels of the EK60 onboard the RRS James Clark Ross during JR211.

12 Sidescan sonar operations

Sidescan sonar and logging system

The shallow water sidescan equipment used was an Ultra Electronics Model 3050E Widescan with a digital logging system. It is a lightweight dual frequency (100/325 kHz) high-resolution system capable of operations down to 300m water depth. The standard system provided by the National Oceanography Centre, Southampton (NOCS) consists of a sidescan sonar towfish, a Signal Processing Unit with basic image correction and gain control, and a 23cm thermal chart paper recorder (Fig. 21). The NOCS system is modified to allow full digital raw data acquisition for onboard and post-cruise 'state-of-the-art' image processing using PRISM software suite, developed at NOCS. All sidescan data were recorded online digitally on a PC disk as well as paper printout. Navigation data were collected with a Furuno DGPS system located on the bridge deck and also stored on the PC.

Figure 21

Winch

The winch used for this survey was a 3-phase electric oceanographic winch (380V/4kW) manufactured by Seatronics Ltd. With remote control, cable counter and approximately 850m double armoured coaxial conduction cable (Fig. 22). The connection between sonar acquisition unit in the lab and the winch (with sidescan sonar towfish) was done with a 100m lightweight Kevlar cable. A remote control camera on the winch allowed the operator to keep an eye on the spooling at the same time as hauling in or paying out cable. The maximum payout of cable was 790m for a water depth of approximately 300m. Lengths of cable could have been reduced if a depressor weight had been used to get the towfish sufficiently close (10-15% of the survey range used) to the seabed but none were available. Maximum speed for hauling and payout was close to 1m/s.

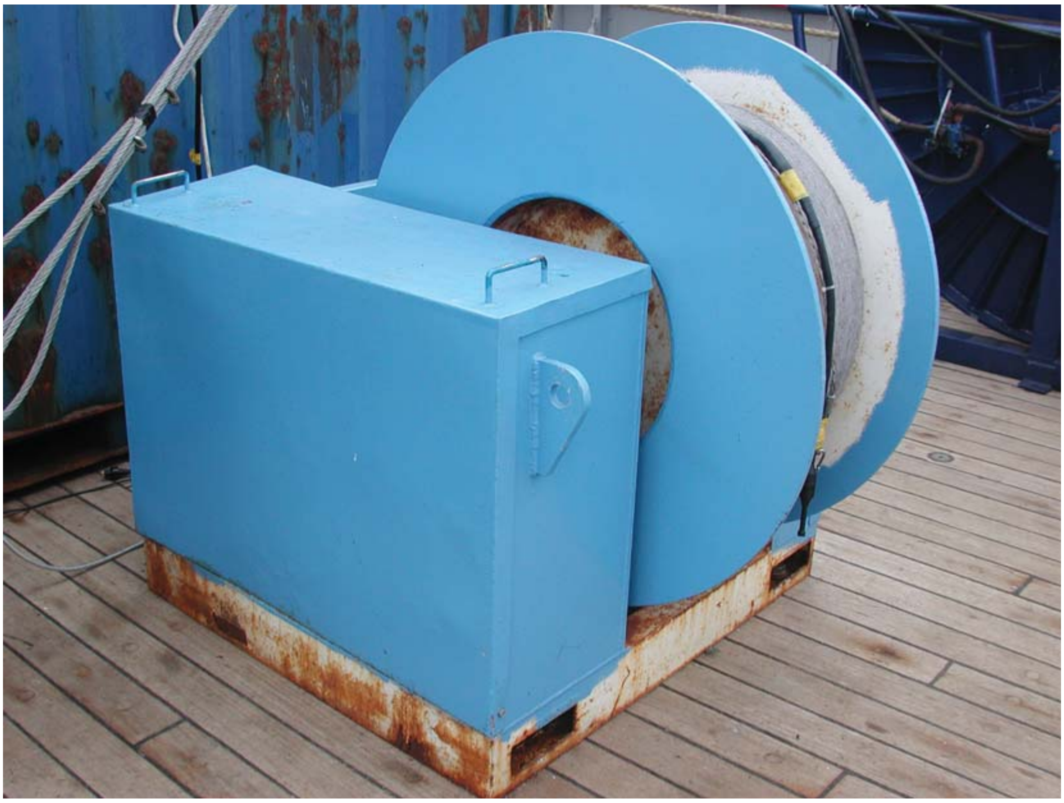


Figure 22

Sidescan sonar survey

The survey carried out during this cruise was designed to cover the areas of interest in the time available. Following a detailed reconnaissance of existing data (onboard multibeam, TOPAS and CTD) it was decided that two types of surveys would be most suitable to fullfil the cruise objectives - water column surveys to detect gas bubbles and flares and seabed mapping. While the first one focuses on the water column, the sonar towfish was 'flown' some 80-140m above the seabed, the seabed surveys were meant to focus on the seafloor-water interface to see if active gas expulsion could be seen coming directly out of the seabed. No overlap of lines was intended. The frequency used for the main survey was 100 kHz with a long pulse to allow maximum swath width without range-dependant absorption losses. But short pulse settings were also selected for comparison. In total 65 km of tracks were run in 8 lines, covering an area of approximately 26km^2. Almost all survey lines were designed to run from NNE to SSW and vice versa, against, and with, the prevailing subsurface current which in parts was strong. The speed over ground during the sonar recordings was relatively constant at 3-3.5 knots, but in some cases 2.5 knots speed was needed to get the towfish closer to the seabed. During the entire survey depth soundings from the ship's Multibeam system EM120 and EA600 profiler provided useful bathymetrical information of the local topography for the sonar operator 'flying' the towfish. During the first two deployments wind force 5-6 and seas of up to 2.5m were influencing the survey causing the towfish to mainly pitch, because the sonar fish was not decoupled from the winch cable and so the ship's pitching movements were transmitted through to the fish. During the last survey on September 17th the sea state was slightly better (1-2m swell). The good and interesting results of the water column surveys allowed running two high-resolution lines (325 kHz) across the flare area, and a 10 minute section in the Northern area around 79°20'N.

Processing of the sidescan sonar data will be continued back at the National Oceanography Centre in Southampton as there was no time to finish it onboard. The corrections to be applied to the data will be radiometric (changing the data value of a pixel, e.g. across-track (time varied gain), along-track (line dropout and speckle removal)) and geometric (changing the position of a pixel, e.g. across-track (slant-range), along-track (anamorphosis)). Processing will be done with PRISM software (v4.0) at 25cm pixel size. The data will then be mosaiced together using ERDAS Imagine software (v9.1), maps can either be produced in form of A0 sheets or on digital media.

Preliminary results

The water column survey in the southern area (flare area) confirms EK60 echo sounder data that show flares rising up to 140m and more into the water mass (Fig. 23). The seabed survey carried out with 325 kHz frequency over the same flume field revealed at least one active gas release feature where bubbles can be seen rising directly out of a 1-2m circular depression. It was also noted that very intense fishing activity (bottom trawling) happens in this area. Amongst the trawl marks lost fishing gear (probably a trawl door) was also found on the seabed.

The seabed survey in the northern area shows fishing activity (trawl marks) and mainly N-S directed iceberg ploughmarks (IPMs). These IPMs are up to 25m wide and have levees up to 2m high. At the end of the second line it was possible to get the towfish very close to the seabed by reducing the ship speed down to 2.5 knots. This enabled the use of the 325 kHz frequency together with a 100m range. On a levee of an IPM, a mound, about 15m in diameter, was found. It resemblance is very similar to sonar imagery of known cold-water coral mounds build by Lophelia pertusa (see Milkert & Huehnerbach, 1997, Freiwald et al. 2002).

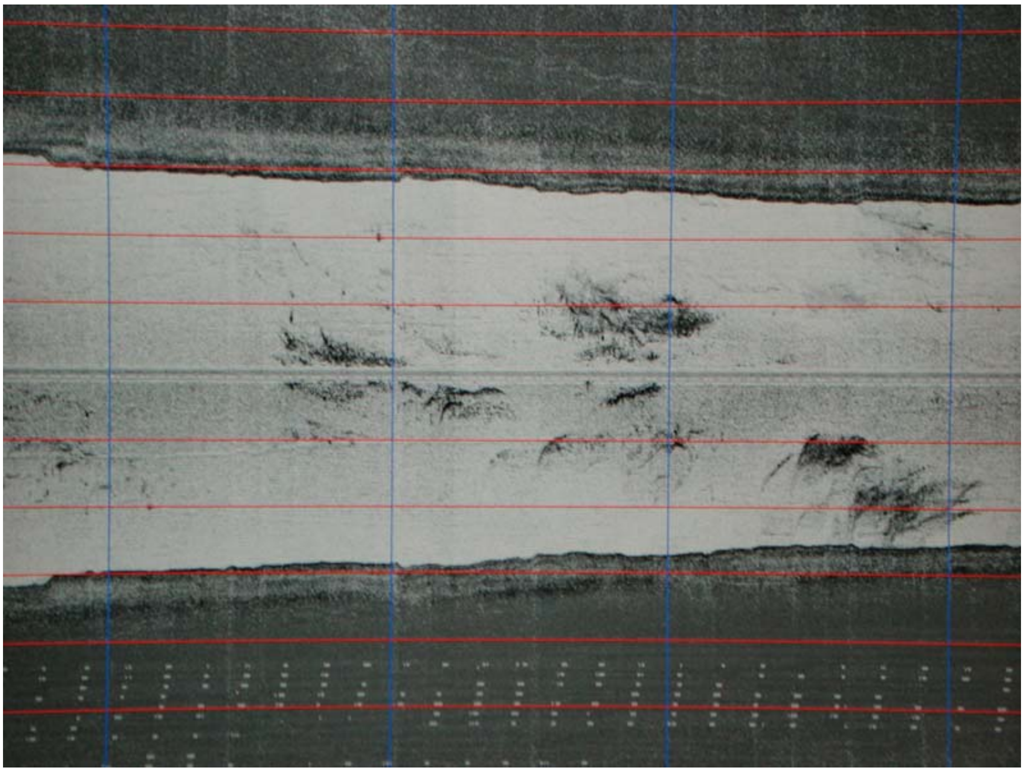


Figure 23

13 MULTIBEAM (EM120)

A multibeam echosounder was used during this cruise to provide high resolution maps of the seabed. The bathymetric maps produced by the multibeam instrument were used to support a variety of other scientific activities taking place on board. It was used as a tool to select sites for sediment coring, CTD sampling, OBS deployment and to define the seismic reflection tracks. The research vessel James Clark Ross was fitted with a SIMRAD EM120 multibeam echosounder in 2000. This system has proved to be reliable in good weather conditions, although some problems occurred during bad weather, short turns and at shallow water depths.

Acquisition

The EM120 is designed to map to full ocean depths with a high resolution. Echo sounders use the echo reflected by the seabed to measure the depth (i.e. a sound signal is sent into the water from a transducer at the bottom of the ship, the sound travels through the water, reflects off the seafloor and return to the transducer where the time taken for the round trip is measured). The water depth can be calculated using the simple formula: Depth = velocity x time/2, the water velocity was here taken from CTD 1 and equals 1.470 km/s.

The nominal sonar frequency is 12 kHz with an angular coverage sector of up to 150° and 191 beams. The EM120 can map a swath width of about 4 times the water depth. The angular coverage sector and beam pointing angles were set to vary automatically with depth according to achievable coverage. This maximizes the number of usable beams. The system corrects for the ship's motion by steering the beams so that they reflect off the correct part of the seafloor. A total of 669 lines were acquired, during a period of 26 days in a nearly continuous fashion, covering a total of 4700.5 km of tracks with a water depth varying from approximately 150 m to 2300 m.

Processing

The CARAIBES (CARtography Adapted to Imagery and BathymEtry of Sonars and multibeam echosounders) seabed mapping software from IFREMER was used during the cruise to process bathymetry from multibeam data. The different modules of the software are linked together with a processing flow editor, with an output of one process feeding the following one. These processing flows, when saved, enable the sequential execution of several operations on the data. Pre-processing included importing the data from the SIMRAD EM120 system (xx.raw.all files) to CARAIBES (xx.raw.mbb files). The data were imported line by line, each line corresponding to about 1 hour of recorded data. After the importation of the data, quality control of each line was carried out by looking at the navigation file extracted from the raw data and at a rough grid of the unprocessed data. Once the navigation and bathymetry files were considered to be of good quality, the following processing flow was applied:

- Invalidation of the incoherent values, with this process it is possible to invalidate interactively georeferenced bathymetry data using a mesh.

- Generation of a Digital Terrain Model (DTM) from the soundings included in each bathymetry file. The interpolation method, used to compute values at DTM nodes (regular grid in X and Y of cartographic projection), is an assignment to the 4 nearest nodes. The grid spacing was chosen depending on the water depth and the swath width: this varies approximately from 10x10m for shallow water depths (less than 500 m); 15x15 m for water depths between 600 and 1000 m and 20x20m grid for water depths greater than 1000 m.

Few tests were made to try to smooth the data using a Spline module but the result proved to add artefacts.

After the processing of each line they were converted injto ArcGIS format (xx.flt and xx.hdr) and imported into Arcmap.

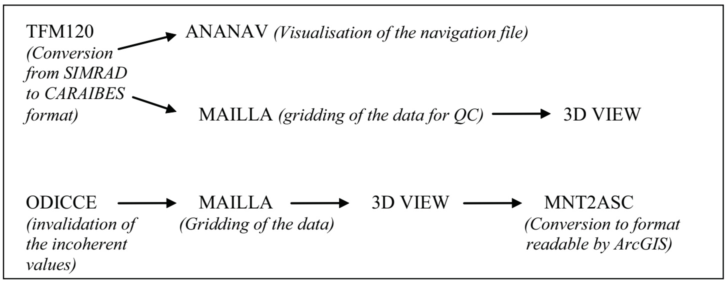


Figure 24: Processing flow applied on the EM120 multibeam data.

Processed data were of overall good quality apart from in the shallow areas, during short turns and bad weather conditions (see Appendix table for more details). During JR211, 493 lines were processed on board, leaving 176 lines to be processed.

Preliminary results

A map displaying the entire coverage of the multibeam survey is presented in Figure 25. Multibeam bathymetric data covers a region of approximately 200 km in length offshore Svalbard, crossing the continental shelf, the continental slope and the oceanic crust over a width of 80 km. The main purpose of the acquisition of the multibeam data was to locate any features in the bathymetry that could be relevant to the escape of gas hydrates. A number of interesting features including pockmarks, iceberg scours and fractures were visualised on the bathymetric map. Figures 26, 27 and 28 show close-ups of the processed multibeam data located in the southeast, southwest and north of the study area respectively. Numerous pockmarks and fractures are seen on Figure 26, an area where the presence of flares has been confirmed by the EK60 system. Figure 26 is mapped on a 10x10m grid with a depth range of 150 to 450 m and was used to support coring and CTD rosette sampling in the area, as well as seismic track lines. A 20x20 m grid of the south western area is shown in Figure 27; the depth range varies between 650 and 900 m, the multibeam data shows a feature approximately 3km long with an N-S direction that is interpreted as a pockmark. The third close-up maps an area in the North (Figure 28) and shows the presence of a complex geological record left by the ice-sheets.

Data storage

Raw.all files from SIMRAD EM120 (via Neptune software) are stored on:

- External USB HD from NOCS
- Anne's computer D drive
- LTO-2 backup tape.

Files can be read by the software CARAIBES or MB-system.

CARAIBES files are stored on:

- External USB HD from NOCS
- Anne's computer C drive

Caraibes files can be read by the Caraibes software - The licence is avaivable at NOCS. The output can be converted to ArcGIS format, GMT grid format or ASCII xyz format.

ArcGIS files are stored on:

- External USB HD from NOCS
- Anne's computer D drive
- LTO-2 backup tape

Files can be read by any version of ArcGIS .

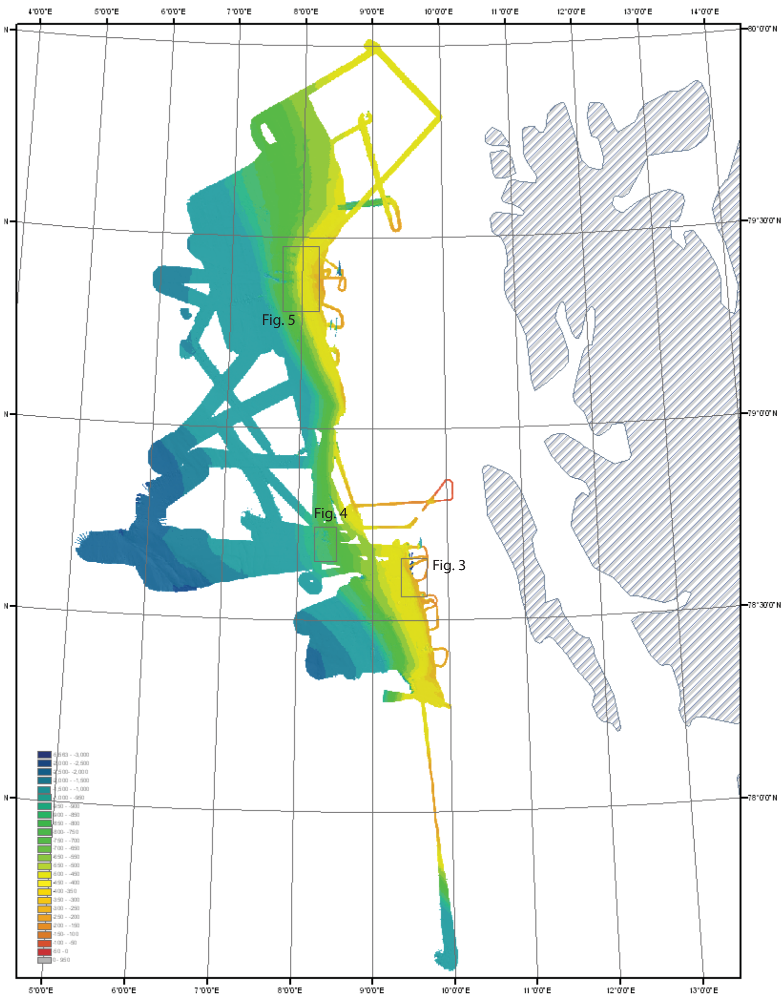


Figure 25: Bathymetry data along the coast of Svalbard acquired during JR211 in august and September 2008. Blacks squares represent close-ups in figures 26, 27 and 28 and discussed in the text (50x50 m grid spacing).

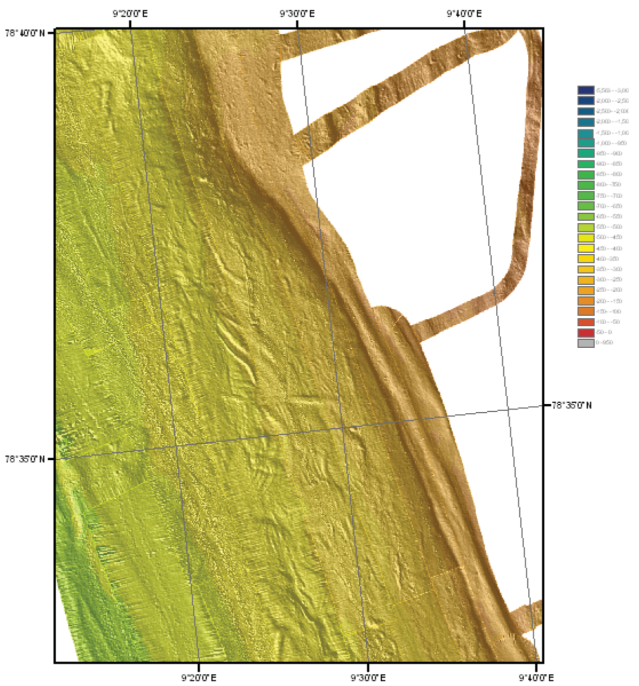


Figure 26: Close-up of the processed bathymetric map showing evidence of pockmarks and cracks in the southeast area (10x10 m grid spacing).

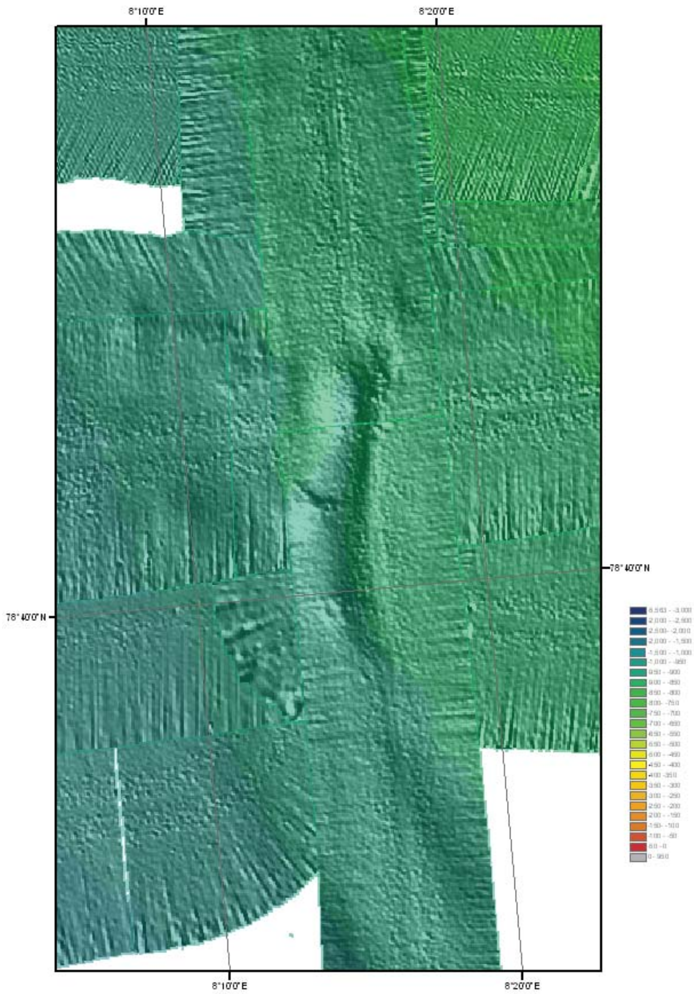


Figure 27: Close-up of the south central area where a large feature was identify as a pockmark (20x20 m grid spacing).

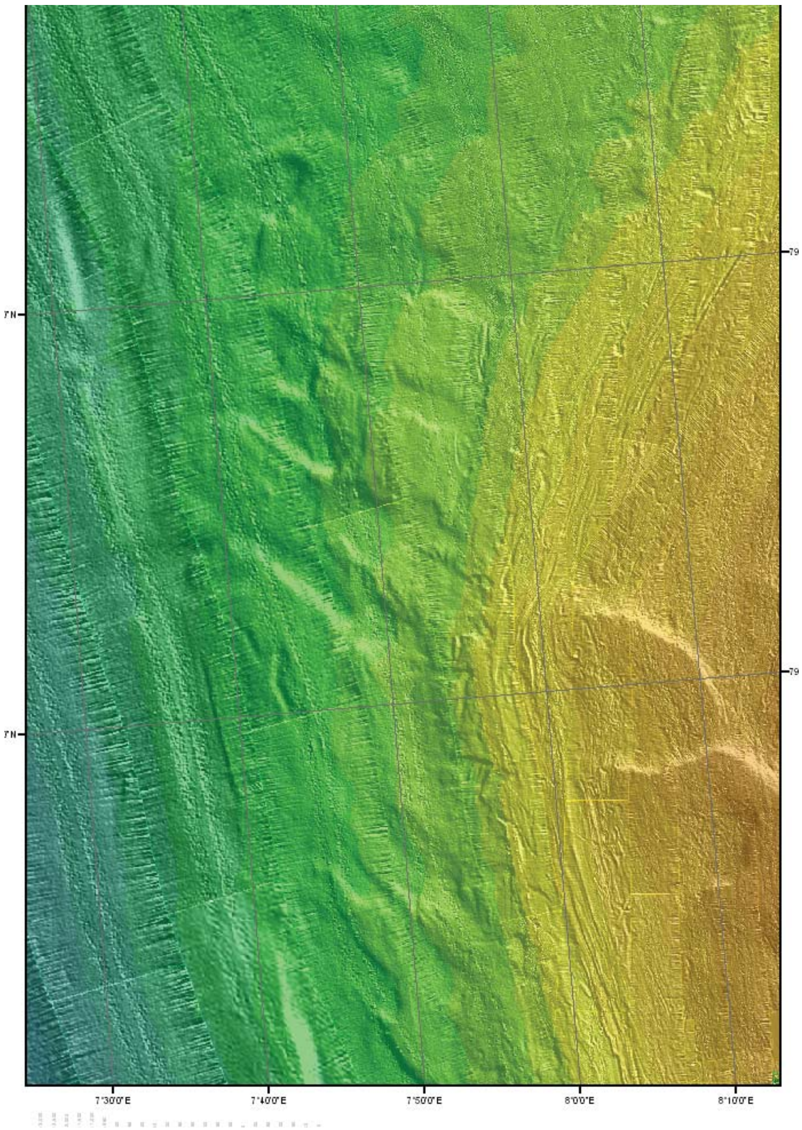


Figure 28: Close-up of the northern area showing complex ice-sheet related features (10x10 m grid spacing).

14 Multibeam backscatter processing

Onboard processing of the multibeam backscatter during this cruise was carried out on the same standard PC laptop (90 Gigabyte disk space) as the sidescan processing work.

During JR211 cruise, 670 EM120 data files were recorded on the shipboard system. These raw data files (.raw_all files) and all additional extended files including the backscatter data (.sidescan files) were downloaded and transferred across the network in batches of 100 files at a time. The total number of 670 files were converted into Common Data File format (.cdf) for use with PRISM software (v4.0). The ship's navigation data, recorded on a UNIX server, was transferred on a daily basis and checked for time-continuity and abnormal speed values. No gaps in the navigation data file occurred. Overall GPS coverage and position quality was good, even during days of bad weather on leg 2. The data was processed at a pixelsize of 20x20m. It should be noted that due to time constraints only around 420 of the 670 files could be processed.

Similar to the sidescan processing steps, the multibeam backscatter processing consists of two phases: Pre-processing and Mosaicing. The pre-processing stage involves filtering of the backscatter data, removal of system specific-artefacts and geographical registration of each individual ping. This processing stage is solely composed of PRISM programs and runs from a graphical user interface. The PRISM software uses a modular approach to 'correct' the imagery, which is predefined by the user in a 'commands.cfg' file. For this data it was defined as:

```
mrgnav -i %1 -o %0 -n navfile.nav -l 0,0
filter -i %1 -o %0 -b 1,21 -z -v 1,253
filter -i %1 -o %0 -b 1,301 -h -v 1,253
filter -i %2 -o %0 -b 13,301 -L -v 1,253
wtcombo -i %2 , %1 -o %0 -c 1,1 -a -128
restorehdr -i %1 -h %5
resol -i %2 -o %0 -r res
```

The processing steps

- Merging of ship navigation with the imagery, basically assigning every ping to a geographical position
- Applying the following filters were applied: lowpass filter to replace zero values in the backscatter imagery, a highpass filter and finally another lowpass filter that changes only data samples. All of these filters apply to different sections and ranges of the backscatter data.
- Creation and attachment of a data header to each data file
- Changing resolution to the desired value

Preliminary results

The sound beam of the EM120's 12 kHz frequency penetrates some metres deep into the sediment. This allows detection of features that do not necessarily have a recent seabed expression. For example, sediment filled channels with no visible morphological expression on the current day seabed. The EM120 could still be able to detect acoustic differences between the original seabed that the channel incised and the sediment that filled it later in time. The area surveyed appears to be uniformly equal in its backscatter. Morphological features as described in the TOBI paragraph (gullies, iceberg ploughmarks and pockmarks) can be clearly seen and identified. Also, elongated patches of varying backscatter (light to medium gray) along slope are noted. These might represent grain size variations or changes in physical properties of the upper sediment layers, probably contourite material transported and deposited by the current of the North Atlantic Water.

15 TOPAS

TOPAS is a high-resolution sub-bottom profiler with a parametric source. Various types of source wavelet are available, and there is a real-time screen display and paper record. To achieve maximum power and therefore deepest sub-bottom penetration, one would expect that it should be operated in Chirp mode with a long sweep. However, experimentation with the sweep length revealed that long sweep lengths resulted in a long seafloor return that masked sub-bottom features. The TOPAS manual gave very little information on what happened during acquisition, but it appeared that the real-time processing available did not include deconvolution. The optimum real-time display was achieved by using a very short (1 ms) Chirp with a set frequency range of 0.5-5.0 kHz. In a 1 ms wavelet, there is of course no significant energy below 1 kHz. The record length was 200 ms and the sample interval 40 s. The delay was set manually and had to be changed frequently on steep slopes. The ping interval was variable due to synchronisation with other Simrad echosounders in operation, but was typically 4-5 seconds. A small amount of data was lost when the delay was not changed quickly enough. Data quality was also poor when the vessel was moving at high speed and also at lower speeds if the vessel was moving in certain directions with respect to the swell.

Raw data were translated into an ASCII format using a program written by Heiko Palike and from ASCII to SEGY using a seismic unix script. The data were divided into a series of 39 "lines" each covering a period from a few hours to a couple of days. For each line an ASCII header file was created with the ping number, the time, the ship's position at that time, the deep-water delay applied, and various other header information. During conversion to SEGY, the delay was written into the "offset" trace header. Examination of the raw data showed that most of the energy was in the 3-4 KHz range. A simple processing sequence consisting of the following steps was then applied in Promax:

1. Zero-phase Ormsby bandpass filter with corner frequencies of 300, 500, 5000 and 6000 Hz (a very broad filter that only removed signals that could not possibly be associated with the source).
2. Resample to 80 μs.
3. Conversion to reflection strength (instantaneous amplitude).
4. Trace length reset to the maximum value required (= maximum delay from header + 200 ms).
5. Static correction with the deep-water delay as stored in the "offset" header.
6. Setting CDP to shot number.
7. Coherency filtering using Promax's "dynamic s/n filtering" operator with a horizontal window length of 20 traces, a time window length of 20 ms, a time window overlap of 2 ms, and a frequency range of 0-5000 Hz.
8. SEGY output and/or screen display.

Promax and seismic unix both appear to be unable to cope with trace lengths greater than 32767 samples ($2^{15} - 1$), presumably because the record length is stored as a signed 2-byte integer. For an 80 μs sample interval, this corresponds to a record length of just over 2.6 s. A few TOPAS "lines" extended into water depths of greater than 2.5 s. For these lines, a second processed SEGY file was generated that had the first 1.5 s of record removed.

Some exploration was made early in the cruise of the effect of different processing parameters to choose an optimal set, but this exploration could not be described as exhaustive. The result was a significant improvement in the clarity of the record as compared with the real-time paper display. Further processing options that might be considered to enhance the image in specific locations are the application of a time-varying gain tied to the seabed reflection time (to display deeper reflectors more clearly) and possibly Kirchoff migration using a narrow migration aperture to match the narrow beam width of the TOPAS.

The screen display was used to pick time windows for plotting, and then seismic unix was used to make postscript files at a standard scale of 0.009 inches per ping and 25 inches per second (vertical exaggeration of 76:1 for a sound velocity of 1.5 m/s, a ship's speed of 8 knots and a ping interval of 5 s). Most postscript plots had a width of 31.1 inches (excluding labels) to use the full width of the ship's 36-inch plotter. The postscript files were converted to pdf format, which typically involved compression by a factor of 20 without loss of resolution. In addition to the raw data, the processed SEGY data and the pdf plots, as well as all the seismic unix scripts used to generate them, were archived.

During the first part of the cruise, a systematic effort was made to classify the seabed according to its appearance in the TOPAS records, as an indication of seabed hardness and therefore suitability for coring and for deployment of ocean bottom seismometers. The three classes used were:

1. No penetration
2. Some penetration but less than 20 ms.
3. Penetration greater than 20 ms.

The shelf area was found to be almost entirely of class 1, while class 3 seabed occurred typically in water depths greater than 600-700 m. The transition from class 1 to 2 to 3 was sometimes quite abrupt and corresponded roughly with the seaward limit of glacigenic sediments and the landward limit of contourite deposits.

16 Weather Report

During the cruise JR211, it was noted that the quality of data obtained by many of the surveying instruments used were strongly affected by weather conditions. This was particularly noticeable for the EM120, but the EK60 and TOPAS were also influenced by the weather. The dominant factor appeared to be the sea state (including waves and swell) and the angle between these and the direction of travel of the ship.

Observations of the sea state (including the height and direction of both waves and swell) were made by the watchkeeping officers of the James Clark Ross, while air and sea temperatures, air pressure and wind speed and direction were all logged automatically by monitoring equipment on the ship along with the ship position, heading and speed at the time. Records of wind speed and direction are taken relative to the ship and are not absolute values.

Summary of weather and sea conditions during JR211

23/08/08
Small waves (ripples) and low sea.
Wind speed increasing during day to a maximum of 25knots, generally at an angle to ship track.
Air pressure rising.
24/08/08
Slight sea and low swell.
Steady wind speed (10-15knots), increasing in the evening (∼20knots), direction becoming increasingly perpendicular to ship.
Air pressure rising.
25/08/08
Swell low but increasing, waves low.
Wind speed and direction relative to ship highly variable (6-24knots).
Air pressure rising.
26/08/08
Very low waves and low swell.
Wind speed <10knots, often with similar heading to the ship.
High pressure system (1025hPa), with pressure decrease in later part of day.

27/08/08
Vessel rolling and pitching moderately, slight waves.
Wind speed increasing to a maximum of ∼30knots in the early afternoon and then falling, direction approximately perpendicular to ship's heading.
Air pressure falling
28/08/08
Low waves and swell.
High wind speed in very early morning (>20knots) then variable for the rest of the day plus variable direction relative to ship.
Air pressure rising.
29/08/08
Low swell, waves decreasing from moderate to slight.
Variable wind strength and direction (5-22knots).
Air pressure rising to a maximum in the early evening (1025hPa).
30/08/08
Slight sea, low swell.
Variable wind strength and direction (<20knots).
Air pressure falling.
31/08/08
Slight sea, low swell.
Wind direction generally inclined to ship, speed decreasing from midmorning (range 1.5-22knots)
Air pressure rising.
01/09/08
Slight sea, low swell.
Low wind speed in morning, becoming increasingly variable (maximum 19knots), variable direction.
Air pressure falling
02/09/08
Sea decreasing from moderate to slight with low swell.
Moderately high wind speeds in the early morning (up to 30knots) dropping rapidly by the middle of the day (2-10knots), increasing again to a maximum of 25knots in the evening.
Air pressure falling.
03/09/08
Rough sea, shipping heavy frequent spray. Vessel rolling and pitching particularly strongly when seas ahead or astern. Swell up to 7m, waves up to 4m.
High wind speeds (up to 44knots) with direction often aligned with ship.
Air pressure falling.
04/09/08
Slight sea with swell decreasing from moderate to low.
Moderate winds speeds in early morning (maximum 23knots), much lower later in day (2-12knots), direction variable.
Low pressure system in early morning (986hPa) with pressure increasing for rest of day.

05/09/08
Slight sea and low swell.
Wind speed relatively constant (∼10knots) with direction generally close to alignment with ship.
Air pressure rising.
06/09/08
Slight sea.
Wind speed relatively constant (∼15knots) with direction generally close to alignment with ship.
Air pressure rising.
07/09/08
Slight sea.
Wind speed relatively constant (∼10knots) with direction generally close to alignment with ship.
Air pressure rising.
08/09/08
Slight sea becoming increasingly rough.
Wind speed low in morning, increasing to 20-30knots by early afternoon with highly variable direction relative to ship.
Air pressure approximately constant (1011hPa).
09/09/08
Slight sea and low swell.
Wind speed moderately constant (∼15knots) with direction often inclined to ship.
Air pressure rising.
10/09/08
Moderate sea but low swell.
Wind speed increasing then falling with peaks at 1200 (30knots) and 1800 (26knots), direction generally close to alignment with ship.
Air pressure stable around high value of 1022hPa.
11/09/08
Moderate sea with low swell.
Wind speed very stable at 15-20knots, often at very low angle to ship alignment.
Air pressure stable around 1021hPa.
12/09/08
Moderate sea.
Wind speed relatively stable with small peaks in the late afternoon and evening (range 13-26knots), direction roughly perpendicular to ship, becoming more aligned at end of day.
Air pressure roughly stable, reaching a maximum of 1024hPa.
13/09/08
Sea becoming increasingly rough through morning with waves up to 4m.
Wind speed high in late morning, reaching a maximum of 45knots, before decreasing to 15-25knots in the evening with direction often inclined to ship.
Air pressure falling, then rising in late evening.

14/09/08
Moderate sea and swell.
Wind speed relatively constant (20-30knots) with direction often inclined to ship.
Air pressure falling, then rising in late evening.
15/09/08
Moderate sea and swell becoming moderately rough.
Wind speed increasing to a maximum in the early afternoon (26.5knots) before falling again, direction roughly aligned with ship.
Air pressure falling.
16/09/08
Moderate sea and swell, becoming rough in evening with waves up to 2.5m.
Wind speed roughly stable (17-28knots), direction roughly aligned with ship, becoming more inclined in evening.
Air pressure falling, then rising slightly in evening.
17/09/08
Moderate sea and swell decreasing to a rippled sea with low/moderate swell.
Wind speed decreasing from 29knots in early morning to a minimum of 1knot, before rising rapidly in the late evening with direction inclined to the ship.
Air pressure rising.
18/09/08
Moderate sea and swell becoming rough with heavy swell.
Wind speed increasing through day to a maximum of 37knots, direction inclined to ship.
Air pressure falling.
19/09/08
Moderate sea with heavy swell (5.5m) decreasing to moderate.
Wind speed moderately high and stable (28-40knots), inclination to ship's direction decreasing during day.
Air pressure roughly stable (999hPa)
20/09/08
Moderately rough sea and swell with wave heights reaching 2.5m.
Wind speed high and stable (32-41knots) with direction generally opposite to ship.
Air pressure rising.

17 Marine mammal observations

Marine mammal watches were carried out from the bridge during and immediately preceding all airgun activity in accordance with "GUIDELINES FOR MINIMISING ACOUSTIC DISTURBANCE TO MARINE MAMMALS FROM SEISMIC SURVEYS" (JNCC, 2004). Watch keepers commenced watches at least 30 minutes prior to shooting although often considerably earlier than this as deployment took longer than anticipated. There were no sightings of marine mammals in the 30 minutes immediately prior to the airguns being turned on, therefore no action was necessary.

Marine mammal watches were 2 hours long and were carried out by a team of 8 watch keepers, aided by lookouts on the bridge. Initially, watches were kept 24 hours a day during airgun activity. As the nights got darker, watches were only kept whilst there was sufficient light. Visibility was also hampered by fog on a number of occasions.

A total of 38 sightings were recorded, including one polar bear. The only dolphin species positively identified was the white-beaked dolphin, distinguished by pale streaks along the side and belly. It is likely that all dolphins observed were white-beaked as this is the only common species in the area. Dolphins were seen in groups ranging from 2 or 3 to 50+ animals. They were seen swimming infront of the boat, swimming along with whales, jumping and flipping as well as swimming fast.

Several species of whale were observed and were distinguished by the presence or absence of blows, the shape of the dorsal fin. The most commonly sighted whales were minke whales which surface without large blows and fin whales which are significantly larger and have big blows. Single sightings of a sperm whale, a pilot whale and 3 blue whales were also recorded.

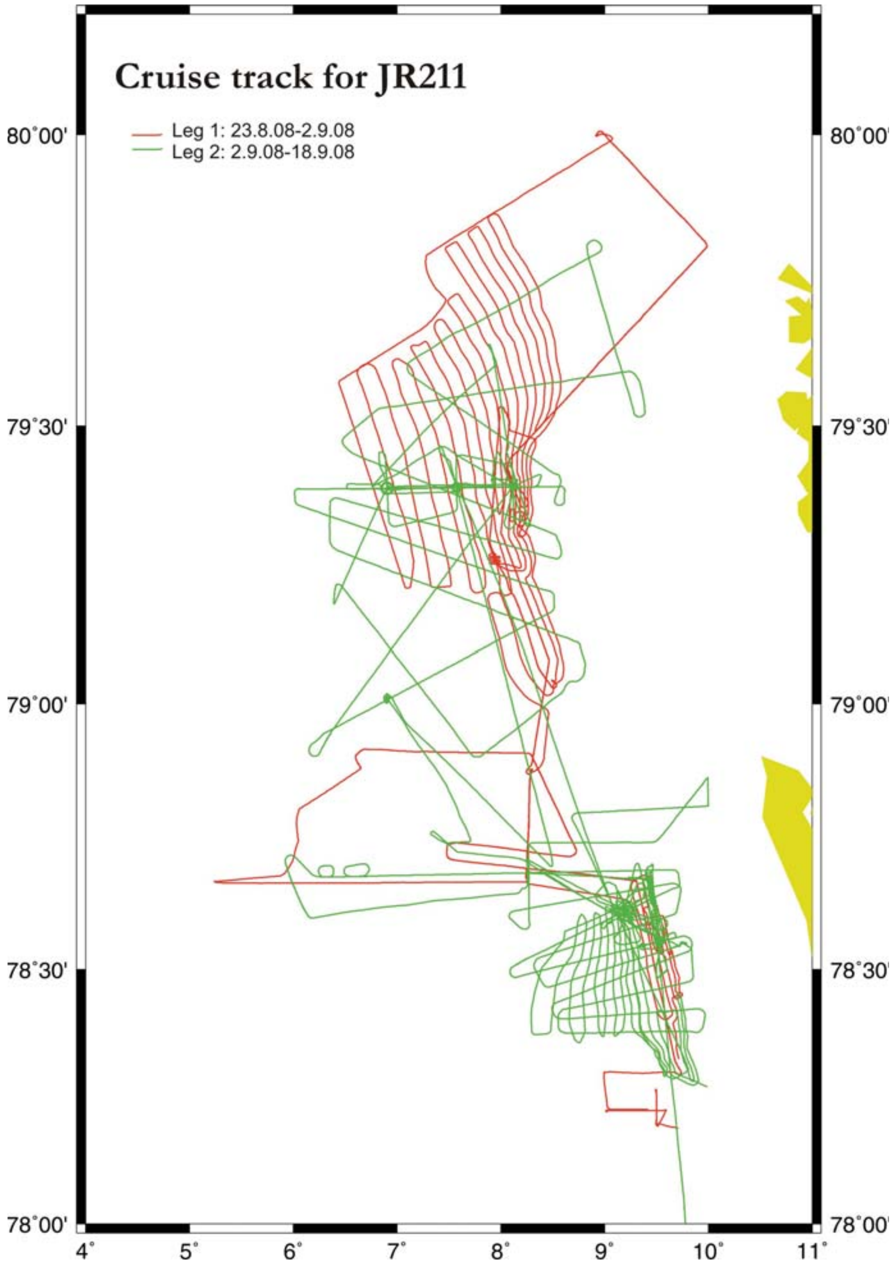
In total 43 whales and around 170 dolphins were recorded.

18 Summary of preliminary results of cruise

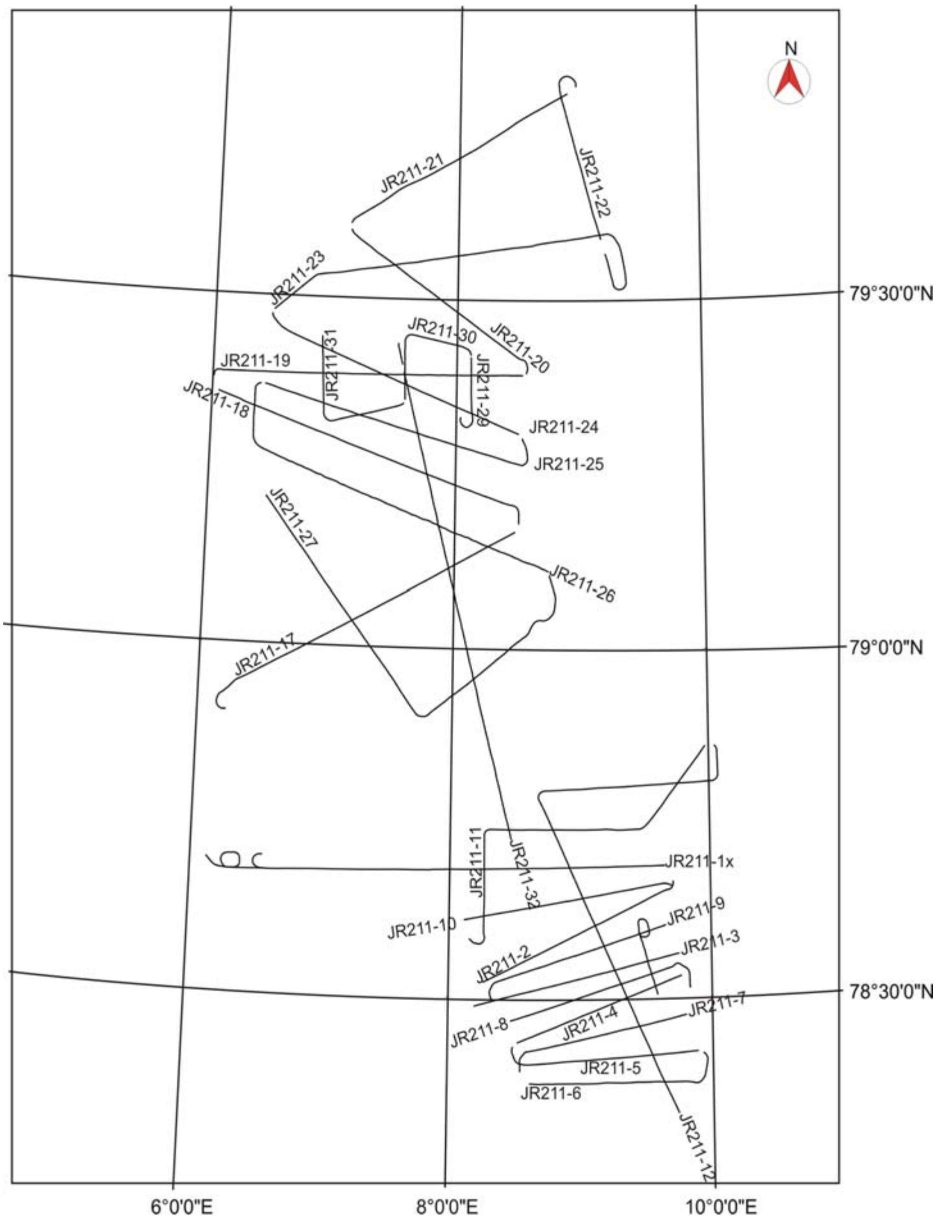
1. Acquisition of the following types and approximate quantities of data:
   - 8000 km^2 of multibeam echo-sounder data.
   - 1710 km^2 of TOBI 30-kHz sidescan-sonar data and 7-kHz sub-bottom profiler data.
   - 25 km^2 of Widescan, 100 kHz and 325 kHz, sidescan-sonar data.
   - 1250 km high-resolution 96-channel seismic reflection profiles.
   - Seismic experiments with 4-component ocean-bottom seismic recorders at 6 locations.
   - 6000 km of Topas sub-bottom sediment profiling data.
   - 6000 km of EK60 sonar data, at frequencies of 38 kHz, 120 kHz and 200 kHz.
   - 33 sediment cores.
   - 13 CTD casts with water sampling.
   - Half-hourly sampling of air and water for methane concentration with equilibrator.
   - Twice-daily air samples for methane concentration and isotopic ratios.
2. Discovery of more than 250 plumes of bubbles of methane gas in water depths between 150 and 400 m, landward of the theoretical limit of the methane hydrate stability field, in an area lying to the west of Prince Karl's Foreland.
3. Sampling of methane hydrate in cores taken from two pockmarks at depths of 890 and 1210 m, the deeper of which has an active plume of gas bubbles.
4. Increase in the area in which bottom-simulating seismic reflectors (BSRs), caused by the presence of free gas at the base of the gas-hydrate stability field, have been identified.
5. Identification of seismic indicators of the presence of free gas, such as bright spots, frequency reduction, localised 'blanking' and scattering, in addition to BSRs, and in areas where BSRs were not seen.
6. Detection of anomalously high concentrations of methane in the water column at several locations along the West Spitsbergen margin.

Appendices

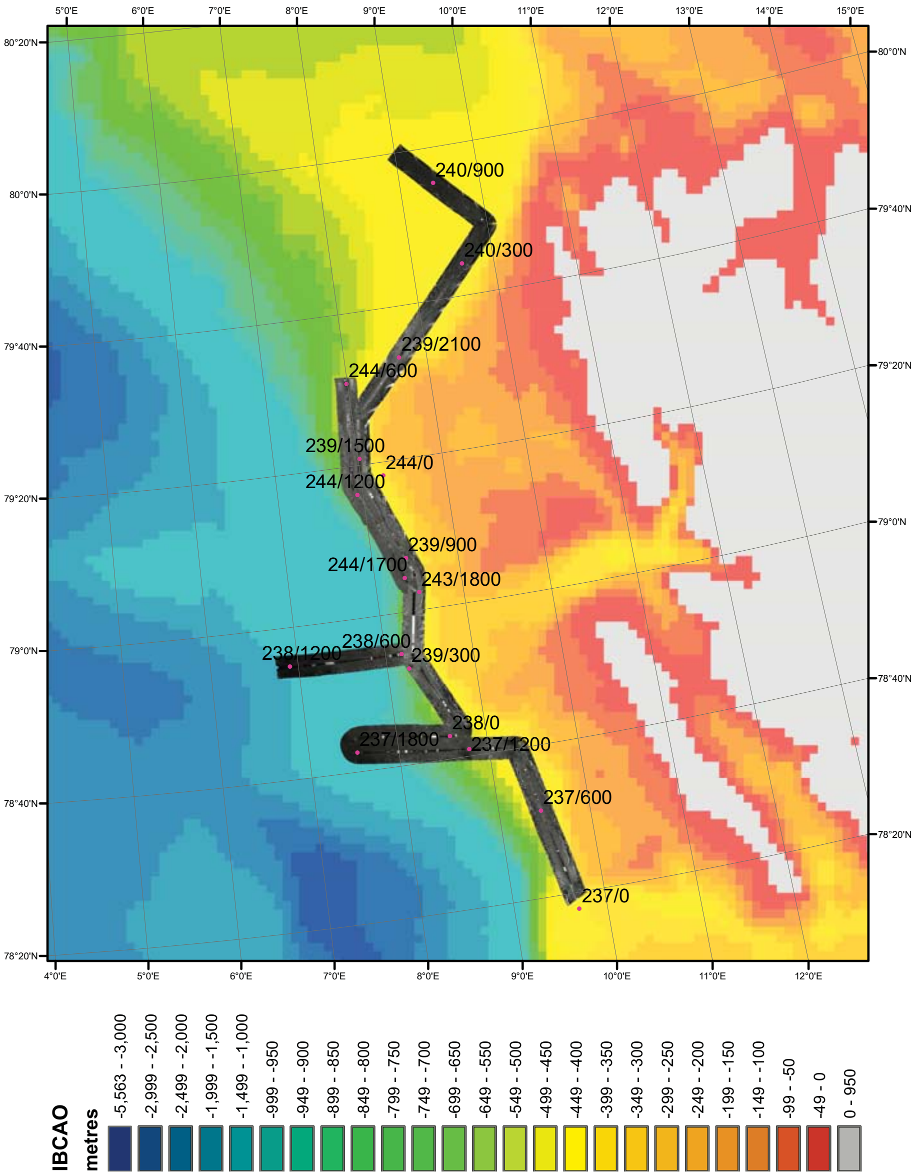
A General track



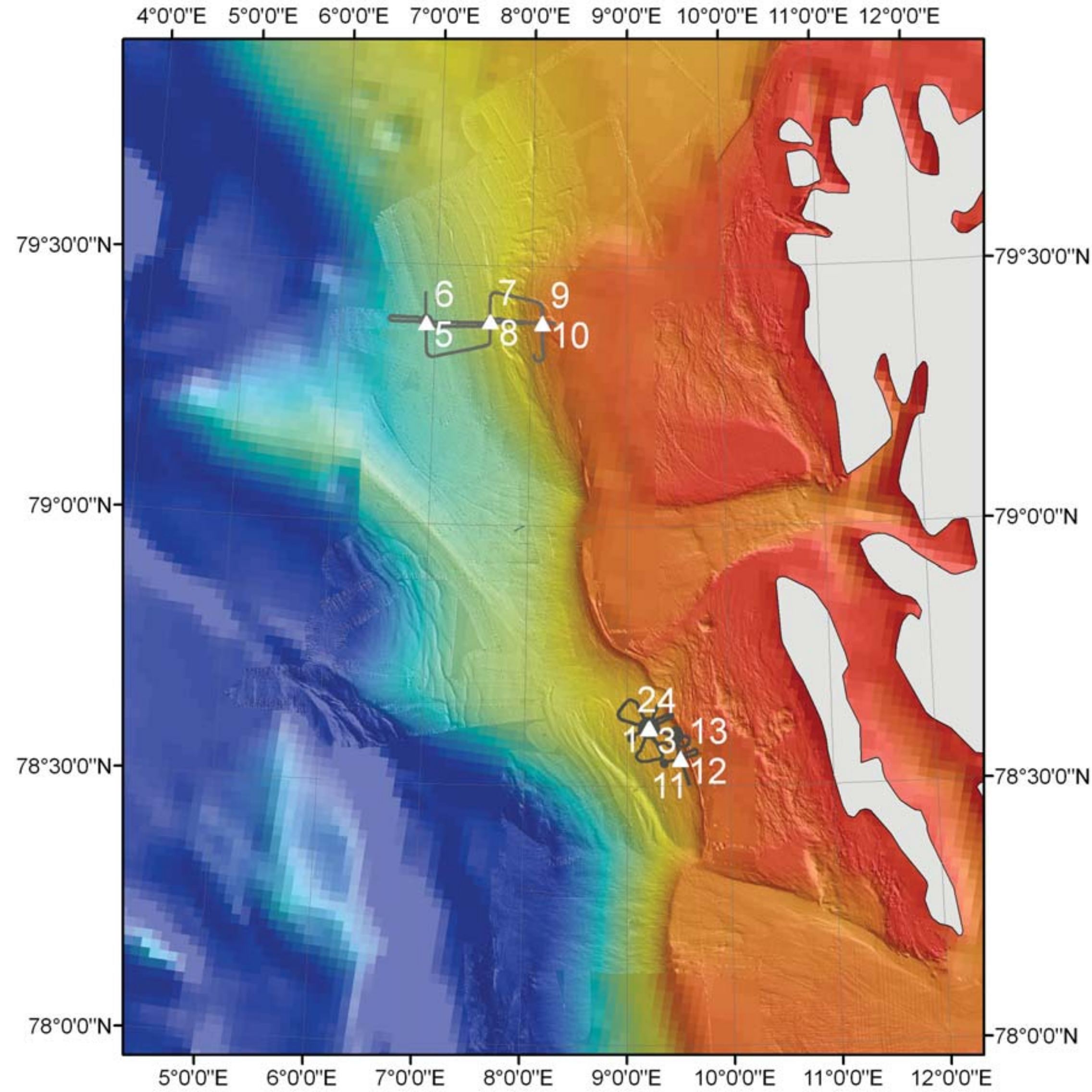
B Seismic track



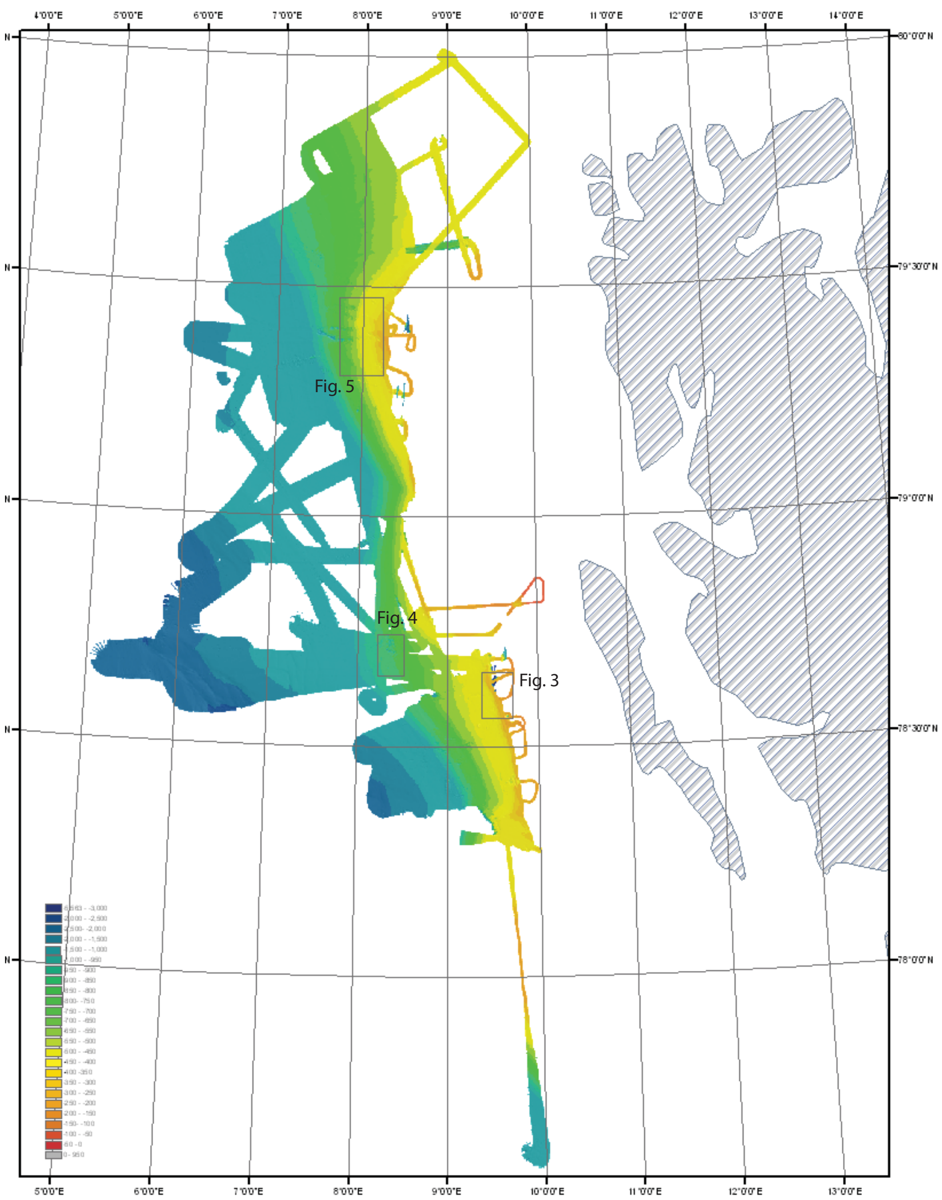
C TOBI coverage



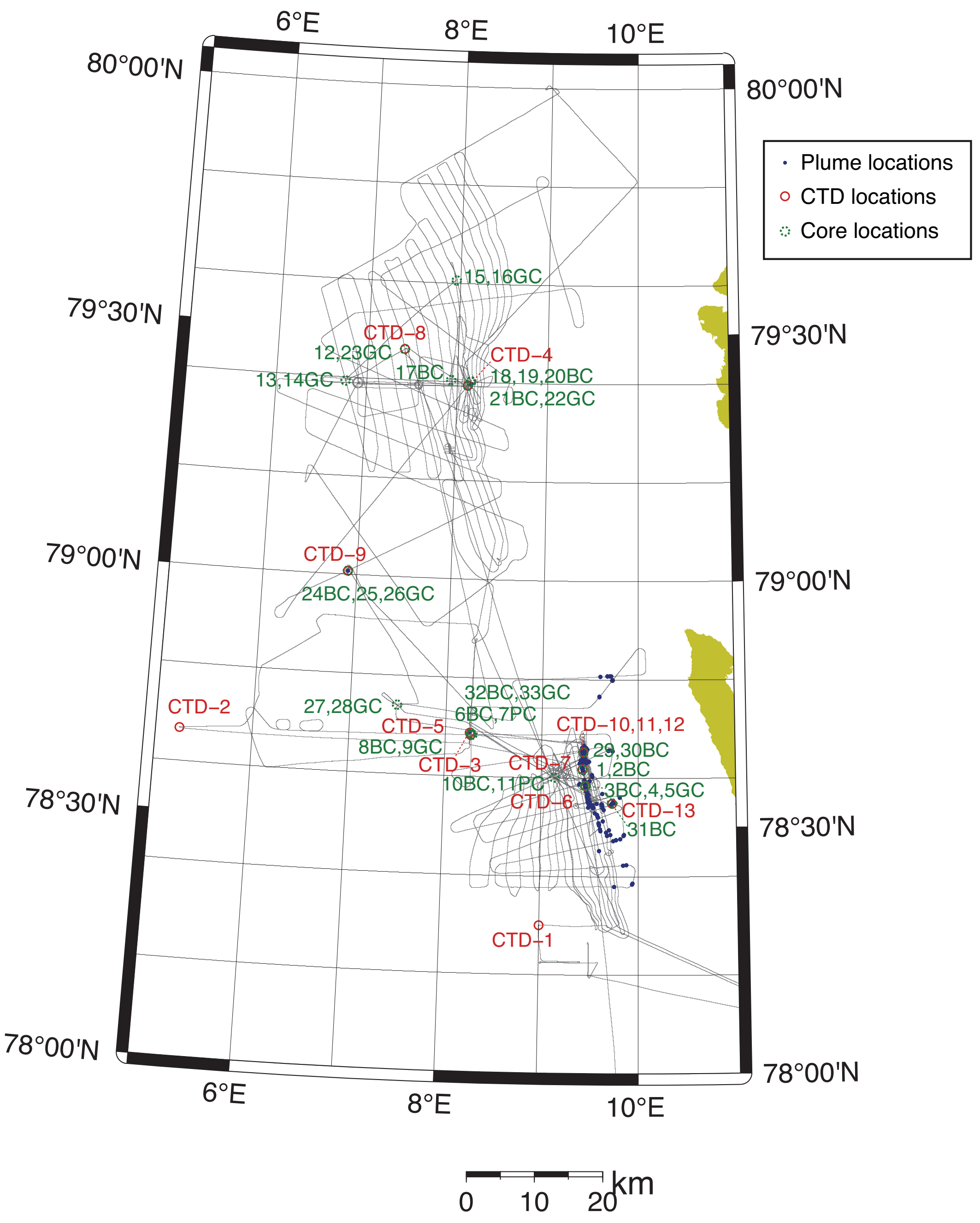
D OBS experiments map



E Multibeam coverage



F CTD and core locations



G CTD firing depths

Readings taken as each bottle fired

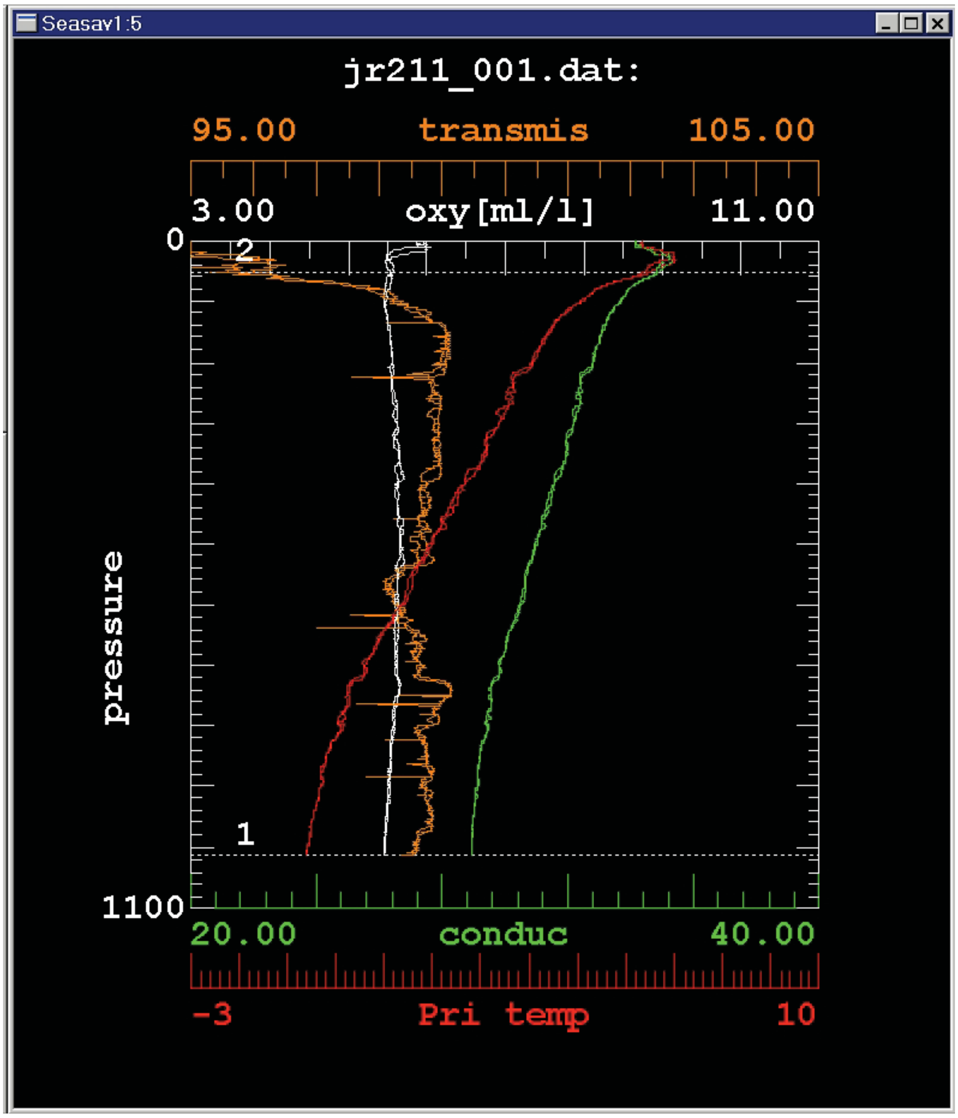
Date	Julian day	Time utc	CTD ref.	Bottle	Lat. deg.	Lat. min.	Long. deg.	Long. min.	Heading	Speed (S.M.G.)	Speed (water)	Firing depth (m)	Seabed depth (m)
23/8/08	236	2216	CTD-1	1	78	18	8	59.96	151.2	0	0.8	1001	1175.8
23/8/08	236	2237	CTD-1	2	78	18	8	59.96	151.2	0	0.9	52.5	1175.9
25/8/08	238	1800	CTD-2	1	78	40	5	14.99	170	0	0.3	2284	2300
25/8/08	238	1802	CTD-2	2	78	40	5	14.99	170	0	0.3	2277	2300
25/8/08	238	1803	CTD-2	3	78	40	5	14.99	170	0	0.3	2275	2300
25/8/08	238	1805	CTD-2	4	78	40	5	14.99	170	0	0.3	2264	2300
25/8/08	238	1807	CTD-2	5	78	40	5	14.99	170	0	0.3	2253	2300
25/8/08	238	1811	CTD-2	6	78	40	5	14.99	170	0	0.3	2213	2300
25/8/08	238	1814	CTD-2	7	78	40	5	14.99	170	0	0.3	2113	2300
25/8/08	238	1818	CTD-2	8	78	40	5	14.99	170	0	0.3	2000	2300
25/8/08	238	1823	CTD-2	9	78	40	5	14.99	170	0	0.3	1799	2300
25/8/08	238	1828	CTD-2	10	78	40	5	14.99	170	0	0.3	1599	2300
25/8/08	238	1833	CTD-2	11	78	40	5	14.99	170	0	0.3	1398	2300
25/8/08	238	1838	CTD-2	12	78	40	5	14.99	170	0	0.3	1199.5	2300
25/8/08	238	1842	CTD-2	13	78	40	5	14.99	170	0	0.3	1000	2300
25/8/08	238	1847	CTD-2	14	78	40	5	14.99	170	0	0.3	799	2300
25/8/08	238	1852	CTD-2	15	78	40	5	14.99	170	0	0.3	599	2300
25/8/08	238	1856	CTD-2	16	78	40	5	14.99	170	0	0.3	400	2300
25/8/08	238	1901	CTD-2	17	78	40	5	14.99	170	0	0.3	200	2300
25/8/08	238	1904	CTD-2	18	78	40	5	14.99	170	0	0.3	101	2300
25/8/08	238	1906	CTD-2	19	78	40	5	14.99	170	0	0.3	51	2300
25/8/08	238	1907	CTD-2	20	78	40	5	14.99	170	0	0.3	40	2300
25/8/08	238	1909	CTD-2	21	78	40	5	14.99	170	0	0.3	30	2300
25/8/08	238	1911	CTD-2	22	78	40	5	14.99	170	0	0.3	20	2300
25/8/08	238	1912	CTD-2	23	78	40	5	14.99	170	0	0.3	10	2300
25/8/08	238	1914	CTD-2	24	78	40	5	14.99	170	0	0.3	6	2300
26/8/08	239		CTD-3	1	78	41.29	8	14.97	150	0	0.9	~890	895.59
26/8/08	239		CTD-3	2	78	41.29	8	14.97	150	0	0.9	~880	895.59
26/8/08	239		CTD-3	3	78	41.29	8	14.97	150	0	0.9	~870	895.59
26/8/08	239	0011	CTD-3	4	78	41.29	8	14.97	150	0	0.9	850	895.59
26/8/08	239	0013	CTD-3	5	78	41.29	8	14.97	150	0	0.9	800	895.59
26/8/08	239	0018	CTD-3	6	78	41.29	8	14.97	150	0	0.9	600	895.59
26/8/08	239	0022	CTD-3	7	78	41.29	8	14.97	150	0	0.9	400	895.59
26/8/08	239	0026	CTD-3	8	78	41.29	8	14.97	150	0	0.9	200	895.59
26/8/08	239	0029	CTD-3	9	78	41.29	8	14.97	150	0	0.9	100	895.59
26/8/08	239	0030	CTD-3	10	78	41.29	8	14.98	150	0	0.9	50.5	895.59
26/8/08	239	0032	CTD-3	11	78	41.29	8	14.98	150	0	0.9	41	895.59
26/8/08	239	0033	CTD-3	12	78	41.29	8	14.97	150	0	0.9	32	895.59
26/8/08	239	0034	CTD-3	13	78	41.29	8	14.97	150	0	0.9	20.5	895.59
26/8/08	239	0035	CTD-3	14	78	41.29	8	14.97	150	0	0.9	6.5	895.59
30/8/08	243	1535	CTD-4	1	79	23.56	8	7.08	270	0	0	280	294.21
30/8/08	243	1537	CTD-4	2	79	23.56	8	7.08	270	0	0	270	294.21
30/8/08	243	1538	CTD-4	3	79	23.56	8	7.08	270	0	0	260	294.21
30/8/08	243	1541	CTD-4	4	79	23.56	8	7.08	270	0	0	230	294.21
30/8/08	243	1542	CTD-4	5	79	23.56	8	7.08	270	0	0	200	294.21
30/8/08	243	1544	CTD-4	6	79	23.56	8	7.08	270	0	0	170	294.21
30/8/08	243	1545	CTD-4	7	79	23.56	8	7.08	270	0	0	140	294.21
30/8/08	243	1547	CTD-4	8	79	23.56	8	7.08	270	0	0	110	294.21
30/8/08	243	1549	CTD-4	9	79	23.56	8	7.08	270	0	0	70	294.21
30/8/08	243	1551	CTD-4	10	79	23.56	8	7.08	270	0	0	40	294.21
30/8/08	243	1552	CTD-4	11	79	23.56	8	7.08	270	0	0	20	294.21
30/8/08	243	1554	CTD-4	12	79	23.56	8	7.08	270	0	0	6.5	294.21
1/9/08	245	0332	CTD-5	1	78	41	8	15.74	164.7	0	0.6	890	901.05
1/9/08	245	0333	CTD-5	2	78	41	8	15.74	164.7	0	0.6	882	901.05
1/9/08	245	0334	CTD-5	3	78	41	8	15.74	164.7	0	0.6	870	901.05
1/9/08	245	0335	CTD-5	4	78	41	8	15.74	164.7	0	0.6	860	901.05
1/9/08	245	0336	CTD-5	5	78	41	8	15.74	164.7	0	0.6	850	901.05
1/9/08	245	0338	CTD-5	6	78	41	8	15.74	164.7	0	0.6	801	901.05
1/9/08	245	0342	CTD-5	7	78	41	8	15.74	164.7	0	0.6	611	901.05
1/9/08	245	0346	CTD-5	8	78	41	8	15.74	164.7	0	0.6	400	901.05
1/9/08	245	0350	CTD-5	9	78	41	8	15.74	164.7	0	0.6	201	901.05

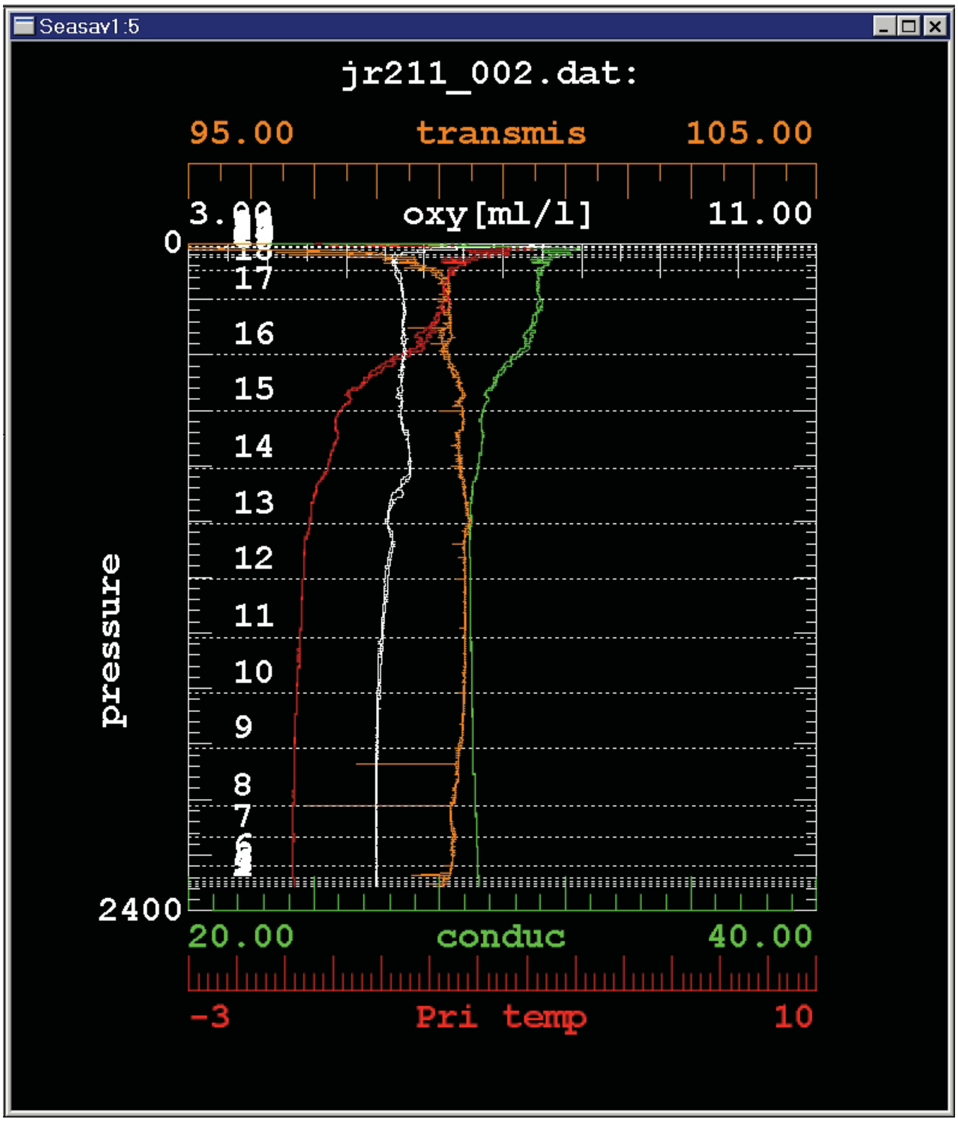
1/9/08	245	0353	CTD-5	10	78	41	8	15.74	164.7	0	0.6	101	901.05
1/9/08	245	0355	CTD-5	11	78	41	8	15.74	164.7	0	0.6	50	901.05
1/9/08	245	0356	CTD-5	12	78	41	8	15.74	164.7	0	0.6	30	901.05
1/9/08	245	0357	CTD-5	13	78	41	8	15.74	164.7	0	0.6	20	901.05
1/9/08	245	0358	CTD-5	14	78	41	8	15.74	164.7	0	0.6	6	901.05
1/9/08	245	0359	CTD-5	15	78	41	8	15.74	164.7	0	0.6	6	901.05
1/9/08	245	1348	CTD-6	1	78	35.08	9	27.4	335.2	0	0	376	385.7
1/9/08	245	1350	CTD-6	2	78	35.08	9	27.4	335.2	0	0	360	385.7
1/9/08	245	1352	CTD-6	3	78	35.08	9	27.4	335.2	0	0	350	385.7
1/9/08	245	1353	CTD-6	4	78	35.08	9	27.4	335.2	0	0	330	385.7
1/9/08	245	1355	CTD-6	5	78	35.08	9	27.4	335.2	0	0	300	385.7
1/9/08	245	1357	CTD-6	6	78	35.08	9	27.4	335.2	0	0	250	385.7
1/9/08	245	1359	CTD-6	7	78	35.08	9	27.4	335.2	0	0	200	385.7
1/9/08	245	1401	CTD-6	8	78	35.08	9	27.4	335.2	0	0	150	385.7
1/9/08	245	1402	CTD-6	9	78	35.08	9	27.4	335.2	0	0	100	385.7
1/9/08	245	1404	CTD-6	10	78	35.08	9	27.4	335.2	0	0	61	385.7
1/9/08	245	1405	CTD-6	11	78	35.08	9	27.4	335.2	0	0	20	385.7
1/9/08	245	1406	CTD-6	12	78	35.08	9	27.4	335.2	0	0	6	385.7
1/9/08	245		CTD-6	13	78	35.08	9	27.4	335.2	0	0		385.7
1/9/08	245		CTD-6	14	78	35.08	9	27.4	335.2	0	0		385.7
1/9/08	245		CTD-6	15	78	35.08	9	27.4	335.2	0	0		385.7
1/9/08	245		CTD-6	16	78	35.08	9	27.4	335.2	0	0		385.7
1/9/08	245	1820	CTD-7	1	78	37.08	9	25.4	359.8	0	0	367	376.71
1/9/08	245		CTD-7	2	78	37.08	9	25.4	359.8	0	0	350	376.71
1/9/08	245		CTD-7	3	78	37.08	9	25.4	359.8	0	0	340	376.71
1/9/08	245		CTD-7	4	78	37.08	9	25.4	359.8	0	0	320	376.71
1/9/08	245		CTD-7	5	78	37.08	9	25.4	359.8	0	0	300	376.71
1/9/08	245		CTD-7	6	78	37.08	9	25.4	359.8	0	0	250	376.71
1/9/08	245	1837	CTD-7	7	78	37.08	9	25.4	359.8	0	0	200	376.71
1/9/08	245	1838	CTD-7	8	78	37.08	9	25.4	359.8	0	0	150	376.71
1/9/08	245		CTD-7	9	78	37.08	9	25.4	359.8	0	0	100	376.71
1/9/08	245	1841	CTD-7	10	78	37.08	9	25.4	359.8	0	0	60	376.71
1/9/08	245	1843	CTD-7	11	78	37.08	9	25.4	359.8	0	0	20	376.71
1/9/08	245	1844	CTD-7	12	78	37.08	9	25.4	359.8	0	0	6	376.71

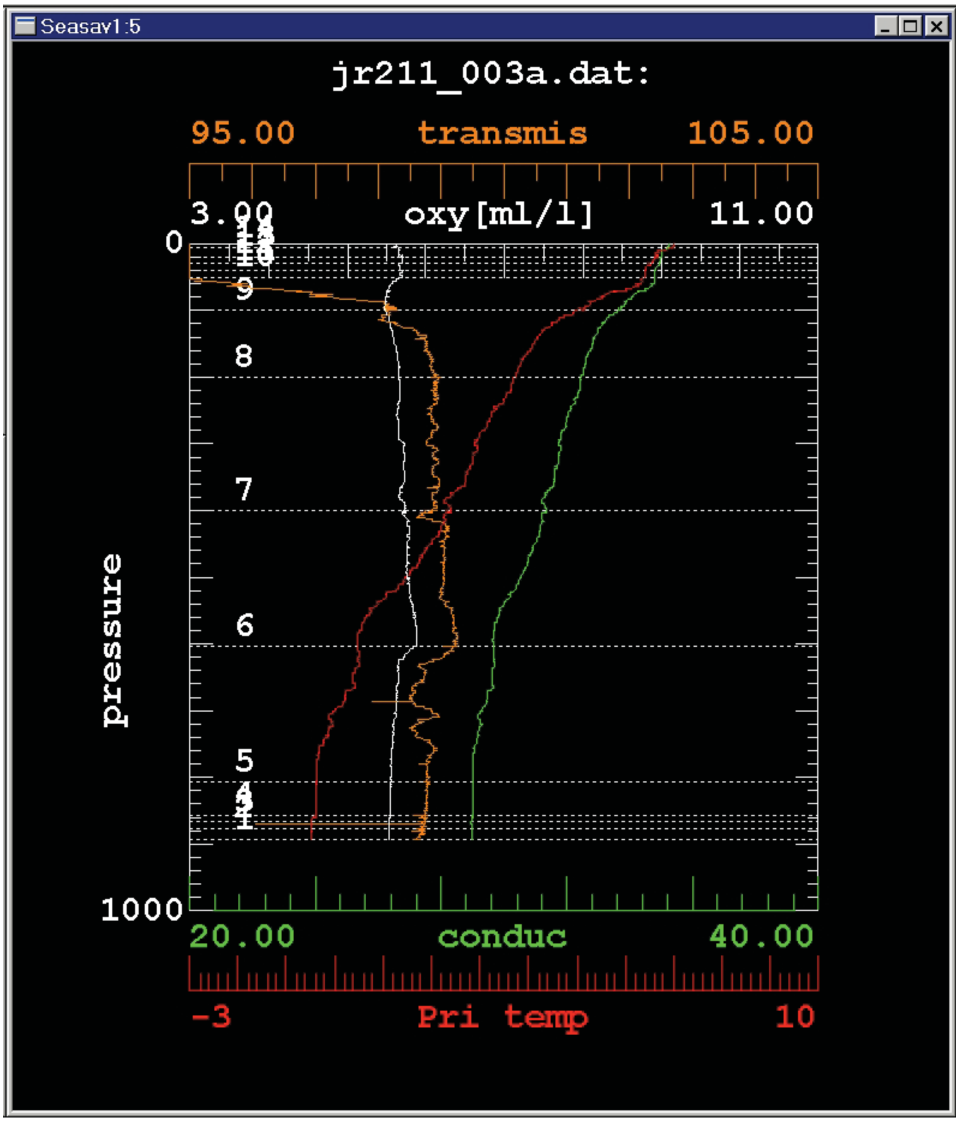
15/9/08	259		CTD-8	1	79	27.74	7	24.28	190.9	0	0	919	928.71
15/9/08	259		CTD-8	2	79	27.74	7	24.28	190.9	0	0	910	928.71
15/9/08	259	0737	CTD-8	3	79	27.74	7	24.28	190.9	0	0	900	928.71
15/9/08	259	0740	CTD-8	4	79	27.74	7	24.28	190.9	0	0	799.6	928.71
15/9/08	259	0743	CTD-8	5	79	27.74	7	24.28	190.9	0	0	700.8	928.71
15/9/08	259	0746	CTD-8	6	79	27.74	7	24.28	190.9	0	0	625.8	928.71
15/9/08	259	0748	CTD-8	7	79	27.74	7	24.28	190.9	0	0	549.8	928.71
15/9/08	259	0750	CTD-8	8	79	27.74	7	24.28	190.9	0	0	500.3	928.71
15/9/08	259	0752	CTD-8	9	79	27.74	7	24.28	190.9	0	0	400	928.71
15/9/08	259	0755	CTD-8	10	79	27.74	7	24.28	190.9	0	0	299.6	928.71
15/9/08	259		CTD-8	11	79	27.74	7	24.28	190.9	0	0	201	928.71
15/9/08	259	0800	CTD-8	12	79	27.74	7	24.28	190.9	0	0	176	928.71
15/9/08	259		CTD-8	13	79	27.74	7	24.28	190.9	0	0	151	928.71
15/9/08	259	0803	CTD-8	14	79	27.74	7	24.28	190.9	0	0	125.5	928.71
15/9/08	259	0803	CTD-8	15	79	27.74	7	24.28	190.9	0	0	125.9	928.71
15/9/08	259	0804	CTD-8	16	79	27.74	7	24.28	190.9	0	0	100.6	928.71
15/9/08	259	0805	CTD-8	17	79	27.74	7	24.28	190.9	0	0	80.5	928.71
15/9/08	259	0807	CTD-8	18	79	27.74	7	24.28	190.9	0	0	60.5	928.71
15/9/08	259	0808	CTD-8	19	79	27.74	7	24.28	190.9	0	0	40.6	928.71
15/9/08	259	0810	CTD-8	20	79	27.74	7	24.28	190.9	0	0	20.8	928.71
15/9/08	259	0811	CTD-8	21	79	27.74	7	24.28	190.9	0	0	10.6	928.71
15/9/08	259	0811	CTD-8	22	79	27.74	7	24.28	190.9	0	0	10.6	928.71
15/9/08	259	0812	CTD-8	23	79	27.74	7	24.28	190.9	0	0	6.7	928.71
15/9/08	259	0813	CTD-8	24	79	27.74	7	24.28	190.9	0	0	6.8	928.71
16/9/08	260	0409	CTD-9	1	79	0.41	6	54.27	190.2	0	0.1	1200	1212
16/9/08	260	0410	CTD-9	2	79	0.41	6	54.27	190.2	0	0.1	1190	1212
16/9/08	260	0412	CTD-9	3	79	0.41	6	54.27	190.2	0	0.1	1180	1212
16/9/08	260	0413	CTD-9	4	79	0.41	6	54.27	190.2	0	0.1	1170	1212
16/9/08	260	0415	CTD-9	5	79	0.41	6	54.27	190.2	0	0.1	1100	1212
16/9/08	260	0417	CTD-9	6	79	0.41	6	54.27	190.2	0	0.1	1050	1212
16/9/08	260	0419	CTD-9	7	79	0.41	6	54.27	190.2	0	0.1	1000	1212
16/9/08	260	0421	CTD-9	8	79	0.41	6	54.27	190.2	0	0.1	900	1212
16/9/08	260	0424	CTD-9	9	79	0.41	6	54.27	190.2	0	0.1	800	1212
16/9/08	260	0428	CTD-9	10	79	0.41	6	54.27	190.2	0	0.1	600	1212

16/9/08	260	0432	CTD-9	11	79	0.41	6	54.27	190.2	0	0.1	400	1212
16/9/08	260	0435	CTD-9	12	79	0.41	6	54.27	190.2	0	0.1	290	1212
16/9/08	260	0438	CTD-9	13	79	0.41	6	54.27	190.2	0	0.1	200	1212
16/9/08	260	0440	CTD-9	14	79	0.41	6	54.27	190.2	0	0.1	150	1212
16/9/08	260	0440	CTD-9	15	79	0.41	6	54.27	190.2	0	0.1	150	1212
16/9/08	260	0442	CTD-9	16	79	0.41	6	54.27	190.2	0	0.1	100	1212
16/9/08	260	0444	CTD-9	17	79	0.41	6	54.27	190.2	0	0.1	50	1212
16/9/08	260	0446	CTD-9	18	79	0.41	6	54.27	190.2	0	0.1	20	1212
16/9/08	260	0447	CTD-9	19	79	0.41	6	54.27	190.2	0	0.1	6	1212
17/9/08	261	1908	CTD-10	1	78	39.16	9	25.92	189.9	0.1	0	230	233
17/9/08	261	1910	CTD-10	2	78	39.16	9	25.92	189.9	0.1	0	220	233
17/9/08	261	1911	CTD-10	3	78	39.16	9	25.92	189.9	0.1	0	205	233
17/9/08	261	1912	CTD-10	4	78	39.16	9	25.92	189.9	0.1	0	190	233
17/9/08	261	1914	CTD-10	5	78	39.16	9	25.92	189.9	0.1	0	174.5	233
17/9/08	261	1915	CTD-10	6	78	39.16	9	25.92	189.9	0.1	0	160	233
17/9/08	261	1916	CTD-10	7	78	39.16	9	25.92	189.9	0.1	0	149.7	233
17/9/08	261	1918	CTD-10	8	78	39.16	9	25.92	189.9	0.1	0	139.7	233
17/9/08	261	1920	CTD-10	9	78	39.16	9	25.92	189.9	0.1	0	100	233
17/9/08	261	1922	CTD-10	10	78	39.16	9	25.92	189.9	0.1	0	59.6	233
17/9/08	261	1924	CTD-10	11	78	39.16	9	25.92	189.9	0.1	0	40	233
17/9/08	261	1925	CTD-10	12	78	39.16	9	25.92	189.9	0.1	0	9.7	233
17/9/08	261	2013	CTD-12	13	78	39.23	9	25.87	199	0	0	233.5	233
17/9/08	261	2017	CTD-12	14	78	39.23	9	25.87	199	0	0	204.5	233
17/9/08	261	2018	CTD-12	15	78	39.23	9	25.87	199	0	0	204.8	233
17/9/08	261	2019	CTD-12	16	78	39.23	9	25.87	199	0	0	180.7	233
17/9/08	261	2020	CTD-12	17	78	39.23	9	25.87	199	0	0	155.5	233
17/9/08	261	2022	CTD-12	18	78	39.23	9	25.87	199	0	0	130.8	233
17/9/08	261	2024	CTD-12	19	78	39.23	9	25.87	199	0	0	105.9	233
17/9/08	261	2026	CTD-12	20	78	39.23	9	25.87	199	0	0	80.5	233
17/9/08	261	2027	CTD-12	21	78	39.23	9	25.87	199	0	0	55.7	233
17/9/08	261	2029	CTD-12	22	78	39.23	9	25.87	199	0	0	30.5	233
17/9/08	261	2030	CTD-12	23	78	39.23	9	25.87	199	0	0	15.9	233
17/9/08	261	2031	CTD-12	24	78	39.23	9	25.87	199	0	0	6.6	233
18/9/08	262	0021	CTD-13	1	78	32.927	9	43.856	158.3	0.1	0.5	175.5	178.5
18/9/08	262	0022	CTD-13	2	78	32.927	9	43.856	158.3	0.1	0.5	165.0	178.5
18/9/08	262	0024	CTD-13	3	78	32.927	9	43.856	158.3	0.1	0.5	156	178.5
18/9/08	262	0025	CTD-13	4	78	32.927	9	43.856	158.3	0.1	0.5	146.5	178.5
18/9/08	262	0026	CTD-13	5	78	32.927	9	43.856	158.3	0.1	0.5	135	178.5
18/9/08	262	0027	CTD-13	6	78	32.927	9	43.856	158.3	0.1	0.5	125.3	178.5
18/9/08	262	0029	CTD-13	7	78	32.927	9	43.856	158.3	0.1	0.5	105.1	178.5
18/9/08	262	0030	CTD-13	8	78	32.927	9	43.856	158.3	0.1	0.5	80.4	178.5
18/9/08	262	0031	CTD-13	9	78	32.927	9	43.856	158.3	0.1	0.5	60.1	178.5
18/9/08	262	0033	CTD-13	10	78	32.927	9	43.856	158.3	0.1	0.5	41.4	178.5
18/9/08	262	0034	CTD-13	11	78	32.927	9	43.856	158.3	0.1	0.5	20.1	178.5
18/9/08	262	0035	CTD-13	12	78	32.927	9	43.856	158.3	0.1	0.5	5.7	178.5

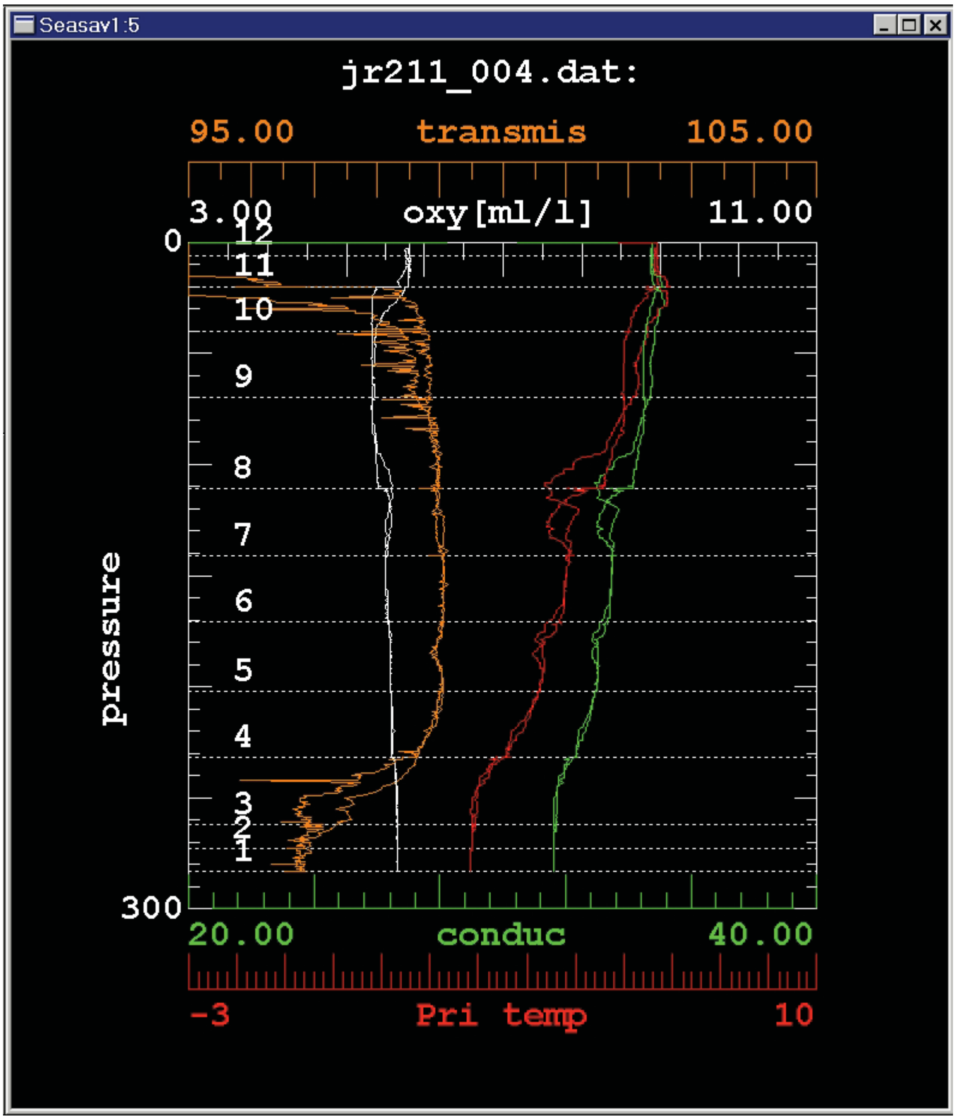
H CTD hydrocast plots



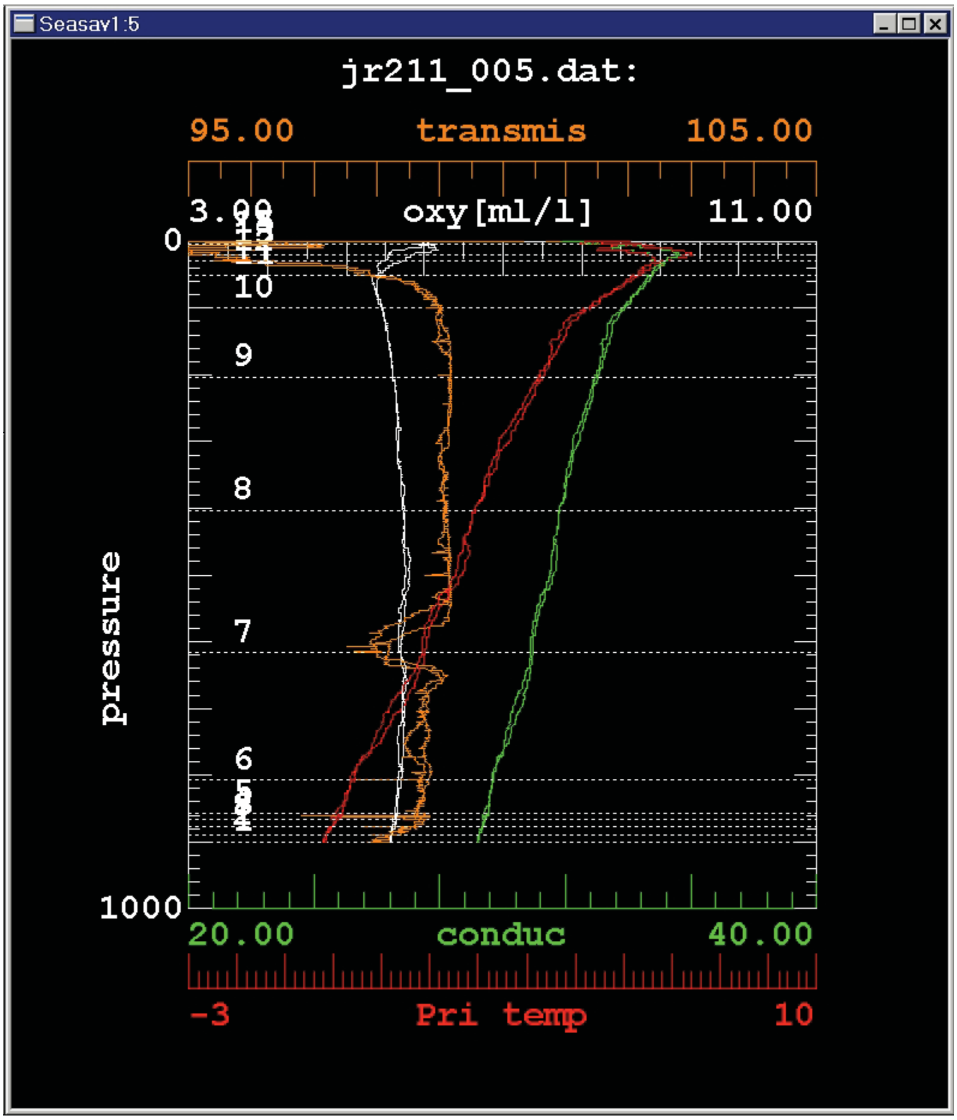

Seasav1:5
jr211_002.dat:
95.00
transmis
105.00
3.00
oxy[ml/l]
11.00
0
17
16
15
14
13
12
11
10
9
8
7
pressure
2400
20.00
conduc
40.00
-3
Pri temp
10

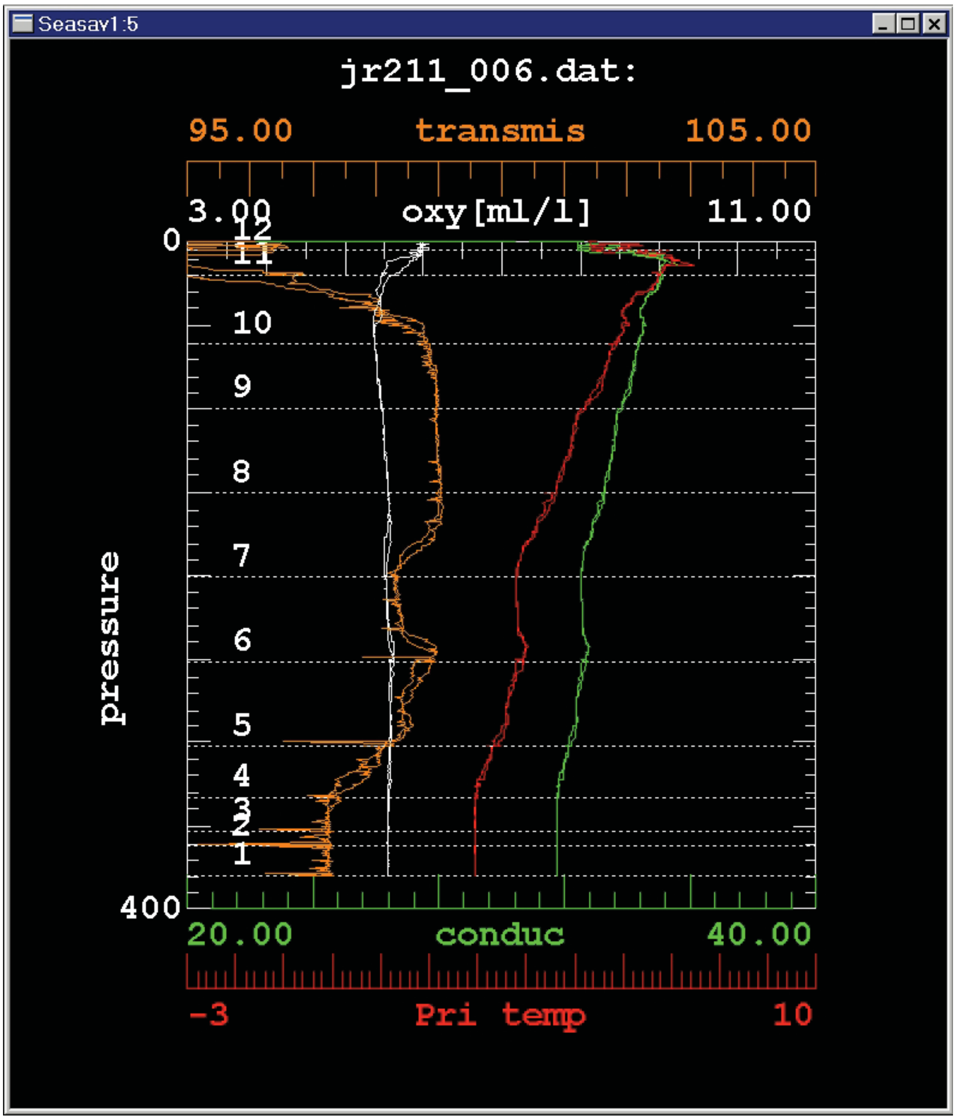


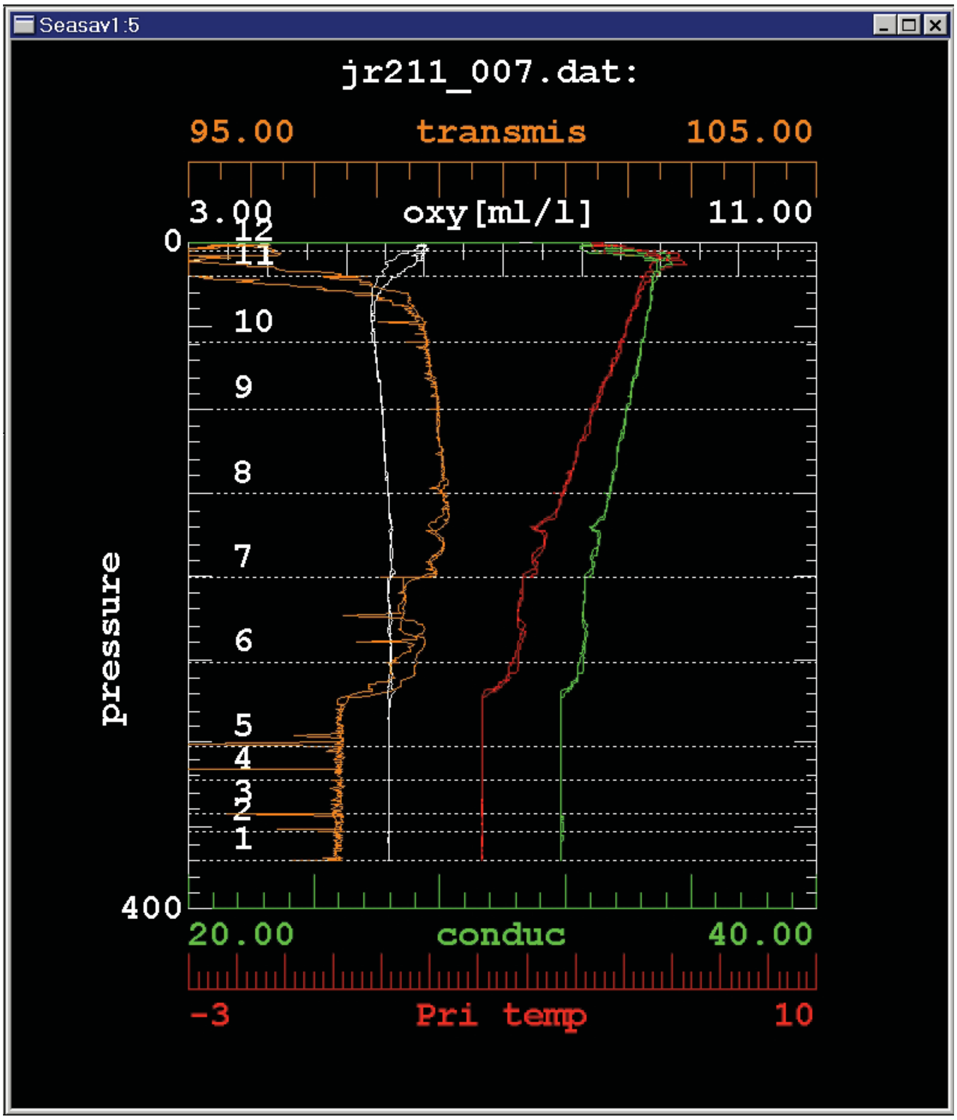
Seasav1:5
jr211_003a.dat:
95.00
transmis
105.00
3.00
oxy[ml/l]
11.00
0
9
8
7
6
5
pressure
1000
20.00
conduc
40.00
-3
Pri temp
10



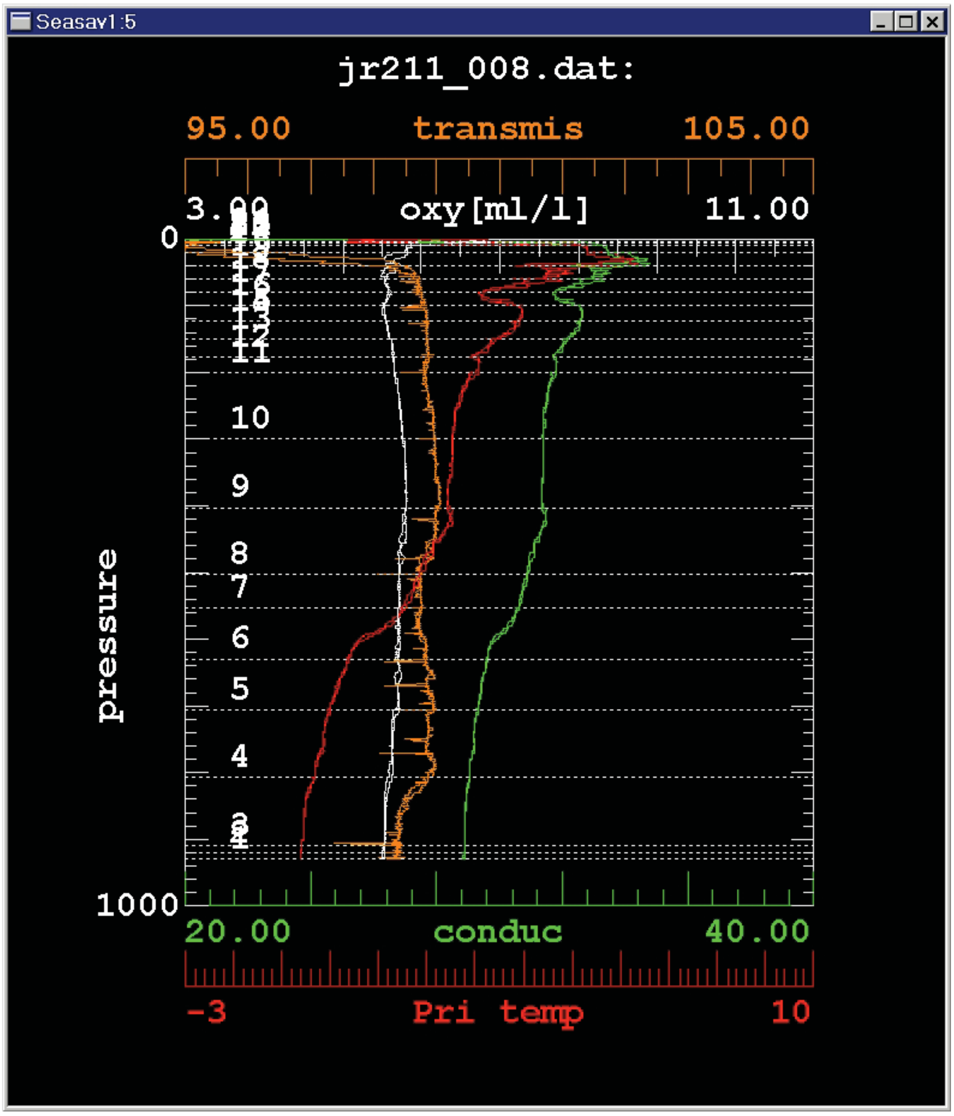
Seasav1:5
jr211_004.dat:
95.00
transmis
105.00
3.00
oxy[ml/l]
11.00
0
300
pressure
12
11
10
9
8
7
6
5
4
3
2
1
20.00
conduc
40.00
-3
Pri temp
10

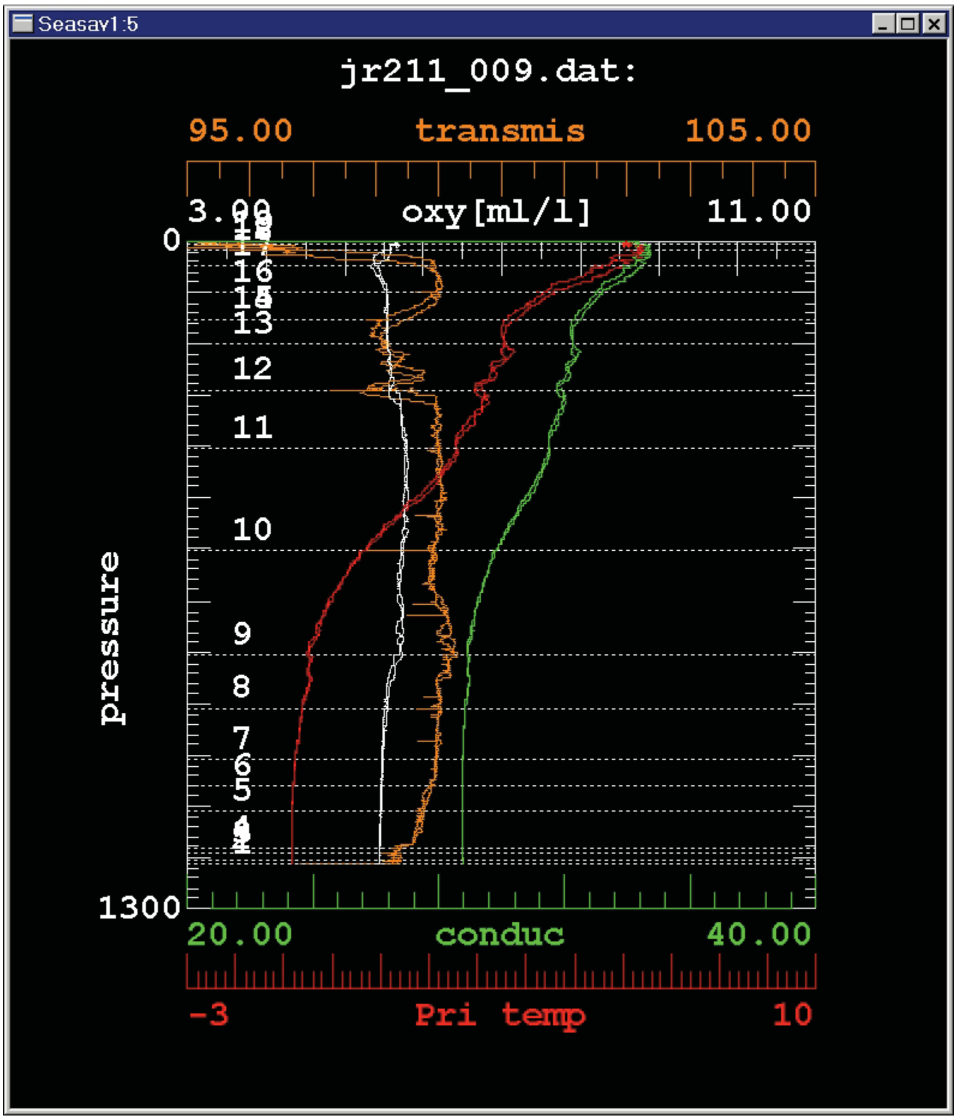

Seasav1:5
jr211_005.dat:
95.00
transmis
105.00
3.00
oxy[ml/l]
11.00
0
10
9
8
7
6
pressure
1000
20.00
conduc
40.00
-3
Pri temp
10

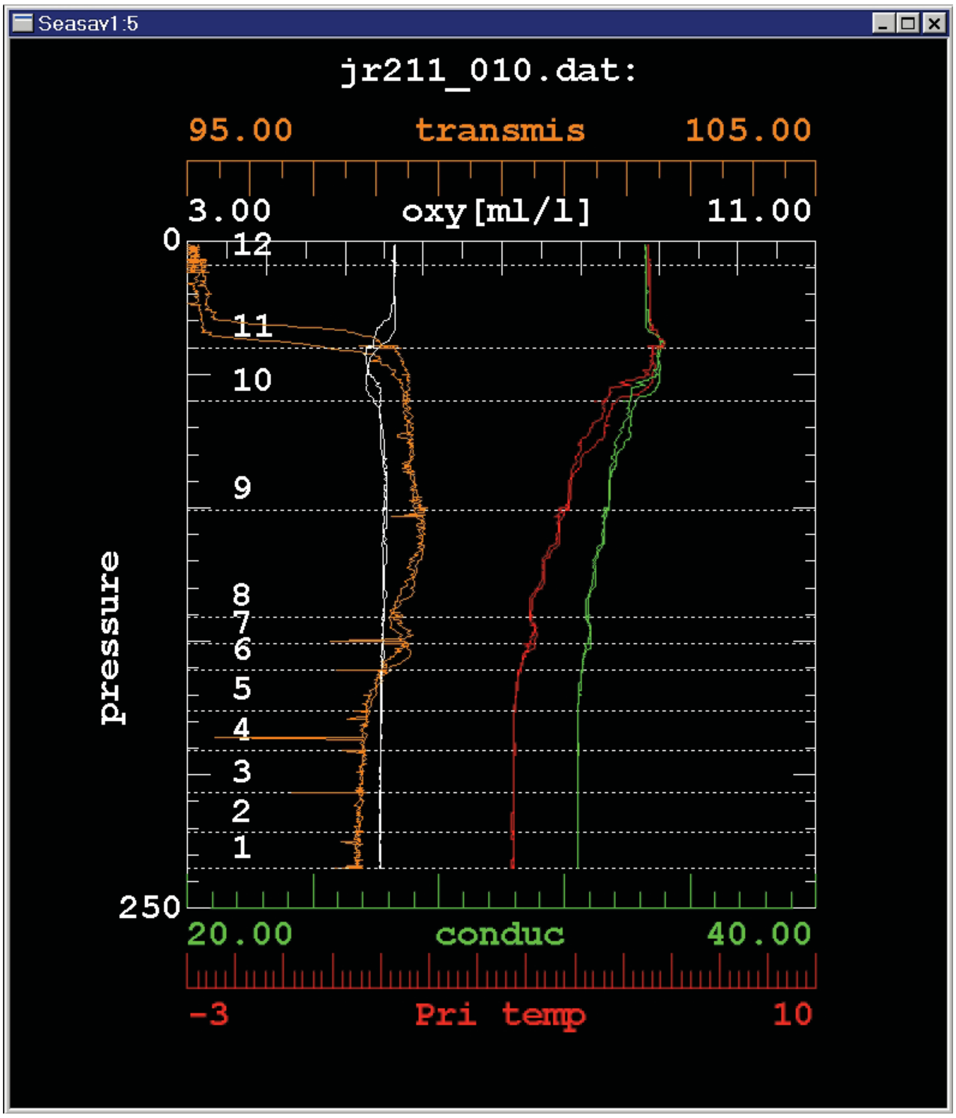

Seasave1:5
jr211_006.dat:
95.00
transmis
105.00
3.00
oxy[ml/l]
11.00
0
400
pressure
12
11
10
9
8
7
6
5
4
3
2
1
20.00
conduc
40.00
-3
Pri temp
10

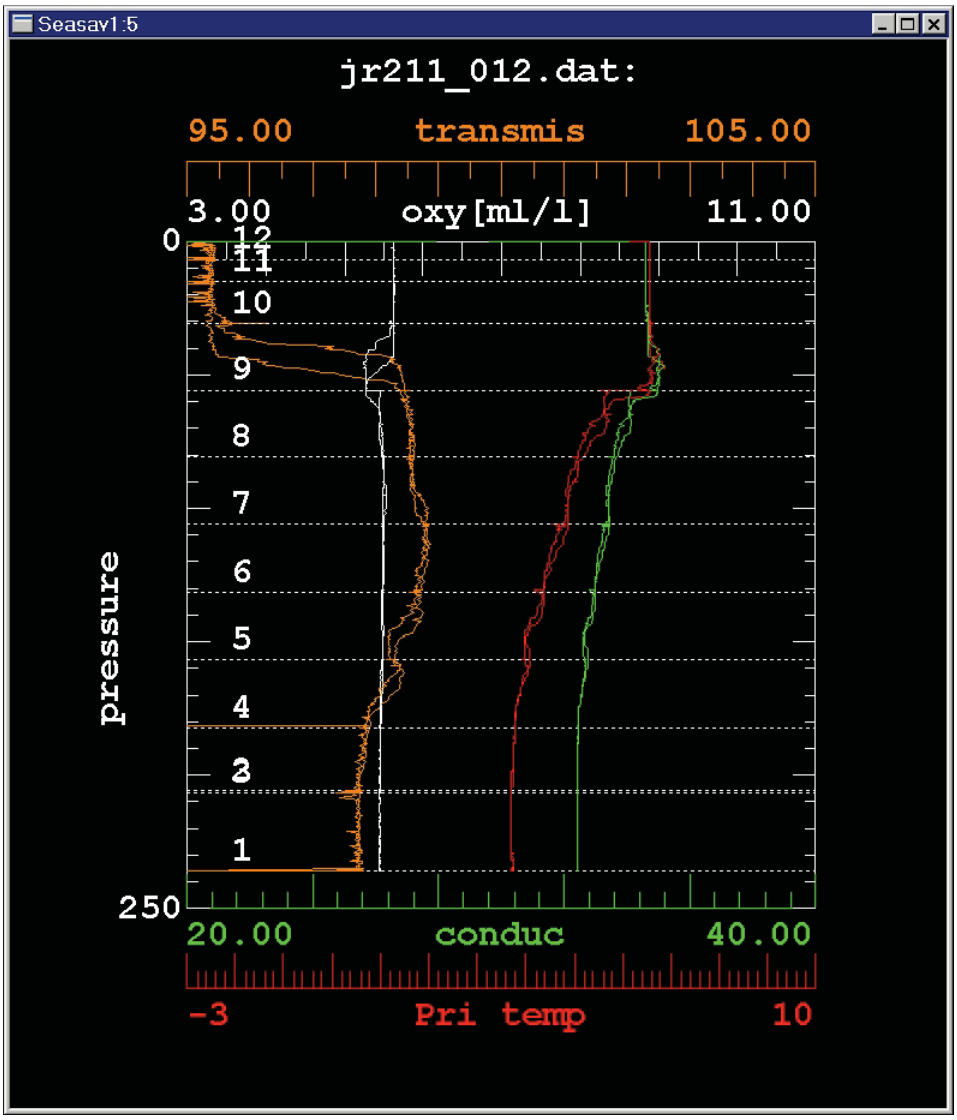


Seasav1:5
jr211_007.dat:
95.00
transmis
105.00
3.00
oxy[ml/l]
11.00
0
pressure
400
12
11
10
9
8
7
6
5
4
3
2
1
20.00
conduc
40.00
-3
Pri temp
10

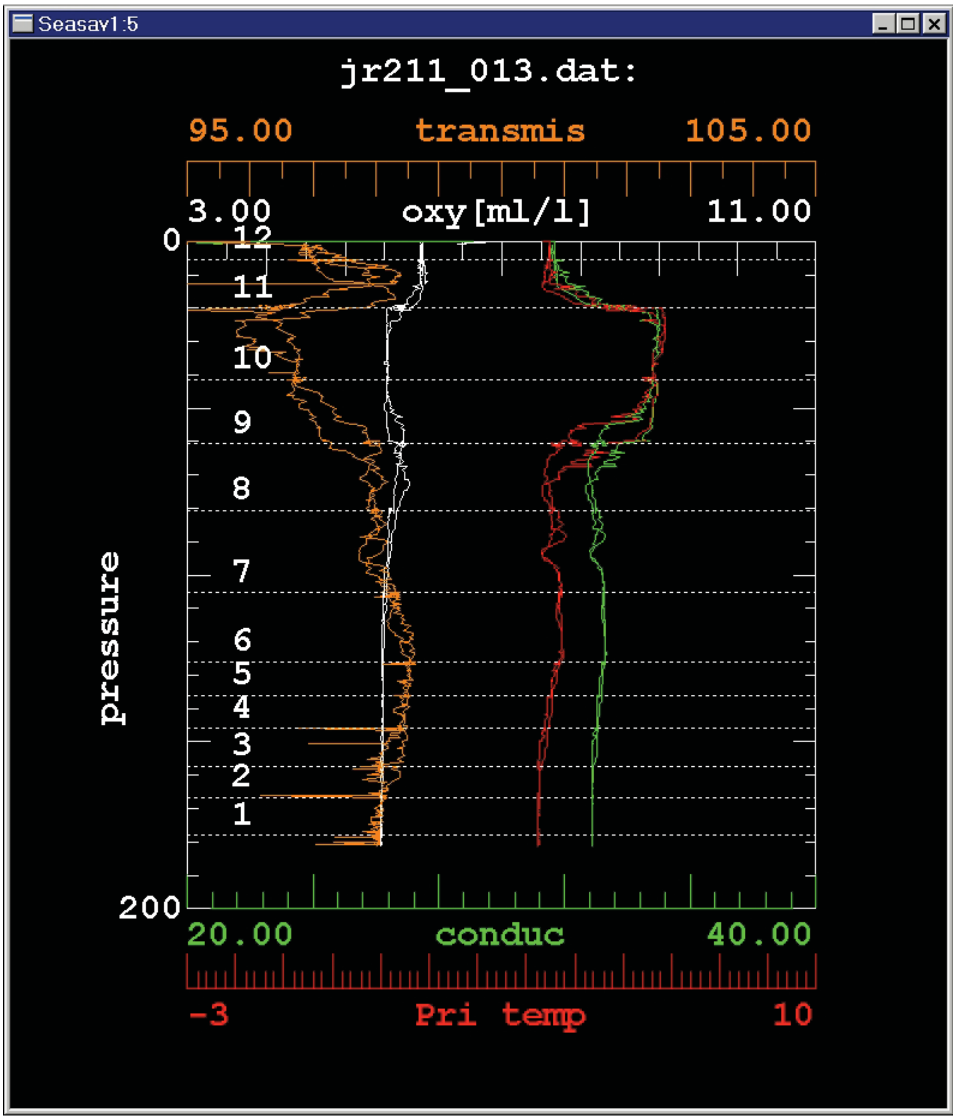

Seasav1:5
jr211_008.dat:
95.00 transmis 105.00
3.00 oxy[ml/l] 11.00
0
10
9
8
7
6
5
4
pressure
1000
20.00 conduc 40.00
-3 Pri temp 10


Seasav1:5
jr211_009.dat:
95.00
transmis
105.00
3.00
oxy[ml/l]
11.00
0
16
13
12
11
10
9
8
7
6
5
pressure
1300
20.00
conduc
40.00
-3
Pri temp
10


Seasav1:5
jr211_010.dat:
95.00
transmis
105.00
3.00
oxy[ml/l]
11.00
0
12
11
10
9
8
7
6
5
4
3
2
1
pressure
250
20.00
conduc
40.00
-3
Pri temp
10



Seasav1:5
jr211_012.dat:
95.00
transmis
105.00
3.00
oxy[ml/l]
11.00
0
12
11
10
9
8
7
6
5
4
3
1
250
pressure
20.00
conduc
40.00
-3
Pri temp
10


Seasav1:5
jr211_013.dat:
95.00
transmis
105.00
3.00
oxy[ml/l]
11.00
0
200
pressure
12
11
10
9
8
7
6
5
4
3
2
1
20.00
conduc
40.00
-3
Pri temp
10

I Core stations

Site	Core No.	Core Type*	Length recovered	Comments
Gas Flare Area A	1	BC	2 × 18cm	No gravity core taken at this site as too stony.
Gas Flare Area A	2	BC	No sample taken	
Gas Flare Area B	3	BC	18cm	
Gas Flare Area B	4	GC	232cm	
Centre of pockmark	6	BC	1 × 13cm; 1 × 15cm	
Centre of pockmark	7	PC	912cm	Middle section of core stuck in core liner; this part of the core is disturbed.
Towards edge of pockmark	8	BC	1 × 24cm; 1 × 36 cm	
Towards edge of pockmark	9	GC	240cm	
'Angular' seafloor features in north	17	BC	0	Corer did not close
Mid-slope of angular feature	18/19	BC	0	Corer did not close on either deployment
Just to south of cores 18/19	20	BC	No sample taken	Recovered rocks and gravel, but no mud
CTD4 site	21	BC	19cm	
CTD4 site	22	GC	26cm	
'Vanished flare', Vestnesa Ridge	24	BC	19cm	Freshly precipitated lump of carbonate recovered
'Vanished flare', Vestnesa Ridge	25	GC	26cm	Corer was bent. Piece of gas hydrate recovered.
'Vanished flare', Vestnesa Ridge	26	GC	386cm	Gas hydrate recovered between 193 and 386cm core depth
Flare Corner	29	BC	0	Corer did not close
Flare Corner	30	BC	17cm	No GC taken; surface too stony
Shallow vent site to east of main flare area	31	BC	24cm	No GC taken; surface too stony
Pockmark escape feature	32	BC	19cm	
Pockmark escape feature	33	GC	178cm	Gas hydrate recovered between 126 and 178cm core depth

For lat/long of sites, see Core Log Sheets.
*BC= box core; GC= gravity core; PC= piston core

Core ID			Date	Julian day	Time corer at bottom (utc)	Position of ship			
						Latitude		Longitude	
Cruise	Number	Type				Degrees	Minutes	Degrees	Minutes
JCR211	01	BC	04/09/2008	248	07:41	78	37.0700	9	25.3900
JCR211	02	BC	04/09/2008	248	08:22	78	37.0333	9	25.4166
JCR211	03	BC	04/09/2008	248	09:56	78	35.0900	9	27.4000
JCR211	04	GC	04/09/2008	248	10:38	78	35.0800	9	27.3900
JCR211	05	GC	04/09/2008	248	12:44	78	35.0800	9	27.3800
JCR211	06	BC	04/09/2008	248	15:58	78	41.2400	8	15.6200
JCR211	07	PC	04/09/2008	248	17:26	78	41.2400	8	15.6100
JCR211	08	BC	04/09/2008	248	20:00	78	41.0600	8	15.5900
JCR211	09	GC	04/09/2008	248	21:46	78	41.0700	8	15.5900
JCR211	10	BC	09/09/2008	253	07:22	78	36.2600	9	7.3800
JCR211	11	PC	09/09/2008	253	09:37	78	36.2600	9	7.3800
JCR211	12	GC	09/09/2008	253	16:23	79	27.7300	7	24.2500
JCR211	13	GC	09/09/2008	253	19:58	79	23.5492	6	46.0158
JCR211	14	GC	09/09/2008	253	22:31	79	23.5492	6	46.0158
JCR211	15	GC	10/09/2008	254	02:08	79	37.5390	7	55.3010
JCR211	16	GC	10/09/2008	254	03:57	79	37.5390	7	55.3010
JCR211	17	BC	10/09/2008	254	13:01	79	24.26	7	55.27
JCR211	18	BC	10/09/2008	254	14:05	79	24.1037	8	8.9709
JCR211	19	BC	10/09/2008	254	14:36	79	24.1000	8	8.9699
JCR211	20	BC	10/09/2008	254	15:17	79	24.0500	8	9.0100
JCR211	21	BC	10/09/2008	254	16:08	79	23.5600	8	7.0500
JCR211	22	GC	10/09/2008	254	17:11	79	23.5600	8	7.0500
JCR211	23	GC	15/09/2008	259	08:57	79	27.7300	7	24.2800
JCR211	24	BC	16/09/2008	259	05:46	79	0.4100	6	54.2700
JCR211	25	GC	16/09/2008	260	07:06	79	0.3900	6	54.2500
JCR211	26	GC	16/09/2008	260	08:39	79	0.3900	6	54.2600
JCR211	27	GC	16/09/2008	260	13:17	78	44.3721	7	29.6369
JCR211	28	GC	16/09/2008	260	15:03	78	44.3283	7	29.6485
JCR211	29	BC	17/09/2008	261	21:08	78	39.15	9	25.9200
JCR211	30	BC	17/09/2008	261	21:38	78	39.1700	9	25.9300
JCR211	31	BC	18/09/2008	262	00:08	78	32.9267	9	43.8531
JCR211	32	BC	18/09/2008	262	04:34	78	41.0730	8	16.8990
JCR211	33	GC	18/09/2008	262	05:54	78	41.0700	8	16.3600

Core ID		Additional positional information for core from transponder						Notes
		Latitude			Longitude			
Cruise	Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds	
JCR211	01	78	37	4	9	25	25	
JCR211	02	78	37	2	9	25	25	
JCR211	03							
JCR211	04							
JCR211	05							
JCR211	06	78	41	16	8	15	33	53.19m from ship, bearing 329.47
JCR211	07							
JCR211	08							40m from ship, heading 324
JCR211	09							
JCR211	10							
JCR211	11							
JCR211	12							
JCR211	13	79	23	32.953	6	46	0.953	
JCR211	14	79	23	32.9	6	46	0	
JCR211	15							
JCR211	16							
JCR211	17	7	55.25		79	24.28		
JCR211	18	79	24	7.179	8	8	59.117	22m from ship, bearing 353
JCR211	19	79	24	7.171	8	8	59.254	25.25m from ship, bearing 353
JCR211	20	79	24	3.856	8	8	57.919	24.87m from ship, bearing 325
JCR211	21	79	23	35	8	7	2	26m from ship, bearing 341
JCR211	22							
JCR211	23							
JCR211	24	79	0	24.355	6	54	14.985	
JCR211	25							
JCR211	26							
JCR211	27							
JCR211	28							
JCR211	29	78	39	10.052	9	25	53.443	
JCR211	30	78	39	10.64	9	25	53.078	
JCR211	31							
JCR211	32	78	41	5.75	8	16	47.925	
JCR211	33							

Core ID		Water depth (m)	Cable out (m)	Pull out tension (t)	Length of core recovered (cm)	Core section lengths 1 (Top of core)			2		
Cruise	Number					Top (cm)	Bottom (cm)	Length (cm)	Top (cm)	Bottom (cm)	Length (cm)
JCR211	01	378	377		~30	n/a	n/a	18	n/a	n/a	18
JCR211	02	378	380		~30			0			
JCR211	03	385	388	1.4	~30	n/a	n/a	19	n/a	n/a	16
JCR211	04	386	389	0.27	232	0	37	37	37	87	50
JCR211	05	387	394	1.41	275	0	125	125	125	275	150
JCR211	06	906	908		~30	n/a	n/a	15	n/a	n/a	15
JCR211	07	904	877	3.58	912	0	50	50	50	100	50
JCR211	08	904	908		~30	n/a	n/a	24	n/a	n/a	36
JCR211	09	915	909		256	0	58	58	58	108	50
JCR211	10	522	516		~30	n/a	n/a	20			
JCR211	11	522	503	3	733	0	143	143	143	297	154
JCR211	12	928	928	2.81	278	0	128	128	128	278	150
JCR211	13	1303	1330	3.45	484	0	46	46	46	196	150
JCR211	14	1301	1330	3.48	456	0	18	18	18	168	150
JCR211	15	706	712	3.8	334	0	46	46	46	184	138
JCR211	16	706	714	3	342	0	56	56	56	192	136
JCR211	17	343	531		0			0			
JCR211	18	271	302	0.6	0			0			
JCR211	19	271	285	0.6	0			0			
JCR211	20	255	264	0.6	~30			0			
JCR211	21	291	300	0.67	19	n/a	n/a	19			
JCR211	22	292	299	1.41	26	0	26	26			
JCR211	23	928	928	2.81	268	0	118	118	118	268	150
JCR211	24	1214	1214		19	n/a	n/a	19			
JCR211	25	1211	1210	2.08	38	0	38	38			
JCR211	26	1210	1215	2.41	386	0	19	19	19	69	50
JCR211	27	1142	1141	2.85	361	0	74	74	74	211	137
JCR211	28	1143	1141	3.15	273	0	123	123	123	273	150
JCR211	29	238	252	0.5	0			0			
JCR211	30	232	254	0.6	17	n/a	n/a	17			
JCR211	31	183	195	0.4	24	n/a	n/a	24			
JCR211	32	874	884		19	n/a	n/a	19			
JCR211	33	890	894	2.54	178	0	21	21	21	71	50

Core ID		3			4			5		
Cruise	Number	Top (cm)	Bottom (cm)	Length (cm)	Top (cm)	Bottom (cm)	Length (cm)	Top (cm)	Bottom (cm)	Length (cm)
JCR211	01									
JCR211	02									
JCR211	03									
JCR211	04	87	137	50	137	187	50	187	232	45
JCR211	05									
JCR211	06									
JCR211	07	100	150	50	150	170	20	170	220	50
JCR211	08									
JCR211	09	108	158	50	158	208	50	208	256	48
JCR211	10									
JCR211	11	297	447	150	447	583	136	583	733	150
JCR211	12									
JCR211	13	196	334	138	334	484	150			
JCR211	14	168	306	138	306	456	150			
JCR211	15	184	334	150						
JCR211	16	192	342	150						
JCR211	17									
JCR211	18									
JCR211	19									
JCR211	20									
JCR211	21									
JCR211	22									
JCR211	23									
JCR211	24									
JCR211	25									
JCR211	26	69	87	18	87	99	12	99	113	14
JCR211	27	211	361	150						
JCR211	28									
JCR211	29									
JCR211	30									
JCR211	31									
JCR211	32									
JCR211	33	71	104	33	104	126	22	126	148	22

Core ID		6			7			8		
Cruise	Number	Top (cm)	Bottom (cm)	Length (cm)	Top (cm)	Bottom (cm)	Length (cm)	Top (cm)	Bottom (cm)	Length (cm)
JCR211	01									
JCR211	02									
JCR211	03									
JCR211	04									
JCR211	05									
JCR211	06									
JCR211	07	220	270	50	270	290	20	290	346	56
JCR211	08									
JCR211	09									
JCR211	10									
JCR211	11									
JCR211	12									
JCR211	13									
JCR211	14									
JCR211	15									
JCR211	16									
JCR211	17									
JCR211	18									
JCR211	19									
JCR211	20									
JCR211	21									
JCR211	22									
JCR211	23									
JCR211	24									
JCR211	25									
JCR211	26	113	146	33	146	162	16	162	190	28
JCR211	27									
JCR211	28									
JCR211	29									
JCR211	30									
JCR211	31									
JCR211	32									
JCR211	33	148	178	30						

Core ID		9			10			11		
Cruise	Number	Top (cm)	Bottom (cm)	Length (cm)	Top (cm)	Bottom (cm)	Length (cm)	Top (cm)	Bottom (cm)	Length (cm)
JCR211	01									
JCR211	02									
JCR211	03									
JCR211	04									
JCR211	05									
JCR211	06									
JCR211	07	346	396	50	396	446	50	446	496	50
JCR211	08									
JCR211	09									
JCR211	10									
JCR211	11									
JCR211	12									
JCR211	13									
JCR211	14									
JCR211	15									
JCR211	16									
JCR211	17									
JCR211	18									
JCR211	19									
JCR211	20									
JCR211	21									
JCR211	22									
JCR211	23									
JCR211	24									
JCR211	25									
JCR211	26	190	193	3	193	227	34	227	258	31
JCR211	27									
JCR211	28									
JCR211	29									
JCR211	30									
JCR211	31									
JCR211	32									
JCR211	33									

Core ID		12			13			14		
Cruise	Number	Top (cm)	Bottom (cm)	Length (cm)	Top (cm)	Bottom (cm)	Length (cm)	Top (cm)	Bottom (cm)	Length (cm)
JCR211	01									
JCR211	02									
JCR211	03									
JCR211	04									
JCR211	05									
JCR211	06									
JCR211	07	496	546	50	546	596	50	596	635	39
JCR211	08									
JCR211	09									
JCR211	10									
JCR211	11									
JCR211	12									
JCR211	13									
JCR211	14									
JCR211	15									
JCR211	16									
JCR211	17									
JCR211	18									
JCR211	19									
JCR211	20									
JCR211	21									
JCR211	22									
JCR211	23									
JCR211	24									
JCR211	25									
JCR211	26	258	308	50	308	348	40	348	386	38
JCR211	27									
JCR211	28									
JCR211	29									
JCR211	30									
JCR211	31									
JCR211	32									
JCR211	33									

Core ID		15			16			17		
Cruise	Number	Top (cm)	Bottom (cm)	Length (cm)	Top (cm)	Bottom (cm)	Length (cm)	Top (cm)	Bottom (cm)	Length (cm)
JCR211	01									
JCR211	02									
JCR211	03									
JCR211	04									
JCR211	05									
JCR211	06									
JCR211	07	635	685	50	685	735	50	735	762	27
JCR211	08									
JCR211	09									
JCR211	10									
JCR211	11									
JCR211	12									
JCR211	13									
JCR211	14									
JCR211	15									
JCR211	16									
JCR211	17									
JCR211	18									
JCR211	19									
JCR211	20									
JCR211	21									
JCR211	22									
JCR211	23									
JCR211	24									
JCR211	25									
JCR211	26									
JCR211	27									
JCR211	28									
JCR211	29									
JCR211	30									
JCR211	31									
JCR211	32									
JCR211	33									

Core ID		18			19			20		
Cruise	Number	Top (cm)	Bottom (cm)	Length (cm)	Top (cm)	Bottom (cm)	Length (cm)	Top (cm)	Bottom (cm)	Length (cm)
JCR211	01									
JCR211	02									
JCR211	03									
JCR211	04									
JCR211	05									
JCR211	06									
JCR211	07	762	812	50	812	862	50	862	912	50
JCR211	08									
JCR211	09									
JCR211	10									
JCR211	11									
JCR211	12									
JCR211	13									
JCR211	14									
JCR211	15									
JCR211	16									
JCR211	17									
JCR211	18									
JCR211	19									
JCR211	20									
JCR211	21									
JCR211	22									
JCR211	23									
JCR211	24									
JCR211	25									
JCR211	26									
JCR211	27									
JCR211	28									
JCR211	29									
JCR211	30									
JCR211	31									
JCR211	32									
JCR211	33									

Core ID					
Cruise	Number	Core operator	Length of core barrel (cm)	Weight on core (kg)	Additional notes
JCR211	01	Andy Tait (BAS)/Darren Young (NMFD)			
JCR211	02	Andy Tait (BAS)/Darren Young (NMFD)			Core not sampled due to coarseness
JCR211	03	Andy Tait (BAS)/Darren Young (NMFD)			
JCR211	04	Andy Tait (BAS)/Darren Young (NMFD)			
JCR211	05	Andy Tait (BAS)/Darren Young (NMFD)			
JCR211	06	Andy Tait (BAS)/Darren Young (NMFD)			
JCR211	07	Andy Tait (BAS)/Darren Young (NMFD)	1500	1500	Sections 4-6 disturbed, section 7 "squeezed out"
JCR211	08	Andy Tait (BAS)/Darren Young (NMFD)			
JCR211	09	Andy Tait (BAS)/Darren Young (NMFD)		3200	
JCR211	10	Andy Tait (BAS)/Darren Young (NMFD)			
JCR211	11	Andy Tait (BAS)/Darren Young (NMFD)	1500		
JCR211	12	Andy Tait (BAS)/Darren Young (NMFD)	1500	1500	
JCR211	13	Andy Tait (BAS)/Darren Young (NMFD)	1200	1500	Approx 60m/s injection speed (per min?)
JCR211	14	Andy Tait (BAS)/Darren Young (NMFD)	1200		
JCR211	15	Andy Tait (BAS)/Darren Young (NMFD)	1200		40m/min payout
JCR211	16	Andy Tait (BAS)/Darren Young (NMFD)	1200		
JCR211	17	Andy Tait (BAS)/Darren Young (NMFD)			Large boulder stuck in jaws of corer; nothing else recovered
JCR211	18	Andy Tait (BAS)/Darren Young (NMFD)			Corer didn't close
JCR211	19	Andy Tait (BAS)/Darren Young (NMFD)			Corer didn't close
JCR211	20	Andy Tait (BAS)/Darren Young (NMFD)			A few rocks
JCR211	21	Andy Tait (BAS)/Darren Young (NMFD)			
JCR211	22	Andy Tait (BAS)/Darren Young (NMFD)	600		
JCR211	23	Andy Tait (BAS)/Darren Young (NMFD)	1200	1200	Lowered at 60m/min
JCR211	24	Andy Tait (BAS)/Darren Young (NMFD)			
JCR211	25	Andy Tait (BAS)/Darren Young (NMFD)	1200		Contains hydrate
JCR211	26	Andy Tait (BAS)/Darren Young (NMFD)	600		Contains hydrate 193-386cm. Core length excludes void spaces created by dis
JCR211	27	Andy Tait (BAS)/Darren Young (NMFD)	900	1200	
JCR211	28	Andy Tait (BAS)/Darren Young (NMFD)	900		Lowered at 45m/min
JCR211	29	Andy Tait (BAS)/Darren Young (NMFD)			Box core didn't shut
JCR211	30	Andy Tait (BAS)/Darren Young (NMFD)			
JCR211	31	Andy Tait (BAS)/Darren Young (NMFD)			
JCR211	32	Andy Tait (BAS)/Darren Young (NMFD)			
JCR211	33	Andy Tait (BAS)/Darren Young (NMFD)	600		Lowered at 40m/min. Contains hydrate 126-178cm

J OBS deployments

Table 1: OBS Locations

Serial	Line/	Site	Deployment Location				Recovery Location				Water
No:	Area		Lat Deg	Lat Min	Lon Deg	Lon Min	Lat Deg	Lat Min	Lon Deg	Lon Min	Depth (m)
12	01	04	78	36.627	009	13.257	78	36.827	009	12.890	479
16	01	04	78	36.627	009	13.257	78	36.827	009	12.890	479
50	01	03	78	36.767	009	13.468	78	37.020	009	12.970	475
53	01	02	78	36.723	009	12.952	78	36.890	009	12.430	479
54	01	01	78	36.676	009	12.490	78	36.870	009	11.940	484
50	02	05	79	23.253	006	53.984	79	23.306	006	54.736	1263
53	02	08	79	23.360	007	34.610	79	23.710	007	35.273	851
54	02	10	79	23.427	008	06.979	79	23.633	008	07.540	303
55	02	07	79	23.370	009	34.030	79	23.734	007	23.541	863
56	02	09	79	23.318	008	07.018	79	23.489	008	07.530	288
57	02	06	79	23.260	006	54.540	79	23.319	006	55.226	1260
50	03	11	78	33.248	009	31.161	78	33.400	009	31.180	366
53	03	12	78	33.140	009	21.300	78	33.266	009	21.315	364
54	03	13	78	33.040	009	31.470	78	33.252	009	31.560	364

NB Loggers 12 and 16 were bolted together into a single instrument at site 04. Logger 12 recorded a hydrophone signal on channel 1 and vertical geophone on channel 2, while logger 16 recorded two horizontal components. For the remaining instruments, channels 0 and 1 are horizontal geophones, channel 2 is the vertical geophone and channel 3 is the hydrophone. Logger 53 was deployed with a double anchor weight at site 08. Logger 55 at site 07 experienced a large clock jump (c. 5 hours). Channel 0 at site 9 has anomalous frequency content, suggesting a possible problem with the geophone package.

OBS Data Timing

Serial	Sync Time				Wake Time				Time Tag						Sample Rate
No:	Year	J. Day	Hour	Minute	Year	J. Day	Hour	Minute	Year	J. Day	Hour	Minute	Secs	Drift (ms)	Hz
12	2008	252	01	50	2008	252	05	30	2008	253	00	37	59	-6.9953	500
16	2008	252	01	23	2008	252	05	30	2008	253	00	53	59	-3.0355	500
50	2008	252	00	25	2008	252	01	00	2008	252	22	59	59	-0.7724	1000
53	2008	252	00	39	2008	252	01	00	2008	252	23	31	00	0.0479	1000
54	2008	251	23	47	2008	252	01	00	2008	252	23	56	59	-1.27	1000
50	2008	257	17	37	2008	257	18	00	2008	259	00	41	59	-1.4184	1000
53	2008	257	17	20	2008	257	18	00	2008	259	04	21	59	-1.4075	1000
54	2008	257	16	07	2008	257	18	00	2008	259	05	39	59	-2.5603	1000
55	2008	257	15	16	2008	257	18	00	2008	259	03	50	00	128.631	1000
56	2008	257	15	47	2008	257	18	00	2008	259	06	11	00	4.3233	1000
57	2008	257	15	32	2008	257	18	00	2008	259	01	42	59	-0.5899	1000
50	2008	260	16	01	2008	260	17	00	2008	261	06	38	59	-0.7127	1000
53	2008	260	15	46	2008	260	17	00	2008	261	06	15	00	0.2913	1000
54	2008	260	15	28	2008	260	17	00	2008	261	05	32	59	-0.853	1000

NB A positive drift means that the OBS internal clock has run slow compared to the GPS standard and reads an earlier time, so a drift correction will move arrivals later in the data. Drift corrections have been applied to the data from loggers 12 and 16 but not elsewhere.

K Seismic lines

Cruise: JR211 | **Ship:** James Clark Ross | **Location:** Offshore Svalbard

Profile no.	Line ID	Date d-m-y	SOL/EOL	H:M (GMT)	Start/End Latitude N	Start/End Longitude W	Remarks	Data storage LTO-2	Data storage HDD	Navipac Event no.
					° ′	° ′	SP interval 12.5 m			
A	JR211-01	05/09/2008	1237	05:59	78° 4,6′	6° 19,7′	SOL	100	E:\JR211-01	575
			1690		° ′	° ′	Sync error			
					° ′	° ′	EOL			
					° ′	° ′	Ship turns			
A	JR211-01x	05/09/2008	1800		° ′	° ′	before on line again	101	E:\JR211-01x	
			2124	08:04	° ′	° ′	SOL			2050
A			2476	08:33	78° 40,7′	6° 45,6′				2402
			3246		° ′	° ′	AU2 out off sync			
			3356	09:47	° ′	° ′				3282
A			4801	11:47	78° 41,0′	8° 5,0′				4728
			6811	14:35	78° 41,3′	9° 12,4′				6737
A	JR211-01x	05/09/2008	7596		° ′	′	Start turn	101	E:\JR211-01x	7523
			7623	15:44	78° 41,4′	9° 39,1′	EOL	101	E:\JR211-01x	
B	JR211-02	05/09/2008	7624	16:06	78° 39,9′	9° 43,3′	SOL, data stored on USB HD	102	H:\JR211-02	
			7625		° ′	° ′				7547
			7855	16:23	78° 39,1′	9° 37,5′	Tail in line			7776
			9125		° ′	° ′				9046
			9630	18:53	78° 34′	8° 43,8′	Bird 2 most of the time in 5m			9551
B	JR211-02	05/09/2008	10555	20:10	° ′	° ′	EOL	102	H:\JR211-02	10476
					° ′	° ′	Streamer in for inspection			
					° ′	° ′	Bird 1 and 2 replaced, lead removed as w			
C	JR211-03	05/09/2008	10558	21:27	78° 29,3′	8° 13,3′	SOL	102	H:\JR211-03	10488
C	JR211-03	06/09/2008	13470	01:30	78° 33,8′	9° 45,6′	EOL	102	H:\JR211-03	13400
D	JR211-04	06/09/2008	13471	02:04	78° 31,9′	9° 45,6′	SOL	102	H:\JR211-04	13412
D	JR211-04	06/09/2008	15868	05:25	78° 26,1′	8° 31,6′	EOL	102	H:\JR211-04	15809
E	JR211-05	06/09/2008	15916	05:37	78° 25,4′	8° 29,6′	SOL	102	H:\JR211-05	15866
			16625		° ′	° ′	sync error,incomplete dar			
			16768		° ′	° ′	sync error, incomplete data			
E	JR211-05	06/09/2008	18568	09:18	78° 25,4′	9° 55,2′	EOL	102	H:\JR211-05	18518
			18569	09:25	° ′	° ′	Test of OBS trigger sytem			18535
F	JR211-06	06/09/2008	19033	10:02	78° 22,7′	9° 52,6′	SOL	102	H:\JR211-06	18999
F	JR211-06	06/09/2008	21385	13:19	78° 22,6′	8° 37,8′	EOL	102	H:\JR211-06	21351
G	JR211-07	06/09/2008	21386	13:39	78 23,8	8 33,2	SOL	102	H:\JR211-07	21382

Cruise: JR211 | **Ship:** James Clark Ross | **Location:** Offshore Svalbard

Profile no.	Line ID	Date d-m-y	SOL/EOL	H:M (GMT)	Start/End Latitude N	Start/End Longitude W	Remarks	Data storage LTO-2	Data storage HDD	Navipac Event no.
G	JR211-07	06/09/2008	23895	17:10	78° 28,6′	9° 49,3′	EOL	102	H:\JR211-07	23891
H	JR211-08	06/09/2008	23901	17:42	78° 31,0′	9° 50,5′	SOL	102	H:\JR211-08	23896
H	JR211-08	06/09/2008	24377	18:20	78° 32,7′	9° 42,2′	Streamer in-line	102	H:\JR211-08	24372
H	JR211-08	06/09/2008	26194	20:53	78° 28,9′	8° 44,2′		102	H:\JR211-08	26189
H	JR211-08	06/09/2008	26700	21:35	78° 28,0′	8° 28,9′	EOL	102	H:\JR211-08	26695
I	JR211-09	06/09/2008	26702	22:10	° ′	° ′	SOL	102	H:\JR211-09	26720
I	JR211-09	06/09/2008	26856	22:22	78° 30,8′	8° 19,9′	Streamer in-line	102	H:\JR211-09	26874
I	JR211-09	07/09/2008	29493	02:02	78° 36,3′	9° 39,9′	EOL	102	H:\JR211-09	29511
J	JR211-10	07/09/2008	29494	02:50	78° 39,7′	9° 42,0′	SOL. Adjusted PC clock on CNT-1	102	H:\JR211-10	29528
J	JR211-10	07/09/2008	29569	02:56	° ′	° ′	Streamer in-line	102	H:\JR211-10	29603
J	JR211-10	07/09/2008	32364	06:49	78° 36,7′	8° 06,9′	EOL	102	H:\JR211-10	32398
K	JR211-11	07/09/2008	32365	07:18	78° 35′	8° 10,2′	SOL	102	H:\JR211-11	32410
K	JR211-11	07/09/2008	32726	07:49	78° 35,9′	8° 16,2′	Streamer in-line	102	H:\JR211-11	32771
					° ′	° ′	Error to write to disk, USB sticker caused			
					° ′	° ′	File 32914 incomplete data. 8 shots			
					° ′	° ′	missed btw. File 32920 and 32921			
K	JR211-11	07/09/2008	33042	08:19	° ′	° ′		102	H:\JR211-11	33125
K	JR211-11A	07/09/2008	33885	09:30	78° 44′	8° 16,1′	Start turn to JR211-11A	102	H:\JR211-11	33968
			34005		° ′	° ′	Serial string not detected (Navipac jump			
			34006		° ′	° ′	from line JR211-11 to 11A)			
K			34007	09:39	° ′	° ′	Serial string OK again	102	H:\JR211-11	34088
			35522		° ′	° ′	Sync error, one shot lost			
K	JR211-11A	07/09/2008	35671	11:59	78° 44,5′	9° 16,6′		102	H:\JR211-11	35752
K	JR211-11B	07/09/2008	36126	12:37	78° 45′	9° 31,8′	Turn to line JR211-11B	102	H:\JR211-11	36207
K	JR211-11B	07/09/2008	37439	14:25	78° 51,7′	9° 59,3′	EOL	102	H:\JR211-11	37520
L	JR211-12	07/09/2008	37440	14:37	78° 51,6′	9° 03,7′	SOL	102	H:\JR211-12	37531
L	JR211-12	07/09/2008	38127	15:35	78° 48,6′	9° 55,4′	Pass the WP for SOL	102	H:\JR211-12	38218
			38792		° ′	° ′	Sync error, one shot lost			
L	JR211-12A	07/09/2008	40252	18:32	78° 47,8′	8° 43,2′	Start turn to JR211-12A	102	H:\JR211-12	40343
L	JR211-12A	08/09/2008	44353	00:15	° ′	° ′	USB HD has been disconnected during n	102	H:\JR211-12	44444
			44561		° ′	° ′	No nav data in header, line stopped in Na			
			44653	00:39	° ′	° ′	Nav data back again			44653
			44795		° ′	° ′	Gun 1 is off			
L	JR211-12A	08/09/2008	44882	00:58	78° 20,0′	9° 45,2′	EOL	102	H:\JR211-12	44882

Cruise: JR211 **Ship:** James Clark Ross **Location:** Offshore Svalbard

Profile no.	Line ID	Date d-m-y	SOL/EOL	H:M (GMT)	Start/End Latitude N	Start/End Longitude W	Remarks	Data storage LTO-2	Data storage HDD	Navipac Event no.
M	JR211-14	08/09/2008	44884	14:02	78° 34,6′	9° 27,9′	SOL	103	H:\JR211-14	50207
			44999	14:33			CNT-1 running again	103	H:\JR211-14	45561
M	JR211-14	08/09/2008	45334	15:01	78° 35,9′	9° 26,3′	Crossing SOL WP on JR211-14	103	H:\JR211-14	45897
			45416				sync error			
			45425				several sync error, restart program			45989
			45542				in sync, store on intern HD	103	E:\JR211-14	46137
			45542				Bird set from 3 m to 4m			
			45728				sync error			
			45744				sync error			
			45756				sync error			
			45787				reg length set to 3000 mS			
M	JR211-14	08/09/2008	46055	16:09			No errors since file 45787	103	E:\JR211-14	46715
M	JR211-14	08/09/2008	46107	16:13	78° 37,6′	8° 59,2′	EOL JR211-14	103	E:\JR211-14	46767
N	JR211-15	08/09/2008	46572				sync error	103	E:\JR211-14	
N	JR211-15	08/09/2008	46843	17:15	78° 39,2′	9° 07,1′	SOL of JR211-15	103	E:\JR211-14	46209
N	JR211-15	08/09/2008	47675	18:24	78° 34,1′	9° 19,5′	EOL of JR211-15	103	E:\JR211-14	47041
			47840				sync error			
O	JR211-16	08/09/2008	48422	19:28	78° 34,1′	9° 07,8′	SOL of JR211-16	103	E:\JR211-14	45929
			48498				sync error, restart of CNT-1PC			
							NEW LOG FILE "JR211-14A"			
O	JR211-16	08/09/2008	48550	19:50	78° 36,1′	9° 11,7′	CNT-1 up running again, still on JR211-1	104	E:\JR211-14	46213
O	JR211-16	08/09/2008	48887	20:18				104	E:\JR211-14	46551
O	JR211-16	08/09/2008	49099	20:36	78° 39,5′	9° 18,0′	EOL	104	E:\JR211-14	46763
P	JR211-17	10/09/2008	101	21:45	78° 54,2′	6° 11,9′	SOL	105	E:\JR211-17	102
			395	22:09				105	E:\JR211-17	397
P	JR211-17	10/09/2008	820	22:44	78° 57,2′	6° 22,5′	Passing WP SOL of JR211-17	105	E:\JR211-17	822
			1110				Bird #1 set to 2 degree, to get Bird #2 to 3			1113
				02:00			Pressur drop down at 2 to 2:30			
P	JR211-17	11/09/2008	4928	04:27	79° 10,0′	8° 28,9′	EOL	105	E:\JR211-17	4931
Q	JR211-18	11/09/2008	4929	04:38	79° 10,9′	8° 30,8′	SOL	105	H:\JR211-18	4936
Q	JR211-18	11/09/2008	5299	05:09	79° 12,4′	8° 25,0′	Passing WP SOL of JR211-18	105	H:\JR211-18	5306
			6185	06:23			Brute Stack turned ON (Geometry is			6192
							wrong on line 17 as well)			

Cruise: JR211 **Ship:** James Clark Ross **Location:** Offshore Svalbard

Profile no.	Line ID	Date d-m-y	SOL/EOL	H:M (GMT)	Start/End Latitude N	Start/End Longitude W	Remarks	Data storage LTO-2	Data storage HDD	Navipac Event no.
Q	JR211-18	11/09/2008	8410	09:28	79° 19,2′	6° 39,2′	Close to the ice shelf ? Salinity low (33,4)	105	H:\JR211-18	8417
Q	JR211-18	11/09/2008	9462	10:56	79° 21,5′	6° 03,4′	EOL	105	H:\JR211-18	9469
R	JR211-19	11/09/2008	9463				SOL	105	H:\JR211-19	4939
R	JR211-19	11/09/2008	9483	11:16	79° 23,2′	6° 01,8′	Wrong event no. from navipac, restart Na	105	H:\JR211-19	9505
R	JR211-19	11/09/2008	9667	11:31	79° 23,3′	6° 06,7′	Crosing SOL WP on JR211-19	105	H:\JR211-19	9689
			12246	15:07			Birds set to 4 meters			12268
R	JR211-19	11/09/2008	13729	17:08	79° 23,5′	8° 31,6′	EOL	105	H:\JR211-19	13752
							Bird #2 was only connected in one collar			
S	JR211-20	11/09/2008	13730	18:51	79° 23,8′	8° 34,3′	SOL	105	H:\JR211-20	13763
S	JR211-20	11/09/2008	13985	19:13	79° 25′	8° 30′	Crosing SOL WP on JR211-20	105	H:\JR211-20	14018
			14213				Speed up to 5,1 kn over ground			
			14533				Speed up to 5,3 kn over ground			
			14780	20:18			Speed back to 5,1 kn over ground			
S	JR211-20	11/09/2008	16606	22:51	79° 35,4′	7° 07,8′	Close to the ice shelf	105	H:\JR211-20	16639
			16696	22:58			EOL, Start turn to line JR211-21			16729
T	JR211-21	11/09/2008	16697	23:05	79° 36,5′	7° 6,6′	SOL JR211-21, new coordinates due to ic	105	H:\JR211-21	16762
T	JR211-21	12/09/2008	19927	03:34	79° 47,8′	8° 54,1′	EOL	105	H:\JR211-21	19992
U	JR211-22	12/09/2008	19928	03:48	79° 48,6′	8° 58,3′	SOL	105	H:\JR211-22	20006
U	JR211-22	12/09/2008	20460	04:32	79° 47,4′	8° 50,9′	Crossing SOL of JR211-22	105	H:\JR211-22	20538
U	JR211-22	12/09/2008	22314	07:07	79° 35,3′	9° 10,7′	EOL, Start turn to line JR211-21	105	H:\JR211-22	22392
V	JR211-23	12/09/2008	22315	07:24	79° 33,8′	9° 13,2′	SOL	105	H:\JR211-23	22413
V	JR211-23	12/09/2008	22775	08:02			Wrong start of line, plan changed to new	105	H:\JR211-23	22873
V	JR211-23	12/09/2008	22951	08:17			Turning to go back to EOL of line 22	105	H:\JR211-23	23049
V	JR211-23	12/09/2008	23818	09:29	79° 35,6′	9° 9,8′	Crossing EOL of Line 22	105	H:\JR211-23	23916
V	JR211-23	12/09/2008	25417	11:42	79° 34′	8° 10,3′	Bird #2 in 3 meter for a long time now	105	H:\JR211-23	25515
V	JR211-23		26925							27023
V	JR211-23	12/09/2008	27630	14:47	79° 31,7′	6° 48,8′	Turning away from line, due to ice ahead	105	H:\JR211-23	27728
V	JR211-23	12/09/2008	28333	15:45	79° 28,6′	6° 28,6′	EOL	105	H:\JR211-23	28431
W	JR211-24	12/09/2008	28334	15:51	79° 28,2′	6° 28,4′	SOL	105	H:\JR211-24	28505
W	JR211-24	12/09/2008	28355				Event from Navipac in sync from this file	105	H:\JR211-24	28461
W	JR211-24	12/09/2008	29560	17:33	79° 24,6′	7° 8,1′	Bird #2 is deep again	105	H:\JR211-24	29666
W	JR211-24	12/09/2008	31994	20:56	79° 18,5′	8° 30,3′	EOL	105	H:\JR211-24	32100
X	JR211-25	12/09/2008	31995	21:03	79° 17,9′	8° 32,6′	SOL, serial string wrong on first shot	105	H:\JR211-25	32179
X	JR211-25	12/09/2008	32410	21:38	79° 15,8′	8° 30,8′	Crossing WP SOL	105	H:\JR211-25	32594

Cruise: JR211	**Ship:** James Clark Ross	**Location:** Offshore Svalbard

Profile no.	Line ID	Date d-m-y	SOL/EOL	H:M (GMT)	Start/End Latitude N	Start/End Longitude W	Remarks	Data storage LTO-2	Data storage HDD	Navipac Event no.
X	JR211-25	13/09/2008	35980	02:35	79 ° 22,3 ′	6 ° 26,1 ′	EOL	105	H:\JR211-25	36164
Y	JR211-26	13/09/2008	35981	02:41	79 ° 22,3 ′	6 ° 23,4 ′	SOL	105	H:\JR211-25	36217
Y	JR211-26	13/09/2008	36003	02:43	79 ° 22,3 ′	6 ° 23,4 ′	Changed to dir H:\JR211-26	105	H:\JR211-26	36248
Y	JR211-26	13/09/2008	38410	06:04	79 ° 13,1 ′	7 ° 15,3 ′	Streamer set to 4 m, due to high sea	105	H:\JR211-26	38655
Y	JR211-26	13/09/2008	41091	09:47	79 ° 06,6 ′	8 ° 45 ′	EOL	105	H:\JR211-26	41336
Z	JR211-27	13/09/2008	41092	09:53	79 ° 06,3 ′	8 ° 45,7 ′	SOL	105	H:\JR211-27	41394
Z			?		° ′	° ′	rope to tow cable broked, streamer dis co			
Z	JR211-27		42000	11:10	° ′	° ′	Streamer pluged on again	105	H:\JR211-27	
Z	JR211-27	13/09/2008	42103	11:17	79 ° 01,0 ′	8 ° 33,4 ′	Can't stay on the rigth cource due to high	105	H:\JR211-27	42405
Z	JR211-27	13/09/2008	43874	13:46	78 ° 54,3 ′	7 ° 43,3 ′	turning to reach EOL WP, new cource is	105	H:\JR211-27	44176
Z	JR211-27	13/09/2008	47274	18:28	79 ° 12,6 ′	6 ° 28,9 ′	EOL	105	H:\JR211-27	47576
AA	JR211-29	14/09/2008	47275	15:02	79 ° 19,8 ′	8 ° 02,0 ′	SOL	105	H:\JR211-29	47659
AA	JR211-29	14/09/2008	47327		° ′	° ′	sync error	105	H:\JR211-29	
AA	JR211-29	14/09/2008	47605	15:29	79 ° 19,8 ′	8 ° 07,9 ′	Streamer in line	105	H:\JR211-29	47989
AA	JR211-29	14/09/2008	47981	16:00	79 ° 22,4 ′	8 ° 07,0 ′	Crossing SOL of JR211-29	105	H:\JR211-29	48365
AA	JR211-29	14/09/2008	48361	16:31	79 ° 29,9 ′	8 ° 06,9 ′	EOL	105	H:\JR211-29	48745
BB	JR211-30	14/09/2008	48363	16:35	79 ° 25,3 ′	8 ° 06,6 ′	SOL, NaviPac event no. is not set correct	105	H:\JR211-30	47655
BB	JR211-30	14/09/2008	49540	18:13	79 ° 25,3 ′	7 ° 34,1 ′	Crossing SOL of JR211-30	105	H:\JR211-30	48832
BB	JR211-30	14/09/2008	50123	19:02	79 ° 21,4 ′	7 ° 34,7 ′	EOL	105	H:\JR211-30	49415
CC	JR211-31	14/09/2008	50125	19:06	79 ° 20,9 ′	7 ° 31,3 ′	SOL	105	H:\JR211-31	49575
CC	JR211-31	14/09/2008	51340	20:48	79 ° 20,5 ′	6 ° 55,0 ′	Crossing SOL of JR211-31	105	H:\JR211-31	50790
CC	JR211-31	14/09/2008	52220	22:01	79 ° 26,5 ′	6 ° 53,4 ′	EOL	105	H:\JR211-31	51670
DD	JR211-32	15/09/2008	52221	10:38	79 ° 26,0 ′	7 ° 31,0 ′	SOL	106	H:\JR211-32	51732
DD			52252		° ′	° ′	sync error, because of check of velocity ta	106	H:\JR211-32	
DD	JR211-32				° ′	° ′	Restart of CNT-1 and cleaning of Tape dr	106	E:\JR211-32	
DD	JR211-32A	15/09/2008	52434	11:10	° ′	° ′	New start, log file name is *321.log	107	H:\JR211-32A	52108
DD	JR211-32A		53150		° ′	° ′	Birds set to 4 m	107	H:\JR211-32A	
DD	JR211-32A	15/09/2008	58997	20:17	78 ° 43,7 ′	8 ° 28,5 ′	EOL	107	H:\JR211-32A	58673
EE	JR211-34	17/09/2008	58999	01:04	78 ° 35,4 ′	9 ° 28,3 ′	SOL, bird set to 3 m	107	H:\JR211-34	58763
EE	JR211-34	17/09/2008	59575	01:52	78 ° 36,1 ′	9 ° 27,3 ′	Crossing WP SOL of line JR211-34	107	H:\JR211-34	59337
EE	JR211-34	17/09/2008	60463	03:06	78 ° 30,3 ′	9 ° 35,8 ′	EOL	107	H:\JR211-34	60225
					° ′	° ′				
					° ′	° ′				
					° ′	° ′				

L Sidescan lines

Line No	Date	SOL_time	Lat	Lon	EOL_time	Lat	Lon
1	09.09.08	01:56:00	78.6728	9.3644	03:50:00	78.5702	9.4699
2	09.09.08	04:38:30	78.555	9.5729	06:03:00	78.6324	9.4641
3	10.09.08	06:35:00	79.4459	8.0693	08:43:00	79.3382	8.257
4	10.09.08	09:23:30	79.3362	8.205	11:25:00	79.4352	8.0132
5	17.09.08	08:09:00	78.6739	9.402	09:10:00	78.6186	9.4721
6	17.09.08	09:48:45	78.6161	9.4867	10:50:50	78.6739	9.4132
7	17.09.08	12:05:00	78.6331	9.4632	12:53:45	78.6713	9.4271
8	17.09.08	14:40:00	78.6284	9.459	15:30:30	78.6682	9.4204

M Multibeam lines

Number	LonE	LatN	Date,Jday,Jday, Time, UTC	Comments
1	9.13897	78.30039	2008,236.956344 236 22:57:08.155	
2	9.68142	78.30011	2008,236.979248 236 23:30:07.022	Turn
3	9.73542	78.30218	2008,237.020922 237 00:30:07.648	
4	9.72912	78.30438	2008,237.023422 237 00:33:43.629	
5	9.72825	78.30468	2008,237.023746 237 00:34:11.612	
6	9.71033	78.31051	2008,237.029821 237 00:42:56.568	
8	9.66602	78.3339	2008,237.056219 237 01:20:57.279	
9	9.62359	78.37528	2008,237.097892 237 02:20:57.909	
10	9.59655	78.40222	2008,237.125564 237 03:00:48.736	
11	9.56469	78.43303	2008,237.156937 237 03:45:59.399	
12	9.51444	78.47348	2008,237.198601 237 04:45:59.149	
13	9.47208	78.51409	2008,237.240275 237 05:45:59.797	
14	9.31245	78.66565	2008,237.394149 237 09:27:34.455	Turn
15	9.28143	78.67018	2008,237.402921 237 09:40:12.378	
16	9.06741	78.67502	2008,237.444584 237 10:40:12.030	
17	8.85014	78.68101	2008,237.486258 237 11:40:12.656	
18	8.64618	78.68508	2008,237.527920 237 12:40:12.267	
19	8.44897	78.68907	2008,237.569592 237 13:40:12.714	
20	8.24468	78.69297	2008,237.611245 237 14:40:11.547	
21	8.03681	78.69851	2008,237.652907 237 15:40:11.205	
22	7.82279	78.70253	2008,237.694581 237 16:40:11.837	
23	7.61109	78.70729	2008,237.736243 237 17:40:11.391	
24	7.53193	78.70947	2008,237.751519 237 18:02:11.251	Turn
25	7.52498	78.73986	2008,237.793194 237 19:02:11.940	
26	7.57772	78.74138	2008,237.803506 237 19:17:02.940	
27	7.79071	78.73693	2008,237.845156 237 20:17:01.447	
28	8.00084	78.7323	2008,237.886831 237 21:17:02.202	
29	8.21031	78.72673	2008,237.928505 237 22:17:02.799	
30	8.42737	78.7202	2008,237.970168 237 23:17:02.495	
31	8.62049	78.71598	2008,238.005141 238 00:07:24.204	Turn
32	8.69312	78.74185	2008,238.046814 238 01:07:24.760	
33	8.66585	78.752	2008,238.058075 238 01:23:37.667	
34	8.57527	78.79054	2008,238.099738 238 02:23:37.337	
35	8.48294	78.82818	2008,238.141412 238 03:23:37.971	
36	8.39398	78.86561	2008,238.183062 238 04:23:36.591	
37	8.30179	78.90249	2008,238.224725 238 05:23:36.228	Turn
38	8.2891	78.90647	2008,238.229690 238 05:30:45.188	
39	8.24084	78.90902	2008,238.239793 238 05:45:18.101	
40	8.02271	78.9097	2008,238.281467 238 06:45:18.761	
41	7.80795	78.90999	2008,238.323129 238 07:45:18.340	
42	6.68139	78.91624	2008,238.545423 238 13:05:24.541	Turn
43	6.62572	78.88942	2008,238.585221 238 14:02:43.115	
44	6.64944	78.8807	2008,238.607014 238 14:34:05.993	
45	6.04132	78.79588	2008,238.646176 238 15:30:29.564	
46	6.03998	78.74044	2008,238.660781 238 15:51:31.447	
47	5.8994	78.6811	2008,238.677759 238 16:15:58.347	
48	5.79365	78.67728	2008,238.682862 238 16:23:19.319	
49	5.24447	78.66825	2008,238.711367 238 17:04:22.066	
50	5.25	78.66681	2008,238.804806 238 19:18:55.256	
51	5.24998	78.6668	2008,238.808822 238 19:24:42.218	Turn
52	5.41701	78.6654	2008,238.819967 238 19:40:45.121	

53	6.25937	78.66524	2008,238.861641 238 20:40:45.818	
54	7.09687	78.66623	2008,238.903304 238 21:40:45.431	
55	7.94526	78.66707	2008,238.944966 238 22:40:45.037	
56	8.25452	78.66974	2008,238.960798 238 23:03:32.947	
57	8.24652	78.68921	2008,238.967916 238 23:13:47.900	
58	8.24958	78.68813	2008,239.009577 239 00:13:47.436	
59	8.24965	78.68814	2008,239.032295 239 00:46:30.281	
60	8.27471	78.83648	2008,239.073968 239 01:46:30.874	
61	8.30271	78.87794	2008,239.093897 239 02:15:12.715	Turn
62	8.24832	78.8764	2008,239.124704 239 02:59:34.437	
63	8.32114	78.91422	2008,239.166367 239 03:59:34.114	
64	8.35493	78.95471	2008,239.208042 239 04:59:34.823	
65	8.46439	79.08111	2008,239.336050 239 08:03:54.757	
66	8.388	79.11988	2008,239.377701 239 09:03:53.398	
67	8.31118	79.15865	2008,239.419364 239 10:03:53.030	
68	8.24957	79.18838	2008,239.452173 239 10:51:07.744	
69	8.21467	79.20458	2008,239.470412 239 11:17:23.607	
70	8.18399	79.21885	2008,239.486880 239 11:41:06.445	
71	8.12137	79.25151	2008,239.522641 239 12:32:36.144	
72	8.0601	79.28215	2008,239.555542 239 13:19:58.856	
73	8.00157	79.3106	2008,239.588143 239 14:06:55.547	
74	8.02335	79.35206	2008,239.629806 239 15:06:55.241	
75	8.04733	79.39395	2008,239.671479 239 16:06:55.770	
76	8.07274	79.43535	2008,239.713130 239 17:06:54.424	
77	8.09307	79.44241	2008,239.721521 239 17:18:59.372	
78	8.24787	79.47294	2008,239.763195 239 18:19:00.081	
79	8.40281	79.50361	2008,239.804869 239 19:19:00.672	
80	8.56264	79.53411	2008,239.846531 239 20:19:00.271	
81	8.71819	79.56475	2008,239.888194 239 21:19:00.001	
82	8.87476	79.5948	2008,239.929857 239 22:18:59.630	
83	9.02911	79.62612	2008,239.971519 239 23:18:59.266	
84	9.19204	79.6572	2008,240.013193 240 00:18:59.863	
85	9.34755	79.68621	2008,240.054856 240 01:18:59.520	
86	9.49794	79.71641	2008,240.096518 240 02:18:59.186	shallow
87	9.65708	79.74705	2008,240.138192 240 03:18:59.749	
88	9.81411	79.77696	2008,240.179844 240 04:18:58.484	
89	9.97487	79.80793	2008,240.221505 240 05:18:58.047	
90	9.97914	79.8088	2008,240.222743 240 05:20:45.024	
91	9.97276	79.81669	2008,240.231574 240 05:33:27.966	
92	9.81624	79.84764	2008,240.273237 240 06:33:27.675	
93	9.65295	79.878	2008,240.314888 240 07:33:26.298	
94	9.49058	79.90789	2008,240.356562 240 08:33:26.952	
95	9.33194	79.93817	2008,240.398213 240 09:33:25.589	
96	9.17468	79.96798	2008,240.439887 240 10:33:26.200	
97	8.40586	79.9194	2008,240.607810 240 14:35:14.784	
98	7.60964	79.83274	2008,240.649483 240 15:35:15.365	
99	7.29404	79.76509	2008,240.675083 240 16:12:07.158	
100	7.38643	79.69552	2008,240.696747 240 16:43:18.963	
101	6.63714	79.60056	2008,240.738410 240 17:43:18.597	
102	6.45776	79.58007	2008,240.748131 240 17:57:18.551	
103	6.48867	79.54809	2008,240.757228 240 18:10:24.464	
104	6.76798	79.39137	2008,240.798890 240 19:10:24.115	
105	7.04052	79.23298	2008,240.840563 240 20:10:24.677	
106	7.10141	79.31468	2008,240.882215 240 21:10:23.407	
107	6.90041	79.43392	2008,240.923888 240 22:10:23.933	
108	6.69469	79.55191	2008,240.965550 240 23:10:23.556	

109	6.86616	79.56696	2008,241.007203 241 00:10:22.326	
110	7.07565	79.44939	2008,241.048888 241 01:10:23.912	
111	7.20507	79.32832	2008,241.090551 241 02:10:23.587	
112	7.3223	79.21709	2008,241.128764 241 03:05:25.180	
113	7.51985	79.2192	2008,241.143577 241 03:26:45.084	
114	7.38666	79.34002	2008,241.185252 241 04:26:45.756	
115	7.23803	79.46084	2008,241.226914 241 05:26:45.378	
116	6.96568	79.60025	2008,241.276886 241 06:38:42.946	
117	7.12921	79.60223	2008,241.294962 241 07:04:44.747	
118	7.36857	79.48775	2008,241.336626 241 08:04:44.502	
119	7.50919	79.3683	2008,241.378288 241 09:04:44.107	
120	7.67663	79.2488	2008,241.419962 241 10:04:44.743	Turn
121	7.80793	79.26243	2008,241.461624 241 11:04:44.312	
122	7.63202	79.37885	2008,241.502026 241 12:02:55.085	
123	7.50124	79.50097	2008,241.543688 241 13:02:54.653	
124	7.2163	79.61024	2008,241.585351 241 14:02:54.345	
125	7.13963	79.63411	2008,241.594957 241 14:16:44.273	Turn
126	7.27922	79.64714	2008,241.607016 241 14:34:06.180	
127	7.56766	79.53711	2008,241.648701 241 15:34:07.743	
128	7.73936	79.41856	2008,241.690352 241 16:34:06.426	
129	7.87498	79.29761	2008,241.732025 241 17:34:06.990	
130	8.10267	79.20369	2008,241.773677 241 18:34:05.678	
131	8.09752	79.21217	2008,241.776582 241 18:38:16.659	
132	7.93851	79.33266	2008,241.818244 241 19:38:16.290	
133	7.81141	79.45271	2008,241.859918 241 20:38:16.930	
134	7.64051	79.57204	2008,241.901581 241 21:38:16.601	
135	7.36891	79.66519	2008,241.937920 241 22:30:36.270	turn
136	7.6733	79.61575	2008,241.979594 241 23:30:36.950	
137	7.88831	79.5	2008,242.021257 242 00:30:36.582	
138	7.95567	79.37538	2008,242.062908 242 01:30:35.209	
139	8.02446	79.3727	2008,242.085104 242 02:02:33.028	
140	7.98535	79.49414	2008,242.126778 242 03:02:33.642	
141	7.82278	79.61321	2008,242.168440 242 04:02:33.198	
142	7.50297	79.71073	2008,242.206677 242 04:57:36.926	turn
143	7.54276	79.72616	2008,242.214813 242 05:09:19.884	
144	7.59673	79.7274	2008,242.218818 242 05:15:05.839	
145	7.93489	79.61975	2008,242.260480 242 06:15:05.482	
146	8.07669	79.49961	2008,242.302143 242 07:15:05.126	
147	8.09517	79.3778	2008,242.343805 242 08:15:04.718	
148	8.17857	79.25988	2008,242.385468 242 09:15:04.472	Noisy data
149	8.1887	79.25398	2008,242.387517 242 09:18:01.455	turns
150	7.98291	79.25483	2008,242.404575 242 09:42:35.277	turn
151	7.90898	79.25405	2008,242.411519 242 09:52:35.211	turn
152	7.89882	79.25728	2008,242.416101 242 09:59:11.157	
153	7.97739	79.25749	2008,242.423763 242 10:10:13.082	circle
154	7.98278	79.26093	2008,242.428056 242 10:16:24.055	
155	7.90572	79.2608	2008,242.434490 242 10:25:39.975	circle
156	7.88019	79.26448	2008,242.439212 242 10:32:27.931	
157	7.97234	79.26412	2008,242.448135 242 10:45:18.847	turn
158	7.9855	79.26746	2008,242.452255 242 10:51:14.839	Noisy data
159	7.89407	79.26752	2008,242.460310 242 11:02:50.789	turn
160	7.93873	79.27127	2008,242.468561 242 11:14:43.680	
161	7.93787	79.25604	2008,242.474845 242 11:23:46.618	turn
162	7.94973	79.25539	2008,242.477541 242 11:27:39.573	
163	7.94877	79.27041	2008,242.484682 242 11:37:56.518	turn
164	7.92588	79.27144	2008,242.487946 242 11:42:38.492	

165	7.93658	79.25733	2008,242.494218 242 11:51:40.440	
166	8.22099	79.26998	2008,242.522850 242 12:32:54.203	
169	8.10147	79.35163	2008,242.554432 242 13:18:22.888	machine rebooted
170	8.1319	79.34076	2008,242.570415 242 13:41:23.865	
171	8.12256	79.4646	2008,242.612088 242 14:41:24.438	
172	8.10946	79.58502	2008,242.653740 242 15:41:23.093	
173	7.8519	79.69936	2008,242.695414 242 16:41:23.762	
174	7.47386	79.80321	2008,242.737076 242 17:41:23.390	
175	7.46595	79.80568	2008,242.738048 242 17:42:47.365	
176	7.61352	79.8081	2008,242.750743 242 18:01:04.213	
177	7.9782	79.70193	2008,242.792418 242 19:01:04.902	
178	8.21285	79.58656	2008,242.834080 242 20:01:04.529	
179	8.18264	79.46492	2008,242.875742 242 21:01:04.115	
180	8.18242	79.34255	2008,242.917417 242 22:01:04.855	
181	8.17764	79.32667	2008,242.922752 242 22:08:45.758	turn
182	8.23218	79.34933	2008,242.936580 242 22:28:40.526	
183	8.24968	79.47151	2008,242.978244 242 23:28:40.301	
184	8.30217	79.59617	2008,243.019918 243 00:28:40.956	
185	8.07839	79.71145	2008,243.061581 243 01:28:40.592	
186	7.72921	79.81853	2008,243.103244 243 02:28:40.276	
187	7.68872	79.8301	2008,243.107757 243 02:35:10.216	turn
188	7.78862	79.84294	2008,243.117316 243 02:48:56.112	
189	8.13115	79.73966	2008,243.158990 243 03:48:56.774	
190	8.36417	79.62335	2008,243.200652 243 04:48:56.313	
191	8.35114	79.50279	2008,243.242315 243 05:48:56.008	shallow
192	8.40924	79.50494	2008,243.256538 243 06:09:24.922	
193	8.44633	79.62485	2008,243.298188 243 07:09:23.448	
194	8.24052	79.74207	2008,243.339874 243 08:09:25.129	
195	7.89561	79.85017	2008,243.381536 243 09:09:24.736	
196	7.88198	79.85452	2008,243.383214 243 09:11:49.718	
197	7.98372	79.86141	2008,243.393746 243 09:26:59.628	
198	8.32016	79.7526	2008,243.435409 243 10:26:59.340	
199	8.52707	79.63008	2008,243.477083 243 11:26:59.966	
200	8.46537	79.50497	2008,243.518745 243 12:26:59.599	
201	8.26495	79.39423	2008,243.560409 243 13:26:59.325	
202	8.26206	79.36567	2008,243.569852 243 13:40:35.220	
203	8.03982	79.42525	2008,243.611514 243 14:40:34.841	
204	8.12628	79.39443	2008,243.673453 243 16:09:46.357	
205	8.18019	79.30843	2008,243.706575 243 16:57:28.060	
206	8.28207	79.23771	2008,243.732093 243 17:34:12.837	
207	8.4659	79.12524	2008,243.773744 243 18:34:11.442	features of note
208	8.51706	79.04183	2008,243.804169 243 19:18:00.189	
209	8.49066	79.04354	2008,243.845831 243 20:17:59.794	
210	8.51367	79.04171	2008,243.900281 243 21:36:24.307	
211	8.50232	79.13703	2008,243.941955 243 22:36:24.944	
212	8.30157	79.23182	2008,243.975378 243 23:24:32.657	
213	8.22177	79.31332	2008,244.004959 244 00:07:08.429	
214	8.22971	79.30594	2008,244.043218 244 01:02:14.069	shallow
215	8.28188	79.42451	2008,244.084904 244 02:02:15.735	
216	8.33237	79.47571	2008,244.102391 244 02:27:26.609	turn
217	8.00344	79.53317	2008,244.227911 244 05:28:11.500	turn
218	7.98456	79.53149	2008,244.231788 244 05:33:46.460	turn
219	7.97783	79.49085	2008,244.273451 244 06:33:46.142	
220	7.9581	79.44978	2008,244.315125 244 07:33:46.760	
221	7.94082	79.40926	2008,244.356774 244 08:33:45.315	
222	7.92688	79.36819	2008,244.398438 244 09:33:45.004	

223	7.90806	79.32736	2008,244.440112 244 10:33:45.647	
224	7.89162	79.29487	2008,244.472377 244 11:20:13.384	
225	7.97002	79.25719	2008,244.514039 244 12:20:12.998	
226	8.06526	79.21953	2008,244.555702 244 13:20:12.632	
227	8.16019	79.18121	2008,244.597364 244 14:20:12.277	
228	8.23997	79.14142	2008,244.639050 244 15:20:13.903	
229	8.30565	79.10063	2008,244.680702 244 16:20:12.618	
230	8.37802	79.06123	2008,244.722376 244 17:20:13.261	
231	8.53347	79.03637	2008,244.794417 244 19:03:57.663	
232	8.19614	79.08234	2008,244.836068 244 20:03:56.244	
233	8.00803	79.19443	2008,244.875323 244 21:00:27.935	
234	7.99858	79.10653	2008,244.916985 244 22:00:27.508	
235	8.32778	79.00242	2008,244.958647 244 23:00:27.122	
236	8.45862	78.98172	2008,244.969884 244 23:16:38.019	
237	8.28897	78.87139	2008,245.011547 245 00:16:37.618	
238	8.28689	78.86992	2008,245.012160 245 00:17:30.634	
239	8.26282	78.75214	2008,245.053823 245 01:17:30.307	
240	8.25932	78.67406	2008,245.085476 245 02:03:05.167	
241	8.26231	78.68333	2008,245.209260 245 05:01:20.030	
242	8.69859	78.65023	2008,245.250934 245 06:01:20.661	
243	9.16649	78.63517	2008,245.281810 245 06:45:48.359	
244	9.28857	78.60683	2008,245.294771 245 07:04:28.251	
245	9.42842	78.48711	2008,245.336445 245 08:04:28.873	
246	9.52711	78.41069	2008,245.362763 245 08:42:22.708	
247	9.64749	78.42029	2008,245.376501 245 09:02:09.659	
248	9.50606	78.54199	2008,245.418162 245 10:02:09.209	
249	9.36847	78.66776	2008,245.459836 245 11:02:09.858	
250	9.41159	78.66825	2008,245.466213 245 11:11:20.816	
251	9.54827	78.55006	2008,245.507876 245 12:11:20.487	
252	9.54659	78.53215	2008,245.516510 245 12:23:46.491	
253	9.45599	78.58573	2008,245.539527 245 12:56:55.129	
254	9.45671	78.58472	2008,245.581202 245 13:56:55.851	
255	9.31941	78.61191	2008,245.622865 245 14:56:55.494	
256	9.28406	78.6693	2008,245.643452 245 15:26:34.268	
257	9.44336	78.67465	2008,245.655777 245 15:44:19.138	
258	9.58614	78.55456	2008,245.697451 245 16:44:19.802	
259	9.61607	78.53064	2008,245.705772 245 16:56:18.723	
260	9.64388	78.5354	2008,245.711755 245 17:04:55.671	
261	9.56682	78.60077	2008,245.734901 245 17:38:15.437	turn
262	9.42332	78.61801	2008,245.790128 245 18:57:47.023	
263	9.55705	78.52898	2008,245.831790 245 19:57:46.647	
264	9.68479	78.45812	2008,245.871277 245 20:54:38.319	
265	9.62508	78.52946	2008,245.895730 245 21:29:51.094	
266	9.65252	78.53197	2008,245.900568 245 21:36:49.063	
267	9.65263	78.4432	2008,245.937983 245 22:30:41.741	
268	9.69968	78.41441	2008,245.948190 245 22:45:23.642	
269	9.66148	78.39194	2008,245.956638 245 22:57:33.561	
270	10.01139	78.26985	2008,246.835127 246 20:02:35.004	
271	9.56516	78.36447	2008,246.876801 246 21:02:35.602	
272	9.50532	78.41746	2008,246.895364 246 21:29:19.439	turn
273	9.69187	78.41736	2008,246.911080 246 21:51:57.354	
274	9.80104	78.3047	2008,246.952743 246 22:51:57.000	
275	9.86217	78.28525	2008,246.968783 246 23:15:02.876	
276	9.7475	78.40017	2008,247.010445 247 00:15:02.464	
277	9.69368	78.4493	2008,247.028106 247 00:40:28.357	turn
278	9.73811	78.44208	2008,247.036114 247 00:52:00.290	shallow

279	9.84357	78.32329	2008,247.077788 247 01:52:00.865	
280	9.90217	78.28179	2008,247.091734 247 02:12:05.810	
281	9.63183	78.30018	2008,247.112184 247 02:41:32.664	
282	9.42285	78.41246	2008,247.153834 247 03:41:31.245	
283	9.32841	78.53016	2008,247.195508 247 04:41:31.930	bad weather
284	9.18052	78.62498	2008,247.229973 247 05:31:09.659	turn
285	9.16427	78.62765	2008,247.231477 247 05:33:19.654	bad weather
286	9.12186	78.61813	2008,247.239358 247 05:44:40.572	bad weather
287	9.17128	78.5964	2008,247.247471 247 05:56:21.488	bad weather
288	9.24108	78.56734	2008,247.257979 247 06:11:29.400	bad weather
289	9.31075	78.45062	2008,247.299641 247 07:11:29.000	bad weather
290	9.45683	78.34812	2008,247.341315 247 08:11:29.573	bad weather
291	9.51051	78.32767	2008,247.382978 247 09:11:29.321	bad weather
292	9.26009	78.41753	2008,247.424640 247 10:11:28.917	bad weather
293	9.22932	78.51875	2008,247.466314 247 11:11:29.562	bad weather
294	9.178	78.62947	2008,247.505292 247 12:07:37.220	bad weather
295	9.12377	78.62131	2008,247.522651 247 12:32:37.038	bad weather
296	9.15955	78.49427	2008,247.564325 247 13:32:37.696	bad weather
297	9.17508	78.38499	2008,247.601301 247 14:25:52.378	bad weather
298	9.09112	78.37369	2008,247.609680 247 14:37:56.311	
299	9.08195	78.47675	2008,247.651354 247 15:37:56.962	
300	9.08996	78.5726	2008,247.693016 247 16:37:56.561	noisy
301	9.06564	78.61208	2008,247.710260 247 17:02:46.423	
302	9.01596	78.5963	2008,247.723256 247 17:21:29.290	
303	8.99973	78.47103	2008,247.764930 247 18:21:29.939	
304	8.99123	78.37158	2008,247.799025 247 19:10:35.774	
305	8.94725	78.38294	2008,247.805946 247 19:20:33.708	
306	8.92165	78.49951	2008,247.847619 247 20:20:34.305	noisy
307	8.92744	78.6068	2008,247.887222 247 21:17:36.002	turn
308	8.83134	78.49403	2008,247.928896 247 22:17:36.608	
309	8.80539	78.37593	2008,247.970200 247 23:17:05.258	
310	8.65969	78.41133	2008,247.997985 247 23:57:05.924	noisy
311	8.77687	78.5229	2008,248.039649 248 00:57:05.653	
312	8.82094	78.59337	2008,248.063026 248 01:30:45.455	
313	8.74051	78.58885	2008,248.074379 248 01:47:06.324	
314	8.5366	78.47467	2008,248.116042 248 02:47:06.026	noisy
315	8.48157	78.38125	2008,248.146456 248 03:30:53.777	turn
316	8.29761	78.38098	2008,248.160702 248 03:51:24.653	
317	8.41096	78.5075	2008,248.202352 248 04:51:23.248	
318	8.63836	78.5746	2008,248.228669 248 05:29:17.029	
319	9.22628	78.61776	2008,248.268560 248 06:26:43.567	turn
320	9.4233	78.61792	2008,248.310211 248 07:26:42.270	ship stationary
321	9.4232	78.61793	2008,248.367416 248 08:49:04.753	ship stationary
322	9.42318	78.61793	2008,248.368469 248 08:50:35.735	turn
323	9.45649	78.58467	2008,248.410132 248 09:50:35.425	ship stationary
324	9.45644	78.58464	2008,248.451784 248 10:50:34.121	ship stationary
325	9.45656	78.58463	2008,248.493458 248 11:50:34.743	ship stationary
326	9.45643	78.58466	2008,248.535121 248 12:50:34.412	
327	9.41184	78.59126	2008,248.550594 248 13:12:51.283	
328	8.51107	78.68217	2008,248.592267 248 14:12:51.900	
329	8.24425	78.70873	2008,248.605391 248 14:31:45.794	
330	8.26027	78.68734	2008,248.647053 248 15:31:45.388	
331	8.26026	78.68733	2008,248.688727 248 16:31:45.980	
332	8.26022	78.68733	2008,248.730389 248 17:31:45.639	
333	8.26024	78.68739	2008,248.772052 248 18:31:45.291	ship stationary
334	8.25976	78.68457	2008,248.937162 248 22:29:30.822	v small file

335	8.25973	78.68458	2008,248.937290 248 22:29:41.822	turn
336	8.25429	78.65987	2008,248.948284 248 22:45:31.747	turn
337	8.11947	78.64459	2008,248.957311 248 22:58:31.643	
338	7.31634	78.63042	2008,248.998973 248 23:58:31.295	
339	6.63856	78.61308	2008,249.033298 249 00:47:56.988	
340	6.18366	78.59858	2008,249.056526 249 01:21:23.882	
341	6.04777	78.63866	2008,249.098177 249 02:21:22.460	features of note
342	5.95858	78.68246	2008,249.139840 249 03:21:22.194	
343	6.1176	78.694	2008,249.181514 249 04:21:22.797	
344	6.36101	78.69739	2008,249.223177 249 05:21:22.456	
345	6.46843	78.67702	2008,249.264839 249 06:21:22.121	
346	6.65726	78.70113	2008,249.306513 249 07:21:22.757	
347	6.55479	78.67771	2008,249.336359 249 08:04:21.454	
348	6.95831	78.67956	2008,249.378022 249 09:04:21.094	
349	7.37098	78.6809	2008,249.419685 249 10:04:20.789	
350	7.78084	78.6824	2008,249.461347 249 11:04:20.413	
351	8.18899	78.68428	2008,249.503010 249 12:04:20.032	
352	8.59144	78.68594	2008,249.544683 249 13:04:20.638	
353	8.99446	78.68747	2008,249.586346 249 14:04:20.319	noisy
354	9.40062	78.68923	2008,249.628021 249 15:04:20.988	noisy
355	9.67951	78.68923	2008,249.656525 249 15:45:23.770	turn
356	9.49829	78.63965	2008,249.698187 249 16:45:23.320	
357	9.13061	78.60491	2008,249.739861 249 17:45:23.952	
358	8.77043	78.57062	2008,249.781524 249 18:45:23.682	depth range incorrect
359	8.40831	78.53567	2008,249.823186 249 19:45:23.240	
360	8.14798	78.50916	2008,249.864860 249 20:45:23.944	turn
361	8.08848	78.49448	2008,249.877672 249 21:03:50.877	turn
362	8.44935	78.50078	2008,249.919335 249 22:03:50.512	
363	8.82664	78.51891	2008,249.960997 249 23:03:50.166	
364	9.21636	78.53772	2008,250.002671 250 00:03:50.781	bad weather
365	9.60386	78.55681	2008,250.044333 250 01:03:50.337	bad weather
366	9.76682	78.56428	2008,250.062467 250 01:29:57.159	turn
367	9.61185	78.51984	2008,250.104142 250 02:29:57.863	
368	9.2378	78.49113	2008,250.145804 250 03:29:57.464	
369	8.86657	78.46217	2008,250.187467 250 04:29:57.115	
370	8.57387	78.43907	2008,250.220171 250 05:17:02.813	
371	8.63488	78.40446	2008,250.254035 250 06:05:48.649	
372	9.0254	78.41049	2008,250.295697 250 07:05:48.195	
373	9.42324	78.41636	2008,250.337360 250 08:05:47.878	depth range incorrect
374	9.82743	78.42297	2008,250.379021 250 09:05:47.422	
375	9.86124	78.3789	2008,250.420684 250 10:05:47.069	
376	9.47103	78.37967	2008,250.462359 250 11:05:47.808	
377	9.09442	78.37749	2008,250.504022 250 12:05:47.472	
378	8.70353	78.37655	2008,250.545684 250 13:05:47.123	v short line
379	8.67197	78.37653	2008,250.549133 250 13:10:45.092	turn
380	8.6616	78.42503	2008,250.590806 250 14:10:45.602	
381	9.04791	78.44185	2008,250.632481 250 15:10:46.375	
382	9.43501	78.45888	2008,250.674144 250 16:10:46.028	
383	9.76864	78.47428	2008,250.709684 250 17:01:56.690	turn
384	9.82071	78.54217	2008,250.751346 250 18:01:56.266	
385	9.7388	78.54939	2008,250.760986 250 18:15:49.190	
386	9.36254	78.52305	2008,250.802661 250 19:15:49.911	
387	8.97667	78.49864	2008,250.844323 250 20:15:49.543	
388	8.5966	78.47417	2008,250.885986 250 21:15:49.182	

389	8.52603	78.46973	2008,250.893670 250 21:26:53.119	
390	8.34431	78.51928	2008,250.935344 250 22:26:53.719	
391	8.69421	78.54377	2008,250.977007 250 23:26:53.400	
392	9.06104	78.56679	2008,251.018670 251 00:26:53.057	
393	9.44154	78.5911	2008,251.060343 251 01:26:53.670	
394	9.65932	78.60501	2008,251.084867 251 02:02:12.470	
395	9.62776	78.6639	2008,251.126529 251 03:02:12.098	
396	9.22681	78.65018	2008,251.168203 251 04:02:12.760	
397	8.82893	78.63649	2008,251.209866 251 05:02:12.395	
398	8.42882	78.62272	2008,251.251539 251 06:02:12.996	turn
399	8.09396	78.60899	2008,251.287311 251 06:53:43.637	turn
400	8.27014	78.60315	2008,251.328975 251 07:53:43.469	
401	8.27024	78.6836	2008,251.370648 251 08:53:44.017	
402	8.26759	78.73072	2008,251.394767 251 09:28:27.856	turn
403	8.30559	78.74146	2008,251.402335 251 09:39:21.772	
404	8.71665	78.74156	2008,251.443985 251 10:39:20.280	
405	9.13236	78.74181	2008,251.485648 251 11:39:20.010	
406	9.49666	78.745	2008,251.522404 251 12:32:15.699	
407	9.66779	78.78382	2008,251.549541 251 13:11:20.343	
408	9.92083	78.84615	2008,251.591193 251 14:11:19.040	
409	9.94418	78.85213	2008,251.595104 251 14:16:57.000	
410	10.05125	78.81219	2008,251.636780 251 15:16:57.768	
411	9.92921	78.80962	2008,251.649208 251 15:34:51.586	
412	9.52097	78.80538	2008,251.690870 251 16:34:51.192	
413	9.11661	78.80134	2008,251.732544 251 17:34:51.779	
414	8.73682	78.79732	2008,251.771140 251 18:30:26.462	turn
415	8.6894	78.78417	2008,251.781404 251 18:45:13.340	
416	8.86999	78.71164	2008,251.823068 251 19:45:13.082	
417	9.0393	78.6393	2008,251.864743 251 20:45:13.759	
418	9.09669	78.61521	2008,251.878526 251 21:05:04.645	
419	9.26532	78.54287	2008,251.920188 251 22:05:04.244	
420	9.42962	78.47193	2008,251.961862 251 23:05:04.860	
421	9.5985	78.39779	2008,252.003524 252 00:05:04.446	
422	9.7617	78.32964	2008,252.045187 252 01:05:04.180	
423	9.80312	78.30842	2008,252.070347 252 01:41:18.002	
424	9.37984	78.37543	2008,252.112020 252 02:41:18.551	
425	9.33996	78.40256	2008,252.119346 252 02:51:51.525	
426	9.27842	78.49695	2008,252.143359 252 03:26:26.240	
427	9.10692	78.60713	2008,252.185035 252 04:26:26.990	
428	9.06634	78.6189	2008,252.192903 252 04:37:46.853	
429	9.22181	78.61083	2008,252.234567 252 05:37:46.547	
430	9.01733	78.58485	2008,252.276228 252 06:37:46.131	
431	9.03195	78.59636	2008,252.311630 252 07:28:44.844	
432	9.40356	78.6306	2008,252.353281 252 08:28:43.475	
433	9.27924	78.60013	2008,252.394944 252 09:28:43.121	
434	9.24168	78.6302	2008,252.436617 252 10:28:43.751	
435	9.17236	78.62306	2008,252.478291 252 11:28:44.381	
436	9.21257	78.62232	2008,252.519955 252 12:28:44.072	
437	9.29799	78.58337	2008,252.561628 252 13:28:44.669	
438	9.52634	78.59627	2008,252.616137 252 14:47:14.236	
440	9.12091	78.567	2008,252.808490 252 19:24:13.560	
441	9.27042	78.64128	2008,252.850154 252 20:24:13.274	
442	9.22382	78.61788	2008,252.917669 252 22:01:26.628	
443	9.21616	78.61722	2008,252.959344 252 23:01:27.360	
444	9.2215	78.616	2008,253.001006 253 00:01:26.960	
445	9.20015	78.62079	2008,253.028782 253 00:41:26.740	

446	9.34663	78.6866	2008,253.070445 253 01:41:26.408	
447	9.41531	78.63067	2008,253.112117 253 02:41:26.888	
448	9.46196	78.57698	2008,253.153780 253 03:41:26.581	
449	9.57245	78.55574	2008,253.194320 253 04:39:49.280	
450	9.49405	78.61108	2008,253.235993 253 05:39:49.816	
451	9.43372	78.65095	2008,253.266130 253 06:23:13.649	
452	9.19818	78.63216	2008,253.307792 253 07:23:13.246	
453	8.86423	78.73447	2008,253.496836 253 11:55:26.618	
454	8.52424	78.92399	2008,253.538499 253 12:55:26.284	
455	8.17044	79.12369	2008,253.580173 253 13:55:26.969	
456	7.76678	79.31383	2008,253.621835 253 14:55:26.556	
457	7.40331	79.46273	2008,253.663498 253 15:55:26.250	ship stationary
458	7.40419	79.4621	2008,253.730725 253 17:32:14.634	
459	6.96015	79.41087	2008,253.772388 253 18:32:14.315	
460	7.50046	79.53322	2008,254.016738 254 00:24:06.206	ship stationary
461	7.50484	79.53398	2008,254.016982 254 00:24:27.207	
462	7.95478	79.60954	2008,254.042268 254 01:00:51.937	
463	7.92166	79.62564	2008,254.083930 254 02:00:51.595	ship stationary
464	7.92162	79.62519	2008,254.202217 254 04:51:11.559	ship stationary
465	7.92171	79.62516	2008,254.202263 254 04:51:15.559	
466	8.07032	79.46797	2008,254.243926 254 05:51:15.216	
467	8.09077	79.43358	2008,254.285600 254 06:51:15.871	
468	8.17326	79.38614	2008,254.327252 254 07:51:14.568	
469	8.27163	79.33052	2008,254.368926 254 08:51:15.241	
470	8.15552	79.36081	2008,254.410600 254 09:51:15.878	
471	8.05959	79.41179	2008,254.452262 254 10:51:15.422	
472	7.97682	79.4528	2008,254.493925 254 11:51:15.124	
473	7.92078	79.39728	2008,254.515311 254 12:22:02.845	turn
474	7.92115	79.40426	2008,254.557124 254 13:22:15.546	
475	8.14789	79.4002	2008,254.653990 254 15:41:44.727	
476	8.1178	79.39276	2008,254.731205 254 17:32:56.120	ship stationary
477	8.11781	79.39275	2008,254.731980 254 17:34:03.104	
478	7.58479	79.26312	2008,254.773654 254 18:34:03.703	
479	7.29802	79.1898	2008,254.793096 254 19:02:03.505	
480	6.69039	79.03405	2008,254.834757 254 20:02:03.028	
481	6.32748	78.9362	2008,254.876422 254 21:02:02.830	
482	6.19969	78.90349	2008,254.908548 254 21:48:18.551	
483	6.3951	78.95525	2008,254.950199 254 22:48:17.215	
484	6.75878	78.99242	2008,254.991872 254 23:48:17.771	
485	7.12717	79.03014	2008,255.033536 255 00:48:17.494	
486	7.49668	79.06776	2008,255.075198 255 01:48:17.091	
487	8.43512	79.1622	2008,255.180419 255 04:19:48.194	turn
488	8.41158	79.20759	2008,255.214929 255 05:09:29.892	
489	8.2533	79.21748	2008,255.231293 255 05:33:03.753	
490	7.84688	79.24354	2008,255.272956 255 06:33:03.438	
491	7.44014	79.2699	2008,255.314618 255 07:33:03.028	
492	7.03404	79.29633	2008,255.356292 255 08:33:03.630	
493	6.7761	79.31246	2008,255.382690 255 09:11:04.390	
494	6.37286	79.33807	2008,255.424341 255 10:11:03.086	
495	6.01305	79.37704	2008,255.466015 255 11:11:03.699	
496	6.39499	79.38843	2008,255.507678 255 12:11:03.376	
497	6.82553	79.38899	2008,255.549329 255 13:11:02.043	
498	7.25246	79.39003	2008,255.591003 255 14:11:02.697	
499	7.68246	79.3906	2008,255.632676 255 15:11:03.214	
500	8.11671	79.39141	2008,255.674351 255 16:11:03.890	
501	8.53816	79.39186	2008,255.715238 255 17:09:56.595	

502	8.61054	79.36508	2008,255.756901 255 18:09:56.266
503	8.53176	79.41453	2008,255.798563 255 19:09:55.853
504	8.49504	79.41743	2008,255.802486 255 19:15:34.804
505	8.12137	79.46546	2008,255.844149 255 20:15:34.442
506	7.7426	79.51345	2008,255.885811 255 21:15:34.092
507	7.3587	79.56055	2008,255.927486 255 22:15:34.825
508	7.1115	79.59393	2008,255.955562 255 22:56:00.586
509	7.42467	79.64683	2008,255.997225 255 23:56:00.226
510	7.84899	79.68806	2008,256.038898 256 00:56:00.811
511	8.25806	79.72997	2008,256.080561 256 01:56:00.511
512	8.64275	79.77161	2008,256.122234 256 02:56:00.998
513	8.85426	79.792	2008,256.144361 256 03:27:52.832
514	8.88232	79.82113	2008,256.171130 256 04:06:25.638
515	8.84812	79.79028	2008,256.188570 256 04:31:32.448
516	8.9764	79.71057	2008,256.230233 256 05:31:32.089
517	9.10207	79.63289	2008,256.271895 256 06:31:31.715
518	9.23443	79.55628	2008,256.313558 256 07:31:31.393
519	9.37958	79.54129	2008,256.355232 256 08:31:32.045
520	9.14542	79.59297	2008,256.396907 256 09:31:32.723
521	8.71274	79.58149	2008,256.438568 256 10:31:32.311
522	8.2662	79.56975	2008,256.480232 256 11:31:32.005
523	7.82338	79.5575	2008,256.521906 256 12:31:32.673
524	7.379	79.54446	2008,256.563568 256 13:31:32.306
525	6.93369	79.53314	2008,256.605254 256 14:31:33.968
526	6.82666	79.53007	2008,256.615299 256 14:46:01.869
527	6.48881	79.47924	2008,256.656302 256 15:45:04.513
528	6.59944	79.44855	2008,256.677689 256 16:15:52.315
529	7.00963	79.41843	2008,256.719363 256 17:15:52.994
530	7.42051	79.38827	2008,256.761026 256 18:15:52.626
531	7.82943	79.35825	2008,256.802687 256 19:15:52.173
532	8.23754	79.32813	2008,256.844351 256 20:15:51.902
533	8.57179	79.28597	2008,256.886013 256 21:15:51.559
534	8.25812	79.27739	2008,256.927676 256 22:15:51.200
535	7.83859	79.299	2008,256.969350 256 23:15:51.823
538	6.35188	79.30303	2008,257.150997 257 03:37:26.150
539	8.16934	78.95684	2008,257.519909 257 12:28:40.114
540	8.16852	78.9567	2008,257.520001 257 12:28:48.115
541	7.83876	78.90862	2008,257.561662 257 13:28:47.625
542	7.69795	78.91068	2008,257.576604 257 13:50:18.566
543	7.44724	78.97597	2008,257.618278 257 14:50:19.236
544	7.18275	79.0404	2008,257.659952 257 15:50:19.883
545	6.91456	79.10493	2008,257.701604 257 16:50:18.543
546	6.65117	79.16903	2008,257.743277 257 17:50:19.119
547	6.40407	79.2104	2008,257.784951 257 18:50:19.774
548	6.49018	79.22162	2008,257.826602 257 19:50:18.379
549	6.86674	79.37708	2008,257.868275 257 20:50:18.963
550	6.90876	79.38755	2008,257.909949 257 21:50:19.613
551	7.57433	79.39241	2008,257.951613 257 22:50:19.350
552	7.70067	79.39139	2008,257.993276 257 23:50:19.036
1	8.31084	79.40933	2008,258.054241 258 01:18:06.457
553	8.31328	79.40956	2008,258.054346 258 01:18:15.457
554	8.16452	79.39158	2008,258.096008 258 02:18:15.066
555	7.72985	79.39053	2008,258.137669 258 03:18:14.584
556	6.62154	79.39696	2008,258.266504 258 06:23:45.957
557	6.9607	79.39159	2008,258.308153 258 07:23:44.382
558	6.87905	79.39734	2008,258.349817 258 08:23:44.203

559	7.22646	79.38116	2008,258.391500 258 09:23:45.627
560	7.61588	79.39489	2008,258.433152 258 10:23:44.305
561	7.54174	79.38879	2008,258.474837 258 11:23:45.897
562	7.91658	79.39275	2008,258.516498 258 12:23:45.469
563	8.1247	79.39226	2008,258.558165 258 13:23:45.418
564	8.07128	79.35478	2008,258.599834 258 14:23:45.662
565	8.12118	79.32136	2008,258.640078 258 15:21:42.698
566	8.11549	79.40209	2008,258.681717 258 16:21:40.363
567	8.11314	79.41857	2008,258.689953 258 16:33:31.940
568	7.72746	79.44436	2008,258.731626 258 17:33:32.504
569	7.57201	79.39422	2008,258.773279 258 18:33:31.348
570	7.37531	79.33851	2008,258.814943 258 19:33:31.038
571	6.94663	79.32324	2008,258.856616 258 20:33:31.588
572	6.89973	79.40449	2008,258.898267 258 21:33:30.230
573	6.82586	79.44395	2008,258.939940 258 22:33:30.850
574	6.90523	79.39308	2008,258.981591 258 23:33:29.505
575	6.91803	79.39246	2008,259.023253 259 00:33:29.054
576	6.92053	79.38867	2008,259.064941 259 01:33:30.865
577	7.57463	79.39417	2008,259.099948 259 02:23:55.506
578	7.57687	79.39497	2008,259.141617 259 03:23:55.687
579	7.6786	79.39461	2008,259.183288 259 04:23:56.087
580	8.13299	79.39474	2008,259.224957 259 05:23:56.321
581	7.78572	79.42539	2008,259.266629 259 06:23:56.715
582	7.40638	79.46162	2008,259.413297 259 09:55:08.845
583	7.54217	79.4126	2008,259.454960 259 10:55:08.510
584	7.649	79.33554	2008,259.496622 259 11:55:08.127
585	7.75359	79.26052	2008,259.538296 259 12:55:08.779
586	7.85575	79.18725	2008,259.579958 259 13:55:08.393
587	7.9568	79.11372	2008,259.621609 259 14:55:07.012
588	8.05524	79.04197	2008,259.663295 259 15:55:08.673
589	8.15075	78.9702	2008,259.704946 259 16:55:07.311
590	8.24659	78.89812	2008,259.746609 259 17:55:07.026
591	8.34548	78.82672	2008,259.788283 259 18:55:07.689
592	8.44092	78.75346	2008,259.829944 259 19:55:07.128
593	8.48493	78.71947	2008,259.852824 259 20:28:04.007
594	8.22236	78.74732	2008,259.894498 259 21:28:04.629
595	7.53093	78.88283	2008,259.936161 259 22:28:04.304
596	6.89497	79.01632	2008,259.977836 259 23:28:04.993
597	6.90472	79.00425	2008,260.019499 260 00:28:04.685
598	6.90936	79.00423	2008,260.061149 260 01:28:03.292
599	6.90006	79.00718	2008,260.102823 260 02:28:03.927
600	6.90423	79.00766	2008,260.144497 260 03:28:04.577
601	6.90443	79.00684	2008,260.186149 260 04:28:03.236
602	6.90448	79.00686	2008,260.227822 260 05:28:03.792
603	6.90463	79.00665	2008,260.269484 260 06:28:03.457
604	6.90453	79.00666	2008,260.311158 260 07:28:04.029
605	6.9156	79.00679	2008,260.410895 260 09:51:41.316
606	6.91613	79.00671	2008,260.410964 260 09:51:47.316
607	7.31358	78.89535	2008,260.452638 260 10:51:47.906
608	7.63575	78.77934	2008,260.494312 260 11:51:48.554
609	7.49411	78.73881	2008,260.535973 260 12:51:48.074
610	7.49406	78.73879	2008,260.577637 260 13:51:47.845
611	7.49407	78.7388	2008,260.619300 260 14:51:47.502
612	7.49416	78.73876	2008,260.660950 260 15:51:46.107
613	7.70488	78.72143	2008,260.702624 260 16:51:46.736
614	8.51894	78.67254	2008,260.744287 260 17:51:46.394

615	9.33817	78.57792	2008,260.785949 260 18:51:46.019
616	9.5244	78.55102	2008,260.827623 260 19:51:46.655
617	9.38138	78.5461	2008,260.869287 260 20:51:46.375
618	9.62088	78.55777	2008,260.910959 260 21:51:46.900
619	9.54168	78.55027	2008,260.982863 260 23:35:19.323
620	9.4972	78.56617	2008,260.997596 260 23:56:32.286
621	9.45456	78.59847	2008,261.039269 261 00:56:32.883
622	9.45609	78.59616	2008,261.080932 261 01:56:32.541
623	9.57859	78.51724	2008,261.122594 261 02:56:32.097
624	9.51652	78.48459	2008,261.164269 261 03:56:32.831
625	9.54593	78.55581	2008,261.205931 261 04:56:32.471
626	9.52982	78.55621	2008,261.247594 261 05:56:32.104
627	9.4835	78.63076	2008,261.289255 261 06:56:31.625
628	9.40875	78.69277	2008,261.324415 261 07:47:09.421
629	9.43542	78.63964	2008,261.366077 261 08:47:09.083
630	9.49925	78.60625	2008,261.401536 261 09:38:12.752
631	9.4255	78.66321	2008,261.443199 261 10:38:12.387
632	9.47896	78.64297	2008,261.484872 261 11:38:12.958
633	9.43793	78.6588	2008,261.526533 261 12:38:12.468
634	9.44372	78.6867	2008,261.559231 261 13:25:17.524
635	9.49956	78.61682	2008,261.600892 261 14:25:17.069
636	9.42493	78.66447	2008,261.642568 261 15:25:17.904
637	9.33062	78.67549	2008,261.684217 261 16:25:16.360
638	9.42728	78.656	2008,261.725889 261 17:25:16.835
639	9.4206	78.66187	2008,261.767554 261 18:25:16.701
640	9.43208	78.65267	2008,261.809215 261 19:25:16.218
641	9.43158	78.65383	2008,261.850890 261 20:25:16.864
642	9.43226	78.65283	2008,261.931113 261 22:20:48.133
643	9.43223	78.65282	2008,261.931182 261 22:20:54.132
644	9.70056	78.54457	2008,261.972844 261 23:20:53.689
645	9.73006	78.5486	2008,262.082175 262 01:58:19.882
646	9.72993	78.54852	2008,262.082568 262 01:58:53.866
647	8.97011	78.61935	2008,262.124230 262 02:58:53.469
648	8.25435	78.68691	2008,262.165893 262 03:58:53.116
649	8.27259	78.68449	2008,262.294467 262 07:04:01.967
650	8.27302	78.68443	2008,262.306306 262 07:21:04.874
651	9.17552	78.67423	2008,262.347969 262 08:21:04.562
652	9.42257	78.66975	2008,262.359103 262 08:37:06.499
653	9.45761	78.63193	2008,262.378337 262 09:04:48.358
654	9.46265	78.63208	2008,262.384911 262 09:14:16.311
655	9.43139	78.66712	2008,262.402606 262 09:39:45.136
656	9.42507	78.6703	2008,262.411575 262 09:52:40.053
657	9.4249	78.66994	2008,262.411725 262 09:52:53.069
658	9.45757	78.63112	2008,262.430785 262 10:20:19.855
659	9.46768	78.63087	2008,262.434095 262 10:25:05.832
660	9.43405	78.67194	2008,262.454116 262 10:53:55.637
661	9.44778	78.67076	2008,262.457936 262 10:59:25.630
663	9.52741	78.5073	2008,262.509599 262 12:13:49.338
664	9.61984	78.32933	2008,262.551256 262 13:13:48.496
665	9.71184	78.14905	2008,262.592907 262 14:13:47.169
666	9.79367	77.96916	2008,262.634577 262 15:13:47.442
667	9.88115	77.79315	2008,262.676249 262 16:13:47.871
668	9.93803	77.66106	2008,262.709588 262 17:01:48.371
669	9.94622	77.6012	2008,262.729667 262 17:30:43.192

N EK60 Raw data inventory of .raw and .out files collected

Line # map label	Raw file (* -EK60.raw)	Out file (* -EK60.out)
01	L0001-D20080823-T221634	L0001-D20080823-T221634
02	L0002-D20080824-T081938	L0002-D20080824-T081938
03	L0003-D20080824-T083929	L0003-D20080824-T083929
04	L0004-D20080824-T084140	L0004-D20080824-T084140
05	L0005-D20080824-T092758	L0005-D20080824-T092758
06	L0006-D20080824-T094005	L0006-D20080824-T094005
06	L0006-D20080824-T142801	L0006-D20080824-T094005
07	L0007-D20080824-T160737	L0007-D20080824-T160737
08	L0008-D20080824-T162841	L0008-D20080824-T162841
09	L0009-D20080824-T180252	L0009-D20080824-T180252
09_2	L0009-D20080824-T221340	L0009-D20080824-T180252
10	L0010-D20080825-T000832	L0010-D20080825-T000832
11	L0011-D20080825-T012419	L0011-D20080825-T012419
12	L0012-D20080825-T054743	L0012-D20080825-T054743
13	L0013-D20080825-T075958	L0013-D20080825-T075958
13_2	L0013-D20080825-T120454	L0013-D20080825-T075958
14	L0014-D20080825-T130619	L0014-D20080825-T130619
15	L0015-D20080825-T144347	L0015-D20080825-T144347
16	L0016-D20080825-T192314	L0016-D20080825-T192314
17	L0017-D20080825-T230535	L0017-D20080825-T230535
18	L0018-D20080825-T231426	L0018-D20080825-T231426
19	L0019-D20080826-T004710	L0019-D20080826-T004710
20	L0020-D20080826-T021607	L0020-D20080826-T021607
21	L0021-D20080826-T030135	L0021-D20080826-T030135
21_2	L0021-D20080826-T072320	L0021-D20080826-T030135
21_3	L0021-D20080826-T115155	L0021-D20080826-T030135
21_4	L0021-D20080826-T171526	L0021-D20080826-T030135
22	L0022-D20080826-T172030	L0022-D20080826-T172030
22_2	L0022-D20080826-T234413	L0022-D20080826-T172030
23	L0023-D20080827-T052243	L0023-D20080827-T052243
24	L0024-D20080827-T053443	L0024-D20080827-T053443
24_2	L0024-D20080827-T105906	L0024-D20080827-T053443
25	L0025-D20080827-T125136	L0025-D20080827-T125136
26	L0026-D20080827-T164443	L0026-D20080827-T164443
27	L0027-D20080827-T202158	L0027-D20080827-T202158
27_2	L0027-D20080828-T010449	L0027-D20080827-T202158
28	L0028-D20080828-T032810	L0028-D20080828-T032810
29	L0029-D20080828-T064006	L0029-D20080828-T064006
30	L0030-D20080828-T070606	L0030-D20080828-T070606
30_2	L0030-D20080828-T113233	L0030-D20080828-T070606
31	L0031-D20080828-T143550	L0031-D20080828-T143551
32	L0032-D20080828-T182523	L0032-D20080828-T182523
32_2	L0032-D20080828-T223646	L0032-D20080828-T182523
32_3	L0032-D20080829-T031910	L0032-D20080828-T182523
33	L0033-D20080829-T051649	L0033-D20080829-T051649
33_2	L0033-D20080829-T101047	L0033-D20080829-T051649
33_3	L0033-D20080829-T152202	L0033-D20080829-T051649
33_4	L0033-D20080829-T194455	L0033-D20080829-T051649
33_5	L0033-D20080830-T013904	L0033-D20080829-T051649
34	L0034-D20080830-T024849	L0034-D20080830-T024849
35	L0035-D20080830-T060452	L0035-D20080830-T060452
35_2	L0035-D20080830-T112037	L0035-D20080830-T060452
36	L0036-D20080830-T161153	L0036-D20080830-T161153
37	L0037-D20080830-T211330	L0037-D20080830-T211330
37_2	L0037-D20080831-T035034	L0037-D20080830-T211330
38	L0038-D20080831-T053856	L0038-D20080831-T053856
38_2	L0038-D20080831-T105304	L0038-D20080831-T053856
38_3	L0038-D20080831-T151556	L0038-D20080831-T053856
39	L0039-D20080831-T190812	L0039-D20080831-T190812
39_2	L0039-D20080831-T230841	L0039-D20080831-T190812

Line # map label	Raw file (* -EK60.raw)	Out file (* -EK60.out)
39	L0039-D20080901-T032131	L0039-D20080831-T190812
40	L0040-D20080901-T050332	L0040-D20080901-T050332
40_1	L0040-D20080901-T100101	L0040-D20080901-T050332
40_2	L0040-D20080901-T164247	L0040-D20080901-T050332
41	L0041-D20080901-T214513	L0041-D20080901-T214513
41_2	L0041-D20080902-T072236	L0041-D20080902-T072236
41_3	L0041-D20080902-T124307	L0041-D20080902-T124308
42	L0042-D20080902-T200059	L0042-D20080902-T200059
42_2	L0042-D20080903-T030139	L0042-D20080902-T200059
43	L0043-D20080903-T061053	L0043-D20080903-T061053
43_1	L0043-D20080903-T104555	L0043-D20080903-T061053
43_2	L0043-D20080903-T151411	L0043-D20080903-T061053
43_3	L0043-D20080903-T193550	L0043-D20080903-T061053
44	L0044-D20080903-T211904	L0044-D20080903-T211904
44_2	L0044-D20080904-T021934	L0044-D20080903-T211904
45	L0045-D20080904-T063049	L0045-D20080904-T063049
45_2	L0045-D20080904-T122925	L0045-D20080904-T063049
45_3	L0045-D20080904-T165523	L0045-D20080904-T063049
45_4	L0045-D20080904-T205448	L0045-D20080904-T063049
45_5	L0045-D20080905-T010856	L0045-D20080904-T063049
45_6	L0045-D20080905-T061342	L0045-D20080904-T063049
46	L0046-D20080905-T084532	L0046-D20080905-T084532
46_2	L0046-D20080905-T131116	L0046-D20080905-T084532
46_3	L0046-D20080905-T184601	L0046-D20080905-T084532
47	L0047-D20080905-T195037	L0047-D20080905-T195037
47_2	L0047-D20080905-T234836	L0047-D20080905-T195037
47_3	L0047-D20080906-T045759	L0047-D20080905-T195037
48	L0048-D20080906-T062427	L0048-D20080906-T062427
48_2	L0048-D20080906-T112000	L0048-D20080906-T062427
48_3	L0048-D20080906-T154756	L0048-D20080906-T062427
48_4	L0048-D20080906-T205602	L0048-D20080906-T062427
48_5	L0048-D20080907-T005633	L0048-D20080906-T062427
48_6	L0048-D20080907-T063903	L0048-D20080906-T062427
49	L0049-D20080907-T085132	L0049-D20080907-T085132
49_2	L0049-D20080907-T140147	L0049-D20080907-T085132
49_3	L0049-D20080907-T205329	L0049-D20080907-T085132
49_4	L0049-D20080908-T024205	L0049-D20080907-T085132
49_5	L0049-D20080908-T075254	L0049-D20080907-T085132
49_6	L0049-D20080908-T134540	L0049-D20080907-T085132
49_7	L0049-D20080908-T183208	L0049-D20080907-T085132
49_8	L0049-D20080908-T233633	L0049-D20080907-T085132
49_9	L0049-D20080909-T052510	L0049-D20080907-T085132
49_10	L0049-D20080909-T104510	L0049-D20080907-T085132
49_11	L0049-D20080909-T153457	L0049-D20080907-T085132
50	L0050-D20080909-T191211	L0050-D20080909-T191211
50_2	L0050-D20080909-T232116	L0050-D20080909-T191211
50_3	L0050-D20080910-T033537	L0050-D20080909-T191211
50_4	L0050-D20080910-T083632	L0050-D20080909-T191211
50_5	L0050-D20080910-T141941	L0050-D20080909-T191211
51	L0051-D20080910-T155018	L0051-D20080910-T155018
51_2	L0051-D20080910-T203218	L0051-D20080910-T155018
51_3	L0051-D20080911-T001531	L0051-D20080910-T155018
51_4	L0051-D20080911-T042221	L0051-D20080910-T155018
51_5	L0051-D20080911-T085531	L0051-D20080910-T155018
51_6	L0051-D20080911-T125337	L0051-D20080910-T155018
51_7	L0051-D20080911-T175107	L0051-D20080910-T155018
51_8	L0051-D20080911-T224820	L0051-D20080910-T155018
51_9	L0051-D20080912-T025840	L0051-D20080910-T155018
52	L0052-D20080912-T064508	L0052-D20080912-T064508
52_2	L0052-D20080912-T123150	L0052-D20080912-T064508
52_3	L0052-D20080912-T164829	L0052-D20080912-T064508
52_4	L0052-D20080912-T220359	L0052-D20080912-T064508

Line # map label	Raw file (* -EK60.raw)	Out file (* -EK60.out)
52_5	L0052-D20080913-T022658	L0052-D20080912-T064508
52_6	L0052-D20080913-T064553	L0052-D20080912-T064508
53	L0053-D20080913-T074058	L0053-D20080913-T074058
53_2	L0053-D20080913-T120645	L0053-D20080913-T074058
53_3	L0053-D20080913-T162745	L0053-D20080913-T074058
53_4	L0053-D20080913-T203450	L0053-D20080913-T074058
53_5	L0053-D20080914-T004405	L0053-D20080913-T074058
53_6	L0053-D20080914-T052003	L0053-D20080913-T074058
53_7	L0053-D20080914-T092443	L0053-D20080913-T074058
53_8	L0053-D20080914-T141336	L0053-D20080913-T074058
54	L0054-D20080914-T191016	L0054-D20080914-T191016
54_2	L0054-D20080914-T231407	L0054-D20080914-T191016
54_3	L0054-D20080915-T032604	L0054-D20080914-T191016
55	L0055-D20080915-T065025	L0055-D20080915-T065025
55_2	L0055-D20080915-T110508	L0055-D20080915-T065025
55_3	L0055-D20080915-T150123	L0055-D20080915-T065025
55_4	L0055-D20080915-T192654	L0055-D20080915-T065025
56	L0056-D20080915-T202851	L0056-D20080915-T202851
56_2	L0056-D20080916-T010057	L0056-D20080915-T202851
57	L0057-D20080916-T031853	L0057-D20080916-T031853
58	L0058-D20080916-T050419	L0058-D20080916-T050419
58_2	L0058-D20080916-T093430	L0058-D20080916-T050419
59	L0059-D20080916-T104549	L0059-D20080916-T104549
59_2	L0059-D20080916-T150928	L0059-D20080916-T104549
60	L0060-D20080916-T194726	L0060-D20080916-T194726
60_2	L0060-D20080917-T014759	L0060-D20080916-T194726
61	L0061-D20080917-T075113	L0061-D20080917-T075113
62	L0062-D20080917-T091644	L0062-D20080917-T091644
63	L0063-D20080917-T093811	L0063-D20080917-T093811
64	L0064-D20080917-T105116	L0064-D20080917-T105116
65	L0065-D20080917-T110828	L0065-D20080917-T110828
66	L0066-D20080917-T115918	L0066-D20080917-T115919
67	L0067-D20080917-T130729	L0067-D20080917-T130729
68	L0068-D20080917-T132536	L0068-D20080917-T132536
69	L0069-D20080917-T143321	L0069-D20080917-T143321
70	L0070-D20080917-T153415	L0070-D20080917-T153415
71	L0071-D20080917-T163446	L0071-D20080917-T163446
72	L0072-D20080917-T170100	L0072-D20080917-T170100
73	L0073-D20080917-T170620	L0073-D20080917-T170620
74	L0074-D20080917-T172851	L0074-D20080917-T172852
75	L0075-D20080917-T173446	L0075-D20080917-T173446
76	L0076-D20080917-T175540	L0076-D20080917-T175540
77	L0077-D20080917-T180408	L0077-D20080917-T180408
78	L0078-D20080917-T182311	L0078-D20080917-T182311
79	L0079-D20080917-T203313	L0079-D20080917-T203313
79_2	L0079-D20080918-T033139	L0079-D20080917-T203313
79_3	L0079-D20080918-T073351	L0079-D20080917-T203313
80	L0080-D20080918-T083602	L0080-D20080918-T083602
81	L0081-D20080918-T090458	L0081-D20080918-T090458
82	L0082-D20080918-T091430	L0082-D20080918-T091430
83	L0083-D20080918-T094007	L0083-D20080918-T094007
84	L0084-D20080918-T095426	L0084-D20080918-T095426
85	L0085-D20080918-T102048	L0085-D20080918-T102048
86	L0086-D20080918-T105434	L0086-D20080918-T105434
87	L0087-D20080918-T121028	L0087-D20080918-T121028
87_2	L0087-D20080918-T175628	L0087-D20080918-T121028

O Positional and time information for individual lines of Appendix N

map label	Start Position (WGS-84) Longitude E	Latitude N	Julian Day 2008	UTC HH	MM	SS	nPings	depth (m)
01	8.99939	78.30008	236.928176	22	16	34.373	1693	1086
02	9.36396	78.61965	237.346977	08	19	38.840	651	413
03	9.34887	78.63316	237.360761	08	39	29.711	5208	420
04	9.34711	78.63463	237.362277	08	41	40.694	1278	422
05	9.31214	78.66592	237.394427	09	27	58.454	1329	449
06	9.28190	78.67018	237.402840	09	40	05.378	5398	450
06	8.28748	78.69184	237.602796	14	28	01.614	1993	876
07	7.93710	78.70014	237.671956	16	07	37.018	1993	1009
08	7.86484	78.70175	237.686596	16	28	41.877	1993	1035
09	7.52955	78.70954	237.751993	18	02	52.236	3994	1129
09_2	8.19869	78.72701	237.926167	22	13	40.812	2118	901
10	8.62491	78.71591	238.005928	00	08	32.220	1727	686
11	8.66473	78.75244	238.058561	01	24	19.653	5127	546
12	8.23232	78.90905	238.241471	05	47	43.065	2080	862
13	7.75569	78.91002	238.333313	07	59	58.262	3720	1129
13_2	6.88669	78.91520	238.503412	12	04	54.828	3322	1410
14	6.67848	78.91615	238.546060	13	06	19.541	3322	1571
15	6.54936	78.86710	238.613749	14	43	47.888	6643	1862
16	5.24997	78.66681	238.807804	19	23	14.235	3986	2301
17	8.25320	78.67404	238.962221	23	05	35.931	1563	901
18	8.24648	78.68981	238.968367	23	14	26.885	1727	893
19	8.25007	78.68800	239.032758	00	47	10.294	1727	898
20	8.30250	78.87818	239.094534	02	16	07.698	1448	780
21	8.25185	78.87757	239.126104	03	01	35.420	4841	836
21_2	8.44265	79.05311	239.307870	07	23	20.008	5134	717
21_3	8.17175	79.22563	239.494391	11	51	55.385	6504	534
21_4	8.08521	79.44057	239.719055	17	15	26.375	996	373
22	8.09697	79.44324	239.722574	17	20	30.393	9484	368
22_2	9.09719	79.63879	239.989040	23	44	13.098	9539	386
23	9.98277	79.80990	240.224109	05	22	43.040	690	399
24	9.97022	79.81745	240.232453	05	34	43.966	7078	402
24_2	9.10302	79.98063	240.457720	10	59	06.991	2118	482
25	9.04500	79.99847	240.535838	12	51	36.382	4447	490
26	7.37261	79.69250	240.697731	16	44	43.962	6643	828
27	7.11980	79.21126	240.848595	20	21	58.631	3983	1305
27_2	7.05973	79.46024	241.045022	01	04	49.937	2253	1113
28	7.51767	79.22196	241.144561	03	28	10.073	3011	1178
29	6.96112	79.60297	241.277858	06	40	06.943	1993	984
30	7.13612	79.60003	241.295912	07	06	06.761	4277	923
30_2	7.72592	79.31806	241.480939	11	32	33.150	3410	805
31	7.29028	79.64482	241.608220	14	35	50.179	4258	859
32	8.02267	79.19823	241.767636	18	25	23.715	4687	785
32_2	7.36410	79.67679	241.942202	22	36	46.218	5422	836
32_3	7.96995	79.52795	242.138316	03	19	10.487	2185	659
33	7.60734	79.72445	242.220021	05	16	49.839	5801	765
33_2	7.98134	79.25750	242.424156	10	10	47.096	6062	694
33_3	8.15888	79.54690	242.640304	15	22	02.251	4801	574
33_4	8.16906	79.61941	242.822866	19	44	55.619	8730	627
33_5	8.03194	79.73024	243.068802	01	39	04.498	1329	658
34	7.78814	79.84308	243.117235	02	48	49.112	3963	660
35	8.38638	79.49964	243.253390	06	04	52.934	6424	333
35_2	8.52009	79.64394	243.472662	11	20	37.995	7244	483
36	8.14201	79.39231	243.674923	16	11	53.340	7184	277
37	8.49823	79.04318	243.884380	21	13	30.446	10486	600
37_2	8.07704	79.51199	244.160117	03	50	34.123	2067	551
38	7.97973	79.52849	244.235376	05	38	56.450	6214	655
38_2	7.90044	79.31411	244.453525	10	53	04.557	4889	668
38_3	8.23437	79.14430	244.636076	15	15	56.939	4483	704
39	8.51470	79.03717	244.797368	19	08	12.635	4456	546
39_2	8.41019	78.99439	244.964364	23	08	41.084	4666	664

	Start Position (WGS-84)			UTC				
map label	Longitude E	Latitude N	Julian Day 2008	HH	MM	SS	nPings	depth (m)
39	8.26189	78.68341	245.139949	03	21	31.585	1880	900
40	8.26230	78.68333	245.210787	05	03	32.023	6006	900
40_1	9.50849	78.53964	245.417375	10	01	01.210	11170	393
40_2	9.58228	78.55763	245.696387	16	42	47.813	8509	258
41	9.67246	78.51554	245.906400	21	45	13.000	3364	214
41_2	15.59375	78.23637	246.307366	07	22	36.407		L.yearbyen
41_3	15.59759	78.24347	246.529951	12	43	07.742	1727	Longyearby
42	10.03544	78.26764	246.834017	20	00	59.028	11358	290
42_2	9.56860	78.33904	247.126152	03	01	39.508	3815	340
43	9.24041	78.56860	247.257563	06	10	53.416	5165	498
43_1	9.20984	78.47594	247.448561	10	45	55.712	5079	783
43_2	9.09717	78.44002	247.634851	15	14	11.092	4625	905
43_3	8.93661	78.41466	247.816558	19	35	50.585	1993	1230
44	8.91383	78.60824	247.888252	21	19	04.986	4055	630
44_2	8.67491	78.52421	248.096923	02	19	34.124	3345	1021
45	9.24328	78.60977	248.271407	06	30	49.562	9665	474
45_2	9.45644	78.58466	248.520434	12	29	25.525	5464	386
45_3	8.26021	78.68748	248.705137	16	55	23.843	4427	905
45_4	8.26001	78.68456	248.871394	20	54	48.469	4070	904
45_5	6.35216	78.60442	249.047881	01	08	56.895	3637	2132
45_6	6.41551	78.67676	249.259516	06	13	42.174	3322	1799
46	6.83370	78.67878	249.364956	08	45	32.195	3719	1502
46_2	8.63906	78.68620	249.549498	13	11	16.613	6597	722
46_3	8.76675	78.57026	249.781964	18	46	01.667	2259	856
47	8.37656	78.53270	249.826820	19	50	37.208	3605	1246
47_2	9.11590	78.53305	249.992094	23	48	36.880	6498	648
47_3	8.69306	78.44842	250.206944	04	57	59.960	3322	1357
48	8.75604	78.40632	250.266985	06	24	27.522	5873	1430
48_2	9.38016	78.37897	250.472231	11	20	00.770	3815	754
48_3	9.28810	78.45290	250.658289	15	47	56.145	6098	746
48_4	8.72073	78.48209	250.872249	20	56	02.300	3567	1208
48_5	9.24844	78.57877	251.039280	00	56	33.828	7726	485
48_6	8.18551	78.61397	251.277127	06	39	03.749	2134	1011
49	8.27037	78.68065	251.369121	08	51	32.045	6965	880
49_2	9.88145	78.83669	251.584573	14	01	47.097	10662	84
49_3	9.06310	78.62928	251.870483	20	53	29.734	8021	545
49_4	9.37372	78.37714	252.112564	02	42	05.538	6172	728
49_5	9.18282	78.60986	252.328411	07	52	54.691	7476	493
49_6	9.37894	78.58275	252.573386	13	45	40.577	5438	423
49_7	9.34248	78.55981	252.772324	18	32	08.820	6541	461
49_8	9.20530	78.61634	252.983717	23	36	33.120	9241	483
49_9	9.51234	78.59772	253.225821	05	25	10.962	7732	292
49_10	9.12303	78.60443	253.448033	10	45	10.071	6180	529
49_11	7.47648	79.43956	253.649276	15	34	57.405	3836	903
50	6.76742	79.39235	253.800128	19	12	11.085	3853	1306
50_2	6.81153	79.40353	253.973108	23	21	16.527	4485	1282
50_3	7.92173	79.62566	254.149746	03	35	38.012	5900	706
50_4	8.24597	79.34432	254.358707	08	36	32.326	8103	245
50_5	8.14998	79.40179	254.597004	14	19	41.167	2441	273
51	8.12723	79.39493	254.659939	15	50	18.728	5862	280
51_2	6.39719	78.95722	254.855775	20	32	18.998	3322	1722
51_3	6.92866	79.01004	255.010784	00	15	31.709	3742	1218
51_4	8.45137	79.16383	255.182189	04	22	21.166	5124	367
51_5	6.88253	79.30582	255.371892	08	55	31.486	3322	1303
51_6	6.70244	79.38869	255.537235	12	53	37.126	4960	1330
51_7	8.61258	79.37582	255.743835	17	51	07.360	5614	167
51_8	7.15261	79.58679	255.950239	22	48	20.623	4304	930
51_9	8.66056	79.77333	256.124086	02	58	40.998	4491	483
52	9.13165	79.61548	256.281350	06	45	08.618	8167	361
52_2	7.82117	79.55745	256.522114	12	31	50.673	4267	735
52_3	6.82126	79.43182	256.700338	16	48	29.174	6029	1264
52_4	8.33904	79.27295	256.919436	22	03	59.272	4848	283

	Start Position (WGS-84)			UTC				
map label	Longitude E	Latitude N	Julian Day 2008	HH	MM	SS	nPings	depth (m)
52_5	6.49415	79.36857	257.102068	02	26	58.690	3631	1402
52_6	7.52228	79.20051	257.281865	06	45	53.134	2657	1204
53	7.88195	79.17427	257.320125	07	40	58.841	4106	1007
53_2	8.29308	78.97593	257.504689	12	06	45.163	4111	719
53_3	7.01448	79.08060	257.685945	16	27	45.662	3674	1354
53_4	6.76679	79.33697	257.857524	20	34	50.094	3963	1324
53_5	8.11676	79.38938	258.030622	00	44	05.729	5709	304
53_6	6.84031	79.38821	258.222264	05	20	03.600	3851	1278
53_7	7.23392	79.38120	258.392172	09	24	43.631	5643	1119
53_8	8.08365	79.36291	258.592787	14	13	36.822	6047	373
54	7.54112	79.34674	258.798798	19	10	16.170	3904	919
54_2	6.90212	79.39821	258.968144	23	14	07.659	3962	1267
54_3	7.57499	79.39563	259.143104	03	26	04.228	3219	853
55	7.43353	79.46267	259.285013	06	50	25.103	4011	910
55_2	7.56029	79.39958	259.461903	11	05	08.459	4189	866
55_3	7.96589	79.10616	259.625972	15	01	23.948	4177	1095
55_4	8.39511	78.78764	259.810352	19	26	54.395	1993	708
56	8.48518	78.71897	259.853379	20	28	51.975	4147	765
56_2	6.90507	79.01243	260.042331	01	00	57.396	2165	1214
57	6.88831	79.00980	260.138121	03	18	53.676	1993	1207
58	6.90442	79.00684	260.211342	05	04	19.990	4247	1211
58_2	6.90447	79.00664	260.398962	09	34	30.334	1993	1211
59	7.27302	78.90615	260.448495	10	45	49.965	4140	1195
59_2	7.49430	78.73880	260.631579	15	09	28.448	4817	1143
60	9.52370	78.55153	260.824614	19	47	26.676	8913	362
60_2	9.45240	78.60651	261.074995	01	47	59.601	9403	358
61	9.40315	78.68932	261.327238	07	51	13.399	2292	356
62	9.48492	78.61271	261.386630	09	16	44.870	1727	292
63	9.49928	78.60623	261.401525	09	38	11.752	2103	298
64	9.41161	78.67502	261.452272	10	51	16.299	1727	319
65	9.44158	78.68199	261.464215	11	08	28.188	1727	317
66	9.46519	78.62664	261.499523	11	59	18.776	2019	224
67	9.39541	78.68112	261.546868	13	07	29.433	1727	346
68	9.44358	78.68643	261.559451	13	25	36.527	2002	316
69	9.46537	78.62252	261.606502	14	33	21.761	1818	277
70	9.41614	78.67146	261.648791	15	34	15.585	1727	312
71	9.42053	78.66635	261.690810	16	34	46.025	788	292
72	9.45731	78.63137	261.709029	17	01	00.088	531	210
73	9.45467	78.63045	261.712742	17	06	20.926	673	213
74	9.42810	78.66082	261.728376	17	28	51.726	531	258
75	9.42191	78.66079	261.732483	17	34	46.515	627	269
76	9.44731	78.63185	261.746999	17	55	40.756	531	220
77	9.44009	78.63264	261.752876	18	04	08.468	571	242
78	9.42167	78.65903	261.766109	18	23	11.780	3884	254
79	9.43168	78.65383	261.856410	20	33	13.792	11896	242
79_2	8.45516	78.67806	262.146983	03	31	39.338	4531	835
79_3	8.42460	78.68262	262.315183	07	33	51.809	1461	849
80	9.41519	78.67131	262.358362	08	36	02.515	1727	310
81	9.45748	78.63170	262.378453	09	04	58.358	1727	209
82	9.46258	78.63245	262.385073	09	14	30.311	1727	204
83	9.43099	78.66761	262.402860	09	40	07.135	1727	292
84	9.42498	78.66743	262.412802	09	54	26.051	1727	293
85	9.45826	78.63048	262.431121	10	20	48.854	1727	208
86	9.43537	78.67270	262.454568	10	54	34.638	2179	288
87	9.52417	78.51722	262.507273	12	10	28.348	8152	403
87_2	9.94539	77.62104	262.747547	17	56	28.051	1993	1280
	END OF SURVEY							

P Provisional mapping of plume locations using EchoView v. 4.0 software

Number	Date	Time (UTC)	Ping	Lat_deg N	Lat_min	Lon-deg E	Lon_min
added by HP				78	35.30	9	23.83
added by HP				78	27.16	9	35.95
added by HP				78	34.99	9	27.57
added by HP				78	37.08	9	25.40
added by HP				78	30.24	9	35.91
added by HP				78	41.44	8	14.79
added by HP				78	54.61	7	54.92
added by HP				78	54.61	7	47.01
added by HP				78	45.93	8	37.93
added by HP				78	46.09	8	37.55
added by HP				78	41.44	8	14.79
added by HP				79	75.97	7	56.04
added by HP				79	17.30	7	59.43
added by HP				79	25.76	8	3.06
added by HP				78	37.81	9	23.97
added by HP				78	23.09	9	56.05
added by HP				78	22.80	9	45.21
added by HP				78	35.45	9	26.34
added by HP				78	35.66	9	29.74
1	25/08/2008	23:16:17	36	78	41.44	8	14.79
2	25/08/2008	23:17:20		78	41.44	8	14.79
3	28/08/2008	17:50:16		79	15.65	7	56.69
4	01/09/2008	10:04:22		78	32.81	9	30.08
5	01/09/2008	10:04:51		78	32.86	9	30.02
6	01/09/2008	10:07:00		78	33.17	9	29.68
7	01/09/2008	10:09:10		78	33.44	9	29.34
8	01/09/2008	10:14:00		78	34.01	9	28.62
9	01/09/2008	10:16:20		78	34.33	9	28.25
10	01/09/2008	10:18:15		78	34.54	9	28.04
11	01/09/2008	10:19:00		78	34.65	9	27.93
12	01/09/2008	10:19:30		78	34.72	9	27.86
13	01/09/2008	10:19:45		78	34.77	9	27.81
14	01/09/2008	10:22:00		78	35.03	9	27.56
15	01/09/2008	10:22:45		78	35.1	9	27.49
16	01/09/2008	10:24:10		78	35.28	9	27.3
17	01/09/2008	10:35:00		78	36.65	9	25.98
18	01/09/2008	10:36:00		78	36.78	9	25.83
19	01/09/2008	10:37:20		78	36.95	9	25.65
20	01/09/2008	10:38:10		78	37.06	9	25.49
21	01/09/2008	10:38:40		78	37.13	9	25.37
22	01/09/2008	10:39:20		78	37.2	9	25.3
23	01/09/2008	10:40:00		78	37.27	9	25.21
24	01/09/2008	10:40:40		78	37.35	9	25.09
25	01/09/2008	10:42:00		78	37.5	9	24.87
26	01/09/2008	10:44:40		78	37.71	9	24.57
27	01/09/2008	11:14:50		78	39.68	9	25.11
28	01/09/2008	11:15:40		78	39.58	9	25.13
29	01/09/2008	11:17:30		78	39.4	9	25.13
30	01/09/2008	11:18:20		78	39.29	9	25.18
31	01/09/2008	11:29:40		78	37.96	9	26.43
32	01/09/2008	12:28:00		78	32.36	9	32.28
33	01/09/2008	12:56:00		78	35.12	9	27.46
34	01/09/2008	12:58:40		78	35.3	9	26.99
35	01/09/2008	13:11:30		78	35.09	9	27.38
36	01/09/2008	16:18:00		78	36.43	9	31.36
37	01/09/2008	17:09:20		78	32.61	9	37.75
38	01/09/2008	17:12:37		78	32.82	9	37.42
39	01/09/2008	17:57:50		78	36.66	9	25.93
40	01/09/2008	17:59:00		78	36.78	9	25.8
41	01/09/2008	19:57:00		78	31.77	9	33.1
42	01/09/2008	19:59:50		78	31.59	9	34.41
43	01/09/2008	20:00:30		78	31.53	9	34.63
44	01/09/2008	20:02:30		78	31.29	9	35.12
45	01/09/2008	20:03:00		78	31.23	9	35.14
46	01/09/2008	20:08:40		78	30.53	9	35.61

Number	Date	Time (UTC)	Ping	Lat_deg N	Lat_min	Lon-deg E	Lon_min
47	01/09/2008	20:10:20		78	30.31	9	35.82
48	01/09/2008	20:14:30		78	29.8	9	36.5
49	01/09/2008	20:16:25	6008	78	29.58	9	36.85
50	01/09/2008	21:06:41	7439	78	28.97	9	40.77
51	01/09/2008	21:09:57	7526	78	29.37	9	40.39
52	01/09/2008	21:19:56	7815	78	30.76	9	38.31
53	01/09/2008	21:34:10	8201	78	32.14	9	38.72
54	01/09/2008	21:55:34	8818	78	29.69	9	41.95
55	01/09/2008	22:00:16	8958	78	29.14	9	42.98
58	04/09/2008	07:03:31	881	78	36.63	9	25.98
59	04/09/2008	07:05:55	946	78	36.78	9	25.83
60	04/09/2008	07:08:55	1026	78	36.94	9	25.62
61	04/09/2008	07:11:23	1092	78	37.08	9	25.41
62	04/09/2008	09:00:52	4050	78	36.98	9	25.74
63	04/09/2008	09:02:11	4085	78	36.88	9	25.85
64	04/09/2008	09:02:49	4102	78	36.81	9	25.88
65	04/09/2008	09:19:37	4557	78	35.3	9	27.29
66	04/09/2008	09:23:38	4664	78	35.11	9	27.3
67	05/09/2008	16:13:16	7227	78	39.39	9	41.84
68	05/09/2008	16:14:29	7252	78	39.36	9	41.42
69	05/09/2008	16:53:21	8078	78	38.1	9	26.93
70	05/09/2008	16:54:14	8097	78	38.07	9	26.6
71	05/09/2008	16:54:52	8111	78	38.04	9	26.37
72	05/09/2008	16:55:26	8123	78	38.02	9	26.16
73	05/09/2008	17:01:00	8242	78	37.82	9	24.13
74	06/09/2008	00:44:32	4460	78	33.06	9	28.73
75	06/09/2008	00:46:17	4487	78	33.09	9	29.43
76	06/09/2008	00:47:32	4506	78	33.12	9	29.93
77	06/09/2008	01:36:37	5673	78	33.66	9	48.6
78	06/09/2008	09:08:31	2486	78	25.4	9	50.77
79	06/09/2008	09:12:56	2590	78	25.43	9	52.57
80	06/09/2008	09:51:06	3672	78	23.18	9	56.35
81	06/09/2008	16:57:37	10887	78	28.38	9	44.47
82	06/09/2008	17:02:18	10982	78	28.46	9	46.28
83	06/09/2008	17:02:46	10991	78	28.47	9	46.45
84	06/09/2008	17:09:20	11125	78	28.6	9	48.96
85	06/09/2008	17:16:29	11270	78	29	9	50.93
86	06/09/2008	17:18:15	11307	78	29.14	9	51.12
87	06/09/2008	18:13:17	12422	78	32.98	9	45.25
88	06/09/2008	18:14:28	12446	78	32.98	9	44.79
89	06/09/2008	18:14:51	12454	78	32.98	9	44.65
90	06/09/2008	18:15:09	12460	78	32.98	9	44.54
91	06/09/2008	18:15:42	12471	78	32.97	9	44.34
92	06/09/2008	18:16:12	12481	78	32.95	9	44.17
93	06/09/2008	18:16:55	12500	78	32.93	9	43.93
94	06/09/2008	18:17:11	12507	78	32.92	9	43.84
95	06/09/2008	18:17:47	12524	78	32.889	9	43.67
96	06/09/2008	18:19:01	12559	78	32.82	9	43.35
97	06/09/2008	18:19:28	12571	78	32.8	9	43.24
98	06/09/2008	18:20:17	12593	78	32.76	9	43
99	06/09/2008	18:33:46	12971	78	32.41	9	37.93
100	07/09/2008	01:18:09	19813	78	35.25	9	23.42
101	07/09/2008	01:29:45	20016	78	35.53	9	27.52
102	07/09/2008	02:42:59	22024	78	39.29	9	44.02
103	07/09/2008	02:44:09	22055	78	39.38	9	43.89
104	07/09/2008	03:24:58	23206	78	39.52	9	28.24
105	07/09/2008	03:25:51	23232	78	39.51	9	28.13
106	07/09/2008	03:29:56	23345	78	39.45	9	26.49
107	07/09/2008	03:32:12	23406	78	39.42	9	25.57
108	07/09/2008	03:33:27	23440	78	39.41	9	25.07
109	07/09/2008	12:53:48	5052	78	45.93	9	35.64
110	07/09/2008	12:54:19	5066	78	45.96	9	35.78
111	07/09/2008	13:25:46	5958	78	47.93	9	43.66
112	07/09/2008	13:26:06	5967	78	47.95	9	43.74
113	07/09/2008	13:26:55	5989	78	48	9	43.95
114	07/09/2008	16:06:12	10374	78	48.45	9	42.9
115	07/09/2008	16:06:57	10394	78	48.45	9	42.58
116	07/09/2008	16:08:09	10427	78	48.44	9	42.08

Number	Date	Time (UTC)	Ping	Lat_deg N	Lat_min	Lon-deg E	Lon_min
117	07/09/2008	16:11:28	10522	78	48.43	9	40.72
118	07/09/2008	16:11:44	10530	78	48.42	9	40.61
119	07/09/2008	16:23:07		78	48.37	9	36.02
120	08/09/2008	08:27:08	6892	78	37.78	9	23.65
121	08/09/2008	08:28:17	6917	78	37.82	9	24.07
122	08/09/2008	08:33:53	7040	78	38.01	9	26.16
123	08/09/2008	08:34:31	7058	78	38.04	9	29.37
124	08/09/2008	08:35:45	7093	78	38.12	9	26.66
125	08/09/2008	08:36:54	7125	78	38.2	9	26.78
126	08/09/2008	08:37:14	7134	78	38.23	9	26.79
127	08/09/2008	08:37:55	7152	78	38.28	9	26.75
128	08/09/2008	08:38:59	7182	78	38.36	9	26.58
129	08/09/2008	08:40:21	7220	78	38.43	9	26.2
130	08/09/2008	08:41:56	7264	78	38.46	9	25.61
131	09/09/2008	02:35:04	11215	78	38.19	9	24.36
132	09/09/2008	02:36:54	11264	78	38.09	9	24.49
133	09/09/2008	02:38:21	11303	78	38.01	9	24.63
134	09/09/2008	02:41:44	11393	78	37.82	9	24.93
135	09/09/2008	02:46:27	11522	78	37.55	9	25.32
136	09/09/2008	02:52:53	11694	78	37.19	9	25.84
137	09/09/2008	02:58:55	11860	78	36.86	9	25.91
26a	01/09/2008	10:44:40		78	37.77	9	24.48
30a	01/09/2008	11:20:58		78	39	9	25.36
30b	01/09/2008	11:22:59		78	38.77	9	25.57
30c	01/09/2008	11:27:15		78	38.28	9	26.01
32a	01/09/2008	12:29:23		78	32.53	9	32.05
32b	01/09/2008	12:31:06		78	32.73	9	31.76
35a	01/09/2008	15:50:50		78	39.7	9	27.6
37a	01/09/2008	17:09:46		78	32.67	9	37.66
37b	01/09/2008	17:10:19		78	32.73	9	37.55
37c	01/09/2008	17:10:47		78	32.79	9	37.47
38a	01/09/2008	17:11:31		78	32.87	9	37.34
40a	01/09/2008	19:48:16		78	32.41	9	29.11
46a	01/09/2008	20:09:11		78	30.46	9	35.67
46b	01/09/2008	20:09:49		78	30.38	9	35.75
138	09/09/2008	02:59:41	11883	78	36.81	9	25.92
139	09/09/2008	03:02:28	11956	78	36.65	9	25.89
140	09/09/2008	03:17:08	12360	78	35.78	9	26.58
141	09/09/2008	03:18:56	12400	78	35.7	9	26.66
142	09/09/2008	03:25:42	12579	78	35.38	9	27.08
143	09/09/2008	03:26:41	12605	78	35.33	9	27.11
144	09/09/2008	03:30:17	12698	78	35.15	9	27.23
145	09/09/2008	03:31:17	12725	78	35.1	9	27.27
146	09/09/2008	03:33:21	12779	78	35	9	27.36
147	09/09/2008	03:34:33	12811	78	34.95	9	27.41
148	09/09/2008	03:35:49	12844	78	34.89	9	27.46
149	09/09/2008	03:37:46	12896	78	34.79	9	27.54
150	09/09/2008	03:39:58	12955	78	34.68	9	27.62
151	09/09/2008	03:40:59	12982	78	34.63	9	27.67
152	09/09/2008	03:42:18	13019	78	34.57	9	27.76
153	09/09/2008	03:43:43	13058	78	34.51	9	27.86
154	09/09/2008	03:46:34	13134	78	34.37	9	28.03
155	09/09/2008	03:53:52	13330	78	34.02	9	28.36
156	09/09/2008	03:58:26	13452	78	33.79	9	28.59
157	09/09/2008	03:59:52	13490	78	33.71	9	28.65
158	09/09/2008	04:03:38	13591	78	33.52	9	28.83
159	09/09/2008	04:06:27	13668	78	33.37	9	28.95
160	09/09/2008	04:09:02	13737	78	33.23	9	29.08
161	09/09/2008	04:11:08	13793	78	33.12	9	29.17
162	09/09/2008	04:16:16	13927	78	32.84	9	29.72
163	09/09/2008	06:05:06	16864	78	38.06	9	27.68
164	09/09/2008	06:06:00	16886	78	38.11	9	27.61
165	09/09/2008	06:22:08	17323	78	39.01	9	26.17
166	09/09/2008	06:22:57	17344	78	39.05	9	26.06
167	09/09/2008	06:23:40	17366	78	39.08	9	25.92
168	09/09/2008	06:27:29	17468	78	39.21	9	24.93
169	10/10/2008	07:40:07	13094	79	23.78	8	9.35
170	11/09/2008	00:11:02	8525	79	0.43	6	54.13

Number	Date	Time (UTC)	Ping	Lat_deg N	Lat_min	Lon-deg E	Lon_min
~~171~~	~~12/09/2008~~	~~09:52:00~~	~~4391~~	~~78~~	~~35.31~~	~~8~~	~~59.82~~
172	16/09/2008	20:16:35	778	78	32.6	9	29.93
173	16/09/2008	20:17:24	800	78	32.56	9	29.79
174	16/09/2008	22:22:34	3772	78	34.11	9	37.8
175	16/09/2008	22:50:23	4408	78	33.2	9	29.41
176	16/09/2008	23:26:39	5303	78	33.15	9	30.07
177	17/09/2008	01:24:52	8372	78	36.19	9	31.62
178	17/09/2008	04:21:41	12470	78	32.37	9	32.16
179	17/09/2008	04:21:57	12478	78	32.41	9	32.23
180	17/09/2008	07:04:52	17043	78	39.44	9	28.17
181	17/09/2008	07:05:05	17049	78	39.48	9	25.11
182	17/09/2008	08:25:04	915	78	39.62	9	25.18
183	17/09/2008	08:27:39	982	78	39.5	9	25.25
184	17/09/2008	08:30:14	1049	78	39.35	9	25.28
185	17/09/2008	08:32:25	1109	78	39.21	9	25.3
186	17/09/2008	08:33:13	1134	78	39.16	9	25.33
187	17/09/2008	08:39:59	1313	78	38.78	9	25.61
188	17/09/2008	08:48:21	1538	78	38.31	9	26.18
189	17/09/2008	08:49:40	1574	78	38.23	9	26.23
190	17/09/2008	10:10:14	911	78	38.14	9	26.99
191	17/09/2008	10:12:14	969	78	38.25	9	26.82
192	17/09/2008	10:12:50	986	78	38.29	9	26.76
193	17/09/2008	10:14:07	1024	78	38.36	9	26.66
194	17/09/2008	10:15:00	1050	78	38.42	9	26.59
195	17/09/2008	10:16:47	1099	78	38.52	9	26.45
196	17/09/2008	10:18:13	1139	78	38.61	9	26.35
197	17/09/2008	10:19:29	1176	78	38.69	9	26.3
198	17/09/2008	10:20:19	1199	78	38.75	9	26.25
199	17/09/2008	10:21:09	1224	78	38.8	9	26.21
200	17/09/2008	10:22:00	1250	78	38.86	9	26.16
201	17/09/2008	10:22:40	1270	78	38.9	9	26.12
202	17/09/2008	10:23:42	1301	78	38.96	9	26.05
203	17/09/2008	10:24:30	1324	78	39.01	9	26.01
204	17/09/2008	10:26:19	1376	78	39.12	9	25.93
205	17/09/2008	10:27:11	1402	78	39.17	9	25.29
206	17/09/2008	10:28:03	1428	78	39.22	9	25.91
207	17/09/2008	10:30:25	1494	78	39.37	9	25.87
208	17/09/2008	12:34:04	2529	78	39.33	9	26.38
209	17/09/2008	12:34:52	2553	78	39.37	9	26.35
210	17/09/2008	12:36:57	2613	78	39.48	9	26.31
211	17/09/2008	12:37:48	2638	78	39.52	9	26.29
212	17/09/2008	12:38:18	2653	78	39.54	9	26.28
213	17/09/2008	12:39:04	2676	78	39.58	9	26.28
214	17/09/2008	12:41:32	2750	78	39.71	9	26.26
215	17/09/2008	12:42:18	2773	78	39.74	9	26.25
216	17/09/2008	12:43:08	2798	78	39.79	9	26.23
217	17/09/2008	12:44:08	2828	78	39.83	9	26.2
218	17/09/2008	12:46:40	2902	78	39.95	9	26.05
219	17/09/2008	13:51:19	1300	78	39.31	9	27.16
220	17/09/2008	13:51:47	1314	78	39.27	9	27.18
221	17/09/2008	14:51:34	544	78	38.25	9	26.88
222	17/09/2008	14:52:22	568	78	38.29	9	26.82
223	17/09/2008	14:53:50	614	78	38.36	9	26.69
234	17/09/2008	14:54:41	638	78	38.4	9	26.61
235	17/09/2008	14:55:28	659	78	38.44	9	26.54
236	17/09/2008	14:57:01	705	78	38.51	9	26.42
237	17/09/2008	14:57:53	731	78	38.56	9	26.4
238	17/09/2008	14:58:59	764	78	38.61	9	26.4
239	17/09/2008	15:03:01	887	78	38.81	9	26.23
240	17/09/2008	15:05:59	975	78	38.95	9	26.09
241	17/09/2008	15:06:31	989	78	38.98	9	26.06
242	17/09/2008	15:07:31	1016	78	39.02	9	26.02
243	17/09/2008	15:09:12	1067	78	39.1	9	25.95
244	17/09/2008	15:10:15	1099	78	39.15	9	25.92
245	17/09/2008	15:11:36	1140	78	39.22	9	25.88
246	17/09/2008	15:12:18	1161	78	39.25	9	25.86
247	17/09/2008	15:14:38	1234	78	39.36	9	25.82
248	17/09/2008	16:39:30	3555	78	39.59	9	25.61

Number	Date	Time (UTC)	Ping	Lat_deg N	Lat_min	Lon-deg E	Lon_min
249	17/09/2008	16:40:04	3572	78	39.54	9	25.65
250	17/09/2008	16:41:58	3601	78	39.46	9	25.7
251	17/09/2008	16:42:06	3634	78	39.37	9	25.76
252	17/09/2008	16:43:31	3677	78	39.26	9	25.84
253	17/09/2008	16:43:54	3688	78	39.23	9	25.86
254	17/09/2008	16:44:39	3711	78	39.16	9	25.9
255	17/09/2008	16:45:15	3728	78	39.11	9	25.94
256	17/09/2008	16:46:09	3753	78	39.04	9	25.99
257	17/09/2008	16:46:47	3771	78	38.99	9	26.03
258	17/09/2008	16:47:07	3782	78	38.96	9	26.05
259	17/09/2008	16:48:21	3820	78	38.85	9	26.11
260	17/09/2008	16:48:43	3831	78	38.82	9	26.13
261	17/09/2008	16:49:07	3843	78	38.79	9	26.15
262	17/09/2008	16:49:45	3862	78	38.74	9	26.19
263	17/09/2008	16:50:21	3880	78	38.69	9	26.22
264	17/09/2008	16:50:43	3891	78	38.67	9	26.24
265	17/09/2008	16:51:15	3907	78	38.62	9	26.27
266	17/09/2008	16:52:34	3946	78	38.52	9	26.36
267	17/09/2008	16:53:18	3970	78	38.46	9	26.4
268	17/09/2008	16:53:36	3979	78	38.43	9	26.42
269	17/09/2008	16:53:52	3987	78	38.41	9	26.44
270	17/09/2008	16:54:28	4005	78	38.36	9	26.49
271	17/09/2008	16:55:31	4037	78	38.26	9	26.61
272	17/09/2008	16:55:52	4048	78	38.24	9	26.64
273	17/09/2008	17:09:04	80	78	38.05	9	26.74
274	17/09/2008	17:11:21	150	78	38.24	9	26.53
275	17/09/2008	17:11:44	161	78	38.27	9	26.5
276	17/09/2008	17:13:13	206	78	38.38	9	26.35
277	17/09/2008	17:13:41	220	78	38.42	9	26.31
278	17/09/2008	17:14:11	235	78	38.46	9	26.27
279	17/09/2008	17:17:16	328	78	38.71	9	26.11
280	17/09/2008	17:18:15	357	78	38.79	9	26.05
281	17/09/2008	17:19:02	382	78	38.85	9	26
282	17/09/2008	17:19:31	397	78	38.89	9	25.96
283	17/09/2008	17:19:59	410	78	38.93	9	25.93
284	17/09/2008	17:21:39	458	78	39.07	9	25.83
285	17/09/2008	17:22:09	474	78	39.11	9	25.81
286	17/09/2008	17:22:35	487	78	39.15	9	25.8
287	17/09/2008	17:22:53	496	78	39.17	9	25.78
288	17/09/2008	17:23:30	515	78	39.22	9	25.74
289	17/09/2008	17:23:52	526	78	39.25	9	25.72
290	17/09/2008	17:35:57	587	78	39.43	9	25.62
291	17/09/2008	17:26:22	599	78	39.46	9	25.6
292	17/09/2008	17:27:18	628	78	39.54	9	25.55
293	17/09/2008	17:34:03	830	78	39.69	9	25.31
294	17/09/2008	17:34:57	858	78	39.63	9	25.3
295	17/09/2008	17:36:09	894	78	39.53	9	25.37
296	17/09/2008	17:37:17	928	78	39.43	9	25.45
297	17/09/2008	17:39:03	981	78	39.27	9	25.56
298	17/09/2008	17:39:31	995	78	39.23	9	25.58
299	17/09/2008	17:40:23	1021	78	39.16	9	25.62
300	17/09/2008	17:41:58	1070	78	39.04	9	25.72
301	17/09/2008	17:43:42	1120	78	38.9	9	25.8
302	17/09/2008	17:44:27	1142	78	38.84	9	25.84
303	17/09/2008	17:45:19	1168	78	38.77	9	25.91
304	17/09/2008	17:45:56	1186	78	38.71	9	25.95
305	17/09/2008	17:46:32	1204	78	38.67	9	25.97
306	17/09/2008	17:47:57	1246	78	38.55	9	26.06
307	17/09/2008	17:48:24	1260	78	38.51	9	26.1
308	17/09/2008	17:49:14	1285	78	38.43	9	26.15
309	17/09/2008	17:49:34	1295	78	38.4	9	26.18
310	17/09/2008	17:50:01	1309	78	38.36	9	26.2
311	17/09/2008	17:51:05	1341	78	38.27	9	26.27
312	17/09/2008	17:51:44	1361	78	38.22	9	26.35
313	17/09/2008	17:53:42	1421	78	38.06	9	26.6
314	17/09/2008	17:54:53	1457	78	37.96	9	26.72
315	17/09/2008	18:04:03	1734	78	37.96	9	26.42
316	17/09/2008	18:06:47	79	78	38.2	9	26.06

Number	Date	Time (UTC)	Ping	Lat_deg N	Lat_min	Lon-deg E	Lon_min
317	17/09/2008	18:07:37	104	78	38.27	9	26.01
318	17/09/2008	18:12:27	249	78	38.65	9	25.84
319	17/09/2008	18:13:57	294	78	38.77	9	25.77
320	17/09/2008	18:14:15	303	78	38.8	9	25.76
321	17/09/2008	18:14:33	312	78	38.82	9	25.74
322	17/09/2008	18:15:09	330	78	38.87	9	25.71
323	17/09/2008	18:16:10	361	78	38.96	9	25.65
324	17/09/2008	18:17:00	387	78	39.03	9	25.6
325	17/09/2008	18:18:51	441	78	39.19	9	25.47
326	17/09/2008	18:19:35	463	78	39.25	9	25.44
327	17/09/2008	18:22:15	544	78	39.47	9	25.33
328	17/09/2008	18:22:53	563	78	39.52	9	25.32
329	17/09/2008	18:24:01	596	78	39.61	9	25.28
330	17/09/2008	18:24:47	619	78	39.68	9	25.26
331	17/09/2008	18:29:51	768	78	39.83	9	26.07
332	17/09/2008	18:36:36	958	78	39.36	9	25.86
333	17/09/2008	18:37:04	972	78	39.32	9	25.86
334	17/09/2008	22:25:05	3329	78	39.01	9	25.88
335	17/09/2008	22:26:56	3412	78	38.95	9	25.89
336	17/09/2008	22:27:40	3434	78	38.89	9	25.91
337	17/09/2008	22:28:08	3449	78	38.84	9	25.96
338	17/09/2008	22:28:41	3466	78	38.79	9	26.06
339	17/09/2008	22:29:48	3498	78	38.67	9	26.34
340	17/09/2008	22:34:12	3630	78	38.11	9	27.73
341	17/09/2008	22:34:30	3639	78	38.07	9	27.84
342	17/09/2008	23:08:27	4661	78	32.89	9	34.49
343	17/09/2008	23:08:53	4674	78	32.83	9	37.55
344	17/09/2008	23:09:37	4696	78	32.71	9	37.69
345	17/09/2008	23:10:02	4709	78	32.64	9	37.76
346	17/09/2008	23:25:14	5169	78	32.87	9	43.69
347	17/09/2008	23:25:54	5191	78	32.91	9	43.87
348	17/09/2008	23:27:12	5229	78	32.99	9	44.24
349	17/09/2008	23:30:32	5331	78	33.02	9	45.26
350	17/09/2008	23:42:13	5681	78	33.15	9	44.56
351	18/09/2008	02:25:25	10582	78	34.01	9	29.43
352	18/09/2008	02:26:09	10604	78	34.07	9	28.74
353	18/09/2008	08:44:11	232	78	39.62	9	26
354	18/09/2008	08:44:49	251	78	39.57	9	26.04
355	18/09/2008	08:45:46	280	78	39.49	9	26.1
356	18/09/2008	08:47:01	317	78	39.39	9	26.2
357	18/09/2008	08:47:49	341	78	39.32	9	26.26
358	18/09/2008	09:00:46	728	78	38.24	9	27.17
359	18/09/2008	09:01:14	742	78	38.2	9	27.2
360	18/09/2008	09:13:16	1087	78	37.83	9	27.76
361	18/09/2008	09:32:49	563	78	39.46	9	26.4
362	18/09/2008	09:33:32	584	78	39.52	9	26.34
363	18/09/2008	09:34:07	602	78	39.57	9	26.29
364	18/09/2008	09:35:01	629	78	39.64	9	26.23
365	18/09/2008	09:35:26	642	78	39.68	9	26.2
366	18/09/2008	09:36:44	681	78	39.78	9	26.11
367	18/09/2008	10:00:03	1329	78	39.51	9	25.96
368	18/09/2008	10:01:13	1364	78	39.41	9	26.06
369	18/09/2008	10:02:09	1392	78	39.32	9	26.13
370	18/09/2008	10:15:43	1797	78	38.22	9	27.05
371	18/09/2008	10:47:19	2754	78	39.77	9	26.43
372	18/09/2008	10:48:27	2788	78	39.86	9	26.37
373	18/09/2008	15:15:06	7194	77	58.58	9	26.37

END OF FILE