CRUISE REPORT

RRS JAMES CLARK ROSS 269A

Arctic Hydrate Dissociation as a Consequence of Climate Change: Determining the vulnerable methane reservoir and gas escape mechanisms

27th August-5th September 2011

Longyearbyen-Longyearbyen

Compiled by T. A. Minshull
National Oceanography Centre Southampton
University of Southampton Waterfront Campus
Southampton SO14 3ZH

Contents **Page Number**

1. SUMMARY

The main goal of cruise JR269A was to use the Ifremer deep-towed low-frequency Chrip profile SYSIF and a high-resolution seismic reflection system to image gas transport structures and their geological setting beneath areas of active escape of methane gas into the ocean through the methane hydrate stability zone and at and close to the landward limit of the hydrate stability zone. These zones of gas escape were identified during RRS James Clark Ross cruise 211 in 2008 and have received further investigation during several subsequent cruises. Subsidiary goals were to determine in detail the seismic velocity structure of the regions imaged using ocean bottom seismometers, and to fully test the refurbished DASI deep-towed electromagnetic source by conducting a controlled source electromagnetic profile across three seabed electromagnetic recorders. Work was focused in two areas: a southern area close to the landward limit of the hydrate stability field, and a smaller northern area around a large pockmark on the Vestnesa Ridge sediment drift.

The cruise was highly successful; the weather was very good, the ship performed well, and there was very little downtime. Spectacular images were obtained with SYSIF and the high-resolution reflection system also performed well. Both survey areas revealed a great deal of complexity.

In the northern area, active gas escape was observed at multiple sites both at the summit of the ridge and on its flanks. In addition to a central large pipe-like structure, ~ 100 m across (CHECK), numerous narrower sub-vertical conduits were observed in the SYSIF data. Many of these were not visible in the lower-frequency seismic reflection profile acquired in 2008. Some show evidence of reflector displacement across them, suggesting that gas escape is following pre-existing fault structures. Numerous high-amplitude diffractive events suggest the presence of small pockets of trapped gas.

In the southern area, a range of subsurface features was imaged in a region of the slope where profiles from the lower-frequency system used in 2008 show very little. Reflectors are commonly discontinuous, and profiles spaced 1 km apart or less show significant variations from profile to profile. In the region of active gas venting to the atmosphere discovered during the immediately previous cruise JR253, high-amplitude dipping reflectors imaged beneath a thin glacial till layer appear to be carrying gas from depth and may connect to similar pre-glacial reflectors beneath the slope.

2. SCIENTIFIC PARTY

Tim Minshull (PSO)	University of Southampton
Martin Sinha	University of Southampton
Graham Westbrook	University of Southampton/Ifremer
Simon Dean	University of Southampton
Mark Vardy	University of Southampton
John Davis	University of Southampton
Sudipta Sarkar	University of Southampton
Hector Moreno	University of Southampton
Angus Best	National Oceanography Centre
Veit Hühnerbach	National Oceanography Centre
Andy Webb	National Oceanography Centre
Neil Sloan	National Oceanography Centre
Bruno Marsset	Ifremer
Stephane Ker	Ifremer
Henri Martinossi	Ifremer
Pierre Leon	Ifremer
Laurent Artzner	Ifremer
Yannick Thomas	Ifremer
Jean-Pierre Regnault	Ifremer
Jean-Luc Le Philippe	Genavir
Indika Samarakoon	OBIC, University of Southampton
Alan Burchell	OBIC, University of Durham
Anupama Rajan	University of Tromsoe
Julian Klepacki	British Antarctic Survey
Doug Willis	British Antarctic Survey

3. SHIP'S COMPANY

Michael (Jerry) Burgan	Master
Joanna Cox	Chief Officer
Wendy O'Donnell	2nd Officer
Spencer Wyles	3rd Officer
Michael Gloistein	ETO Comms
David Peck	Scientific Deck Officer
Duncan Anderson	Chief Engineer
Thomas Elliott	2nd Engineer
James Stevenson	3rd Engineer
Robert Couper	4th Engineer
Gareth Wale	Deck Engineer
Alex Strange	ETO Engineer
Richard Turner	Purser
Albert Bowen	Bosun
Kelvin Chappell	Bosun's Mate
George Dale	Seaman
Ian Raper	Seaman
David Triggs	Seaman
John Dunne	Seaman
David Phillips	Seaman
Matthew Ashworth	Motorman

Philip Hansen	Motorman
Ashley Huntley	Chief Cook
Jamie Lee	2nd Cook
Lee Jones	Senior Steward
Nicholas Greenwood	Steward
Graham Raworth	Steward
Glyndor Henry	Steward

4. SHIP AND SCIENTIFIC EQUIPMENT PERFORMANCE

The vessel performance was excellent and overall there were very few problems with scientific equipment and little downtime. The longest period of downtime resulted from leakage in the high-voltage cable termination bottle that required remaking the termination and about 12 hours of delay whilst this was done; about half of this time was usefully employed in collecting surface seismic data. The following minor issues arose:

1. The after-deck and starboard deck were very crowded with equipment, which meant that it was difficult to move equipment around without a crane. Much of this equipment was not required for the cruise; it would have been better if at least some of it had been stored elsewhere on the ship or onshore in Longyearbyen for the duration of the cruise.
2. The stern A-frame developed an electrical fault that took about 3 hours to resolve; this was the only science time lost due to problems with the vessel.
3. Because of problems with HyBIS on JR253, a transformer in the clean chemistry container had become a critical part of the HyBIS power supply. This container occupied a space on deck that would have been used for the SYSIF container.
4. Although it had been repeatedly emphasised during cruise planning that the McCartney winch driver would need to sit next to each of the three teams (for HyBIS, DASI and SYSIF) deploying vehicles near the seabed, and therefore that the winch driver would need to be able to move between the three areas where the shipboard controls of these vehicles were mounted, in fact this was not possible because of limited cable lengths. The winch control was beside the HyBIS controls but on the opposite side of the UTC lab from the SYSIF and DASI controls. The problem was overcome by setting up a monitor next to the winch control point with a repeat of key SYSIF and DASI displays.
5. Track lines loaded into the USBL system were displayed incorrectly above a certain zoom level, so that the vessel location relative to the desired track line was different from the location seen in the Bridge navigation system. This issue sometimes caused confusion between the scientific party and the Bridge. A workaround was devised which involved loading additional waypoints into the USBL system, or sticking to a lower zoom level.

5. CRUISE NARRATIVE

All times below are local.

Thursday 25th August (237)

RRS James Clark Ross arrived alongside in Longyearbyen, the scientific party of cruise JR253 disembarked and most of the scientific party of cruise JR269A boarded. Much of the day was spent moving equipment for JR253 to the hold, and equipment for JR269A from the hold to the afterdeck. The clean chemistry container had been discovered to be an essential element of HyBIS operation because of the additional transformer that it provided. This container occupied a space that would have been occupied by the IFREMER container. Therefore the IFREMER container had to be unpacked on the dockside and the empty container returned to the hold. The vessel moved away from the dockside at 1530, a few miles down the fjord from Longyearbyen.

Friday 26th August (238)

The vessel returned close to Longyearbyen to board the remainder of the scientific party by boat transfer at 0900. Preparation of scientific equipment continued, and a meeting was held to discuss the use of high-voltage scientific equipment during the cruise. Given the good sea state in the work area, by early evening equipment was judged to be ready enough to complete the passage to the work area. The vessel departed Longyearbyen around 2030.

Saturday 27th August (239)

We arrived in the first work area during the night and commenced science at 0800 with a CTD, followed by an acoustic release test, an XBT and an XSV to provide velocity information for the USBL and for the swath system. The sea was flat calm. Deck tests on SYSIF revealed a number of problems attributed to excessive vibration during shipping. While these issues were being dealt with, two swath profiles were completed in regions of noisy data from the JR211 survey, and a brief towing test of the multichannel hydrophone streamer was completed. Finally at 1930 SYSIF was ready for deployment (with its larger, lower-frequency transducer). Various further issues arose once SYSIF was deployed and most of these were solved, but the USBL navigation, used in an unfamiliar triggered mode, did not work. SYSIF was lowered to its profiling depth and a short profile (Line 1a) acquired without USBL navigation, and then SYSIF work was abandoned for the night at 2300 because a limit on hours of work was reached.

Sunday 28th August (240)

During the night a further swath survey was completed, covering areas of noisy data from JR211. At 0800 SYSIF deployment commenced, and this time the USBL was used in its normally mode of acoustic transponding. Previous experience with SYSIF had been that this mode suffered from interference from the SYSIF source, but in fact the USBL worked very well. SYSIF profiling therefore continued throughout the day and most of the night. There was a little bit of wind but the swell remained very small.

Monday 29th August (241)

At 0500 SYSIF recovery began. The fibre-optic cable was then switched to HyBIS and OBS deployments with HyBIS commenced. The HyBIS frame required some small modifications because the OBSs would not quite fit inside, but once these were completed the deployments went extremely smoothly, with OBSs dropped from about 3 m above the seabed and good video images of the seafloor, which in each case was muddy with a few stones. The whole operation took only just over an hour per instrument. One seafloor electromagnetic instrument was then assembled on deck and also deployed from HyBIS. The instrument assembly was much more time-consuming than for the OBSs, and this deployment took about three hours. In the evening SYSIF was re-deployed to complete the survey in the plume area. The sea state was flat calm.

Tuesday 30th August (242)

SYSIF profiling continued throughout the day, with no problems. The sea state remained flat calm.

Wednesday 31st August (243)

SYSIF profiling was completed at 0945. The remaining two electromagnetic instruments were deployed with HyBIS. During this time the weather deteriorated somewhat, though the swell was still only a couple of metres. We then began the seismic programme in the plume area. The first seismic profile showed a series of artifacts in the data that were the result of false triggering of the GI gun. Halfway through the second profile, the firing box failed. After a couple of hours the problem was diagnosed as due to incorrect connections in the firing system. The seismic survey was resumed and then continued through the night.

Thursday 1st September (244)

The seismic programme was completed at 0930, the OBSs recovered, and a transit to the Vesnesar site completed. A CTD, XBT and XSV were acquired and the velocity structure from the CTD was loaded into the swath and USBL systems. A decision was made to deploy only three OBSs at this site, to maximize the time available for SYSIF work. HyBIS was then launched for the first OBS deployment. However, an earth leakage problem was found, which was eventually tracked down to flooding of the opto-electric cable termination bottle.

Since repair of the bottle required re-potting and would take at least 6-8 hours, it was decided to deploy the OBSs using an alternative method of dropping from an acoustically navigated wire, using an acoustic release. The coring wire was set up for this purpose and the coring weight placed at the bottom to keep tension on the wire. The first OBS was acoustically released about 50 m from the seabed, but reappeared at the surface shortly after the end of the coring wire was recovered. The OBS was recovered, and it was found that the release pin had dropped out during deployment and the anchor weight had therefore fallen off. An attempt was made to deploy the second OBS, but this time the anchor weight fell off as the OBS entered the water, so the instrument was recovered immediately. The motion of the stern was causing large swings of the suspended instrument package as it entered the water. Therefore this deployment method was abandoned. Instead a programme of seismic profiling was commenced to make use of the time while the cable termination was being repaired.

Friday 2nd September (245)

Shooting eventually began at 0315 and continued until the cable termination was ready at around 0930; during this time most of the seismic programme planned for the Vesnesa area was completed. HyBIS was then re-connected to the new termination bottle and two OBSs were deployed. To save time, and since the imaging with SYSIF was ultimately more important than the detailed velocity constraints provided by additional OBSs, the other two OBS deployments were abandoned. The central seismic profile through the OBSs was then completed. SYSIF was prepared rapidly for launch, but the launch was delayed for about three hours whilst an electrical fault with the stern A-frame was diagnosed and resolved. SYSIF surveying began finally at around 2200.

Saturday 3rd September (246)

A truncated programme of lines with the lower-frequency SYSIF source was completed at around 1030 and SYSIF was recovered to switch to the smaller, higher-frequency transducer. While this work was going on, the two deployed OBSs were recovered, and during the ascent of the second one to the surface two OBS tubes were lowered to 800 m depth to test for leakage. Profiling with the higher-frequency SYSIF transducer commenced at 1530 and was completed at 2040.

Sunday 4th September (247)

DASI deployment began in our southern survey area shortly after midnight. The new deep-water high-voltage connectors were found to be faulty, so an alternative cable termination had to be constructed, which took several hours. A 15 km DASI profile was then completed without incident and DASI was recovered at around 1400. The seafloor electromagnetic instruments were then recovered; these had much slower rise rates than the seismic instruments, so recovery was not completed until around 1800. Three final seismic profiles were then acquired and gun and streamer recovery commenced at 2300. The vessel sailed for Longyearbyen at around 2330 and scientific data acquisition was terminated.

Sunday 5th September (248)

The vessel arrived in Longyearbyen early in the morning and was able to go alongside for demobilization at 1030.

6. NAVIGATION

Vessel navigation used GPS in non-differential mode. Several GPS receivers were logged, but the Seatex GPS was used as the primary device for scientific navigation. This receiver uses information from both the GPS and the GLONAS systems.

Acoustic navigation of HyBIS, SYSIF and DASI used a Sonardyne Fusion Ultra-Short-Baseline (USBL) acoustic positioning system. This system consist of a Fusion Data Engine, USBL transceiver, transponders and various inputs from other sensor packages such as GPS and attitude sensors. The transponders is interrogated acoustically or electrically, to which it then replies. The USBL system then provides a range and bearing estimate of the transponder relative to the ship's position. The transceiver was a Sonardyne Big-Head Transceiver Type 8023, with an acoustic cone of ±50°. The transponders were Sonardyne WideBand Sub-Mini Transponder Type 8070. Electrical interrogation was attempted during the first SYSIF deployment, but was not successful. For the remainder of the cruise, acoustic interrogation was used instead and worked well.

Because the scientific navigation and the navigation used by the Bridge were, for good reasons, independent systems, there were differences of up to 5-10 metres between the positions reported by the two systems.

7. ECHOSOUNDERS

7.1. Kongsberg EM122 Multibeam Echosounder (G. K. Westbrook)

The Kongsberg EM122 multibeam echosounder, newly installed in July 2011, was operated throughout the cruise and logged except whilst on station. The multibeam used a velocity function based on the initial CTD cast in each survey area. The system was primarily used only in seabed tracking mode in the southern area, because in the the water depths of that area, the signals from TOPAS sub-bottom profiler inteferes too strongly with those from targets in the water column. At the Vestnesa pockmark site, in water depths around 1200 m, there was very little interference from TOPAS, and the EM122 was also used in hydroacoustic mode to map bubble plumes within the water column.

The weather conditions during the cruise were good and the quality of the multibeam data was good, in consequence. Exceptions were when the ship was crabbing across the West Spitsbergen current while towing SYSIF at 2 knots, which caused bubbles to be draggged under the hull, and when the ship was running at 10 knots between the southern and Vestnesa areas during choppy sea conditions.

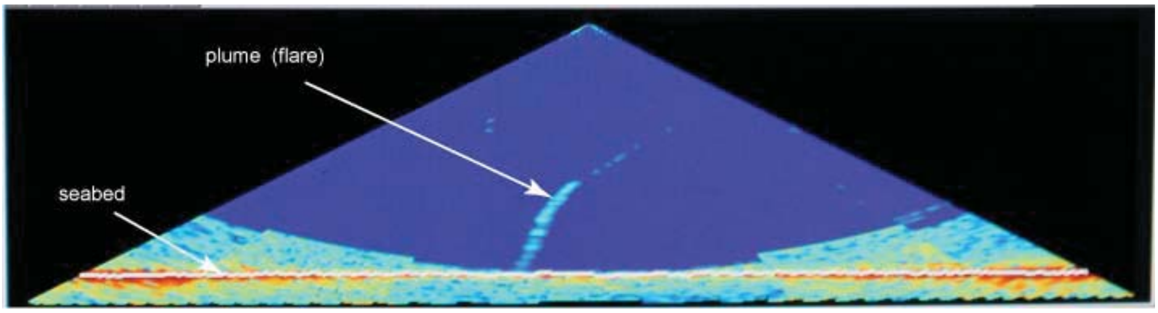


Figure 7.1: Screen image from the EM 122 of acoustic flare emanating from the seabed at a pockmark on the Vestnesa Ridge. Water depth approx 1200 m.

7.2. EM122 Data Processing (A. Chabert)

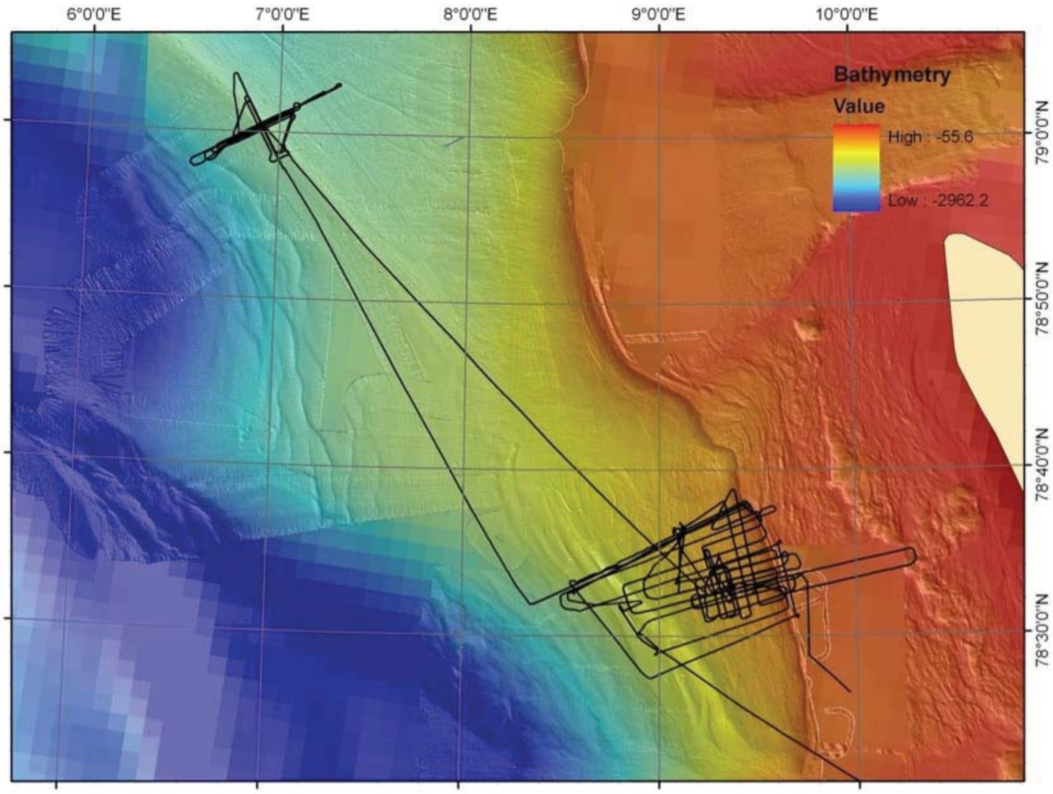


Figure 7.2: Navigation tracks of the JR269 cruise off Svalbard

The CARAIBES (CARtography Adapted to Imagery and BathymEtry of Sonars and *multibeam* echosounders) seabed mapping software from IFREMER was used to process bathymetry from multibeam data. Pre-processing included importing the data from the SIMRAD EM122 system (xx.all files) to CARAIBES (xx.mbb files).
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); and 20x20m grid for water depths greater than 500 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.

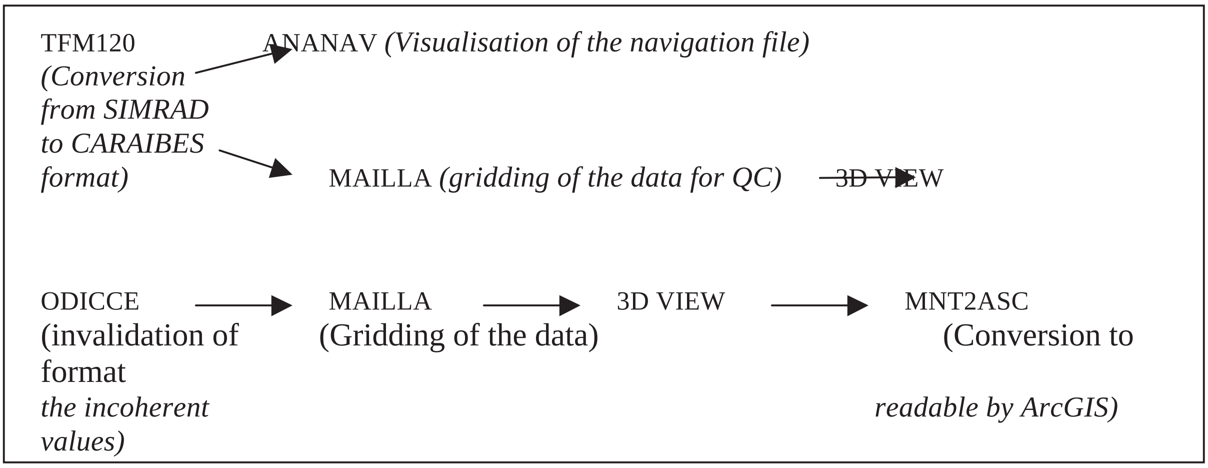


Figure 7.2: Processing flow applied on the EM120 multibeam data.

Processed data were of overall good quality apart from in the shallow areas, during short turns and bad weather condition. During JR269, 179 lines were processed.

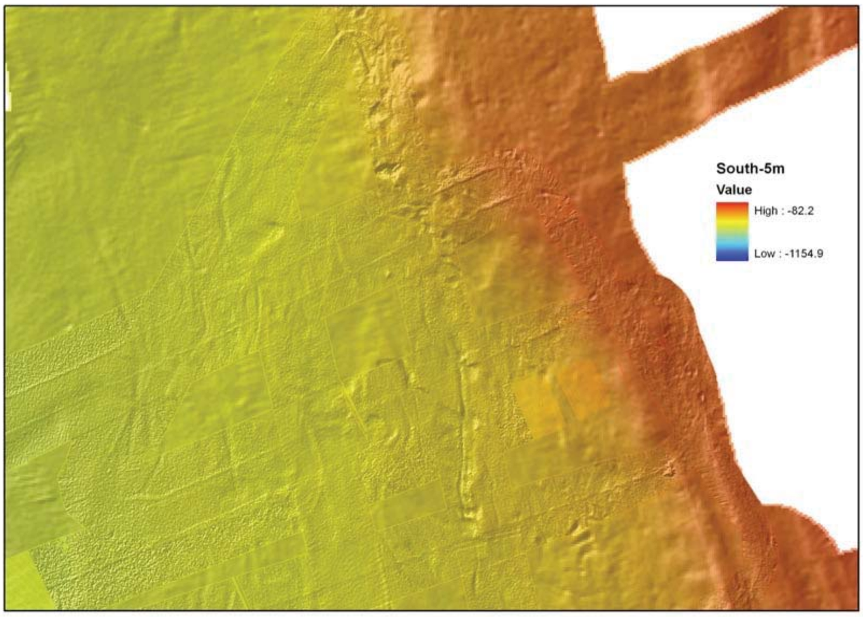


Figure 7.3: Bathymetric map from the JR269 cruise (with a 5m grid) superimposed on the JR211 20m grid.

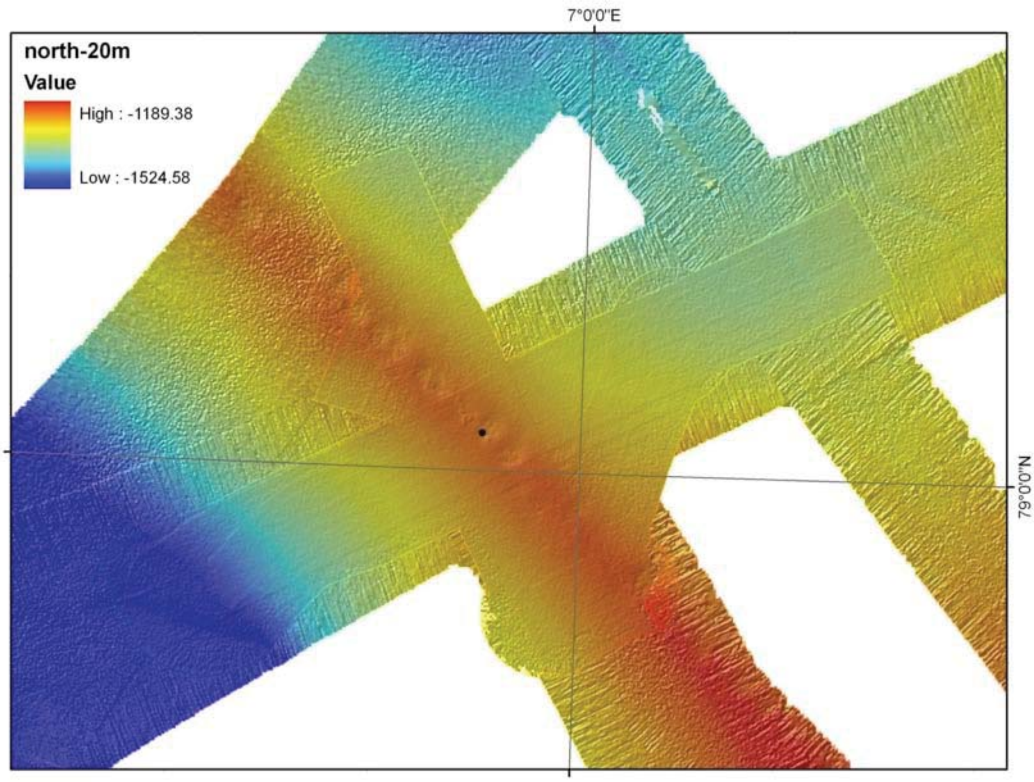


Figure 7.4: Bathymetric map from the JR269 cruise (20m grid) on the Vestnesa Ridge superimposed on a 20m grid from the JR211 cruise.

7.3. Kongsberg TOPAS PS18/15 sub-bottom profiler (G. K. Westbrook)

TOPAS was run for all the seismic and SYSIF survey lines and for some connecting lines between different areas. After tests of the different source types that TOPS can operate. a chirp source of 40 ms length, with a sweep from 1 kHz to 5 kHz was chosen. A matched filter a time variant gain, which reduced the amplitude of the seabed reflection and progressively increased the amplitude of th sub-seabed refelctors, and a a trapezoidal bandpass filter with corner frequencies of 1900, 3100, 3900 and 5100 Hz were used for the display. The TOPAS signal was sampled at 30 kHz with a 195 ms record length and variable time delay to track the seabed. The raw data were recorded in TOPAS file format version 3 and the processed displays were recorded in SEGY format.

In water deeper than around 600 metres, in which hemipelagic sediments predominate, penetration and resolution were very good. At the pockmark site on the Vestnesa Ridge, reflectors as deep as 100 ms beneath the sebed were shown clearly. In water shallower than 400-450 metres close to the shelf edge off Prince Carl's Foreland, penetration of as much as 10 ms was rare and patchy, and only the seabed reflection was visible over most of this area. This reduced penetration is a consequence of the presence of glaciogenic sediment, which gives a 'hard' seabed and is poorly stratified.

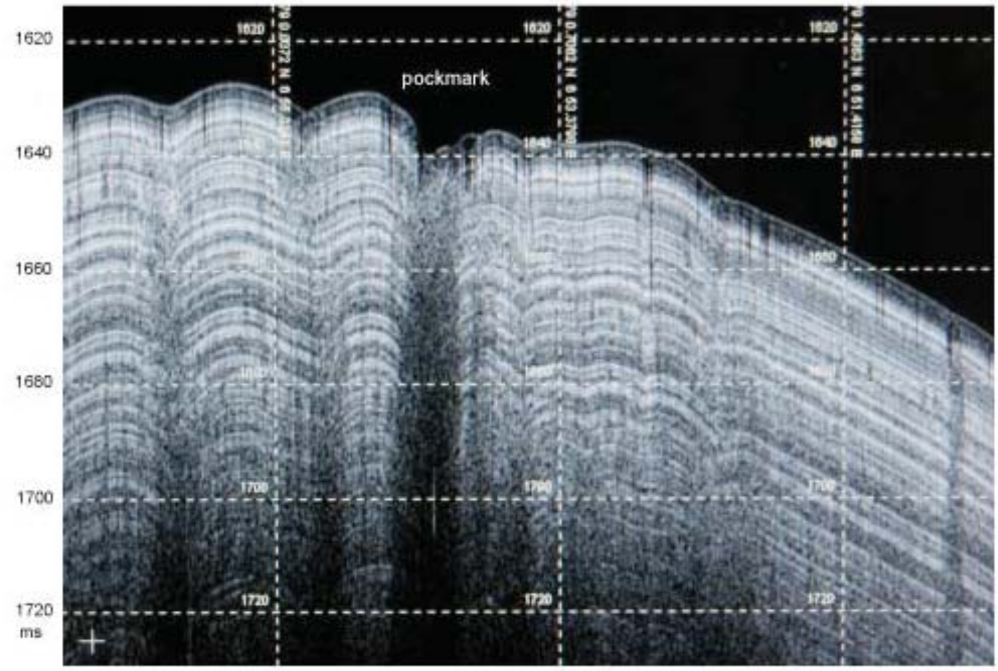


Figure 7.5: Screen image of TOPAS record across pockmark on the Vestnesa Ridge

7.4. Simrad EK60 (G. K. Westbrook)

Simrad EK60 split-beam 'fishfinder' sonar was operated at 38, 120 and 200 kHz to detect and image bubble plumes.The depths logged by the EK60 used a constant sound velocity of 1493 m/s. The EK60 record was noisy when the dynamic positioning thrusters were in use, so the record was often poor during SYSIF profiling. Also, it was noticeable that the EK60 did not 'see' many plumes shown by the EM122 and EA600, presumably because of its narrower beam width.

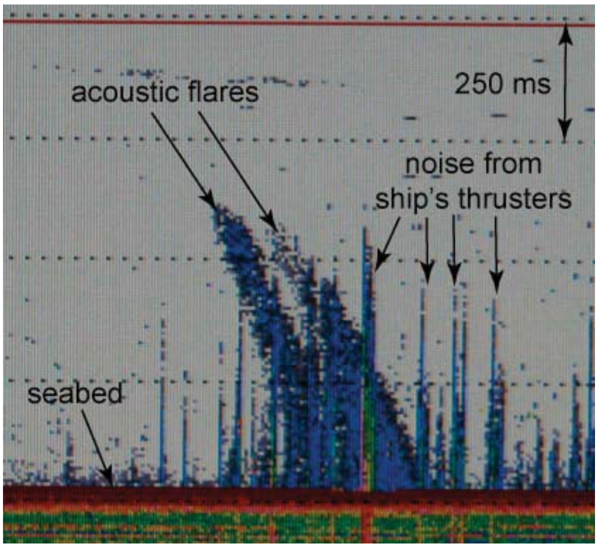


Figure 7.6: EK60 image at 38 kHz of two acoustic flares from pockmark on the Vestnesa Ridge. The flares lean to the left because of the effect of the current. Noise bursts from the ship's thrusters are vertical and extend beneath the seabed.

7.5. Simrad EA600 (G. K. Westbrook)

The Simrad EA600 12 kHz system was operated in passive mode while surveying, with the source being provided by the EM122. It was not logged, but was used occasionally as a depth reference. The depths provided by this system used a constant sound velocity of 1500 m/s, so depths taken from it will be slight over-estimates. The EA600 imaged well many of the bubble plumes, and so provided another indicator of their presence. The times at which plumes were seen were noted in the scientific watch keepers' log.

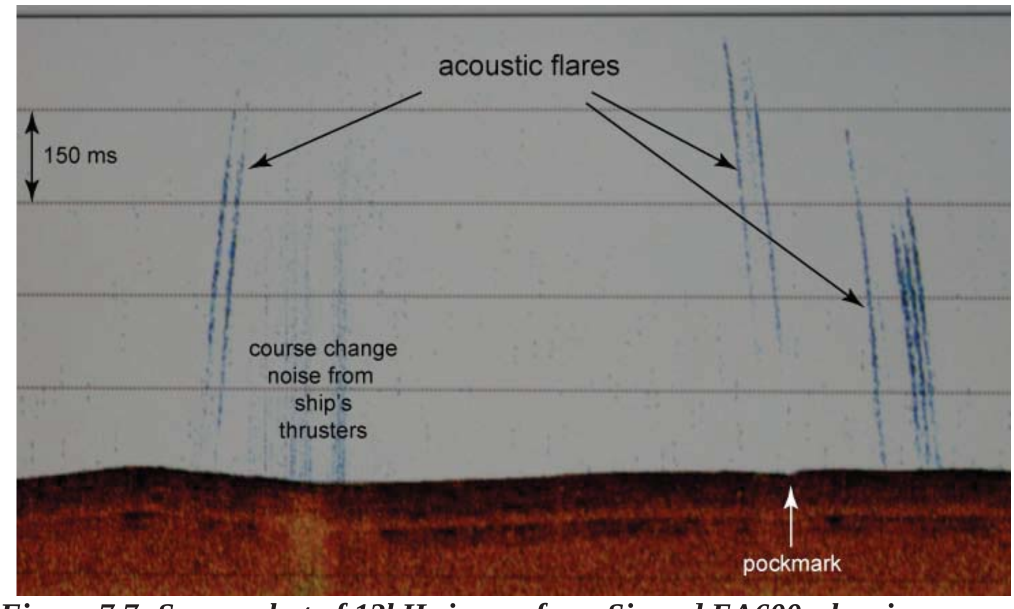


Figure 7.7: Screen shot of 12kHz image from Simrad EA600, showing several acoustic flares from the seabed of the Vestnesa Ridge.

8. CTDs, XBTs AND XSVs

CTD casts were carried out in each of the two survey areas to provide sound velocity structures for the swath and USBL systems. A Sea-Bird's 911*plus* CTD system was used. This consists of an underwater unit with built in pressure sensor, to which a suite of modular sensors can be connected, and a SBE11*plus* Deck Unit. Sea-Bird's standard modular temperature and conductivity sensors (SBE 3*plus* and SBE 4*plus*) are mounted to the underwater unit within the guard cage. Two pairs of sensors are used to provide *primary* and *secondary* temperature and conductivity data sets for error comparison and redundancy. The CTD also had a fluorometer, transmissometer, altimeter and dissolved oxygen meter. Sippican XBT probes types T5 (maximum depth 1870m) and T7 (maximum 780m) were used to complement the CTD casts.

9. SYSIF (B. Marsset and S. Ker)

9.1. Introduction

The SYSIF deep-towed device, designed by IFREMER and illustrated in Figure 9.1, consists in a piezoelectric seismic source and an analog dual channel streamer. This heavy vehicle, weighing 2.4 tons in air, is towed behind the vessel with an armoured electro-optical cable delivering 1000 VAC power, and bi-directional telemetry for the seismic payload and safety controls. The navigation is achieved through four systems: the 120 kHz altimeter measures the vertical distance to the seabed, the quartz pressure sensor calculates the depth from the sea level, the miniature attitude and heading reference system measures the stability of the vehicle whilst an ultra-shortbaseline provides the relative position of the vehicle through acoustic positioning.

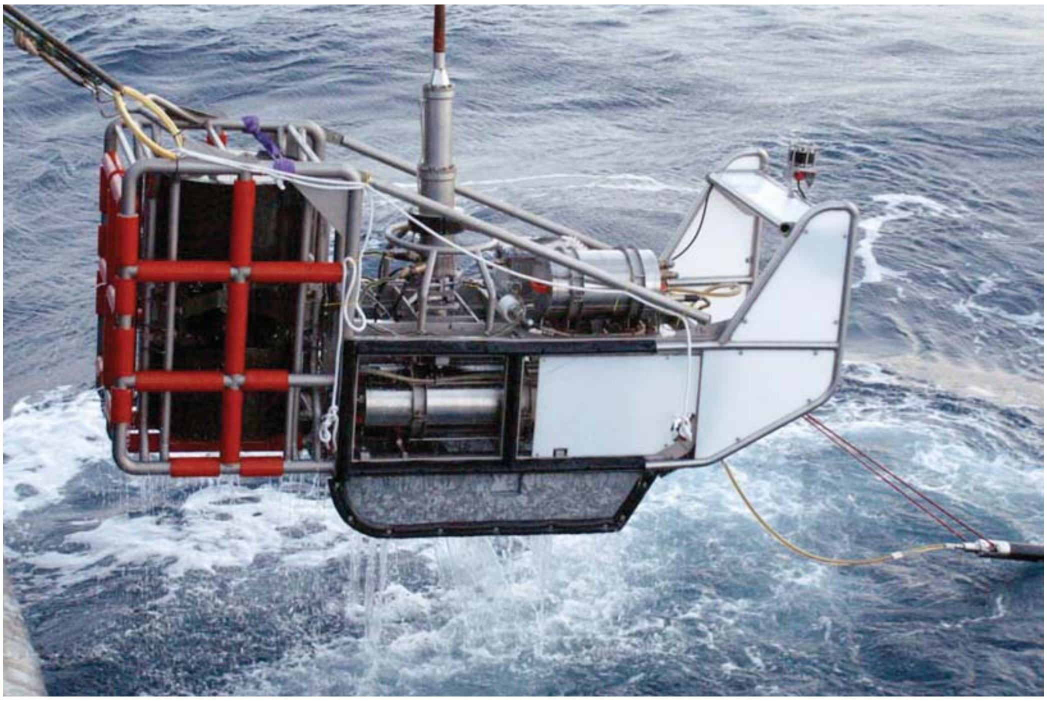


Figure 9.1 : SYSIF

The SYSIF seismic source has to withstand high hydrostatic pressure; the solution was to adapt the technology of a Janus-Helmholtz acoustic transducer, initially designed for low frequency active sonars, to the needs of seismic surveying. A Janus-Helmholtz transducer consists of a piezoelectric ceramic stack inserted between two similar head-masses. This structure, called a Janus driver, is mounted inside a vented rigid cylindrical housing, providing a Helmholtz cavity. The coupling of mechanical resonance and fluid resonance permits a large frequency bandwidth greater than two octaves. With this performance, the seismic source is able to emit long duration frequency modulated acoustic signals, called Chirp signals, well adapted to increasing both resolution and signal to noise ratio using specific processing algorithms. The amplitude variations of the output signal due to the Transmitted Voltage Response of the transducer are taken into account through amplitude modulation. Based on this mature technology, two seismic sources have been designed: the JH250-6000 and the JH650-6000. The source JH250-6000 (HR) operates between 220 Hz and 1050 Hz, and is 112-cm high, 72-cm diameter and weighs 450 kg. The JH650-6000 (THR) for very high resolution surveys operates between 580 Hz and 2200 Hz, is 61-cm high, 45-cm diameter and weighs 90 kg. The output level of 196 dB (ref. 1 µPa @ 1 m) over the whole frequency range is achieved using a single 6.5 kVA D-class power amplifier.

The SYSIF streamer is a dual channel antenna made of TUBA 6000 hydrophones. These hydrophones are piezoelectric ceramic cylinders whose sensitivity (-193 dB ref. 1 V/µPa) withstands high hydrostatic pressure without a loss of sensitivity (1 dB / 600 bars). The first channel of the streamer is a single hydrophone with an offset of 10 m from the seismic source; this trace is used in the experiment to process the recorded signal amplitude. The second channel has an offset of 15 m from the source and is made up of 6 hydrophones, 30 cm apart and parallel-mounted to increase the signal to noise ratio. In order to prevent saturation from the direct wave, analog electronics includes a bandpass filter of 18 dB/octave in the range 100-3000 Hz and a 26.3 dB preamplifier. Analog to digital conversion is then achieved at 10 kHz through a 26 bit ADC.

Since the device lacks multichannel technology to achieve depth imaging, Ocean Bottom seismometers (OBS) were deployed on the seafloor during the cruise to record offset data. The OBSs are autonomous recording instruments that allow the digitization of acoustic measurements of the hydrophone and three geophones. Their synchronisation is achieved through a GPS clock compensated for long time drift.

9.2. SYSIF operation

Five dives of the Sysif deep-towed seismic system collected 27 profiles or a total line-length of 241 km. The total dive time was 83 hours. Details concerning the dives achieved during the JCR 269 cruise may be found in table 9.1. The acquisition scheme was fulfilled according to the scientific program.

Date	*Area*	*dive*	*Source*	*Immersion*	*Profiles*	*Dive time*	*Acquisition time*	*Distance*
27/8	South	1	HR	500m	1	3h30	1h	4km
28/8-	South	2	HR	700m	4	20h30	19h30	70km

29/8								
29/08-31/8	South	3	HR	700m	15	39h	38h	115km
2/9-3/9	North	4	HR	1300m	4	13h	12h	30km
3/9	North	5	THR	1300m	3	7h	6h	12km
Total		**5**			**27**	**83h**	**77h**	**241km**

Table 9.1

9.3. Day by day description

25/8/2011

SYSIF mobilisation on board JCR (HR configuration)

26/8/2011

Connexion to the USBL *Sonardyne* and on board network
Connexion to the EOP cable EOP of *Hybis*
High Voltage procedure meeting
High Voltage test (a minor problem, due to incorrect shipment condition is fixed)
Transit to the south area

27/8/2011

High Voltage test (Failure of the power amplifier)
The dive checklist is completed at 19h00

Dive 1 3h20*, 500m, HR, 4km*
19h50 : SYSIF launch
21h50 : SYSIF at working altitude
22h50 : end of dive
23h15 : SYSIF recovery
Remarks:

- No USBL navigation data for this dive, this dive will not be processed

28/8/2011

Dive 2 *21h, 700m, HR, 70km*
08h30 : SYSIF launch
09h00 : SYSIF at working altitude

29/8/2011

05h00 : End of dive 2
05h30 : SYSIF recovery
Disjunction of the EOP cable
Deployment of 4 OBSs
Dive 3 *39h, 600m, HR, 115km*
17h00 Connexion of the Eop cable
19h00 : SYSIF launch
19h45 : SYSIF at working altitude
Remarks:

- The use of a remote screen for winch handling occasionally ends in a loss of immersion data
- The NTP synchronization between the navigation and acquisition computers underlines a constant shift of 20s.

31/8/2011

10h00 : End of dive 3
10h30 : SYSIF recovery

1/9/2011

Transit to the north area.
OBS deployement.

2/9/2011

End of OBS deployment
A frame malfunction
Dive 4 ***13h, 1200m, HR, 30km***
17h00 : Connexion to the EOP cable
22h00 : SYSIF launch
22h30 : SYSIF at working altitude

3/9/2011

10h30 : End of dive 4
11h00 : SYSIF recovery
Change from the HR transducer to the THR transducer
Dive 5 ***6h, 1200m, THR, 12km***
15h10 : SYSIF launch
15h44 : SYSIF at working altitude
20h30 : end of dive 5
21h00 : SYSIF recovery
Remarks:
- no more NTP synchronization between the navigation and acquisition computers

4/9/2011

SYSIF demobilisation

5/9/2011

SYSIF demobilisation

9.4. On board Data Quality Control (QC)

A QC was systematically applied on navigation data (USBL, immersion and altitude)
A QC was systematically applied on seismic data was realised including the following sequence : Signature deconvolution, Band-pass filtering, Immersion correction.

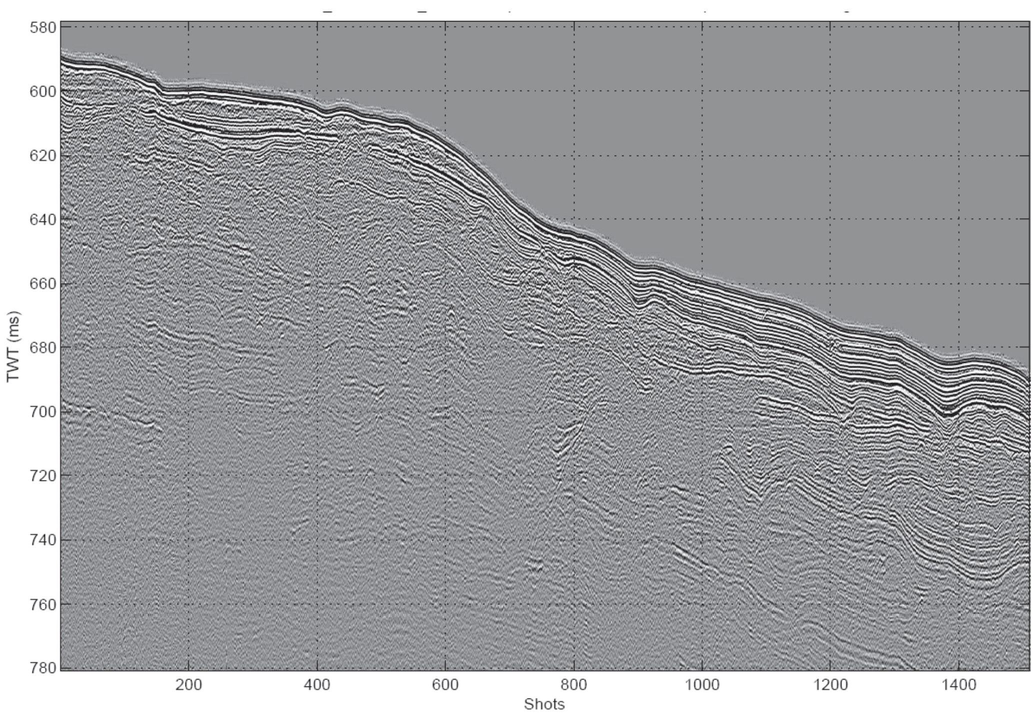


Figure 9.2 : Example of onboard seismic QC

9.5. Comments on Records from SYSIF (G. K. Westbrook)

The low frequency version of SYSIF was able to image reflectors at greater than 300 ms beneath the seabed in the hemipelagic sediments of the Vestnesa Ridge. In the southern area, imaging of reflectors of up to 250 ms beneath the seabed was achieved in the deeper water, which is dominated by hemipelagic sediment. In shallower water, the depth of imaging was reduced. This is a consequence of several factors. The height above the sea bed at which SYSIF is towed is typically between 80 m and 160 m. In water shallower than about 160 to 320 m, the reflection from the sea surface arrives at the same time as the reflection from the seabed and in water depths only moderately deeper, the sea-surface reflection limits the depth beneath the seabed at which primary reflections can be imaged. In addition, in water depths of around 400 m in this area the sediment at the seabed, and for many tens of metres beneath it, is primarily of a glacigenic origin, giving a high acoustic impedance at the seabed and very poor stratification. Nevertheless, semi-continuous reflectors of negative polarity and isolated ‘bright spots’ are evident a few tens of metres beneath the seabed. In depths, deeper than 450-500 metres, reflectors of typical stratigraphic origin are evident at times of up to 150 ms beneath the seabed.

In the Vestnesa area, both the the high- and low-frequency versions of SYSIF, provide detailed images of gas chimneys that feed pockmarks and gas seeps at the seabed.

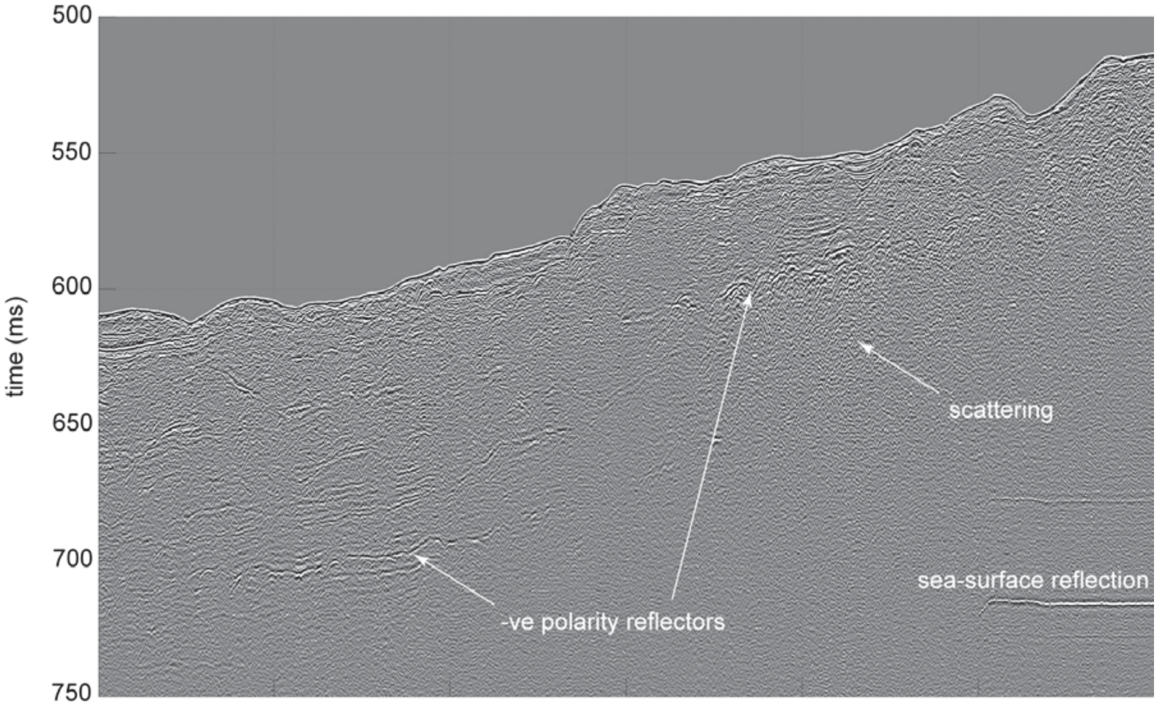


Figure 9.3: Preliminary image of record from SYSIF line 7, showing bright reflectors and scattering, which are probably caused by the presence gas, near the landward limit of the hydrate stability field. The hydrate is not stable at water depths shallower than about 400 m (520 ms on the seismic record. This section is approximately equivalent to the section between cmp 3000 and cmp 4000 of the seismic reflection record shown in Fig. 10.18, which comes from an adjacent line.

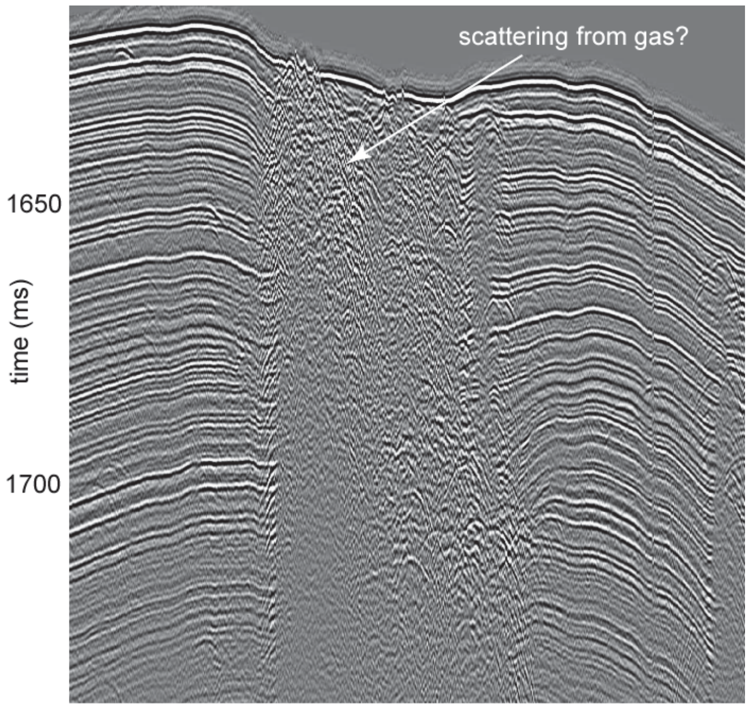


Figure 9.4: Detail of a seismic record from SYSIF across a pockmark on the Vestnesa Ridge. At least two active gas flares emanate from the seabed within the pockmark. The scattering is probably caused by the gas that feeds the flares.

9.6. OBS data

OBS data were downloaded from instruments, signature deconvolution and a band-pass filtering were applied as a Quality Control check for the hydrophone component.

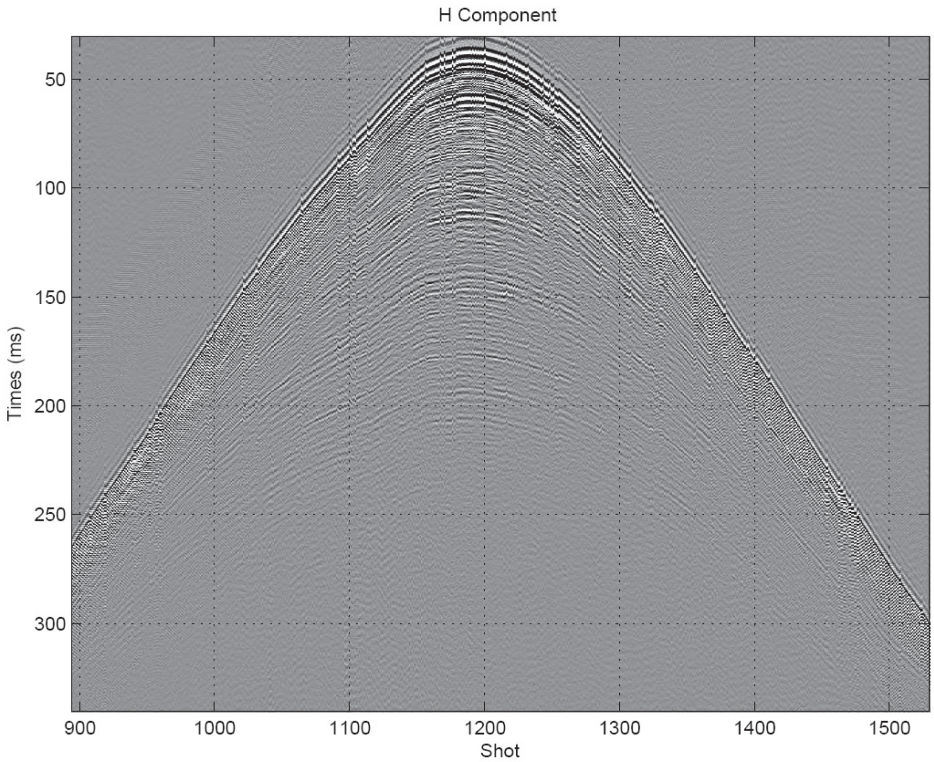


Figure 9.3 : Example of onboard OBS QC

9.7. SYSIF lines

Dive 2

Profile	Acquisition files	Altitude (m)	Shot interval
Profil2_1	JCR007 JCR008	150	2.4
Profil2_2	JCR009 JCR010 JCR011	100	2.4
Profil2_3	JCR012 JCR0013 JCR014	100	2.4
Profil2_4	JCR015 JCR0016	100	2.4

Dive 3

Profile	Acquisition files	Altitude (m)	Shot interval
Profil3_1	JCR019- JCR020	100	2.4
Profil3_2	JCR021 JCR022	150	2.9
Profil3_3	JCR023 JCR024	100	2.4
Profil3_4	JCR025	100	2.4

Profil3_5	JCR026 JCR027 JCR028	100	2.4	
Profil3_6	JCR029	100	2.4	
Profil3_7	JCR030	100	2.4	OBS Line
Profil3_8	JCR031	100	2.4	
Profil3_9	JCR032	100	2.4	
Profil3_10	JCR033 JCR034	100	2.4	
Profil3_11	JCR035 JCR036	100	2.4	
Profil3_12	JCR037	100	2.4	
Profil3_13	JCR038	150	2.9	OBS Line
Profil3_14	JCR039 JCR040	150	2.9	OBS Line
Profil3_15	JCR041 JCR042	100	2.4	

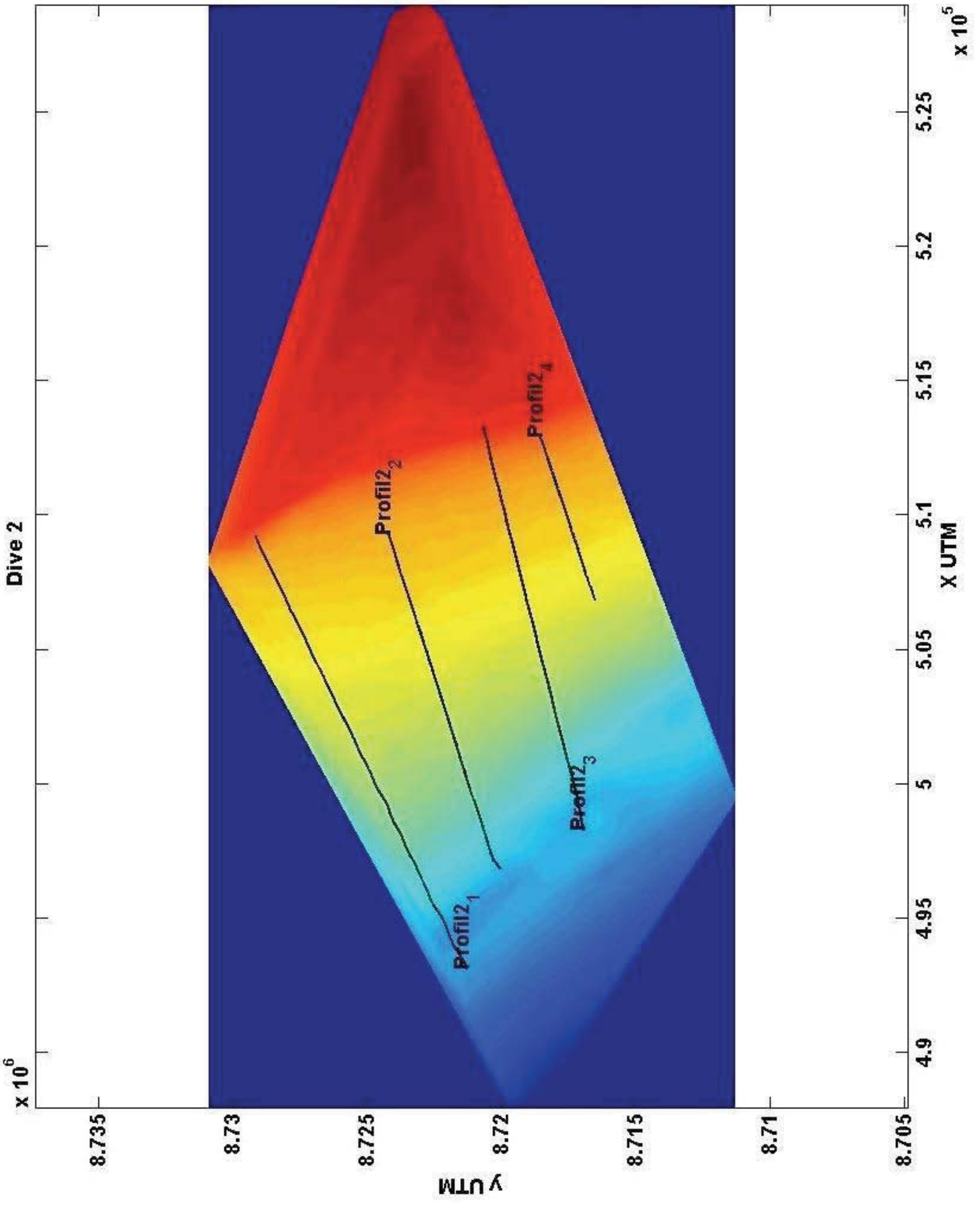
Dive 4

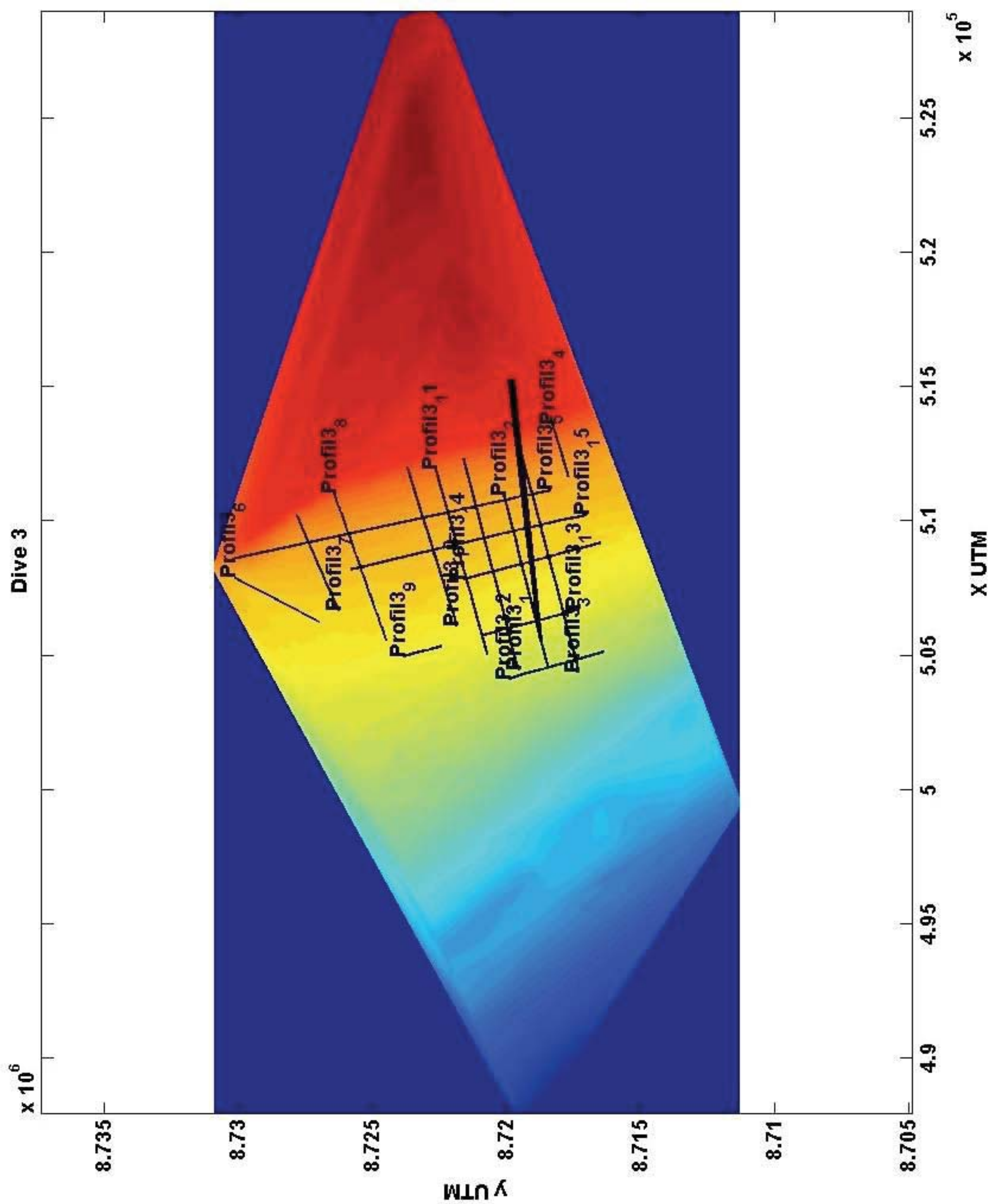
Profile	Acquisition files	Altitude (m)	Shot interval	
Profil4_1	JCR044 JCR045 JCR046	150	2	OBS line
Profil4_2	JCR047 JCR048	150	2	
Profil4_3	JCR049	150	2	
Profil4_4	JCR050 JCR051	150	2	

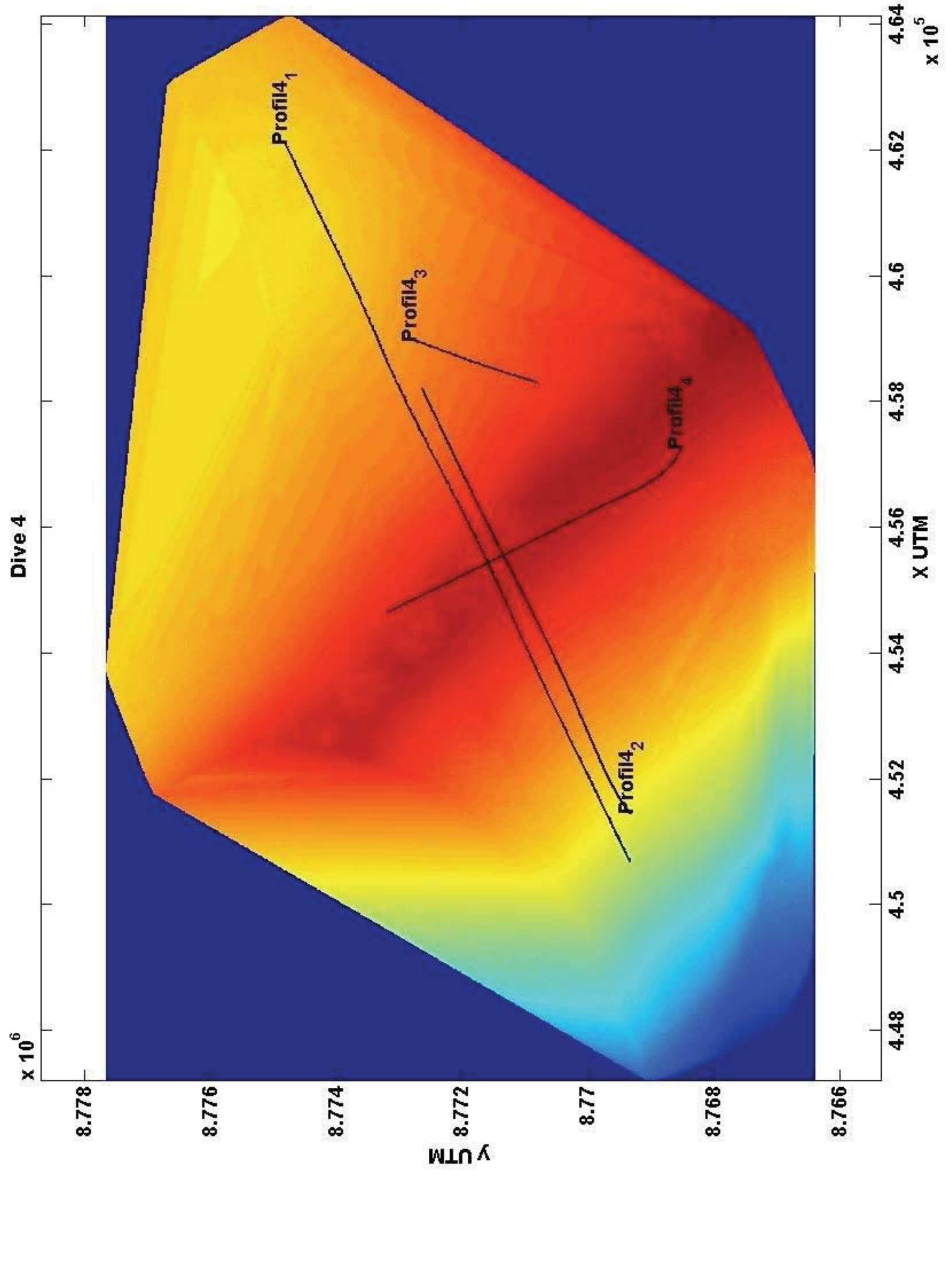
Dive 5

Profile	Acquisition files	Altitude (m)	Shot interval
JCR269-23	JCR052 JCR053	80	2
JCR269-24	JCR054	80	2
JCR269-25	JCR055	80	2

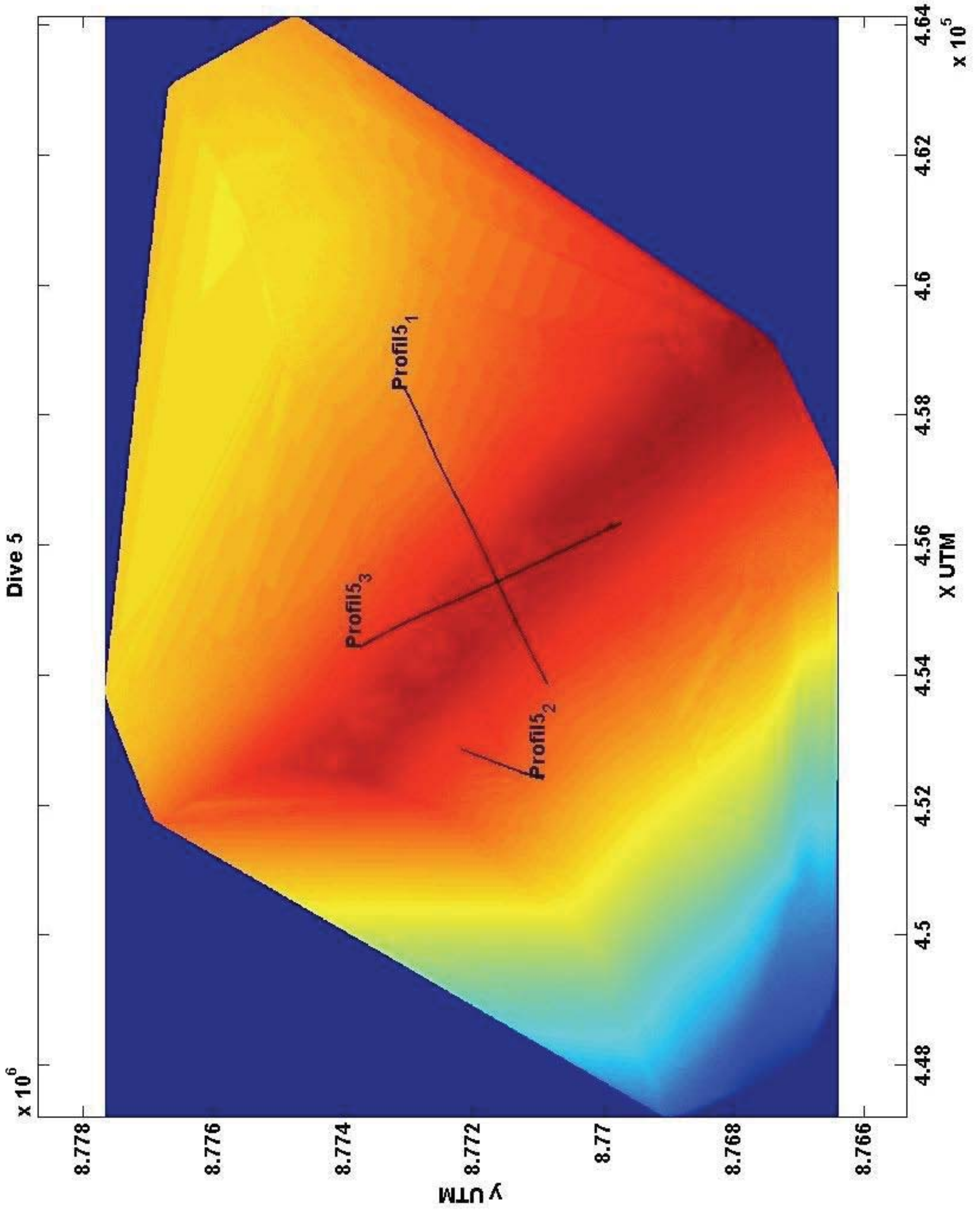
9.8. Location maps



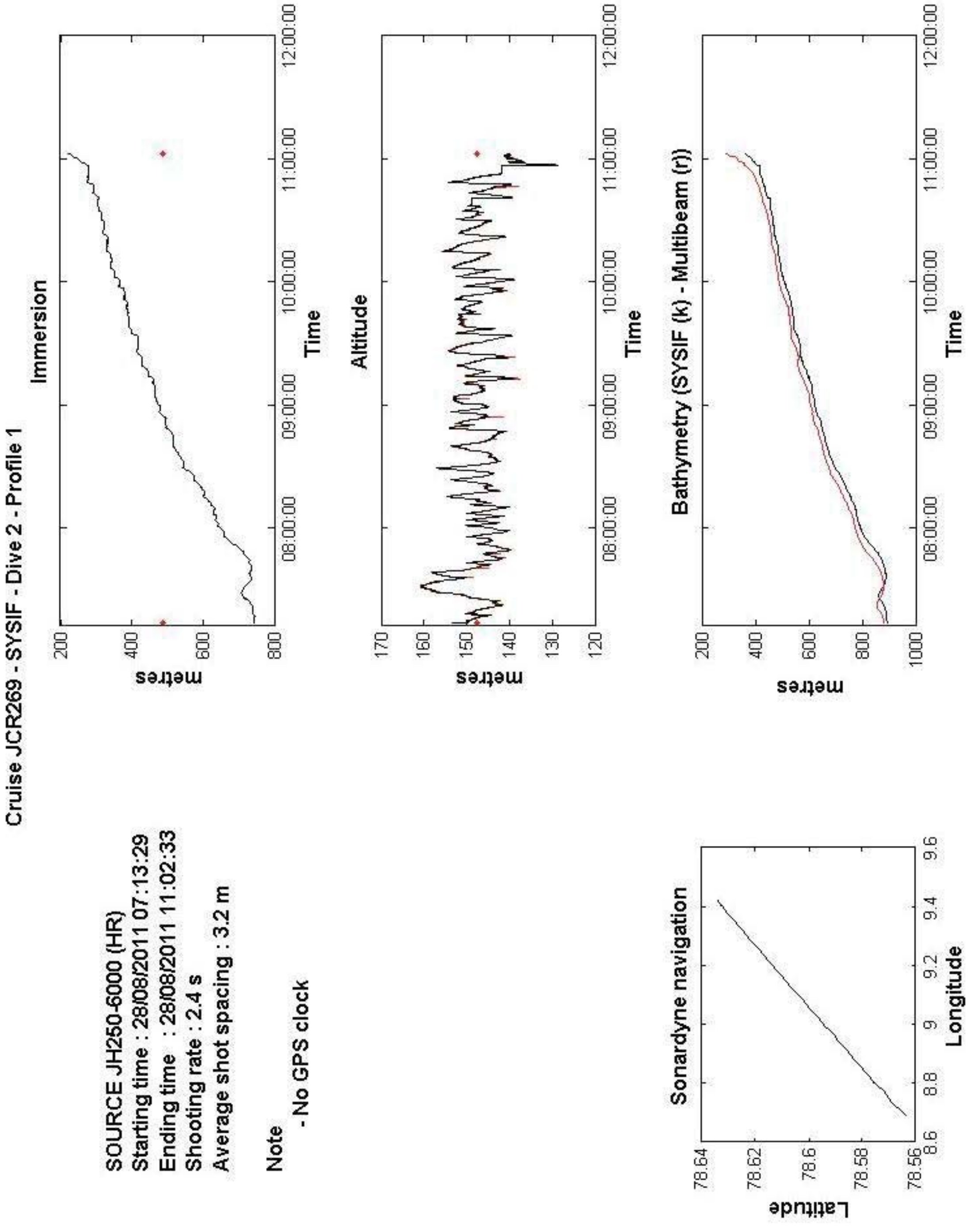

Dive 3
X UTM
y UTM
x 10^5
x 10^6
4.9
4.95
5
5.05
5.1
5.15
5.2
5.25
8.705
8.71
8.715
8.72
8.725
8.73
8.735



Dive 4
Profil4_1
Profil4_2
Profil4_3
Profil4_4
X UTM
y UTM
x 10^5
x 10^6
4.48
4.5
4.52
4.54
4.56
4.58
4.6
4.62
4.64
8.766
8.768
8.77
8.772
8.774
8.776
8.778


Dive 5
Profil5_1
Profil5_2
Profil5_3
x 10^6
8.778
8.776
8.774
8.772
8.77
8.768
8.766
y UTM
4.48
4.5
4.52
4.54
4.56
4.58
4.6
4.62
4.64
x 10^5
X UTM

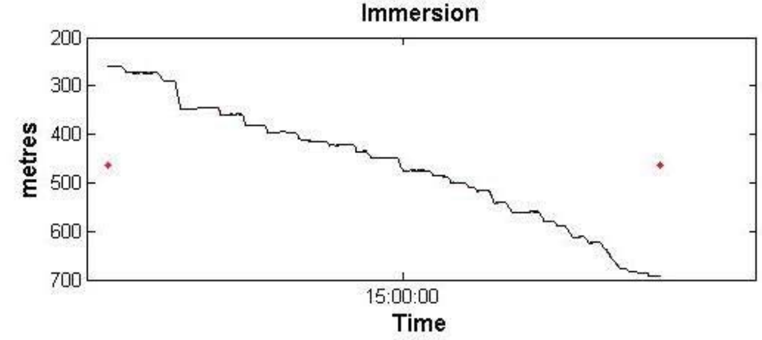
9.9. Profile information

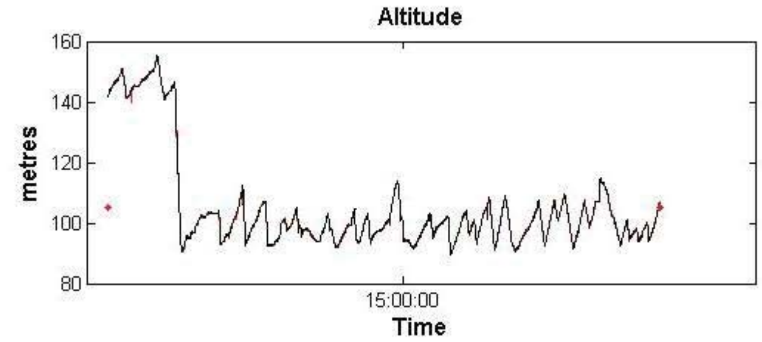


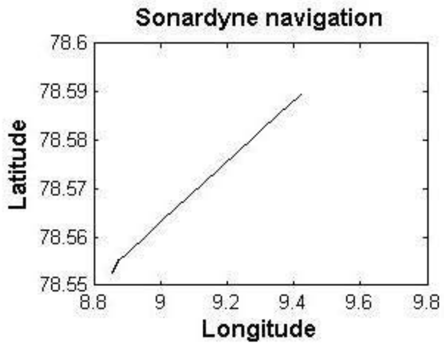
Cruise JCR269 - SYSIF - Dive 2 - Profile 2

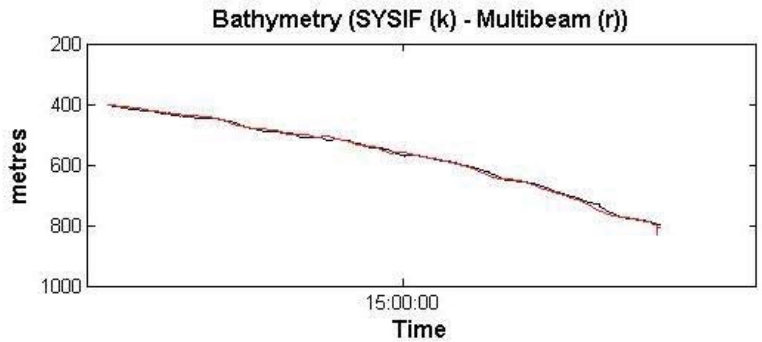
SOURCE JH250-6000 (HR)
Starting time : 28/08/2011 13:05:19
Ending time : 28/08/2011 16:39:07
Shooting rate : 2.4 s
Average shot spacing : 2.62 m

Note
- No GPS clock





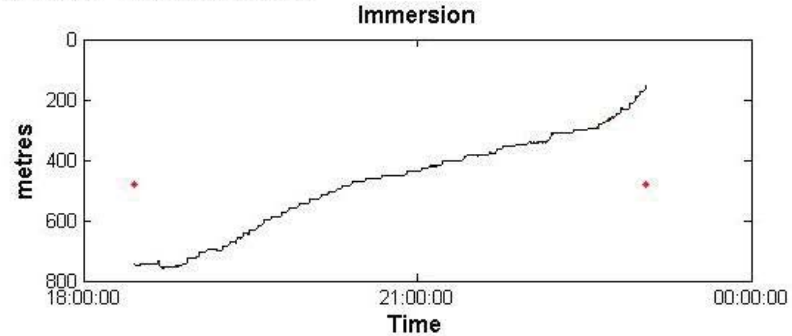


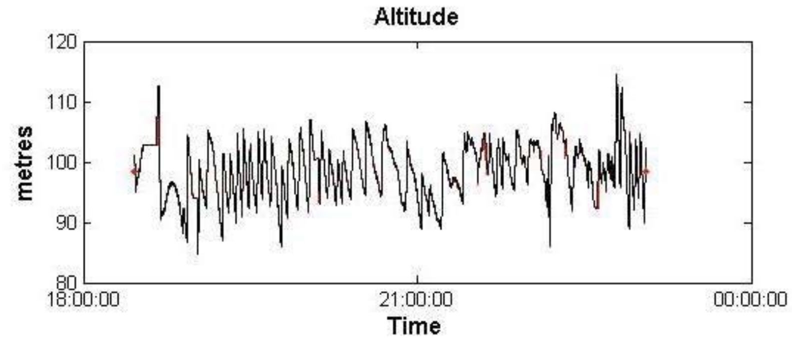


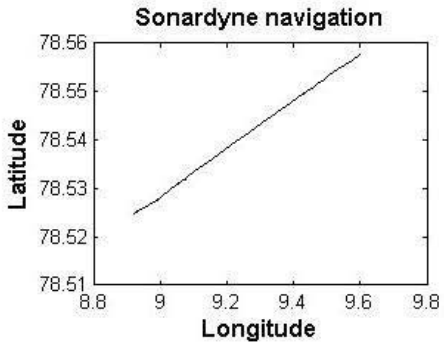
Cruise JCR269 - SYSIF - Dive 2 - Profile 3

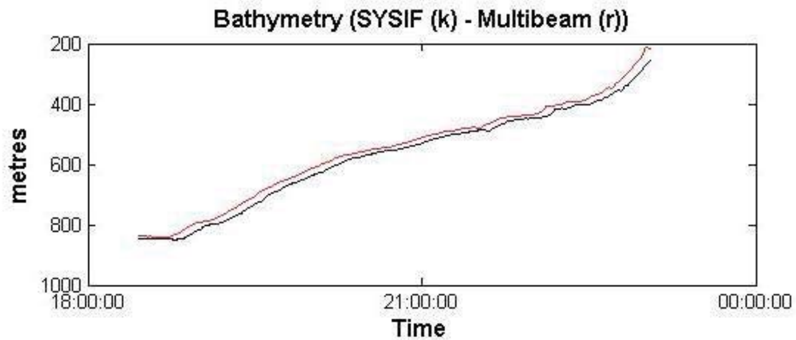
SOURCE JH250-6000 (HR)
Starting time : 28/08/2011 18:27:03
Ending time : 28/08/2011 23:03:01
Shooting rate : 2.4 s
Average shot spacing : 2.33 m

Note
- No GPS clock





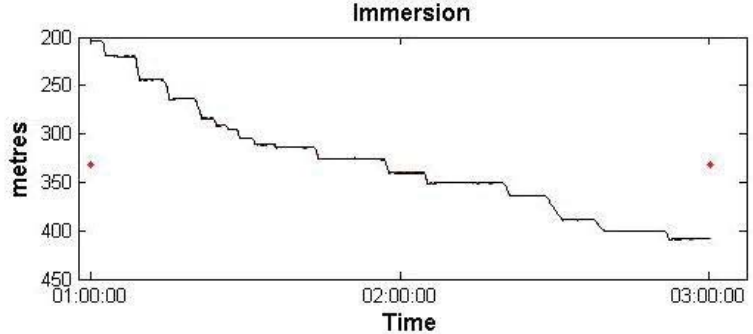


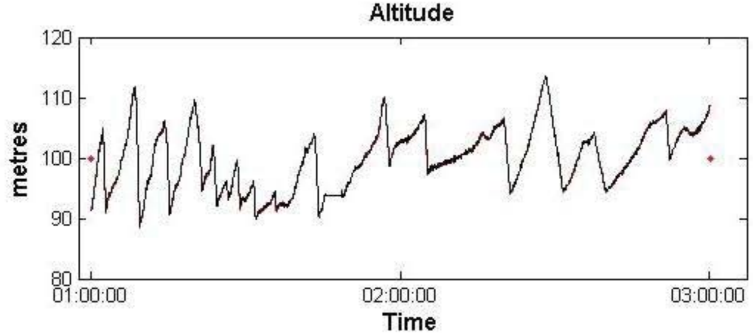


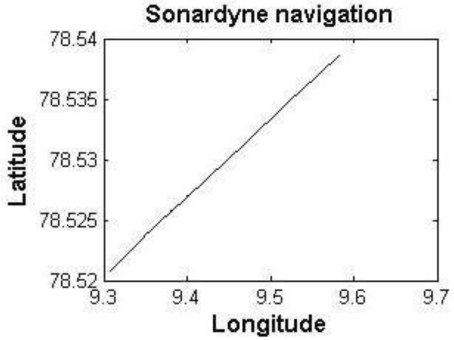
Cruise JCR269 - SYSIF - Dive 2 - Profile 4

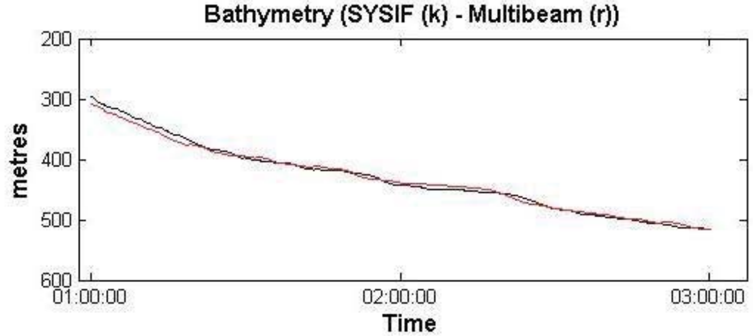
SOURCE JH250-6000 (HR)
Starting time : 29/08/2011 01:00:06
Ending time : 29/08/2011 03:00:04
Shooting rate : 2.4 s
Average shot spacing : 2.16 m

Note
- No GPS clock





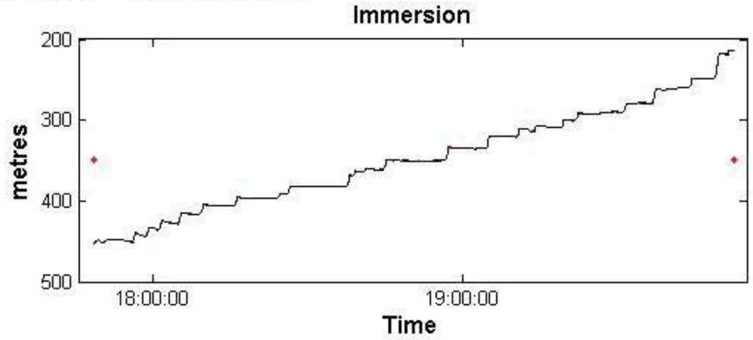


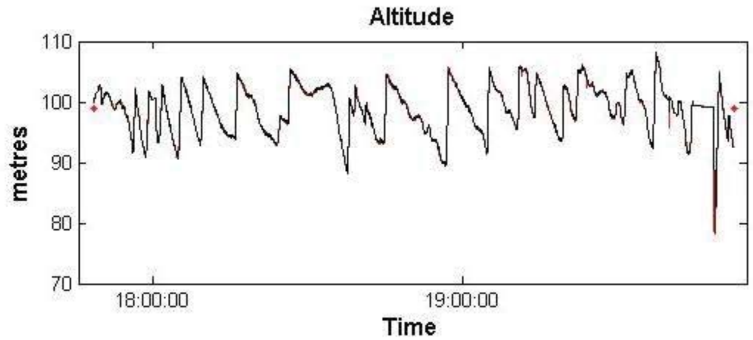


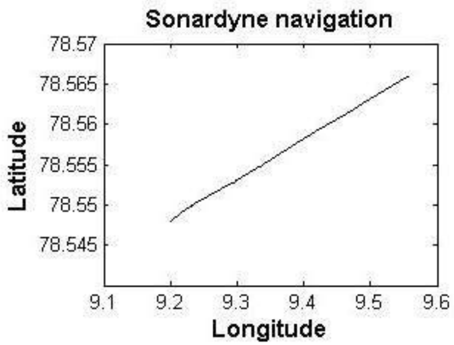
Cruise JCR269 - SYSIF - Dive 3 - Profile 1

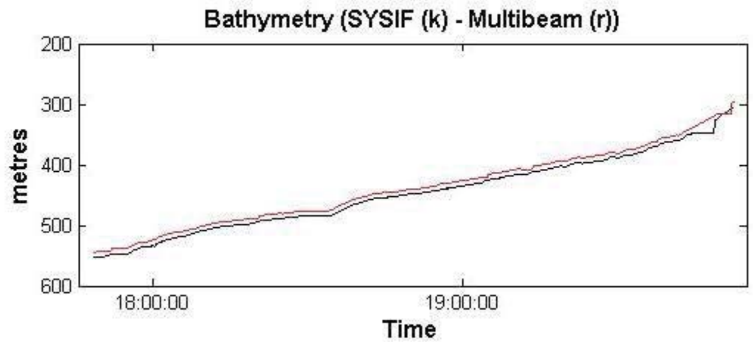
SOURCE JH250-6000 (HR)
Starting time : 29/08/2011 17:48:27
Ending time : 29/08/2011 19:52:39
Shooting rate : 2.4 s
Average shot spacing : 2.68 m

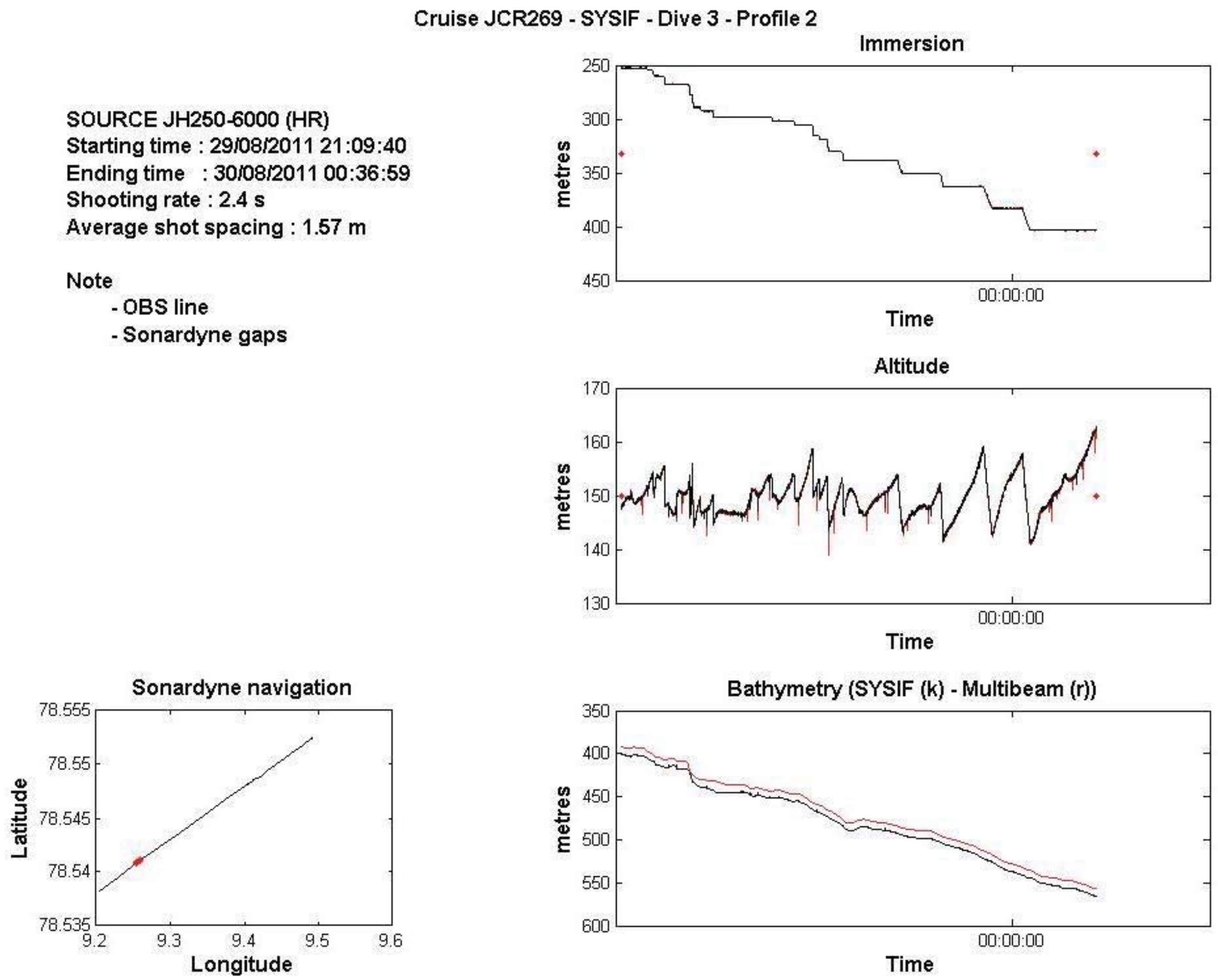
Note







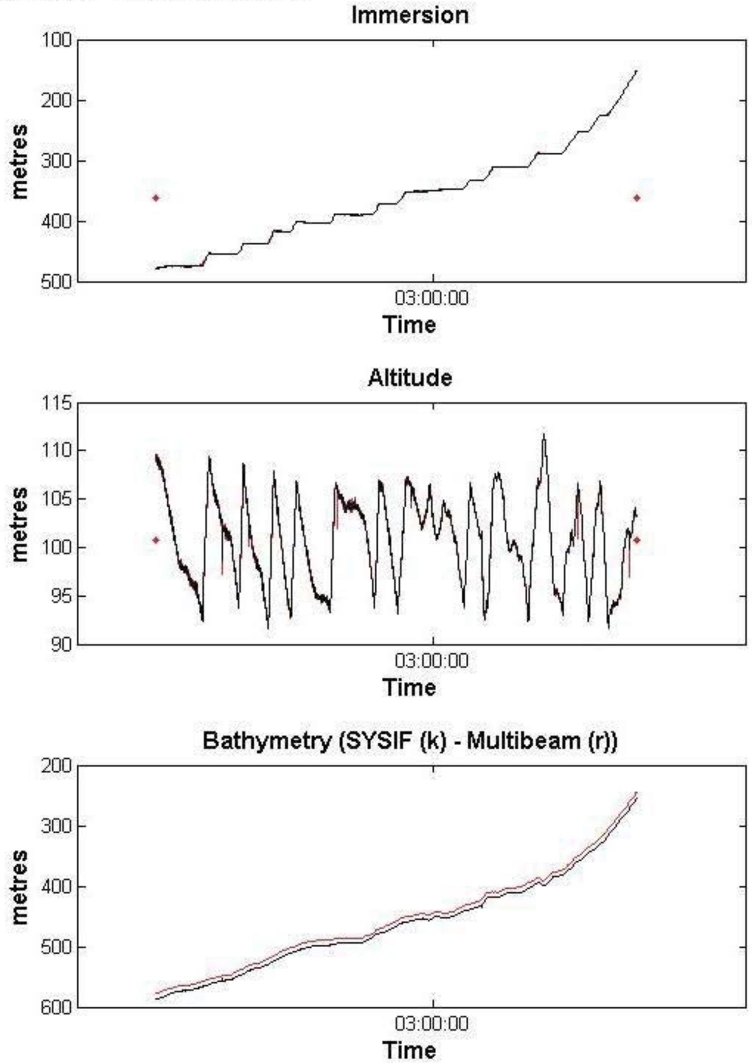


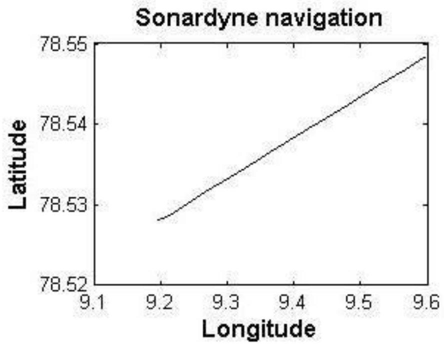

Cruise JCR269 - SYSIF - Dive 3 - Profile 2
SOURCE JH250-6000 (HR)
Starting time : 29/08/2011 21:09:40
Ending time : 30/08/2011 00:36:59
Shooting rate : 2.4 s
Average shot spacing : 1.57 m
Note
- OBS line
- Sonardyne gaps
Immersion
metres
250
300
350
400
450
00:00:00
Time
Altitude
metres
170
160
150
140
130
00:00:00
Time
Sonardyne navigation
Latitude
78.555
78.55
78.545
78.54
78.535
9.2
9.3
9.4
9.5
9.6
Longitude
Bathymetry (SYSIF (k) - Multibeam (r))
metres
350
400
450
500
550
600
00:00:00
Time

Cruise JCR269 - SYSIF - Dive 3 - Profile 3

SOURCE JH250-6000 (HR)
Starting time : 30/08/2011 01:24:23
Ending time : 30/08/2011 04:09:59
Shooting rate : 2.4 s
Average shot spacing : 2.25 m

Note

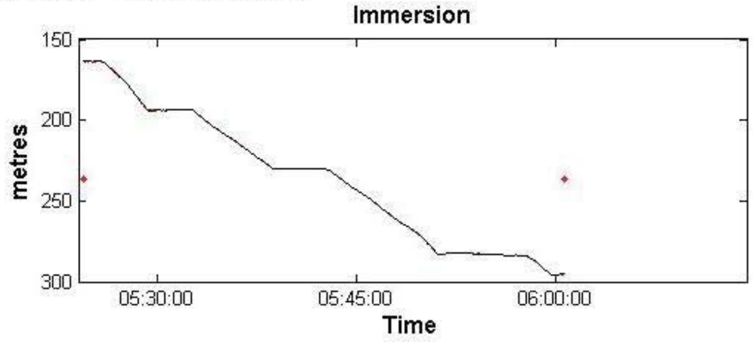


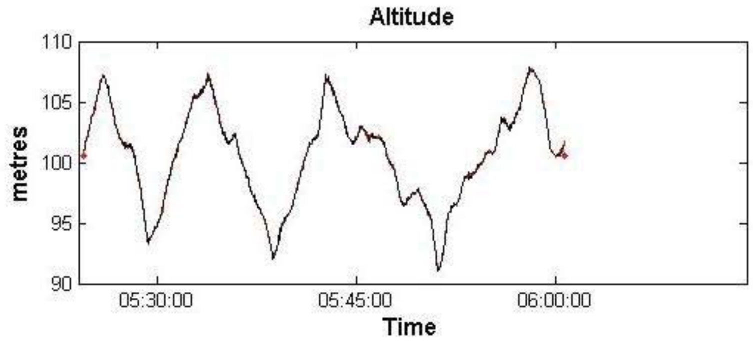


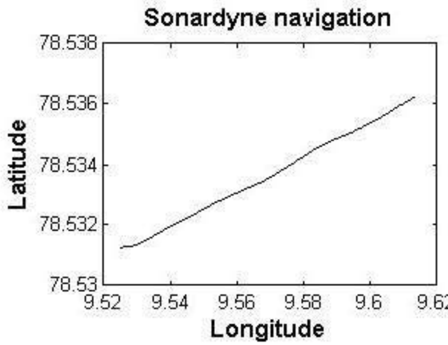
Cruise JCR269 - SYSIF - Dive 3 - Profile 4

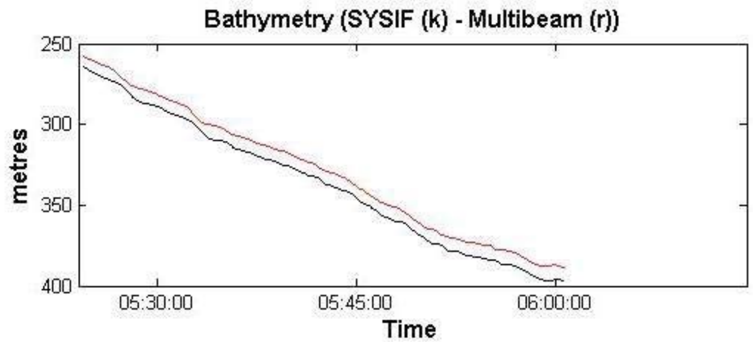
SOURCE JH250-6000 (HR)
Starting time : 30/08/2011 05:24:23
Ending time : 30/08/2011 06:00:38
Shooting rate : 2.4 s
Average shot spacing : 2.28 m

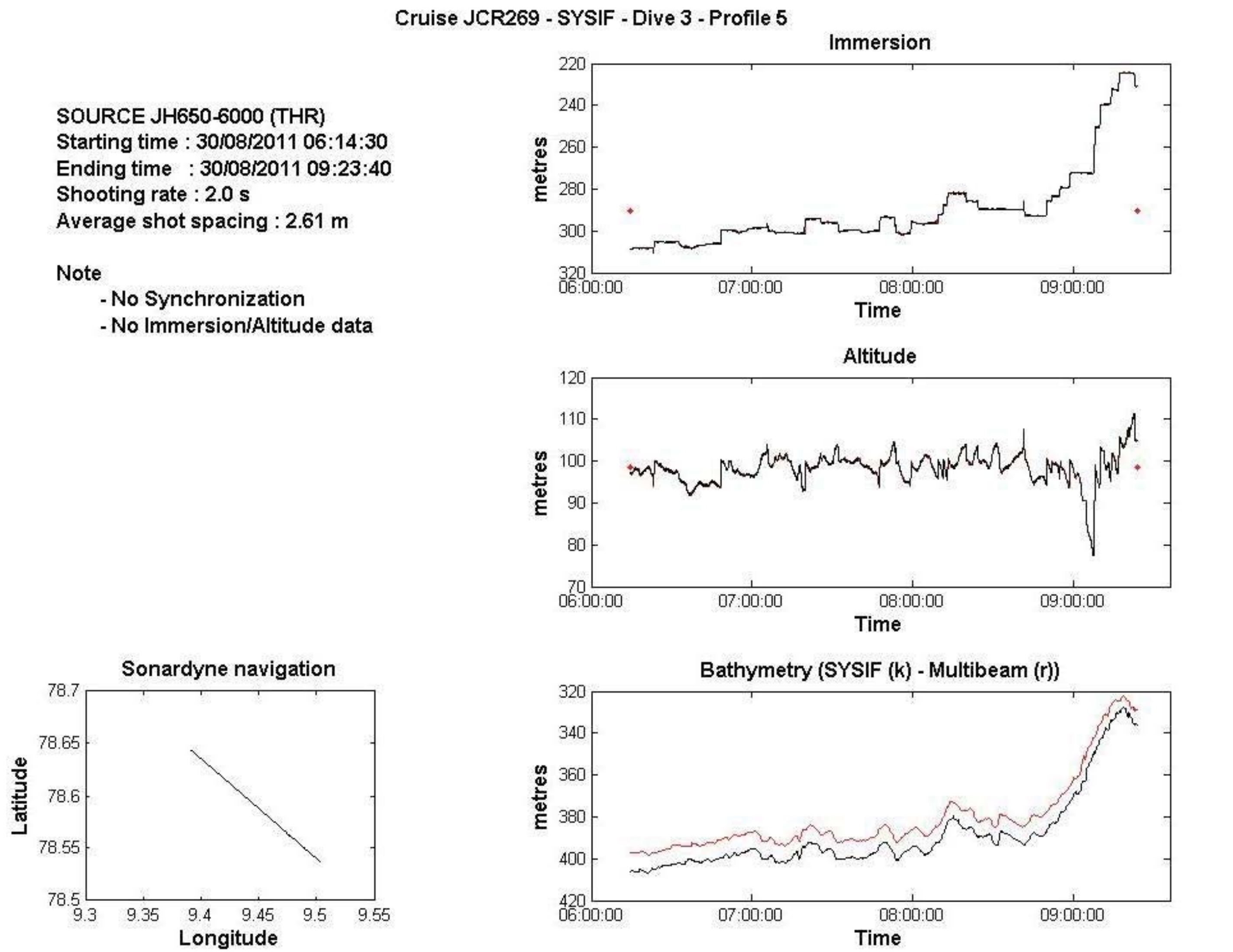
Note









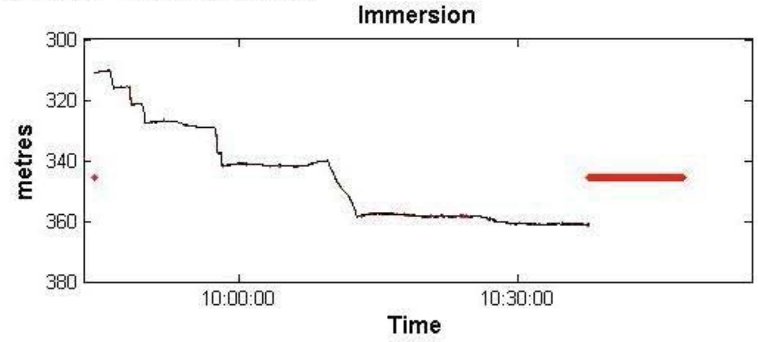


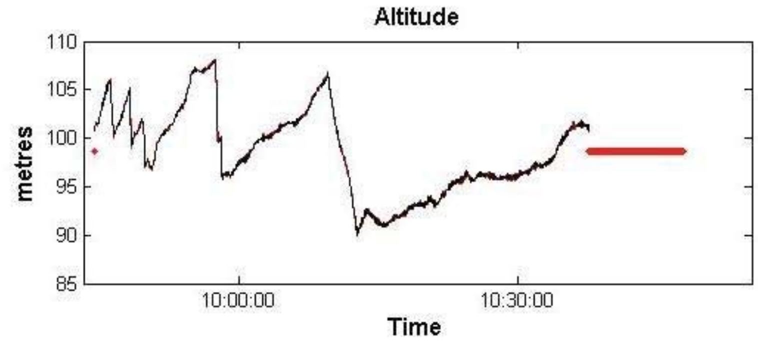
Cruise JCR269 - SYSIF - Dive 3 - Profile 5
SOURCE JH650-6000 (THR)
Starting time : 30/08/2011 06:14:30
Ending time : 30/08/2011 09:23:40
Shooting rate : 2.0 s
Average shot spacing : 2.61 m
Note
- No Synchronization
- No Immersion/Altitude data
Immersion
Altitude
Bathymetry (SYSIF (k) - Multibeam (r))
Sonardyne navigation
metres
Time
Latitude
Longitude
06:00:00
07:00:00
08:00:00
09:00:00

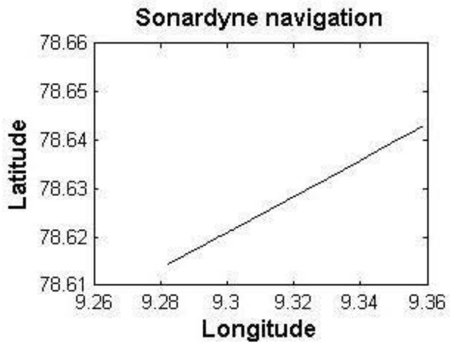
Cruise JCR269 - SYSIF - Dive 3 - Profile 6

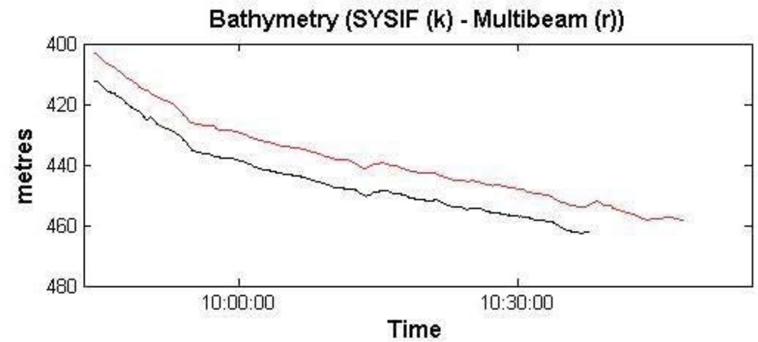
SOURCE JH250-6000 (HR)
Starting time : 30/08/2011 09:44:19
Ending time : 30/08/2011 10:47:45
Shooting rate : 2.4 s
Average shot spacing : 2.31 m

Note
- Immersion / Altitude gaps





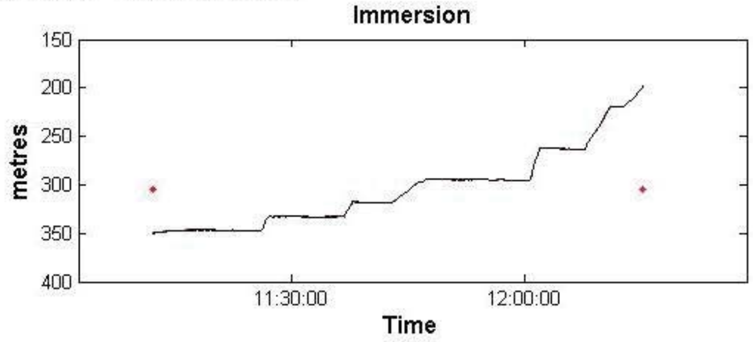


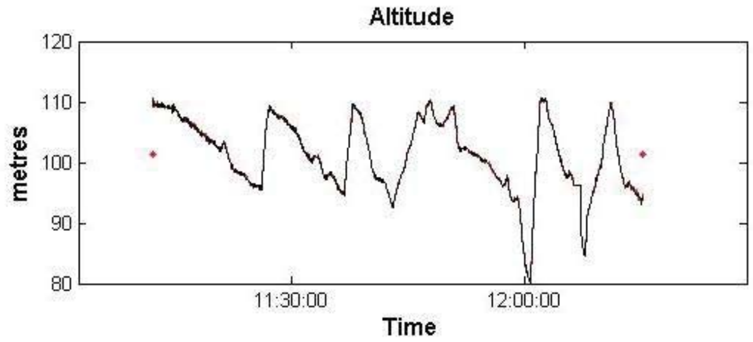


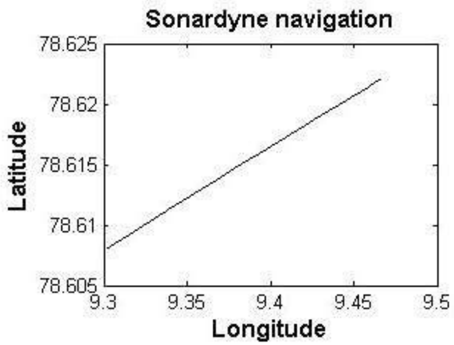
Cruise JCR269 - SYSIF - Dive 3 - Profile 7

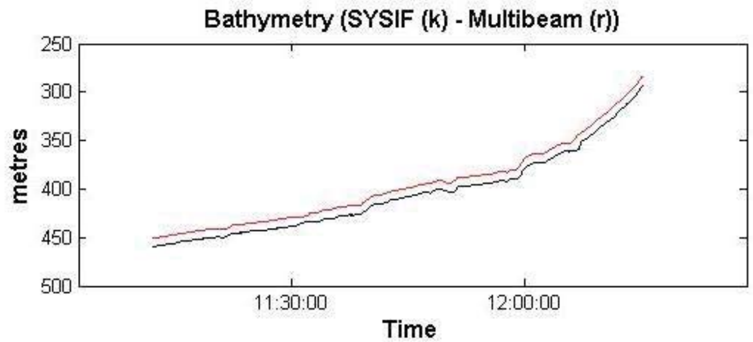
SOURCE JH250-6000 (HR)
Starting time : 30/08/2011 11:11:58
Ending time : 30/08/2011 12:15:24
Shooting rate : 2.4 s
Average shot spacing : 2.52 m

Note





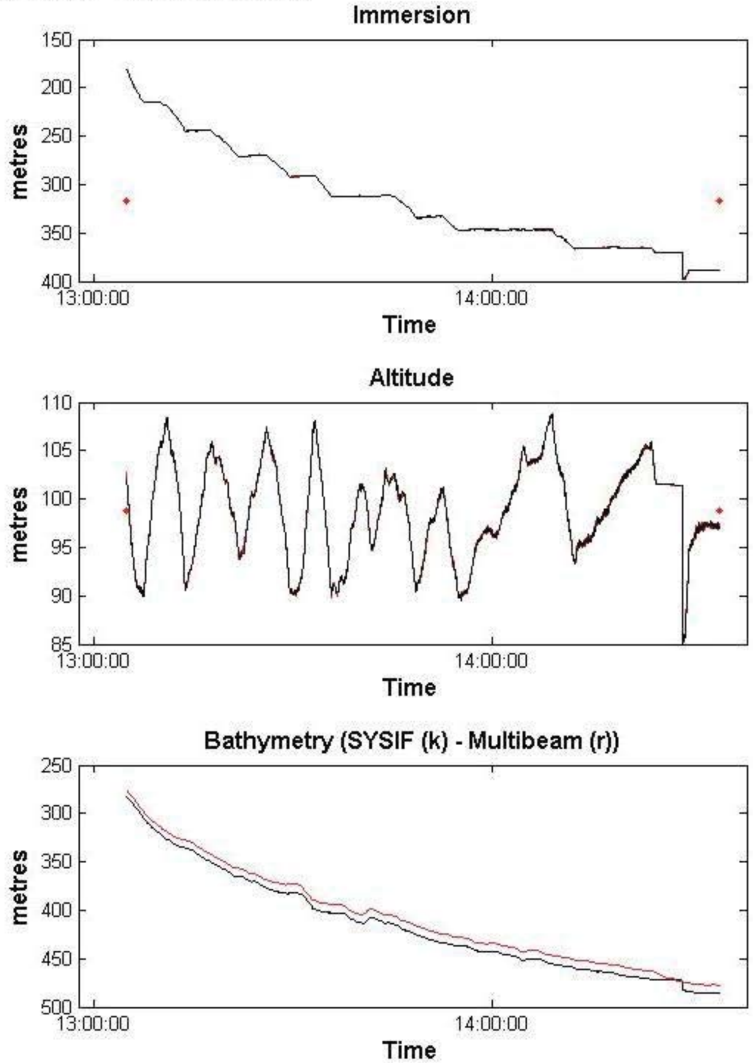


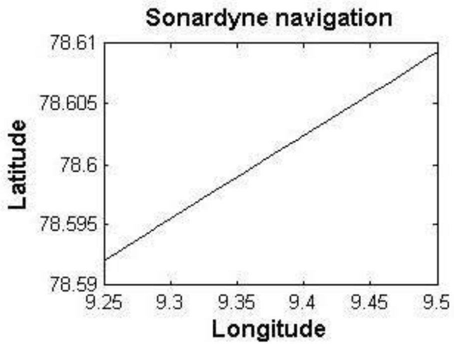


Cruise JCR269 - SYSIF - Dive 3 - Profile 8

SOURCE JH250-6000 (HR)
Starting time : 30/08/2011 13:04:48
Ending time : 30/08/2011 14:34:20
Shooting rate : 2.4 s
Average shot spacing : 2.63 m

Note

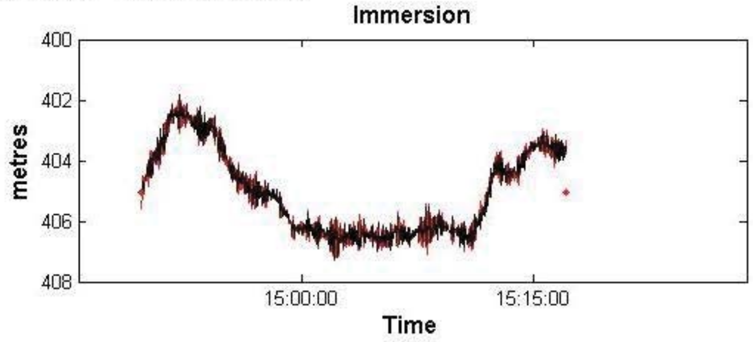


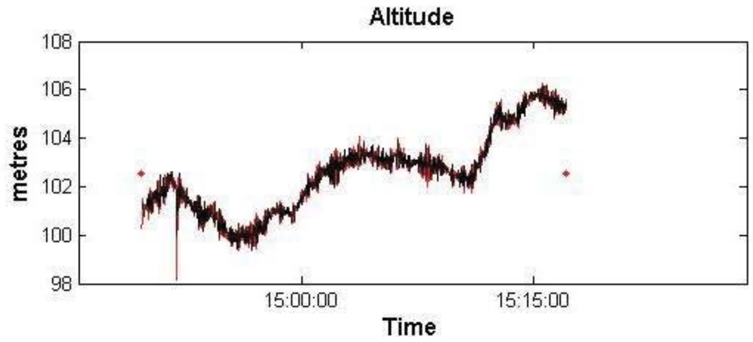


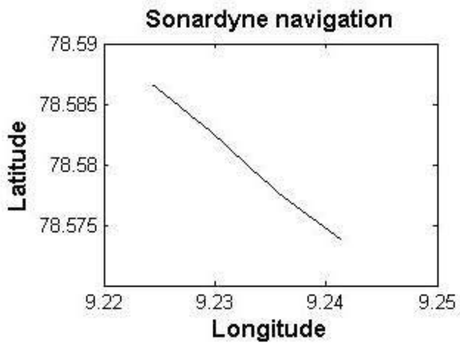
Cruise JCR269 - SYSIF - Dive 3 - Profile 9

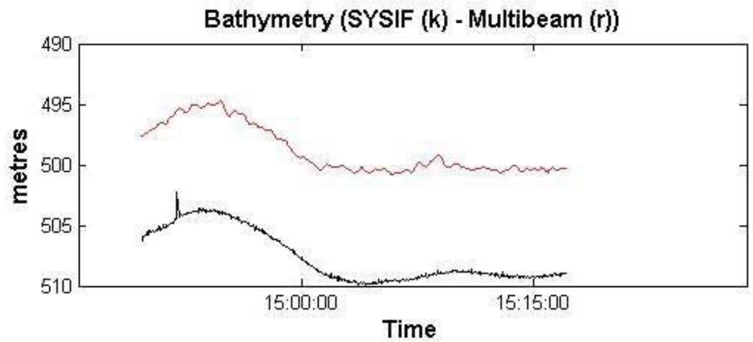
SOURCE JH250-6000 (HR)
Starting time : 30/08/2011 14:49:41
Ending time : 30/08/2011 15:17:08
Shooting rate : 2.4 s
Average shot spacing : 2.17 m

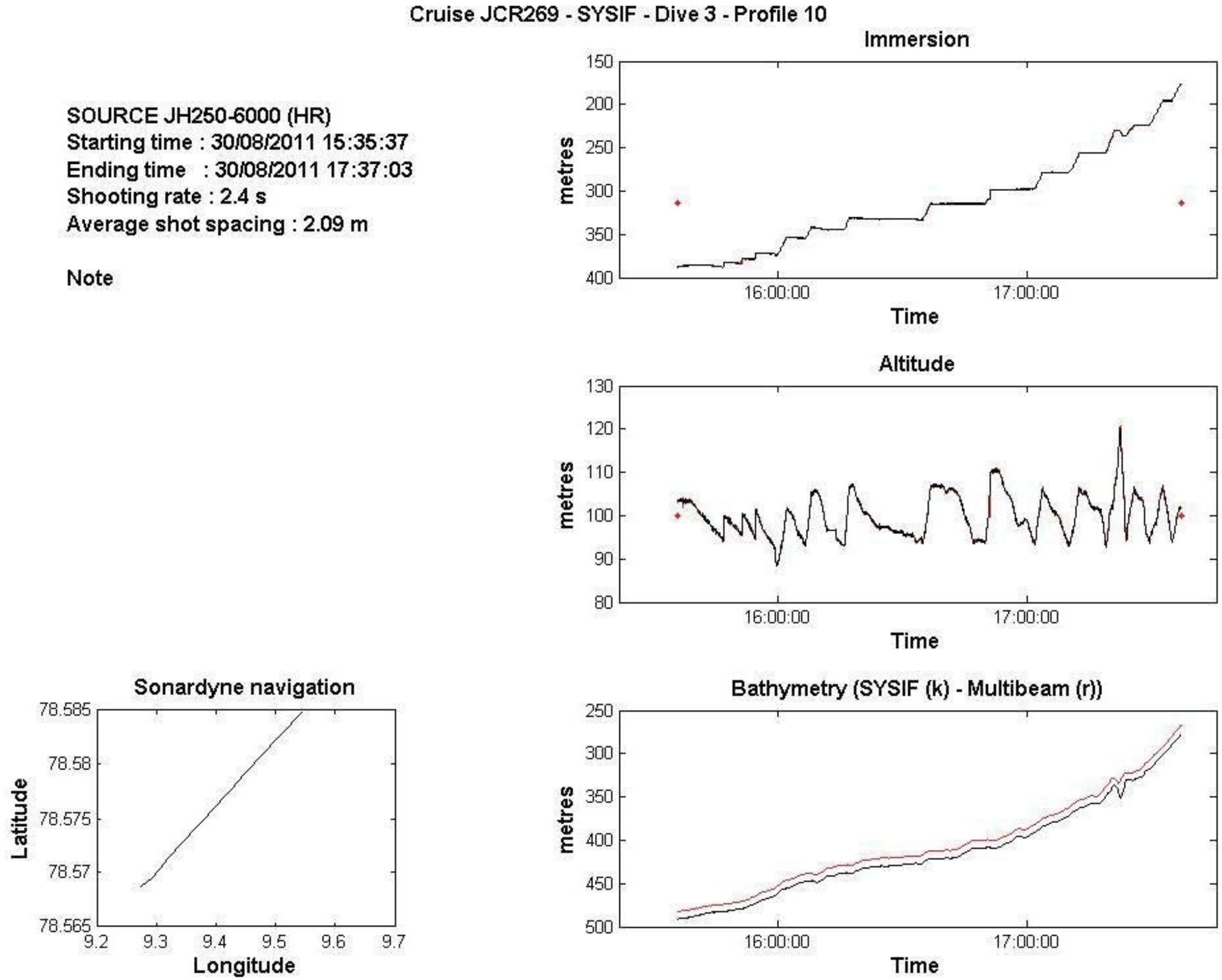
Note







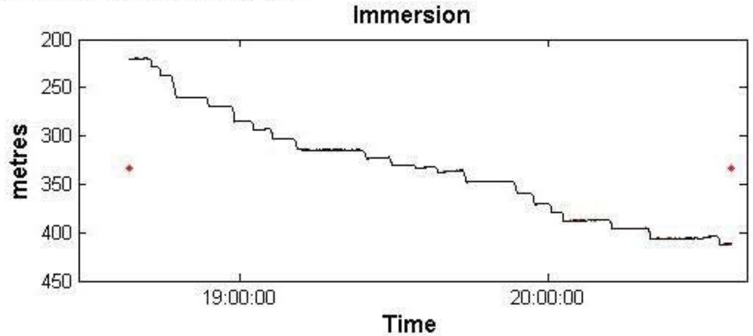


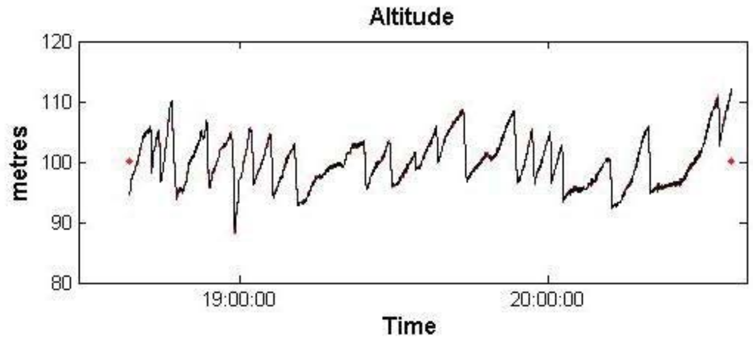

Cruise JCR269 - SYSIF - Dive 3 - Profile 10
SOURCE JH250-6000 (HR)
Starting time : 30/08/2011 15:35:37
Ending time : 30/08/2011 17:37:03
Shooting rate : 2.4 s
Average shot spacing : 2.09 m
Note
Immersion
metres
150
200
250
300
350
400
16:00:00
17:00:00
Time
Altitude
metres
130
120
110
100
90
80
16:00:00
17:00:00
Time
Sonardyne navigation
Latitude
78.585
78.58
78.575
78.57
78.565
9.2
9.3
9.4
9.5
9.6
9.7
Longitude
Bathymetry (SYSIF (k) - Multibeam (r))
metres
250
300
350
400
450
500
16:00:00
17:00:00
Time

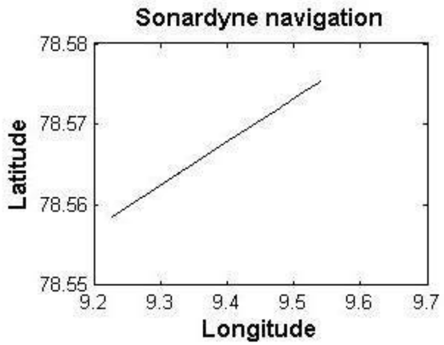
Cruise JCR269 - SYSIF - Dive 3 - Profile 11

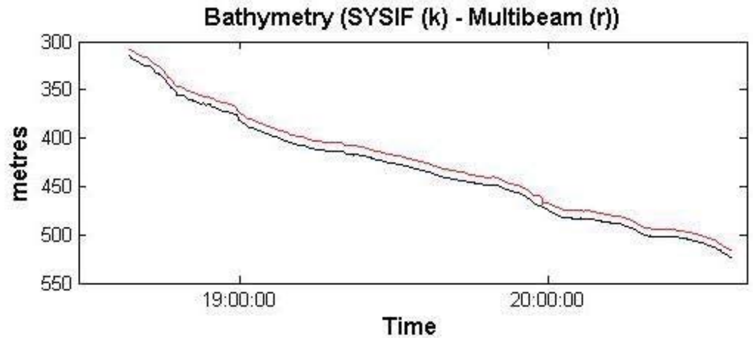
SOURCE JH250-6000 (HR)
Starting time : 30/08/2011 18:38:39
Ending time : 30/08/2011 20:35:25
Shooting rate : 2.4 s
Average shot spacing : 2.51 m

Note





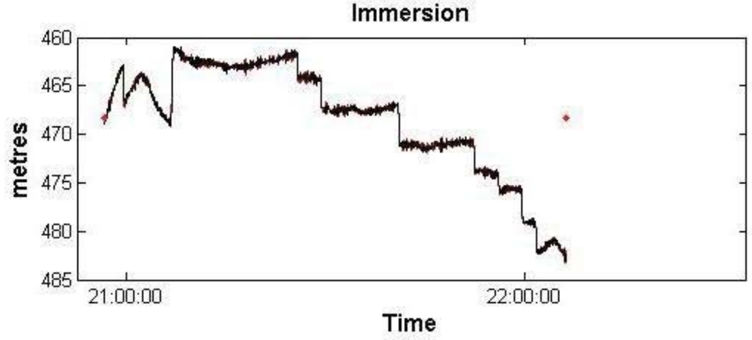


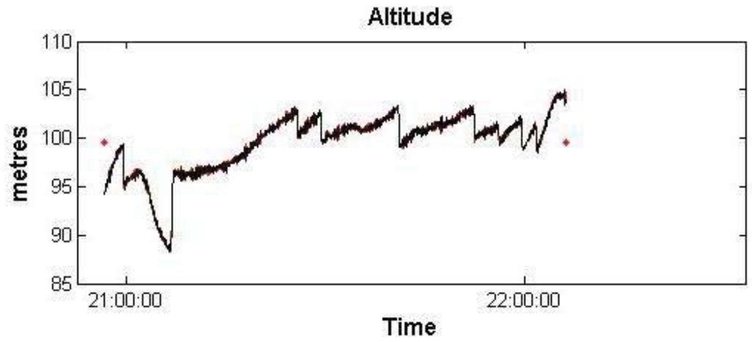


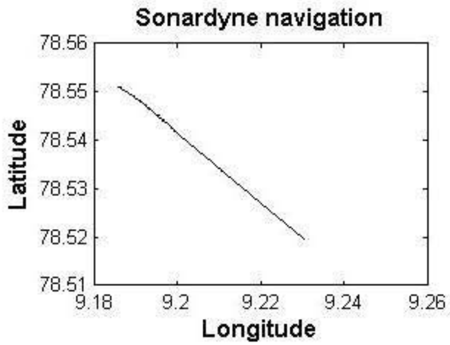
Cruise JCR269 - SYSIF - Dive 3 - Profile 12

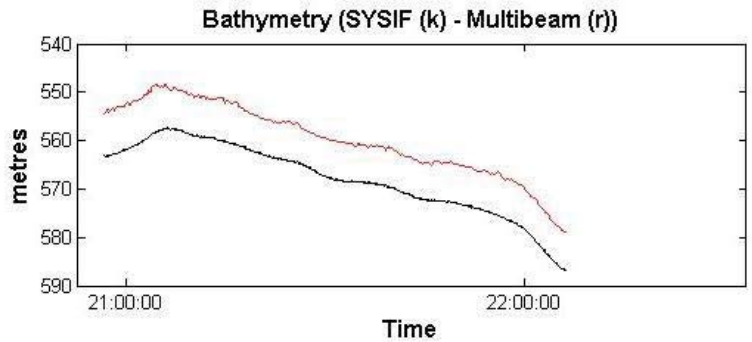
SOURCE JH250-6000 (HR)
Starting time : 30/08/2011 20:56:44
Ending time : 30/08/2011 22:06:25
Shooting rate : 2.4 s
Average shot spacing : 2.2 m

Note





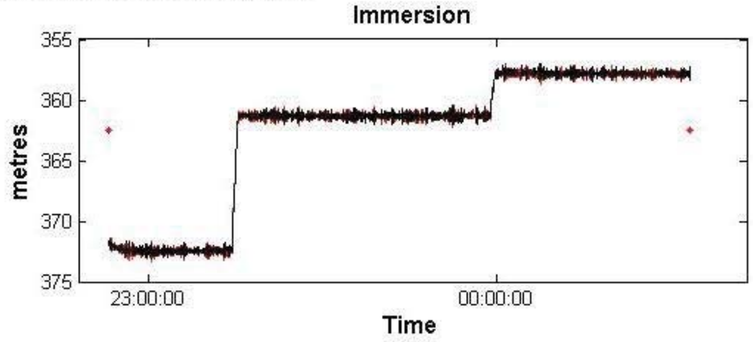


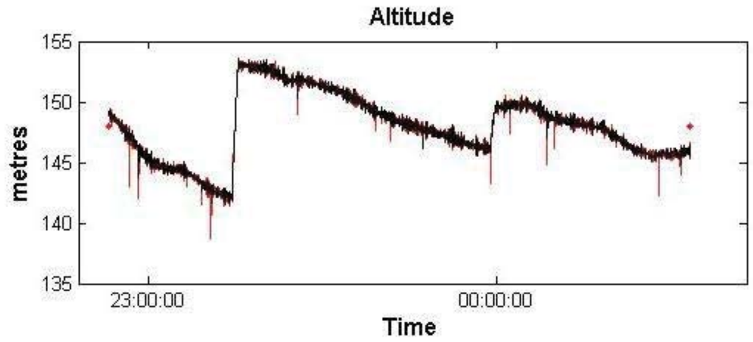


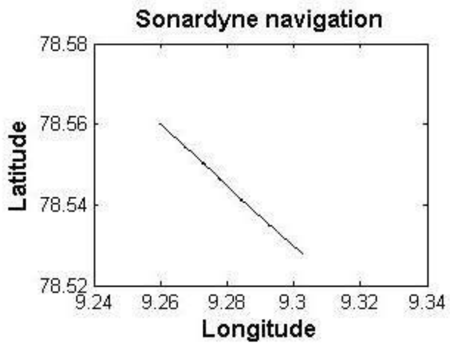
Cruise JCR269 - SYSIF - Dive 3 - Profile 13

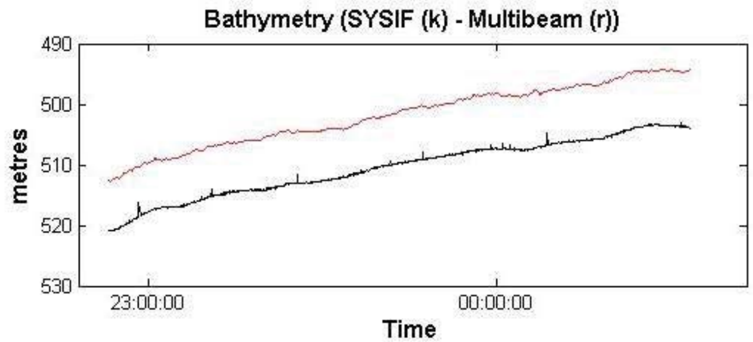
SOURCE JH250-6000 (HR)
Starting time : 30/08/2011 22:53:13
Ending time : 31/08/2011 00:33:29
Shooting rate : 2.9 s
Average shot spacing : 1.84 m

Note
- OBS line





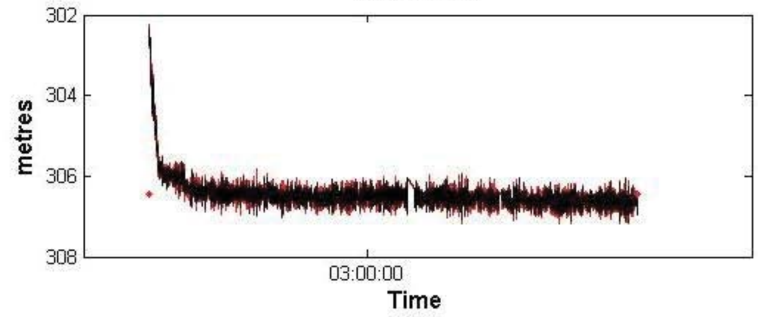


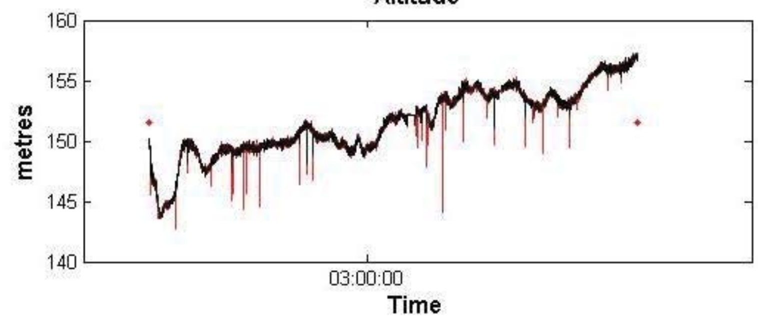


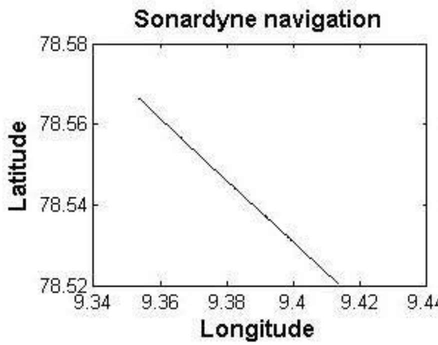
Cruise JCR269 - SYSIF - Dive 3 - Profile 14

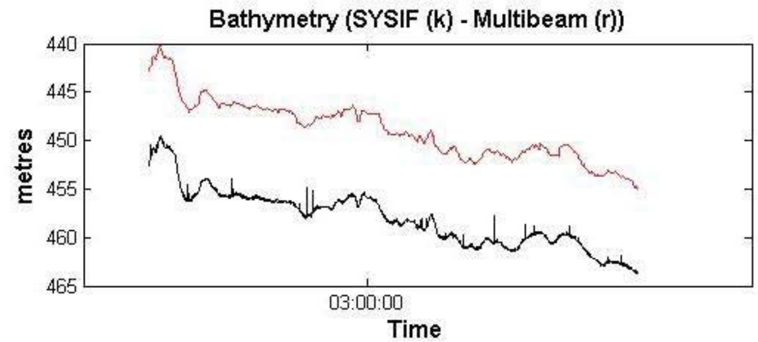
SOURCE JH250-6000 (HR)
Starting time : 31/08/2011 01:25:53
Ending time : 31/08/2011 04:56:29
Shooting rate : 2.9 s
Average shot spacing : 1.26 m

Note
- OBS line





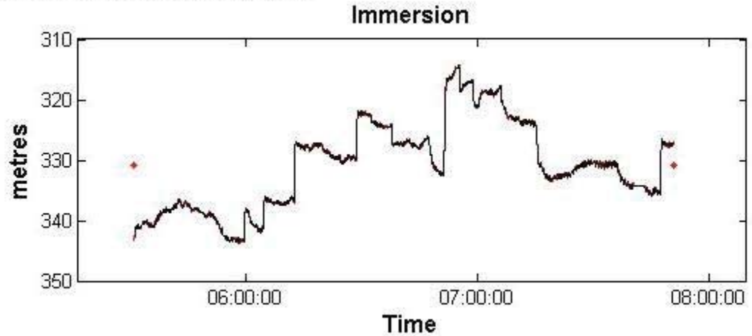


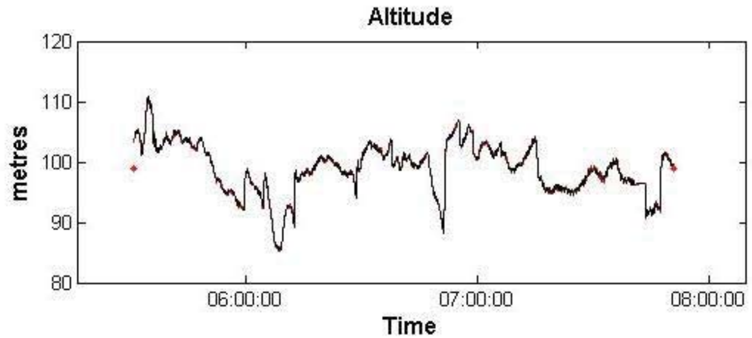


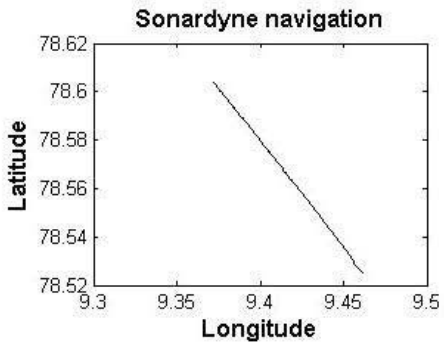
Cruise JCR269 - SYSIF - Dive 3 - Profile 15

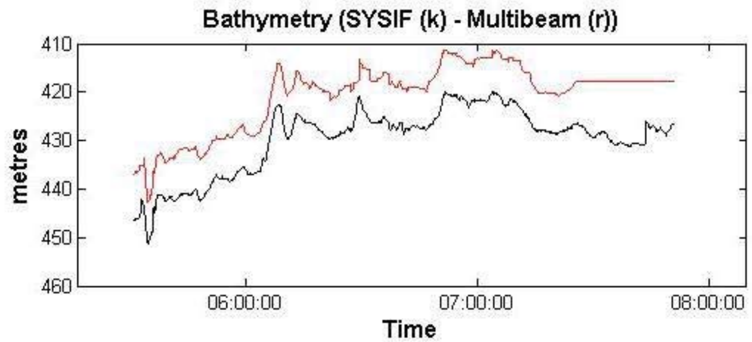
SOURCE JH250-6000 (HR)
Starting time : 31/08/2011 05:31:11
Ending time : 31/08/2011 07:50:35
Shooting rate : 2.4 s
Average shot spacing : 3.25 m

Note





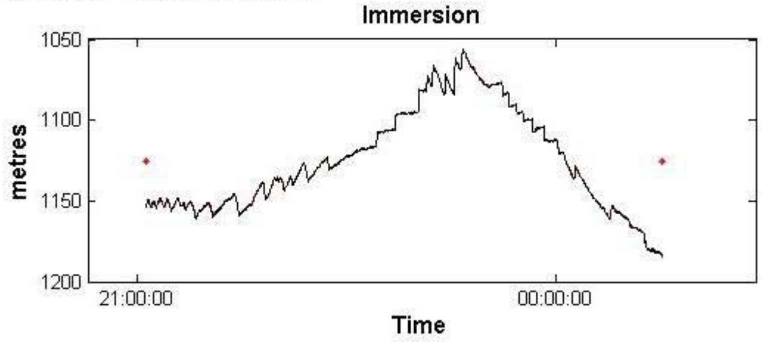


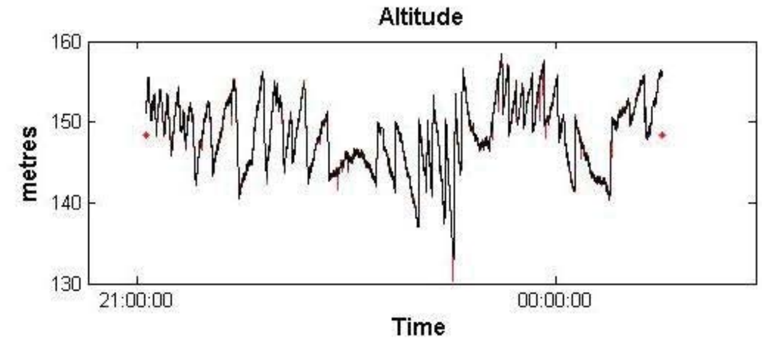


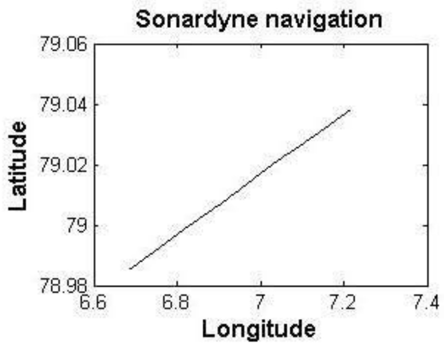
Cruise JCR269 - SYSIF - Dive 4 - Profile 1

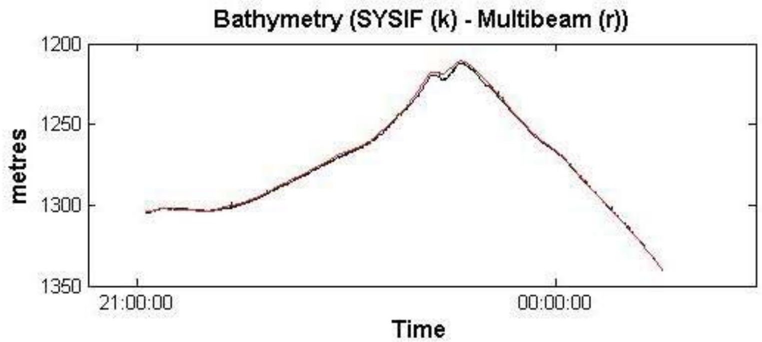
SOURCE JH250-6000 (HR)
Starting time : 02/09/2011 21:03:28
Ending time : 03/09/2011 00:46:16
Shooting rate : 2.0 s
Average shot spacing : 1.95 m

Note
- OBS line





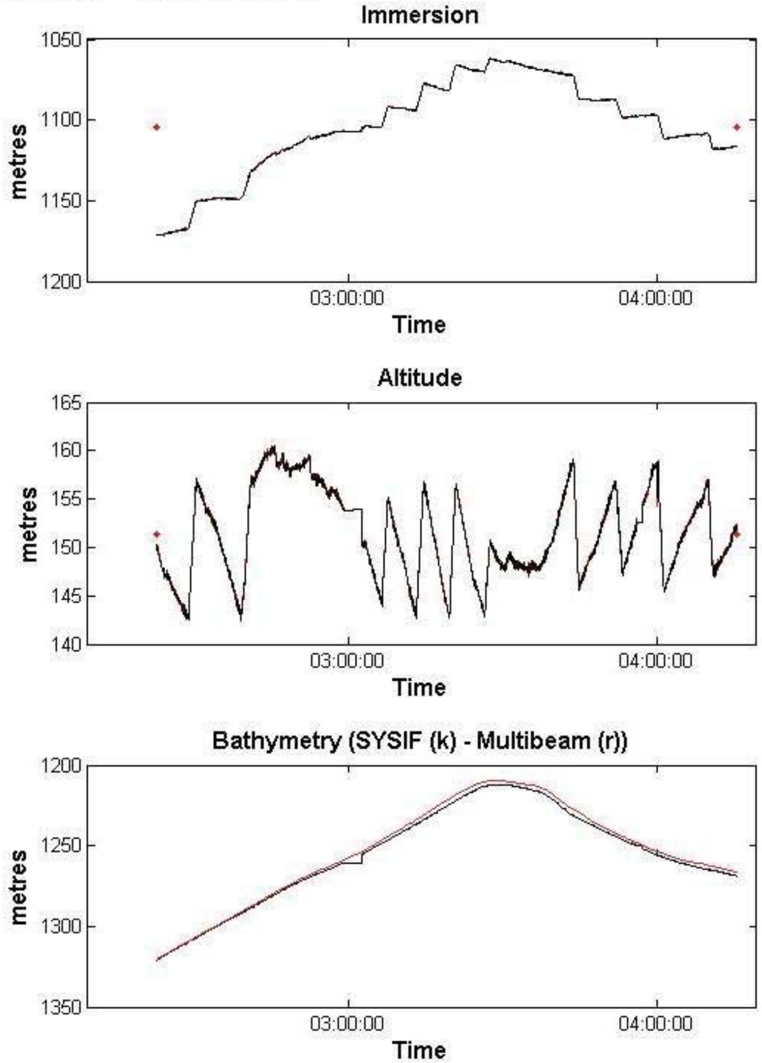


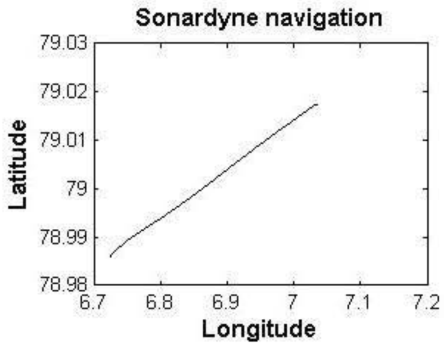


Cruise JCR269 - SYSIF - Dive 4 - Profile 2

SOURCE JH250-6000 (HR)
Starting time : 03/09/2011 02:22:46
Ending time : 03/09/2011 04:15:26
Shooting rate : 2.0 s
Average shot spacing : 2.27 m

Note

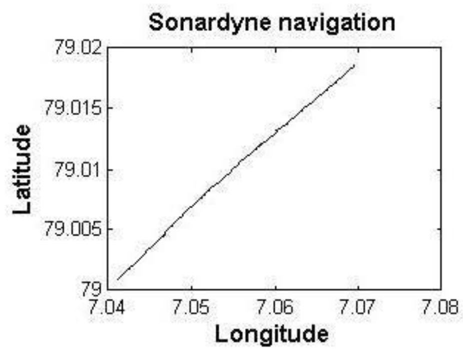


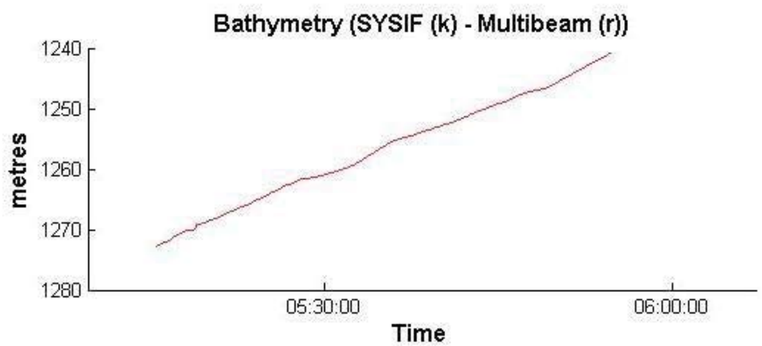


Cruise JCR269 - SYSIF - Dive 4 - Profile 3

SOURCE JH250-6000 (HR)
Starting time : 03/09/2011 05:15:32
Ending time : 03/09/2011 05:54:38
Shooting rate : 2.0 s
Average shot spacing : 1.81 m

Note
- No Synchronization
- No Immersion/Altitude data

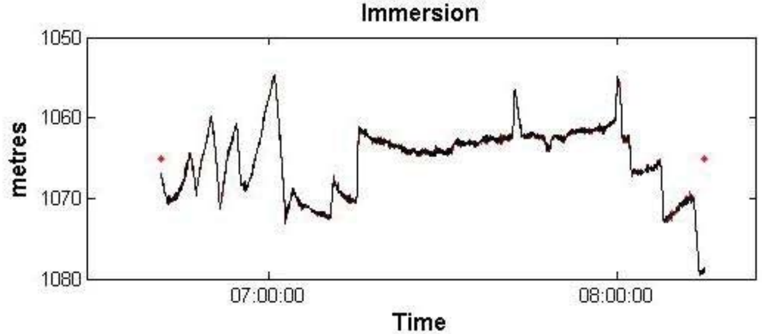


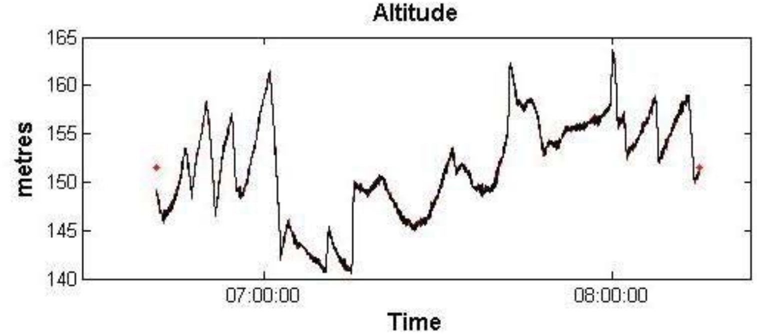


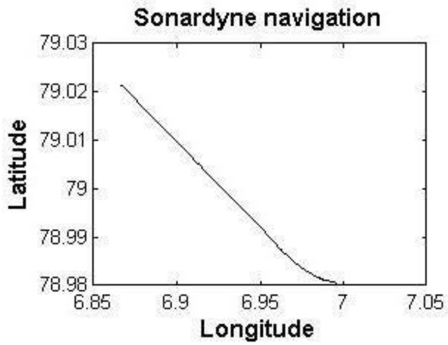
Cruise JCR269 - SYSIF - Dive 4 - Profile 4

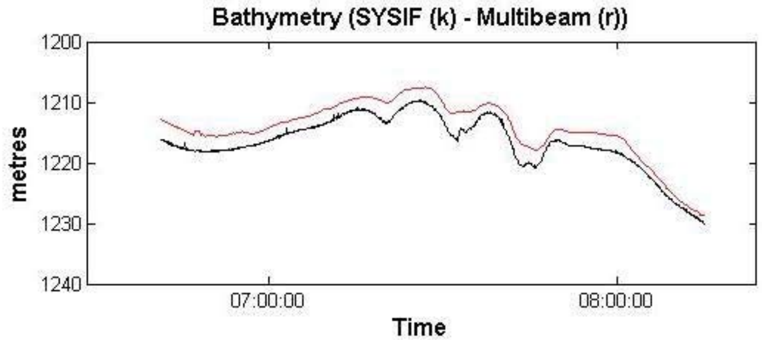
SOURCE JH250-6000 (HR)
Starting time : 03/09/2011 06:41:24
Ending time : 03/09/2011 08:14:56
Shooting rate : 2.0 s
Average shot spacing : 2.07 m

Note





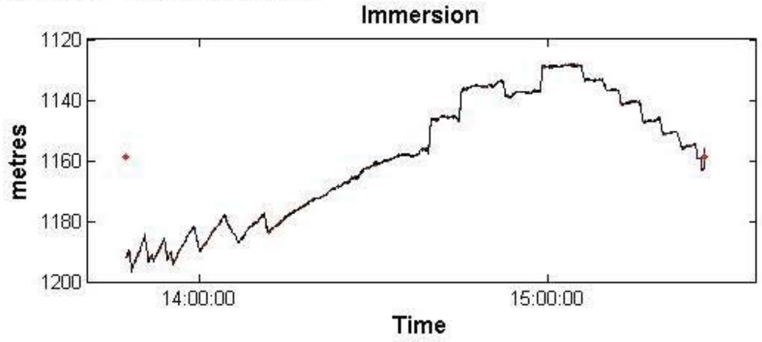


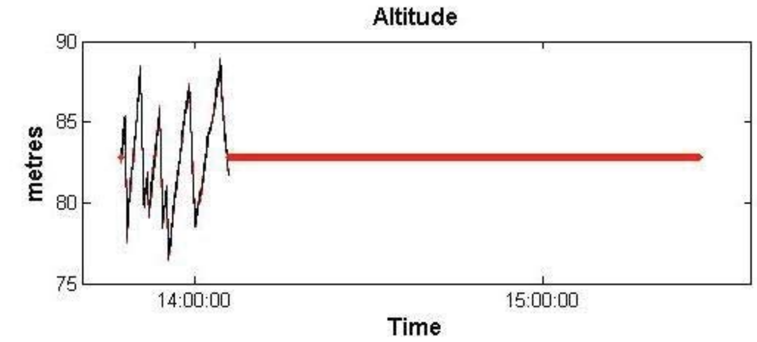


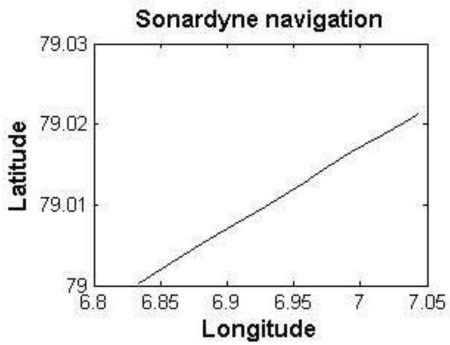
Cruise JCR269 - SYSIF - Dive 5 - Profile 1

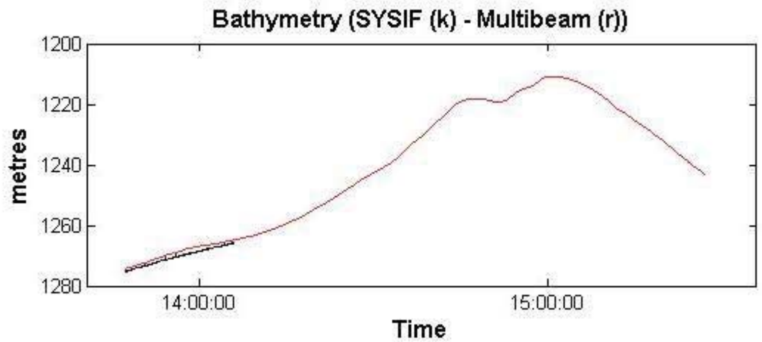
SOURCE JH650-6000 (THR)
Starting time : 03/09/2011 13:47:19
Ending time : 03/09/2011 15:27:05
Shooting rate : 2.0 s
Average shot spacing : 1.7 m

Note
- Altitude gaps





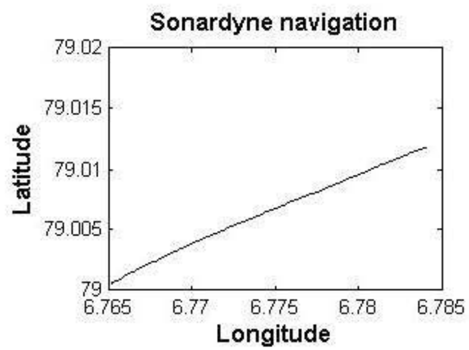


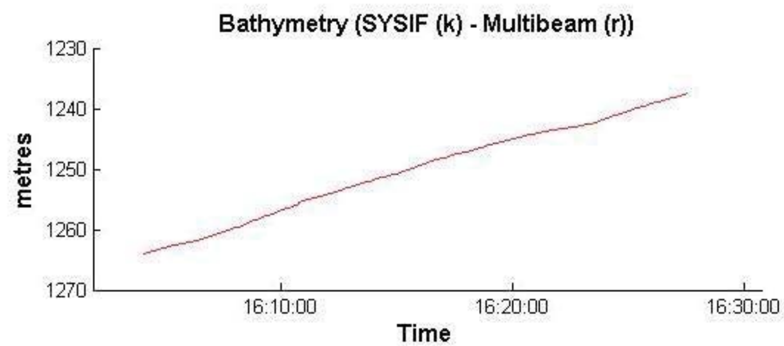


Cruise JCR269 - SYSIF - Dive 5 - Profile 2

SOURCE JH650-6000 (THR)
Starting time : 03/09/2011 16:04:07
Ending time : 03/09/2011 16:27:30
Shooting rate : 2.0 s
Average shot spacing : 1.94 m

Note
- No Synchronization
- No Immersion/Altitude data

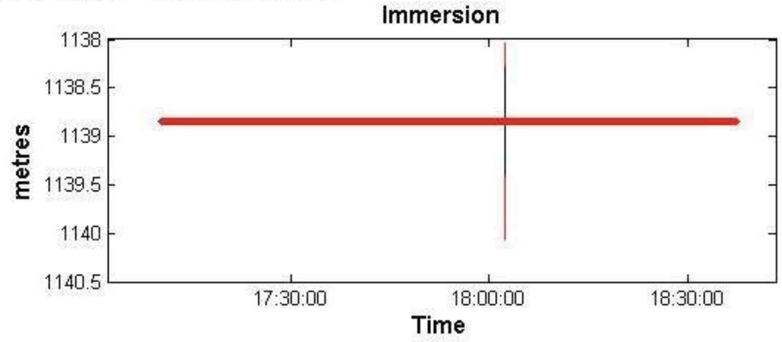


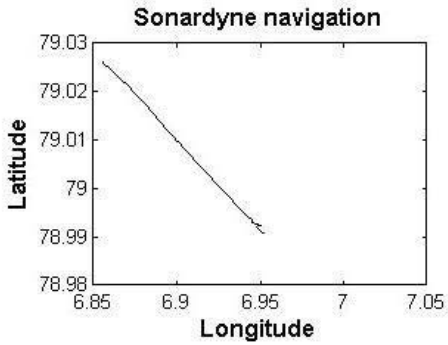


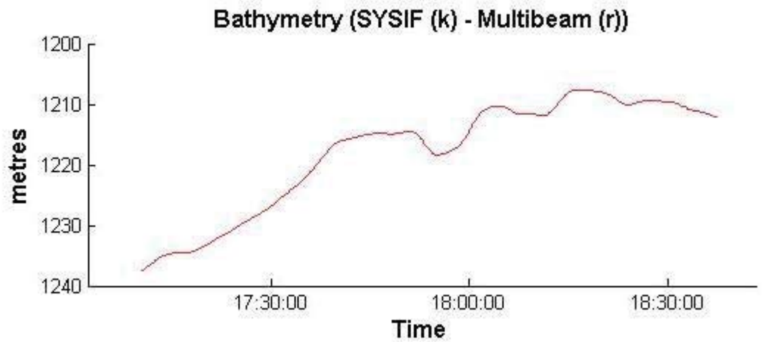
Cruise JCR269 - SYSIF - Dive 5 - Profile 3

SOURCE JH650-6000 (THR)
Starting time : 03/09/2011 17:10:32
Ending time : 03/09/2011 18:37:17
Shooting rate : 2.0 s
Average shot spacing : 1.8 m

Note
- No Synchronization
- No Immersion/Altitude data







10. MULTICHANNEL SEISMIC REFLECTION (Y. Thomas, B. Marsset, S. Ker and M. Vardy)

10.1. Summary

The seismic source was a single GI gun provided by IFREMER-GENAVIR with a 45 cu. in. generator and 45 cu. in. injector, operating at 2000 psi. The gun was suspended by 3.5 m of rope from an 80L surface buoy, and expected to tow at 1.5-2 m depth at a survey speed of 4 knts through the water. The towing point was 2.5 m starboard of the axis of the vessel. The tow cable was attached to the front of the gun and the rope from the buoy was attached to the back of the gun. It was towed 20 m astern of the vessel. The gun trigger was generated by a trigger box from IFREMER. The gun was set to fire approximately 42 ms after the trigger. A gun hydrophone signal was monitored and recorded on a system provided by IFREMER. The same trigger was used to trigger acquisition by the University of Southampton Geometrics Strataview acquisition system. The trigger time was also recorded independently by the OBIF team on a Verify datalogger. The gun hydrophone signal showed that the gun firing time had a jitter of 1-2 ms, which is large enough to be significant for the high frequencies involved in this experiment. The shot time from digitization of this gun hydrophone signal should therefore be used in preference to the trigger time recorded on the OBIF Verify system. A "soft start" was used at the start of each period of shooting, comprising 10 minutes of shots once per minute, 5 minutes of shots every 30 s, and 5 minutes of shots every 10 s. Marine mammal observations were carried out for at least one hour prior to commencement of each period of shooting.

The hydrophone streamer comprised a 60-m, 60-group active section, a 5 m tail section, a 20 m rope to a small tail buoy, and a tow cable of around 40 m, of which around 15 m was on the deck, so that the first channel was around 30 m from the stern. Each group comprised 7 elements. The towing point was 13.5 m to port from the axis of the vessel, on a swinging boom. Because of limitations on cable lengths, the acquisition electronics were housed in a waterproof box bolted to the deck on the port side. The streamer was deployed by hand. The streamer depth was somewhat variable, between about 2 m and 5 m. Data acquisition used a Strataview datalogger, with a sample interval of 0.5 ms and data were recorded in standard SEG-D format, with one file per shot. The first period of acquisition was done with a record length of 4 s and a shot interval of 6 s; subsequently a record length of 3 s (plume area) or 3.5 s (Vestnesa area) and a short interval of 5 s was used. A single auxiliary trace from the shot hydrophone was recorded on an Ifremer PC.

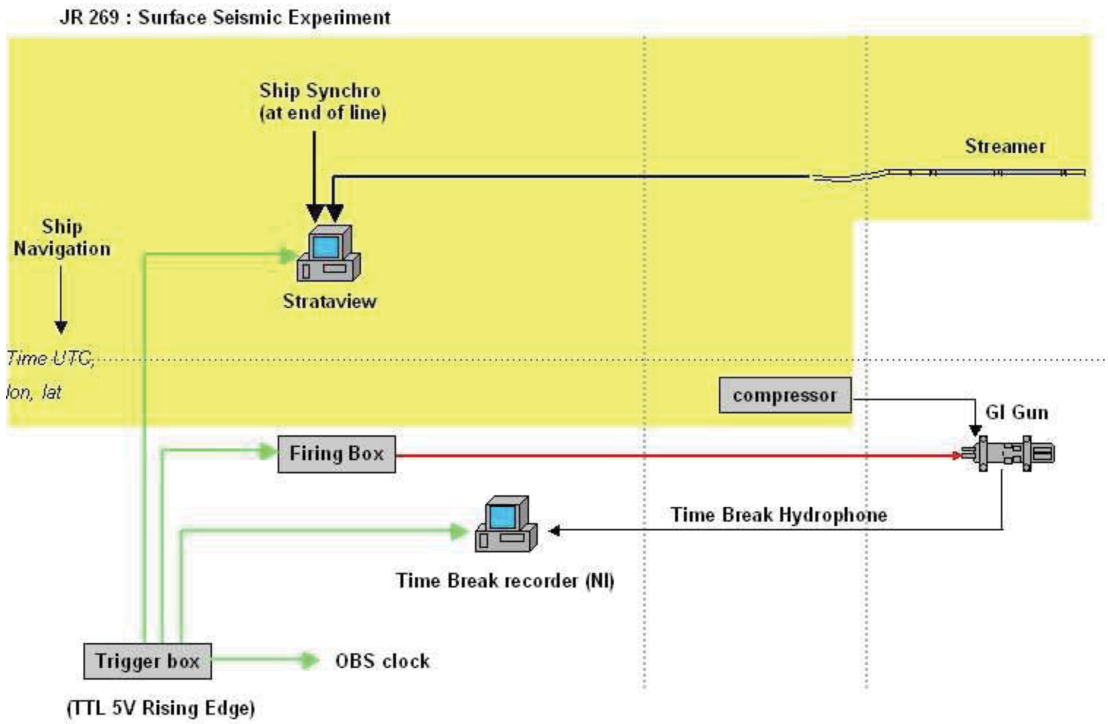


Figure 10.1 : Surface seismic equipment operated during the JR269 cruise

10.2. Profiles

A new line was normally required every hour to maintain time synchronization between the Strataview seismic recorder and GPS clock. However, given the length of lines for this survey it was sufficient to start a new recording line for each survey line (most of which were approximately an hour in length). Stop/Start could be done within several seconds, and was always completed at the end of a survey line, during a turn. The Stop/Start had to be done on both seismic recorder and auxiliary recorder in order to maintain correlation between the FFIDs recorded on the Strataview seismic recorder and the shot numbers on the auxiliary recorder. Data recording continued during turns, with FFID of start/end of line logged in Seismic Logbook.

10.3. Seismic Navigation

For MCS seismic acquisition, navigation data was taken from ship's DGPS navigation system. On the RRS James Clark Ross, this comprises a SEATEX system with two antennae mounted above the bridge. Offset between the vessel's Navigation Reference Point (NRP) and the waterline at centre of the stern of the vessel was known from installation (55.18 m astern, parallel to vessel axis; 0.0 m perpendicular to vessel axis; and -7.558 m down in the vertical, Z axis). Shot position is computed off-line using dating of navigation log and time of shot from the OBS clock.

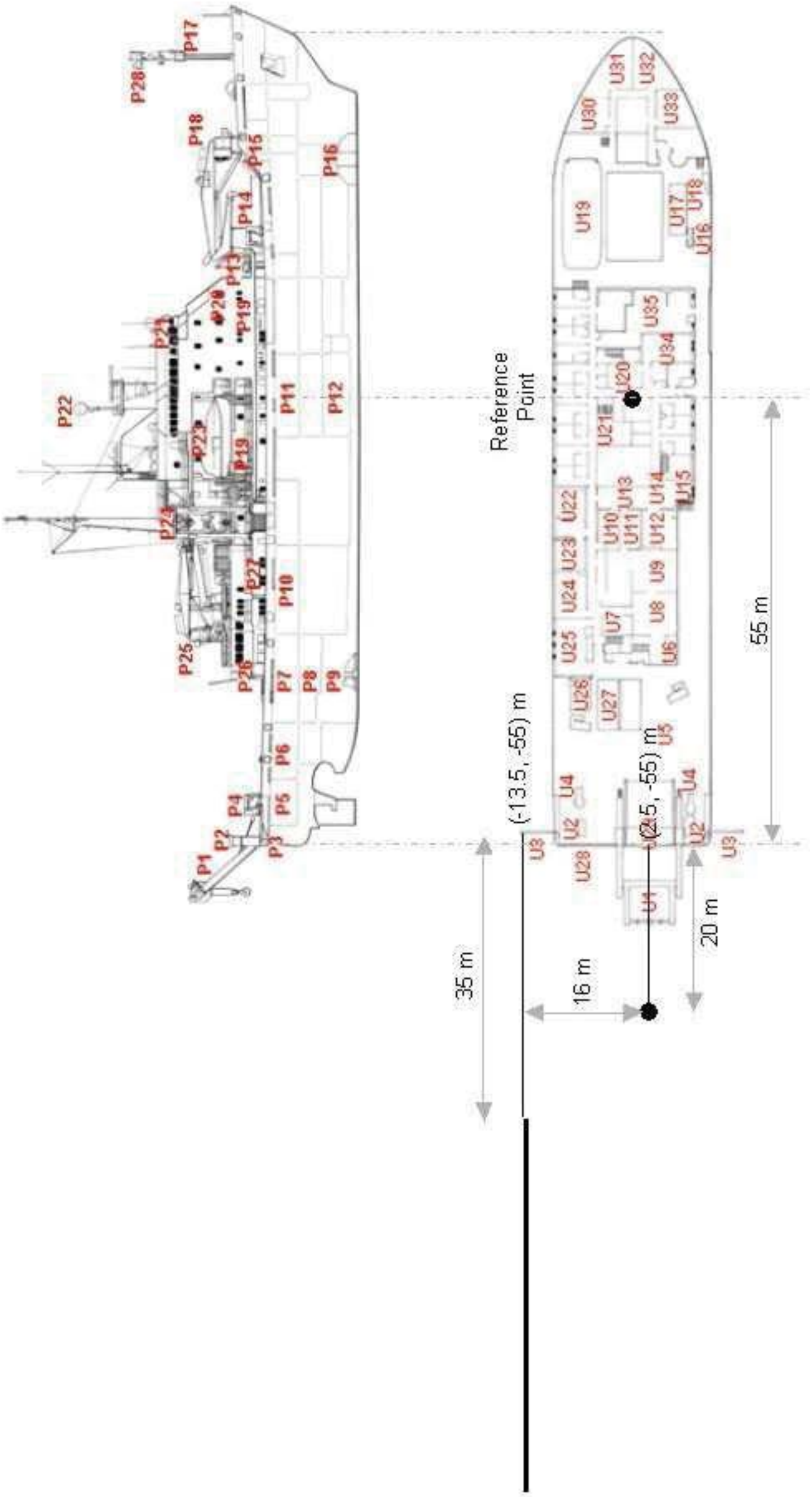


Figure 10.2 : Seismic Acquisition Geometry

10.4. Auxiliary trace

Time Break hydrophone of the air gun;
Recorded using NI-USB9162, laptop and Matlab code;
Frequency sampling: 5 kHz; 0 delay, 250 ms record length

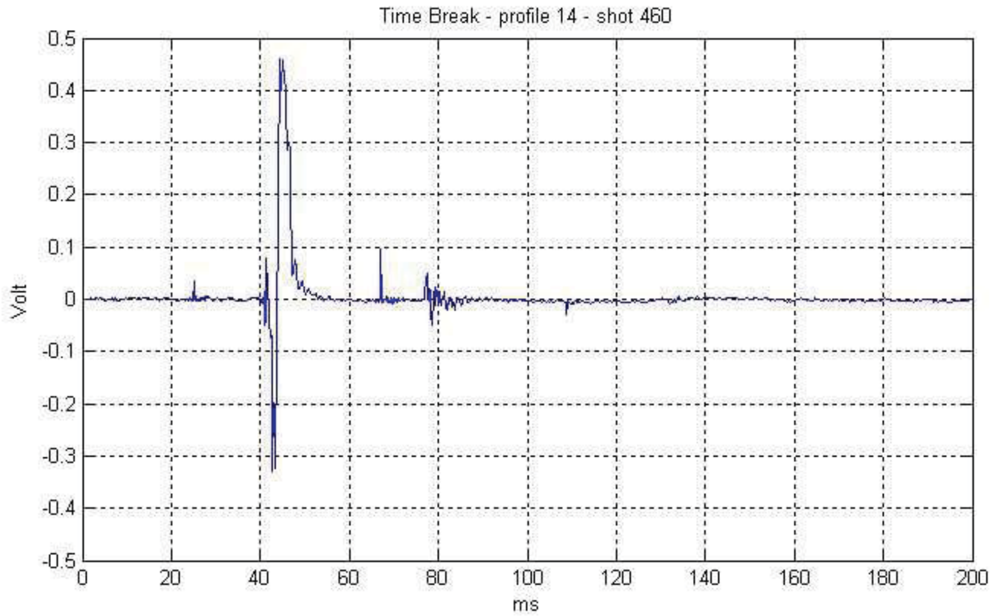


Figure 10.3: Example of TB signal – source delay is 42 ms

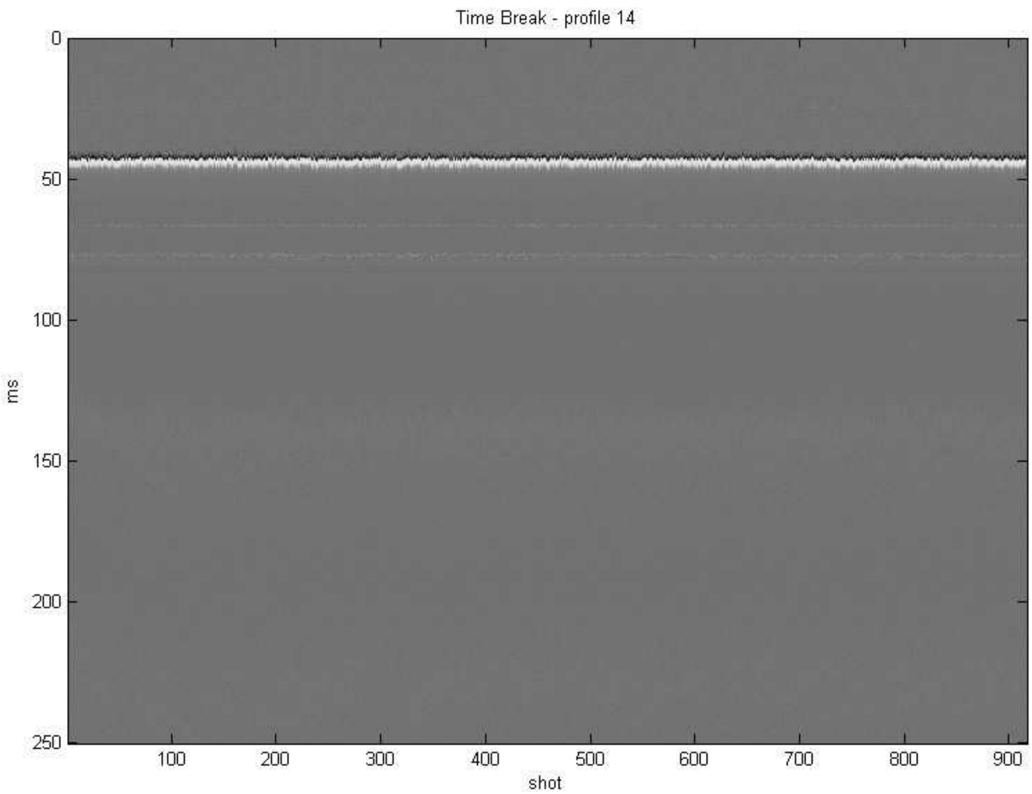


Figure 10.3: Example of TB section (profile 14)

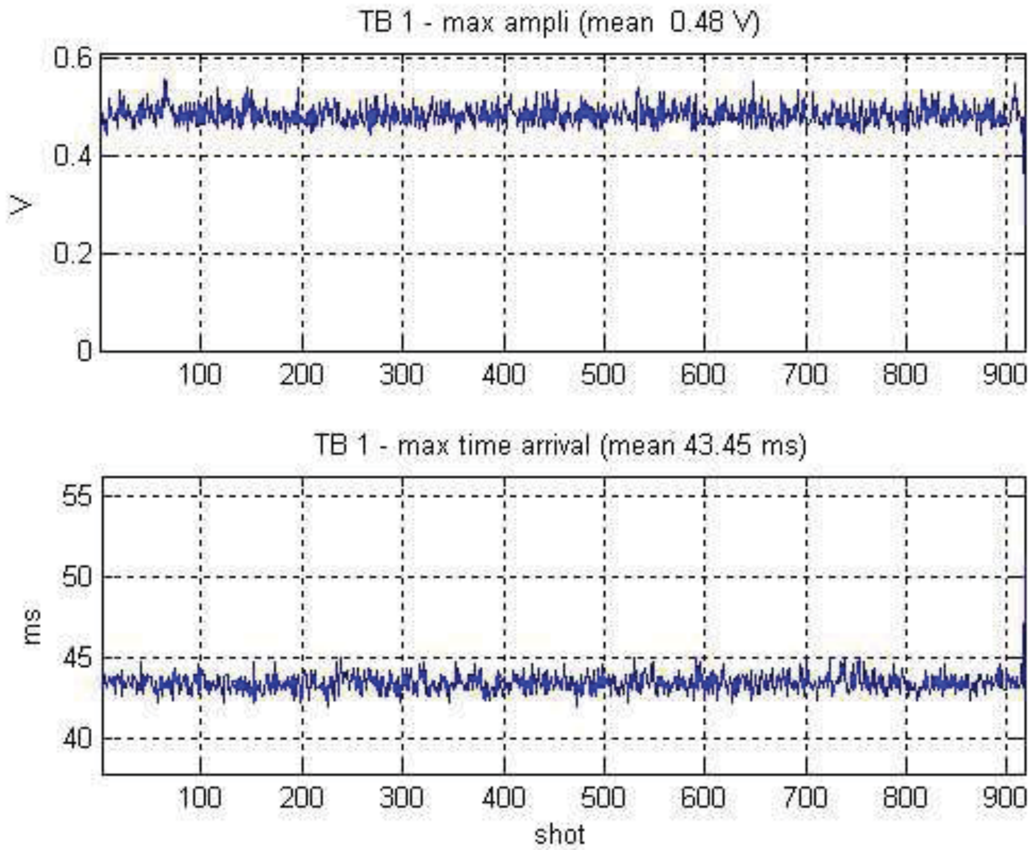


Figure 10.4: Time Break: picking of maximum amplitude from TB section (profile 14)

Amplitude and delay are quite constant, showing that the air-gun and the triggering system work well.

10.5. Check on the geometry and the source delay using direct arrival

Results from modeling of direct arrival:

- source delay: 42 ms ± 1 ms;
- surface water velocity: 1500 m/s
- source – first trace offset:
- X (perpendicular to the vessel axis): 16.0 meters,
- Y (parallel to the vessel axis): 15 meters

With a water velocity of 1500 m/s (plume area, S 30.4, T 6.6°, 1504 m/s) this correlates to an estimated Y offset (parallel to the vessel axis) of 15 m for channel 1. Although slightly large, it is not unreasonable given that all the seismic streamer lead-in was deployed, and the height of the A-frame block from which the airgun was towed (which shortened the tow distance significantly relative to the 30 m of rope paid out). Absolute offsets are thus: 22 (first channel) to 76 meters (last channel)

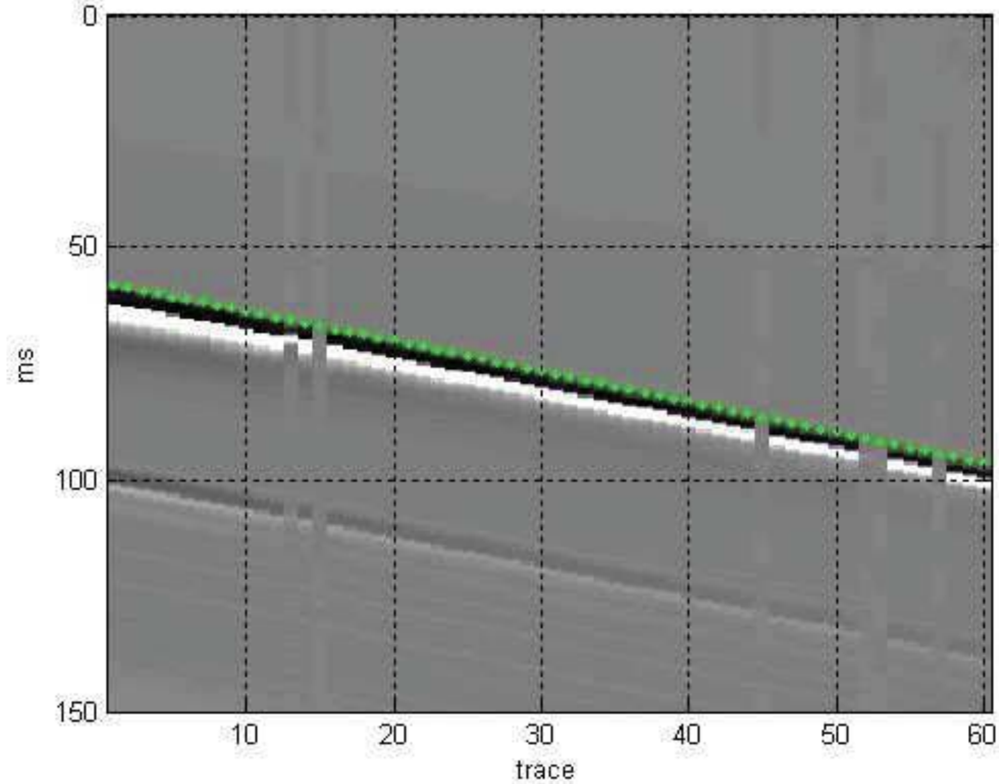


Figure 10.5: Direct arrival from mean shot gather (profile JCR269-19, FFID 9000-9200); green points are modelled direct arrival times

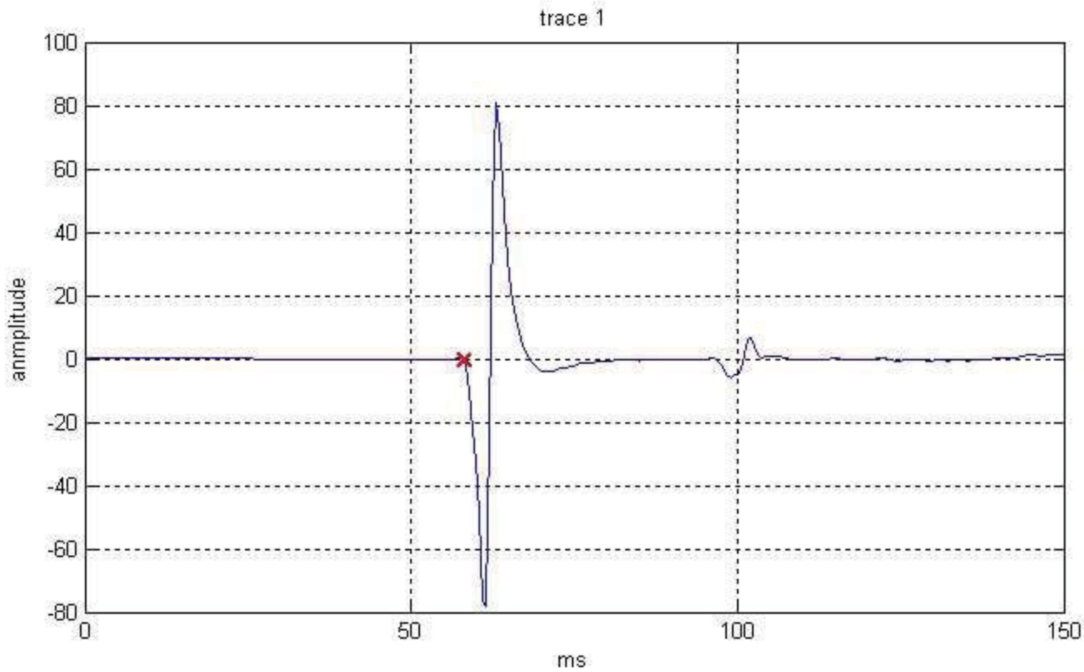


Figure 10.6: Direct arrival from mean shot gather, trace 1 (profile JCR269-19, FFID 9000-9200)

10.6. Signal spectrum versus streamer depth

Examples of Common Receiver Gathers used to compute spectrum sections are shown below.

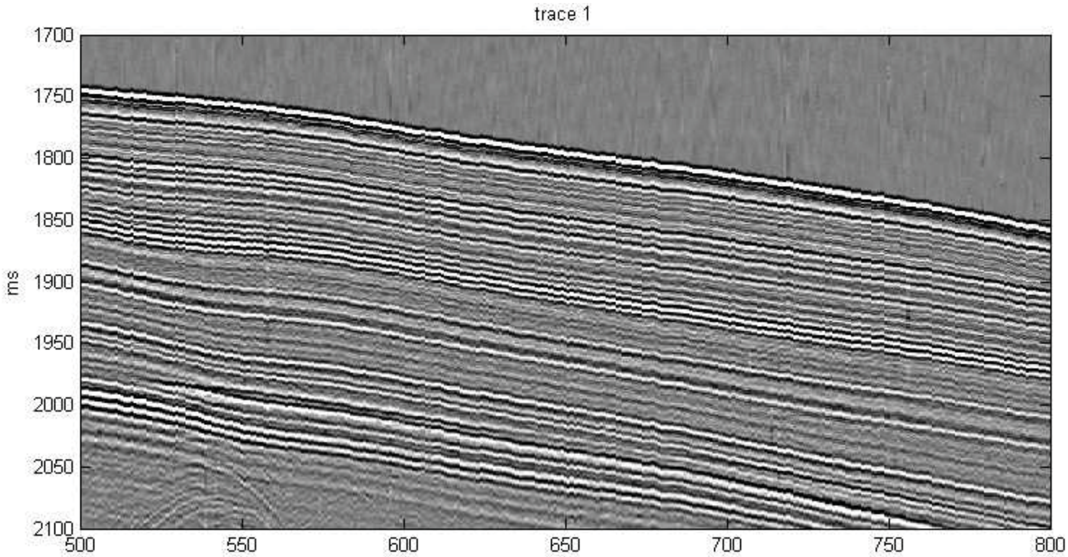


Figure 10.7: Profile 19 – CRG 1

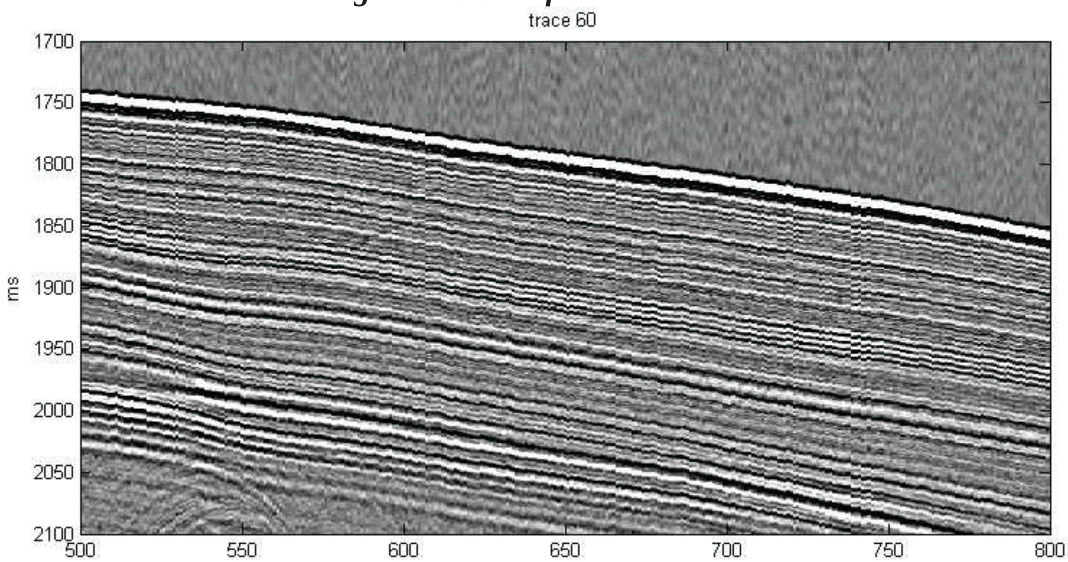


Figure 10.8: Profile 19 – CRG 60

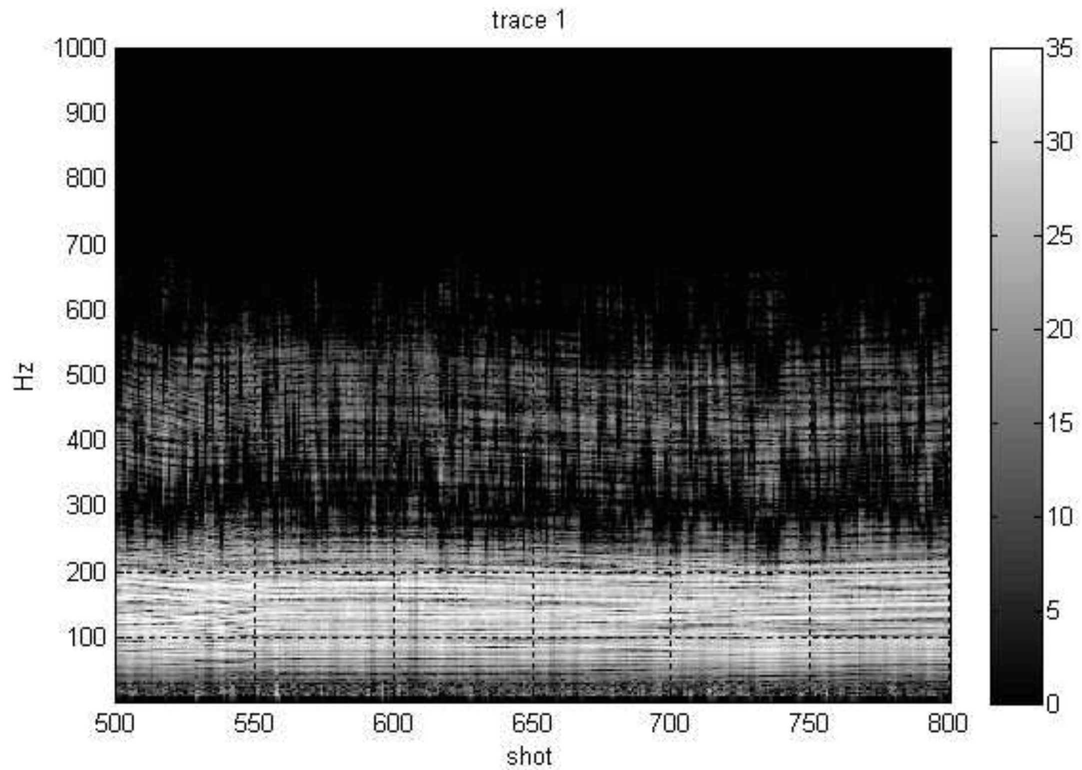


Figure 10.10: Profile 19 – CRG 1 – Spectrum section (amplitude in dB). Horizontal black line corresponds to low energy (streamer notch: 300 Hz_ 2.5 m depth)

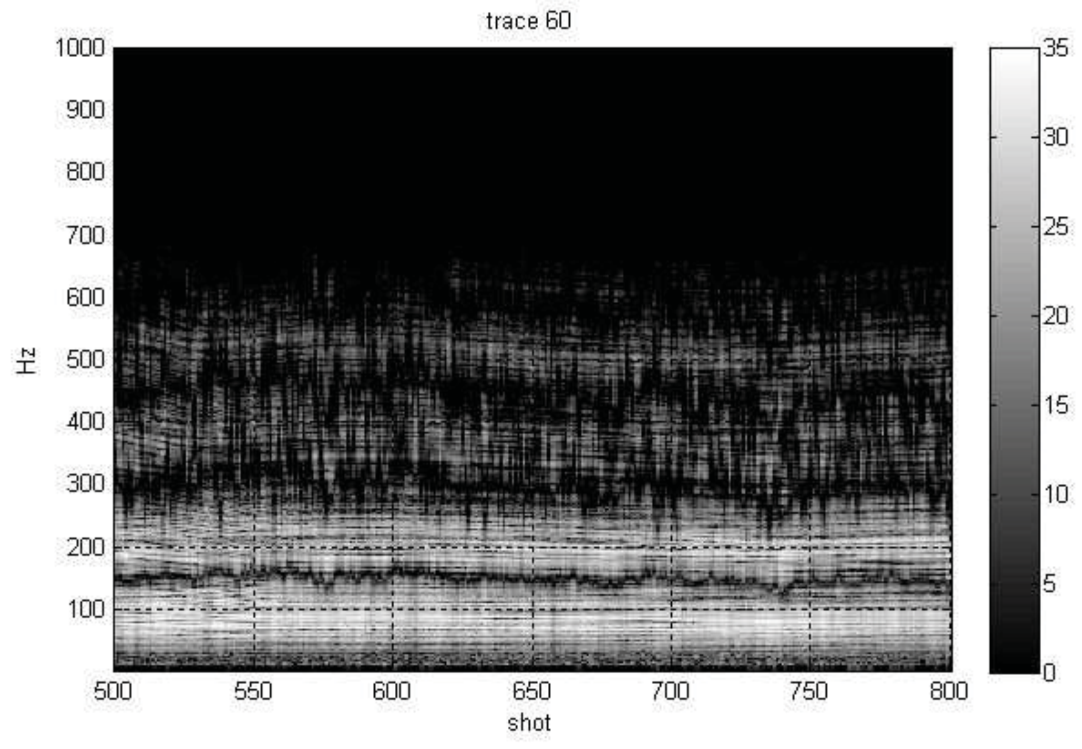


Figure 10.9: Profile 19 – CRG 60 – Spectrum section (amplitude in dB). Horizontal black lines corresponds to low energy (streamer notch and harmonic: 150 Hz_ 5 m depth)

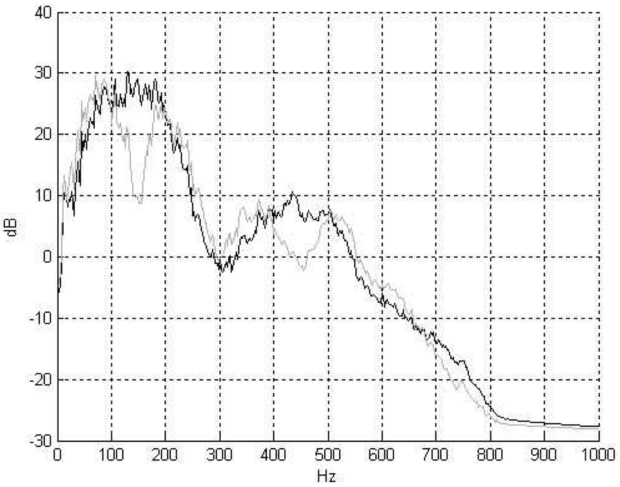


Figure 10.10: Mean spectrum: trace 1 (black curve), trace 60 (gray curve)

Streamer notch frequency for trace 1: 300 Hz implies 2.5 m depth
150 Hz central frequency, 50-210 Hz @ -6 dB
Streamer notch frequency for trace 60: 150 Hz implies 5 m depth
90 Hz "central frequency"
Loss of low high frequencies on traces of streamer's tail.
Note: from profile JCR269-26 to the end of the survey, the small tailbuoy was removed.

10.7. Signal to noise ratio

Signal to noise ratio computed for profile JCR269-19
Shot 500 to 750 – Filter 25-350 Hz
Noise time window: above sea bottom, sample 2500-2900, 200 ms long
Signal time window: 400 samples from the sea floor, 200 ms long

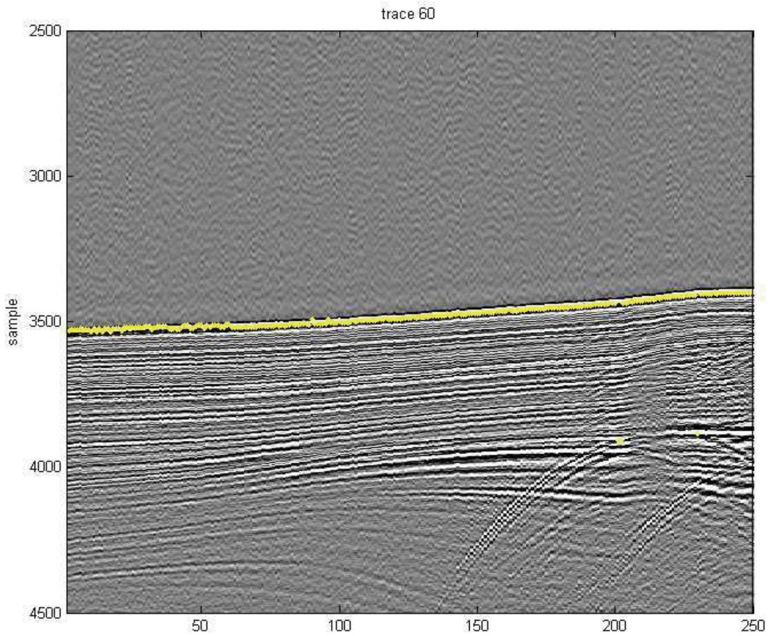


Figure 10.11: Example of CRG (#60) – automatic picking of the sea floor (yellow points) to define start of the signal window (400 samples long) – filter 25-350 Hz. Mean signal ratio for this trace is 21.5 dB

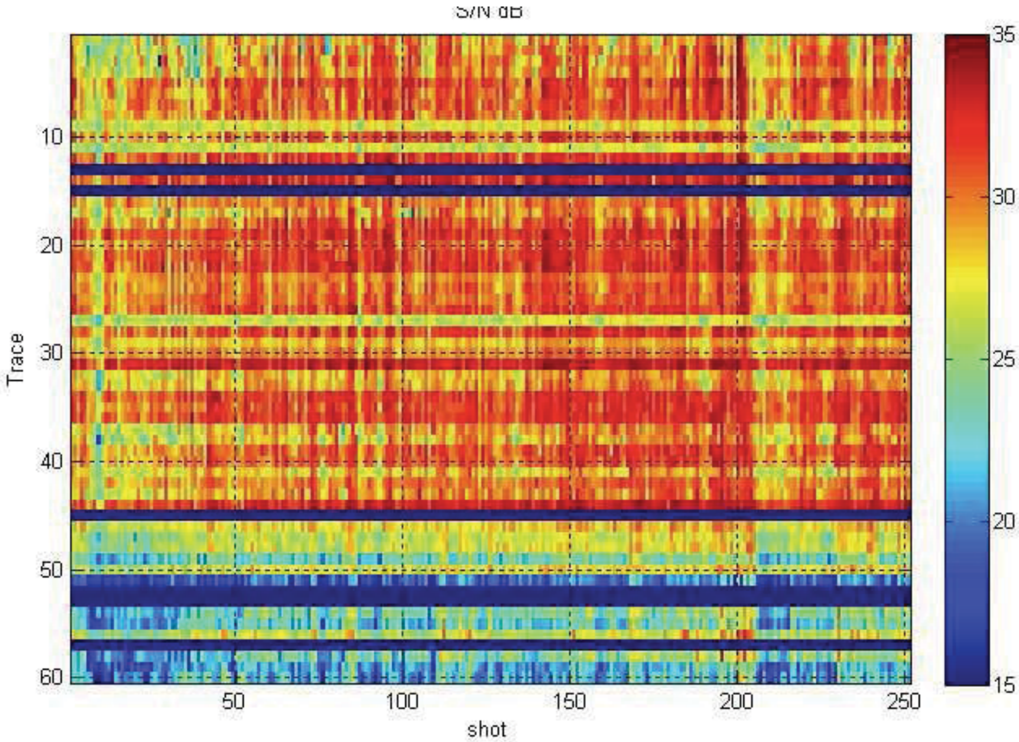


Figure 10.12: Signal to noise ratio computed from profile JCR269-19 Shot 500 to 750 – Filter 25-350 Hz

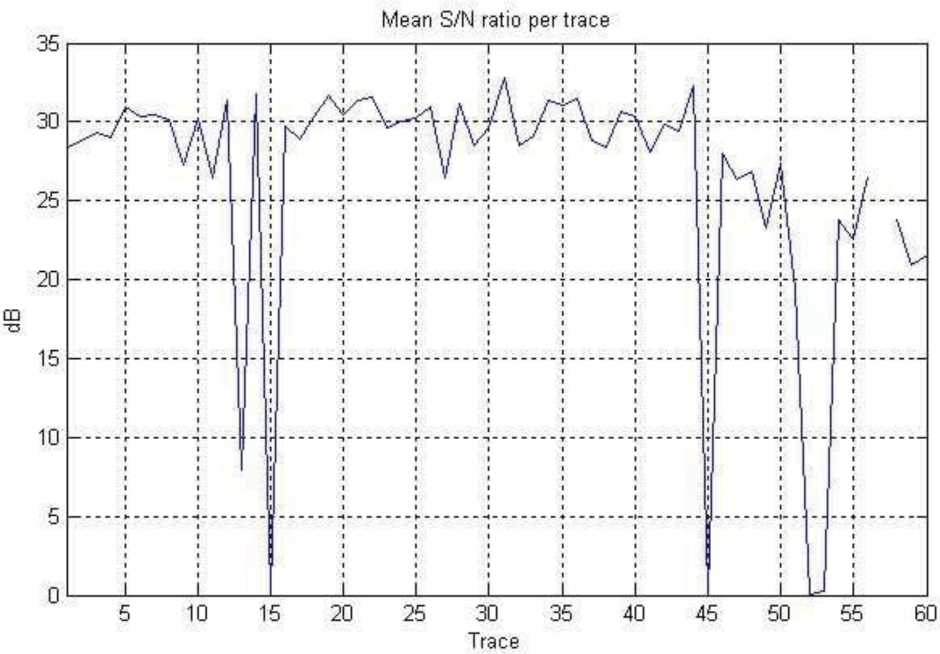


Figure 10.13: Mean S/N ratio per trace

Channels 13, 15, 45, 52, 53, 57 were previously known to be damaged and noisy. These traces are not used during processing. All the other traces display high signal to noise ratio, with a slight increase of noise from trace 46 to 60. Thus, the full data set is of rather good quality.

10.8. "Seismic signature" extracted from the sea-floor

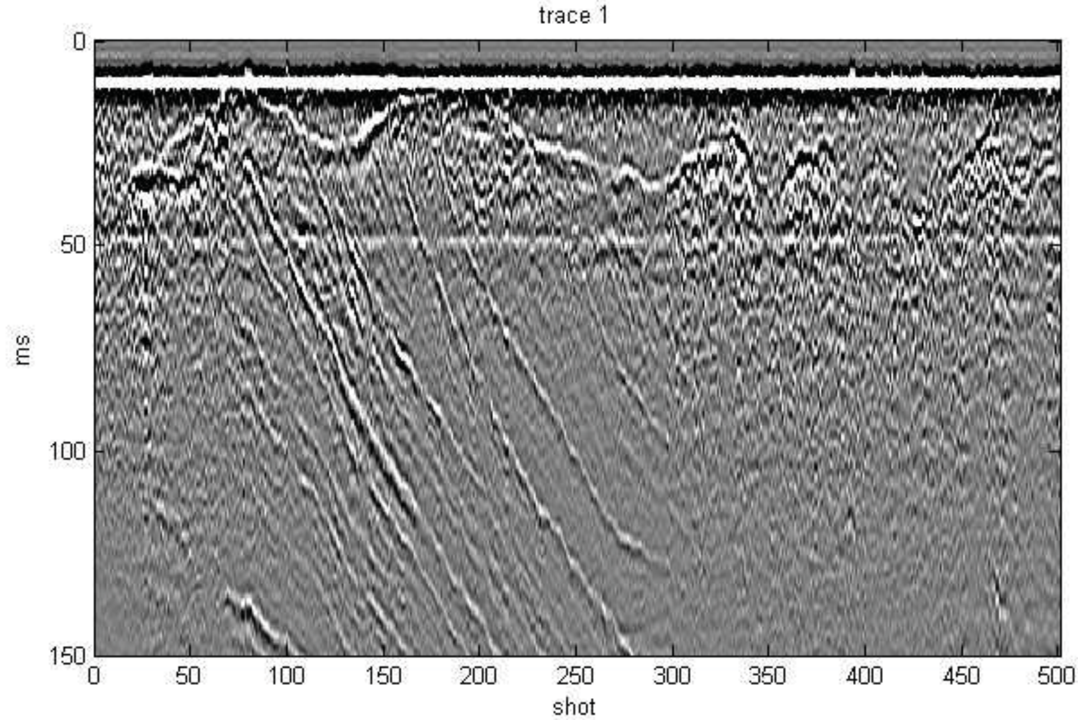


Figure 10.14: Profile 17 – single trace # 1 flattened following the sea floor

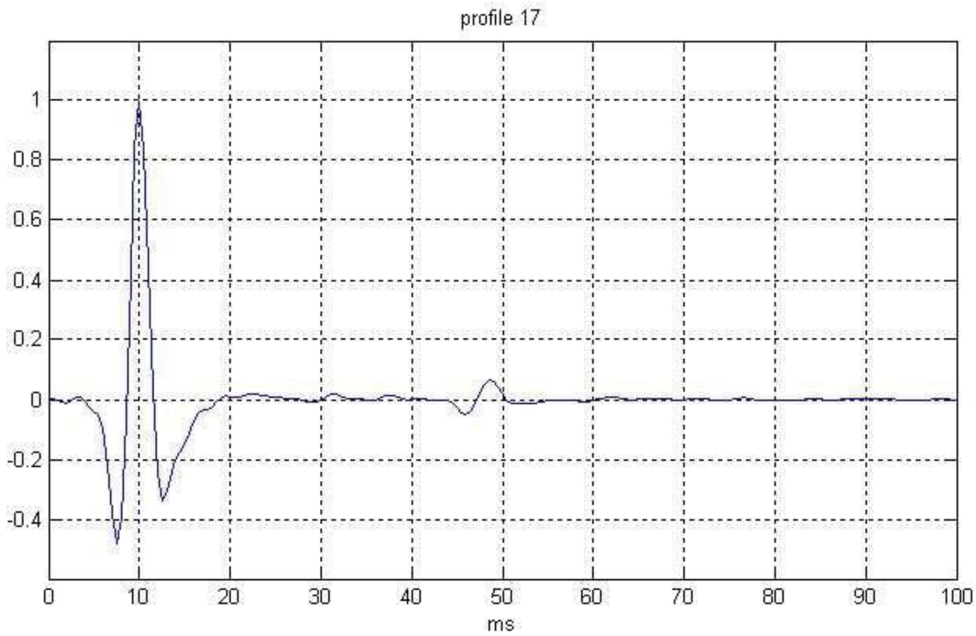


Figure 10.15: Mean seismic signature from the sea floor (profile 17). The secondary arrival corresponds to the injector blast, 40 ms delayed from the generator blast; relative amplitude is 6.5 % of the primary blast.

10.9. Initial on-board processing

All survey lines were processed into basic stacked sections while on board using Landmark's ProMAX software. This facilitated generic estimation of profile QC, and confirmed that data could be successfully binned onto a CDP bin spacing equivalent to SYSIF trace spacing (thereby allowing direct comparison). The processing sequence was as follows:

1. Data were divided into survey lines before loading SEG-D files into ProMAX.
2. Nav data was loaded and basic geometry was applied:
   a) Gun:
      Y offset (parallel to vessel axis): 75.2 m
      X offset (perpendicular to vessel axis): -2.5 m
      Tow depth: 1.5 m
   b) Streamer:
      Y offset: 90.0 m
      X offset: 13.5 m
      Tow depth: 3.5 m (for simplicity, average was assumed)
3. Using this geometry, traces could be assigned into 2.0 m CDP bins.
4. Channels 13, 15, 45, 52, 53, 57 were removed and a static correction of -42.0 ms was applied for the delay between triggering and the airgun firing.
5. Bandpass filter: 10 Hz, 30 Hz, 600 Hz, 1000 Hz.
6. Normal move-out correction using a simple 1500 m/s velocity function.
7. CDP mid-point stack.
8. Amplitude recovery, correcting for spherical spreading and a subtle 1.8 dB/s signal attenuation. Although too subtle to be realistic, this successfully boosted later arrivals without over-gaining the high-amplitude first and second order mutliple arrivals.

10.10. Basic processing to have a first quick look at the data set

This processing was completed by Ifremer using an in-house Matlab code, with the following steps:

1. Data were divided into survey lines (same as NOC); see further tables;
2. Extraction of vessel GPS data from raw seatex file (position of reference point) along the survey line; computing and display of the ground heading to select shots to avoid during turning (start or end of line);
3. Interpolation of vessel position at shot time, smoothing of positions;
4. Extraction of vessel gyrocompass data from raw vessel log file;
5. Interpolation of vessel gyrocompass at shot time, smoothing;
6. Computation of source and receivers positions using geometry layout, gyrocompass and GPS processed data; streamer and source cable are projected behind the vessel using the gyrocompass heading;
7. Binning: bin size 3 meters + output of CMP positions (lon,lat) WGS84
8. Pre-processing of seismic data:
   reverse polarity;
   band-pass filter: 25-350 Hz;
   static correction: 42 ms (source delay);
   trace edit: 13, 15, 45, 52, 53, 57;

time selection: 0- 2 s ("plume" area), 0-3 s ("Vestnesa" area) ;
output of a SEGY file per line

9. Normal Move Out (constant velocity 1475 m/s, strech limit 150 %) and stack
10. SEGY output
11. Stolt migration (constant velocity 1475 m/s)
12. SEGY output

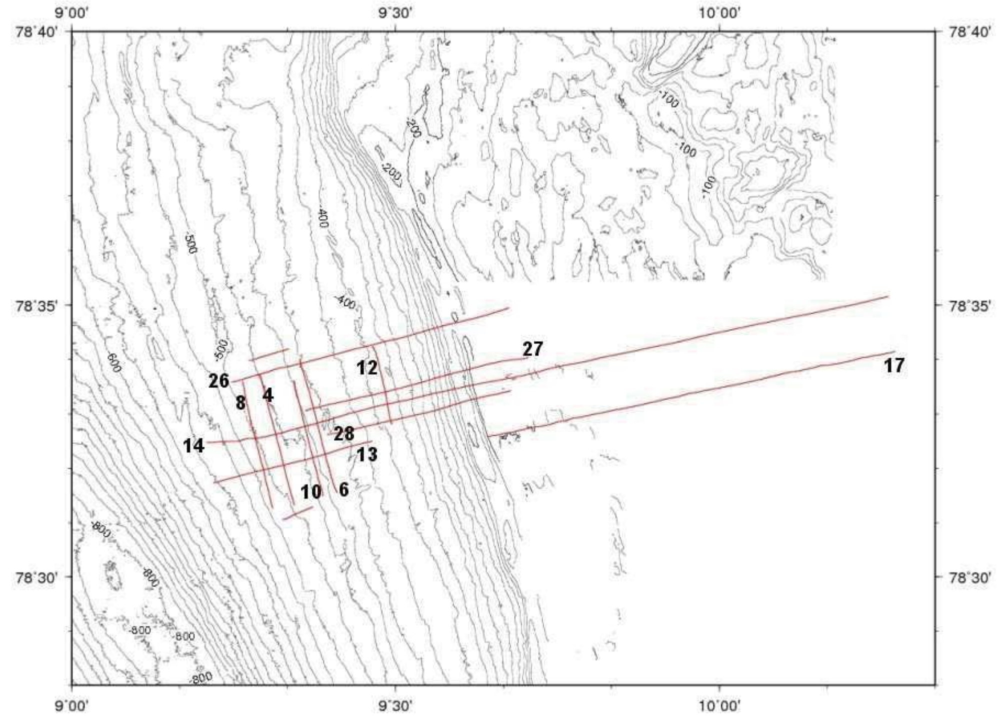


Figure 10.16: Plume area - Location of seismic line (HR surface seismic)

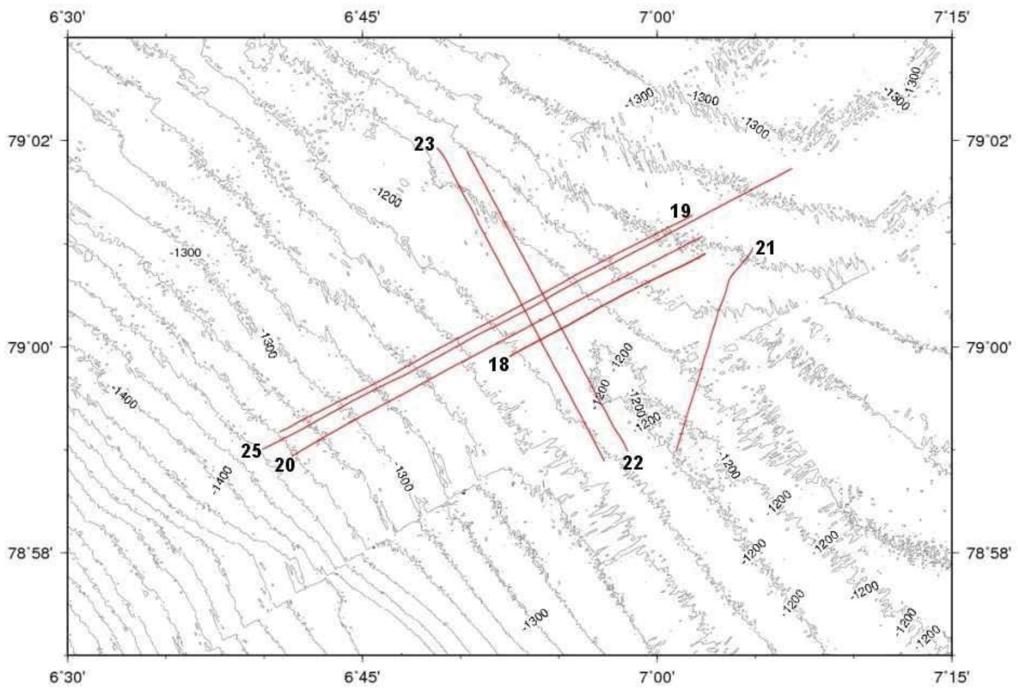


Figure 10.17: Vestnesa area - Location of seismic line (HR surface seismic)

10.11. Initial Interpretation (G. K. Westbrook)

The seismic sections obtained were of good quality, showing clear reflectors as deep as the water column multiple in both areas. As do the 96-channel seismic reflection data from JR211 in 2008, the sections image the marine sedimentary sequence extending landward beneath the glacigenic sediments in the area of the shelf-slope break. In the water depth range of 500-900 m, the mixed marine and glacigenic sequence extendin about 200 ms beneath the seabed , with its high impedance contrasts and many discontinuities is clear distiguished from the predominantly marine sequence below, which contains a large proportion of contourite drifts. The sections also show evidence of the presence of gas in the form of high-amplitude negative-polarity reflections, bright spots and zones of scattering.

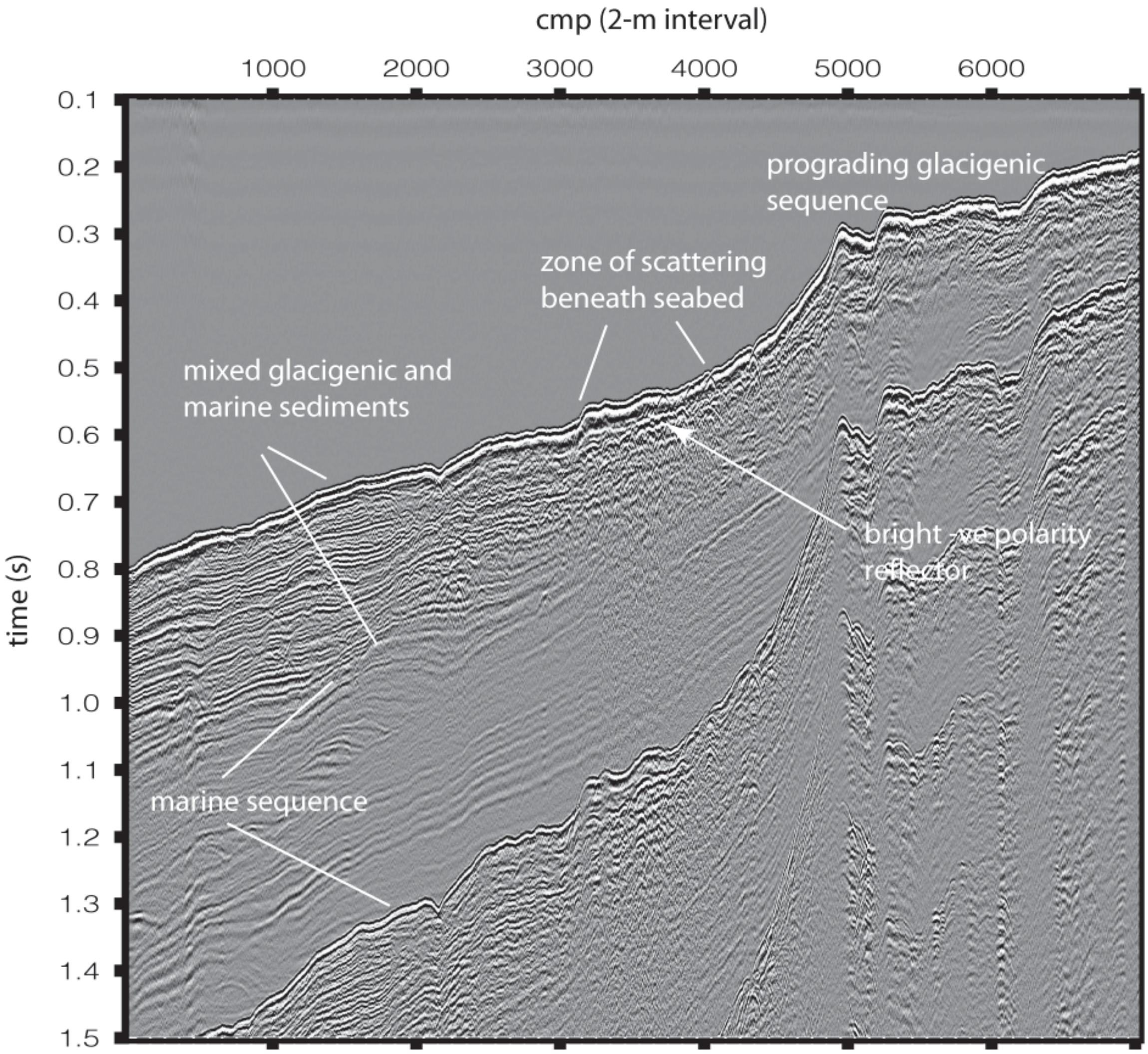


Figure 10.18: Seismic reflection section across the landward margin of the gas hydrate stability field, where the depth of the seabed is about 400 m (520 ms on the seismic section), close to the shelf slope break. Detail of the region between cmp 3000 and cmp 4000 imaged in a record from SYSIF is shown in Fig 9.3.

11. OCEAN BOTTOM INSTRUMENTS (I. Samarakoon and A. Gonzalez-Nakazawa)

11.1 Summary

Ocean bottom seismometers and electromagnetic receivers were provided by the NERC Ocean Bottom Instrumentation Facility (OBIF). Ocean bottom seismometers recorded four channels of data (hydrophone and three orthogonal geophones) at 4 kHZ on two independent data loggers because the data rate for four channels at 4 kHz was more than the loggers could cope with. The geophones had a natural frequency of 4.5 Hz and were housed in a gimballed package. Electromagnetic instruments had two orthogonal 12 m electrodes.

Cement anchor weights were used for all instruments; for the electromagnetic instruments this was to minimize distortion introduced by local conducting bodies, and for the seismic instruments it was a way of achieving better coupling. There were several problems with the ocean bottom instruments. During the first seismic deployment, two loggers suffered clock jumps and one of these loggers recorded no data. Two further loggers also showed a problem with the data recording. On the second deployment, two attempts at lowering instruments from a wire (when HyBIS was out of action) resulted in the instrument detaching from its anchor weight during deployment.

The mini-ROV HyBIS was used for precise deployment of seabed instruments at pre-selected locations. A deployment frame had been constructed in advance of the cruise for this purpose. During deployments, HyBIS was lowered to a few metres above the seabed and instruments released once within a certain radius (typically 10 m or less) of the desired position. The HyBIS video showed the instruments settling on the seafloor and also showed the nature of the seafloor, which was soft mud at all deployment sites.

11.2. Preparation

The OBIF team used one area in the main lab (see Figure 11.1), just inside the wet lab for OBS preparations. The area was shared with the EM group.

Figure 11.1: Area in the Main Lab used for OBS Preparation

As early as practicable an OBS and an OBEM were built to allow testing with HyBIS. This highlighted two problems:

OBS: the inner guides (shown in the Figure 11.2) on the HyBIS deployment system, there to ensure the OBS did not swivel during deployment, were too long, and fouled the anchor before the OBS could be secured in place. This was remedied by trimming about 10-15 cm from the guides.

Figure 11.2: Inner guides of HyBIS

OBEM: the HyBIS deployment system had not been designed to take into account the external mini-floats. By removing the flanges from the mini-floats and sealing the hardhats with a variety of tape (see Figure 11.3), it was possible to mount the floats securely inside the EM chassis.

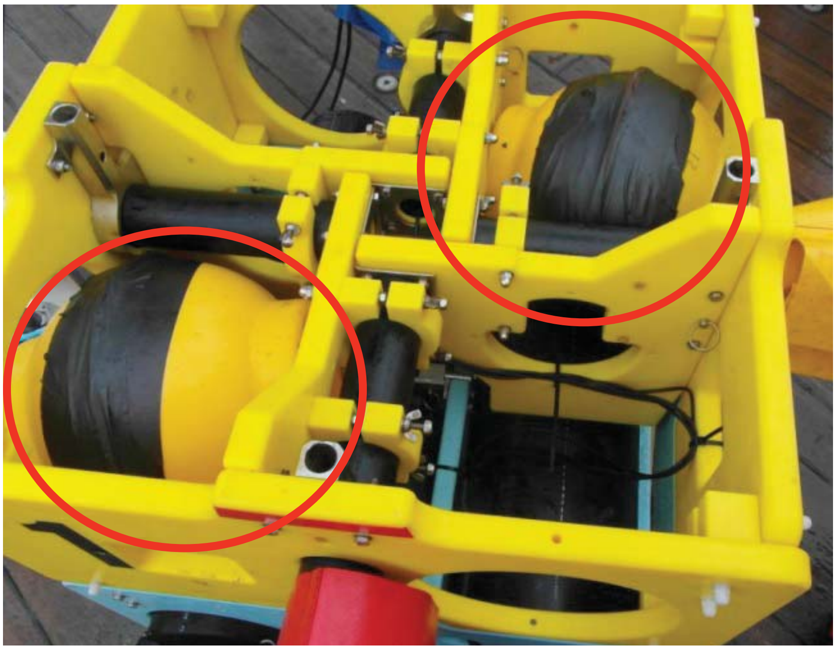


Figure 11.3: Floats mounted inside the EM Chassis

Because of the use of high air pressure for seismic work and high voltage for HyBIS and SYSIF, the back deck was out of bound when these two systems were in operation. This was a major hindrance during the preparation of the OBS's before deployment. The preparation of an instrument frame and the anchors could not be done on the back deck while HyBIS or SYSIF were in operation. In addition, there was a lot of equipment left from the previous cruise on the back deck and the side deck, as shown in Figures 11.4 and 11.5. This also prevented the preparation of OBS in the side deck.

Figure 11.4: Container on the back deck left from the previous cruise

Figure 11.5: Coring equipment on the side deck left from the previous cruise

11.3. Deployment 1

The HyBIS team first prepared HyBIS for deployment and tested it with a dummy deployment (without the instrument) in order to test its manoeuvrability and control. After the test run, the deck hands helped to secure the OBS to HyBIS. The OBIC team, HyBIS team and the deck hands were involved in this process. The OBIC staff checked that the OBS was placed properly under HyBIS while it was being lowered by the A-frame in order to make sure that the instrument frame and the floats were not damaged.

The clearance between the HyBIS control components at the top and the OBS once the OBS was attached to HyBIS was fairly small. Therefore, the flag and the antenna of radio beacon had to be bent when attaching the OBS to HyBIS.

Figure 11.6: OBS Secured to HyBIS with bent flag and radio bacon antenna

Two pallet frames were required to secure the OBS to HyBIS in order to achieve the required height to hook the OBS on to HyBIS.

Figure 11.7: Securing the OBS to HyBIS

Having resolved the issues with HyBIS; the first deployment went smoothly. Four instruments were deployed in Area 1 using HyBIS. The OBS deployment locations can be seen in Figure 11.8.

The instruments were shot over using the airguns and SYSIF, a deep towed seismic system that generates a chirp source signature. SYSIF was towed at c. 100m above the seafloor. Figures 11.8 – 11.11 show the airgun and SYSIF activity in Area1. An airgun line, comprising over 8000 shots, and three SYSIF lines were shot above the instruments.

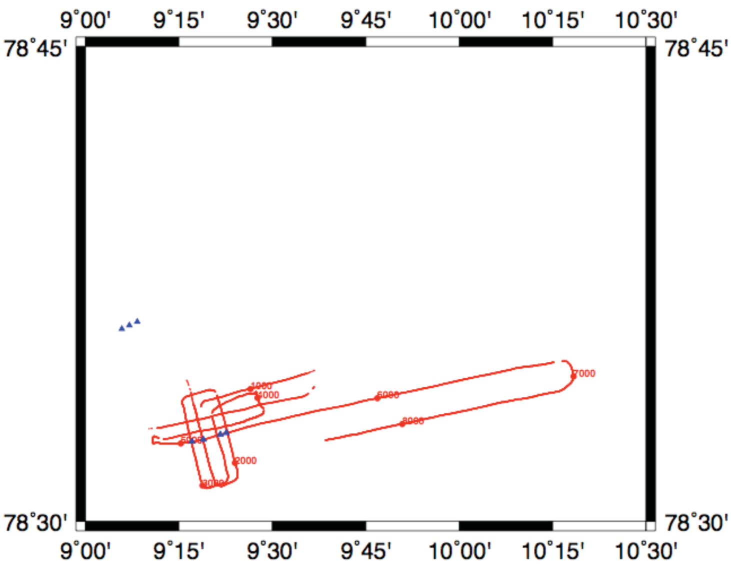


Figure 11.8: Airgun lines

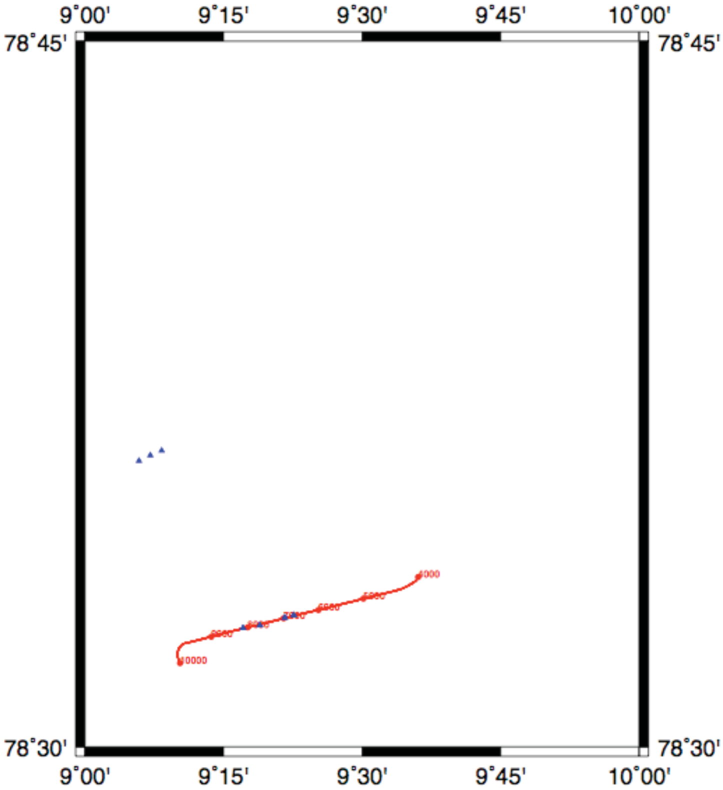


Figure 11.9: SYSIF Line1

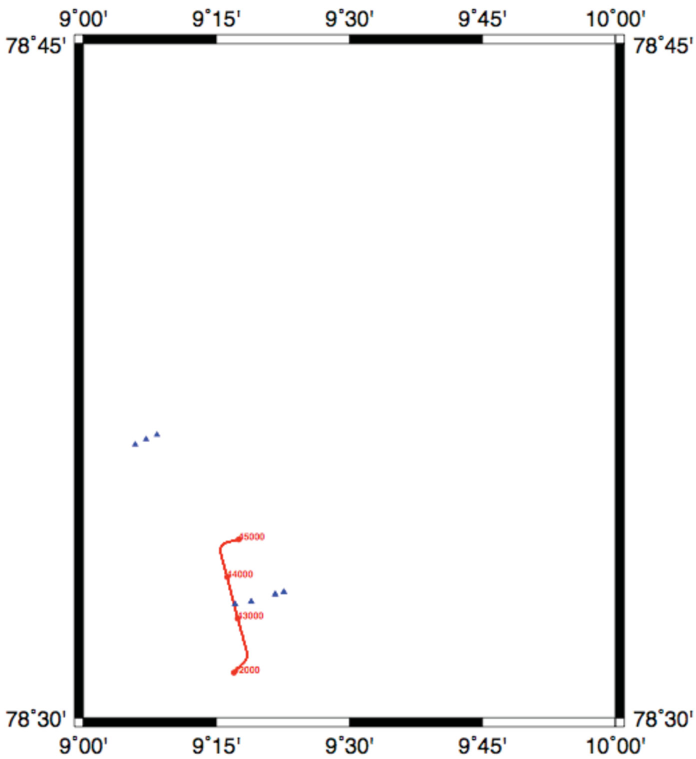


Figure 11.10: SYSIF Line2

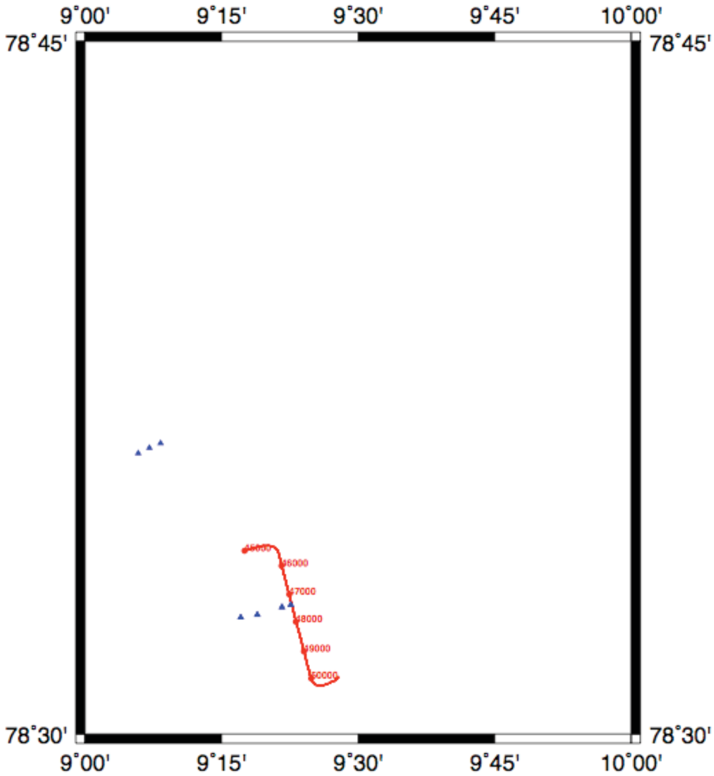


Figure 11.11: SYSIF Line3

11.4. Recovery 1

Recovery using stray lines and grappling hooks went without any incidents. Grappling and recovery of the instrument was done by the ships crew. The OBIC personnel also helped with recovery poles and manoeuvring the OBS to get it on the back deck via the main crane of the ship once it was attached to the crane from the side of the ship.

The data were processed as follows: the airgun data as a single line and the SYSIF data in three separate lines. QC was done using section plots and hodocrons. There were some issues due to clock jumps; instrument reset and Firmware reporting wrong data, which will be discussed later in this report in detail. The shot file used had the position of the ship instead of the airgun position.

11.5. Deployment 2

HyBIS was unavailable when the deployments were originally scheduled. An attempt was made to deploy the instruments using a winch, with a coring bomb for weight and a USBL to allow the deployment position to be determined. However, after the first instrument was deployed it was spotted on the surface just after the winch wire was recovered.

A second instrument was deployed in a similar manner. The instrument was lowered into the water and given time for the air to escape from the hardhats etc. However, while it was sitting there, the waves caused it to sway, which resulted in it floating at about a 45deg angle. The release mechanism only works when the pull is, more or less, straight down. If it is pulled too much to the side, the jaws opened and released the anchor.

Because of this problem it was decided that the instrument deployment should be delayed till HyBIS was operational again. After HyBIS become operational, two instruments were deployed in Area 2.

The instruments were shot over using a single airgun and SYSIF, a chirp type source towed at c. 100m above the seafloor.

Again, the same problems were encountered as in the case of Deployment 1 because of the lack of deck space and restricted access to the deck due to high voltage operation of HyBIS and SYSIF.

Figures 11.12 to 11.15 show the airgun and SYSIF activity in Area1.

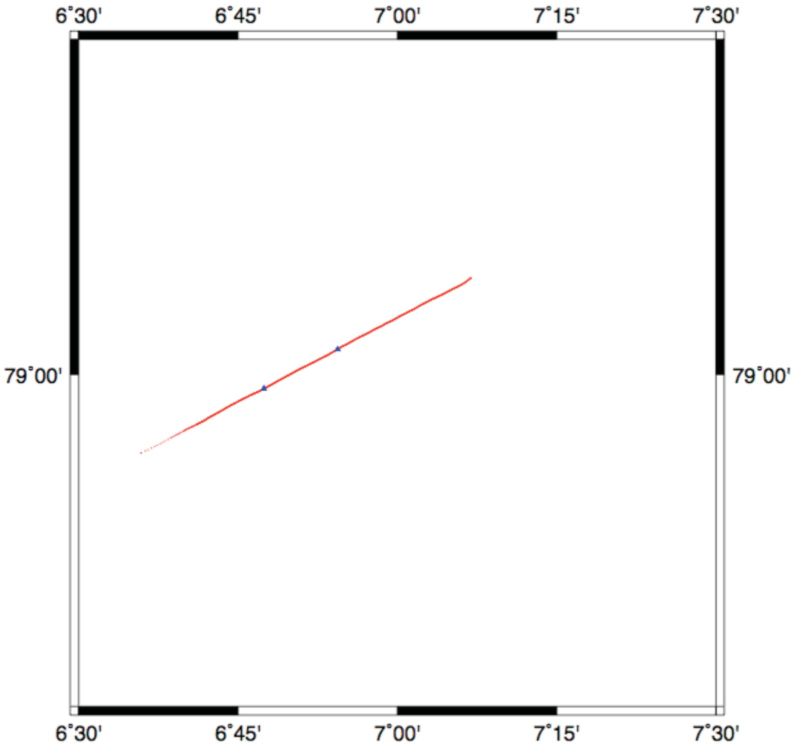


Figure 11.12: Airgun Line in Area2

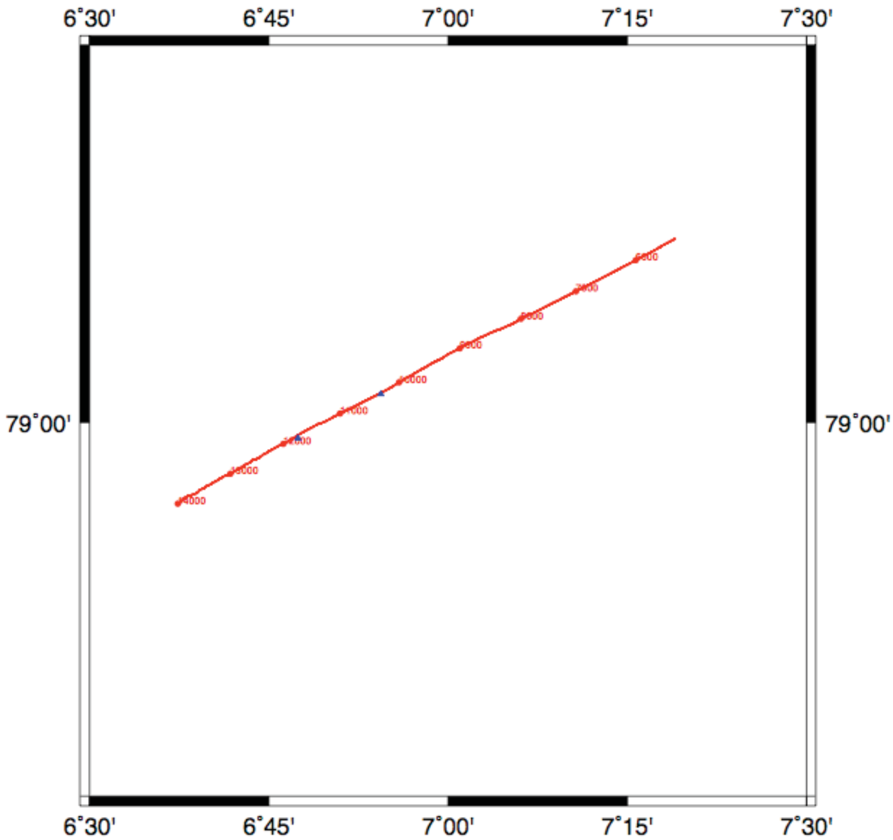


Figure 11.13: SYSIF Line1 in Area2

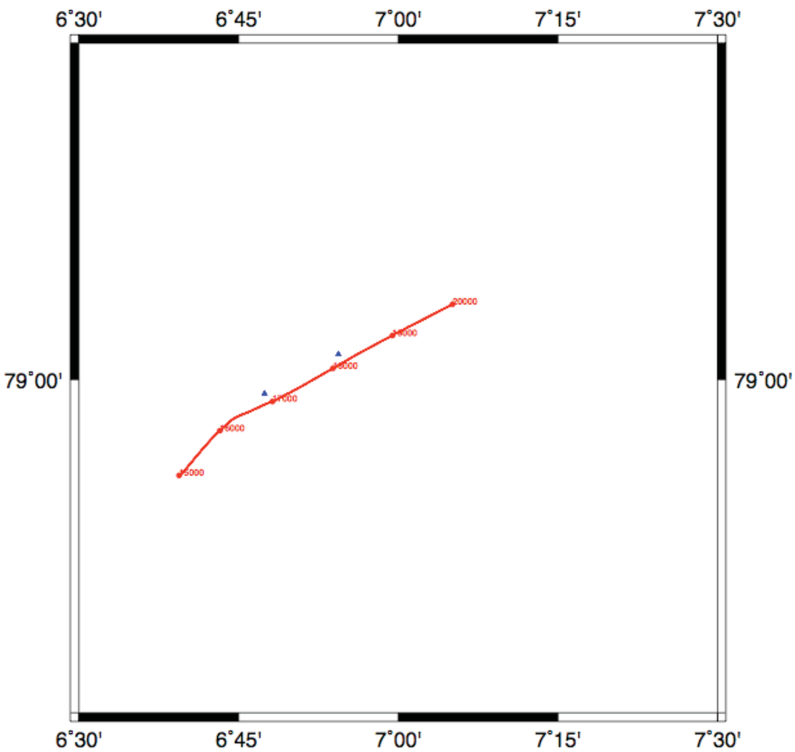


Figure 14: SYSIF Line2 in Area2

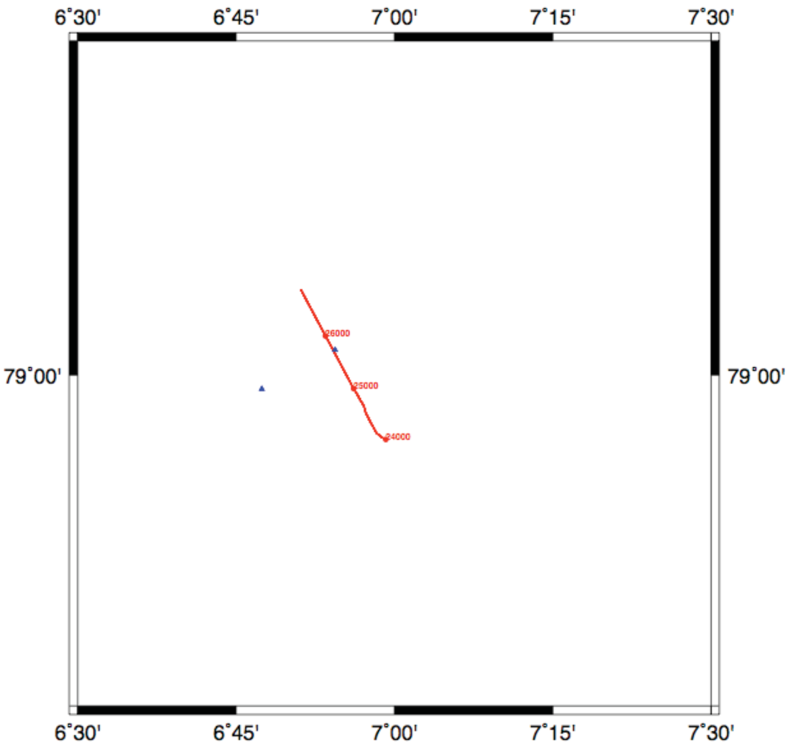


Figure 11.15: SYSIF Line3 in Area2

11.6. Recovery 2

Recovery using stray lines and grappling hooks went without any incidents. Recoveries were done similar to the recovery 1 with grappling and recovery of the instrument done by the ship's crew and the OBIF personnel helping with recovery poles and manoeuvring the OBS to get it on the back deck.

The data were processed in 4 chunks: the airgun data as a single line and three separate SYSIF lines. QC was done using section plots. There were some issues due to CF card corruption and Firmware reporting wring data length of CF cards, which will be discussed later in this report in detail. The shot file used had the position of the ship instead of the airgun position.

11.7. EM Deployment

Three EM instruments were deployed in Area 1 using HyBIS. The farings (or sleeves) of the electrode end of the long arms needed to be shortened to secure the electrode and attach the glass rods to the arm.

Figure 11.16: Orientation of instrument on deck while being prepared

Figure 11.17: Securing the EM Instrument to HyBIS

While the instruments were being assembled they were oriented in such a way that two arms could be easily pushed out of the A-frame when deploying, as shown in Figure 16. The other two arms were carefully handled by two people when the instrument was extended out by the A frame and then lowered to the sea surface. Unlike the OBSs the EM instruments required only one pallet frame to secure it to HyBIS, as the EM Chassis gave the required height for mounting the EM Instruments to HyBIS (See Figure 17).

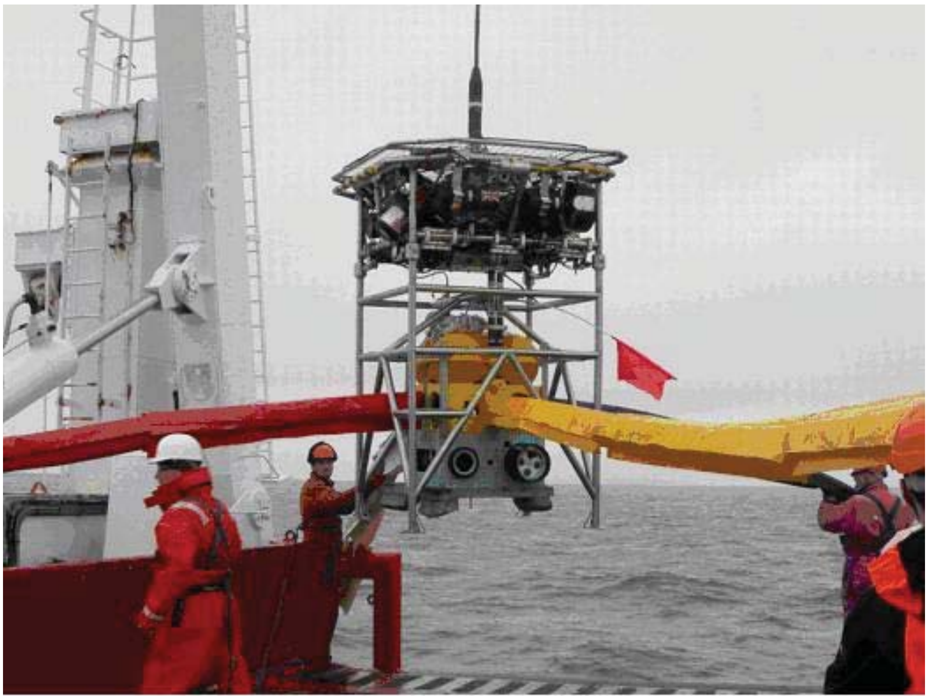


Figure 11.18: Deploying EM Instrument with HyBIS

The deployment of the EM instruments required a team of 4-5 people. Another difficulty we had was the lack of deck space. Even though JCR had a lot of deck space there was a lot of equipment left on deck including a container from the previous cruise. This was more critical for EM instruments because of the arms.

The deployment of EM instruments using HyBIS worked fairly well, however, because of the arms HyBIS could not be rotated, even though forward/ backward and sideways movements worked. Therefore, in some instances the instruments were deployed nearest to its intended (ideal) location.

11.8. EM Recovery

Since the instruments were deployed in fairly close proximity and the deployment depth was shallow, the recovery period was quite busy as we had to release the next instrument almost immediately after one instrument was recovered and placed on deck. The bench in the lab was prepared such that two instrument tubes could be securely placed on it for programming and data downloading. This arrangement helped the situation where the instrument could be removed from the frame and brought to the lab immediately after it was on deck. Then the 4 arms were removed from the instrument and the instrument was placed on the side in preparation for the next instrument on deck. Data was downloaded after all three instruments were recovered.

During the recovery one arm was broken or bent in two of the instruments, as a result of it being dragged along the side of the ship as it was being winched up. However, none of the glass rods were damaged.

Again the recoveries were done similar to the recovery 1 (please refer to that section for details). The OBIC staff had to get more involved with moving the instrument from the side of the ship to the back deck, as one person was required for manoeuvring each of the long arms.

11.9. EM Data QC

While DASI was transmitting the trigger from the DASI timing generator was recorded using the OBIC GPStarplus clock. This gave the approximate ship position at every second during the transmission.

The shot file was generated using shots at ddd:hh:mm:30 to give the approximate ship location half-way through the minute period. However, 30s was subtracted from the time, to give the shot start time as ddd:hh:mm:00. The scripts used for this are shot_downsampling.csh and convert.pl which rearranges the format into the LC2000 shot file format.

Unfortunately, not every second was recorded by the GPS clock, see map below. Therefore, to fill the gaps, the missing location data has been taken from time = ddd:hh:mm:31.

Plots were produced for EM active source data with no filtering, 4Hz filtering, 12Hz filtering and 20Hz filtering.

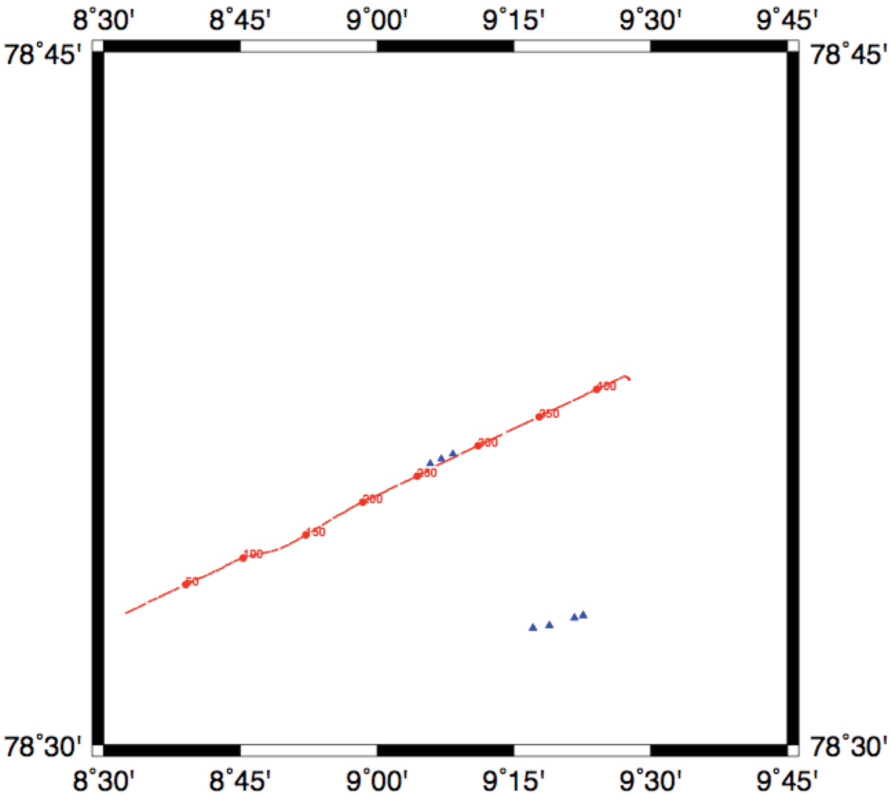


Figure 11.19: DASI Line

11.10. Instrument Deployment and recovery details

Serial No:	Line/ Area	Site	Deployment			Deployment Time	Recovery Time
			Latitude	Longitude	Depth (m)		
005	01	OBEM03	78.605616000	009.138439000	530.00	2011:243:13:30	2011:247:16:20
010	01	OBEM02	78.603894000	009.117705000	537.62	2011:243:11:40	2011:247:15:18
016	01	OBEM01	78.602014167	009.097093967	531.00	2011:241:14:49	2011:244:14:17
045	01	OBS03	78.543425300	009.315045550	491.00	2011:24112:37	2011:244:10:40
049	01	OBS01	78.546153067	009.360788200	468.00	2011:241:08:18	2011:244:09:43
052	01	OBS04	78.542440133	009.284744700	504.00	2011:241:11:34	2011:244:11:32
061	01	OBS02	78.547041667	009.376906550	449.00	2011:241:09:29	2011:244:08:45
052	02	OBS08	78.995746000	006.790427000	1259.50	2011:245:11:30	2011:246:10:48
061	02	OBS05	79.007537000	006.906674000	1207.30	2011:245:09:45	2011:246:12:06

Line/ Area	Serial No:	Hydrophone/EM			Geophone				
		Type	SN	Gain	Package	Type	XGain	YGain	ZGain
01	05	EM	NA	NA	NA	NA	NA	NA	NA
01	10	EM	NA	NA	NA	NA	NA	NA	NA
01	16	EM	NA	NA	NA	NA	NA	NA	NA
01	45	HTI	32	08	32	L-28	64	64	64
01	49	HTI	28	08	28	L-28	64	64	64
01	52	HTI	45	08	45	L-28	64	64	64
01	61	HTI	42	08	42	L-28	64	64	64
02	52	HTI	42	08	42	L-28	64	64	64
02	61	HTI	45	08	45	L-28	64	64	64

11.11 Status of 4x4 Instruments and Problems

Total of 6 deployments of 4x4 instruments were done in this cruise, 4 in Area 1 and 2 in Area 2. In the first deployment the duration of the deployment and the sampling rate was enough to write data to two out of the 3 CF cards installed in each logger, where as in the second deployment data was written only to the first card.

Deployment	Serial No	CF Cards Used	Comments
D1	045a	CF58;CF59;CF01	Data Recorded
D1	045b	CF53;CF63;CF08	Data Recorded
D1	049a	CF72;CF34;CFU11-8-005	Did not record data due to clock jump
D1	049b	CF48;CF66;CFU11-8-008	Data Recorded
D1	052a	CF12;CF75;CF56	Reset c. 8 minutes before opening; Clock Jump ~4s
D1	052b	CF62; CFU11-8-004	Data Recorded
D1	061a	CF41;CF69;CF09	Data Recorded
D1	061b	CF30;CF16;CF02	Data Recorded
D2	052a	CF49;CFUII-08-0007;CF07	Corrupted after 606Mb. Data recovered but 600 blocks missing.
D2	052b	CF33;CF39;CF76	Data Recorded
D2	061a	CF64;CF77;CF14	Data Recorded
D2	061b	CF70;CF54;CF80	Data Recorded

Status of CF Cards

Deployment	Serial No	Comments
D1	045a	CF0 & CF1 had data as expected, CF2 had no data as expected
D1	045b	CF0 & CF1 had data as expected, CF2 had no data as expected. However, firmware reported that the last block was 2048 (beginning of the card)
D1	049a	Instrument did not wakeup and CF0, CF1 & CF2 had no data as expected
D1	049b	CF0 & CF1 had data as expected, CF2 had no data as expected
D1	052a	CF0 & CF1 had data as expected, CF2 had no data as expected
D1	052b	CF0 & CF1 had data as expected, CF2 had no data as expected
D1	061a	CF0 & CF1 had data as expected, CF2 had no data as expected
D1	061b	CF0 & CF1 had data as expected, CF2 had no data as expected. However, firmware reported that the last block was 2048 (beginning of the card)
D2	052a	CF0 & CF1 had data as expected, CF2 had no data as expected. However the 4x4-download utility only downloaded about 606MB of data.
D2	052b	CF0 & CF1 had data as expected, CF2 had no data as expected
D2	061a	CF0 had data as expected, CF1 & CF2 had no data as expected
D2	061b	CF0 had data as expected, CF1 & CF2 had no data as expected

11.12. Firmware reporting wrong last-block in Logger 61b & 49b Issue

In the 4x4 firmware, before the 4x4 instrument goes to sleep after option “F” has been chosen before deployment, the firmware writes a zero-block to every 100000th block on the CF card. After recovery, when the instrument is reset, the instrument searches for a zero block every 100000 block in order to identify the last block in a particular CF card. If a zero block is found, then the firmware searches at a finer granularity (1000) to home in on the last block written. When the last block is found, the firmware writes that value to the header block, and reports it via the instrument’s terminal output.

In some rare instances, the firmware fails to find a zero-block. In such cases where a zero-block is not found, currently the firmware reports the last block as 2048 and writes that value to the CF header block. Further investigation in to the algorithm for finding the last block revealed that it fails when the last lock written is in the last 10000 blocks of the CF card; because the search stops when the block count goes beyond the maximum block count of the CF card.

There are two approaches to solving this problem:

i. when the search goes beyond the maximum block count of the CF card, a known value, say “999999” is reported by the firmware to indicate to the user that the data been written to more than (maximum block count – 10000) blocks.

ii. When the search goes beyond the maximum block count of the CF card, start the search again from the maximum block count and search from bottom to top in order to find the last block written.

It was thought that the second option was more useful, even though it took more time to find the last block than the first option. During the transit to UK, the second option was implemented on the firmware and tested with the CF0 of Loggers 61b and 49b. More details are available in the instrument testing and debugging section of this report.

11.13. Corrupted CF card issue in Logger 52a Area2 deployment

The 4x4-download script was able to download only about 606MB of data from this CF card. In these situations the approach was to use the dd utility which is called from the 4x4-download script to read larger block sizes. The dd utility is operated with the bs parameter equal to 512, i.e. read one block at a time, as follows.

```
dd bs=512 count=5137 conv=swab if=/dev/disk1 of=obs_data.4x4
```

Here the count value is the last block which is found prior to running dd within the 4x4-download script.

When a corrupted CF card is found the bs parameter is generally set to about 4094 which generally used to read the entire CF card even if there are unreadable blocks. However, in the logger 52a corrupted CF card this approach did not work.
So the cfread utility which was developed during the Canada cruise last year was used. This utility was modified slightly from the version that was used in the Louden cruise. The current cfread utility, reads data one block at a time using fread, and when it get to a unreadable block, it jumps to a readable section using fseek.
Using the new cfread utility a total of 4.77 GB of data was recovered. But about 600 blocks were lost in the recovery process.

11.14. Time jump issue

It was observed that the trace data was drifting in certain parts of the segy files in the first deployment in all loggers. Closer analysis showed that one of the psegy files for each instrument's processed data was smaller in size compared to the other psegy files. Further investigation revealed that the smaller psegy file corresponded to the portion of data at the beginning of CF1 card of each instrument.

Extra debug information was then integrated to the split code to further investigate this issue. These debugs indicated that there were no gaps in data when the firmware switched from CF0 to CF1, and all the frame numbers followed sequentially as expected.

Further debugs were integrated to the spit code to investigate whether samples were being dropped by firmware. The dropped samples are reported by the "extra" field of block. Printing the value of extra within the split processing code revealed that about two seconds after switching to CF1 the value of extra field was set to around 9000, which corresponded to about 30 blocks (or 1s) worth of data being dropped by the ANA_4CH thread.

The reason for this drop of data would have been the extra processing involved in switching from one CF card to another. The current firmware doesn't seem to cope with receiving data at 4K and switching the CF cards without dropping samples (indicated by the extra field).

In order to overcome this issue, the split code was modified to add the required number of samples (all zero) to each channel when the extra field was nonzero. This compensated for the dropped samples and it was observed that after this modification, the corresponding psegy file had the same size as the other psegy files.

Figures 19 and 20 show the effect of compensating for time jumps due to extras for channel 4 of SN061b.

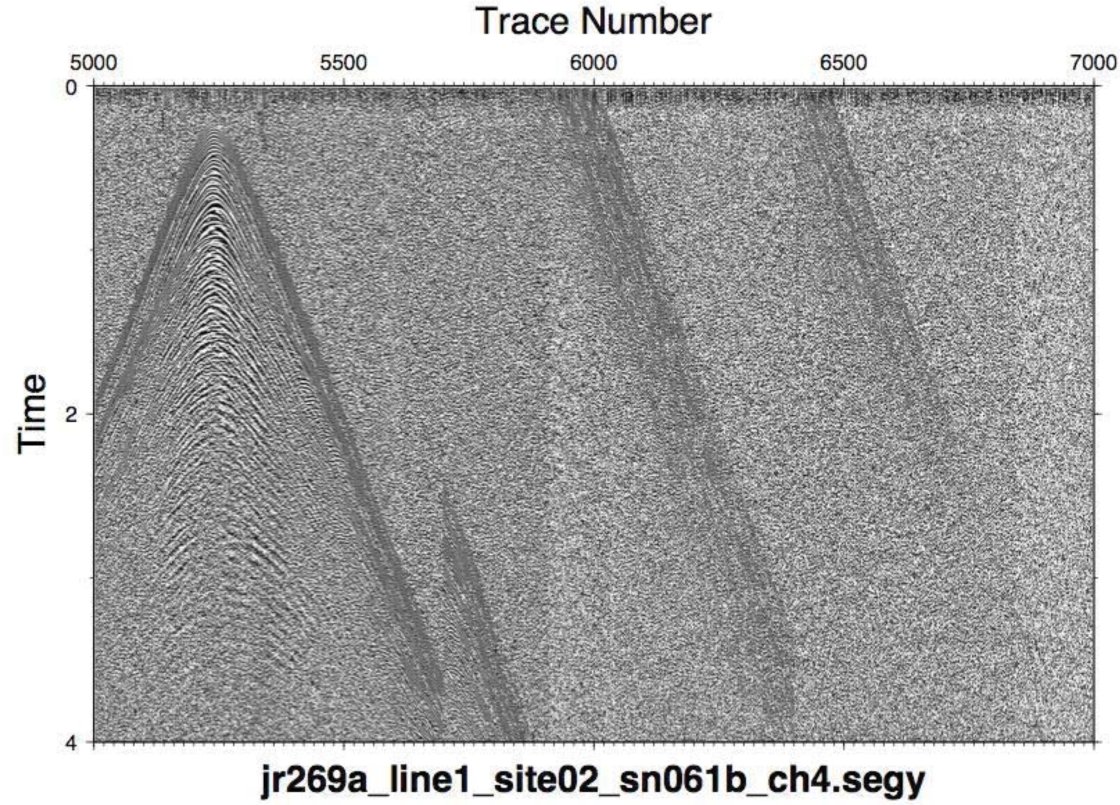


Figure 11.19: Time Jumps observed at card switching without compensation for extras

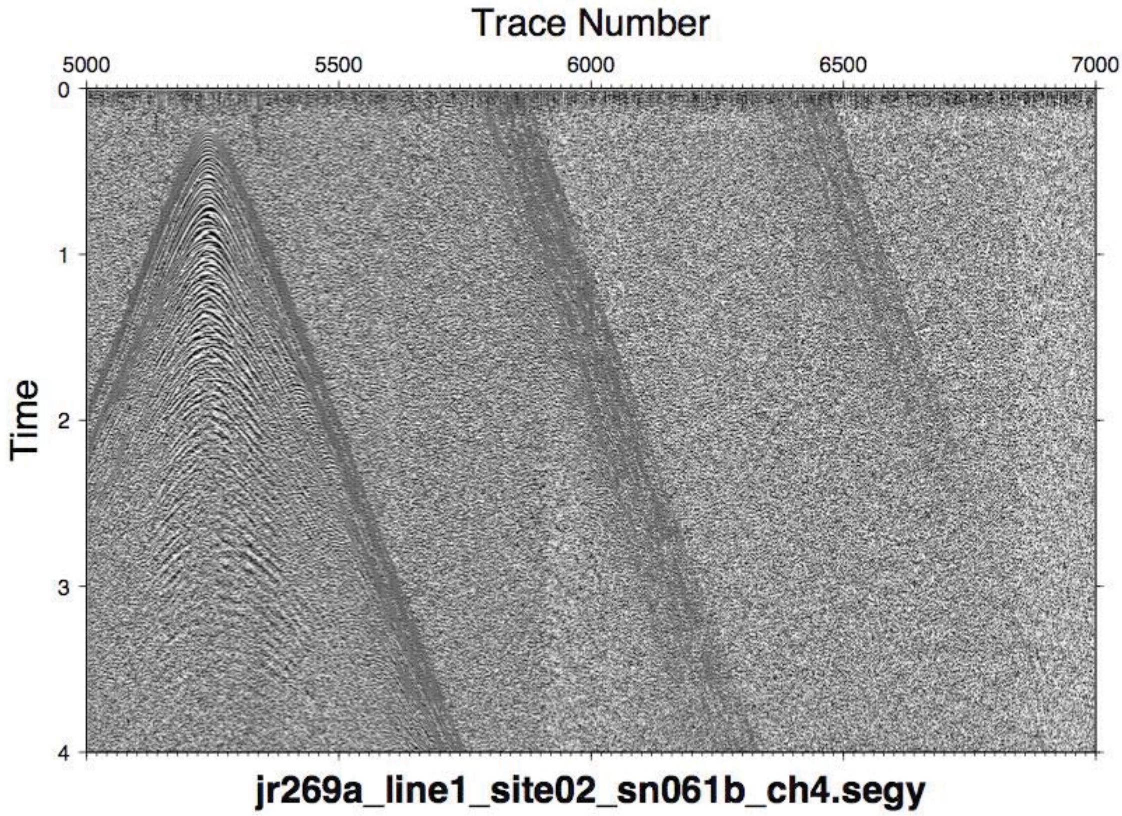


Figure 11.20: Time jumps not observed at card switching time, when extras are compensated for with zero samples

The above problem of dropped samples due to card switching at high sampling rates may not be resolved with the current processor and clock speeds and memory.

Currently the number of buffers allocated for the queue for transferring blocks from ANA_4CH to CF_Write threads is 100, i.e. defined by **BUFFERPOOL_SIZE**. One way to resolve this problem is to increase the number of blocks in the queue. We have observed about 30 blocks of data being dropped at card switching. So we can see if the BUFFERPOOL_SIZE can be increased to say 140 or 150.

An attempt was made in Southampton to do a few quick tests to see if this was possible, and the logger was tested with BUFFERPOOL_SIZE=120. This test revealed that at that level of buffer allocation, samples were still being dropped. See below for the user interface output of the test instrument. Here, test_val indicates the number of extras or samples missed when switching CF cards. The last block of the cards was set to a low value (25048) to force the firmware to switch cards after about 5 minutes of logging data. The threshold for card switching is calculated by subtracting the number of blocks per time-break from the last block value. Since the last block is set to a low value, the threshold here is shown as a negative number. In this instance, when the current block value equals the last block the firmware switches the cards.

```
STARTUP
Init the device A2D Card Registers
Init Decimation Engine
Turn on IRQs
Turn on ReadEngine
Turn on Decimation Filter
```

```
Sync up to minute mark
Sample: 488638 @ 1970:001:01:25:18
Sample: 969170 @ 1970:001:01:26:18
Sample: 1449702 @ 1970:001:01:27:19
Sample: 1930318 @ 1970:001:01:28:19
Sample: 2410930 @ 1970:001:01:29:19
CF_switch_threshold[0]: -207211          curBlock: 25048
Switching to Card 1
test_val = 4906          frameNo: 23120
first_timebreak_rxed: 0
Sample: 2891458 @ 1970:001:01:30:19
Sample: 3372078 @ 1970:001:01:31:19
Sample: 3852690 @ 1970:001:01:32:19
Sample: 4333310 @ 1970:001:01:33:19
Sample: 4813930 @ 1970:001:01:34:19
Sample: 5294546 @ 1970:001:01:35:19
CF_switch_threshold[1]: -207211          curBlock: 25048
Switching to Card 2
test_val = 4880          frameNo: 46120
first_timebreak_rxed: 0
Sample: 5775162 @ 1970:001:01:36:19
```

Attempt to make the BUFFERPOOL_SIZE=130 was not successful as the firmware did not work due to lack of memory.

The other option is to replace the current processor with a faster processor of the same type so that the firmware changes would hopefully be minimal.

11.15. Ancillary Equipment Issues

One of the GPS clocks had a problem. Also two of the light beacons did not work.

1.16. Instrument Testing and Debugging

1. *Firmware modifications*

The firmware was modified to fix the wrong last block reporting problem. This test version of the firmware was flashed to instrument SN49a for testing.

The test revealed that the firmware reported a valid last block number for the CF cards in question. In addition, these CF cards were installed in CF1 & CF2 positions in order to verify that the new algorithm worked properly for all card positions, and the firmware debug outputs confirmed that the last block reported correctly for in all CF card positions.

The firmware debug output is given below.

Wait for CF to init and defaults to be loaded.
Found 3 compact flash cards
  Slot: 3, Card: 0, Size: 7839 MB (16055424 blocks)
  Slot: 3, Card: 1, Size: 7839 MB (16055424 blocks)
  Slot: 3, Card: 2, Size: 7839 MB (16055424 blocks)
No defaults could be found on the compact flash.

Shutting down pre-amps, decimation engine, filter, dac, mux, etc.
card[0].firstBlock: 2048 card[0].lastBlock: 16055424
zeroblock_found: 0   count: 161   j: 16102048   k: 0
fine11: j: 16055424   k: 16055424
fine33: j: 16055424   k: 16055424
zeroblock_found: 1   count: 1   j: 16055424   k: 16055424 #############
zeroblock_found: 1 *entry: 0   *block: 16055424   ulblock: 16055424
CARD: 0   LAST BLOCK: 16055424

card[1].firstBlock: 2048 card[1].lastBlock: 16055424
zeroblock_found: 0   count: 162   j: 16102048   k: 0
fine11: j: 15955424   k: 16055424
fine22: j: 15955424   k: 16034424
fine33: j: 15955424   k: 16034424
zeroblock_found: 1   count: 2   j: 15955424   k: 16034424 #############
zeroblock_found: 1 *entry: 1   *block: 16034424   ulblock: 16034424
CARD: 1   LAST BLOCK: 1603442

card[2].firstBlock: 2048 card[2].lastBlock: 16055424
fine0: j: 2048   k: -97952   firstBlock : 2048   cardList[2].firstBlock: 2048
gotin: j: 2048   k: 2048
fine1: j: 2048   k: 2048
fine3: j: 2048   k: 2048
zeroblock_found: 1   count: 3   j: 2048   k: 2048
zeroblock_found: 1 *entry: 2   *block: 2048   ulblock: 2048
CARD: 2   LAST BLOCK: 2048

In the above test, CF0 & CF1 are the two CF cards that the 4.1.64 firmware reported the last block to be 2048. The CF2 card was an actual empty card which only had the header data written to.

Here the j is the variable that searches every 100000th position, and k is the variable that searches at a finer granularity. In card 0 and card 1, it can be seen that the top to bottom search could not find the last block where "zeroblock_found: 0" is reported, and subsequently the bottom to top search finds the last block where "zeroblock_found: 1" is reported.

In addition to the above tests, the position of each CF cards were changed to make sure that the algorithm worked for all card positions. All theses tests confirmed that the bug fix worked for each card position.

2. *Cold store test*

One instrument (SN61) was setup and was left in the cold store of the ship to see if clock jumps occurred due to temperature change. The cold store temperature was set to 5 degrees Celsius.

Logger	61a	Comments

Sync time	2011:252:14:13:00	
Wakeup time	2011:252:15:00:00	
Time check	2011:256:11:51:00.0096907	
CF status	Data on both CF0 & CF1	

Logger	61b	Comments
Sync time	2011:252:14:33:00	
Wakeup time	2011:252:15:00:00	
Time check	2011:256:11:57:00.0208204	
CF status	Data on both CF0 & CF1	

3. Deck tests

Two instruments (SN49 & SN52) were setup and left on the deck to see if there were any clock jumps. It should be noted that SN49a was the instrument that did not record any data during deployment 1.

Logger	52a	Comments
Sync time	2011:252:14:59:00	Had to be synchronized twice as time was visibly drifting
Wakeup time	2011:252:16:00:00	
Time Tag check	2011:256:07:48:04.1506785	Instrument reset 16 minutes before time check. Unacceptable Time drift ~ 4s
CF status	Data on both CF0 & CF1	

Logger	52b	Comments
Sync time	2011:252:15:05:00	
Wakeup time	2011:252:16:00:00	
Time Tag check	2011:256:07:57:59.9908400	
CF status	Data on both CF0 & CF1	Firmware reported last block for CF0 as 2048

Logger	49a	Comments
Sync time	2011:253:10:35:00	
Wakeup time	2011:252:12:00:00	
Time Tag check	2011:256:08:20:00.0066880	Reset on plugging in the GPS cable
CF status	No data on CF0. Duration of the test was only enough to fill partially fill CF0	This instrument did not record any data in deployment 1 as well

Logger	49b	Comments
Sync time	2011:252:10.44:00	
Wakeup time	2011:252:12:00:00	
Time Tag check	2011:256:08:31:00.0123367	Reset on plugging in the GPS cable
Drift		
CF status	Data on CF0. Duration of the test was only enough to fill partially fill CF0	

11.17. Post-cruise notes on EM instruments (M. Sinha)

1/ Overview:

3 instruments were deployed, spaced approximately 500 m apart, using HYBIS and in water depths of about 530 m. The DASI-2A transmitter was towed along a line approximately 23 km in length, with the instruments close to the centre of the line. All were recovered safely. Two instruments were fitted with pre-existing AIS electrodes; one was fitted with new electrodes by Castle. No serious mechanical difficulties were experienced during deployment or recovery. Two instruments had recorded good electric field data on both channels; the third had recorded on one channel only.

2/ Mechanical observations and recommendations:

The provision of buoyancy and bottom weights as per the deployments for JR269A worked well. There is no need to vary this.

The video coverage of the instrument electrode arms during deployment using HYBIS showed very little movement or waving, even at the maximum descent speeds. The arms appeared to sit well on the sea bed in all cases. Considerably movement due to vortex shedding would be expected during descent from unfaired cylindrical arms – although we do not have a 'control' comparison. However the evidence would seem to indicate that the canvas fairings should be retained. Note that these fairings could easily be fitted prior to shipping, saving a bit of work and time for the OBIC team at sea.

The arms showed alarming amounts of bend at the points where they exit from the frame – although none broke. It would be prudent to fit strengthening cylinders, identical to those used at the arm joints, to the inboard 70 cm or so of each arm, to prevent the arms from creasing where they exit from the frames. An approach similar to the old LEMUR instruments would work here.

Two of the instruments were deployed with 4 glass rod weights per arm, and one was deployed with 6 per arm. There is no apparent effect on receiver performance (see below), so I recommend that only 4 rods per arm are used in future.

Note also that it should be possible to place the pairs of rods inside the electrode arms in future, secured by nylon nuts and bolts. This would make the arm ends less liable to snagging or damage.

Lastly – the new Castle electrodes, like their AIS predecessors, have end caps that are much smaller in diameter than the insides of the arms. There is no reason why this should be the case – future electrodes could be ordered with end caps sized to make them a good but slightly loose fit inside the ends of the arms, to make inserting and securing them pre-deployment as easy as possible. I recommend that this be done.

3/ Electric field recording data quality.

It has not been possible at this stage to fully process the data from the 3 instruments. However some initial conclusions can be reached from preliminary inspection of the data.

The data were processed at sea into SEG-Y files, at 125 Hz sample rate, with samples in the form of 32 bit integer. Each trace is of 60 s duration and traces on each channel are sequential, starting on each minute. The data have subsequently (a) been read into Promax for inspection as time domain traces; (b) been converted to ASCII comma-separated-value files and imported to Matlab for frequency domain analysis. Instruments 1 and 2 were both fitted with AIS electrodes. Both recorded good data on both channels. The best quality data were on Instrument 1 – noise levels on Instrument 2 were higher. Instrument 1 had 4 glass weights per arm, Instrument 2 had 6. Instrument 3 was fitted with Castle electrodes. One channel did not record recognisable data. The other channel had data on it, but the noise level was higher than on either of instruments 1 or 2. On the basis of this test, the AIS electrodes outperformed the Castle electrodes both for noise and reliability, but the sample size is small.

The best quality data are from Instrument 1. The data have a signal to noise ratio substantially better than 1 at 4 Hz, for a 60 second stack, at horizontal offsets out to about 3 km. However clipping of the signal at short range occurs out to approximately 450 m offset. So, the usable data at 4 Hz are in the range of offsets from 450 m to 3 km.

The one good channel on Instrument 3 (Castle electrodes) is clipped over a range interval of about 300 m on either side of the instrument. The corresponding maximum offset for a signal to noise ratio substantially better than 1 is only about 1.8 km. However it is possible that this channel was oriented in an approximately cross-line direction, so that the E-field signals are smaller for that reason – that will be something to investigate using the HYBIS video data from the deployments.
The data from Instrument 2 (AIS electrodes) are intermediate in quality between Instruments 1 and 3.

The USBL navigation data for the DASI instrument have not yet been merged with the receiver electric field data, so all range/offset values used above are approximate at this stage. Further analysis will require more detailed processing, taking account of the absolute calibration of both the receivers and the transmitter signal, and including the USBL navigation data and the instrument orientation data from HYBIS.

12. HYBIS (V. Hühnerbach)

12.1. The HyBIS vehicle

HyBIS is a simple, low-cost, multi-purpose, survey and sampling robotic underwater vehicle (RUV) with a depth capability of 6000m. It was designed and built in the UK by Hydro-Lek Ltd. in collaboration with the National Oceanography Centre, Southampton (NOC), back in 2008. Since then, the vehicle has had 3 successful trials cruises and completed 5 scientific expeditions, from the Arctic to the Tropics.
The vehicle has a modular design that make its very versatile, with the top module being a command and power system that comprises power management, cameras, lights, hydraulics, thrusters and telemetry. Telemetry is via a single-mode fibre optic link and provides 3 channels of real-time standard-definition colour video plus vehicle attitude data. Power is supplied through a single-phase 1500V ac, 8kVA

umbilical and converted to 3-phase 120V on the vehicle by two silicon motor controllers, 240V ac for the lights, and 24 to 12 V dc for onboard instruments.
The easily changeable lower modules available at the moment include a clam-shell sampling grab, a 5-function manipulator-arm and tool sled, a winch with 600m rope for instrument recovery and an ocean bottom seismometer deployment module. The sampling module, a 0.5 cubic metre clamshell grab with a payload capacity of 750kg and closure force of 4 tonnes, was not used during JR253.
Unlike a conventional ROV, HyBIS does not have any floatation or buoyancy, it is rather suspended by its umbilical cable directly from the ship which makes it slightly susceptible to ship roll and heave motion. On the positive side, the advantage of direct suspension is that HyBIS can recover or deploy a payload of up to 750kg.

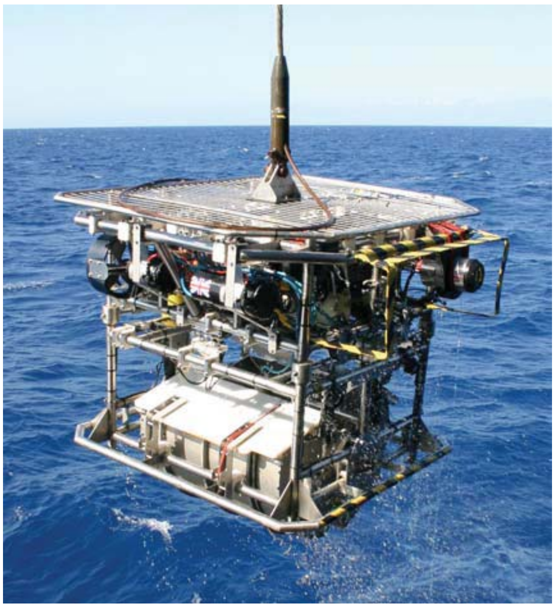


Fig1: HyBIS vehicle with grab module.

12.2. Laboratory control unit setup

The top-side control centre was established in the main lab, on the starboard side, towards the aft and next to the high-voltage bulk-head connections. This minimised the length of trailing high-voltage leads across the lab. The vehicle's primary control box was supplemented with additional monitors and a relay of the USBL navigation screen. A video-extended Cat5 cable was used to relay the forward-looking camera's video stream to a 21-inch flat screen in the main lab to enable group viewing. A dedicated GPS aerial was mounted on an out-rigger over the port side and provided a continuously recorded GPS string to the Garmin GPS navigation system in the control box. Winch controls were established adjacent to the vehicle pilot's position, allowing synchronisation between winch operator and pilot.

Video was recorded digitally as DV and AVI formats on 2Tb hard-discs. All three cameras (forward and downward SD and forward HD) were recorded continuously in standard definition. The forward looking camera with vehicle attitude data overlain was also recorded on DVDs of about one hour length. Full HD video (1080i, PAL, 30fps, AVCHD format) was downloaded from the vehicle's HD camera after the dives at each site and copied to another 2Tb hard drive provided. Back-ups of all dive data and videos were then made on regular intervals. All GPS navigation data were recorded on the top-side command unit and copied to a USB portable drive. Time codes were all set and synchronised to GMT.

Acoustic navigation was provided by the ‘Sonardyne’ USBL system on the RRS James Clark Ross and a transponder on the HyBIS vehicle. Tracking was generally good although transponder battery conditions of the wideband beacon deteriorated with time. The computing representative onboard recorded all USBL navigation data.

12.3. High-voltage power setup

In order to comply with UK high-voltage regulation, the 1500V HyBIS power supply, had to be placed within a lockable room, inaccessible to the public. HV safe working procedures were put in place, which meant that neither HyBIS nor any other high-voltage equipment were to be switched on prior to deployment and recovery. All procedures were communicated to and agreed with the crew. HV working permits were issued and signed off for each deployment. In addition, the lab entrance from the deck side was closed off after power up of the HV equipment to limited access to the area.

12.4. Summary

With almost 10 hours of dive time, HyBIS became an important part of the science activity during this short cruise. HyBIS deployed 6 Ocean Bottom Seismometers (OBS) and 3 Ocean Bottom Electro-Magnetic Landers (OBEM).

The vehicle worked without problems during 9 of the 10 deployments. One dive had to be abandoned due to a fault in the termination bottle. This was fixed overnight while a new F/O termination was made. The 6m long EM receivers limited manoeuvrability of the vehicle under water, so that bigger distances had to be managed by moving the vessel as the vehicle thrusters were not powerful enough to move the bulky OBEMs against the current.

HyBIS received great support from NMF-Techs Andy Webb and Neil Sloan during this trip.