PROJECT EDIPO
PROJECT DEGLABAR

Istituto Nazionale di Oceanografia e di Geofisica Sperimentale – OGS
Infrastrutture Section - IRI

RESEARCH PROJECTS

EDIPO: Eirik DrIft PaleOceanographyc investigation
DEGLABAR: Deglaciacion History of the North-Western Barents Sea from sediments generated by Paleo Ice Streams

Cruise Report

OGS Explora, 2015
21 September Longyearbyen
03 October Tromsø

Rel. 2016/XX Sez. IRI X NAVE dd. XX/XX/XXXX

AUTHORS

Lorenzo Facchin, Andrea Caburlotto, José Luis Casamor, Fabrizio Zgur, Daniela Accettella, Davide Deponte, Vedrana Kovacevic, Marina Monti, Paolo Visnovic, Claudio Pelos, Diego Cotterle, Leonardo Rui

Table of Content

1. Introduction

1.1. Foreword

The present report describes the activities performed by the r/v OGS Explora during the geophysical survey carried out in the Barents Sea from September 21st to October 03rd within the research projects EDIPO and DEGLABAR.

The survey was funded by OGS with a contribution from the Chief Scientist José Luis Casamor of University of Barcelona, that provided part of the ship time rate.

1.2. Scientific Context

Recent studies have further highlighted the correlation between the flow of North Atlantic Deep Water (WATER FORMATION) and bottom currents flows in the area of the Eirik Drift (Muller – Michaelis A., Uenzelmann – Neben G., in press).
In particular, the authors have highlighted how the NADW affects directly the intensity and path of the bottom currents along the eastern margin of Greenland and the Eirik drift.
Along the western continental margin of the Svalbard archipelago two sediment drifts (Isfjorden and Bellsund Drift; Fig. 1 and 2) developed under the influence of NADW and have been the subject of recent geological and oceanographic studies in the frame of the project EUROFLEET2 – PREPARED (Present and past flow regime on Contourite drifts west of Spitsbergen) during summer 2014.

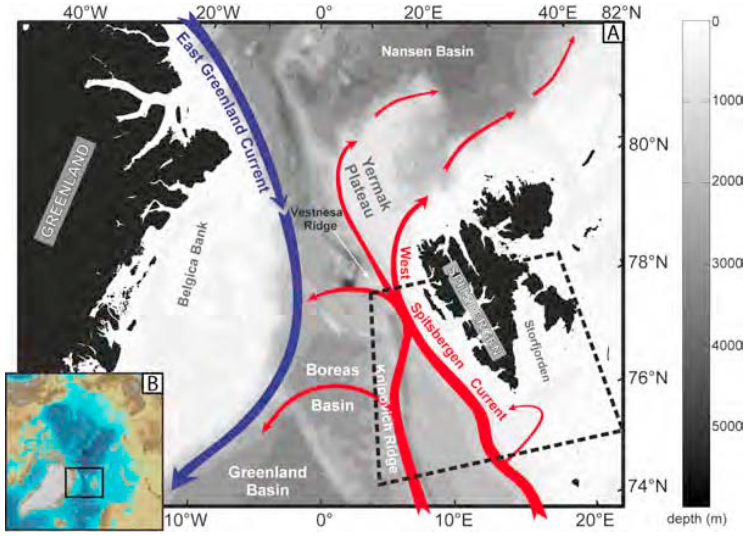


Figure 1: Map of the western Svalbard continental margin with the main oceanographic currents (Jakobssen et al., 2012).

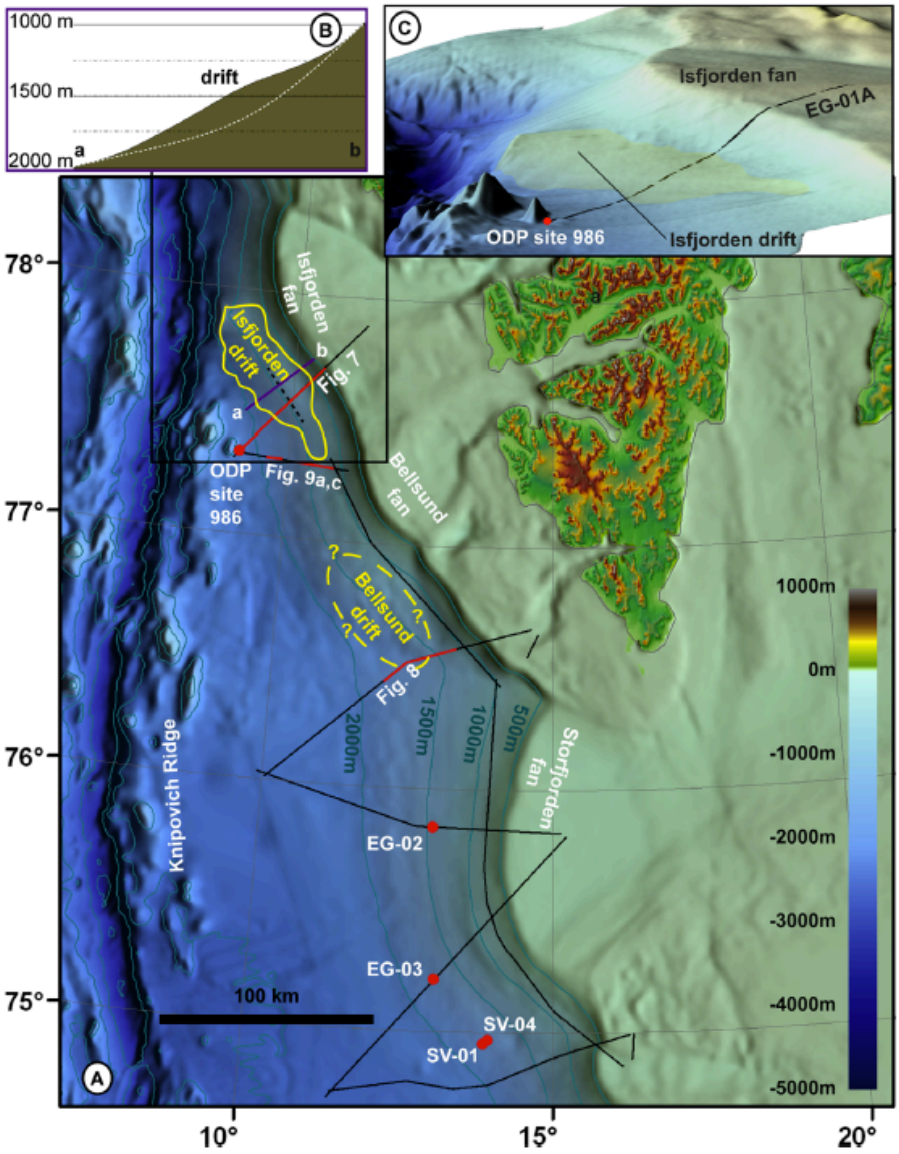


Figure 2: Isfjorden and Bellsund sediment drifts (Rebesco et al., 2013).

Preliminary results indicate that the two sedimentary deposits are characterized by high sedimentation rates, and characterized by a very expanded and continues Holocene sequence (up to 5-6 meters Fig.3). These features make this area of particular interest to study the relationship between deepwater ocean circulation and climate change, a topic of great importance but still much discussed in the international scientific community.

The DEGLABAR project aims to reconstruct the mechanism of marine sediment transport and dispersal during the last deglaciation stage of the Svalbard/Barents Sea Ice Sheet and evaluate the effect of sediment laden melt-water plumes on the ocean circulation, benthic habitats and sediment accumulation and distribution on polar continental margins.

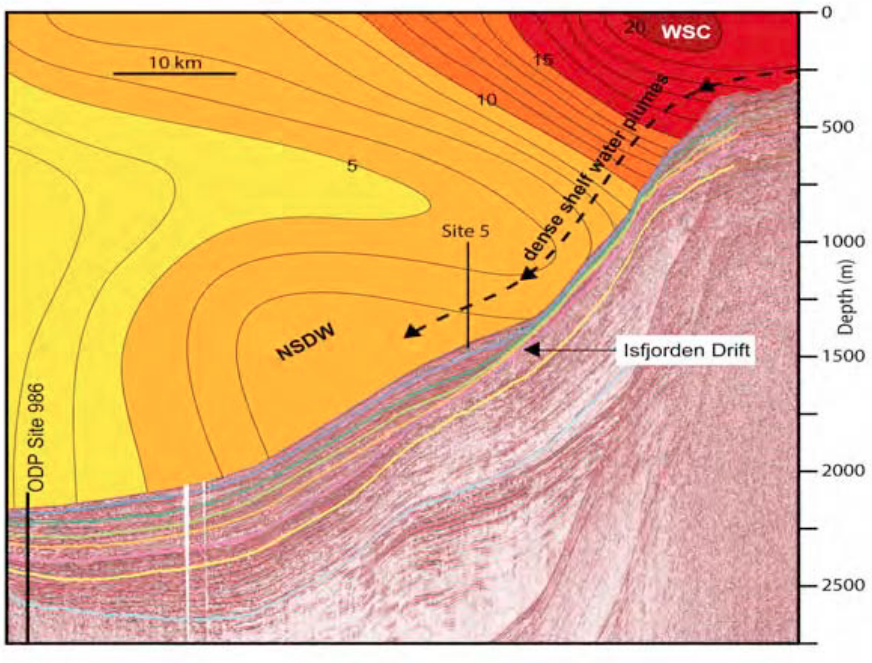


Figure 3: Relation between the deep current and the sedimentary sequence geometry (Rebesco et al., 2014)

1.3. Objectives

The NW Barents Sea continental margin has been the target of several surveys in the last decade: SVAIS (R/V Hesperides) in 2007, EGLACOM (R/V OGS Explora) in 2008, GLACIBAR (R/V Jan Mayen) in 2009, CORIBAR (R/V Maria S. Merian) in 2013 and PREPARED (R/V G.O. Sars) in 2014.

One target of this cruise is the acquisition of a wealth of new geophysical and oceanographic data that allowed improving the knowledge on glacial and climatic history of this area.

Furthermore, another objective of the EDIPO-DEGLABAR cruise is to map an underwater canal system along the continental slope off Bear Island. This channel has a strategic importance in the understanding of glacial, oceanographic and sedimentological dynamics along this margin.

1.4. Methods

To achieve the scientific objectives of this research 4 areas have been identified for geophysical and oceanographic exploration. The acquisition of 6 seismic lines, with water samples and oceanographic physical parameters measurements along the profiles has been planned in the Barents Sea.

Together with the multichannel seismic lines, sub bottom Chirp profiles and multibeam have been simultaneously acquired.

At the end of the survey 250Km of seismic data, 6685Kmq of multibeam data, 1049 Km of CHIRP data, 5 water samples and CTD profiles, 21 samples from thermosalinograph pump for

microzooplankton isotopes and salinity were acquired, and 34 XBT have been launched along the seismic profiles.

1.5. Plan of work

The first area to be investigated is the northern one (located at 77°N latitude and corresponding to the Isfjorden drift), followed by the second (76° latitude, Bellsund drift). The third area is the INBIS channel, main interest of the DEGLABAR project.

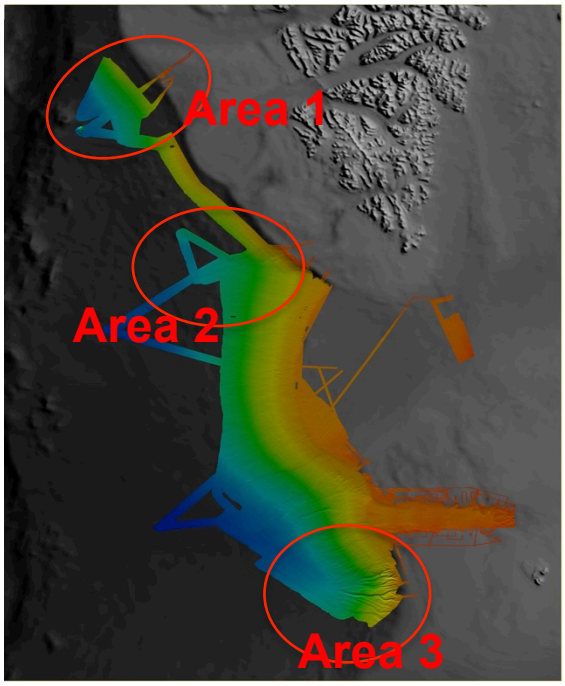


Figure 4: Plan of work.

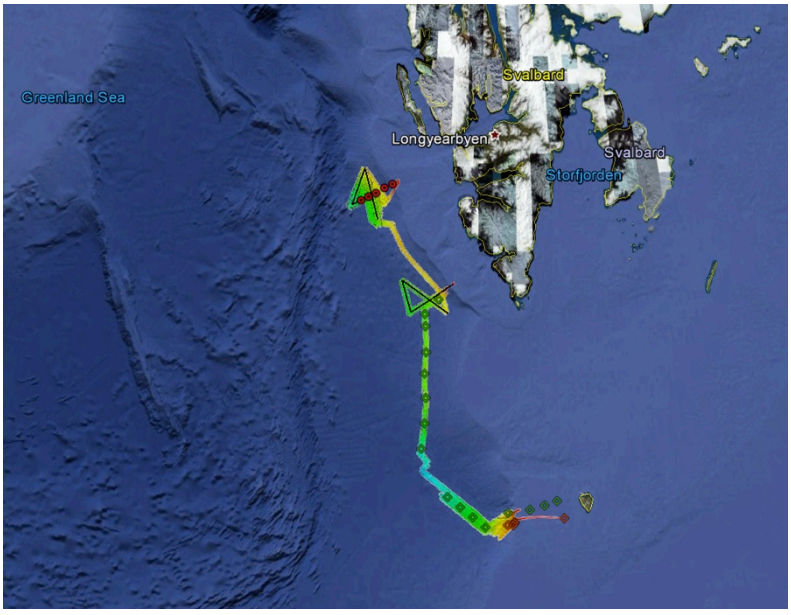


Figure 5: Data acquired.

Black lines: Seismic data, Red dots: CTD stations, green squares: Microzooplankton stations, orange squares: isotope stations, and MBES Raw DTM.

1.6. Participants

1.6.1. Scientific crew

Position	Name	Institute / Company
Chief Scientist	Andrea Caburlotto	OGS - GEO
Chief Scientist	José Luis Casamor	UB
Party Chief	Lorenzo Facchin	OGS - IRI
MBES Surveyor	Fabrizio Zgur	OGS - IRI
MBES Surveyor	Daniela Accettella	OGS - IRI
MBES Surveyor	Leonardo Rui	UniTS
Gun mechanic	Paolo Visnovic	OGS - IRI
Seismic observer	Claudio Pelos	OGS - IRI
Seismic observer	Diego Cotterle	OGS - IRI
Biologist	Marina Monti	OGS – OCE
Oceanograper	Vedrana Kovacevic	OGS – OCE
Oceanographic engineer	Davide Deponte	OGS – OCE

Table 1

1.7. Cruise narrative

1.7.1. Survey Agenda

Date	Activity
20-22/09/2015	Port of Longyearbyen – People onboard, safety induction meeting and MOB operations.
23/09- 01/10/2015	Data acquisition
02-03/10/2015	Navigation to Tromsø

Table 2

1.7.2. Cruise diary

NB: Hours are in UTC

20th September 2015

00.00 Port of Longyearbyen 78.229645° N – 015.601038°E
13.30 OGS personnel arrival on board
14.30 Safety induction meeting

21st September 2015

00.00 Port of Longyearbyen 78.229645° N – 015.601038°E
06.00 MOB starts. During this activity, the SSS-rosette cable is closely inspected and is found to be rotten and weak. About 500-600 m are cut and stored on the second deck. This causes a delay in the MOB as the back deck crane is used for this operation.

22nd September 2015

00.00 Port of Longyearbyen 78.229645° N – 015.601038°E
06.00 MOB operations.

23rd September 2015

00.00 Port of Longyearbyen 78.229645° N – 015.601038°E
05.40 Pilot on board
06.00 Departed from harbour and start transit to survey area
07.20 Pilot off the vessel
07.40 General drill followed by man overboard alarm
11.00 EDIPO project presentation meeting by Chief Scientist A. Caburlotto
13.30 Permit area entered. Both of MB systems switched on
SOL SV15_01.C.L.-20150923-133033. WD 254 m , HDG 236°.

13.40 Tool Box Talk with Master, crew and personnel involved in the backdeck operations.
14.00 End transit, start of CTD acquisition
14.01 SOL ED_S1.C.L.-20150923-140121 HDG 248 DEPTH 253
14.20 EOL ED_S1.C.L.-20150923-140121HDG 255 DEPTH 307
14.20 Loop to CTD station CDP38
14.41 Rosette-SVP **CTD39** into water. Lat. 77° 41.174'N, Long. 010°44.651'E, WD 301m.
14.47 Rosette **CTD39 DownCast Start**. Lat. 77° 41.220'N, Long. 010°44.814'E, WD 301m
14.56 Rosette **CTD39 OnBottom**. Lat. 77° 41.201'N, Long. 010°44.648E, WD 301m
15.07 Rosette and SVP on board Lat. 77° 41.199'N, Long. 010°44.59'E, WD 300m
15.15 Start transfer for SV15_01 Seismic Line.
15.50 XBT1 Lat. 77° 41.97'N, Long. 010°51.055'E, WD 300m
15.51 End water recovery on Rosette
16.05 SOL SV15_01.C.L.-20150923-160507, HDG 68, WD 292 m
16.33 SOL SV15_01.C.L.-20150923-160507, HDG 211, WD 302 m
16.54 SOL SV15_MB.C.L.-20150923-165422, HDG 211, WD 352 m
17.28 SV15_MB.C.L.-20150923-172857, HDG 211, WD 963 m
18.15 EOL SV15_MB.C.L.-20150923-172857, HDG 211, DEPTH 1189 m
18.15 Loop
18.23 SOL SV15_MB.C.L-20150923-182335, HDG 325, WD 1211 m
19.26 SV15_MB.C.L-20150923-192602, HDG 325, WD 1270 m
20.28 SV15_MB.C.L-20150923-202829, HDG 325, WD 1170 m
20.36 EOL SV15_MB.C.L-20150923-202829, HDG 325, WD 1180 m
20.36 Loop
20.53 SOL SV15_MB.R.1-20150923-205319, HDG 145, WD 1318 m
21.57 SV15_MB.R.1-20150923-215741, HDG 145, WD 1339 m
23.06 SV15_MB.R.1-20150923-230625, HDG 145, WD 1313 m
23.13 EOL SV15_MB.R.1, HDG 145, WD 1306 m
Start loop to SV15_MB.R.2.
SV15_MB.R.1-20150923-231308, HDG ---, WD 1313 m
SV15_MB.R.2-20150923-231412, HDG ---, WD 1312 m
23.30 SOL SV15_MB.R.2-20150923-233020, HDG 325, WD 1411 m

24th September 2015

00.00 Regular MBES and SBP acquisition along line SV15_MB.R.2.
00.39 SV15_MB.R.2-20150924-003903, HDG 325, WD 1443 m
01.46 EOL SV15_MB.R.2, WD 1442
Start loop to SV15_MB.R.3
SV15_MB.R.3-20150924-014648, HDG ---, WD 1443 m
02.05 SOL SV15_MB.R.3-20150924-020535, HDG 146, WD 1559 m
04.13 EOL SV15_MB.R.3-20150924-020535, HDG 1876, WD 1518 m
04.13 Loop
04.18 SOL SV15_MB.R.3-20150924-041801, HDG 1876, WD 1518 m
06.10 Start guns deployment
06.25 Guns in the water and start loop to SV15_03.C.L
07.03 End of loop, alinement for line SV15_03.C.L and start streamer deployment
07.25 Streamer in the water
Offset guns 25 m from stern, offset streamer 55 m from stern, lateral offset 20 m
07.30 Soft start
07.45 **SOL SV15_03**.C.L-2015-20150924-074510, HDG 347, WD 1669 m

Trigger problem with acquisition system. File 100 = shot 124
Logging, seismic, SBP, MBES and water column

09.19 XBT4 in Lat. 77°23'52,6''N Long. 010°01'45.4'' E, WD 1699 m
09.53 SV15_03.C.L-20150924-095340, HDG 346, WD 1685 m
10.00 Set Min. Depth filter for 7150 to 0.0 m
10.51 XBT5 in Lat. 77°29'09,2''N Long. 009°53'16.0'' E, WD 1643 m
12.02 SV15_03.C.L-20150924-120215, HDG 346, WD 1557 m
12.17 XBT6 in Lat. 77°34'10,8''N Long. 009°45'02.8'' E, WD 1535 m
13.44 XBT7 in Lat. 77°39'21,0''N Long. 009°36'30.2'' E, WD 1411 m
14.01 SV15_03.C.L-20150924-141045, HDG 346, WD 1437 m
15.05 XBT8 in Lat. 77°44'04,6''N Long. 009°28'33,60'' E, WD 1334 m
16.18 SV15_03.C.L-20150924-161839, HDG 346, WD 1221 m
16.40 **EOL SV15_03**.C.L-20150924-161839, Lat. 77°49'20,6''N Long. 009°19'32,90'' E, WD 1334 m
HDG 346, WD 1234 m, End WC, Chirp, MBES, Seismic acquisition
16.59 **SOL SV15_02**.C.L-20150924-165956 Lat. 77°49'23,0''N Long. 009°20'57,50'' E, WD 1334 m
HDG 200, WD 1234 m
17.09 XBT9 in Lat. 77°48'58,7''N Long. 009°19'24,70'' E, WD 1250 m
18.34 XBT10 in Lat. 77° 43.917' N Long. 009° 13.899' E, WD 1493 m
19.07 SV15_02.C.L-20150924-190745, HDG 198, WD 1609 m
19.56 XBT11 in Lat. 77°38.722'N Long. 009°08.120'E, WD 1780 m
21.22 XBT12 in Lat. 77°33.496'N Long. 009°02.319'E, WD 2002 m
21.28 SV15_02.C.L-20150924-212812, HDG 199, WD 2016 m
22.49 XBT13 in Lat 77°28'10.7"N Long. 008°56'30.8"E, WD 2084 m
23.26 **EOL SV15_02**.C.L-20150924-212812, HDG 199, WD 2083 m, End Chirp and Seismic acquisition.
Run-out distance of about 300 m. Last Event No. 3105
Start loop to SV15_01.C.L.
SV15_01.C.L-20150924-232656, HDG ---, WD 2083 m

25th September 2015

00.00 Loop towards SOL profile SV15_01
00.04 **SOL SV15_01**.C.L-20150925-000400, WD 1334 m, HDG 63, WD 2080 m. First Event No. 100.
Run-in distance of about 300 m.
00.12 XBT14 in Lat. 77°26'21.3"N Long. 008°55'54.8"E, WD 2083 m. Data error. Drop must be repeated.
00.30 XBT14 in Lat. 77°27'00.4"N Long. 009°00'31.5"E, WD 2073 m. Data OK.
01.54 XBT15 in Lat. 77°30'02.1"N Long. 009°22'08.4"E, WD 1914 m.
02.42 SV15_01.C.L-20150925-024215, HDG 63, WD 1708 m. First Event
03.20 XBT16 in Lat. 77°32'53.4"N Long. 009°43'47.1"E, WD 1582 m.
04.02 Seismic screen frozen: Lost shots from 1570 to 2067 (7.5 km), new start in shot 2067
Lat. 77°34'44.6"N Long. 010°00'03.3"E, WD 1340 m.
04.19 **EOL SV15_01**.C.L-20150925-024215 Stop MBES, WC, Chirp, Seismic
Lat. 77°34'44.6"N Long. 010°00'03.3"E, WD 1350 m Event 2260.
04.20 Loop and transit to Event 1570
05.57 End Loop Kp33.4
06.04 **SOL SV15_01**.C.L-20150925-060348 Lat. 77°49'23,0''N Long. 009°20'57,50'' E, WD 1710 m
HDG 63
Multibeam, seismic (no CHIRP, no WC).
07.30 **EOL SV15_01**.C.L-20150925-060348, HDG 67, WD 1418 m in Lat. 77.576° N Long. 009.976° E
Start airguns and streamer recovery.
07.44 Airguns recovered

08.20 Streamer recovered. Transit to Station 40
09.03 **Station 40** reached. Start CTD deployment.
09.10 Start CTD profile. CTD Station 40 in Lat. 77°38'26.7''N Long. 010°21'57.8'' E, WD 980 m
09.35 CTD reaches the bottom. Stop downcast, start upcast.
09.57 End CTD profile. Start CTD recovery.
10.01 CTD on board. Start transfer to CTD station 411
10.54 **Station 411** reached. Start CTD deployment
10.56 CTD in the water
11.00 Start CTD downcast. Lat. 77°34'47.8''N Long. 009°59'57.2'' E, WD 1386 m
11.38 CTD downcast stopped at 1356 m . Start upcast. Lat. 77°34'48.0''N Long. 010°00'02.6'' E, WD 1371 m.
12.27 CTD at surface. Start recovery. Lat. 77°34'47.7''N Long. 009°59'42.1'' E
12.30 CTD on board. Start transfer to CTD station 421
13.14 **Station 421** reached. Start CTD deployment
13.15 CTD in the water
13.18 Start CTD downcast. Lat. 77°32'10.0''N Long. 009°38'16.5'' E, WD 1664 m
13.50 CTD downcast stopped at 1632 m . Start upcast. Lat. 77°32'10.0''N Long. 009°38'16.5'' E, WD 1672 m.
14.30 CTD at surface. Start recovery. Lat. 77°32'14.2''N Long. 009°35'56.6'' E
14.34 CTD on board. Start transfer to CTD station 43
15.20 **Station 43** reached. Start CTD deployment
15.22 CTD in the water
15.25 Start CTD downcast. Lat. 77°29'38.5''N Long. 009°19'17.5'' E, WD 1958 m
16.01 CTD downcast stopped at 1958 m . Start upcast. Lat. 77°29'41.6''N Long. 009°19'17.3'' E, WD 1958 m
16.49 CTD at surface. Start recovery. Lat. 77°29'41.2''N Long. 009°19'21.0'' E
16.58 CTD on board. Start transfer to **TransitArea1Area2**
17.02 **SOL SV15_TransitArea1Area2**.C.L-20150925-170206 Lat. 77°29'51,0''N Long. 009°18'49,0'' E, WD 1958m HDG 333
17.58 **SV15_MBTransferArea1Area2**.C.L-20150925-175800 WD 1653m, HDG 127
20.05 SV15_MBTransferArea1Area2.C.L-20150925-200529, HDG 1161, WD 1823 m
21.46 SV15_MBTransferArea1Area2.C.L-20150925-214621, HDG ---, WD 1180 m. Start loop.
22.00 End of loop.
SV15_MBTransferArea1Area2.C.L-20150925-220012, HDG 149, WD 1213 m

26th September 2015

00.00 Regular MBES and SBP acquisition during transfer from Area 1 to Area2
00.06 SV15_MBTransferArea1Area2.C.L-20150926-000653, HDG 140, WD 1084 m.
02.15 SV15_MBTransferArea1Area2.C.L-20150926-021517, HDG 137, WD 1350 m.
04.07 SV15_MBTransferArea1Area2.C.L-20150926-044740, HDG 137, WD 1331 m.
05.26 **EOL SV15_TransitArea1Area2**.C.L-20150926-044740 Lat. 76°24'05,0''N Long. 013°31'19,6'' E, WD 1260m HDG 157
06.00 Start streamer deployment
06.21 Streamer in the water. Start loop.
06.31 End of loop. Start airguns deployment.
06.41 Airguns in the water.
06.44 Soft start.
Offset guns 25 m from stern, offset streamer 55 m from stern, lateral offset 20 m
06.57 **SOL SV15_06**-20150926-065734 in Lat. 77°23'36''N Long. 013°31'54''E, HDG 305, WD 1250 m

07.15 XBT18 in Lat. 76°24.223'N Long. 013°28.998'E, WD 1277 m
08.39 XBT19 in Lat. 76°27.352'N Long. 013°09.632'E, WD 1448 m
09.06 SV15.SV15_06-20150926-090657, HDG 305, WD 1500 m
09.59 XBT20 in Lat. 76°30.445'N Long. 012°49.823E, WD 1610 m. No data. Drop is repeated
10.03 XBT21 in Lat. 76°30.592'N Long. 012°48.843E, WD 1613 m
11.16 SV15.SV15_06-20150926-111629, HDG 305, WD 1685 m
11.19 XBT22 in Lat. 76°33.516'N Long. 012°29.795E, WD 1688 m
12.39 XBT23 in Lat. 76°36.417'N Long. 012°10.567E, WD 1737 m
13.26 SV15.SV15_06-20150926-132600, HDG 305, WD 1754 m
13.57 XBT24 in Lat. 76°39.309'N Long. 011°51.154E, WD 1749 m
15.35 SV15.SV15_06-20150926-153537, HDG 305, WD 1787 m
15.44 **EOL SV15_06**-20150926-153537 in Lat. 76°42'53''N Long. 011°26'54.0''E, HDG 305, WD 1785 m
15.46 Loop
15.57 **SOL SV15_05**-20150926-155738 in Lat. 76°42'56''N Long. 011°27'37.6''E, HDG 164, WD 1757 m
16.03 XBT25 in Lat. 76°42'29.2''N Long. 011°28'23.2'E, WD 1771 m
17.34 XBT26 in Lat. 76°37'17.5''N Long. 011°36'07.5''E, WD 1906 m
18.07 SV15.SV15_05-20150926-180717, HDG 164, WD 1959 m
19.02 XBT27 in Lat. 76°31.835'N Long. 011°44.183'E, WD 1960 m
20.17 SV15.SV15_05-20150926-201714, HDG 164, WD 1908 m
20.30 XBT28 in Lat. 76°26.745'N Long. 011°51.592'E, WD 1920 m
21.26 **EOL SV15_05**-20150926-201714, HDG 164, WD 1908 m. Start loop to SV15_04.C.L.
21.55 **SOL SV15_04**.C.L-20150926-215512, HDG 56, WD 1903 m.
22.06 XBT29 in Lat. 76°23.776'N Long. 011°58.515'E, WD 1893 m
23.41 XBT30 in Lat. 76°27.003'N Long. 012°18.048'E, WD 1803 m

27th September 2015

00.00 Regular MCS, MBES and SBP acquisition along line SV15_04
00.04 SV15.SV15_05-20150926-000449, HDG 56, WD 1760 m
01.16 XBT31 in Lat. 76°30.325'N Long. 012°38.391'E, WD 1681 m
02.14 SV15.SV15_04-20150926-021424, HDG 56, WD 1473 m
02.48 XBT32 in Lat. 76°33.571'N Long. 012°57.42'E, WD 1446 m
04.04 SV15.SV15_04-20150927-040400, HDG 56, WD 1104 m
04.25 XBT33 in Lat. 76°37.101'N Long. 013°17.767'E, WD 920 m
04.49 MB8111 Switch ON
05.02 SV15.SV15_05-20150927-050223, HDG 56, WD 665 m
05.30 SV15.SV15_05-20150927-053006, HDG 56, WD 371 m
05.54 XBT34 in Lat. 76°40.265'N Long. 013°36.718'E, WD 212 m
06.24 EOL SV15.SV15_04-20150927-053006, HDG 56, 233 m. Start loop to Station 26.
06.45 Start airguns and streamer recovery.
07.30 Airguns and streamer on board.
08.19 MB8111 Switch OFF
08.20 Station 26 reached. Start CTD deployment.
08.22 CTD in the water.
08.37 Standby. Problem with the winch.
08.42 CTD cast aborted. Start CTD recovery for winch check.
08.47 CTD on board. Several problems with winch.
09.21 Due to bad weather forecasts for the next few days, Area 2 is abandoned. Start transfer to DEGLABAR project area, following a route in MBES coverage overlapping with EGLACOM dtm.
09.39 Transfer.C.L-20150927-093946, HDG 232, WD821 m.

10.23 MZ1 START, microzoooplancton sampling at Lat. 76°31.910'N Long. 013°08.051'E, WD 1449 m
10.33 MZ1 STOP, microzooplancton sampling at Lat. 76°30.991'N Long. 013°02.326'E, WD 1506 m
10.35 MZ1 END SALINITY AND ISOTOPES, at Lat. 76°30.776'N Long. 013°00.999'E, WD 1525 m
11.24 Stop C.L-20150927-093946. Start Loop
Transfer.C.L-20150927-112439, HDG ---, WD 1710 m.
11.30 Transfer.C.L-20150927-113045, HDG 176, WD 1713 m.
11.39 XBT35 in Lat. 76°24.953'N Long. 012°31.872'E, WD 1699 m
11.57 MZ2 START, microzoooplancton sampling at Lat. 76°22.670'N Long. 012°33.299'E, WD 1682 m
12.07 MZ2 STOP, microzooplancton sampling at Lat. 76°21.200'N Long. 012°33.975'E, WD 1670 m
12.10 MZ2 END SALINITY AND ISOTOPES, at Lat. 76°20.909'N Long. 012°34.110'E, WD 1664 m
12.49 MZ3 START, microzoooplancton sampling at Lat. 76°15.332'N Long. 012°36.393'E, WD 1662 m
12.59 MZ3 STOP, microzooplancton sampling at Lat. 76°13.910'N Long. 012°36.985'E, WD 1651 m
13.00 MZ3 END SALINITY AND ISOTOPES, at Lat. 76°13.710'N Long. 012°37.085'E, WD 1649 m
13.39 Transfer.C.L-20150927-133915, HDG 176, WD 1609 m
14.40 MZ4 START, microzoooplancton sampling at Lat. 75°59.515'N Long. 012°40.710'E, WD 1583 m
14.47 MZ4STOP, microzooplancton sampling at Lat. 75°58.461'N Long. 012°40.483'E, WD 1585 m
14.48 MZ4 END SALINITY AND ISOTOPES, at Lat. 75°58.189'N Long. 012°40.425'E, WD 1587 m
15.47 Transfer.C.L-20150927-154758, HDG 176, WD 1623 m
16.07 MZ5 START, microzoooplancton sampling at Lat. 75°46.41'N Long. 012°39.21'E, WD 1601 m
16.17 MZ5STOP, microzooplancton sampling at Lat. 75°44.97'N Long. 012°39.09'E, WD 1606 m
16.18 MZ5 END SALINITY AND ISOTOPES, at Lat. 75°44.807'N Long. 012°39.110'E, WD 1608 m
17.45 MZ6 START, microzoooplancton sampling at Lat. 75°31.67'N Long. 012°44.476'E, WD 1640 m
17.53 MZ6 STOP, microzooplancton sampling at Lat. 75°30.50'N Long. 012°45.276'E, WD 1644 m
(**SALINITY AND ISOTOPES not sampled)**
17.57 Transfer.C.L-20150927-175704, HDG 170, WD 1644 m
18.33 Transfer.C.L-20150927-183359, HDG 175, WD 1699 m. Multibeam and CHIRP.
19.32 MZ7 START, microzoooplancton sampling at Lat. 75°16.091'N Long. 012°44.166' E, WD 1841 m
19.41 MZ7 STOP, microzoooplancton sampling at Lat. 75°14.905'N Long. 012°43.741' E, WD 1856 m
(**SALINITY AND ISOTOPES not sampled)**
21.20 MZ8 START, microzoooplancton sampling at Lat. 75°00.486'N Long. 012°38.859'E, WD 2116 m
21.30 MZ8 STOP, microzoooplancton sampling at Lat. 74°59.088'N Long. 012°38.509'E, WD 2141 m
(**SALINITY AND ISOTOPES not sampled)**
21.45 **START OF DEGLABAR PROJECT**. SVP in water, Lat. 74°58.308' N Long. 012°32.131'E, WD 2155 m
23.43 SVP on board, Lat. 74°57.617' N Long. 012°32.287'E, WD 2197 m. Start loop to SOL DEGLABAR

28th September 2015

00.00 Loop to first route DEGLABAR
00.10 SOL DEGLABAR.C.L-20150928-001005, HDG 142, WD 2176.
01.26 DEGLABAR.C.L-20150928-012631, HDG 235, WD 2173
01.26 DEGLABAR.C.L-20150928-012631, HDG 235, WD 2173
02.09 Loop
02.11 DEGLABAR.C.L-20150928-021101, HDG 120, WD 2270
04.19 DEGLABAR.C.L-20150928-041934, HDG 129, WD 2160 m
06.27 EOL DEGLABAR.C.L-20150928-062746, HDG 130, WD 1925 m
08.31 Transfer to DEGLABAR2.C.L.
08.49 SOL DEGLABAR2.C.L-20150928-084953, HDG 308, WD 1713 m
08.51 MZ9 START in Lat. 74°13.083'N Long. 015°11.247'E, WD 1709 m
+ SALINITY AND ISOTOPES sampling
09.00 MZ9 STOP in Lat. 74°13.976'N Long. 015°06.983'E, WD 1759 m

09.53 MZ10 START, microzoooplancton sampling + Salinity and Isotopes in Lat. 74°19.253'N Long. 014°42.392'E, WD 1896 m.
10.05 MZ10 STOP, microzoooplancton sampling + Salinity and Isotopes in Lat. 74°20.384'N Long. 014°37.060'E, WD 1915 m.
10.58 MZ11 START, microzoooplancton sampling in Lat. 74°25.350'N Long. 014°13.413'E, WD 2021 m.
11.09 MZ11 STOP, microzoooplancton sampling in Lat. 74°26.359'N Long 014°08.504'E, WD 2040 m.
10.57 DEGLABAR.2.C.L-20150928-105714, HDG 308, WD 2021
12.06 MZ12 START, microzoooplancton sampling in Lat. 74°31.403'N Long. 013°43.920'E, WD 2120 m.
12.17 MZ12 STOP, microzoooplancton sampling in Lat. 74°32.423'N Long. 013°38.896'E, WD 2161 m.
12.27 EOL DEGLABAR.2.C.L-20150928-105714, HDG 308, WD 2176. Line interrupted due to meteomarine conditions worsening earlier then expected.
12.31 Start recording during loop.
SOL DEGLABAR2.R.1-20150928-123106, HDG 231, WD 2167 m
12.53 EOL DEGLABAR2.R.1-20150928-123106, HDG 231, WD 2176 m
12.55 SOL DEGLABAR2.R.1-20150928-125547, HDG 128, WD 2171 m
15.00 DEGLABAR2.R.1-20150928-150330, HDG 128, WD 1940 m
15.00 DEGLABAR2.R.1-20150928-150330, HDG 128, WD 1940 m
17.11 DEGLABAR2.R.1-20150928-171115, HDG 128, WD 1689m
17.18 Loop
17.34 DEGLABAR3.C.L-20150928-173445, HDG 37, WD 1637 m
19.42 MZ13 START, microzoooplancton sampling + Salinity and Isotopes in Lat. 74°21.909'N Long. 016°02.141'E, WD 1065 m
19.53 MZ13 STOP, microzoooplancton sampling in Lat. 74°22.800'N Long. 016°06.848'E, WD 783 m
19.54 EOL DEGLABAR3.C.L-20150928-173445, HDG 37, WD 783 m
19.54 Loop to DEGLABAR4.C.L
20.12 SOL DEGLABAR4.C.L-20150928-201228, HDG 232, WD 734 m
21.56 DEGLABAR4.C.L-20150928-215627, HDG 219, WD 1318 m
21.56 EOL DEGLABAR4.C.L-20150928-215627, HDG 219, WD 1458 m
22.44 Start loop to SOL DEGLABAR4.L.1
DEGLABAR4.L.1-20150928-224436, HDG 144, WD 1416 m
22.59 SOL DEGLABAR4.L.1-20150928-225953, HDG 56, WD 1370 m

29th September 2015

00.00 Regular acquisition along route DEGLABAR4
00.49 DEGLABAR4.L.1-20150928-004955, HDG 43, WD 766 m
01.38 DEGLABAR4.L.1-20150928-013835, HDG 70, WD290 m
01.51 EOL DEGLABAR4.L.1-20150928-013835, HDG 70, WD255 m. Stop MBES acquisition.
DEGLABAR area abandoned as a consequence of bad weather incoming. Vessel headed for shelter in the NE shore of Bear Island. Microzoooplancton sampling every 10 nm to be conducted during transfer.
Waiting on weather start.
02.33 MZ14 START, microzoooplancton sampling in Lat. 74°23.474'N Long. 016°52.274'E, WD 400 m
02.42 MZ14 STOP, microzoooplancton sampling in Lat. 74°23.486'N Long. 016°56.889'E, WD 400m
02.47 MZ14 END SALINITY AND ISOTOPES, Lat. 74°23.536'N Long. 016°59.189'E, WD 400m
03.41 MZ15 START, microzoooplancton sampling and ISOTOPES, in Lat. 74°25.805'N Long. 017°26.158'E, WD 142 m
03.53 MZ15 STOP, microzoooplancton sampling in Lat. 74°26.259'N Long. 017°32.161'E, WD 142 m
04.59 MZ16 START, microzoooplancton sampling and ISOTOPES, in Lat. 74°28.213' N Long. 017°55.085'E, WD 115 m

05.12 MZ16 STOP, microzoooplancton sampling in Lat. 74°28.450'N Long. 017°55.710'E, WD 115 m
08.59 MBES 8111 scouting along route Ridosso.C.L
09.39 Sheltered at anchor north of Bear Island. Lat. 74°31.098'N, Long. 019°02.772'E.
16.30 Due to swell increasing from West, ship moves to the North eastern side of the island for sheltering.

30th September 2015

00.00 **Waiting on weather**. Sheltered offshore Bear Island. Lat. 74°29.2'N, Long. 019°14.2'E.

1st October 2015

00.00 **Waiting on weather**. Sheltered offshore Bear Island. Lat. 74°24.2'N, Long. 019°17.0'E.
08.30 Ship moves from shelter south of Bear Island to check marine conditions in open water.
10.30 Ship headed towards southern area of DEGLABAR project.
12.07 IS42, ISOTOPS sampling in Lat. 74° 17.345'N Long. 018°10.292'E.
16.36 MB Reson 7150 SwitchON
17.11 SOL DEGLABAR5.L.1-20151001-171134, HDG 213, WD 659 m
17.48 IS43, ISOTOPS + salinity sampling in Lat. 74° 14.418'N Long. 016°01.264'E, WD 929 m.
18.02 DEGLABAR5.C.L-20151001-180234, HDG 232, WD 1038 m
18.48 DEGLABAR5.C.L-20151001-184812, HDG---, WD 1157 m. Start loop.
18.54 DEGLABAR5.C.L-20151001-185424, HDG 30 , WD 1105 m
20.22 DEGLABAR5.C.L-20141001-202213, HDG---, WD 521 m. Start loop.
20.34 DEGLABAR5.C.L-20141001-203419, HDG 214, WD 387 m
20.43 IS44, ISOTOPS + salinity sampling in Lat. 74°16.041'N Long. 016°17.802'E, WD 512 m
20.57 IS46, ISOTOPS + salinity sampling in Lat. 74°14.274'N Long. 016° 13.922'E, WD 562 m
21.06 DEGLABAR5.C.L-20141001-210616, HDG 222, WD853 m
22.16 EOL DEGLABAR5.C.L-20141001-210616, HDG 222, WD1076 m.
END OF SURVEY
22.17 Ship headed to Tromsø.

2nd October 2015

00.00 On the way back to Tromsø

3rd October 2015

10.00 Berthed in Tromsø

2. Data Acquisition

2.1. Navigation

2.1.1. Geodetic Parameters

Acquisition Datum	WGS84	
	Spheroid	WGS84
	Semiaxis Major	6378137
	Inverse Flattening	298.25722356
Target Datum	WGS84	
	Spheroid	cs
	Semiaxis Major	cs
	Inverse Flattening	cs
Datum Transformation	Null	
Projection	Universal Transverse Mercator (UTM)	
	Zone	33N (15E)
	Origin Latitude	00°00’00”N - Equator
	Central Meridian	15°00’00”E
	False Northing	0.00 m
	False Easting	500000 m
	Scale Factor	0.999600

Table 3

2.1.2. Operations

The navigation has been managed by using the “Teledyne Reson - PDS2000” software, configured to send the fire commands (fix) at 15.625m (Five times the Hydrophone distance 3.125m) shot point distance to trigger both the gun controller and the recording system (see Figure 6).

The same system is used for MBES data acquisition, while the CHIRP data were acquired by “Swanpro” software.

A comprehensive description of the navigation system and its interfaces to the ship equipment is provided in Annex B (paragraph B.1. an B.3.).

2.2. Multichannel Seismic - MCS

2.2.1. Acquisition Parameters

The choice of the acquisition parameters was driven by the needing of a good compromise between resolving power, to fully discriminate the shallower reflectors, and penetration.

2.2.1.1. Seismic Source

The source consisted of one Mini GI-Gun 60 cu.in. (ca. 1l) and one GI Gun 210 cu.in. (ca 3.44l) for a total volume of 270 cu.in (ca. 4,4l). See Annex B for a detailed description of the seismic source.

The shot point distance was set to 15.625 m, corresponding to a time interval of about 8 seconds at 3.8 knots of ship speed. The record length was set to 4.5 seconds, with more than 3 seconds left to the acquisition system automatic re-arm.

The array was towed at a depth of 3 m to reduce the noise from the sea surface whilst confining the spectra to an acceptable upper limit of 250 Hz, corresponding to 6 m long wavelengths; according to the λ/4 Rayleigh criterion, for speed of sound ranging from 1520 m/s to 3500 m/s, a resolving power from about 1.5 m for the shallower events to 3.5 m for the deepest ones can be expected.

2.2.1.2. Receivers

The data were collected by a 96 channels, 300 m long digital streamer, with a channels distance of 3.125 m, corresponding to an effective horizontal sampling of 1.5625 m in the stacked section.

With a 15.625 m shot point interval, the fold coverage attainable was 9.6 traces / CDP.

The distance between the source and the first channel (near offset) was 40m, large enough to prevent saturation (data clipping), and the lateral offset was 20m.

Like the source, the streamer was towed at a depth of 3 m below the sea surface (Figure 5).

The general acquisition parameters are summarized in Table 5. A more detailed description of the seismic equipment can be found in Annex B. The SEGD format recorded data were logged on the acquisition computer hard disk and on an external hard disk. Back up copies were stored at the end of each line on an extra external USB HD.

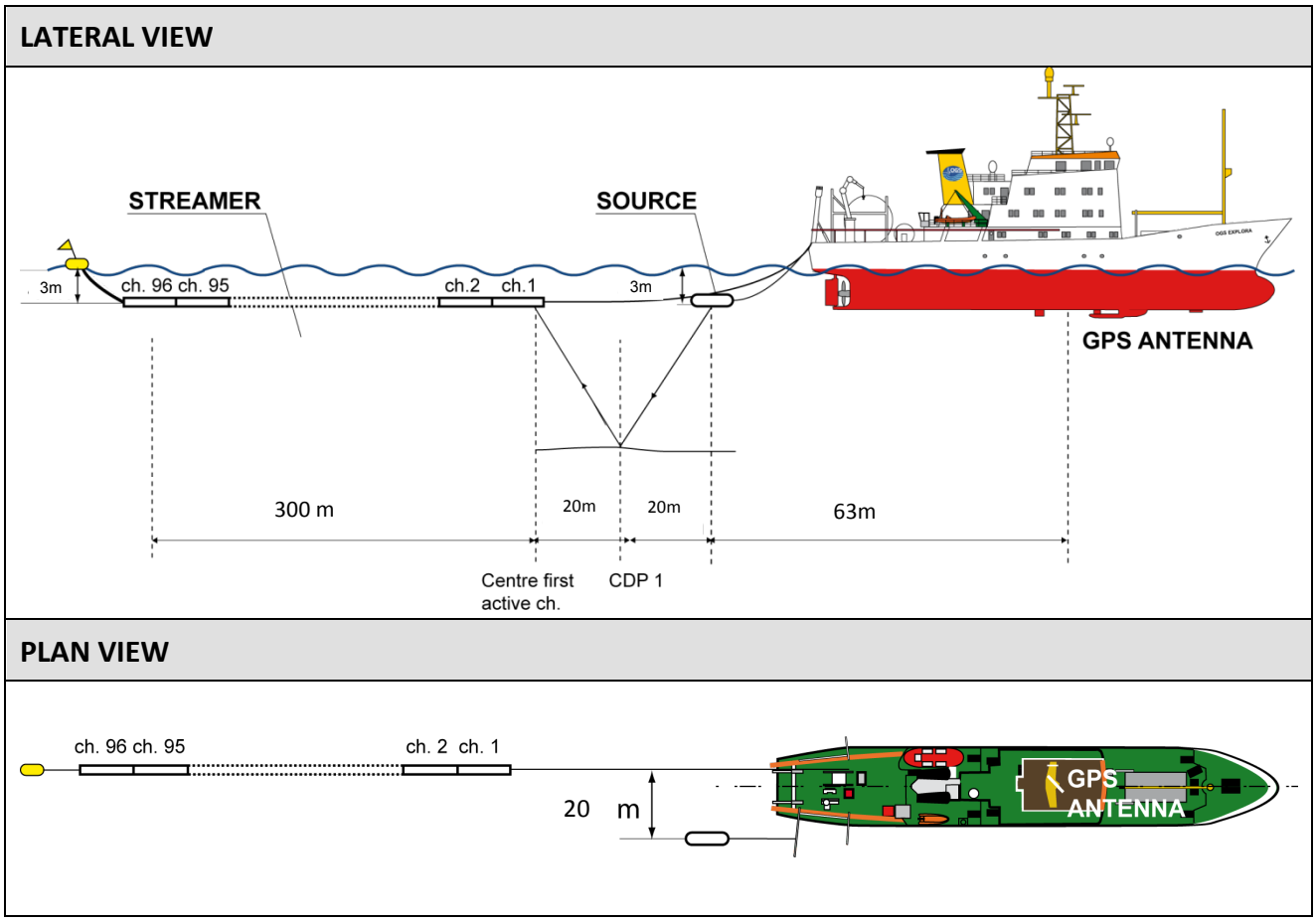


Figure 6: Acquisition geometry

ACQUISTION PARAMETERS					
SOURCE		**STREAMER**		**RECORDING**	
Model	Mini GI-GUN Sercel GI-GUN Sercel	Model	Geometrics Geoeel	Model	Geometrics CNT-1
Array	1 x 60 cu.in (1l) 1x210 cu.in (3.44l)	Length	300 m	Sampling rate	0.5 ms
Gun Mode	30G+30I Harmonic 105G+105I Harmonic	Ch. No.	96	Record length	4.5 sec
Shot Interval	15.625 m	Ch. Dist.	3.125 m	LC filters	3 Hz (LC);
Depth	3 m ± 0.5 m	Depth	3 m ± 0.5 m	HC filters	Antialias
Pressure	140 atm.	Min off.	40 m	Aux channels	Ch.2
SYNCHRONIZATION		Max off.	340 m		
Controller	RTS Big Shot	Max fold	9.6		
Aim Point	50 ms delay				

Table 4. Acquisition parameters

2.3. Sub Bottom Profiling - SBP

Contextually to the MCS survey, a SBP survey was carried out by means of the hull mounted 16 transducers Chirp Benthos system. The ping rate was set to 0.25 sec (with a speed of about 4 kn, that is 2 m/s, this corresponds to two trace/m). The data were stored in the acquisition workstation in SEGY format with the positioning from GPS automatically incorporated within the data headers.

No processing has been performed for these data except for a general Quality Control during the acquisition.

2.4. Multibeam Echosounding - MBES

Both the shallow water Reson Seabat 8111 multibeam echosounder and the deep water Reson Seabat 7150 were used during the survey. The acquisition was conducted by means of the PDS2000 system along all of the profiles simultaneously to the MCS and SBP acquisition. The MBES data, as well as all those data coming from the equipment interfaced to the acquisition system (positioning, motion sensors, echosounder) were stored in PDS2000 format. Two sound velocity profile - SVP were measured during the survey to real time correct the incoming seafloor echoes.

2.5. CTD measurements

Vertical, high-resolution profile of pressure, temperature, conductivity, dissolved oxygen concentration, fluorescence, turbidity, and light transmission were registered at a sampling frequency equal to 24 Hz. Table B10 reports the equipment employed, Seasave and SBE Data Processing Software of Sea-Bird Electronics Inc. were used for the data acquisition, visualization, and preliminary post processing, as well as for bin averaging (in 1 dbar bins). Four water samples for salinity were taken at two stations at 1000m and 1400m depths respectively. They will be analysed by Autosal in the on-shore laboratory of the OGS calibration centre (“Centro Taratura”). Table 5 report details about the CTD stations and water samplings.

Station No.	Depth m	Latitude N	Longitude E	Date and time	Sample depth m	Bottles	Niskin bottle
39	300	77°41'10.32"	010°44'44.52"	23/09/2015 14:40	292 200 151 100 50 30 20 10 2	5 2 2 4 2 2 2 2 3	1-5 6-7 8-9 10-13 14-15 16-17 18-19 20-21 22-24
40	982	77°38'28.68"	010°22'27.12"	25/09/2015 09:00			
411	1382	77°34'50.88"	009°59'55.68"	25/09/2015 10:53	1357 1001 800 600 400 200 80 51 9 1	6 1 1 3 1 1 3 1 1 2	5-10 11 12 13-15 16 17 18-20 21 22 23-24
412	1665	77°32'15.00"	009°39'38.52"	25/09/2015 13:14			
43	1950	77°29'39.48"	009°19'22.80"	25/09/2015 15:21	1923 1400 800 701 600 450 130 100 59 2	6 1 1 1 1 3 1 3 1 2	5-10 11 12 13 14 15-17 18 19-21 22 23-24

Table 5: CTD Station location and water samples

2.6. Underway sea current

Sea current profiles along the vessel route were measured continuously by the vessel hull mounted RDI OS75 ADCP. Sampling bin average is set to 5 minutes. Dimensions of the vertical bins was set to 8m.

2.7. Underway salinity and temperature

Temperature and salinity at 4m water depth were measured by the SBE21 system. The real-time sample interval was set to 5 seconds. Data were subsequently averaged inot bins of 1 minute for visualization. On September 29th the registration of data is interrupted. Registration started again on October 1st. there are gaps for certain time interval on the day, because the sea pump switched off frequently due to the pitching and rolling of the ship during the rough sea.

2.8. Sampling from thermosalinograph pump for microzooplankton isotopes and salinity

Details for the microzooplankton, isotopes, and salinity sampling are described in the following table.

Station	Bottom Depth m	Latitude N	Longitude E	Date and time	ISO	S
MZ1	1449	76°31'54.48"	013°08'03.12"	27/09/2015 10:23		
	1506	76°31'59.52"	013°02'19.68"	27/09/2015 10:33		
	1525	76°30'46.44"	013°01'00.12"	27/09/2015 10:35	31	05
MZ2	1682	76°22'40.08"	012°33'18.00"	27/09/2015 11:57		
	1670	76°21'11.88"	012°33'58.68"	27/09/2015 12:07		
	1664	76°20'54.60"	012°34'06.06"	27/09/2015 12:10	32	06
MZ3	1662	76°15'19.80"	012°36'23.76"	27/09/2015 12:49		
	1651	76°13'54.48"	012°36'59.04"	27/09/2015 12:59		
	1649	76°13'42.60"	012°37'05.16"	27/09/2015 13:00	33	07
MZ4	1583	75°59'30.84"	012°40'42.60	27/09/2015 14:40		
	1585	75°58'27.84"	012°40'28.92"	27/09/2015 14:47		
	1587	75°58'11.28"	012°40'25.68"	27/09/2015 14:48	34	08
MZ5	1601	75°46'24.60"	012°39'12.60"	27/09/2015 16:07		
	1606	75°44'34.08"	012°39'05.40"	27/09/2015 16:17		
	1608	75°44'48.12"	012°39'06.48"	27/09/2015 16:18	35	09
MZ6	1640	75°31'40.08"	012°44'26.68"	27/09/2015 17:45		
	1644	75°30'29.88"	012°45'16.56"	27/09/2015 17:53		
MZ7	1841	75°16'05.52"	012°44'09.96"	27/09/2015 19:32		
	1856	75°14'54.24"	012°42'44.64"	27/09/2015 19:41		
MZ8	2116	75°00'29.16"	012°38'51.72"	27/09/2015 21:20		
	2141	74°59'05.28"	012°38'30.48"	27/09/2015 21:30		
MZ9	1709	74°13'05.16"	015°11'15.00"	28/09/2015 08:51	36	10
	1759	74°13'58.44"	015°06'59.04"	28/09/2015 09:00		
MZ10	1896	74°19'15.24"	014°42'23.40"	28/09/2015 09:53	37	11
	1915	74°20'22.92"	014°37'03.72"	28/09/2015 10:05		
MZ11	2021	74°25'21.00"	014°13'24.96"	28/09/2015 10:58		
	2040	74°26'21.48"	014°08'30.12"	28/09/2015 11:59		
MZ12	2120	74°25'21.00"	014°13'24.96"	28/09/2015 10:58		
	2161	74°26'21.48"	014°08'30.12"	28/09/2015 11:59		
MZ13	1065	74°21'54.72"	016°02'08.52"	28/09/2015 19:42	38	
	783	74°22'48.00"	016°06'50.76"	28/09/2015 19:53		
MZ14	400	74°23'28.32"	016°52'16.32"	29/09/2015 02:33		
	400	74°23'29.04"	016°56'53.52"	29/09/2015 02:42		
	400	74°23'32.28"	016°59'11.40"	29/09/2015 02:47	39	
MZ15	142	74°25'48.36"	017°26'09.60"	29/09/2015 03:41		
	142	74°26'15.72"	017°32'09.60"	29/09/2015 03:53	40	
MZ16	115	74°28'12.72"	017°55'05.16"	29/09/2015 04:59		
	115	74°28'27.12"	017°55'42.60"	29/09/2015 05:12	41	
IS42	140	74°17'20.76"	018°10'17.40"	01/10/2015 12:07	42	
IS43	929	74°14'25.08"	016°01'15.96"	01/10/2015 17:48	43	12
IS44	512	74°16'02.64"	016°17'48.12"	01/10/2015 20:43	44	13
	512	74°16'02.64"	016°17'48.12"	01/10/2015 20:43		14
IS45	540	74°15'28.80"	016°16'40.80"	01/10/2015 20:47	45	
IS46	562	74°14'16.44"	016°13'55.20"	01/10/2015 20:57	46	

Table 6: Sampling scheme from the thermosalinograph pump, situated at 4m depth approximately, for microzooplankton, salinity (S) and Isotopes (ISO). MZ stands for the stations where microzooplankton was sampled, while ISO stands for the stations without microzooplankton sampling. For each station there are two or three sampling times, indicating the start and the end of the water uptake.

2.9. XBT Launches

Station	Bottom Depth m	Latitude N	Longitude E	Date and time
X2	300	77°41'58.20"	010°51'03.60"	23/09/2015 15:53
X3	1600	77°18'36.00"	010°09'00.00"	24/09/2015 07:57
X4	1699	77°23'52.20"	010°01'45.60"	24/09/2015 09:22
X5	1643	77°29'09.00"	009°53'16.20"	24/09/2015 10:53
X6	1535	77°34'10.80"	009°45'03.00"	24/09/2015 12:19
X7	1411	77°39'21.00"	009°36'30.00"	24/09/2015 13:47
X8	1334	77°44'04.20"	009°28'33.60"	24/09/2015 15:08
X9	1250	77°48'58.80"	009°19'24.60"	24/09/2015 17:11
X10	1493	77°43'55.02"	009°13'53.94"	24/09/2015 18:36
X11	1780	77°38'43.32"	009°08'07.20"	24/09/2015 19:58
X12	2002	77°33'29.76"	009°02'23.46"	24/09/2015 21:25
X13	2084	77°28'10.80"	008°56'30.84"	24/09/2015 22:52
X14	2083	77°14'00.00"	008°55'00.00"	25/09/2015 00:16
X15	2073	77°27'00.00"	009°00'31.26"	25/09/2015 00:32
X16	1914	77°30'01.80"	009°22'08.40"	25/09/2015 01:56
X17	1582	77°32'53.40"	009°43'46.80"	25/09/2015 03:20
X18	1277	76°24'13.20"	013°28'60.00"	26/09/2015 07:17
X19	1448	76°27'21.00"	013°09'37.80"	26/09/2015 08:41
X20	1610	76°30'26.70"	012°49'49.38"	26/09/2015 10:01
X21	1613	76°30'35.40"	012°48'50.40"	26/09/2015 10:05
X22	1688	76°33'30.96"	012°29'47.70"	26/09/2015 11:22
X23	1737	76°36'25.20''	012°10'34.20''	26/09/2015 12:41
X24	1749	76°39'18.60''	011°51'09.00''	26/09/2015 14:00
X25	1771	76°42'29.16''	011°28'23.16''	26/09/2015 16:08
X26	1906	76°37'17.40''	011°36'07.20''	26/09/2015 17:35
X27	1960	76°31'50.10''	011°44'10.98''	26/09/2015 19:05
X28	1920	76°26'44.70''	011°51'35.52''	26/09/2015 20:32
X29	1893	76°23'46.56''	011°58'30.90''	26/09/2015 22:08
X30	1803	76°27'00.18''	012°18'02.88''	26/09/2015 23:42
X31	1681	76°30'19.50''	012°38'23.46''	27/09/2015 01:18
X32	1446	76°33'34.26''	012°57'25.20''	27/09/2015 02:49
X33	920	76°37'06.06''	013°17'46.02''	27/09/2015 04:27
X34	212	76°40'15.90''	013°36'43.08''	27/09/2015 05:55
X35	1699	76°24'57.18''	012°31'52.32''	27/09/2015 11:41

Table 7: XBT launches position.

3. Onboard data processing and preliminary results

3.1. Quality Control - QC

The SEG-D raw data were processed on a dedicated workstation by means of GEDCO Vista Seisimager package. The quality control was performed on both the single shots and the whole profiles by screen display and plotting of the near trace sections.

The raw data were first transferred from the external USB back up HD to the processing workstation and loaded and reformatted by means of the Vista processing package.

The overall quality of the raw data was first checked and single traces edited. Noisy traces, traces with transient glitches, or mono frequency signals were deleted; if present, polarity reversals were corrected.

The shot point position was checked for miss shot and double shot. After the first line (SV15_01) checking, lots of miss shots were found. The time interval between the shots was too close to the record length time, this caused many shots were not recorded. The shot point interval was changed from 15.625m to 18.75m to solve the problem.

3.2. Preliminary Results

3.2.1. Geophysical data

The EDIPO/DEGLABAR cruise focused the study of two areas in particular: the first one being the one W-SW of Isfjorden, on the Isfjorden TMF; the second one at SW of the Kveithola trough, on the INBIS channel (Figure 7).

During the EDIPO-DEGLABAR cruise, new geophysical (multibeam, MCS and sub-bottom profiler) data have been acquired on the two sediment drifts, that, integrated with all the other available information, will allow to contribute to the comprehension of the relationships between the glacial sedimentary input and the water circulation in NW Barents Sea (Figure 8).

The INBIS channel (Figure 9) originates from a series of tributary canyons, converging in a trunk-type channel, leading to a deep sea lobe system, and is inferred to have been produced by turbidity flows, flowing from tributary canyons incising the upper part of the continental slope between Bear Island TMF and Kveithola TMF. It is a very peculiar structure in the Barents Sea; channel systems are in fact rare on the Northern Norwegian margin and confined to the INBIS and Lofoten Basin channels.

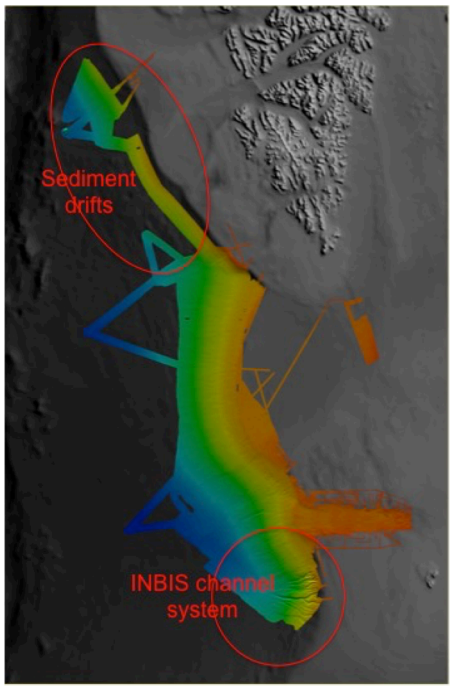


Figure 7: The multibeam dataset acquired on the NW Barents Sea continental margin since 2007 with the 2 areas deeply investigated by the EDIPO-DEGLABAR 2015 cruise

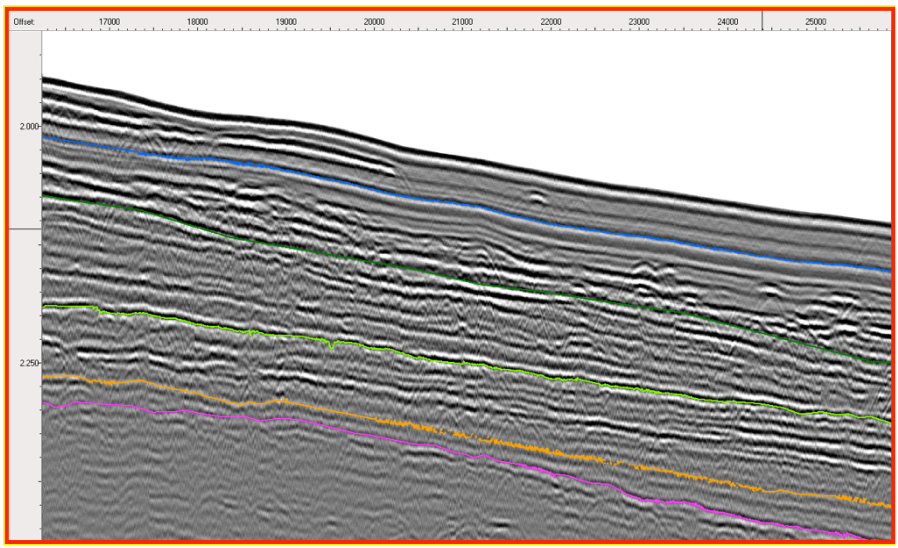


Figure 8: A portion of alongside Seismic profile SV15_03, near the shelf edge in front of Isfjorden. It's possible to identify, between reflectors R1 (blue) and R2 (dark green), sediments produced by glacigenic debris flows; this suggest a major intensity and/or a higher frequency of ice sheet expansions during that period.

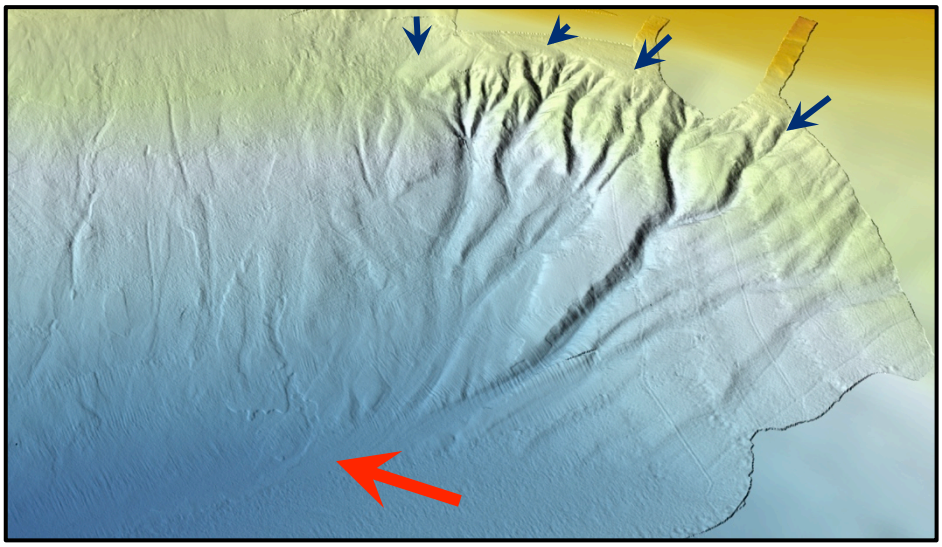


Figure 9: The INBIS channel is inferred to have originated from turbidity currents, flowing from tributary canyons (blue arrows) incising the upper part of the continental slope between Bear Island TMF and Kveithola TMF. These tributary canyons converge in a trunk-type channel (red arrow), inferred to be leading to a deep sea lobe system.

3.2.2. CTD data

Temperature is expressed as a potential temperature with reference to pressure = 0 dbar (θ, °C), and density as potential density anomaly with reference to 0 dbar (σ_0, kg/m^3).

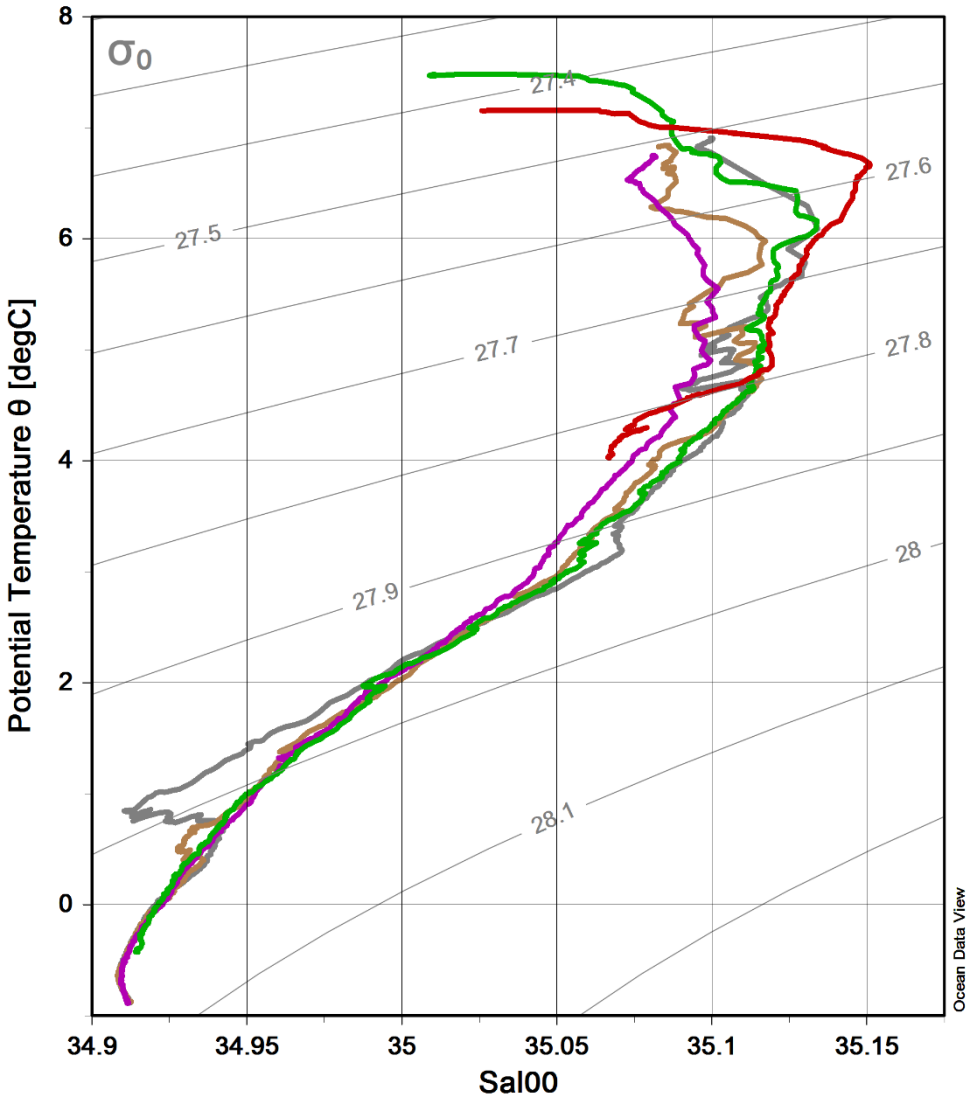


Fig. 10: θ-S diagram of five CTD profiles in the EDIPO study area.

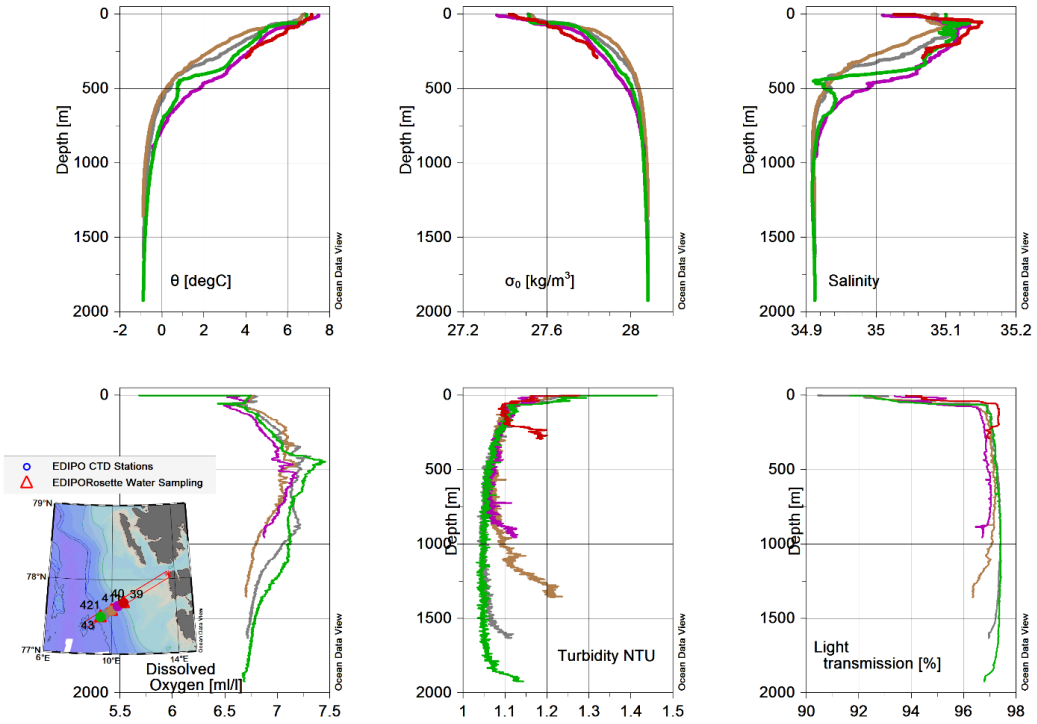


Fig. 11: Vertical profiles measured by the SBE911 CTD probe and auxiliary sensors at five locations.

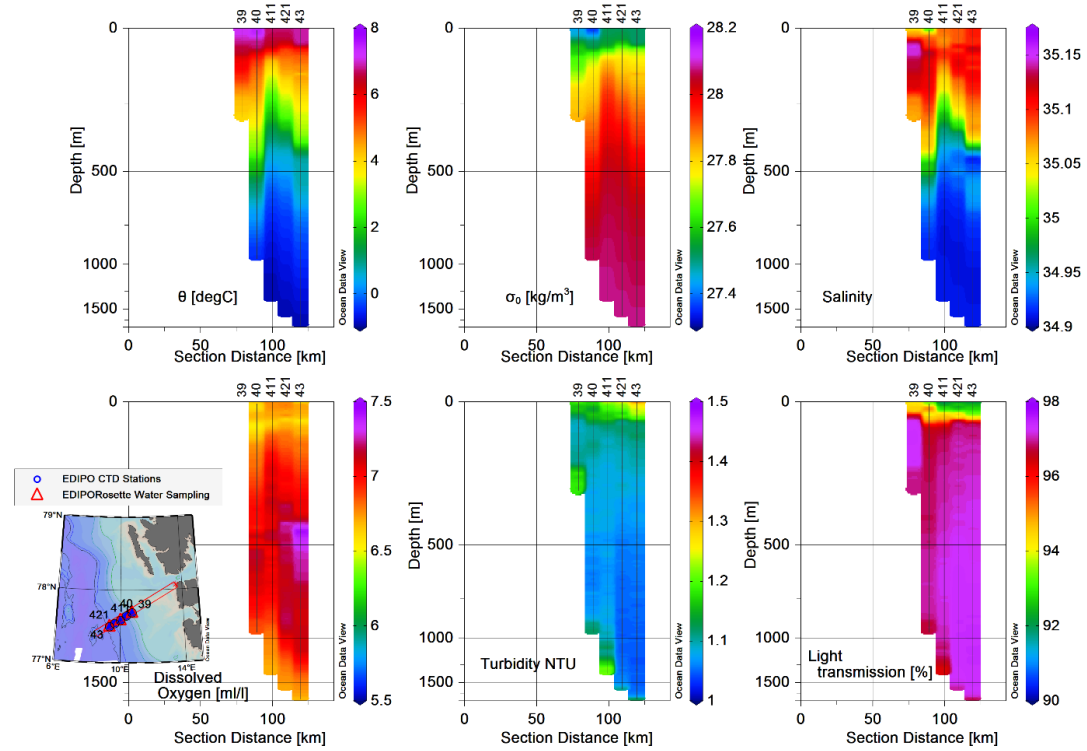
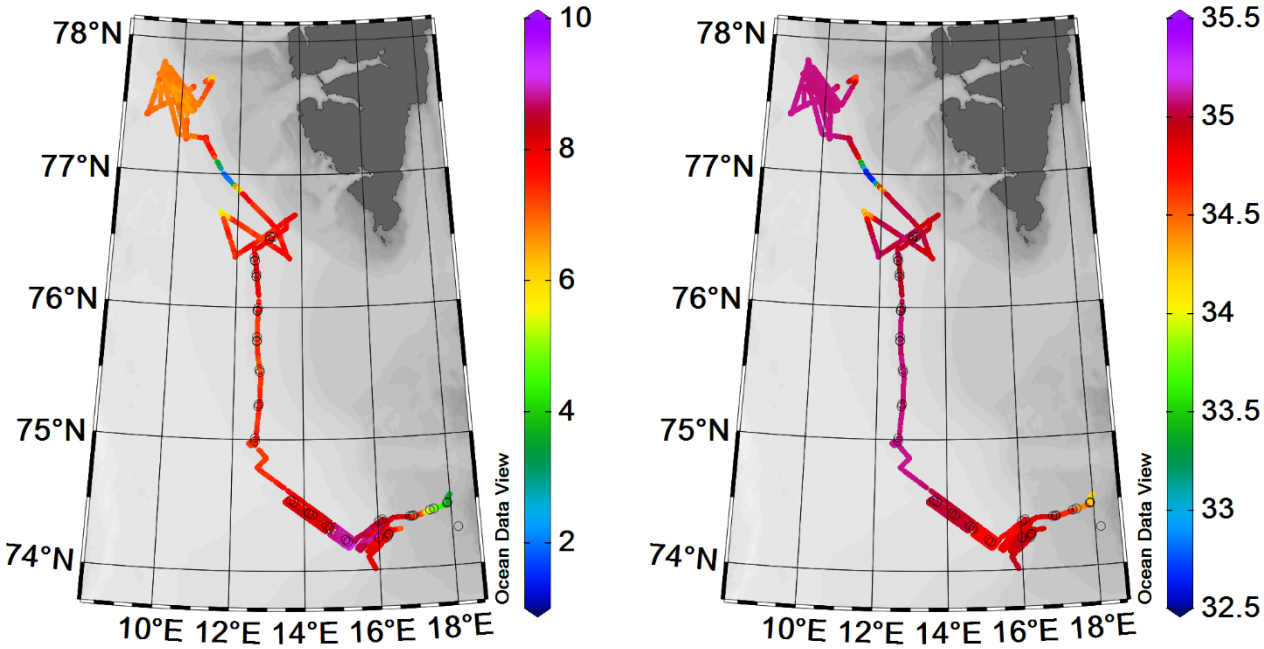


Fig. 12: Vertical distribution of five parameters along the CTD section.

3.2.3. Thermosalinograph data



(a) (b)

Fig. 13: View on temperature (a) and salinity (b) averaged into 1-minute intervals, measured along the ship track. Open circles indicate the sampling sites for the microzooplankton and isotopes (Table 7).

3.2.4. Temperature from XBT

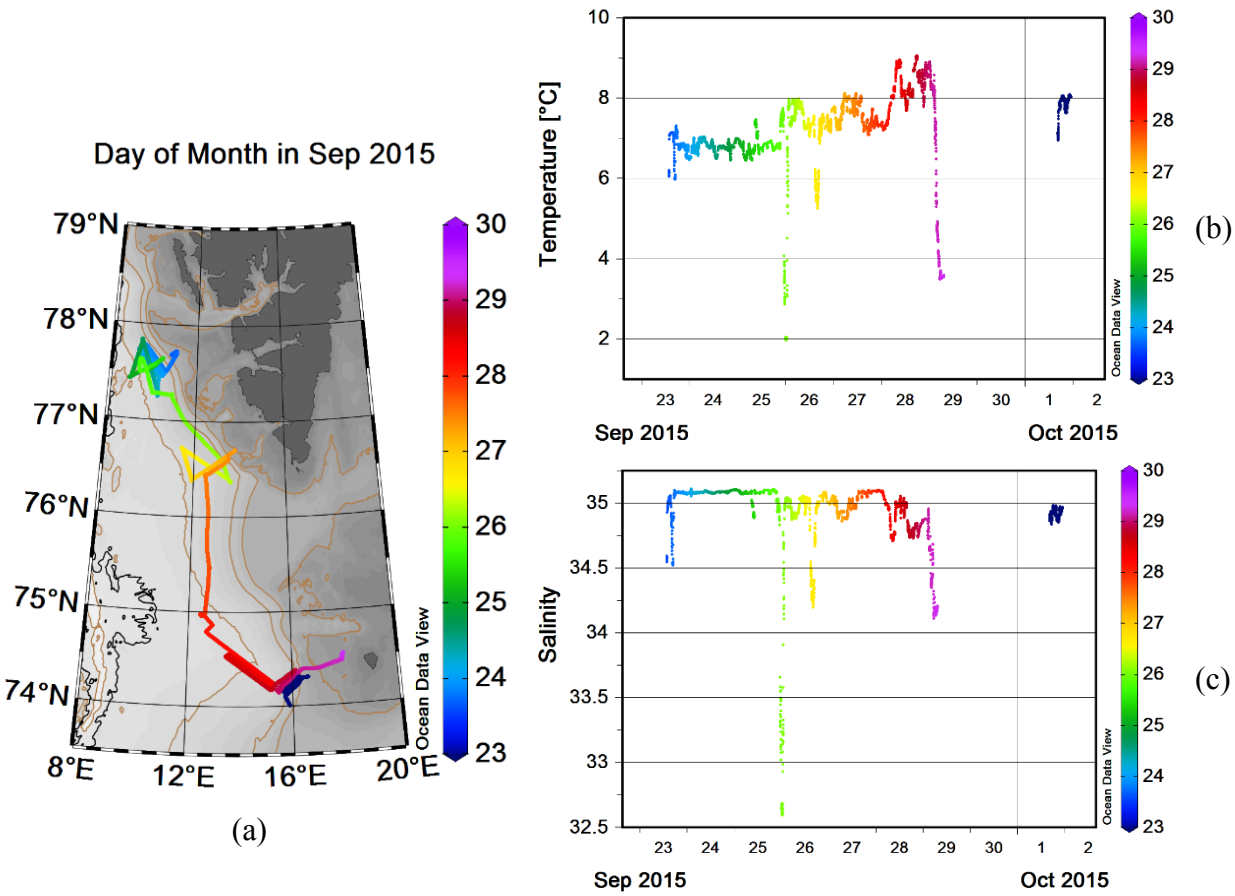


Fig. 14: Thermosalinograph temperature and salinity versus time during the cruise: color coded for the date in September 2015: on the map (a), and in a time series of temperature (b) and salinity (c). Dark blue dots in (a), (b) and (c) correspond to the date of 1st October 2015.

4. Cruise Summary

The mobilization started on Sunday 20th September at 14.30 UTC and involved seismic and oceanographic equipment installation, PDS2000 project configuration, pre-cruise meeting to plan the activities, and safety induction meeting. The ship departed on Wednesday 23rd September from Longyearbyen early in the morning and the acquisition started the at 13.30 UTC. The acquisition ended on October 1th at 22:16 UTC, and the ship arrived in Tromsø on October 3rd at 10:00 UTC.

4.1. Multichannel seismic

As a whole, 310 km of multichannel seismic where recorded. In Table 7, the general statistics are reported line by line.

Line Name	Date dd/mm/yy	Time hh/mm	Duration hh/mm	SP	SP No.	Lon E deg-min-sec	Lat N deg-min-sec	Dist. km
SV15-01	SOL 25/09/2015 EOL 25/09/2015	00.04 04.19	04.15	100 2161	2062	008°53'44"E 009°59'45"E	77°26'05"N 77°34'42"N	31
SV15-01A	SOL 25/09/2015 EOL 25/09/2015	06.04 07.30	01.26	100 790	691	009°36'00"E 009°58'27"E	77°31'52" N 77°34'34" N	10
SV15-02	SOL 24/09/2015 EOL 24/09/2015	16.59 23.26	6.27	100 3105	3006	009°20'18"E 008°54'10"E	77°49'28"N 77°25'58"N	45
SV15-03	SOL 24/09/2015 EOL 24/09/2015	07.45 16.40	08.55	100 4151	4052	010°10'19"E 009°19'30"E	77°18'27"N 77°49'21"N	61
SV15-04	SOL 26/09/2015 EOL 27/09/2015	21.55 06.24	08.29	100 4026	3927	011°56'13"E 013°44'56"E	76°23'23"N 76°41'30"N	58
SV15-05	SOL 26/09/2015 EOL 27/09/2015	15.57 21.26	05.29	101 2786	2686	011°27'35"E 011°56'27"E	76°42'56" N 76°23'23" N	39
SV15-06	SOL 26/09/2015 EOL 26/09/2015	06.57 15.44	08.47	100 4604	4505	013°32'33"E 011°26'55"E	76°23'27" N 76°42'51" N	65

Table 8.

4.2. Multibeam echosounding

About 6635 squared kilometres of morphobatimetric data were acquired simultaneously to the seismic and oceanographic operation along the profiles routes. During the CTD measurements an SVP probe was applied to the rosette carousel to measure the speed of sound along the water column to real time correct the incoming data. The data where stored within the navigation workstation in PDS2000 format.

4.3. Sub Bottom Profiling

Very high resolution sub bottom profiler chirp data were acquired during the survey, together with the seismic, the transfer route and in the area of multibeam coverage. The SBP data were logged by the chirp workstation in SEGY format with the positioning data from GPS automatically stored within the data header.

4.4. CTD acquisition, XBT and water samples

The conductivity-temperature-depth (CTD) probe for vertical profiling was utilized at five stations along the northernmost transect going offshore from the Isfjorden. On 3 stations (39 – 411 – 43) water samples were taken for isotopes and salinity measures. A CTD carousel system SBE 911plus was installed onboard to measure the physical and chemical-biological parameters in the water column. A winch with an 11.6mm iron-armoured coaxial cable was used for the mechanical and electric connections.
Underway measurements of the current velocity in the upper portion of the water column were conducted to quantify the sub-basin and mesoscale motion and energetics.
Underway sea temperature and salinity at approximately 4m beneath the surface were measured at real time sample interval of 5 seconds by the thermosalinograph (SBE21 SBE38). The bow sea-water intake, through to a pomp brings the water to TSG, allowing to collect water samples for analysis. In correspondence of the bow sea-water intake an additional thermometer (SBE38) allows an accurate measure of sea surface temperature with minimal thermal contamination from the interior of the ship. On 16 locations water samples were taken for microzooplankton analysis.
An expendable bathythermograph (XBT) system is installed onboard to measure the temperature in the sea water column without stopping the vessel. The system consist of a PC interfaced with the CSIRO acquisition card controlled by software Devil UI XBT Launch Quality control and Transmission program. The system can be interfaced with a GPS to acquire the real time position when the operator launch the probe. XBT launches were conducted along the route during the seismic acquisition.

A.1. Vessel's carachteristics

Table A1

The Vessel	
Built	Elsflether Werft A.G., Germany, 1973
Owner	Istituto Nazionale di Oceanografia e di Geofisica Sperimentale – OGS
Flag	Italia
Class	Ricerca scientifica RINA 100-A-1.1 IAQ-1; Ice Class B
LOA	72.62 m
Wide	11.8 m / 6.55 m
Ton	1408 T
Working boat	Zodiac Ribo 600 (6m, 70 Hp)
Endurance	50 days
Engine	2 x 1294.5 Kw (1780 Hp)
Speed	13 Knots
Capability	12 tecnici 17 marittimi 1 medico

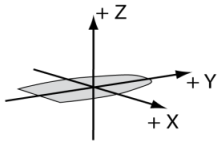
Safety	
MOB	Rescue boat PESBO BSC (40 m)
Rescue boat	Rescue boat PESBO BSC (42 people)
Zattere	5 x 25, 1 x 20, 1 x 6 (156 people)
Survival suits	48
Firefighting	Hydrants, hoses and nozzles (3 fire pumps + 1 emergency fire pump) 58 portable fire extinguishers (6 kg – 9 lt – 5 kg) 5 fire estiguisher 50 kg
Engine room	CO_2
Compressor room	Estinguisher + fixed fire CO_2

Navigation & communications	
VHF	2 VHF SKANTI 1000 DSC (GMDSS A4)
Immarsat	Inmarsat C SKANTI Scansat (GMDSS A4) Immarsat B-M NERA SATURN Immarsat Fleet77 Thrane
Radar+ARPA	FR2117 FURUNO + AIS TM 340AM SPERRY X band Bridgemaster DECCA
Gyro Compass	3 Gyro Star II Anshutz
Autopilot	1 Naviplot AP50 FURUNO
Echosounder	1 EA600 Simrad
Log	1 Dopplerlog EML500 Yokogawa
GPS	1 GPS Acquarius 1 GPS GB500 TOPCON 1 LANDASTAR Veripos 1 RS500 SHIPMATE (maritime only)
Compass	Navipol II Plath
Net	Ethernet
Net speed	100 Mb / sec

A.2. Vessel's offsets

	OFFSET	X (m)	Y (m)	Z (m)
1	CRP	0.00	0.00	0.00
2	GPS TOPCON	2.69	8.60	20.36
3	GPS AQUARIUS	2.24	8.20	20.00
4	GPS VERIPOS	-2.13	8.63	20.28
5	PHINS	-0.28	-0.76	0.25
6	MBES 8111	-0.29	17.89	-4.82
7	MBES 8150	0.00	16.49	-4.50
8	SBP	-0.63	6.93	-4.32
9	SBES	-0.63	27.23	-4.46
10	ADCP	-0.73	3.75	-4.92
11	THERM. INTAKE	0.87	30.08	-3.75
12	THERM. SENSOR	0.83	16.32	-4.49

SIGN CONVENTION



(Offset referred to Central Reference Point - CRP)

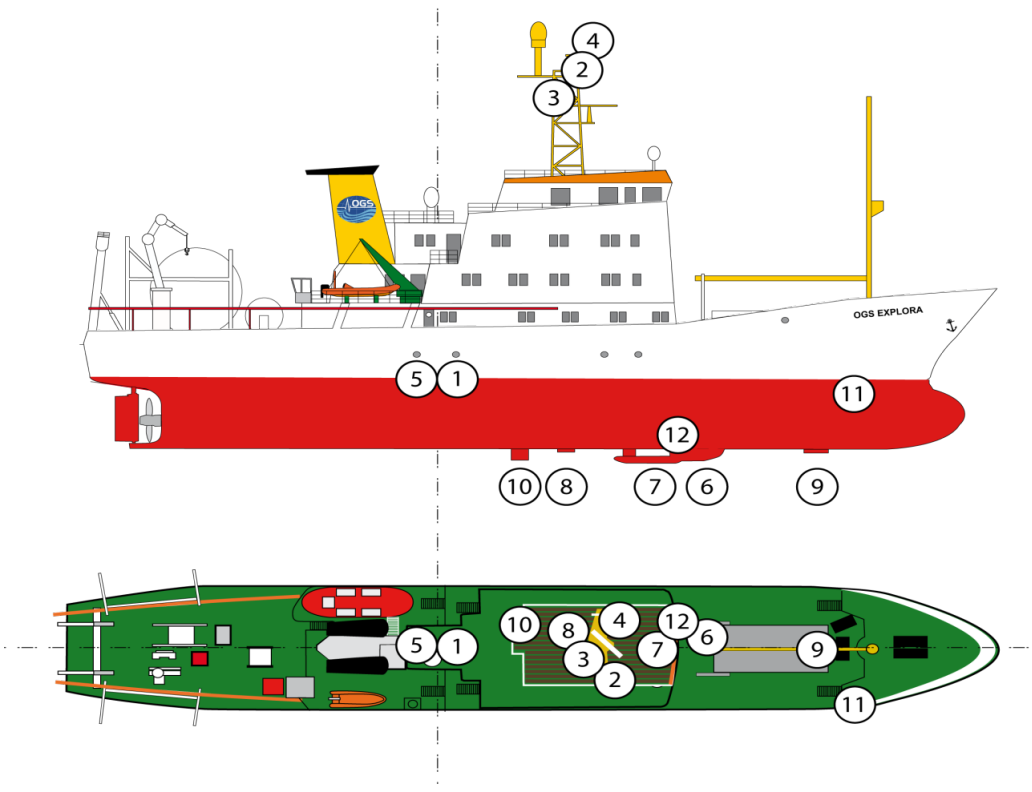


Figure A1.

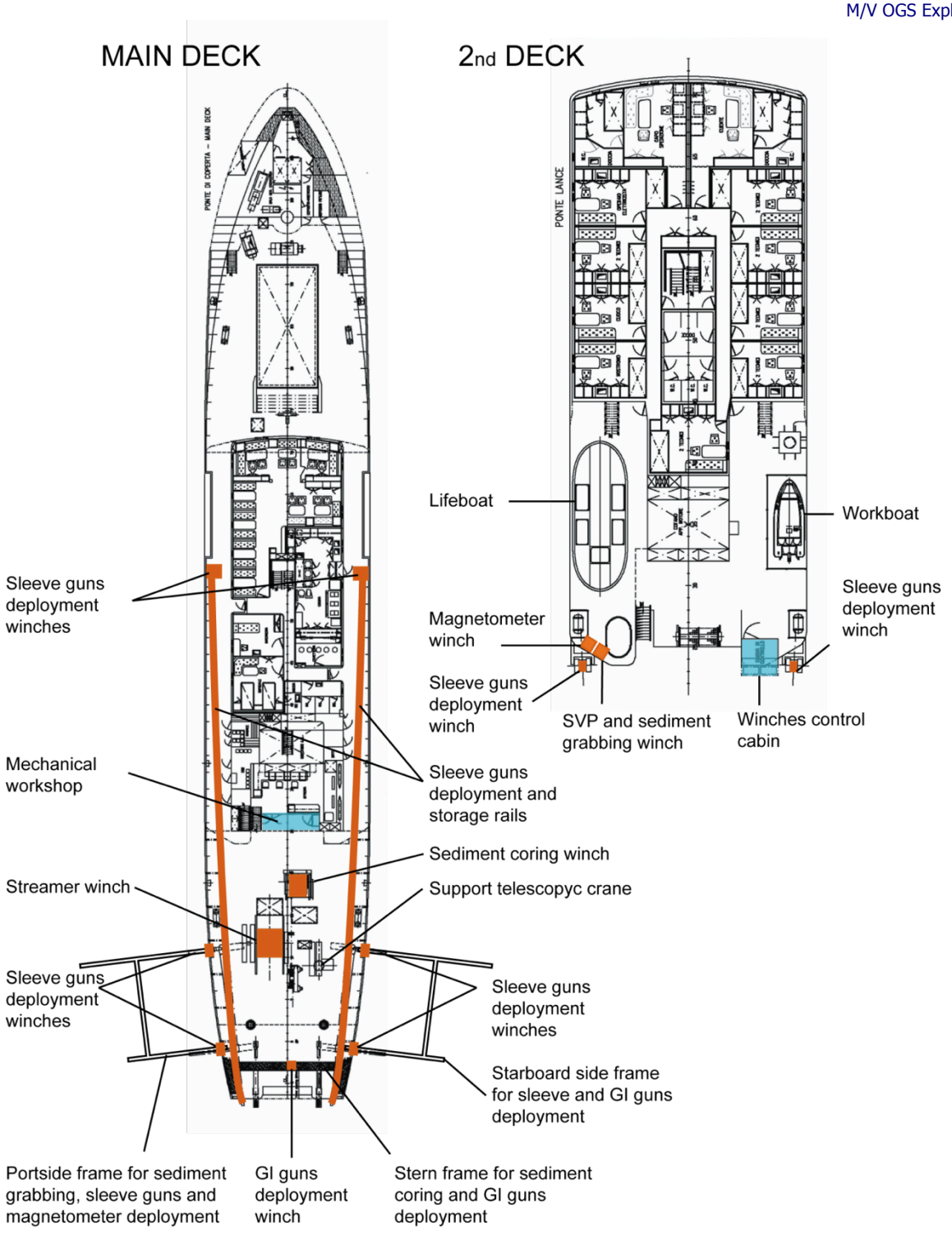


Figure A2.

B. Scientific Equipment

The general equipment configuration is shown in the block diagram of Figure B 1. A detailed description of each component is provided over the following paragraphs.

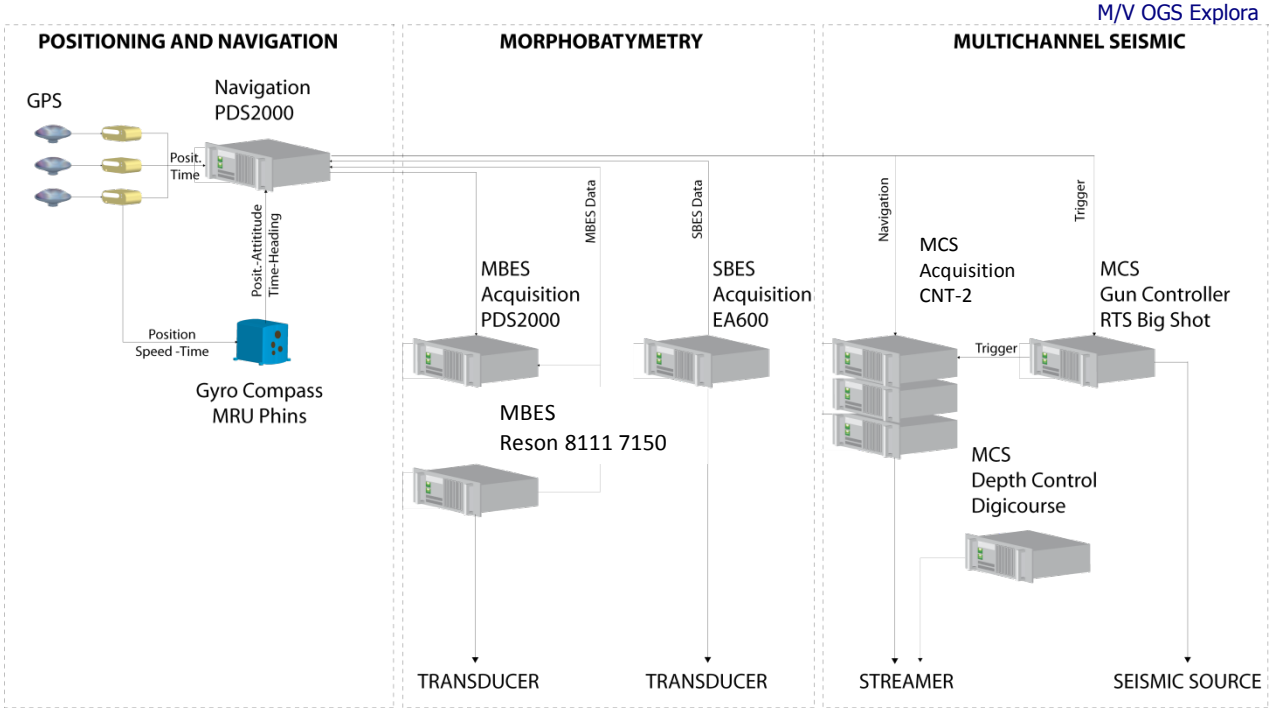


Figure B1: General block diagram.

B.1. Positioning and navigation

B.1.1. GPS and Gyros

The ship is equipped with three GPS systems:

1. Ashtec Aquarius (primary)
2. Topcon GB-500 (GPS+GLONASS)
3. Landstar MK Veripos (also DGPS).

The primary system detecting ship motion and ship heading is IXSEA Octans. The ship is also equipped with the secondary system (Mahrs). The GPS, Octans and PDS2000 navigation software are interfaced according to the scheme in Figure B2. All the data can be displayed in real time both in the navigation room and on the bridge. Data are stored in formats CVS, XLS or ASCII.

B.1.2. Navigation

Navigation is managed by the PDS2000 software. Such system manages also the MBES bathymetry. Additional tasks of the software are:

1. Logging from external sensors
2. Guidance (tracks, Acquisition lines, waypoints);
3. Computation (upon request);
4. Real time management of performance;

5. Quality Control;
6. Messaging output towards other acquisition systems. And Events marks through serial port.

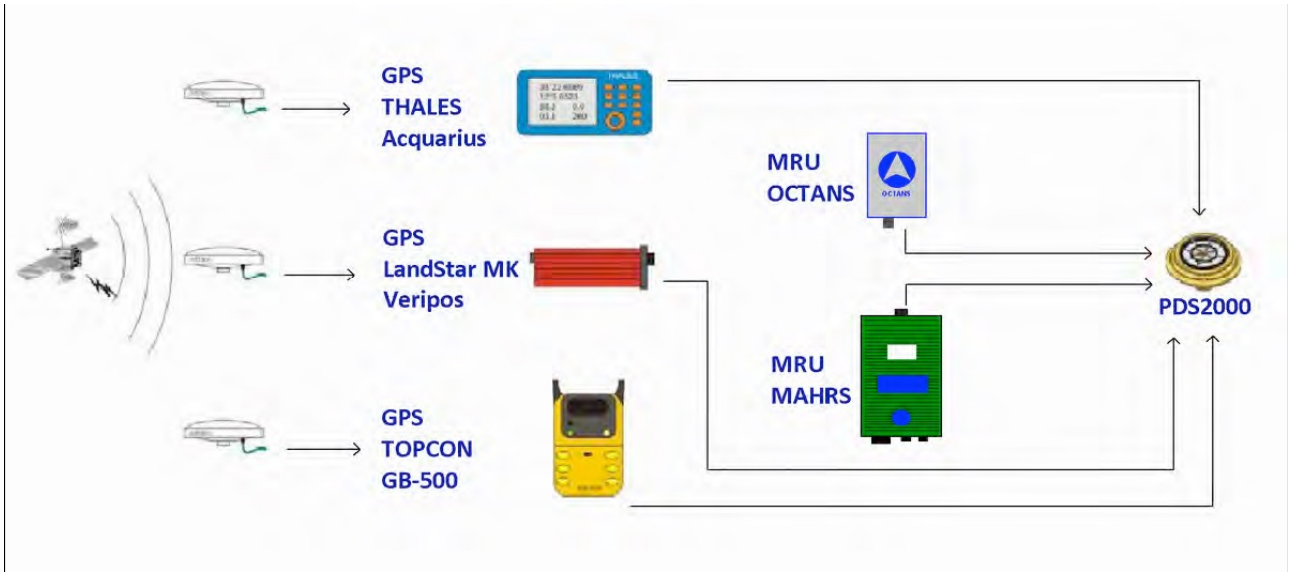


Figure B2: Positioning and navigation; Interfacing among GPS positioning,

B.2. Morpho-Bathymetry

B.2.1. Single beam echosounder (SBES)

The Simrad EA600 Oceanic Depth Echosounder, manufactured by Kongsberg Maritime , is a Single Frequency 18 kHz system, with a maximum power of 2 kW, 160 dB of dynamic range and a transducer 12-16-60 with 16° circular, 60° passive beams.

Depth values are logged by the main navigation system (PDS2000) via the RS-232 serial connection.

EA600 FEATURES AND TECHNICAL SPECIFICATIONS	
Manufacturer	Simrad Kongsberg
Model	EA600
Installation	Hull mounted
Transducer type	18-11
Frequency	18 kHz
Pulse duration	8 ms
Beam angle	11°
Beam width	382 Hz

Transmit power	2000 W
Range bottom	7000
Gain function	20 log TVG, 30 log TVG, 40 log TVG, or none
Ping rate	Adjustable
Start depth and range	5 to 15.000 m in manual or auto range
Bottom detector	Software tracking algorithm

Table B1.

B.2.2. Multi beam echosounder (MBES)

The R/V OGS Explora is equipped with two keel mounted Multibeam Echosounders: the Reson SeaBat 8111 for shallow water (up to 500 m WD) surveys (the only one that was used during the survey); and the Reson SeaBat 7150 for deep water surveys.

The SeaBat 8111 operates at a frequency of 100 kHz; it illuminates a swath on the sea floor that is 150° across track by 1.5° along track. The swath consists of 101 individual 1.5° by 1.5° beams with a bottom detection range resolution of 3.7 cm. The maximum swath width (7.4 times the water depth) is reached with the system working in less than 150 metres of water. The 8111 employs Pitch Stabilization to steer the transmitted beam so that it remains vertical through pitch angles of ±10 degrees.

The SeaBat 7150 operates at a frequency of 12 kHz; it illuminates a swath on the sea floor that is 150° across track by 2° along track. The swath consists of 880 individual beams in "equidistance" mode. The data are logged through the PDS2000 acquisition software.

Figure B3: Navigation room. Real time navigation and acquisition control (1&2), MBES control (3&4)

B.2.3. Sound velocity profiles

Sound velocity profile measurements are needed for real time correction of the incoming raw water depth data. They are supplied on a daily basis by means of a Sound Velocity Probe Valeport MiniSVP, that also logs temperature measures along the water column. The probe is operated by a winch located on the second deck and is placed in the sea by hanging it on to the portside lateral frame pulley.

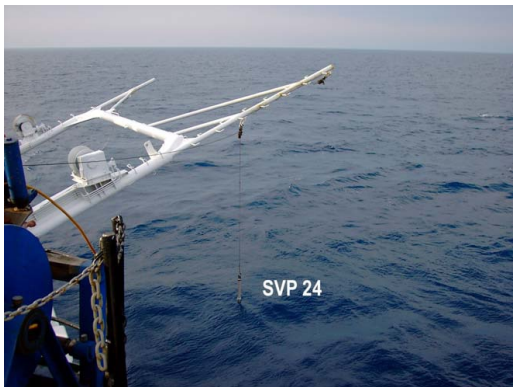
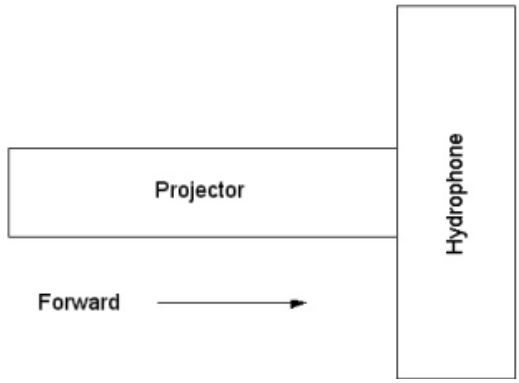


Figure B4: SVP-24 deployment.

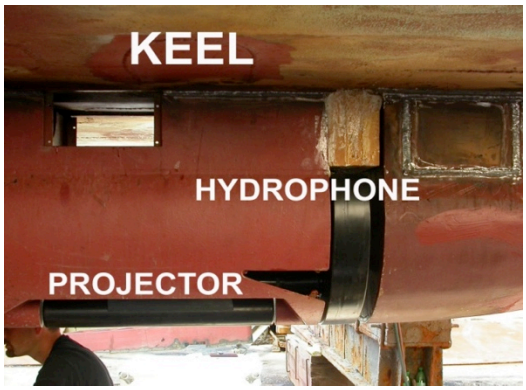
SEABAT 8111 FEATURES AND TECHNICAL SPECIFICATIONS	
Manufacturer	Reson
Model	SeaBat 8111
Installation	Hull mounted
Number of beams	101

Beamwidth across track	1.5°
Beamwidth along track	1.5°
Center-to-center beam separation	1.5°
Max Swath	150°
Max swath coverage	7.4 x water depth
Operating frequency	100 kHz
Pulse length	Variable, operator selectable
Depth range	600 m (max scale 1400 m)
Max ping rate	35 swaths per second
Max vessel speed	20 knots
Stabilization	Pitch stabilization within +/- 10°
Sound probe	Reson SVP 24
Acquisition software	PDS2000
Processing software	PDS2000

SEABAT 8111 SYSTEM CONFIGURATION



Head orientation



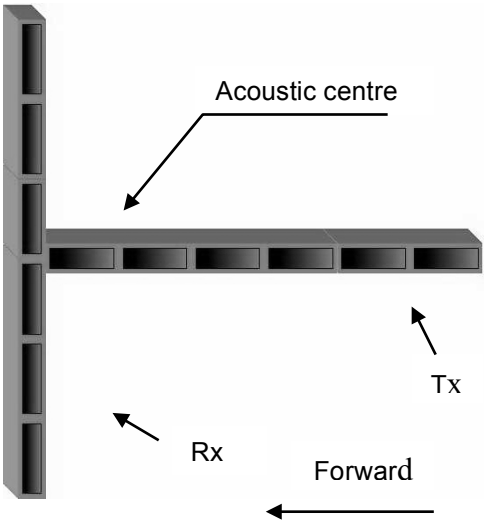
The keel mounted Reson SeaBat 8111.

Table B2.

SEABAT 7150 FEATURES AND SPECIFICATIONS	
Manufacturer	Reson
Model	SeaBat 7150
Installation	Hull mounted
Number of beams	234
Number of transmitters (Tx)	6 - configuration B
Number of receivers (Rx)	6 - configuration B
Beam width	2 x 2°
Max swath coverage	5 x water depth
Operating frequency	12 kHz
Pulse length	0.5 – 20.4 ms
Depth range	12000 m
Max update rate	15 swaths per second
Update rate	Range dependent
Pitch motion compensation	+/- 10°

Roll motion compensation	+/- 10°
Sound probe	Reson SVP 25
Acquisition software	PDS2000
Processing software	PDS2000

SEABAT 7150 - B CONFIGURATION



The keel mounted Reson Seabat 8150 .

Table B3.

B.3. Multichannel seismic (MCS)

To achieve a good trade-off between penetration and resolution, a seismic source consisting of a 270 cu.in (4.4 l) linear sub-array of one GI-gun and one Mini GI_Gun was adopted. The data were logged by a complete acquisition system composed by a 300 m long digital streamer interfaced to a Geometrics CNT-2 Recorder. The complete block diagram is illustrated in the Figure B5.

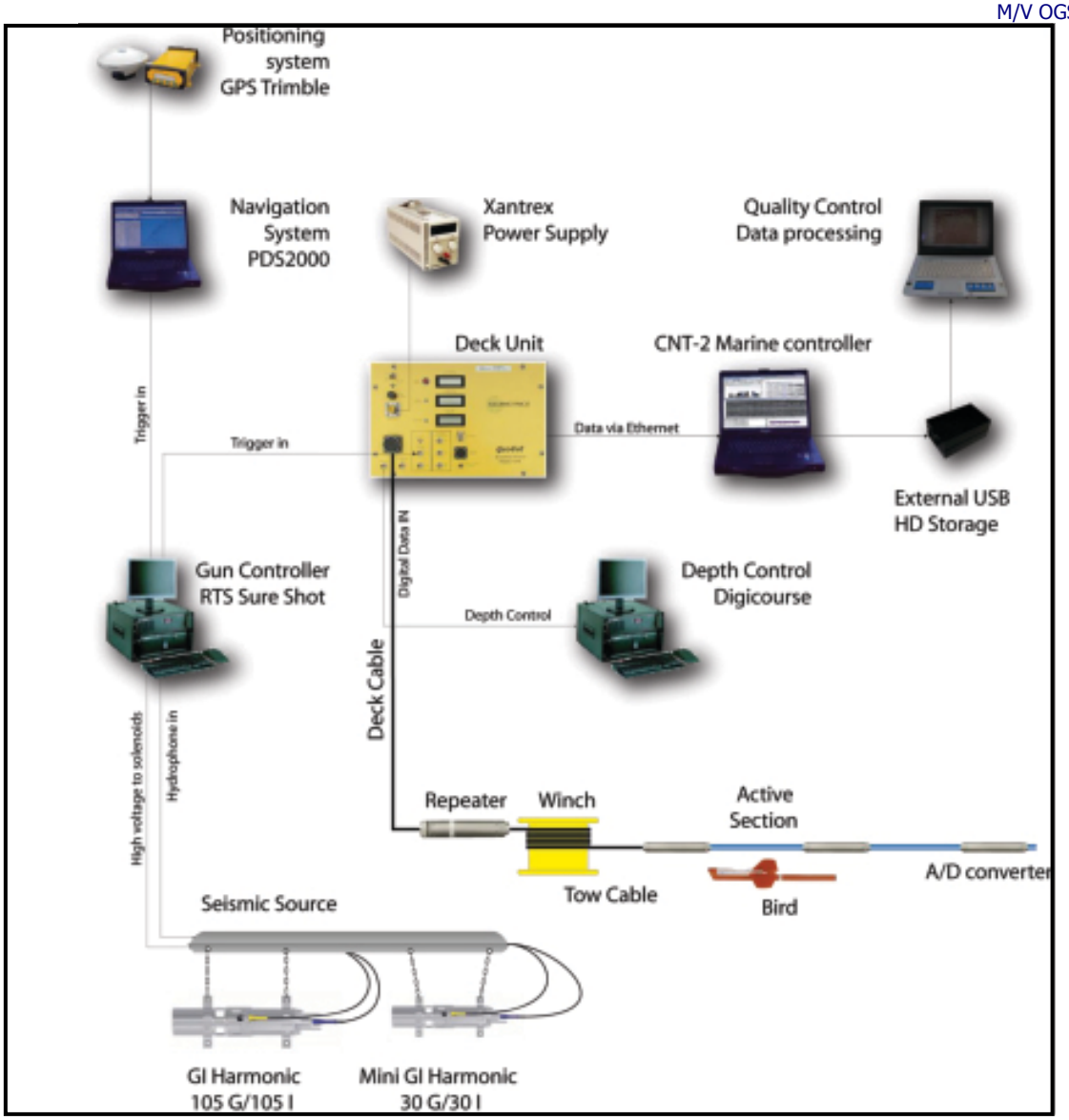
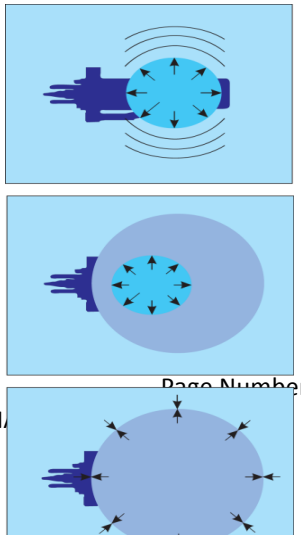


Figure B5

B.3.1. Seismic source

The GI GUN is made up of two independent chambers within the same casing, used to control and reduce bubble oscillations. The first chamber is called the Generator, as it generates the primary pulse and creates the bubbles. The second one is called the Injector, as it injects air inside the bubble. Each gun has its own reservoir, its own shuttle, its own set of exhaust ports, and its own solenoid valve. A common hydrophone provides both the time break and the shape of the near field signal. This gun phone is located inside the bubble and responds to the actual air blast.



Basic principle

Phase 1:
The Generator (G) is fired. The blast of compressed air produces

the primary pulse and the bubble starts to expand.
Phase 2 :
When the bubble approaches its maximum size, it encompasses the Injector ports, and its internal pressure is far below the outside hydrostatic pressure. At this time, the Injector (I) is fired, injecting air directly inside the bubble. Due to the quasi-static state of the bubble, the timing of the Injector is not critical.
Phase 3 :
The volume of air released by the Injector increases the internal pressure of the bubble, and prevents its violent collapse.
The oscillations of the bubble and the resulting secondary pressure pulses are reduced and re-shaped.

Figure B6.

The bubble represents a secondary blast of energy that eventually appears in the seismic trace as a fake signal following the primary reflection with a delay equal to the bubble period.
In Figure B7 the sensor response is illustrated (green line) when only the Generator is activated (top) and when both of the chambers (Generator Injector) are activated (bottom). The reduction of the bubble effect (between 130 ms and 160 ms in the top) is evident.

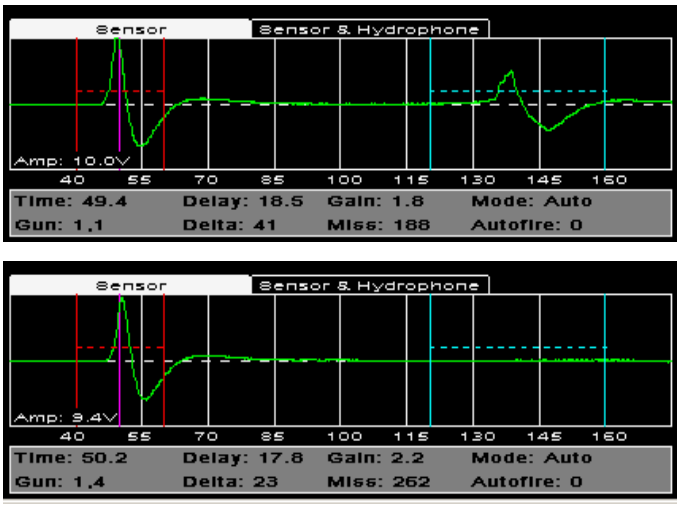
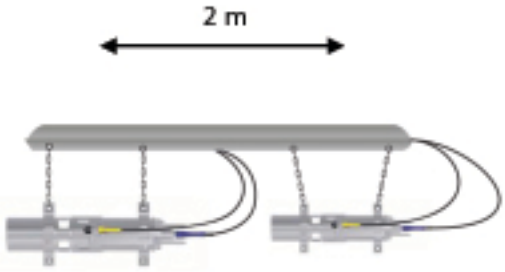


Figure B7.

SOURCE ARRAY	
Manufacturer	SERCEL
Model	1. GI Gun 2. Mini GI Gun
Volume	1. 210 cu.in. (3.44l) 2. 60 cu.in. (1l)
Mode	1. Harmonic 105 G / 105 I 2. Harmonic 30 G / 30 I
Weight	1. 74 Kg 2. 30 Kg
Firing cycle	1. 7 sec 2. 3 sec
Air pressure	2000 psi (140 bar)

ARRAY GEOMETRY



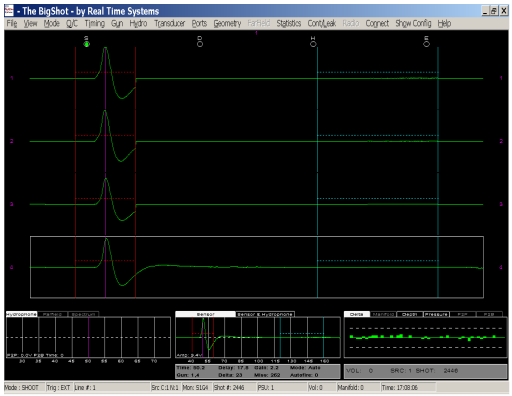
Gun array sketch

Gun array deployment

Table B3: Source details.

B.3.2. Source Synchronization

GUN CONTROLLER FEATURES AND TECHNICAL SPECIFICATIONS	
Manufacturer	Realt Time systems
Model	Big Shot
Installation	Fixed
Number of modules	2
Number of guns	16
Gun types	Bolt, Sleeve, G and G.I.
Timing resolution	0.1 msec
Record out	100 msec closure (programmable time)
Predicted fire out	5 ms TTL high going
Field Time Break Out	Summed sensor or hydrophone signal
Sensors and hydrophone signature	16 bit D / A
Aim Point	25 – 75 msec after trigger
Fire pulse width	1 -80 msec
Delta error Q / C limits	0.1 – 5.0 msec
Auto-fire detect level	0 – 10 Volts
Sensor signal gain	x 0.1 – x 5
Sensor detection look window	2 – 40 msec
Sensor peak threshold	0 – 10 Volt
Sensor peak type	Threshold, Peak or Zero Cross

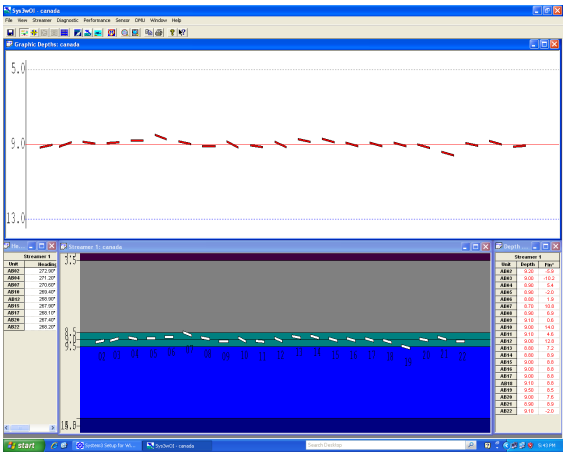
	**The Big Shot gun controller main window. It is possible to see the first four bursts of energy perfectly centred on the 50 ms aim point (red vertical solid line), that is the delay between the navigation trigger arrival and the actual shot time.**

Tab B6.

B.3.3. Receivers

STREAMER	
Manufacturer	Geometrics
Active streamer length	300 m
Number of groups	96
Active group length	3.125 m
Hyrophones per group	16
Streamer sensitivity	17.4 V/bar
Streamer towing depth	1.5 m ± 1 m
Source to 1st channel offset	18 m
	
DEPTH CONTROL	
Manufacturer	Digicourse
Model	Digibird5010
Number of birds	4

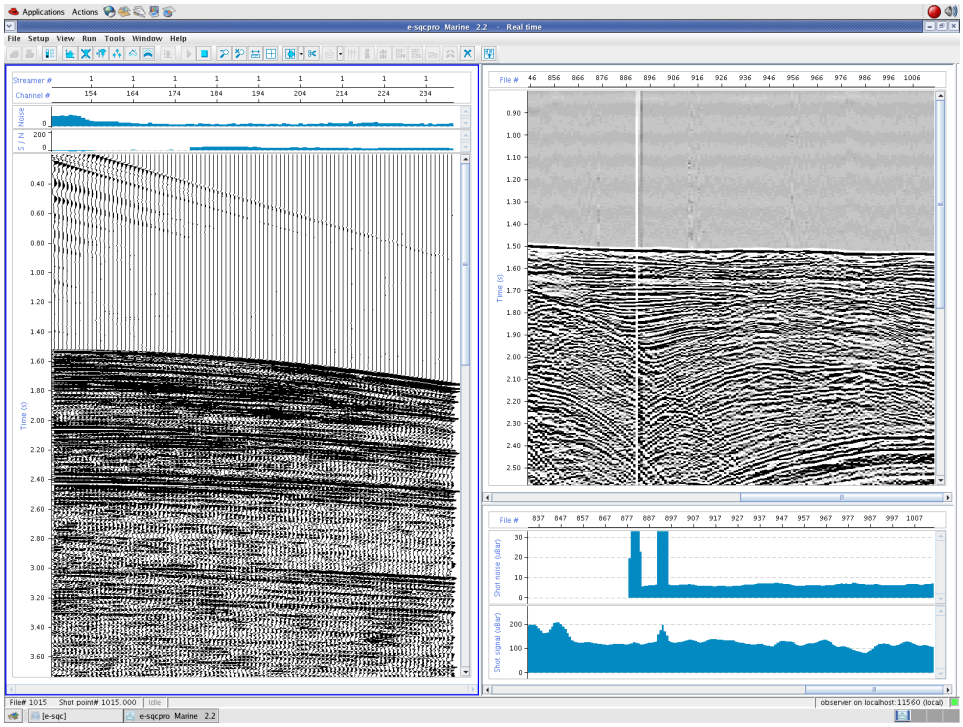
Depth control real time monitoring.



Tab B7.

B.3.4. Seismic Recorder

GENERAL CHARACTERISTICHS	
Type	Geometrics Geoeel digital
Sampling rates	2 – 1 – 0.5 – 0.25 – 0.125 – 0.0625
Resolution	24 bits
Dynamic range	120 dB
A/D conversion	24 bits
Gain accuracy	6.25 %
Data Format	SEG2, SEGD, SEGY



Real Time QC. The recorded shot is diplay on the left of the screen and automatically uptdated shot by shot. On the right hand side a near trace section is continuously displayed and updated.

Table B8.

B.4. Sub-bottom profiling

SBP FEATURES AND TECHNICAL SPECIFICATIONS	
Manufacturer	Benthos
Model	Chirp II
Installation	Hull mounted
Number of transducers	16
Transducers type	AT 471
Signal generator / DSP	CAP-6600 Chirp II Workstation
DSP Sonar Signal Processing	16 bit A/D, continuous FFT
Operating sweep frequency	2 – 7 kHz
Ping rate	Variable, operator selectable (max 12 ping/sec)
Sweep Length	Variable, operator selectable
Multiping option	yes
Gain	Automatic gain control
Bottom tracking	Interactive
Navigation / Annotation	NMEA 0183
Data format	XTF or SEG Y
Real time printer	EPC
Acquisition software	SwanPRO / ChirpScan II
Processing software	Swan PRO

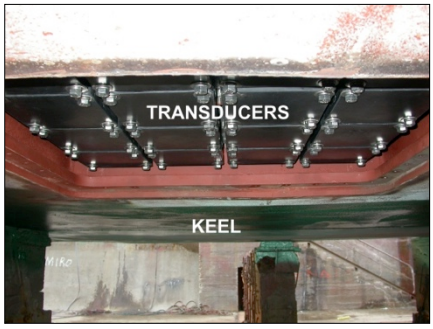
BENTHOS CHIRP II	
The system consists of sixteen hull mounted AT 471 transducers	

Table: B9.

B.5. Physical Oceanography

B.5.1. Water acoustic profiling

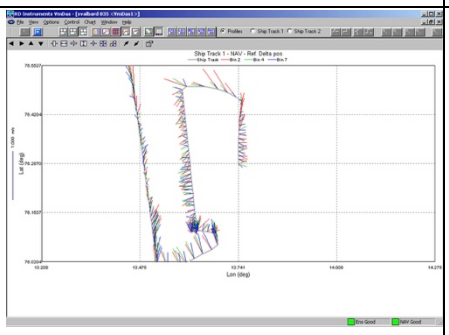
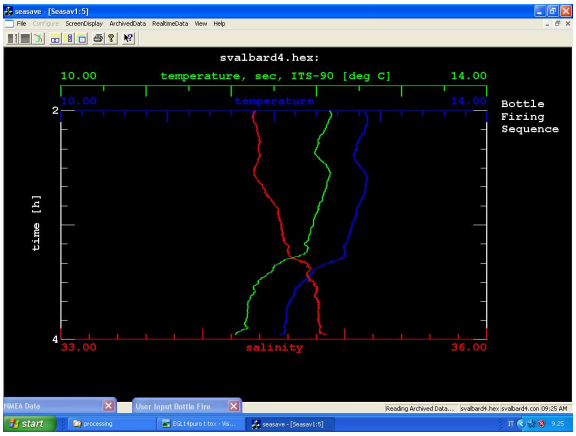
ADCP FEATURES AND TECHNICAL SPECIFICATIONS		
Manufacturer	RDI	
Model	OS 75	
Installation	Hull mounted	
Profile Parameters	Velocity accuracy (typical): ± 1.0%, ± 0.5 m/s Velocity range: -5 to 9 m/s No of depth cells: 1-128 Max ping rate: 75 kHz	
Bottom track	Maximum altitude (precision < 2 cm/s): 75 kHz 950 m Range accuracy:=< ± 2%	
Echo intensity profile	Dynamic range: 80 dB Precision: ± 1.5 dB	
Transducer and hardware	Beam angel: 30° Configuration: 4 – beam phased array Communication: RS-232 or RS-422	
Standard sensors	Temperature (mounted on transducer) - Range: -5 °C to 45 °C - Precision: ± 0.1 °C - Resolution: 0.03 °C	
Long Range Mode		
Vertical resolution cell size	Max Range (m)	Precision (cm/s)
8 m	520 - 650	30
16 m	560 - 700	17
High Precision Mode		
Vertical resolution cell size	Max Range (m)	Precision (cm/s)
8 m	310 - 430	12
16 m	350 - 450	9
 Real time current profiles monitoring	 The transducers are permanently located on the vessel's keel (on the left in the picture)	

Table: B 10

B.5.2. Water physical properties

B.5.2.1. Thermosalinograph

THERMOSALINOGRAPH FEATURES AND TECHNICAL SPECIFICATIONS			
Manufacturer	Sea Bird electronics		
Model	SBE21 Seacat		
Installation	Hull mounted		
	Range	**Accuracy**	**Resolution**
Conductivity (S/m)	0 -7	0.001	0.0001
Temperature, primary (°C)	-5 to +35	0.01	0.001
Temperature, SBE remote (°C)	-5 to +35	0.001	0.0003
Sample interval	3 sec. or longer in steps of 1 sec.		
Water jacket	Approx. 5 liters		
Recommended flow rate	Approx. 1 lt/sec.		
Water jacket pressure limit	3.45 x 105 decibars (50 psi)		



Real Time monitoring of water physical parameters

The thermosalingraph is located in the hold of the ship

Table: B 11

B.5.2.2. Expendable Bathytermograph

MK21 SYSTEM FEATURES AND TECHNICAL SPECIFICATIONS	
Manufacturer	Sippican
Model	MK21
Probe type	XBT

Sampling rate	10 Hz
Vertical resolution	60 cm
System accuracy	± 0.2 °C
Temperature resolution	0.01 °C
Temperature range	-2 to 35 °C

Probe specifications

Probe	**Applications**	**Max depth**	**Rated ship speed**
T-4	Standard	460 m	30 kn
T-5	Deep ocean	1830 m	6 kn
Fast Deep	Max depth max speed	1000 m	20 kn
T-6	Oceanographic applications	460 m	15 kn
T-7	Sonar prediction	760 m	15 kn
Deep blue	Increased launch speed	760 m	20 kn
T-10	Commercial fisheries applications	200 m	10 kn
T-11	High resolution (US navy)	460 m	6 kn

Table: B 12

Aerial photo of the r/v OGS Explora.