Sabrina Coast
Marine Record of Cryosphere – Ocean Dynamics

January 29 – March 16, 2014

NSF/OPP Antarctic Integrated Systems Science
1143834, 1143836, 1143837, 1143843, 1313826

Photo David Gwyther

TABLE OF CONTENTS

DATA MANAGEMENT

All data, figures, maps and descriptions in this report are proprietary. Nothing may be used without the written permission of the project principal investigators. All materials collected as part of this project are subject to a three-year moratorium. The data management scheme outlined in our proposal is copied below.

1. Types of data, samples, physical collections, software, curriculum materials and other materials to be produced in the course of the project: Marine geologic samples include surface and downcore sediment samples; marine geophysical data include multibeam bathymetry data and chirp and multi-channel seismic data. Physical oceanographic data include standard CTD/ lowered ADCP profiles and ship ADCP measurements; moored arrays will provide current, temperature, salinity (conductivity) and pressure data. Water samples will be collected for calibration of CTD data, oxygen isotope analysis, and for development of marine geologic proxies. Standard underway measurements of meteorological and ocean surface parameters will be recorded throughout the cruise.

2. Standards to be used for data and metadata format and content: Metadata records for the cruise will be developed using templates from, and archived via, the Marine Geoscience Data System (MGDS) hosted at LDEO. MGDS funding is provided by the National Science Foundation as part of a Cooperative Agreement through Integrated Earth Data Applications. Data set registration at the Antarctic Master Directory, as required by NSF, will be carried out in consultation with the MGDS managers to ensure continuity across the various data sets to be collected by this project. Data formats used will be those recognized and supported by the data archival centers listed in 5. below.

3. Policies for access and sharing including provisions for appropriate protection of privacy, confidentiality, security, intellectual property, or other rights or requirements: We request a **3-year moratorium** on all samples and data collected in order for the investigators and their students to complete analytical work and publish their findings. **[January 29, 2014 – January 29, 2017]**

4. Policies and provisions for re-use, re-distribution and the production of derivatives: Results of this project will be presented as posters and oral presentations at international meetings and in internationally-peer-reviewed publications.

5. Plans for archiving data, samples, and other research products and for preservation of access to them. All data collected during this program will be shared among national and international collaborators to facilitate thorough analysis of the regional set of measurements. TAMU hosts the online WOCE Southern Ocean Atlas (http://wocesoatlas.tamu.edu). Dr. Orsi will extend the Southern Ocean Database with these and other datasets being generated by international CLIVAR programs. Our datasets will be submitted to the National Oceanographic Data Center. Marine sediment samples, core photos and multi-sensor track data will be curated at the Antarctic Marine Geology Research Facility at Florida State University. Marine geophysical data, such as the multibeam data, underway data, and cruise metadata will be archived and available online via the MGDS/Southern Ocean Data Portal hosted at LDEO. Processed seismic reflection data will be archived at the Marine Seismic Data Center hosted by UTIG: http://www.ig.utexas.edu/sdc/ and shared with the Antarctic Seismic Data Library System: http://sdls.ogs.trieste.it/.

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With great appreciation from the NBP1402 Science Team!

1. PROPOSED CRUISE OBJECTIVES

The primary objective of this project was to investigate the marine component of the Totten Glacier and Moscow University Ice Shelf, East Antarctica, a system of critical importance because it drains one-eighth of the East Antarctic Ice Sheet (EAIS) and contains a volume equivalent to nearly 7 meters of potential sea level rise, greater than the entire West Antarctic Ice Sheet (WAIS). This nearly unexplored region is the single largest and least understood marine glacial system that is potentially unstable. Despite intense scrutiny of marine based systems of the WAIS, little is known about the Totten Glacier system. This study was intended to add substantially to the meager oceanographic, marine geology and geophysics data available in this region, and to advance understanding of this poorly understood glacial system and its potentially sensitive response to environmental change.

Driving our interest in the Sabrina Coast was data from independent, space-based platforms that indicate accelerating mass loss of the Totten system. Recent aerogeophysical surveys of the Aurora Subglacial Basin, which contains the deepest ice in Antarctica and drains into the Totten system, have provided the subglacial context for measured surface changes and indicate that the Totten Glacier has been the most significant drainage pathway for at least two previous ice flow regimes. However, the offshore context is far less understood – hence the need for acquisition of marine-based data. Physical oceanographic data from the nearby shelf/slope break also are extremely limited; these indicate the presence of Modified Circumpolar Deep Water within a thick bottom layer at the mouth of a trough with apparent access to Totten Glacier, suggesting the possibility of sub-glacial bottom inflow of relatively warm water, a process considered to be responsible for WAIS grounding line retreat.

Given the rationale presented above, NBP1402 conducted a ship-based marine geologic and geophysical survey of the region, combined with a physical oceanographic study, in order to evaluate both the recent and longer-term behavior of the glacial system and its relationship to the adjacent oceanographic system. Our intent was to work along the Sabrina Coast, in proximity to the Totten Glacier – Moscow University Ice Shelf System, as our primary target, with secondary targets to the east, in the Mertz Polynya. Almost no bathymetric or physical oceanographic data were previously available for our primary field site, due to a history of heavy sea ice cover. Consequently, we chose the Shackleton – Denman system as a backup site, in case we were unable to access the Totten – Moscow system. Specific boxes (Fig. 1), defined by latitude and longitude, were presented as potential work sites at the request of NOAA. Although most of our work was permitted outside these recognized boxes, multichannel seismic acquisition was permitted only within these boxes. This limitation was based on permitting associated with the use of air guns and the requirement for marine mammal observation while conducting seismic operations in a pre-determined region.

2. OVERVIEW OF NBP1402

Cruise NBP1402 departed Hobart on January 29, 2014 and transited directly south to the George V Coast (Fig. 2). The decision to transit due south was based on the Captain's intention to sail the most direct path through the potentially rough seas between Tasmania and about 60°S. Based on evaluation of sea ice conditions in both the Mertz and Sabrina Coast regions, the PIs decided to continue directly to the Mertz once reaching 60°S, reaching our work area on February 4, 2014, working in the Mertz region for 2 days, then transiting west to work in the Moscow University Ice Shelf polynya. We conducted operations in the Moscow polynya from February 10 – March 8, 2014. We made three attempts to access open water in front of the Totten Glacier, but were unable to penetrate the sea ice.

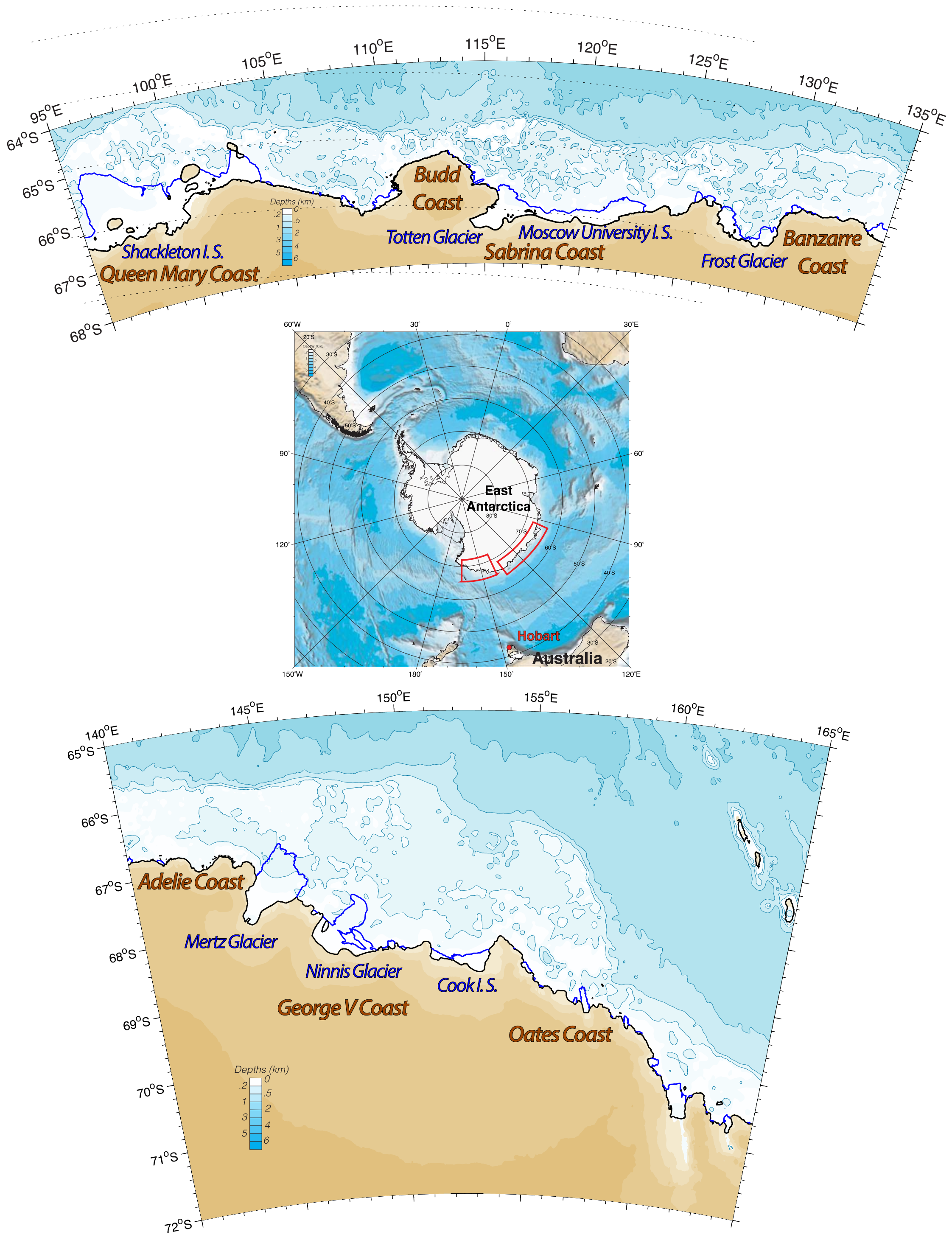


Figure 1. Proposed primary field site = Totten Glacier – Moscow University Ice Shelf System
Secondary field site = George V Coast
Backup field site = Shackleton – Denman Glacier System

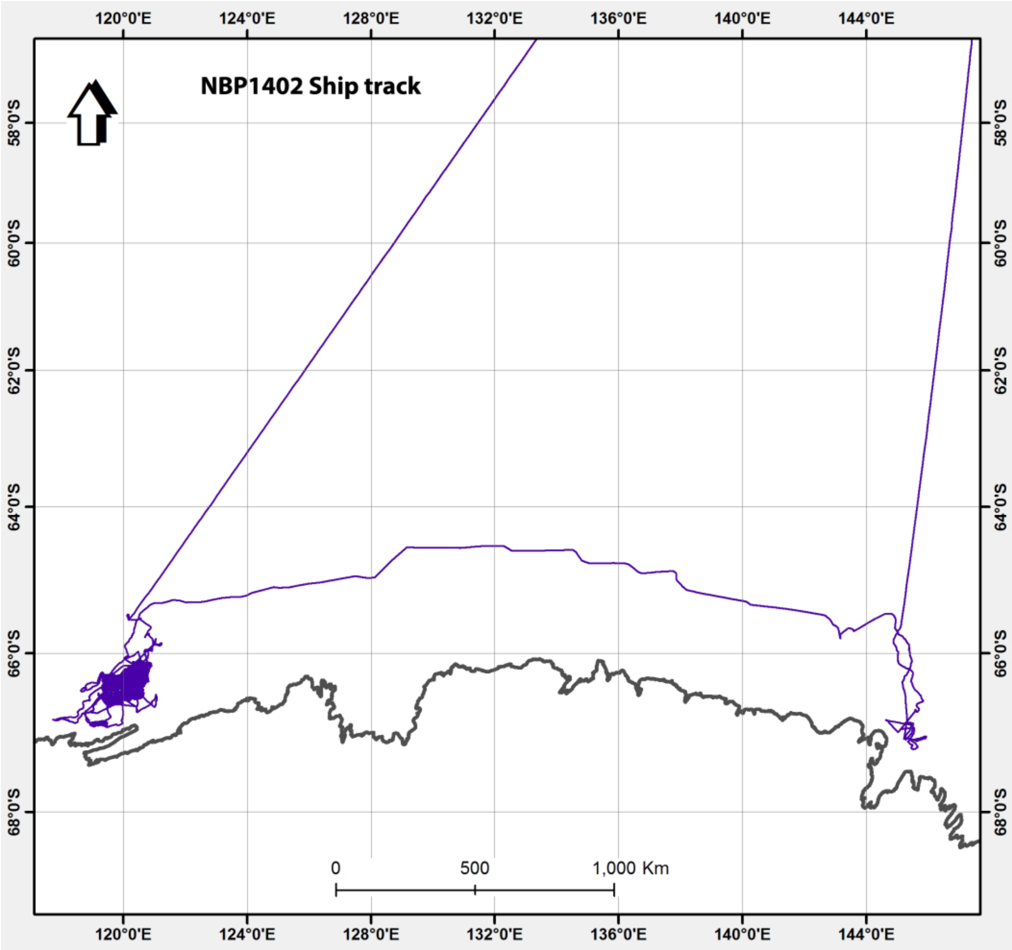


Figure 2a. NBP1402 Cruise Track

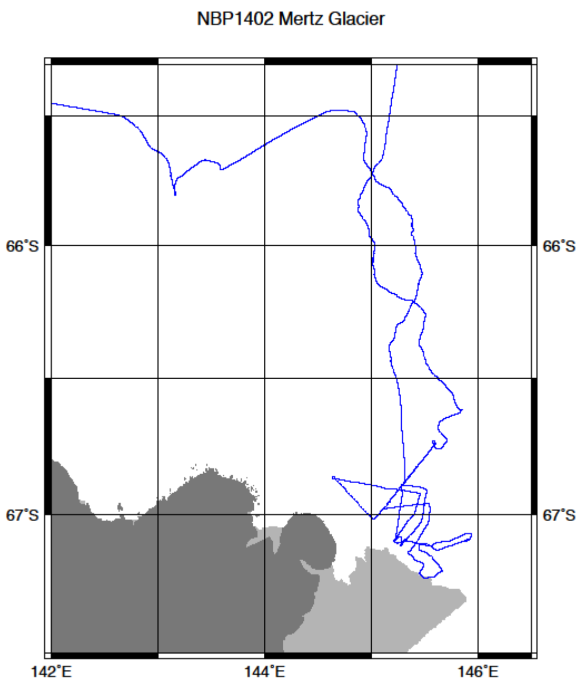


Figure 2b. NBP1402 Cruise Track Mertz Region

NBP1402 Sabrina Coast

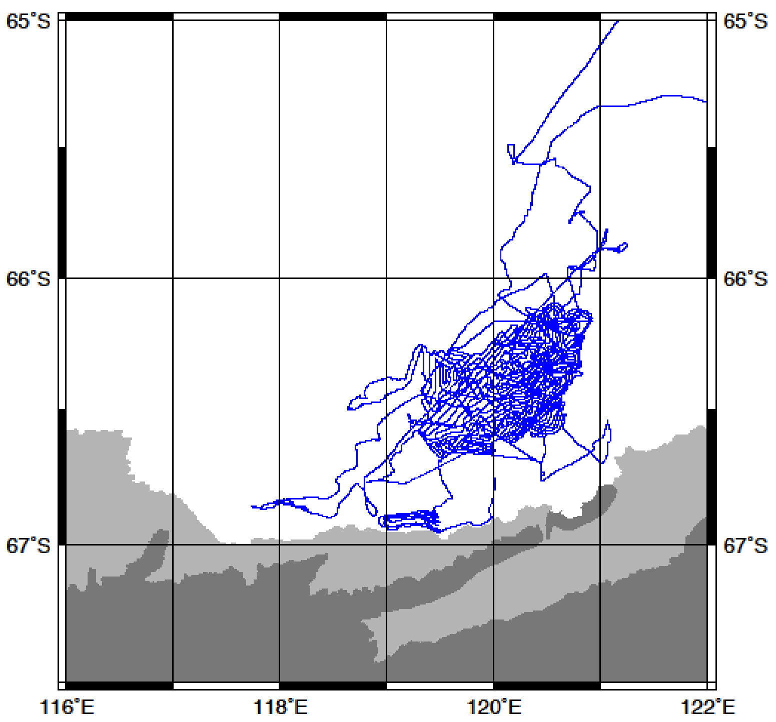


Figure 2c. NBP1402 Cruise Track Sabrina Coast

2.1 MERTZ POLYNYA

We conducted two days of science in the Mertz region (Fig. 3), with three major accomplishments. (1) We collected 4 multichannel seismic lines (~ 70 nm) to evaluate the Mesozoic and Cenozoic history of the Mertz region (Fig. 4), using a higher resolution system (~3 m vertical resolution, 12.5 m horizontal resolution) than has been used previously in this region (Fig. 6). These data, and the line crossings, provide insight into longstanding questions regarding the climate history of East Antarctica identified in our proposal, and will provide supporting information for IODP, with a potential future drilling Leg in the Mertz region. (2) Given the rapidly processed seismic data, we were able to choose dredge sites that avoided overly thick glacial sediment cover, based on the expected proximity of the strata to the seafloor. We completed five dredges (Fig. 5) that concentrated on the reflectors near the seafloor, below and above the high amplitude reflector (Eocene-Oligocene boundary?). These dredges, plus the three dredges from NBP01-01, provide excellent information on the nature of the strata to be encountered by future drilling efforts. We succeeded in collecting seabed outcrop samples from the E-O strata that appear to consist of the juxtaposition of ferruginous, poorly sorted, gravelly sandstones and sandy conglomerates. We also feel that we collected representative sedimentary rocks from below and above the outcropping reflector. (3) We developed protocols for use of the underway CTD (uCTD), a system that has not been used on the *NB Palmer* before. A total of 18 casts were successfully completed the within the Mertz region. These include casts in regions previously covered by the Mertz Glacier Tongue. A rosette/CTD/LADCP cast was completed in the deepest part of the trough, also in an area previously covered by the Mertz Glacier Tongue and therefore not previously sampled. The data collected are discussed in detail in the Marine Geology, Geophysics, and Physical Oceanography sections later in this report.

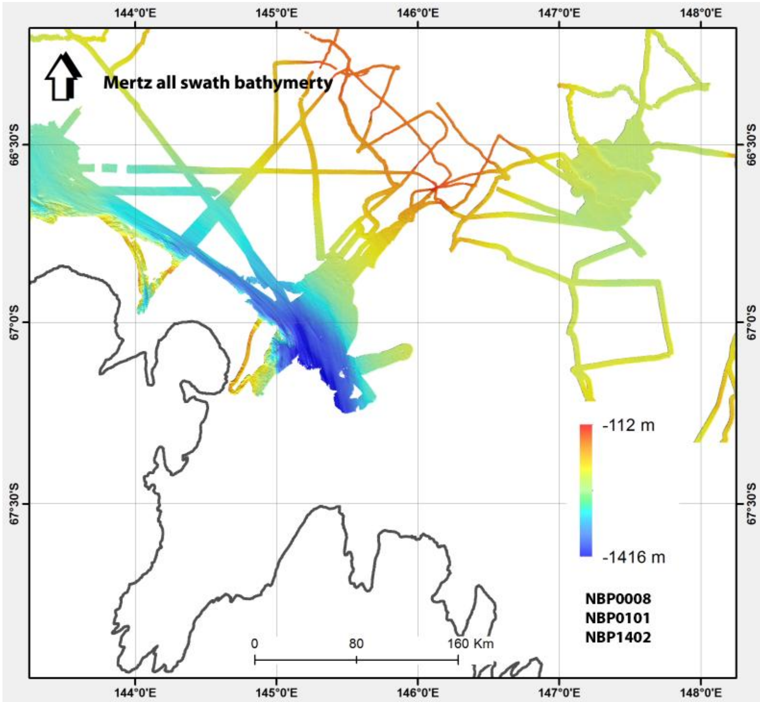


Figure 3. Swath-bathymetry map, Mertz Polynya

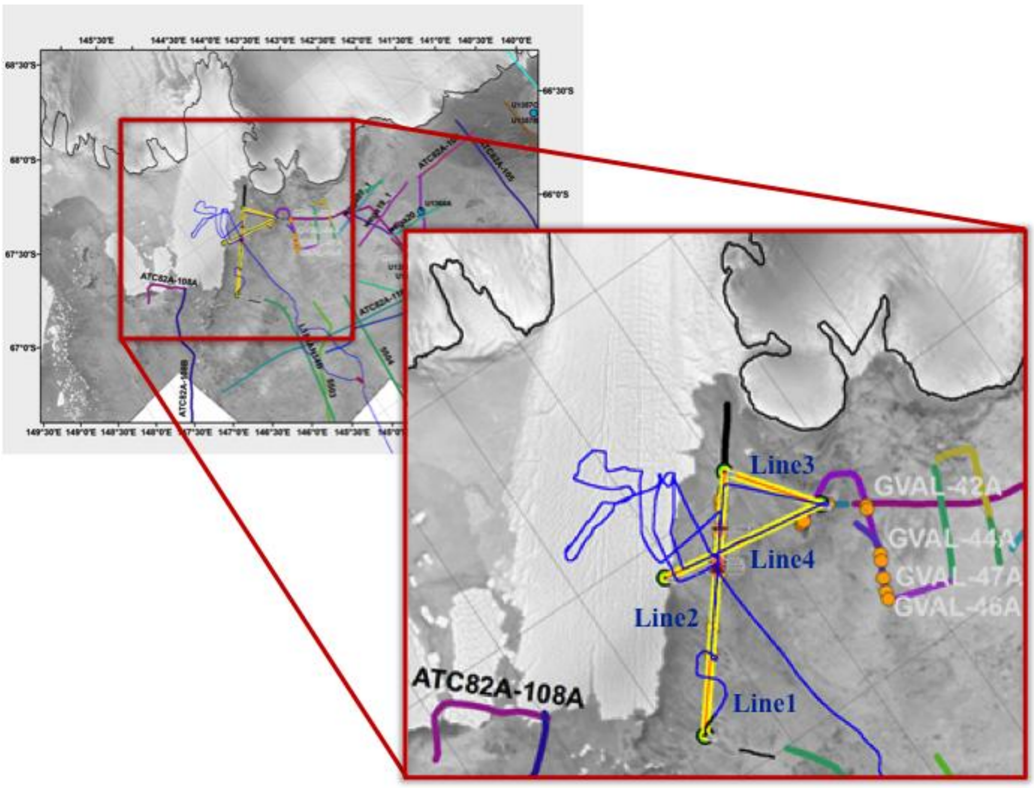


Figure 4. NBP1402 MCS lines 1, 2, 3, and 4 within context of previously existing lines. Blue line is additional multibeam mapping on NBP1402, which expanded coverage to regions previously inaccessible due to the presence of the Mertz Glacier Tongue.

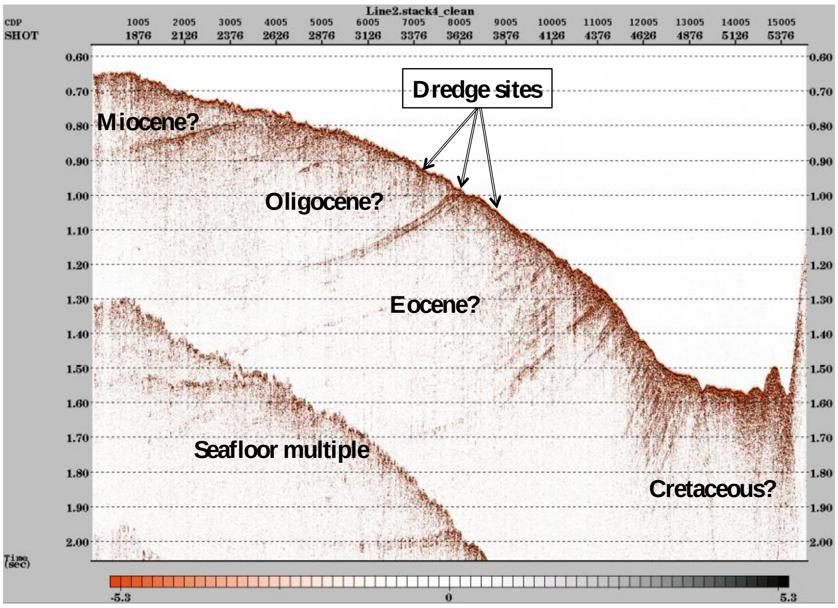


Figure 5. Multichannel seismic line 2. Hypothesized ages as indicated, along with dredge locations intended for biostratigraphic work.

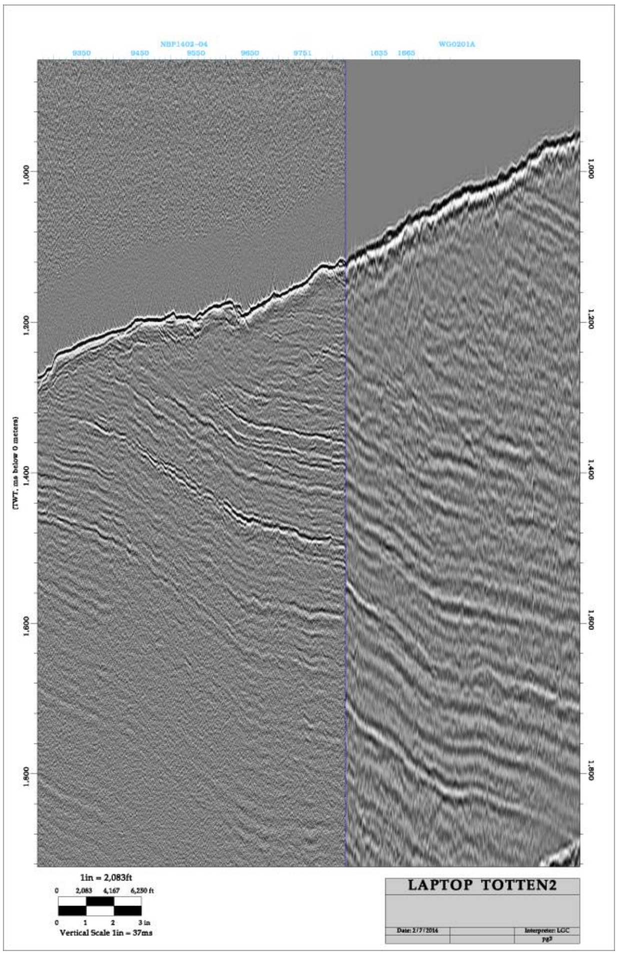


Figure 6. Comparison of NBP1402-04 UTIG (left) MCS data resolution vs. Italian WEGA Survey WG0201A (right). Note higher resolution quality of UTIG data.

Two objectives were not met in the Mertz region. First, within the limitations of sea ice and time allocated we were unable to accomplish the Jumbo Piston Coring of the breached moraine site identified in our proposal. Second, the Rintoul Polynya moorings remained covered by sea ice, making any attempt at recovery impossible.

2.2 TRANSIT

After completing work in the Mertz polynya region, NBP1402 transited to the Moscow University Ice Shelf – Totten Glacier System. On the way, we sampled a coral hard ground on the mouth of the Mertz-Ninnis Trough, on February 7. Coral hard grounds are now recognized as important constituents of Antarctic benthic communities and, while their distributions are still being investigated, they seem to be focused in areas where very cold, saline outflows are concentrated at the mouth of trough mouth fans, shelf breaks, and around shallow headlands. Because of this, they seem to occur at the frontal boundaries of shelf and slope water masses. As such they can serve as useful paleoceanographic indicators as they fix calcite over time periods of at least a few hundred years.

For these reasons, we collected two short dredges that recovered coral and coral rubble on the mouth of the Mertz-Ninnis Trough, Eastern Wilkes Land. A large basket dredge was used for both transects 7A and 7B. The lower transect extended over a distance of 90 m and a depth range of 707 to 692 m. The upper transect, at 669 to 616 m, collected over a distance of 200 m. Several specimens of *Errina antarctica* (Fig. 7), in excess of 20 cm in length were recovered from the upper transect, as well as significant dead coral stems and pieces which seem to carpet the immediate down-slope area of the live growth. If growth rates similar to those observed elsewhere apply here we may have captured a continuous time series of water mass properties that extends to about 1000 years!

Figure 8 illustrates currents in the vicinity of the coral dredge site from shipboard ADCP. These data show increased northward flow in the vicinity of the coral dredge site near 143.16 E.

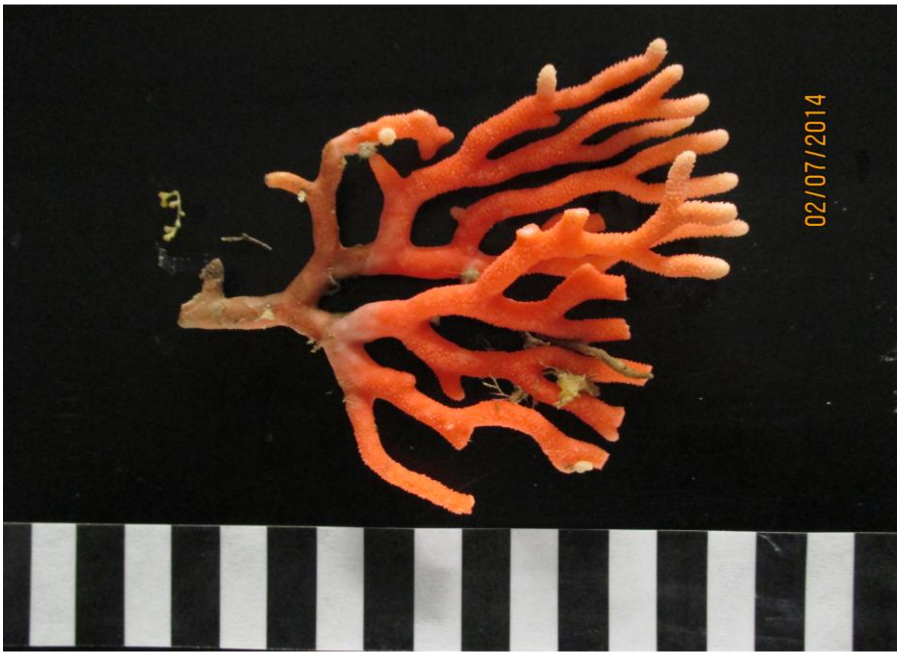


Figure 7. *Errina antarctica*

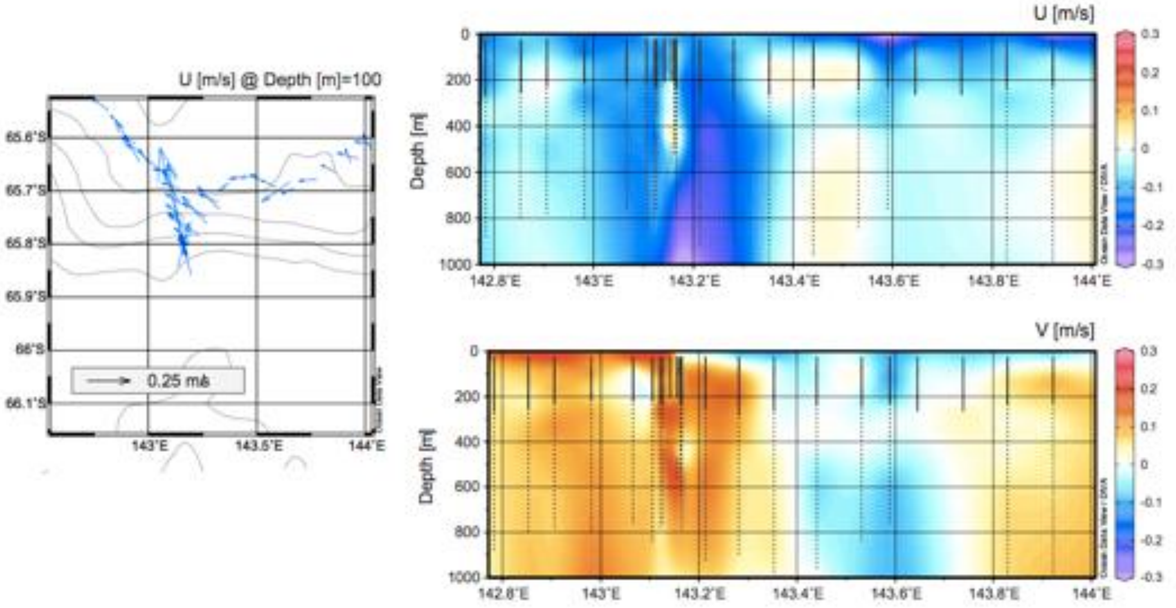


Figure 8. Currents along ship track from shipboard ADCP. Data are a composite of the NB150 (range of about 200 m) plus the OS38 (range about 800 m). Note indication of increased northward flow in the vicinity of the coral dredge site near 143.16 E.

2.3 SABRINA COAST

We arrived at the Totten Glacier - Moscow University Ice Shelf region on February 10, 2014. We entered the Moscow University Ice Shelf polynya from the eastern side, along 120°E longitude, after only a few hours of breaking through the loose pack ice. We worked for the remainder of our cruise, until 9:30 AM March 8th, within the polynya, with the exception of three attempts to access open waters in front of the Totten Glacier. In each case, attempts were predicated on satellite imagery that indicated a potential path through the pack ice. Our closest approach, early in the cruise, took a southerly route, allowing us to get within a few nm of the open water in front of the Totten. A combination of dense pack ice, icebergs, and multi-year fast ice prevented access to open water. Our final attempt was stopped short due to increasingly difficult navigation through pack ice, the result of sustained 40 knot easterly winds and white-out conditions.

Our overall working strategy for the polynya was to initiate a reconnaissance survey followed by more targeted work. The goal was to start by developing a basic framework of knowledge of the sea floor, sub-sea floor morphology, and of water mass structure and flow. This approach was intended to provide the structure from which we could design dedicated coring efforts, focused swath mapping and Multichannel seismic lines, and high-resolution underway CTD transects. The more specific design and accomplishments of this work are presented below, divided by discipline, but with links that highlight the interdisciplinary nature of the science program: Marine Geology, Marine Geophysics, and Physical Oceanography. Additional sections are dedicated to specific aspects of our field program, such as mooring deployments / recovery. Finally, appendices at the end of this report are intended as a working archive of materials collected on this cruise. A total of 61 working stations cover the target areas (Fig. 9 and Table 1).

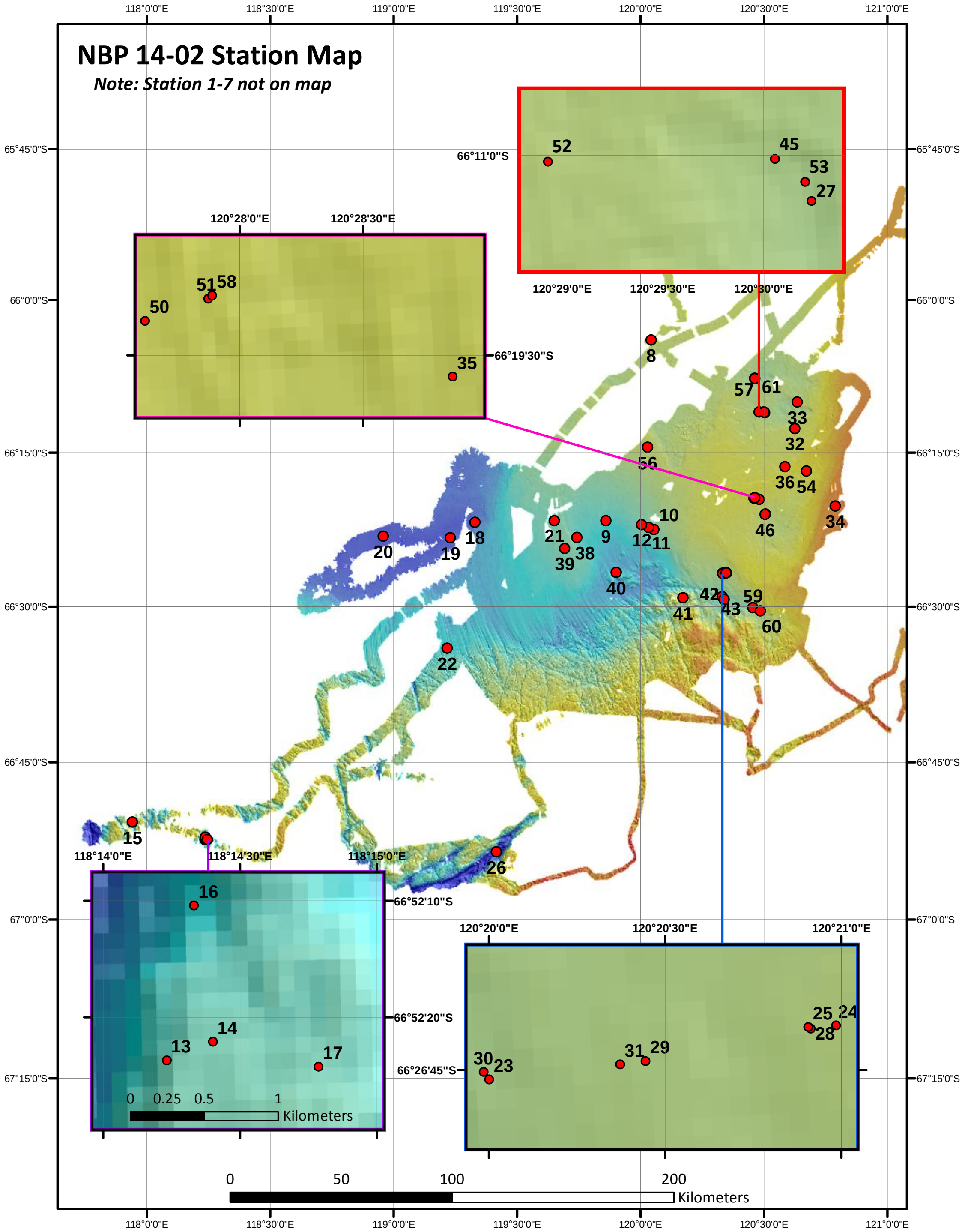


Figure 9. NBP1402 Station Locations

Table 1. Station Activity Log

Station	Julian Day	GMT	Lat (°S)	Long (°E)	WD (m)	Activity
1	36	6:24	66 53.4869	145 17.7676	740	Mertz, Large box dredge, upper Eocene
2	36	8:36	66 53.0067	145 18.770	735	Mertz, Smalll box dredge, E/O boundary
3	36	9:55	66 52.3187	145 20.1910	687	Mertz, Small basket dredge, Oligocene above unconformity
4	36	11:23	66 49.641	145 25.641	590	Mertz, Small basket dredge, upper Oligocene
5	37	2:38	67 05.607	145 13.389	1356	Mertz, CTD #1
6	37	5:45	66 53.311	145 18.064	732	Mertz, Ring dredge, E/O boundary
7A	38	8:21	66 48.192	143 09.831	707	Upper slope Mertz sill, NTT Basket dredge
7B	38	9:57	65 48.345	143 09.831	669	Upper slope Mertz sill, NTT Basket dredge
8	41	13:35	66 03.936	120 02.6436	495	Sabrina Coast, CTD #2
9	42	14:56	66 21.64	119 51.72	676	Sabrina Coast, CTD #3
9	42	15:59	66 21.644	119 51.716	683	Sabrina Coast, toe large moraine, KC9, 2.05 m + 0.16 m CN
10	43	16:51	66 22.505	120 03.337	602	Sabrina Coast, YoYo 10
11	43	20:04	66 22.3091	120 02.1240	604	Sabrina Coast, Mooring M1 deployment
12	43	21:17	66 22.02	120 00.36	627	Sabrina Coast, CTD #4
13	44	9:00	66 52.3947	118 14.2337	646	Sabrina Coast, KC13, 1.725 m + 0.25 m CN
14	44	10:38	66 52.3691	118 14.4022	643	Sabrina Coast, KC14, 2.63 m + 0.15 m CN
15	44	16:58	66 50.7152	117 56.5942	656	Sabrina Coast, JKC15, CN only 0.13 m
16	44	21:43	66 52.1733	118 14.3324	692	Sabrina Coast, JGC16, 3.05 m
17	45	3:34	66 52.403	118 14.786	647	Sabrina Coast, same as Stn 16, JPC17, 3.05m, JTC17, 1.05 m
18	47	23:28	66 21.73	119 19.76	845	Sabrina Coast, CTD #5
19	48	3:33	66 23.32	119 13.87	876	Sabrina coast, CTD #6
20	48	14:02	66 23.145	118 57.583	895	Sabrina Coast, KC20, 1.79 m + 0.18 m CN
20	48	15:16	66 23.14	118 57.58	896	Sabrina Coast, CTD #7
20	48	16:26	66 23.14	118 56.529	896	Sabrina Coast, YoYo
21	48	4:05	66 21.6289	119 39.0944	624	Sabrina Coast, SKC21, no recovery
M2	49	7:39	66 22.99	119 42.343	620	Sabrina Coast, Mooring M2 deployment
T1	49	12:53	66 32.5584	119 12.6846	708	Sabrina Coast, Mooring T1 deployment
23	49	19:46	66 26.7609	120 19.997	566	Sabrina Coast, Dredge I-I'
24	49	21:17	66 26.7389	120 20.4460	553	Sabrina Coast, Dredge H-H'
25	49	22:44	66 26.7014	120 20.9077	541	Sabrina Coast, Dredge G-G'
M3	51	7:53	66 52.981	119 26.204	1051	Sabrina Coast, Mooring M3 deployment
26	51	10:30	66 53.56	119 25.05	1102	Sabrina Coast, CTD #9
27A	52	2:52	66 11.092	120 30.2403	544	Sabrina Coast, KC27A, 2.952 m
27	52	3:59	66 11.09	120 30.24	549	Sabrina Coast, CTD #10
27B	52	4:45	66 11.0907	120 30.2385	547	Sabrina Coast, KC27B, 2.71 m
27	52	9:30	66 11.0568	120 30.1483	544	Sabrina Coast, JPC27, 13.00 m, JTC27, 1.39 m
28	52	16:13	66 26.7036	120 20.9138	523	Sabrina Coast, JPC28, 0.235 m, JTC28 sieved

29	52	19:45	66 26.7398	120 20.4442	534	Sabrina Coast, JPC29, 0.76 m, JTC29, 0.415 m
30	52	23:17	66 26.7522	120 19.9846	548	Sabrina Coast, JPC30, 0.705 m, JTC30, 0.40 m
31	53	3:02	66 26.739	120 20.3723	534	Sabrina Coast, JPC31, 0.52 m, JTC31, 0.47 m
32	53	13:00	66 12.6283	120 37.6378	496	Sabrina Coast, Mooring T2 deployment
33	54	17:38	66 10.02	120 38.16	508	Sabrina Coast, CTD #11
33	54	18:29	66 10.0232	120 38.1564	509	Sabrina Coast, McLean Pumps, north of JPC27
34	54	12:53	66 20.20	120 47.432	280	Sabrina Coast, YoYo 34
35	54	14:59	66 19.536	120 28.872	457	Sabrina Coast, YoYo 35
36	54	16:52	66 16.364	120 35.224	459	Sabrina Coast, YoYo 36
37	55	21:45	66 21.531	119 59.383	619	Sabrina Coast, Mooring M1 recovery
38	56	0:22	66 23.27	119 44.65	665	Sabrina Coast, CTD #12
39	56	3:11	66 24.3365	119 41.6583	622	Sabrina Coast, JGC39, 1.78 m
40	56	6:05	66 26.6927	119 54.2010	697	Sabrina Coast, YoYo 40
41	56	8:00	66 29.1119	120 10.3885	448	Sabrina Coast, failed YoYo
42	56	11:27	66 29.0254	120 19.9457	610	Sabrina Coast, KC42, 2.81 m + 0.20 CN
42	0:00	12:21	66 29.10	120 19.95	606	Sabrina Coast, CTD #13
43	56	14:30	66 29.279	120 20.406	612	Sabrina Coast, JPC43, 9.05 m, JTC43, 1.35 m
44	57	21:30	66 11.16	120 30.31	544	Sabrina Coast, failed YoYo
45	57	22:42	66 11.0069	120 30.0591	537	Sabrina Coast, MC45
46	58	3:13	66 21.0132	120 30.404	499	Sabrina Coast, Dredge U-U'
47	62	13:58	66 35.6190	120 13.2344	339	Sabrina Coast, YoYo 47
49	62	16:25	66 35.693	120 10.403	444	Sabrina Coast, YoYo 49
50	62	19:53	66 19.444	120 27.619	454	Sabrina Coast, YoYo 50
51	62	21:04	66 19.4106	120 27.8755	450	Sabrina Coast, SMG51
52	62	23:19	66 11.011	120 28.894	512	Sabrina Coast, YoYo 52
53	63	0:38	66 11.053	120 30.208	545	Sabrina Coast, JKC53, 5.20 m + 0.27 m CN
53	63	3:45	66 11.058	120 30.213	547	Sabrina Coast, Sediment trap mooring deployment
54	63	5:53	66 16.815	120 40.350	442	Sabrina Coast, JPC54, 1.20 m, JTC54, mud in bag
55	63	916	66 20.998	120 30.454	520	Sabrina Coast, JPC55, 1.69 m, JTC55, 1.69 m
56	63	13:06	66 14.9277	120 01.8175	495.5	Sabrina Coast, JGC56, 1.55 m
57	63	18:19	66 07.7325	120 27.8407	583	Sabrina Coast, JPC57, 8.76 m, JTC57, 1.15 m
57	63	20:10	66 07.7321	120 27.8403	578	Sabrina Coast, KC57, 2.54 m + 0.18 m CN
58	63	23:00	66 19.403	120 27.891	451	Sabrina Coast, JTC58, 0.425 m
59	64	3:22	66 30.882	120 27.398	546	Sabrina Coast, Mooring T3 deployment
60	64	4:13	66 30.387	120 29.192	499	Sabrina Coast, CTD #14
61	64	15:00	66 07.691	120 27.826	582	Sabrina Coast, MC61
61	64	16:06	66 07.6913	120 27.8252	580	Sabrina Coast, McLean Pumps

3. MARINE GEOLOGY

3.1 MULTIBEAM SWATH-BATHYMETRY

Mapping revealed a complex set of glacially carved and eroded seascapes with constructional grounding line wedges and lineated to corrugated subglacial surfaces (Fig. 10). What is surprising is the close juxtaposition of all the features in small area of the shelf - where normally such features are organized across broad regions on other Antarctic shelves. Striking observations of superimposed ice flow directions are indicated as well as several sets of recessional morainal bank constructs -- both of which indicate a complex glacial and deglacial history.

The morphology of the seafloor shows a wide variety of unusual bedforms of both erosional and depositional character, some of which have never been reported from the Antarctic continental shelf. These include:

- unusual grounding zone wedges which stack in broad sweeping sets, which, for lack of a better term, we refer to as "feather moraines"
- parabolic dune forms, and
- parallel 2-dimensional mega waves.

Several larger and more typical morainal bank systems have also been mapped yet they similarly provide unique signatures including a spectacular bank collapse and slide block terrains wherein large portions of the grounding zone crest has detached and slid seaward by several kilometers producing a rubble field and glide block terrain in the downslope (seaward) direction. The causal mechanism(s) for this instability are being discussed.

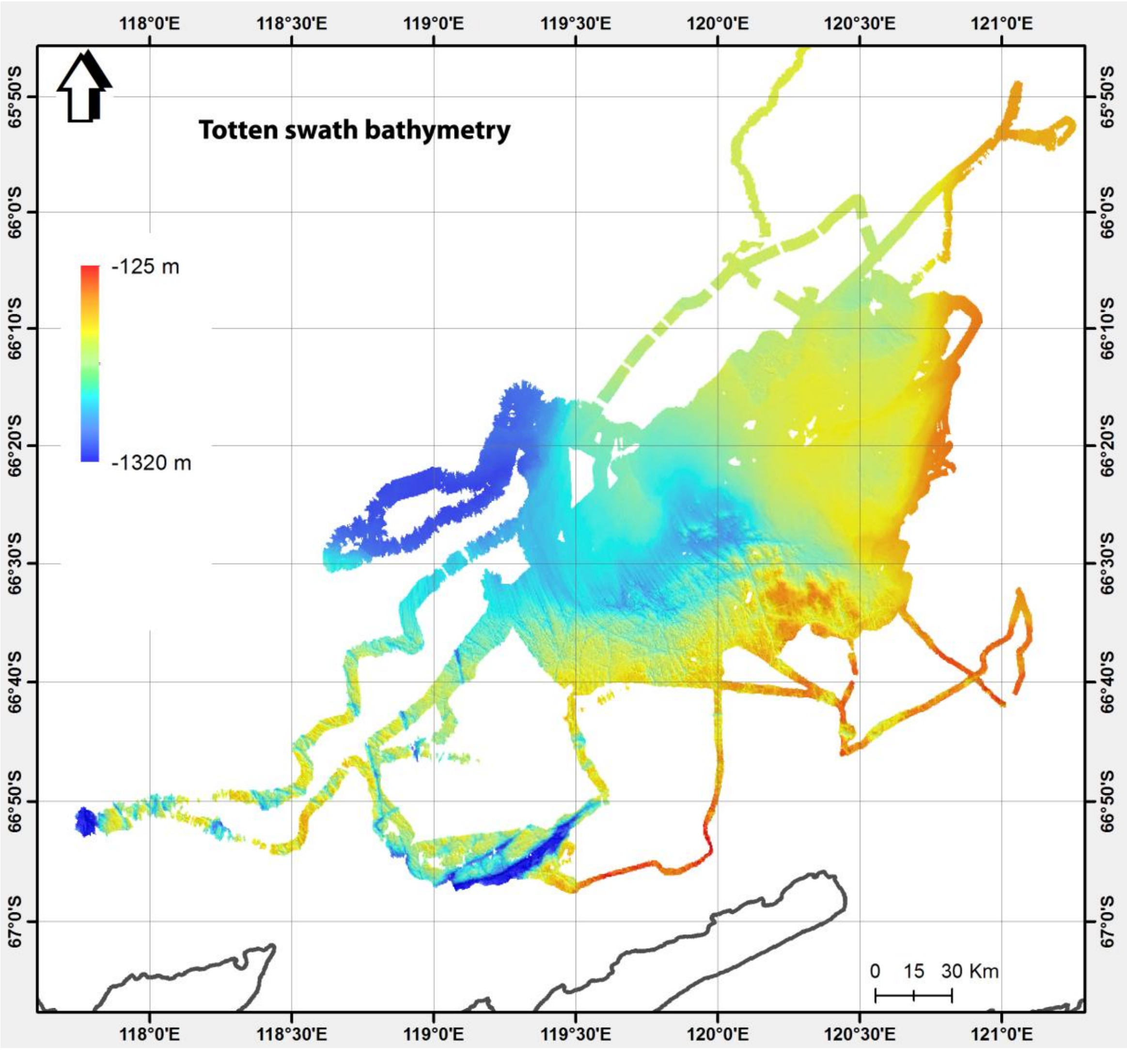


Figure 10. Moscow University Ice Shelf Polynya bathymetry.

Multibeam mapping of the juncture of crystalline bedrock with the sedimentary strata of the continental shelf was completed to help resolve the nature of bedrock channels which appear to serve as subglacial meltwater conduits during times of expanded ice sheet cover. The channel networks are complex, reflect the structural character of the crystalline rocks (i.e. joints, faults, and contrasts in rock type), and range in depth from hundreds to over a thousand meters. It is important to establish the geometry of these features in order to understand how subglacial melt water sculpted and was/is conveyed towards the margin, as offshore features give evidence for periodic outbursts of flowing water of a considerable magnitude.

3.2 CORING AND DREDGING OPERATIONS

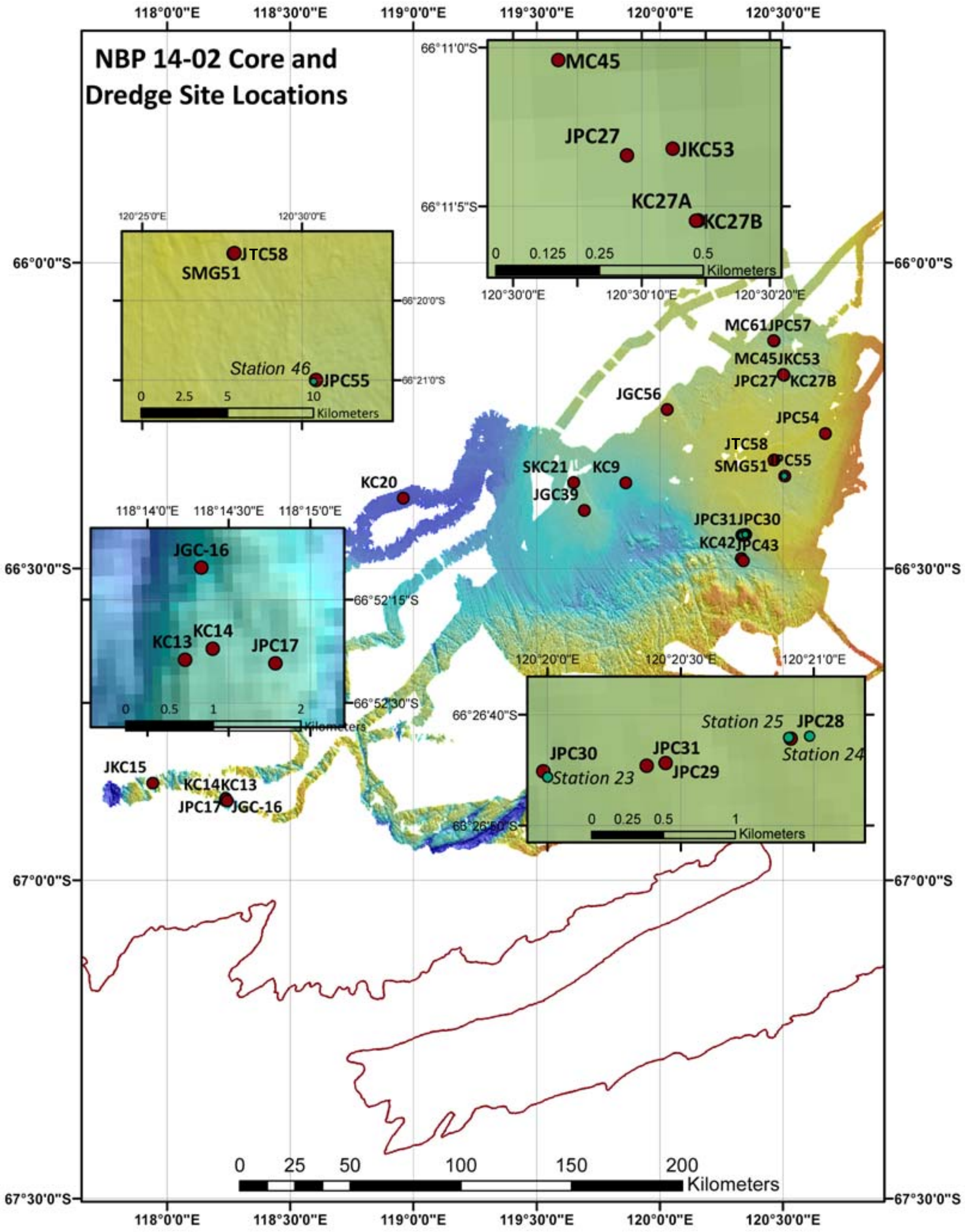


Figure 11. Core and dredge locations.

3.2.1 Coring summary

Three major kinds of coring targets were identified in this project (Fig. 11):

1. We conducted strategic short coring of unique sites. After evaluating the remarkable seismic stratigraphy provided by the UTIG team, we conducted a set of dredges and one barrel JPCs across areas of outcropping strata at the seafloor. The dredges recovered the usual assortment of ice rafted crystalline rocks but also an abundance of partly weathered mudstone, diatomite, and diamictite lithologies -- in sufficient abundance and character to confirm our interpretation as seafloor outcrop of sedimentary units. Subsequently, the single barrel JPCs and special cutter nose were deployed at selected locations along our dredge and seismic reflection sections. The material recovered is more than adequate to provide biostratigraphic information, if appropriate microfossils are present. We highlight this new mode of operation for jumbo piston coring as a relatively inexpensive way to acquire stratigraphic samples at key seafloor outcroppings and note the tremendous benefits of being able to conduct this kind of sampling from a mobile platform. Annotated seismic lines illustrating the location of dredge and JPC sites are included in the Appendices at the end of this report.

We also collected a pair of short gravity cores on the top of two moraine complexes that resemble feathers on a bird wing (feather moraines); these cores were acquired in order to characterize the physical properties and till rheology, aspects that will help us understand the depositional processes leading to the development of these unique features.

Our discovery of “mega-dune” bed forms at 600 m water depth was followed up with a Smith-McIntyre grab, a Jumbo Trigger core, and a bottom camera. We recovered well-sorted medium to coarse-grained sand, which appears to blanket the seafloor with a surficial scattering of ice rafted boulders (all heavily encrusted with epifauna). The trigger coring revealed that the sand is interbedded with mud in the near subsurface. Hence, the “sand plains basin” appears to have a more complex history of sand deposition and dune formation than we had originally supposed. This type of seafloor appears to be even more extensive in other basins, those that were partly imaged and which lay farther seaward on the continental shelf.

2. The 3.5 kHz record shows that the sea floor is, in general, carpeted by a uniform drape of glacial marine silty clay which varies very little in thickness, usually about 3 m (Figs. 12 and 13). Three meter kasten cores were used to recover these sediments, which were comprised mainly of silty clays that are virtually devoid of coarse ice rafted debris, but are rich in foraminifera and diatom frustules. Profiles of magnetic susceptibility can be correlated between these cores. Dating of the transition between the till and the overlying silty clay will provide information concerning the timing of deglaciation in this understudied portion of the Antarctic continental margin.

3. Although, as noted above, the chirp data indicated only a thin sediment drape over most of the region studied, we identified three sites with between 9 – 15 meters of acoustically transparent sediment, all located along the eastern side of the polynya. At the two sites located in the northeast we conducted interdisciplinary water column to sediment sampling. Here, we used a suite of sampling devices to characterize the physical oceanography, water column properties, and surface to deep sedimentation. Such studies will enable ecologic investigations, paleoceanographic proxy development, and will enable us to improve understanding of how and why sediment is deposited at each site.

At Station 27 (~540m), we collected two 3 m kasten cores (2.9 and 2.7 m) comprised of laminated diatomaceous ooze and mud; the second core recovered an intact sediment water interface. These deployments were followed by the deployment and recovery of a 13 m Jumbo Piston Core (JPC). Five days later, we returned to the same site and deployed a rosette CTD, two McLean pumps, and a Megacore. The rosette CTD was intended to characterize the physical oceanography of the region and revealed warm modified Circumpolar Deep Water at depth. ADCP data revealed a local recirculation feature associated with the local bottom topography. The McLean pumps were then deployed for three hours at 480 m (core of mCDW) and at 25 m (surface) to filter large volumes of mCDW and surface water at 0.2µm for DNA/RNA and geochemical analyses of viruses, archaea, and phytoplankton in the water column as well as those associated with each water mass. Upon completion of pumping, we deployed a megacore and recovered 11 tubes with 35cm of sediment in each tube. Megacores were subsampled for DNA, foraminifers (samples between 0 and 10 cm were stained with a Rose Bengal and 3.8% formalin solution for 36 hours), diatoms, sedimentology, radiocarbon, ^{210}Pb, and organic geochemistry. Several days later, we returned to the site for a third time and recovered a 5.0 m jumbo kasten core with an intact sediment water interface. This core enabled us to extend the DNA/RNA sampling downcore to 5 m; this type of sampling must be conducted immediately upon recovery and samples are immediately frozen and kept at -80°C. Because of the low temperatures required for preservation, sediment DNA/RNA analyses cannot be conducted on the JPCs that are stored at 4°C and opened upon arrival at Florida State. See figures 11 and 12 for core locations and lithologic logs.

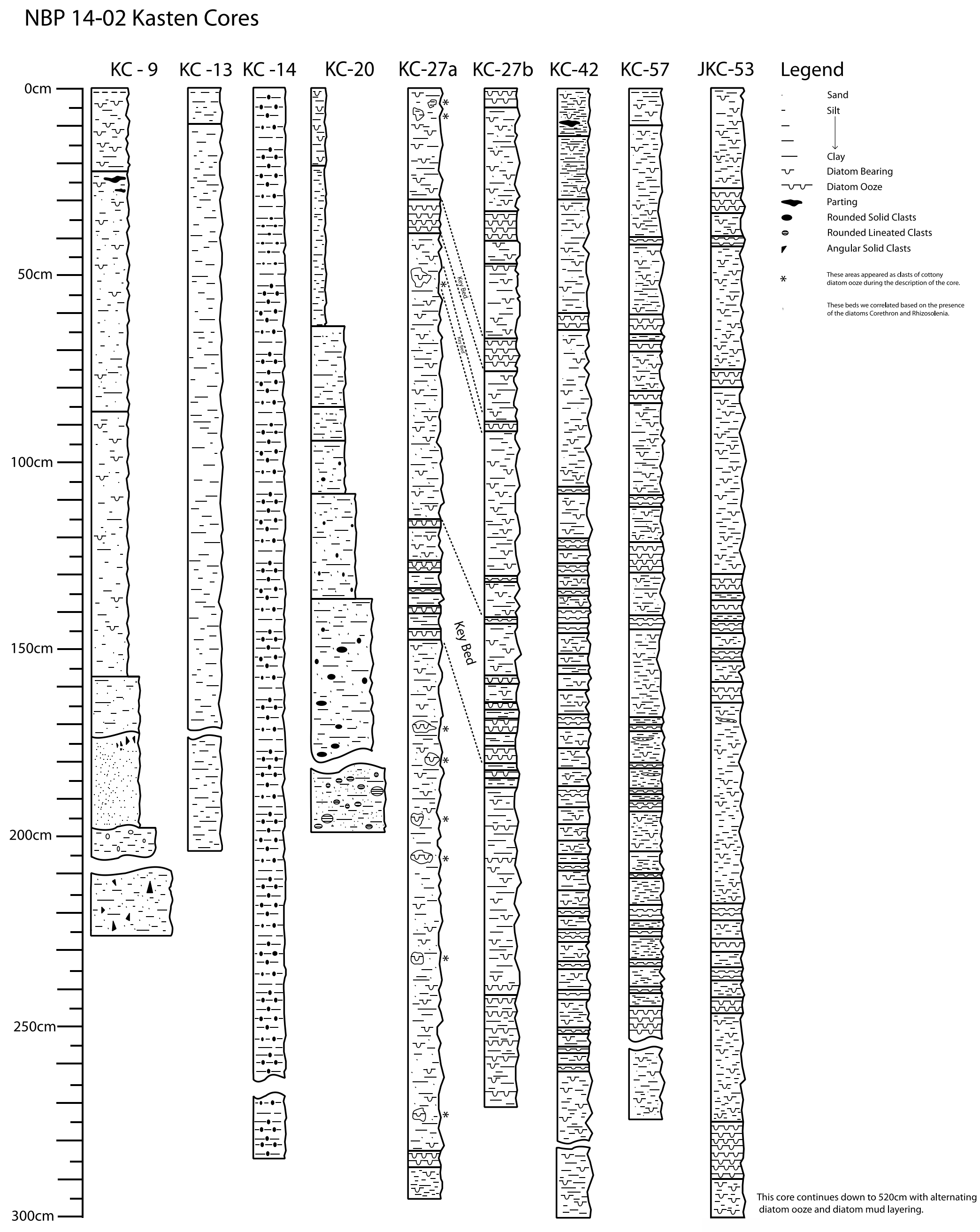


Figure 12. Lithologic description of kasten cores.

At the second water column to sediment station (57/61, Fig. 11), we collected an 8.76 m jumbo piston core and a 2.5 m long kasten core that also revealed a sequence of laminated diatom oozes and muds and an intact sediment water interface. We then conducted a rosette CTD and discovered the warmest water and lowest dissolved oxygen concentration at depth in the polynya (~450m). We also deployed a megacore and recovered 12 tubes of sediment (37 cm each) with excellent sediment water interfaces; one tube included a small fish. The megacores were subsampled using the same approach as described above. Following the megacore deployment, the McLean pumps were deployed for 3 hours at depths of 450m and 25m to collect particulate matter associated with the mCDW and surface waters, respectively.

Two highlights of the expanded sedimentary sections include (a) shipboard visual inspection of sediments indicates the presence of carbonate microfossils throughout the upper 3 m of sediment, and (b) the dominance of *Thalassiothrix antarctica* in the diatom mats. The presence of the carbonates, primarily forams, will allow for the development of stable isotopic and Mg/Ca records that will be used for paleoclimatic reconstruction and for comparison to new proxies currently being developed. The abundance of *Thalassiothrix* is notable because it is not common in diatom mats elsewhere around the Antarctic margin, and may be a key to the apparently low organic content of these sediments. The sediments contain a very low abundance of *Chaetoceros* resting spores, which are instrumental in delivering organic carbon to the sea floor in other areas of the Antarctic shelf.

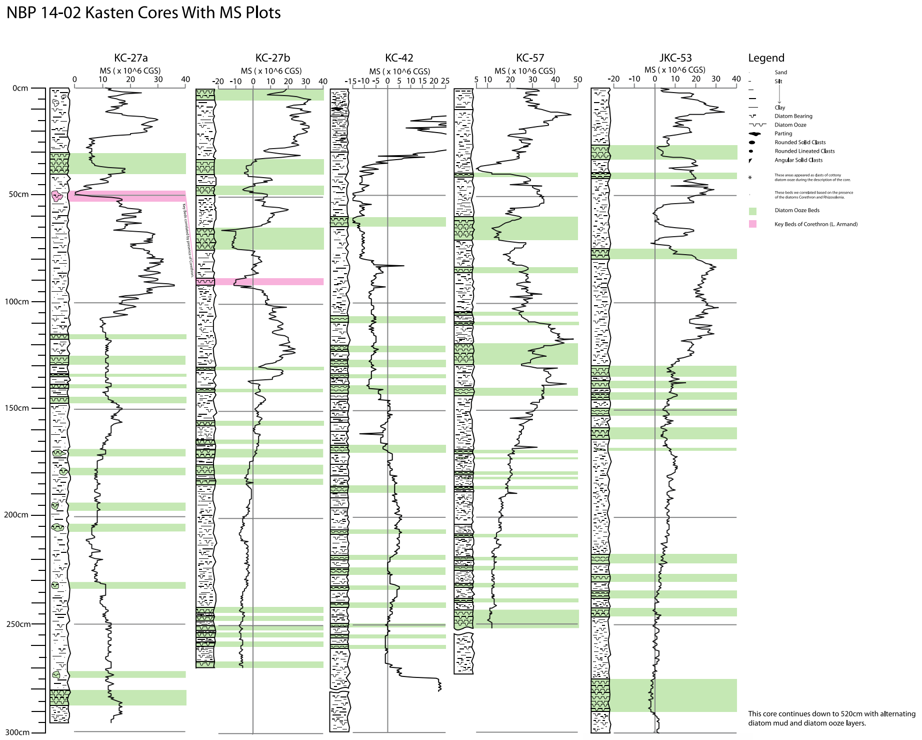


Figure 13. Magnetic susceptibility profiles for kasten cores characterized by alternating diatom oozes and clays. Green shading highlights diatom ooze layers. Red shading denotes a diatom ooze comprised of *Thalassiothrix antarctica* that can be correlated between cores.

3.2.2 Dredge Summary

This cruise conducted one of the more extensive dredging programs on the Antarctic continental shelf and resulted in over 12 stations which recovered material which we believe ranged in age from Recent to Cretaceous (Table 2). We occupied three distinct regions during the cruise, each summarized as follows:

Table 2: Details of dredge locations and objectives NBP14-02

Dredge # order	Station #	Start drag, depth Lat. Long.	End drag*, depth Lat. Long.	Objective Dredge Type	Seismic line ref. **
1	1	740 m 66° 53.4869' 145° 17.7676'	728 m 66° 53.1958' 145° 18.356'	Upper Eocene ? modified large rectangular dredge	UTIG-2 Shot#3752
2	2	735 m 66° 53.0067' 145° 18.743'	719 m 66° 52.780' 145° 18.743'	Eocene/Oligocene contact, high amplitude reflector small basket dredge	UTIG-2 Shot#3643
3 listed as dredge "site" 5?	3	687 m 66° 52.3187' 145° 20.1910'	681 m 66° 52.181' 145° 20.343'	Oligocene, above high amplitude reflector small basket dredge	UTIG-2 Shot#3491
4	4	590 m 66° 49.641' 145° 25.641'	590 m 66° 49.506' 145° 25.877'	upper Oligocene small basket dredge	UTIG-2 Shot#2918
6	6	732 m 66° 53.311' 145° 18.064'	713 m 66° 52.782' 145° 19.2462'	Eocene/Oligocene contact, high amplitude reflector large ring dredge	UTIG-2 Shot#3718
7	7A	707 m 65° 48.192' 143° 09.831'	706 m 65° 48.251' 143° 09.835'	benthic ecosystem large box dredge	Knudsen-038 Shot#7908
8	7B	669 m 65° 48.345' 143° 09.831'	not entered 65° 48.457' 143° 09.827'	benthic ecosystem large box dredge	Knudsen-041 Shot#11685
9 I-I' see JPC-30, 31	23 30, 31	566 m 66° 26.7609' 120° 19.997'	530 m 66° 26.753' 120° 20.552'	lowermost reflector above regional unconformity, age unknown, Oligocene ? large ring dredge	UTIG-13 Shot# 30888
10 H-H' See JPC-29	24 29	553 m 66° 26.7389' 120° 20.4460'	519 m 66° 26.6881' 120° 21.1066'	indistinct reflectors above regional unconformity large ring dredge	UTIG-13 Shot# 30826
11 G-G' see JPC-28	25 28	541 m 66° 26.7014' 120° 20.9075'	530 m 66° 26.6592' 120° 21.4371'	second reflector above regional unconformity large ring dredge	UTIG-13 Shot# 30831
12 U-U' see JPC-55	46 55	499 m 66° 21.0132' 120° 30.4001'	500 m 66° 20.8951' 120° 31.0185'	section below fluvial deltaic sequence, pre-regional unconformity, Eocene? large ring dredge	UTIG-17 Shot# 38894
R-R' NOT TAKEN see JPC-54	-------- 54	442 m 66° 16.815' 120° 40.350'		Strata above "deltaic sequence" pre-regional unconformity, Eocene ? Jumbo piston core only	UTIG-17 Shot# 39799

*End of drag is overestimate due to catenary of 9/16" wire as dredge leaves bottom some distance back of end point.
** shot point given as start of drag or location of piston core.

3.2.2.1 Mertz-Ninnis Trough, George Vth margin, eastern Wilkes Land

Six dredges were taken along a pre-existing seismic survey conducted by OGS (WEGA) and across sites previously dredged during NBP01-01. We expanded the spatial coverage of all the dredge sites but narrowed the drag length of individual dredges in order to sample near-seafloor outcrops in a detailed manner. One of our targets was a regional, high-amplitude reflector—believed to represent the Eocene/Oligocene contact. We also targeted our dredges based upon the new higher resolution seismic survey conducted on this cruise by the UTIG group (Fig. 5). We used a variety of dredges and adjusted our techniques as results dictated. We finally settled on the large ring dredge for acquiring the most material in the most efficient manner. Rock types were cleaned sorted, and photographed and tabulations were made of preliminary lithology (see appendix). The Eocene/Oligocene contact, shown as a high amplitude reflector, appears to consist of a poorly sorted, coarse grained, ferruginous sandstone, consistent with the seismic expression. Other notable rock types included gray, fine grained, well sorted sandstone, diamictite, gray mudstone, and black lignite. Unusual numbers of small, very well rounded and smoothed quartz pebbles of various colors were also recovered in two of the dredges.

3.2.2.2 Mertz-Ninnis Trough, outer continental shelf, George Vth Margin, eastern Wilkes Land

Two dredges were conducted in order to sample specimens of *Errina antarctica*, a cold water hydrocoral known to grow across this portion of the seafloor (Fig. 7). These corals have proven themselves useful as paleoceanographic recorders of water mass properties such as ^{14}C content. Short 9 cm specimens from the Ross Sea record approximately 400 years of time. We recovered quite a few nice specimens of living coral which exceed 20 cm and hence with expected growth histories exceeding 1000 years! Assorted dead coral rubble and other detritus also were recovered at these two stations where at we used the large box dredge.

3.2.2.3 Sabrina Coast, inner continental shelf, western Wilkes Land

Four distinct dredges and associated jumbo piston cores were collected for a total of 9 samples of seafloor outcrop that we discovered at various stratigraphic levels. We selected our sites based upon the expression of seafloor outcrop, as based upon GI gun seismic reflection survey and Knudsen Chirp profiles, and location with respect to prominent seismic "sequences" believed during the survey to represent regionally important intervals of time and or change in acoustic facies (as from non-glacial to glacially influenced deposition).

Initial use of the large ring dredge proved useful but it also acquired quite a bit of erratic material from iceberg rafting. Given that sections were clearly cropped out on the seafloor and we expected some rather softer sedimentary units we decided to rig the Jumbo Piston Core with a single 3 m long barrel and minimal free fall. This strategy proved successful on a number of occasions where we collected unaltered or weathered lithologies of semi-lithified to fully lithified state, including sandstone. Hence we believe we have integrated a new method of strategically sampling seafloor outcrop using the seismic reflection data and the JPC. Outcrop has been sampled in the past via piston core (e.g., Domack et al., 1980) but that sampling was fortuitous. Much of our material collected in this manner remains within the core liner sections and thus awaits core opening back in the U.S. Yet some lithologies recovered in the cutter nose include: sandstone, compact semi-lithified diatom bearing siltstone, dark mudstone, and sand. Clast types brought up on the dredges include: diamictite, lignite, friable poorly sorted sandstone, mudstone, and pink coarse grained sandstone.

3.3 YOYO CAMERA TRANSECTS

During NBP14-02 a yoyo camera was used to complete ten photographic transects within the polynya region off the Sabrina coast (Fig. 14 and Table 3) (see the Appendices for locations, preliminary data, and descriptions and selected images from each transect). These transects were designed, where possible, to coincide with other key datasets, such as oceanographic moorings, CTD casts and sediment cores. In addition, we targeted several interesting features revealed by the multibeam sonar and Knudsen sub-bottom profiler as outlined in the table.

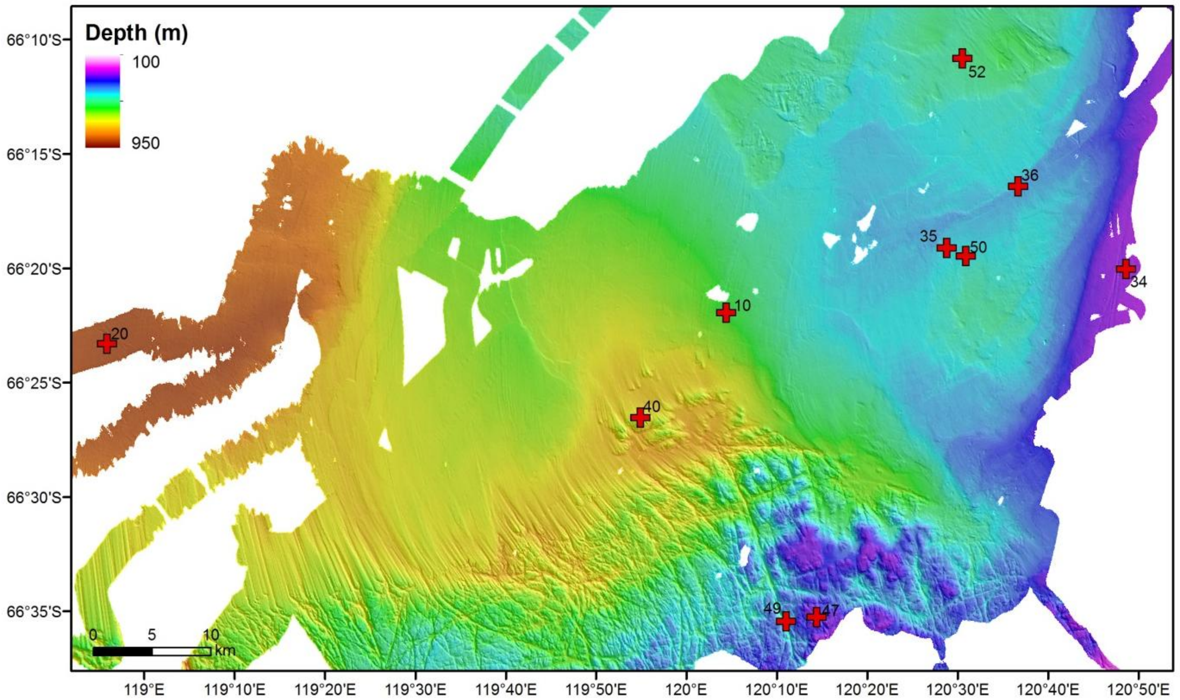


Figure 14. Location of yoyo transects completed during NBP1402.

Table 3: Objectives and datasets at each yoyo camera transect

Station	Coincident data	Objective
Yoyo10	Mooring, CTD	Coincident with mooring
Yoyo20	CTD, kasten core	Deep basin site
Yoyo34		Test cast for camera system over shallow moraine
Yoyo35	Core, grab samples	Target parabolic dunes
Yoyo36	Core	Base to top of moraine
Yoyo40		Investigate crag and tail feature
Yoyo47		Investigate shallow basement
Yoyo49		Communities / sedimentary patterns in deep basement channel
Yoyo50	Core, grab samples	Target larger parabolic dune features
Yoyo52	Cores, CTD	Communities on flanks of sediment depocenter

On the whole, the benthic macrofauna of this region was relatively depaurate. Soft sediment areas typically consisted of sparse assemblages of mobile and infaunal communities, with brittle stars typically the dominant taxa visible on the surface. Low faunal abundances and dominance by mobile feeders suggests a low organic carbon supply to the seafloor, despite the widespread diatom drifts that were observed on the sediment surface. Diatom drifts were likely deposited during the current spring/summer season, with dense marine snow observed on the video during yoyo downcasts. These diatom deposits are likely quickly scavenged by the mobile feeders, with abundant feeding tracks visible across the drifts.

To further investigate the impact of sedimentation on the nature of the benthic macrofaunal community, we conducted one camera transect along the flanks of a sediment depocenter in the northern part of the survey area. Fauna along this transect were relatively sparse, but we observed a greater abundance of suspension feeders (anemones and gorgonian whips) than in the other soft sediment areas. Mobile feeders, such as brittle stars and burrowing urchins were still present, but in relatively lower abundance. The high occurrence of suspension feeders on this transect suggests a larger advected input of organic matter along the edges of this sediment basin.

Ice rafted debris (IRD) was frequently observed throughout the eastern part of the survey region. Dropstones and cobbles form anchor points for a prolific epifaunal community, providing islands of diversity amongst the sparsely populated softer sediments. The occurrence of IRD therefore significantly enhances diversity and biomass at a local scale. Dense epifaunal communities were also associated with the crystalline basement in the southeastern part of the survey region, consisting of a diverse assemblage of massive, encrusting and hollow sponges, bryozoans, ascidians, anemones and gorgonians.

The crystalline basement was also imaged to investigate sedimentary processes associated with a deep channel feature. The edges of the channel comprised exposed bedrock, while the deeper sections were muddy, with extensive diatom drifts. Sediments on the plateau adjacent to the channel, by contrast, had a much sandier appearance, with little or no diatom drifts present. These observations indicate that the channel system is not currently a conduit for bottom flow, but rather forms a sink for sediments from the surrounding plateau.

A parabolic dune system in the northeastern part of the survey area was a key feature that we explored with the yoyo camera. The footage across the dunes confirmed that these bedforms are a relict feature. Several accumulations of dropstones are superimposed on the dune surface. These boulders are densely populated by mature epifaunal organisms, including sponges, bryzoans, bottlebrush gorgonians, ascidians and anemones. The surface of the boulders appears to be coated with manganese oxide. The development of a mature sessile community on the boulders, and their coating with manganese oxide indicates that the boulders have been in place on top of the dune system for at least several hundreds of years.

We also used the yoyo camera to investigate a 30 m high moraine, with a transect from the base to the top of the feature. The images revealed that the face of the moraine is composed of gravelly sediment, consistent with the deposition of glacial debris. Low sedimentation rates over the past thousands of years have preserved this, and other relict features across this area. The glacial debris now forms a habitat for a diverse epifaunal community.

4. HIGH-RESOLUTION SEISMIC REFLECTION SURVEYING

4.1 NBP1402 MULTICHANNEL SEISMIC SYSTEM

MCS data were acquired and processed during the NBP1402 leg using combined components of the UTIG high-resolution and the NBP shipboard systems. Specifics are included below.

4.1.1 Seismic Source

Two Sercel G.I. airguns were configured at 45/45 in^3 (harmonic mode) with an in-line separation of 2 m, towed at nominal depths of 2.5 m or 3 m (inferred from frequency analysis of acquired data to be actually 2.3 m or 2.8 m). A third 45/45 in^3 airgun was towed midway after of the two primary guns, which served as a hot spare. The in-line center of the two airguns was 35.5 m from the stern initially (Lines 1-4), shortened to 29 m for subsequent lines. The source was fired every 5 s, for a nominal shot spacing of 12.5 m. As noted in watch logs, at times the hot spare ("gun 3") airgun was substituted for a malfunctioning primary airgun, or times only one airgun was fired. Source frequency content was approximately 20-300 Hz, with maximum power at 100-160 Hz (Fig. 15).

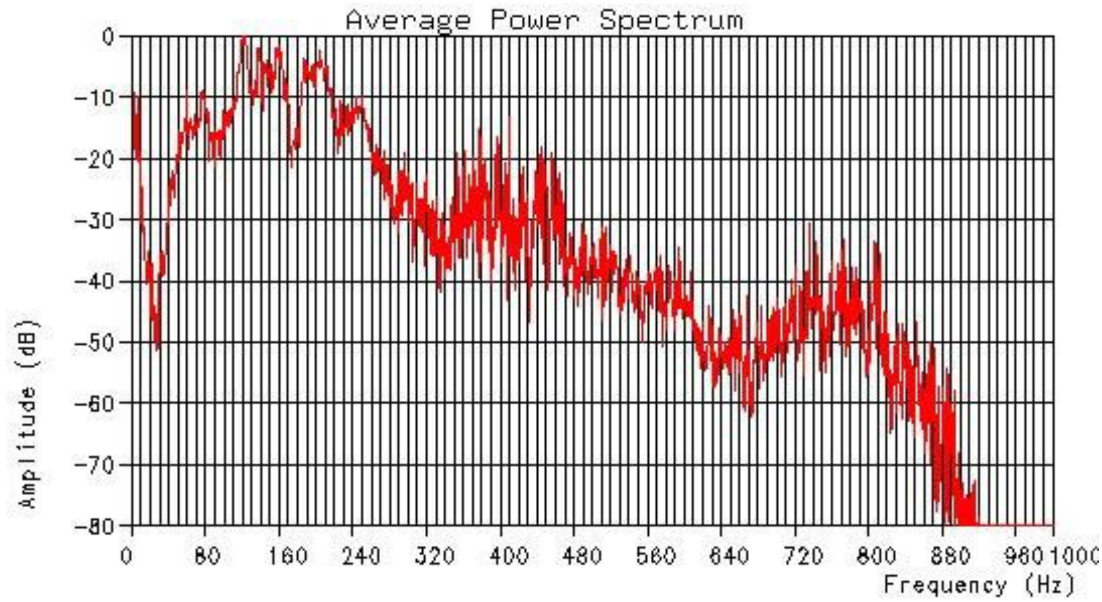


Figure 15. Representative Power Spectrum taken from MCS Line NBP1402-07

4.1.2 Firing Control

Airgun synchronization and timing were controlled by a Real-Time Systems HotShot shotbox and HotShot software running on a shipboard Compaq laptop. Guns were fired every 5s, with injector delay set to 39 ms (3.0 m gun depth) or 40 ms (2.5 m gun depth).

4.1.3 Seismic Receiver

A gel-filled Teledyne 24-channel streamer was towed during MCS operations. Channel spacing was 3.125 m, with 3 hydrophones per channel. Total active length was 75 m, with the center of the near channel located 23 m behind the stern (maximum allowed by streamer lead-in). This towing configuration led to a geometry with the near channel forward of the airguns by 12.5 or 6.25 m, depending on source towing location. Depending on ice conditions, a small drogue or a Polyform buoy was attached to the tail of the streamer.

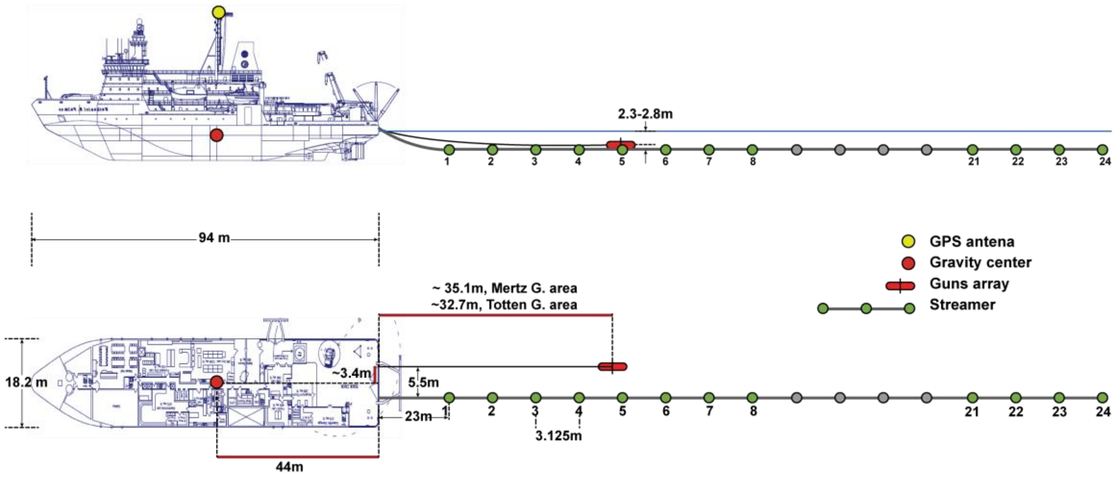


Figure 16. Geometry of the seismic array.

4.1.4 Seismic Recorder

Analog signals from the streamer were digitized by a Geometrics Geode and recorded on a laptop running Geometrics' Seismodule Controller software. Internally, the "A" and "B" jumpers were removed from all 3 Geode recording boards and the software was set to the "All Channels Low" setting – resulting in 24 dB recording gain. No recording filter was used. Data were recorded in SEGY format, with shot time information pulled from a serial GPS string taken from the NBP's Kongsberg Seapath 330. Position errors according to the Seapath 330 were generally < 2 m although no differential correction was available. See Processing Summary for description of additional layback corrections done for the shot position.

4.2 NBP1402 MULTICHANNEL SEISMIC SHIPBOARD PROCESSING

Multichannel processing was performed on laptops running Paradigm's Echos software. Raw seismic data was recorded in segy format and imported into Paradigm's Echos processing software. Data were initially processed in real time using a "brute" processing sequence (Table 4) with a nominal shot spacing of 12.5m. After initial processing, shotpoint navigation processing and more advanced seismic processing were performed. Geographic location of shotpoint and spacing was determined by feeding Geode logfile lat/lon values through a Matlab script. Shot point spacing and true location respect to the center of gravity of the ship are determined by projecting shotpoint locations into UTM coordinates (UTM 50S for Totten G. area and UTM 55S for Mertz G. area). The script was designed to account for: a) the offset of the guns respect to the ships center of gravity which is where the onboard GPS positions are referred to, and b) ship's crabbing. Maximum estimated offset between the position of the GPS coordinates and the actual position of the guns array was ~80m. Once all corrections are made and shotpoint spacing is calculated, corrected UTM coordinates are projected back to geographical coordinates and a navigation file including station locations is generated to be used during the processing and visualization stages. The script also produces a series of plots (Figure S3) to help to analyze the geographic geometry of each line and identify shots that might cause problems or artifacts for the processing and an interpretation stage.

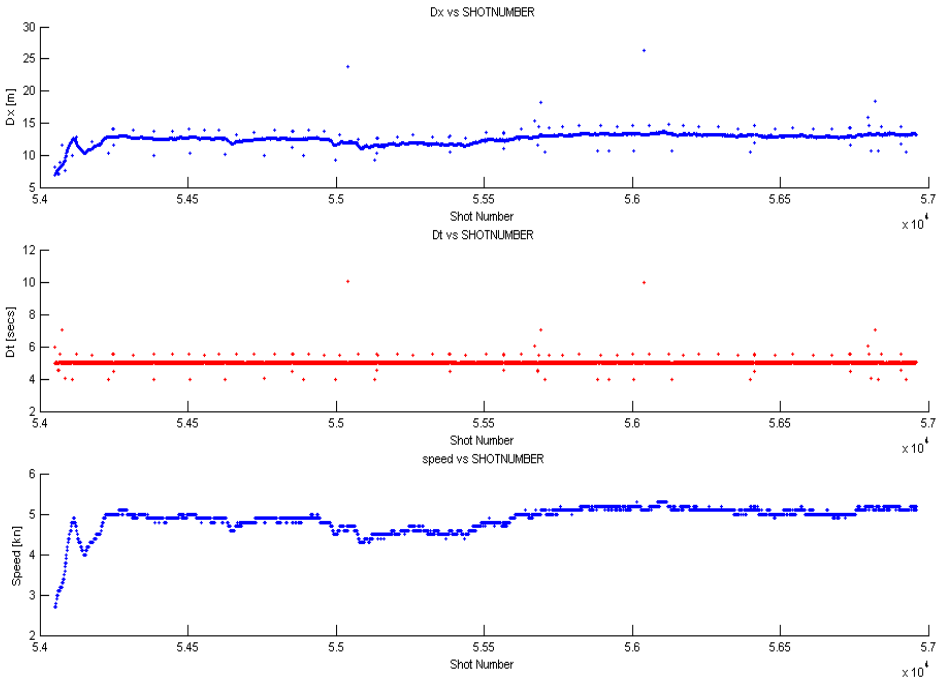


Figure 17. One of the series of plot generated by the Matlab script for Line 26 showing shotpoint spacing, firing rate and ship' speed.

Final shipboard processing incorporated this corrected shotpoint navigation, in addition to more advanced methods including F/K filtering, F/K noise attenuation, velocity analysis, multichannel deconvolution, offset muting, seafloor muting, spherical divergence correction, and F/K migration SEGY data were output for loading into seismic interpretation software.

Table 4. Summary of shipboard processing sequence.

Conversion from SEGY format*
Polarity Reversal* (streamer input polarity is reversed from convention)
Bandpass Filter* (Butterworth 30-450Hz)
Geometry Definition
F/K Filter (removing water velocity arrivals)
Spherical Divergence Correction (Velocity pick based)
Multichannel Predictive Deconvolution (11 traces, 4 ms gap, 40 ms filter length)
Trace Balance
Noise Reduction (TFCLEAN)
CDP Sort* (3.125m cdp interval)
Velocity Analysis
NMO Correction*
Offset Mute
Seafloor Mute
CDP Stack* (6 fold nominal)
F/K Migration* (1480 m/s constant)
SEGY Output*

*Denotes real time "brute" processing

4.3 SEISMIC INTERPRETATION

Following processing, seismic sections were imported into Landmark DecisionSpace software for preliminary horizon and sequence stratigraphic interpretation. A 200ms automatic gain control (AGC) was applied to the raw seismic data for improved interpretation accuracy of deeper stratigraphic horizons. Bathymetric and basement horizons were initially picked in all seismic sections where basement reflectors were apparent above the seafloor multiple. For the majority of the seismic lines shot, the seafloor multiple fell below the target sedimentary stratigraphy as a result of characteristically deep Antarctic continental shelf water depths compared to most global passive margins. This result was fortuitous as the relatively short streamer length and dense receiver spacing makes subsequent multiple attenuation processing problematic due to reduced offset.

While a few initial seismic lines were shot across areas of scoured basement, the vast majority of subsequent seismic data was collected across regions with significant fluvial and glacial sediment sequences. An extensive regional unconformity was prominent across a portion of every seismic section shot in the MUIS-Dalton Ice Tongue region, and as such, was the first horizon to be mapped. This grounding line *A horizon* was determined to be the base of the moraine complex across the region. Subsequent shallower erosional surfaces were mapped within the moraine sequence between horizon *A* and the bathymetric surface. Each unconformity, potentially representing a glacial advance across a prior depositional retreat moraine, was identified, mapped and labeled in sequence deep to shallow *horizons B-E*. Horizons beneath the regional unconformity were initially picked in the gently dipping flat continental shelf stratigraphy to tie together multiple 2D seismic sections across a 3D fence diagram representation of the continental shelf platform to better assess potential facies and environments of deposition. The deepest horizon was labeled *ASB-1* with each subsequent shallower horizon labeled in sequence *ASB-2* through *ASB-11*. These shallower horizons appear to represent depositional sequences progressing from purely fluvial environments, with associated clinoforms and prograding beds, to geologic depositional periods marked by more intermittent, catastrophic temperate glacial and warm-based ice facies. In every case, these deeper stratigraphic *ASB* units terminate against the regional grounding line *A* horizon above.

4.4 SEISMIC OPERATIONS AND OBSERVATIONS

In total we acquired 866 line kilometers of data in 8 surveys as summarized in Table S2. Overall the entire seismic operation from guns to streamer to geode to processing to interpretation worked without a hitch and can be viewed as an example methodology and setup for high-resolution seismic imaging in ice covered waters. Clearly a longer streamer would have improved these images, but there were only rare instances when it would have been advisable to tow a longer streamer off the Mertz or Totten Glacier areas. Below we include a week-by-week summary of seismic operations during NBP1402. Preliminary observations from these seismic data are included at the end of this section of the cruise report including figures showing select examples of key features. Additionally, Appendix 8 includes each acquired seismic profile in order of acquisition with the bathymetry acquired during that profile shown in a strip at the bottom of the figure.

4.4.1 Mertz Area

In the Mertz area, we collected 4 seismic lines in total (~ 70 nm) (Fig. 4). Line NBP1402-01 paralleled a previous seismic line WEGA02 due to the presence of a large iceberg on the originally planned seismic line. However we were able to turn onto WEGA02 executing a crossing line at the start (approximately located at a proposed IODP Site GVAL-1A). We then acquired our Line NBP1402-02 which is a WEGA02 duplicate line shot with our higher resolution system (~3 m vertical resolution, 12.5 m horizontal resolution); the line ended on the basement high south of the Cretaceous. Once we observed we were on basement using the Knudsen CHIRP we turned to starboard and acquired Line NBP1402-03, which was shot SE-NW in order to cross previous seismic lines. At this point we looped back over ourselves, an outside turn to port, to form a crossing line at the IODP proposed Site GVAL-37A. Lastly we acquired Line NBP1402-04 back east which crossed WEGA02 and our Line 2 between the IODP proposed sites GVAL-5A and GVAL-6A.

Operationally, during ice breaking, we initially tried towing the UTIG 100 m long streamer with a Polyform tail buoy. After losing the buoy rapidly to a growler, the marine technicians rigged up a drogue that would tow beneath the surface. The four seismic lines were acquired using this drogue, which seemed to be fine despite small amounts of ice being present. For NBP1402-01 and NB1402-02, the dual 45/45 GI gun source with a hot spare was towed 5 m from the streamer where the center of the source was located at approximately channel 4 of the 24 channel streamer. However, katabatic winds as we neared the southern end of NGP1402-02 required greater spacing between guns and streamer to avoid their crossing over in the rougher sea state. Therefore in the turn between NBP1402-02 and NBP1402-03, we moved the streamer 1.2 m farther to port. Therefore the near offset for all four lines was +9.375 m and the lateral offset was 5 m for the first two lines and 6.3 m for the latter two. Data were recorded at 0.5 ms for 2.5 s throughout.

4.4.2 Moscow University Ice Shelf

Seismic reflection operations were conducted in the Moscow University Ice Shelf region during week 2 of the expedition. We acquired 71 nm of high-resolution, multichannel data in three profiles. Line 5 was oriented approximately NE-SW and crossed greater than 1.5 s of dipping sedimentary strata overlain at a slope break by a morainal bank and then crossed onto topographic rough basement for the remainder of the profile. Line 6 was oriented SE-NW and imaged entirely basement, initiating a change of plans. Line 7 was then acquired back toward the northeast, crossing out of the basement terrane and imaging the dipping reflectors with several erosional surfaces and two prominent morainal banks. Numerous smaller features of glacial origin visible on the bathymetry data and the Knudsen data were also imaged at a lower resolution vertically on the seismic data.

Operationally, no problems occurred with navigation or the streamer during the seismic profiling. Gun 1 successfully shot throughout the survey, while Gun 2 had syncing errors due to blowing its blast phone off near shot 12940 over the exposed basement portion of the line. We switched to Gun 3 (the hot spare) that shot throughout the remainder of Line 5 and all of Line 6 (<5000 shots) before failing on Line 7 as we reached the basement sediment contact. For the remainder of Line 7 we acquired data with only Gun 1.

After some discussion, it was determined that the blast phone issue could be solved by using *Lock Tite* on all screws holding in the blast phones (and solenoids), and with fabrication of a new blast phone fitting. The failure of Gun 3 after just a few shots was likely due to the subfreezing temperatures that it was subjected to without being fired, or having *No-Tox* antifreeze delivered to it for a number of hours prior to being used as the hot spare on Line 5. Strategy for future deployments was altered to hit all guns with *No-Tox* prior to placing them on the bridles, and then to test fire all three guns in succession after ramp up to ensure all are ice free at the start of operations.

During week 3 we acquired an additional, nominal 16-hour seismic survey in the Moscow University Ice Shelf area. This survey was ~65 nm in length and included: Line 8 - a strike line in front of the primary morainal bank imaged on Line 7; Line 9 – an oblique crossing back to south of this primary moraine; Line 10 – a dip line across the morainal bank attempting to reach the next proximal moraine to the northeast; Line 11 - shot in a westerly direction when Line 10 had to be cut short due to ice; Line 12 - shot southeasterly to serve as a strike line on the crest of the northern moraine; and Line 13 - shot southwesterly down slope towards the topographic low where basement is close to the surface. The southern moraine and its immediately adjacent sedimentary products were well imaged including the megascale lineations superimposed on larger morainal banks. We continued to observe the regional erosional surface at the base of the moraine as well as additional surfaces within the moraine and note that with these unconformities approaching the seafloor on the slope flank between the southern and northern moraines. These unconformities allowed seaward-dipping reflective packages within the sub-moraine sedimentary strata to be imaged within a few meters of the bathymetric surface in certain places. These sites were targeted for initial dredging and subsequent coring activities to establish the age of these older units.

Operationally, the use of *Lock Tite* on the screws and *No-Tox* in the air chambers during setup was very successful. No subsequent issues occurred during the latter two weeks of surveying survey due to blast phone detachment or gun failure due to freezing. In addition to putting *No-Tox* in the airguns before hanging them on the bundles, we also sequentially fired test shots for each of the three guns once in the water before initiating the survey with only guns 1 and 2. During seismic line turns, the hot spare (gun 3) would be temporarily fired instead of gun 2 to keep the hot spare ice free and in good working order should it be needed. The hard plastic, round tail buoy float also proved successful as it slipped around or under bergy bits and growlers without hanging up and putting undue stress on the streamer.

During the last 2 weeks of science, we acquired an additional 266 nm of seismic reflection data. All of these lines used the new operational protocols to minimize the time the guns were on deck in cold temperatures, to use *No-Tox* and *Lock Tite* in advance of deployment, and to fire the hot spare (gun 3) a few times during the turns. Additionally, the adjustments on the mount for the blast phone on gun 2 proved stable. These changes proved so successful that we had no subsequent failures on guns 1 or 2 for the remainder of these profiles. All profiles were acquired with a 5s shot rate, a sampling interval of 0.5ms, and a record length of 2.5s.

Lines 14 through 18 were acquired with the intent to image the more eastern area closer to the Dalton Ice Tongue. Lines 14 and 15 crossed the older sedimentary section into the deeper embayment that leading to the western glacial trough and onto outcropping basement. Line 16 was shot from shallower water to the southwest towards the deeper area. A brief geode communication failure resulted in a loss of a few shots and duplicate shot point numbering requiring ~2/3 of the profile to be named 16a. Line 17 was a longer line across older sedimentary strata in the region of shallow erosional and potential dune-like features before turning west across a moraine lying closer to the Dalton Ice Tongue. A surprising result along Line 17 was a clearly imaged delta complex within the dipping older strata. The final line shot that day was Line 18 initially acquired E-W and then turned NW-SE; thus during processing Line 18 was segregated into 18a and 18b. All of these lines shot in the eastern area showed a significantly more eroded seafloor with little till and virtually absent Holocene strata.

Lines 19-25 were acquired with the intent to initially cross our existing seismic profiles within the older strata and then turn north crossing a large moraine and an area of intriguing topography originally thought to be crenulated; the seismic lines would then continue to the north into an area recently ice-free and significantly further north along the continental shelf. Line 19 was shot in an E-W direction followed by Line 20, shot NW-SE to connect to Line 21 (the long northern line). The unusual topography along Line 21 turned out to include evidence of slump scars consisting of till where slump blocks, also consisting of till, were observed in the bathymetry to the west of the line. Line 21 continued to show evidence of deeper dipping strata getting progressively younger as we proceeded northwards. Within the upper younger strata there were 2-3 erosional surfaces that were clearly both glacial in orogen and dipping northwards following the underlying older strata; these glacial surfaces were distinctly different in scale, facies, and dip from the overlying regional unconformity, moraines and till that make up the seafloor related features. Along the northern part of the continental shelf, thicker ice coverage resulted in Lines 22-25 being shot eastward then looping back to the southwest and then crossing back to the west. Both Lines 22 and 25 cross an ~2 km wide glacial trough that trended northwards towards the continental shelf edge.

During Julian Day 57, four hours of daylight were available for seismic operations during which Line 26 was acquired to cross previous lines in a westerly direction to the north of prior crossing lines. Line 26 was acquired to cross over one of the subsurface deltaic features and terminate by crossing a potential buried glacial moraine observed on Line 21. The next morning seismic operations resumed with the acquisition of Line 27 to the northeast crossing Line 21 a little farther south within the region of slump blocks and then turning northwest along Line 28 that crossed Line 21 within a region with thinner till deposits. While acquiring Line 28, a new satellite ice image was transmitted to the ship that showed the region to the west of all our previous profiles to be ice-free. Thus Line 29 was acquired shooting southward maintaining about 1 nm from the ice edge. Line 29 reached the entrance to the deeper western glacial trough and showed three clear back-stepping moraines, the southernmost of which was the edge of a “feather moraine”. When ice proved too thick to proceed further south, Line 30 was acquired shooting back east across the thickest till layer adjacent to the deeper basement within which numerous glacial surfaces were observed.

The final seismic survey was undertaken during our transit out of the polynya and included Lines 31-35. At the start of Line 31 we had two marine mammal shutdowns, both lasting less than 7 minutes. The first shutdown resulted from a seal on an ice floe, and the second due a seal in the water, but neither seal was in the water within the 100 m radius when the guns were operating. Line 31 crossed 18a and Line 21 heading northwest to provide an additional tie line, and then ice forced a turn to the north to create Line 32. We then turned east on Line 33 when a ship-wide power outage occurred. The repairs and safety checks on the power outage resulted in missing the critical data to cross Line 21 at the northernmost moraine on that line. Therefore we chose to circle back west during marine mammal observations and re-sail to the east generating Line 33a. Once we crossed Line 21 and were unable to proceed farther east due to ice from the Dalton Ice Tongue, we turned northwards on Line 34. This line showed parallel reflectors within the moraine and the underlying dipping reflectors progressing toward younger strata toward the shelf edge. For our last line (Line 35), we chose to sail to the northwest and to continue to image the edge of the moraine associated with the Dalton system.

4.5 PRELIMINARY SUMMARY OF SEISMIC OBSERVATIONS

NBP1402 included the acquisition of the first-ever high-resolution seismic images of the shelf between the Dalton Ice Tongue and the Totten Glacier system (Fig. 18). In between these data crossed a portion of the continental shelf influenced the advance and retreat of ice from the Moscow University Ice Shelf system and more specifically out of the Reynolds Trough. All of these systems originate from the Aurora subglacial Basin which drains ~1/8 of all East Antarctica and thus it is critical to determine the history of glacial development on this margin and the dynamics of glacial advances and retreats up through to the modern systems. Describing the seismic imaging results from the basement upwards, we observe: 1) two distinct types of acoustic basement within some evidence of extensional deformation, 2) a deeper sequence of less reflective seismic horizons that dip northwards with very little sediments that could be considered syn-rift, 3) a meso-depth sequence of reflective seismic horizons whose geometry is interpreted as deltaic deposits and which all dip northwards, 4) a shallower section of complex relationships that includes significant erosional features interspersed with conformable sequences that also all dip northwards, and 5) a shallow regional unconformity above which there a number of chaotic sequences with isolated mappable horizons within that represent a series of glacial advance and retreat cycles that are shelf wide and include the LGM and most recent deglacial times.

The record of the glacial sequences is incomplete in that the inner shelf has the basement exposed from the coast/ice shelf edge northwards to an >1 km deep mid-shelf embayment that leads to a wide trough trending northwest. The only sediments within this embayment and trough appear to be the glacial till sequences that are stratigraphically younger than the regional unconformity and lie disconformably over basement lithologies. All sequences between the basement and the regional unconformity largely are preserved at their seaward shelf extents such that the proximal portions that likely would have been deposited sub-horizontally are either absent or experienced tilting post-deposition. Still, the dipping sequences from the mid-shelf deep embayment and trough appear to include a nearly complete record of strata with successively younger sequences being accessible in a northerly direction. The exact cause of all of these strata to be dipping northwards is likely some combination of glacial loading/unloading, changes in sediment supply, and tectonic subsidence.

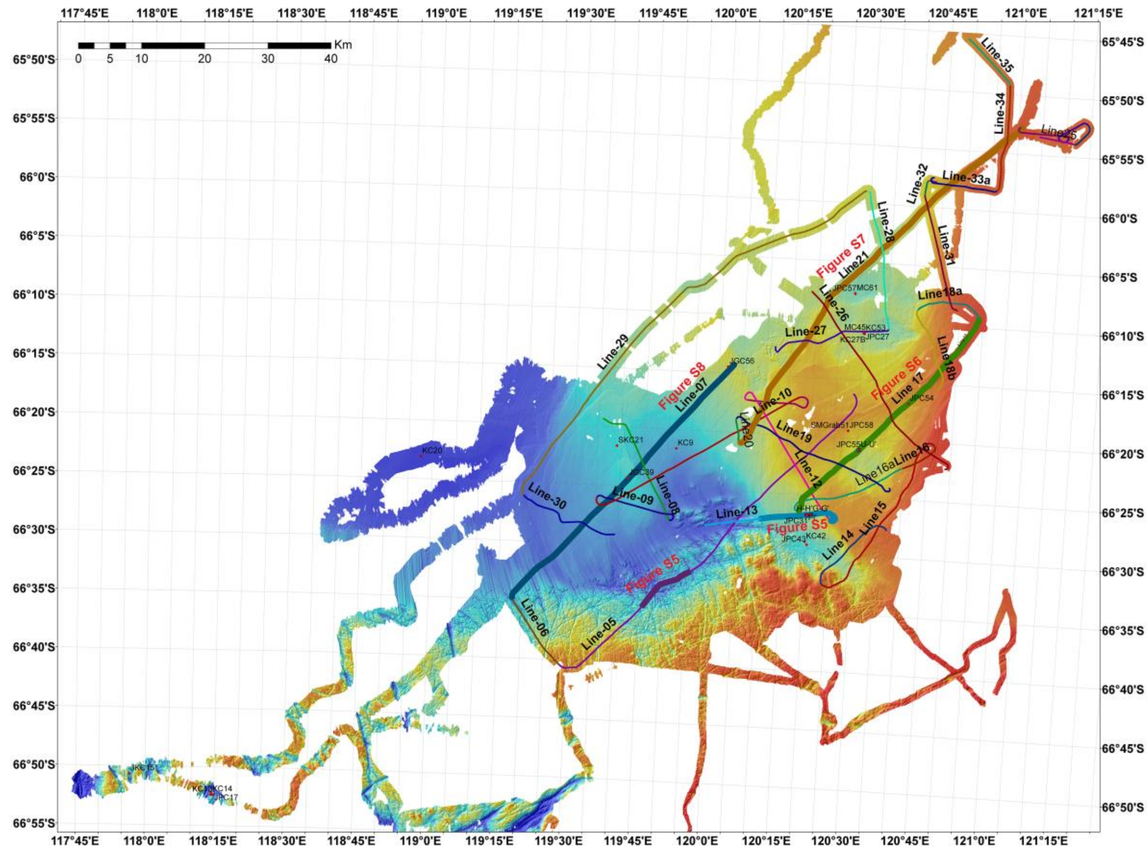


Fig. 18. High-resolution seismic images of the shelf between the Dalton Ice Tongue and the Totten Glacier system.

For this report we include some examples of each of these key features observed within the high-resolution seismic reflection data. Figure 19 shows two contrasting basement reflection types. The smoother reflection style basement, that may represent minimal expressed deformation and/or a capping sequence of earliest sediments, is present towards the southeastern part of the shelf. A distinctly rough basement character is present south and west where imaged and is suggestive of a faulted surface consistent with what may be large-scale fracture patterns visible in the bathymetry at two cross-cutting orientations. A preliminary interpretation is that these are conjugate extensional structures likely related to Antarctic-Australian rifting that occurred from 160-80 Ma. Further interpretation will be required to seek to identify the “break-up unconformity” that should mark the end of syn-rift deposits.

Figure 20 shows the contrast in deep, less-reflective sequences and meso-depth, more reflective sequences. The zoom-in panel shows a very well imaged prograding sequence suggestive of a fluvial delta that is preserved within these reflective sequences. There appears to be no evidence for ice contact seismic facies or erosional surfaces within these units and thus, preliminarily, both the less reflective sequences and the more reflective sequences, coeval with delta formation, are all pre-glacial.

Figure 21 shows clearly imaged erosional surfaces, based on significant reflector truncations and an irregular seismic reflection, and variable facies of channel fill that are indicative of sub-ice glacial erosion and retreat surfaces. However these are in large but isolated valleys that may be subglacial tunnel valleys marking the path of specific ice streams. This time of glaciation does not appear to persist through the entire upper sequences however as between the glacial erosional and retreat facies there are intervals of conformable parallel sequences suggestive of non-glacial environments. This interval of intermittent glaciation will be important to date to consider the evolution from fluvial (Fig.

20) to intermittently glaciated (Fig. 21) did not apparently yet bring on full shelf-wide erosion. The full regional glaciation and significant ice loading from the Antarctic ice sheet appears to be marked by the regional unconformity observed to truncate all the deeper sequences and be sub-parallel to the modern seafloor unlike all lower sequences.

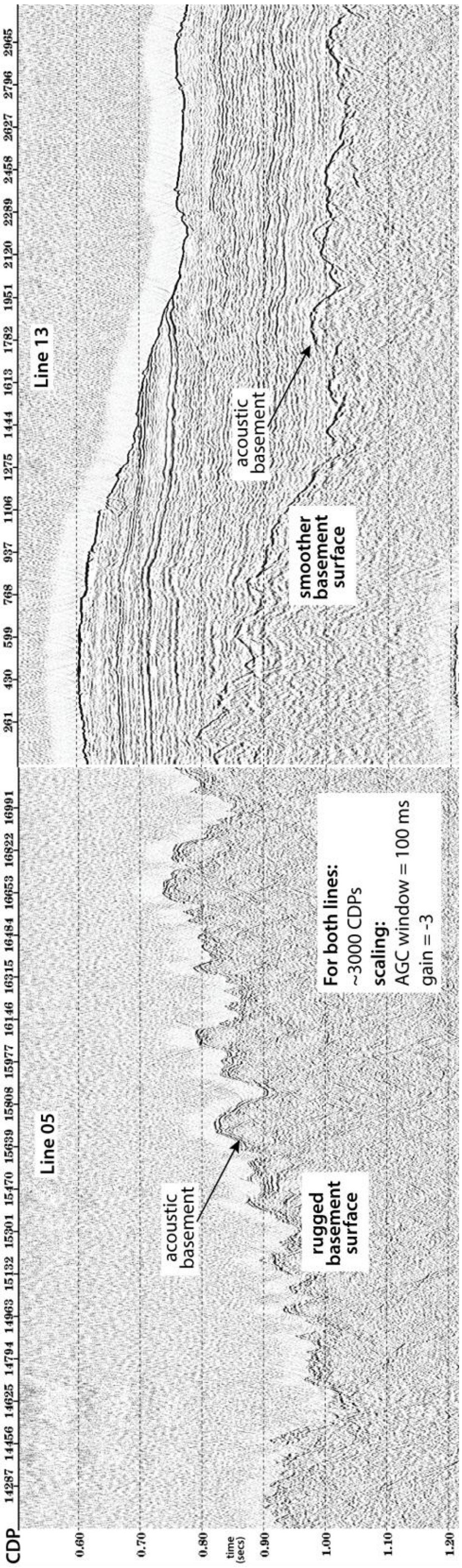


Figure 19. Lines 5 and 13, acoustic basement.

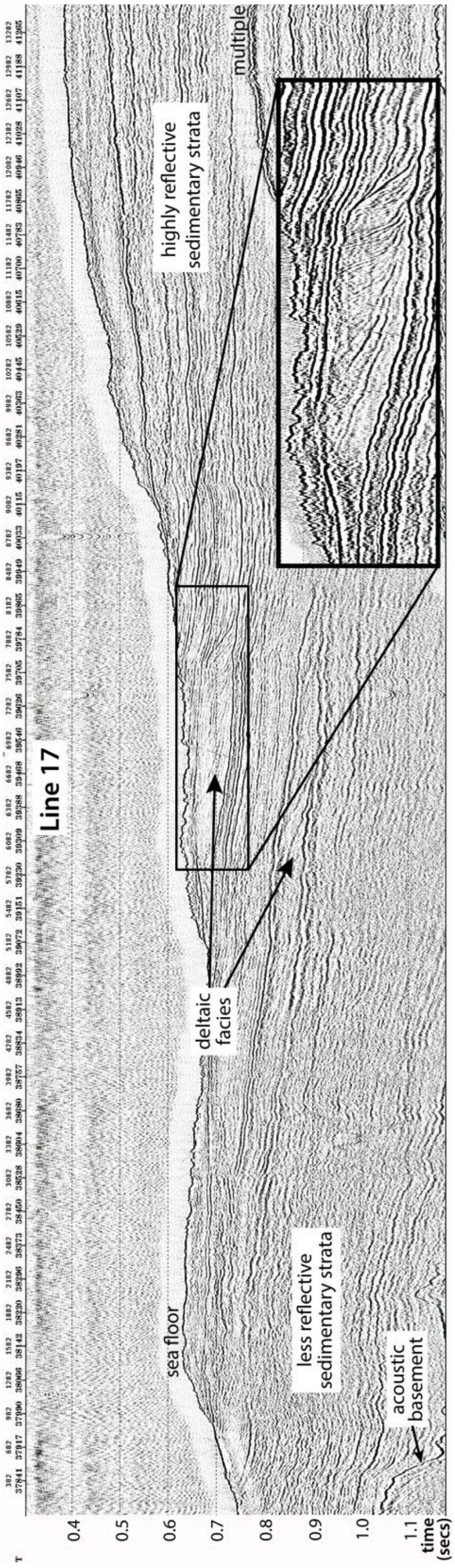


Figure 20. Line 17.

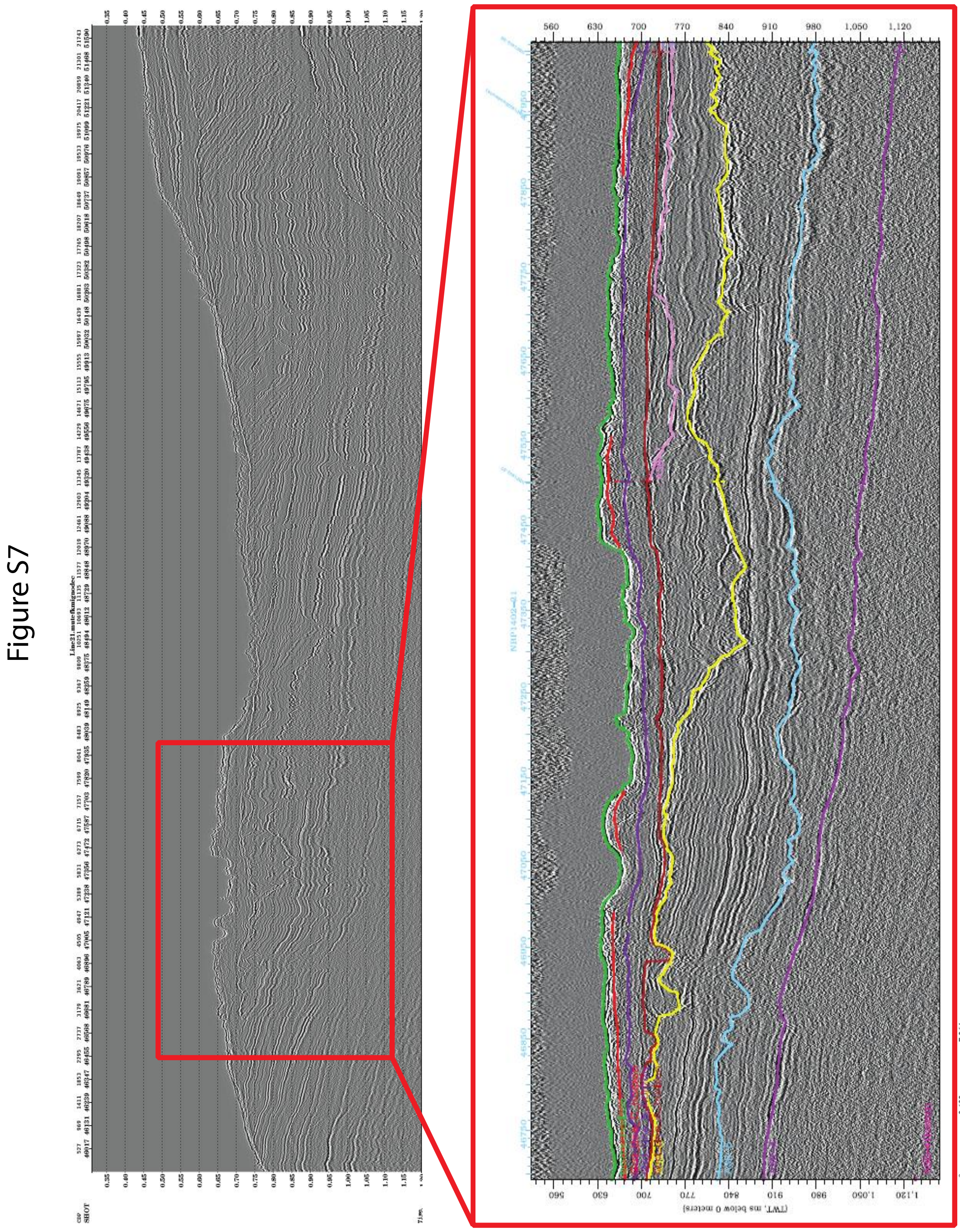


Figure 21. Imaged erosional surfaces and variable facies of channel fill indicative of sub-ice glacial erosion and retreat surfaces.

Figure 22 shows some examples of this regional glacial unconformity and overlying glacial moraines or morainal banks and/or glacial advance and retreat surfaces and facies. There are at least eight distinct syn-glacial surfaces preserved on this shelf and suggestions of distinct patterns of erosion and deposition coming from the Moscow University Ice Shelf, the Reynolds Trough and the Dalton Ice Tongue. Unraveling these sequences and assessing rates, styles, and patterns of glacial retreat will be a clear goal of post-cruise research. Additionally the most recent glacial retreat is also well preserved on the seafloor and thus integrating these seismic images with the higher resolution CHIRP profiles and the high-resolution multibeam bathymetry data will be the focus of several papers to understand glacial geomorphology and dynamics.

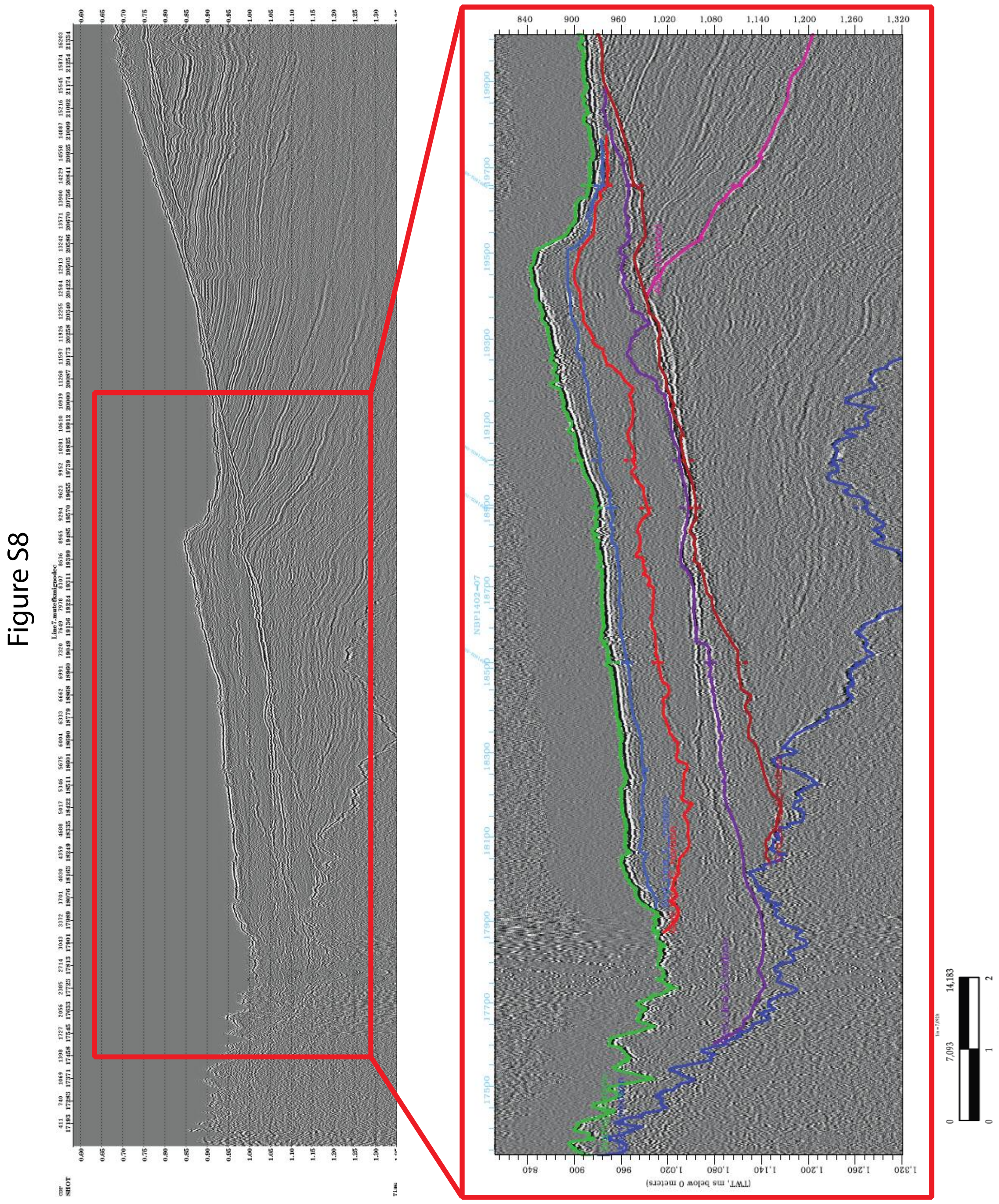


Figure 22. Regional glacial unconformity and overlying glacial moraines or morainal banks and/or glacial advance and retreat surfaces and facies.

Table 5. Seismic Lines

Line	Location	Time Start	Time Stop	Shot Start	Shot Stop	CDP Start	CDP Stop	Shot Int (s)	Sampling (s)	Rec Length (s)	Line Length (km)
1	Mertz	35:11:16:04	35:12:35:22	715	1628	4201	7799	5	0.5	2.5	11.2
2	Mertz	35:12:36:17	35:18:01:10	1630	5514	85	13769	5	0.5	2.5	42.7
3	Mertz	35:18:02:53	35:20:55:57	5516	7589	86	7988	5	0.5	2.5	24.7
4	Mertz	35:20:57:47	36:00:53:47	7592	10417	85	10960	5	0.5	2.5	33.9
5	Totten	41:19:45:08	42:03:31:35	10432	16012	82	21258	5	0.5	2.5	66.1
6	Totten	42:03:32:19	42:05:02:23	16013	17091	86	4213	5	0.5	2.5	12.9
7	Totten	42:05:03:08	42:11:01:49	17092	21389	82	16434	5	0.5	2.5	51.1
8	Totten	46:20:28:15	46:22:30:29	21440	22902	86	4213	5	0.5	2.5	16.6
9	Totten	46:22:31:17	47:00:14:35	22903	24133	82	4444	5	0.5	2.5	13.7
10	Totten	47:00:14:55	47:04:43:42	24135	27362	85	12090	5	0.5	2.5	37.5
11	Totten	47:04:45:40	47:06:07:09	27363	28339	82	3821	5	0.5	2.5	11.7
12	Totten	47:06:08:10	47:09:03:29	28341	30371	86	8366	5	0.5	2.5	25.9
13	Totten	47:09:04:12	47:11:43:10	30372	32275	85	7133	5	0.5	2.5	22.0
14	Totten	53:20:11:29	53:22:03:15	32317	33512	82	4968	5	0.5	2.5	15.2
15	Totten	53:22:04:12	54:01:27:45	33514	35953	82	9858	5	0.5	2.5	30.5
16	Totten	54:01:28:45	54:02:10:57	35955	36450	86	2238	5	0.5	2.5	6.7
16a	Totten	54:02:12:07	54:04:20:03	36237	37770	82	6303	5	0.5	2.5	19.4
17	Totten	54:04:20:34	54:09:18:29	37771	41338	82	13573	5	0.5	2.5	42.1
18a	Totten	54:09:19:33	54:10:30:00	41339	42183	82	3631	5	0.5	2.5	11.1
18b	Totten	54:10:30:05	54:11:48:20	42184	43249	3624	7539	5	0.5	2.5	13.8
19	Totten	56:21:54:13	57:01:10:53	43258	45613	117	9044	5	0.5	2.5	27.9
20	Totten	57:01:12:29	57:01:36:38	45615	45905	86	1269	5	0.5	2.5	3.7
21	Totten	57:01:37:43	57:09:39:21	45906	51676	85	20965	5	0.5	2.5	68.4
22	Totten	57:09:40:13	57:10:43:17	51677	52432	82	3113	5	0.5	2.5	8.8
23	Totten	57:10:45:19	57:11:42:07	52433	53115	85	2588	5	0.5	2.5	7.8
24	Totten	57:11:42:12	57:12:18:33	53115	53547	85	1377	5	0.5	2.5	4.0
25	Totten	57:12:19:06	57:12:59:47	53548	54036	85	1861	5	0.5	2.5	5.5
26	Totten	64:02:05:50	64:12:09:38	54050	56960	85	11792	5	0.5	2.5	36.6
27	Totten	64:20:37:16	64:23:04:38	56961	58640	82	6398	5	0.5	2.5	19.7
28	Totten	64:23:05:26	65:01:36:35	58641	60451	82	7153	5	0.5	2.5	22.1
29	Totten	65:01:38:24	65:10:03:59	60452	66502	82	24177	5	0.5	2.5	75.3
30	Totten	65:10:04:42	65:12:00:34	66503	67892	86	5389	5	0.5	2.5	16.5
31	Totten	66:03:49:59	66:06:09:33	67898	69517	85	6283	5	0.5	2.5	19.3
32	Totten	66:06:09:57	66:06:27:05	69518	69722	86	872	5	0.5	2.5	2.4
33	Totten	66:06:27:34	66:06:35:00	69733	69813	86	436	5	0.5	2.5	1.1
33A	Totten	66:07:16:26	66:09:04:51	69818	70798	86	3755	5	0.5	2.5	11.4
34	Totten	66:09:05:32	66:11:01:37	70799	72190	86	5521	5	0.5	2.5	17.0
35	Totten	66:11:02:32	66:12:07:56	72191	72975	86	3209	5	0.5	2.5	9.7
											866.1

5. PHYSICAL OCEANOGRAPHY

Number of Stations: 134 Underway CTD, 15 Rosette CTDO2/LADCP
Moorings Deployed or Recovered: 7 deployed, 1 recovered

5.1 SCIENTIFIC PROGRAM

Prior to this cruise only scant information of the oceanic circulation and stratification over the continental shelf region off Sabrina Coast, East Antarctica was available from a handful of recent oceanographic stations or autonomous profiling drifters. They revealed a bottom layer of Modified Circumpolar Deep Water over the upper slope near the mouth of a cross-shelf trough, in turn believed to connect to the Totten Glacier and Moscow University Ice Shelf sub-cavities found farther to the south. The possibility, thus, existed of relatively warm bottom water inflow reaching the local sub-glacial grounding line of the East Antarctic Ice Sheet.

To elucidate current ocean-ice interactions in this region, a cruise was conducted aboard the USAP *RV/IB Nathaniel B. Palmer* from 29 January to 16 March 2014, back to back from Hobart, Australia. The main goal of the physical oceanographic component of this interdisciplinary survey is to directly measure, for the first time, present day processes and interactions affecting the stability of the Totten Glacier/Moscow University Ice Shelf system, and to assess their role in the observed decadal changes of thermohaline characteristics in the deep adjacent Antarctic basins (Fig. 23, Table 6).

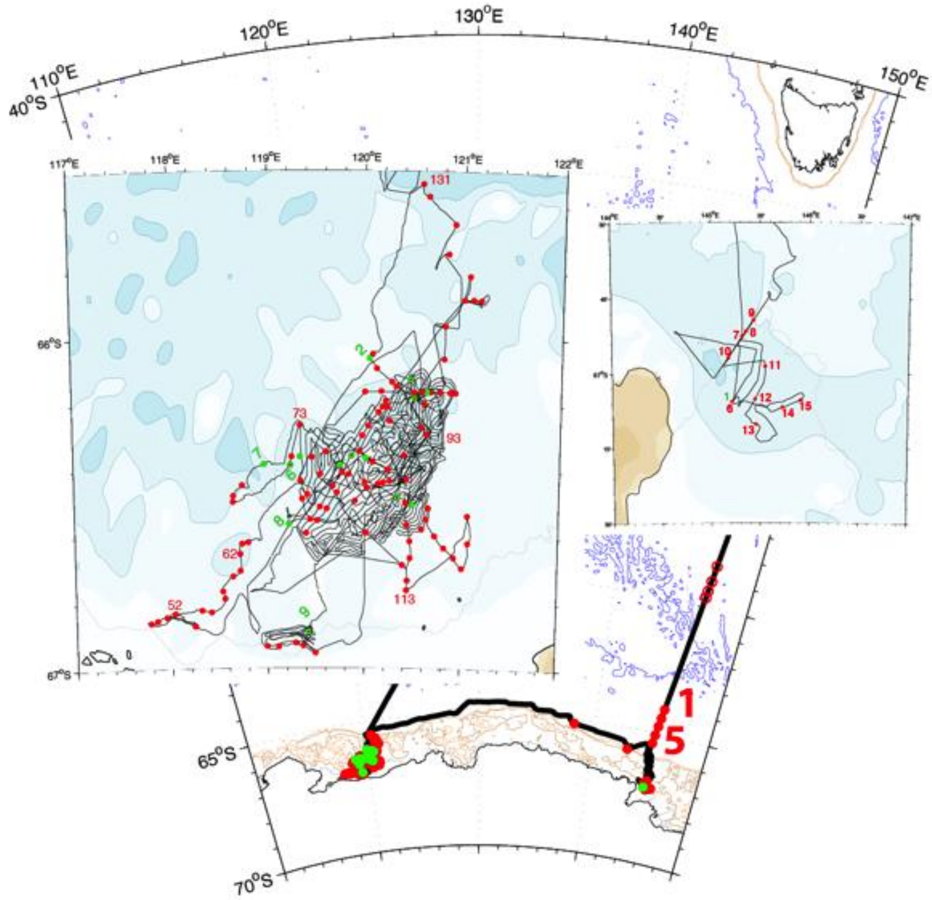


Figure 23. Location of NBP1402 Underway (red) and Rosette CTD (green) stations.

Table 6. Underway CTD station details.

Station	Longitude	Latitude	Year	Month	Day	Water Depth (m)
1	145.62	-64.09	2014	2	3	3703
2	145.51	-64.44	2014	2	3	3607
3	145.42	-64.75	2014	2	3	3461
4	145.31	-65.09	2014	2	3	3134
5	145.21	-65.41	2014	2	3	2775
6	145.21	-67.10	2014	2	5	1341
7	145.32	-66.88	2014	2	5	711
8	145.36	-66.86	2014	2	5	658
9	145.43	-66.82	2014	2	5	594
10	145.18	-66.95	2014	2	5	1015
11	145.55	-66.98	2014	2	5	700
12	145.45	-67.09	2014	2	5	1076
13	145.46	-67.17	2014	2	5	1143
14	145.72	-67.12	2014	2	5	691

15	145.91	-67.09	2014	2	5	582
16	145.76	-67.09	2014	2	5	647
17	145.59	-67.11	2014	2	5	797
18	145.33	-67.10	2014	2	6	1160
19	143.16	-65.80	2014	2	7	683
20	138.26	-65.17	2014	2	8	2452
21	120.08	-66.05	2014	2	10	482
22	120.12	-66.10	2014	2	10	509
23	120.27	-66.14	2014	2	10	506
24	120.25	-66.25	2014	2	10	458
25	120.21	-66.19	2014	2	11	514
26	120.18	-66.21	2014	2	11	498
27	120.14	-66.23	2014	2	11	504
28	120.08	-66.25	2014	2	11	495
29	120.03	-66.27	2014	2	11	518
30	119.97	-66.30	2014	2	11	574
31	119.86	-66.36	2014	2	11	675
32	119.76	-66.41	2014	2	11	661
33	119.67	-66.45	2014	2	11	673
34	119.54	-66.52	2014	2	11	706
35	119.44	-66.55	2014	2	11	718
36	119.39	-66.59	2014	2	11	576
37	119.51	-66.56	2014	2	11	737
38	119.61	-66.52	2014	2	11	710
39	119.71	-66.47	2014	2	11	681
40	119.83	-66.42	2014	2	11	716
41	120.00	-66.44	2014	2	11	769
42	120.32	-66.15	2014	2	12	518
43	120.23	-66.21	2014	2	12	491
44	119.95	-66.35	2014	2	12	631
45	120.01	-66.59	2014	2	12	490
46	120.39	-66.69	2014	2	12	479
47	120.01	-66.37	2014	2	12	628
48	120.08	-66.38	2014	2	12	592
49	120.23	-66.40	2014	2	12	501
50	118.24	-66.87	2014	2	13	651
51	118.24	-66.87	2014	2	13	644
52	117.94	-66.85	2014	2	13	665
53	117.78	-66.86	2014	2	14	1590
54	117.84	-66.86	2014	2	15	625
55	118.03	-66.83	2014	2	15	591
56	118.31	-66.83	2014	2	15	430
57	118.41	-66.83	2014	2	15	638
58	118.55	-66.79	2014	2	15	423
59	118.53	-66.77	2014	2	15	444
60	118.64	-66.72	2014	2	15	399
61	118.71	-66.71	2014	2	15	700

62	118.71	-66.66	2014	2	15	498
63	118.73	-66.63	2014	2	15	560
64	118.79	-66.62	2014	2	15	657
65	119.90	-66.50	2014	2	16	690
66	119.69	-66.56	2014	2	16	759
67	119.35	-66.49	2014	2	16	733
68	119.41	-66.48	2014	2	16	729
69	119.45	-66.37	2014	2	16	678
70	119.60	-66.35	2014	2	16	636
71	119.54	-66.42	2014	2	16	674
72	119.34	-66.44	2014	2	16	752
73	119.33	-66.27	2014	2	17	839
74	119.25	-66.36	2014	2	17	890
75	119.23	-66.39	2014	2	17	876
76	118.64	-66.50	2014	2	17	691
77	118.64	-66.48	2014	2	17	752
78	118.73	-66.45	2014	2	17	865
79	120.42	-66.43	2014	2	19	434
80	120.25	-66.44	2014	2	19	540
81	120.19	-66.44	2014	2	19	593
82	120.13	-66.45	2014	2	19	672
83	120.02	-66.46	2014	2	19	759
84	118.99	-66.94	2014	2	20	583
85	119.11	-66.94	2014	2	20	643
86	119.29	-66.93	2014	2	20	1263
87	119.37	-66.93	2014	2	20	459
88	119.49	-66.96	2014	2	20	305
89	119.42	-66.89	2014	2	20	1103
90	120.50	-66.18	2014	2	21	548
91	120.58	-66.27	2014	2	21	463
92	120.40	-66.36	2014	2	22	462
93	120.63	-66.29	2014	2	22	459
94	120.61	-66.20	2014	2	22	518
95	120.33	-66.49	2014	2	25	608
96	120.33	-66.49	2014	2	25	607
97	120.33	-66.49	2014	2	25	606
98	121.06	-65.82	2014	2	26	325
99	121.00	-65.89	2014	2	26	318
100	121.09	-65.89	2014	2	26	353
101	121.17	-65.89	2014	2	26	346
102	120.81	-65.97	2014	2	26	395
103	120.80	-66.07	2014	2	26	367
104	120.59	-66.58	2014	3	3	380
105	120.63	-66.55	2014	3	3	396
106	120.65	-66.52	2014	3	3	375
107	120.72	-66.60	2014	3	3	284
108	120.82	-66.64	2014	3	3	216

109	120.92	-66.67	2014	3	3	296
110	121.00	-66.70	2014	3	3	276
111	121.07	-66.62	2014	3	3	277
112	121.06	-66.54	2014	3	3	309
113	120.44	-66.77	2014	3	3	214
114	120.44	-66.74	2014	3	3	620
115	120.47	-66.67	2014	3	3	347
116	120.46	-66.62	2014	3	3	357
117	120.43	-66.57	2014	3	3	483
118	120.42	-66.50	2014	3	3	599
119	120.46	-66.13	2014	3	5	580
120	120.00	-66.17	2014	3	6	526
121	120.16	-66.17	2014	3	6	521
122	120.50	-66.17	2014	3	7	520
123	120.58	-66.17	2014	3	7	556
124	120.67	-66.17	2014	3	7	499
125	120.77	-66.17	2014	3	7	399
126	120.87	-66.17	2014	3	7	466
127	120.92	-66.17	2014	3	7	269
128	120.84	-65.75	2014	3	7	406
129	120.90	-65.66	2014	3	7	550
130	120.63	-65.58	2014	3	7	762
131	120.57	-65.54	2014	3	7	1569

5.2 BASIC HYDROGRAPHY

On the transit to the Mertz Polynya, (~146°E, 58°-60°S) four test Underway CTD (uCTD) casts were occupied on 2 February. Upon reaching the continental slope the next day, the first 5 UCTDs were made at ship speeds ranging from 8 to 11 knots. A series of 14 uCTD casts were occupied within the Mertz Depression within the next two days (more details are given in Table 6). Two additional uCTD cast (19-20) were done along the slope farther to the west, before entering the main study area off Sabrina Coast on 10 February, with the first cast (21) taken near 66°S after breaking ice in the outer shelf.

During the following two weeks inside the polynya as many as 43 uCTD casts, as opportunities allowed, were fit along a cruise track designed for the high-resolution mapping of the ocean floor. Four stationary uCTD casts (52-55) were occupied in front of the Totten Glacier, at the westernmost reach of the cruise. A short synoptic uCTD section (84-88) in front of the Moscow University Ice Shelf resolved the exchange of waters between the inner shelf regime and the sub-ice cavity, and in turn determined the optimal site for deployment of one of the US long-term moorings (M3).

The multiple advantages from operating an Underway CTD system on the N.B. Palmer for the first time were clearly demonstrated by the end of the science work in this area. Rapid occupation of four short synoptic transects across the Antarctic Coastal Current (15 [8] consecutive stationary uCTD casts were done in only 11 [4] hours on March 3 [7]) provided adequate spatial and temporal resolution to describe the evolution of this current's shear structure and the water mass stratification with unprecedented detail. The influence of this strong southward-flowing boundary current to the Dalton Ice Tongue was traced from near the shelf break, and to the Moscow Ice Shelf along its westward continuation farther downstream. See figures 23 and 24 for locations of shipboard CTD locations, uCTDS, and moorings.

5.2.1 In-situ Underway Conductivity/Temperature/Depth (uCTD)

System Setup

The 131 profiles of temperature and conductivity measured during the NBP1402 cruise used an Oceanscience UCTD 10-400 Underway Profiling System part of the permanent equipment pool property of Texas A&M University. It is a ship-based system for the measurement of conductivity and temperature profiles while underway, capable of profiling to over 400 m at a ship speed of 10 kt. The system's main components (Fig. 25) are: a probe assembly, winch, rewinder, davit, and power supply.

The probe assembly consists of a CTD instrument and a tail spool. The probe samples conductivity, temperature, and depth at a sampling rate of 16 Hz while descending vertically through the water column. Three new probes (serial numbers 127, 128, and 156) were used in this cruise. The data are stored internally and downloaded wirelessly via Bluetooth to a host computer after deployment. The sensor is connected to a tail spool via a simple turn-and-lock mechanism that in turn is attached to the line on the winch (Fig. 25a).

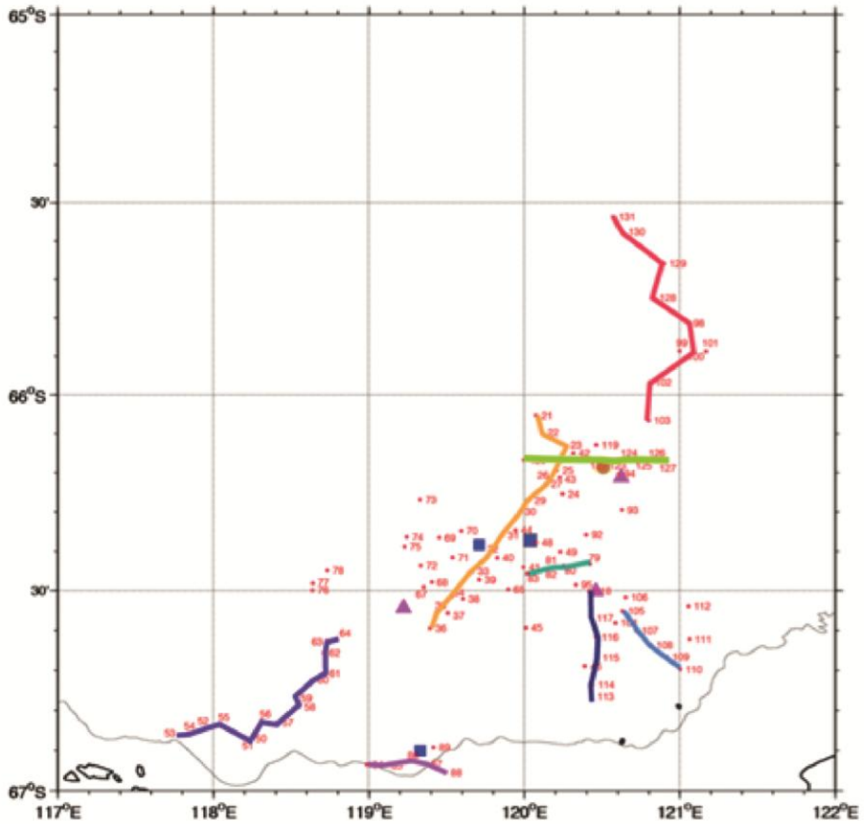


Figure 24. Distribution of uCTD casts along a series of synoptic sections occupied inside the Totten Polynya; also shown are the short (US: M1) and long-term (US: M2, M3 and ST, and AUS: T1-T3) mooring locations.

The winch (Fig. 25b) has a capacity of over 1300 m of high strength (300 lbs) Spectra line. It has a powerful two-speed DC motor for fast and safe recovery of the probe assembly. Two new winch units were used during this cruise.

The automatic levelwind ensures proper winding of the line onto the spool during the reel-in phase. The rewinder is used to load the tail spool of the probe assembly with an amount of line equal to the desired profile depth. The rewinding of the tail spool is computer controlled and semi-automated for quick turnaround (Fig. 25c). The davit has a telescopic arm with a custom guide block for the Spectra line and a holder for the probe. It is also provides a convenient mounting platform for both the winch and rewinder. Since the arm and winch are fixed on a turntable, the rewinder can be facing forward or aft depending on whether the davit is attached to a rail (Fig. 25d) or a post.

The UCTD system comes equipped with a universal power supply that accepts 110/220 Volts 45-60 Hz at 1500 W. It supplies the winch and rewinder with the required 24 V DC voltage. The receptacles have different form factors (Fig. 25e) to prevent connection errors by the operator.

Modes of UCTD Operation (Table 7 and Fig. 26)
Stationary Free Cast Profiling

These casts required the vessel to be stationary, in the safest and easiest way to perform CTD casts in heavy ice conditions, by attaching the tail spool to the probe with the desired length of line winded on the tail spool first. The winch is then simply put into free-spool until the target depth is reached, which is in much less time that it takes to complete a CTD station with a rosette.

Underway Free Cast Profiling

This is the primary mode of operation for the Oceanscience UCTD, with the probe's descent fully decoupled from the ship motion. In this mode the tail spool is also pre-loaded with an amount of line corresponding to the desired profile depth. On probe deployment, line is paid out from both the tail spool and the winch. Since it is necessary to re-load the tail spool with line after every cast and more line has to be reeled in after every dive, a profile to 800 m at 5 kt requires about 200 seconds.

Acquisition

uCTD data were acquired using Oceanscience 's uCast software on a dedicated TAMU notebook computer running Windows 7 Professional. Immediately after each cast all uCTD raw data outputs were copied over to thumb drives and backed up on two separate desktop computers provided by TAMU.

Processing and Sensor Calibrations

Raw uCTD data was processed using Sea-Bird's Data Processing software on a dedicated notebook computer running Mac OSX, and generally made available to the science staff within an hour of each cast completion.

Figure 25. Photographs of Underway CTD system.

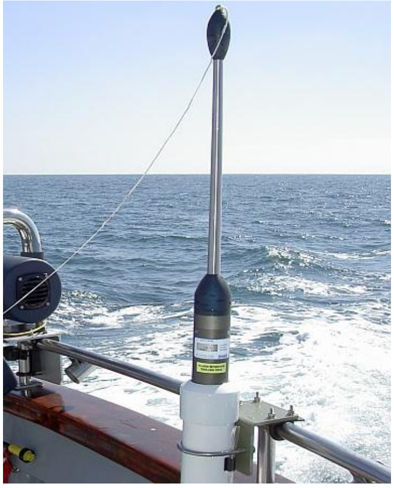


Figure 25a. CTD probe assembly: disconnected probe and tail spool components (left), and ready for deployment (right).

Figure 25b. Winch with automatic levelwind.

Figure 25c. Computer-controlled and semi-automated rewinder of tail spool.

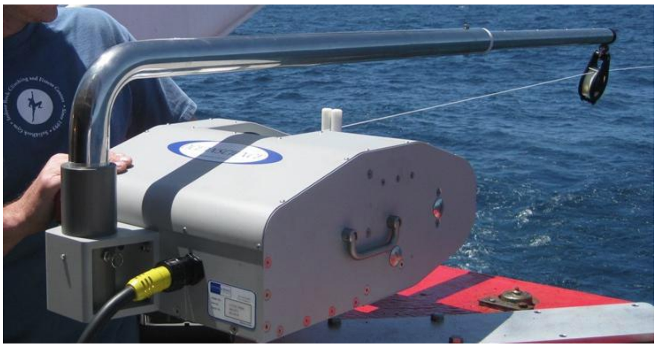


Figure 25d. Davit with telescopic arm and spectra line guide block.

Figure 25e. Universal power supply with winch and rewinder cables.

Table 7. Underway CTD operations protocol.

Personnel:
- UCTD winch operator
- Radio Identities:
  - Bridge
  - UCTD radio operator: “UCAST” is the single bridge radio point of contact
  - UCTD elog operator: “Aft Control”
  - [Passive listener: watch leader or POC: “Dry Lab”]

Protocol:
- Cast planning meeting on the bridge:
  - UCAST visits bridge, jointly evaluates sea-ice, water depth, sea state, etc.
  - UCAST and bridge identify operational mode, that is either “stationary” or “underway at 5 knots”
- Pre-cast:
  - From hydrolab, UCAST informs bridge of movement to back deck for probe preparation: “BRIDGE, HYDROLAB; UCAST TEAM GOING TO BACK DECK”
  - UCAST elog operator moves to Aft Control room
- Cast start:
  - UCAST informs bridge that team is standing by, requests slowing of vessel: “BRIDGE, UCAST; STANDING BY FOR SHIP TO SLOW DOWN”
  - Bridge contacts UCAST when vessel has slowed down to identified speed
  - Bridge provides permission to launch
  - UCAST launches probe and informs bridge of probe launch: “BRIDGE, UCAST; PROBE IN THE WATER”
  - Aft Control enters elog
- Max depth:
  - UCAST reports over radio: “MAX DEPTH REACHED, PROBE COMING UP”
  - Aft Control enters elog
  - Winch operator begins probe recovery
- End of upcast:
  - UCAST informs bridge when probe is on deck: “BRIDGE, UCAST; PROBE ON DECK”
  - Aft Control enters elog
  - UCAST informs bridge when deck is clear: “BRIDGE, UCAST; DECK IS CLEAR”

5.3 <u>MOORED CURRENT METERS AND T/C/P RECORDERS</u>

An array of three moorings with current meters, temperature, conductivity, and pressure (TCP) recorders were deployed along the eastern flank of the continental shelf off Sabrina Coast (Fig. 24), at the main path of the Antarctic Coastal Current indicated by the uCTD data collected earlier during the cruise. Time series from this mooring array will characterize the current's flow structure, variability and property transports carried out by subsurface to bottom waters (M1 and M2), and at a deep channel in front of the Moscow University Ice Shelf (M3) connected to the cavity underneath it.

Deployed at the 625-m (M1), 620-m (M2) and 1051-m (M3) isobaths, these moorings are instrumented with a total of 9 Nortek (Aquadopp) and 3 Teledyne Work Hose (2 Sentinel 300 kHz and one Long Ranger 75 kHz) current meters, 15 SeaBird (MicroCat SBE-37) TCP and TC recorders, and 9 RBR (Solo) T recorders to provide high vertical resolution below 300 m.

M1 was recovered on 25 February, with a full data return from all of its instruments; whereas M2 and M3 will provide a year-long record until their recovery tentatively on board of the Australian RVI Aurora Australis next year.

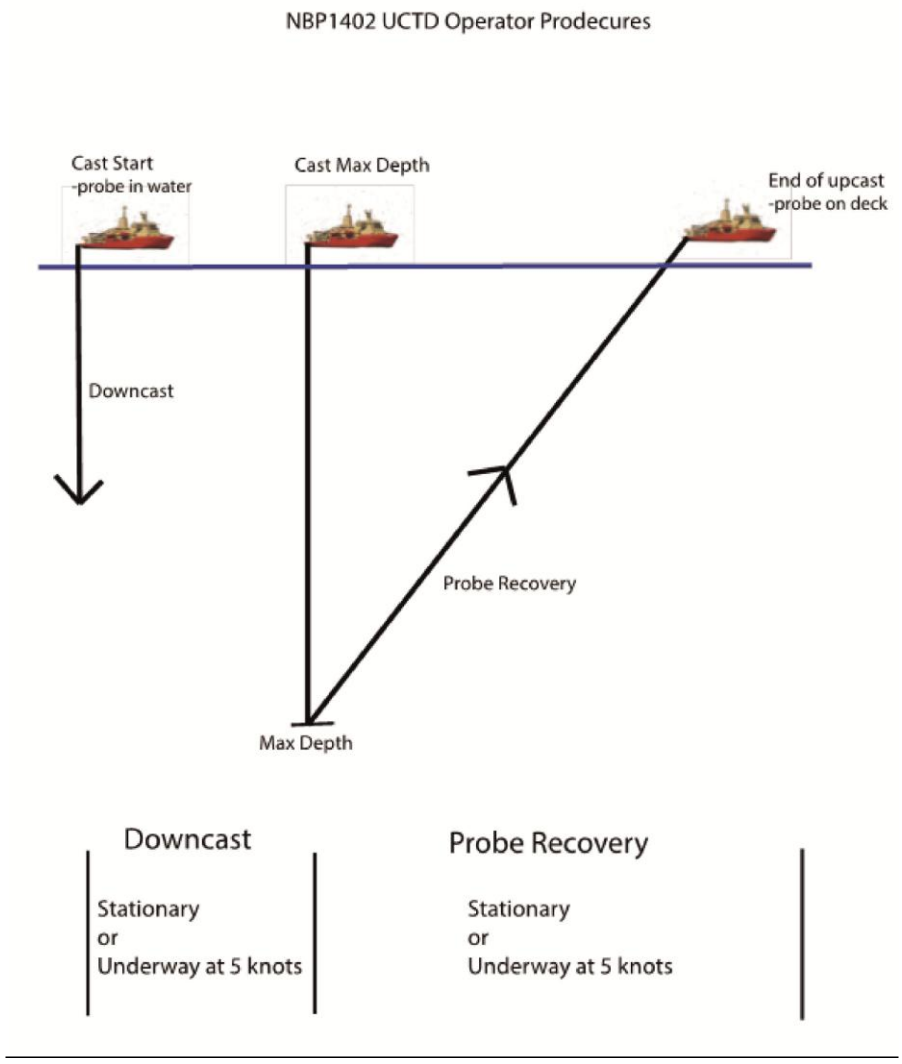


Figure 26. Bimodal operation of the Underway CTD system: "Stationary" and "Underway at 5 knots".

5.3.1 *Moorings Setup*

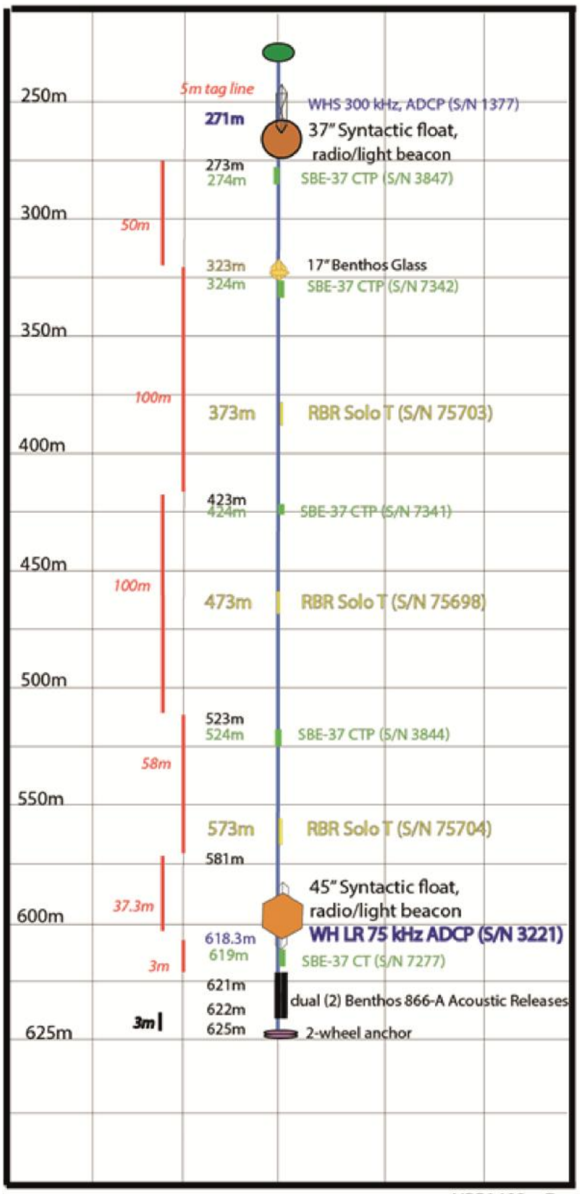
Design and construction of all three (M1-M3) moorings was done by the Buoy Group at GERG-TAMU. They were modeled using two different programs: an X windows version of "WHOI Cable" by Mark Grosenbaugh and Jason Gobat at WHOI, and the Matlab program "Mooring Design and Dynamics" by Richard Dewey at University of Victoria. Both programs use a model with a conservative currents velocity profile of 1.5 m/s above 100 m, 1.25 m/s between 100 m and 500 m, 1m/ s between 500 m and 1500 m, and 0.25 m/s below 1500 m.

The moorings use 1/4" 12 strand Vectran rope with a tensile strength of 8,400 lbs, with heavy-duty galvanized thimbles. Each termination was load-tested at GERG to at least 1,500 lbs, i.e. the maximum tension expected to be caused during the anchor free-fall, and all terminations were stitched, whipped and protected by heavy-duty adhesive lined shrink tube after load-testing. Galvanized oceanographic swivels and pear links were included beneath each buoyancy component. All galvanized shackles were load rated, domestic screw pin shackles with insulated 12 ga. Copper seizing wire. Dual Benthos 866-A Continental shelf acoustic releases were used on all three moorings.

All moored instruments were set to the ship's GPS time. Half-hour sampling intervals were set to record at the exact hour and half hour, and thus facilitate the later data analysis from different depths and moorings. All MicroCats recorders and Aquadopp current meters were set up identically, i.e. with delayed-starts that enabled them to start sampling at the exact same time, and they were all checked following the first cycle to make sure they were all working and recording data correctly.

See figures 27a, 27b, and 27c for schematics of Mooring M1, M2 and M3, and Table 8 for a description of the composition of each mooring.

M1



Beacon: U08-057, 159.480 mHz
Strobe flasher: M11-019

Inventory

1: 37" Syntactic ADCP float
1: 45" Syntactic ADCP float
1: Single 17" Benthos Glass float

1: WH Sentinel 300 kHz
1: WH Long Range 75 kHz
5: SBE-37
3: RBR Solos
2: Benthos Releases

Deployment Notes

Start:19:10 GMT, Feb 12, 2014
End: 20:04 GMT, Feb 12, 2014
Out of site: 20:07 GMT, Feb 12, 2014

Triangulation:
1. -66° 21.70' S
120° 03.3' E
2. -66° 23.065' S
120° 01.97' E
3. -66° 22.025' S
120° 00.36' E

Recovery Notes

-Start: 20:40 GMT, Feb 25, 2014
-End: 21:45 GMT, Feb 25, 2014
Lat: -66° 22.25' S
Lon:120° 2.332' E
Depth: 625m

Beacon: W08-061, 159.480 mHz

S/N: 50289
Receiving: 10 kHz,
Transmitting: 12 kHz,
Enabling Code: C
Releasing Code: D
S/N: 50290
Receiving: 11 kHz,
Transmitting: 12 kHz,
Enabling Code: A
Releasing Code: B

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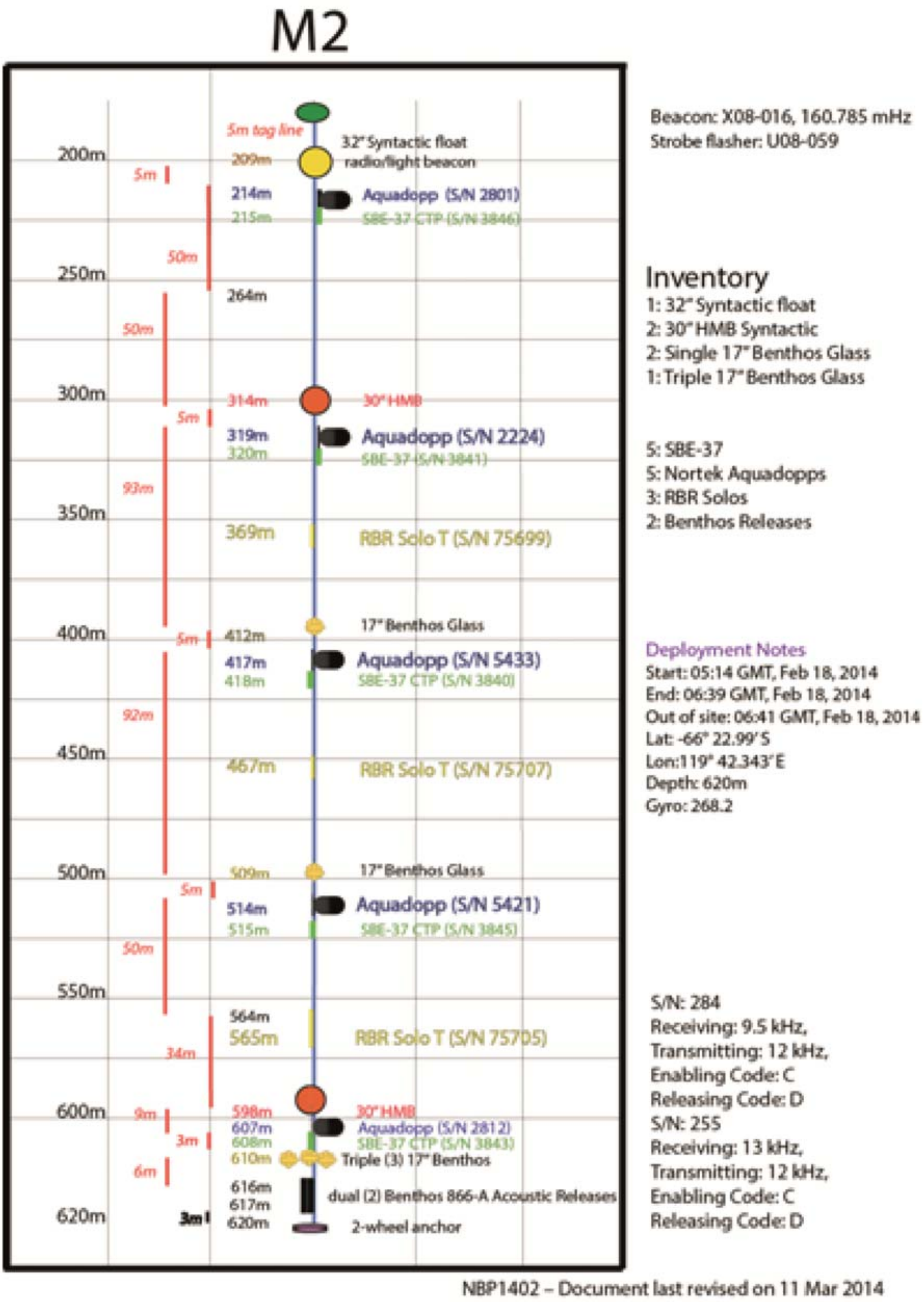

M2
5m tag line
32" Syntactic float
radio/light beacon
200m
209m
5m
214m
Aquadopp (S/N 2801)
215m
SBE-37 CTP (S/N 3846)
50m
250m
264m
50m
300m
314m
30" HMB
5m
319m
Aquadopp (S/N 2224)
320m
SBE-37 (S/N 3841)
93m
350m
369m
RBR Solo T (S/N 75699)
400m
17" Benthos Glass
5m
412m
417m
Aquadopp (S/N 5433)
418m
SBE-37 CTP (S/N 3840)
92m
450m
467m
RBR Solo T (S/N 75707)
500m
509m
17" Benthos Glass
5m
514m
Aquadopp (S/N 5421)
515m
SBE-37 CTP (S/N 3845)
50m
550m
564m
565m
RBR Solo T (S/N 75705)
34m
600m
9m
598m
30" HMB
607m
Aquadopp (S/N 2812)
3m
608m
SBE-37 CTP (S/N 3843)
610m
Triple (3) 17" Benthos
6m
616m
617m
dual (2) Benthos 866-A Acoustic Releases
620m
3m
620m
2-wheel anchor
Beacon: X08-016, 160.785 mHz
Strobe flasher: U08-059
Inventory
1: 32" Syntactic float
2: 30" HMB Syntactic
2: Single 17" Benthos Glass
1: Triple 17" Benthos Glass
5: SBE-37
5: Nortek Aquadopps
3: RBR Solos
2: Benthos Releases
Deployment Notes
Start: 05:14 GMT, Feb 18, 2014
End: 06:39 GMT, Feb 18, 2014
Out of site: 06:41 GMT, Feb 18, 2014
Lat: -66° 22.99' S
Lon:119° 42.343' E
Depth: 620m
Gyro: 268.2
S/N: 284
Receiving: 9.5 kHz,
Transmitting: 12 kHz,
Enabling Code: C
Releasing Code: D
S/N: 255
Receiving: 13 kHz,
Transmitting: 12 kHz,
Enabling Code: C
Releasing Code: D
NBP1402 – Document last revised on 11 Mar 2014

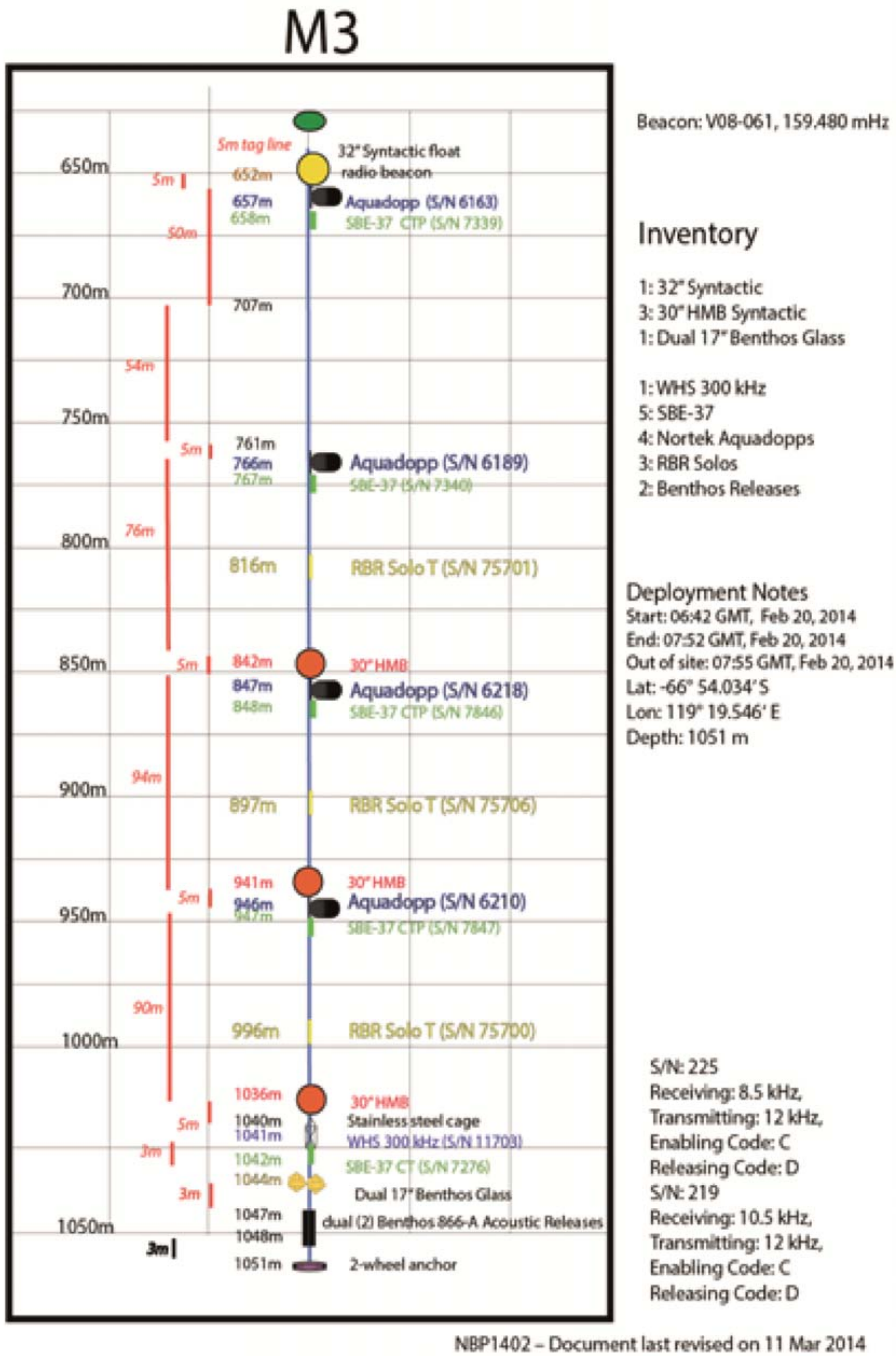


Figure 27a, b, c: Schematic instrument distributions at three US mooring sites (M1-M3); details are provided in Table 8.

Mooring	*Longitude*	*Latitude*	*Water Depth*	*Deployment Date*	*Recovery Date*
M1	*120° 2.33' E*	*66° 22.25' S*	*625 m*	*12-Feb-2014*	*25-Feb-2014*
WHS-300	U, V	271 m			
SBE-37	T, C, P	274 m			
SBE-37	T, C, P	324 m			
RBR-Solo	T	373 m			
SBE-37	T, C, P	424 m			
RBR-Solo	T	473 m			
SBE-37	T, C, P	524 m			
RBR-Solo	T	573 m			
SBE-37	T, C	619 m			
WHLR-75	U, V	618 m			
M2	*119° 42.34' E*	*66° 22.99' S*	*620 m*	*18-Feb-2014*	
Aquadopp	U, V	214 m			
SBE-37	T, C, P	215 m			
Aquadopp	U, V	319 m			
SBE-37	T, C, P	320 m			
RBR-Solo	T	369 m			
Aquadopp	U, V	417 m			
SBE-37	T, C, P	418 m			
RBR-Solo	T	467 m			
Aquadopp	U, V	514 m			
SBE-37	T, C, P	515 m			
RBR-Solo	T	565 m			
Aquadopp	U, V	607 m			
SBE-37	T, C, P	608 m			
M3	*119° 19.55' E*	*66° 54.03' S*	*1051 m*	*20-Feb-2014*	
Aquadopp	U, V	657 m			
SBE-37	T, C, P	658 m			
Aquadopp	U, V	766 m			
SBE-37	T, C, P	767 m			
RBR-Solo	T	816 m			
Aquadopp	U, V	847 m			
SBE-37	T, C, P	848 m			
RBR-Solo	T	897 m			
Aquadopp	U, V	946 m			
SBE-37	T, C, P	947 m			
RBR-Solo	T	996 m			
WHS-300	U, V	1041 m			
SBE-37	T, C	1042 m			

5.4 SEDIMENT TRAP MOORING

In addition to M1, M2 and M3, a mooring with 3 conical fiberglass sediment traps was deployed on 04 March 2014 at latitude 66 11.058’ S longitude 120 30.213’ E in 547 m of water. Additional instruments on the mooring were a Sea-Bird Electronics SBE19 CTD with transmissometer, an SBE37 microcat temperature, salinity, pressure recorder, and an SBE39 temperature, pressure recorder (Table 9 and Fig. 28).

Table 9: Instrument specifications

Instrument	parameters	Serial number	Start date	Sampling interval (minutes)
SBE19	T, C, Pr, transmittance	6112	1 March 1200	60
SBE37	T, C, Pr	7141	16 Feb 1200	15
SBE39	T, Pr	4907	16 Feb 1200	15

The mooring is secured to its anchor with an EG&G CART release sn 32307. Codes are as follows:

Enable: 617207
Disable: 617224
RELEASE: 633375

Recovery aids: Top float of 13” Benthos glass ball in hard hat on 20 m of braided ½” polypropylene line. The top float is fitted with one Novatech xenon flasher and one Novatech radio beacon (159.480 MHz (Ch B) duty cycle 2 s on 4 s off).

The mooring was deployed anchor first with the ship on heading of 095. GPS to stern gate distance is 41 m. The mooring was not triangulated.

5.5 <u>CTD/ROSETTE</u>

Fifteen casts were made with the ASC CTD/Rosette system (hereafter CTD). See the LADCP section for a separate description of the lowered acoustic Doppler profiler system mounted on the rosette frame. The CTD was a Sea-Bird Electronics SBE9 fitted with dual sensor suites (two each conductivity-temperature pairs with oxygen sensor, each with their own pump). A fluorometer and transmissometer were also installed. See the separate ASC data report for a complete description of the sensors including calibration data, serial numbers and instrument wiring. Proximity to the bottom was determined by an acoustic altimeter with an SBE bottom contact switch as backup (lanyard length 10 meters). All casts were to within 10 m of the bottom. The CTD sample rate is 24 Hz. Preliminary processed data were available within a few minutes after each cast. Profiles for each down cast (uncalibrated) are given in the appendix. See the report section on Operational Considerations for a description of problems with the CTD system.

Water samples were obtained using the 24-position rosette system fitted with 10 liter Ocean Test Equipment rosette bottles. Since most of the casts were relatively shallow, bottles were frequently tripped two per level. Bottles were tripped on the up cast. For most bottles on casts 2 et seq. the bottles were tripped only after the CTD had been stopped for 30 seconds. This was not done uniformly at the beginning of the cruise; typically only those bottles being tripped for calibration samples of salinity and dissolved oxygen were subject to the 30 second wait period. Later in the cruise all bottles were subject to the wait period (need to check the logs to see which station this was implemented).

Samples were drawn for analysis of dissolved oxygen and salinity, to be performed during the cruise for calibration of the CTD sensors. Sample for 18-O, dissolved inorganic carbon/alkalinity (for E Shadwick), filtration for diatoms and viruses were also drawn for some bottles for later analyses.

The table below lists CTD cast positions, date and time and corresponding ship station. Copies of the water sampling and CTD station logs are given as appendices.

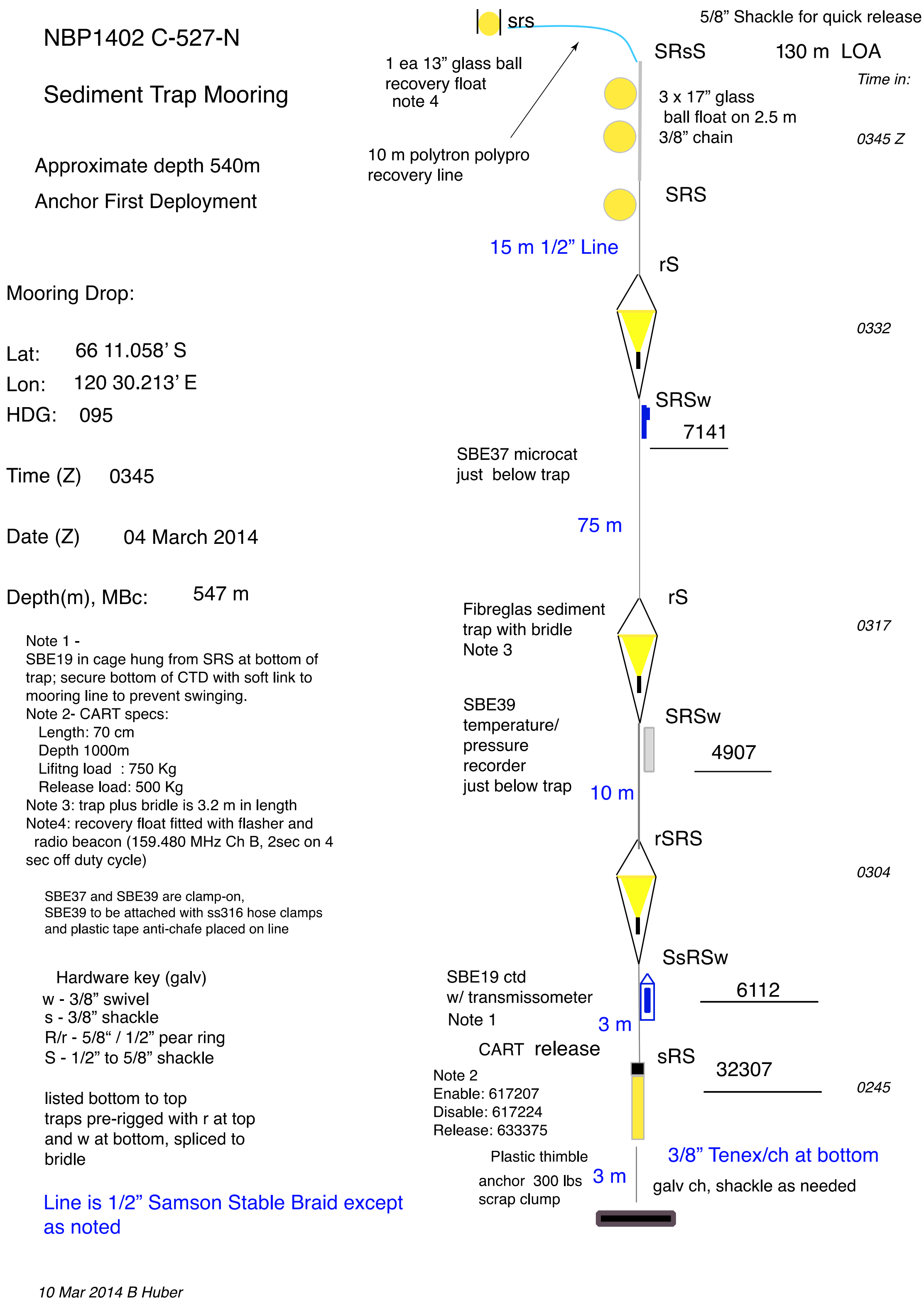


Figure 28. Sediment trap mooring schematic.

Table 10. CTD cast positions, date and time, and corresponding ship station.

CTD	Sta	Date/time Z	Latitude S		Longitude E		Depth
1	5	02/06/2014 02:43	67	5.61	145	13.39	1338
2	8	02/10/2014 13:21	66	3.77	120	3.00	495
3	9	02/11/2014 14:56	66	21.64	119	51.72	676
4	12	02/12/2014 21:17	66	22.02	120	0.36	627
5	18	02/16/2014 23:28	66	21.73	119	19.76	845
6	19	02/17/2014 03:33	66	23.32	119	13.87	876
7	20	02/17/2014 14:56	66	23.14	118	57.58	896
8	22	02/18/2014 15:21	66	34.01	119	13.05	698
9	26	02/20/2014 10:30	66	53.56	119	25.05	1102
10	27	02/21/2014 03:59	66	11.09	120	30.24	549
11	33	02/23/2014 17:38	66	10.02	120	38.16	508
12	38	02/25/2014 00:22	66	23.27	119	44.65	665
13	42	02/25/2014 12:21	66	29.10	120	19.95	606
14	60	03/05/2014 03:59	66	30.39	120	29.19	500
15	61	03/05/2014 13:42	66	7.74	120	27.84	580

5.6 DISSOLVED OXYGEN SAMPLING AND ANALYSIS

Samples for dissolved oxygen were analyzed using a modified Winkler technique implemented on a Langdon amperometric automatic titration system. The system was provided by ASC (system #1). It performed well throughout the cruise with one exception, described below. Reagents remaining from the previous cruise were used throughout, with the exception of standard solution that was mixed fresh from a pre-weighed dry standard sent from LDEO. Reagent blanks were not run. Values reported below are those reported by the titrator software and are preliminary. No buoyancy corrections or quality control have been applied. All values will be recalculated later.

Procedures followed were those outlined in the documentation available on board. Samples were drawn using an aged glass tube with rubber hose attached to the rosette bottle pet cock. Samples were shaken a second time approximately 20 minutes after drawing. Deionized water was squirted into the top of the closed flasks during storage to prevent sample evaporation. Samples were stored for several days in their closed boxes before titrating. Standards were run before each titration session. Glassware for standards was thoroughly scrubbed in mild detergent water and liberally rinsed first with tap water then with DI water. Six 125ml Ehrlenmeyer flasks were used for standards. Sample flasks were also thoroughly washed after sample titration. The titrator was turned off between sessions. Sampling was done by B Huber, M Rosenberg and D Gwyther. Titrations were performed initially by B Huber then by D Gwyther.

Preliminary CTD-rosette comparison of oxygen values is given in the figures below (Fig. 29 and Fig. 30). No quality control has been applied other than a rough 3-sigma screening for extreme outliers. In general it appears that the secondary oxygen sensor performed better that the primary. In the figures below, CTD values are those reported in the SBE-processed *.btl files, an average of 241 scans about each bottle trip on the upcast. Scatter in the rosette values is modest to large depending upon the station. Replicate samples were drawn and were generally within 0.04 ml/l or better. A total of 147 samples were processed.

One minor problem was encountered with the titrator – during one run, endpoints were being reached well before the standard or sample had been titrated to the visual end point. The run was terminated until Chris Langdon was contacted via email for advice. He suggested checking the current by substituting resistors for the probe. The system checked out using his suggested diagnostics, and subsequent runs were trouble free. The cause of the problem was not determined.

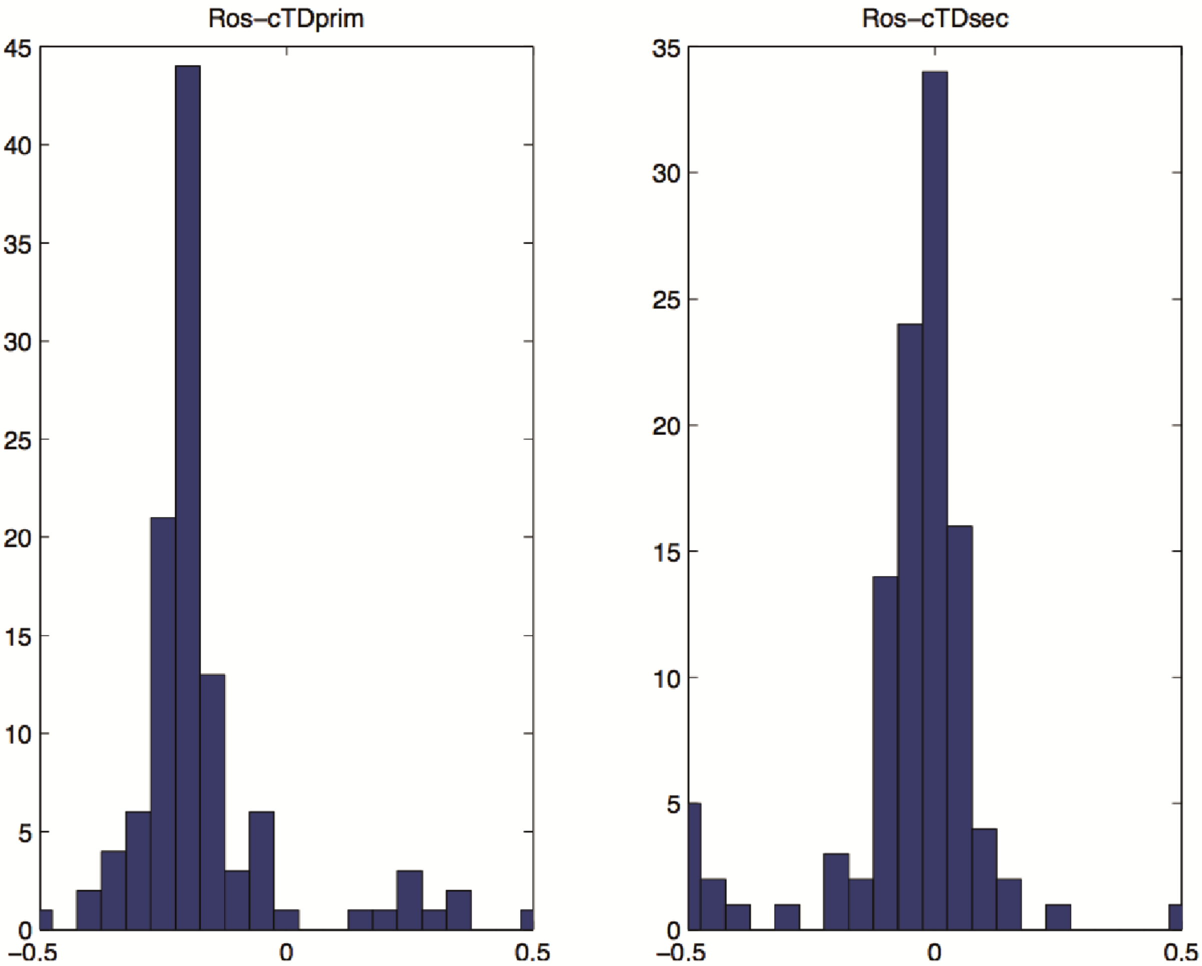
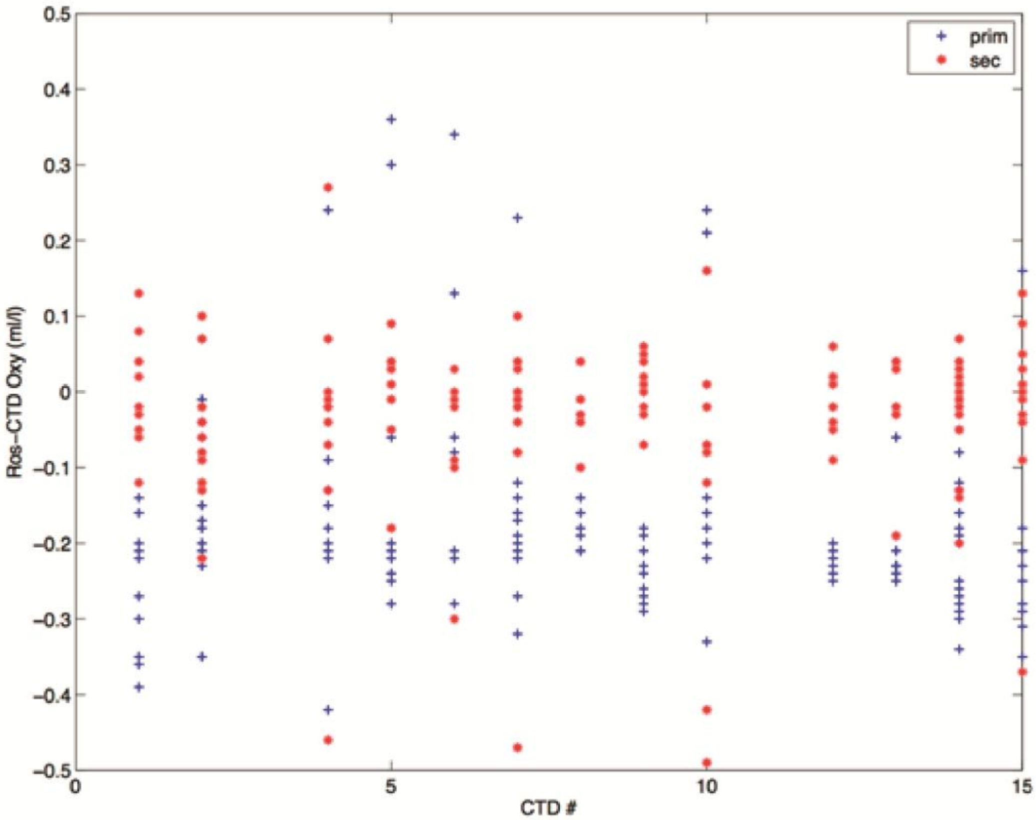
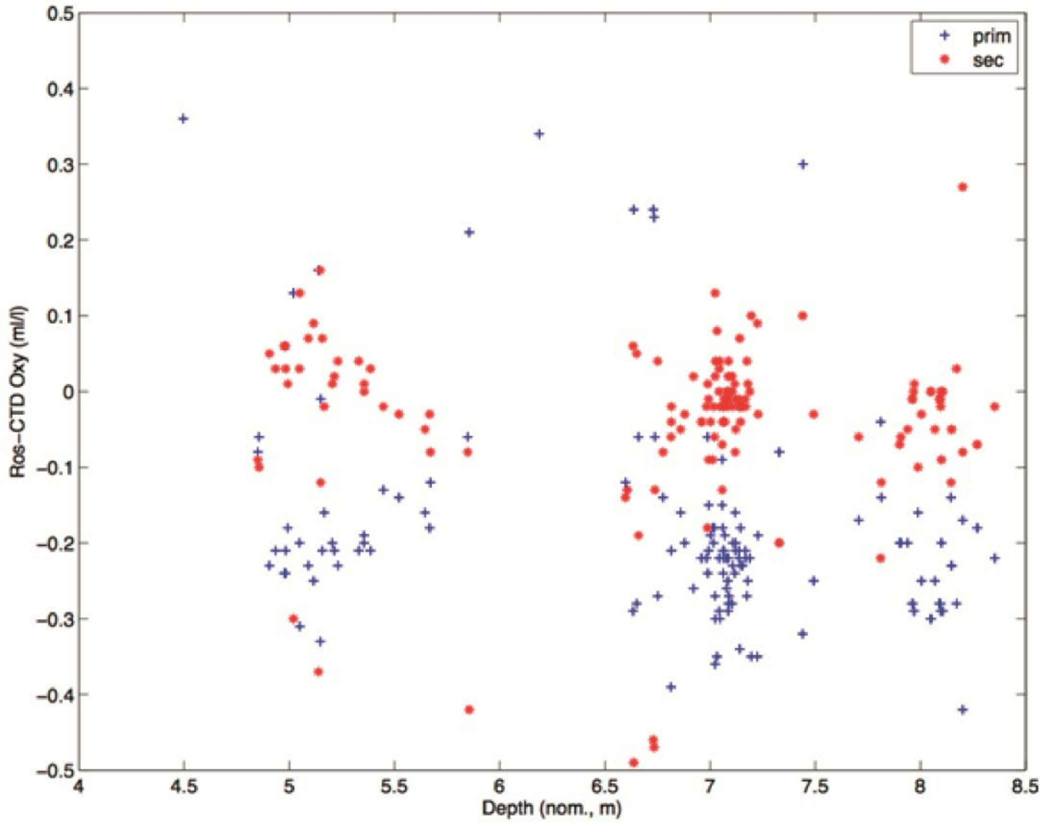
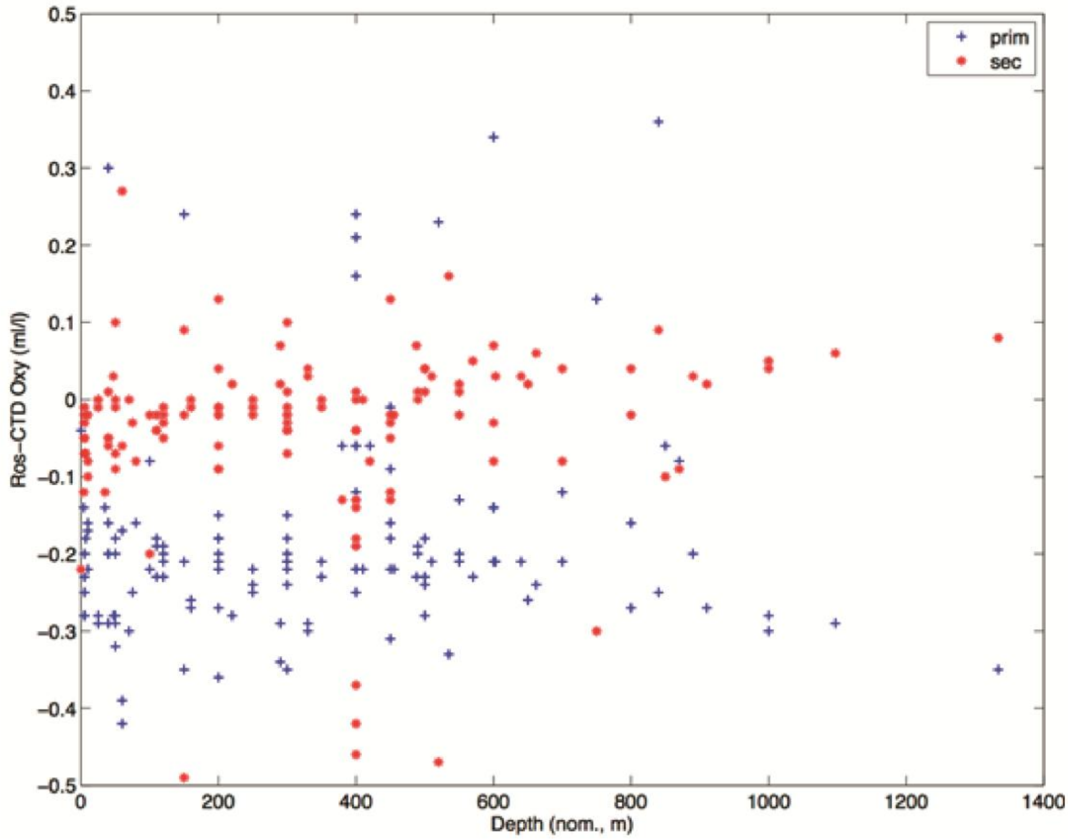


Figure 29. Histogram of Rosette-CTD oxygen differences for the two sensors.
No quality control applied.


prim
sec
Ros−CTD Oxy (ml/l)
CTD #
0.5
0.4
0.3
0.2
0.1
0
−0.1
−0.2
−0.3
−0.4
−0.5
0
5
10
15


prim
sec
Ros−CTD Oxy (ml/l)
Depth (nom., m)
0.5
0.4
0.3
0.2
0.1
0
−0.1
−0.2
−0.3
−0.4
−0.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5



Figures 30a, b, c. Rosette-CTD dissolved oxygen comparisons. Only first pass 3-sigma screening has been applied.

5.7 <u>CTD AND NISKIN BOTTLE SALINITY</u>

Niskin bottle samples for the analysis of salinity were collected from 13 of the 15 full depth CTD casts on the cruise. The Guildline Autosal was run in the temperature controlled lab, with bath temperature set to 24°C, and ambient laboratory temperature typically ~23.5°C.

IAPSO salinity standard P155 (19th Sep 2015 use by date) was used for all salinometer runs. Bottle sample analyses were used for calibration of CTD data. Overall, salinometer analyses were problematic, and calibrated CTD salinity data should only be considered accurate to ~0.004 (PSS78). Salinometer problems were initially procedural (not wiping the drawing tube between samples, or allowing old sample to flush out), and then instrumental (numerous bubbles through the cell, making it difficult to obtain stable readings).

5.7.1 CTD data processing and calibration

The first processing step is application of a suite of the SeaBird "Seasoft" processing programs to the raw data, in order to:
* convert raw data signals to engineering units
* despike
* remove the surface pressure offset for each station

* realign the oxygen sensor with respect to time (note that conductivity sensor alignment is done by the deck unit at the time of data logging)
* remove conductivity cell thermal mass effects
* apply a low pass filter to the pressure data
* flag pressure reversals
* search for bad data (e.g. due to sensor fouling, data erorrs etc)

Further processing and data calibration were done using a suite of fortran and matlab programs. Processing steps here include:
* forming upcast burst CTD data for calibration against bottle data, where each upcast burst is the average of 10 seconds of data centered on each Niskin bottle firing
* merging bottle and CTD data, and deriving CTD conductivity calibration coefficients by comparing upcast CTD burst average conductivity data with calculated equivalent bottle sample conductivities
* forming pressure monotonically increasing data, and from there calculating 2 dbar averaged downcast CTD data
* calculating calibrated 2 dbar averaged salinity from the 2 dbar pressure, temperature and conductivity values

CTD oxygen data were not processed at sea (awaiting final calculations of bottle oxygen titrations).

5.7.2 Conductivity/salinity calibration results and data quality

CTD conductivity data were calibrated using the in situ salinity bottle samples. Bottle - CTD salinity residuals before and after the calibration are shown in Figures 31 and 32 respectively. Note that salinity plots are shown here for ease of interpretation - equivalent plots for conductivity show all the same features.

From the Figures, 3 orders of error are evident:

1. Using the June 2013 lab. calibrations from Seabird, and prior to calibration against bottle samples, a clear offset exists between the 2 conductivity sensors (Figure 1), equivalent to a salinity of ~0.013 (PSS78). Bottle samples are clearly required for any improvement to accuracy.

2. A significant number of obvious outliers occur (not shown in the Figures, and not used in the calibration). Close inspection of the full 25 Hz data at bottle stops (not shown here) shows significant wake water going past the sensors, and in retrospect longer bottle stops (i.e. longer than the usual 30 seconds) may have been needed due to the higher than expected flow interference from the rosette package. This accounts for some of the large outliers, particularly those close to steep vertical gradients; others may be due to leaking Niskin bottles, or contaminated salinity samples.

3. Within each station, there is a larger than desired scatter in residuals. Given the salinometer problems encountered, it is difficult to separate error sources (i.e. CTD sensors, sampling, or salinometer). This also applies to any drift or step in the mean residual value between stations (Figure 1). Specifically, a small step is evident after between stations 8 and 9, with mean pre-calibration residuals ~0.006 (PSS78) for stations 1 to 8, and ~0.003 (PSS78) for stations 9 onwards. If salinometer data were reliable, this shift could be attributed to the CTD, and smaller station groupings could be used for the calibration (i.e. stations 1-8, and station 9-15). Given the lower reliability of the salinometer, a single station grouping was used. Note that the last set of samples (the top half of station 14, and all of station 15) could not be run due to salinometer failure.

An additional unexpected feature is differences in the bottle-CTD residuals for the primary and secondary sensors (e.g. compare primary and secondary sensor residuals for station 12 in Figure 1). This may be due to variability of wake water going past the sensors at bottle stops (therefore longer bottle soaks required). Alternatively, there may be a sensor plumbing issue (not investigated).

Residuals between duplicate bottle samples drawn from the same Niskin are shown in Figure 3. These residuals are mostly smaller than ±0.002 (PSS78).

5.7.3 Recommendations

* A spare salinometer is required for all cruises. In this case, the Portasal was already out of commission prior to the cruise, so no spare was available.

* For shallow CTD’s around the Antarctic shelf, bottle stops longer than 30 seconds may be required.

* Undersampling of Niskin bottles is sometimes required (various reasons, including lab supplies, or manpower for analyses), but it is always high risk. CTD procedures should err on the side of oversampling. This is particularly true for Antarctic shelf work, where significant numbers of unusable samples are to be expected (e.g. due to high biology content, frazil ice, freezing of Niskins etc).

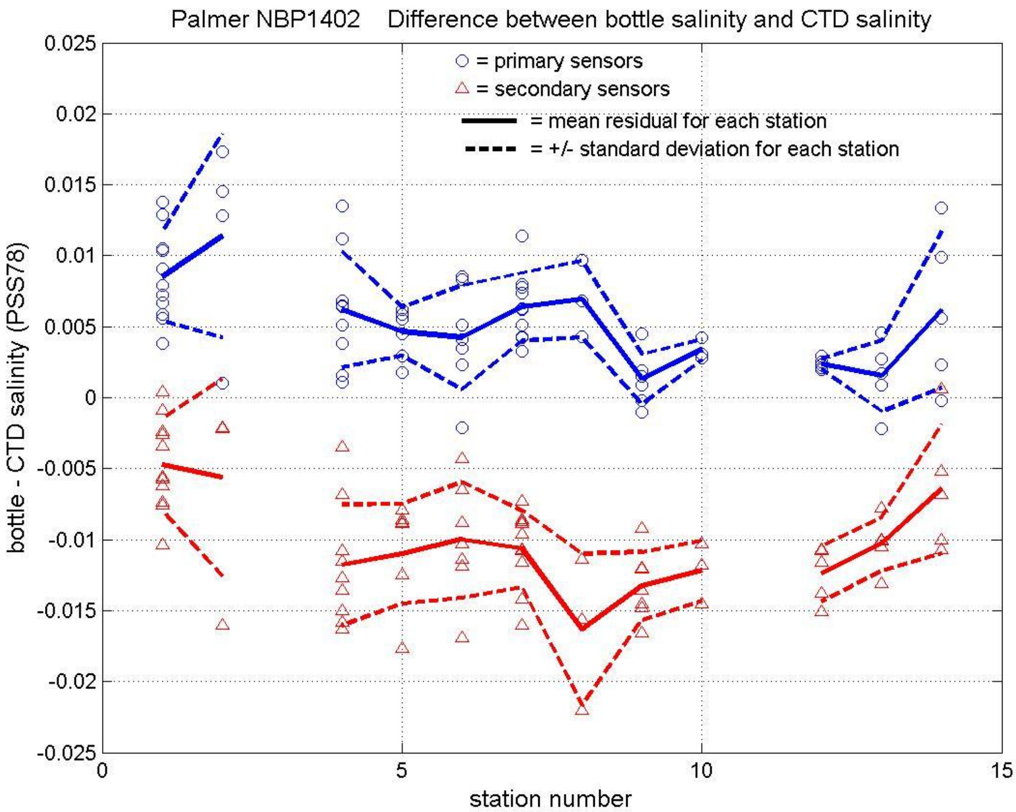


Figure 31. Salinity difference bottle – CTD, prior to calibration of CTD data against bottle samples.

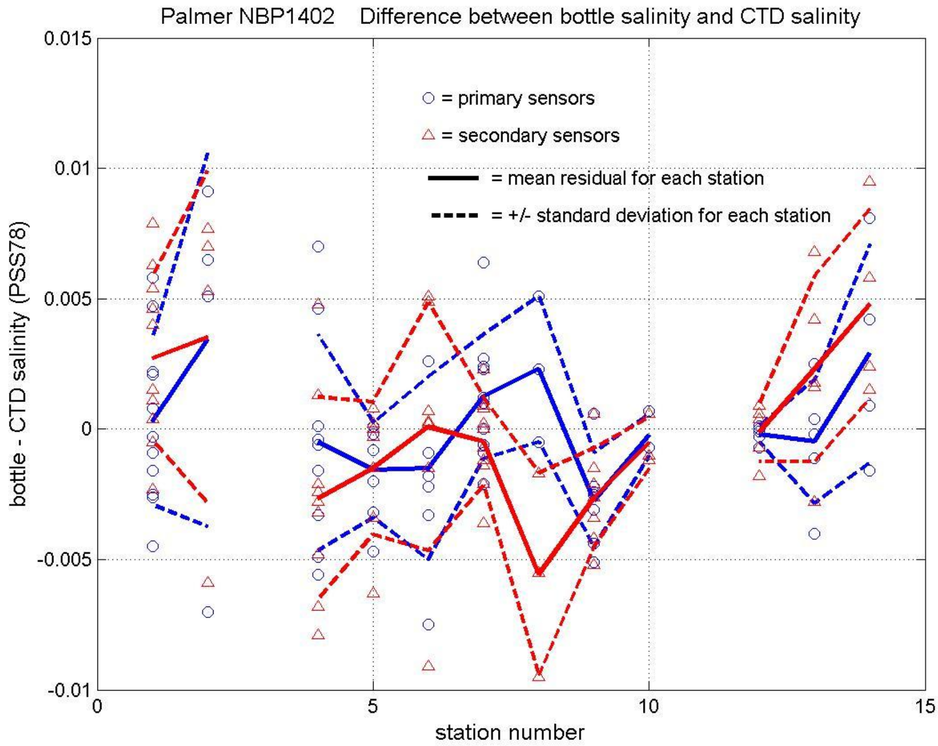


Figure 32. Salinity difference bottle – CTD, after calibration of CTD data against bottle samples.

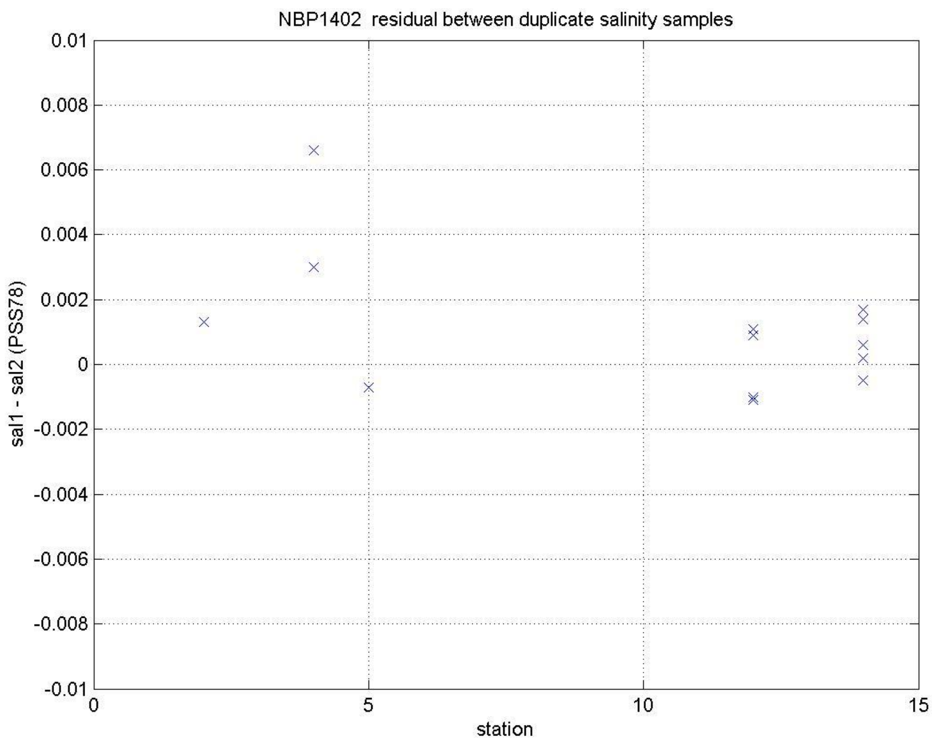


Figure 33. Difference between duplicate salinity samples drawn from the same Niskin bottle.

5.8 SHIP ADCP

The NBP is equipped with two hull mounted acoustic Doppler current profiler systems (ADCP): a narrow band 150 kHz and an Ocean Surveyor OS38 38 kHz system operated in narrow band mode. Data from both systems are recorded simultaneously with the raw and processed data managed by software developed and maintained by University of Hawaii (E. Firing and J. Hummon). Processed data are available as 15 minute averages and as 5 minute ensembles. The 15 minute data are readily available on line. The 5 minute data are also available but require a bit of Matlab programming to enable their use. We encountered no problems with the system during the cruise. See Fig. 8 for an example of underway ADCP data.

The ship ADCP (SADCP) ran continuously once we cleared the 200 nm EEZ. In addition to providing continuous underway velocity profiles, the SADCP is used in the processing of the Lowered ADCP system. Matlab software was written to access the 15 min data for importing it into Ocean Data View (ODV) for ease of display and manipulation.

Data quality is degraded when breaking ice or when transiting through newly formed sea ice. Often, the only useful data were obtained while on station. Post processing of the data will be required to remove data severely impacted by ice. As UH is no longer directly funded by OPP to carry out the post cruise processing, this will be done either at LDEO or via subcontract to UH. A complete backup of the data will be returned to UH and LDEO at the end of the cruise.

We found that very good quality data were obtained during the seismic lines. The combination of relatively low speed (4.5 knots) and little ice yielded the optimum conditions for greatest range and least noise in the data. Example ADCP lines coincident with a seismic line are shown below in Figure 34 for data near ship station 27 and for a section in the SE corner of the basin in Figure 35. The 15 min data were used to produce the surface map and section in the first panel; the 5 minute data are plotted for the sections in the second panel. The third figure below shows a block-averaged view of the velocity field produced using ODV. The westward-flowing shelf-slope current is evident at the shelf break, as is a branch of the current rounding the shoal at the Dalton ice tongue and proceeding generally southward into the basin then along the front of the Moscow University Ice Shelf. Note too the suggestion of recirculation near 66.5S. This is an average over the entire cruise, averaged from 100 to 200 m. The data have not been quality controlled beyond the standard screening provided by the UH processing software.

5.8.1 Lowered Acoustic Doppler Current Profiler (LADCP)

Motivation: The LADCP provides continuous profiles of horizontal and vertical components of water velocity at each CTD cast from the surface to within a few meters of the bottom. The lowered system can resolve the near surface and near bottom portions of the water column that are unmeasured by the ship's ADCP due to side lobe contamination. An LADCP system provided by LDEO was used throughout the cruise, mounted on the ASC CTD/rosette system. Measurements are obtained with a pair of Teledyne RD Instruments WHM300 ADCP heads operating at a nominal frequency of 305 KHz, mounted in up- and down-looking positions on the periphery of the CTD/Rosette frame. Mounting considerations include avoiding interference of the acoustic beams with frame members or CTD wire, but it is not necessary for the ADCP heads to be collinear. Power is provided with a rechargeable lead-acid battery in a deep-sea housing (Deep-Sea Power and Light, 48 volt, sn 01637). A novel mounting bracket for the down looking head (Fig. 37) was devised by Hannah Gray of ASC. Hannah's design permits two degrees of adjustment for positioning the ADCP head making it very easy to avoid beam interference. Mounting the up looking head followed the method used previously – spanning a cord of the top Rosette frame ring with aluminum angle to hold one side of the PVC bracket, with the other side of the bracket resting on the outer ring, secured with a stainless steel hose clamp. After the first cast, the ADCP head was rotated about 10 degrees to minimize occasional interference with the CTD wire.

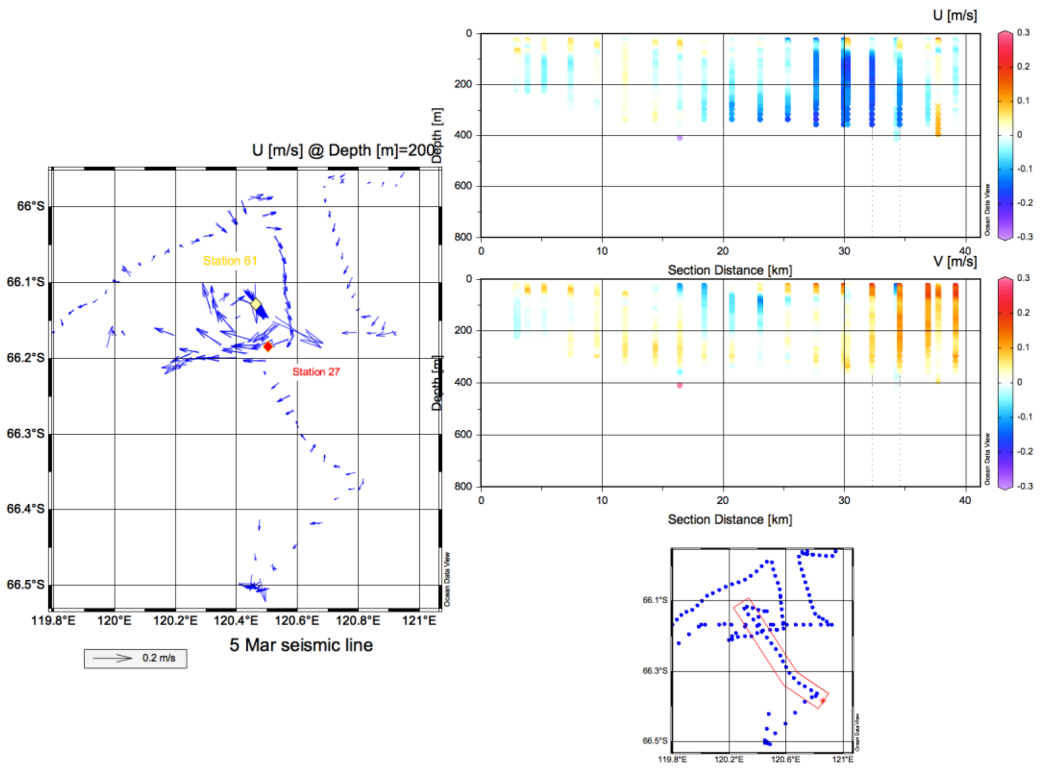


Figure 34. Example ADCP lines coincident with a seismic line for data near ship station 27.

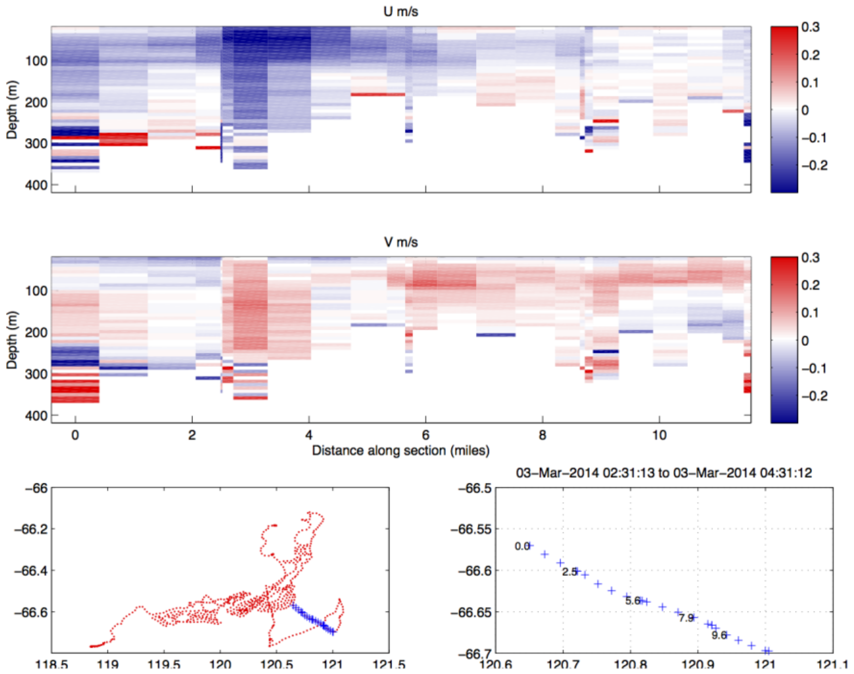


Figure 35. Example ADCP lines for a section in the SE corner of the basin.

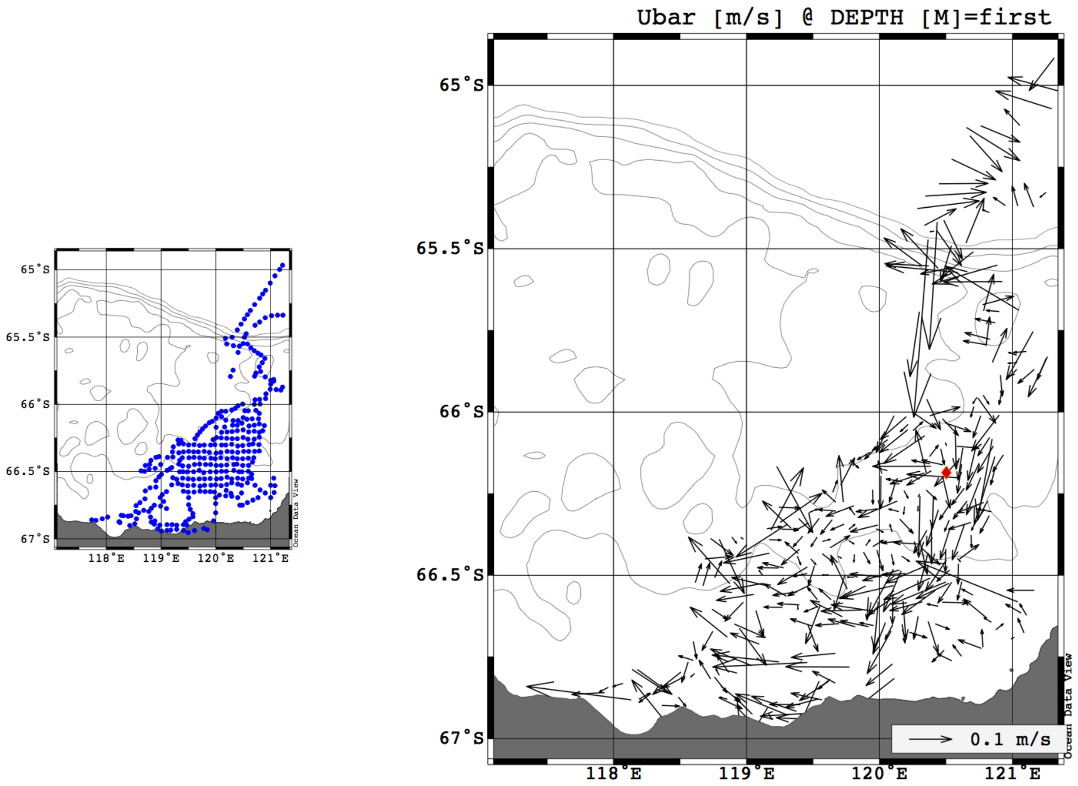


Figure 36. Average ADCP-derived velocity field. Horizontal block average over 0.1 degree longitude and 0.05 degree latitude, vertically average from 100 to 200 m.

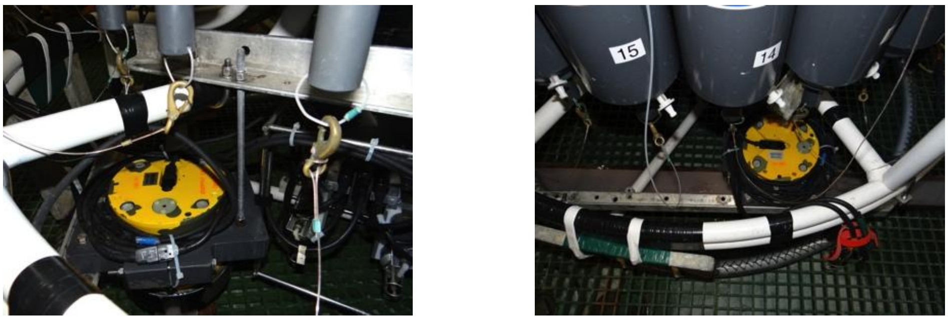


Figure 37. LADCP mounting on CTD/Rosette Frame

ADCP heads used were serial numbers 3441 (down looker, master) and 149, operating in Master-Slave mode. Interconnections on the rosette frame were provided by a Teledyne RDI Star cable, rather than an LDEO Octopus cable. The LDEO cable design requires only a single deck cable for communicating with both ADCP heads nnd it has two plugs for power, allowing for simultaneous battery charging and data upload. The Star cable needs two separate deck cables, one for each head, and has but one battery/power connector. We have been finding that the LDEO cable, with its shared communications ground wire, suffers from occasional cross talk when ending a cast oruploading data. The Star cable worked flawlessly and the two cable constraint was not a problem. Since the casts were short, we uploaded data before disconnecting the battery from the ADCPs for recharging. The cable is diode protected so it should not be a problem to power the ADCPs from the bench supply via the cable breakout on deck, but we did not test that.

One meter extension cables were installed on the Star cable ends that were to be routinely accessed during the cruise to protect the Star Cable from excessive wear and tear. The LPMIL-7-[FS|MP] plugs and dummy plugs were lubricated with water-based silicone spray at the beginning of the cruise and rinsed with deionized water throughout the cruise before mating and unmating.

Cast setup and initiation, and end of cast data upload and housekeeping tasks were executed using software developed by A. Thurnherr, run on a Mac Mini computer (PowerPC based). The software is written to use the 'expect' control platform and will run on any *nix like operating system. The version used for this cruise was V1.5 (Oct-Nov 2013). The clock on the Mac Mini was automatically set by synchronizing with the NBP clock server (name tic.nbp.usap.gov). The PC that handles CTD data acquisition is likewise synched to tic so the ctd and adcp heads share the same time base. Post processing was performed immediately after data upload using version LDEO_IX processing software (Matlab-based).

5.8.2 ADCP Compass Issues

Our work areas are close enough to the South magnetic pole that the resulting weak horizontal component of the earth's magnetic field causes problems with the ADCP compasses. In an effort to ameliorate the compass problems, A. Thurnherr (LDEO) has developed a prototype heading reference unit (dubbed the IMP – "Inertial Measurement Package") that can potentially provide an independent and more robust package orientation history for use with the LADCP post processing. The unit is controlled by a Raspberry Pi computer attached to a precision clock chip, a heading/pitch/roll sensor and a 3-axis magnetometer. Communication with the package is via WiFi that works even when the package is installed in its pressure case. Power is provided by 8 D cells in the housing. The electronics package was hand-carried to the ship, tested and installed beginning with cast 12. Preliminary indications are that the IMP-processed data are much improved. In some cases, the differences are dramatic (eg CTD 12, Fig. 38). IMP-based processing was done by A. Thurnherr remotely from files sent from the ship. Since the IMP samples at a high data rate, the IMP files plus required LADCP files can be tens of megabytes in size. We requested and received additional internet bandwidth to allow us to exchange files with our home lab to facilitate prompt evaluation of the package.

The two-head LADCP configuration typically requires some assumptions about the individual ADCP compasses. Normally, the processing includes a step to adjust one head's compass against the other (the heads are not mounted collinearly nor with the same orientation). Poor compass behavior makes this adjustment difficult or impossible if one of the compasses simply can't get a good reading.

5.8.3 Mounting the IMP

The LDEO pressure housing used for the IMP is made from anodized aluminum and is mounted with a stainless steel ring-and-bar clamp (Fig. 39). It was mounted in the only space available, on the angle support for the down looking ADCP, which put it in close proximity to the down looking ADCP head. In retrospect this may have been a mistake; the compass on the downlooker exhibited more problems that the uplooker when processed with the IMP data. We'll have to go back to the earlier stations to see if compass problems can be detected- otherwise we may have to assume that the IMP may have further compromised the downlooker compass. In the photo below, the IMP internal arrangement places the batteries at the end closes to the ADCP head. Turning the IMP on consists of replacing the end cap dummy plug with a modified plug that shorts pins 3 and 7 to allow continuity of the battery supply. Communicating with the IMP was simply a matter of initiating a wifi session with IMP's on board wireless access point. It was not necessary to open the case for this but it was necessary to stand in the Baltic room just inside the door to initiate the session. Once the wireless connection was made it was then possible to continue the download at the bench in the aft dry lab.

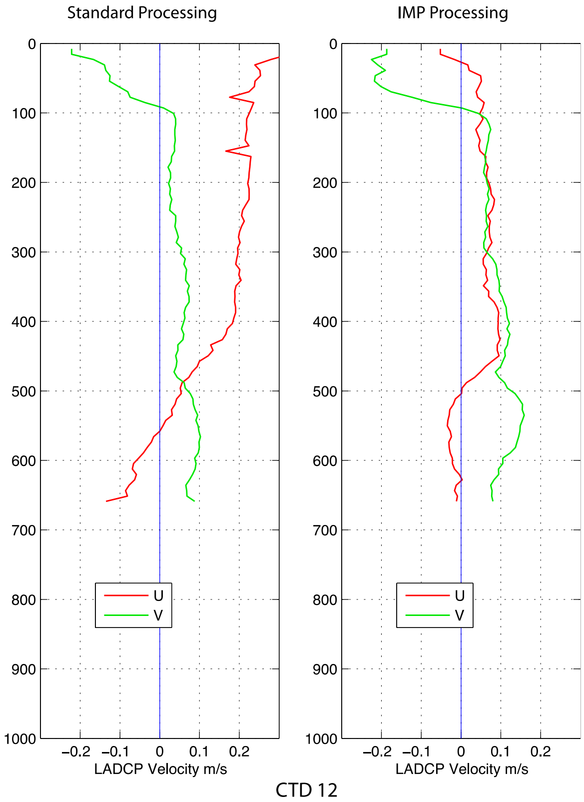


Figure 38. Standard and IMP processing of ADCP data.

The complete set of LADCP profiles with the corresponding profiles of temperature and salinity are given in the appendix. Compass corrections based on the IMP are still preliminary. The data will be reprocessed to achieve the best compass configuration.

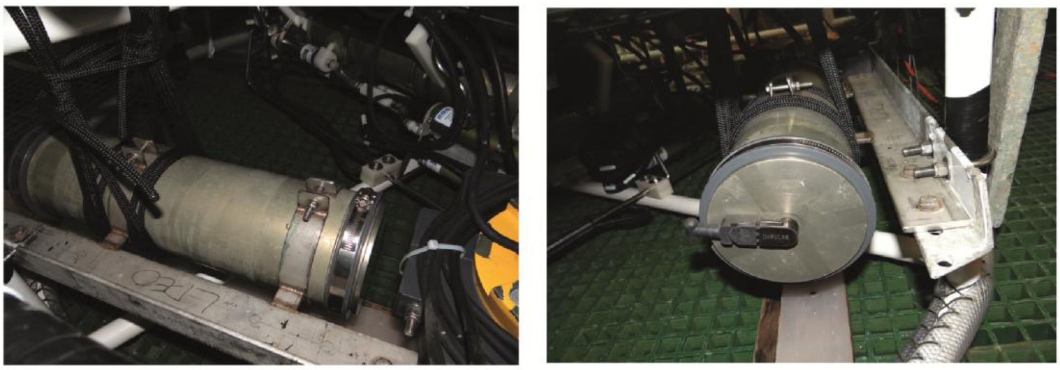


Figure 39. LDEO pressure housing for the IMP.

5.9 TOTTEN AUSTRALIAN MOORING DEPLOYMENTS

Mark Rosenberg (ACE CRC)

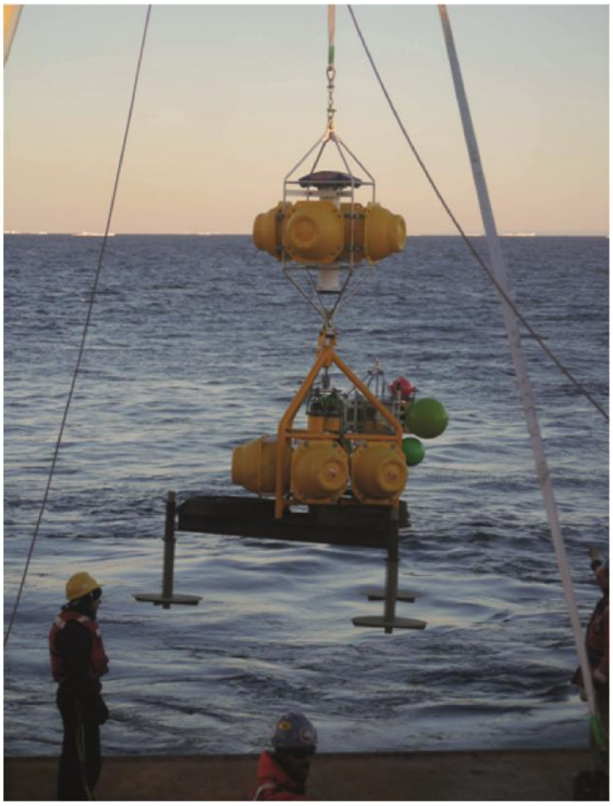


Figure 40. Australian Mooring deployment
(pic by Amelia Shevenell)

This report summarizes information for the Totten mooring deployments and TOGS package recoveries on cruise nbp1402 in the 2013/14 season. These moorings were originally intended for deployment in the Mertz region, to replace the mooring array deployed on *Aurora Australis* cruise au1121 in January 2011. The intended turnaround was on *Tangaroa* cruise tan1302 the previous season (2012/13), however the old mooring array could not be accessed due to pack ice beyond the capabilities of *Tangaroa*, and thus the new moorings were never deployed. After enjoying their scenic round trip from New Zealand, they were rescheduled for deployment in the Totten region from the Palmer on cruise NBP1402, from Hobart.

A brief visit was made to the Mertz region at the start of NBP1402 for geoscience work, however the old Mertz mooring array remained inaccessible – satellite images clearly showed the array covered by fast ice and icebergs. A final attempt to reach these moorings will hopefully be scheduled for the following season (2014/15) on *Aurora Australis*.

Bathymetry in the Totten region was mostly unknown prior to sailing, other than from gravity data, so flexibility was required in setting mooring lengths. Specific deployment locations were also unknown prior to sailing, and site selection depended on several factors: the cruise’s multibeam bathymetry mapping, limited CTD measurements, and the overriding factor of sea ice. The goal was to obtain measurements of “warm” inflow to, and (if possible) outflow from, the Totten Glacier system. As it happened, access right to the Totten was not possible, and moorings were sited closer to the Dalton Iceberg Tongue and Moscow University Ice Shelf, possibly part of the Totten inflow story.

5.9.1 General preparation and deployment/recovery notes

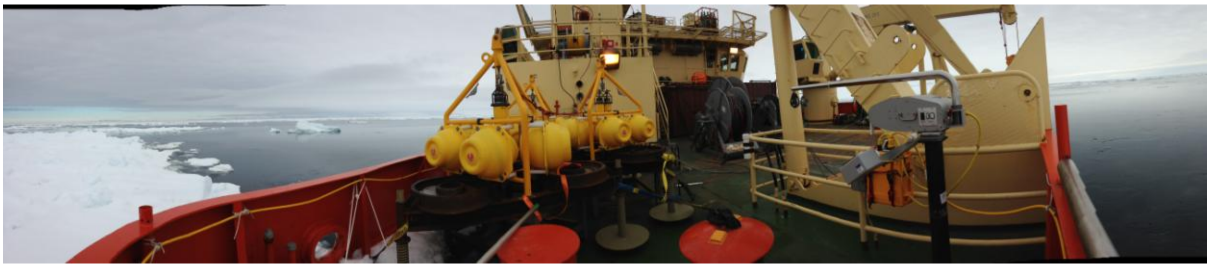


Figure 41. Australian mooring (pic by Natalie Zielinski)

* Gear was loaded at Macquarie Wharf, with the 3 ADCP's and a wire spool cage stored in the helohangar, the 3 anchor tripods and 3 float cages on the helodeck, a single cage stored in the wetlab, and the remainder offloaded from cages into various labs. The TOGS was stored in the aquarium, with easy access to the back deck. The aft hydro lab was used for instrument storage and prep.

* After entering the ice on the way into the Totten region polynya area, a 6 hour cargo operation was required to crane all mooring gear (including the US mooring gear) from upper decks down to the main deck. The 3 anchor tripods were stored around the port stern; the 3 ADCP's were stored under cover up the starboard alley; float groups were lifted from the cages and stored on the deck around the port and starboard stern; wire spools were stored lashed against the cage in the wetlab.

* The TSE winch on the main deck was used for all mooring work, with a thick rope lead line already on the drum. All 3 moorings were deployed anchor first, using a tugger winch from the O1 deck (via the A-frame) as a vertical stopper. The mooring winch was quite far aft, due to the seismic container ("gun shack") on the back deck, and together with the height of the A-frame (~9 m) this made for steep vertical angles for the mooring line run through the A-frame. This always left the stoppered join right at the stern lip. Fortunately it was not a problem, as conditions were calm during the deployments, and alternative stoppering rigs from the main deck were not required.

* Each mooring came with a 99 and 73 m wire shot for the top section. The following spare wire shots were included in the mooring kit: 3 x 150 m, 3 x 100 m and 3 x 50 m. This gave the flexibility to adjust mooring lengths to fit most 25 metre increments of expected bottom depths. Ideally, lengths were adjusted (by wire selection) during spooling on, once a target depth had been selected. However changing ice conditions just prior to T1 and T2 deployments meant that wire changes were necessary during the deployments. Final mooring diagrams are shown in Figures 4 to 6.

* For an addition of up to 300 m of wire to the original design, addition of extra flotation was not required.

* ADCP's were programmed for a delayed start when still in the helohangar. Pinging of all transducers was checked after craning the ADCP's to the main deck.

* The TOGS package was prepped in the aquarium (except for switch on), with all components fitted except for the green float adjacent to the VHF beacon – this had to be fitted on deck. The TOGS package was loaded on the anchor tripod on deck, and only switched on as a final step just prior to deployment. This significantly saved on battery capacity. The flashing lights on the logger were used to determine gyro stabilization (i.e. laptop communication was not used on deck). After deck switch on, a constant ship heading was maintained for 15 minutes to help stabilization of the TOGS.

* All moorings were deployed anchor first. The lander/ADCP string was hoisted as a single lift with the mooring line from the TSE winch (via the A-frame). For the top set of glass floats, the lead rope on

the TSE winch was used for hoisting, with a TR7 Seacatch release for deployment. Note that the pick-up line and pick-up floats were flaked out on deck at the stern, and allowed to self deploy after releasing the top set of glass floats. For each microcat immediately below the two float groups, the float group was first attached then lifted, transferring the load to the mooring line on the TSE winch; the microcat was then fitted to the wire under load (going directly down from the stern) below the float group.

* The Seacatch used was the pneumatic release style. The safety pin was pulled once the package was clear of the stern, leaving just the air hose going to the Seacatch. This system works very well, as release can occur even if the package spins.

* All mooring wire was 7 mm, but insulation tape was still required to get a snug fit for microcat clamps.

* For all 3 deployments, dynamic positioning of the ship on station meant negligible drift during the deployments (Figures 1 to 3).

* Ideally, it would have been good to leave the TOGS in the water long enough to test the 90 minute delayed reinitialization on the bottom. Ice conditions however at T1 and T2 meant this corner had to be cut, and the reinitialization was not programmed in; it was only used at T3. The package was left on the bottom for ~1.25 hours at T1, ~1.5 hours at T2 and ~2 hours at T3.

* The hull mounted acoustic release transducer (outlet in the dry lab) and shipboard EdgeTech deck unit were used for all communication with the TOGS CART releases. Note that the multibeam (and Knudsen) must be switched off to allow release comms. Communication with the releases was possible during ascent, but not possible with the hull-mounted transducer when the package reached the surface. To be conclusive about whether or not the CARTS can be contacted with the package at the surface, tests would have to be done with a transducer lowered from the deck.

* For all 3 TOGS recoveries, the package was released with the ship 2 cables from the deployment location.

* The TOGS GPS antenna was installed on the rails above the ice tower, with the deck unit in the ice tower. A GPS feed was patched into the serial outlet there. For the TOGS VHF beacon, the Palmer had it’s own RDF aerial and Taiyo deck unit on the bridge. The VHF beacon and GPS beacon flasher worked each time. For T1 and T3, the GPS beacon failed to ever find the satellite. For T2, the beacon found the satellite some time near recovery from the water (unknown if this was before or after lifting clear of the water). When the TOGS package was at the surface during T3 recovery, the package was observed listing towards the GPS beacon side, meaning the GPS aerial might not be sufficiently clear of the water.

* The TOGS pick-up line deployed successfully each time, though on T1 only half the line fed out of the bucket (the remainder was pulled out by hand from the deck, with the package still in the water). Ship handling approaching the TOGS package was excellent. The package was grappled from the starboard side, and the pick-up line was attached to the line from the TSE winch (via the A-frame), and the package hoisted over the stern. Note the following programming for the pick-up float release:
T1 - activation at 550 m, firing at 200 m
T2 – activation at 300 m, firing at 200 m
T3 – activation at 300 m, firing at 200 m

* After each recovery of the TOGS package, the summary file was downloaded, and the logger housing was opened for memory card download and battery pack change. New batteries were also installed in the VHF and GPS beacons prior to each deployment.

Table 11. Summary of mooring deployment and recovery information; positions and depths are at the landing positions (anchor first deployments, so no anchor fallback). Depths are from the TOGS logger pressure sensor. "Release time" = final component released (for deployments); = release signal sent to releases, and release confirmed, for TOGS recoveries.

Mooring	position		depth (m)	release time (UTC)	position (decimal degrees)
deployments					
TOTTEN1	66° 32.558'S	119° 12.685'E	708	125306, 18/02/2014	66.54263°S 119.21142°E
TOTTEN2	66° 12.628'S	120° 37.638'E	501	130000, 22/02/2014	66.21047°S 120.62730°E
TOTTEN3	66° 30.082'S	120° 27.398'E	550	032200, 05/03/2014	66.50137°S 120.45663°E
TOGS recoveries					
@TOTTEN1				1412, 18/02/2014	
@TOTTEN2				1436, 22/02/2014	
@TOTTEN3				0543, 05/03/2014	

In the following deployment and recovery notes, all times are UTC.

5.9.2 T1 mooring deployment

* An anchor first deployment in open water.

* The original target depth at the time of spooling on was 750 m. At deployment time, the site had to be moved a safe distance from the ice for TOGS recovery, with a new target depth of close to 700 m. A 50 metre wire shot, already prespooled onto the winch with a pear link at each join, was removed during the deployment to shorten the mooring (and the second from top microcat position was adjusted accordingly). Note that a pear link is required at all permanent wire joins, in case wire swaps are required during a deployment.

* The pumped microcat serial 9880 (with oxygen sensor) was programmed for a delayed start in the water post deployment.

* When talking to the TOGS CART releases, good ranges were obtained from release 35112, but it would not release. CART 34038 was required for release. 35112 was tested on deck after recovery, and released okay.

* From TOGS pressure sensor data:
anchor descent rate (anchor first deployment) after release = 1.484 m/s
TOGS ascent rate after release = 0.958 m/s
TOGS deployment depth (1 m above bottom) = 707 m (exact correspondence with the multibeam depth of 708 m)

Mooring component	UTC time in the water
ADCP-14489 + tripod anchor + releases 29300 and 35504 + microcat 913	1145, 18/02/2014
6 glass floats + microcat-9880	1204, 18/02/2014
microcat-4906	1214, 18/02/2014
6 glass floats + microcat-4905	1253, 18/02/2014
pick-up floats	1253, 18/02/2014

At release of top floats:

position = 66° 32.558'S, 119° 12.685'E
depth = 708 m (from multibeam)
ship's gyro heading = 273.9°

TOGS recovery:
- 34038 used for release (35112 wouldn't release), released at 1412, 18/02/2014; TOGS on deck at 1447, 18/02/2014.

5.9.3 T2 mooring deployment

* An anchor first deployment in open water.

* The original target depth at the time of spooling on was 550 m. At deployment time, the site had to be moved several miles from the southward moving ice, with a new target depth of 500 m. The 99 metre wire shot, already prespooled onto the winch with a pear link at each join, was removed during the deployment and a 50 metre wire shot was spooled back on, shortening the mooring by 49 m (the second from top microcat position was adjusted accordingly).

* From TOGS pressure sensor data:
anchor descent rate (anchor first deployment) after release = 1.452 m/s
TOGS ascent rate after release = 0.951 m/s
TOGS deployment depth (1 m above bottom) = 500 m (differing from multibeam depth by ~4 m)

* TOGS data show an unexpected reinitialization after firing of the pick-up float solenoid at 200 m on the ascent – speculating this may have been due to a depleted battery getting a kick in the guts from the solenoid.

Mooring component	UTC time in the water
ADCP-14397 + tripod anchor + releases 29301 and 35506 + microcat 909	1202, 22/02/2014
6 glass floats + microcat-3140	1218, 22/02/2014
microcat-3124	1225, 22/02/2014
6 glass floats + microcat-1777	1300, 22/02/2014
pick-up floats	1300, 22/02/2014

At release of top floats:

position = 66° 12.628'S, 120° 37.638'E
depth = 497 m (from multibeam)
ship's gyro heading = 77.2°

TOGS recovery:
- 34038 used for release, released at 1436, 22/02/2014; TOGS on deck at 1458, 22/02/2014.

5.9.4 T3 mooring deployment

Figure 42. Australian mooring deployment (pic by Natalie Zielinski)

* Deployment was at first planned for an outer shelf location, north of the ice, in the hope of finding an outflow trough. Following a useful underway CTD transect, the location was changed to inside the polynya, at a confluence of contours from the N and NW, and along the assumed inflow path between T1 and T2.

* An anchor first deployment in open water.

* There were no problems with ice, so the target depth of 550 m was retained, and no wire changes were required during deployment. The deployment was therefore significantly faster than for T1 and T2.

* The TOGS was programmed for a delayed re-initialization after 90 minutes on the bottom.

* The pumped microcat serial 9881 (with oxygen sensor) was programmed for a delayed start in the water post deployment.

* From TOGS pressure sensor data:
anchor descent rate (anchor first deployment) after release = 1.558 m/s
TOGS ascent rate after release = 0.950 m/s
TOGS deployment depth (1 m above bottom) = 549 m (differing from multibeam depth by ~4 m)

Mooring component	UTC time in the water
ADCP-14462 + tripod anchor + releases 35503 and 35505 + microcat 911	0244, 05/03/2014
6 glass floats + microcat-9881	0255, 05/03/2014
microcat-3141	0302, 05/03/2014
6 glass floats + microcat-4907	0322, 05/03/2014
pick-up floats	0322, 05/03/2014

At release of top floats:
position = 66^{o} 30.082’S, 120^{o} 27.398’E
depth = 546 m (from multibeam)

ship's gyro heading = 74^{o}

TOGS recovery:
- 34038 used for release, released at 0543, 05/03/2014; TOGS on deck at 0615, 05/03/2014.

5.9.5 Set-up and turnaround of mooring instruments

* All times referred to are UTC.

Microcat SBE37's - all clocks set to correct UTC between 0530 and 0630 on 31/01/2014
- all set to start at 000000 on 03/02/2014
- 10 min. sampling interval; no. of samples to average = 4 i.e. NAVG=4

Microcat SBE37ODO serial 9880
- clock set to correct UTC 2330 on 17/02/2014
- set to start at 000000 on 19/02/2014
- 60 min. sampling interval

Microcat SBE37ODO serial 9881
- clock set to correct UTC 2309 on 04/03/2014
- set to start at 030000 on 05/03/2014
- 60 min. sampling interval

ADCP's - clocks set to correct UTC between 0230 and 0300 on 03/02/2014
- first ping set to 000000 on 04/02/2014
- set-up captures:
  Dpl1_ = serial 14462 (TOTTEN-3)
  Dpl2_ = serial 14489 (TOTTEN-1)
  Dpl3_ = serial 14397 (TOTTEN-2)

* All 3 ADCP's confirmed pinging on deck at correct time after shift down to main deck.

TOGS
TOTTEN-1: float activation depth = 550 m
float trigger depth = 200 m
no delayed mode re-initialization
TOTTEN-2: float activation depth = 300 m
float trigger depth = 200 m
no delayed mode re-initialization
TOTTEN-3: float activation depth = 300 m
float trigger depth = 200 m
set delayed mode re-initialization, 90 minute delay

5.9.6 Post deployment notes

* CART release 35112 needs testing. It ranges okay, but does not release at depth (releases okay on deck).

* Balancing of TOGS package in the water needs fine tuning. When ascending after release, tilt sensors show typical values of roll ~-35^{o} and pitch ~-5 to -10^{o}. At the surface, roll ~-10^{o}, pitch negligible. The listing at the surface prevents sufficient clearance of the GPS aerial above the water.

* TOGS tilt sensors show the tripod lander sitting on the bottom at the following angles:
TOTTEN-1: pitch -1.5^{o}, roll 4.5^{o} ; TOTTEN-2: pitch 1^{o}, roll 1.5^{o} ; TOTTEN-3: pitch -8^{o}, roll 6^{o}

5.9.7 Acknowledgments

Many thanks to the ship's crew, and technical and scientific personnel. Thanks in particular for the solid and professional work of the deck MT's, winch/A-frame operators on the main deck/O1 deck/aft control, and ship handlers on the bridge. The mooring program was funded through the Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, with ship support from the US National Science Foundation and US Antarctic Program.

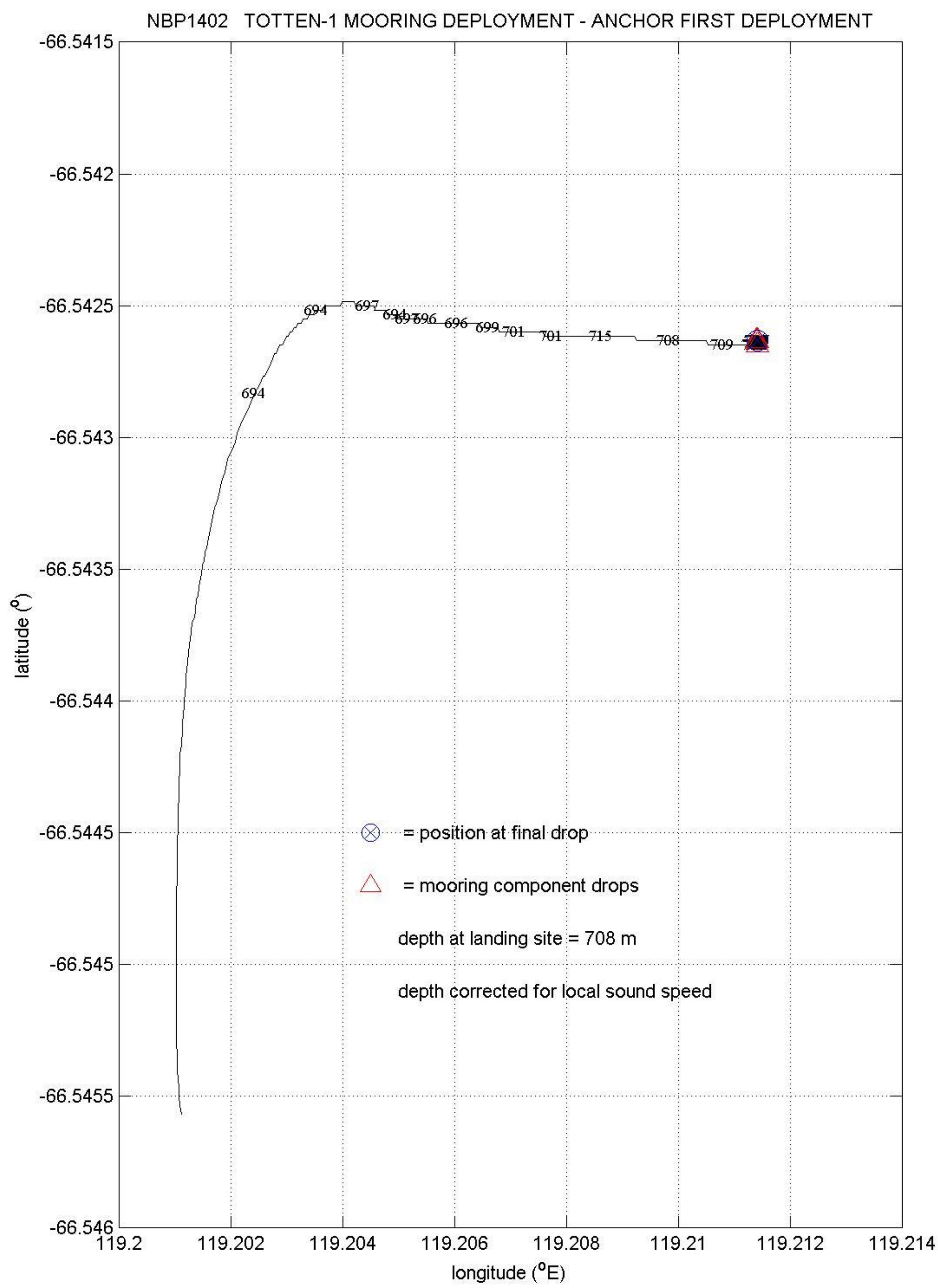


Figure 43. TOTTEN-1 mooring deployment diagram, ship track and bathymetry. Along track bottom depths from multibeam; final depth at landing site from TOGS pressure sensor.

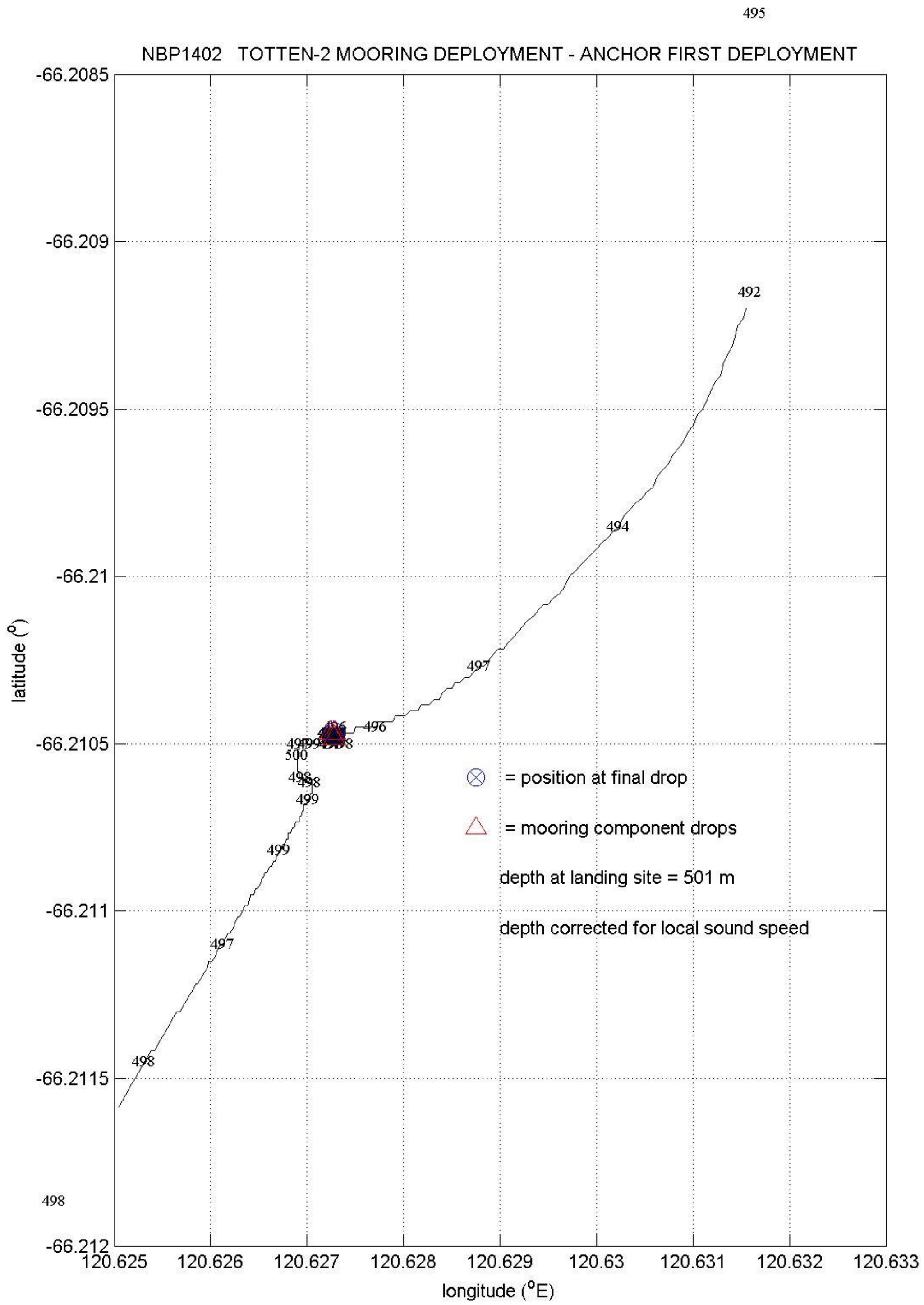


Figure 44. TOTTEN-2 mooring deployment diagram, ship track and bathymetry. Along track bottom depths from multibeam; final depth at landing site from TOGS pressure sensor.

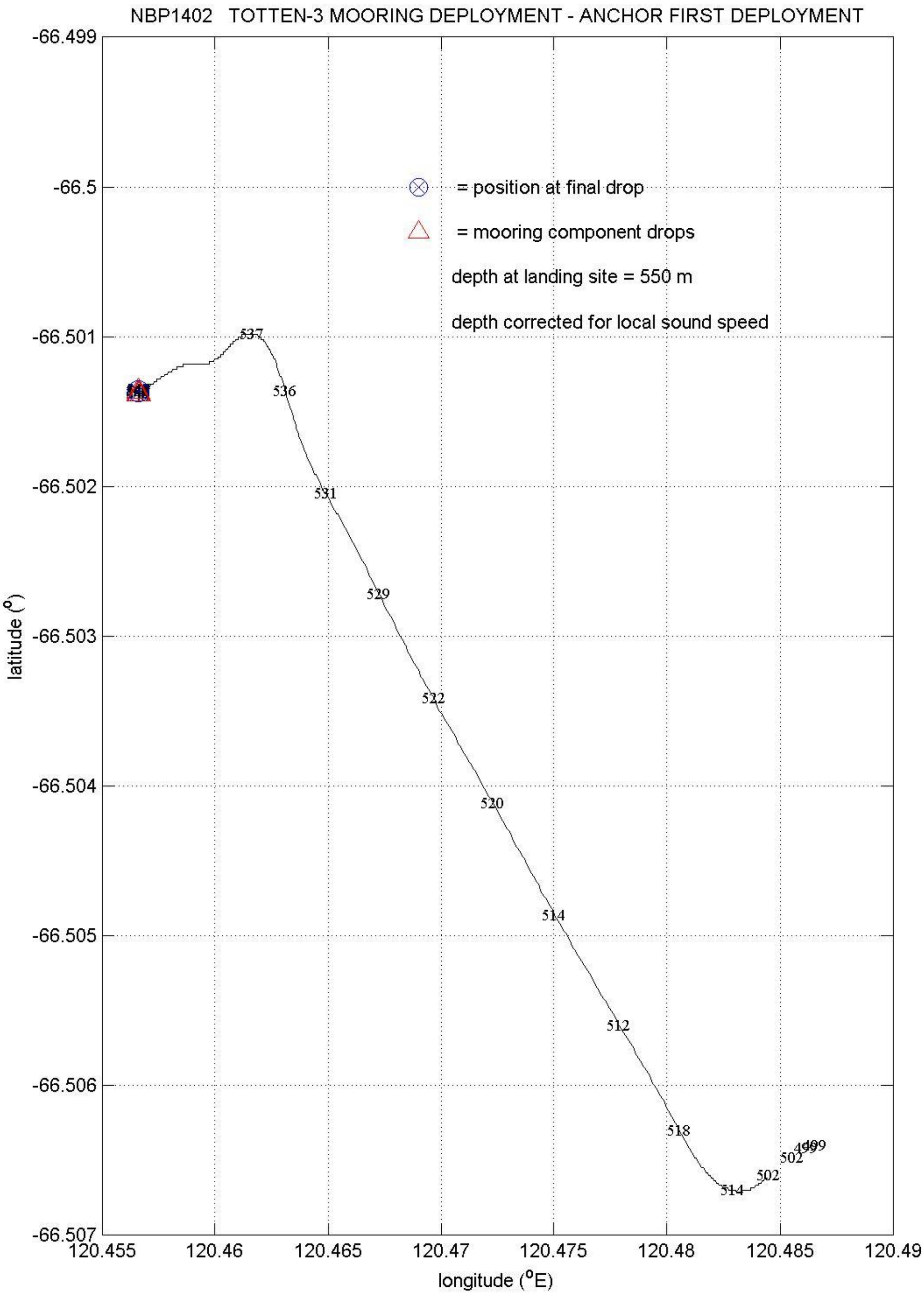


Figure 45. TOTTEN-3 mooring deployment diagram, ship track and bathymetry. Along track bottom depths from multibeam; final depth at landing site from TOGS pressure sensor.

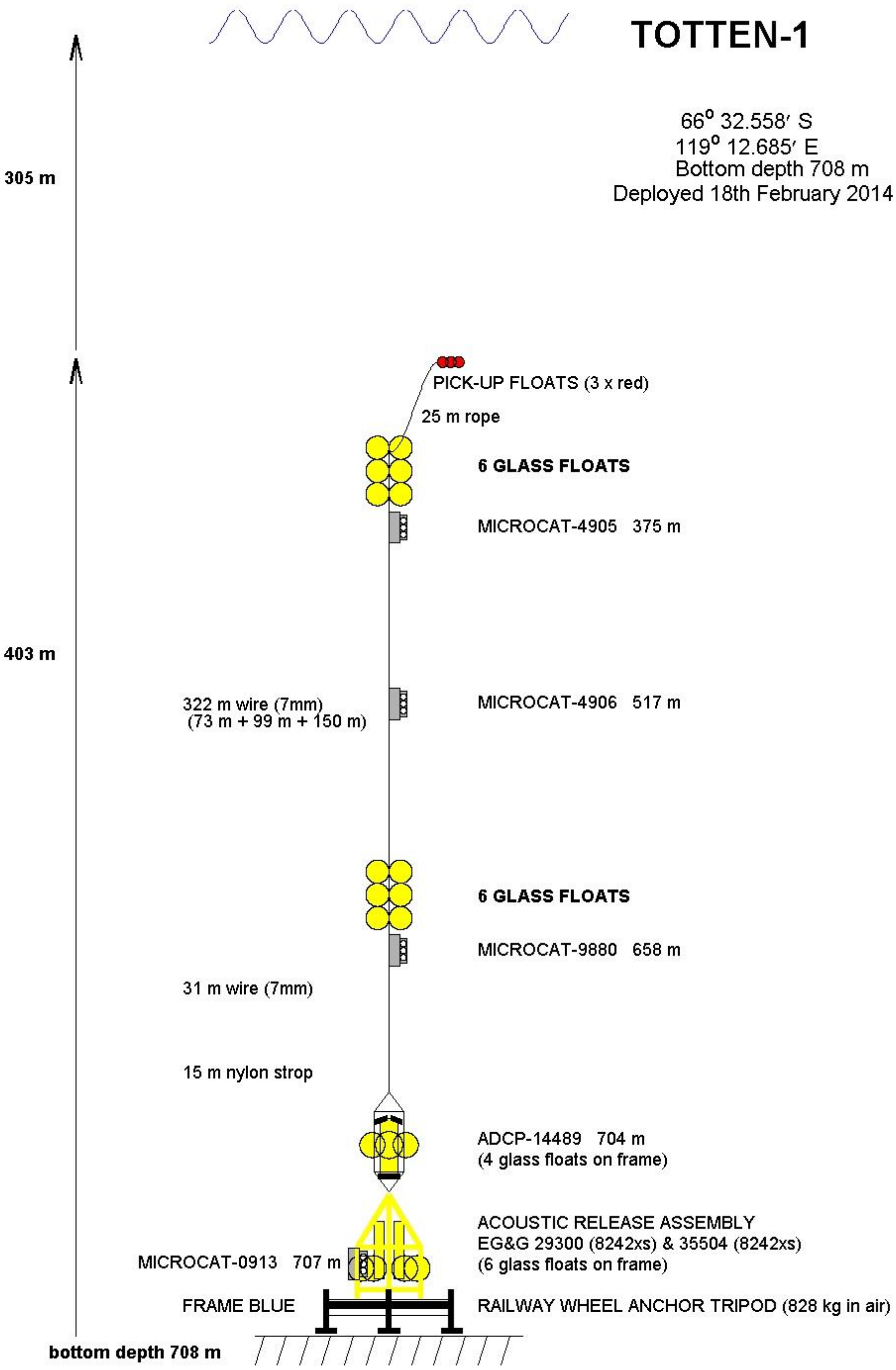


Figure 46. TOTTEN-1 mooring.

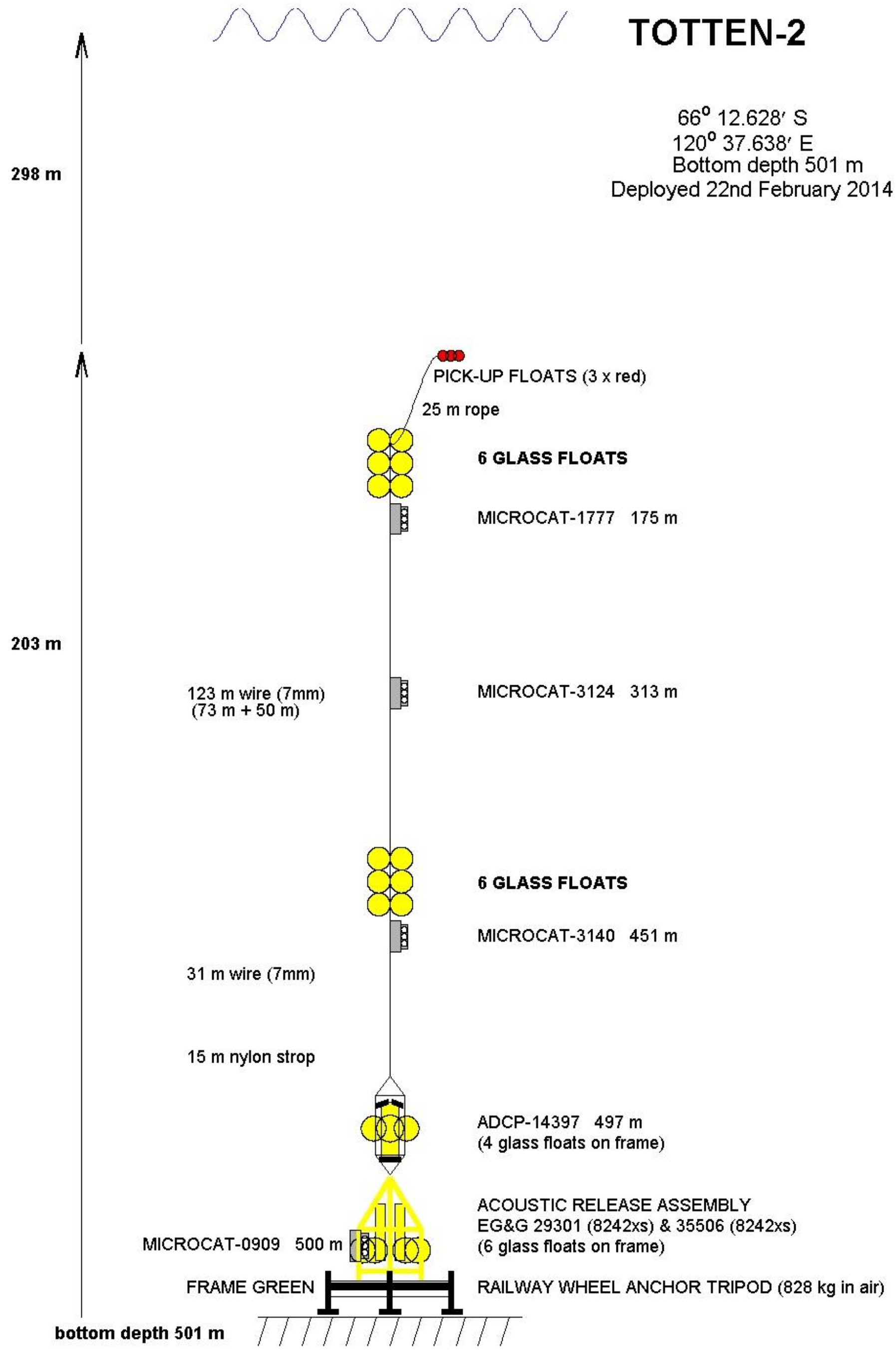


Figure 47. TOTTEN-2 mooring.

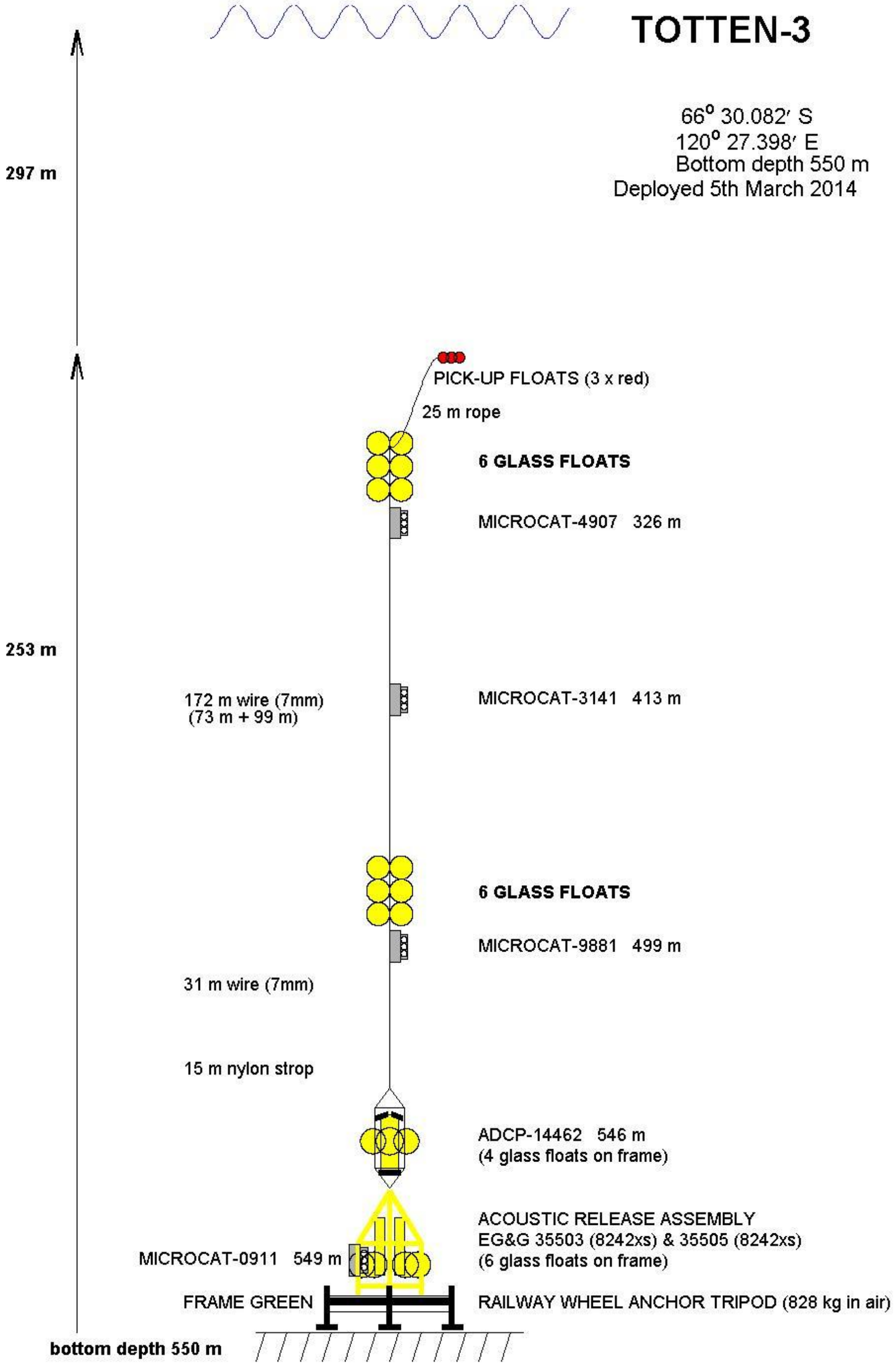


Figure 48. TOTTEN-3 mooring.

6. LINKS TO AEROGEOPHYSICAL DATA AND POTENTIAL FIELDS DATA SUMMARY

6.1 RECENT AEROGEOPHYSICS IN THE INDO-PACIFIC SECTOR OF THE EAIS

NBP1402 is an interdisciplinary project with a science team composed of both marine and aerogeophysical expertise. The principal investigators and their teams represent several decades of experience describing both the landward and seaward sides of the East Antarctic grounding line. Specifically, NBP1402 follows five consecutive Antarctic deployments of airborne geophysical surveying of the Indo-Pacific sector (~100E to 165E) of the East Antarctic Ice Sheet (EAIS) by the ICECAP project (International Collaborative Exploration of the Cryosphere using Aerogeophysical Profiling) under the direction of NBP1402 Co-Investigator Blankenship. Little was known about the subglacial configuration of this sector of Antarctica before ICECAP began as a collaborative NSF/IPY initiative in 2008, with the subglacial landscape characterized by a few ice soundings from the 1980s and earlier and their coastal connections virtually unknown. The effort has provided insight into the geological and glaciological settings of the EAIS relevant to NBP 1402 by enabling several key findings:

- The Wilkes and Aurora Subglacial Basins (WSB and ASB), two of the largest reservoirs of sea level potential in Antarctica, are broader, deeper, and more susceptible to marine ice sheet instability than previously understood (Fretwell et al., 2013).
- The broad morphology and coastal connections of the ASB indicate a dynamic early ice sheet with a significant erosional history and multiple ice sheet configurations (Young et al., 2011; Roberts et al., 2011).
- A large, active, subglacial hydrological system terminates into the Sabrina Coast (Wright et al., 2012) following flow paths that more than likely predate large scale glaciation.
- A new tectonic interpretation of Wilkes Land suggests that pre-EAIS tectonic features are the primary control on subglacial topography and a previously-unknown sedimentary basin landward of the Sabrina Coast grounding line may have been an inland sea prior to the onset of large scale glaciation (Aitken et al., in press).
- ICECAP ice surface elevation and cross-track slope data have been used to improve the 10-year record of satellite laser altimetry data along the coast, revealing extensive lowering of the Totten and Denman glaciers in the Sabrina and Knox coasts, respectively and to measure active subglacial hydrology beneath George V glaciers (Young et al., submitted).
- Three large seafloor depressions near and beneath the Sabrina Coast ice shelves may represent oceanographic inflow and outflow areas critical for ice-ocean interactions (Greenbaum et al., in prep.).

The above combined with recent work highlighting the importance of the EAIS to Pliocene and Eemian sea level change motivates marine exploration of the Indo-Pacific Antarctic margin, towards which NBP1402 has provided a significant first step.

6.2 PRIMARY AND SECONDARY TARGET AREAS FOR NBP1402

NBP1402 identified three target coastal areas for marine survey in light of the above insights: The continental shelves of the Sabrina Coast, the George V/Oates coasts, and the Knox Coast (see figure below). These areas all share these common qualities:

- They are seaward of areas of the EAIS with large sea level potential (WSB and ASB).
- Their coastal glaciers are experiencing active coastal glaciological processes either through surface lowering (Totten and Denman Glaciers) or active subglacial hydrology (the unnamed glacier feeding the Cook Ice Shelf).
- Few or no direct bathymetric or oceanographic measurements exist between the grounding line and the shelf break.

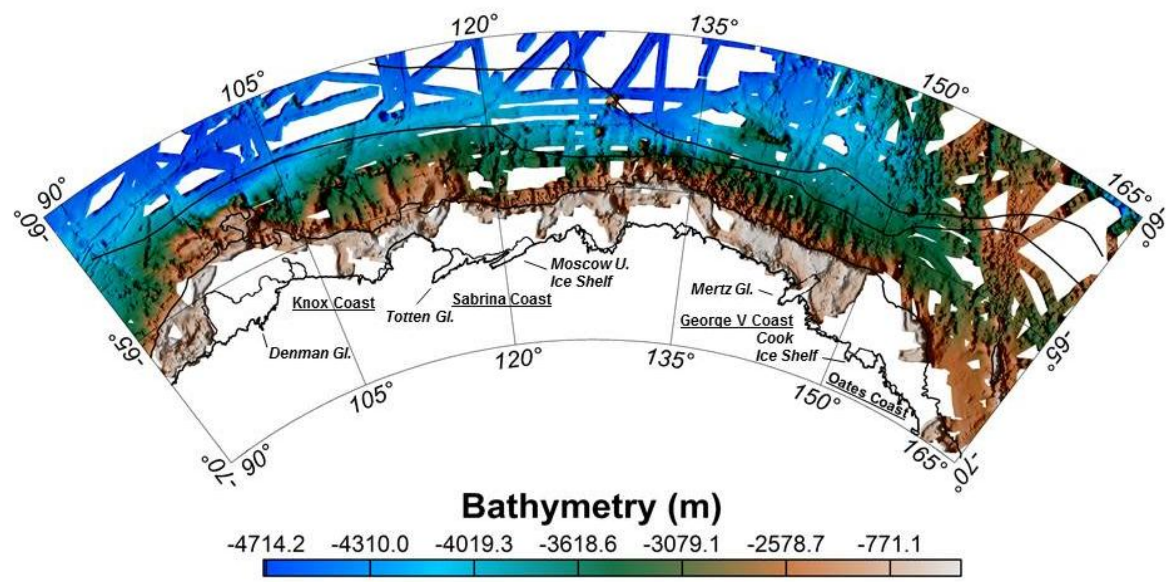


Figure 49. Coast names (underlined) and major glaciers (italicized) identified as primary and secondary targets for NBP1402. Gridded data represent bathymetry knowledge prior to NBP1402.

6.3 THE SABRINA COAST: TOTTEN GLACIER, DALTON AND MOSCOW UNIVERSITY ICE SHELVES

The ice shelves of the Sabrina Coast are experiencing high rates of basal melting at a time when independent platforms reveal accelerating mass loss from the region. Two glaciers drain into the Sabrina Coast, an unnamed glacier that terminates into the Dalton and Moscow University ice shelves and the Totten Glacier. They are separated by low-lying, ice-covered terrain, a region that satellite-based surface altimetry has shown to be steadily lowering since the beginning of all spaceborne altimetry records. The amplitude of these changes is highest near the Totten although the close proximity and low topography between the glaciers suggests that changes to one could influence the other. Both are over two kilometers thick near the deepest areas of their grounding lines so small changes in their stress states could have important implications for regional mass balance and sea level.

The Sabrina Coast was given the top priority for exploration and the majority of survey time over the Knox and George V coasts because the current mass loss occurring along the coast is the largest in Antarctica after only Pine Island and Thwaites Glaciers in West Antarctica and this mass loss is accelerating. Establishing whether enhanced ocean forcing is to blame for these changes requires direct oceanographic observations available on an ice-hardened platform like the NBP. Additionally, the large sediment deposits located seaward of the shelf break combined with the hydrological and erosional regimes inferred by recent ICECAP data and analyses indicate that these sediments would likely have been deposited through the Sabrina Coast and across the continental shelf, likely leaving behind a record of glacial advance and retreat cycles evident in multibeam, shallow cores, and seismic data.

The following subsections discuss NBP1402's accomplishments in the context of ICECAP insights introduced above and what has been left on the table for future work. The final sections describe the magnetometer and dual-instrument gravimetry component of NBP1402 as the link between marine surveys and past and future airborne surveys. Practical information on the experimental setup and performance of the gravimeters and magnetometer during NBP1402 is included at the end with specifications and other ancillary information provided in the Appendices.

6.4 PALEO ICE SHEET CONFIGURATIONS AND SUBGLACIAL GEOLOGY

The morphology of the ASB revealed by ICECAP ice sounding radar can be best explained by a dynamic early ice sheet having undergone many cycles of advance and retreat with multiple paleo-ice sheet configurations. Gravimetry and magnetics acquired with the radar sounding have been used to infer the subglacial geology landward of the NBP1402 survey area, including the tectonic framework and sediment distribution of the ASB and the previously unknown Sabrina Subglacial Basin positioned upstream of the Sabrina Coat continental shelf, NBP1402's primary target area. Airborne surface and subsurface data have been used to map the subglacial hydrological potential of the Indo-Pacific sector of the EAIS, revealing that the Sabrina Coast acts as the primary sink for subglacial water from between the Dome C ice divide to the ASB, possibly assisting movement of sediment to the coast.

6.4.1 NBP1402 Accomplishments

NBP1402's multibeam data reveal channels in exposed bedrock seaward of the MUIS that may be related to subglacial hydrological erosion when the paleo-Sabrina Coast ice sheet was grounded 60km north of its present position. Grain size analysis and material dating from the NBP1402 shallow core inventory may be used to find evidence and potential timing of meltwater events within these channels.

NBP1402's multichannel seismic data reveal the sediment record of the eastern half of the Sabrina Coast continental shelf and provide linkages to the potential subglacial sediment sources inferred by ICECAP that may have been transported via the unnamed glacier feeding the Moscow University Ice Shelf (MUIS).

6.4.2 Remaining Questions

The sea ice distribution this season did not allow the NBP to survey the area immediately north or west of the Totten Glacier. As a result, we are left with several questions with respect to the western half of the Sabrina Coast continental shelf:

- Does the exposed bedrock observed from the Dalton Rise to ~118E extend farther to the west or does it dive beneath sediment? ICECAP aerogeophysical data suggest that either the seafloor deepens in this region if the material density remains constant or that a sediment layer overlies less dense bedrock which could result in a shallower seafloor to the West.
- Is there a similar record of channels west of 118E? Are they similar in aspect ratio and depth to those observed on the MUIS side?

6.5 CONTEMPORARY COASTAL GLACIER CHANGE

ICECAP data have extended and improved upon two decades of satellite-based radar and laser surface altimetry that indicate a dynamic contemporary EAIS. Airborne laser altimetry repeats of satellite altimetry tracks along the coastline have measured some of the most rapid surface lowering signals anywhere in Antarctica along the Sabrina and Knox coasts. Combined ice surface velocity and radar sounding has shown that sub-ice shelf melting of the Totten and MUIS far exceed calving. Radar sounding data collected in the George V region indicate significant marine ice sheet instability associated with the WSB with significant sea level potential but little change to the coastal glaciers in recent years. The variation in glacier change along the EAIS coastline has been linked to the contemporary climatology and oceanography of the area. For Totten Glacier in particular surface altimetry and firn modeling suggest that the massive lowering signal cannot be explained by firn compaction or changes in accumulation, which leaves enhanced ocean forcing, changes in upglacier subglacial bed conditions, or ongoing retreat from a former instability as a few remaining hypotheses. Enhanced ocean forcing has been linked to retreating glaciers elsewhere in Antarctica, which makes it a popular hypothesis in areas like the Sabrina Coast.

6.5.1 NBP1402 Accomplishments

A significant oceanographic program was conducted on NBP1402 utilizing state-of-the-art underway CTD casts, traditional rosette casts, and moorings as described in the oceanography section of this final report. We are hopeful that these data will characterize inflow and outflow between the shelf break and the Dalton Ice Shelf / MUIS system and allow us to compare the energy available for melt with the ICECAP-derived surface lowering data recently analyzed along the Dalton/MUIS. Significant warm water was found on the continental shelf but the southernmost CTD casts do not indicate that this water reaches the Dalton/MUIS. These data will also be critical for understanding at least part of the inflow to the Totten Glacier because the coastal current will move currents through the NBP1402 survey area to the west along isobaths.

6.5.2 Remaining Questions

By not reaching the face of the Totten Glacier, questions remain concerning the contemporary changes occurring in the Sabrina Coast:

- Are there additional inflow/outflow pathways for oceanic exchange west of 118E and, if so, do the additional pathways allow MCDW observed on the mid-shelf to reach the Totten Glacier cavity?
- Why is the Totten Glacier thinning 1.5 times faster than the Dalton/MUIS even though their grounding lines are at similar depths?

6.6 BATHYMETRY NEAR AND BENEATH SABRINA COAST ICE SHELVES

The high calving rate of the ice shelves and the steady production of sea ice from a large polynya normally active in the east combined with the presence of seafloor rises that slow the movement of ice to the west make the area difficult to access. As a result, few direct bathymetry measurements had been made around the Sabrina Coast prior to NBP1402 and no direct measurements have been made beneath the ice shelves and fast ice-choked regions in East Antarctica. This data gap presents an impediment to understanding and reliably predicting oceanographic forcing on the EAIS coastline. In areas like this it is possible to use disturbances in the gravity field to infer the general bathymetry of the seafloor. A significant uncertainty in these estimates is the presence of variations in the column-averaged density of the seafloor. Density variations can be significant in areas with sediments so unconstrained gravity inversions in such regions will be less accurate if an incorrect density model is used. With the addition of magnetic depth to basement solutions for sediment thickness estimates and available grounding lines and ice rises as constraints, the density model can be improved and the error can be decreased. ICECAP airborne gravity and magnetics data have been used to infer the shape of the seafloor of the inner continental shelf and beneath the Totten, Dalton, and Moscow University ice shelves so that potential oceanographic inflow and outflow depressions connecting the cavities to the continental shelf could be identified.

6.6.1 NBP1402 Accomplishments

During the second week of Sabrina Coast operations the NBP fought its way through multiyear ice into the edge of the ICECAP airborne gravity and magnetics grid, providing an opportunity to verify the existence, actual shape, and potential oceanographic significance of the seafloor depressions. Two bathymetry lows predicted by airborne inversions were verified by the NBP. The first is located at about 117.75E / -66.8S and reached a maximum depth of ~1300 mbsl with an approximate width of 4 km that could not be verified since we were unable to sample the western ridge due to sea ice. Another slightly wider depression located near 119.5E / -66.8S measured about 5 km across and reached a depth of ~1240mbsl. The western canyon was discovered during the NBP's initial push to the Totten area and the second was found during the second attempt. Due to a heavy storm that encouraged the crew to remain in the lee of the Dalton Ice Shelf for over a day the second of these depressions was surveyed more extensively than it may have been otherwise, leading to the decision to conduct a series of CTD casts and to leave the third Texas A&M mooring on the east (inflow) side of the feature.

The locations of the deepest parts of the canyons were located where airborne gravimetry predicted they would be but they were deeper than predicted by a few hundred meters. A discrepancy between the inversions and the truth was expected for such narrow features since the ability of a gravimeter to discriminate between two ridges is limited by the velocity over and the elevation above the topography. The spatial resolution of the gravimeter at the speeds flown by the platform was between 4 and 5km, nearly the same as the distance between the sides of the canyons.

Before getting turned back by thick ice, the first of these canyons was found and the water properties within were measured, data that may help understand why the Dalton Ice Shelf is lowering so rapidly. In total, the NBP crossed three of the aerogeophysical lines and sailed in other areas where the aircraft did not fly. Together, the airborne and marine datasets provide a high-resolution view of the seafloor from the NBP complemented by the broad seafloor shape in un-navigable areas provided by airborne data.

6.6.2 Remaining Questions

Verifying and accurately characterizing the two Dalton/MUIS seafloor depressions predicted with airborne gravity inversions was an encouraging start. Gravity inversions predict a wider and deeper seafloor depression ~24 km to the west of where the ship was able to access this season. Given the experience of NBP1402, it is possible that the next canyon is at least 1.3km at its deepest. The following questions remain:

- How deep is the next canyon and what is its role in delivering heat to the western Sabrina Coast?
- What is the western extent of the westernmost depression observed by NBP1402?

6.7 INFORMING FUTURE AEROGEOPHYSICS

ICECAP data and related analyses provided the grounded ice and near coastal context for NBP1402 and an opportunity exists to fill in areas where NBP1402 was unable to sail with future aerogeophysical flights. Logistical support for two additional seasons of ICECAP aerogeophysical surveying along the Sabrina Coast have been funded by the Australian Antarctic Division. Assuming funding for flight hours are secured, these potential deployments will be leveraged to extend what has been learned by NBP1402 and previous ICECAP missions and provide context for potential future marine surveys to the region in the same way that previous airborne data did for NBP1402. Specific objectives of these potential deployments include:

- Filling in the area between NBP1402's ship tracks and existing ICECAP coverage of the eastern Sabrina Coast to develop a more complete model for the seafloor beneath the Dalton and MUIS ice shelves with a density model made more accurate by what was learned by NBP1402.
- Survey the Dalton Rise to determine how far the sediments observed by NBP1402 on its western flank extend to the east.

- Fly the area to the East of the Dalton Rise to infer the seafloor shape and identify potential inflow and outflow depressions into the cavity beneath the Moscow University Ice Shelf from the east side of the Dalton Rise.

6.8 NBP1402 GRAVIMETRY AND MAGNETICS AS THE LINK TO AEROGEOPHYSICS

The gravimeter and magnetics sensors aboard the NB Palmer had the unique capacity to tie the existing record of airborne potential fields data to the gravity and magnetics data acquired by the NBP complemented by multibeam and seismic data. Since the cruise tracklines intersected a few airborne survey lines, it will be possible to level these datasets to one another and register the airborne data to the marine data. Doing so extends the marine data into areas where the ship cannot sail but the airplane has flown (e.g. fast ice and the ice shelves) while at the same time increasing the accuracy of the airborne data through leveling and improved density models from the combination of marine bathymetry, seismic, and potential fields. Additionally, gravity and magnetics enables inferences of deep earth structure beyond the penetration depth of the multichannel seismic system which can only penetrate ~2 km.

Our preference was to operate two gravimeters in parallel because side-by-side surveys offer the ability to quantify uncertainty in the gravity data. Data from a single gravimeter is noise limited, often with considerable ambiguity in the actual noise level, i.e. it is difficult to tell where the signal ends and the noise begins. Uncertainty quantification normally involves repeating survey lines, a practice common with airborne surveying but impractical for a polar cruise due to limited ship time. However, operating two gravimeters side-by-side is similar to having survey line repeats for the entire survey. In addition, gravimeters are notoriously temperamental so operating two meters increases the likelihood that we will have a continuous dataset. Finally, side-by-side marine gravity surveys are uncommon in general and unprecedented in Antarctica in the published literature so a publishable quantitative comparison between the two meters will be a unique result of NBP1402.

The compiled Free Air Disturbance and Bouguer Anomaly data reveal a notable density variation in the bedrock along the Dalton Ice Shelf, low-density material near the Dalton Rise, and interesting high density regions in between. Notably, the UTIG and CMG Ops-provided GT2M gravimeter has produced exceptional data with less than 1 mgal crossover error after just preliminary processing. The preliminary BGM3 product made available to the MGDC is downsampled to 1-minute sample intervals so a fair comparison cannot be made to the 1second GT2M data and further, post-season processing will be required to accurately evaluate the relative performance of the two gravimeters throughout the deployment.

Gravimetry data can be acquired at all times as long as the meter is functioning. For primary survey operations, both the BGM3 and the GT2M functioned properly, producing 5,230 km of dual-instrument gravimetry data over the Sabrina Coast continental shelf. The BGM3 roll axis gyro failed on the transit from Antarctica to Hobart during a particularly heavy storm near the end of the transit requiring a gyro swap after arrival into Hobart.

Preliminary data processing indicate notable changes in magnetic intensity where the continued underway gravimetry dataset reveal column-averaged density variations, an indication that there are variations in geology in those areas. Acquiring magnetics data in ice-choked areas like the Sabrina Coast is difficult because the sensor uses a 300m-long cable to maintain adequate distance from the electromagnetic noise of the vessel. While the NBP was breaking ice or sailing around large chunks there was concern that the sensor and cable could be damaged so it was not deployed on those occasions. The spare magnetometer was not functioning for NBP1402 which encouraged added caution during icy conditions. An additional constraint was that the magnetometer could not be deployed on transects where underway CTDs were planned since the winches for the two systems shared the starboard side for NBP1402 and could become entangled. Nominal seismic deployment operations allow simultaneous magnetometer operation and the data are very complementary so the systems were deployed together whenever possible. In total, 610 km of scalar magnetics data were acquired in the Sabrina Coast survey area including all of the longest seismic lines that crosscut the largest dimensions of the region. The magnetometer was towed for the transit between Antarctica and Hobart at the end of the cruise.

The southern extent of the NBP's gravity and magnetics coverage connects to existing ICECAP airborne geophysical data that used the same two gravimeters and similar magnetics sensors over what the NBP's multibeam system reveals to be exposed bedrock along the calving front of the Dalton Ice Shelf.

6.9 A NEW SEMI-PERMANENT GRAVIMETER FOR THE NBP – BGM3

It was discovered during preparations for NBP1402 that the NBP's gravimeter was unusable. The gravimeter, a Lacoste and Romberg Air-Sea zero-length spring model had been on the ship for a decade but was officially retired prior to NBP1402 due to issues too expensive to justify addressing. Shortly before the NBP set sail, the NSF secured a semi-permanent loan of a marine BGM3 from UNOLS, serviced by WHOI. The BGM3 was shipped to Hobart using commercial airlines under regular supervision by ASC personnel due to the requirement that it not lose power at any time between manufacturer calibrations.

The BGM3 utilizes a sensitive vertical-axis accelerometer stabilized in two axes (pitch and roll) by a gyro-stabilized platform and a filter sized according to the speed and acceleration environment of the NBP to isolate vertical accelerations due to variations in the gravity field.

6.9.1 First time demonstration of a 3-axis gravimeter on the NBP – GT2M

The second meter on NBP1402 was a Gravimetric Technologies GT-2M provided by its commercial operator, CMG-Operations of Perth, Australia in partnership with the University of Texas at Austin Institute for Geophysics.

The GT2M is one of a new generation of gravimeters that utilize a 3-axis stabilized platform. Like the BGM3, the GT2M uses a sensitive vertical axis accelerometer but the platform that it rests on is stabilized in the yaw axis as well as pitch and roll. The addition of yaw-axis control results in less susceptibility to horizontal accelerations which enables higher sensitivity to otherwise undetectable signals and reliable data recovery in dynamic environments. A real-time GPS feed to the GT2M is required for the platform to make real-time adjustments. 3-axis gravimeters are new to the market but are growing quickly in popularity for both marine and airborne applications worldwide. NBP1402 is the first marine geophysical cruise in Antarctica to use a 3-axis gravimeter.

6.10 FIGURES

The figures that follow are meant to show where NBP1402 data were acquired with respect to existing ICECAP data and to introduce initial interpretations of the GT2M gravity and SeaSpy magnetics datasets after initial corrections have been applied.

Sabrina Coast airborne and marine gravimetry data locations

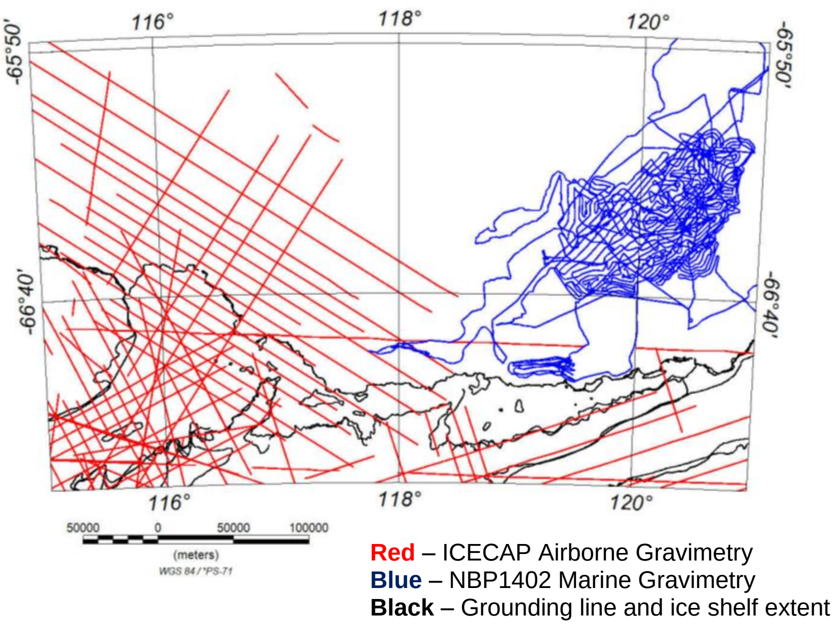


Figure 50. Locations of acceptable gravimetry data acquired by ICECAP (red) and NBP1402 (blue). Note that the majority of recoverable airborne gravity data were acquired on three flights in November, 2012 using the 3-axis GT1A. Ice shelf calving front and grounding line are shown in black.

Sabrina Coast Airborne and Marine magnetics data locations

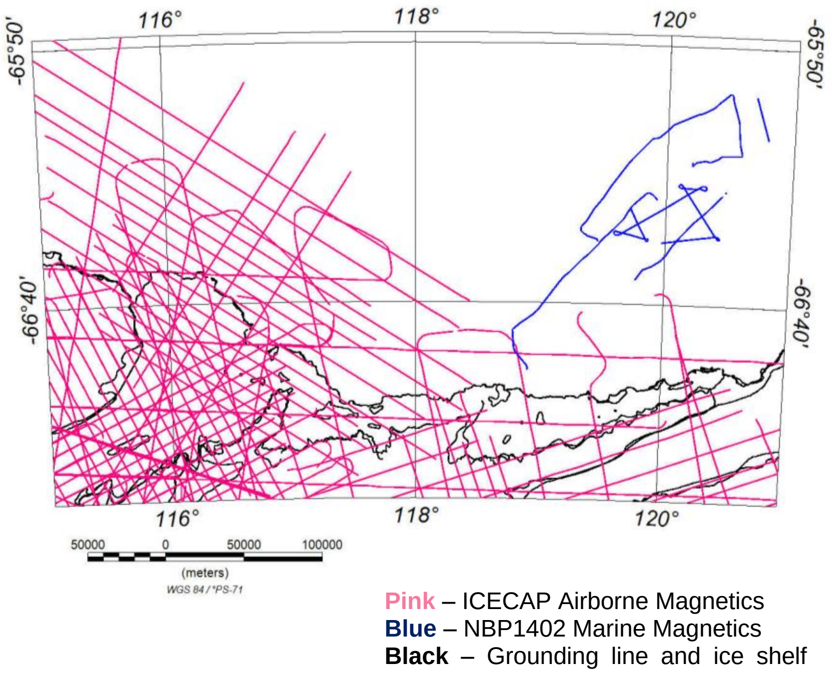


Figure 51. Locations of total magnetic intensity anomaly data acquired by ICECAP (pink) and NBP1402 (blue). Marine magnetics were acquired during seismic/gravity operations. Ice shelf calving front and grounding line are shown in black.

Sabrina Coast Bathymetry

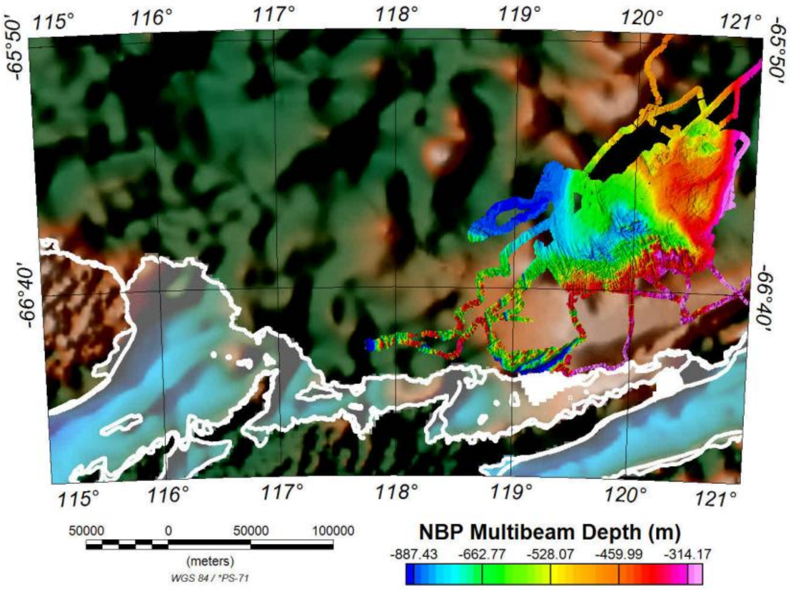


Figure 52. Compiled NBP1402 multibeam result superimposed on a merged grid of ICECAP airborne- and GEBCO satellite-inferred seafloor bathymetry and ICECAP radar-derived ice-bottom elevation beneath grounded ice. Sub ice shelf bathymetry is shown beneath a semi-transparent layer meant to represent the Totten, Dalton, and Moscow University ice shelves. The white polygons represent the MOA-derived ice shelf calving front and ERS- and ASAID-derived grounding lines.

NBP1402 Bouguer Anomaly Compilation

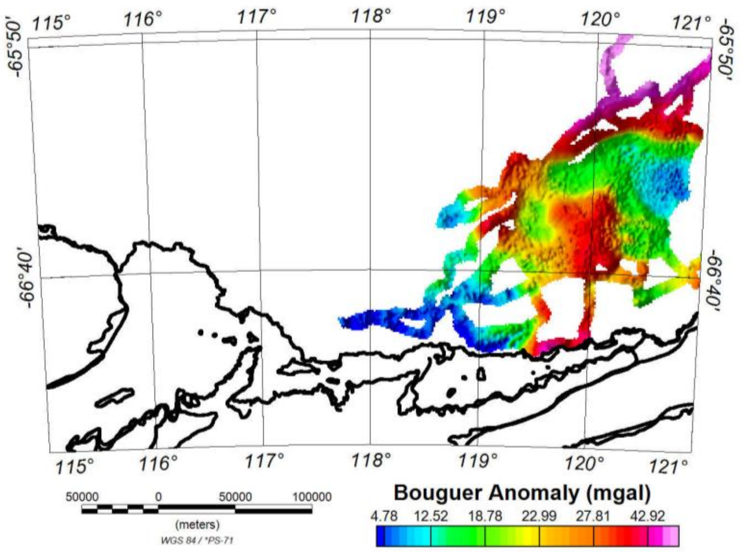


Figure 53. Bouguer gravity anomaly compilation from NBP1402 computed using coincident multibeam data and assuming a constant terrain density of 1.85 g/cc iteratively selected to minimize the effects of topography. The Bouguer low in the northeast corresponds to sediments identified with NBP1402 seismic data and the low to the southwest may indicate a change in the character of the exposed bedrock west of the channel near 119E. A notable Bouguer high lies between 119.5E and 120.5E.

Inverted 3D column-averaged seafloor density

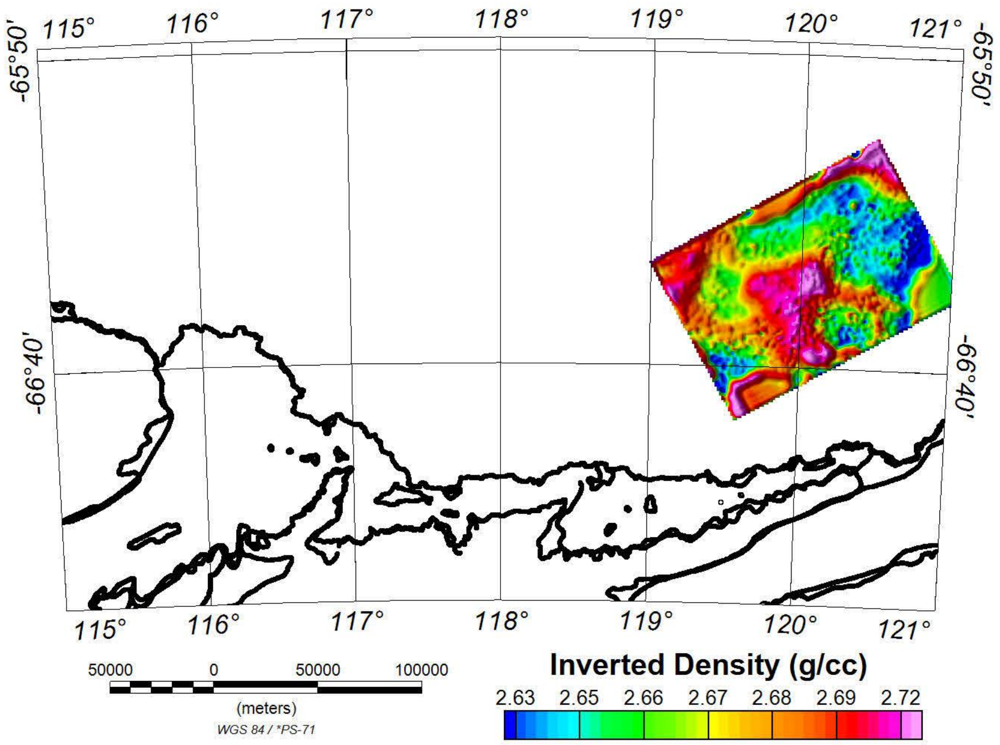


Figure 54. Column-averaged seafloor density inverted in 3D where sufficient data were present to produce a grid without significant gaps in the NBP1402 data in the center of the multibeam survey area. The inversion used a two-layer model containing seawater (density = 1.03 g/cc) above the seafloor defined by multibeam data. The topography was made constant and the density field was iterated until the computed gravity field matched the GT2M free air gravity data. The general character of the result is consistent with the Bouguer anomaly of the area. The low density area in the northeast occurs where NBP1402's seismic data verified the presence of sediments that would decrease the column-averaged density of the area. The high density area in the center corresponds to a high Bouguer Anomaly.

Modeled 2D column-averaged seafloor density along the Dalton Ice Shelf

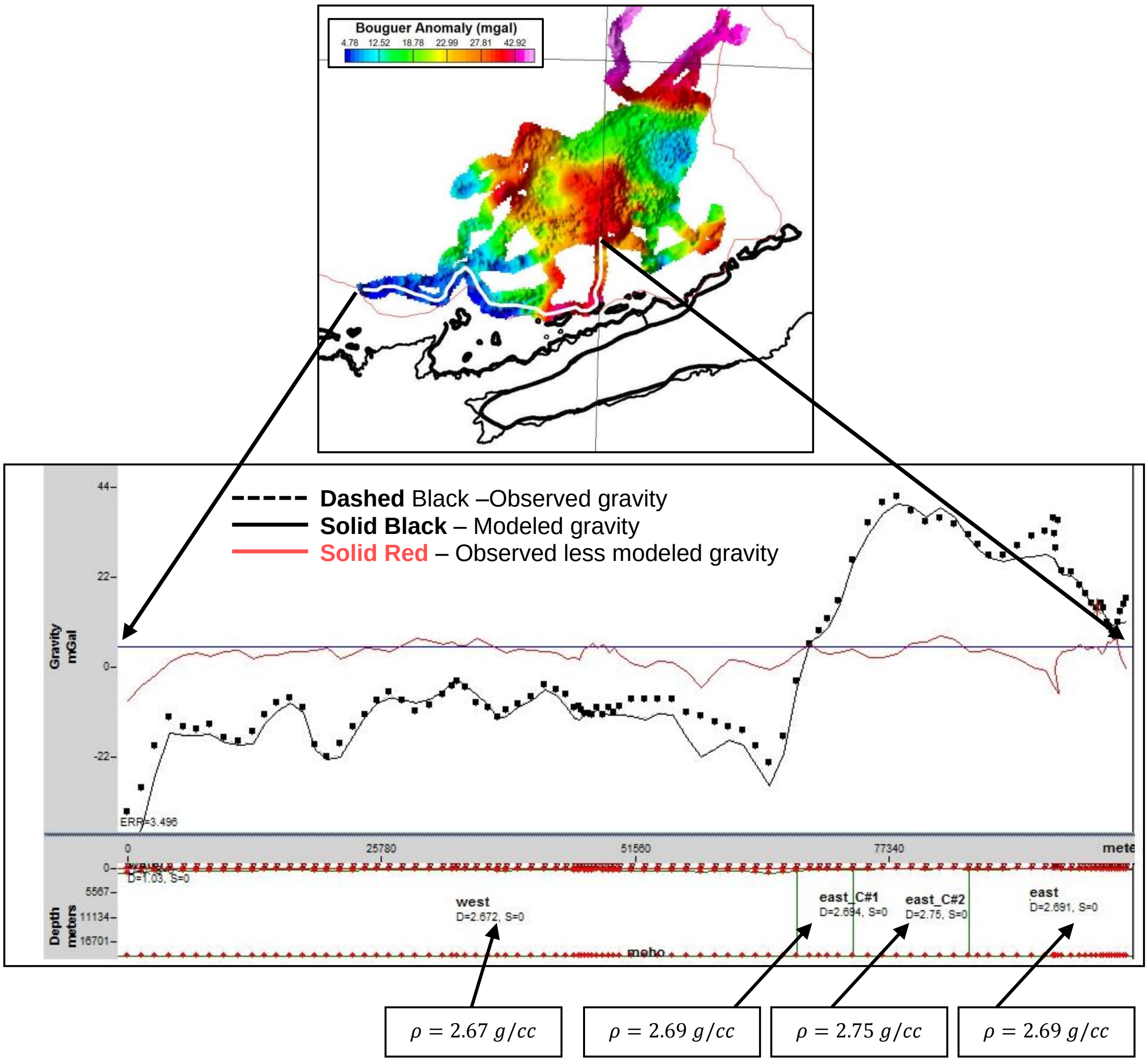


Figure 55. Computed and observed GT2M gravity data along the white profile in the upper image north of the Dalton Ice Shelf calving front. Model densities were varied (as labeled in the lower figure) along the profile until the computed gravity approximately matched the observed gravity. The column averaged density increases from west to east along what the character of the multibeam data indicate is exposed bedrock. The transition is similar to what is found in the 3D inversion area suggesting that the less well-sampled bedrock geology along the calving front is similar to what is observed further to the north.

NBP1402 Magnetic Intensity Anomaly Compilation

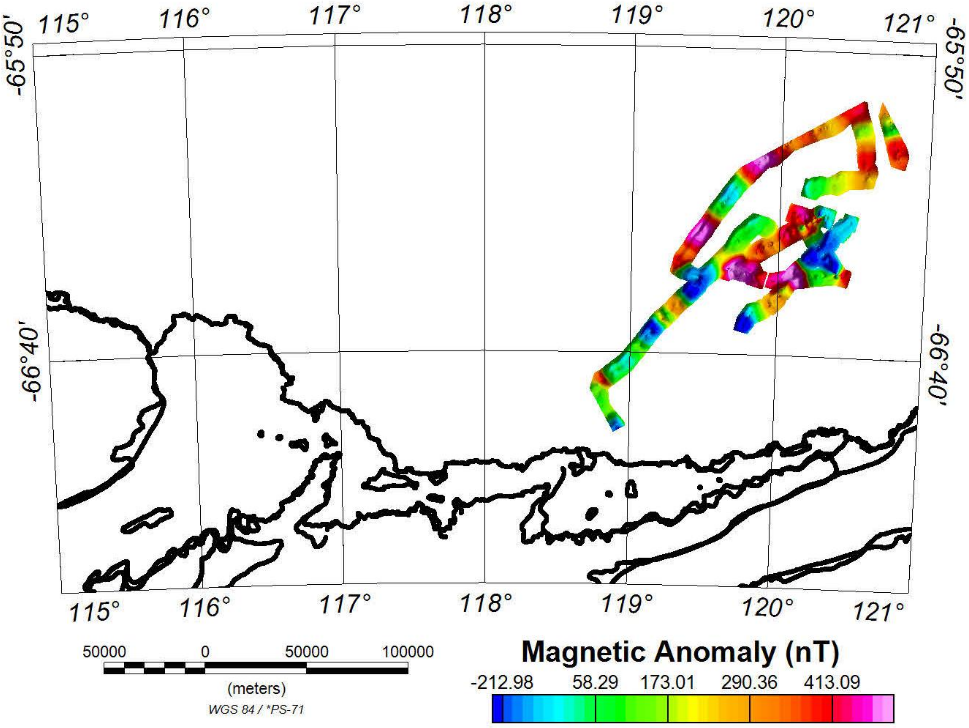


Figure 56. Compiled NBP1402 magnetic anomaly data acquired by a towed SeaSpy sensor. The data have been corrected for diurnal effects using base station data from Casey Station and the most recent IGRF reference model has been removed. High anomalies appear to correspond to the boundaries of the primary Bouguer Anomaly high (and inverted high density area). Used in conjunction with the underway gravity and seismic data, these data will be useful for interpreting geological boundaries that may or may not be apparent in the multibeam data.

Gravity, Magnetics, & Multibeam Profile along Seismic Line 5

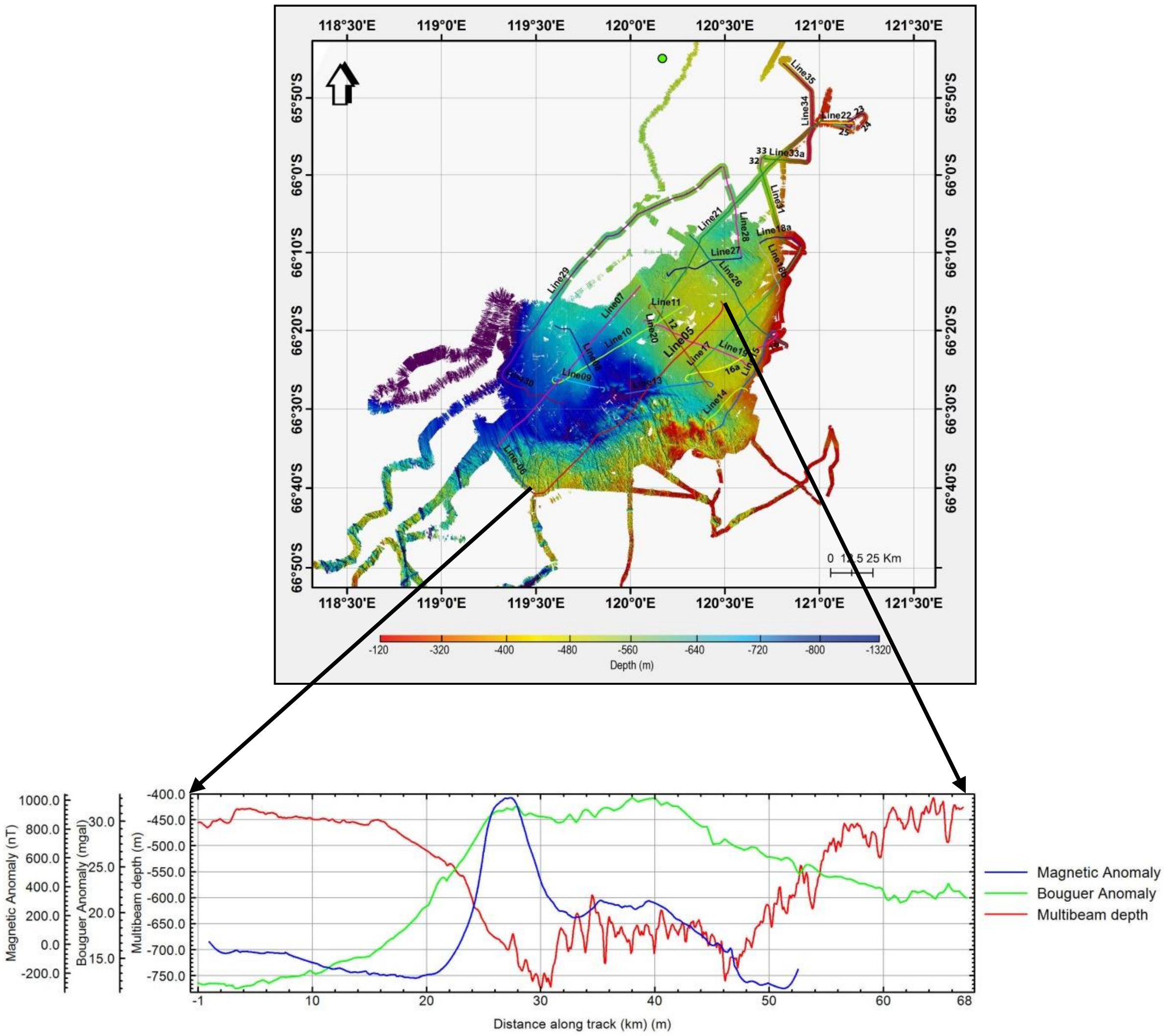


Figure 57. The lower figure shows the Bouguer gravity anomaly, magnetic anomaly, and multibeam centerline depth along seismic line 5 which cuts along the center of the primary survey area as shown in the upper figure. We find high Bouguer and magnetic anomalies in a seafloor low suggesting variations in sediment load and/or basement configuration. The figure illustrates how potential fields complements multibeam data for interpreting subsurface geology. Similar profiles for all seismic lines have been included with each seismic section in the marine geophysics portion of this report.

7. NBP1402 GRAVITY EXPERIMENT SETUP AND OPERATIONS SUMMARY

7.1 OVERVIEW

NBP1402 sailed from Hobart, Tasmania to Antarctica on a six weeks cruise including stops along the George V and Sabrina Coasts to study the Mertz and Totten glacier systems, respectively. Two gravimeters were operated on the cruise: a BGM3 on semi-permanent loan from the university-national oceanographic laboratory system (unols) was mounted in the NBP's gravity room and a gravimetric technologies-2 marine edition (GT-2m) collaboratively provided by cmg operations PTE ltd and the University of Texas at Austin institute for geophysics was mounted in the biology lab across the hall from the BMG3.

7.1.1 BGM3 Serial Number S210

- Fastened down in the NBP gravity closet with a small real-time qc laptop plotting raw and filtered gravity (with the tie applied).
- Scale factor relates output frequency to change in gravity (converts raw counts to mgals) based on the last instrument calibration:
    - Scale factor: 4.994070552 (from December, 2013 calibration)
- No real time GPS feed is required for the BGM3. There is a GPS RS232 connection to the optional laptop displayed in the figure below which is used for real time qc purposes but not required.

Figure 58. BGM3 electronics modules (left) and gyro-stabilized sensor platform (right) mounted in the NBP's gravity closet. The BGM3was a last-minute replacement for the Lacoste and Romberg air-sea marine gravimeter that suffered serious problems prior to the cruise.

7.1.2 GT2M Serial Number 04

- The GT2M was fastened to the floor in the forward-starboard area of the Bio Lab close to the fume hood. Bungee cords were used to deter touching/leaning on the meter.
- Relative location: The GT-2M was located ~18 feet forward and 15 feet port of the BGM3.
- A real-time GPS feed was supplied to the GT2M from one of the NBP's Seapath 2 system via the RS232 breakout boxes between the dry lab and the bio lab. Errors in the GPS stream were eliminated by using a RS232 powered splitter provided by Steffen Saustrup of UTIG.
- The GT2M records four preselected filter lengths: 150, 300, 450, 600, and 750 seconds to a small computer with a solid state hard drive (called "CDU").
- Raw data were acquired to a second, identical computer (called "Smart Box") so that eventual comparisons with the raw BGM3 data could be made.
- 110VAC power was supplied to the power electronics using one of the NBP's UPS-protected power ports.
- Additional backup batteries were connected to the power electronics as a secondary power source. Notably, the battery backup was briefly used when the NBP's power system, including the UPS, failed due to contamination of the generators in an area with a significant krill population.
- See Appendix for additional technical specifications of the GT2M
- Steffen referred to the splitter as a NMEA buffer box with a store bought component inside. It simply repeats any incoming NMEA string at higher strength and to multiple outlets.

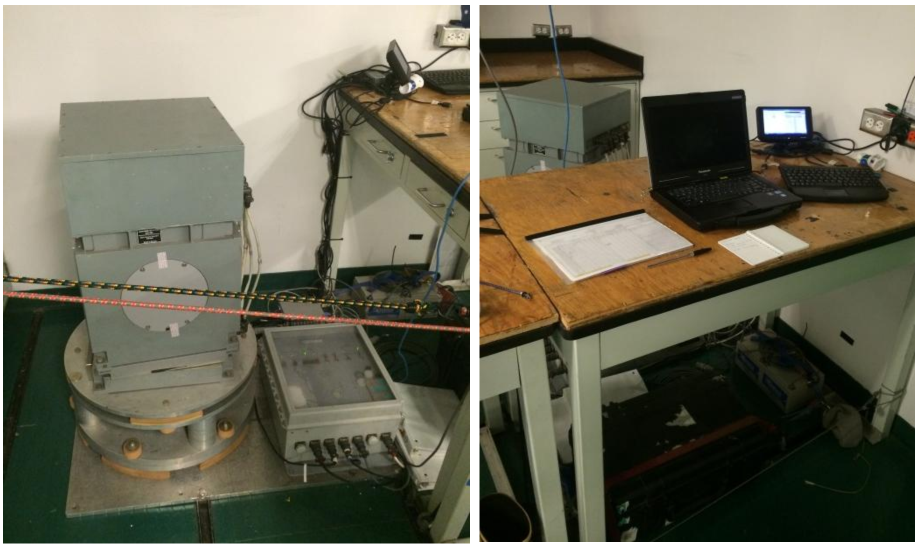


Figure 59. GT2M gravimeter mounted in the NBP's biology lab (left). The gravimeter is the tall stack of electronics mounted on the circular vibration isolation system and its power electronics are contained in the case to the right of the gravimeter. recording and real time monitoring is done with the two computers displayed to a small monitor and keyboard (right)

7.2 GRAVITY TIES

7.2.1 Pre-cruise Hobart gravity ties

- Two gravity ties were completed between the pier next to the NBP and separate monuments in Hobart:
    - the University of Tasmania monument at the steps of the engineering building
    - the Elizabeth Streent Pier monument
- The pier was assumed to be level with the BGM3.
- Dr. James Kinsey completed the ties (jkinsey@whoi.edu)
- Tie #1, 27-January 2014
    - Gravity at pier, next to gravimeter: 980437.74 mgal
- Tie #2, 28-January 2014
    - Gravity at pier, next to gravimeter: 980437.82 mgal
- Note for the BGM3:
    - While Dr. Kinsey didn't document the raw counts that were recorded before and after the tie he provided the resulting bias that is added to the counts after applying the scale factor:
        - Bias: 855459.39 mgal
        - As a result, the average raw counts that he would have recorded can be derived as follows:
            - (980437.82-855459.39)/4.994070552 = 25025.36 counts
        - Heritage NBP software calls the bias "grav_offset" in their instrument coefficients file: grav_offset: 855459.39 mgal

7.2.2 Post-cruise Hobart gravity ties

- Two gravity ties were completed between the pier next to the NBP and the University of Tasmania monument next to the steps of the Engineering building. The Elizabeth Street pier monument was not used.
- The ties were completed by Jamin Greenbaum of UTIG (jamin@utexas.edu) and Barry Bjork of ASC.
- Tie #1, 16-March, 2014
    - Gravity at pier, next to gravimeter: 980437.91 mgals
    - BGM3 drift since last tie = 2.40 mgals
- Tie #2, 16-March, 2014
    - Gravity at pier, next to gravimeter: 980437.94 mgals
    - BGM3 Drift since last tie = 2.43 mgals
- Notes on the computed drift
    - The ties discussed above closed well and should be considered good. The drift of only ~2.4 mgals measured by differencing the bias from the pre- and post-cruise gravity ties should be considered acceptable.

7.3 GRAVIMETER CORRECTIONS

7.3.1 Latitude Corrections

- BGM3: This is not well documented on the NBP. Looking through code provided by Kathleen Gavahan ("rvxmerge.sh") revealed the following formula that they refer to as "theoretical gravity" but that is the latitude correction:

  latitude correction = $g_0*(1+a_1*\sin^2(lat) + a_3*\sin^4(lat))$

  g_0=978031.85

  a_1=0.005278895

  a_3=0.000023462
- GT2M: The GT latitude correction is similar but there are differences with the constants, trigonometry, and a 14 mgal bias is required:

  latitude correction = $g_0*(1+c_1*\sin^2(lat)-c_2*\sin^2(2*lat)) - 0.00014\ cm/s^2$

  g_0 = 9.78030

  c_1 = 0.005302

  c_2 = 0.000007
- Geosoft's Latitude Correction and constants are identical to the BGM3 implementation:

  latitude correction = g_0* (1+ a_1*slat2+ a_3*(slat2**2))

  g_0=978031.85

  a_1=0.005278895

  a_3=0.000023462

  r2d = 57.29578

  lat = Latitude/r2d

  slat2 = sin(lat)**2

7.3.2 Free Air Correction

- The ship's gravity code claims to put out the "Free Air Anomaly"
- Strictly speaking, the Free Air Anomaly would be the difference between the observed scalar gravity on the geoid (which we can assume to be MSL) and the theoretical gravity on the WGS84 ellipsoid. However, the code makes no mention of a the ellipsoid or an associated free air correction (0.3086*(height diff between WGS84 and MSL)
- The WGS-84/MSL difference around the survey area is ~20 meters

7.3.3 Eotvos Corrections

- BGM3: I'm not familiar with the constants they've used and they don't provide any comments in the code but this appears to be the eotvos correction in rvxmerge.sh:

  eotvos = $7.503*Veast*\cos(lat)+0.004154*V^2$

  Veast = east velocity component smoothed with a moving window of 1800 s

  V = ship speed smoothed using a moving window of 1800 seconds

- Geosoft Eotvos correction formula

```
eotvos = 100000*(en+ea)
    en = (a*latd2)*((3*slat2-2)*f+ha)
    ea = (a*clat2*(longd2+2*w*longd))*(ha+f*slat2))
        a = 6378137.0
        f = 1/298.2572221
        w = 0.000072921151467
        ha = 1+ Height/a
        latd = LatitudeDerivative/r2d/td;
            lat = Latitude/r2d
            r2d = 57.29578 (180/pi)
            td = TimeDerivative*3600;  // assumes time in hours
        latd2 = latd**2;
        longd = LongitudeDerivative/r2d/td;
            long = Longitude/r2d
            td = TimeDerivative*3600;  // assumes time in hours
        longd2 = longd**2;
        slat2 = sin(lat)**2
        clat2 = cos(lat)**2
```

- The eotvos correction formula for the GT2M is unknown at the moment

8. BIOLOGICAL WORK

Diatom community composition and distribution in the Mertz and Totten Polynya regions, East Antarctica, and short palaeontological records from the underlying sediments.

Collaborators outside NBP1402
Isoprenoid Study:
Prof. Simon Belt (Plymouth University, U.K.)
Single cell approach DNA Study:
Dr Martin Ostrowski (Macquarie University, Australia)
Prof. Ian Paulsen (Macquarie University, Australia)

8.1 ABSTRACT

Phytoplankton occurrences in the water column and from the sea floor sediment were sampled during NBP14-02 via the various operations: underway water sampling, plankton net haul, CTD rosette water sampling, Kasten, Gravity, Piston and Megacore coring. Water samples (underway and CTD) and net samples were preserved with acid Lugols and will be returned for microscopic analysis at Macquarie University, Sydney.

Preliminary data on the net hauled diatom qualitative abundance from 27 stations has been made available and mapped, along with presence-absence of major zooplankton groups encountered. Approximately 2000 photographs of the taxa observed in underway samples, phytoplankton net haul, some Kasten and Dredge samples have been taken.

Future analysis will be cover the taxonomic and morphological variation in two diatoms (*Chaetoceros atlanticum* and *Eucampia antarctica* v. *recta*) whilst the role of *Thalassiothrix antarctica* to the regional deposition in the Totten Polynya will be investigated to assist with determining palaeo-proxy interpretations relevant to the core records. Smear slide analysis will be completed to help in biostratigraphically linking cores or identifying mat-layer composition. A prioritized analysis of the diatom community abundance, biometrics and biomass contribution to the Totten Polynya ecosystem will be developed from water samples. Additional sediment analyses will be ongoing until 2015 principally as student projects and in collaboration with Principal Investigators.

8.2 OVERVIEW OF THE PROJECT AND OBJECTIVES

Dr Armand's contribution aims to provide biological information at the base of the food chain to aid in solving the following:

1) what is the diversity, distribution and biomass contribution of the diatom community?
2) can we characterize the pathways that lead to the export and the fate of diatoms exported to the sediments, and subsequently, are there seasonal or specific physical regimes that produce/enhance fossilized diatom mat formation?

Two supporting studies in have also been undertaken linked specifically to the regional diatom characterization during the mission.

A) Isoprenoid study.

Matched geochemical sampling with the diatom characterization study was undertaken during this mission. The aim here is an attempt to ground truth the source and variability of dienne and trienne isoprenoids from the surface waters of the Southern Ocean and Antarctic. Recent studies from the Antarctic have hypothesized that varying levels of highly branched isoprenoids (HBI) can be used from sediments to provide a proxy for past sea ice cover (e.g. Collins et al. 2013). Varying diatom genera have been implicated as being the source for this geochemical signature. This proxy has been established and applied in the Artic through the HBI biomarker IP25 (Belt et al. 2013) in association with the genera *Haslea* and *Pleurosigma (pers. comm. submitted S. Belt)*. IP25 has not been observed in the Antarctic, however other HBIs (diennes and triennes) have. This study thus aims to:

3) Characterize the normal production levels and distribution of diennes and triennes from surface water samples in both non-sea ice and sea-ice environments.
4) identify likely candidate diatom species as a function of their abundance as producers of the HBI biomarkers.
5) identify potential core sampling tests for HBI analysis as a function of fossil diatom records.

B) DNA study.

A transect approach to detailing the small microbes and Eukaryotes for the Southern Ocean was also undertaken in parallel to the diatom community study. Archives of bulk DNA already exist thus this approach is novel in that we have focused on samples suitable for single-cell approaches. Here we sample for both bulk DNA (Sterivex filtration) and single cells (Cell Trap filtration).
The aims are:

6) The ability to sort, or dissect, single cells from bulk samples will enable us to get a deeper understanding of the relative activity and abundance of potential keystone species that are less numerous than the abundant heterotrophic bacteria.
7) Diatom DNA will be assessed and associated through the single cell approach and linked to the diatom community study.
8) To open a potential new study enabling a genetic link to HBI producing diatoms and thus refining the proxy utility assignment of ecological/physical conditions represented by fossilized records of HBI.

Finally, preliminary fossil diatom analyses in conjunction with the marine geoscience program was undertaken (see Cruise Report entries by Domack, Shevenell and Leventer). On-board analyses were focused on smear slide analyses of visually interpreted diatom mat layers in Kasten cores, biostratigraphic analysis of dredged samples, and sample collection for future analysis from one tube at each mega core site. Dr Armand will work with Leventer, Domack and Shevenell on lab-based analyses of the core material as requested.

8.3 METHODOLOGY AND SAMPLING STRATEGY

1. Cell distributions in surface waters.

- Underway surface water samples were taken whilst in transit from Hobart to the Mertz Glacier region, west along the Banzare Coast into the Totten Polynya region and then northeast in transit until ~56°S.
- ~10-30 minute meshed sieving at 50 or 20μm (principally 20) of the intake water line is undertaken. 1ml of concentrate is placed on to a Sedgewick-Rafter cell. The SR cell is placed for observation under an Olympus IMT-2 Inverted phase microscope at x10 or x40 magnification. The microscope was supplied by Macquarie University.
- Qualitative assessment of the concentrated community is undertaken and diatoms were identified down to the smallest taxonomic level (species). A generalised indication of species dominance was noted.
- All species or cell aberrations/life cycle phases were photographed using a Canon EOS 60D camera with a Zarf Enterprises ZDSLRA-CAN microscope camera attachment. Camera and microscope attachment were NFS-ship's supplied equipment.
- A 1x100mL acid Lugol preserved (0.4mL) sample is bottled and added to the cold room store boxes for future reference in the lab.
- One horizontal surface phytoplankton net haul (50μm mesh, 50cm diameter, 2m long with detachable cod end) was taken at a CTD rosette station. The haul was made from the stern of the ship

to a distance of ~10-15m and hand hauled back in. The net was hosed with seawater to concentrate the cells into the cod end. Species were identified where possible and dominances and photographic evidence of the community was collected. 2x 100mL acid Lugol preserved (0.4mL) samples were bottled and added to the cold room store boxes for future reference in the home lab.

2. Isoprenoid analysis.

- 2-4L of intake water was filtered on to 25mm Whatman GF/F filters (Cat. No. 1825-025) with a Gast pump (~150mm Hg in vac). Replicate filters were used for sampling: one precombusted GF/F and a second non-combusted normal GF/F.
- Filters were wrapped in aluminium foil, bagged and frozen at -80°C.
- Additional samples have also been filtered from the phytoplankton net (30mL per filter) and the CTD rosette (2-4L from water bottles representing water from the surface, Chl a max (or thermocline when no Chl max was observed) and bottom) and the bulk overlying water taken from the two Megacore stations.

3. DNA Cell concentrates for single cell analysis in surface waters.

- 2L of intake water (and one CTD at three depths) was filtered on to Millipore Sterivex (0.22µm) filter units on a Watson-Marlow 323 peristaltic pump at a rate of 120 rpm and frozen at -80°C. These filters will be processed at Macquarie University. Dr Armand is interested in linking the diatom observations of (1), whilst Dr Ostrowski and Prof. Paulsen will focus on small eukaryotes captured from the Southern Ocean Transits.
- 8L of intake water (and one CTD at three depths) was filtered through a MEM-TEQ Ventures Ltd. Cell Trap on a Watson-Marlow 323 peristaltic pump at a rate of 79 rpm. Initial cell traps were immediately frozen at -80°C. Later samples included an additional step with the syringing of 2mL of filtrate from the Cell Trap, which was subsequently frozen at -80°C in Fisherbrand (external thread, cat no. 0566964) cryovials. The remnant Cell Trap was also frozen at -80°C. These samples will be used for Flow Cytometry to extract individual cells to verify and confirm attribution of the DNA processed from the Sterivex filters.

4. Diatom sediment samples.

- Smear slides were taken using a toothpick sample of visually-identified mat layers in Kasten cores and from internal clean-breaks made from sediment clasts. Sediment was dispersed on a slide with milleQ water and coverslipped.
- Observations at x10 and x40 magnification on an Olympus IMT-2 Inverted phase microscope (Macquarie University) were made. Qualitative assessment of the smear was undertaken and diatoms were identified down to the smallest taxonomic level.
- All species were photographed using a Canon EOS 60D camera with a Zarf Enterprises ZDSLRA-CAN microscope camera attachment. Camera and microscope attachment were NFS-ship's supplied equipment.
- Megacore sediment samples were sectioned as per Megacore methods detailed elsewhere in this report. Diatom samples collected for future analysis were sampled at 1cm intervals between 1-5cm and every 2cm to the base of the core. The fluff layer was extracted by pipetting and half of this volume was preserved with acid Lugols whilst the remaining was not. Both fluff samples were bottled rather than bagged.

8.4 DATA FILES

- ***Underway water property data*** were copied from the onboard DATA server. Files relevant to the water intake line from which the samples were taken, are represented by data captured by water passing through "Flow meter 2". The raw data file is located in the underway folder (UW) and detailed by the daily "hdas" and "QC" files (underway measurements made for fluorometry and SST on this flow meter are here). Representative daily ship's output files of the summarised underway water parameter data are found in the process folder under the daily "JGOFS" files. Copies of these files were taken by Dr Armand daily.

- ***CTD files*** are copied from the CTD_DATA server. CTD files are batched by CTD number. The "processed" bottle data file is used to identify various parameters per bottle. Copies of the processed files are taken by Dr Armand the after each event.
- ***Log Sheets*** are filled in per event and a photocopy placed in the NBP14-02 Station or CTD Logs. The originals of these documents are kept by Dr L. Armand.
- ***Microscopy community log*** is kept in an Excel file maintained by Dr L. Armand and backed up to a Hard Drive. The final data file is available on the Science Drive under the Folder titled " Diatom Data and Images".
- ***Photographs*** have been batched by sampling event on Dr L. Armand's Mac laptop (and back-up Hard drive) and are saved in iPhoto. Scale bars are yet to be applied to all 2000+ images taken (via Adobe Illustrator) and will be added on return to Australia. These images will be uploaded to an Australian public-accessible marine database (e.g. AODN) in due course for access to all.
- ***Supporting Core data*** was accessed from station log sheets and core description logs.
- ***Smear slide analyses*** of Kasten cores and diamicton clasts were documented and posted as pdf files with supporting images from each level investigated (at x10 principally or some at x40) on to the SCIENCE drive under the folder "Diatom data and Images". Printed versions of the data only were placed in the core log folder.

8.5 SUMMARY OF WATER STATIONS AND DATA COLLECTED

A total of 76 water sampling events were completed during the mission. This included underway water samples (59 events), CTD rosette sampling (13 events), net haul (1 event) and megacore overlying water samples (3 events). Sampling at these stations represents:

- 33 Sterivex and 21 Cell Trap filtered samples (16 cryovials from Cell traps) (representing 234 L of filtered water).
- 182 Isoprenoid GF/F filtered samples (representing ~389 L of filtered water).
- 94 bottles of acid Lugols preserved samples from intake, net and CTD stations (representing 13.4 L preserved water).
- Microscopy reports from 32 stations.
- 2301 phytoplankton photographs from 32 stations (principally from underway intake line samples).

Figures 60-62 represent the samples taken from the underway, Plankton net, rosette CTD and Megacore stations during the mission. An appendix lists all sample data related to water sampling activities and summarises the diatoms observed under microscopy at Transit stations.

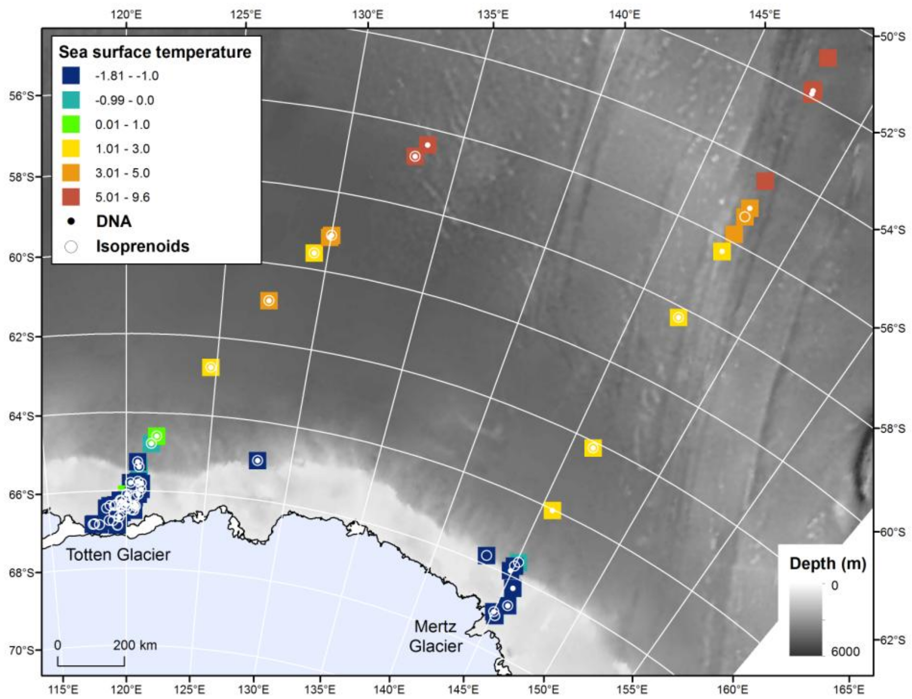


Figure 60. All water sampling stations undertaken for diatom (all stations), isoprenoid (large circle) and DNA (dot) against underway station-recorded sea surface temperature (°C, coloured square scale). See Figure 61 for a detailed Mertz station map and Figure 62 for Totten station map. (Figure plotted by A. Post)

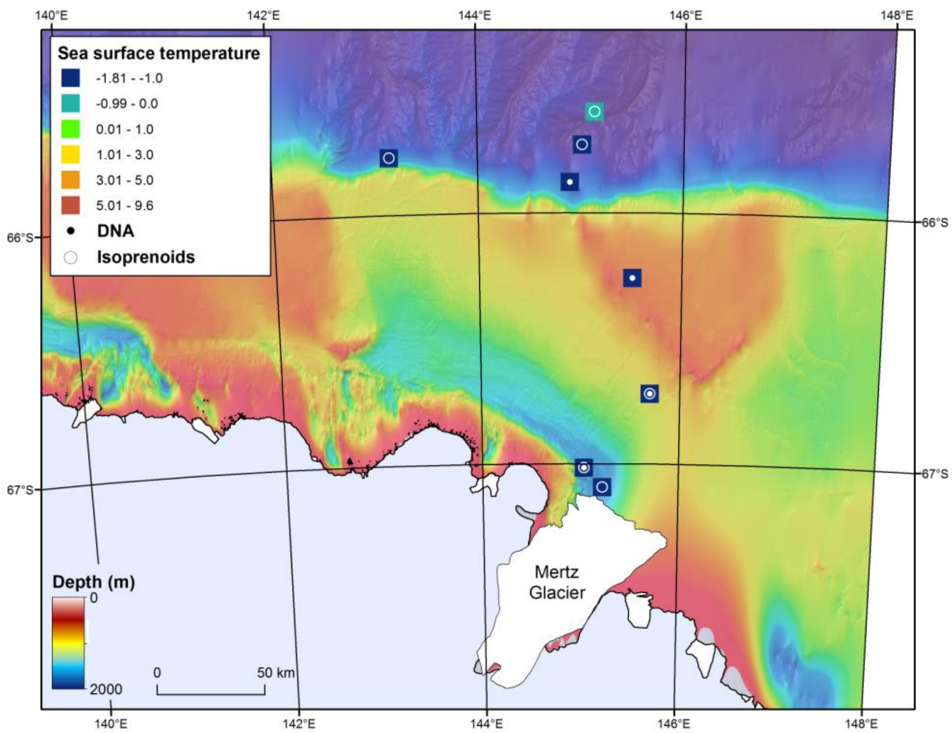


Figure 61. Detailed Mertz Region sampling stations undertaken for diatom (all stations), isoprenoid (large circle) and DNA (dot) against underway station-recorded sea surface temperature (°C, coloured square scale). (Figure plotted by A. Post).

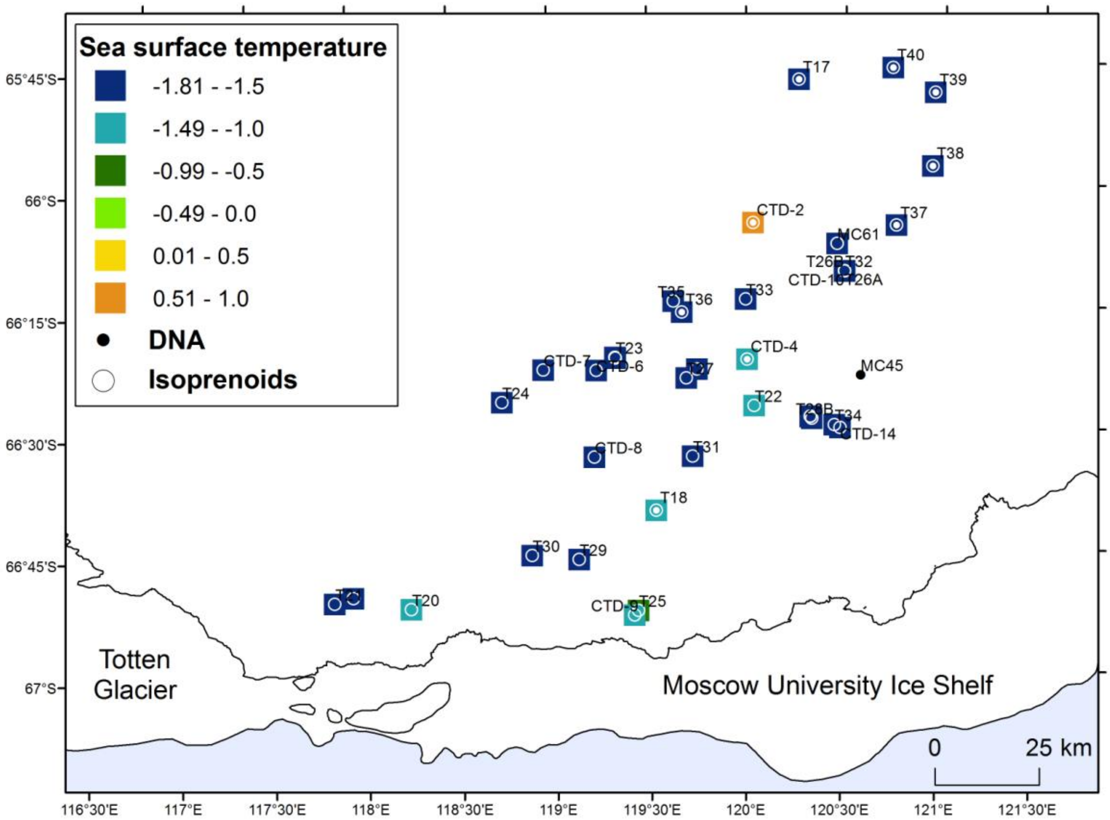


Figure 62 Detailed Totten Region sampling stations undertaken for diatom (all stations), isoprenoid (large circle) and DNA (dot) against underway station-recorded sea surface temperature (°C, coloured square scale). Note: Position of MC45 is potentially incorrect and needs checking. (Figure plotted courtesy of A. Post).

8.6 SUMMARY OF SEDIMENT MATERIAL COLLECTED

Two megacore stations were sampled (MC45 and 61). At each station 1 megacore tube was sampled for the fluff layer and by section for future diatom analysis. Study of these Megacores are envisioned for short-term Master student projects in 2015 at Macquarie University. Data from the cores will be made available to Prof. Leventer for publication consideration where merited. The palaeontological diatom analysis will follow standard silica-selective methods (Rathburn et al. 1997). Fluff and overlying water samples will be microscopically analysed and then be processed to a permanent slide using the same method as for sediment samples. Where warranted after microscopic observation, fluff sample material may undergo SEM analysis.

Smear samples of Kasten cores 9, 14, 20, 27A, 27B, 42, 53 and 57 were taken. Of these eight cores, three were analysed on-board (KC9, 27A and 27B). All remaining samples will be returned to the lab and analysed by July 2014. Results will be provided to the NBP14-02 scientific party.

A map of the coring stations in contrast to the water sampling stations in the Totten Polynya region are found in Figure 62. Details of the samples taken back for future study to Macquarie University are listed in an Appendix.

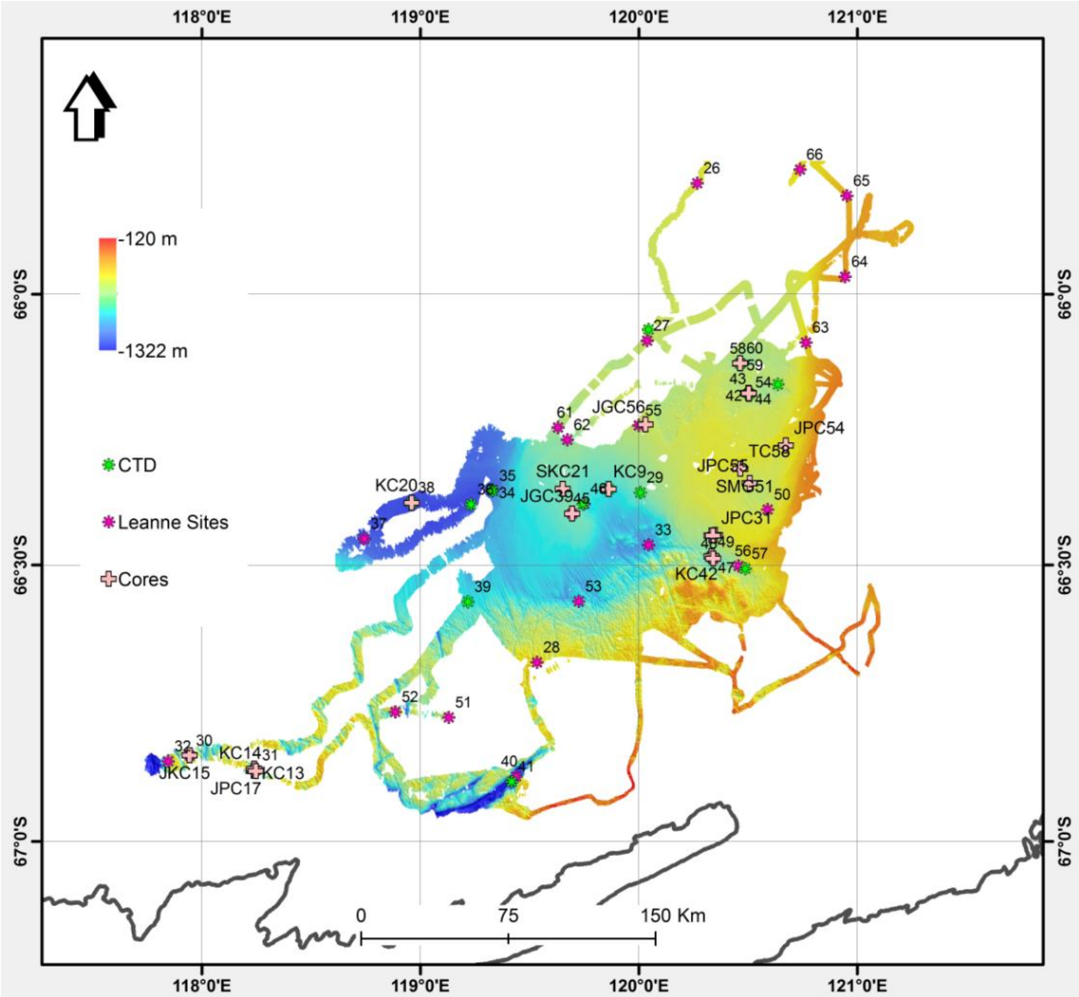


Figure 63. Detailed Totten Region sampling stations undertaken for diatom surface water and all coring and CTD stations. (Figure plotted courtesy of C. Lavoie).

8.7 POST CRUISE PLANS

All samples entering Australia will be kept in a Quarantine Approved Lab at Macquarie University until gamma irradiated to release them from quarantine so they can be processed within the normal laboratory. Sample distribution to collaborators will be a priority due to the nature of the deep-frozen samples.

Quantitative diatom composition analysis from water sample will occur on a regional and station-focused basis. Samples from the Totten are being prioritised prior to all others. The water samples will be studied by Dr. L. Armand and may also be a partial basis to a PhD project offered for 2015. The diatom community abundance, biometrics and biomass contribution to the Totten Polynya ecosystem will be compiled from these water samples. The taxonomic and morphological variation in two diatoms (*Chaetoceros atlanticum* and *Eucampia antarctica* v. *recta*) will be focused on, whilst the role of *Thalassiothrix antarctica* to the regional deposition in the Totten Polynya will be investigated to assist with determining palaeo-proxy interpretations relevant to the core records.

DNA analysis and Isoprenoid analyses should be completed by the respective collaborators in 2014. Future collaboration with Dr Armand, Prof. Leventer and Dr Shevenell will be forthcoming from the results.

Dr Armand will focus on finalising the smear slide analysis of Kasten cores and distribute to the shipboard party before July 2014. Smear slide analysis will help to biostratigraphically link cores or identify diatoms composition of visually identified mat-layers. Megacore sample processing and analysis is unlikely to occur until 2015 when Dr Armand will return from an overseas sabbatical and take on new Master students.

8.8 REFERENCES

Belt, S. et al. 2013. Quantitative measurement of the sea ice diatom biomarker IP25 and sterols in Arctic sea ice and underlying sediments: further considerations for palaeo sea ice reconstruction. Organic Geochemistry, 62: 33-45.

Collins et al. 2013. Evaluating highly branched isoprenoid (HBI) biomarkers as a novel Antarctic sea-ice proxy in deep ocean glacial age sediments. Quaternary Science Reviews.

Rathburn, et al. 1997. Microfossil and stable-isotope evidence for changes in Late Holocene paleoproductivity and paleoceanographic conditions in the Prydz Bay region of Antarctica. Palaeogeography, Palaeoclimatology, Palaeoecology 131, 485-510.

9. MARINE MAMMAL OBSERVATIONS – ANDREA WALTERS AND TASHA SNOW

Marine mammal observations (MMOs) were carried out for both icebreaking and seismic operations aboard the *Palmer* from the 4th February to 7th March 2014. Visual observations for icebreaking and seismic operations occurred for a total duration of 20 and 15 days, respectively. A total of 236 take were recorded for icebreaking operations, including killer whales, minke whales, unidentified whales, crabeater seals, leopard seals, Weddell seals and unidentified seals (Table 1). For seismic operations, a total of 15 take were recorded, including minke whales, crabeater seals, Weddell seals and unidentified seals (Table 1). Two marine mammal shutdowns and four avoidance maneuvers were conducted during seismic operations. For all operations, crabeater seals were the most numerous and frequently recorded take, followed by unidentified seals, Weddell seals and minke whales (Table 1). Leopard seals, killer whales and unidentified whales were also recorded as take during icebreaking operations.

9.1 MMO TRAINING FOR ICEBREAKING OPERATIONS

To facilitate 24 hour icebreaking observations (as required), members of the science party were trained and utilized, in addition to the two dedicated Protected Species Visual Observers (PSVOs; lead PSVO Andrea Walters and Tasha Snow) which were on 24 hour call to commence observations for seismic operations. A pre-operations training session was carried out by the PSVO's for all science members on the 3rd February. The training session included an overview of the: a) Incidental Harassment Authorization (IHA) guidelines for icebreaking, b) cetacean and pinniped species protected under the Endangered Species Act (ESA) and the authorized level of take for each of the ESA listed species, c) taxonomy, physical and behavioral characteristics, and identification cues for species most likely to be encountered within the survey area, and d) MMO monitoring and recording methods, including how to calculate distance to animals using reticule binoculars, and record weather and visibility conditions. PSVOs also conducted one-on-one training with members of the science party on the bridge prior to observations and were available during operations as required/available.

9.2 MMO RECORDING DATABASE

To record observations for icebreaking and seismic operations, an on-line database (ELOG) was set-up by Jamin Greenbaum and used by the science party (deputised MMOs) and PSVOs (http://elog.nbp.usap.gov/MMO-Sighting-Behavior+Log/). ELOG is a password protected logging program on the *Palmer* intranet that allowed access to all participants. The intranet-based system was used to log all environmental and survey effort, and sightings and behavior information. The benefits of ELOG included larger fonts allowed for more efficient readability and data entry for all MMOs, especially those with imperfect vision, scrolling between line items and automated input of time, ship position and heading, and weather allowed for more rapidly recorded log entries. ELOG was much more efficient for MMOs after its inception, but sighting frequencies remained low for the rest of the cruise and it was, thus, never tested during high frequency sightings. ELOG proved to be an effective record keeping application that allowed the lead PSVO to track cumulative take on the *Palmer* for daily reporting purposes to NSF and NOAA. The convenient excel output made data analysis more efficient for end of cruise reporting requirements.

9.3 MMOS FOR ICEBREAKING OPERATIONS

Visual observations for icebreaking operations took place during weeks one, two and three (4th to 21st February) aboard the *Palmer*. Members of the science party and the two dedicated PSVOs conducted visual observations (2 hourly watches) during day and night operations as we transited through greater than 50% ice cover. During week one, observations for icebreaking operations occurred as we transited to and from the open water region of the Mertz Glacier survey area on the 4th and 7th February, respectively (Figure 1). Crabeater seals (n=120), an unidentified whale and minke whale were recorded as take on the 4th February, while a number of crabeater seals (n=61) and a single killer whale were recorded as take on the 7th February. Of those seals recorded as take, only a small number of animals hauled out and on the sea ice entered the water upon passing of the vessel (n=10, 5.5% of cumulative take for week one).

During week two, observations occurred during our attempt to reach the open water region of the Totten Glacial survey area (10th, 13th and 14th February), and as we returned to the open water region of the Moscow University Ice Shelf (15th and 16th February; Figure 2). Several pinniped species were observed during transit to and from the Totten survey area, including crabeater (n=106), leopard (n=3) and Weddell seals (n=8). Most seals remained hauled out and on the sea ice upon passing of the vessel, with only a small number of crabeater (n=8, 7.5% of cumulative take for week two), leopard (n=2, 25.0% of cumulative take for week two) and Weddell seals (n=2, 16.7% of cumulative take for week two) entering the water.

During the third and final week of icebreaking operations, observations occurred on the 17th and 21st February as we searched for open water regions along the Sabrina Coast survey area (Figure 2). Weddell seals (n=2) were recorded as take during operations on the 17th and crabeater (n=4) and unidentified seals (n=2) were both recorded as take during operations on the 21st February. All animals remained hauled out and on the sea ice upon passing of the vessel.

9.4 MMOS FOR SEISMIC OPERATIONS

Observations for seismic operations took place during weeks one to four (4th February to 7th March). Visual observations were carried out by the two dedicated PSVOs (4 hourly, alternating watches) during daylight/twilight for a maximum operational period of 16 continuous hours. During the first week, observations for seismic operations occurred in the open water region of the Mertz Glacial survey area on the 4th and 5th February. No marine mammal sightings or take were recorded during this period. The second week of operations took place in the open water region of the Moscow University Ice Shelf, with the two PSVOs conducting visual observations over two 16 hour daylight periods on the 11th and 16th February. Again, no sightings or take were recorded.

During the third week, observations for seismic operations took place over a 16 hour period on the 23rd February in shallow, productive open waters located to the west of the Dalton Rise. The first take for seismic operations was recorded during this time, with crabeater seals (n=5) encountered on passing ice floes within the full mitigation (take) zone (Figure 2). Four of the five seals entered the water upon passing of the vessel (80% of total crabeater seal take). A single avoidance manoeuvre was successfully conducted, with the vessel safely altering course slightly to avoid four seals. No source mitigation (shutdown) action was required.

The fourth and final week of seismic operations occurred over three consecutive days (5th, 6th and 7th March) in the open water region of the Moscow University Ice Shelf survey area. Both cetacean (minke whales, n=2) and pinniped species (crabeater seals, n=2) were sighted and recorded as take during operations on the 5th March and pinnipeds were recorded as take during operations on the 6th (crabeater seals, n=7) and 7th March (crabeater seals, n=1; Weddell seals, n=2, and unidentified seals, n=1; Figure 2). Nearly all seals, apart from a single Weddell seal (14% of total pinniped cumulative take for week four) were hauled out and on the sea ice upon passing of the vessel. A single avoidance maneuver and source mitigation (shutdown) action was required during the last day of operations (7th March). A single Weddell seal hauled out on a passing ice floe entered the 100 m exclusion (shutdown) zone despite slight course alteration. A second Weddell seal was observed in the water within the 100 m exclusion zone and consequently, a second shutdown of operations was executed. Both seals remained in the 100m exclusion zone for less than 1 minute each time, with both animals observed exiting the exclusion zone.

9.5 RECOMMENDATIONS FOR FUTURE MMOS

During icebreaking operations, 99% of total marine mammals recorded as take were pinnipeds and 1% cetaceans. Of those pinnipeds, only a small proportion of animals hauled out and on the sea ice entered the water upon passing/presence of the vessel (4.4% of pinniped cumulative take). This indicates that the initial behaviour of most animals (96.6% of pinniped cumulative take) did not alter with icebreaking operations and more importantly, that very few animals recorded during icebreaking operations were actually exposed to >120db of sound. For future cruises where observations for icebreaking operations are required, it is highly recommended that only those seals that enter the water be recorded as "take". This would produce a more representative count on marine mammals actually exposed to >120db sound during icebreaking (and seismic operations).

ELOG was much more efficient than excel or paper logs however, it is likely that having multiple, simultaneous sightings at the frequency seen earlier in the cruise would have rendered ELOG still insufficient for keeping up. The number of line items required to be filled are unwieldy for high density MMO sightings. We highly suggest that a streamlined, quick entry logging system be produced and tested for functionality so that it may be used by all MMOs across every NOAA regulated cruise. This will ensure that data acquisition standards will be the same between cruises, more rapidly logged, and more easily utilized for census purposes.

Table 12. Cetaceans and Pinnpeds – Take from icebreaking and seismic operations during the RVIB *Nathaniel B. Palmer's* inter-disciplinary research survey in the Dumont d'Urville Sea off the Sabrina Coast in east Antarctica, January to March 2014.

Species	Icebreaking Operations		Seismic Operations				Icebreaking and Seismic Operations	
	No. takes	No. individuals	No. takes	No. individuals	Shutdowns	Avoidance manoeuvres	No. takes	No. individuals
Mysticetes								
Southern right whale	0	0	0	0	0	0	0	0
Minke whale	1	1	1	2	0	0	2	3
Sei whale	0	0	0	0	0	0	0	0
Blue whale	0	0	0	0	0	0	0	0
Fin whale	0	0	0	0	0	0	0	0
Humpback whale	0	0	0	0	0	0	0	0
Odontocetes								
Dolphin (unidentified)	0	0	0	0	0	0	0	0
Long-finned pilot whale	0	0	0	0	0	0	0	0
Hourglass dolphin	0	0	0	0	0	0	0	0
Spectacled Porpoise	0	0	0	0	0	0	0	0
Killer whale	1	1	0	0	0	0	1	1
Sperm whale	0	0	0	0	0	0	0	0
Whale (unidentified)	1	1	0	0	0	0	1	1
Pinnipeds								
Crabeater seal	199	281	10	25	0	3	209	306
Leopard seal	3	3	0	0	0	0	3	3
Ross seal	0	0	0	0	0	0	0	0
Weddell seal	9	9	2	2	2	1	11	11
Southern elephant seal	0	0	0	0	0	0	0	0
Antarctic fur seal	0	0	0	0	0	0	0	0
Seal (unidentified)	16	22	2	2	0	0	18	24
Total	**230**	**318**	**15**	**31**	**2**	**4**	**245**	**349**

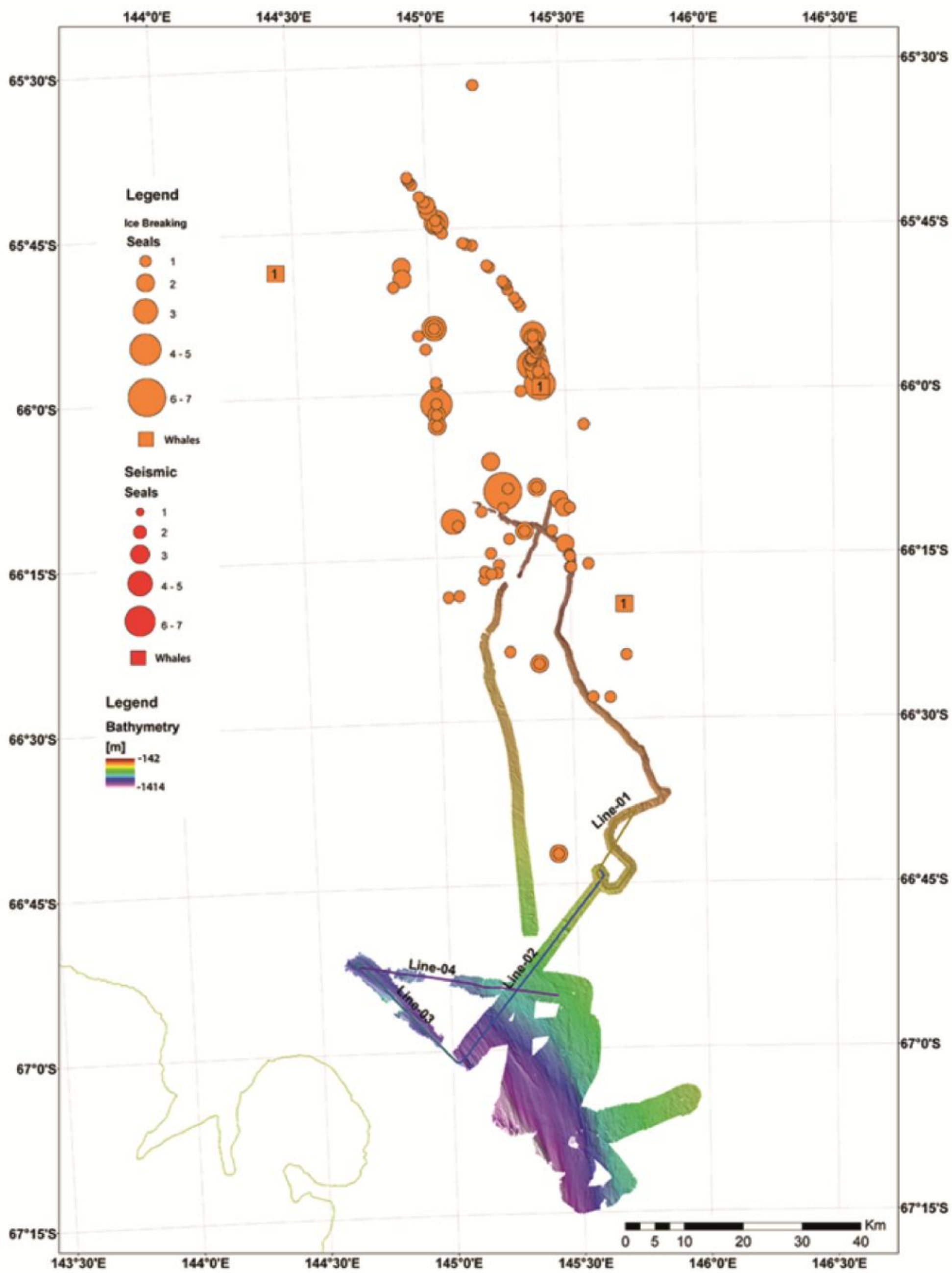


Figure 64. Locations of marine mammal take from icebreaking and seismic operations in the Mertz Glacial survey area off the coast of east Antarctica. Locations are colour-coded according to icebreaking (orange) and seismic (red) operations. Circle and square symbols represent seal and whale take, respectively. The size of the circle symbols indicates the number of seals visually detected for each take event (1 to 6-7 individuals for small to large symbols, respectively). Also shown is the bathymetry (m) overlaid with the survey lines for the Multichannel seismic survey.

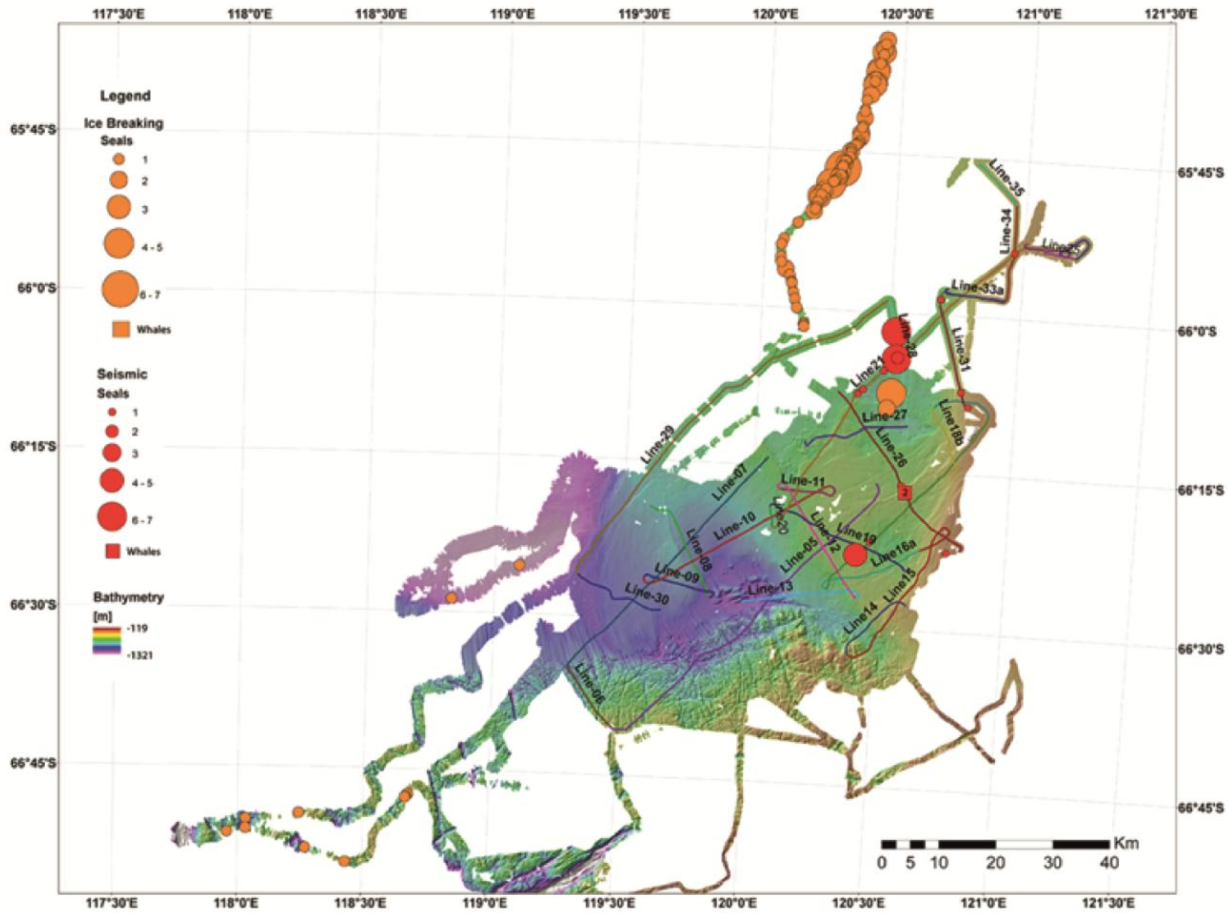


Figure 65. Locations of marine mammal take from icebreaking and seismic operations in the Totten Glacial survey area off the coast of east Antarctica. Locations are colour-coded according to icebreaking (orange) and seismic (red) operations. Circle and square symbols represent seal and whale take, respectively. The size of the circle symbols indicates the number of seals visually detected for each take event (1 to 6-7 individuals for small to large symbols, respectively). Also shown is the bathymetry (m) overlaid with the survey lines for the Multichannel seismic survey.

10. POLARTREC TEACHER

Glenn Clark Parishville-Hopkinton School, NY

I was blessed with the opportunity to have been part the now completed cruise of the NB Palmer 14-02. It is a great honor to be selected and to participate in such a valuable expedition. What I have taken from this experience reaches far past the photos and memories. It has exposed me to what real science looks like and the incredible amount of work that must done to be successful.

The expedition's interdisciplinary approach enabled me to observe far more than one that focuses on one discipline. It was enlightening to see all the PI's work as a unified team. Through stressful situations that included, ice, weather and time constraints they would successfully deploy the science equipment. This was evident based on the volume of data and samples that will now be reviewed and processed.

My mission as a PolarTrec teacher was to disseminate the day in and day out activities of a science expedition. Because of that I needed to work a regular 12-hour shift as well as meet and talk with all members of the cruise.

Not being a teacher or student with experience in geology or earth science I originally was apprehensive and frankly overwhelmed. Through the assistance of the scientists and shift partners, I am far more capable in and knowledgeable about these subjects. In addition it has taught me to multi task and manage time more efficiently.

In respect to the mission of this cruise and others like it I am now more capable to explain polar science. I will go back with the knowledge to be a better teach and mentor. This experience could never have been replicated in any college course and certainly not in a professional development workshop. The immersion into to all the aspects of the cruise, whether it be working on the back deck, the lab, manning the watch desk or communicating with the crew makes this program an irreplaceable opportunity. I only hope that future collaborations between expeditions and teachers continue. The science is vital but the outreach can also have far reaching benefits

11. SVP BUOY DEPLOYMENTS

Twenty drifting buoys were deployed during our transits in support of project O-238 led by Dr. Ignatius Rigor of University of Washington, 10 each along the southbound and northbound legs. The buoys were delivered to the ship in Hobart packed in 4 large cardboard cartons. The buoys are compact surface drifters that measure air temperature and pressure, and sea surface temperature. Buoy position is provided by the ARGOS telemetry system. The buoys are drogued to follow the local current.

Preparation for deployment was minimal. The buoys were packed 3 to 5 in a carton, with each buoy wrapped in plastic wrap. Each buoy is fitted with a handle for ease of carrying by one person. To deploy, one only had to remove the plastic outer wrap, pull the magnet off, and drop the buoy off the stern. On the northbound leg, high wind and heavy seas required that some of the buoys be deployed from the O1 deck instead of the stern.

Positions and surface conditions at each drop are given in the tables below and illustrated on the map. The photo gives an indication of the size and ease of handling of the buoys.

Figure 66. Preparing to deploy an SVP buoy. The cardboard wrapping dissolves in the water allowing the drogue and buoy to drift free. Photo courtesy of G. Clark.

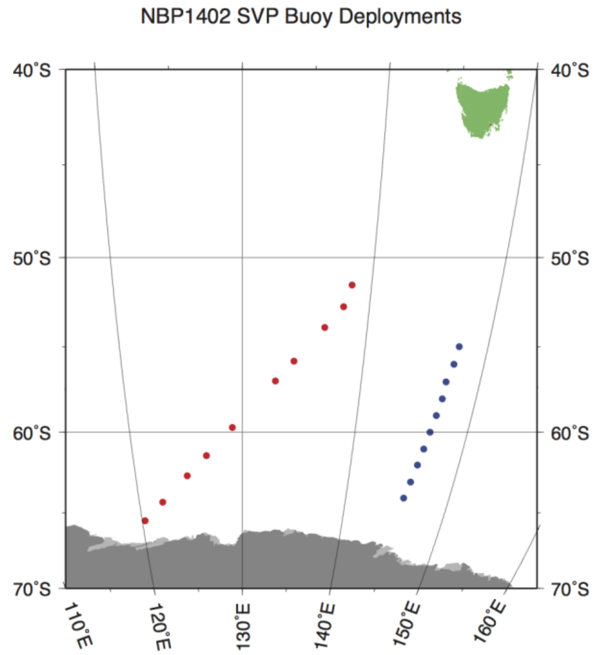


Figure 67. Buoy deployments on southbound (blue) and northbound (red) transits

Table 13. Buoy Deployments.

	BuoyID	Date (gmt)	Time (gmt)	Latitude (S)	Longitude (E)	comments	WMO#
Southbound leg. All deployments in open water							
1	126960	1 Feb 2014	0311	54 59.0	147 39.1		55615
2	126958	1 Feb 2014	0930	56 00.6	147 31.0		55612
3	126959	1 Feb 2014	1600	57 01.5	147 19.1	Ta=3.1; Pa=989.5; Ts=2.7	55613
4	126961	1 Feb 2014	2200	58 01.1	147 07.5	Ta=3.4; Pa=988.1; Ts=2.3	55616
5	126976	2 Feb 2014	0356	59 00.0	146 55.1	Ta=3.2; Pa=986.7; Ts=2.4	55617
6	126979	2 Feb 2014	1048	60 00.5	146 41.6	Ta=3.0; Pa=989.8; Ts=2.8	55618
7	126977	2 Feb 2014	1657	61 01.5	146 27.3	Ta=3.0; Pa=990.5; Ts=3.2	73659
8	126962	2 Feb 2014	2250	62 01.4	146 11.5	Ta=2.4; Pa=990.5; Ts=2.5	73655
9	126974	3 Feb 2014	0457	63 04.3	145 55.2	Ta=2.4; Pa=989.1; Ts=2.1	73657
10	126975	3 Feb 2014	1035	64 03.7	145 37.6	Ta=0.7; Pa=989.7; Ts=1.3	73658
Northbound leg. All deployments in open water.							
1	127365	7 Mar 2014	2253	65 30.60	120 16.40	Ts: -1.5 Ta: -6.2 Pa: 983	73650
2	127364	8 Mar 2014	0817	64 19.11	122 16.18	Ts: 0.6 Ta: -1.0 Pa: 982	56917

3	127362	8 Mar 2014	2113	62 40.84	124 50.25	Ts: 2.4 Ta: 1.5 Pa: 983	73660
4	127367	9 Mar 2014	0713	61 25.66	126 42.80	Ts: 2.6 Ta: 2.6 Pa: 985	56918
5	127363	9 Mar 2014	2109	59 43.08	129 08.58	Ts 2.9 Ta: 2.6 Pa: 985	56912
6	127031	10 Mar 2014	1941	56 58.35	132 48.18	Ts: 4.9 Ta: 4.4 Pa: 987	
7	127032	11 Mar 2014	0440	55 48.94	134 15.72	Ts: 5.9 Ta: 6.5 Pa: 959 (eye of the storm)	
8	127033	11 Mar 2014	2011	53 53.60	136 35.90	Ts: 6.4 Ta: 5.2 Pa: 980	
9	127034	12 Mar 2014	0610	52 43.41	137 58.17	Ts: 6.6 Ta: 7.8 Pa: 973 [deployed from 01 deck]	
10	127036	13 Mar 2014	0019	51 30.52	138 29.80	Ts: 7.7 Ta: 7.6 Pa: 990 { deployed from 01 deck]	

12. OPERATIONS EVALUATION

12.1 ICE IMAGERY

Cruise operational planning and decision making relied heavily on visible band MODIS images downloaded from the NASA Rapidfire site [http://rapidfire.sci.gsfc.nasa.gov/subsets/?mosaic=Antarctica] and forwarded to us by Phil Mele of LDEO and Andy Archer of ASC. We had requested the mosaics as georeferenced jpg files so we could use them on board with ArcMapper and QGIS software. We gratefully acknowledge Phil and Andy's efforts to get us timely images. A sample of the graphics we produced on board is given below for the Mertz area, in which the CSIRO moorings, previously occupied stations and our stations appear.

When clouds obscured visible images, we relied on AMSR2 images automatically forwarded to the vessel each day. Since the AMSR2 pixel size is more than 6 km, the AMSR2 data were less informative when it came to judging ice conditions in the Totten region in near coastal or ice edge regions. Figures of the georeferenced ice images were produced daily and copies given to the bridge.

We benefited tremendously by the sea ice reports forwarded to us by Jan Lieser, from the AAD/ACE CRC Sea Ice Group in Hobart Tasmania. Jan sent frequent reports on the sea ice conditions in the Moscow University Ice Shelf polynya, and in the Mertz Polynya while we were working there. These reports included his interpretation of the ice conditions and commentary on changes in conditions, and included both AMSR-2 and MODIS imagery.

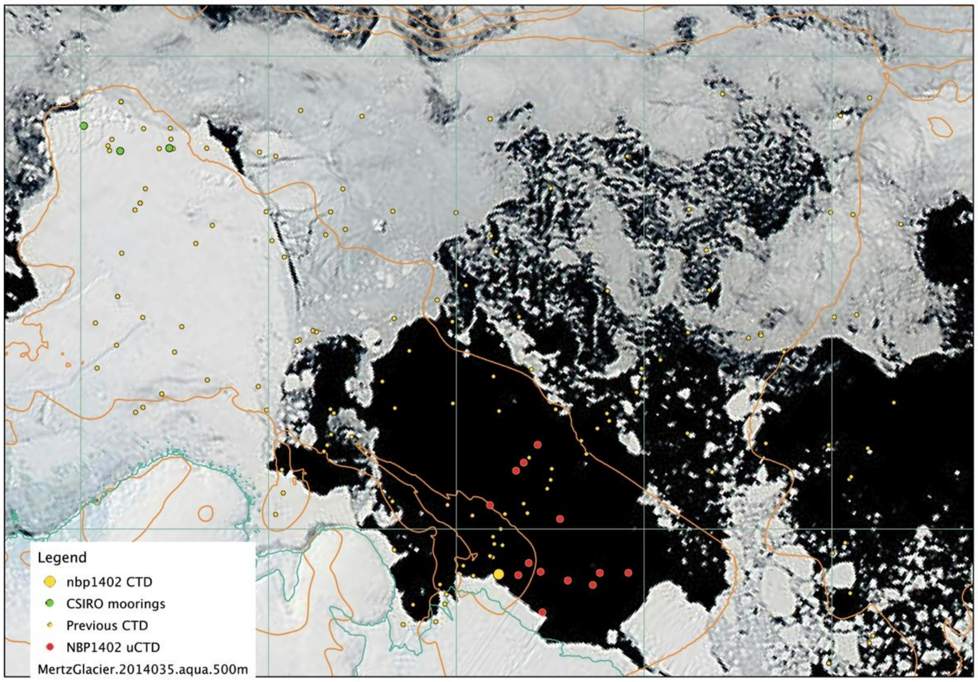


Figure 68. MODIS image of Mertz region.

12.2 WEATHER FORECASTING

We were extremely fortunate to receive detailed weather forecasts that were specific to our work locations, courtesy of two members of the TAS AntForecasters, Jane Golding and Michelle Hollister, based out of Casey Station. These forecasts were incredibly accurate and were instrumental in our day-to-day planning, as we encountered periods of strong easterly winds that pushed sea ice westward, followed by periods of calm winds, during which the sea ice relaxed and drifted back toward the east (Fig. 69). In addition, we received helpful forecasts from Olivier, from Dumont d'Urville meteorologic station

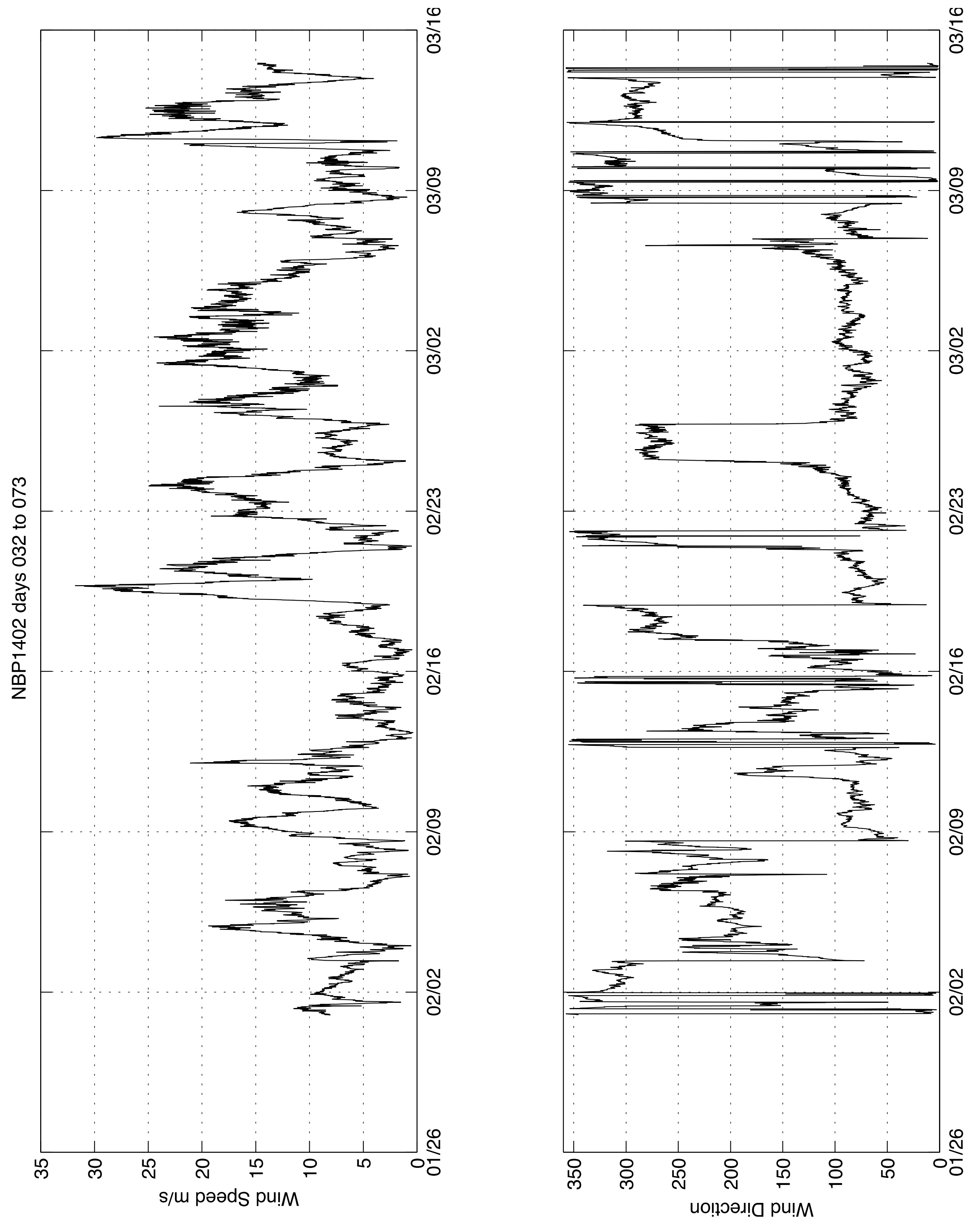


Figure 69. Wind speed and wind direction data for NBP1402 cruise period.

12.3 CTD

The ASC rosette/CTD system performed reasonably well, with the exception of troublesome excessive noise in both primary and secondary sensor suites and spikes in the pressure sensor. The noise was initially confined to the down trace, but later casts displayed some (reduced) noise on the upcast as well. Normally, the CTD signal is virtually spike-free but from the first cast, excessive spiking was evident. The wire had been newly terminated before the first cast. After several attempts to isolate the problem by selectively re-seating underwater connectors, the conducting cable was re-terminated. Spiking continued for the remainder of the cruise, but was noticeably reduced for the last few casts following re-securing of a pump cable.

There is a possibility that the CTD underwater unit and deck unit are not compatible with the length of wire on the winch. The CTD and deck unit had been modified to provide a serial data link up the wire; Sea-Bird recommends that CTDs with this modification be used only on wires less than 8000 m. The NBP winch currently has nearly 10000 m of wire. This should be further investigated - if the serial modification is the cause of the spiking then the modification should be reversed as the serial uplink is not a generally useful feature. If the spiking is not related to the serial uplink feature, then the cause must be found and remedied as soon as possible.

Rosette trigger positions 5 and 7 need some attention. The latches do not re-seat easily when cocking the bottles, indicating the possibility of dirt or wear in the trigger mechanisms. We did not experience significant misfires of the rosette, nor were there any persistent problems with individual bottles. Many of the bottles leak noticeably after the air vent is opened but the leaks were easily stopped by tapping firmly on the bottom end cap.

12.4 MULTIBEAM

In total, we had 147 multibeam crashes. During each crash, we lost multibeam time as a consequence of slowing the ship down and/or circling back to cover lost ground. We estimate a time loss of about 20 minutes for each crash/reboot – totaling 2940 minutes, or about 49 hours.

MultiBeam Crash Recap, Kathleen Gavahan and Barry Bjork

"The EM 120 MultiBeam started malfunctioning on Feb 6, 2014. It continued failing until March 6th with a two-week period from February 16 until March 1 with no failures. There were a total of 147 failures during the cruise.

The workstation running the SIS software would stop pinging and give the error message, "CCUH connection to sounder Type 120, serial number:999 has been lost". No reference to this message could be found in the Maintenance Manuals. After a failure, power would be cycled in the Transceiver Unit and the SIS Operator Workstation. The above procedure was repeated after every failure. The failures would happen randomly, sometimes within minutes of the last failure or more usual, after running for several hours. As the cruise went on, the failures became more frequent.

After consulting Kongsberg, the following actions were performed on the Transceiver Unit over the next few days, to no effect. It should be noted that very little time could be allocated for shutting down the system to troubleshoot and replace hardware. This is because the MultiBeam data is critical to the success of the cruise.

- All of the circuit boards in the Processing Rack were removed, one-by-one, cleaning both the board connectors and the back plane jacks.

- Spare Ethernet Card was swapped in.
- Spare Low Voltage Power Unit was swapped in. Spare immediately blew a board fuse upon powering up. Original LVPU was put back in. No other LVPUs were on hand.
- Spare, unused High Voltage Power Unit was swapped in.
- Spare CPU board swapped in. Transceiver Unit would then not fully power up, so original was put back in.
- Spare Upper (Master) BSP Board was swapped in.
- VGA Board was installed on the ISA backplane of the Processing Rack of the Transceiver Unit and a monitor was connected to it. A keyboard was also connected to the CPU Board. This way, boot-up routines could be monitored when bringing the system back up and error messages would be displayed upon failure.
- Spare Lower (Slave) BSP Board was swapped in after making sure it was jumpered as a slave.
-

A couple of hours after the second BSP board swap, the same failure occurred. Then the system ran for two weeks without failure. After two weeks of flawless operations, the old failure started occurring again. The time span between failures varied from minutes to hours. Rebooting the Transceiver Unit was becoming more difficult, taking several power cycles to get a clean boot. The monitor was invaluable in watching the boot sequence for any error messages.

The system eventually failed to the point where it would not re-boot, even after trying ten times. It was decided to try a quick board swap of the CPU board while the ship was halted. The CPU board was suspected, partly because of the random, self-boots and also due to the fact that failed re-boots would stop at various places in the boot-up sequence.

Lacking a 100% functioning spare PU board, the original (pre-upgrade) spare PU board was installed and the system was re-booted. Unfortunately, the board did not initiate its BIOS routine even after a couple of tries. It was decided to abort the MultiBeam survey at this time and start dredging operations to allow more time to work on the MultiBeam. At this point the original CPU board was re-installed and the BIOS was queried and logged. The replacement CPU board was re-installed and the BIOS started this time. The BIOS was accessed and several changes were made to match the original configuration. These changes were mainly to the hard drive configuration. The changes to BIOS were saved and the boot routine was allowed to continue. The boot routine continued error free. The SIS operator computer was restarted.

The system has not failed in the 12 days since the PU board swap. During this time, we had a ship power failure and the system came back with no problems.”

12.5 <u>NBP1402 IMAGING SYSTEMS TROUBLESHOOTING REPORT – YOYO CAMERA</u>

Sheldon Blackman & Barry Bjork
ASC Marine Electronics Technicians

Telemetry System (MacCartney)

The MacCartney Telemetry System was mounted on Yo-Yo Cam frame for use with OIS digital still camera system, as was done during NBP1203 Larissa II. We didn't have the nice stainless frame that was physically better for accommodating the system, but we made do. After working with the system, it was deployed on Feb. 12th. However, the video looked much better on the analog output to the CCTV than on the digital input to the monitoring and control laptop. We discovered later that if we went into the deck-box and disconnected power to the video decoder (which disables the analog video), the video on the laptop was much cleaner with smooth motion. We decided at that time to try using it in that mode. The next cast gave fairly good video, but we feel that additional lighting would help.

So, on Feb 19, we added the second set of lights. This required that we utilize the Laser adapter cable to power the lasers off one of the sensor ports. We installed that cable which we connected to Sensor Port 1-3, and thus the lasers were powered on Sensor 2. We then added the spare light "Y" cable to the Laser/Light2 connector (blue).

On Feb 20th, when we powered up the system to test if for possible deployment, we got a red "fail" light on the deck box. After a lot of troubleshooting we discovered that in the process of putting the 2nd set of lights we might have pulled the coax out of the J-box gland slightly. This might have caused a short to ground inside the oil filled J-box. When we pushed the coax back in and tightened the gland, the system started working fine on deck. However, the next time the system went in the water, the ground fault tripped. It turned out that it was pure coincidence that this occurred after the other lights were added. And moving the coax was not the cause of the problem.

We went ahead and removed the second set of lights, and the Laser adapter cable and moved the primary lights away from the camera. We used the bigger lights this time, and they seemed to be working fine.

We removed the j-box, drained the oil and found water in the oil. Also we noticed that the compensating bladder had collapsed inside the j-box resulting from the cap being left on. We cleaned out the j-box and replaced the oil. However, when we deployed the system again, it ground faulted.

It is hard to keep straight how many times the system tested good on deck and then when we put it in the water, it failed. However, on Feb. 22nd, we found that the lights were not working properly. One light was out and the other flickering. We put the original lights back on and they worked fine. We were not sure if this was related to the ground fault. Anyway, we put the system back in the water and it tripped the ground fault. So we were back to square one.

This time we removed the j-box and cut off the termination. We completely re-terminated the cable, replaced the oil and deck tested the system. It all looked good.

On Feb. 24th we deployed and we had three good casts. We thought we had fixed it. However, when we deployed again, we got about 20 meters down and it ground faulted. We brought it back up, it seemed to work ok on deck, so we tried again. This time we we got a good 600m cast. But then on the next cast it ground faulted and stayed faulted on deck. So we decided to check out the j-box.

Once again we drained and opened the j-box. It all looked good, but we went ahead and cleaned it all out, replaced the oil and prepared for re-deployement.

It was at this point that we decided to put the standard Yo-Yo Cam Battery /Altimeter /Laser /Bottom Contact harness on the system as a backup (see OIS Camera below), so that in the event that the Telemetry System failed we could switch over to a "blind" Yo-Yo running the harness through the Oil Filled J-box.

On Mar. 03, everything checked out good on deck, so we deployed again. But almost as soon as we got it back in the water, it ground faulted. So we immediately switched over to the Standard Yo-Yo harness and were able to make four good casts with stills only. It should be noted that after we finished, we put the sea-cable (through oil filled j-box) back on the Telemetry System and it checked out good on deck. Also we used the Mega-ohmeter on the sea-cable and found that there is, in fact, a lower than normal resistance between coax shield and armour if about 1.8Mohm at 100volts. However, after it sat on deck for a few days, we checked the cable and the coax shield to armour was >2 Gohm. So it would seem that something is drying out when it is on deck, the cable perhaps.

After all science ops stopped on March 7th, we broke the system down and the MTs cutoff the termination, leaving a few meters of cable for us to inspect. We opened up the j-box and found that the oil was clean and free of any water. We inspected all splices and connections. We inspected where the armour ends with just the coax going to the j-box. We even removed the armour from the cable above that point. We could find nothing out of the ordinary.

In retrospect, we feel we were possibly fighting two separate problems resulting in the same symptoms:

1. Initially, water in the J-Box due to the lack of documentation on the correct use of the compensating bladder. Consulting with MacArtney resulted in the correct use of the bladder and we resolved that problem. However, we still had ground fault problems after that was corrected.

2. An external short that resulted from the system being immersed in the water. Extensive troubleshooting never did reveal the source of the problem. Forensics were performed on the termination and the cable just above the termination. Everything looked good. The symptoms appear that there was a very small break in the insulation separating the outer armour from the coax shield, thus resulting in a short between the two when the system was immersed. If this is the case, we feel that enough cable has been cutoff such that the problem will no longer be there (the MTs cutoff an additional 7 meters to send in for tensil strength evaluation). But this will only be confirmed when the system is setup, the .680 cable re-terminated and the underwater electronics immersed in the ocean for a cast.

12.5.1 OIS Camera (Yo-Yo Cam)

So we could keep the OIS Camera powered up on deck, and download the pictures from inside Aft MT Shop we built an extension cable with WetPluggable connectors and ran it out of the Aft MT Shop ROX-BLOX to the main deck, where the Yo-Yo Cam was to live. We mounted a laptop by the Maggie J-Box to download the pictures with.

The Yo-Yo Cam system was setup in conjunction with the Telemetry System for video, lights, lasers and altimeter. This made it unnecessary to utilize the seacable harness for lasers, altimeter and bottom contact alarm, as we could see the weight touch the bottom and the strobe go off. However, during the cruise we had a lot of problems with the Telemetry System. When we were able to make a cast, the OIS camera and strobe worked flawlessly. However, we had to cancel a number of casts because of Ground Fault failures with the Telemetry System (See above).

In lieu of the incredible number of problems with the Telemetry System, we decided to go ahead and rig the Yo-Yo Cam with its standard Seacable harness, battery pack, bottom contact switch and alarm. When the Telemetry System once again failed on 03 Mar., we were able to switch over to the "Standard" Yo-Yo Cam mode. We were able to do four perfect casts in this "blind" mode and all the pictures came out good. We did notice that the Bottom Contact Alarm would go off with a weak signal even though we were not near the bottom. This could be a symptom of a high resistant short between the coax shield and the .680 armour when the system is in the water, thus contributing to the ground fault failure of the Telemetry System.

Also, after each of the last few casts, it became increasingly difficult to stay connected to the camera via the USB cable. It turned out the 6 pin MCIL (Wet-Pluggable) Bulkhead Connector on the OIS housing was very worn, with frayed rubber and bent, corroded pins. After the last cast, we replaced the bulkhead connector and ordered a couple of replacements.

In spite of the problems with the video system, the OIS Still Camera System (AKA Yo-Yo Cam) worked very well and is extremely reliable.

ACKNOWLEDGMENTS.

This project reflects the hard work of many people. Our deep thanks to the ship’s crew, and technical and scientific personnel for long hours under difficult conditions. This project was supported by the National Science Foundation Antarctic Integrated Systems Science Program.

With great appreciation from the NBP1402 Science Team!

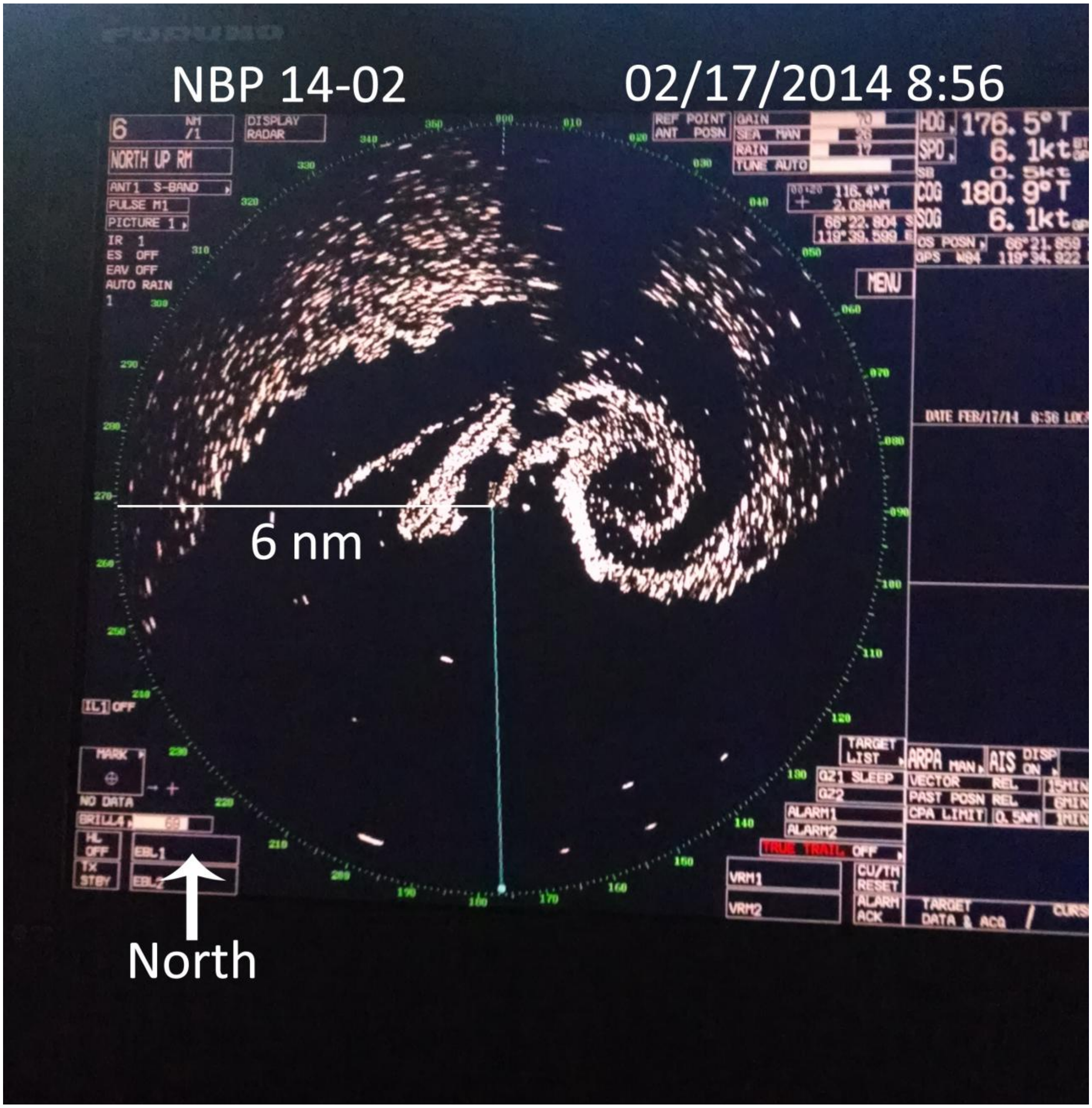
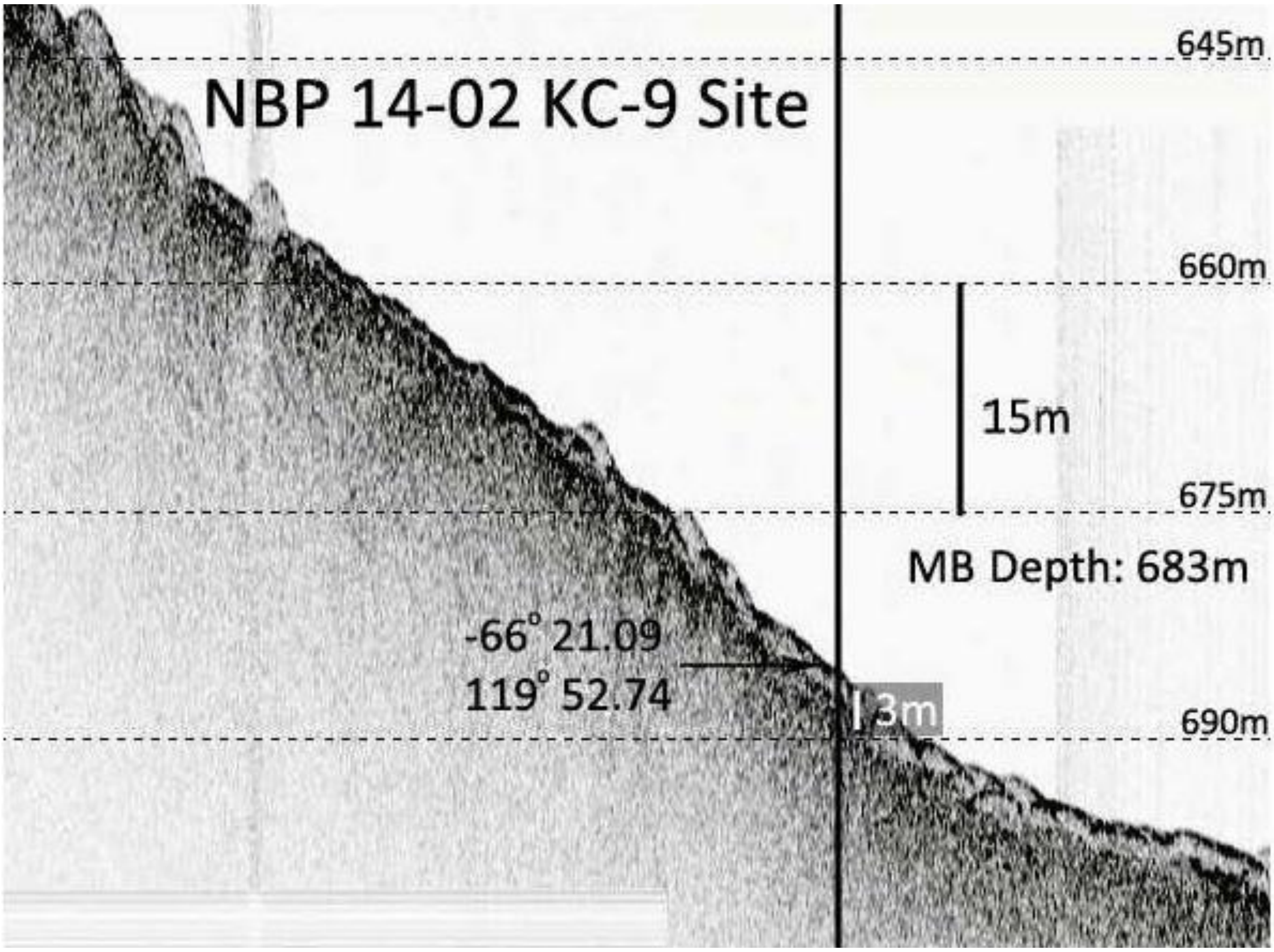


Photo of the bridge radar image of brash ice near the edge of the persistent western ice pack in the Moscow University Ice Shelf Polynya

LIST OF APPENDICES

1. KC locations on Knudsen lines



645m
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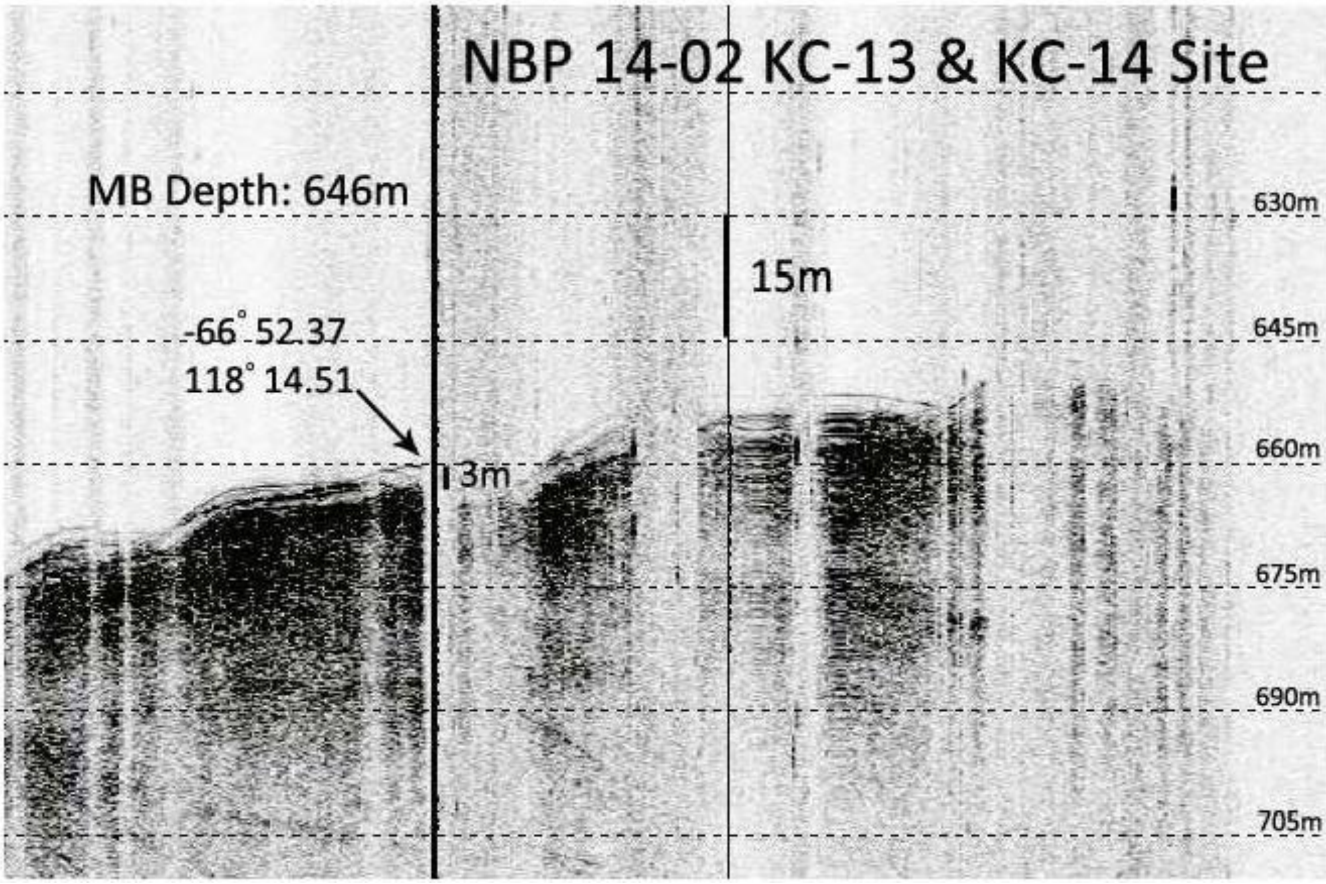
660m
15m
675m
MB Depth: 683m
-66° 21.09
119° 52.74
3m
690m


NBP 14-02 KC-13 & KC-14 Site
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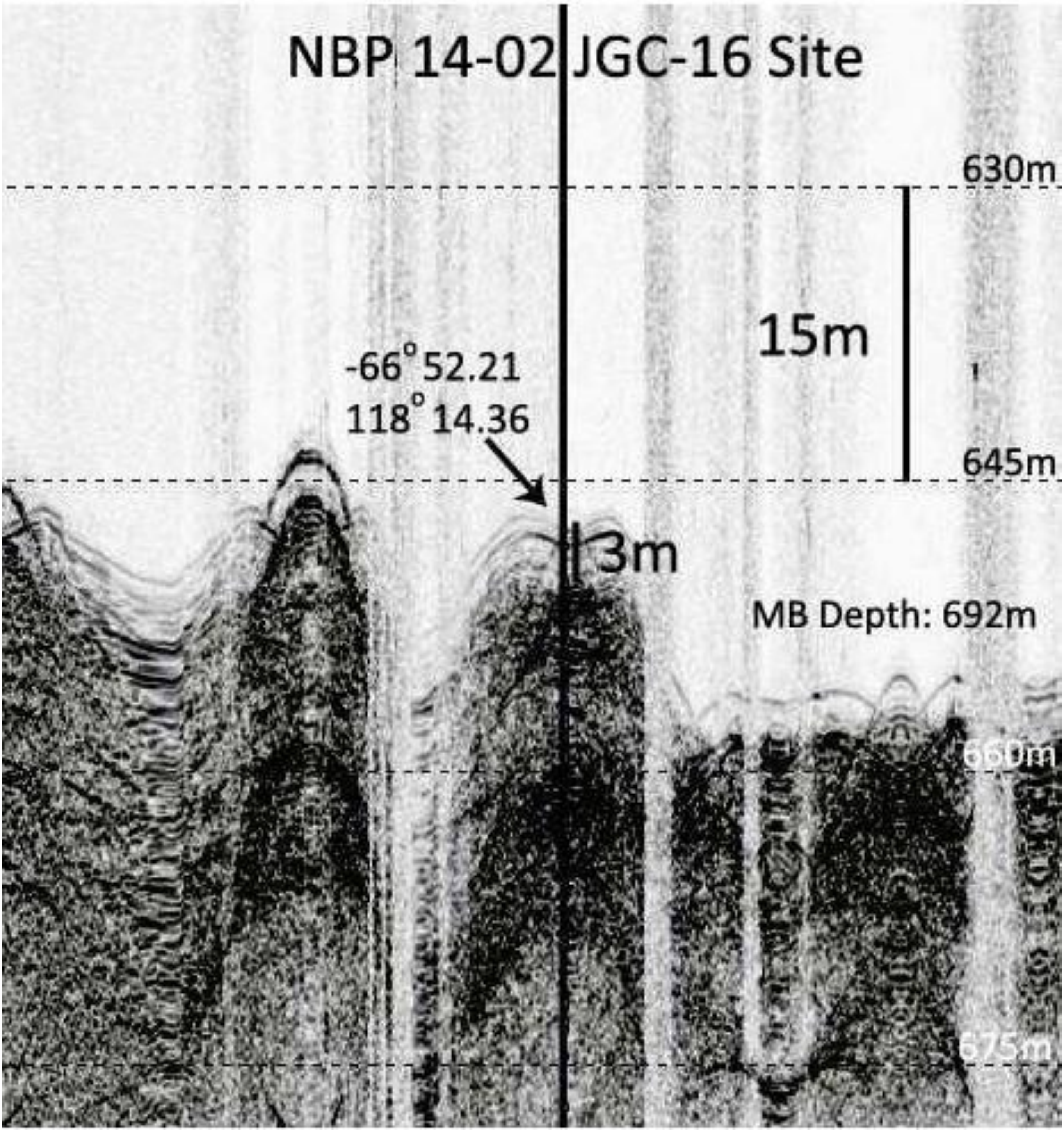
118° 14.51
3m
15m
630m
645m
660m
675m
690m
705m



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630m
15m
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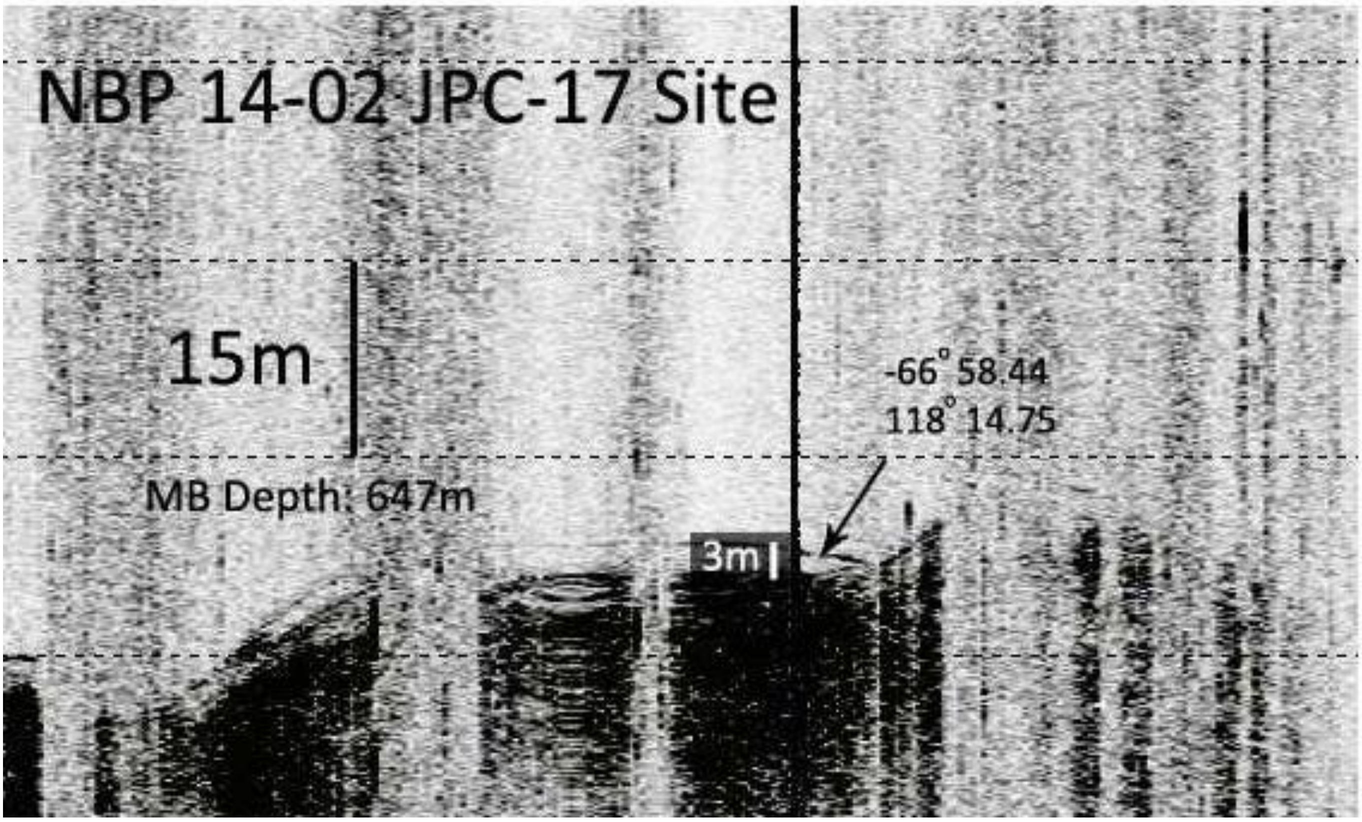
118°14.36
645m
3m
MB Depth: 692m
660m
675m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15m
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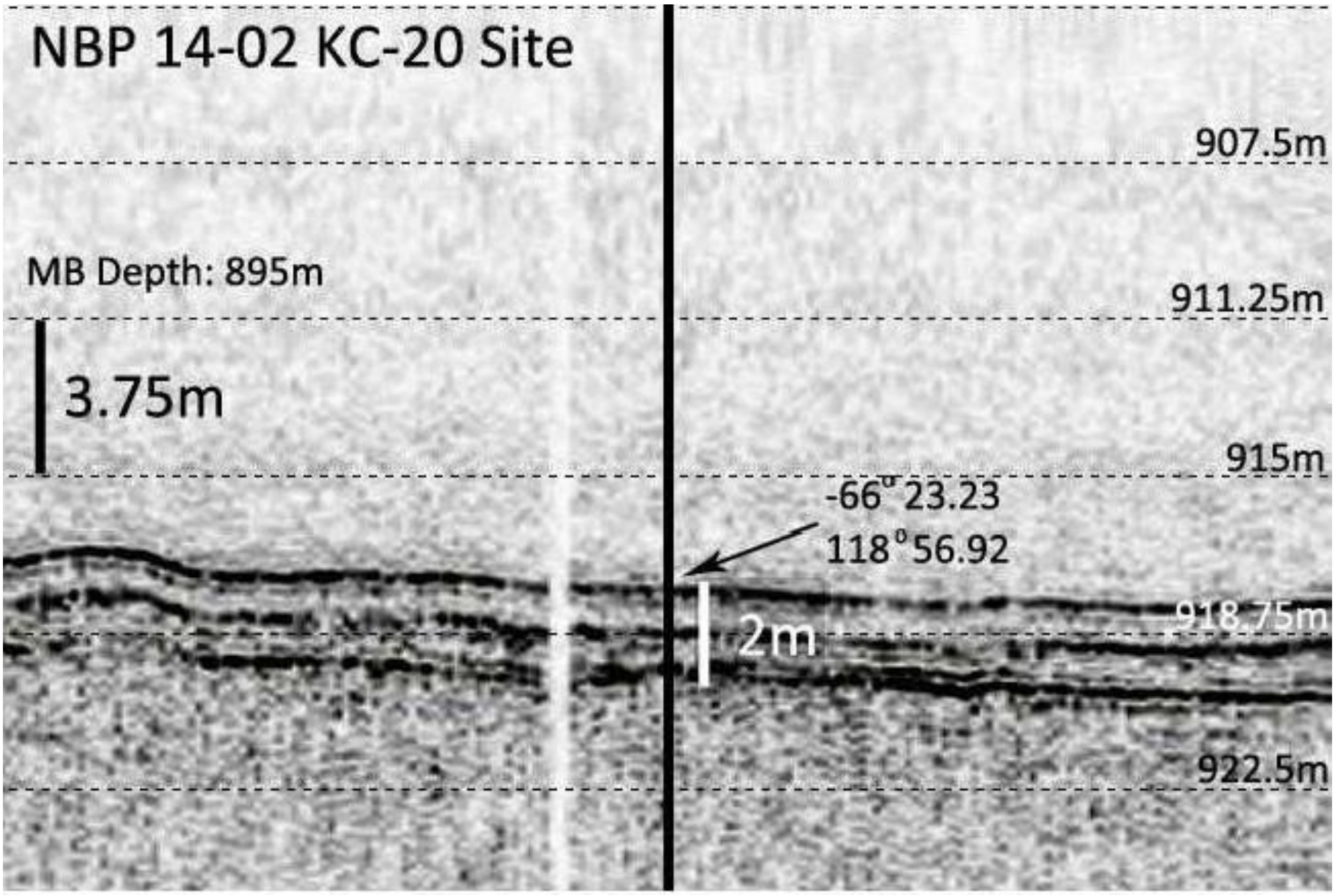
118° 14.75
MB Depth: 647m
3m


NBP 14-02 KC-20 Site
907.5m
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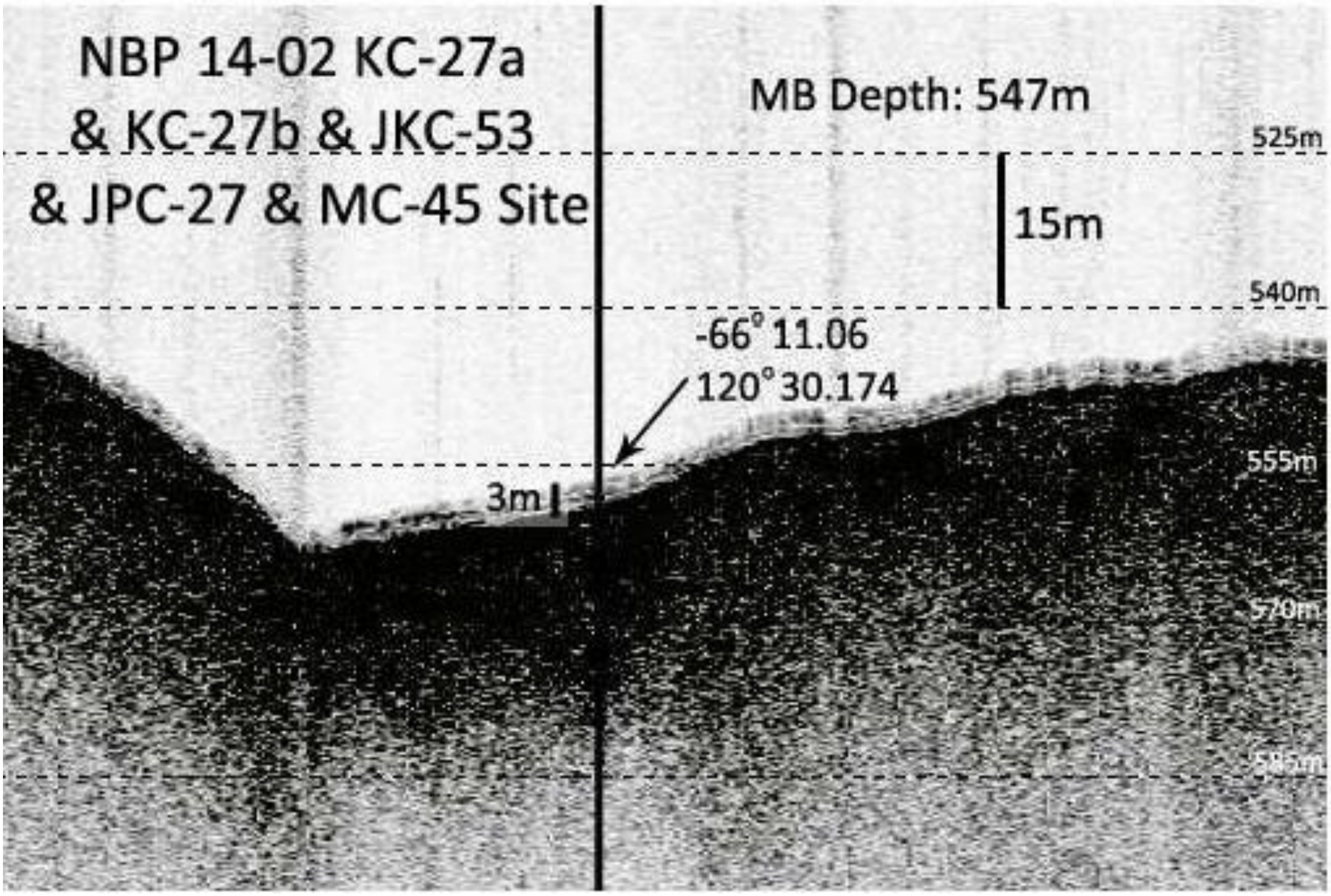
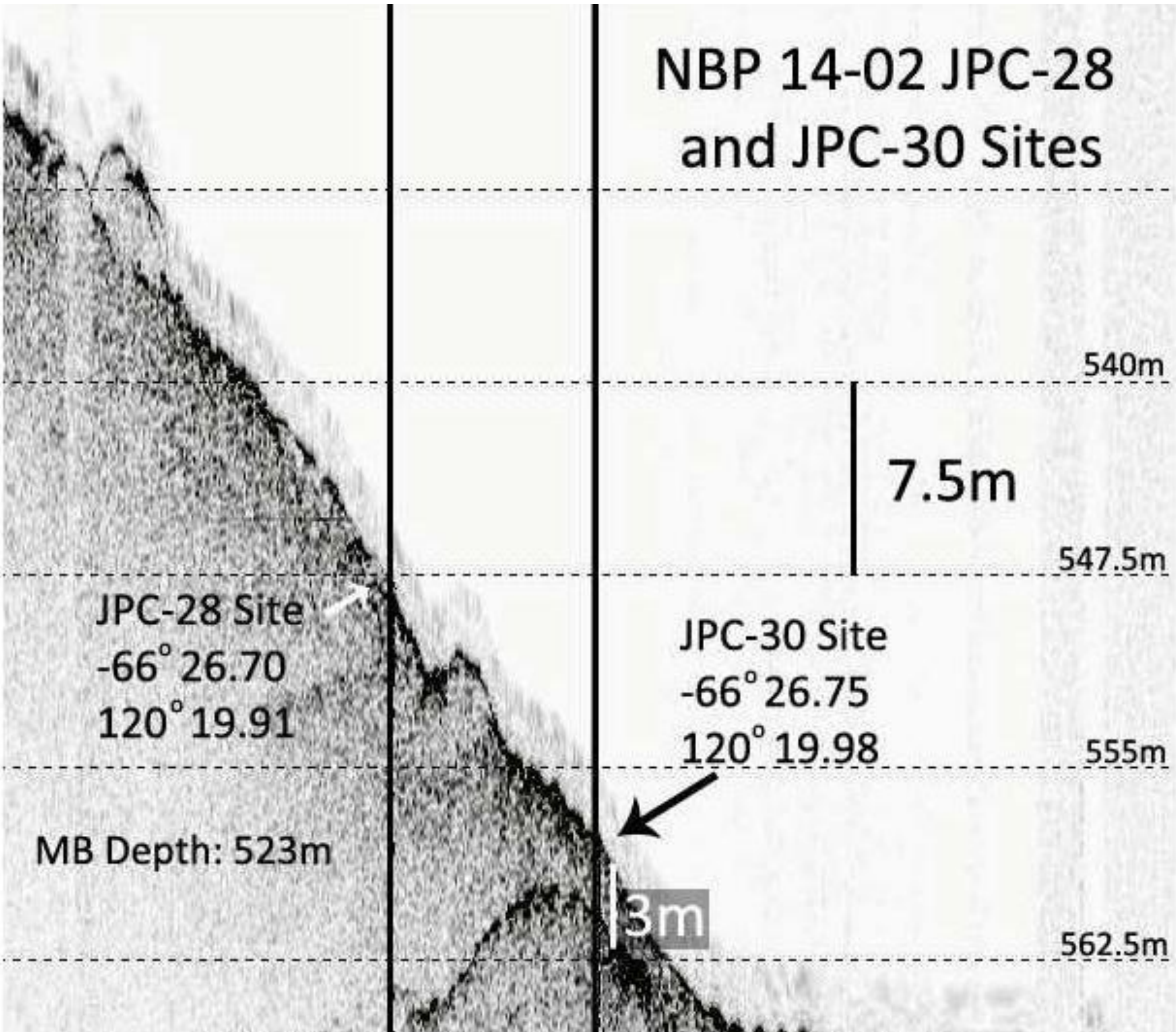
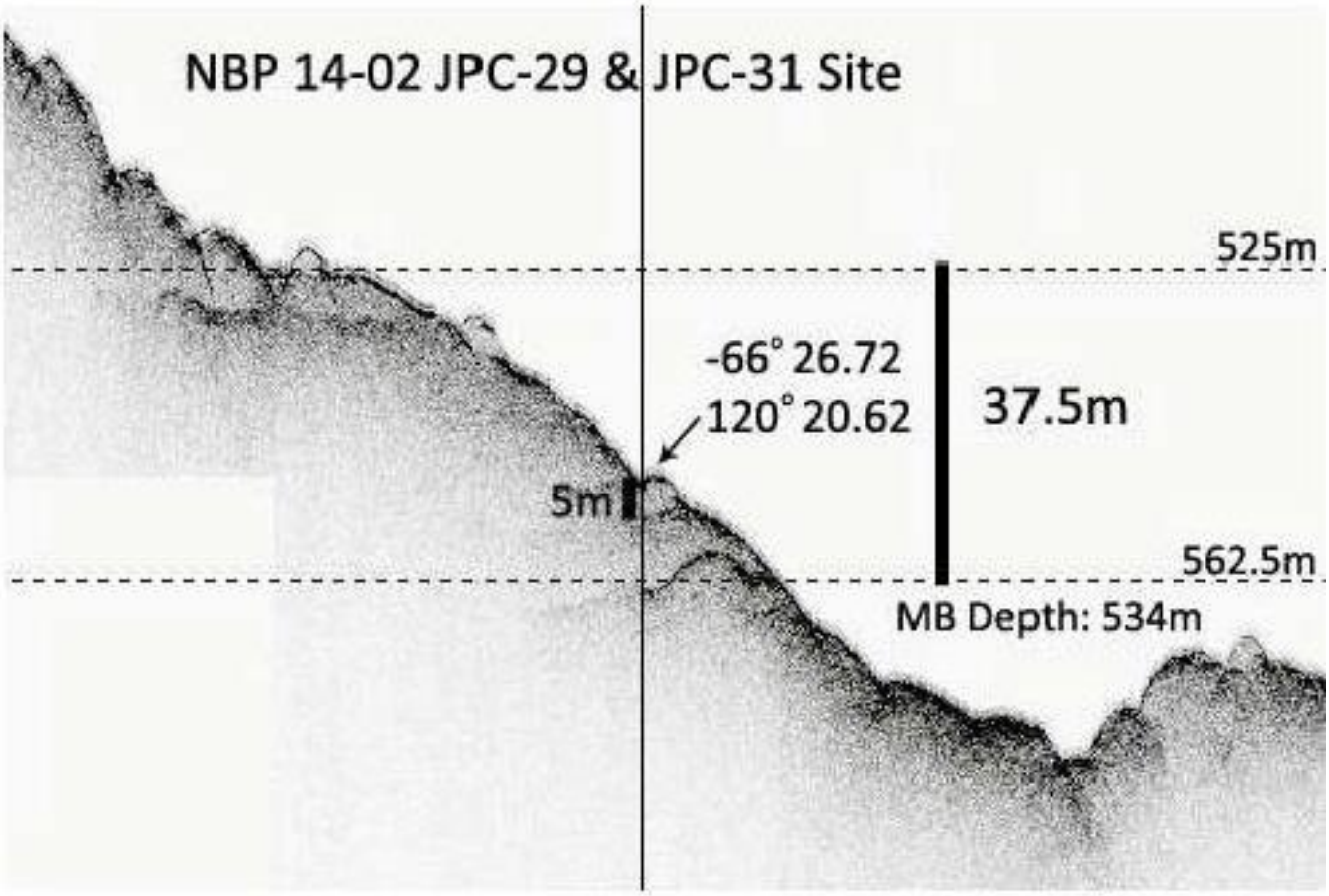
911.25m
3.75m
915m
-66°23.23
118°56.92
918.75m
2m
922.5m


NBP 14-02 KC-27a
& KC-27b & JKC-53
& JPC-27 & MC-45 Site
MB Depth: 547m
525m
15m
540m
-66° 11.06
120° 30.174
555m
3m
570m
585m



NBP 14-02 JPC-28
and JPC-30 Sites
540m
7.5m
547.5m
JPC-28 Site
-66° 26.70
120° 19.91
JPC-30 Site
-66° 26.75
120° 19.98
555m
MB Depth: 523m
3m
562.5m
570m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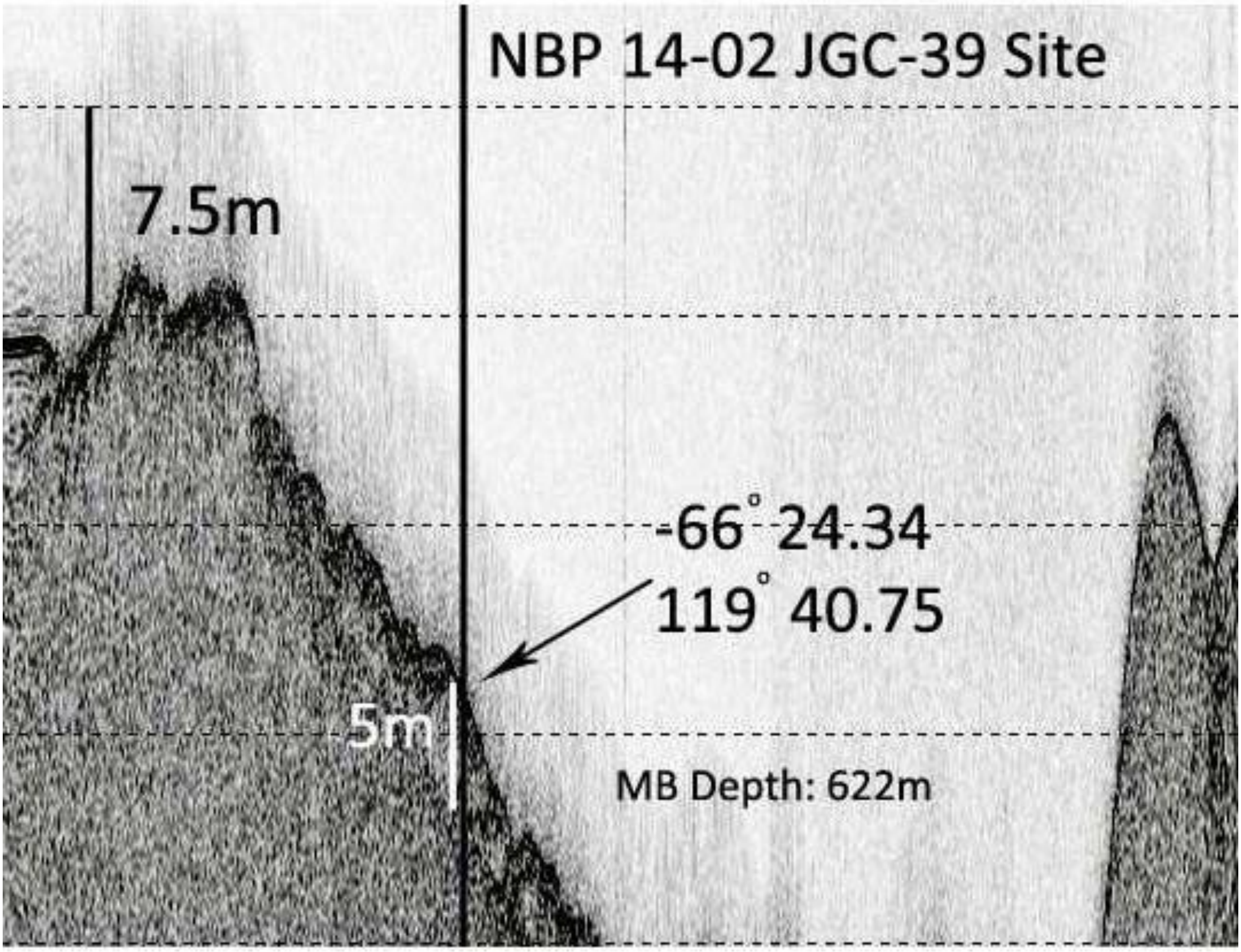
120° 20.62
37.5m
5m
562.5m
MB Depth: 534m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7.5m
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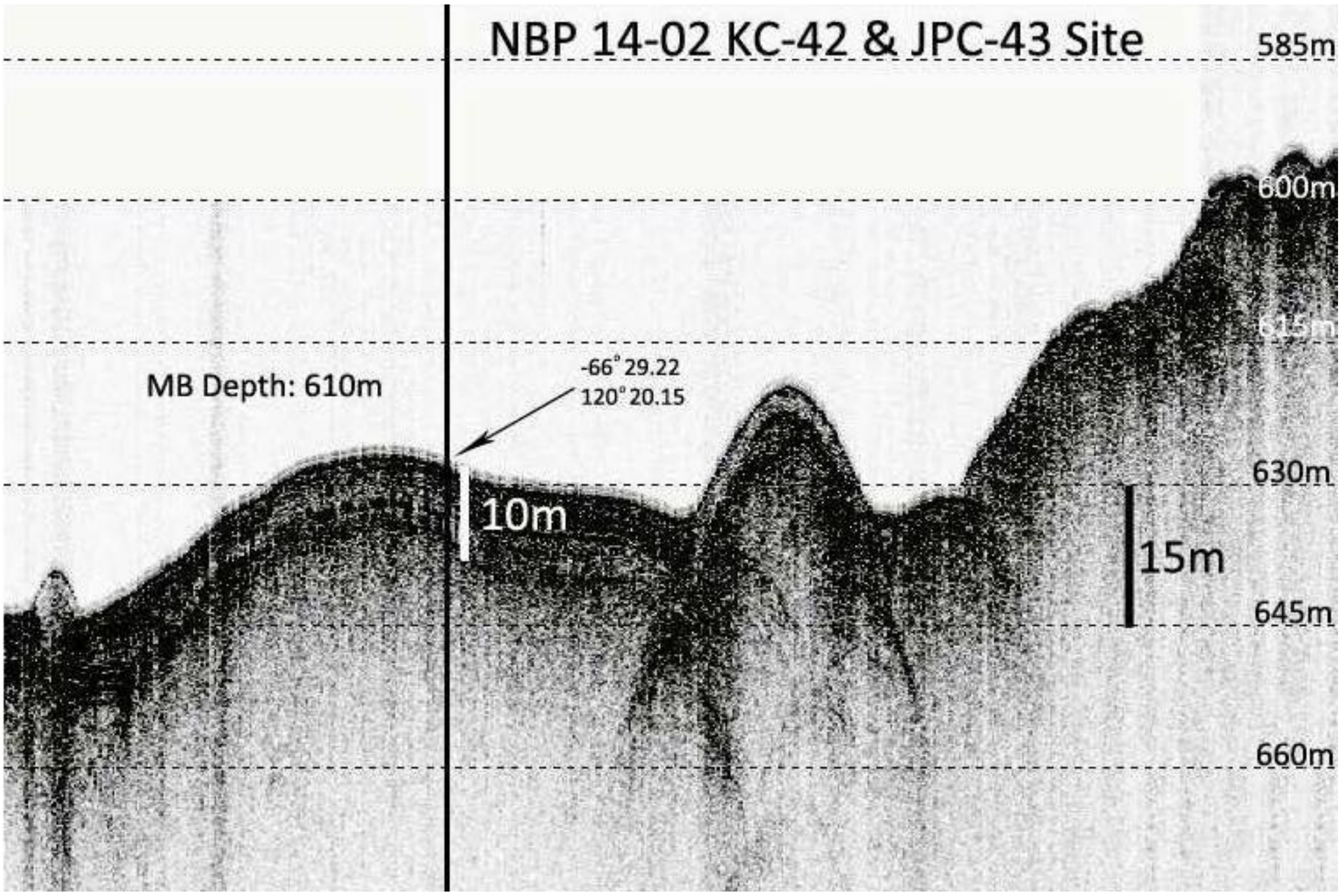
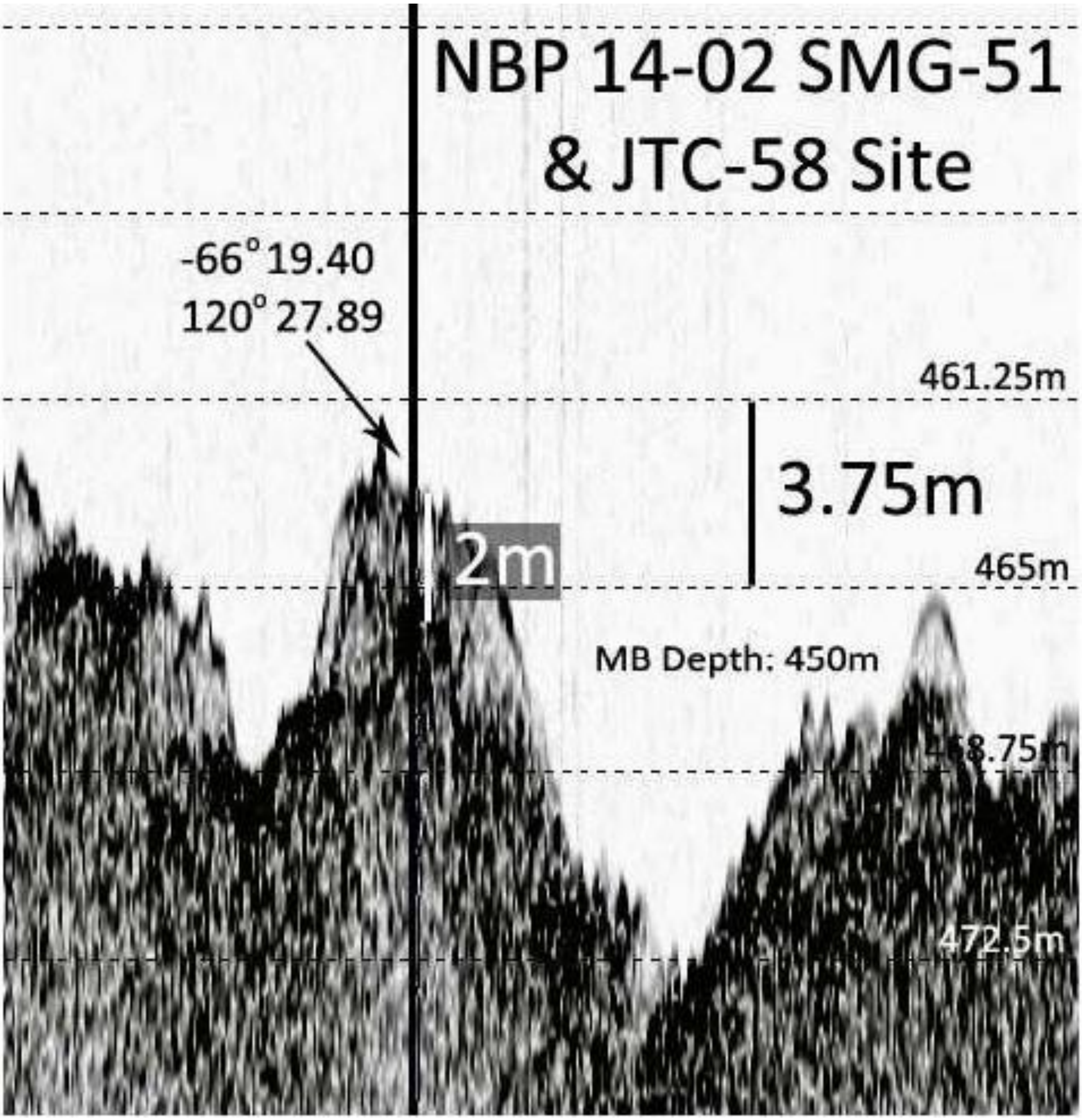
119° 40.75
5m
MB Depth: 622m


NBP 14-02 KC-42 & JPC-43 Site
585m
600m
615m
630m
645m
660m
MB Depth: 610m
-66° 29.22
120° 20.15
10m
15m


NBP 14-02 SMG-51
& JTC-58 Site
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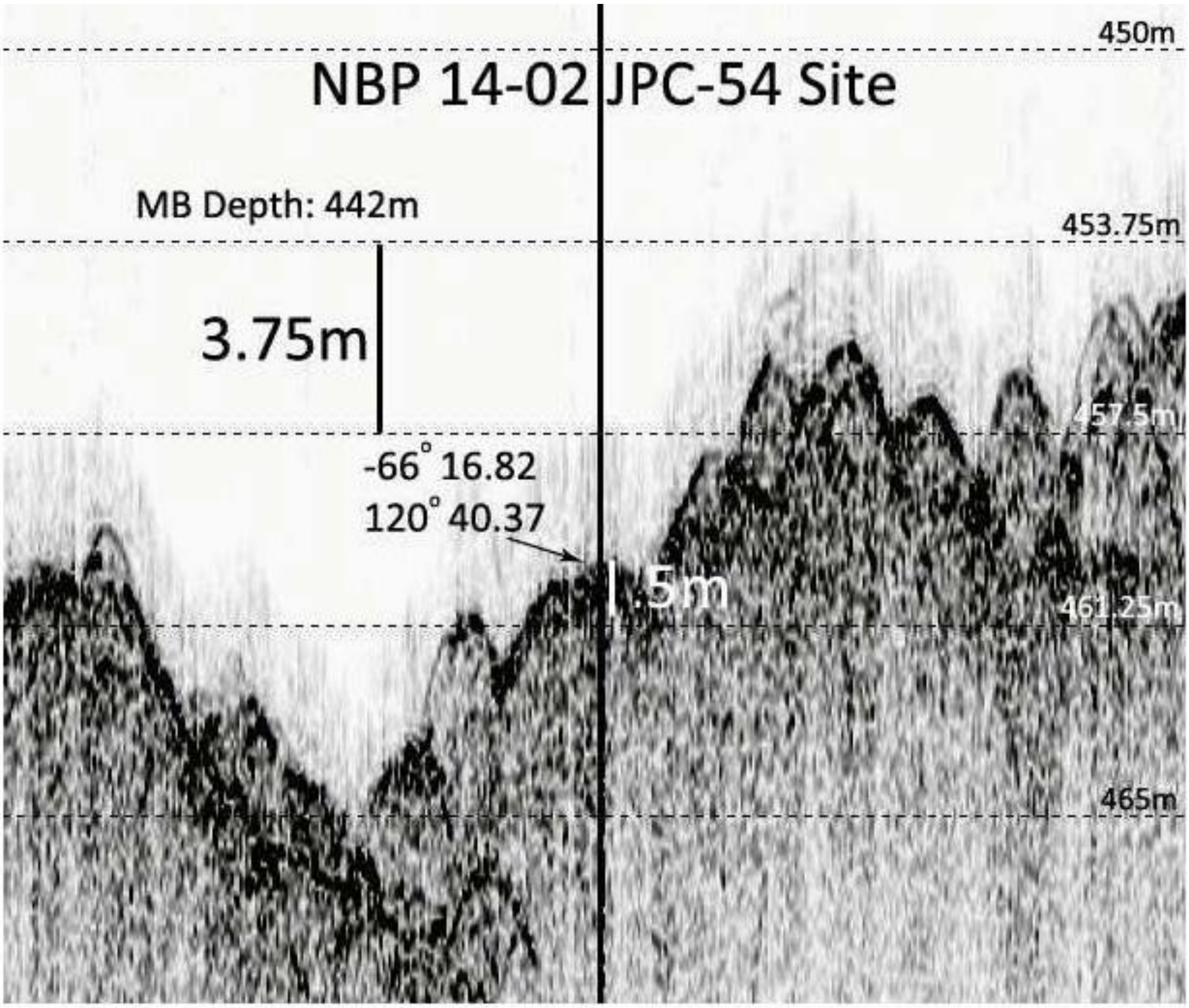
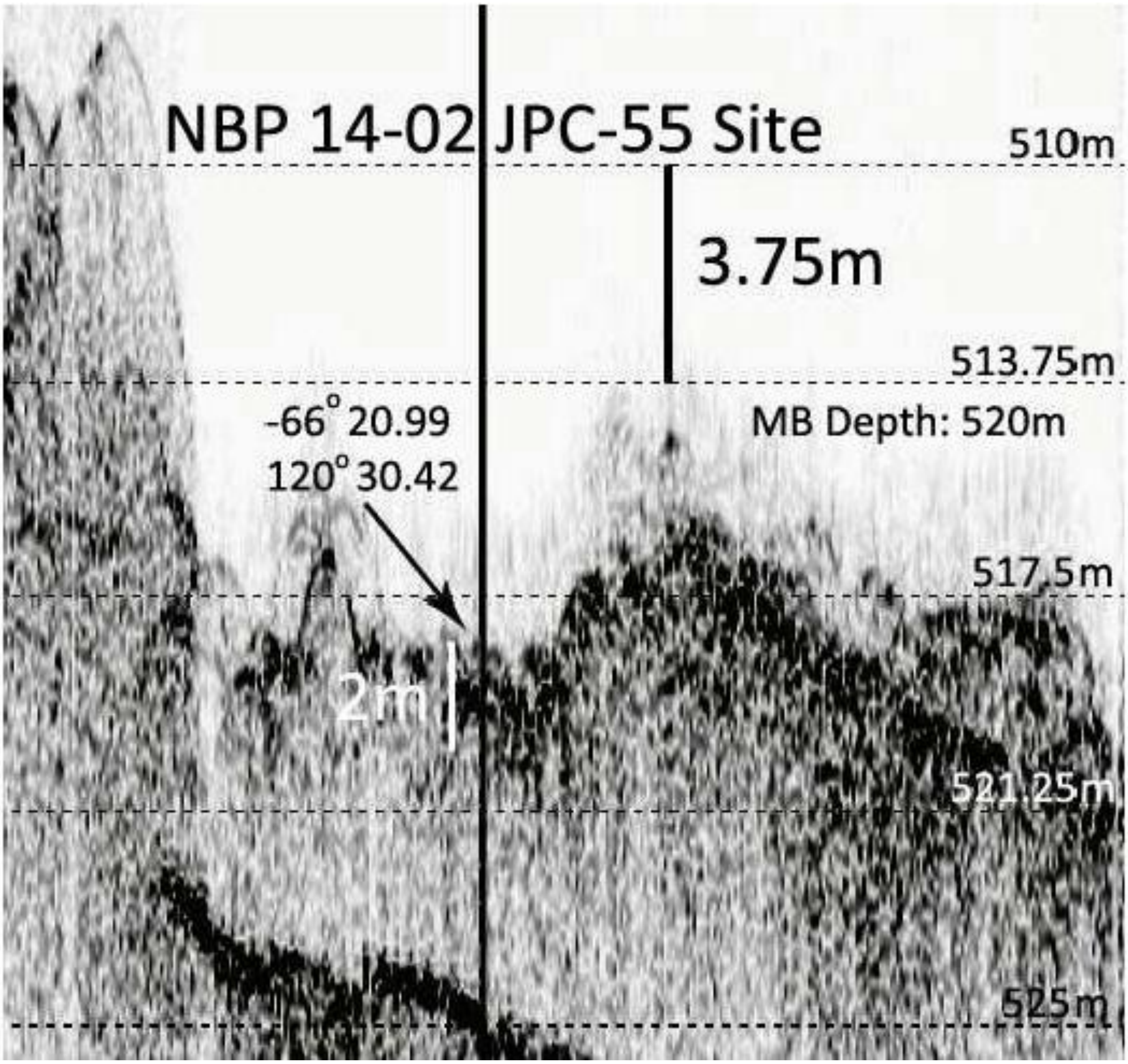
120° 27.89
461.25m
3.75m
2m
465m
MB Depth: 450m
468.75m
472.5m


450m
NBP 14-02 JPC-54 Site
MB Depth: 442m
453.75m
3.75m
457.5m
-66° 16.82
120° 40.37
5m
461.25m
465m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510m
3.75m
513.75m
-66° 20.99
120° 30.42
MB Depth: 520m
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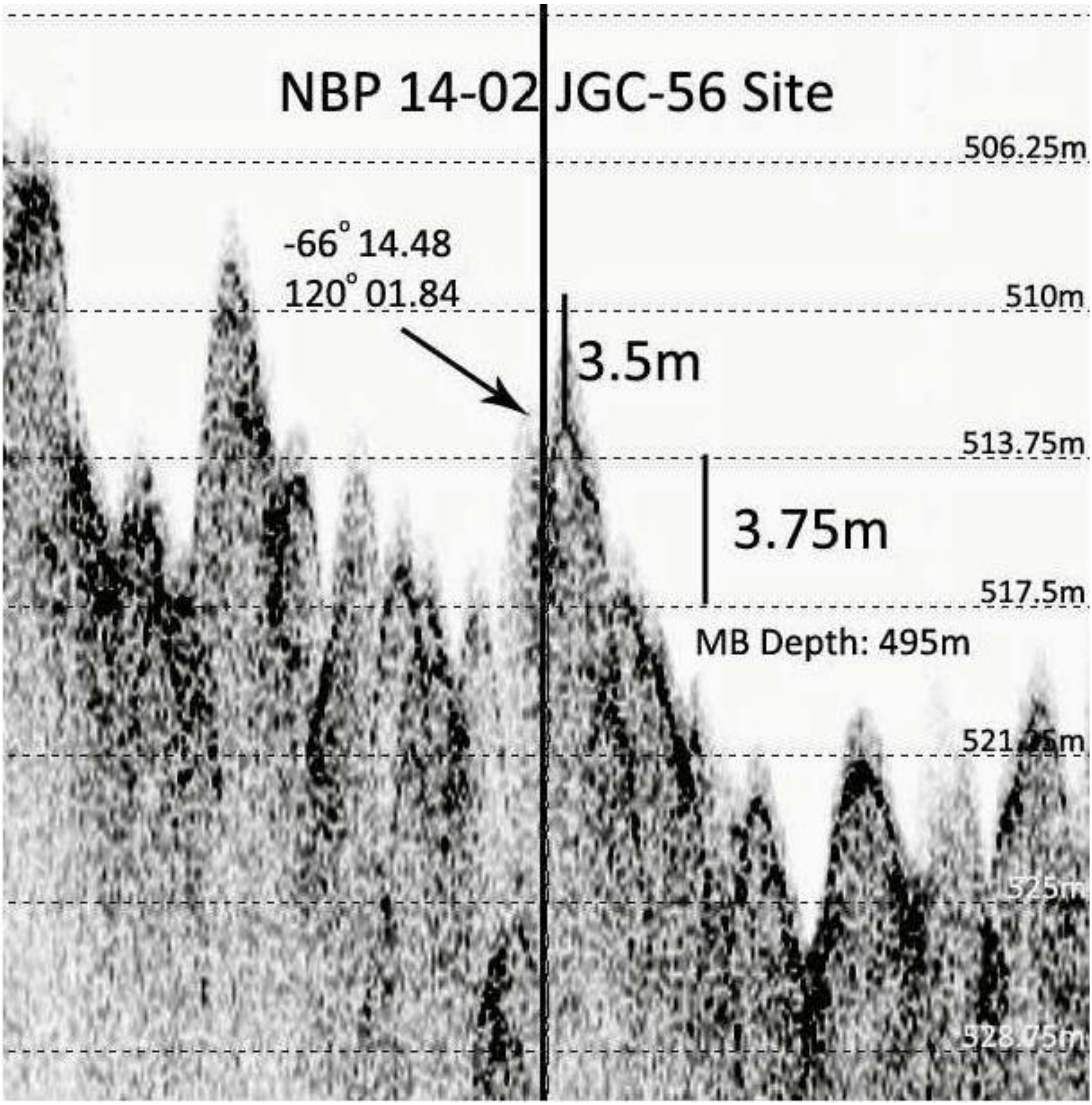
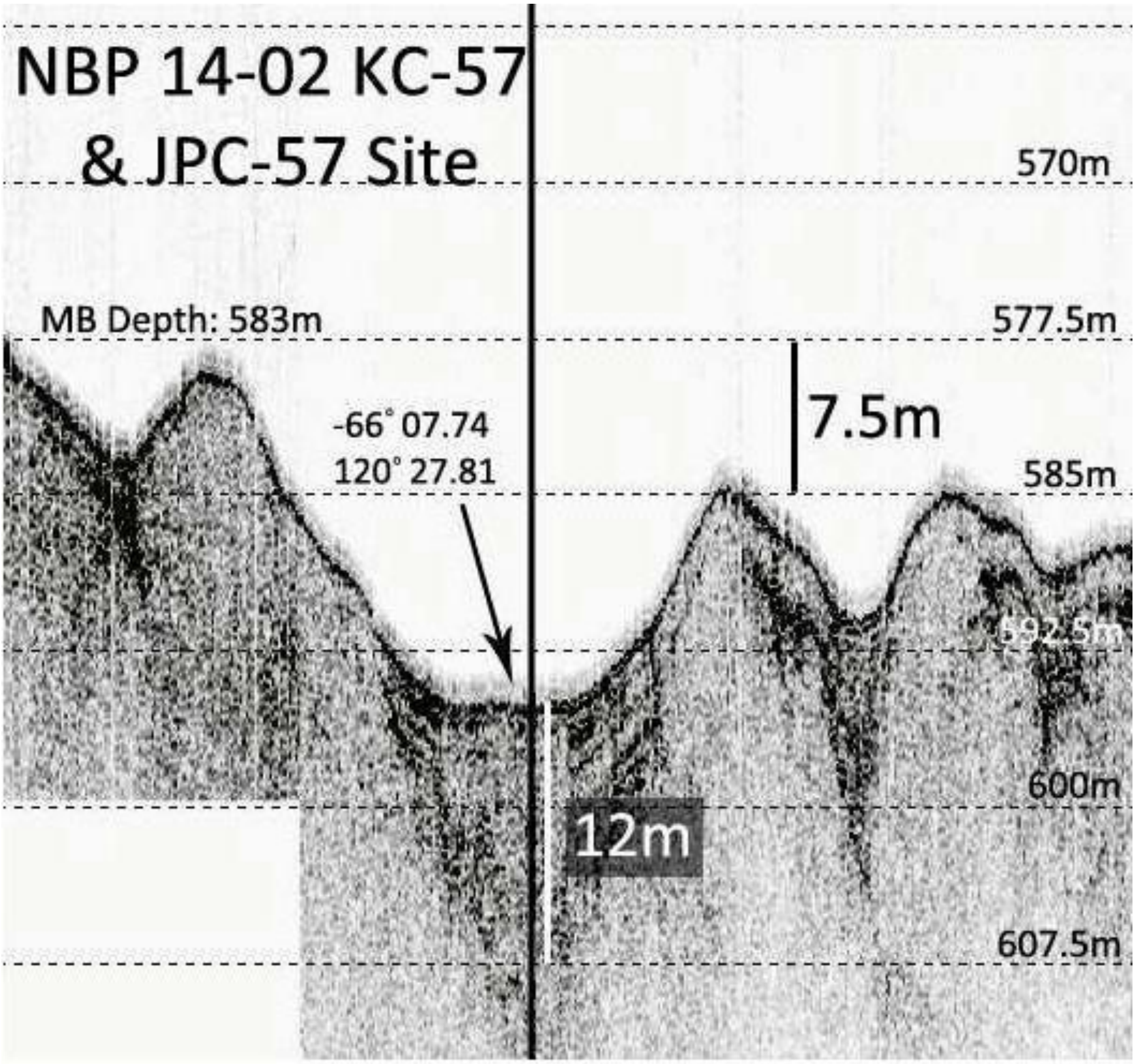
2m
521.25m
525m


NBP 14-02 JGC-56 Site
506.25m
-66° 14.48
120° 01.84
510m
3.5m
513.75m
3.75m
517.5m
MB Depth: 495m
521.25m
525m
528.75m

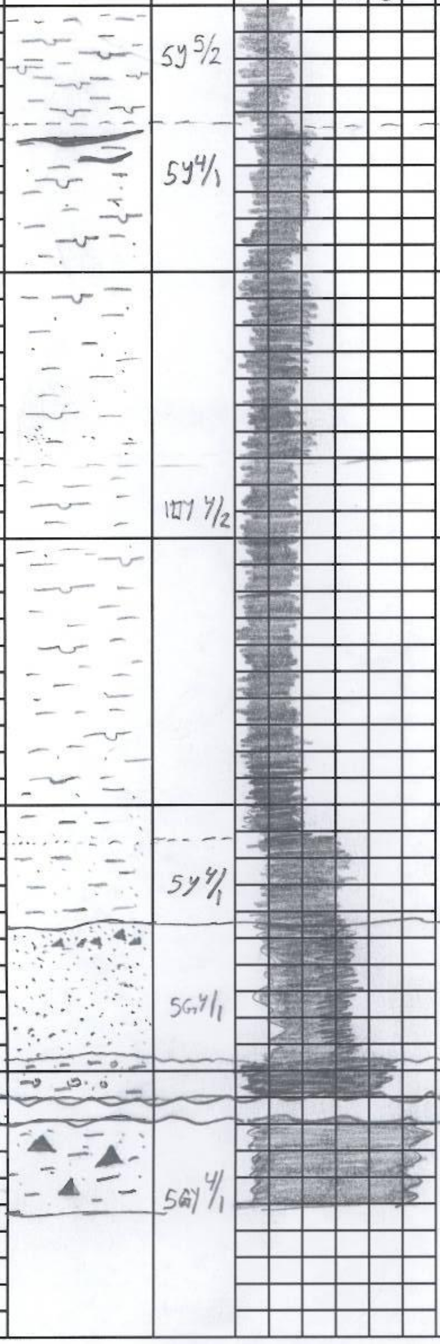

NBP 14-02 KC-57
& JPC-57 Site
570m
MB Depth: 583m
577.5m
7.5m
-66° 07.74
120° 27.81
585m
592.5m
600m
12m
607.5m

2. KC descriptions

Core Number: KC-9 **Station Location:** 1st core at Sabrina coast, Toe of moraine **Total Core length (m)** ~~2.3 m~~ 2.05 + CN

Latitude: 66°21.644 **Longitude:** 119°51.716 **Date:** 02/11/14 (GMT); JD:42

Depth (cm)	Visual Log	Color Code	grain size (clay, silt, f. sand, m. sand, cr. Sand, gravel)	fossils	Sed. Structures	water depth (m) 704 m knudsen general description, disturbance, notes
0–50 (parting)		5Y 5/2 5Y 4/1		diatoms		→ good H_2O/sed interface 0–22 cm Light olive gray diatom mud., bioturbated. Shp. cnt w/ 22–86cm olive gray Slightly sandy (scattered) mud. forams?, diatom bearing. Sharp parting
50–100		10Y 4/2				at cnt w/ overlying unit. subtle color change at 86cm w/ 86–153 cm Grayish olive diatom bearing mud, very sparse sand grains. grad. cnt at
100–150						153 cm w/ 153–174 Dark greenish gray sandy mud. Shp cnt. @ 174 cm w/ 174–199 cm Dark greenish gray
150–200		5Y 4/1 5G 4/1				muddy sand, poorly sorted vr. cr. to fine shp. cnt. @ 199–205 dark greenish gray very poorly sorted sandy, gravelly mud (ent?)
200–250 (CN 0–16)		5GY 4/1				END CN 0–16cm Dark greenish gray diamicton, firm.



Page 1 of 1

NBP 14-2

Core Number: KC-13 **Station Location:** 13 **Total Core length (m)** 1.725 + CN

Latitude: 66° 52.3947 S **Longitude:** 118° 14.2337 W **Date:** 02/12/14

Depth (cm)	Visual Log	Color Code	grain size: clay	silt	f. sand	m. sand	cr. Sand	gravel	fossils	Sed. Structures	water depth (m) 646 m — general description, disturbance, notes
											← Sed water interf. ?
10		5Y 5/2 - 5Y 4/4; 10Y 4/2							?		0-10 cm bioturbated mod. olive brown to light olive gray silty clay w/ streaks of olive gray. gradient at ~10 cm w/ 10-172 cm grayish olive silty clay - no obvious sand. ? bioturbated ?
50											w/ few clots of mod. olive brown ? diatom mud.
100											
150		10Y 4/2									CN: grayish olive silty clay 0-25 cm
200											

Page 1 of 1

NBP14-02

Core Number: KC 14 | Station Location: 14 | Total Core length (m) 263 cm + 15cm in cutter nose

Latitude: -66° 52.3691 | Longitude: 118° 14.4022 | Date: 02/12/14

Depth (cm)	Visual Log	Color Code	clay	silt	f. sand	m. sand	cr. Sand	gravel	fossils	Sed. Structures	water depth (m) 643 m — general description, disturbance, notes
0–50 (10, 20, 30, 40)		5y 5/2, 5y 4/4, 10y 4/2									0-3 – sed H2O interface; 0-15 cm: mod. olive brown to lt olive gray. Silty clay / Gradational contact from 5-15cm with olive gray. 15-175 grayish olive silty clay tons of bioturbation.
50–100											
100–150											
150–200 (160, 170, 180, 190)		5y 5/2									~175 – 263 Lt olive gray silty clay Bioturbated w/ IRD visible
200–											15 cm CN: lt olive gray. Silty clay

Page 1 of 1

TD 263 cm + 15 cm in cutter nose

Core Number: JKC-15	Station Location: Totten	Total Core length (m) 0.13 m
Latitude: -66° 50.72	Longitude: 117° 56.59	Date: 2/13/14 GMT

Depth (cm)	Visual Log	Color Code	grain size: clay	silt	f. sand	m. sand	cr. Sand	gravel	fossils	Sed. Structures	water depth (m) 652 — general description, disturbance, notes
0–10		5Y 5/2									CN only: 0-13 cm light olive gray diatom ooze, homogenous with sparse sand grains
10–13											

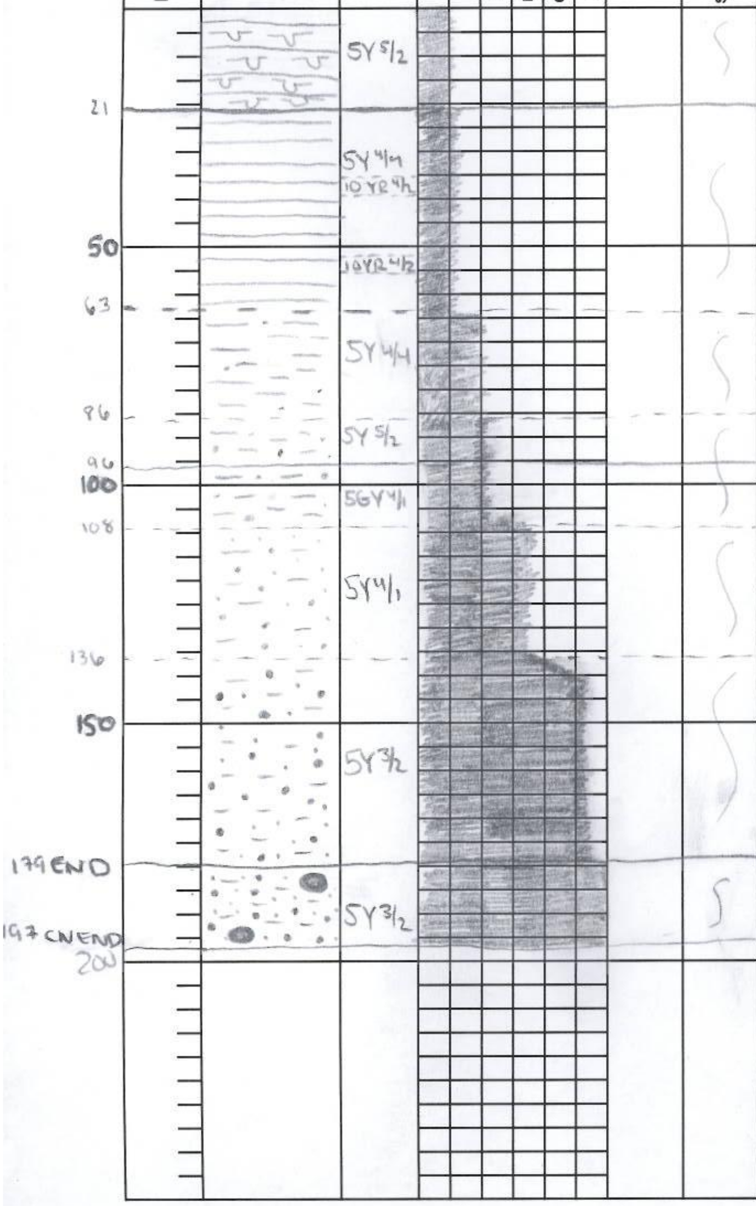
Page of

Core Number: KC-20 **Station Location:** Totten Trough **Total Core length (m)** 1.79

Latitude: 66°23.145' **Longitude:** 118°57.583' **Date:** 2/17/2014

water depth (m) 895 m

Depth (cm)	Visual Log	Color Code	grain size: clay / silt / f. sand / m. sand / cr. Sand / gravel	fossils	Sed. Structures	general description, disturbance, notes



general description, disturbance, notes

poor sed/H2O interface, heavily disturbed 0-21 cm before parting

0-21 cm: Light olive gray bioturbated diatom silty clay sharp contact (parting) with 21-63 cm: moderate olive brown clay rich mud (less water saturated), with dark yellowish brown mottling at 37-40 cm and 52-55 cm.

gradational contact w/ 63-86 cm moderate olive brown silty mud with scattered sand. olive gray mottling at 65-73 cm. Gradational contact with 86-96 cm light olive gray sandy silty mud.

Sharp contact at 96-108 cm dark greenish gray sandy silty mud, bioturbation (finer, paler clay settled out from 108-136 cm). Gradational contact w/ 108-136 cm with olive gray sandy mud (f. m. grain sand). Grad. contact w/ 136-179 cm olive gray poorly sorted sandy granular mud

CN: 179-197 olive gray clast rich IRD layer with mud matrix: granular grains to large cobble clasts → striated, faceted plutonic and metamorphic rocks (clean and photographed)

Page of

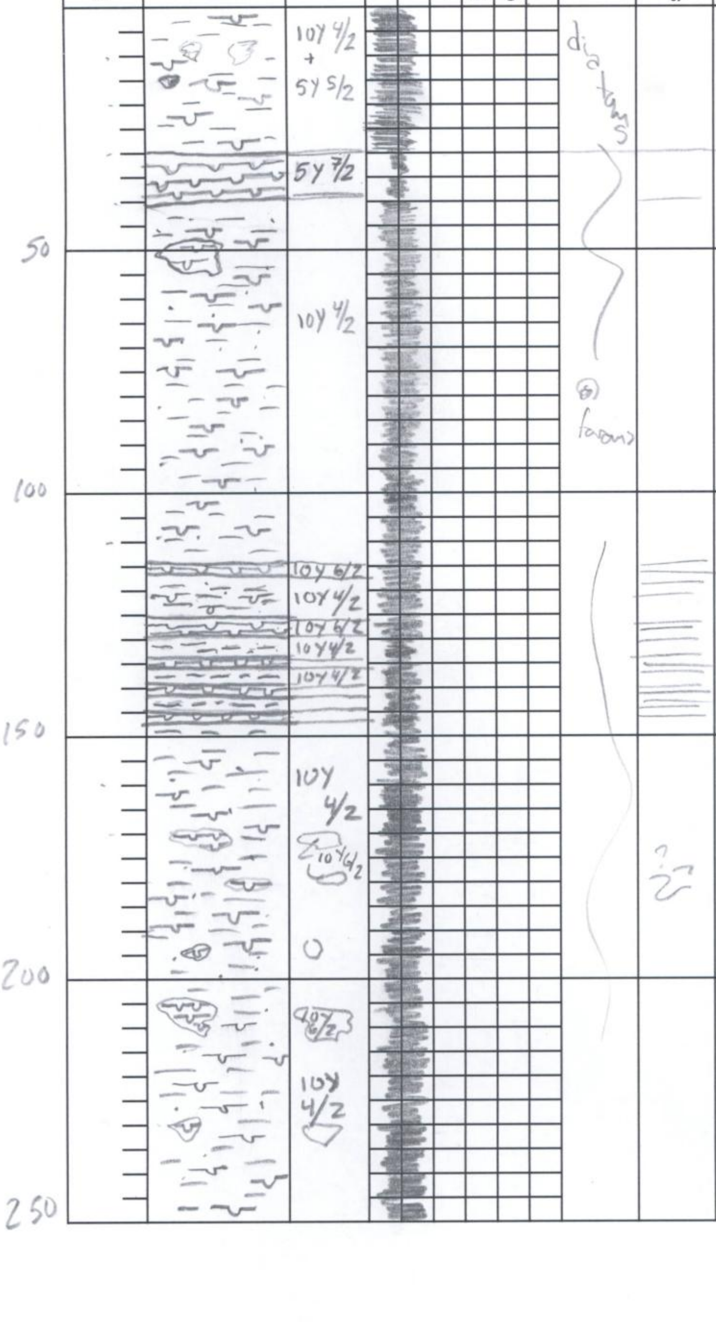
= clay = silt

EWD

Core Number: KC-27a	Station Location: N.E Moscow	Total Core length (m) 2.952 m
Latitude: -66 11.0912	Longitude: 120° 30.2385'	Date: 02/21/14

water depth (m) 546

Depth (cm) | Visual Log | Color Code | grain size (clay, silt, f. sand, m. sand, cr. Sand, gravel) | fossils | Sed. Structures | general description, disturbance, notes



↗ disturbed no sed/H2O interface

0-30 Mottled grayish olive + light olive gray diatom. mud. Shp. cnt. at 30 w/
30-40± Yellowish gray diatom ooze (cottony), shp cut at 40 cm w/
40-115 grayish olive slightly sandy diatom mud diatom ooze lamin. at 115 cm (pale olive).
115-125 grayish olive diatom mud.

125-148 Interbedded diatom mud (grayish olive) and diatom ooze (pale olive) 4 ooze beds. Shp. cut. at 148 w/

148-285 cm w/ slightly sandy grayish olive diatom mud w/ isolated 5-8 cm clots of pale olive diatom ooze (cottony) at. 170, 180, 195, 205, 230, 270 cm.

Page 1 of 2

EWD

Core Number: KC-27A	Station Location: N/E Moscow	Total Core length (m) 2.952 m
Latitude: -66 11.0912'	Longitude: 120°30.2385'	Date: 02/21/14

water depth (m) 546 m

Depth (cm)	Visual Log	Color Code	grain size: clay	silt	f. sand	m. sand	cr. Sand	gravel	fossils	Sed. Structures	general description, disturbance, notes
250–295 (300)		10Y 4/2; 10Y 6/2; 5GY 4/1									Shp. cnt @ 280 w/ 280-287cm pale olive diatom ooze 287-295 w/ dark greenish gray diatom. clay
											All sections of mud foram bearing. +ooze....

Page 2 of 2

EWD

Core Number: KC-27B **Station Location:** EAST MOSCOW **Total Core length (m)** 2.71

Latitude: -66° 11.0907' **Longitude:** 120° 30.2385 **Date:** Febr. 21, 2014

Depth (cm)	Visual Log	Color Code	grain size: clay	silt	f. sand	m. sand	cr. Sand	gravel	fossils	Sed. Structures	water depth (m) ~546 m; general description, disturbance, notes
0–50		10Y 6/2; 10 4/2; 10Y 6/2; 5GY 4/1							DIATOMS		↙ good Sed H_2O/interface. 0-5 cm Pale olive diatom ooze (cottony) shp. cnt. at 5 cm w/ 5 - 33 cm grayish olive diatom. mud, slightly sandy, forams present. shp. cnt @ 33 w/
50–100		5 Y 5/2 + 10Y 4/2; 5/Y 7/2									33 - 40 cm pale olive diatom ooze (cottony) shp. cnt at 40 cm w/ 40-45 dark greenish gray diatom. clay shp. cnt at 45 w/
100–150		10Y 4/2							@ forams		45-50 pale olive diatom ooze (cottony) shp. cnt at 50 cm w/ 50 - 65 grayish olive to light olive gray diatom. mud shp.
150–200		10Y 6/2 + 10Y 4/2									cnt. at 65 w/ 65 - 75 cm yellowish gray diatom ooze (cottony). Shp. cnt @ 75 w/ 75 - 88 cm grayish olive
200–250		10Y 4/2; 5Y 4/4									diatom. mud shp. cnt at 88 cm w/ 88 - 93 cm pale olive diatom ooze (cottony) shp. cnt @ 93 w/

Page 1 of 2

EWD

Core Number: KC-27B Station Location: EAST MOSCOW, Total Core length (m) 2.71 m

Latitude: -66° 11.0907' Longitude: 120° 30.2385 Date: 2/21/14

Depth (cm)	Visual Log	Color Code	grain size: clay	silt	f. sand	m. sand	cr. Sand	gravel	fossils	Sed. Structures	water depth (m) ~ 546 m general description, disturbance, notes
250		10Y 4/2 5Y 4/4							diatoms		93 - 155 gray. olive diatom mud w/ thin ooze laminations at 130, 140 cm. 155 - 185 thinnly bedded diatom ooze and thin diatom. clay lamination — grayish olive + pale olive
END											185 - 240 cm grayish olive diatom. mud. 240 - 265 interbedded grayish olive + diatom. mud + diatom ooze
											Forams likely in all sections.

Page 2 of 2

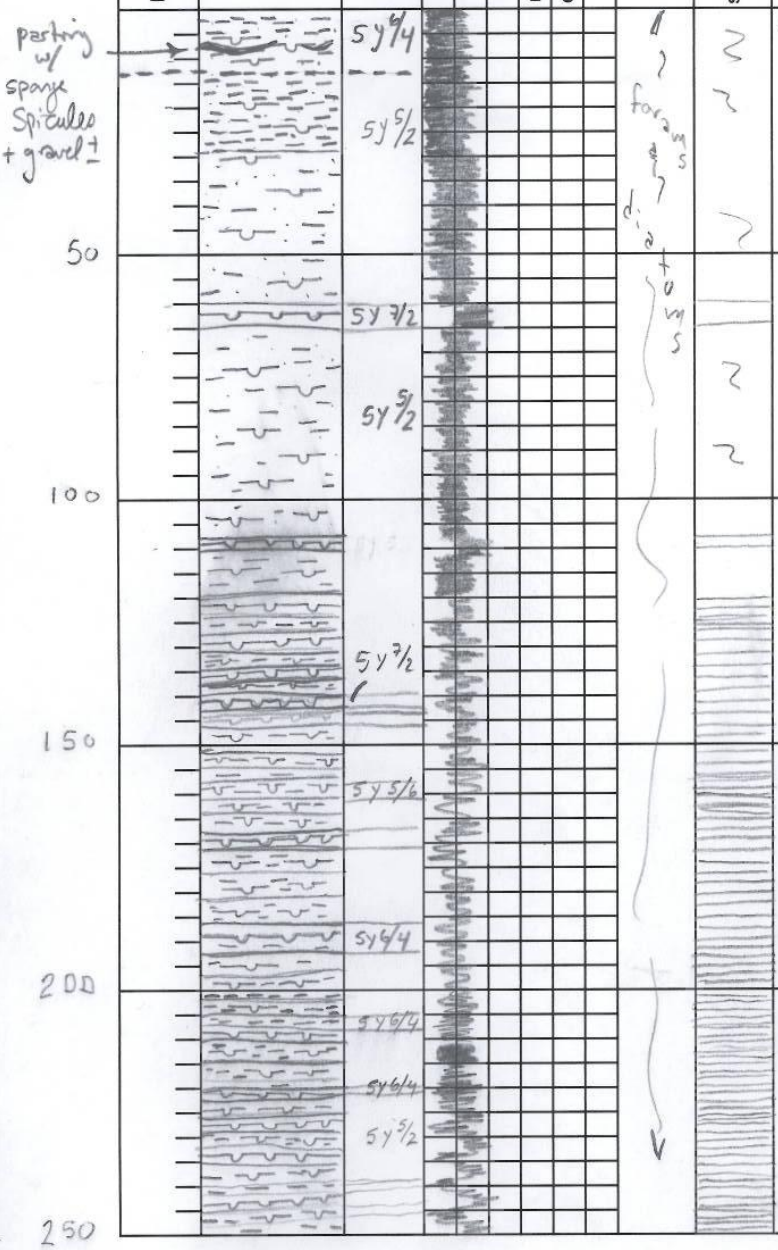
EWD

Core Number: KC-42 **Station Location:** "Aurora" Drift **Total Core length (m)** 2.81 + C.N. (20cm)

Latitude: -66° 29.0254 **Longitude:** 120° 19.9457' **Date:** 56, Feb. 25th 2014

water depth (m) 610 m

Depth (cm)	Visual Log	Color Code	grain size: clay	silt	f. sand	m. sand	cr. Sand	gravel	fossils	Sed. Structures	general description, disturbance, notes



→ good Sed/H₂O interface

0-15cm Dusky yellow, Sandy diatom mud gradational w/ 15-29cm Clay rich *

15-60cm light olive gray slightly sandy diatom mud. shp. cnt @ 60 w/

60-65cm dusky yellow diatom ooze (cottony) shp. cnt @ 65cm w/ 65-120cm light olive gray diatom mud very thin bed diatom ooze @ 60-65cm. / Shp. cnt @ + 108-110cm

120 w/ 120-268 cm Interbedded very thickly laminated to very thinly bedded diatom mud + diatom ooze alternating light olive gray and dusky yellow w/ thicker mud @ 210-218 + 200-207

Shp. cnt @ 268-281 "grayish olive diatom mud"

CN = grayish olive diatom mud.

→ scaphopod at 5cm

} foram bearing

Page 1 of 2

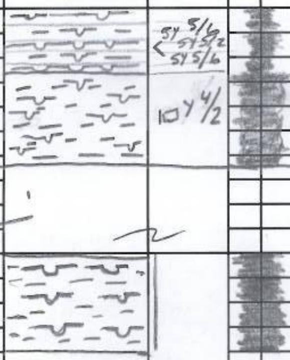
EWD.

Core Number: KC-42 **Station Location:** "Aurora" Drift **Total Core length (m)** 2.81 + CN.

Latitude: 66° 29.0254' **Longitude:** 120° 19.9457' **Date:** 56 = JD, 25th Febr. 2014

water depth (m) 610 m

Depth (cm)	Visual Log	Color Code	grain size: clay	silt	f. sand	m. sand	cr. Sand	gravel	fossils	Sed. Structures	general description, disturbance, notes
250		5Y 5/6, 5Y 5/2, 5Y 5/6, 10Y 4/2									
281											END
CN 0–20 cm: 0, 10, 20											



AES

Core Number: JKC-53 Station Location: NE Moscow Basin Total Core length (m) 5.20 m + 0.27 m C/N

Latitude: ~66° 11.053 Longitude: 120°30.208 Date: 63

water depth (m) 545 m (mb)

Depth (cm)	Visual Log	Color Code	clay	silt	f. sand	m. sand	cr. Sand	gravel	fossils	Sed. Structures	general description, disturbance, notes
0–100		5Y 6/4 + 5Y 5/2 ↓									GOOD Sed H_2O interface → Dusky yellow to light olive gray mottled to 7cm Diatom mud 27-32: yellowish → dusky yellow diatom ooze 40-42 " → cottony 75-80: Dusky yellow ooze → dia
100–200		10Y 6/2 5Y 3/2									129-135 - cottony Diatom ooze 135-141 - Diatom mud Alternating/Lam Diatom ooze + mud 128-167 (160-165 - cottony diatom) trm olive gray mottling 167-170
200–300		10Y 6/2 5Y 7/2									220-224 Dusky yellow diatom ooze ↓ Lam. Diatom int. 245 245-275: Pale olive diatom mud 275-290 ↓ cottony diatom unit Yellowish gray
300–400		5Y 5/2 Lt olive gray 5Y 7/2 5Y 5/2									290-320 Diatom mud 320 → 350 mottled diatom ooze 360-367 → yellowish gray Cottony Diatom unit 367-395 Diatom mud 395-402: Cottony Diatom unit
400–500		5Y 7/2 5Y 5/2 5Y 7/2 5Y 5/2 ↓ 5Y 5/6									402-417: Diatom ooze + mud 417-425 - Diatom unit cottony 425-520 Lam. alt. diatom ooze + mud Diat layers at 475-480 cm (5Y 7/2)

Page 1 of 2

↳ Lt olive Brown 505-510 cm

TD = 520 cm

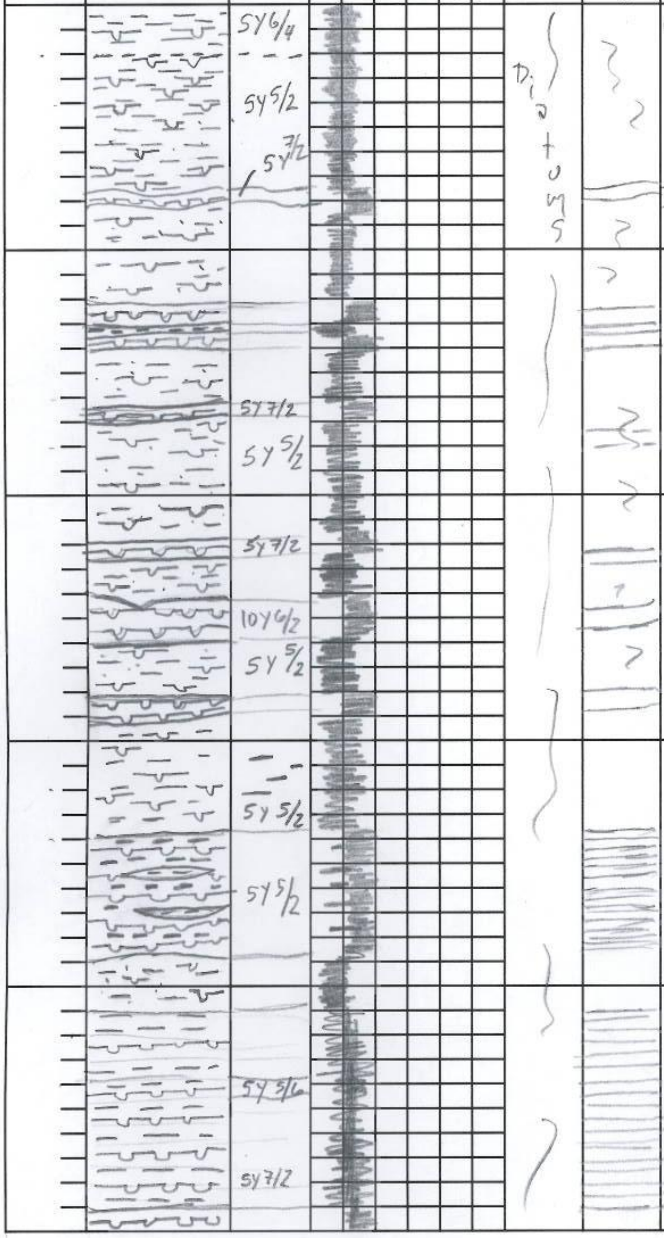
CN = 27 cm: Lam Diatom ooze + mud 5Y 5/2
A 5Y 5/6 ooze (papery) from 0-2 cm

Cren. terrain w/ sed fan of moraine

Core Number: KC57	Station Location:	Total Core length (m) 254 cm + CN (18 cm)
Latitude: 66° 07.7321	Longitude: 120 27.8403	Date: March 4 2014

water depth (m) 578

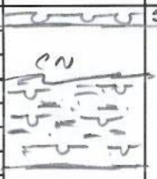
Depth (cm)	Visual Log	Color Code	grain size (clay, silt, f. sand, m. sand, cr. Sand, gravel)	fossils	Sed. Structures	general description, disturbance, notes
						good sed / H_2O interface
0–50		5Y 6/4, 5Y 5/2, 5Y 7/2		Diatoms		0-10 Dusky yellow, diatom. mud, grad. cnt. @ 10 cm w/ light olive gray, slightly sandy diatom. mud yellowish gray shp. irregular cnt at 40 cm
50–100		5Y 7/2, 5Y 5/2				w/ 40-42 cm yellowish gray diatom ooze (cottony). shp. cnt at 42 cm w/ 42-60 cm light olive gray slightly sandy, diatom mud shp. cnt at 60 cm w/
100–150		5Y 7/2, 10Y 6/2, 5Y 5/2				60-72 cm light olive gray diatom ooze (cottony) shp. cnt at 72 w/ 72-120 cm light olive gray slightly sandy diatom mud w/ ooze lam'n. at 84
150–200		5Y 5/2, 5Y 5/2				110, 105 shp. cnt at 120 w/ 120-130 light olive gray diatom ooze (cottony) 130-142 cm light olive gray diatom mud
200–250		5Y 5/6, 5Y 7/2				142-146 pale olive diatom ooze (cottony) 146-170 light olive gray diatom mud w/ fine black streaks.



Page 1 of 2

Crenulation ridge basin

Core Number: KC-57	Station Location:	Total Core length (m) 254 cm + CN
Latitude: 66°07·7321	Longitude: 120°27·8408'	Date:
		water depth (m) 578 m

Depth (cm)	Visual Log	Color Code	grain size: clay	silt	f. sand	m. sand	cr. Sand	gravel	fossils	Sed. Structures	general description, disturbance, notes
254	CN 	5Y 5/2							Diatoms		170-190 interlaminated diatom ooze + diatom mud light olive gray and yellowish gray 190-205 light olive gray diatom mud 205-245 interbedded diatom mud light olive gray and yellowish gray w/ one light olive brown lamin. 220-221 cm. } very thick laminations 245-254 cm light olive gray diatom ooze (cottony).
											CN 0-18 cm lightolive gray diatom mud.

Page 2 of 2

3. Marine Geology sample distribution

NBP14-02 Kasten Core Sample Log

Station:____9______ Number of weights

Kasten Core:_____9___ Core Type: Kasten core

Core length (cm) __205 cm____

In table, indicate sampling intervals (in cm) and any sampling comments/notes.

Sample Set	Sampling scheme, depths collected
Photos	located in KC-9 photos, all intervals accounted for
Shevenell: DNA (wear gloves/lab coat/teflon sampling)	not collected
Leventer: Diatoms	0-20 cm: every 1 cm; 20-205 cm: every 2 cm interval
Shevenell: Organic Geochem	0-3 cm, 3-6 cm, 6-9 cm, 9-12 cm, 12.5-15.5 cm, 15.5-18.5 cm, 29.5-32.5 cm, 40-43 cm, 49.5-21.5 cm, 60-63 cm, 70-73 cm, 80-83 cm, 90-93 cm, 99.5-
Domack: PP, org geochem, grain size, Pb-210	0-20 cm: every 1 cm; 20-205 cm: every 2 cm interval; Blue vials: # 1-113
Domack: 14C in jars for AIOM	0-5 cm, 22-26 cm, 33-38 cm, 44-48 cm, 54-59 cm, 74-79 cm, 94-99 cm, 145-149 cm, 154-159 cm, 164-169 cm, 174-179 cm
Domack/Rosenheim: 14C 32 oz jars / pyrolysis	Same as Domack 14C jars for AIOM
Shevenell: Forams	Same as organic geochem.
Korean x-ray slabs	0-30 cm, 30-60 cm, 60-90 cm, 90-120 cm, 120-150 cm, 150-180 cm, 180-205 cm
Archive tubes	0-152 cm, 152-205 cm
Biogenic carbonate	none found
Rocks	172-175 cm, 172-176 cm, 180 cm, 201 cm

NBP14-02 Kasten Core Sample Log

Station:____13______ Number of weights

Kasten Core:___13_____ Core Type: Kasten

Core length (cm) _0-172 cm_____

In table, indicate sampling intervals (in cm) and any sampling comments/notes.

Sample Set	Sampling scheme, depths collected
Photos	Uploaded on computer; all intervals accounted for
Shevenell: DNA (wear gloves/lab coat/teflon sampling)	0-20 cm: every 1 cm (appox.); 20-172 cm: every 10 cm interval
Leventer: Diatoms	0-20: 1 cm interval every 2 cm; 20-172 cm: 1 cm interval every 5 cm
Shevenell: Organic Geochem	0-15 cm: every 3 cm; 15-172 cm: every 5 cm interval
Domack: PP, org geochem, grain size, Pb-210	0-10 cm: every 0.5 cm; 10-172 cm: 1 cm intervals every 2 cm; Orange vials: #1-114
Domack: 14C in jars for AIOM	0-2 cm, 20-22 cm, 60-62 cm, 100-102 cm, 130-132 cm, 170-172 cm
DomackRosenheim: 14C 32 oz jars / pyrolysis	Same as Domack: 14C in jars for AIOM
Shevenell: Forams	Same as Organic Geochem.
Korean x-ray slabs	30 cm slabs, 6 slabs
Archive tubes	3 archive tubes: 0-152 cm, 152-173 cm, 173-198 cm (CN)
Biogenic carbonate	none found
Rocks	.pebble, granite:156-157 cm

NBP14-02 Kasten Core Sample Log

Station:__________ Number of weights

Kasten Core:________ Core Type

Core length (cm) ______

In table, indicate sampling intervals (in cm) and any sampling comments/notes.

Sample Set	Sampling scheme, depths collected
Photos	Uploaded; intervals all accounted for
Shevenell: DNA (wear gloves/lab coat/teflon sampling)	None taken for NBP1402 KC-14
Leventer: Diatoms	0-20 cm: 1 cm interval every 2 cm; 20-263 cm: 1 cm interval every 5 cm
Shevenell: Organic Geochem	0-15 cm: 3 cm interval every 3 cm; 15-263 cm: 3 cm interval every 5 cm
Domack: PP, org geochem, grain size, Pb-210	0-10 cm: 0.5 cm interval every 0.5 cm; 10-263 cm: 1 cm interval every 2 cm; Orange vials: #115-264
Domack: 14C in jars for AIOM	0-5 cm, 20-25 cm, 60-65 vm, 100-105 cm, 140-145 cm, 180-185 cm, 220-225 cm, 260-265 cm
DomackRosenheim: 14C 32 oz jars / pyrolysis	Same as Domack: 14C in jars for AIOM
Shevenell: Forams	Same as forams
Korean x-ray slabs	
Archive tubes	0-152 cm, 152-263 cm
Biogenic carbonate	
Rocks	.Rock at 251-253 cm

NBP14-02 Kasten Core Sample Log

Station:_____15_____ Number of weights

Kasten Core:___JKC 15_____ Core Type Jumbo Kasten

Core length (cm) ___CN only, not structured___

In table, indicate sampling intervals (in cm) and any sampling comments/notes.

Sample Set	Sampling scheme, depths collected
Photos	
Shevenell: DNA (wear gloves/lab coat/teflon sampling)	
Leventer: Diatoms	
Shevenell: Organic Geochem	
Domack: PP, org geochem, grain size, Pb-210	
Domack: 14C in jars for AIOM	
DomackRosenheim: 14C 32 oz jars / pyrolysis	
Shevenell: Forams	
Korean x-ray slabs	
Archive tubes	
Biogenic carbonate	
Rocks	.

Cutter nose Gallon Ziploc bag

NBP14-02 Kasten Core Sample Log

Station:____20______ Number of weights

Kasten Core:___20_____ Core Type: 3 m Kasten

Core length (cm) __179 cm____

In table, indicate sampling intervals (in cm) and any sampling comments/notes.

Sample Set	Sampling scheme, depths collected
Photos	uploaded and checked
Shevenell: DNA (wear gloves/lab coat/teflon sampling)	0-10 cm: every 1 cm; 20-170 cm: every 10 cm
Leventer: Diatoms	0-20 cm: every 1 cm; 20-179 cm: every 5 cm
Shevenell: Organic Geochem	0-15 cm: every 3 cm; 20-170 cm: every 10 cm
Domack: PP, org geochem, grain size, Pb-210	0-10 cm: every 0.5 cm; 10-179 cm: 1 cm interval every 2 cm; Black vials: #1-105
Domack: 14C in jars for AIOM	0-2 cm; 18-20 cm; 50-52 cm; 93-95 cm; 107-109 cm
DomackRosenheim: 14C 32 oz jars / pyrolysis	Same as Domack :14C in jars for AIOM
Shevenell: Forams	0-15 cm; every 1 cm; 20-170 cm: every 10 cm
Korean x-ray slabs	0-30 cm, 15-45 cm, 75-105 cm, 105-135 cm, 135-165 cm, 149-179 cm
Archive tubes	0-152 cm, 152-179 cm
Biogenic carbonate	none found
Rocks	C/N rocks and gravel washed and bagged; 112 cm, 94 cm, 160-161 cm, 126-127 cm, 156-157 cm, 162-164 cm, 169-172 cm, 126-130 cm, 134-135 cm
	other rocks: 80-100 cm, 100-110 cm, 110-120 cm, 120-130 cm, 130-140 cm,140-150 cm, 140-146 cm, 150-160 cm, 160-172 cm, 176 cm, 178 cm (11 b

NBP14-02 Kasten Core Sample Log

Station:____27______ Number of weights

Kasten Core:__27 A______ Core Type: 3 m Kasten

Core length (cm) __296____

In table, indicate sampling intervals (in cm) and any sampling comments/notes.

Sample Set	Sampling scheme, depths collected
Photos	uploaded
Shevenell: DNA (wear gloves/lab coat/teflon sampling)	0-10 cm: every cm; 11-20 cm: 1 cm interval every ~3 cm; 25-101 cm: 1 cm interval every 5 cm; 110-15- cm: 1 cm interval every ~2 cm; 155-270 cm: 1
Leventer: Diatoms	0-20 cm: every cm; 20-293 cm: 1 cm interval every 5 cm
Shevenell: Organic Geochem	0-20 cm: every 3 cm; 20-296 cm: 3 cm interval every 5 cm
Domack: PP, org geochem, grain size, Pb-210	None taken
Domack: 14C in jars for AIOM	0-5 cm, 202-207 cm, 265-270 cm, 290-295 cm
DomackRosenheim: 14C 32 oz jars / pyrolysis	Same as Domack: 14C for AIOM
Shevenell: Forams	Same as Organic geochem.
Korean x-ray slabs	0-30 cm, 30-60 cm, 60-90 cm, 90-120 cm, 120-150 cm, 150-180- cm, 180-210 cm, 210-240 cm, 240-270 cm, 270-295 cm
Archive tubes	0-152 cm, 152-295 cm
Biogenic carbonate	none found
Rocks	none found

NBP14-02 Kasten Core Sample Log

Station:____27______ Number of weights
Kasten Core:___27B_____ Core Type: 3 m kasten core
Core length (cm) __271 cm____

In table, indicate sampling intervals (in cm) and any sampling comments/notes.

Sample Set	Sampling scheme, depths collected
Photos	uploaded
Shevenell: DNA (wear gloves/lab coat/teflon sampling)	0-10 cm: every cm; 10-60 cm: 1 cm interval every 5 cm
Leventer: Diatoms	0-20 cm: every cm; 20-271 cm: 1 cm interval every 5 cm
Shevenell: Organic Geochem	0-15 cm: every 3 cm; 20-265 cm: 3 cm invterval every 5 cm
Domack: PP, org geochem, grain size, Pb-210	0-30 cm: every 0.5 cm; 30-271 cm: 1 cm interval every 2 cm
Domack: 14C in jars for AIOM	0-4 cm, 33-36 cm, 82-84 cm, 151-154 cm, 230-233 cm
DomackRosenheim: 14C 32 oz jars / pyrolysis	same as Domack:14C for AIOM
Shevenell: Forams	0-15 cm: every 3 cm; 20-265 cm: 3 cm invterval every 5 cm
Korean x-ray slabs	30 cm slabs starting at 5 cm (ie 5-35 cm, 35-65 cm…) until 270 cm
Archive tubes	2 tubes: 0-151 cm, 151 cm-271 cm; u-channel (2): 0-150 cm, 150-269 cm (2 cm missing from the end of homogenous layer)
Biogenic carbonate	none
Rocks	117-118 cm

NBP14-02 Kasten Core Sample Log

Station:____42______ Number of weights
Kasten Core:__42______ Core Type: 3m Kasten
Core length (cm) __281____

In table, indicate sampling intervals (in cm) and any sampling comments/notes.

Sample Set	Sampling scheme, depths collected
Photos	Taken and proofed
Shevenell: DNA (wear gloves/lab coat/teflon sampling)	0-10 cm: every cm; 10-275 cm: 1 cm interval every 5 cm
Leventer: Diatoms	0-20 cm: every cm; 20-280cm: 1 cm interval every 5 cm
Shevenell: Organic Geochem	0-15 cm: every 3 cm; 20-280 cm: 3 cm interval every 5 cm
Domack: PP, org geochem, grain size, Pb-210	0-30 cm: every 0.5 cm; 30-280 cm: 1 cm interval every 2 cm
Domack: 14C in jars for AIOM	0-3 cm, 24-26 cm, 34-36 cm, 104-106 cm, 178-180 cm, 267-269 cm
DomackRosenheim: 14C 32 oz jars / pyrolysis	same as Domack: 14C for AIOM
Shevenell: Forams	Same as Organic geochem.
Korean x-ray slabs	30 cm slabs starting at 0 cm and continuing to 281 cm
Archive tubes	0-151 cm, 151-281 cm; CN archive: 0-19 cm
Biogenic carbonate	5-6 cm: gastropod
Rocks	8-9 cm, 10-11 cm

Core	Tube	Samples
NBP1402 MC45	1	O-chem
NBP1402 MC45	1	Diatoms
NBP1402 MC45	2	phys props
NBP1402 MC45	4	14C
NBP1402 MC45	6	Forams
NBP1402 MC45	9	archives
NBP1402 MC45	11	archives
NBP1402 MC45	12	DNA
NBP1402 MC45	7	Francesca
NBP1402 MC45	8	Geology
NBP1402 MC45	10	Alix Post
NBP1402 MC45	10	Leanne: Diatoms

Sampling intervals

0-29 cm: every 1 cm

0-29 cm: every 1 cm

black vials: #106-154; 0-20cm: every 0.5 cm; 20-36cm: every 2 cm

0-1cm; 1-2cm, 2-3cm, 10-12cm, 20-22 cm, 26-28 cm
(extra sed: 4-6cm, 6-8, 8-10, 12-14, 14-16cm,
16-18cm, 18-20cm, 22-24cm, 24-26cm)

0-10cm: every 0.5 cm; 10-32cm: every 1cm

0-38 cm

0-36 cm

1.5-34.5 cm: every 1 cm

0-1 cm, 1-2 cm; 2-28 cm: every 2 cm

0-0.5, 0.5-33.5 cm: every cm

1-5cm: every cm; 5-35 cm: every 2 cm

0-5 cm: every cm; 5-21: every 2 cm

Sample identifier	Container	Number of samples
Sediment Sample from Grab	Large Gallon Bags	2 bags
Surface sediment sample: DNA	whirlpack (2 oz)	1
Surface sediment sample	whirlpack	1
Surface sediment sample: Forams and "other"	whirlpacks	2
surface sediment sample:diatoms	whirlpack	1
surface sediment sample: Francesca	whirlpack	1

Cooler/holder #	**Holding area**
Misc. cores and CN bin	Big Antarctica -80°C cooler
Domack 2 cooler	Big Antarctica
Shevenell cooler	Big Antarctica
Leventer cooler	Big Antarctica
Shevenell cooler	Big Antarctica

NBP14-02 Kasten Core Sample Log

Station:____53_____ Number of weights

Kasten Core:___53_____ Core Type: 6 m Kasten

Core length (cm) _520_____

In table, indicate sampling intervals (in cm) and any sampling comments/notes.

Sample Set	Sampling scheme, depths collected
Photos	Uploaded
Shevenell: DNA (wear gloves/lab coat/teflon sampling)	0-520 cm: 1 cm interval every 5 cm
Leventer: Diatoms	0-520 cm: 1 cm interval every 5 cm
Shevenell: Organic Geochem	0-520 cm: 3 cm interval every 5 cm
Domack: PP, org geochem, grain size, Pb-210	0-520 cm: 1 cm interval every 5 cm
Domack: 14C in jars for AIOM	0-520 cm: 5 cm interval every 50 cm
DomackRosenheim: 14C 32 oz jars / pyrolysis	Same as 14C for AIOM
Shevenell: Forams	Same as Organic Geochem.
Korean x-ray slabs	0-510cm: every 30 cm; 510-520 cm slab
Archive tubes	0-152 cm, 152-304 cm, 304-458 cm, 458-520 cm
Biogenic carbonate	N/A
Rocks	N/A
Uchannel	0-151, 151-302, 302-450, 450-519 cm

NBP14-02 Kasten Core Sample Log

Station:_____57_____ Number of weights

Kasten Core:____57____ Core Type: 3 m kasten core

Core length (cm) ___254___

In table, indicate sampling intervals (in cm) and any sampling comments/notes.

Sample Set	Sampling scheme, depths collected
Photos	
Shevenell: DNA (wear gloves/lab coat/teflon sampling)	0-10 cm: every cm; 10-254 cm: 1 cm interval every 5 cm
Leventer: Diatoms	0-10 cm: every 1 cm; 10-254 cm: 1 cm interval every 5 cm
Shevenell: Organic Geochem	0-18 cm: every 3 cm interval; 20-254 cm: 3 cm interval every 5 cm
Domack: PP, org geochem, grain size, Pb-210	0-10 cm: every 0.5 cm; 10-20 cm: every cm; 20-254 cm: 1 cm interval every 2 cm
Domack: 14C in jars for AIOM	
DomackRosenheim: 14C 32 oz jars / pyrolysis	
Shevenell: Forams	0-18 cm: every 3 cm interval; 20-254 cm: 3 cm interval every 5 cm
Korean x-ray slabs	0-254 cm: 30 cm slabs (9 ct.)
Archive tubes	0-152 cm, 152-254 cm
Biogenic carbonate	N/A
Rocks	N/A
U-Channels	0-151 cm, 151-254 cm

Core	Tube	Samples
NBP1402 MC61	1	Archive
NBP1402 MC61	2	Phys Props
NBP1402 MC61	3	Archive
NBP1402 MC61	4	Forams
NBP1402 MC61	5	Ochem
NBP1402 MC61	5	Diatoms
NBP1402 MC61	6	Post
NBP1402 MC61	6	Armand
NBP1402 MC61	7	C14
NBP1402 MC61	8	Francesca
NBP1402 MC61	9	Geology
NBP1402 MC61	12	DNA

Sampling intervals

0-28: every 0.5 cm in PP vials

0-10 cm: every 0.5 cm; 10-32 cm: every 1 cm

0-31 cm: every 1 cm

0-31 cm: every 1 cm

0-10 cm: every 1 cm; 10-34 cm: every 2 cm

0-10 cm: every 1 cm; 10-34 cm: every 2 cm

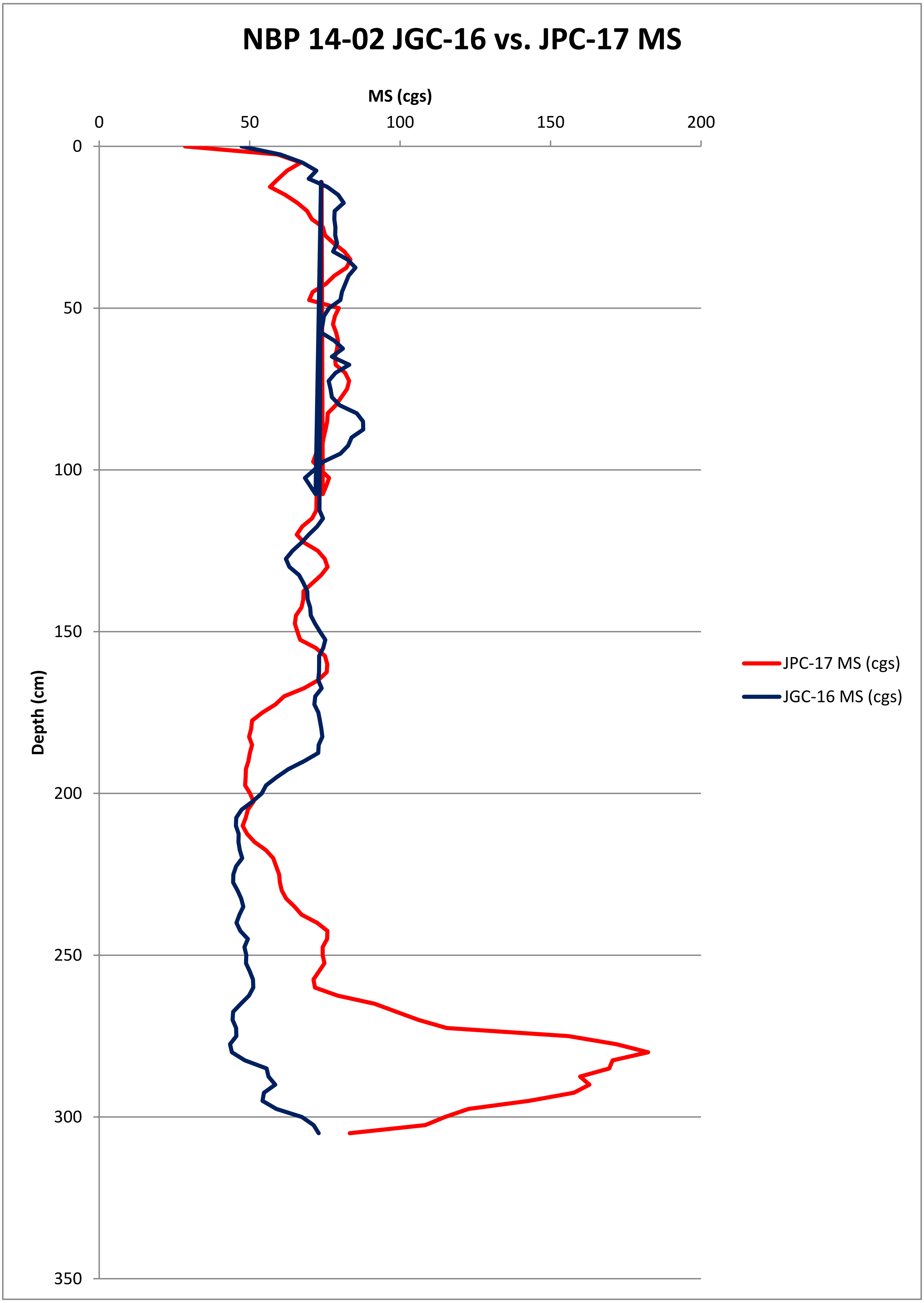
0-1 cm, 1-2 cm, 10-12 cm, 20-22 cm, 26-28 cm
Extra sed: 4-6, 6-8, 8-10, 12-14, 14-16, 16-18, 18-20, 22-24, 24-26 cm

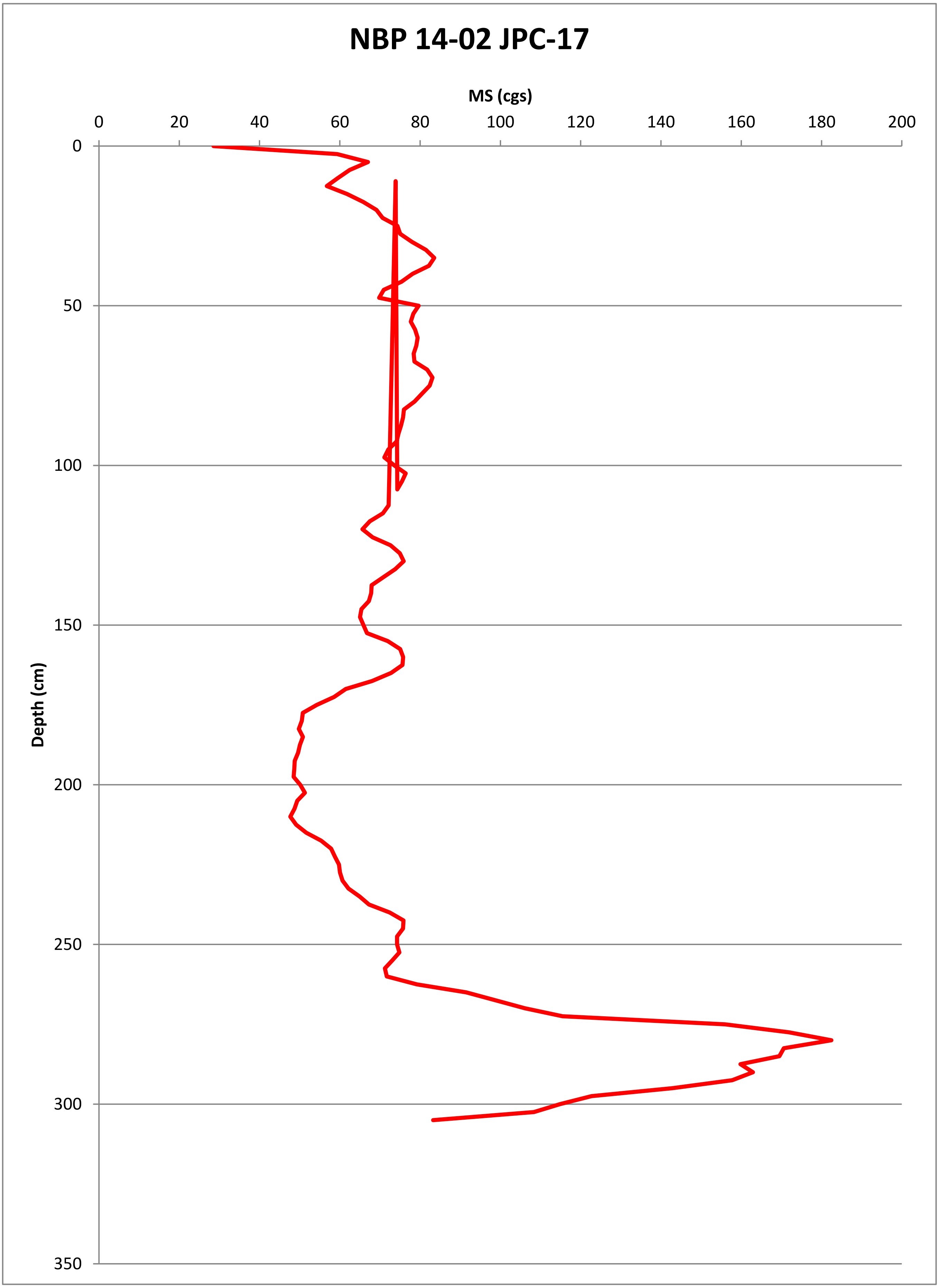
0-1, 1-2 cm; 2-32: every 2 cm

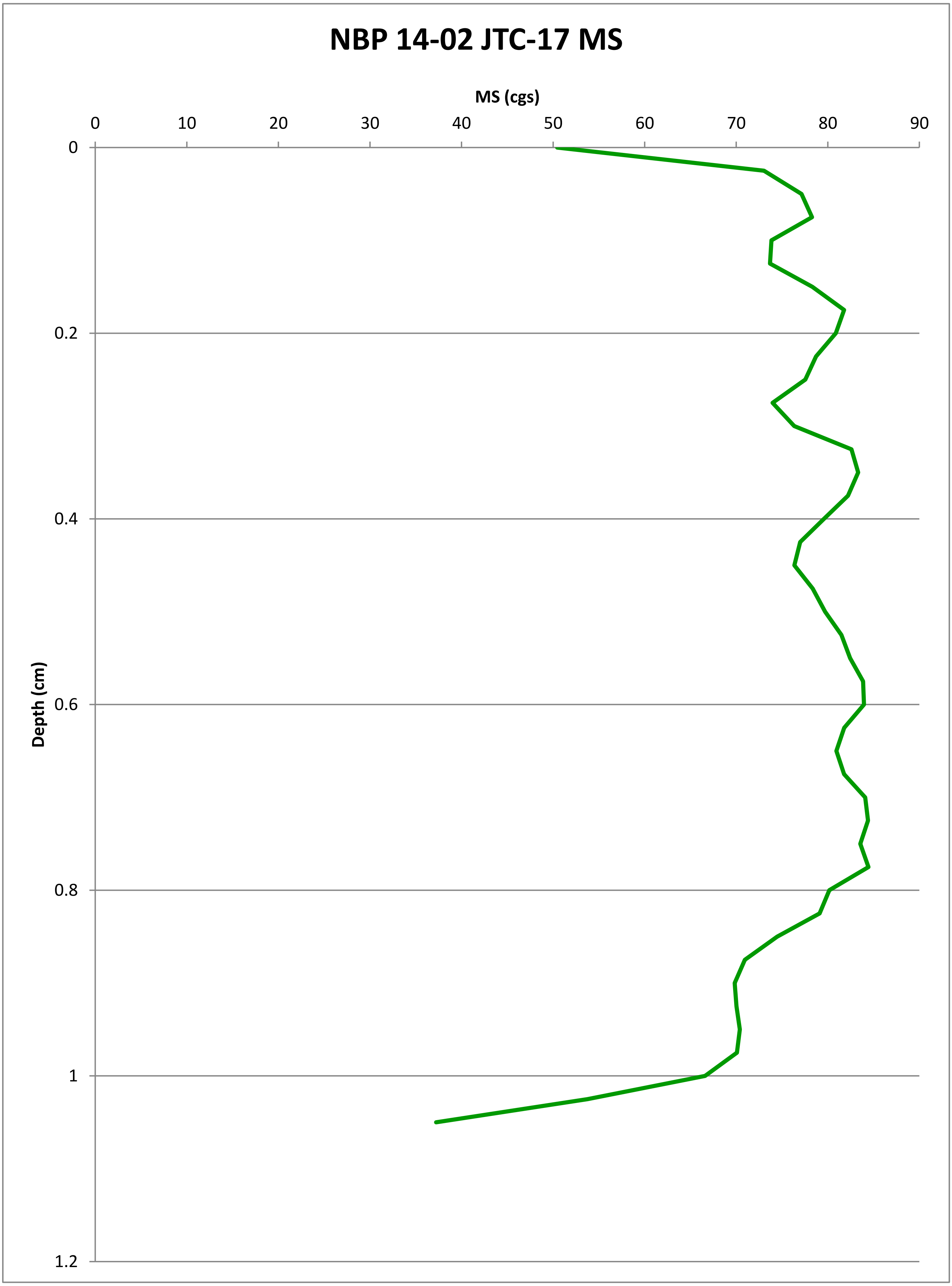
0-38 cm: every 1 cm

0-1.5 cm (diatom fluff); 1.5-34.5 cm: every cm

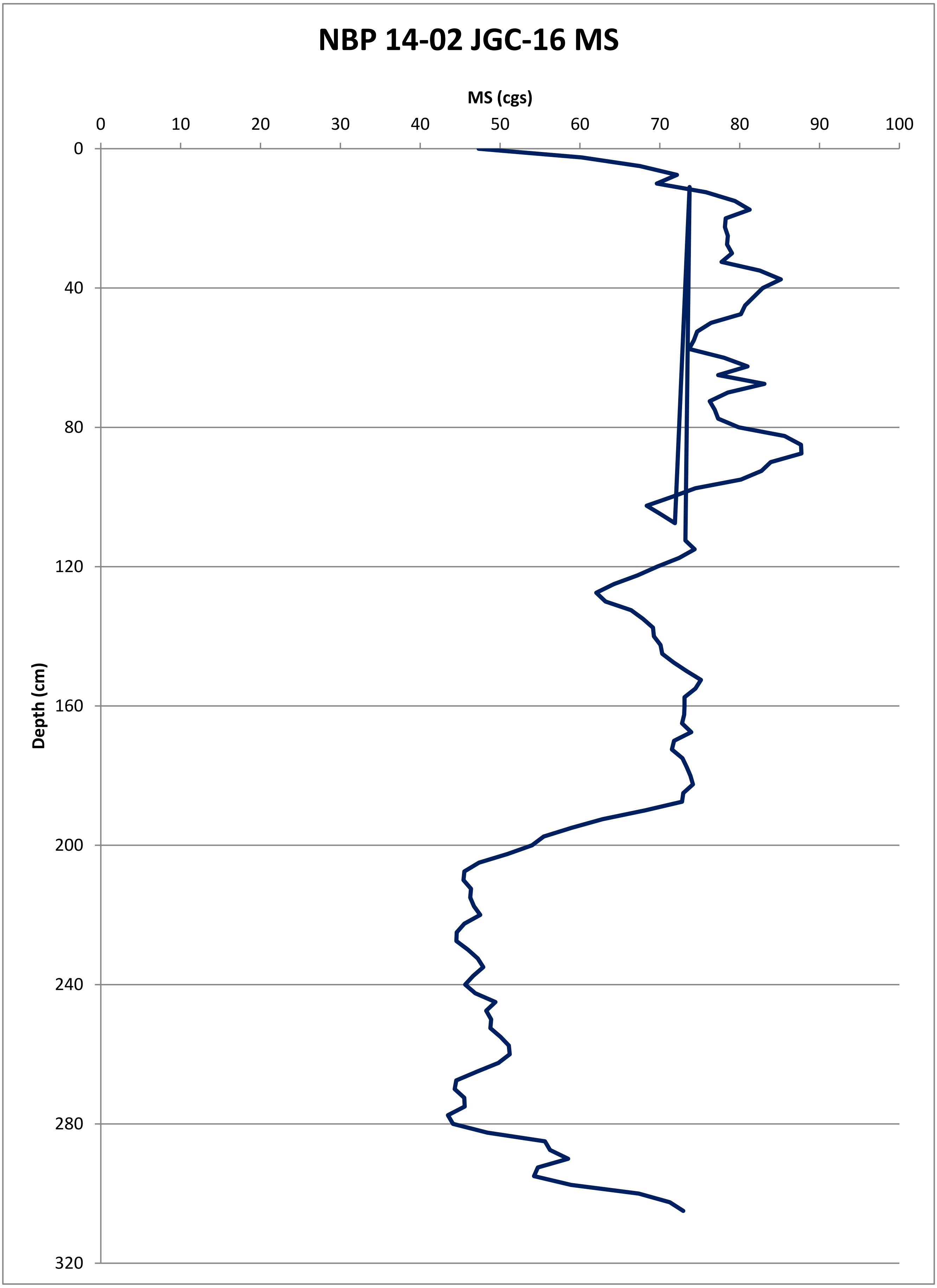
4. JPC_JGC_JTC MS graphs

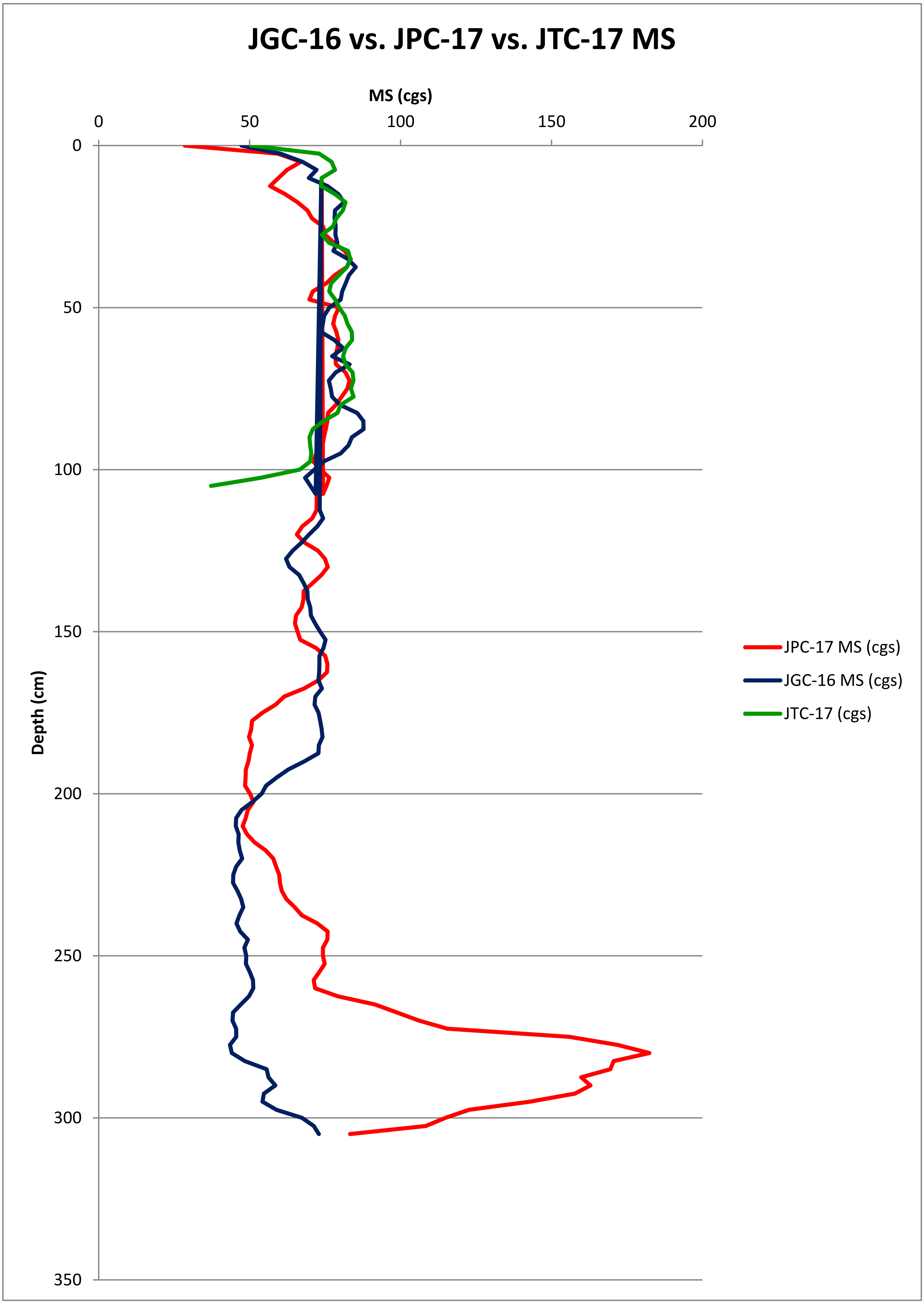

NBP 14-02 JGC-16 vs. JPC-17 MS
MS (cgs)
0
50
100
150
200
Depth (cm)
0
50
100
150
200
250
300
350
JPC-17 MS (cgs)
JGC-16 MS (cgs)

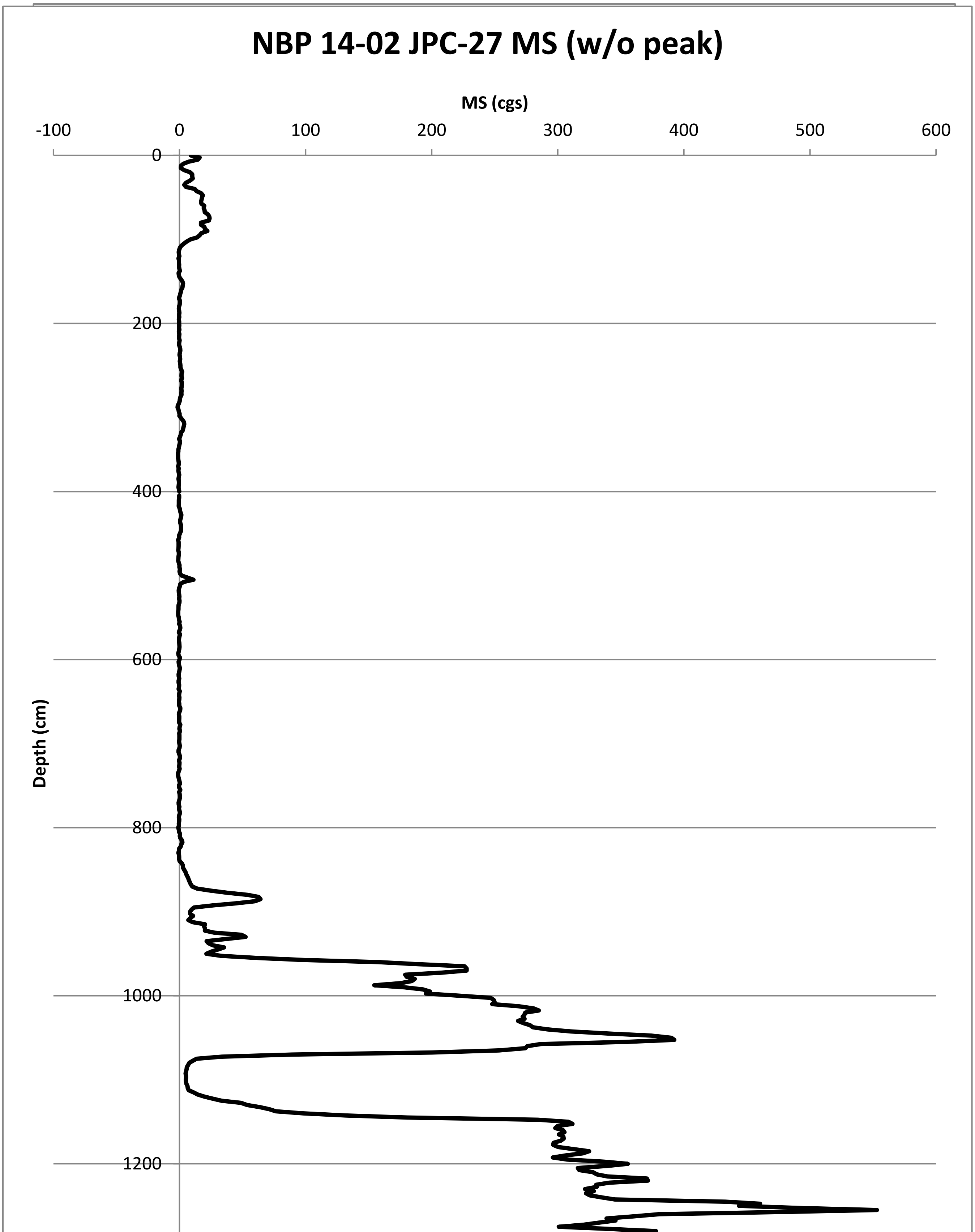

NBP 14-02 JPC-17
MS (cgs)
0
20
40
60
80
100
120
140
160
180
200
Depth (cm)
0
50
100
150
200
250
300
350

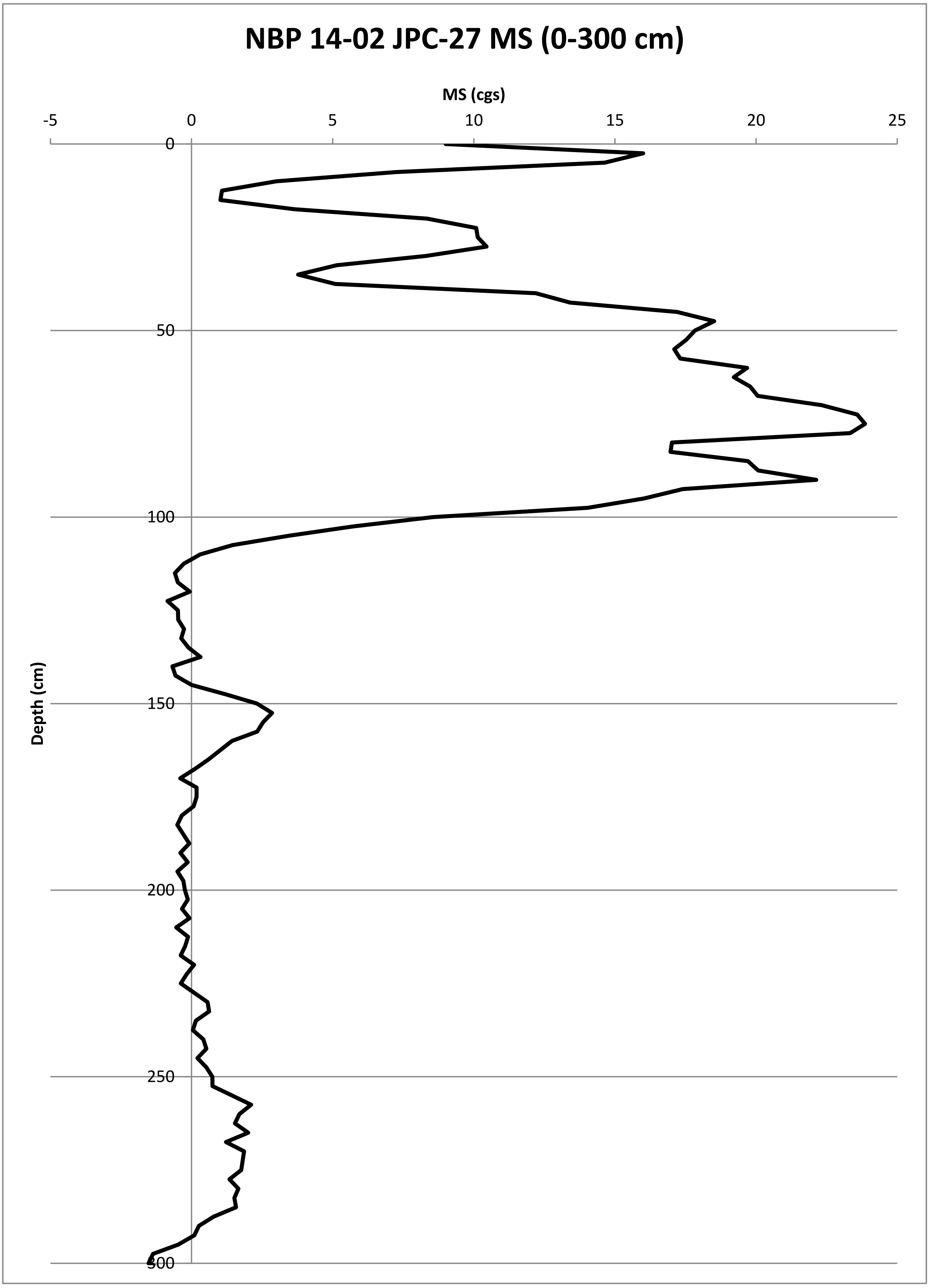


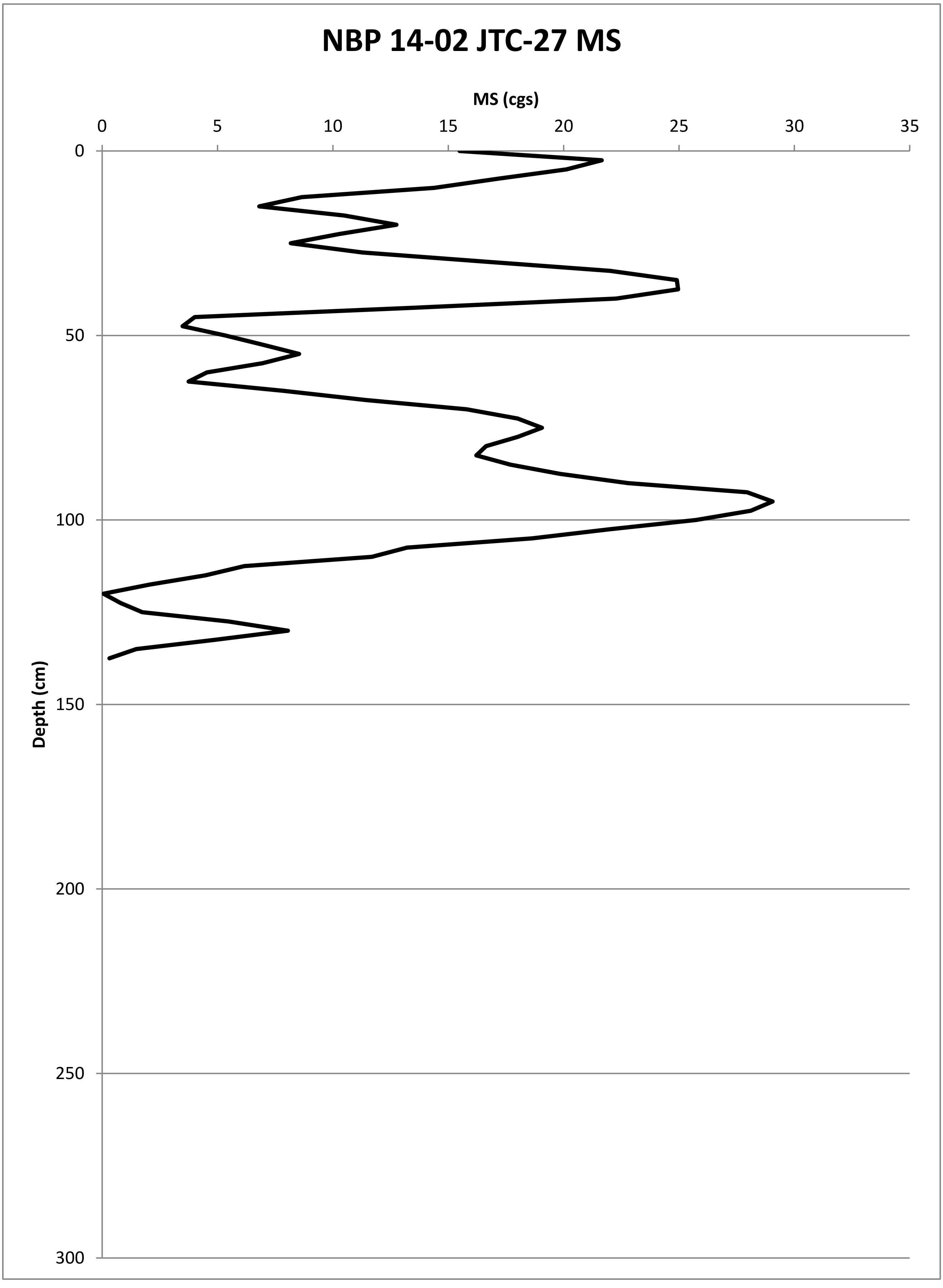
NBP 14-02 JTC-17 MS
MS (cgs)
0
10
20
30
40
50
60
70
80
90
Depth (cm)
0
0.2
0.4
0.6
0.8
1
1.2

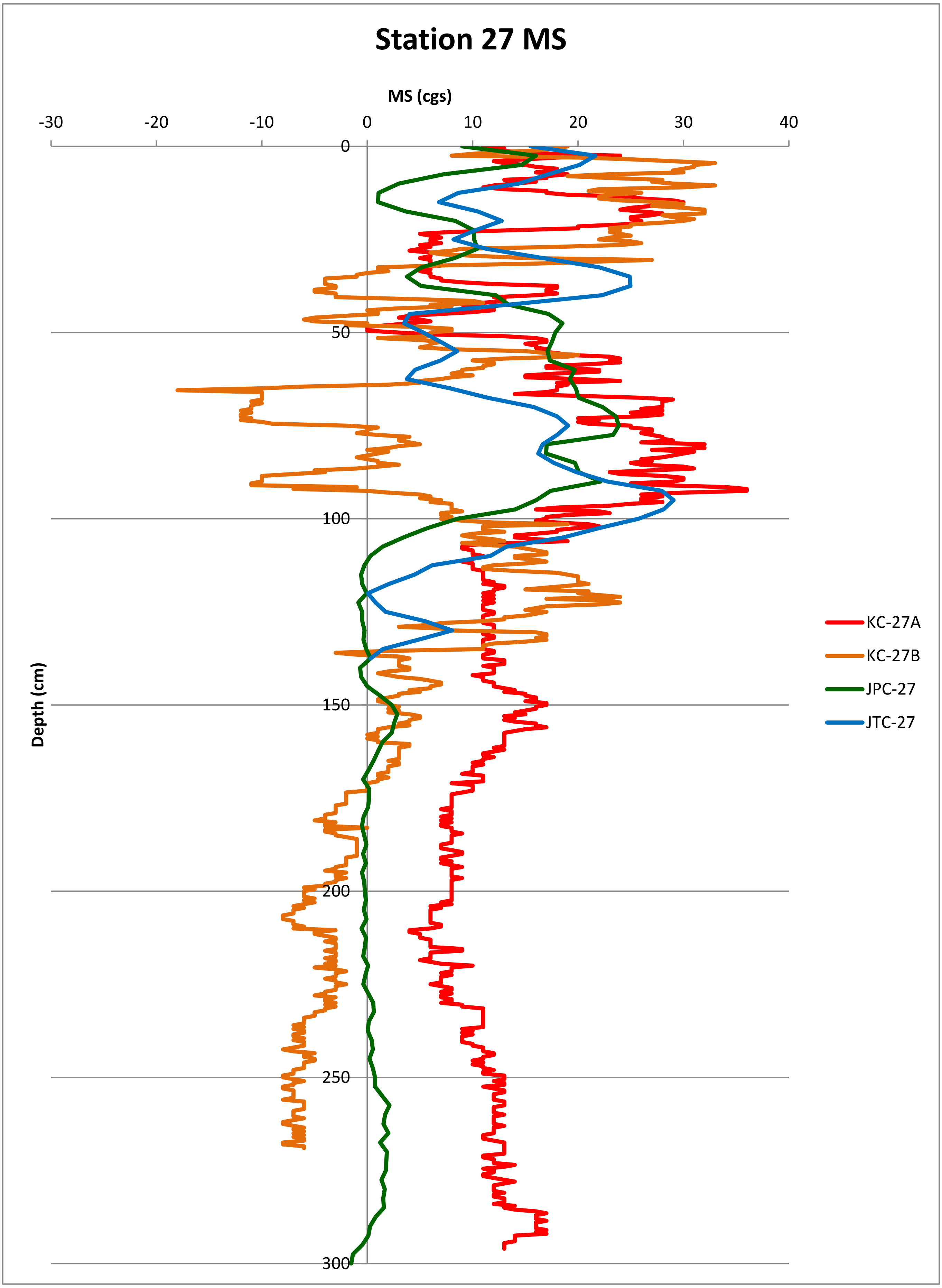

NBP 14-02 JGC-16 MS
MS (cgs)
0
10
20
30
40
50
60
70
80
90
100
0
40
80
120
160
200
240
280
320
Depth (cm)


JGC-16 vs. JPC-17 vs. JTC-17 MS
MS (cgs)
0
50
100
150
200
0
50
100
150
200
250
300
350
Depth (cm)
JPC-17 MS (cgs)
JGC-16 MS (cgs)
JTC-17 (cgs)

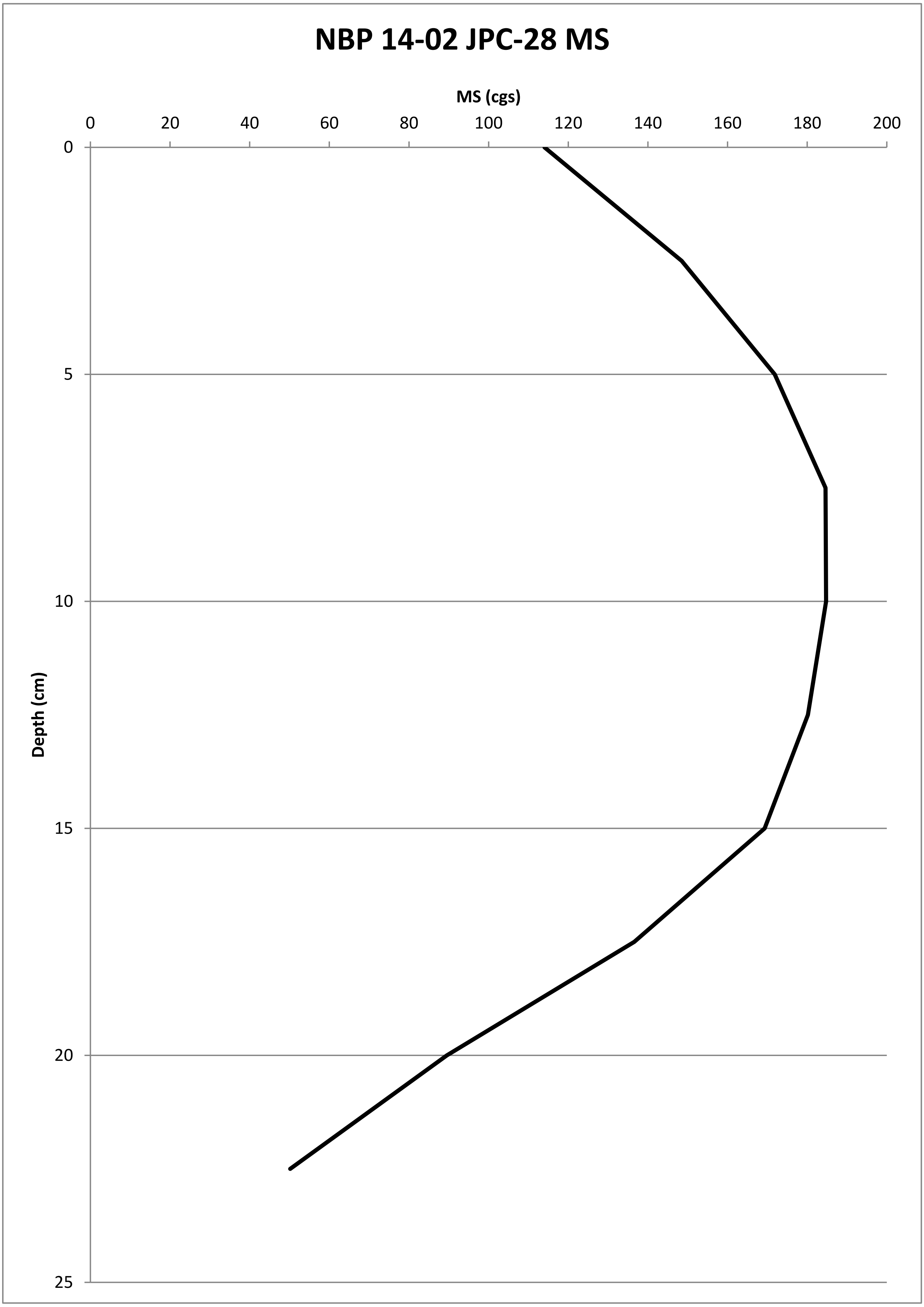

NBP 14-02 JPC-27 MS (w/o peak)
MS (cgs)
-100
0
100
200
300
400
500
600
Depth (cm)
0
200
400
600
800
1000
1200
1400

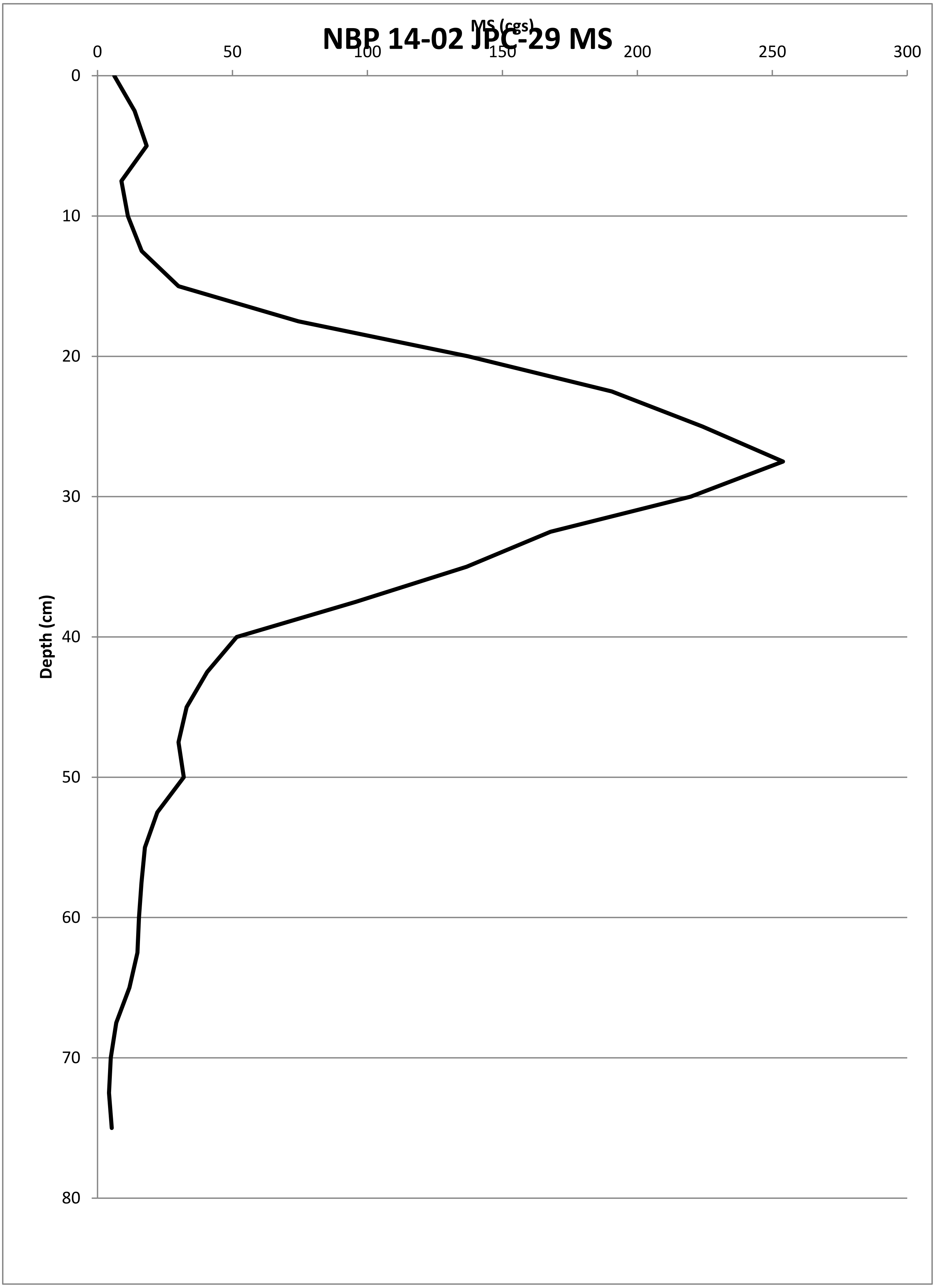

NBP 14-02 JPC-27 MS (0-300 cm)
MS (cgs)
-5
0
5
10
15
20
25
Depth (cm)
0
50
100
150
200
250
300

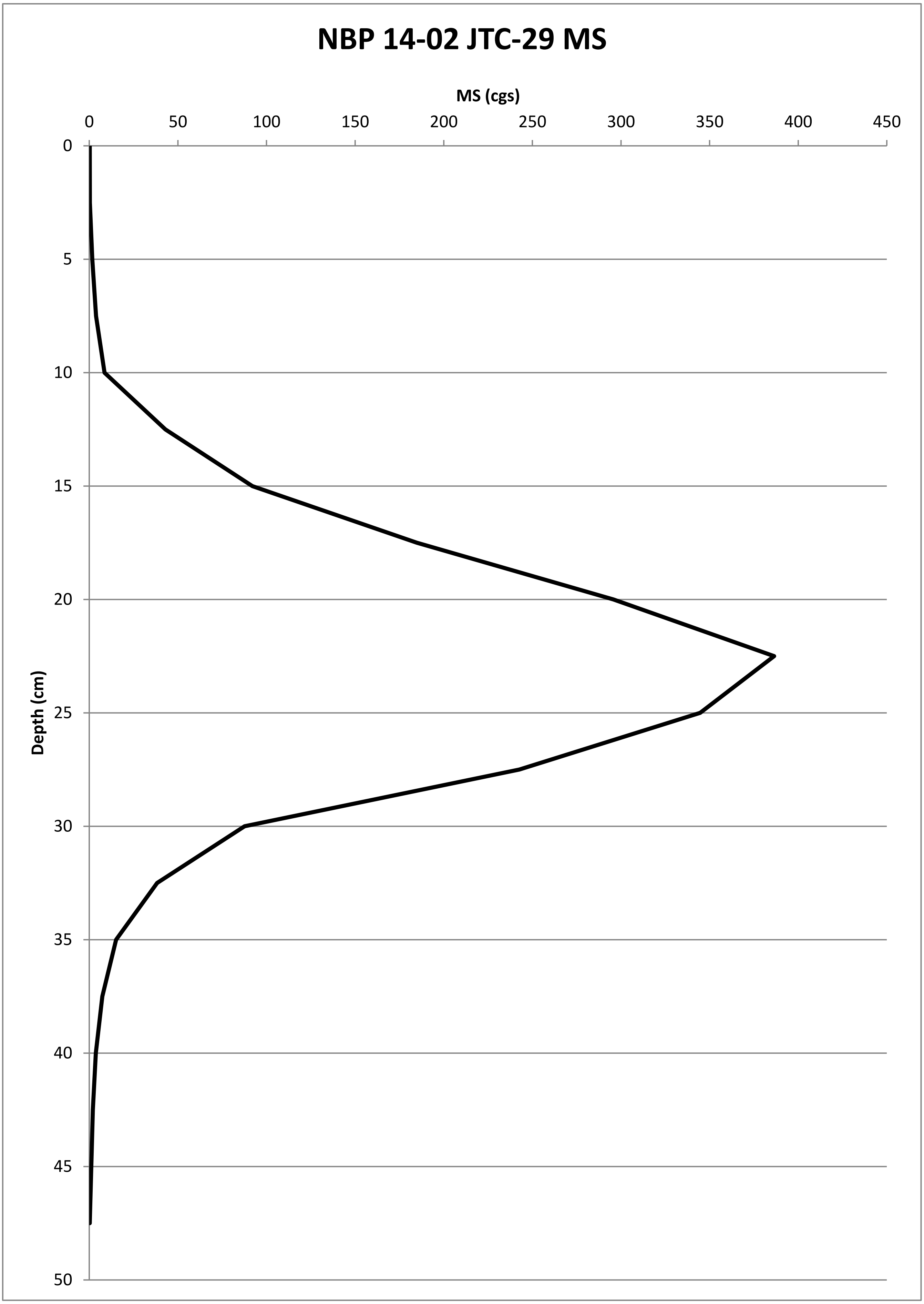

NBP 14-02 JTC-27 MS
MS (cgs)
0
5
10
15
20
25
30
35
0
50
100
150
200
250
300
Depth (cm)

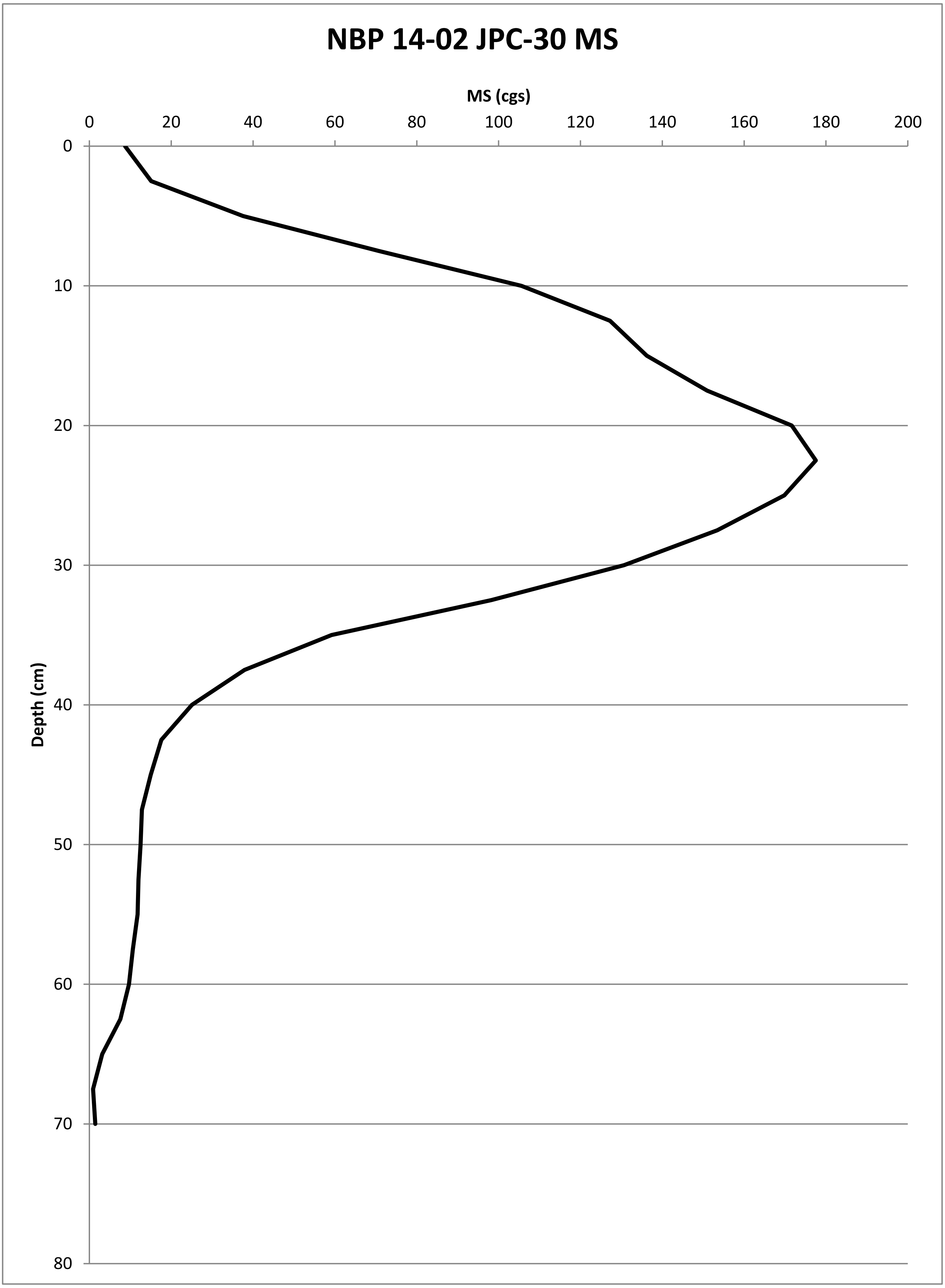


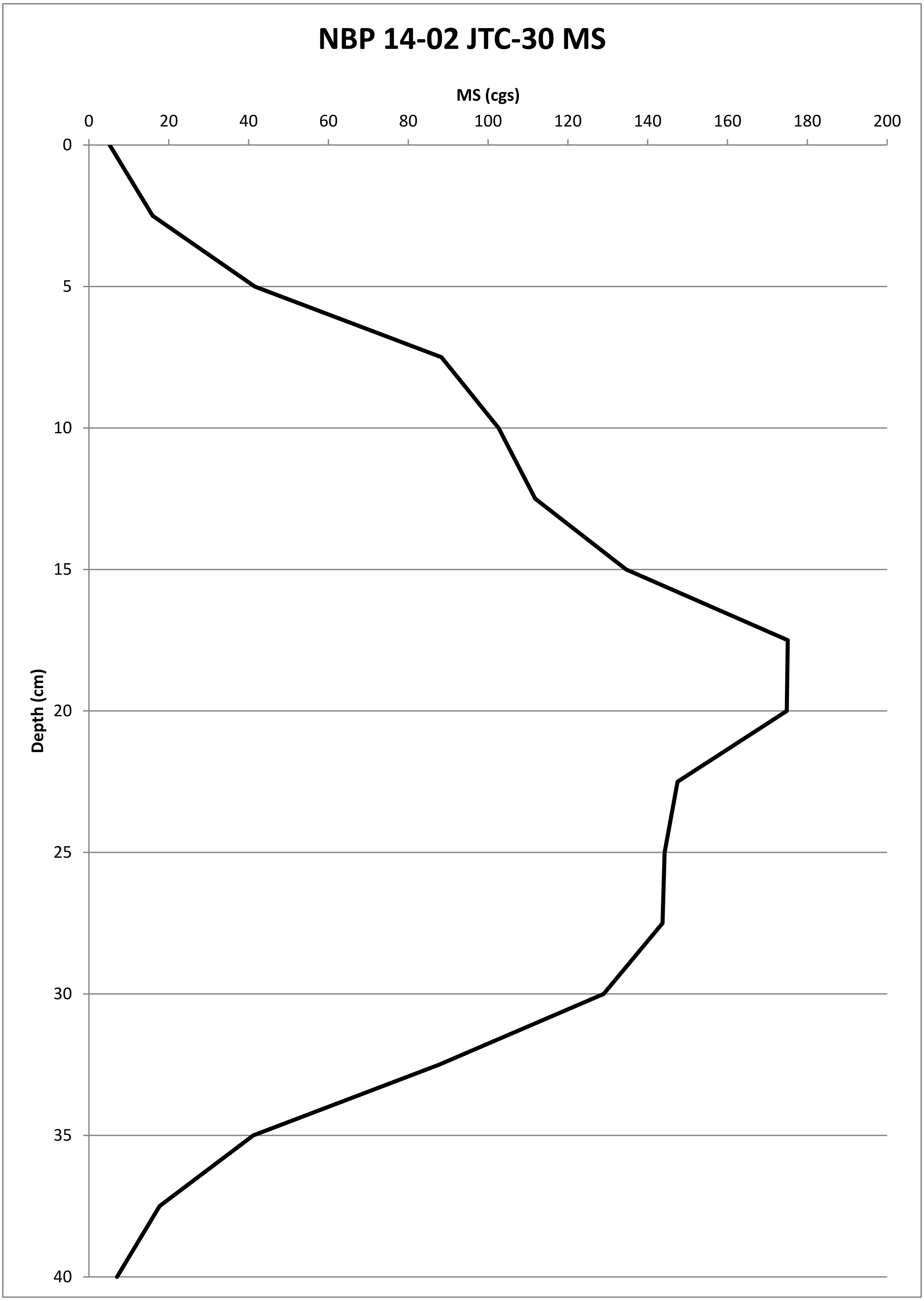
Station 27 MS
MS (cgs)
-30
-20
-10
0
10
20
30
40
0
50
100
150
200
250
300
Depth (cm)
KC-27A
KC-27B
JPC-27
JTC-27

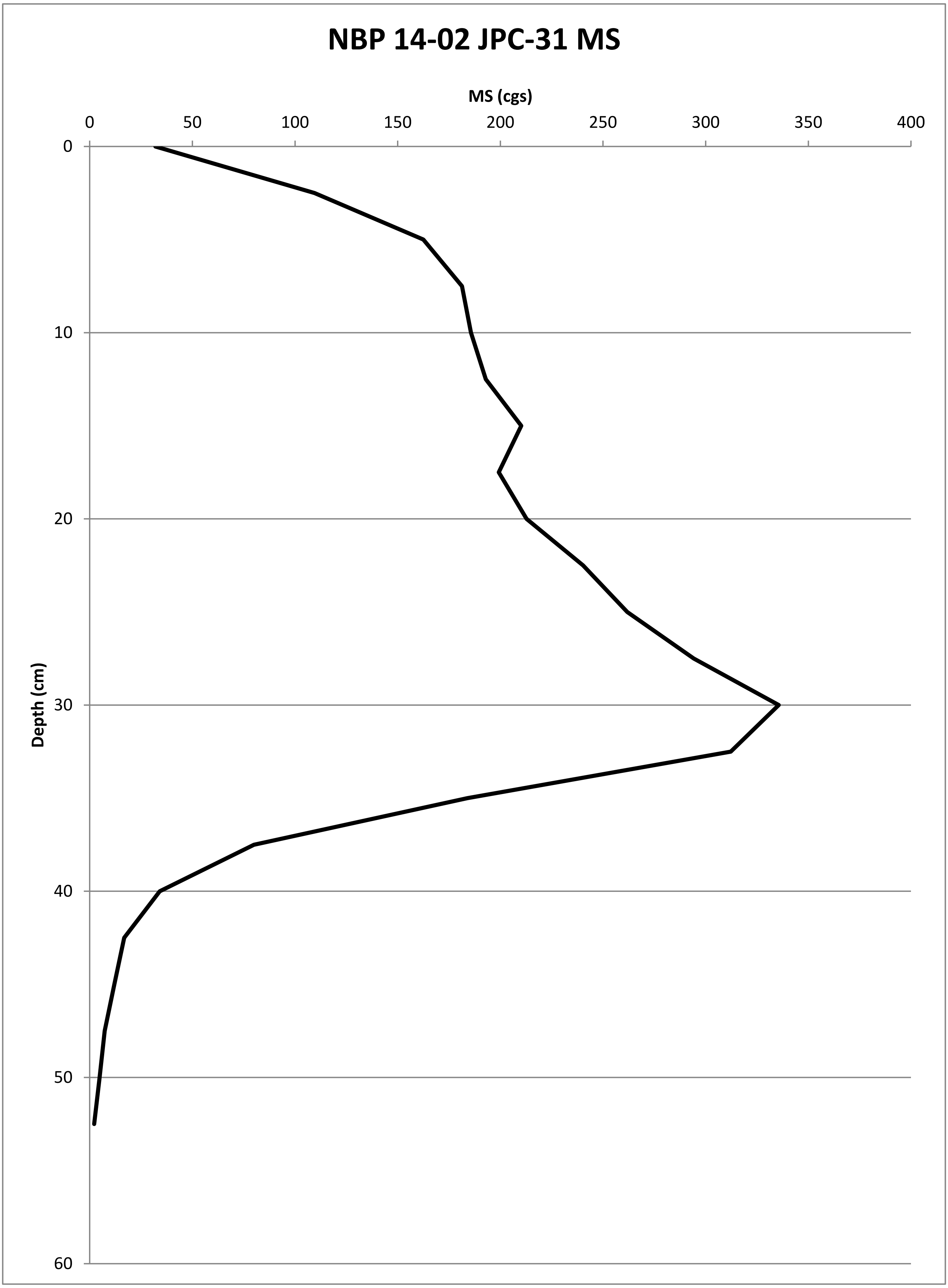

NBP 14-02 JPC-28 MS
MS (cgs)
0
20
40
60
80
100
120
140
160
180
200
Depth (cm)
0
5
10
15
20
25

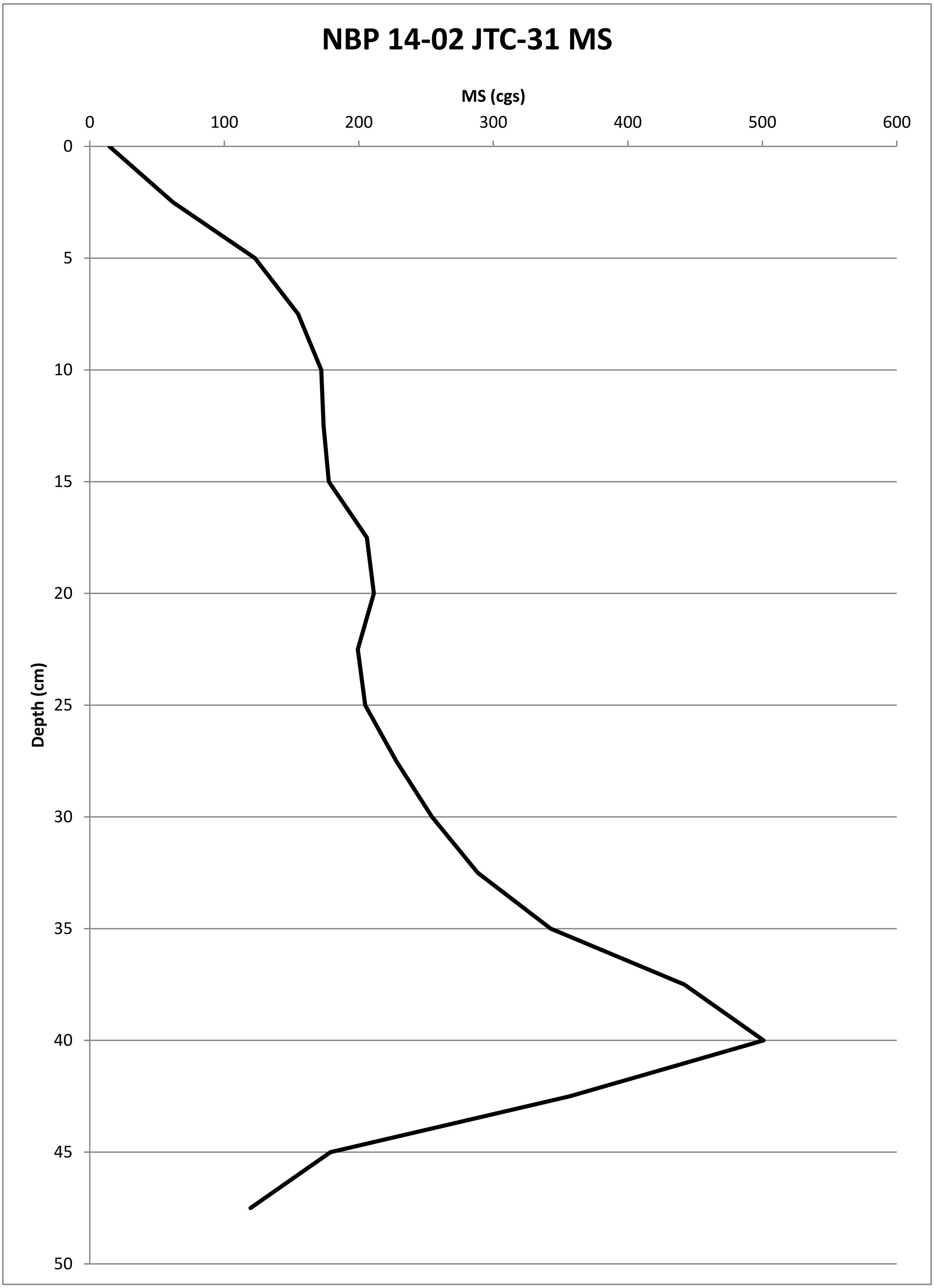

NBP 14-02 JPC-29 MS
MS (cgs)
0
50
100
150
200
250
300
0
10
20
30
40
50
60
70
80
Depth (cm)

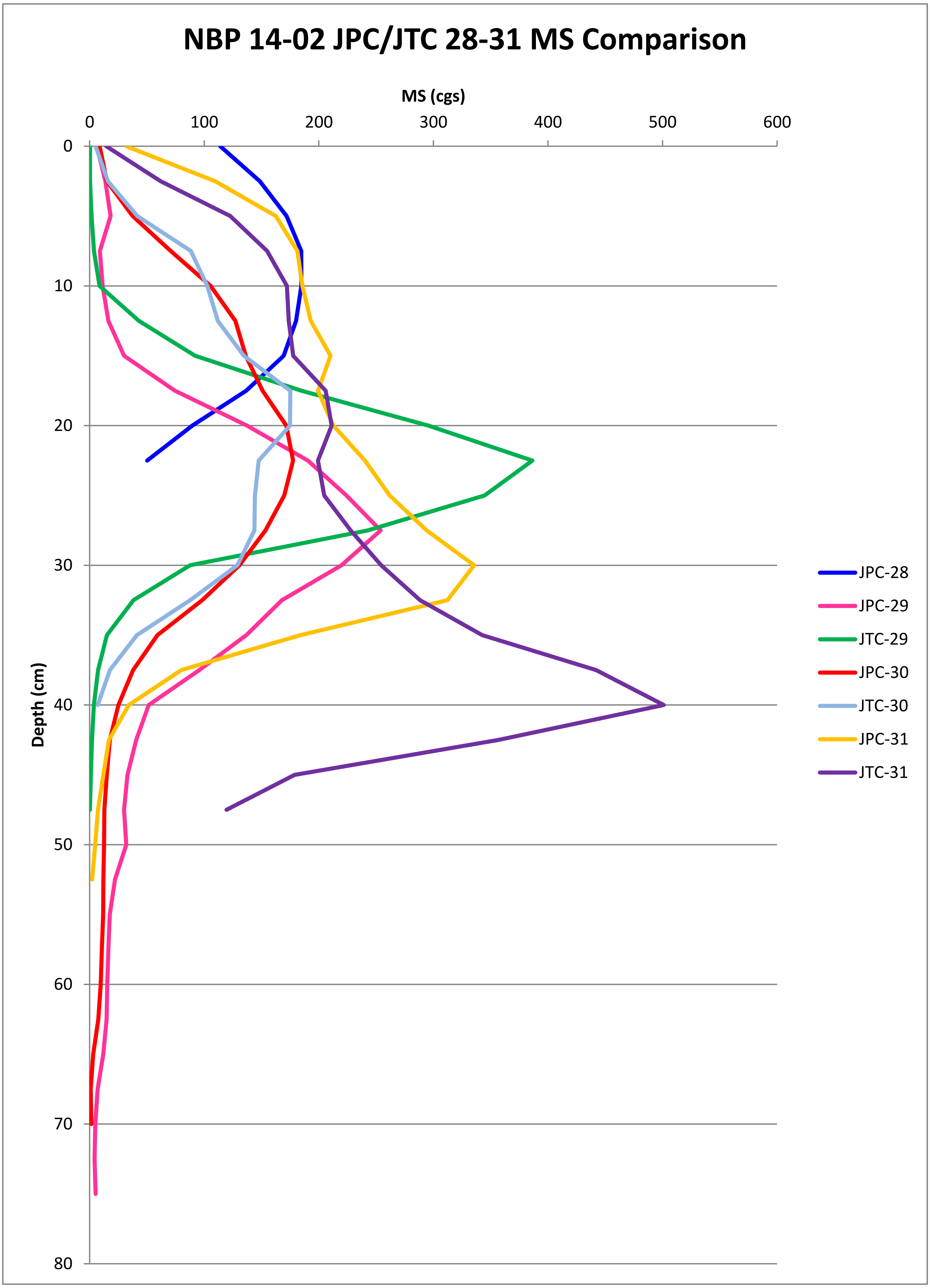

NBP 14-02 JTC-29 MS
MS (cgs)
0
50
100
150
200
250
300
350
400
450
Depth (cm)
0
5
10
15
20
25
30
35
40
45
50


NBP 14-02 JPC-30 MS
MS (cgs)
0
20
40
60
80
100
120
140
160
180
200
Depth (cm)
0
10
20
30
40
50
60
70
80


NBP 14-02 JTC-30 MS
MS (cgs)
0
20
40
60
80
100
120
140
160
180
200
Depth (cm)
0
5
10
15
20
25
30
35
40


NBP 14-02 JPC-31 MS
MS (cgs)
0
50
100
150
200
250
300
350
400
Depth (cm)
0
10
20
30
40
50
60


NBP 14-02 JTC-31 MS
MS (cgs)
0
100
200
300
400
500
600
Depth (cm)
0
5
10
15
20
25
30
35
40
45
50



NBP 14-02 JPC/JTC 28-31 MS Comparison
MS (cgs)
0
100
200
300
400
500
600
Depth (cm)
0
10
20
30
40
50
60
70
80
JPC-28
JPC-29
JTC-29
JPC-30
JTC-30
JPC-31
JTC-31

5. Mertz Bio dredge data

Rock dredge station form

Station: NBP14-02 – D1 **Date:** 5 Feb 2014
Equipment type: Large basket dredge **Sediments:** mud with some dropstones
Comments: Upper Eocene target – Mertz Trough

	Time (GMT)	Latitude	Longitude	Depth (m)
On bottom (SOL):	0624	-66° 53.4659	145° 17.7676	740
Off bottom (EOL):	0712	-66° 53.1987	145° 18.3562	729

Taxon	Common Name	Quantity	Wet volume (ml)
VME taxa			
Isididae	Bamboo coral		
Coralliidae	Red coral		
Primnoidae	Bottle brush/sea fans	3	50
Paragorgiidae	Bubblegum coral		
Chrysogorgiidae	Golden coral		
Hydroidolina	Hydroids		
Stylasterids	Hydrocorals		
Scleractinia	Stony corals		
Antipatharia	Black corals		
Zoantharia	Zoanthids		
Hexactinellida	Glass sponges		
Demospongiae	Siliceous sponges		
Actiniaria	Anemones		
Alcyonacea	Soft corals		
Pennatulacea	Sea pens		
Ascidiacea	Sea squirts	3 pieces	60
Bryozoans	Lace corals	fragments	2
Brachiopoda	Lamp shells		
Pterobranchia	Acorn worms	2 clumps	70
Serpulidae	Serpulid tube worms		
Xenophyophora	Xenophyophora		
Bathylasmatidae	Goose/acorn barnacles		
Adamussium colbecki	Antarctic scallop		
Stalked crinoid	Sea lillies		
Euryalida	Basket/snake stars		
Cidaroida	Pencil urchins		
Octopodidae	Octopuses		
Bivalvia	Bivalves		
Polyplacophora	Chitons		
Gastropoda	Gastropods		
Scaphopoda	Tusk shells		
Holothuroidea	Sea cucumbers	3	300
Asteroidea	Sea stars		
Echinoidea	Sea urchins (not pencil)		
Ophiuroidea	Brittle stars	3	1
Crinoidea	Feather stars (not stalked)		
Pycnogonida	Sea spiders		
Crustacea	Crustaceans		
Polychaeta	Polychaetes (not serpulid)	2	5
Other worms	e.g. Peanut worms, flat worms, penis worms, echiurans (not acorn)	1	1

Rock dredge station form

Station: NBP14-02 – D2 **Date:** 5 Feb 2014
Equipment type: Small basket dredge **Sediments:** stiff mud
Comments: Eocene/Oligocene boundary – Mertz Trough

	Time (GMT)	Latitude	Longitude	Depth (m)
On bottom (SOL):	0836	-66° 53.0067	145° 18.770	735
Off bottom (EOL):	0858	-66° 52.7879	145° 18.7712	722

Taxon	Common Name	Quantity	Wet volume (ml)
VME taxa			
Isididae	Bamboo coral		
Coralliidae	Red coral		
Primnoidae	Bottle brush/sea fans		
Paragorgiidae	Bubblegum coral		
Chrysogorgiidae	Golden coral		
Hydroidolina	Hydroids		
Stylasterids	Hydrocorals		
Scleractinia	Stony corals		
Antipatharia	Black corals		
Zoantharia	Zoanthids		
Hexactinellida	Glass sponges		
Demospongiae	Siliceous sponges		
Actiniaria	Anemones		
Alcyonacea	Soft corals		
Pennatulacea	Sea pens		
Ascidiacea	Sea squirts	1	1
Bryozoans	Lace corals	11 fragments	20
Brachiopoda	Lamp shells		
Pterobranchia	Acorn worms	4	40
Serpulidae	Serpulid tube worms		
Xenophyophora	Xenophyophora		
Bathylasmatidae	Goose/acorn barnacles		
Adamussium colbecki	Antarctic scallop		
Stalked crinoid	Sea lillies		
Euryalida	Basket/snake stars		
Cidaroida	Pencil urchins		
Octopodidae	Octopuses		
Bivalvia	Bivalves		
Polyplacophora	Chitons		
Gastropoda	Gastropods		
Scaphopoda	Tusk shells	1	0.5
Holothuroidea	Sea cucumbers		
Asteroidea	Sea stars	1	2
Echinoidea	Sea urchins (not pencil)		
Ophiuroidea	Brittle stars		
Crinoidea	Feather stars (not stalked)		
Pycnogonida	Sea spiders		
Crustacea	Crustaceans		
Polychaeta	Polychaetes (not serpulid)	20	50
Other worms	e.g. Peanut worms, flat worms, penis worms, echiurans (not acorn)	1	1

Rock dredge station form

Station: NBP14-02 – D3 **Date:** 5 Feb 2014
Equipment type: Small basket dredge **Sediments:** stiff mud with dropstones
Comments: Oligocene – above unconformity – Mertz Trough

	Time (GMT)	Latitude	Longitude	Depth (m)
On bottom (SOL):	0955	-66° 52.3127	145° 20.191	687
Off bottom (EOL):	1015	-66° 52.2185	145° 20.3904	683

Taxon VME taxa	Common Name	Quantity	Wet volume (ml)
Isididae	Bamboo coral		
Coralliidae	Red coral		
Primnoidae	Bottle brush/sea fans		
Paragorgiidae	Bubblegum coral		
Chrysogorgiidae	Golden coral		
Hydroidolina	Hydroids		
Stylasterids	Hydrocorals		
Scleractinia	Stony corals		
Antipatharia	Black corals		
Zoantharia	Zoanthids		
Hexactinellida	Glass sponges		
Demospongiae	Siliceous sponges		
Actiniaria	Anemones		
Alcyonacea	Soft corals		
Pennatulacea	Sea pens		
Ascidiacea	Sea squirts	1	0.5
Bryozoans	Lace corals	1 fragment	0.5
Brachiopoda	Lamp shells		
Pterobranchia	Acorn worms		
Serpulidae	Serpulid tube worms		
Xenophyophora	Xenophyophora		
Bathylasmatidae	Goose/acorn barnacles		
Adamussium colbecki	Antarctic scallop		
Stalked crinoid	Sea lillies		
Euryalida	Basket/snake stars		
Cidaroida	Pencil urchins		
Octopodidae	Octopuses		
Bivalvia	Bivalves		
Polyplacophora	Chitons		
Gastropoda	Gastropods		
Scaphopoda	Tusk shells		
Holothuroidea	Sea cucumbers		
Asteroidea	Sea stars		
Echinoidea	Sea urchins (not pencil)		
Ophiuroidea	Brittle stars		
Crinoidea	Feather stars (not stalked)	1	5
Pycnogonida	Sea spiders		
Crustacea	Crustaceans		
Polychaeta	Polychaetes (not serpulid)	1	1
Other worms	e.g. Peanut worms, flat worms, penis worms, echiurans (not acorn)		

Rock dredge station form

Station: NBP14-02 – D4 **Date:** 5 Feb 2014
Equipment type: Small basket dredge **Sediments:** glacial till
Comments: Upper Oligocene – Mertz Trough

	Time (GMT)	Latitude	Longitude	Depth (m)
On bottom (SOL):	1123	-66° 49.641	145° 25.641	590
Off bottom (EOL):	1144	-66 ° 49.5056	145° 25.878	590

Taxon VME taxa	Common Name	Quantity	Wet volume (ml)
Isididae	Bamboo coral		
Coralliidae	Red coral		
Primnoidae	Bottle brush/sea fans	3	2
Paragorgiidae	Bubblegum coral		
Chrysogorgiidae	Golden coral		
Hydroidolina	Hydroids		
Stylasterids	Hydrocorals		
Scleractinia	Stony corals		
Antipatharia	Black corals		
Zoantharia	Zoanthids		
Hexactinellida	Glass sponges		
Demospongiae	Siliceous sponges	2 pieces	5
Actiniaria	Anemones		
Alcyonacea	Soft corals		
Pennatulacea	Sea pens		
Ascidiacea	Sea squirts		
Bryozoans	Lace corals	100's fragments	300
Brachiopoda	Lamp shells		
Pterobranchia	Acorn worms	2	10
Serpulidae	Serpulid tube worms	1	5
Xenophyophora	Xenophyophora		
Bathylasmatidae	Goose/acorn barnacles		
Adamussium colbecki	Antarctic scallop		
Stalked crinoid	Sea lillies		
Euryalida	Basket/snake stars	1	10
Cidaroida	Pencil urchins		
Octopodidae	Octopuses		
Bivalvia	Bivalves	2	1
Polyplacophora	Chitons		
Gastropoda	Gastropods		
Scaphopoda	Tusk shells		
Holothuroidea	Sea cucumbers	1	5
Asteroidea	Sea stars	1	10
Echinoidea	Sea urchins (not pencil)		
Ophiuroidea	Brittle stars	5	5
Crinoidea	Feather stars (not stalked)	1	5
Pycnogonida	Sea spiders		
Crustacea	Crustaceans	1	5
Polychaeta	Polychaetes (not serpulid)	5	5
Other worms	e.g. Peanut worms, flat worms, penis worms, echiurans (not acorn)	1	1

And 1 salp (presumably caught near the surface)

Rock dredge station form

Station: NBP14-02 – D7A **Date:** 7 Feb 2014
Equipment type: Basket dredge (NTT)
Sediments: Nil
Comments: Targeting hydrocorals on upper slope, George V Shelf. 100 m wire laid out

	Time (GMT)	Latitude	Longitude	Depth (m)
On bottom (SOL):	0821	-65^{o} 49.192	143^{o} 9.831	707
Off bottom (EOL):	0829	-65^{o} 48.242	143^{o} 9.830	686

Taxon VME taxa	Common Name	Quantity	Wet volume (ml)
Isididae	Bamboo coral		
Coralliidae	Red coral		
Primnoidae	Bottle brush/sea fans		
Paragorgiidae	Bubblegum coral		
Chrysogorgiidae	Golden coral		
Hydroidolina	Hydroids		
Stylasterids	Hydrocorals	Rubble frags, 1 live	200, 0.5
Scleractinia	Stony corals		
Antipatharia	Black corals		
Zoantharia	Zoanthids		
Hexactinellida	Glass sponges		
Demospongiae	Siliceous sponges		
Actiniaria	Anemones		
Alcyonacea	Soft corals		
Pennatulacea	Sea pens		
Ascidiacea	Sea squirts		
Bryozoans	Lace corals		
Brachiopoda	Lamp shells	1 live	0.1
Pterobranchia	Acorn worms		
Serpulidae	Serpulid tube worms		
Xenophyophora	Xenophyophora		
Bathylasmatidae	Goose/acorn barnacles		
Adamussium colbecki	Antarctic scallop		
Stalked crinoid	Sea lillies		
Euryalida	Basket/snake stars		
Cidaroida	Pencil urchins		
Octopodidae	Octopuses		
Bivalvia	Bivalves		
Polyplacophora	Chitons	1	0.5
Gastropoda	Gastropods		
Scaphopoda	Tusk shells		
Holothuroidea	Sea cucumbers		
Asteroidea	Sea stars		
Echinoidea	Sea urchins (not pencil)		
Ophiuroidea	Brittle stars		
Crinoidea	Feather stars (not stalked)		
Pycnogonida	Sea spiders		
Crustacea	Crustaceans		
Polychaeta	Polychaetes (not serpulid)		
Other worms	e.g. Peanut worms, flat worms, penis worms, echiurans (not acorn)		

Rock dredge station form

Station: NBP14-02 – D7B **Date:** 7 Feb 2014
Equipment type: Basket dredge (NTT) **Sediments:** minor mud, some drop stones
Comments: Targeting hydrocorals on upper slope, George V Shelf. 200 m wire laid out

	Time (GMT)	Latitude	Longitude	Depth (m)
On bottom (SOL):	0957	-65° 48.345	143° 9.831	669
Off bottom (EOL):	1013	-65° 48.4572	143° 9.8268	616

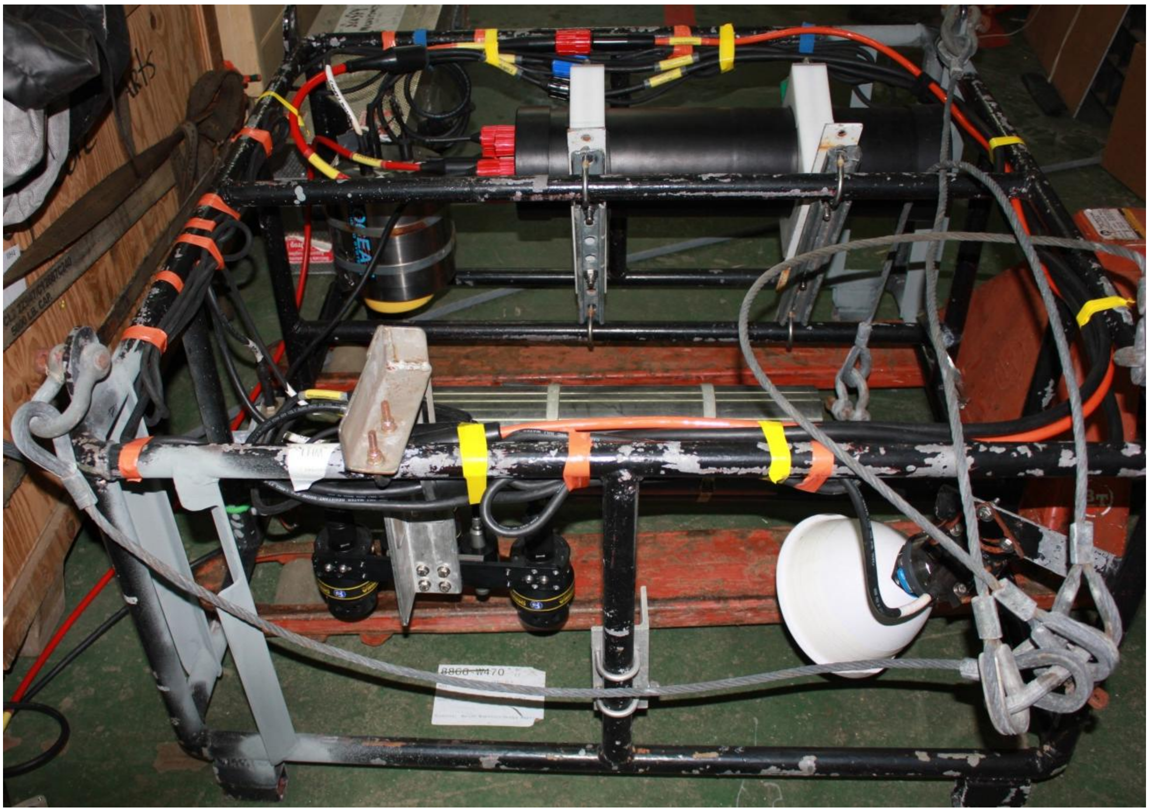
Taxon	Common Name	Quantity	Wet volume (ml)
VME taxa			
Isididae	Bamboo coral		
Coralliidae	Red coral		
Primnoidae	Bottle brush/sea fans	35	150
Paragorgiidae	Bubblegum coral		
Chrysogorgiidae	Golden coral	1	2
Hydroidolina	Hydroids		
Stylasterids	Hydrocorals	164	2500
Scleractinia	Stony corals	3	2
Antipatharia	Black corals		
Zoantharia	Zoanthids		
Hexactinellida	Glass sponges		
Demospongiae	Siliceous sponges	58	435
Actiniaria	Anemones	2	2
Alcyonacea	Soft corals		
Pennatulacea	Sea pens		
Ascidiacea	Sea squirts	27	125
Bryozoans	Lace corals	30 (H=16, S=14)	15 (H=7, S=8)
Brachiopoda	Lamp shells	1	0.5
Pterobranchia	Acorn worms		
Serpulidae	Serpulid tube worms		
Xenophyophora	Xenophyophora		
Bathylasmatidae	Goose/acorn barnacles		
Adamussium colbecki	Antarctic scallop		
Stalked crinoid	Sea lillies		
Euryalida	Basket/snake stars	1	1
Cidaroida	Pencil urchins	1 fr.	0.5
Octopodidae	Octopuses		
Bivalvia	Bivalves	11 (2 live)	5
Polyplacophora	Chitons		
Gastropoda	Gastropods	1	3
Scaphopoda	Tusk shells		
Holothuroidea	Sea cucumbers	2	2
Asteroidea	Sea stars		
Echinoidea	Sea urchins (not pencil)		
Ophiuroidea	Brittle stars	148	95
Crinoidea	Feather stars (not stalked)	3	10
Gorgonian	Other (e.g. whips)	2	0.5
Pycnogonida	Sea spiders	1	0.1
Crustacea	Crustaceans	2	2
Polychaeta	Polychaetes (not serpulid)	7	9
Other worms	e.g. Peanut worms, flat worms, penis worms, echiurans (not acorn)	6	6

6. Yoyo camera transects and methods

Methods and descriptions of NBP14-02 Yoyo camera transects

Methods

The yoyo camera consisted of a digital still and video camera, deployed on a coaxial cable to provide live video feed. The still camera was contained within a titanium housing, and consisted of a downward looking Ocean Imaging Systems DSC 10000 digital still camera (10.2 megapixel, 20 mm, Nikon D-80 Camera). Camera settings were: F-8, Focus 1.9 m, ASA-400. An Ocean Imaging Systems 3831 Strobe (200 W-S) was positioned 1 m from the camera at an angle of 26u from vertical. The video camera was a Multi *SeaCam* 2060 (768x494 pixels, 3.0 mm wide angle lens, f2.0), with imagery saved to NTSC format. This was also contained within titanium housing rated to 6000 m. All of these systems are contained within a tubular steel frame (see photo below).



Yoyo camera system

A Model 494 Bottom Contact Switch was used to trigger the camera and strobe at 2.5 m above the seafloor, imaging 3 m^2 of seafloor. Parallel laser beams (10 cm separation) provided a scale for the images. During regular deployment, the live video feed was used to determine bottom contact, with the flash of the strobe light indicating the collection of an image. This mode allowed good spacing of images across the seafloor. However, ongoing problems with the control box for the video and altimeter meant that the final four deployments had to be run without the live video feed, relying instead on a contact alarm which sounded as soon as the bottom contact was activated on the seafloor. This 'blind' method, combined with variable readings from the altimeter, sometimes made it difficult to determine height above the seafloor and to space images regularly along a transect.

Post-processing of images involved colour correction in Adobe Photoshop to remove the blue bias. Images were then scored in broad taxonomic categories to determine presence/absence, dominant and sub-dominant taxa (see results tables). Substrate characteristics were also recorded. For long transects every 2^{nd} image was analysed to provide an overview of the communities and substrate. More detailed analysis will be done over the coming months using random point count analysis.

Average layback from the camera position to the vessel was estimated based on the water depth and wire out along each transect. To allow images to be mapped to the multibeam and Knudsen data, corrections were also made based on the distance between the GPS locations for these sensors and the towing point at the stern of the vessel.

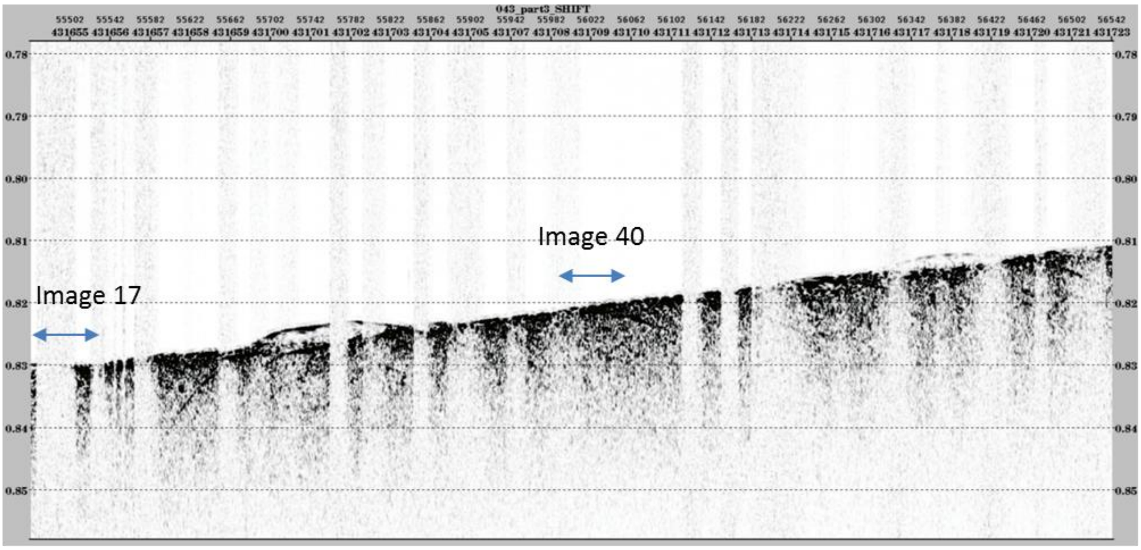
Table: Yoyo camera transects and attempted deployments during NBP14-02

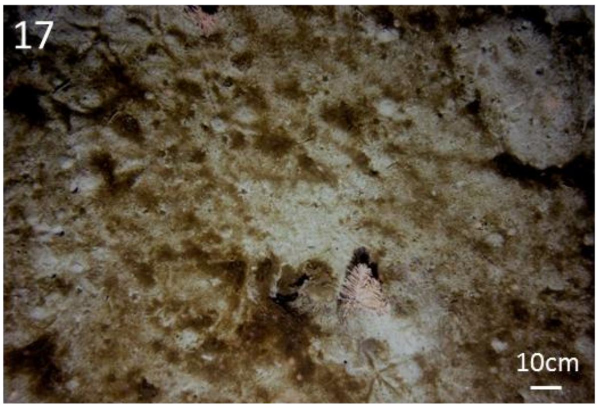
Station	Date	JD	Time SOL (UTC)	Lat SOL	Long SOL	Depth down (m)	Time EOL (UTC)	Lat EOL	Long EOL	Depth up (m)	SOG (kn)	Stills count
NBP14-02-Yoyo10	12/02/2014	43	16:51	66^o 22.505	120^o 3.337	602	1724	66^o 22.213	120^o 4.328	587	1.1	47
NBP14-02-Yoyo20	17/02/2014	48	16:26	66^o 23.140	118^o 57.575	895	17:04	66^o 23.331	118^o 56.529	896	1.0	62
NBP14-02-Yoyo27	21/02/2014	52	5:26	66^o 11.091	120^o 30.238	545	Yoyo failed					
NBP14-02-Yoyo27	21/02/2014	52	5:50	66^o 11.091	120^o 30.238	545	Yoyo failed					
None assigned	22/02/2014	53	4:34	66^o 26.732	120^o 19.880	549	Yoyo failed					
None assigned	23/02/2014	54	13:44	66^o 13.913	120^o 48.123	326	Yoyo failed					
NBP14-02-Yoyo34	24/02/2014	55	12:53	66^o 20.200	120^o 47.432	280	13:13	66^o 20.172	120^o 47.966	274	1.0	46
NBP14-02-Yoyo35	24/02/2014	55	14:59	66^o 19.536	120^o 28.871	457	15:45	66^o 19.680	120^o 30.474	469	0.8	207
NBP14-02-Yoyo36	24/02/2014	55	16:52	66^o 16.364	120^o 35.224	459	17:25	66^o 16.605	120^o 36.098	429	0.8	86
NBP14-02-Yoyo40	25/02/2014	56	5:29	66^o 26.777	119^o 54.308	688	Yoyo failed on first attempt					
NBP14-02-Yoyo40	25/02/2014	56	6:09	66^o 26.693	119^o 54.201	697	6:36	66^o 26.804	119^o 54.894	683	0.8	53
NBP14-02-Yoyo41	25/02/2014	56	7:57	66^o 29.139	120^o 10.388	440	Yoyo failed					
NBP14-02-Yoyo44	26/02/2014	57	21:43	66^o 11.161	120^o 30.238	547	Yoyo failed					
NBP14-02-Yoyo47	3/03/2014	62	13:33	66^o 35.621	120^o 13.206	337	Yoyo failed on first attempt					
NBP14-02-Yoyo47	3/03/2014	62	13:58	66^o 35.619	120^o 13.234	339	14:24	66^o 35.519	120^o 14.334	340	0.6	26
NBP14-02-Yoyo49	3/03/2014	62	16:25	66^o 35.693	120^o 10.403	444	16:49	66^o 35.706	120^o 10.978	497	0.6	55
NBP14-02-Yoyo50	3/03/2014	62	19:53	66^o 19.444	120^o 27.619	455	20:25	66^o 19.334	120^o 28.397	457	0.7	87
NBP14-02-Yoyo52	3/03/2014	62	23:19	66^o 11.011	120^o 28.894	512	23:50	66^o 11.039	120^o 29.891	531	0.8	91

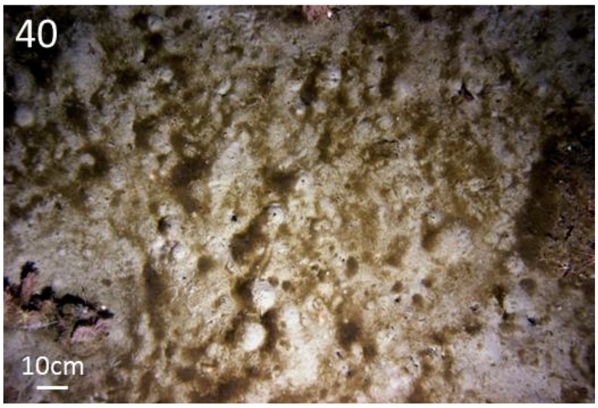
Description of transects

NBP14-02-Yoyo10

A yoyo transect was run for 0.5 nm at Station 10 over a depth range of 587 to 602 m, coinciding with the location of a short term oceanographic mooring M1. The video revealed abundant marine snow throughout the water column, with the seafloor covered in diatom drifts. The high diatom flux and deposition reflects the bloom conditions at the time of sampling. The still images revealed a mixed benthic community, consisting of abundant infauna, mobile feeders (such as brittle stars and urchins) and some sessile suspension feeders (gorgonians, bryozoa, sponges and anemones). Brittle stars and burrows were the most dominant taxa throughout. Sessile taxa were often associated with drop stones, which were either fully visible or partially buried in the sediment.



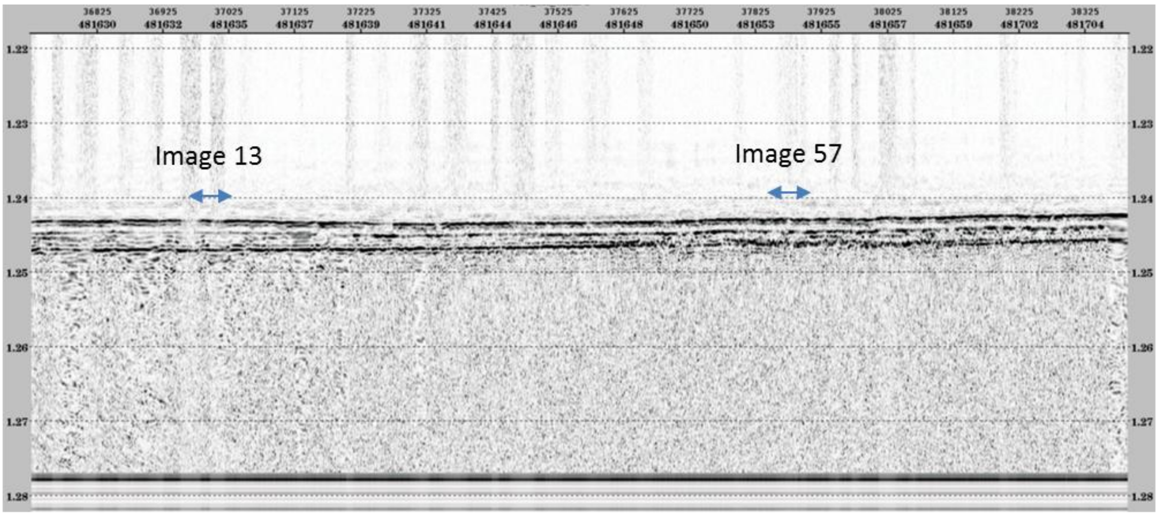


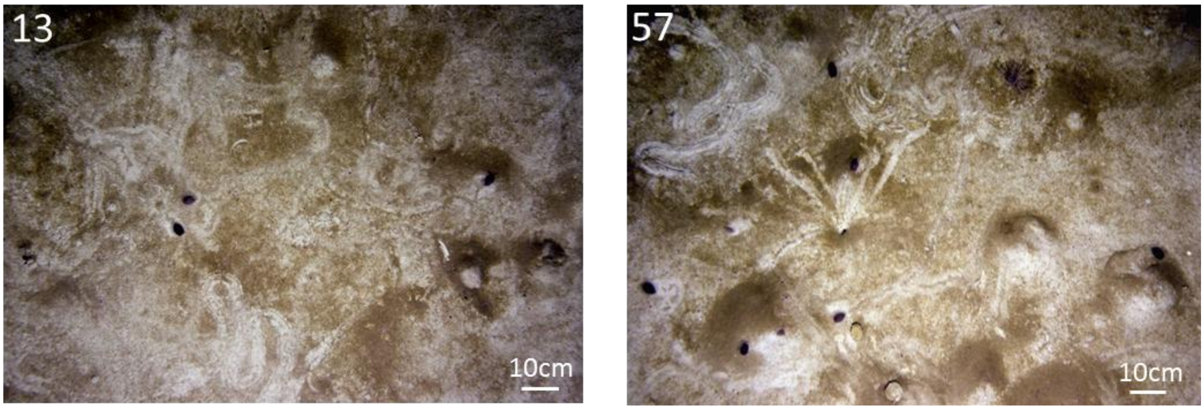


The chirp profile indicates little to no surface sediments, while the seafloor photos indicate muddy sediments which are heavily burrowed and covered in diatom drifts. The muddy sediments are interpreted as a thin drape that is therefore not resolved by the chirp data.

NBP14-02-Yoyo20

This transect was within the deep basin region on the western part of the survey area, at a depth of 895 m. The chirp line indicates the presence of a ‘toothpaste’ reflector, 3-4 m thick. The benthic fauna along this transect were characterised by sparse mobile forms and infauna, with highest abundances of brittle stars, urchins and polychaetes. Burrows were present throughout, with crustaceans occasionally observed at their head. Diversity and biomass were relatively low throughout. Sessile epifauna, such as bryozoans, sponges and anemones, were occasionally observed, mostly associated with dropstones. The video recorded thick marine snow through the water column, and diatom drifts were visible on the seafloor.

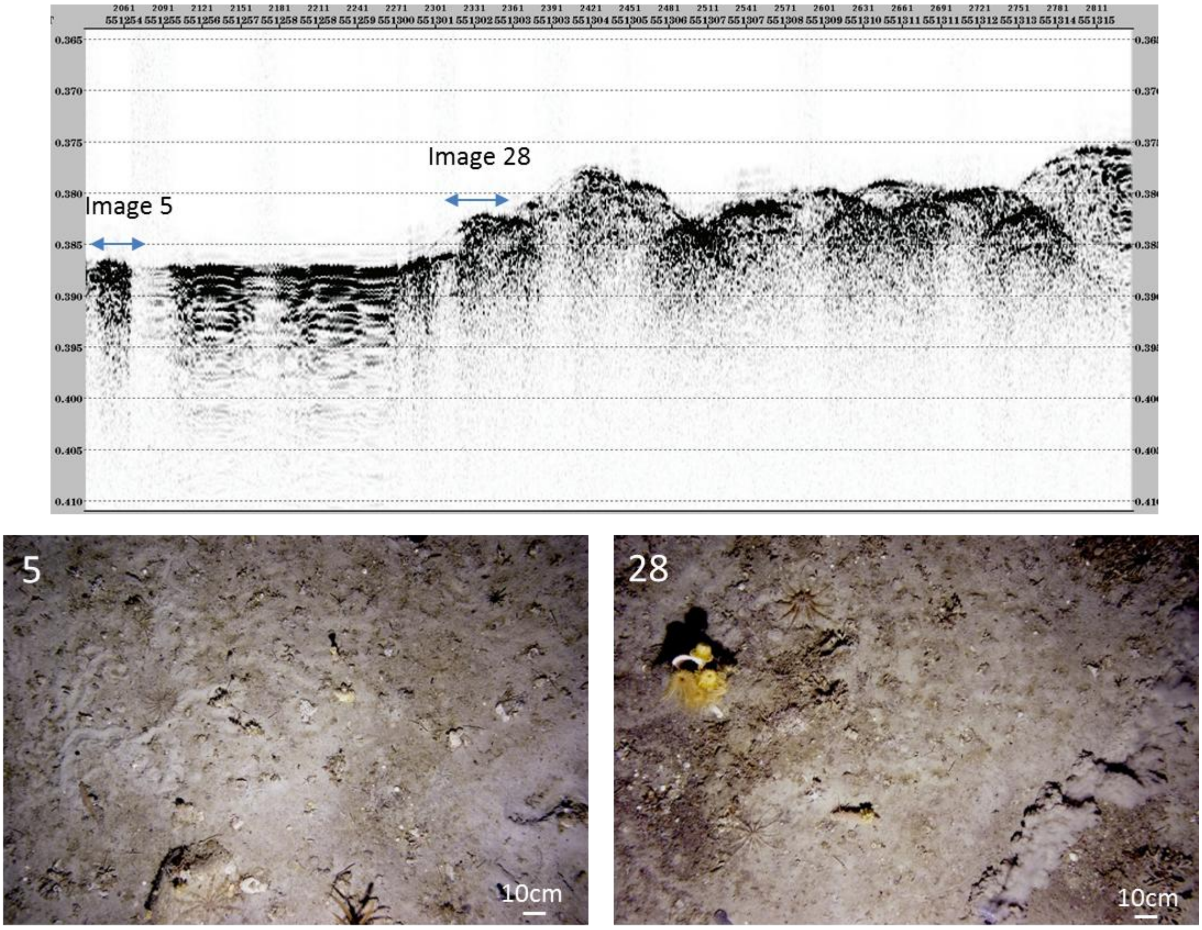




Muddy sediments in this deep basin were inhabited by a sparse mobile and infaunal community.

NBP14-02-Yoyo34

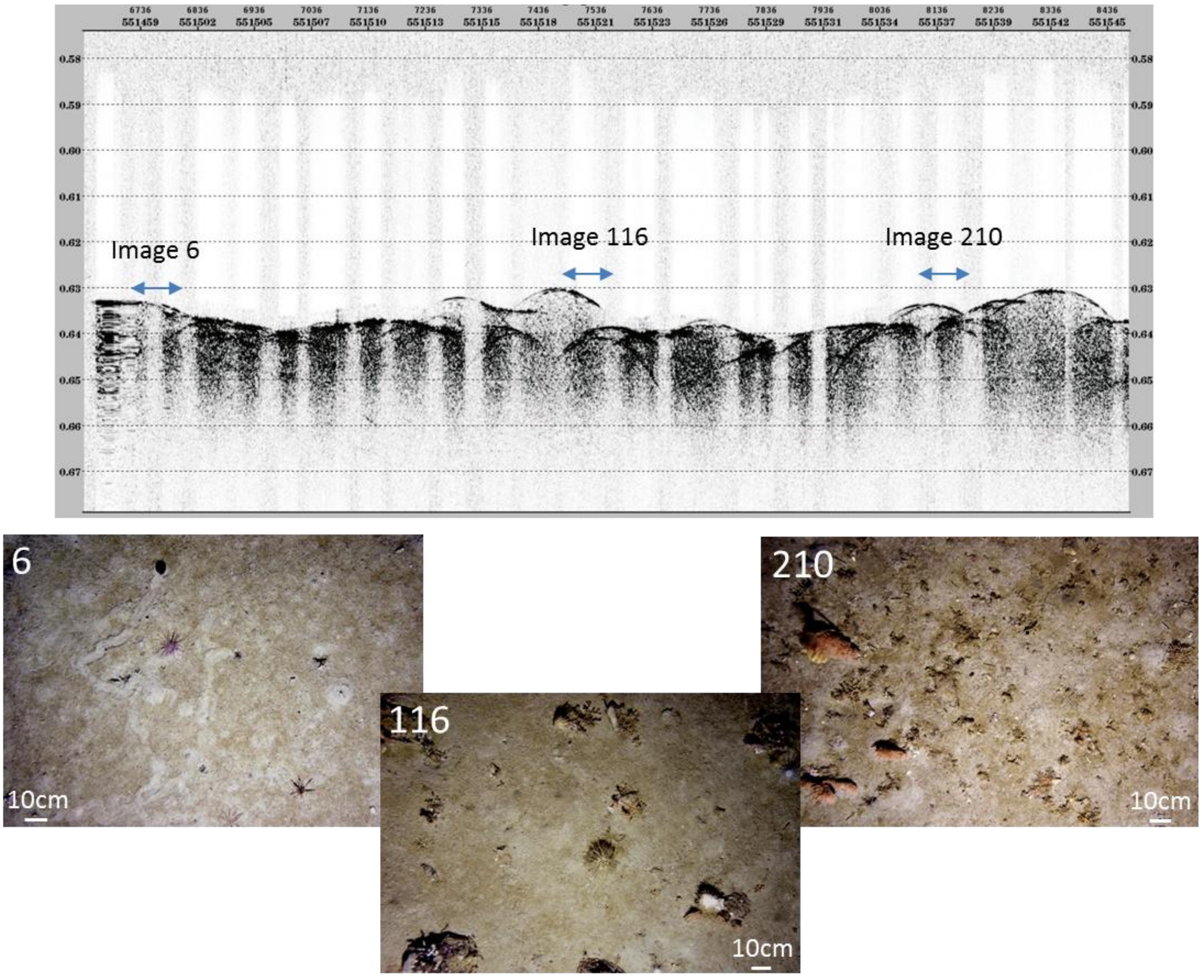
This transect was run across the top of a shallow moraine (275 m water depth) on the eastern part of the survey area. The chirp line indicates a hummocky surface, with an elevation range of 2-3 m, possibly reflecting iceberg scouring. Sediments are not visible in the sub-bottom reflectors. The benthic fauna observed were characterised by a range of epifauna, dominated by bryozoans, with a variety of massive, hollow and encrusting sponges, bottlebrush gorgonians, whips and ascidians also abundant. Crinoids were also abundant, often perching on top of the sponges and gorgonians. Gravel, cobbles and boulders provide hard attachment points for the epifauna.



A coarse substratum of gravels and dropstones along this transect provides habitat for a diverse range of epifauna.

NBP14-02-Yoyo35

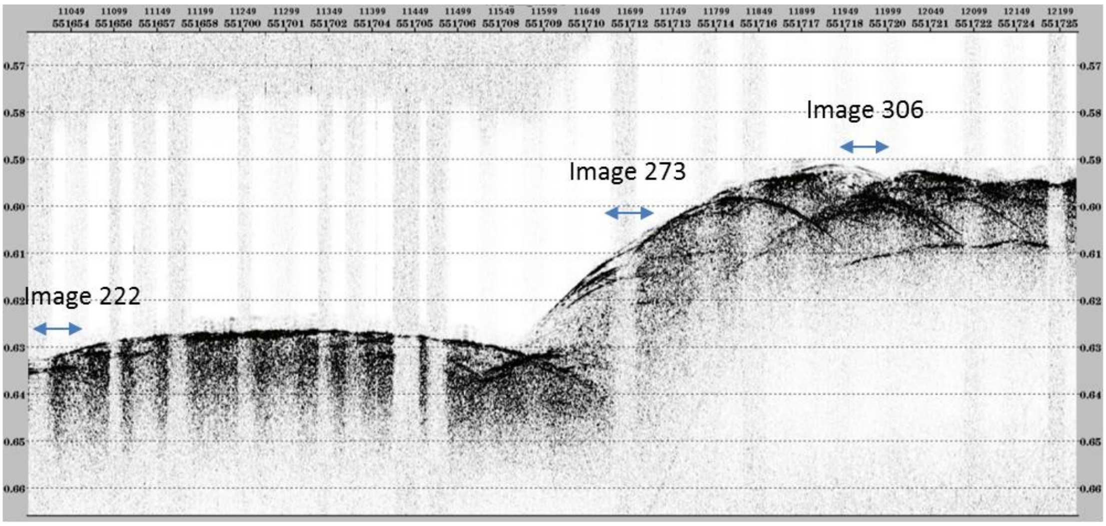
This transect crossed obliquely over a dune complex, with amplitudes of up to 4 m, at a depth of 460 m. The presence of ice rafted debris (IRD) of gravel up to boulder sized clasts has enabled the development of a diverse epifauna community on areas of hard substratum. The epifauna is comprised of bryozoans, encrusting sponges, bottlebrush gorgonians, ascidians and anemones. Muddy sands away from areas of IRD are populated by a much sparser mobile and infaunal community. Brittle stars are dominant, with burrowing and pencil urchins, polychaetes, crustaceans and sea spiders also occurring.

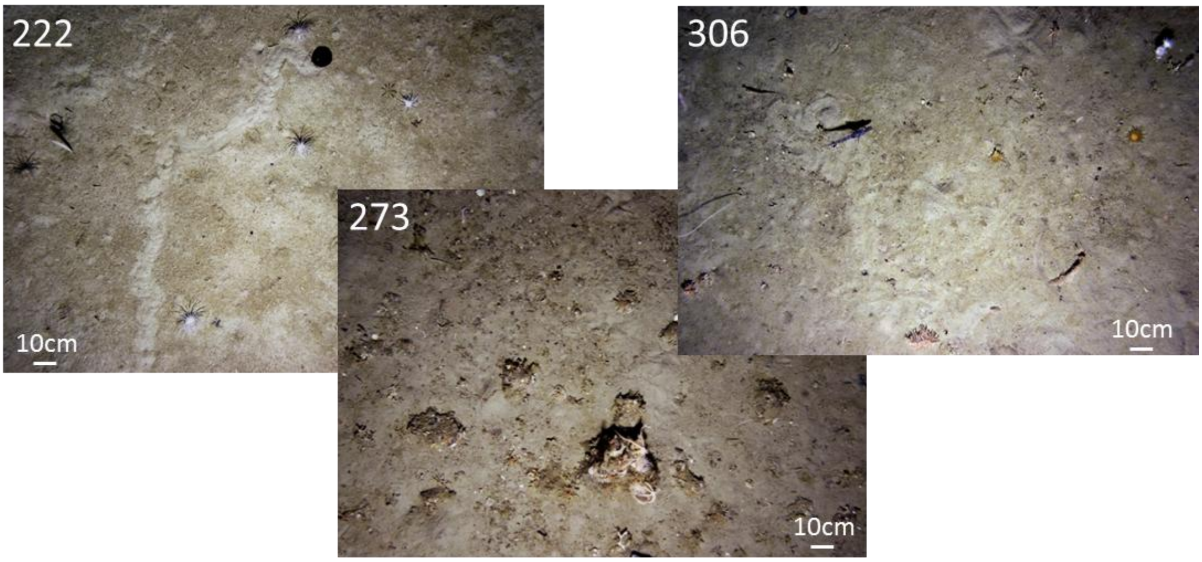


Superimposed on the dune complex, scattered dropstones (image 116) and partially buried IRD (image 210) create a hard substrate for a range of epifauna. This contrasts with the sparse mobile and infaunal taxa on areas of muddy sand with no IRD.

NBP14-02-Yoyo36

This transect traversed a major moraine feature in the north eastern part of the survey area, imaging from the base to the top of the feature. Along the base of the moraine, sediments were predominantly muddy/sandy with a dominance by anemones and brittle stars, and burrowing and pencil urchins and large clam burrows were also observed. On the moraine itself, gravels, cobbles and boulders were more dominant features of the substrate, resulting in the occurrence of a diverse epifaunal community. While brittle stars remained a dominant component of this community, bryozoans, encrusting sponges and bottlebrush gorgonians were also abundant.

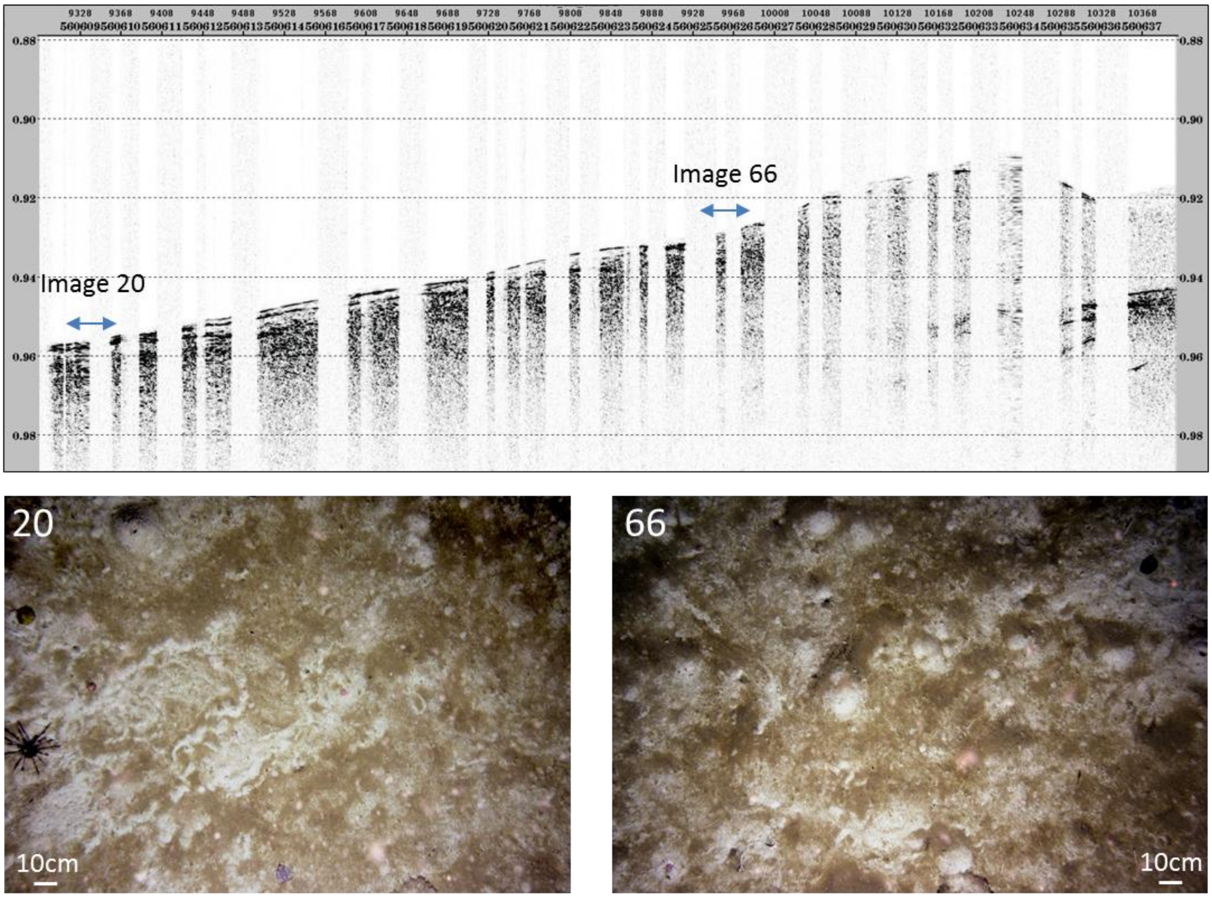




The base of the moraine is composed of muddy/sandy sediments with anemones, brittlestars and urchins observed (Image 222). The moraine itself is characterised by more gravelly sediments (Image 273 and 306) with cobbles and boulders inhabited by a range of epifauna (Image 273).

NBP14-02-Yoyo40

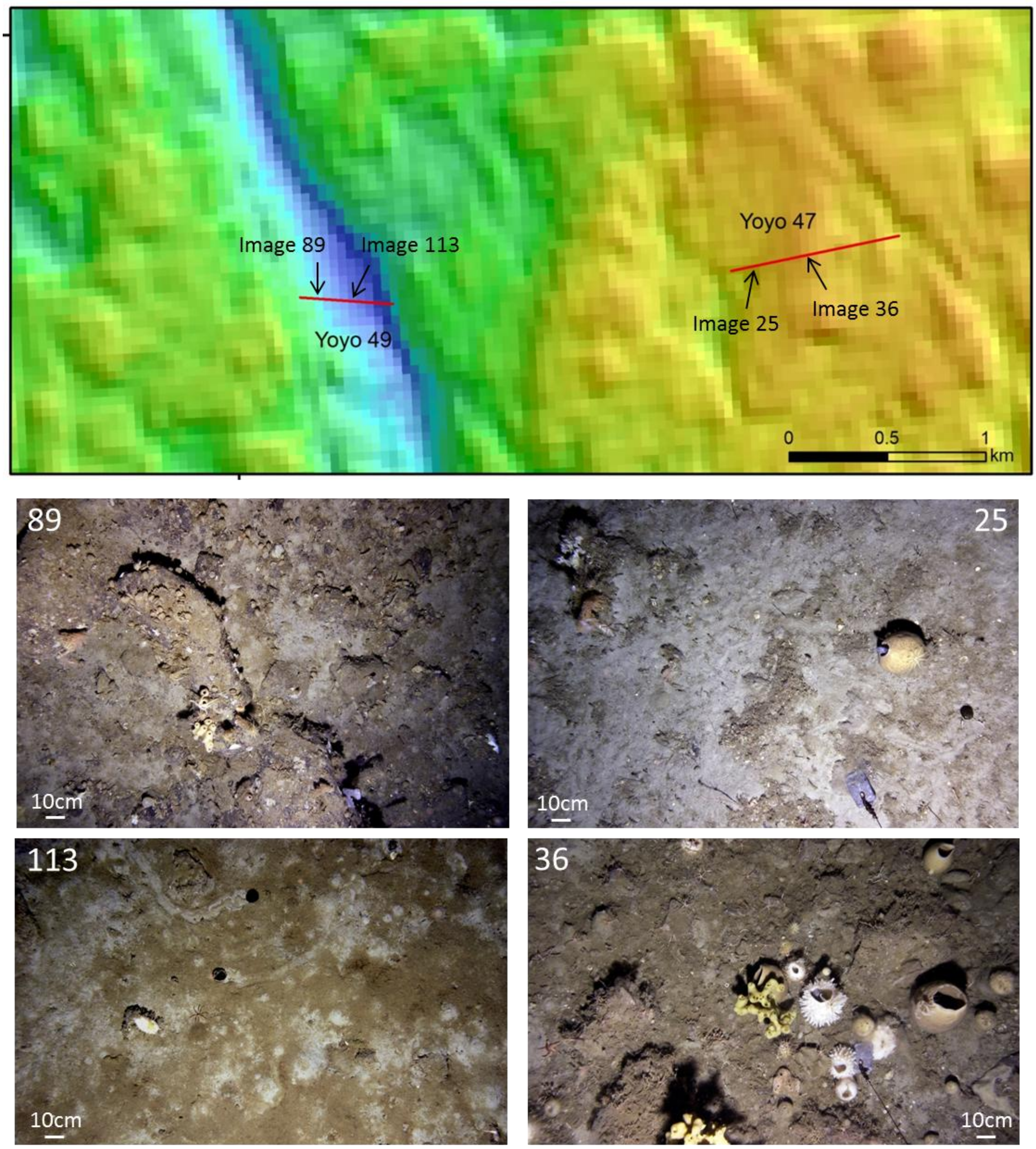
This transect was designed to image a crag and tail feature at 680 – 700 m, just west of the interface between the crystalline basement and sedimentary deposits. The presence of large tabular icebergs meant that the transect could not be run in the preferred south easterly direction, and had to cut short before reaching the upslope extent of the feature. The seafloor is characterised by muddy sediments, which can be seen as a fine toothpaste reflector in the chirp profile along the first part of the transect. The fauna were predominantly mobile and infaunal forms, with brittle stars, crustacea, holothurians, polychaetes and urchins occurring throughout, however, gorgonian whips were also abundant along parts of the transect.



Muddy sediments characterise this transect up towards the top of the tail and crag feature, with mobile and infaunal taxa dominating the assemblage.

NBP14-02-Yoyo47

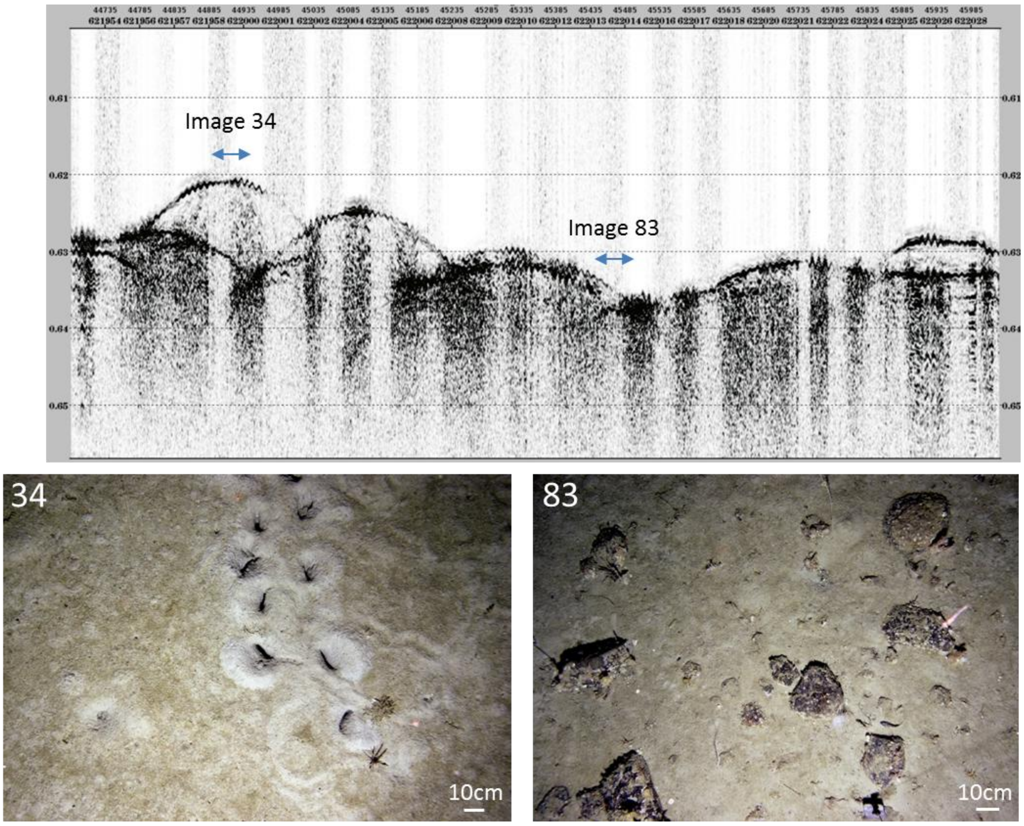
This transect was run across a shallow section of crystalline basement (340 m water depth) in the south western part of the survey region. The aim of the transect was to understand the fauna associated with this shallow outcrop, and to provide a broader context for understanding the sedimentary processes across this plateau and adjacent deep channel (Yoyo49). The substrate consists of basement outcrops, with boulders, cobbles and gravel also present. Sandy sediments were observed in the first part of the transect and between areas of harder substrate. The taxa had a relatively high diversity and biomass, with the primary taxa comprised of bryozoa and brittle stars, with a variety of massive and hollow sponges also abundant at times.



The shallow plateau (Yoyo47) consists of areas of sandy sediment (Image 25) and basement outcrop (Image 36). The adjacent channel (Yoyo49) also has areas of outcropping basement (Image 89), while the deepest parts of the channel (Image 113) have a layer of diatom fluff not observed on the adjacent plateau.

NBP14-02-Yoyo49
This transect was located within a channel that has incised 150 m into the crystalline basement. The water depth in the deepest part of the channel is 538 m. The flanks of the channel are comprised of basement outcrop, with cobbles and gravelly sediments also common. The deepest parts of the channel, along the eastern side, have a more muddy composition, with thick drifts of diatoms. Brachiopods, brittle stars and bryozoa were abundant, particularly on areas of basement outcrop. A diversity of massive, hollow and encrusting sponges, ascidians, gorgonians, anemones, crinoids and polychaetes were also present on the rocky substrate. Sea spiders, along with brittle stars, were most abundant on the muddy sediments, with urchins present throughout.

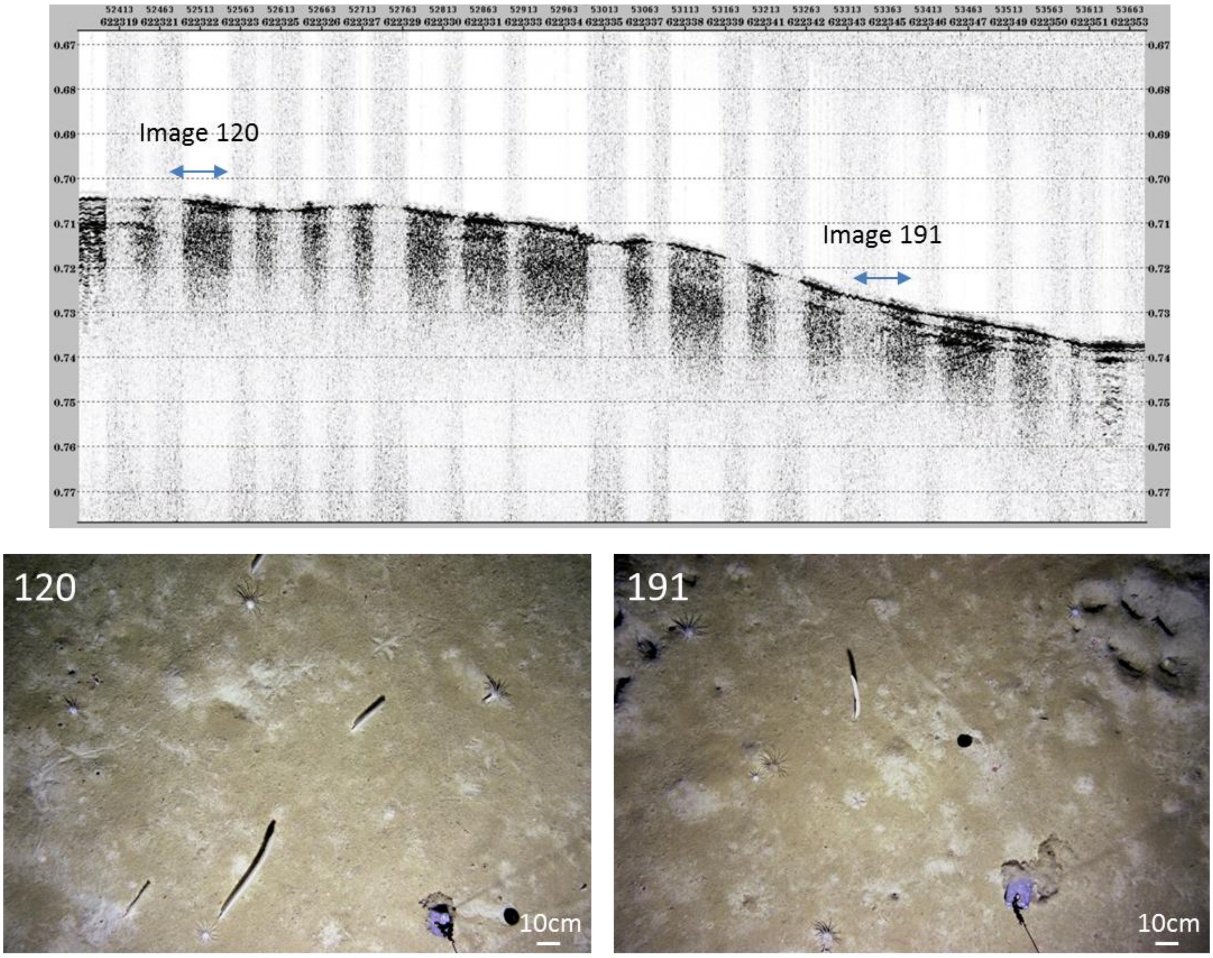
NBP14-02-Yoyo50
This transect was selected to cross directly over the crests of several parabolic dune features. Sand could be seen clearly in some of the images, particularly within large clam burrows. Elsewhere, the sediments are overprinted by recent diatom deposition and the occurrence of IRD. The IRD was present as boulders, cobbles and gravel, with the blackened surface of the boulders indicative of manganese oxides. The boulders were densely colonised by epifauna, comprised of bryozoans, gorgonians, massive and encrusting sponges and anemones. Crinoids were also commonly observed perching on the epifauna. Some of the boulders were partially buried within the sediments, indicating emplacement prior to the deposition of the upper sediments.



Several dune crests were crossed during this transect. Sand was visible within the burrows, while diatom drifts covered the adjacent sediment surface (Image 34). IRD was abundant along parts of the transect, comprised of surficial and partially buried boulders (Image 83).

NBP14-02-Yoyo52

This transect crossed the flanks of a basin containing thick (~12 m) sedimentary deposits in the north eastern part of the survey region. The sediments imaged by the camera were muddy, with diatom drifts visible on the surface. The fauna were dominated by anemones, brittle stars and gorgonian whips. The abundance of sessile epifauna on this transect suggests that food particles were advected across this area in suspension. Mobile feeders, such as the brittle stars, burrowing urchins and holothurians were also observed.



Sediments along this transect were muddy, with a surface cover of diatom drifts. Gorgonian whips, anemones and brittle stars had high abundances along the flanks of this sedimentary basin.

7. Yoyo camera results table

Yoyo camera results

NBP14-02-Yoyo10 Date: 12 Feb 2014

Time on bottom: 16:51 **Lat on bottom:** -66° 22.50 **Long on bottom:** 120° 3.337 **Depth on bottom:** 602 m

Time at end: 17:24 **Lat at end:** -66° 22.213 **Long at end:** 120° 4.328 **Depth at end:** 587 m

X = dominant; x = sub-dominant; p = present

Image/Time	DSC0009_16:52	DSC0010_16:56	DSC0011_16:56	DSC0012_16:56	DSC0013_16:56	DSC0014_16:58	DSC0015_16:58	DSC0016_16:58	DSC0017_16:59	DSC0018_17:02	DSC0019_17:02	DSC0020_17:03	DSC0021_17:04	DSC0022_17:04	DSC0023_17:05	DSC0024_17:07	DSC0025_17:07	DSC0026_17:08	DSC0027_17:08
Anemone				p				p				p	p				p		
Ascidian						p									p				
Bivalve																			
Brachiopod														p					
Brittle star	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**	**X**	**X**
Bryozoa	x		p					x	x						**X**				p
Crinoid						p			p								p		
Crustacea					p	x		p				p		p					
Fish						p											p		
Gastropod																			
Gorgonian	x		x	p	x	x	x	x	x			p	p						p
Holothurian													p	p		p	p	p	x
Hydroid																			
Octopus																			
Polychaete	p		p									p		p					p
Ray/skate																			
Seapen			p				p						p			p			
Sea spider										p									
Sea star																			
Soft coral																			
Sponge - crust																			
Sponge - hollow																		p	
Sponge - massive			p					p											
Stony coral																			
Urchin	p		p					p			p	p			p				
Worm - other						p										p			
Burrows	**X**	**X**		x		p	**X**	**X**	**X**	**X**	**X**		p	p				**X**	**X**
Sea star imprints	p			p	p	p			p	p		p					p		
muddy/sandy	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
gravel																			
pebble																			
cobble																			
boulders / bedrock																			

NBP14-02-Yoyo10 cont.

Image/Time	DSC0028_17:09	DSC0029_17:09	DSC0030_17:09	DSC0031_17:10	DSC0032_17:11	DSC0033_17:11	DSC0034_17:12	DSC0035_17:12	DSC0036_17:13	DSC0037_17:14	DSC0038_17:15	DSC0039_17:15	DSC0040_17:15	DSC0041_17:16	DSC0042_17:17	DSC0043_17:17	DSC0044_17:18	DSC0045_17:18	DSC0046_17:19
Anemone						p			x	p									
Ascidian				p												p			
Bivalve							p												
Brachiopod																			
Brittle star	X	X	X	X	X	X	X	X	x	X	X	X	X	X	X	X	X	X	X
Bryozoa		p	x		X		p				p	p	p	p			p		p
Crinoid	p											p			p				
Crustacea																			p
Fish												p						p	
Gastropod																			
Gorgonian	p	p	p	p	x	p	p	p		p			x	p	x	p	p		p
Holothurian	p	x		x	p	p	p		p	p	p	p			p	p	x		
Hydroid																			
Octopus																			
Polychaete					p					p	p		p		p				
Ray/skate																			
Seapen		p											p					p	p
Sea spider							p												
Sea star																			
Soft coral																			
Sponge - crust																			
Sponge - hollow																			
Sponge - massive							p												
Stony coral																			
Urchin	p											p						p	
Worm - other																			
Burrows	x	x	X	X	p	X	X	X	X	X	X	X	X	X		X	X	p	X
Sea star imprints	p	p	p	p	p			p				p		p	p				p
muddy/sandy	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
gravel																			
pebble																			
cobble																			
boulders / bedrock																			

NBP14-02-Yoyo10 cont.

Image/Time	DSC0047_17:19	DSC0048_17:20	DSC0049_17:20	DSC0050_17:20	DSC0051_17:21	DSC0055_17:24
Anemone	p	p				
Ascidian						
Bivalve						
Brachiopod						
Brittle star	X	X	X	X	X	X
Bryozoa						p
Crinoid	p					
Crustacea				p		p
Fish						
Gastropod						
Gorgonian			p			p
Holothurian	p	x			p	p
Hydroid						
Octopus						
Polychaete						
Ray/skate						
Seapen						
Sea spider						
Sea star						
Soft coral						
Sponge - crust						
Sponge - hollow						
Sponge - massive						p
Stony coral						
Urchin						
Worm - other						
Burrows	X	X	X	X	X	X
Sea star imprints	p					
muddy/sandy	X	X	X	X	X	X
gravel						
pebble						
cobble						
boulders / bedrock						

NBP14-02-Yoyo20 Date: 17/02/2014

Time on bottom: 16:26 **Lat on bottom:** -66° 23.14 **Long on bottom:** 118° 57.595 **Depth on bottom:** 895 m
Time at end: 17:04 **Lat at end:** -66° 23.331 **Long at end:** 118° 56.529 **Depth at end:** 896 m
X = dominant; x = sub-dominant; p = present

Image/Time	DSC0006_16:26	DSC0007_16:29	DSC0008_16:38	DSC0009_16:39	DSC0010_16:41	DSC0011_16:41	DSC0012_16:42	DSC0013_16:42	DSC0014_16:43	DSC0015_16:44	DSC0016_16:44	DSC0017_16:45	DSC0018_16:45	DSC0019_16:46	DSC0020_16:46	DSC0021_16:47	DSC0022_16:47	DSC0023_16:47	DSC0024_16:48
Anemone			p				p												
Ascidian																			
Bivalve																			
Brachiopod																			
Brittle star	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Bryozoa			p	p	p	p												p	
Crinoid																			
Crustacea							p										p		
Fish	p					p			p										
Gastropod																			
Gorgonian																			
Holothurian																			
Hydroid																			
Octopus																			
Polychaete	p	x	p	p		p		p	p	p	x	x		p		p			p
Ray/skate																			
Seapen																			
Sea spider																			
Sea star																			
Soft coral																			
Sponge - crust																		p	
Sponge - hollow																			
Sponge - massive							p							p				p	
Stony coral																			
Urchin	**X**	p	p	p	x	p	p	p	p	p	p	p	p	p	p	p	p	p	x
Worm - other																			
Burrows	p		x	x	x	p	x	p	p	p	p	p	p	x	p	p	p	p	p
Sea star imprints					p														
muddy/sandy	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
gravel																			
pebble																			
cobble																			
boulders / bedrock																		p	

NBP14-02-Yoyo20 cont.

Image/Time	DSC0025_16:48	DSC0026_16:49	DSC0027_16:49	DSC0028_16:50	DSC0029_16:50	DSC0030_16:50	DSC0031_16:51	DSC0032_16:51	DSC0033_16:51	DSC0034_16:52	DSC0035_16:52	DSC0036_16:52	DSC0037_16:53	DSC0038_16:53	DSC0039_16:53	DSC0040_16:54	DSC0041_16:54	DSC0042_16:54	DSC0043_16:55
Anemone														p					
Ascidian																			
Bivalve																			
Brachiopod											p								
Brittle star	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Bryozoa						p	p		p		p	p	p	p		p			
Crinoid										p									
Crustacea					p					p				p			p		p
Fish																			
Gastropod																			
Gorgonian	p																		
Holothurian															p			p	p
Hydroid																			
Octopus																			
Polychaete		p	p	p		p	x		p	p	p	p	p	p	p	p		x	x
Ray/skate																			
Seapen																			
Sea spider																			
Sea star																			
Soft coral																			
Sponge - crust																			
Sponge - hollow																			
Sponge - massive												p							
Stony coral																			
Urchin	p		p	x	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
Worm - other																			
Burrows	p	p	x	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
Sea star imprints						p				p									
muddy/sandy	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
gravel																			
pebble																			
cobble																			
boulders / bedrock																			

NBP14-02-Yoyo20 cont.

Image/Time	DSC0044_16:56	DSC0045_16:57	DSC0046_16:57	DSC0047_16:58	DSC0048_16:58	DSC0049_16:59	DSC0050_16:59	DSC0051_16:59	DSC0052_17:00	DSC0053_17:00	DSC0054_17:00	DSC0055_17:01	DSC0056_17:01	DSC0057_17:02	DSC0058_17:02	DSC0059_17:02	DSC0060_17:03	DSC0061_17:03	DSC0062_17:03
Anemone															p	p			p
Ascidian					p														
Bivalve											p	p	p	p					
Brachiopod																			
Brittle star	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bryozoa					p								p					p	
Crinoid													p	p					
Crustacea								p					p						
Fish			p												p				
Gastropod																			
Gorgonian																			
Holothurian		p		p	p													p	
Hydroid																			
Octopus																			
Polychaete	p	p	p		p	p	p		p	p		p	x		p	p	x	p	p
Ray/skate																			
Seapen																			
Sea spider			p																
Sea star																			
Soft coral																			
Sponge - crust																			
Sponge - hollow																			
Sponge - massive														p					
Stony coral																			
Urchin	p	p	p			p	p	p		p	p	p		x	p	p	x		p
Worm - other																			
Burrows	p	p	p	p		p		p		p	p				p	p	p		
Sea star imprints										p		p							
muddy/sandy	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
gravel																			
pebble																			
cobble																			
boulders / bedrock																			

NBP14-02-Yoyo20 cont.

Image/Time	DSC0063_17:04	DSC0064_17:04	DSC0065_17:05	DSC0066_17:05	DSC0067_17:05
Anemone					
Ascidian					
Bivalve					
Brachiopod					
Brittle star	X	X	X	X	X
Bryozoa			p		p
Crinoid					
Crustacea					
Fish					
Gastropod					
Gorgonian					p
Holothurian					
Hydroid					
Octopus					
Polychaete	x	p			p
Ray/skate					
Seapen					
Sea spider					
Sea star					
Soft coral					
Sponge - crust					
Sponge - hollow					
Sponge - massive					
Stony coral					
Urchin	x	p		p	p
Worm - other				p	
Burrows		p	p	p	
Sea star imprints					
muddy/sandy	X	X	X	X	X
gravel					
pebble					
cobble					
boulders / bedrock					

NBP14-02-Yoyo34 Date: 24/02/2014

Time on bottom: 12:53 **Lat on bottom:** -66° 20.20 **Long on bottom:** 120° 47.432 **Depth on bottom:** 280 m
Time at end: 13:13 **Lat at end:** -66° 20.172 **Long at end:** 120° 47.966 **Depth at end:** 274 m
X = dominant; x = sub-dominant; p = present

Image/Time	DSC0005_12:54	DSC0006_12:56	DSC0007_12:57	DSC0008_12:57	DSC0009_12:58	DSC0010_12:59	DSC0011_13:01	DSC0012_13:02	DSC0013_13:02	DSC0014_13:02	DSC0015_13:02	DSC0016_13:02	DSC0017_13:03	DSC0018_13:04	DSC0019_13:04	DSC0020_13:05	DSC0021_13:05	DSC0022_13:05	DSC0023_13:05
Anemone	p	p	p	p	p		P			p	p	p				p	p		
Ascidian	p	p	p	p	p		p						p	p	p	x	x		p
Bivalve													p	**X**	p				
Brachiopod	p		p			p	p												
Brittle star	p	**X**	x	x	x	x	x	p	p	p	p	p		p	p	x	p	x	p
Bryozoa	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	x	**X**	**X**	**X**	**X**	**X**
Crinoid	x	p	p	p	p	p	x	p	p	p	p	x	p	p		p	p	x	
Crustacea							p												
Fish																			
Gastropod																			
Gorgonian	p		p	p	p		p	p	p				p						
Holothurian							p					p			p	p		p	p
Hydroid											p	p							
Octopus																			
Polychaete		p					p	p	p	p				p		p	p		p
Ray/skate																			
Seapen																			
Sea spider																			
Sea star																		p	
Soft coral																			
Sponge - crust						p	p	p	p	x	x	x	p						
Sponge - hollow		x	x	x			p	p	p	p	p				p	p		p	
Sponge - massive	**X**	x	p	p	**X**	p		p			p	p	p	p	p	p	p	p	p
Stony coral																			
Urchin	p	p		p		p	p	p		p				p	p	p	p	p	
Worm - other							p			p									p
Burrows																			
Sea star imprints	p																		
muddy/sandy	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
gravel			p	p	p	p	p			p	p	p	p	p	p				
pebble													p						
cobble										p									
boulders / bedrock	p		p	p	p	p	p	p	p		p	p							

NBP14-02-Yoyo34 cont.

Image/Time	DSC0024_13:05	DSC0025_13:06	DSC0026_13:06	DSC0027_13:06	DSC0028_13:07	DSC0029_13:07	DSC0030_13:07	DSC0031_13:08	DSC0032_13:08	DSC0033_13:09	DSC0034_13:09	DSC0035_13:09	DSC0036_13:09	DSC0037_13:10	DSC0038_13:10	DSC0039_13:10	DSC0040_13:11	DSC0041_13:11	DSC0042_13:11
Anemone	p	p	p	p	p	p	p	p									p	p	p
Ascidian	x	x		p			p	p	p	p	p	p	x	p	p	p	p	p	p
Bivalve			p							p	p		p						
Brachiopod					p														
Brittle star	p	p	x	x	x	x		x	x	x	x	x	x	x	x	x	x	p	p
Bryozoa	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Crinoid	p	x	p	p	x			p		p	p	p	p	p	p	p			p
Crustacea																			
Fish																			
Gastropod						p													
Gorgonian			p		p		p	p								p		p	
Holothurian	p	p	p			p			p		p	p	p					p	
Hydroid																			
Octopus																p			
Polychaete	p		p									p		p					
Ray/skate																			
Seapen																			
Sea spider																			
Sea star		p					p				p							p	
Soft coral					p														
Sponge - crust						x	x									p			
Sponge - hollow				p	p		p			p			p	p	p		p		
Sponge - massive	x		x	p		p	p	p	p	p	x	p	p		p	p		p	
Stony coral																p			
Urchin	p	p	p	p	p			p	p	p		p		p	p			p	p
Worm - other										p									
Burrows																			
Sea star imprints								p											
muddy/sandy	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
gravel			p	x	x	x	p		p	p		p	p	p			p		
pebble																			
cobble																			
boulders / bedrock								p							p				

NBP14-02-Yoyo34 cont.

Image/Time	DSC0043_13:12	DSC0044_13:13	DSC0045_13:13	DSC0046_13:13	DSC0047_13:14	DSC0048_13:14	DSC0049_13:14	DSC0050_13:15
Anemone	p		p	p		p	p	
Ascidian	p	p	p		p	X	x	x
Bivalve								
Brachiopod					p			
Brittle star	x	x	x	x	x	x	X	X
Bryozoa	X	X	X	X	X	x	p	
Crinoid	p	p		p	p			p
Crustacea						x		
Fish								
Gastropod								
Gorgonian	p	p	p		p			
Holothurian	p		p	p	p			
Hydroid				p				
Octopus								
Polychaete				p				
Ray/skate								
Seapen								
Sea spider								
Sea star			p	p	p			
Soft coral								
Sponge - crust	x	p		p				
Sponge - hollow			p		p			
Sponge - massive	p	p		X				
Stony coral								
Urchin	p	p			p			p
Worm - other								
Burrows								
Sea star imprints								
muddy/sandy	X	X	X	X	X	X	X	X
gravel						p	p	
pebble								
cobble								
boulders / bedrock	p	p		x	p			

NBP14-02-Yoyo35 Date: 14 February, 2014

Time on bottom: 14:59 **Lat on bottom:** -66° 19.536 **Long on bottom:** 120° 28.871 **Depth on bottom:** 457 m

Time at end: 15:45 **Lat at end:** -66° 19.6802 **Long at end:** 120° 30.4742 **Depth at end:** 469 m

X = dominant; x = sub-dominant; p = present

Note: results for every 2nd image shown here

Image/Time	DSC0006_14:59	DSC0008_15:00	DSC0010_15:00	DSC0012_15:02	DSC0014_15:03	DSC0016_15:03	DSC0018_15:04	DSC0020_15:04	DSC0022_15:05	DSC0024_15:06	DSC0026_15:06	DSC0028_15:07	DSC0030_15:07	DSC0032_15:08	DSC0034_15:08	DSC0036_15:09	DSC0038_15:09	DSC0040_15:10	DSC0042_15:10	DSC0044_15:11
Anemone	x	p	x	p	p	p	p	p	p	p	p	p	p	p	p	p			p	p
Ascidian		p	p			p													p	
Bivalve				p			p													
Brachiopod		p																		
Brittle star	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	X	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	p
Bryozoa		p	p		p	p				p	p	x	x	x	x				p	
Crinoid	p				p	p								p		p				
Crustacea	p	p	p	p	p	p	p		p	p	p	p			p		p	p		p
Fish									p					p	p			p		
Gastropod																				
Gorgonian					x	x	p		p	p	p	p	p	p	p	p		p		
Holothurian				p				p		p	p		p		p	p	p	p	p	p
Hydroid									p											
Octopus																				
Polychaete					p	p	p	p	p	p	p	p		p	p			p	p	p
Ray/skate																				
Seapen																		p		
Sea spider							p	p			p									
Sea star															p					
Soft coral						p											p			
Sponge - crust		p	p		p	p			p	p	p	p	p	p	p					
Sponge - hollow			p																	
Sponge - massive						p			p											
Stony coral		p																		
Urchin	p	p			p		p				p	p						p		p
Worm - other																				
Burrows				p				x	p		p	p			p	p	p	p	p	p
Sea star imprints																				
muddy/sandy	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
gravel										p		p	p	p	p	p			p	
pebble																				
cobble										p										
boulders/bedrock		p	p		p	p			p		p	p	p	p	p				p	

NBP14-02-Yoyo35 cont.

Image/Time	DSC0046_15:11	DSC0048_15:12	DSC0050_15:13	DSC0052_15:13	DSC0054_15:14	DSC0056_15:15	DSC0058_15:15	DSC0060_15:16	DSC0062_15:16	DSC0064_15:17	DSC0066_15:17	DSC0068_15:18	DSC0070_15:18	DSC0072_15:19	DSC0074_15:19	DSC0076_15:19	DSC0078_15:20	DSC0080_15:20	DSC0082_15:20
Anemone	p		p	p		p	p	x	p		p		x	p	p	p	p	p	p
Ascidian														p					p
Bivalve																			
Brachiopod																			
Brittle star	**X**		**X**			**X**	**X**	**X**	**X**	**p**	**X**	**X**	**X**	**p**	**X**	**X**			
Bryozoa						x									p				p
Crinoid															p				
Crustacea		p				p			x	p	p		p	p	p	p	p		p
Fish																			
Gastropod					p				p										
Gorgonian						p	p								p				p
Holothurian		p	p	p	p	x	p	p	p	p	p	p		p	p	p	p		p
Hydroid																			
Octopus				p															
Polychaete	p		p	p	p	p	p	p	p	p		p		p	p		p	p	
Ray/skate																			
Seapen			p																
Sea spider		p						p											
Sea star															p				
Soft coral																			
Sponge - crust						p													p
Sponge - hollow																			
Sponge - massive															p		p		
Stony coral																			
Urchin		p	p			p										p	p	p	p
Worm - other																			
Burrows	p	p	p	p	p		x	p	p	p	p	p		**X**		p	p	p	p
Sea star imprints								p				p							
muddy/sandy	**p**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
gravel																	?beneath mud??		
pebble																			
cobble	p					p				p									p
boulders/bedrock						p									p				

NBP14-02-Yoyo35 cont.

Image/Time	DSC0084_15:21	DSC0086_15:21	DSC0088_15:22	DSC0090_15:22	DSC0092_15:23	DSC0094_15:24	DSC0096_15:24	DSC0098_15:24	DSC0100_15:24	DSC0102_15:25	DSC0104_15:25	DSC0106_15:25	DSC0108_15:26	DSC0110_15:26	DSC0112_15:26	DSC0114_15:27	DSC0116_15:27	DSC0118_15:27	DSC0120_15:28
Anemone	p	p	p	p				p	p	p	p	p	p		p	p	p	p	p
Ascidian						p					p	p		p		p	p		
Bivalve																			
Brachiopod										p		p			p				
Brittle star	**X**	**X**	**X**		**X**		**X**	p	**p**	**X**		**X**	**X**			**X**	**X**	**X**	
Bryozoa		p	x							x	p	x	x	p	p	x	**X**		
Crinoid			p			p				p			p	p		p	p		
Crustacea	p		p	p					p	p		p	p				p		p
Fish										p		p							
Gastropod																			
Gorgonian		p	p				p		p	p		p	p	p	p	p	p		p
Holothurian	p		p	p	p	p	p	p		p	p		p		p	p			p
Hydroid																p			
Octopus																			
Polychaete			p	p	p	p	p		p	p	p	p		p		p			p
Ray/skate																			
Seapen																			
Sea spider													p	p	p				
Sea star							p												
Soft coral																			
Sponge - crust			p				p			p		p	p		p	p	p		
Sponge - hollow																	p		
Sponge - massive																p	p		
Stony coral																p			
Urchin				p		p		p		p	p	p		p	p				
Worm - other																			
Burrows	p			p	p	p	p		p		p		p		p			p	p
Sea star imprints																			
muddy/sandy	**X**	**X**	**X**	**p**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
gravel		?	x			p	p			p		x	x	x	p	p	p		p
pebble																			
cobble			p			p	p			p	p		p	p	p	p	p		
boulders/bedrock			p							p		p	p			x	x		

NBP14-02-Yoyo35 cont.

Image/Time	DSC0122_15:28	DSC0124_15:29	DSC0126_15:29	DSC0128_15:30	DSC0130_15:30	DSC0132_15:30	DSC0134_15:31	DSC0136_15:31	DSC0138_15:31	DSC0140_15:32	DSC0142_15:32	DSC0144_15:32	DSC0146_15:33	DSC0148_15:33	DSC0150_15:34	DSC0152_15:34	DSC0154_15:34	DSC0156_15:35	DSC0158_15:35
Anemone	p	p	p	p	p	p	p	p	p		p	x		p	p	p		p	p
Ascidian			p			p			p					p		p			
Bivalve																			
Brachiopod																			
Brittle star			X	X	p	p	X	p	X	X	X	X	p	X	X	X	p	X	X
Bryozoa			x	p		p			p	p					p	p			x
Crinoid			p												p	p			p
Crustacea	p	p	p	p	p		p		p	p	p			p	p		p		
Fish																			
Gastropod																			
Gorgonian	p		x	p		p			p	p					p	p		p	x
Holothurian		p	p	p	p	p	p	p	p	p	p	p	p	p	p		p		p
Hydroid												p							
Octopus																			
Polychaete			p	p		p			p	p		p	p		p	p			p
Ray/skate																			
Seapen	p																		
Sea spider			p	p											p		p	p	
Sea star	p	p																	p
Soft coral																			
Sponge - crust			p						p							p			
Sponge - hollow																			
Sponge - massive			p			p			p	p					p				p
Stony coral																			
Urchin		p	p				p	p	p	p	p	p		p	p	p	p	p	p
Worm - other																			
Burrows		p		p	p			p	p	p	p	p	p	p	p	p	p		p
Sea star imprints																			
muddy/sandy	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	x
gravel	p		x			p	p		p		p	p		x	x	p	p		p
pebble																			
cobble				p		p			p						p	p			x
boulders/bedrock			p			p			p							p			X

NBP14-02-Yoyo35 cont.

Image/Time	DSC0160_15:35	DSC0162_15:36	DSC0164_15:36	DSC0166_15:36	DSC0168_15:37	DSC0170_15:37	DSC0172_15:37	DSC0174_15:38	DSC0176_15:38	DSC0178_15:38	DSC0180_15:39	DSC0182_15:39	DSC0184_15:39	DSC0186_15:40	DSC0188_15:40	DSC0190_15:41	DSC0192_15:41	DSC0194_15:41	DSC0196_15:42
Anemone	p	p		p	p	p	p	x	p	p	p	p	p	p	p	p	p	p	p
Ascidian				p									p		p				p
Bivalve																			
Brachiopod												p							
Brittle star		X	X	X	p	X	X	X		p	X	X	X	X	X	X	X	X	X
Bryozoa					p		x					p	p	p	x	x	x	p	
Crinoid			p				p					p							
Crustacea	p	p	p	p			p		p			p	p		p	p			
Fish													p						
Gastropod																			
Gorgonian							p				p		p	p		p	p	p	
Holothurian		p	p		p		p		p		p	p	p	p	p	p	p	p	p
Hydroid																			
Octopus																			
Polychaete	p					p			p	p	p		p	p	p				
Ray/skate																			
Seapen			p							p									
Sea spider					p								p		p			p	
Sea star																	p	p	
Soft coral																			
Sponge - crust												p							
Sponge - hollow			p				p										p		
Sponge - massive																			
Stony coral																			
Urchin	p					p	p	p	p	p	x	p	p	p		p		p	p
Worm - other																			
Burrows	p	p		p	p	p		p	p		p	p	p	p	p	p	p	p	p
Sea star imprints																			
muddy/sandy	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
gravel						p		p			p	p	p	p	p	p			
pebble																			
cobble													p		p		x		
boulders/bedrock					p		p					p		p					

NBP14-02-Yoyo35 cont.

Image/Time	DSC0198_15:42	DSC0200_15:43	DSC0202_15:43	DSC0204_15:43	DSC0206_15:44	DSC0208_15:44	DSC0210_15:44	DSC0212_15:45	DSC0214_15:45	DSC0216_15:45
Anemone	p		p	p	p	p			p	
Ascidian										
Bivalve										
Brachiopod				p			p			
Brittle star	X	X	X	X	X	X	X	X	x	X
Bryozoa						p	X		p	
Crinoid						p	p			
Crustacea	p	p	p	p	p	p		p		
Fish				p						
Gastropod										
Gorgonian	p					x	x			
Holothurian		p					p	p	p	
Hydroid										
Octopus										
Polychaete	p		p	p			p			
Ray/skate										
Seapen				p					p	
Sea spider										
Sea star					p					
Soft coral										
Sponge - crust										
Sponge - hollow										
Sponge - massive										
Stony coral										
Urchin		p	p	p			p		p	p
Worm - other										
Burrows	p	p	x	p	p		p	X	X	p
Sea star imprints										
muddy/sandy	X	X	X	X	X	X	X	X	X	X
gravel				p		p	x			
pebble										
cobble				p		p				
boulders/bedrock										

NBP14-02-Yoyo36 **Date:** 14 February, 2014

Time on bottom: 16:52 **Lat on bottom:** -66° 16.364 **Long on bottom:** 120° 35.224 **Depth on bottom:** 459 m
Time at end: 17:25 **Lat at end:** -66° 16.605 **Long at end:** 120° 36.098 **Depth at end:** 429 m
X = dominant; x = sub-dominant; p = present

Image/Time	DSC0221_16:54	DSC0222_16:54	DSC0223_16:55	DSC0224_16:56	DSC0225_16:57	DSC0226_16:57	DSC0227_16:57	DSC0228_16:58	DSC0229_16:58	DSC0230_16:58	DSC0231_16:58	DSC0232_16:59	DSC0233_16:59	DSC0234_17:00	DSC0235_17:00	DSC0236_17:00	DSC0237_17:01	DSC0238_17:01	DSC0239_17:02
Anemone	p	**X**	**X**	x	x	x	**X**	**X**	**X**	x			**X**	x	**X**	p	**X**	p	x
Ascidian											p							p	
Bivalve															p				
Brachiopod																			
Brittle star	**X**	p	**X**	**X**	**X**	x	x	x	p	**X**	**X**	p	x	**X**	x	x	p	**X**	**X**
Bryozoa	p	p							p	p		p		p	p			x	
Crinoid		p	p												p				
Crustacea	p				p									p			p		
Fish											p			p					
Gastropod								p		p									
Gorgonian	p	p					p		p	p	p			p				x	
Holothurian				p					p	x		p				p	p		p
Hydroid																			
Octopus																			
Polychaete		p			p			p				p	x	p		p		x	
Ray/skate																			
Seapen																	p		
Sea spider																			
Sea star																	p	x	
Soft coral																			
Sponge - crust				p						p					p			x	x
Sponge - hollow																			
Sponge - massive		p		p						p					p				
Stony coral									p									p	
Urchin	p	p	p			p	p				p						p	p	x
Worm - other																			
Burrows					p	**X**	**X**				p			p	p	**X**	p		
Sea star imprints	p																		
muddy/sandy	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
gravel																		p	
pebble																			
cobble				p															p
boulders / bedrock															p			p	

NBP14-02-Yoyo36 cont.

Image/Time	DSC0240_17:02	DSC0241_17:02	DSC0242_17:02	DSC0243_17:03	DSC0244_17:03	DSC0245_17:04	DSC0246_17:04	DSC0247_17:04	DSC0248_17:05	DSC0249_17:05	DSC0250_17:06	DSC0251_17:06	DSC0252_17:06	DSC0253_17:07	DSC0254_17:07	DSC0255_17:08	DSC0256_17:08	DSC0257_17:08	DSC0258_17:09
Anemone	p	x	p	X	x	X	X	p	X	X	p	p	p	p			p	X	X
Ascidian					p									p				p	
Bivalve																			
Brachiopod													p						
Brittle star	X	X	x	p	X	x	x	X	x	x	x	X		p	X	X	X	x	p
Bryozoa		p		p							p			p	X				
Crinoid												p							
Crustacea							p												
Fish																			p
Gastropod																			
Gorgonian				p	p	p			p		p	p	p						
Holothurian		p	x	x				p	p	p	p	p	p	p	p	x	x	x	
Hydroid																			
Octopus																			
Polychaete		x	p		p	p	p				p	p	p		p	p	p	p	p
Ray/skate																			
Seapen																			p
Sea spider					p								p			p	p		
Sea star										p									
Soft coral														p					
Sponge - crust											X			X					
Sponge - hollow																p			
Sponge - massive														x					
Stony coral												p							
Urchin	p					x	x			p	p	p	p				p		x
Worm - other																			
Burrows		p	X	p	x		p		p		p		p			p	p		
Sea star imprints																			
muddy/sandy	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
gravel																p	p		
pebble																			
cobble																			
boulders / bedrock											p			p					

NBP14-02-Yoyo36 cont.

Image/Time	DSC0259_17:09	DSC0260_17:10	DSC0261_17:10	DSC0262_17:10	DSC0263_17:11	DSC0264_17:11	DSC0265_17:12	DSC0266_17:12	DSC0267_17:12	DSC0268_17:12	DSC0269_17:13	DSC0270_17:13	DSC0271_17:13	DSC0272_17:14	DSC0273_17:14	DSC0274_17:15	DSC0275_17:15	DSC0276_17:15	DSC0277_17:16
Anemone	X	X	X	p		p	p		p				p	p	p	p	p	p	
Ascidian															p			p	
Bivalve																			
Brachiopod												X		p	p			p	p
Brittle star	p	x	x	p	p	X	X	X	p	X	p	X	X	X	X	p	X	X	X
Bryozoa	p	p	X	p				p			p	p		p	X	p	p	x	p
Crinoid												p		p				p	
Crustacea							p		p	p			p			p			
Fish									p										
Gastropod																			
Gorgonian		p	p	p								p		p	p		p	p	p
Holothurian	p	p	p	p		p	p	p		p	p			p		p		p	p
Hydroid																			
Octopus																			
Polychaete			p						p									p	
Ray/skate																			
Seapen																			
Sea spider																			
Sea star												p		p					
Soft coral														p	p			p	
Sponge - crust		p	p					p			p	p		x	x			x	p
Sponge - hollow												p		p	p				
Sponge - massive		p									p				p		p		
Stony coral																		p	
Urchin						p		p	p	p	p	p	p		p	p	x	p	p
Worm - other																			
Burrows	p	p			p		p	p		p						p			p
Sea star imprints					p			p										p	
muddy/sandy	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
gravel			p							p	p	p	p		x		p	p	p
pebble																			
cobble											p	p							
boulders / bedrock								p				p		x	x			p	p

NBP14-02-Yoyo36 cont.

Image/Time	DSC0279_17:16	DSC0280_17:17	DSC0281_17:17	DSC0282_17:17	DSC0283_17:17	DSC0284_17:18	DSC0285_17:18	DSC0286_17:18	DSC0287_17:18	DSC0288_17:18	DSC0289_17:19	DSC0290_17:19	DSC0291_17:19	DSC0292_17:20	DSC0293_17:20	DSC0294_17:20	DSC0295_17:21	DSC0296_17:21	DSC0297_17:21
Anemone	p	p	p	p	p	p	p	p	p		p		p	p	p	p	p	p	p
Ascidian		p	p		p				p		p					p			
Bivalve																			
Brachiopod					p	p								p	p			p	
Brittle star	X	X	X	p	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bryozoa		p		p	x	x	x	p	p		p	p	p	p	x	x	p	x	x
Crinoid	p					p							p	p					
Crustacea																	p		p
Fish		p			p										p				
Gastropod																		p	
Gorgonian	x	p		p	x	x	x	x	p		x	p	p	p	p	X	p	p	p
Holothurian			p		p							p				p		p	p
Hydroid		p								p	p		p	p		p		p	p
Octopus																			
Polychaete	p									p	p			p					p
Ray/skate																			
Seapen			p																
Sea spider																			
Sea star						p													
Soft coral																		p	p
Sponge - crust	p	p	p			p	p	p	p		x			p	p	p	p	p	p
Sponge - hollow											p								
Sponge - massive	p					p	p						p		p	p		p	
Stony coral							p												
Urchin	p	p	p	p	p	p	p		p	p		p	p		p	p	p	p	p
Worm - other																			
Burrows		p	p	p						p		p							
Sea star imprints												p							
muddy/sandy	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
gravel	p				p	p	p	p	p	p	p	p	p	x	p	x	x	x	x
pebble																			
cobble			p		p	p									p				p
boulders / bedrock	x	p			p		p	p	p		p			p		p	p	p	

NBP14-02-Yoyo36 cont.

Image/Time	DSC0298_17:22	DSC0299_17:22	DSC0300_17:22	DSC0301_17:23	DSC0302_17:23	DSC0303_17:23	DSC0304_17:24	DSC0305_17:24	DSC0306_17:24
Anemone		p	p		p	p	p		p
Ascidian									
Bivalve									
Brachiopod		p			p				
Brittle star	X	X	X	X	X	X	X	X	X
Bryozoa	p		p		p		p	p	p
Crinoid									
Crustacea			p		p	p		p	
Fish			p						p
Gastropod									
Gorgonian	p	p	p	p	p	p	p	p	p
Holothurian	p		p	p		p	p	p	p
Hydroid	p	p	p						
Octopus									
Polychaete								p	p
Ray/skate									
Seapen									
Sea spider									
Sea star				p					
Soft coral		p							
Sponge - crust		p				p			
Sponge - hollow									
Sponge - massive			p	p	p				
Stony coral									
Urchin		p	p		p	p		p	p
Worm - other									
Burrows	p								
Sea star imprints									
muddy/sandy	X	X	X	X	X	X	X	X	X
gravel	p	p	x	x	x	p	x	x	p
pebble									
cobble						p			
boulders / bedrock		p							

NBP14-02-Yoyo40 Date: 25 February, 2014

Time on bottom: 06:05 **Lat on bottom:** -66° 26.693 **Long on bottom:** 119° 54.201 **Depth on bottom:** 697 m
Time at end: 06:36 **Lat at end:** -66° 26.804 **Long at end:** 119° 54.894 **Depth at end:** 683 m
X = dominant; x = sub-dominant; p = present

Image/Time	DSC0014_06:06	DSC0015_06:07	DSC0016_06:07	DSC0017_06:08	DSC0018_06:09	DSC0019_06:09	DSC0020_06:13	DSC0021_06:13	DSC0022_06:13	DSC0023_06:14	DSC0024_06:14	DSC0025_06:15	DSC0026_06:15	DSC0027_06:15	DSC0028_06:16	DSC0029_06:16	DSC0030_06:16	DSC0031_06:17	DSC0032_06:17
Anemone	p		p	p	p	p	p		p				p			p		p	p
Ascidian																			
Bivalve																			
Brachiopod																			
Brittle star	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	p
Bryozoa																			
Crinoid																			
Crustacea	p	p	p				p					p	p		p	p	p	p	p
Fish											p								
Gastropod																			
Gorgonian	p	p	p	x	x	p		p	x	p		p	x	x	p	p	x	p	x
Holothurian	p	p	p	p			p					p	x	p	x	p	p	x	p
Hydroid																			
Octopus																			
Polychaete	p	p	p	p	p	p			p		p			p			p		
Ray/skate																			
Seapen																			
Sea spider	p	p	p			p						p						p	
Sea star																			
Soft coral																			
Sponge - crust																			
Sponge - hollow																			
Sponge - massive																			
Stony coral																			
Urchin						p	x	p	p		p			p		p			p
Worm - other																			
Burrows								p				p		p		p		p	p
Sea star imprints								p	p	p									p
muddy/sandy	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
gravel																			
pebble																			
cobble																			
boulders / bedrock																			

NBP14-02-Yoyo40 cont.

Image/Time	DSC0033_06:18	DSC0034_06:18	DSC0035_06:18	DSC0036_06:19	DSC0037_06:19	DSC0038_06:20	DSC0039_06:20	DSC0040_06:20	DSC0041_06:21	DSC0042_06:21	DSC0043_06:22	DSC0044_06:22	DSC0045_06:22	DSC0046_06:24	DSC0047_06:25	DSC0048_06:25	DSC0049_06:25	DSC0050_06:26	DSC0051_06:26
Anemone	p	p								p					p				p
Ascidian																			
Bivalve																			
Brachiopod																			
Brittle star	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bryozoa																			
Crinoid																			
Crustacea		p	p		p			p			p		p		p				
Fish																	p		
Gastropod																			
Gorgonian	x	p	p	x	p	p	p	p	x	p			p	p	p	x		p	p
Holothurian	x	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
Hydroid																			
Octopus																			
Polychaete		p	x	p	p			p	p	p	p	p		p	p		p	p	p
Ray/skate																			
Seapen																			
Sea spider								p						p				p	
Sea star																			
Soft coral								p											
Sponge - crust																			
Sponge - hollow	p																		
Sponge - massive																			
Stony coral																			
Urchin				p				p	p	p		p		p	p		p		p
Worm - other																			
Burrows	p	p	p		p				p	p	p	p		p		p	p	p	
Sea star imprints		p						p									p		
muddy/sandy	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
gravel																			
pebble																			
cobble																			
boulders / bedrock																			

NBP14-02-Yoyo40 cont.

Image/Time	DSC0053_06:27	DSC0054_06:27	DSC0055_06:27	DSC0056_06:28	DSC0057_06:28	DSC0058_06:28	DSC0059_06:29	DSC0060_06:29	DSC0061_06:29	DSC0062_06:30	DSC0063_06:30	DSC0064_06:30	DSC0065_06:31	DSC0066_06:31
Anemone														
Ascidian	p	p	p		p	p	p							
Bivalve														
Brachiopod														
Brittle star	X	X	X	X	X	X	X	X	X	X	X	p	p	X
Bryozoa														
Crinoid	p		p											
Crustacea	p		p	p				p		p	p			p
Fish		p							p					
Gastropod														
Gorgonian		p		p			p		p	p				p
Holothurian	p	p	p	p	p	p	p	p	p	p	x	p	p	x
Hydroid												p		
Octopus					p									
Polychaete	p		p		p	p	p				p	p	p	
Ray/skate														
Seapen														
Sea spider										p				p
Sea star														
Soft coral														
Sponge - crust														
Sponge - hollow														
Sponge - massive														
Stony coral	p													
Urchin	p			p	p	p				p				p
Worm - other														
Burrows		p	p			p		p				p	p	p
Sea star imprints		p	p	p	p			p	p				p	
muddy/sandy	X	X	X	X	X	X	X	X	X	X	X	X	X	X
gravel														
pebble														
cobble														
boulders / bedrock														

NBP14-02-Yoyo47 **Date:** 3 March, 2014

Time on bottom: 13:58 **Lat on bottom:** -66° 35.619 **Long on bottom:** 120° 13.234 **Depth on bottom:** 339 m
Time at end: 14:24 **Lat at end:** -66° 35.519 **Long at end:** 120° 14.334 **Depth at end:** 340 m
X = dominant; x = sub-dominant; p = present

Image/Time	DSC0020_14:01	DSC0021_14:02	DSC0022_14:07	DSC0023_14:07	DSC0024_14:07	DSC0025_14:08	DSC0026_14:09	DSC0027_14:09	DSC0028_14:10	DSC0029_14:10	DSC0030_14:13	DSC0031_14:18	DSC0032_14:18	DSC0033_14:18	DSC0034_14:19	DSC0035_14:20	DSC0036_14:20	DSC0037_14:20	DSC0038_14:21
Anemone		p		p		p	p				p	p				p		p	
Ascidian	p	p	p	p		p	p	p	p	p	p		p	p	p	p	p	p	p
Bivalve																			
Brachiopod	p	p							p		p					**X**	p		p
Brittle star	**X**	x	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	x	x	x	**X**	x	**X**	x	x
Bryozoa	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Crinoid	p		p	p		p			p			p	p		p		p		p
Crustacea									p										
Fish			p		p	p	p		p			p			p	p	p		p
Gastropod		p																	
Gorgonian		p	p	p		p	p	p	p				p		p				p
Holothurian	p	p		p		p	p	p	p				p			p			p
Hydroid												p							
Octopus																			
Polychaete	p	x	x	x	x	p	p	p	p	p	p	p						p	
Ray/skate																			
Seapen															p				
Sea spider																			
Sea star	p						p		p	p			p	p	p		p		
Soft coral																			
Sponge - crust																	p	p	p
Sponge - hollow	p	p	p	x	p	p	x	p	x	p	x	p	p	p	p	x	x		p
Sponge - massive	x	**X**	p	p	x		p	p		x	x		x	p		p	x	x	x
Stony coral																		p	
Urchin			p	p	p	p		p	p		p			p			p	p	p
Worm - other																			
Burrows																			
Sea star imprints																			
muddy/sandy	**X**	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**	**X**	x	x	x	p	p	p	x	x
gravel	p						p				p	**X**	**X**	**X**				p	**X**
pebble																			
cobble						p			x	x			p	p		x	x	**X**	p
boulders / bedrock				x		p	p					p			**X**	**X**	**X**		

NBP14-02-Yoyo47 cont.

Image/Time	DSC0039_14:21	DSC0040_14:21	DSC0041_14:21	DSC0042_14:21	DSC0043_14:21	DSC0044_14:21	DSC0047_14:24
Anemone	p		p		p		
Ascidian	p	p	p	p	p	p	p
Bivalve							
Brachiopod	p	p		p			
Brittle star	x	x	x		X	x	x
Bryozoa	X	X	X		X	X	X
Crinoid	p	x	p		p		p
Crustacea							
Fish		p					
Gastropod		p					
Gorgonian	p	p	p	p	p	p	
Holothurian					p		
Hydroid			p	p			
Octopus							
Polychaete	p		p		p		
Ray/skate							
Seapen							
Sea spider							
Sea star							
Soft coral							
Sponge - crust			p				p
Sponge - hollow	p	p		p	p		
Sponge - massive	x	p	p	p	p	p	p
Stony coral							
Urchin				p	p		p
Worm - other							
Burrows							
Sea star imprints							
muddy/sandy	p	x	p	x	p	x	p
gravel	x	X	X	X	X	X	
pebble							
cobble		p	x	p			x
boulders / bedrock	X						X

NBP14-02-Yoyo49 Date: 3 March, 2014

Time on bottom: 16:25 **Lat on bottom:** -66° 36.693 **Long on bottom:** 120° 10.403 **Depth on bottom:** 444 m

Time at end: 16:49 **Lat at end:** -66° 35.706 **Long at end:** 120° 10.978 **Depth at end:** 497 m

X = dominant; x = sub-dominant; p = present

Note: only every 2nd image analysed

Image/Time	DSC0072_16:26	DSC0074_16:27	DSC0076_16:28	DSC0078_16:29	DSC0080_16:29	DSC0082_16:30	DSC0084_16:30	DSC0086_16:31	DSC0088_16:32	DSC0090_16:32	DSC0092_16:34	DSC0094_16:36	DSC0096_16:38	DSC0098_16:39	DSC0100_16:40	DSC0102_16:41	DSC0104_16:42	DSC0106_16:43	DSC0108_16:43
Anemone			p	p			p	p	p	p	p								
Ascidian			p	p	p	p	p	p	p	p	p	p							
Bivalve																			
Brachiopod		p	x	p	p	x	x	X	x	X	X	X	x	X	x	x	x	p	p
Brittle star	X	X	X	x	X	x	X	x	x	x	x	x	X	x	X	X	X	X	X
Bryozoa	p	p	p	X	x	X	x	X	X	x	x	p	p	p	p	p	p	p	p
Crinoid			p	p				p	p	p		p							
Crustacea	x		p				p							p			p		
Fish				p															
Gastropod	p									p									p
Gorgonian		p	p	p	p	p	p	p	p	p		p	p		p	p	p	p	p
Holothurian	p					p								p					p
Hydroid							p												
Octopus																			
Polychaete	p	p		p	p			p	p	p		p		p	p			p	p
Ray/skate																			
Seapen	p																		
Sea spider															p			p	p
Sea star							p	p	p	p									p
Soft coral									p										p
Sponge - crust				p	p	p	p	p	p	p	p	p	p	p	p		p		p
Sponge - hollow				p				p		p		p							
Sponge - massive			p	p	p	p	p	p	p		p	p	p		p				p
Stony coral																			
Urchin		p	p			p		p		p	p	p			p			p	
Worm - other																			
Burrows	p	p	p																
Sea star imprints																			
muddy/sandy	X	p	X		x	X	X	p							p	x	x	X	
gravel				p	X	x	x	X	X	X	x	x	X	X	x	X	X	p	X
pebble																			
cobble			p	X				p	x	p	p		x	x			p	x	x
boulders / bedrock			p	x		p	p		p	x	X	X	p	p	X				p

NBP14-02-Yoyo49 cont.

Image/Time	DSC0110_16:44	DSC0112_16:45	DSC0114_16:45	DSC0116_16:46	DSC0118_16:47	DSC0120_16:47	DSC0122_16:48	DSC0124_16:49	DSC0126_16:49
Anemone	p								
Ascidian	p				p	p		p	p
Bivalve									
Brachiopod	p	p							
Brittle star	X	X	X	X	X	X	p	X	X
Bryozoa	p				p		p	p	
Crinoid									
Crustacea	p	p			p		p		
Fish			p					p	p
Gastropod									
Gorgonian					p			p	
Holothurian	p	p	p						
Hydroid									
Octopus									
Polychaete				p				p	p
Ray/skate									
Seapen									
Sea spider	p	p	x	x	p	x	p	x	x
Sea star									
Soft coral									
Sponge - crust							p		
Sponge - hollow			p				p		
Sponge - massive							p	p	
Stony coral									
Urchin			p	p		p			p
Worm - other									
Burrows									
Sea star imprints									
muddy/sandy	x	X	X	X	X	p	X	X	X
gravel	X			x		X		p	p
pebble									
cobble	p	x		p	p	x	p	p	
boulders / bedrock									

NBP14-02-Yoyo50 Date: 3 March, 2014

Time on bottom: 19:53 **Lat on bottom:** -66° 19.444 **Long on bottom:** 120° 27.619 **Depth on bottom:** 454 m

Time at end: 20:25 **Lat at end:** -66° 19.334 **Long at end:** 120° 28.397 **Depth at end:** 457 m

X = dominant; x = sub-dominant; p = present

Image/Time	DSC0014_19:53	DSC0015_19:54	DSC0016_19:54	DSC0017_19:54	DSC0018_19:54	DSC0019_19:55	DSC0020_19:55	DSC0021_19:55	DSC0022_19:55	DSC0023_19:56	DSC0024_19:56	DSC0025_19:56	DSC0026_19:56	DSC0027_19:57	DSC0028_19:57	DSC0029_19:57	DSC0030_19:57	DSC0031_19:57	DSC0032_19:57
Anemone											p	x	p	p	p	p		p	p
Ascidian													p	p					p
Bivalve																			
Brachiopod								p	p	p	p								
Brittle star	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	x	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Bryozoa	p	p	p	p	p	p	p	p	**X**	**X**	p		x	p	p	p	p		p
Crinoid																			
Crustacea	p							p								p	p	p	p
Fish																p	p		
Gastropod																			
Gorgonian							p	p	x	x	p		p	p	p	p	p		p
Holothurian	x	p	p	p	p							p		p				p	
Hydroid	p											p							
Octopus																			
Polychaete	p	p	p	p	p	p	p	p	p	p	p	p	p			p			p
Ray/skate																			
Seapen																			
Sea spider											p								p
Sea star													p	p	p				
Soft coral																			
Sponge - crust										p	p		p	p					p
Sponge - hollow																			
Sponge - massive													p	p	p	p			
Stony coral																			
Urchin		p	p	p	p	p	p	p	p	p	p		p	p	p	p		p	p
Worm - other																			
Burrows	p	p	p	p	p	p	p	p	p	p	p	x	p	p	p	p	p	p	p
clam burrows																p			
Sea star imprints																p	p		
muddy/sandy	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
gravel	p	p	p	p	p	p	p	p	p	p	p		p		p	p	p	p	p
pebble												p							
cobble									p	p	p			p	p	p			
boulders / bedrock													p						p

NBP14-02-Yoyo50 cont.

Image/Time	DSC0033_19:57	DSC0034_19:58	DSC0035_19:58	DSC0036_19:58	DSC0037_19:59	DSC0038_19:59	DSC0039_19:59	DSC0040_19:59	DSC0041_19:59	DSC0042_20:00	DSC0043_20:00	DSC0044_20:00	DSC0045_20:00	DSC0046_20:00	DSC0047_20:01	DSC0048_20:01	DSC0049_20:01	DSC0050_20:01	DSC0051_20:02
Anemone	p		p		p	p	p		p	p			p		p	p			
Ascidian	p			p			p	p					p						
Bivalve																			
Brachiopod				p	p	p		p									p		p
Brittle star	X	X	X	X	X	X		X	X		X	X	X	X	X	X	X		X
Bryozoa	p	p	p	x	x	x	x	p		p	p		x	p		p	p		x
Crinoid				p	p	p		p					p		p		p		
Crustacea					p	x	p	p	p	p					p	p	p	p	p
Fish				p	p	p		p		p	p								
Gastropod				p															
Gorgonian	p			p	p	p		p			p	p	p	p		p	p		p
Holothurian	p			p	p	p	p	p	p	p	p			p		p	p		
Hydroid																			
Octopus																			
Polychaete	p	p	p		p	p	p	p		p					p				
Ray/skate																			
Seapen				p															
Sea spider	p			p	p	p													
Sea star			p															p	
Soft coral																			
Sponge - crust	p			p	p	p	p				p		p				p		x
Sponge - hollow																			
Sponge - massive													p						
Stony coral																			
Urchin	p	p	p	p	p	p	x							p	p	p		p	
Worm - other																			
Burrows	p			p					p			p	p	p	p	p	p	p	p
clam burrows		x	x																
Sea star imprints																			
muddy/sandy	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
gravel	p	p		p	p	p	x	p					x	p					
pebble																			
cobble				p	x	x		p		p						p	p		p
boulders / bedrock	p												p						

NBP14-02-Yoyo50 cont.

Image/Time	DSC0052_20:02	DSC0053_20:04	DSC0054_20:04	DSC0055_20:07	DSC0056_20:08	DSC0057_20:08	DSC0058_20:09	DSC0059_20:09	DSC0060_20:10	DSC0061_20:11	DSC0062_20:12	DSC0063_20:13	DSC0064_20:13	DSC0065_20:14	DSC0066_20:14	DSC0067_20:14	DSC0068_20:14	DSC0069_20:15	DSC0070_20:15
Anemone	p	p		p	p		p	x		p	p		p	p	p	p		p	
Ascidian	p	p			p			p	p							p	p	p	
Bivalve		p																	
Brachiopod				p	p				p	p			x				p		
Brittle star	X	X	X	X	X	X	X	x	X	X	p	X	X	X	X	X			X
Bryozoa	p		p	p	x	p	p	X	x	x		p	p	x	p	p		x	
Crinoid		x		p	p			p	p				p					p	
Crustacea	p			p		p	p	p		p							p		
Fish													p						
Gastropod																			
Gorgonian	p	p		p	p	p	x	p	p	p			x	p		p	p	p	
Holothurian				p		p								p	p				
Hydroid								p	p										
Octopus														p	p				
Polychaete	p	p	p		p	p		p	p	p			p	p	p		p	p	p
Ray/skate																			
Seapen																			
Sea spider			p				p		p							p	p		
Sea star				p	p						p								
Soft coral																			
Sponge - crust	p																p		
Sponge - hollow																			
Sponge - massive		p			p									p					
Stony coral																			
Urchin	p	p	p	p		p	p	p		p		p		p	p	p	p		
Worm - other																			
Burrows	p	p	p	p		p					p	p	p	p			p		p
clam burrows																			
Sea star imprints																			
muddy/sandy	X	X	X	X	x	X	X	x	X	X	X	X	X	X	X	X	X	X	X
gravel	p					p	x	p	x	x									
pebble																			
cobble	p	p		p	X			X	p					p	p		p	p	
boulders / bedrock		p			p								p						

NBP14-02-Yoyo50 cont.

Image/Time	DSC0071_20:15	DSC0072_20:15	DSC0073_20:16	DSC0074_20:16	DSC0075_20:16	DSC0076_20:16	DSC0077_20:16	DSC0078_20:17	DSC0079_20:17	DSC0080_20:17	DSC0081_20:18	DSC0082_20:18	DSC0083_20:19	DSC0084_20:19	DSC0085_20:20	DSC0086_20:20	DSC0087_20:21	DSC0088_20:21	DSC0089_20:21
Anemone						p	p	p		p	p		p	p	p	p	p	p	p
Ascidian						p	p	p	p				p						
Bivalve																			
Brachiopod					p	p	p						p			p			
Brittle star	X	X	X	X		X	X		X	X	X	X		X	X	X		X	X
Bryozoa	p	p			X	x	x		p	p	x		p			p			
Crinoid		p				p	p						p		p		p		
Crustacea	p			p	p	p	p				p	p	p						
Fish					p			p	p				p			p			
Gastropod																			
Gorgonian				p	p	p	p	p	p	p	p		p		p	p	p		
Holothurian	p										p				p			p	p
Hydroid																			
Octopus																			
Polychaete	p					p		p	p		p		p		p		p	p	p
Ray/skate																			
Seapen																			
Sea spider			p							p		p				p			
Sea star					p												p		
Soft coral																			
Sponge - crust										p									
Sponge - hollow																			
Sponge - massive																	p		
Stony coral							p												
Urchin						p	p			p	p	p	p	p		p	p	p	p
Worm - other																			
Burrows	p	p	p	p				p	p		p	p		p	p	p	p	p	
clam burrows														p					
Sea star imprints																			
muddy/sandy	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
gravel					x	p	p			p			p						
pebble																			
cobble					p	x	x		p	p			x						
boulders / bedrock																			

NBP14-02-Yoyo50 cont.

Image/Time	DSC0090_20:21	DSC0091_20:21	DSC0092_20:21	DSC0093_20:22	DSC0094_20:23	DSC0095_20:23	DSC0096_20:24	DSC0097_20:24	DSC0098_20:24	DSC0099_20:24	DSC0100_20:25
Anemone	p	x	p	p	p	X	x	x	X	p	x
Ascidian		p	p	p							
Bivalve											
Brachiopod						p			p		
Brittle star	X	X	X	X	X	x	X	X	x	X	X
Bryozoa		p	p	p		p					p
Crinoid		p	p							p	
Crustacea				p		p		p			
Fish					p				p		
Gastropod											
Gorgonian		p	p	p		p	p			p	
Holothurian	p	p	p	p	p	p				p	
Hydroid											
Octopus											
Polychaete		p		p			p	p	p		
Ray/skate											
Seapen											
Sea spider						p					p
Sea star											
Soft coral							p				
Sponge - crust											
Sponge - hollow											
Sponge - massive											
Stony coral											
Urchin		p	p	p	p		p				
Worm - other											
Burrows	p		p	p	p		p	p	p	p	p
clam burrows											p
Sea star imprints											
muddy/sandy	X	X	X	X	X	X	X	X	X	X	X
gravel											
pebble											
cobble									p	p	
boulders / bedrock		p	p								

NBP14-02-Yoyo52 Date: 3 March, 2014

Time on bottom: 23:19 **Lat on bottom:** -66° 11.011 **Long on bottom:** 120° 28.894 **Depth on bottom:** 512 m

Time at end: 23:50 **Lat at end:** -66° 11.039 **Long at end:** 120° 29.891 **Depth at end:** 531 m

X = dominant; x = sub-dominant; p = present

Note: every 2nd image analysed

Image/Time	DSC0107_11:20	DSC0109_11:20	DSC0111_11:21	DSC0113_11:22	DSC0115_11:23	DSC0117_11:23	DSC0119_11:24	DSC0121_11:25	DSC0123_11:26	DSC0125_11:26	DSC0127_11:27	DSC0129_11:28	DSC0131_11:29	DSC0133_11:29	DSC0135_11:30	DSC0137_11:31	DSC0139_11:32	DSC0141_11:32	DSC0143_11:33
Anemone	X	X	X	X	p	p	p	p	x	X	X	x		x	p	X	X	p	x
Ascidian																p			
Bivalve																			
Brachiopod	p																		
Brittle star	x	x	x	x	X	X	x	x	X	p	x	x	x	X	X	p	p	X	X
Bryozoa									p					p					
Crinoid																			
Crustacea	p	p	p	p		p		p	p	p	p	p	X	x	p	p	x		p
Fish																p			
Gastropod								p						X					
Gorgonian	p	p	p	p	p	p	X	X	x	p	X	X	p		X	X	X	p	x
Holothurian	p	p	p						p	p	p		p		p		p		p
Hydroid																			
Octopus																			
Polychaete							p	p						p				p	
Ray/skate																			
Seapen												p				p			
Sea spider														p					
Sea star												p							
Soft coral				p															
Sponge - crust																			
Sponge - hollow																			
Sponge - massive									p		p				p				p
Stony coral																			
Urchin		p	p	p		p		p	p	p	p			p	p				
Worm - other																			
Burrows	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p		p	p	p
clam burrows					p		p												
Sea star imprints																			
muddy/sandy	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
gravel																			
pebble																			
cobble																			
boulders / bedrock																			

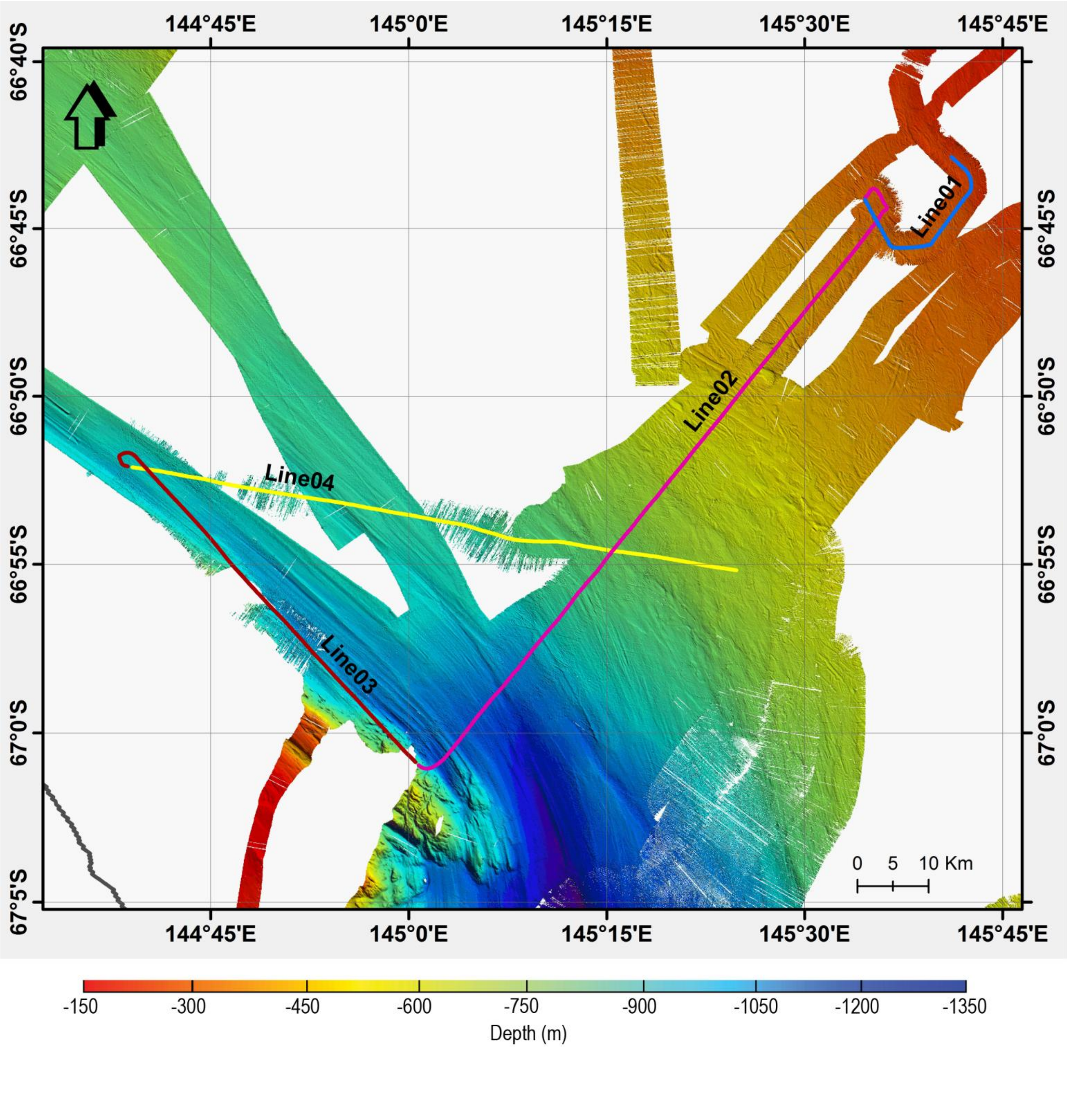
NBP14-02-Yoyo52 cont.

Image/Time	DSC0145_11:34	DSC0147_11:35	DSC0149_11:36	DSC0151_11:36	DSC0153_11:37	DSC0155_11:37	DSC0157_11:38	DSC0159_11:39	DSC0161_11:39	DSC0163_11:40	DSC0165_11:40	DSC0167_11:41	DSC0169_11:42	DSC0171_11:43	DSC0173_11:43	DSC0175_11:44	DSC0177_11:45	DSC0179_11:45	DSC0181_11:46
Anemone	p	p	X	x	p	x	p	p	p	X	X		X	x	X	X	X		p
Ascidian								p				p							
Bivalve			p																
Brachiopod											p	X							
Brittle star	X	X	p		X	X	x	X	x	p	p	x	X	p	p	p	p	p	p
Bryozoa					p						p	X							
Crinoid																			
Crustacea	p	p	p	p	p	p	p	p	x	p	p		p	p	x	p	x	p	
Fish																			
Gastropod																			
Gorgonian	x	x	X	X		X	X	x	X	p	p	x	p	X		p			
Holothurian		p			p	p	p	p	p		p			p	p	p	p		p
Hydroid																			
Octopus																			
Polychaete			p	p		p												p	p
Ray/skate													p						
Seapen		p							p					p		p	p	p	
Sea spider										p									
Sea star			p							p									
Soft coral			p																
Sponge - crust												p							
Sponge - hollow																			
Sponge - massive																			
Stony coral																			
Urchin	p				p	p		p	p	p		p	p	p	p		p	p	p
Worm - other																			
Burrows	p	p		p	p		p	p	p	p	p	p	p	p	p	p	p	p	p
clam burrows							x												
Sea star imprints																			
muddy/sandy	X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
gravel																			
pebble																			
cobble																			
boulders / bedrock												p							

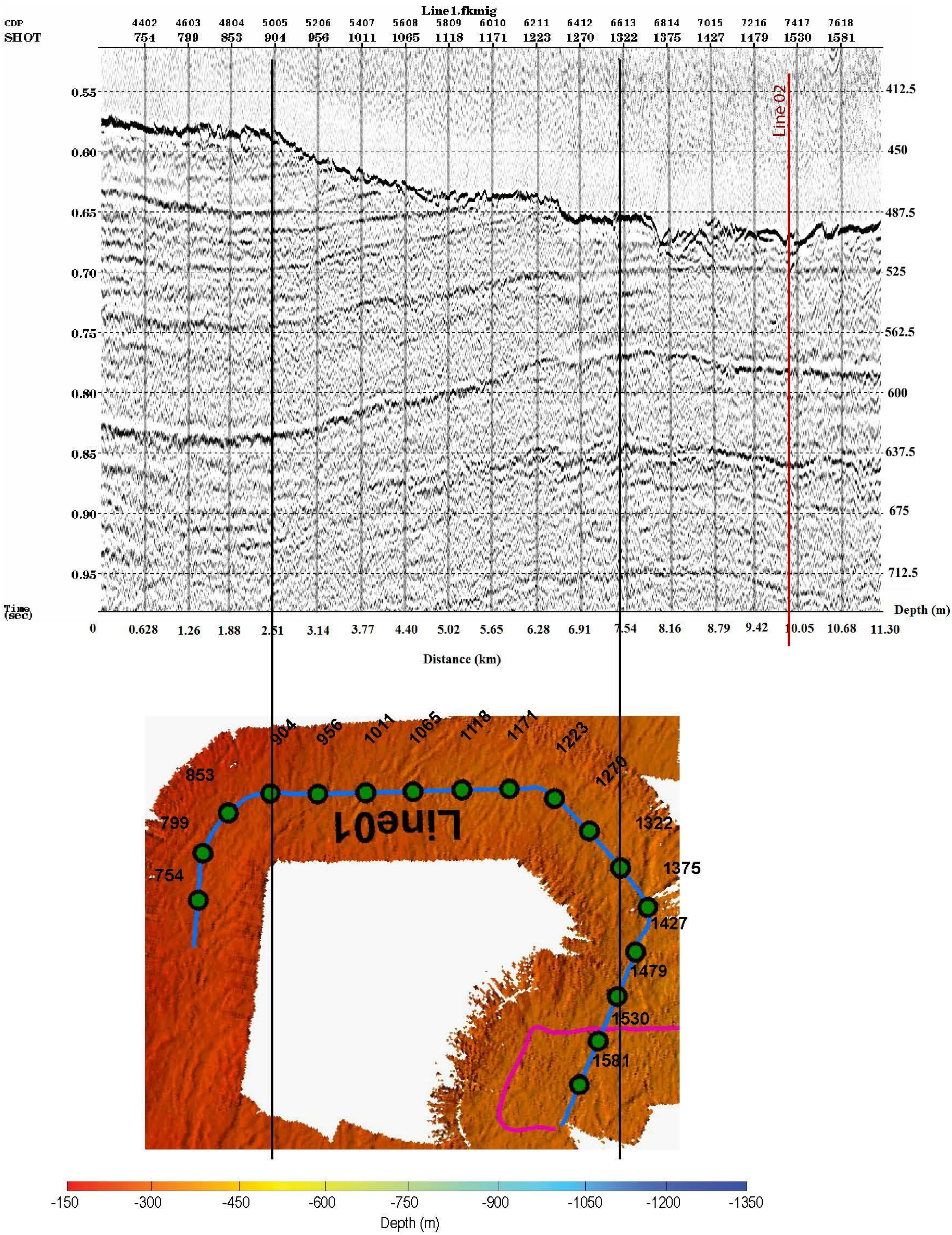
NBP14-02-Yoyo52 cont.

Image/Time	DSC0183_11:46	DSC0185_11:47	DSC0187_11:48	DSC0189_11:48	DSC0191_11:49	DSC0193_11:50	DSC0195_11:50	DSC0197_11:51
Anemone	p	p	p	p	X	X	X	X
Ascidian								p
Bivalve								
Brachiopod								
Brittle star	p	p	X	p	p	p		p
Bryozoa								
Crinoid								
Crustacea	p	X	x	p	p	p	p	
Fish							p	
Gastropod								
Gorgonian	p	p	X	p			p	
Holothurian					p		p	p
Hydroid								
Octopus								
Polychaete						p		
Ray/skate								
Seapen	p	p			p	p	p	
Sea spider							p	
Sea star								
Soft coral				p			p	
Sponge - crust								
Sponge - hollow								
Sponge - massive		p						
Stony coral								
Urchin	p	p	p		p	p	p	p
Worm - other								
Burrows	p	p	p	p	p	p	p	p
clam burrows			p		p			
Sea star imprints								
muddy/sandy	X	X	X	X	X	X	X	X
gravel								
pebble								
cobble								
boulders / bedrock								

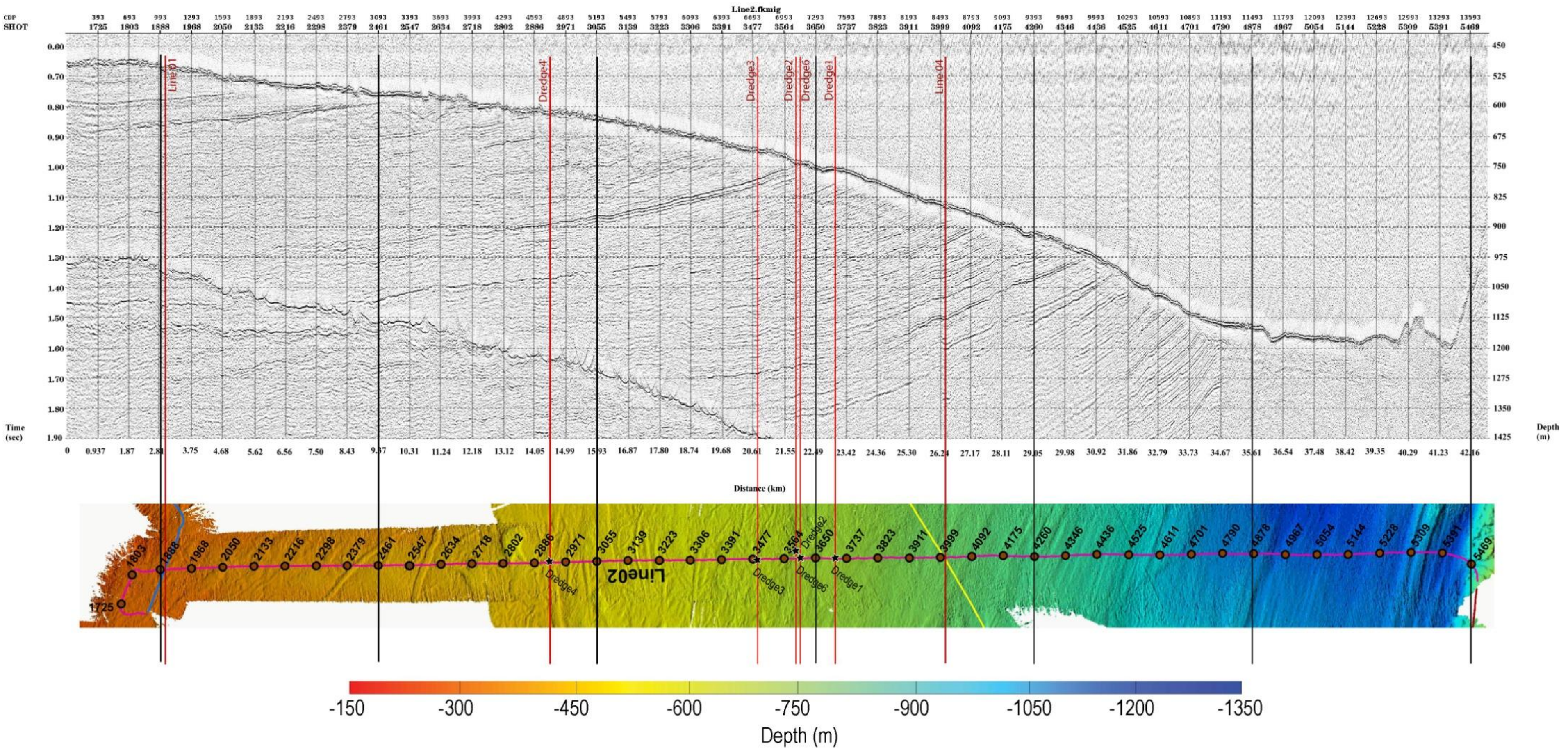
8a. Seismic lines with swath map - dredge/core sites located

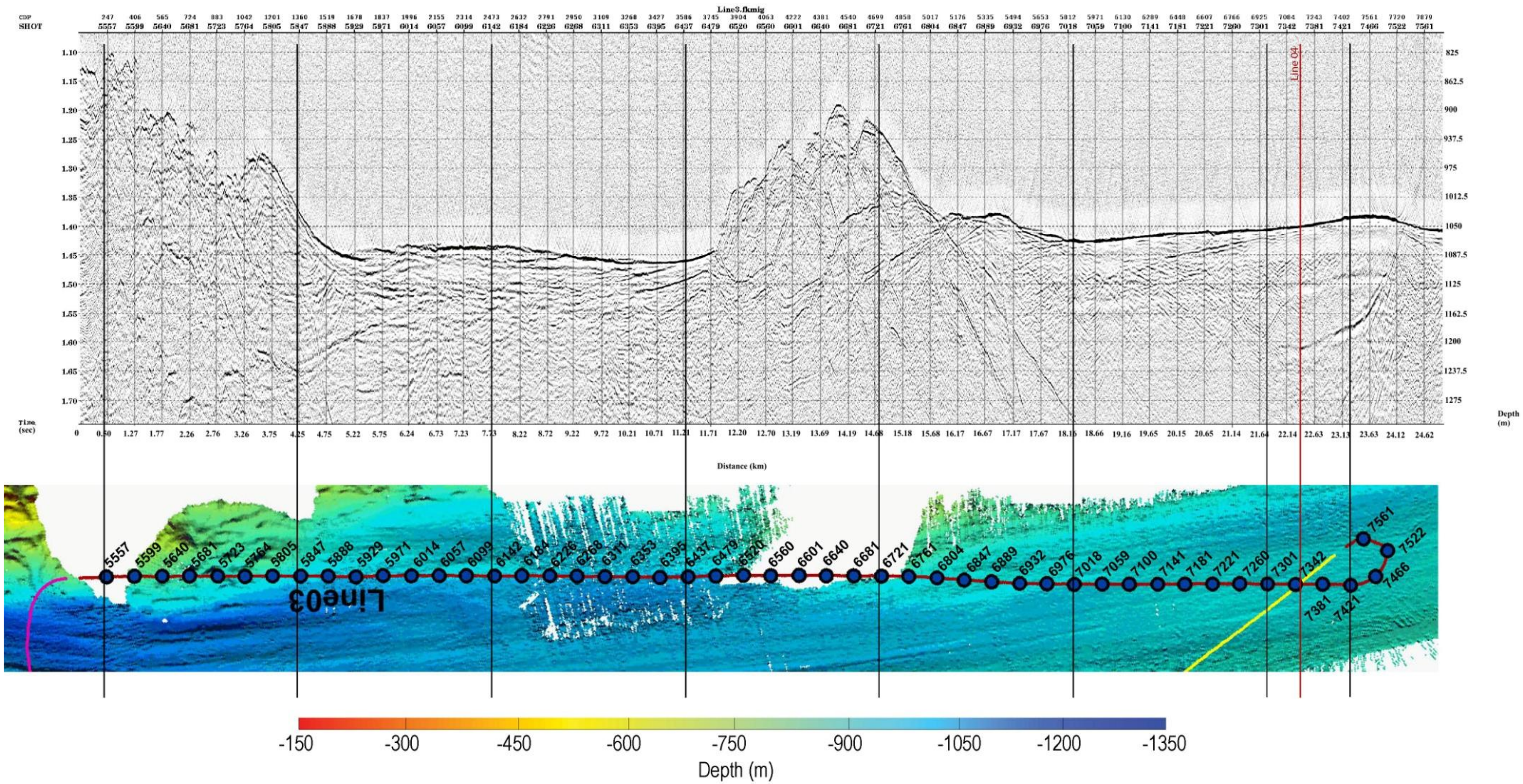


144°45'E
145°0'E
145°15'E
145°30'E
145°45'E
66°40'S
66°45'S
66°50'S
66°55'S
67°0'S
67°5'S
Line01
Line02
Line03
Line04
0 5 10 Km
-150
-300
-450
-600
-750
-900
-1050
-1200
-1350
Depth (m)

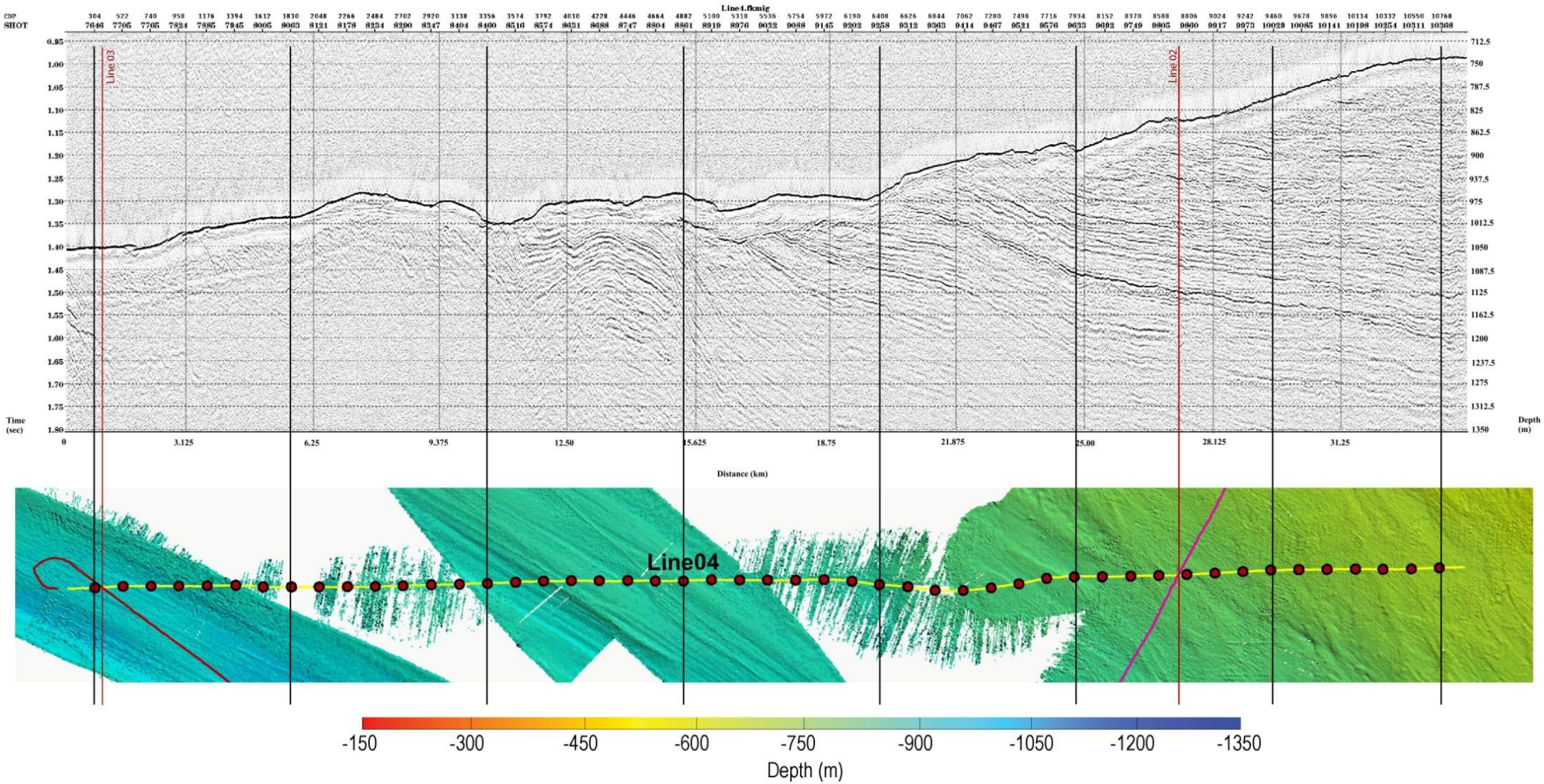


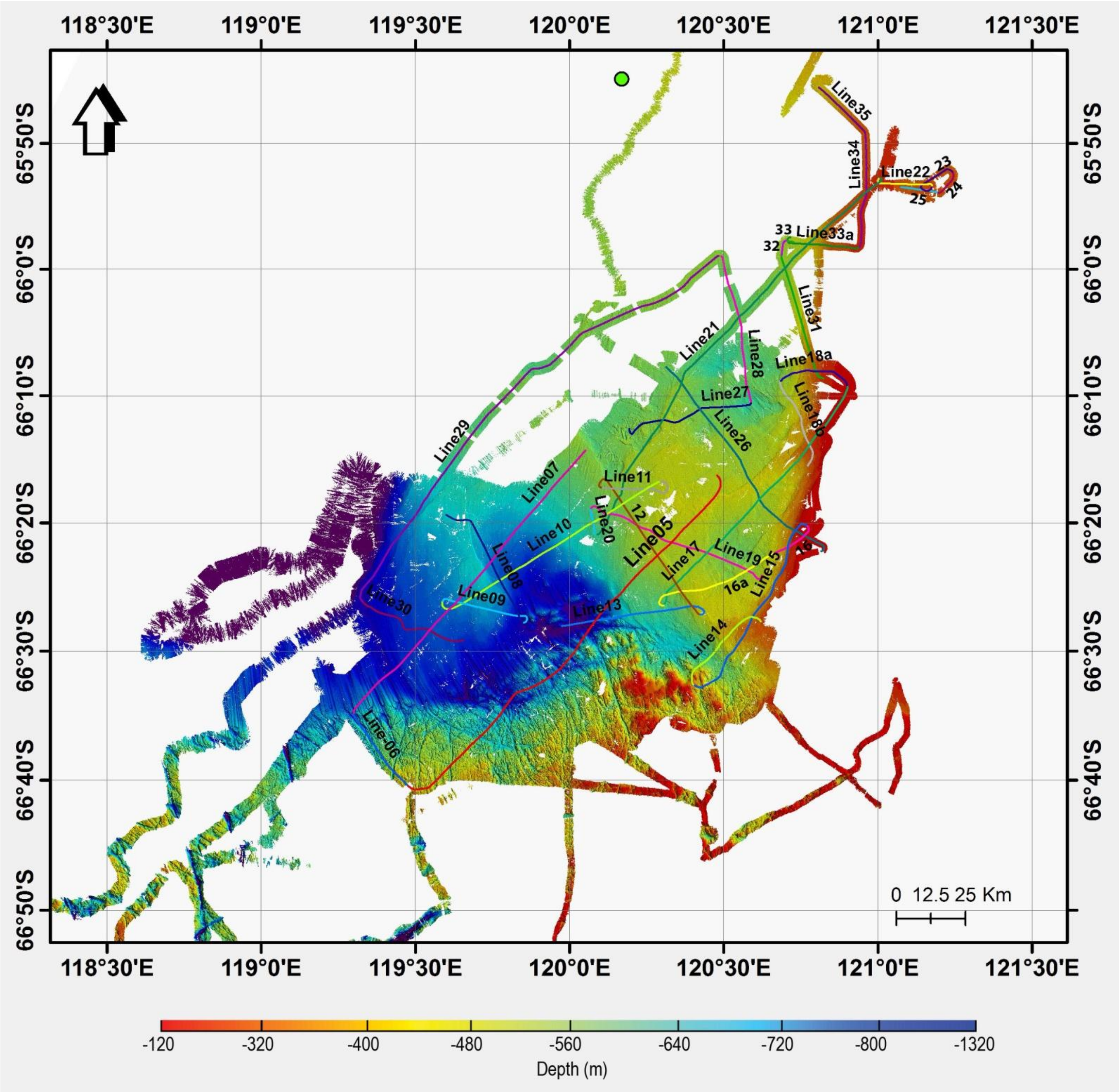
Line1.fkmig
CDP
SHOT
4402 4603 4804 5005 5206 5407 5608 5809 6010 6211 6412 6613 6814 7015 7216 7417 7618
754 799 853 904 956 1011 1065 1118 1171 1223 1270 1322 1375 1427 1479 1530 1581
0.55
0.60
0.65
0.70
0.75
0.80
0.85
0.90
0.95
Time (sec)
412.5
450
487.5
525
562.5
600
637.5
675
712.5
Depth (m)
Line 02
0 0.628 1.26 1.88 2.51 3.14 3.77 4.40 5.02 5.65 6.28 6.91 7.54 8.16 8.79 9.42 10.05 10.68 11.30
Distance (km)
904 956 1011 1065 1118 1171 1223 1270
853
799
754
1322
1375
1427
1479
1530
1581
Line01
-150 -300 -450 -600 -750 -900 -1050 -1200 -1350
Depth (m)

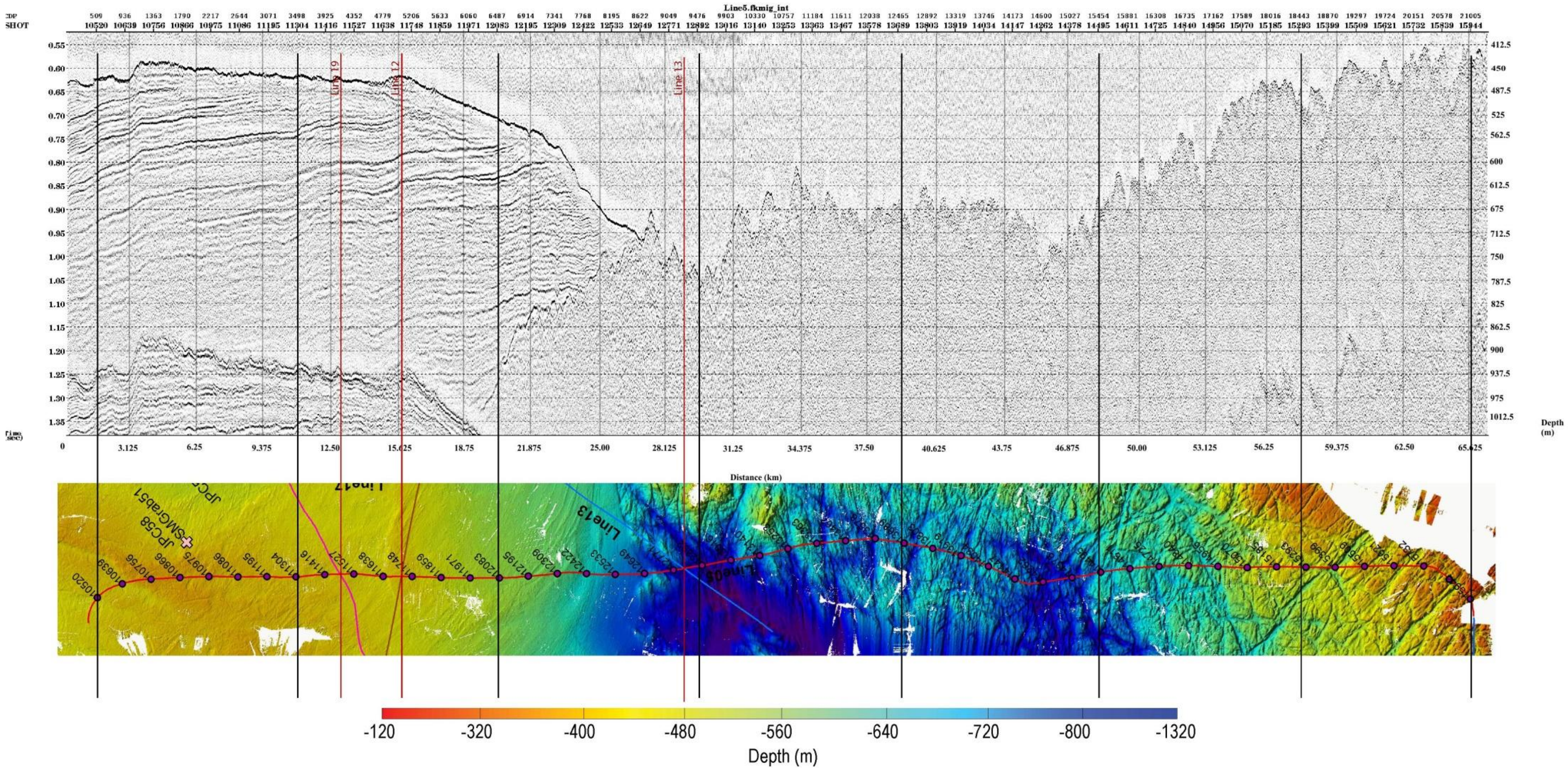

Line2.fkmig
CDP
SHOT
Time (sec)
Depth (m)
Distance (km)
Line01
Dredge4
Dredge3
Dredge2
Dredge6
Dredge1
Line04
Line02
-150
-300
-450
-600
-750
-900
-1050
-1200
-1350
Depth (m)



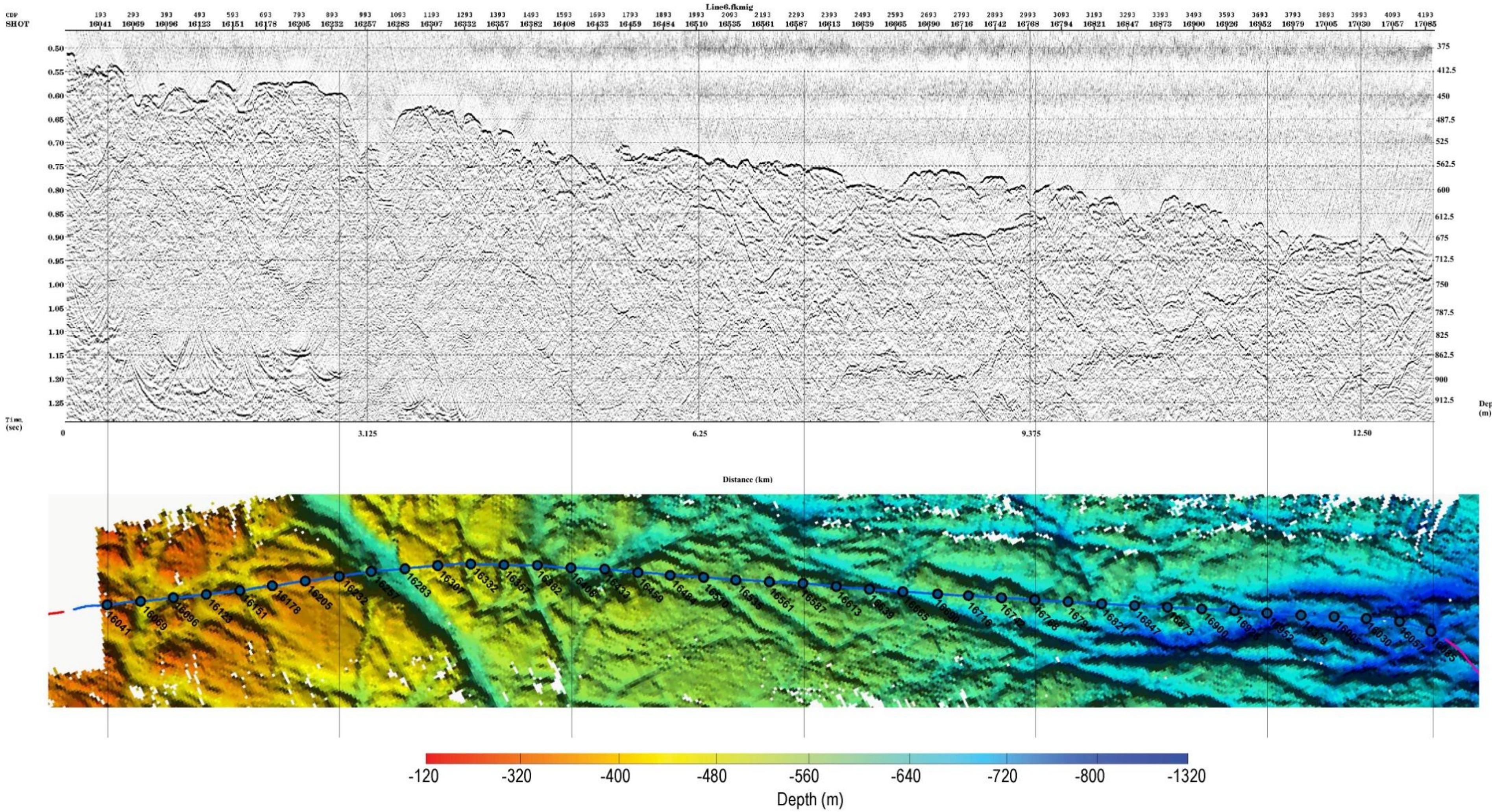
Line3.fkmig
CDP
SHOT
5557 5599 5640 5681 5723 5764 5805 5847 5888 5929 5971 6014 6057 6099 6142 6184 6226 6268 6311 6353 6395 6437 6479 6520 6560 6601 6640 6681 6721 6761 6804 6847 6889 6932 6976 7018 7059 7100 7141 7181 7221 7260 7301 7342 7381 7421 7466 7522 7561
Time (sec)
1.10 1.15 1.20 1.25 1.30 1.35 1.40 1.45 1.50 1.55 1.60 1.65 1.70
Depth (m)
825 862.5 900 937.5 975 1012.5 1050 1087.5 1125 1162.5 1200 1237.5 1275
Distance (km)
Line 04
Line03
-150 -300 -450 -600 -750 -900 -1050 -1200 -1350
Depth (m)

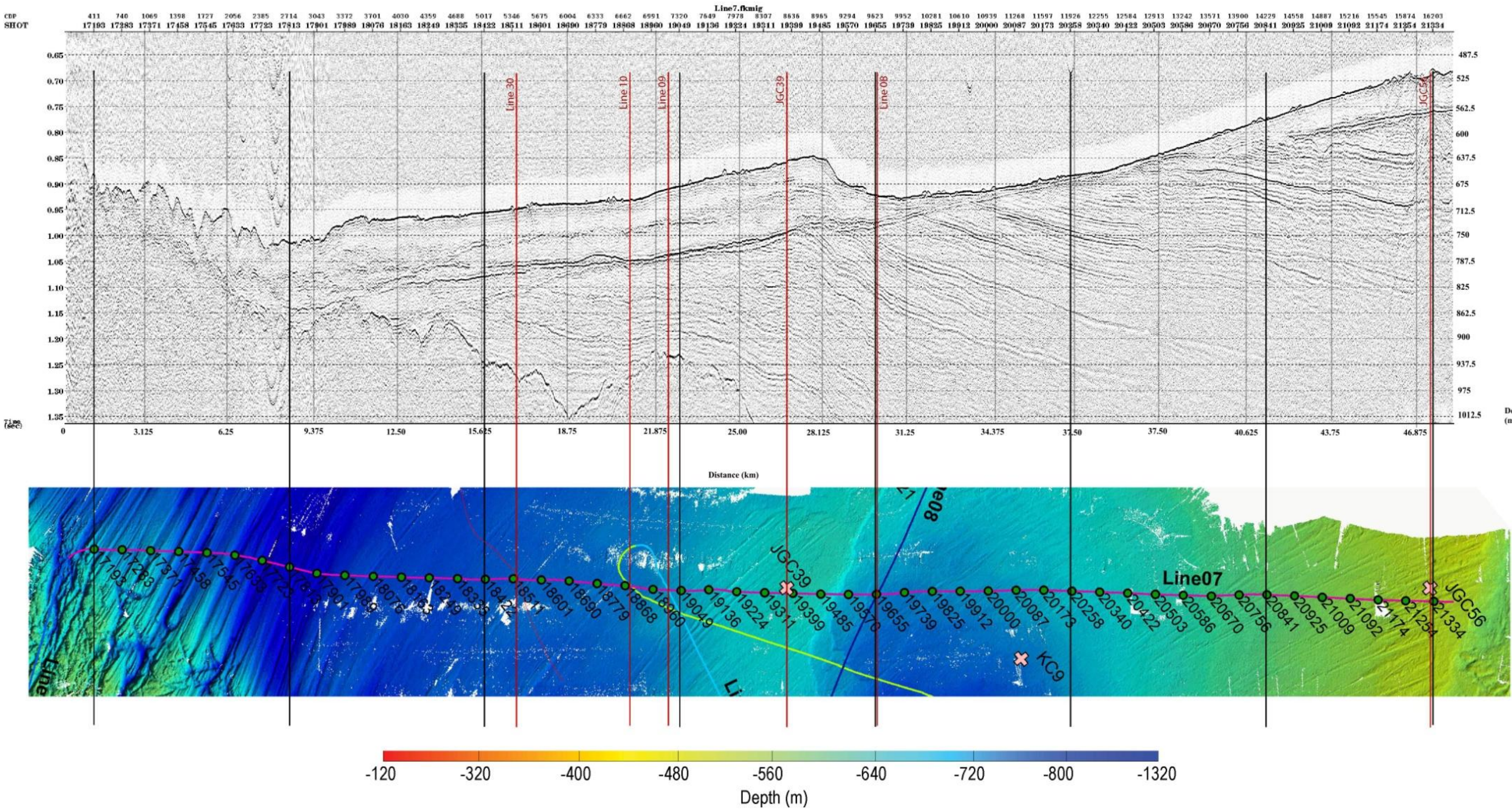

Line4.fkmig
CDP
SHOT
Time (sec)
Depth (m)
Distance (km)
0
3.125
6.25
9.375
12.50
15.625
18.75
21.875
25.00
28.125
31.25
Line 03
Line 02
Line04
-150
-300
-450
-600
-750
-900
-1050
-1200
-1350
Depth (m)


118°30'E
119°0'E
119°30'E
120°0'E
120°30'E
121°0'E
121°30'E
65°50'S
66°0'S
66°10'S
66°20'S
66°30'S
66°40'S
66°50'S
Line35
Line34
Line22
23
24
25
33
32
Line33a
Line31
Line21
Line28
Line18a
Line27
Line18b
Line26
Line29
Line07
Line11
Line20
12
Line05
Line10
Line08
Line17
Line19
Line15
16
16a
Line09
Line13
Line30
Line14
Line-06
0 12.5 25 Km
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)

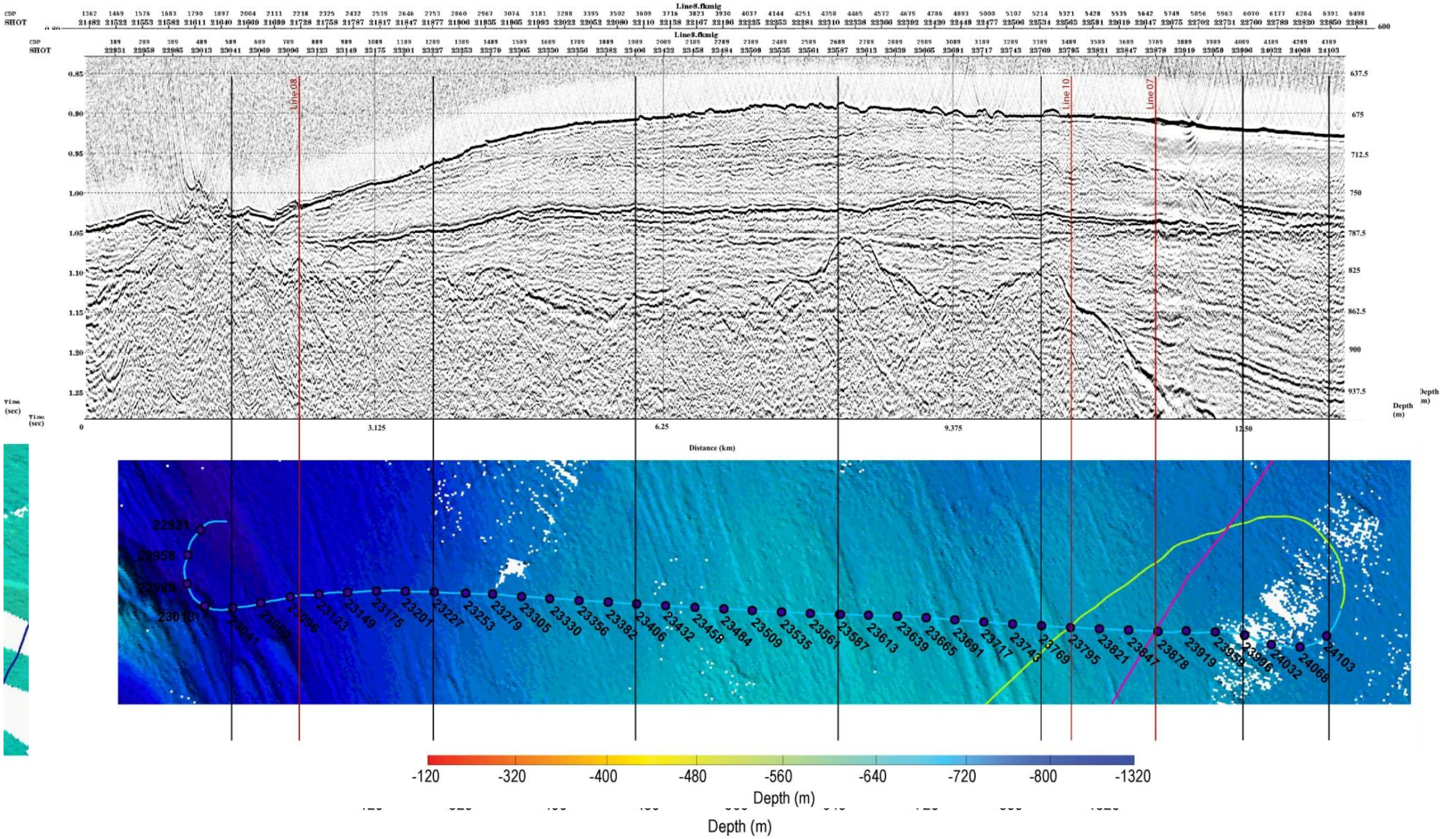


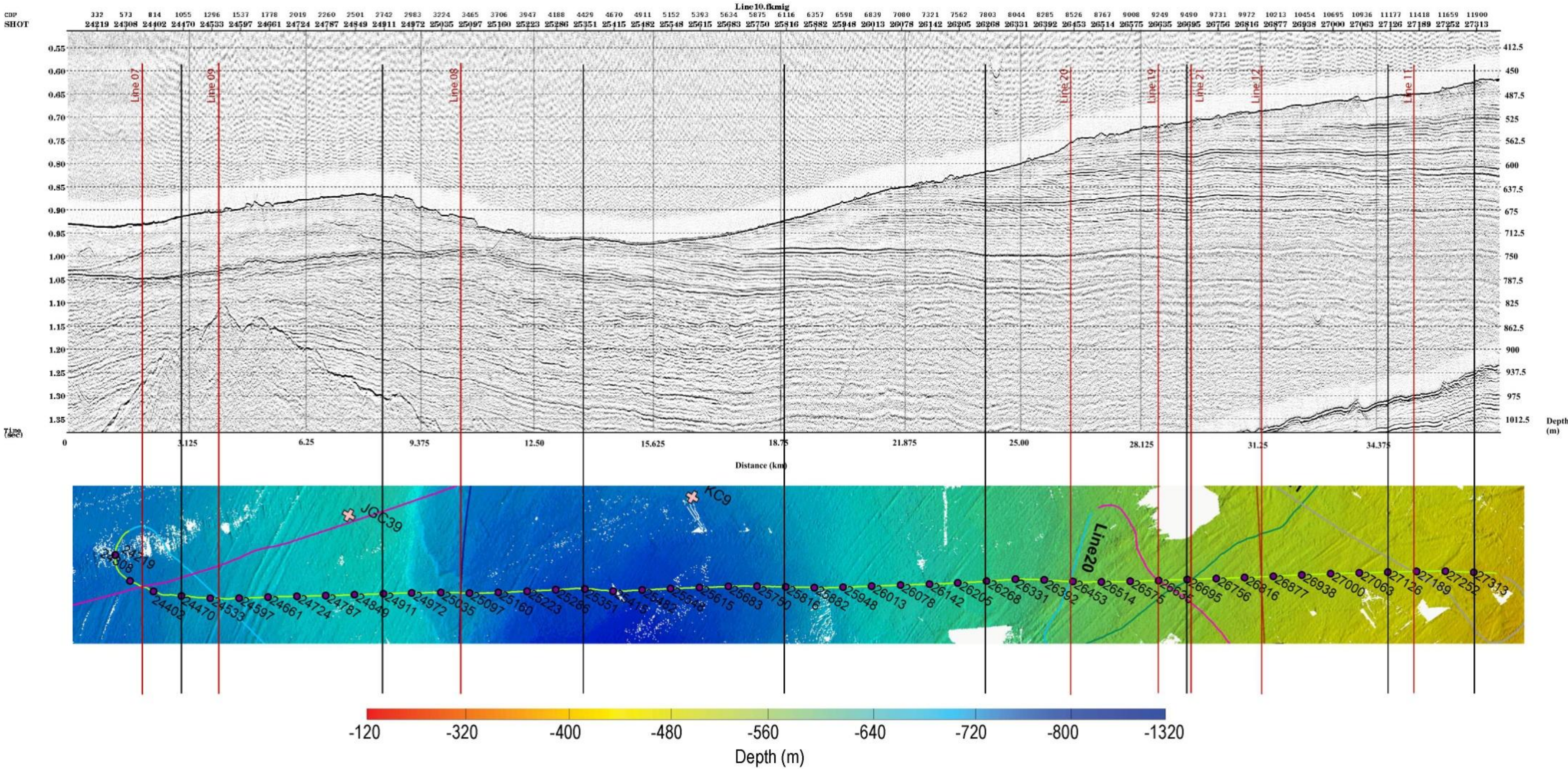
Line5.fkmig_int
CDP
SHOT
Line 19
Line 12
Line 13
Depth (m)
0
3.125
6.25
9.375
12.50
15.625
18.75
21.875
25.00
28.125
31.25
34.375
37.50
40.625
43.75
46.875
50.00
53.125
56.25
59.375
62.50
65.625
Distance (km)
Line17
Line13
JPC58
SMGrab51
Line05
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)

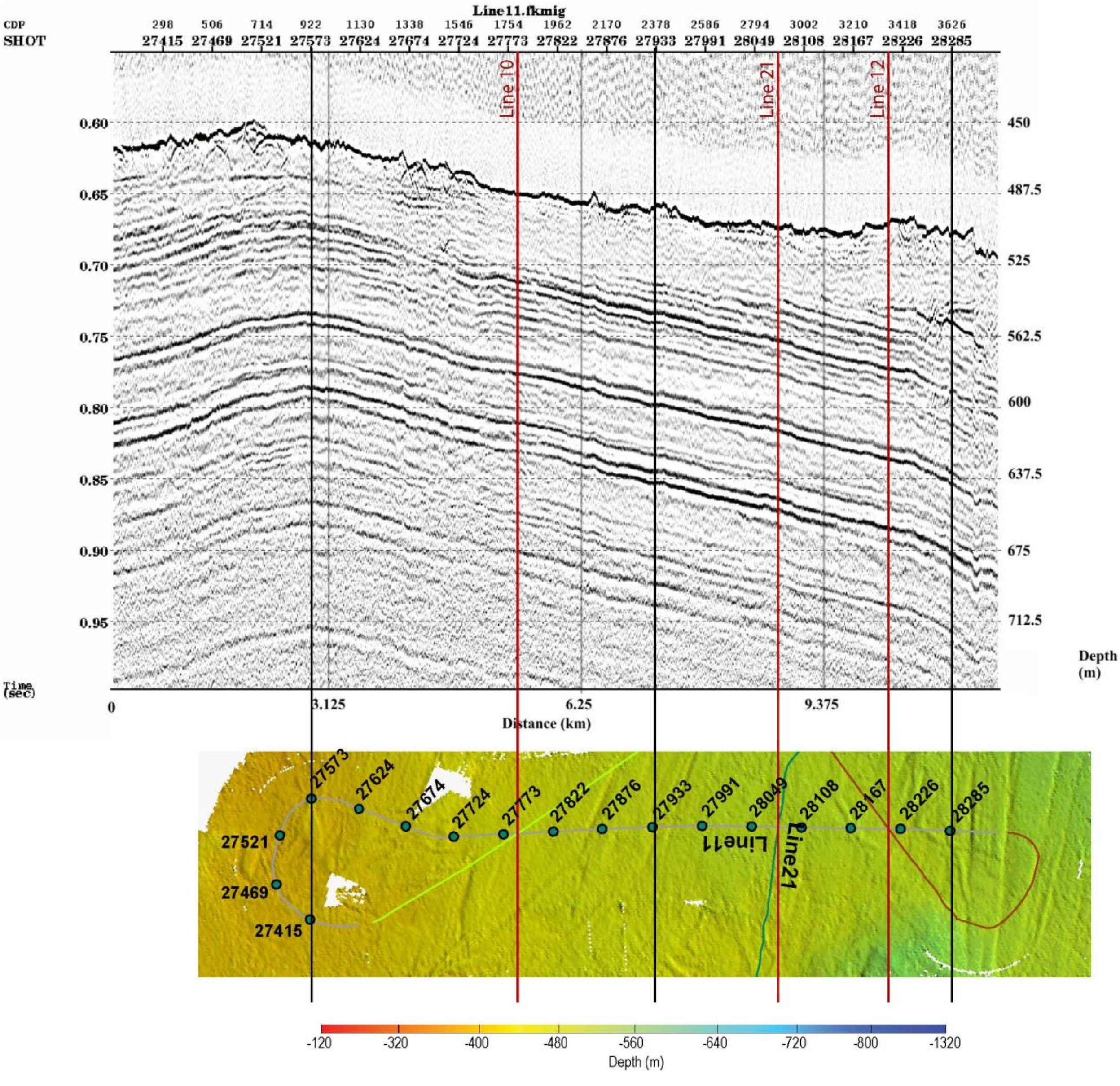

Line6.fkmig
CDP
SHOT
Time (sec)
Distance (km)
0
3.125
6.25
9.375
12.50
Depth (m)
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)

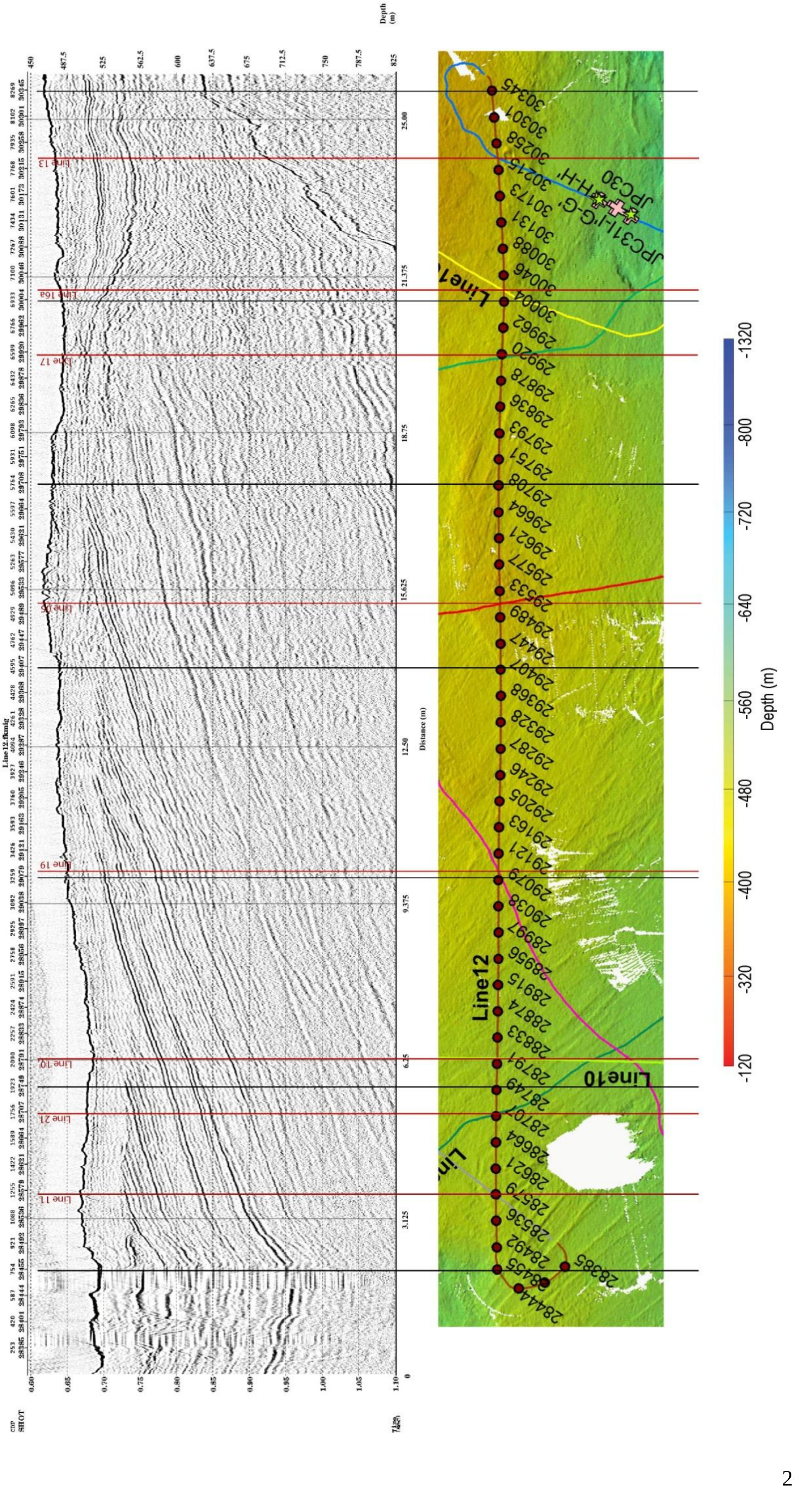


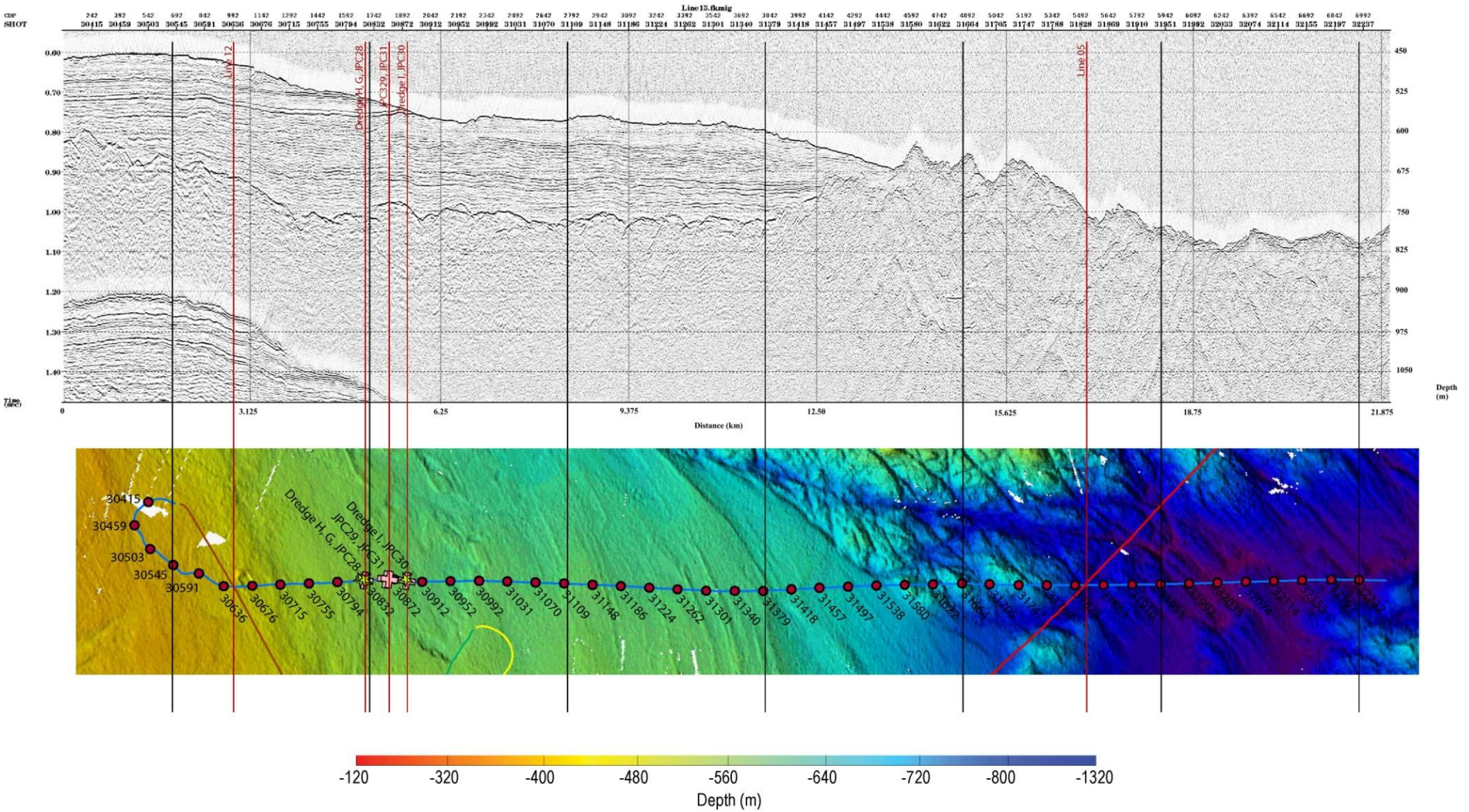
Line7.fkmig
CDP
SHOT
Line 30
Line 10
Line 09
JGC39
Line 08
JGC56
Time (sec)
Depth (m)
Distance (km)
Line07
KC9
-120 -320 -400 -480 -560 -640 -720 -800 -1320
Depth (m)


Line8.fkmig
Line9.fkmig
CDP
SHOT
Line 08
Line 10
Line 07
Time (sec)
Depth (m)
Distance (km)
0
3.125
6.25
9.375
12.50
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)

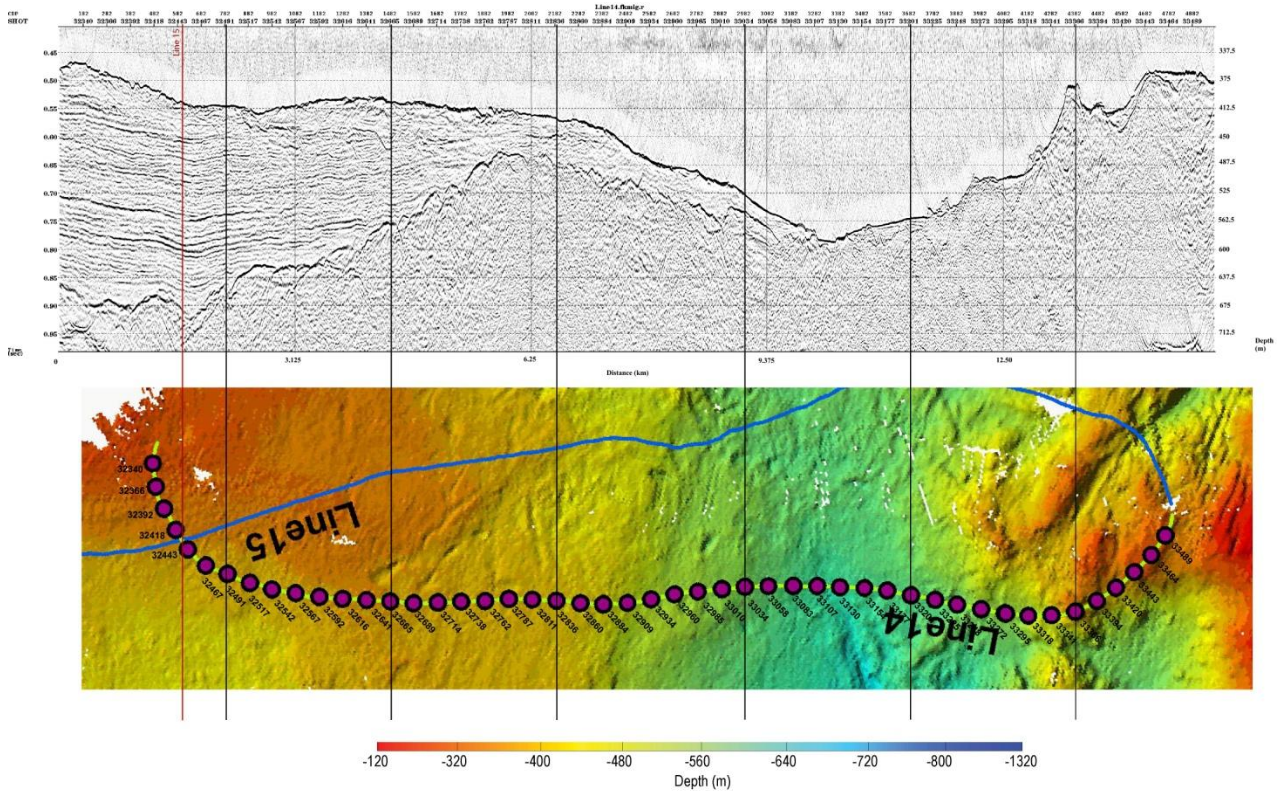

Line10.fkmig
CDP 332 573 814 1055 1296 1537 1778 2019 2260 2501 2742 2983 3224 3465 3706 3947 4188 4429 4670 4911 5152 5393 5634 5875 6116 6357 6598 6839 7080 7321 7562 7803 8044 8285 8526 8767 9008 9249 9490 9731 9972 10213 10454 10695 10936 11177 11418 11659 11900
SHOT 24219 24308 24402 24470 24533 24597 24661 24724 24787 24849 24911 24972 25035 25097 25160 25223 25286 25351 25415 25482 25548 25615 25683 25750 25816 25882 25948 26013 26078 26142 26205 26268 26331 26392 26453 26514 26575 26635 26695 26756 26816 26877 26938 27000 27063 27126 27189 27252 27313
0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00 1.05 1.10 1.15 1.20 1.25 1.30 1.35
Time (sec)
412.5 450 487.5 525 562.5 600 637.5 675 712.5 750 787.5 825 862.5 900 937.5 975 1012.5
Depth (m)
Line 07
Line 09
Line 08
Line 20
Line 19
Line 27
Line 12
Line 11
0 3.125 6.25 9.375 12.50 15.625 18.75 21.875 25.00 28.125 31.25 34.375
Distance (km)
JGC39
KC9
Line20
-120 -320 -400 -480 -560 -640 -720 -800 -1320
Depth (m)

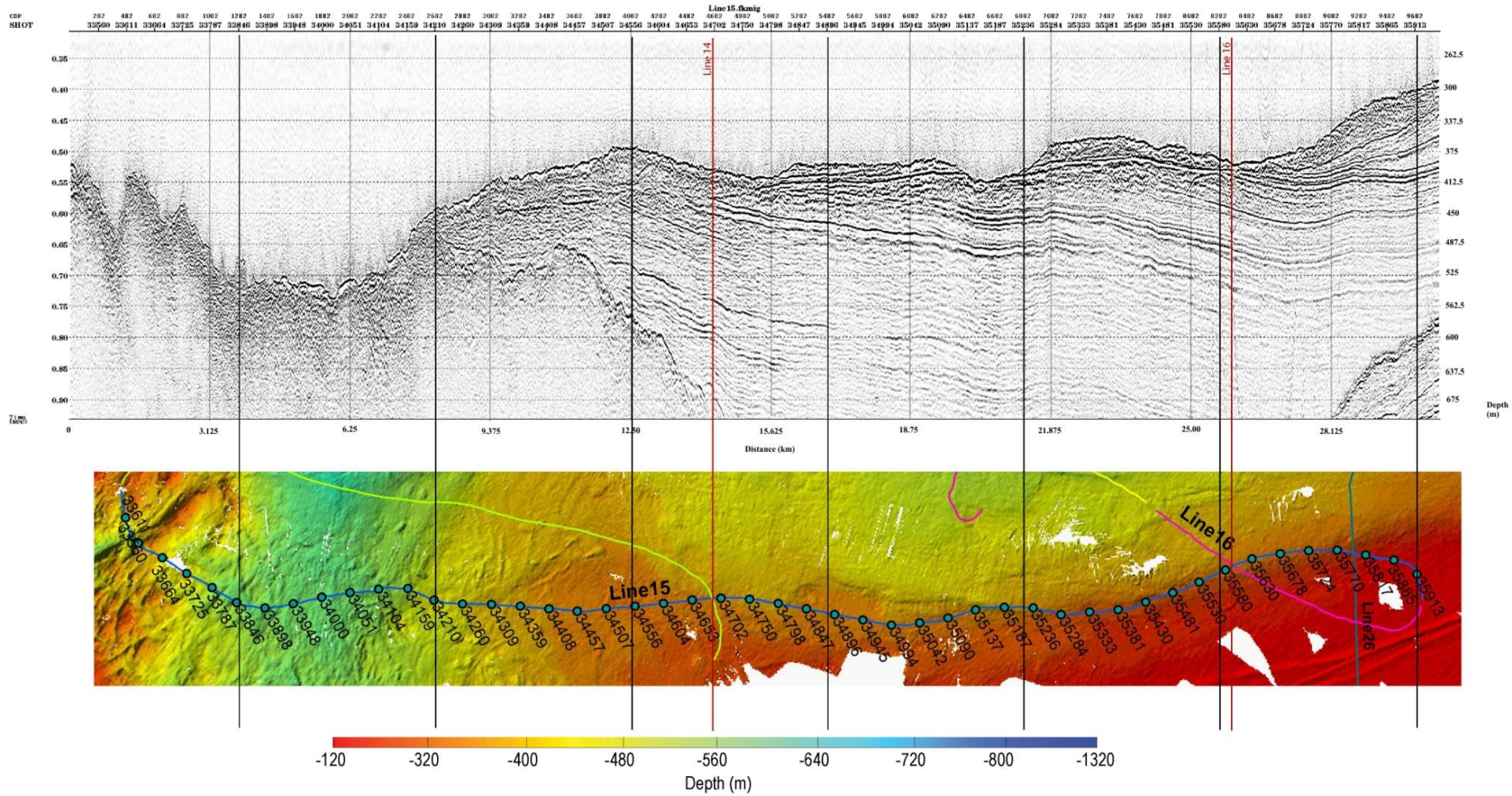

Line11.fkmig
CDP
SHOT
298 506 714 922 1130 1338 1546 1754 1962 2170 2378 2586 2794 3002 3210 3418 3626
27415 27469 27521 27573 27624 27674 27724 27773 27822 27876 27933 27991 28049 28108 28167 28226 28285
Line 10
Line 21
Line 12
0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95
Time (sec)
450 487.5 525 562.5 600 637.5 675 712.5
Depth (m)
0 3.125 6.25 9.375
Distance (km)
Line11
Line21
-120 -320 -400 -480 -560 -640 -720 -800 -1320
Depth (m)

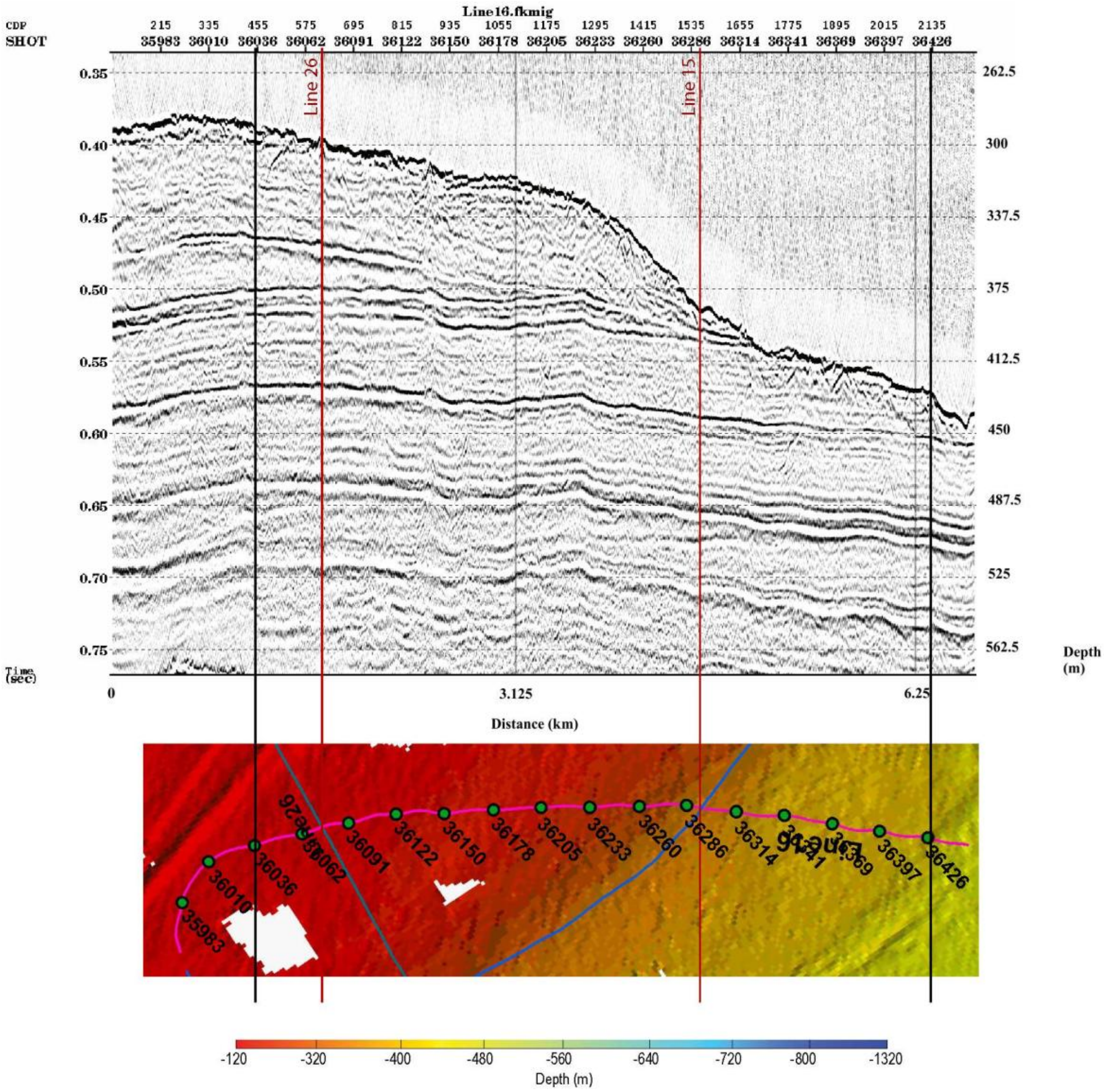

Line12.flxmig
Distance (m)
Depth (m)
Line12
Line10
Line 13
Line 17
Line 19
Line 21
Line 11
Depth (m)
-1320
-800
-720
-640
-560
-480
-400
-320
-120

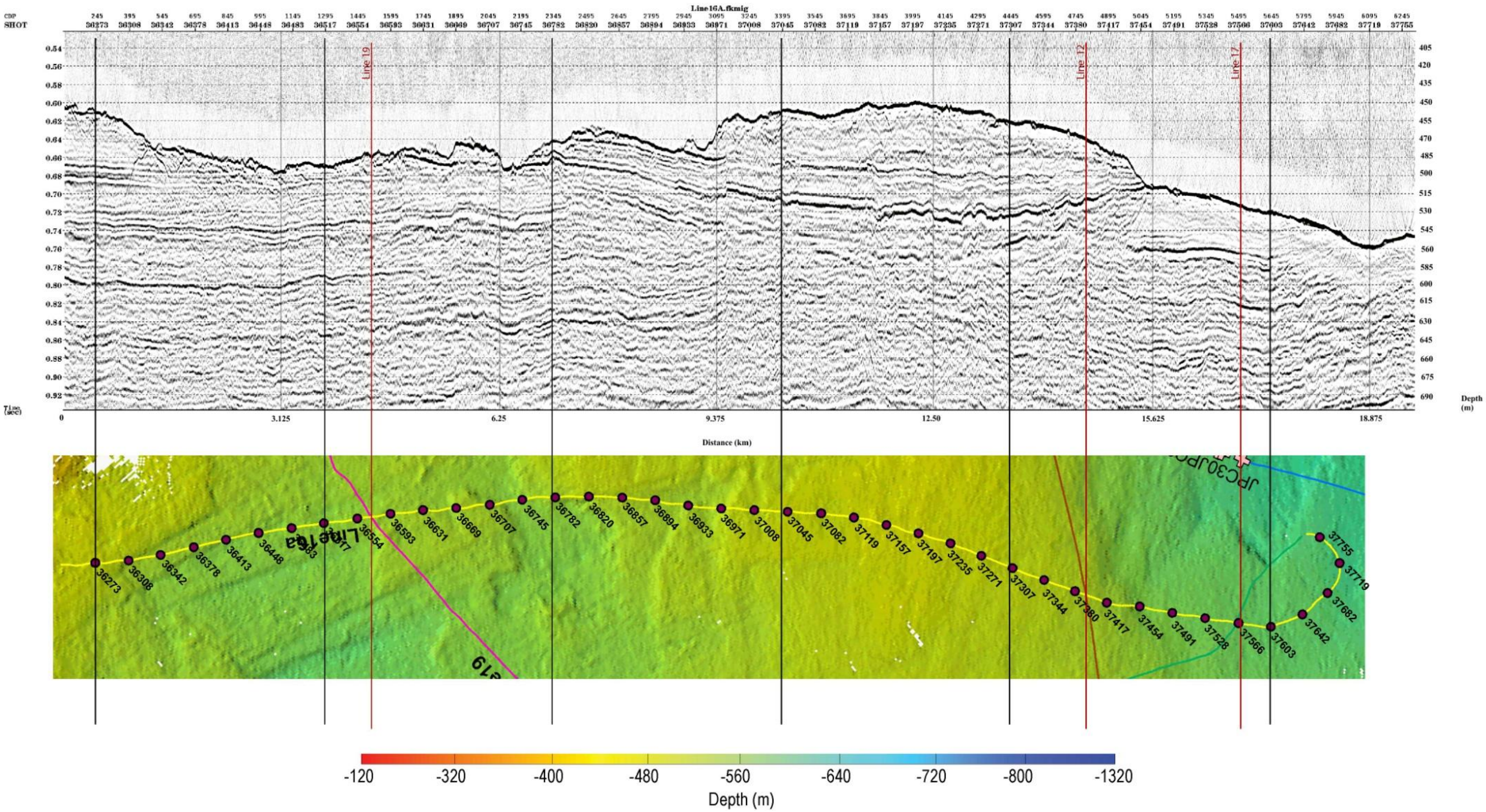

Line13.fkmig
CDP
SHOT
Time (sec)
Line 12
Dredge H, G, JPC28
JPC329, JPC31
Dredge I, JPC30
Line 05
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
1.40
450
525
600
675
750
825
900
975
1050
Depth (m)
0
3.125
6.25
9.375
12.50
15.625
18.75
21.875
Distance (km)
Dredge H, G, JPC28
JPC29, JPC31
Dredge I, JPC30
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)

270

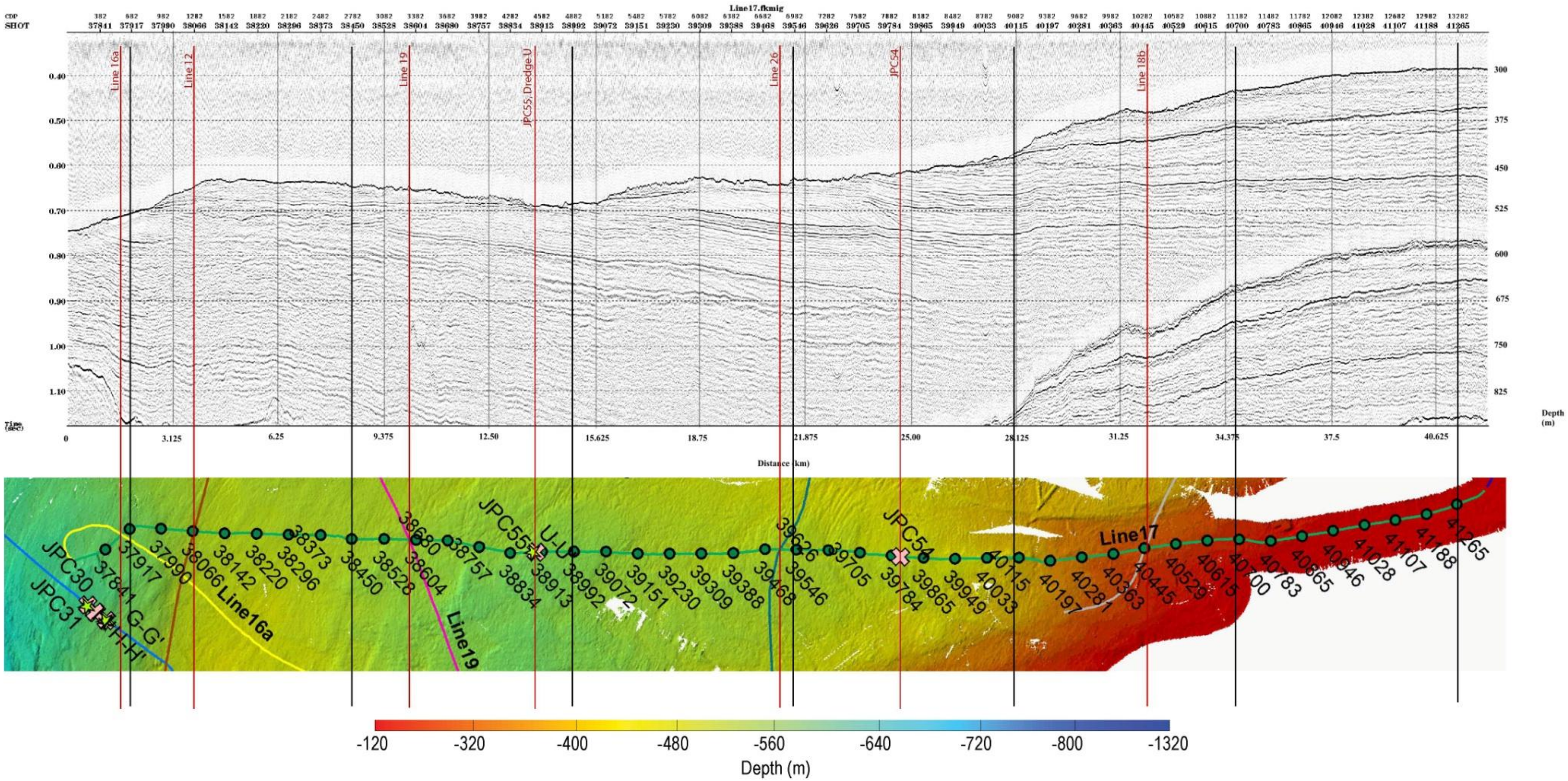

Line14.fkmig.r
Line 15
Distance (km)
0
3.125
6.25
9.375
12.50
Depth (m)
Line15
Line14
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)


Line15.fkmig
CDP
SHOT
Line 14
Line 16
Distance (km)
Depth (m)
Line15
Line16
Line26
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)

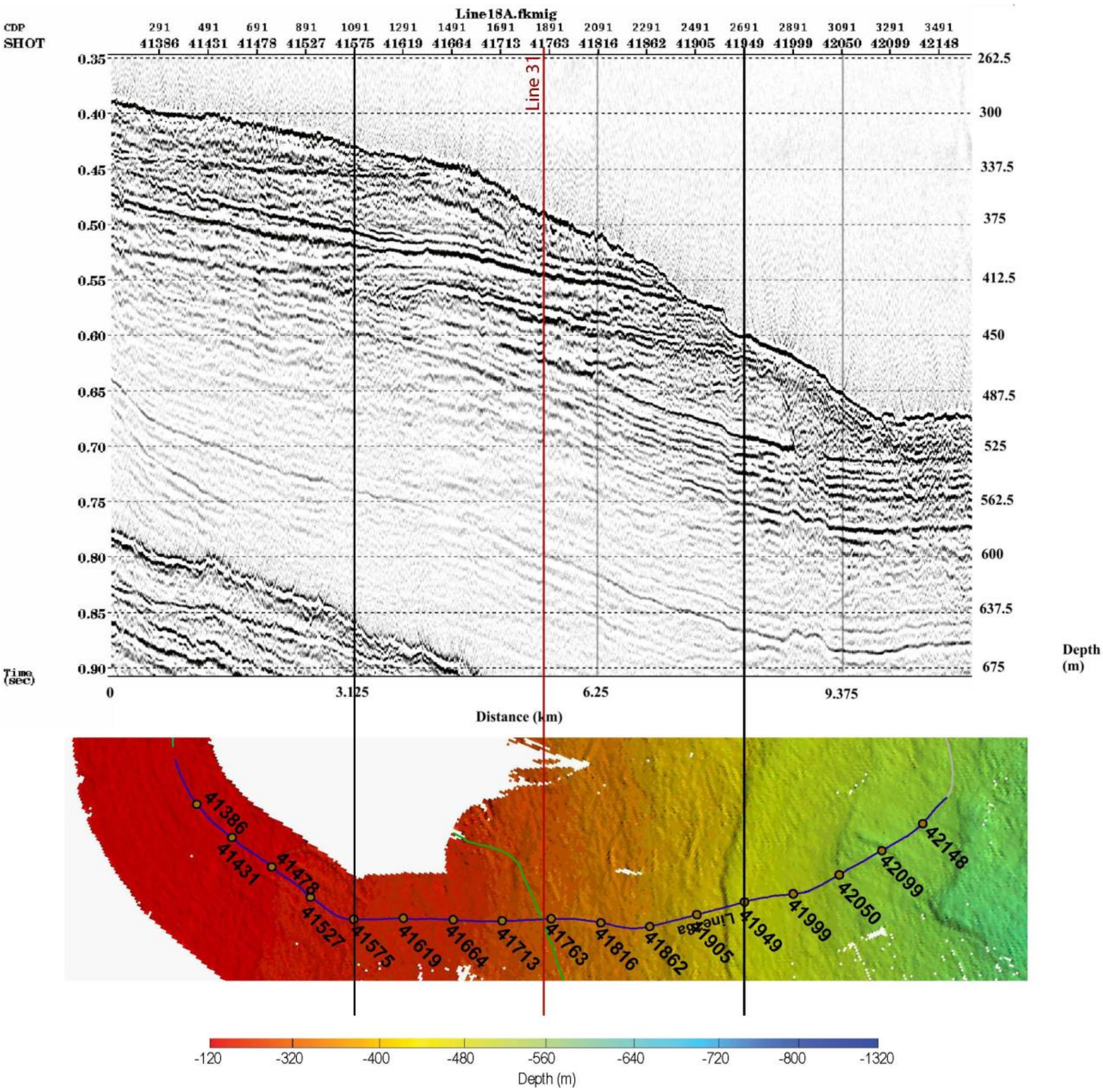

Line16.fkmig
CDP
SHOT
215 335 455 575 695 815 935 1055 1175 1295 1415 1535 1655 1775 1895 2015 2135
35983 36010 36036 36062 36091 36122 36150 36178 36205 36233 36260 36286 36314 36341 36369 36397 36426
Line 26
Line 15
0.35
0.40
0.45
0.50
0.55
0.60
0.65
0.70
0.75
Time (sec)
262.5
300
337.5
375
412.5
450
487.5
525
562.5
Depth (m)
0
3.125
6.25
Distance (km)
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)



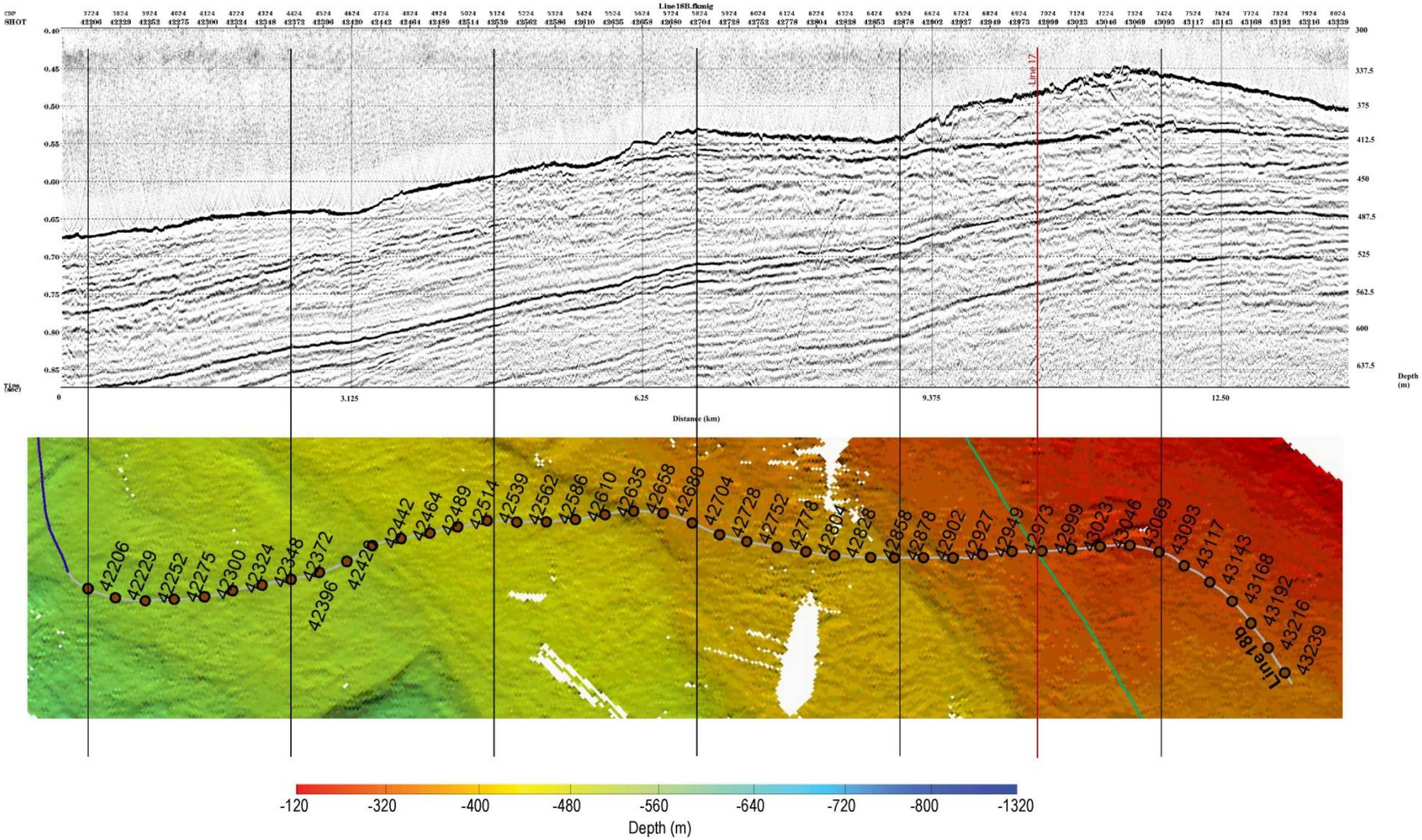
Line16A.fkmig
CDP
SHOT
Line 19
Line 12
Line 17
Time (sec)
Depth (m)
0
3.125
6.25
9.375
12.50
15.625
18.875
Distance (km)
Line 16a
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)

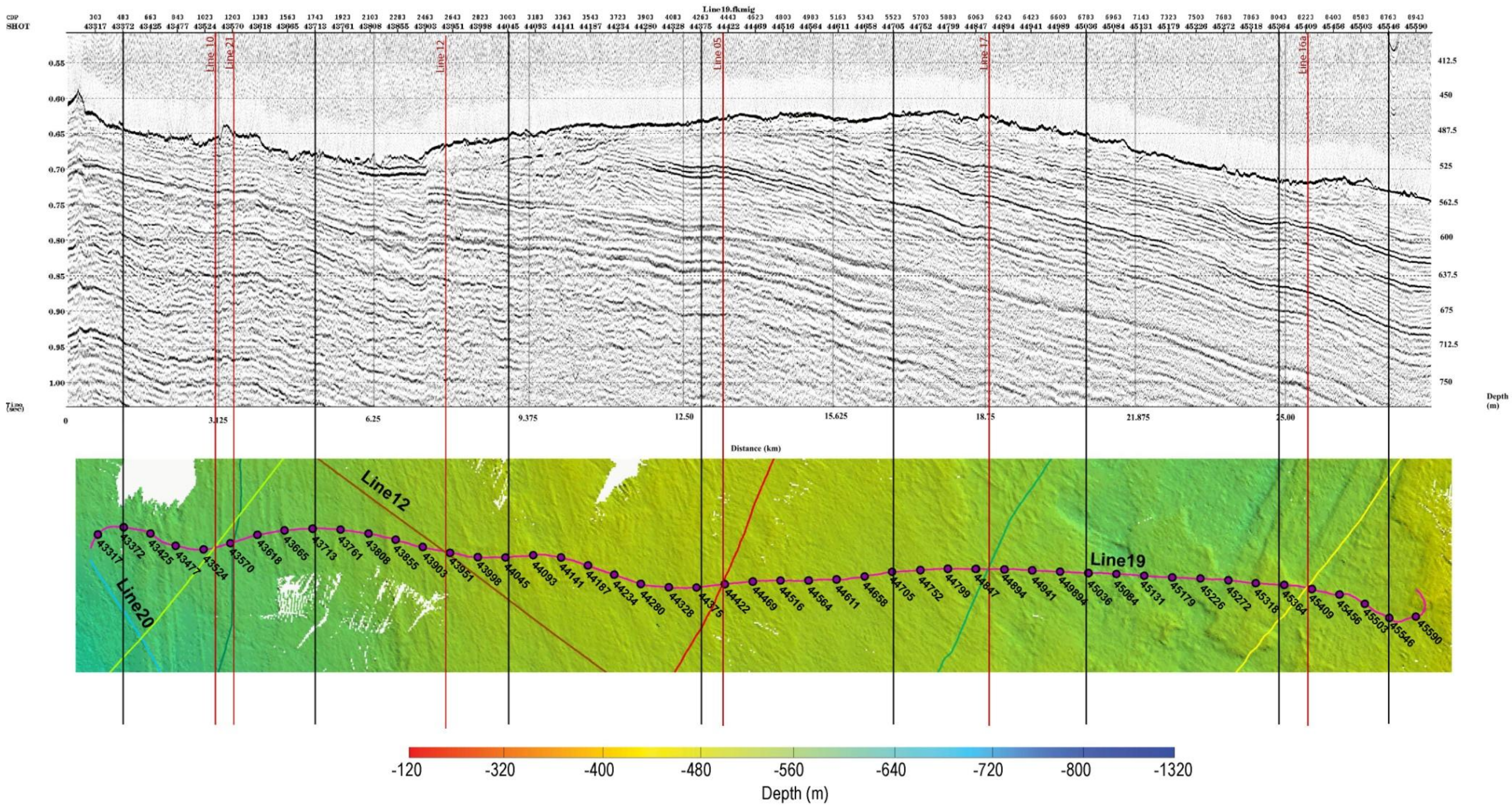


Line17.fkmig
CDP
SHOT
Line 16a
Line 12
Line 19
JPC55, Dredge U
Line 26
JPC54
Line 18b
Time (sec)
Depth (m)
Distance (km)
0
3.125
6.25
9.375
12.50
15.625
18.75
21.875
25.00
28.125
31.25
34.375
37.5
40.625
JPC30
JPC31
G-G'
H-H'
U-U'
JPC55
JPC54
Line16a
Line19
Line17
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)

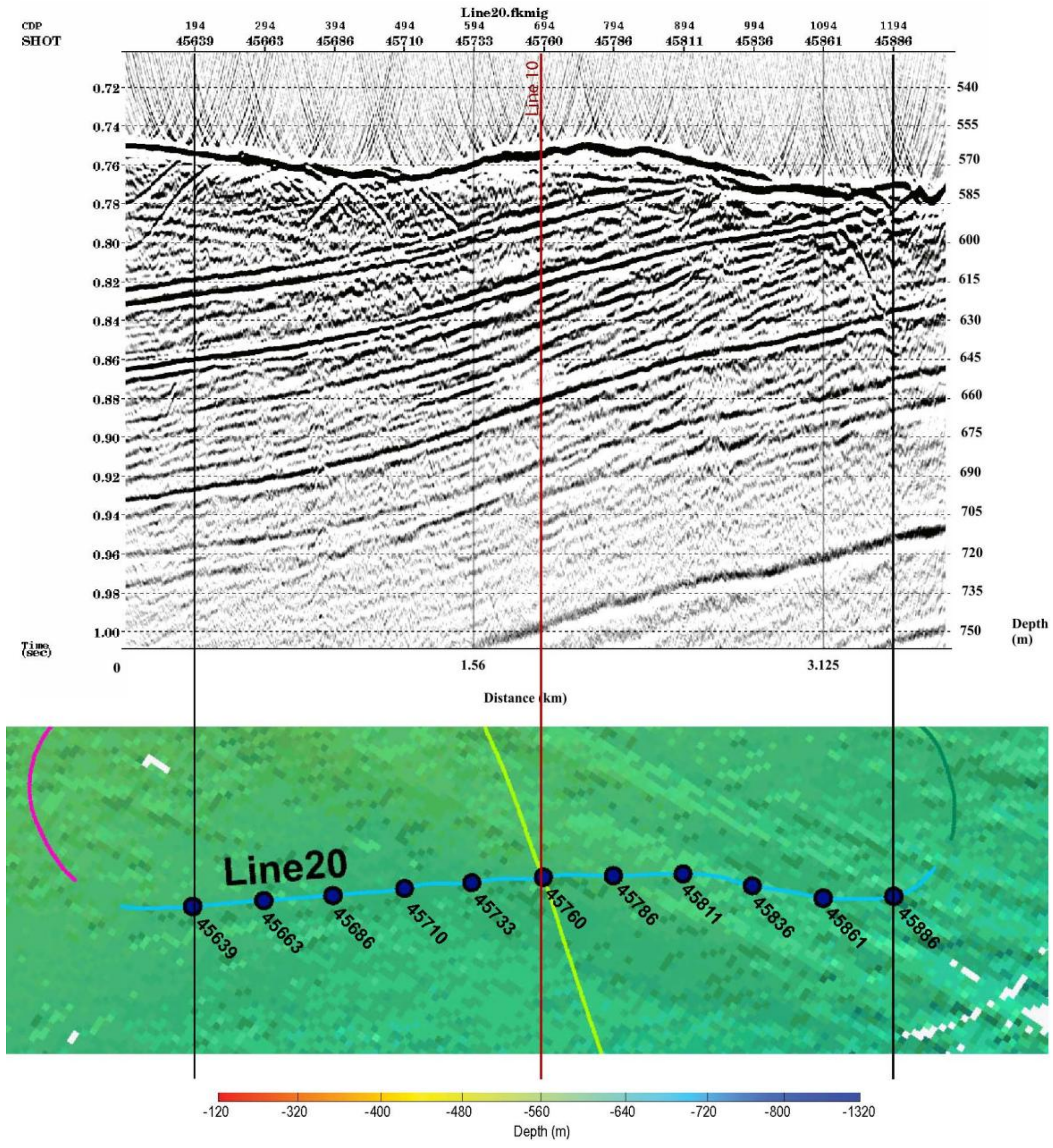


Line18A.fkmig
CDP
SHOT
Line 31
Time (sec)
Depth (m)
Distance (km)
0
3.125
6.25
9.375
Depth (m)
-120
-320
-400
-480
-560
-640
-720
-800
-1320

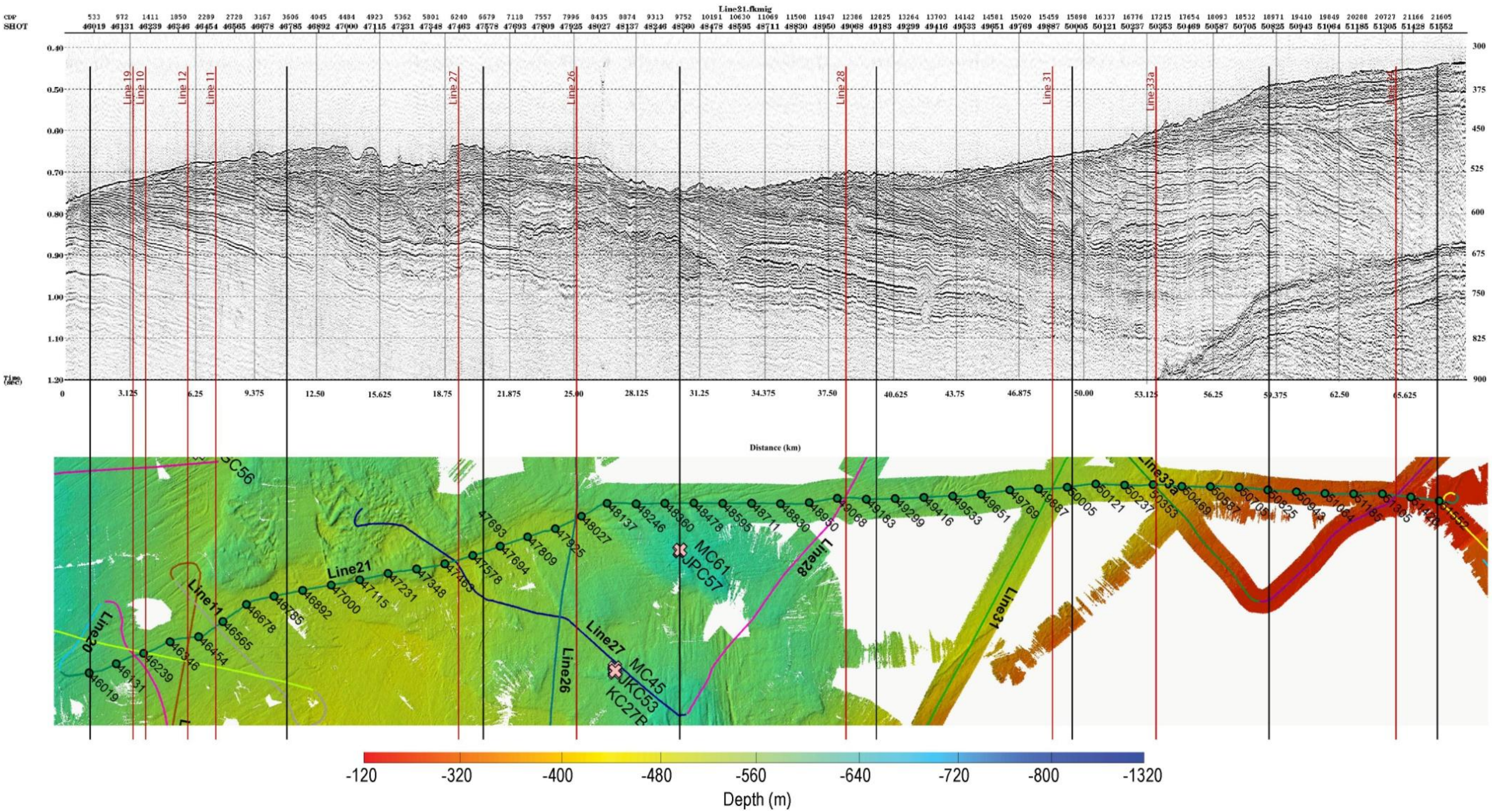

Line18B.fkmig
CDP
SHOT
Time (sec)
Distance (km)
0
3.125
6.25
9.375
12.50
Depth (m)
Line 17
Line18b
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)



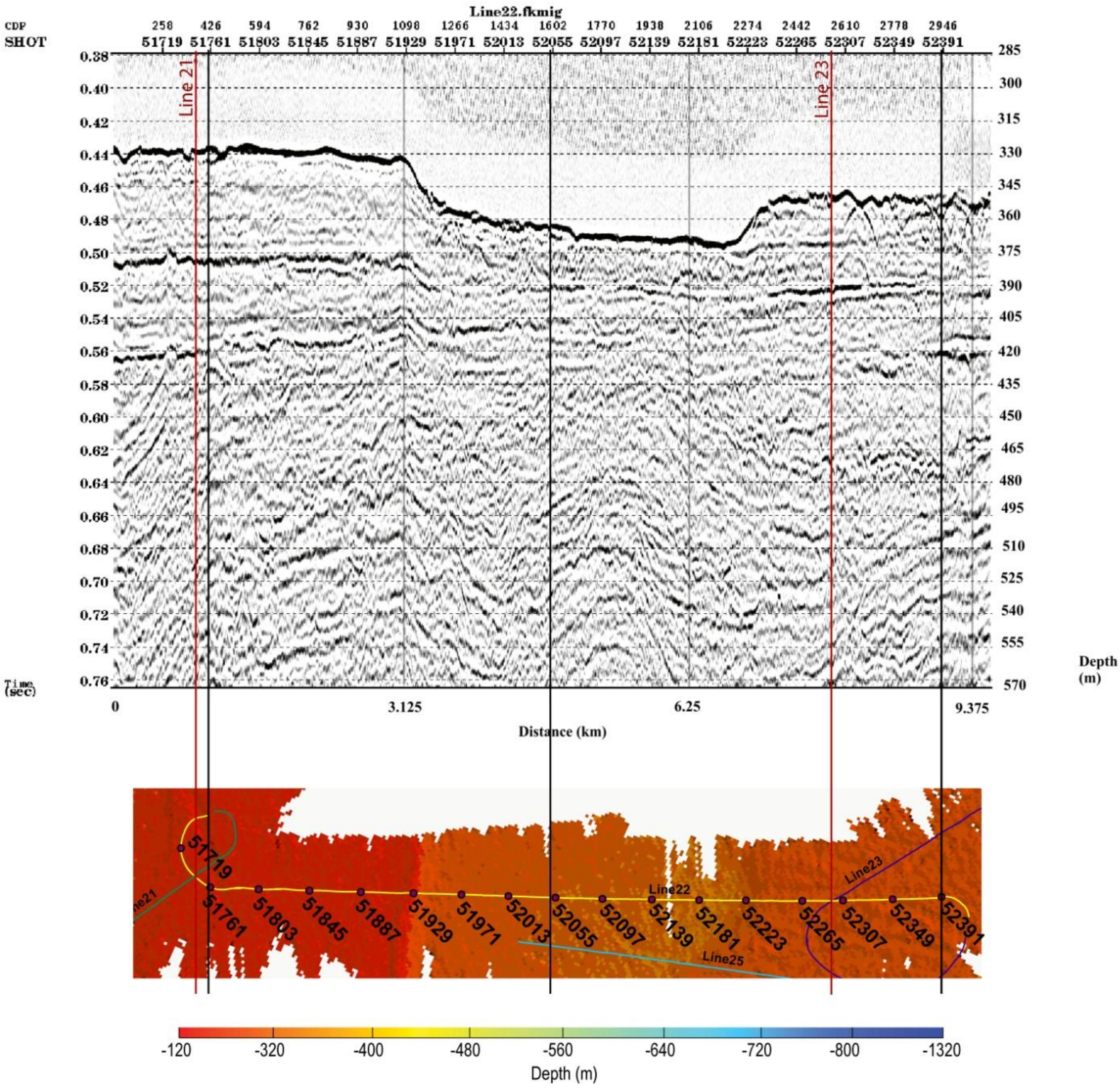
Line10.fkmig
CDP
SHOT
Line 10
Line 21
Line 12
Line 05
Line 17
Line 16a
Time (sec)
Depth (m)
Distance (km)
0
3.125
6.25
9.375
12.50
15.625
18.75
21.875
25.00
Line12
Line19
Line20
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)



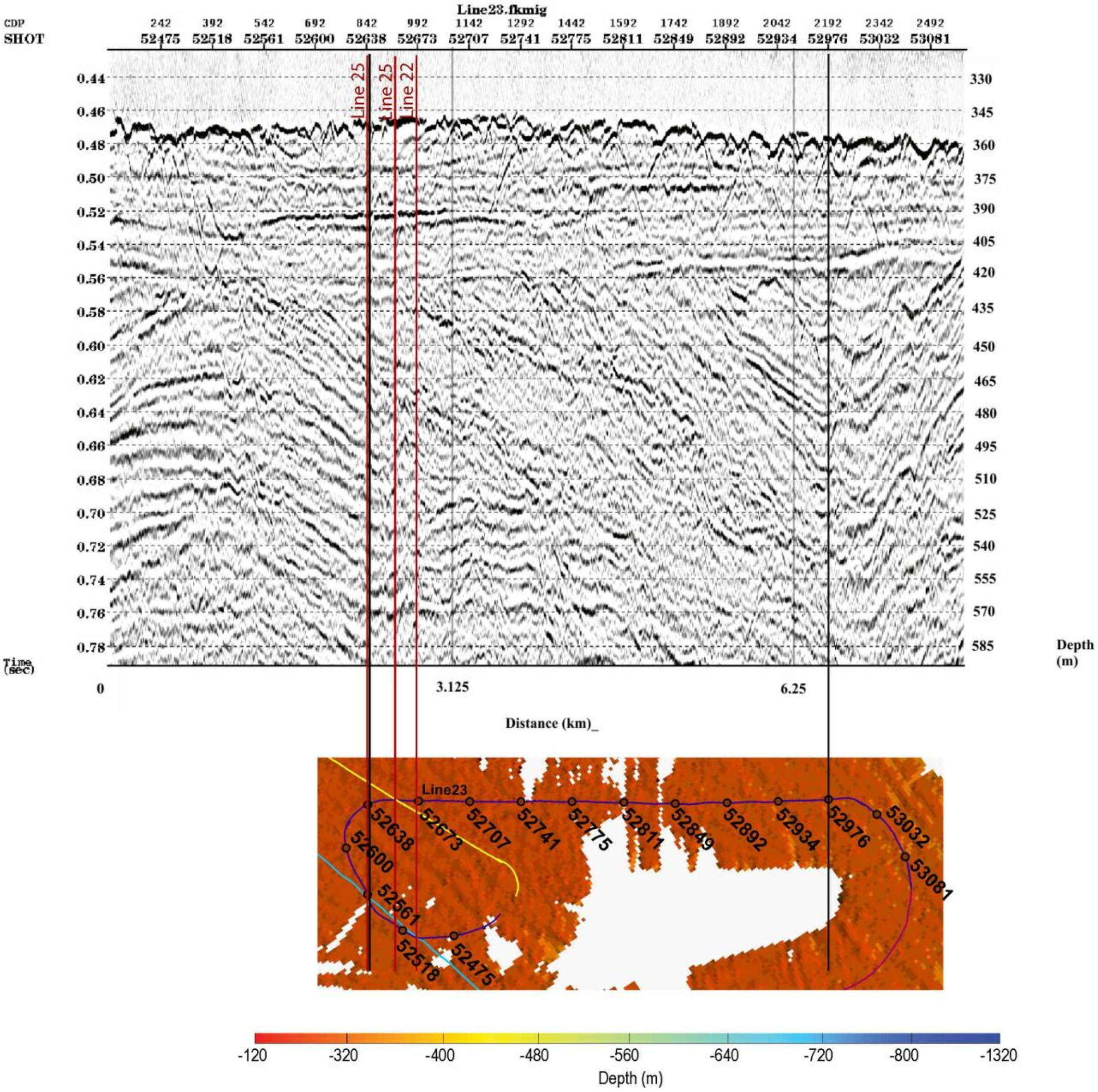
Line20.fkmig
CDP
SHOT
194 294 394 494 594 694 794 894 994 1094 1194
45639 45663 45686 45710 45733 45760 45786 45811 45836 45861 45886
Line 10
0.72 0.74 0.76 0.78 0.80 0.82 0.84 0.86 0.88 0.90 0.92 0.94 0.96 0.98 1.00
540 555 570 585 600 615 630 645 660 675 690 705 720 735 750
Time (sec)
Depth (m)
0 1.56 3.125
Distance (km)
Line20
45639 45663 45686 45710 45733 45760 45786 45811 45836 45861 45886
-120 -320 -400 -480 -560 -640 -720 -800 -1320
Depth (m)

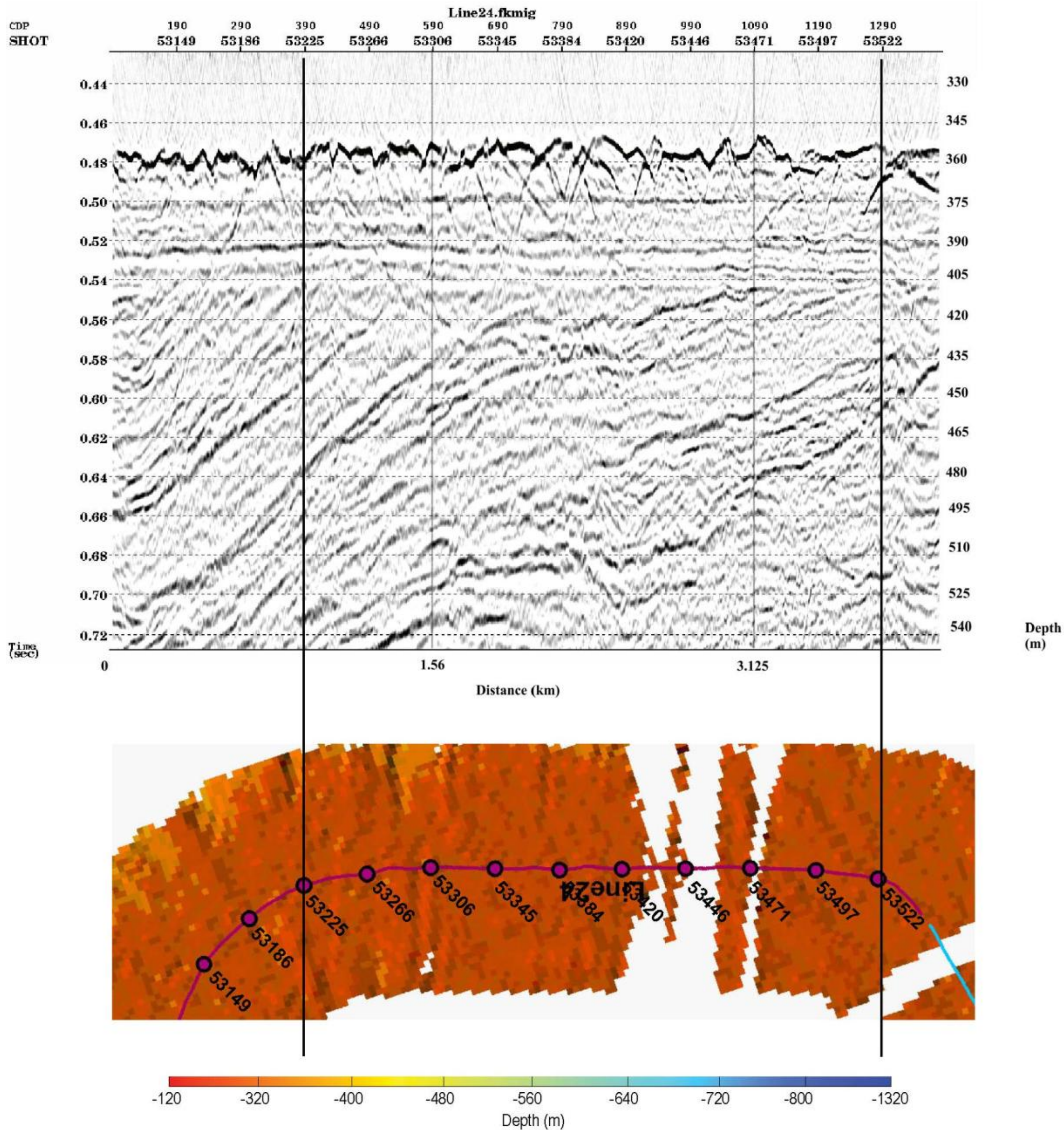


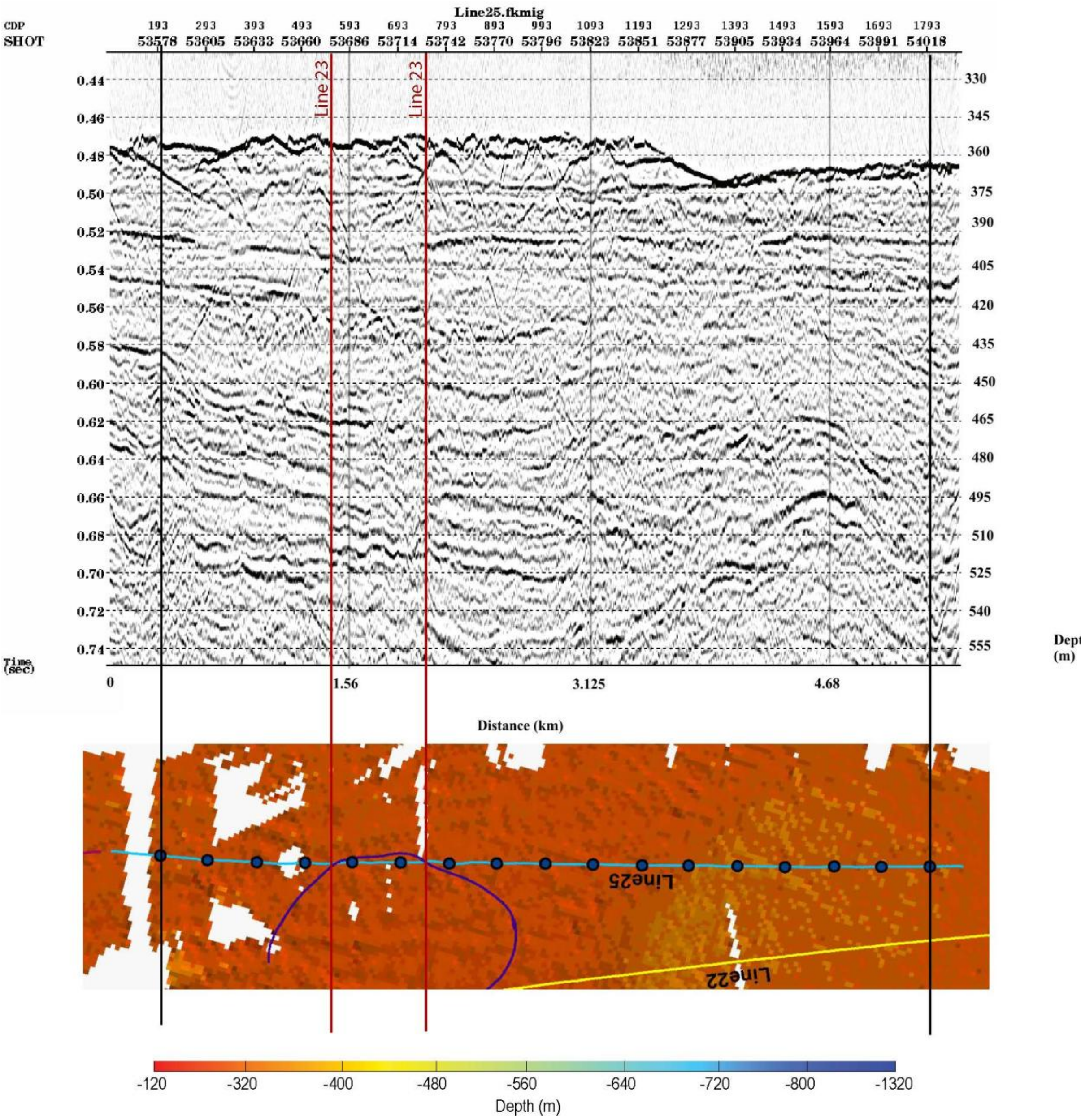
Line21.fkmig
CDP
SHOT
Line 19
Line 10
Line 12
Line 11
Line 27
Line 26
Line 28
Line 31
Line 33a
Distance (km)
Depth (m)
Line20
Line11
Line21
Line27
Line26
Line28
Line31
Line33a
MC61
JPC57
MC45
JKC53
KC27B
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)

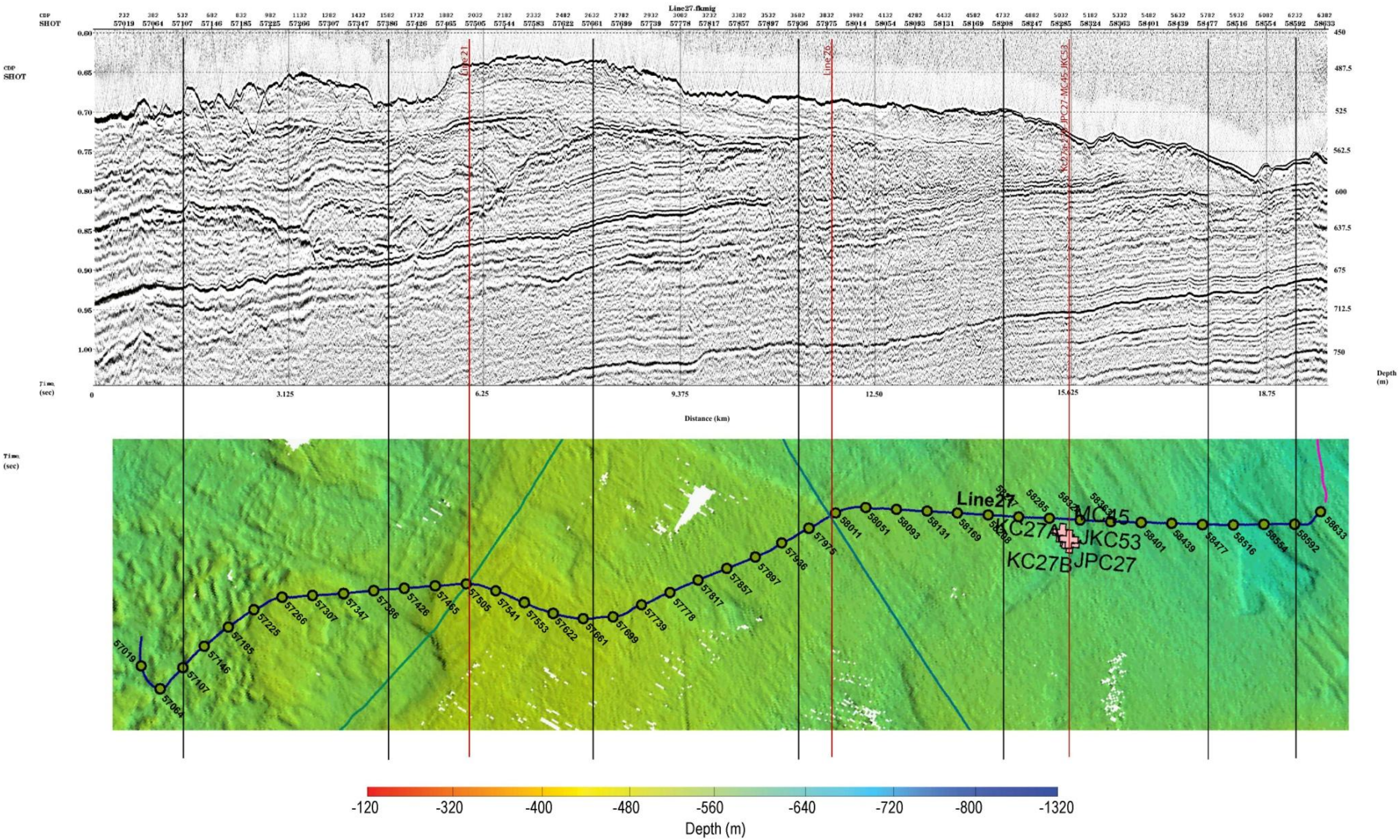


Line22.fkmig
CDP
SHOT
Line 21
Line 23
Time (sec)
Depth (m)
Distance (km)
0
3.125
6.25
9.375
Line22
Line23
Line25
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)

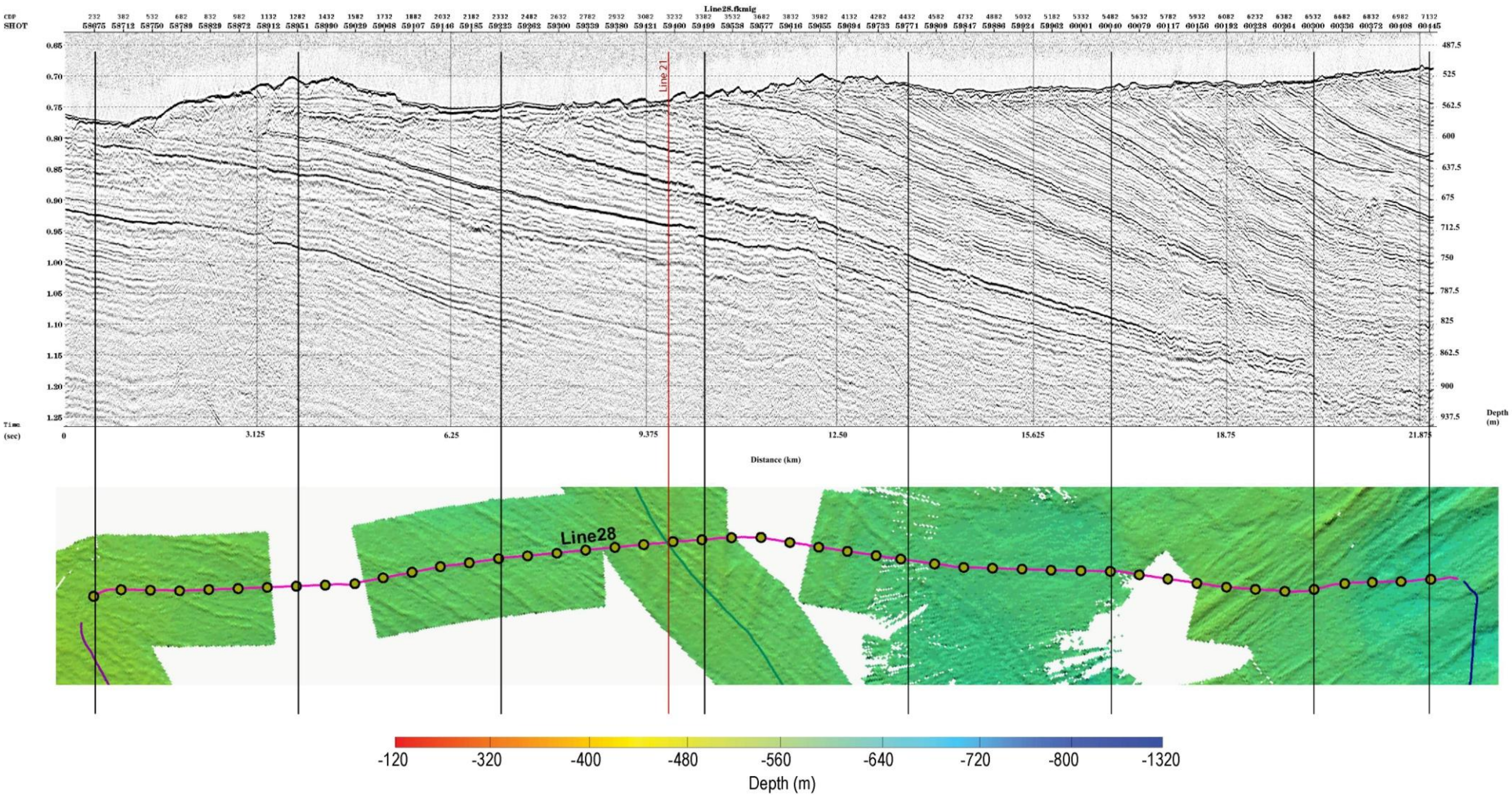

Line23.fkmig
CDP
SHOT
242 392 542 692 842 992 1142 1292 1442 1592 1742 1892 2042 2192 2342 2492
52475 52518 52561 52600 52638 52673 52707 52741 52775 52811 52849 52892 52934 52976 53032 53081
Line 25
Line 25
Line 22
0.44 0.46 0.48 0.50 0.52 0.54 0.56 0.58 0.60 0.62 0.64 0.66 0.68 0.70 0.72 0.74 0.76 0.78
Time (sec)
330 345 360 375 390 405 420 435 450 465 480 495 510 525 540 555 570 585
Depth (m)
0
3.125
6.25
Distance (km)_
Line23
52638 52673 52707 52741 52775 52811 52849 52892 52934 52976 53032 53081 52600 52561 52518 52475
-120 -320 -400 -480 -560 -640 -720 -800 -1320
Depth (m)


Line24.fkmig
CDP
SHOT
190 290 390 490 590 690 790 890 990 1090 1190 1290
53149 53186 53225 53266 53306 53345 53384 53420 53446 53471 53497 53522
0.44 0.46 0.48 0.50 0.52 0.54 0.56 0.58 0.60 0.62 0.64 0.66 0.68 0.70 0.72
Time (sec)
330 345 360 375 390 405 420 435 450 465 480 495 510 525 540
Depth (m)
0 1.56 3.125
Distance (km)
-120 -320 -400 -480 -560 -640 -720 -800 -1320
Depth (m)

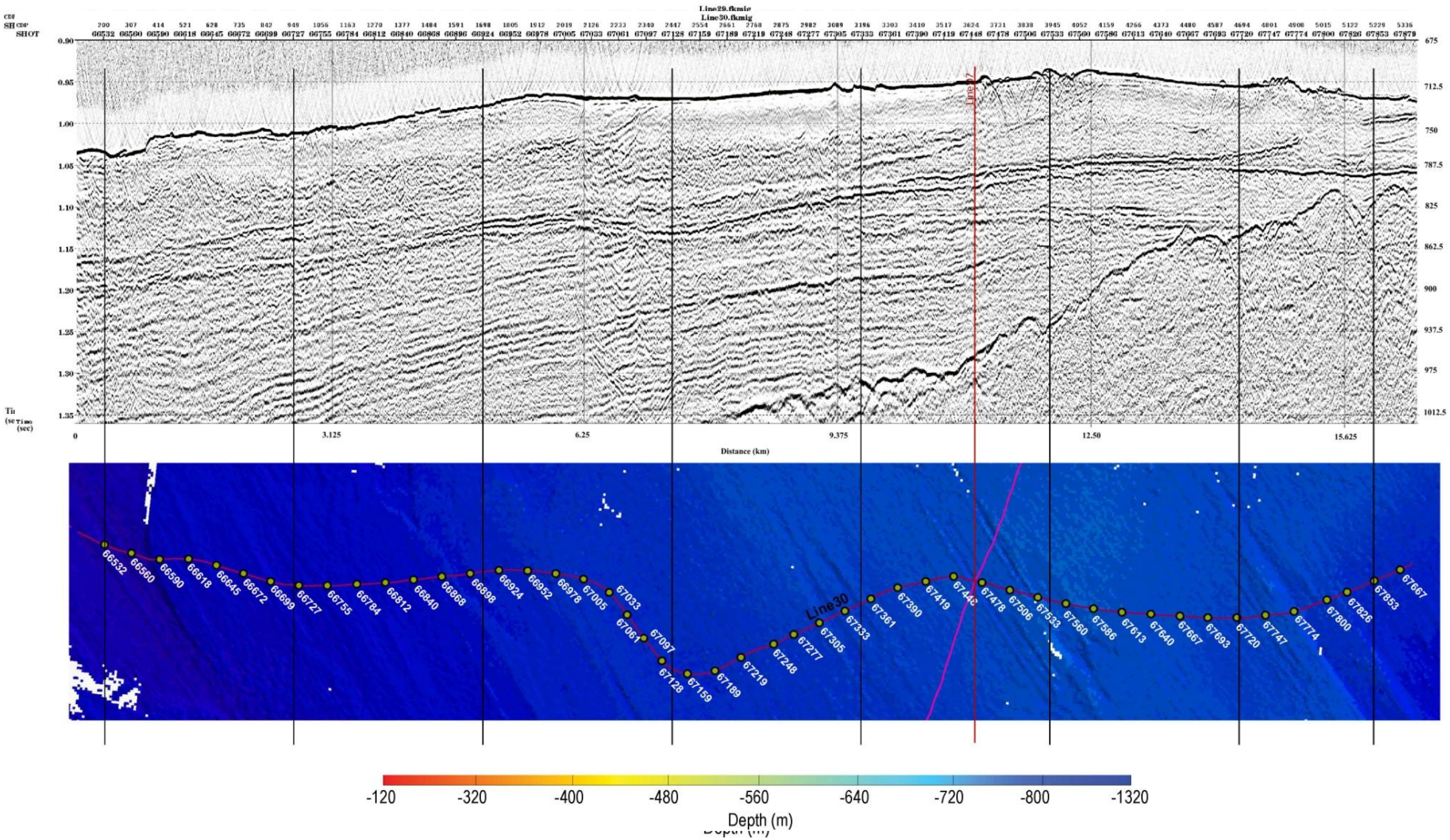

Line25.fkmig
CDP
SHOT
193 293 393 493 593 693 793 893 993 1093 1193 1293 1393 1493 1593 1693 1793
53578 53605 53633 53660 53686 53714 53742 53770 53796 53823 53851 53877 53905 53934 53964 53991 54018
Line 23
Line 23
0.44 0.46 0.48 0.50 0.52 0.54 0.56 0.58 0.60 0.62 0.64 0.66 0.68 0.70 0.72 0.74
Time (sec)
330 345 360 375 390 405 420 435 450 465 480 495 510 525 540 555
Depth (m)
0 1.56 3.125 4.68
Distance (km)
Line25
Line22
-120 -320 -400 -480 -560 -640 -720 -800 -1320
Depth (m)

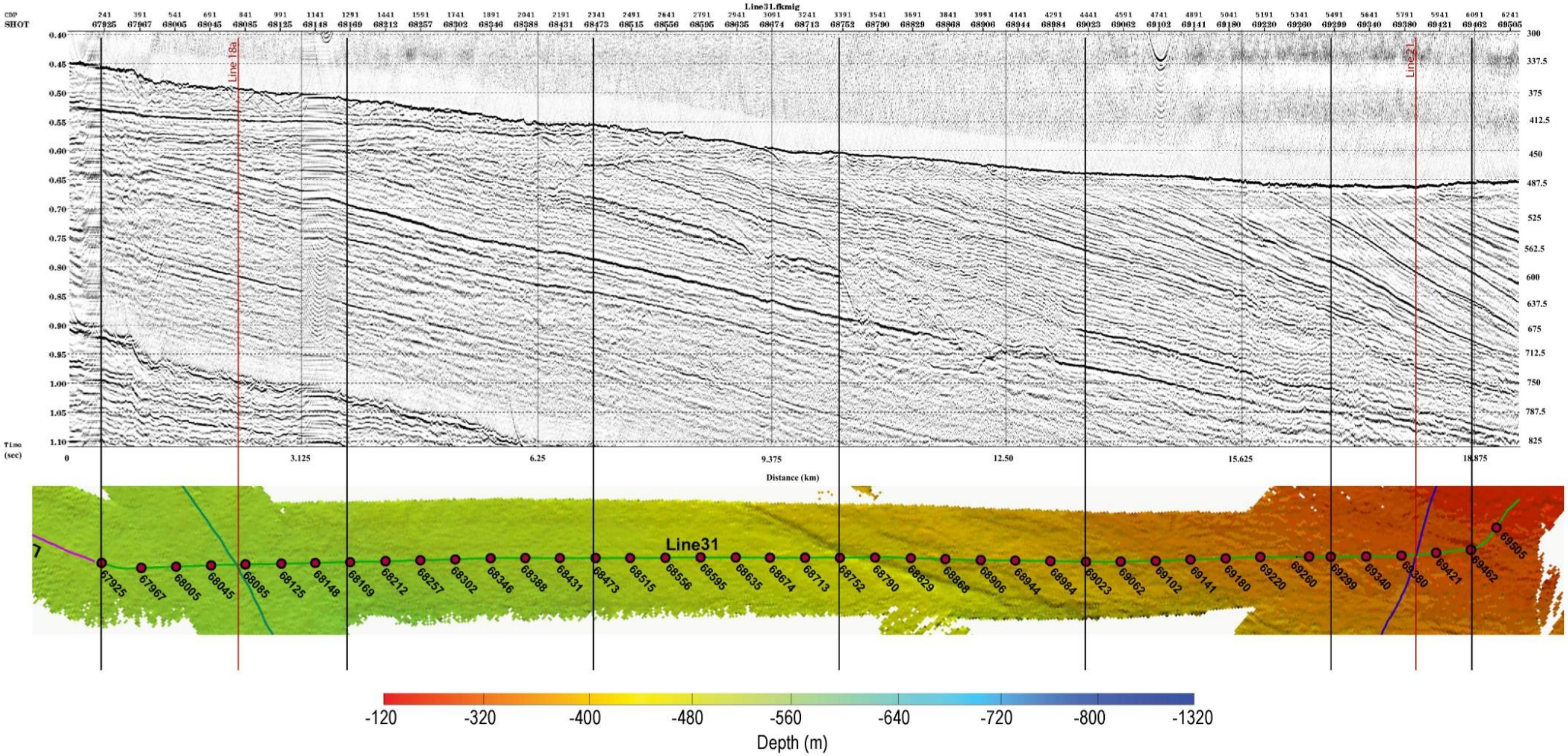


Line27.fkmig
CDP
SHOT
Line 21
Line 76
Time (sec)
Depth (m)
Distance (km)
0
3.125
6.25
9.375
12.50
15.625
18.75
Line27
MC45
KC27A
JKC53
KC27B
JPC27
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)

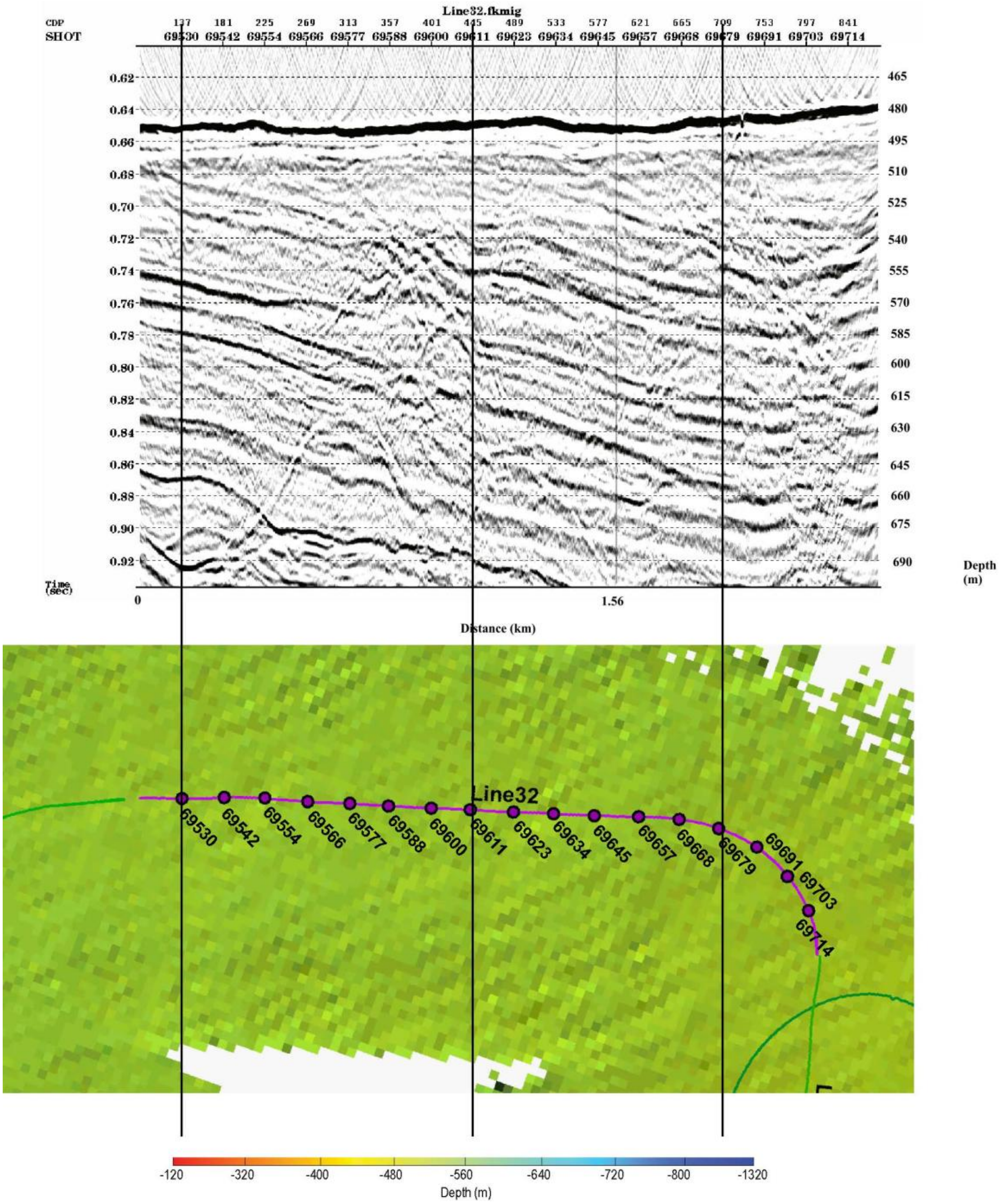


Line28.fkmig
CDP
SHOT
232 382 532 682 832 982 1132 1282 1432 1582 1732 1882 2032 2182 2332 2482 2632 2782 2932 3082 3232 3382 3532 3682 3832 3982 4132 4282 4432 4582 4732 4882 5032 5182 5332 5482 5632 5782 5932 6082 6232 6382 6532 6682 6832 6982 7132
58675 58712 58750 58789 58829 58872 58912 58951 58990 59029 59068 59107 59146 59185 59223 59262 59300 59339 59380 59421 59460 59499 59538 59577 59616 59655 59694 59733 59771 59809 59847 59886 59924 59962 60001 60040 60079 60117 60156 60192 60228 60264 60300 60336 60372 60408 60445
0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00 1.05 1.10 1.15 1.20 1.25
Time (sec)
487.5 525 562.5 600 637.5 675 712.5 750 787.5 825 862.5 900 937.5
Depth (m)
Line 21
0 3.125 6.25 9.375 12.50 15.625 18.75 21.875
Distance (km)
Line28
-120 -320 -400 -480 -560 -640 -720 -800 -1320
Depth (m)

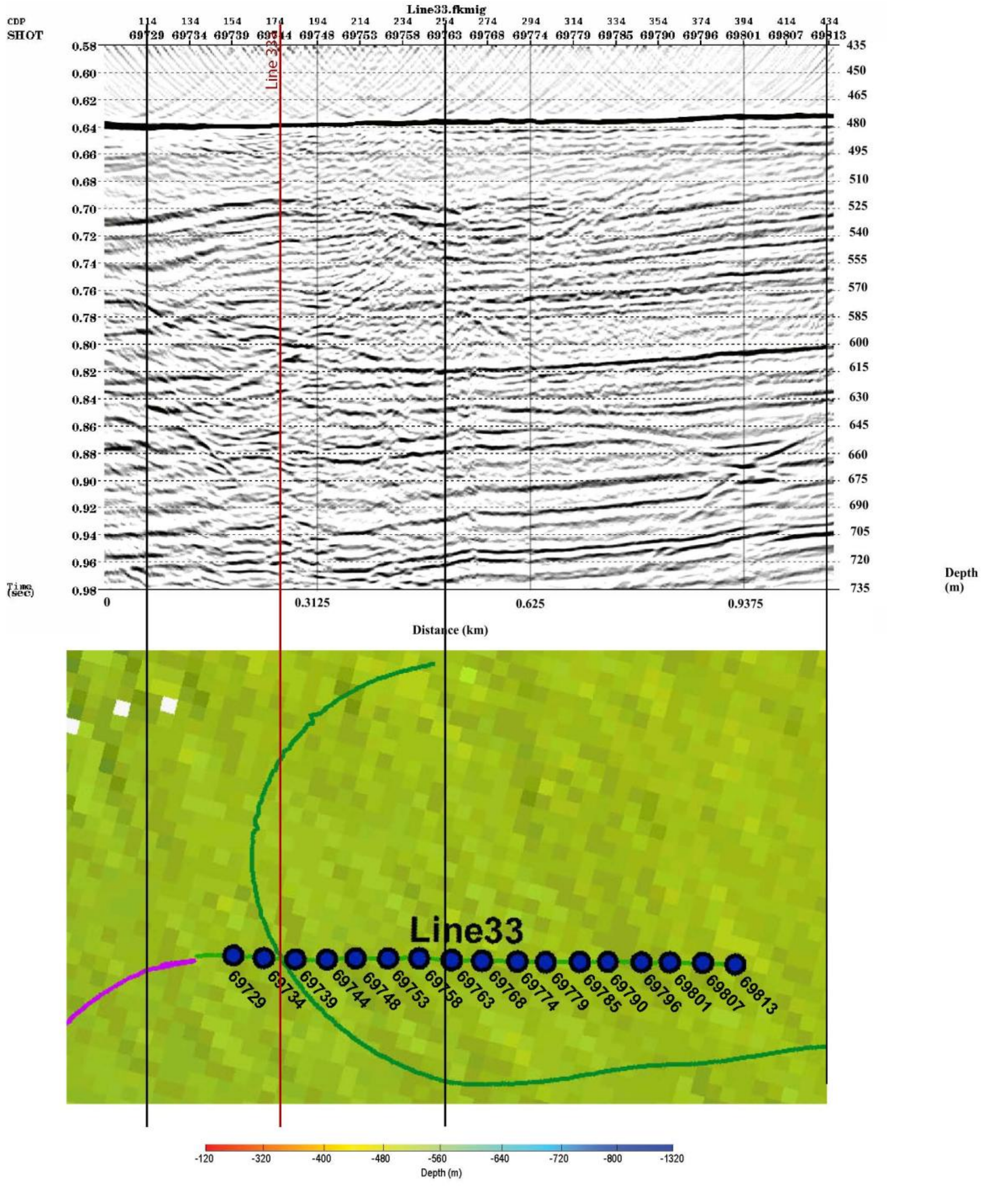

Line29.fkmig
Line30.fkmig
CDP
SHOT
Time (sec)
Distance (km)
Depth (m)
Line30
Line 27
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)



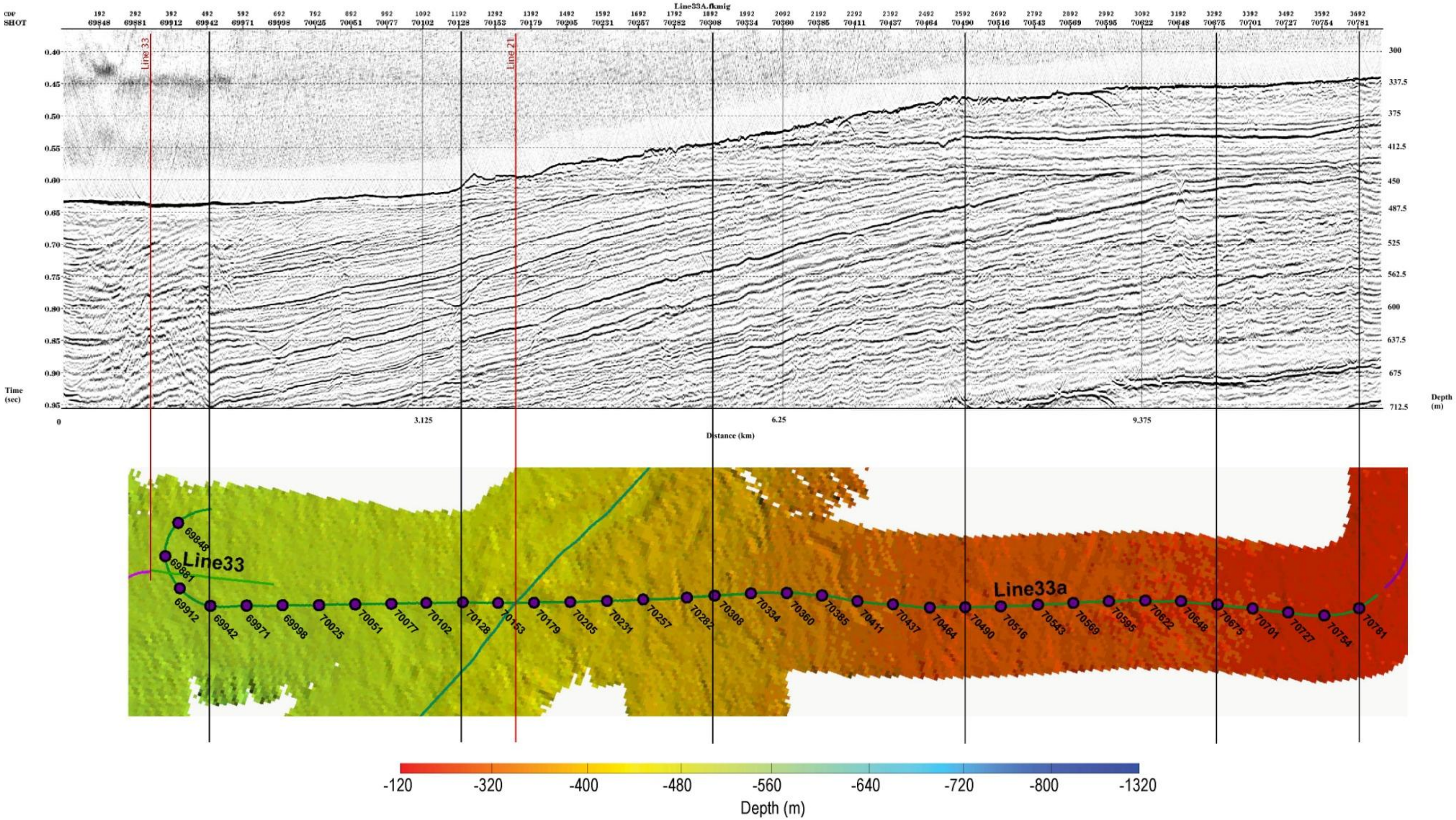
Line31.fkmig
CDP
SHOT
Time (sec)
Depth (m)
Distance (km)
0
3.125
6.25
9.375
12.50
15.625
18.875
Line 18a
Line21
Line31
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)



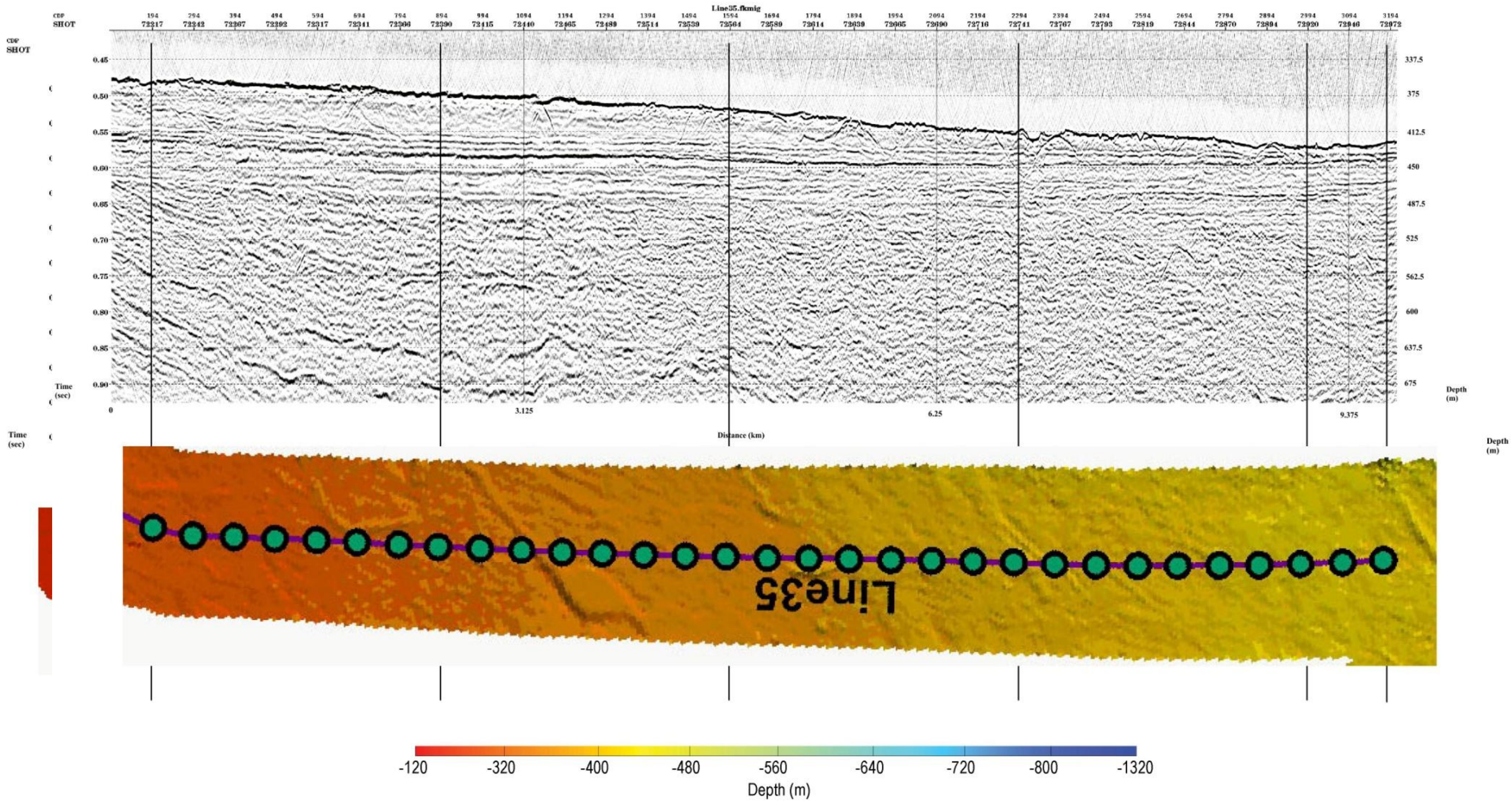
Line32.fkmig
CDP
SHOT
137 181 225 269 313 357 401 445 489 533 577 621 665 709 753 797 841
69530 69542 69554 69566 69577 69588 69600 69611 69623 69634 69645 69657 69668 69679 69691 69703 69714
0.62
0.64
0.66
0.68
0.70
0.72
0.74
0.76
0.78
0.80
0.82
0.84
0.86
0.88
0.90
0.92
465
480
495
510
525
540
555
570
585
600
615
630
645
660
675
690
Depth (m)
Time (sec)
0
1.56
Distance (km)
Line32
-120 -320 -400 -480 -560 -640 -720 -800 -1320
Depth (m)



Line33.fkmig
CDP
SHOT
Line 33
Time (sec)
Depth (m)
Distance (km)
0
0.3125
0.625
0.9375
Line33
69729
69734
69739
69744
69748
69753
69758
69763
69768
69774
69779
69785
69790
69796
69801
69807
69813
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)

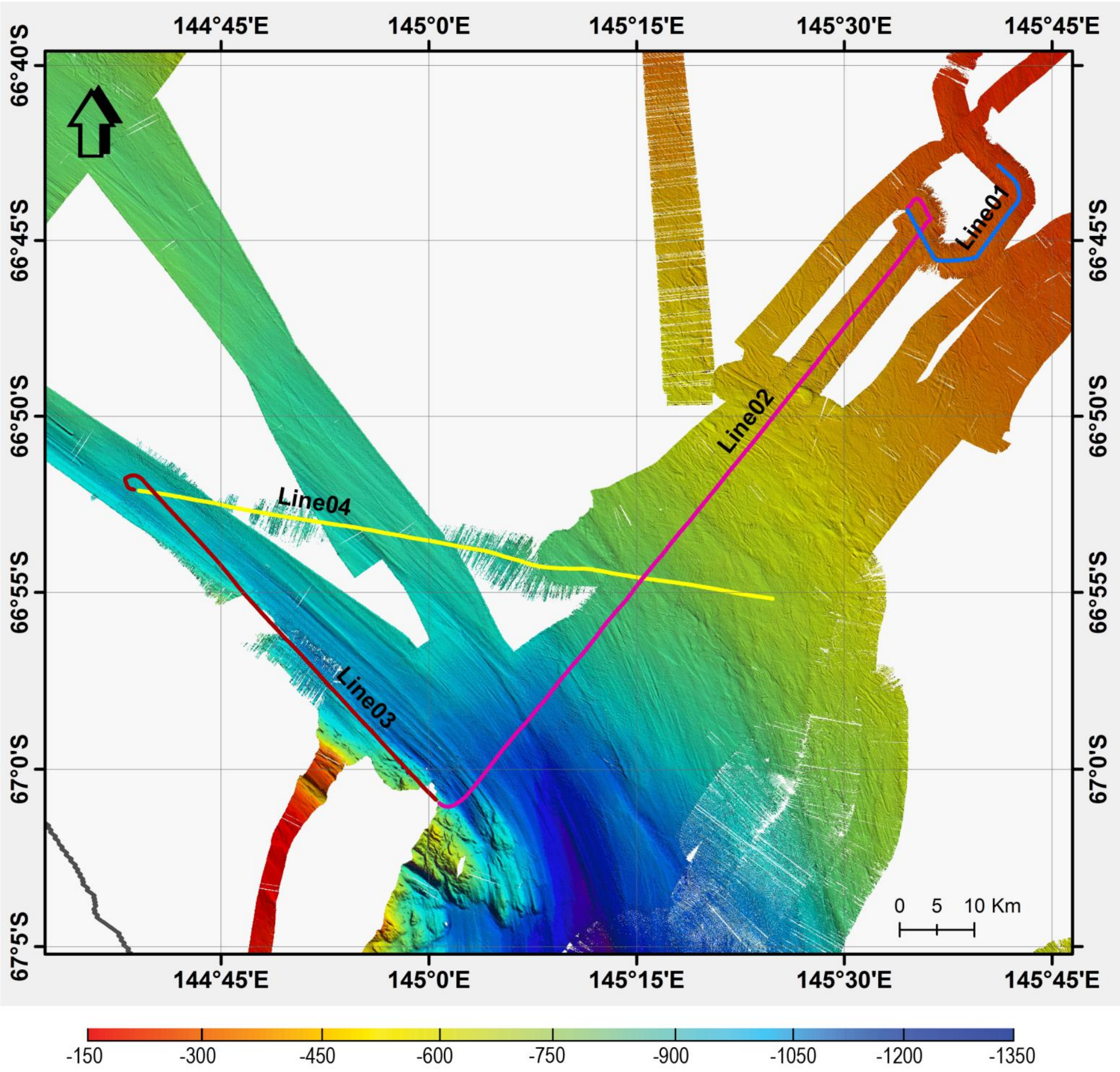


Line33A.fkmig
CDP
SHOT
Line 33
Line 21
Time (sec)
Depth (m)
Distance (km)
0
3.125
6.25
9.375
Line33
Line33a
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)

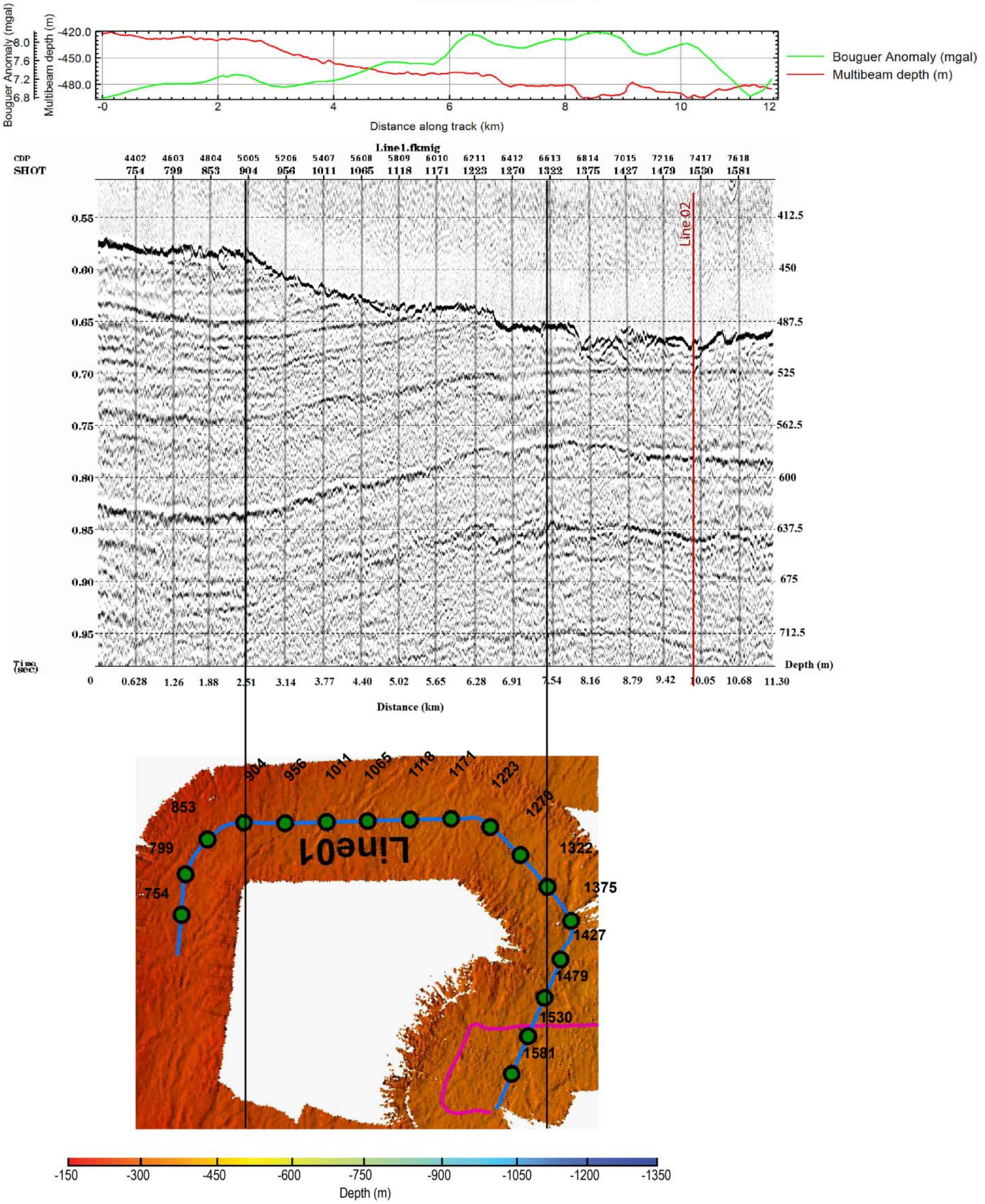


Line35.fkmig
CDP
SHOT
0.45
0.50
0.55
0.60
0.65
0.70
0.75
0.80
0.85
0.90
Time (sec)
337.5
375
412.5
450
487.5
525
562.5
600
637.5
675
Depth (m)
0
3.125
6.25
9.375
Distance (km)
Line35
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)

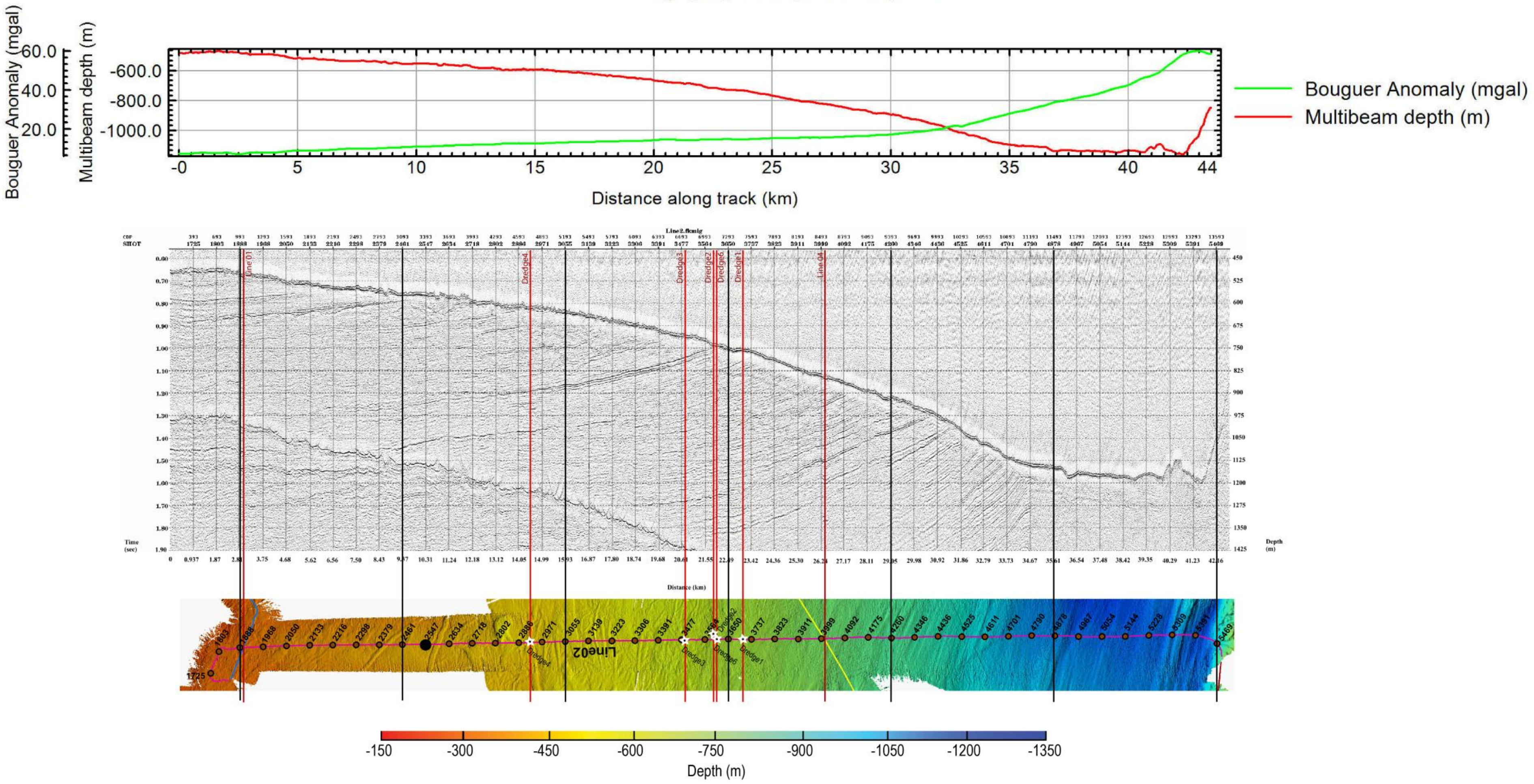
8b. Seismic lines along swath map with magnetic and gravity


144°45'E
145°0'E
145°15'E
145°30'E
145°45'E
66°40'S
66°45'S
66°50'S
66°55'S
67°0'S
67°5'S
Line01
Line02
Line03
Line04
0 5 10 Km
-150
-300
-450
-600
-750
-900
-1050
-1200
-1350
Depth (m)

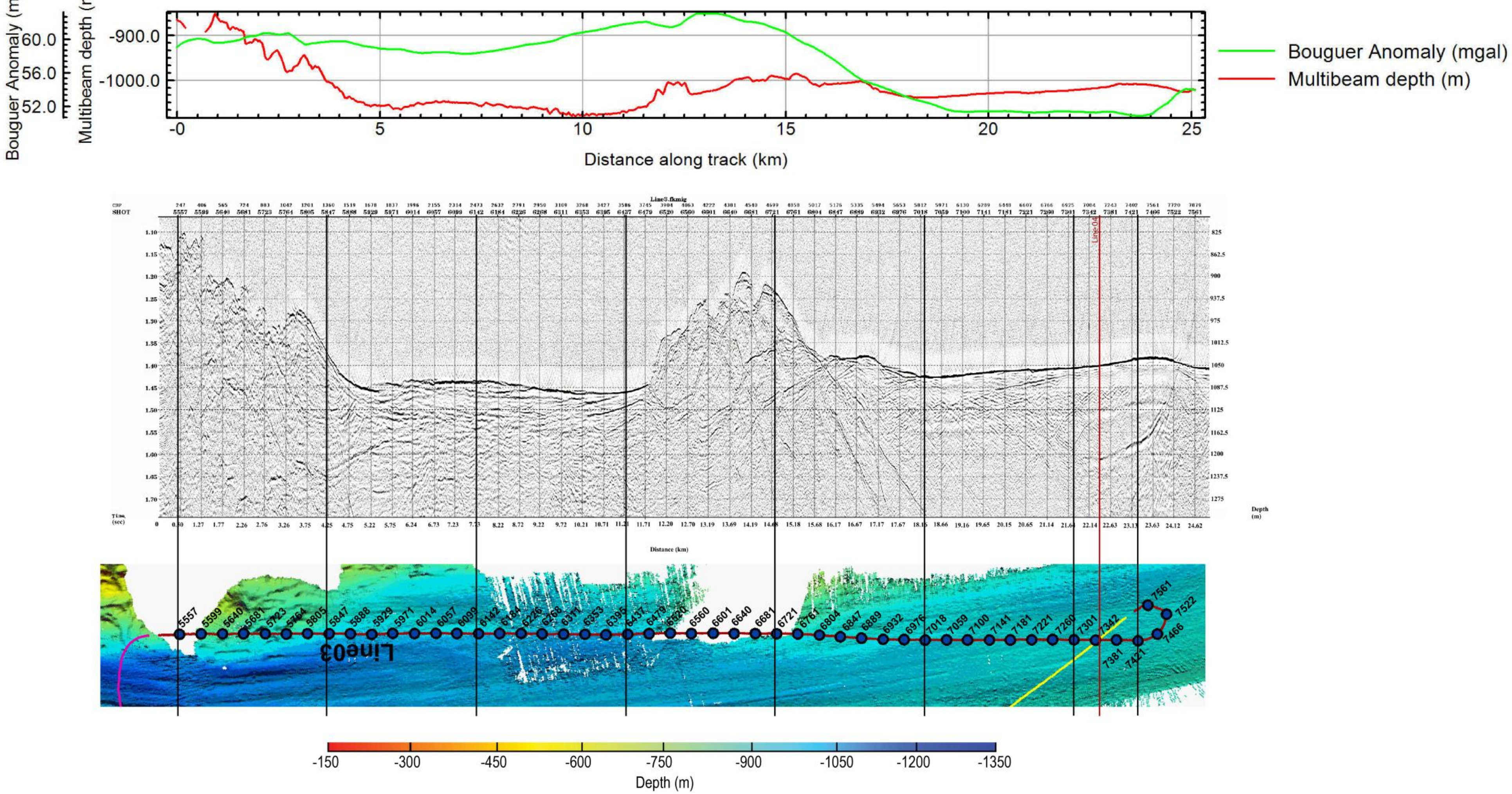
Seismic Line 1



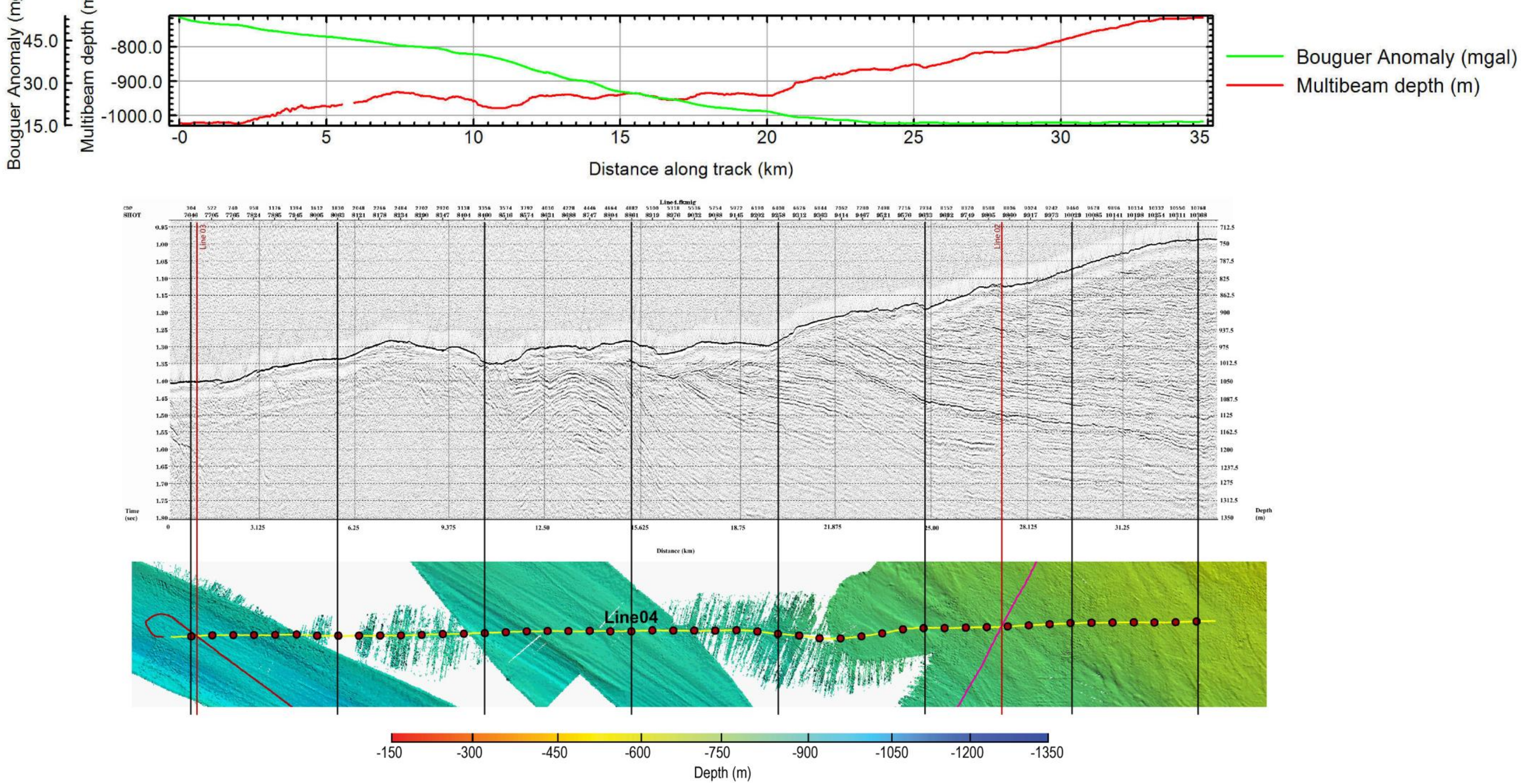
Seismic Line 2

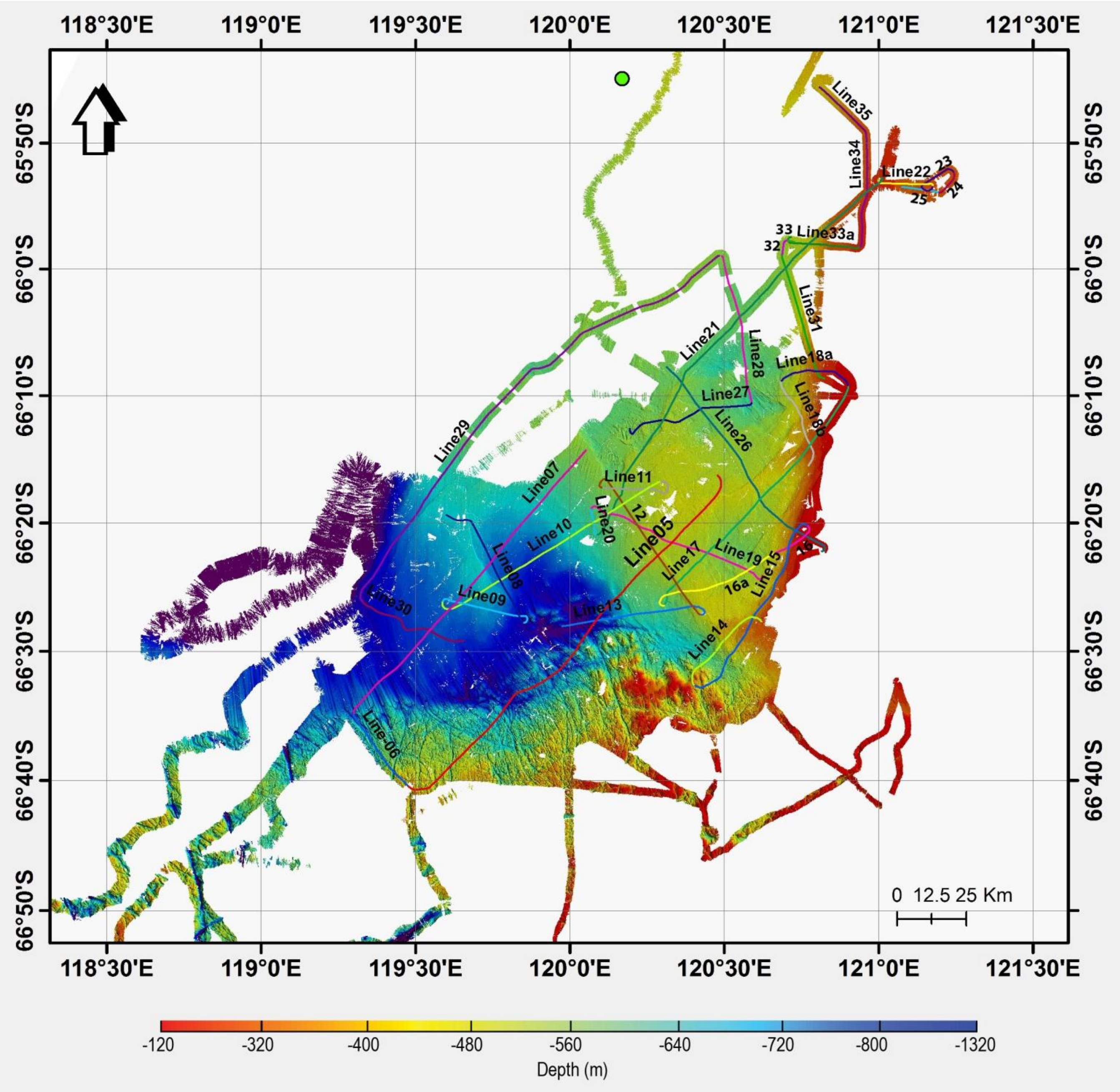


Seismic Line 3

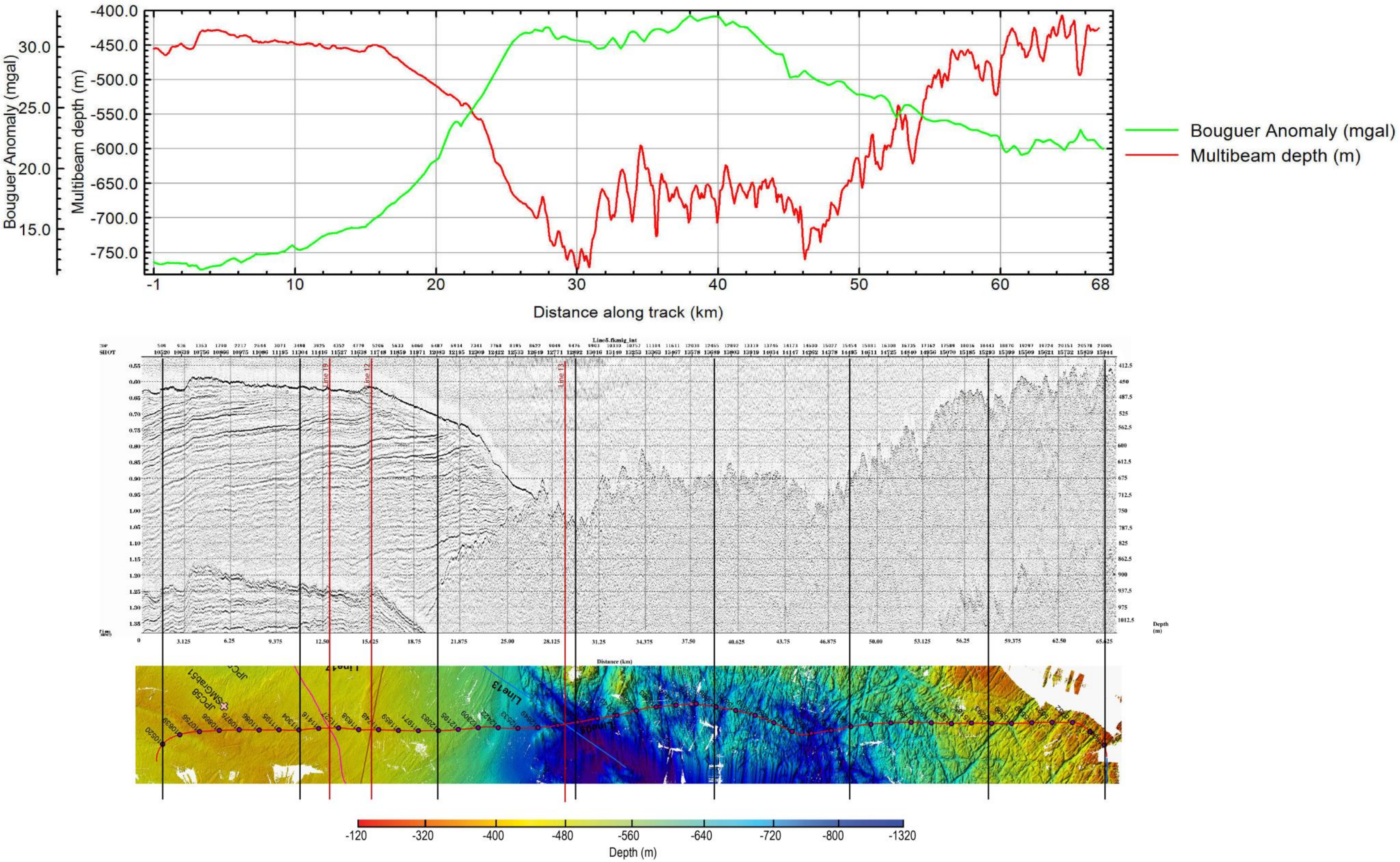


Seismic Line 4

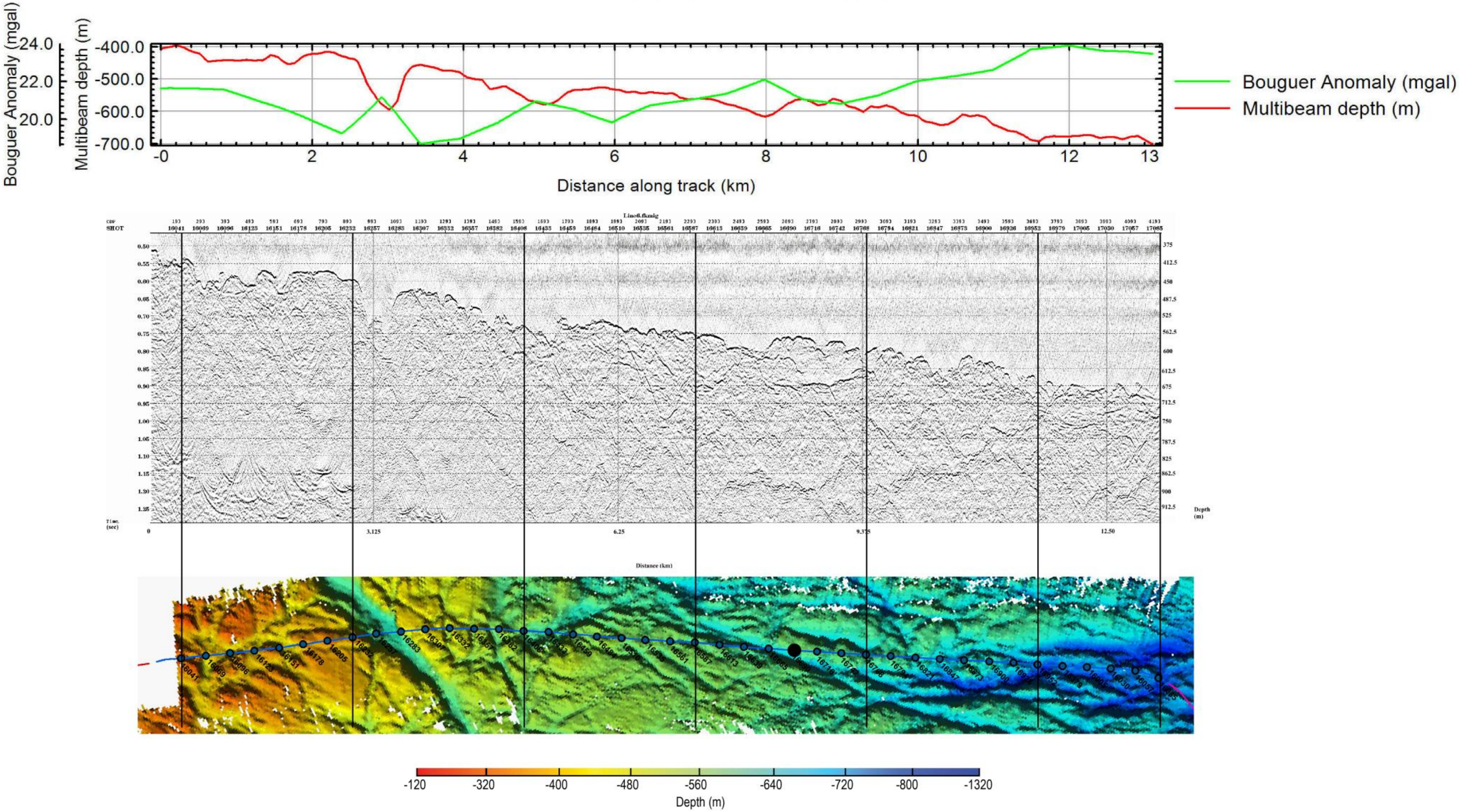



118°30'E
119°0'E
119°30'E
120°0'E
120°30'E
121°0'E
121°30'E
65°50'S
66°0'S
66°10'S
66°20'S
66°30'S
66°40'S
66°50'S
Line35
Line34
Line22
23
24
25
33 Line33a
32
Line31
Line21
Line28
Line18a
Line27
Line18b
Line26
Line29
Line07
Line11
12
Line20
Line10
Line05
Line08
Line17
Line19
Line15
16a
Line30
Line09
Line13
Line14
Line-06
0 12.5 25 Km
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)

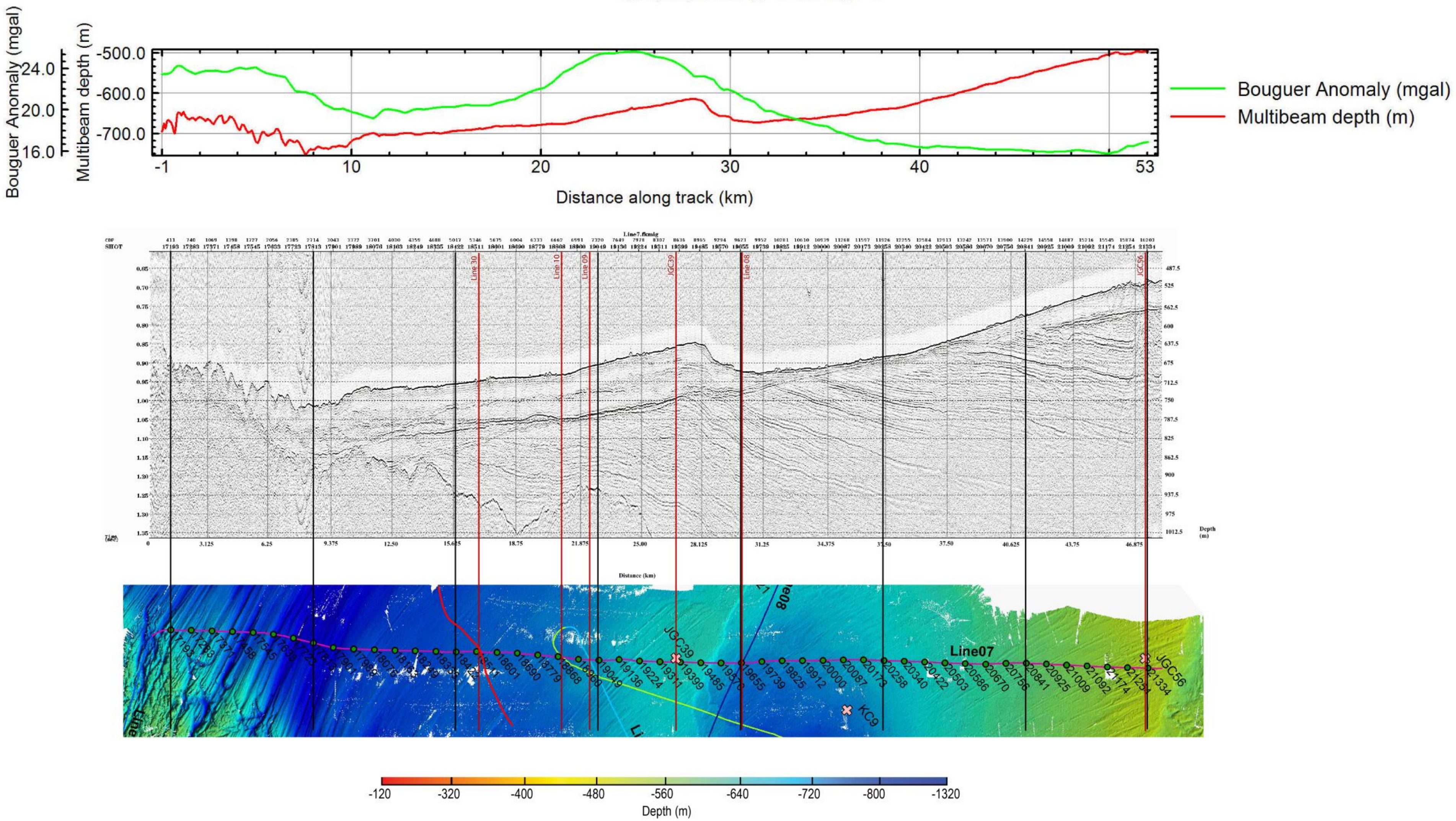
Seismic Line 5



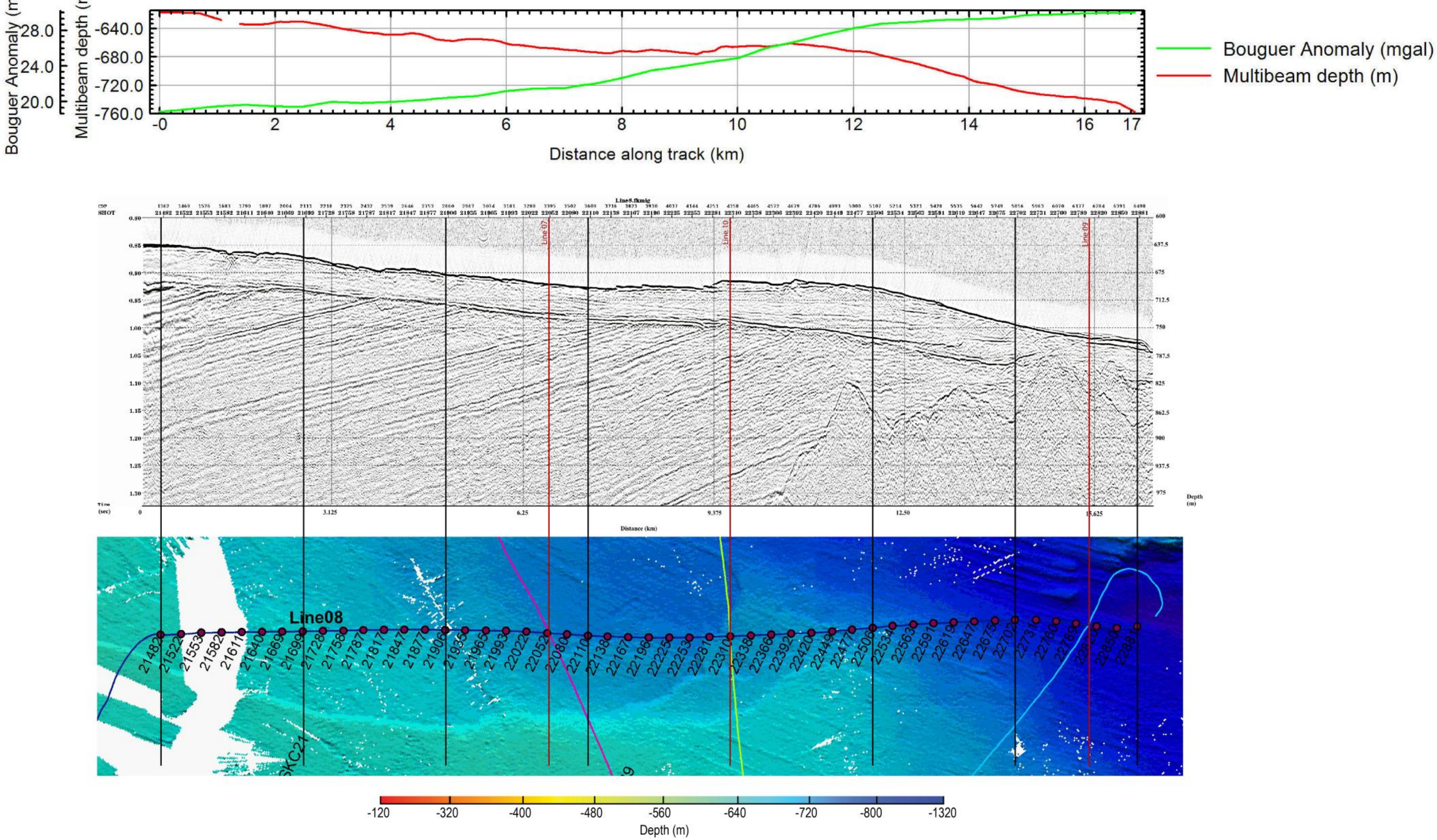
Seismic Line 6



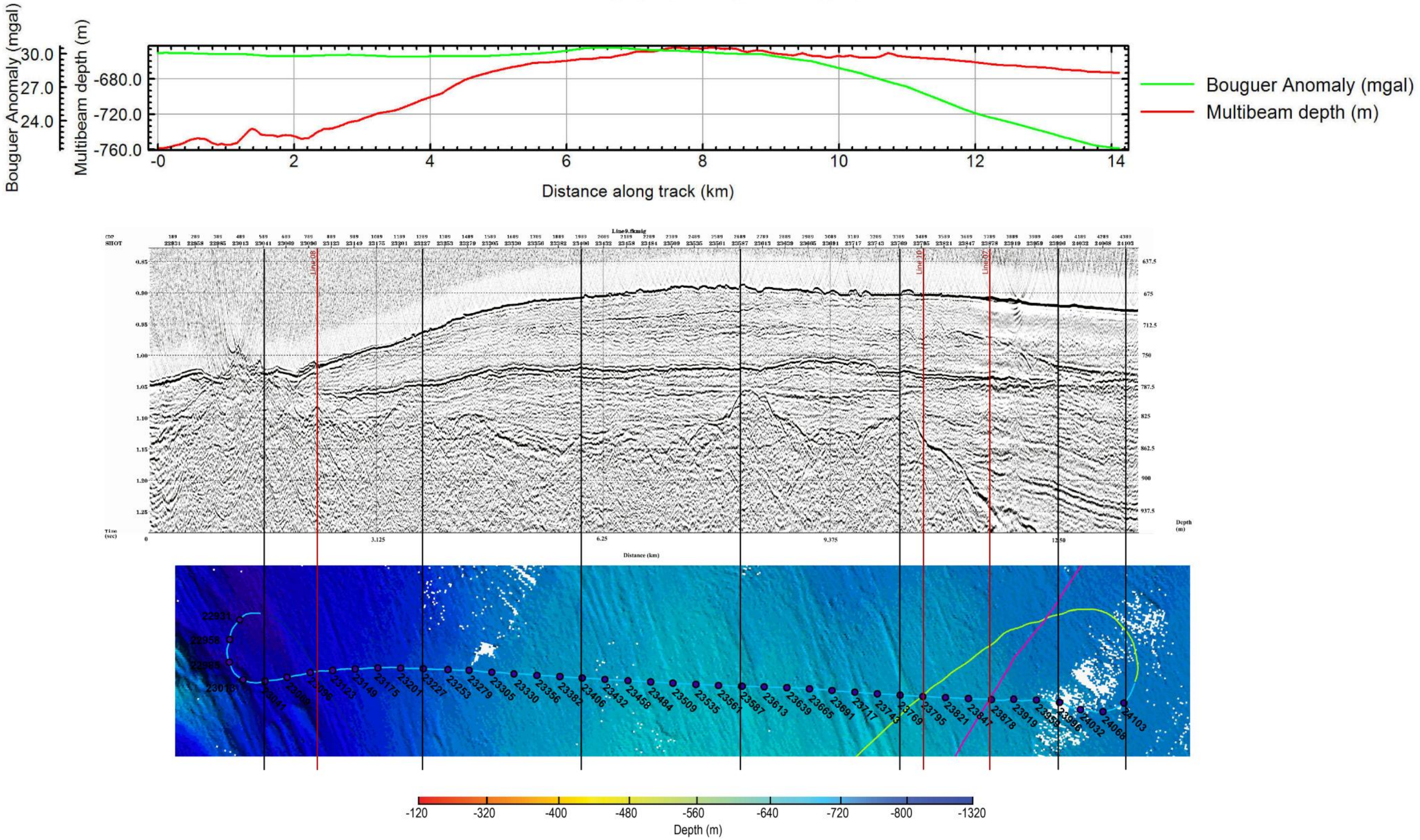
Seismic Line 7



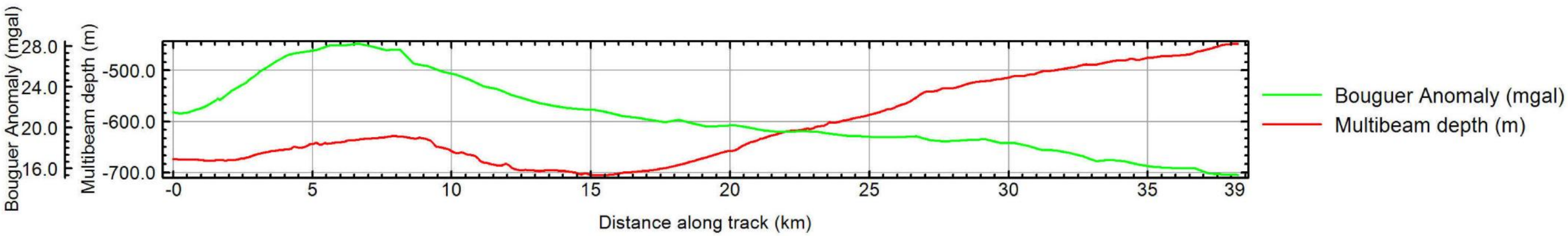
Seismic Line 8

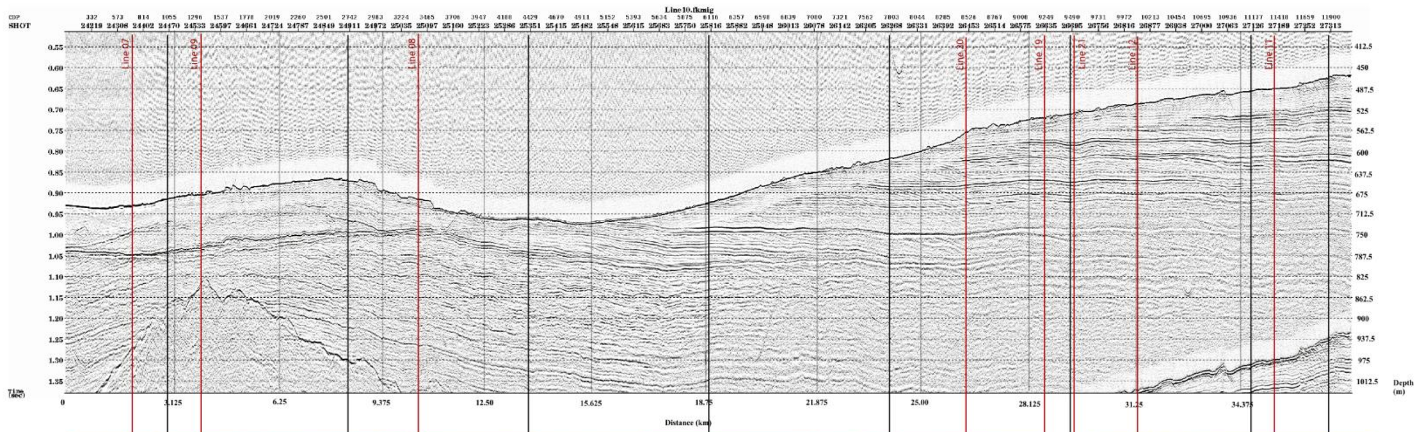


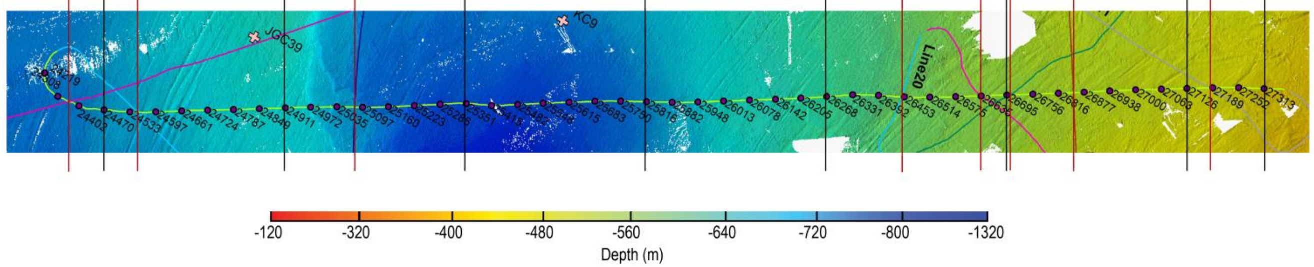
Seismic Line 9



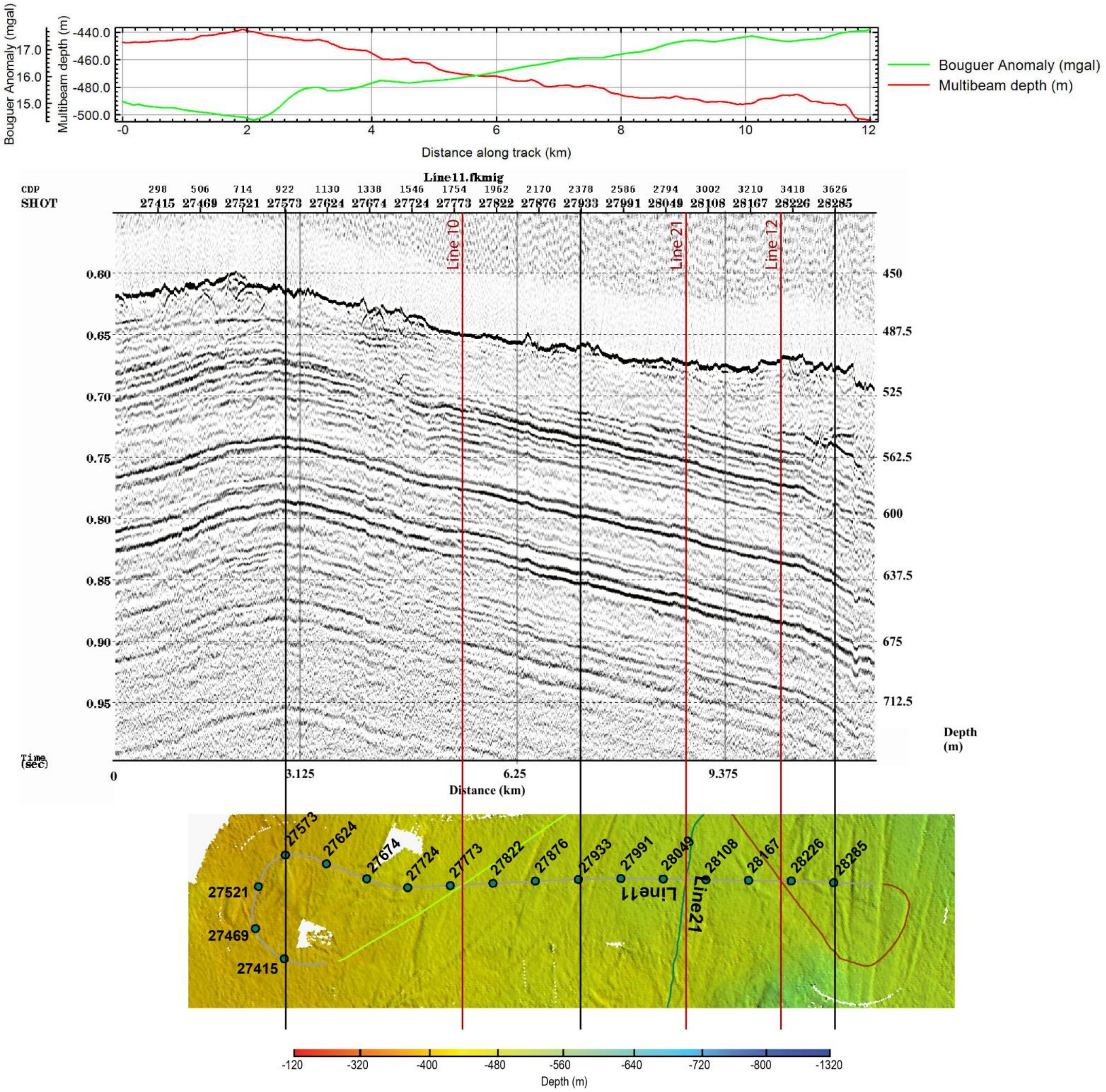
Seismic Line 10



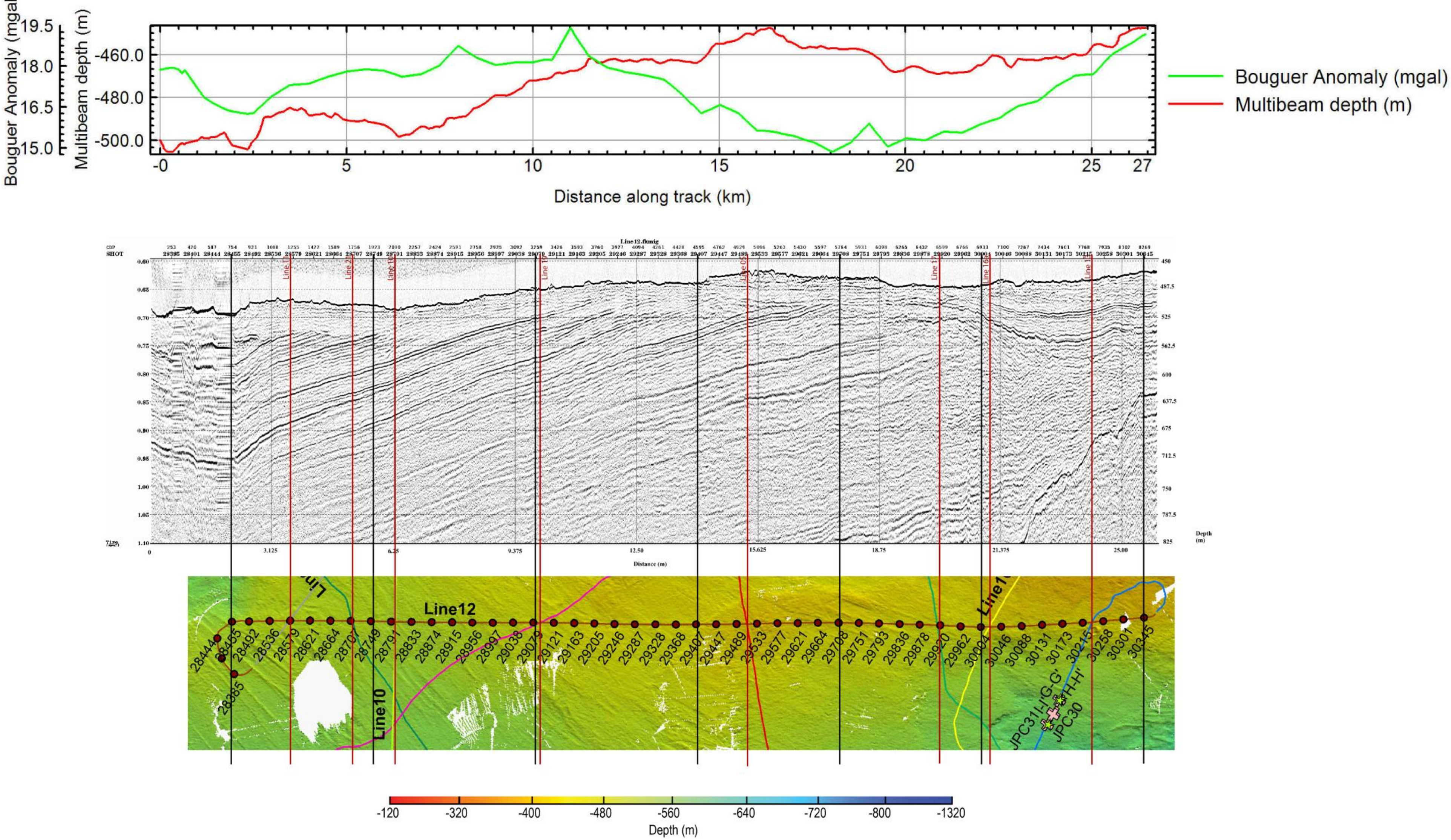




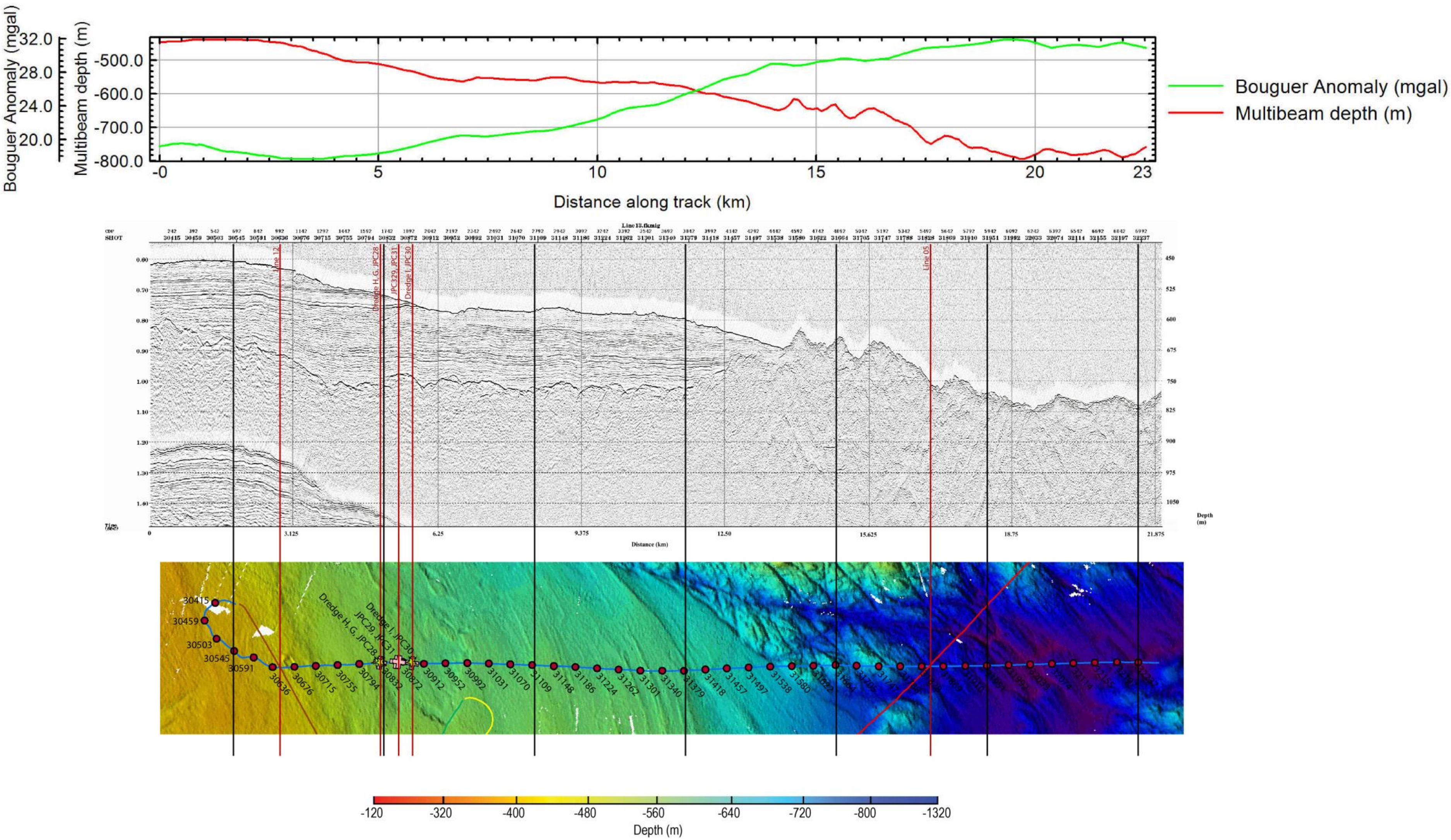
Seismic Line 11



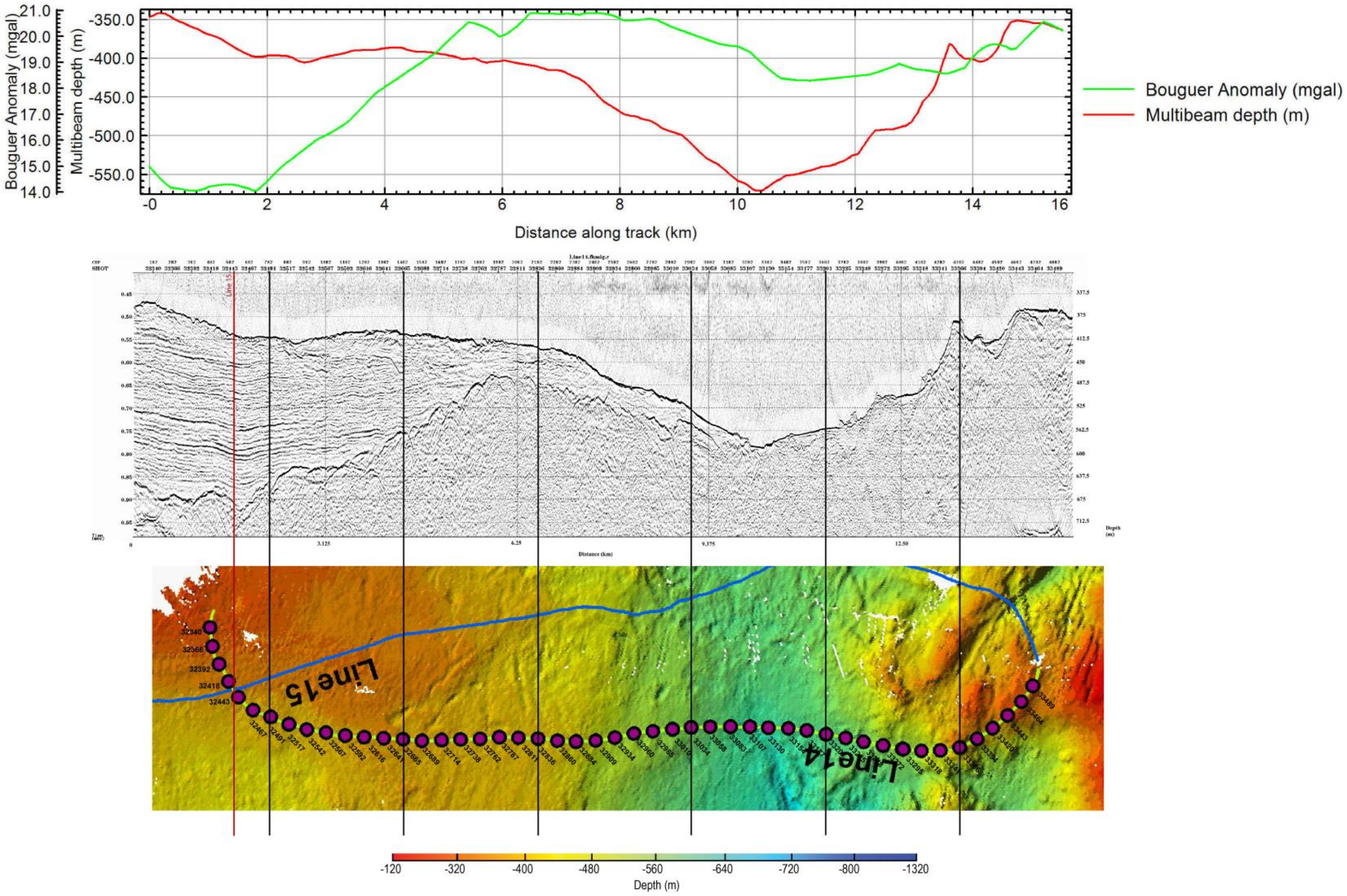
Seismic Line 12



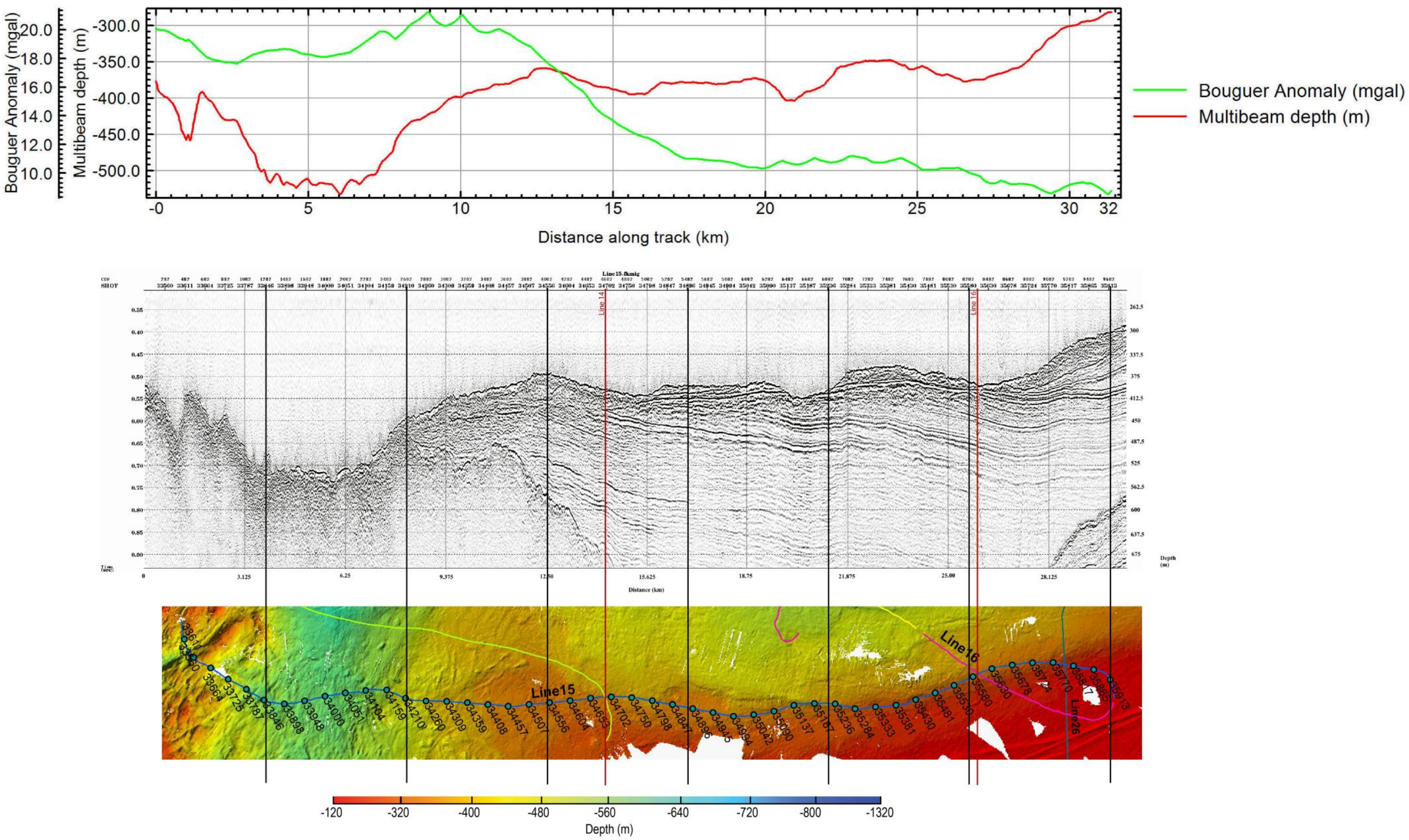
Seismic Line 13



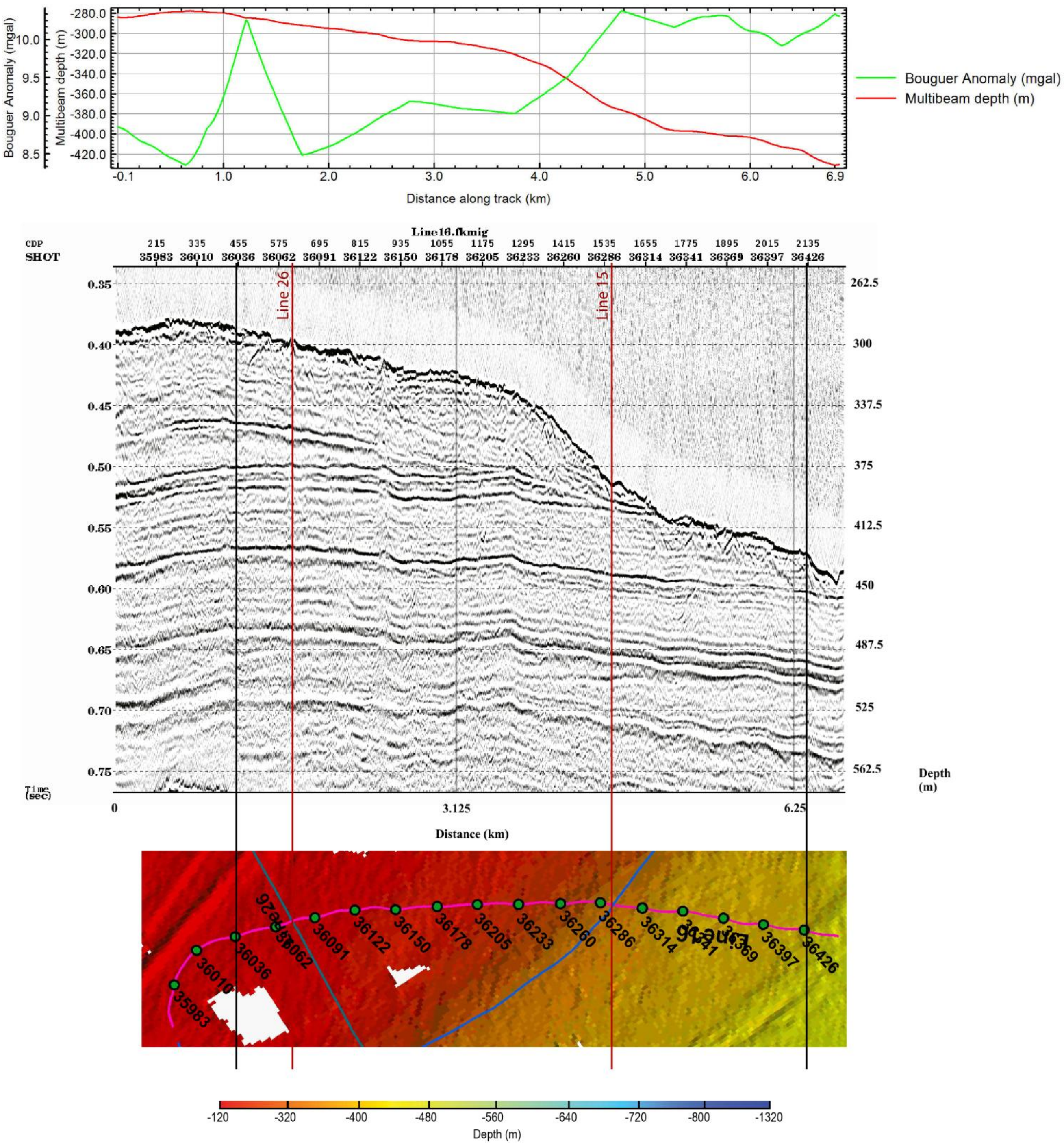
Seismic Line 14



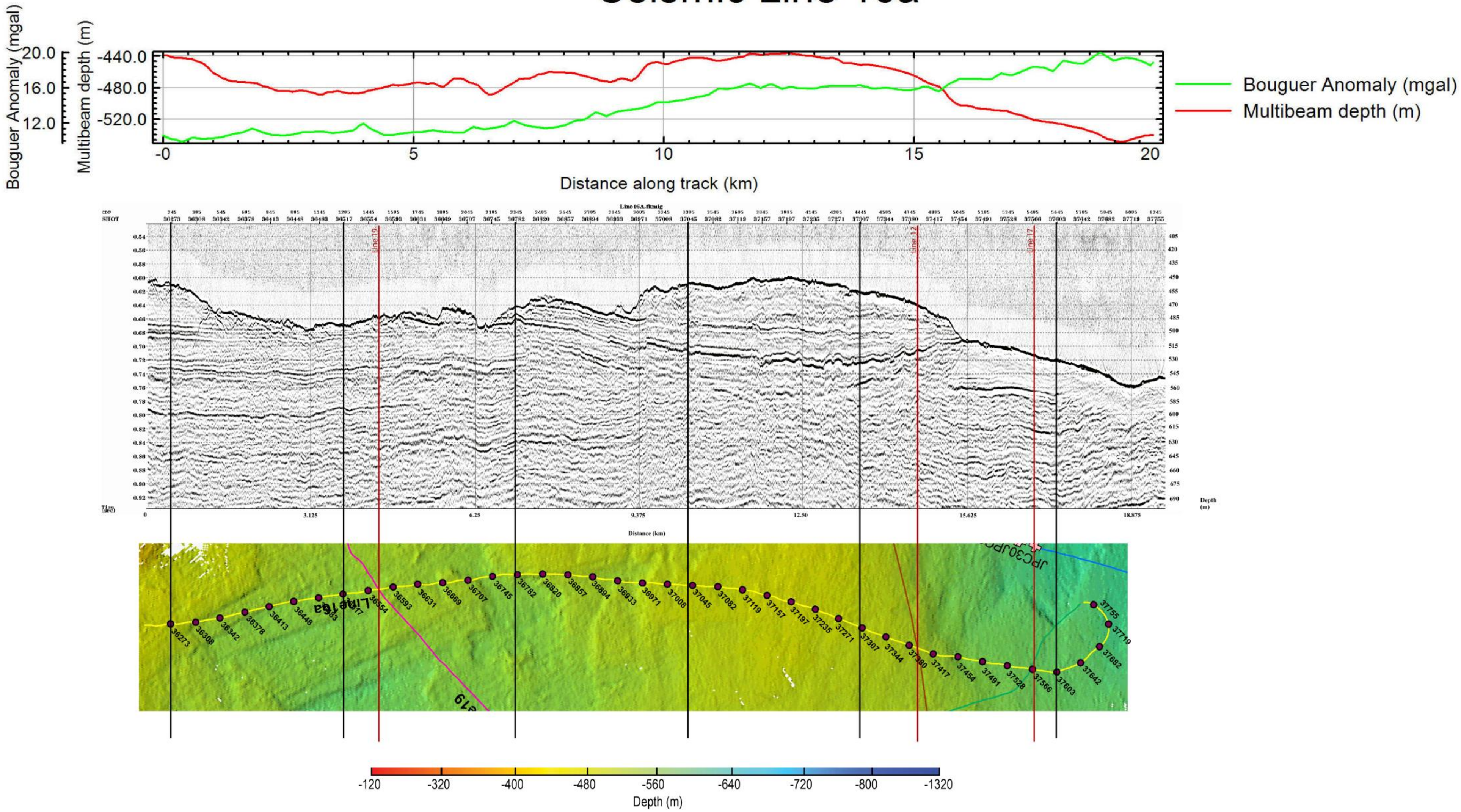
Seismic Line 15



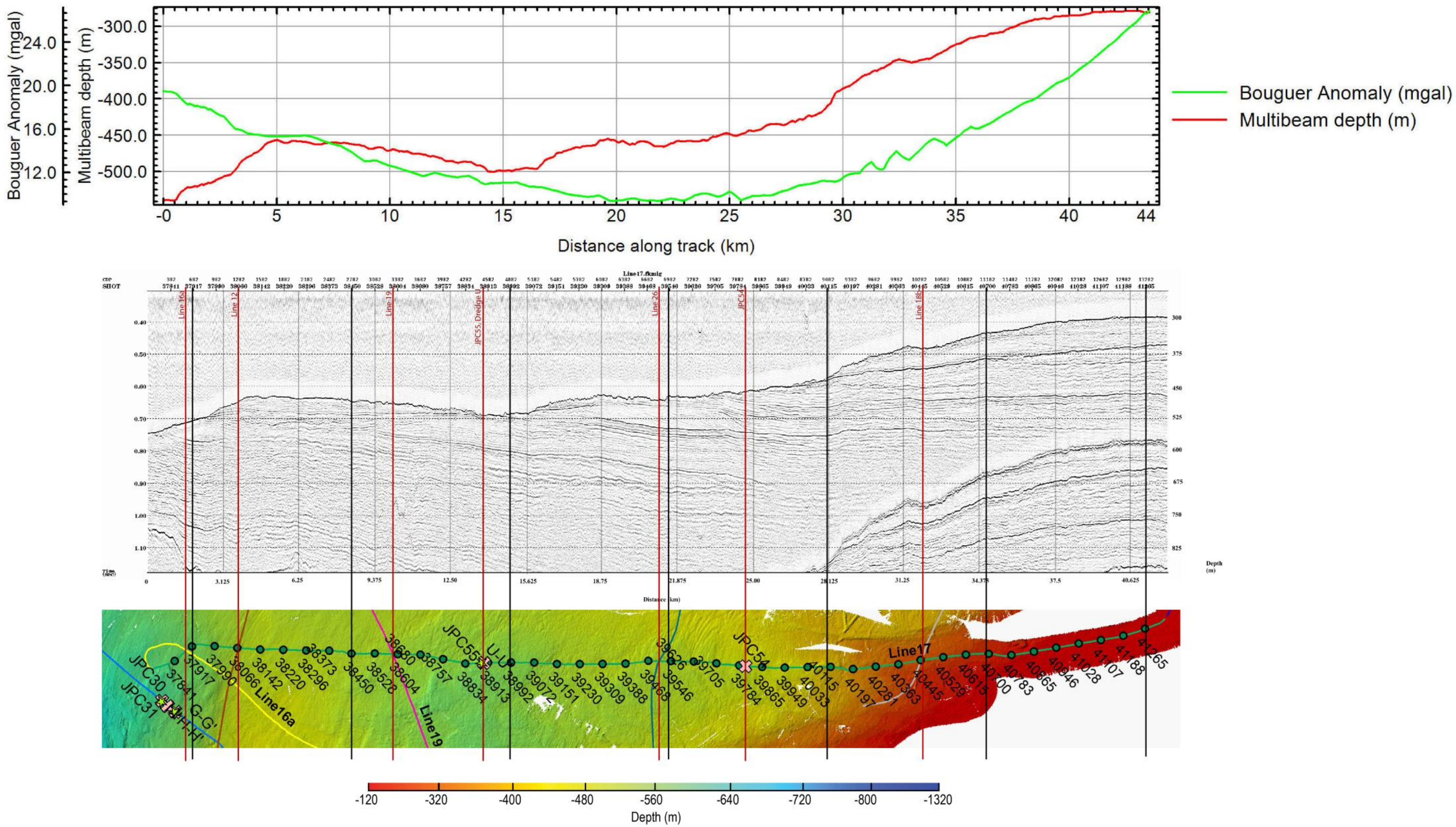
Seismic Line 16



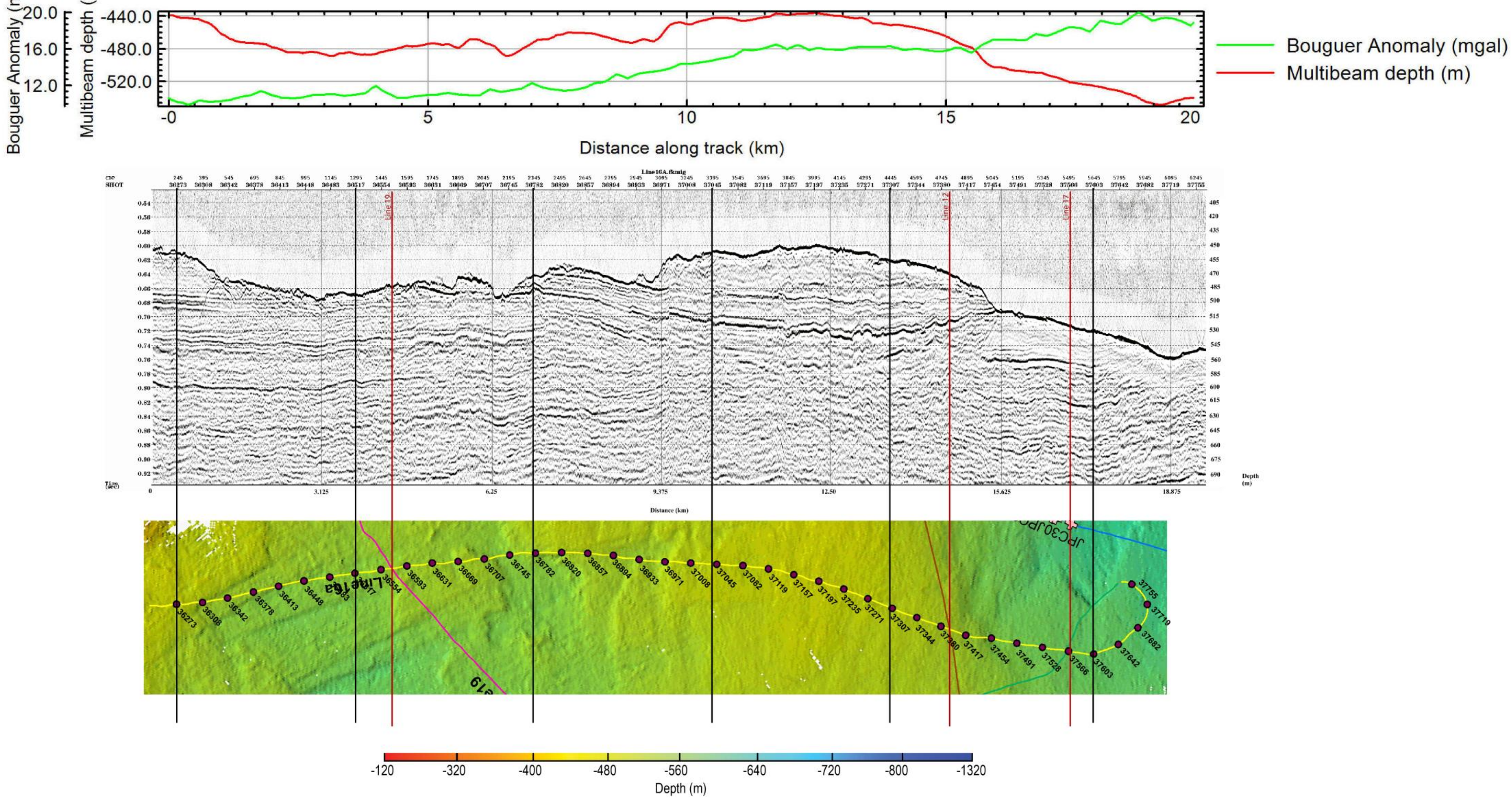
Seismic Line 16a



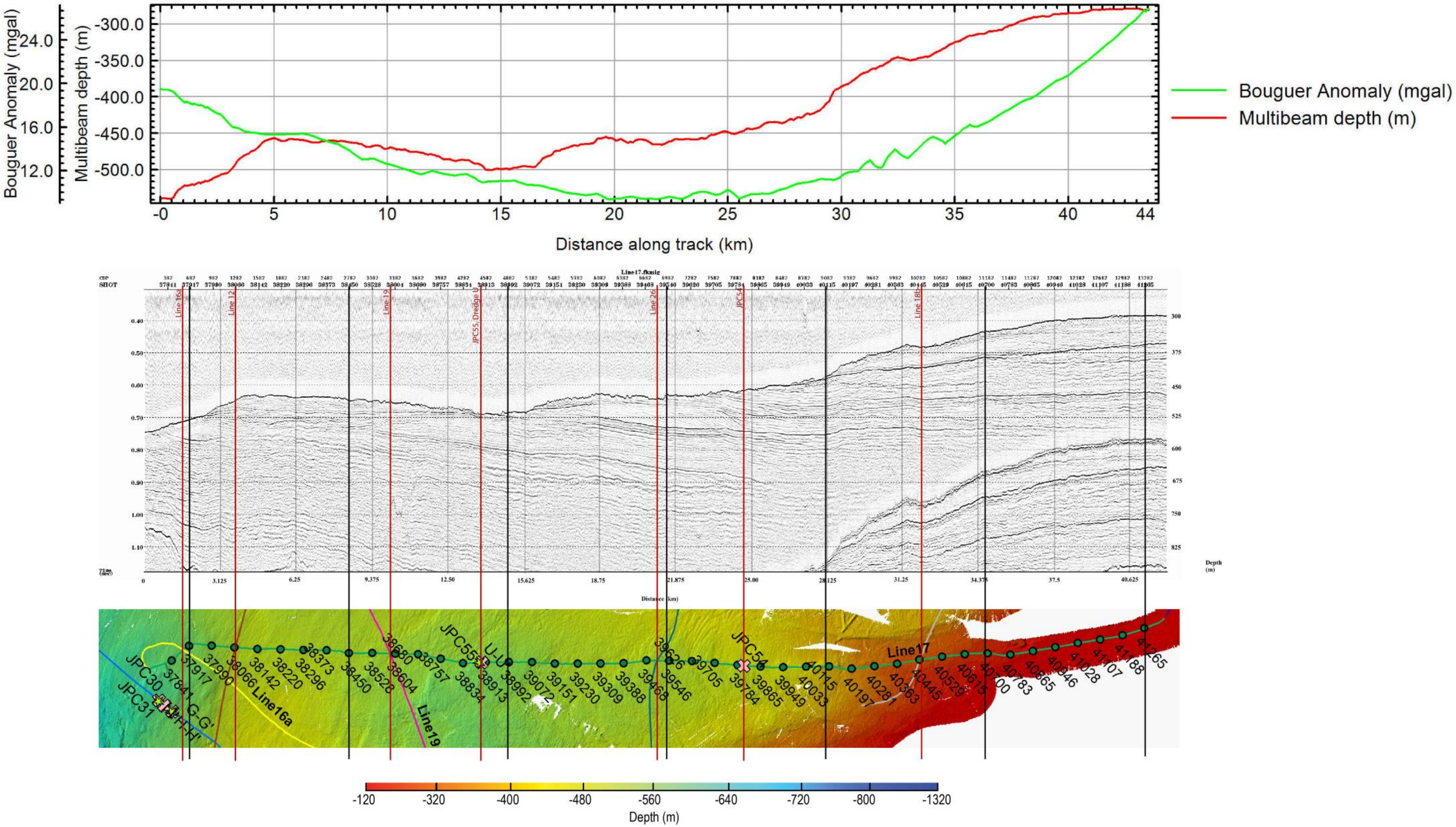
Seismic Line 17



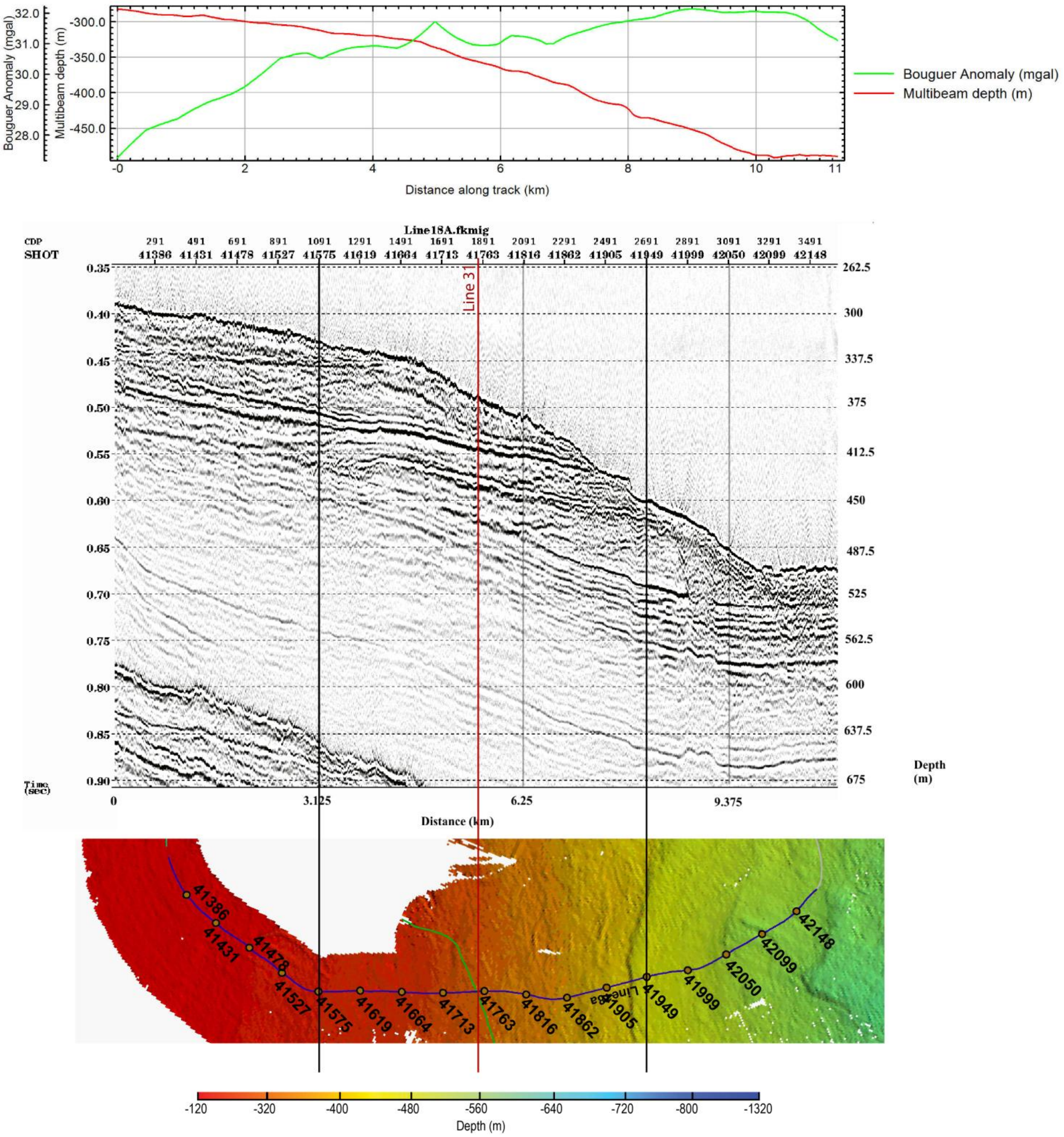
Seismic Line 16a



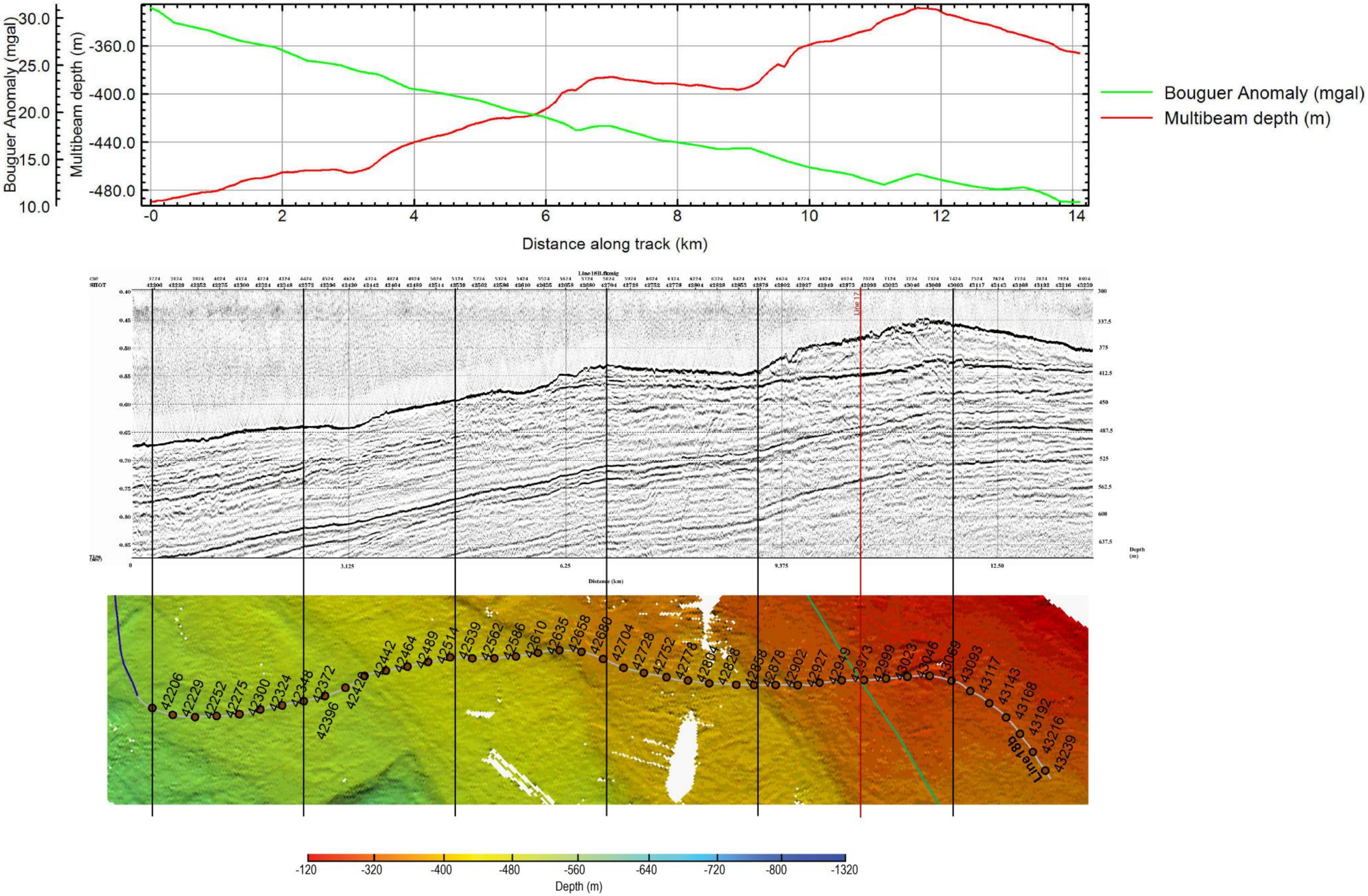
Seismic Line 17



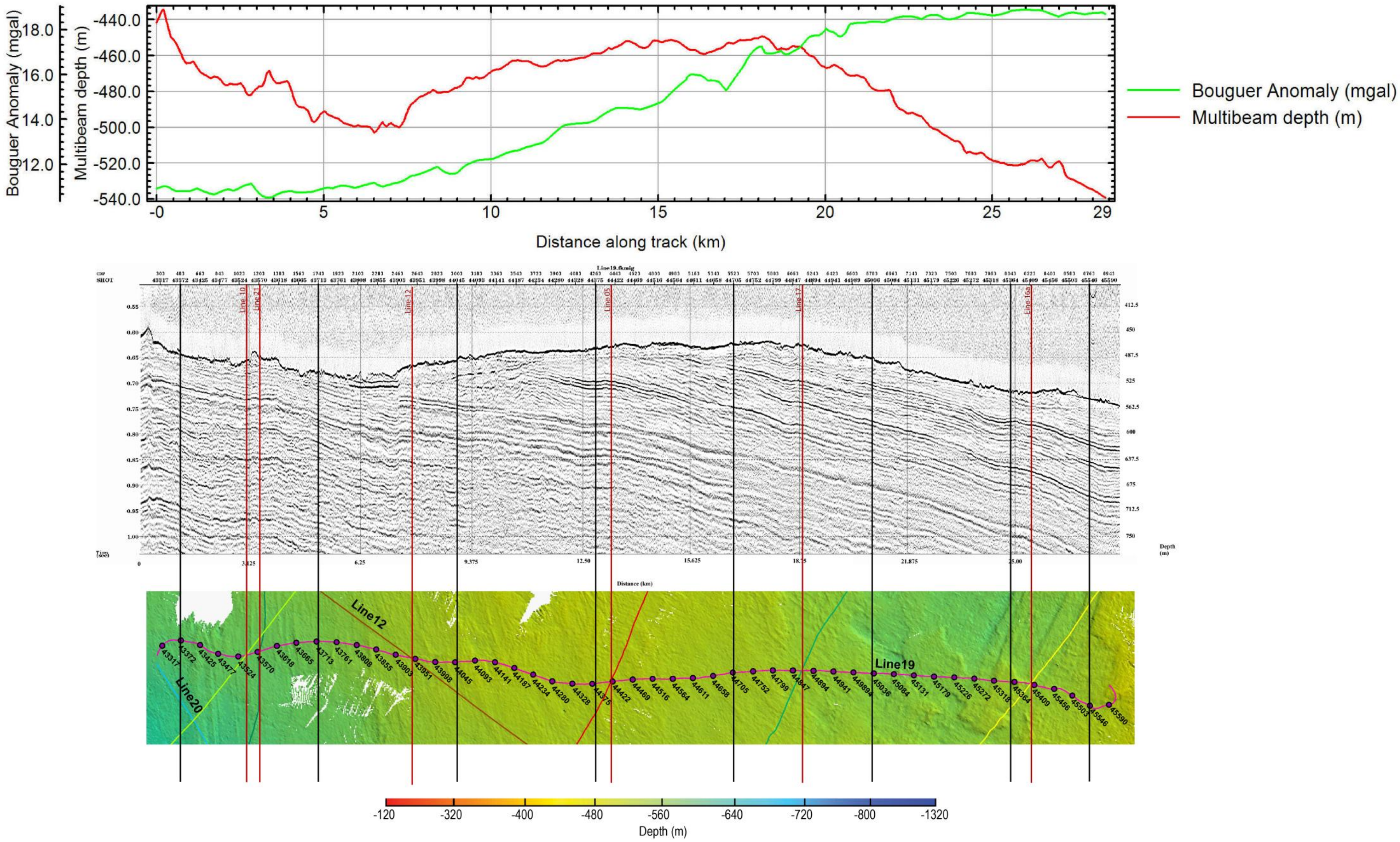
Seismic Line 18



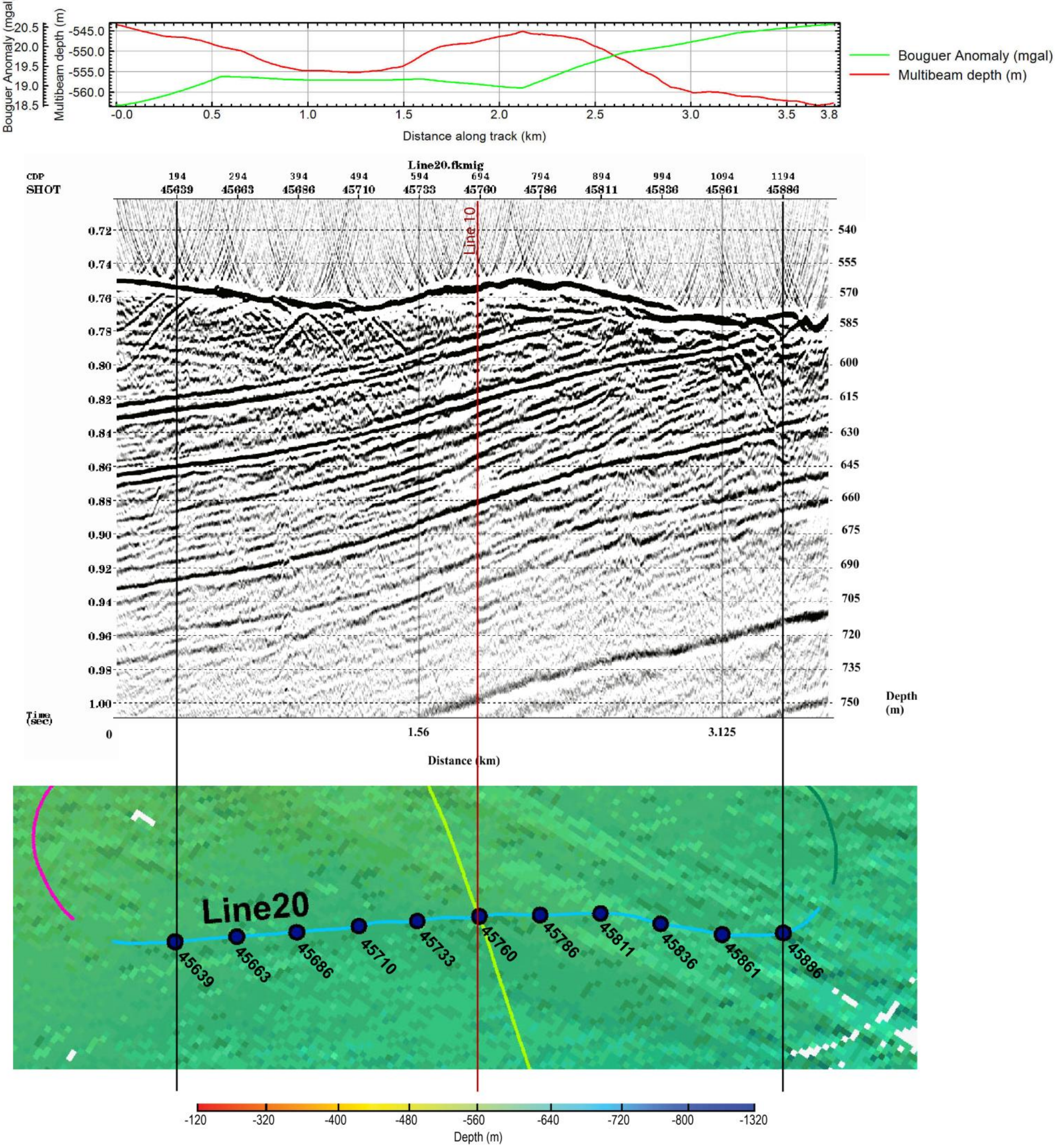
Seismic Line 18b



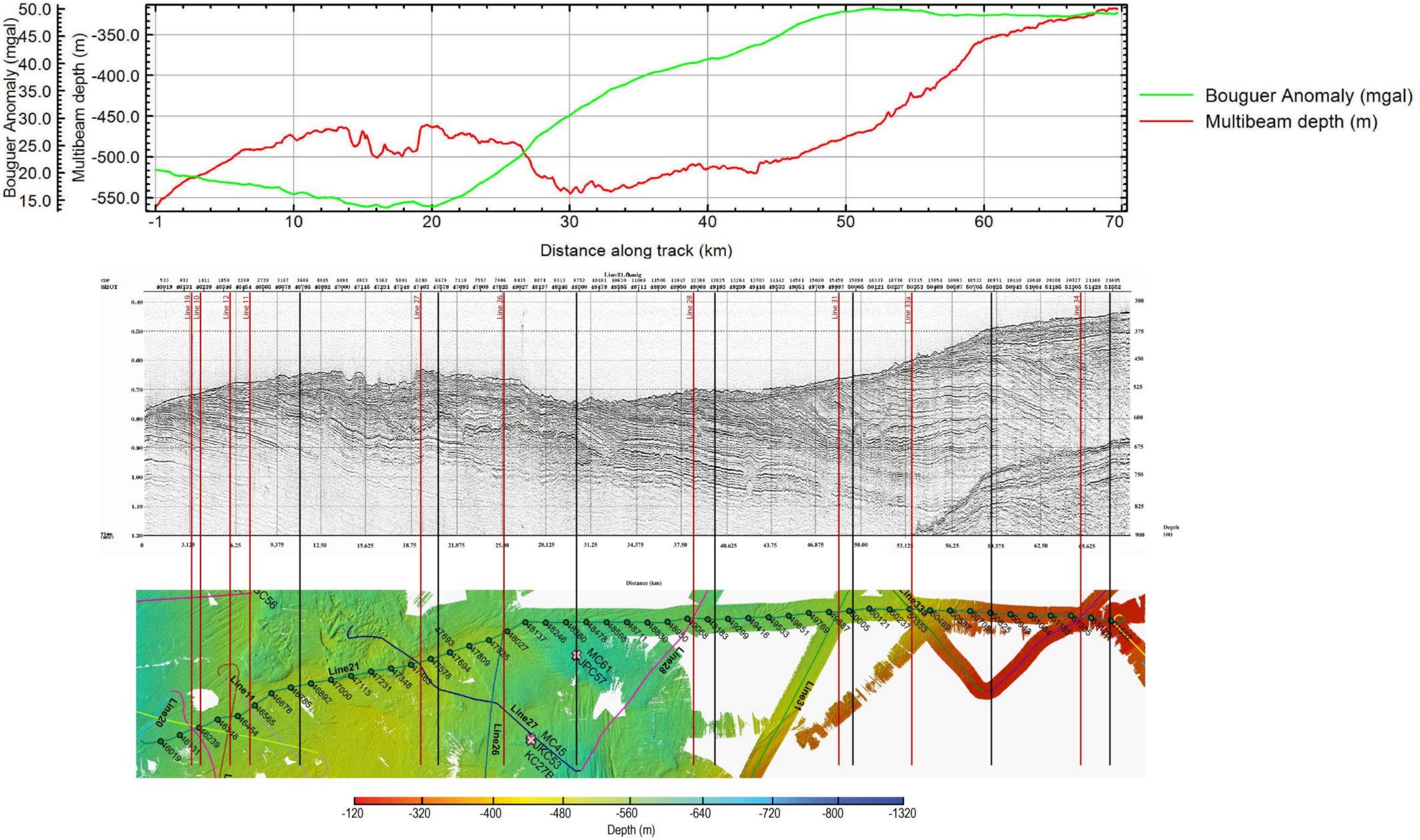
Seismic Line 19



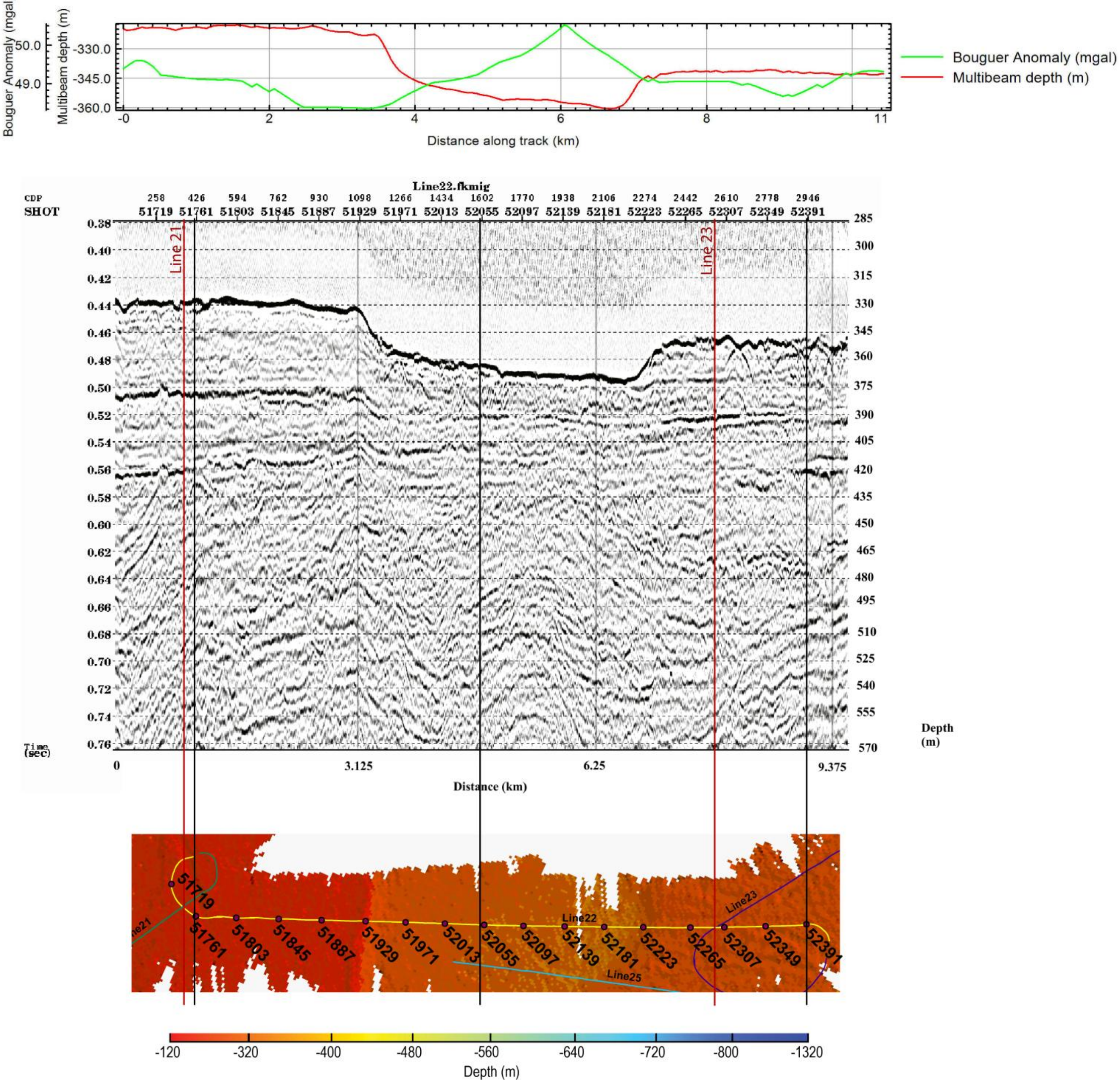
Seismic Line 20



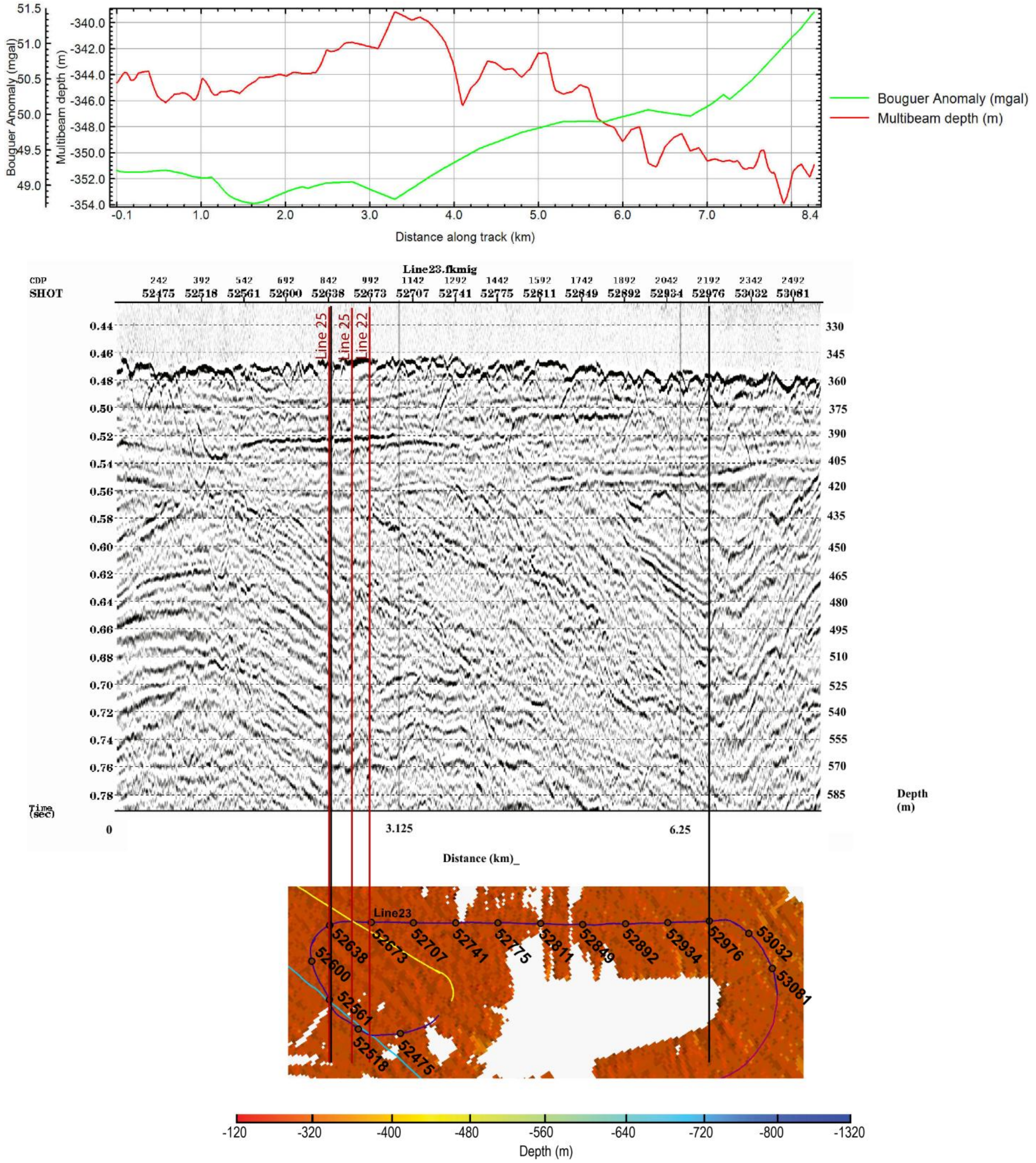
Seismic Line 21



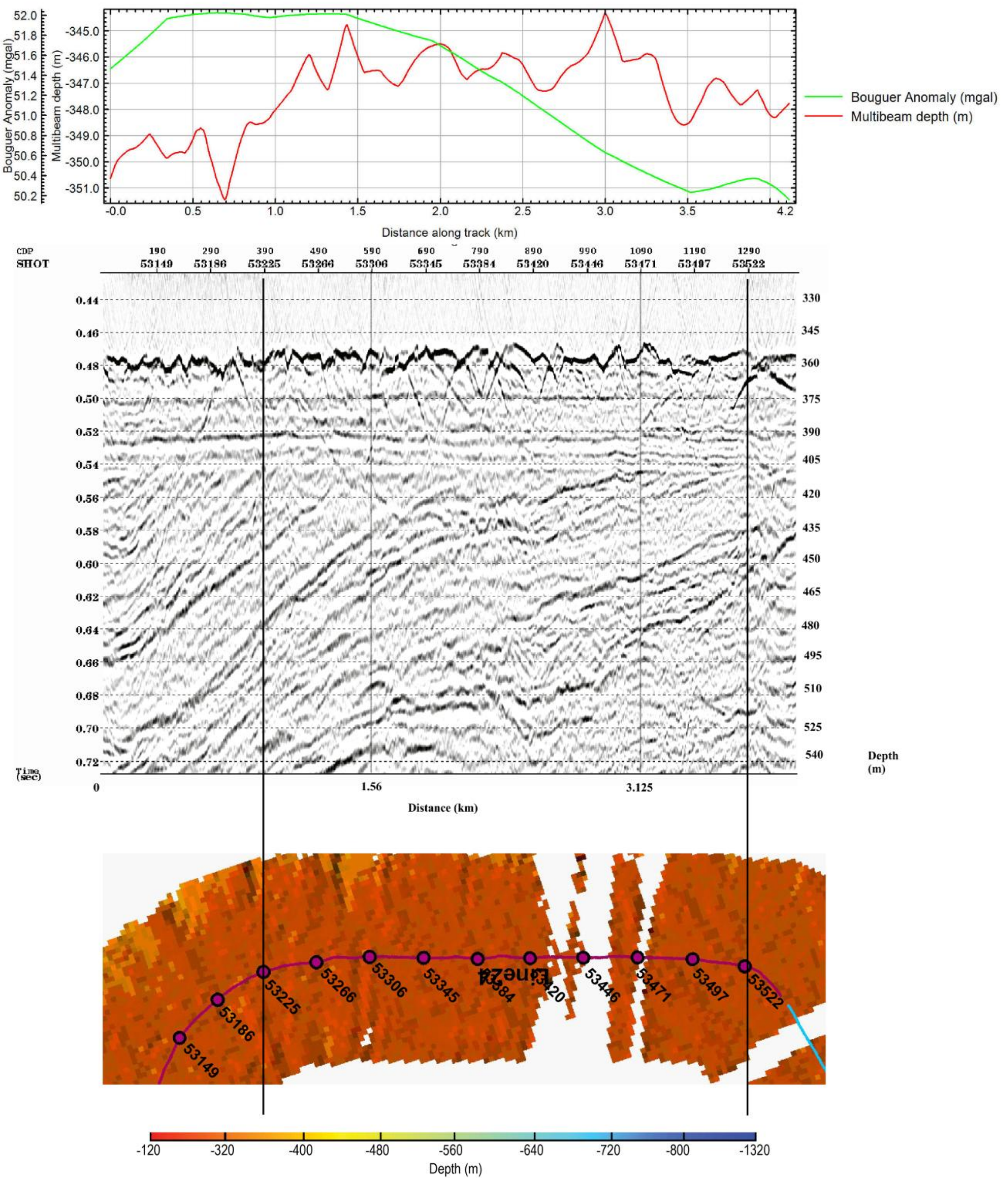
Seismic Line 22



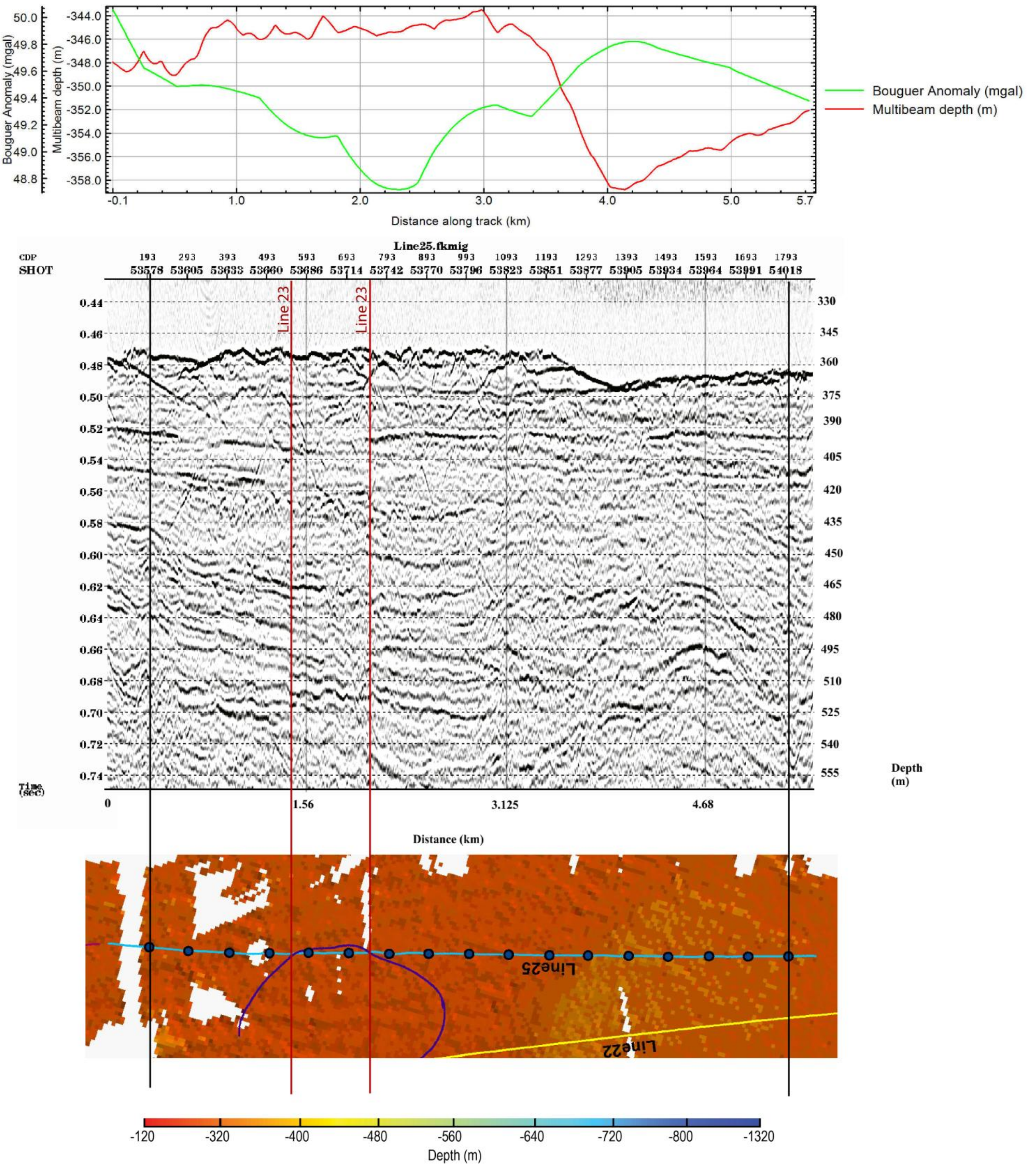
Seismic Line 23



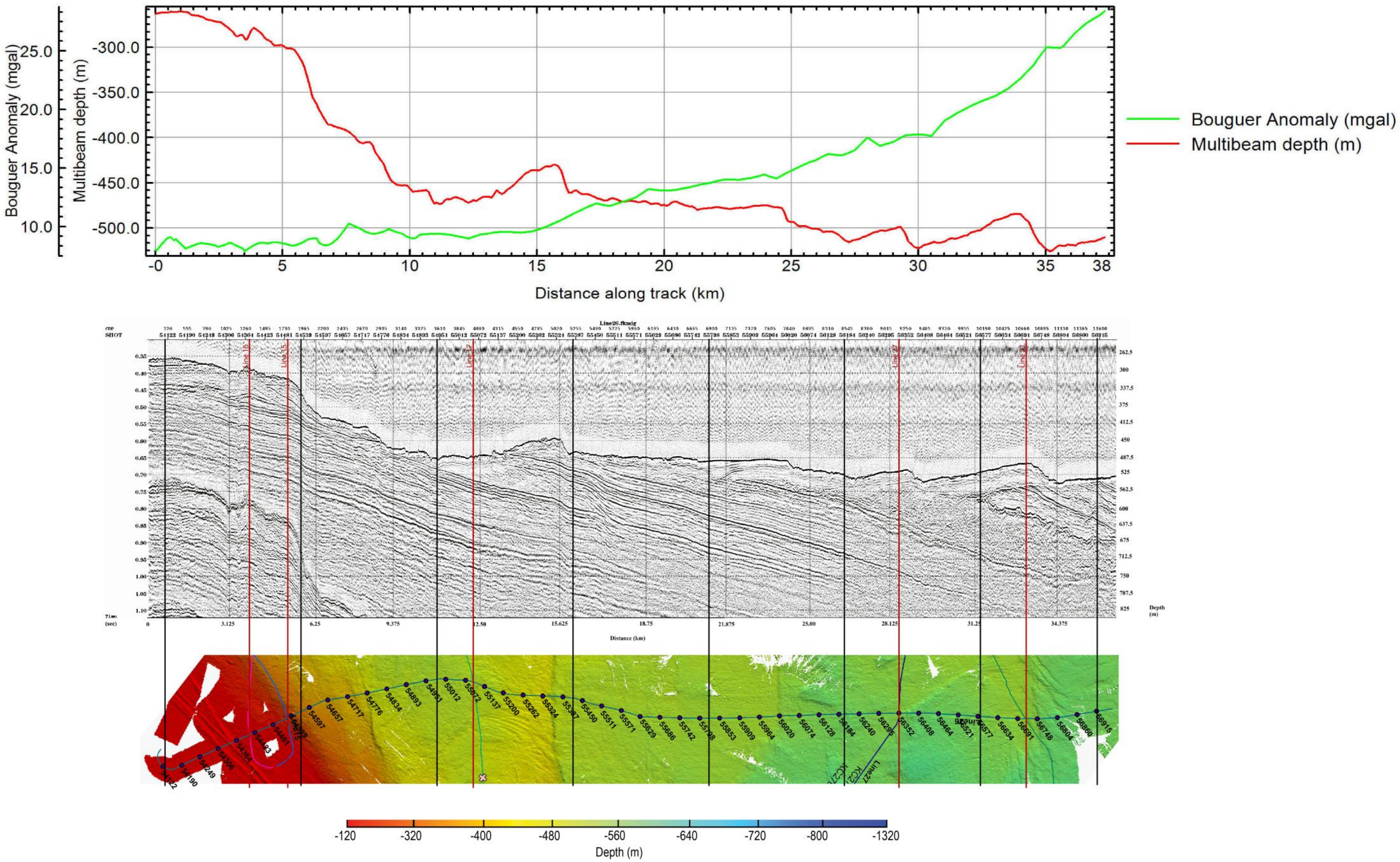
Seismic Line 24



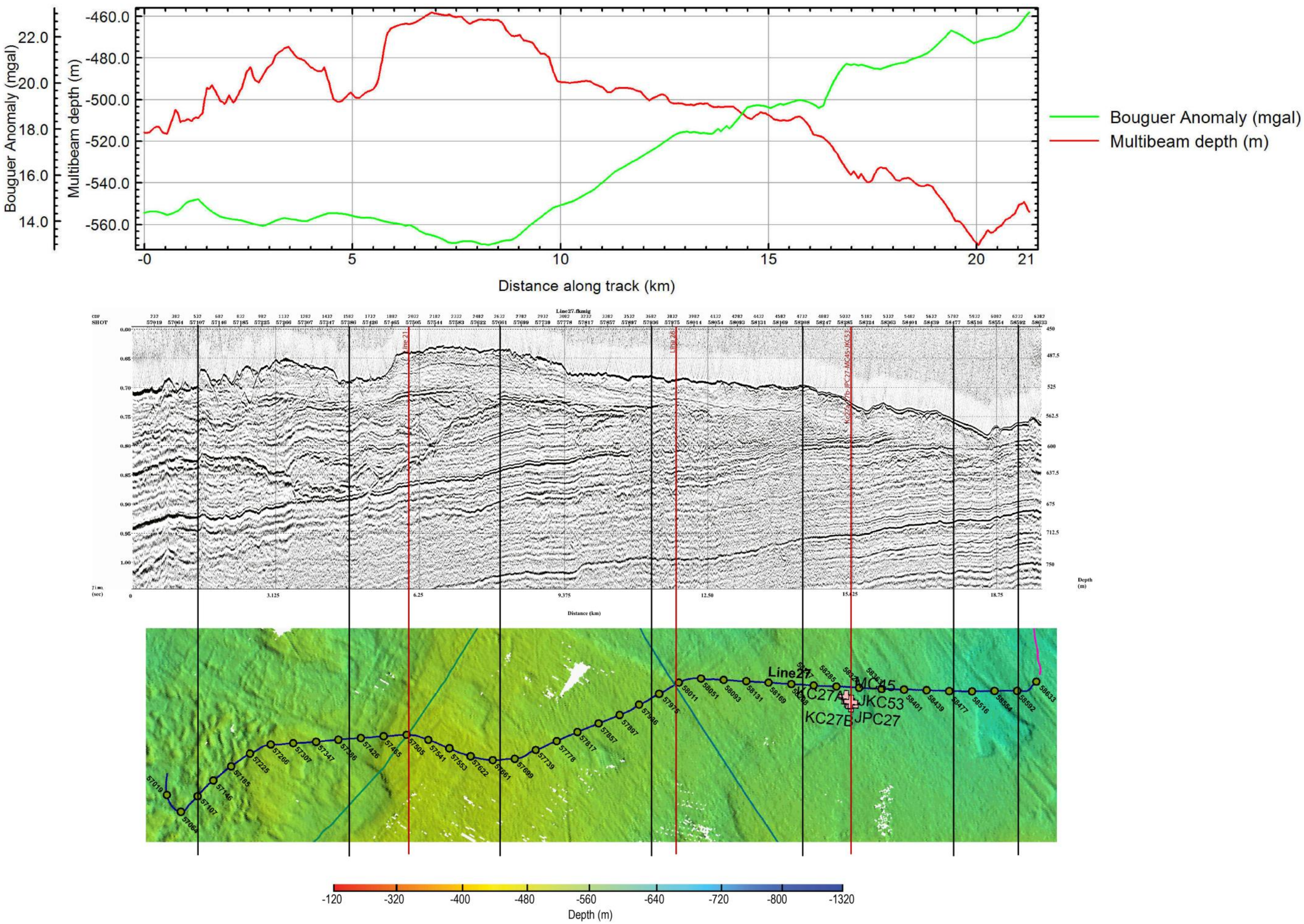
Seismic Line 25

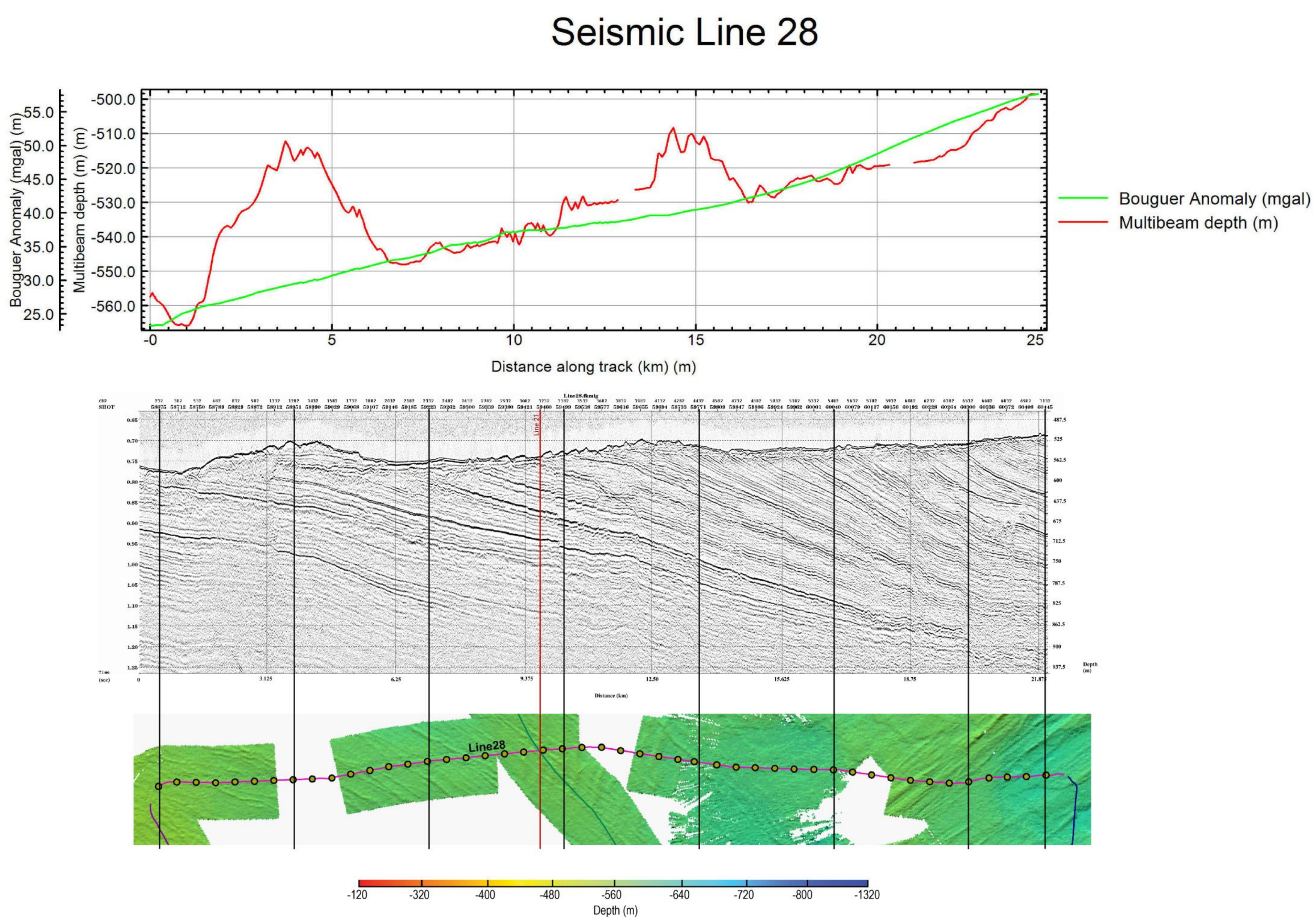


Seismic Line 26

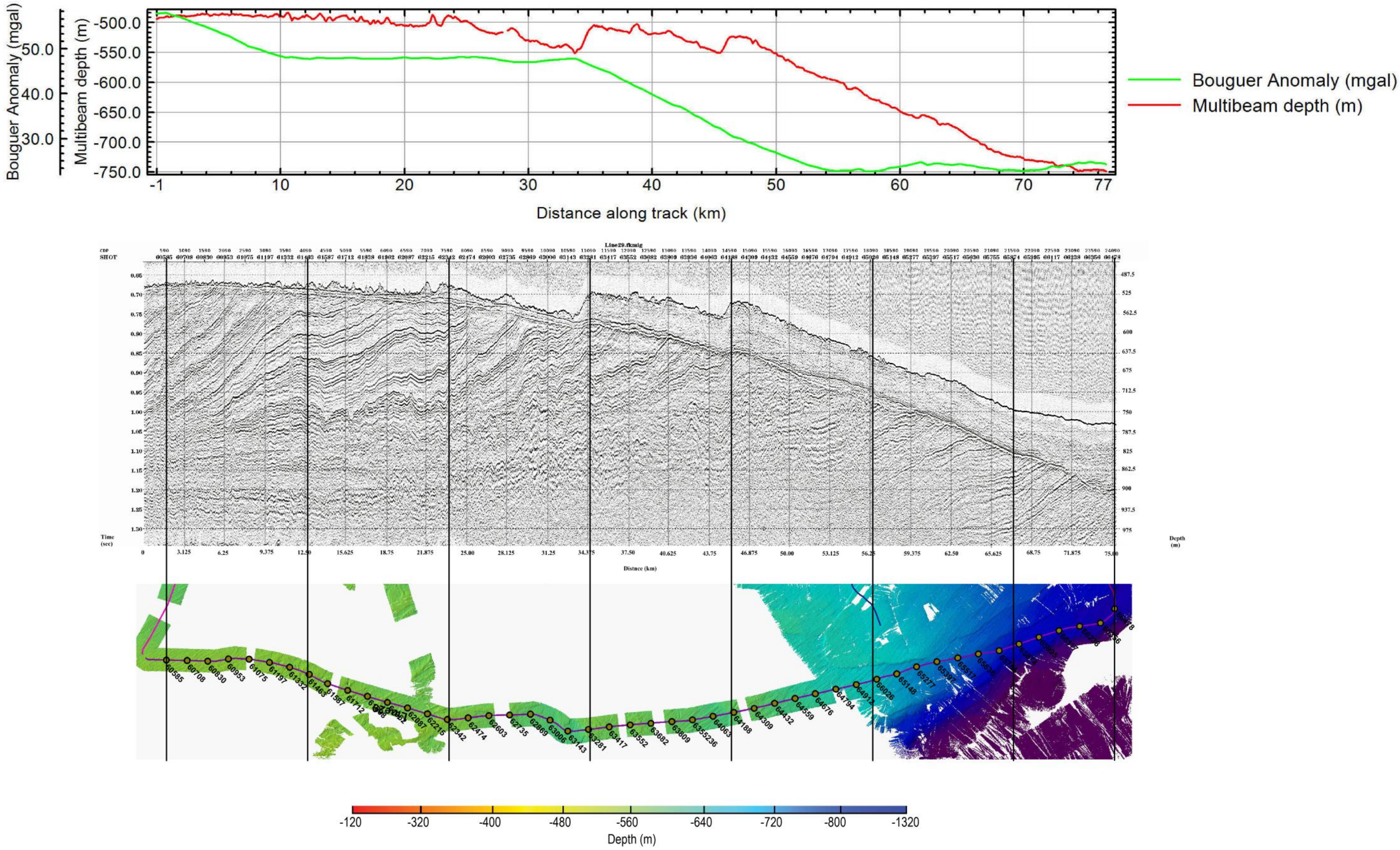


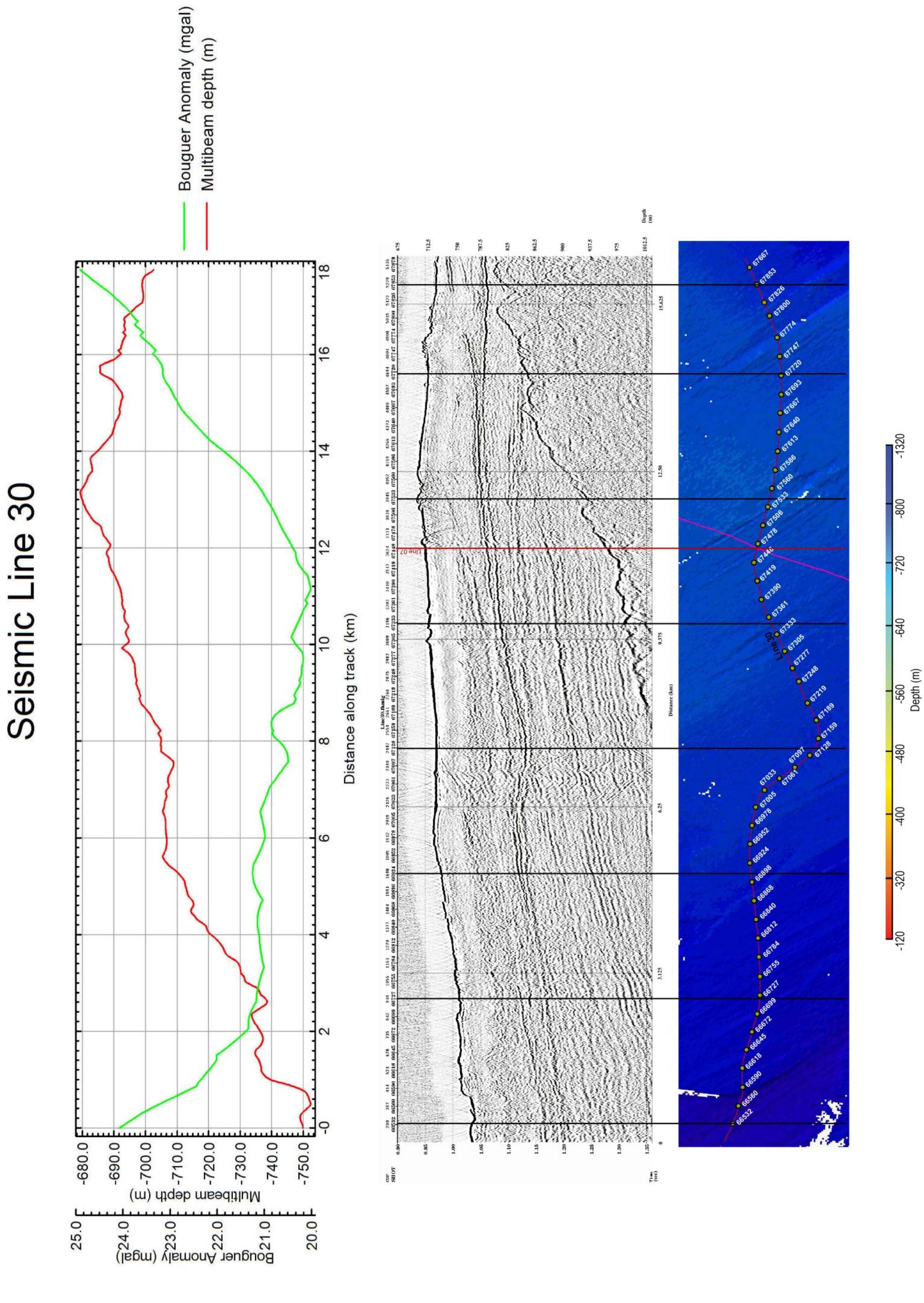
Seismic Line 27




Seismic Line 28
Bouguer Anomaly (mgal)
Multibeam depth (m)
Bouguer Anomaly (mgal) (m)
Multibeam depth (m) (m)
Distance along track (km) (m)
Line28.fkmig
Line 21
Line28
Distance (km)
Depth (m)
Time (sec)
CDP
SHOT
-120
-320
-400
-480
-560
-640
-720
-800
-1320
Depth (m)

Seismic Line 29



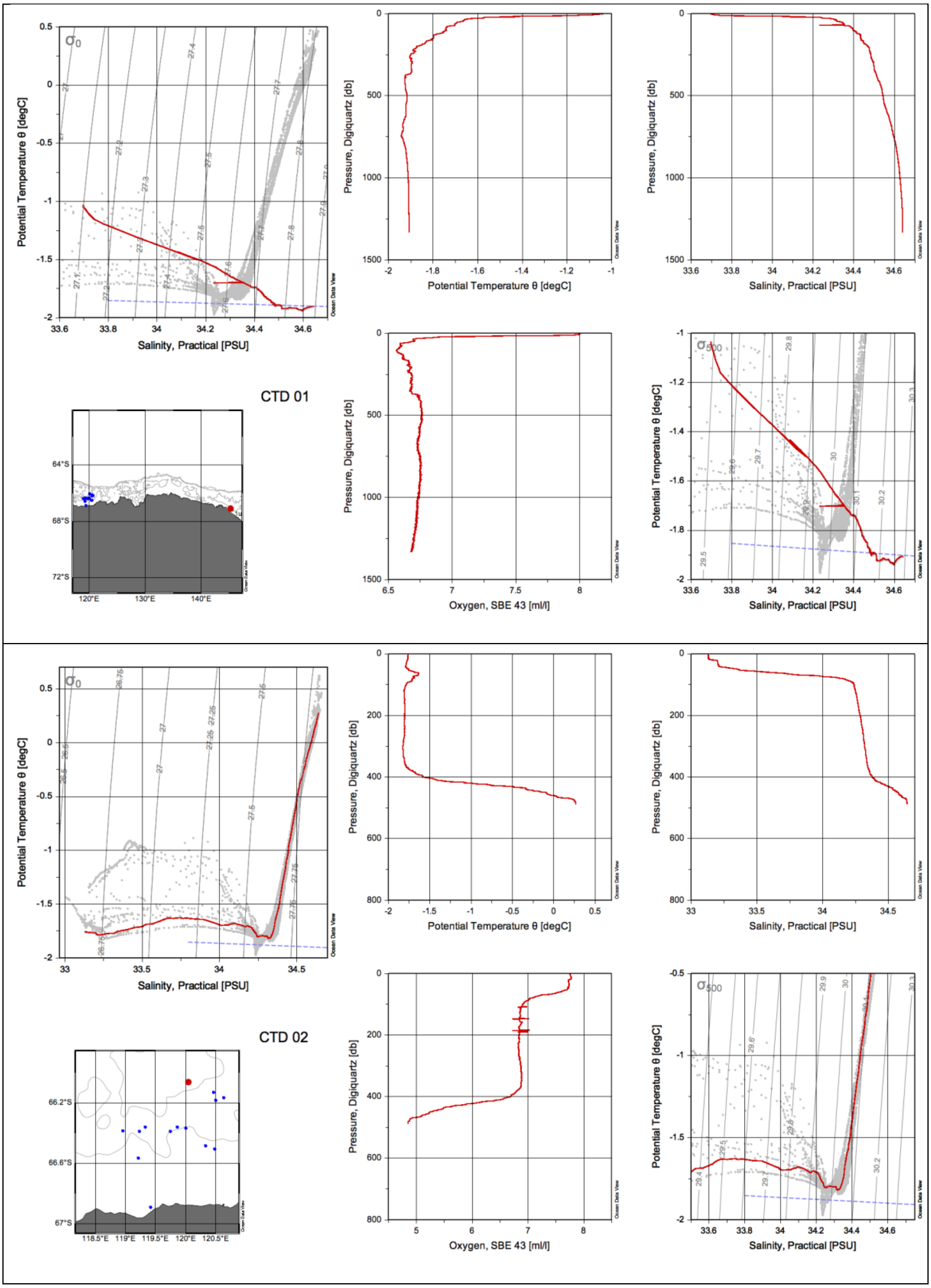


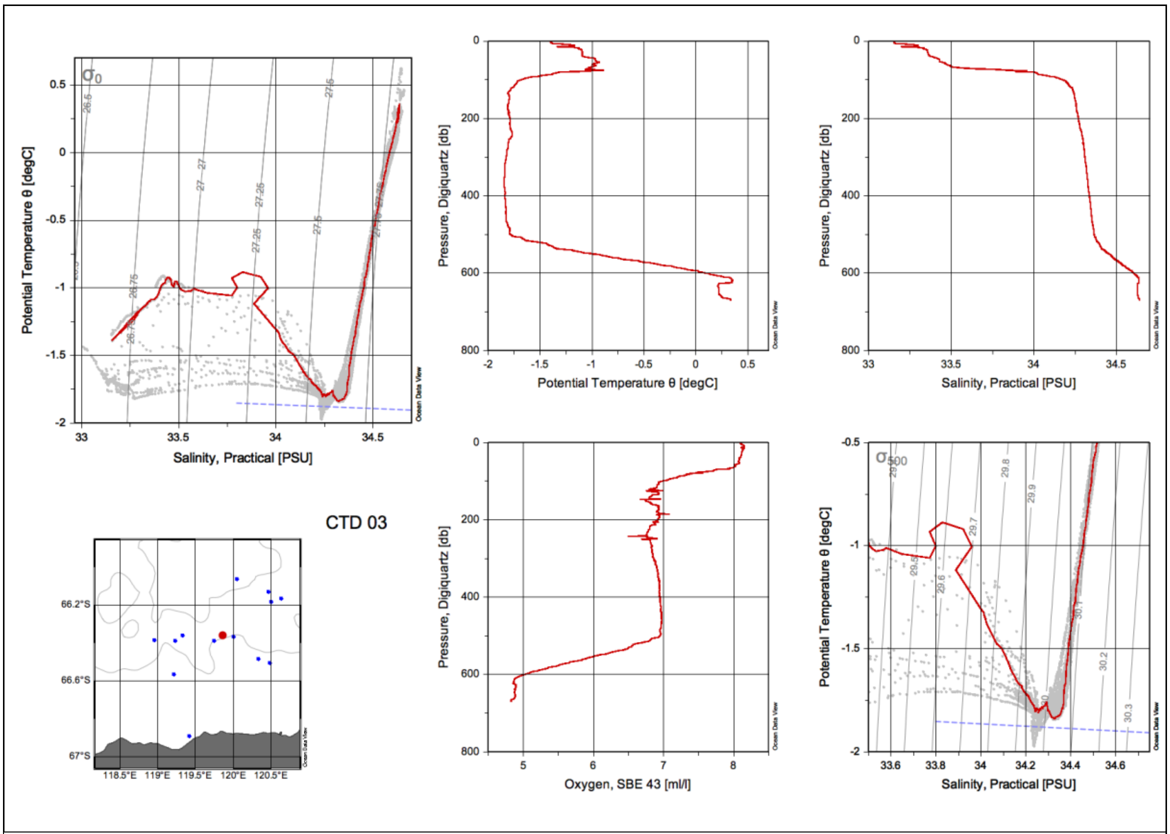
Seismic Line 30
Bouguer Anomaly (mgal)
Multibeam depth (m)
Distance along track (km)
Line 07
Line 30
Distance (km)
Depth (m)

9.CTD profiles

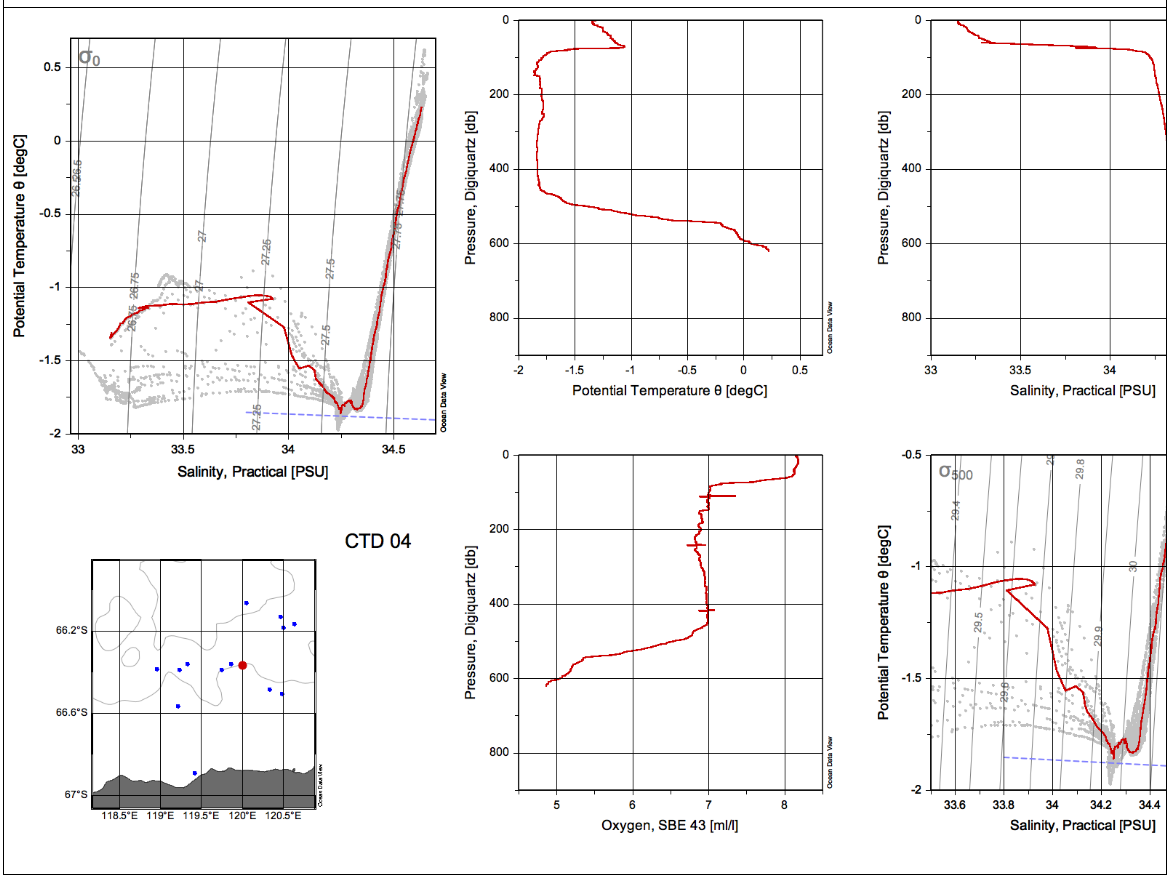
Appendix – CTD profiles (15)

Data are from down cast primary sensor pair except CTD 1 which is upcast data from the primary sensors. Data are preliminary and have had only shipboard post-station processing applied. The dashed blue lines in the Potential Temperature-Salinity (T/S) plots are the surface freezing point curves. Curved grey lines on the T/S plots are lines of constant potential density anomaly referenced to the surface (upper left) and 500 decibars (lower right). Data are plotted every decibar. All casts were within 10 meters of the bottom.

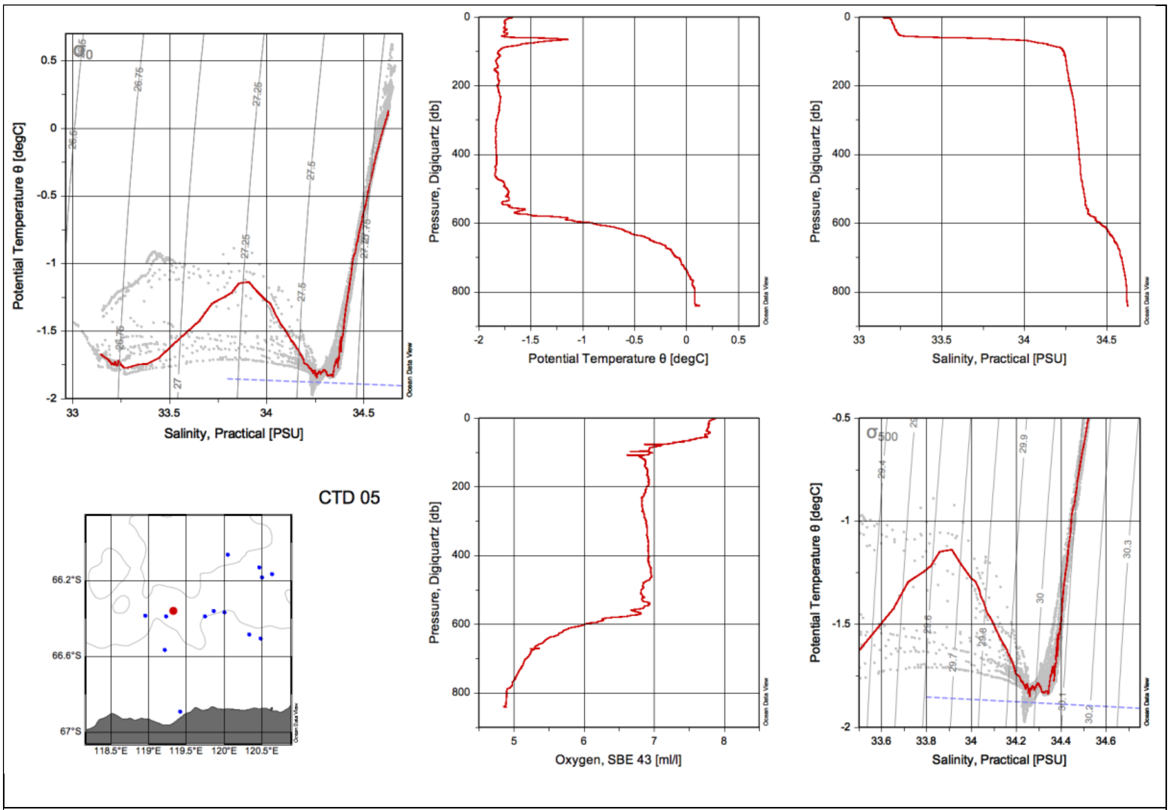

CTD 01
Potential Temperature θ [degC]
Salinity, Practical [PSU]
Pressure, Digiquartz [db]
Potential Temperature θ [degC]
Pressure, Digiquartz [db]
Salinity, Practical [PSU]
Pressure, Digiquartz [db]
Oxygen, SBE 43 [ml/l]
Potential Temperature θ [degC]
Salinity, Practical [PSU]
64°S
68°S
72°S
120°E
130°E
140°E
CTD 02
Potential Temperature θ [degC]
Salinity, Practical [PSU]
Pressure, Digiquartz [db]
Potential Temperature θ [degC]
Pressure, Digiquartz [db]
Salinity, Practical [PSU]
Pressure, Digiquartz [db]
Oxygen, SBE 43 [ml/l]
Potential Temperature θ [degC]
Salinity, Practical [PSU]
66.2°S
66.6°S
67°S
118.5°E
119°E
119.5°E
120°E
120.5°E
Ocean Data View

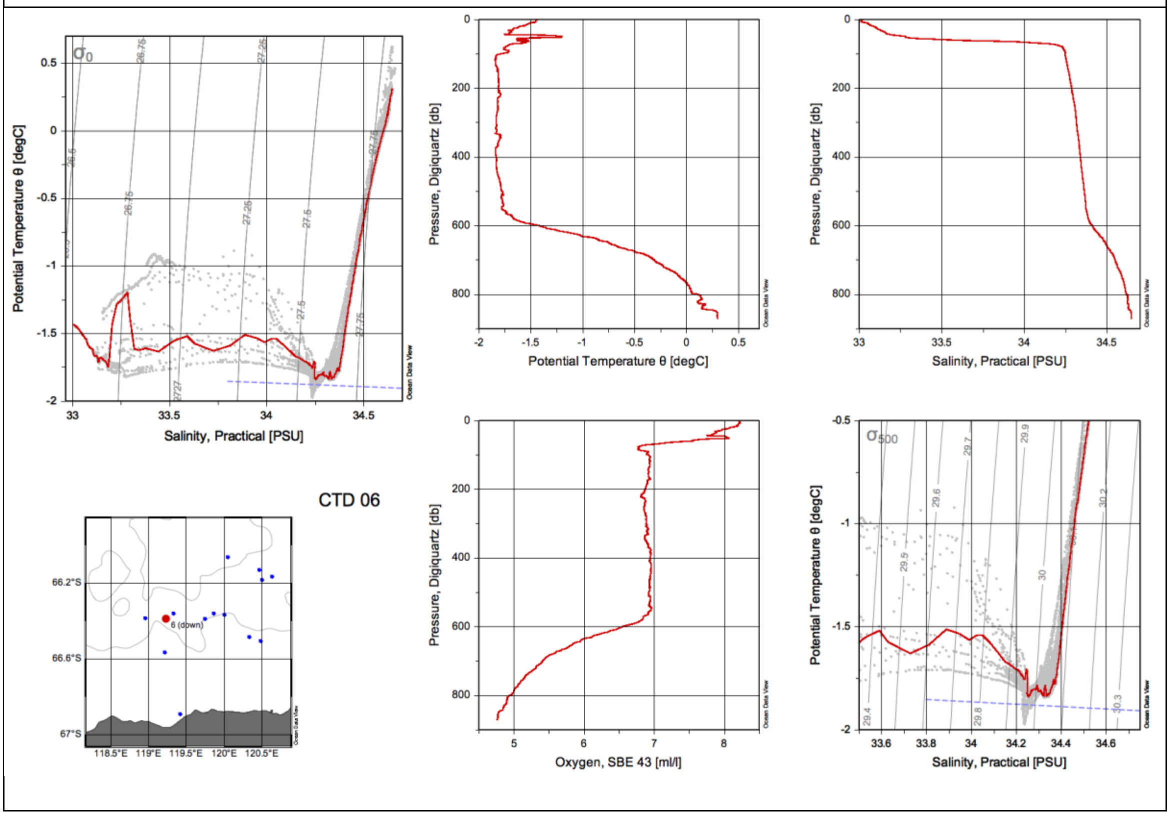


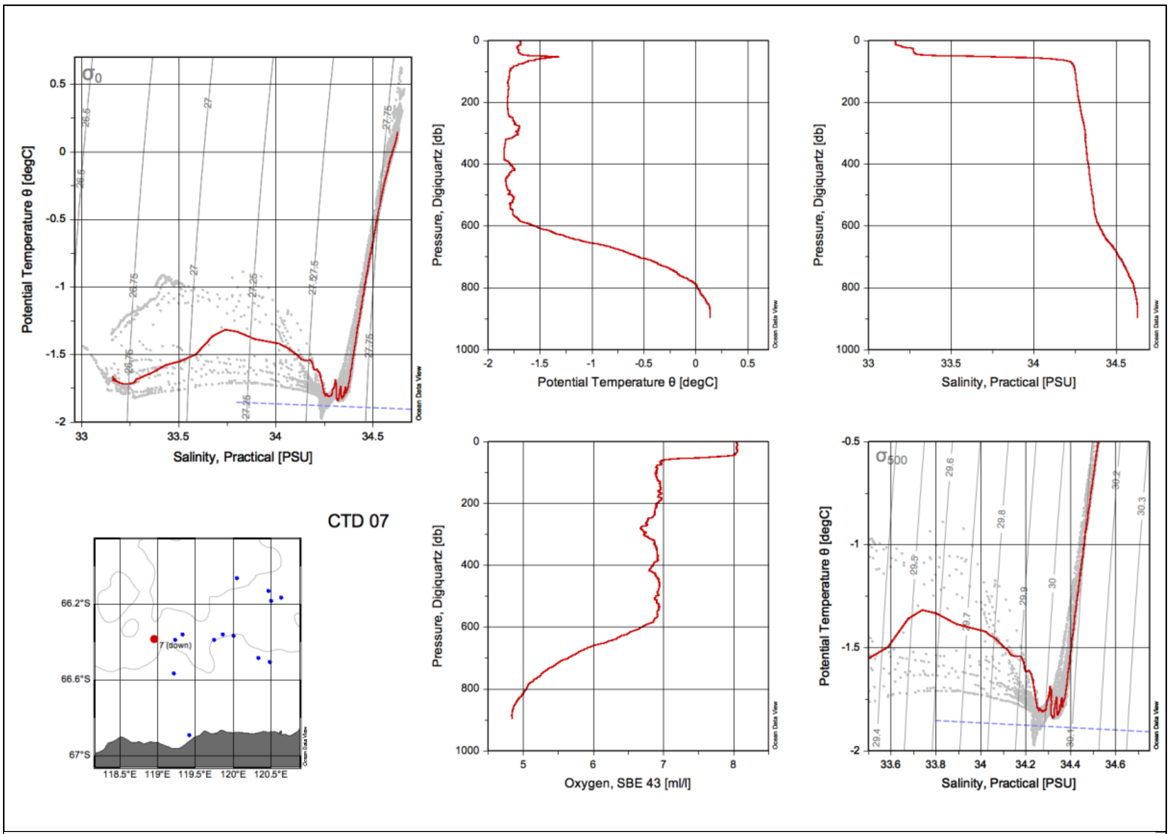
CTD 03
Potential Temperature θ [degC]
Salinity, Practical [PSU]
Pressure, Digiquartz [db]
Oxygen, SBE 43 [ml/l]
66.2°S
66.6°S
67°S
118.5°E
119°E
119.5°E
120°E
120.5°E
Ocean Data View

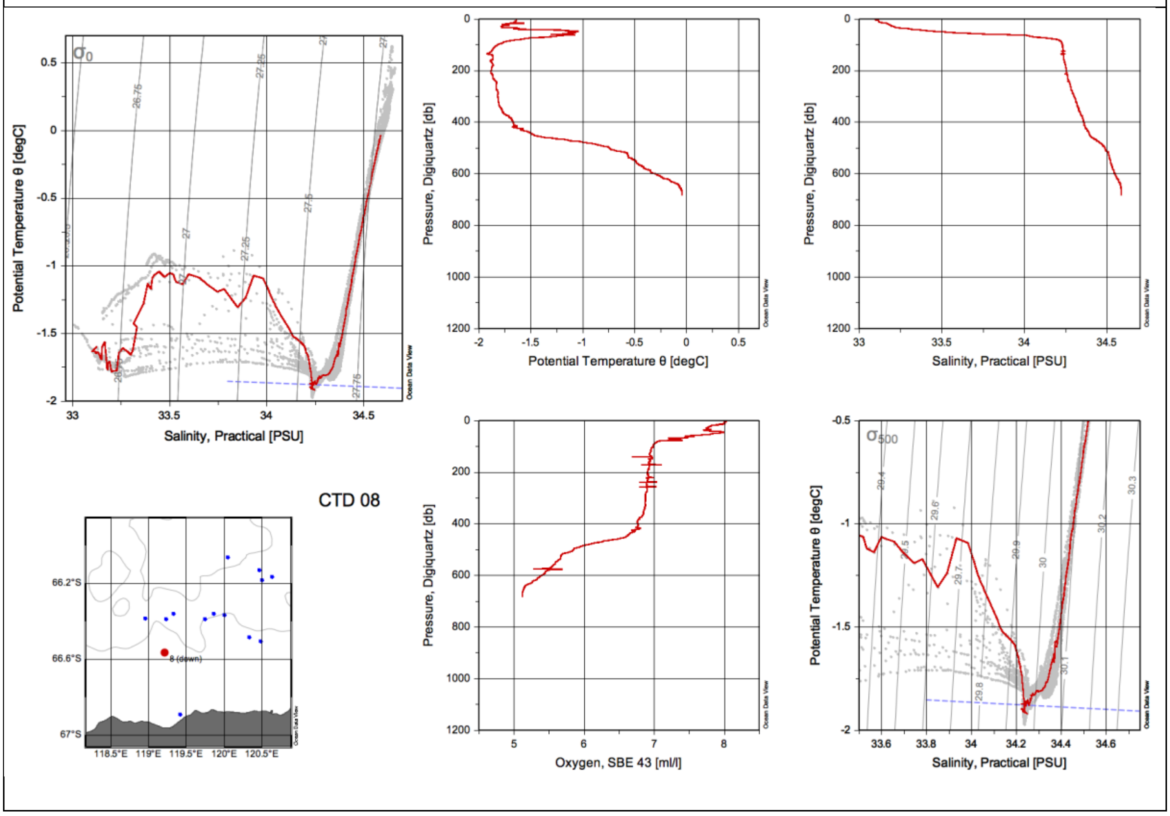


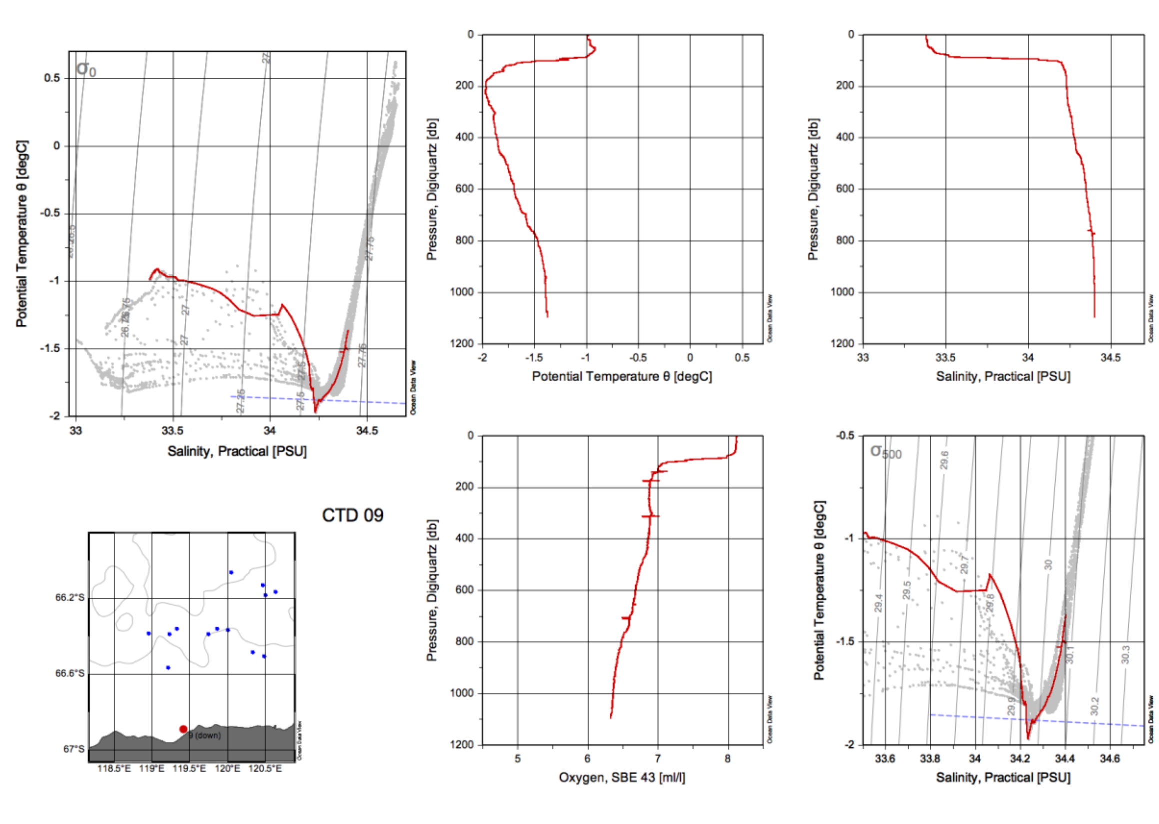
CTD 04
Potential Temperature θ [degC]
Salinity, Practical [PSU]
Pressure, Digiquartz [db]
Oxygen, SBE 43 [ml/l]
66.2°S
66.6°S
67°S
118.5°E
119°E
119.5°E
120°E
120.5°E
Ocean Data View

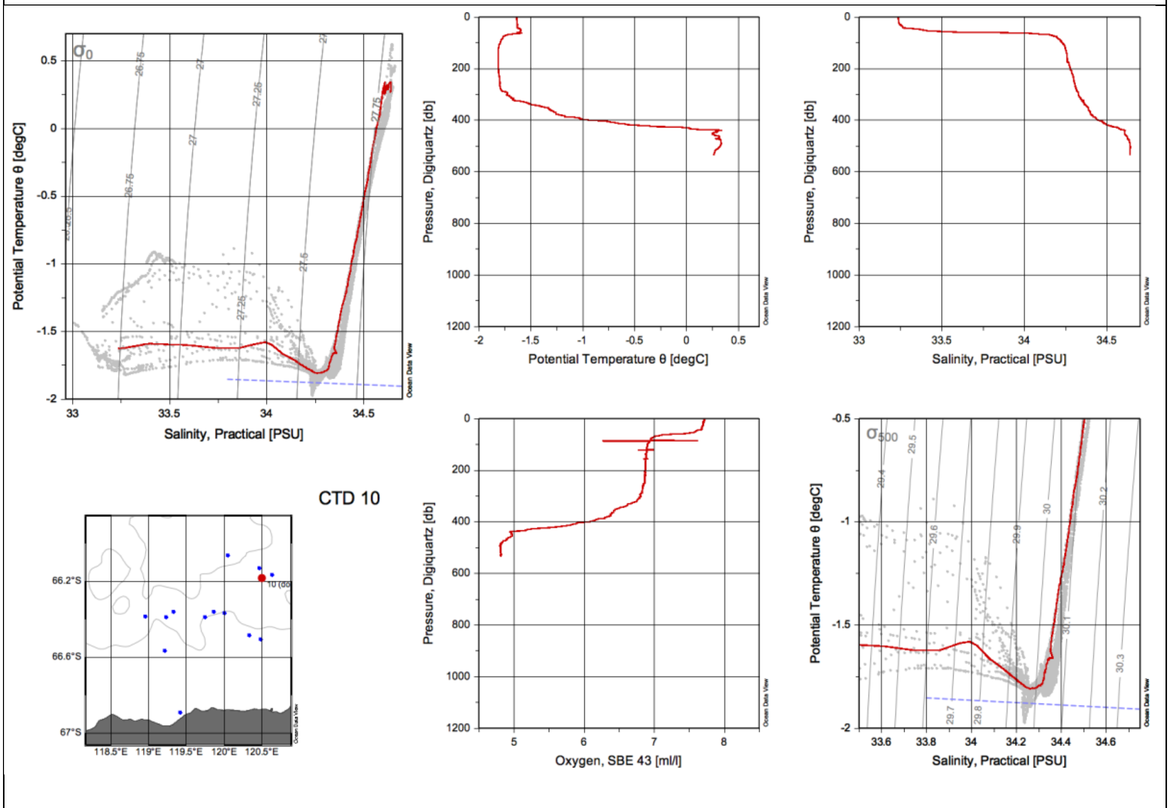

CTD 05
Potential Temperature θ [degC]
Salinity, Practical [PSU]
Pressure, Digiquartz [db]
Oxygen, SBE 43 [ml/l]
66.2°S
66.6°S
67°S
118.5°E
119°E
119.5°E
120°E
120.5°E

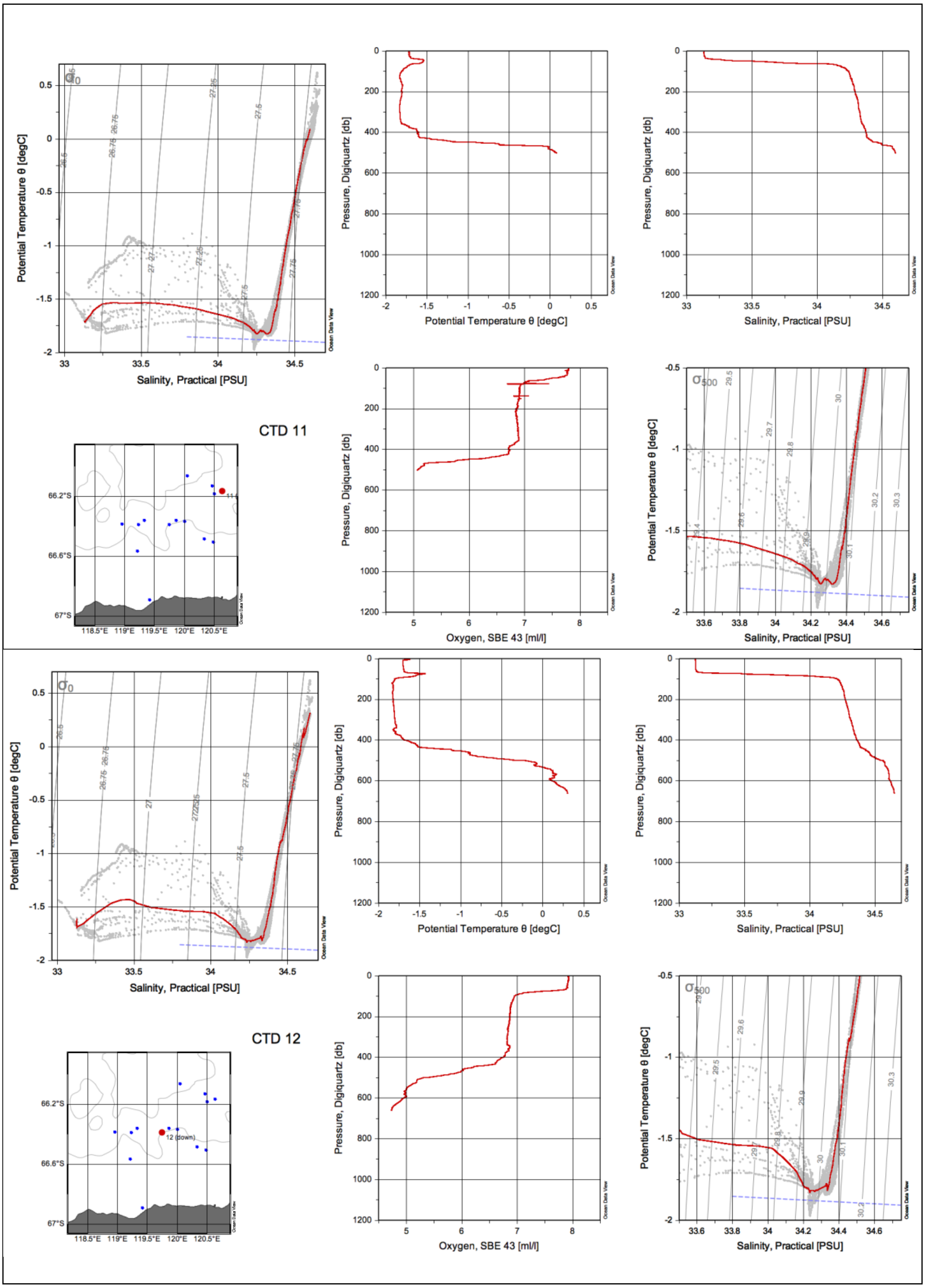

CTD 06
Potential Temperature θ [degC]
Salinity, Practical [PSU]
Pressure, Digiquartz [db]
Oxygen, SBE 43 [ml/l]
66.2°S
66.6°S
67°S
118.5°E
119°E
119.5°E
120°E
120.5°E

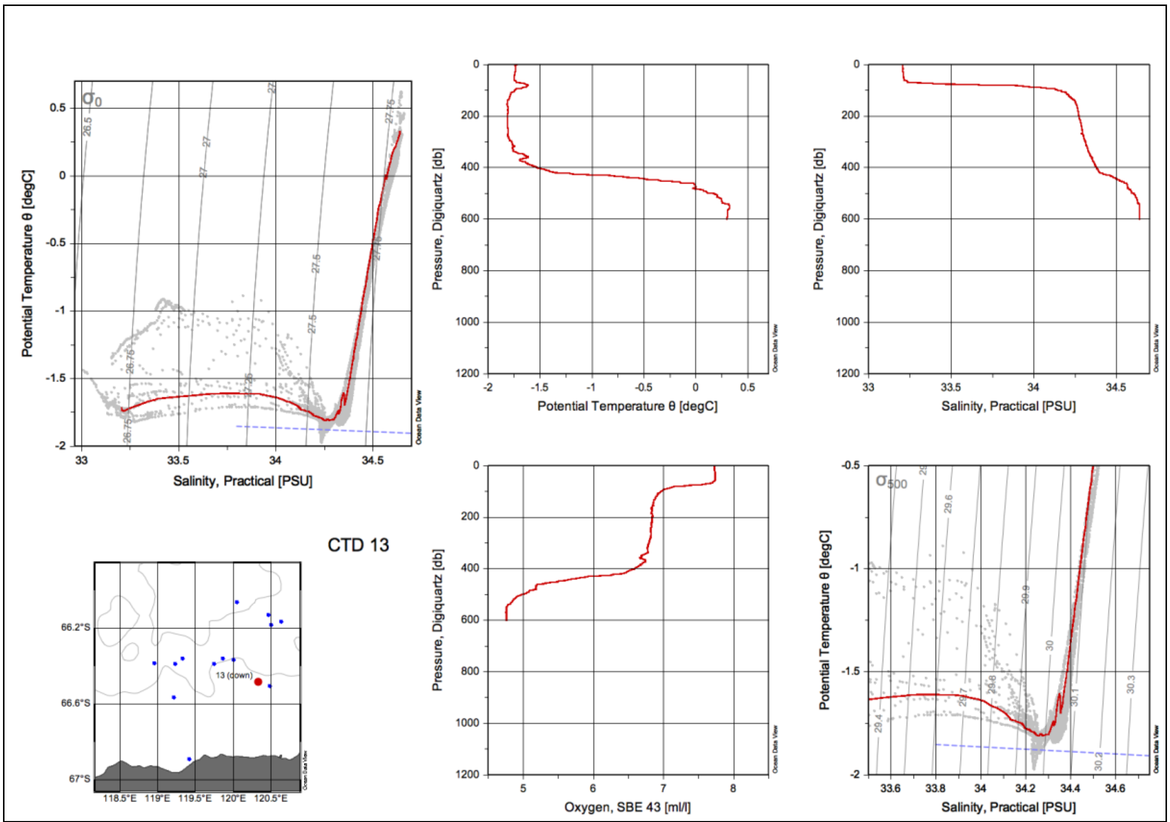

CTD 07
Potential Temperature θ [degC]
Salinity, Practical [PSU]
Pressure, Digiquartz [db]
Oxygen, SBE 43 [ml/l]
66.2°S
66.6°S
67°S
118.5°E
119°E
119.5°E
120°E
120.5°E
7 (down)
Ocean Data View

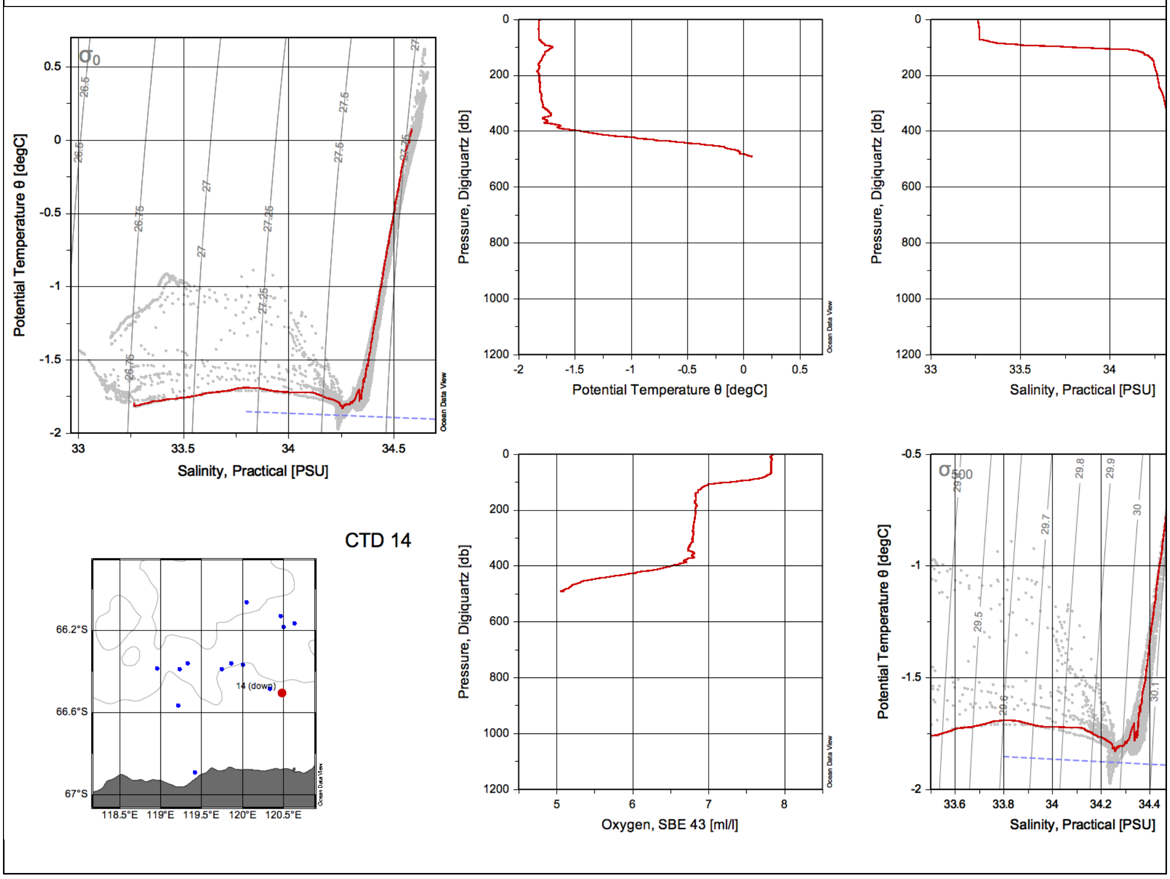

CTD 08
Potential Temperature θ [degC]
Salinity, Practical [PSU]
Pressure, Digiquartz [db]
Oxygen, SBE 43 [ml/l]
66.2°S
66.6°S
67°S
118.5°E
119°E
119.5°E
120°E
120.5°E
8 (down)
Ocean Data View

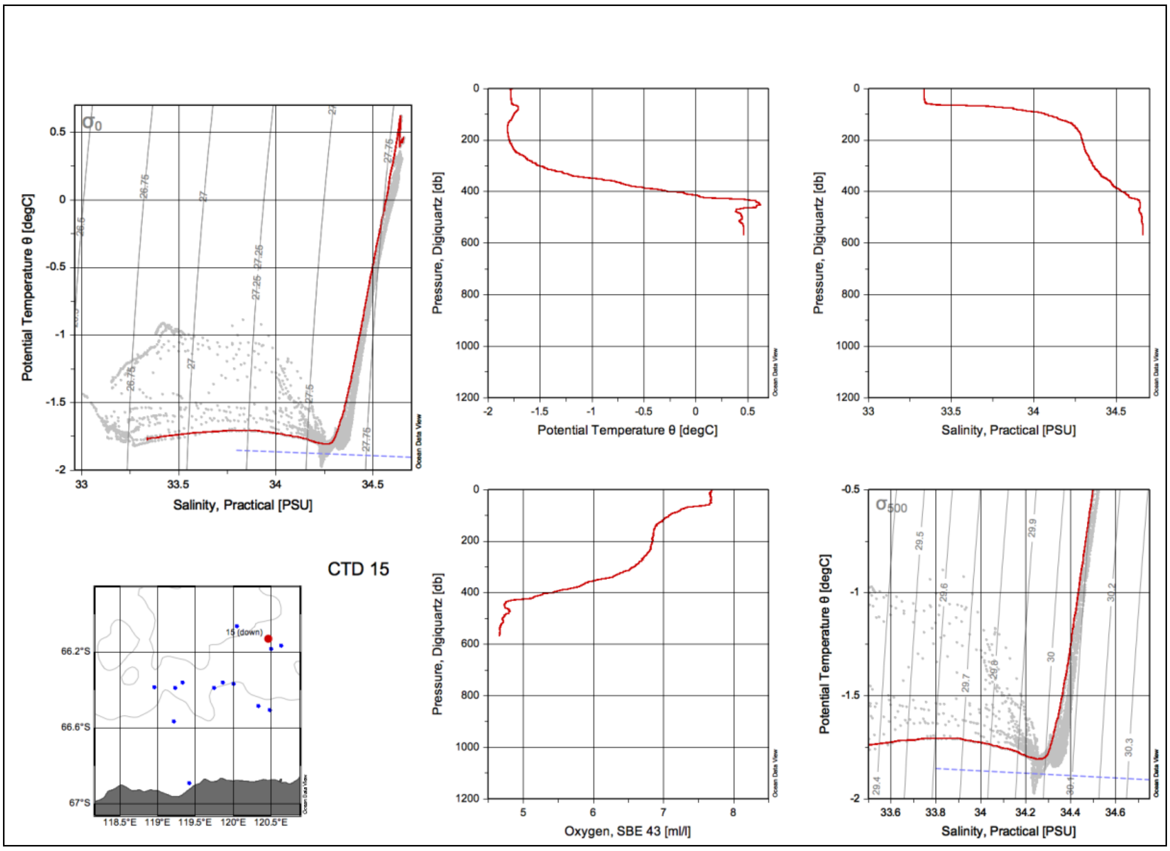

CTD 09
Potential Temperature θ [degC]
Salinity, Practical [PSU]
Pressure, Digiquartz [db]
Oxygen, SBE 43 [ml/l]
Ocean Data View


CTD 10
Potential Temperature θ [degC]
Salinity, Practical [PSU]
Pressure, Digiquartz [db]
Oxygen, SBE 43 [ml/l]
Ocean Data View


CTD 11
Potential Temperature θ [degC]
Salinity, Practical [PSU]
Pressure, Digiquartz [db]
Oxygen, SBE 43 [ml/l]
66.2°S
66.6°S
67°S
118.5°E
119°E
119.5°E
120°E
120.5°E
Ocean Data View
CTD 12
12 (down)


CTD 13
Potential Temperature θ [degC]
Salinity, Practical [PSU]
Pressure, Digiquartz [db]
Oxygen, SBE 43 [ml/l]
13 (down)
66.2°S
66.6°S
67°S
118.5°E
119°E
119.5°E
120°E
120.5°E


CTD 14
Potential Temperature θ [degC]
Salinity, Practical [PSU]
Pressure, Digiquartz [db]
Oxygen, SBE 43 [ml/l]
14 (down)
66.2°S
66.6°S
67°S
118.5°E
119°E
119.5°E
120°E
120.5°E


CTD 15
Potential Temperature θ [degC]
Salinity, Practical [PSU]
Pressure, Digiquartz [db]
Oxygen, SBE 43 [ml/l]
15 (down)
66.2°S
66.6°S
67°S
118.5°E
119°E
119.5°E
120°E
120.5°E
Ocean Data View

10. CTD logs

NBP1402 CTD CAST LOG

RVIB Nathaniel B. Palmer

Cast #	Station	Observer
Ø01	5	S. Blackman
GMT Start Date	**GMT End Date**	**Data File**
06 FEB 14	06 FEB 14	nbp1402001.HEX
GMT *Start Archiving* Time	**GMT End Time**	**Config. File**
Ø2Ø7	Ø3:23	NBP1402.xml/CON
Latitude Start	**Latitude End**	**Water Depth**
67° 5.606' S	67° 5.606' S	1343
Longitude Start	**Longitude End**	**Ice Conditions**
145° 13.388' E	145° 13.388' E	Ø

CTD Bottle Plan

Niskin	DEPTH Planned	DEPTH Rev.	DEPTH Actual	Comments
1	BOT		1317	
2	BOT		1317	
3	1000		1000.1	
4	1000		1000.2	
5	900		900.0	
6	710		710.3	
7	600		599.8	
8	450		450.1	
9	450		450.0	
10	300		300.0	
11	300		300.1	
12	200		200.1	
13	200		200.1	
14	150		150.1	
15	150		150.0	
16	100		99.8	
17	100		99.8	
18	60		60.1	
19	60		60.1	
20	40		39.9	
21	20		20.5	
22	20		20.5	
23	4		4.Ø	
24	SFC		1.9	

Comments: BOTTLES FOR LEANE, AMELIA, E. SHADWICK, OK

P spike at ~650 on downcast

NBP1402 CTD CAST LOG

RVIB Nathaniel B. Palmer

Cast # 002	Station SHIPSTA 8	Observer Barry
GMT Start Date 1323	GMT End Date 18Feb 14	Data File
GMT *Start Archiving* Time	GMT End Time 1356	Config. File
Latitude Start 66 03.81 S	Latitude End	Water Depth 495
Longitude Start 120 02.91E	Longitude End	Ice Conditions 10/10

CTD Bottle Plan

Niskin	DEPTH Planned	Rev.	Actual	Comments
1	BOT			
2	BOT			
3	450			
4	450			
5	420			
6	420			
7	380			
8	380			
9	300			
10	300			
11	300			
12	200			
13	200			
14	200			
15	100			
16	100			
17	60			
18	60			
19	40			
20	40			
21	40			
22	SFC			
23	SFC			
24	SFC			

30 sec soak
10 sec soak
30 sec

Comments: No Chl max
Tmax 60m (-1.6°C)
50G = 0.7 KTS @ 226°

380m - Bottom Tmax, O_2 Min
TM = >0.27°C
O_2 < 5

NBP1402 CTD CAST LOG

RVIB Nathaniel B. Palmer

Cast # 003	**Station** SHIP 09	**Observer** BB
GMT Start Date 11 Feb14	**GMT End Date** 12 Feb 2014	**Data File** NBP1402003.HEX
GMT *Start Archiving* **Time** 1456	**GMT End Time** 06:32:40	**Config. File** NBP1402.xml/con
Latitude Start -66.36072	**Latitude End** -66.36073 66° 21.643'S	**Water Depth** 677
Longitude Start 119.8619	**Longitude End** 119.86194 119° 51.715'E	**Ice Conditions** 0/10

CTD Bottle Plan

Niskin	DEPTH Planned	Rev.	Actual	Comments
1		No BOTTLES –		
2		examine data feed after re-seating		
3		connectors		
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				

Comments:

Errors 5 Mod before 150m

Spiked @ 150m

Spiking in 2nd day from start of cast.

TOTAL Mod errors: 11 dt UT:0

NBP1402 CTD CAST LOG

Mooring M1

RVIB Nathaniel B. Palmer

Cast # 004	Station SHIP12	Observer PB
GMT Start Date 12 Feb	GMT End Date 12 FEB 14	Data File nbp1402004.hex
GMT *Start Archiving* Time 2117	GMT End Time 1258	Config. File NPB1402.xmlcon
Latitude Start 66 22.025	Latitude End 66°22.019'S	Water Depth 626
Longitude Start 120 00.565	Longitude End 120°0.366'E	Ice Conditions 0/0

CTD Bottle Plan

Niskin	DEPTH Planned	Rev.	Actual	Comments
1	Bot			
2	BOT			
3	600			
4	600			
5	550			
6	550			
7	450			
8	450			
9	400			
10	400			
11	350			
12	350			
13	300			
14	300			
15	200			
16	200			
17	110			
18	110			
19	60			
20	60			
21	40			
22	40			
23	Sfc			
24	Sfc			

Comments: Chlmax: N/A - ML com
Tmax: -1.05

Mederrent:
DN 2
UP

~~402 - Sea~~
~~0 - KT~~
~~.02 DAV~~
~~0.07 BAF~~
~~0.10 BF~~
~~0.005 BB~~

NBP1402 CTD CAST LOG

RVIB Nathaniel B. Palmer

Cast # 005	Station SHP 18	Observer BB
GMT Start Date 16 FE 14	GMT End Date	Data File
GMT *Start Archiving* Time 2330	GMT End Time	Config. File
Latitude Start 66 21.7565	Latitude End	Water Depth 844
Longitude Start 119 19.800E	Longitude End	Ice Conditions 8/10

CTD Bottle Plan

Niskin	DEPTH Planned	Rev.	Actual	Comments
1	840			BOT
2	690			
3	500			
4	400			
5	300			
6	250			
7	200			
8	40	NO WAIT		
9	40			
10	10			
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				

Comments: No chl. Max

500m? local ~~[illegible]~~ Dmax Cmin

Modulo error CNT. DV: 0.

NBP1402 CTD CAST LOG

RVIB Nathaniel B. Palmer

Cast #	Station	Observer
006	19	S. Blackman
GMT Start Date	**GMT End Date**	**Data File**
17 FEB 14	17 FEB 14	NBP1402006.HEX
GMT *Start Archiving* Time	**GMT End Time**	**Config. File**
0332	04:27	NBP1402.XMLCON
Latitude Start	**Latitude End**	**Water Depth**
66° 23.317'S	66° 23.318'S	875m
Longitude Start	**Longitude End**	**Ice Conditions**
119 13.871'E	119° 13.871'E	2/10

CTD Bottle Plan

Niskin	PRESS. Planned	~~DEPTH~~ PRESS. Rev.	Actual	Comments
1	BOT		871	
2	850		850.3	
3	850		850.3	
4	750		750.2	
5	600		600.2	
6	450		449.9	
7	450		449.9	
8	250		250.2	
9	120		120.0	
10	40		40.1	
11	25		24.7	
12	25		24.7	
13	10		10.0	
14	10		10.0	
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				

Comments:

Chl max @ 25

No spikes, no modulo errors. (WTF!)

NBP1402 CTD CAST LOG
RVIB Nathaniel B. Palmer

Cast # 007	**Station** 20	**Observer** BB
GMT Start Date 17 Feb 1450	**GMT End Date**	**Data File**
GMT *Start Archiving* Time 1450	**GMT End Time**	**Config. File**
Latitude Start 66 23.455	**Latitude End**	**Water Depth** 896
Longitude Start 118 57.583	**Longitude End**	**Ice Conditions**

CTD Bottle Plan

Niskin	PRESSURE (DB) Planned	Rev.	Actual	Comments
1	890			
2	890			
3	800			
4	800			
5	700			
6	700			
7	600			
8	600			
9	520			
10	520			
11	450			
12	450			
13	410			
14	410			
15	300			
16	300			
17	200			
18	200			
19	110			
20	110			
21	50			
22	50			chl MAX - LEANNE
23	10			
24	10			

CORE WATER Dumped during upcast

BH +0.28
DG +0.11
BB 0.12
Amy 0.34

Comments:
AT CORESITE

2 m CDW, intrusions 300 420

chl max @ 50m
Double m/ins

MOD Error ct: BN 2 UP

Deep Tcline starts @ 600m

Deep Tmax ~2.8

XMIS plot for END

NBP1402 CTD CAST LOG
Mooring T1

RVIB Nathaniel B. Palmer

Cast # 008	**Station** 22	**Observer** BR
GMT Start Date 18 FEB 2014	**GMT End Date**	**Data File**
GMT *Start Archiving* Time 1520	**GMT End Time**	**Config. File**
Latitude Start 66 34.009S	**Latitude End**	**Water Depth** 690
Longitude Start 119 13.048E	**Longitude End**	**Ice Conditions** OPEN WATER

CTD Bottle Plan

Niskin	PRESSURE (DB) Planned	Rev.	Actual	Comments
1	700 ✓		675	30 sec soak
2	700 ✓		675	
3	600 ✓			=> FALSE TRIP? INTENDED ONLY
4	600			ONE BUT 2 LINES SHOW
5	400 ✓			
6	300 ✓			
7	200 ✓			
8	60 ✓			
9	10			
10	10			
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				

BH 0.23
BR .125
DG 0.20
BF 0.126
Taslim 0.05

Comments:
Pressure spikes
T BOT - 0.009

Mod CNT
DN/2

with UCTD 127 attached to frame

NBP1402 CTD CAST LOG

RVIB Nathaniel B. Palmer

Cast #	Station MOORING M3	Observer
009	9	S. Blackman
GMT Start Date	**GMT End Date**	**Data File**
20 Feb 2014	20 Feb 2014	nbp1402009.hex
GMT *Start Archiving* Time	**GMT End Time**	**Config. File**
1028	11:32	nbp1402.xmlcon
Latitude Start	**Latitude End**	**Water Depth**
66°53.564'S	66°53.564'S	1101 m
Longitude Start	**Longitude End**	**Ice Conditions**
119°25.054'E	119°25.054'E	∅

CTD Bottle Plan

Niskin	PRESSURE (DB) Planned	Rev.	Actual	Comments
1	BOT		1097.3	
2	BOT		1097.3	
3	1000		1000.3	
4	1000		1000.4	
5	800		799.6	
6	800		799.5	
7	650		649.6	
8	650		649.5	
9	500		500.1	
10	500		500.1	
11	350		349.9	
12	350		349.8	
13	200		200.0	
14	200		199.9	
15	120		120.2	
16	120		120.1	
17	80		80.1	
18	80		80.2	
19	50		49.9	
20	50		49.8	
21	7		7.4	
22	7		7.2	
23				
24				

Comments:

STILL SPIKES of MODULO ERRORS

NBP1402 CTD CAST LOG

with UCTD 156 attached

RVIB Nathaniel B. Palmer

Cast #	Station	Observer
Ø1Ø	SNIP 27	S. Blackman
GMT Start Date	**GMT End Date**	**Data File**
21 FEB 2014	21 FEB 2014	nbp1402010.HEX
GMT *Start Archiving* Time	**GMT End Time**	**Config. File**
Ø344	0418	nbp1402.xmlcon
Latitude Start	**Latitude End**	**Water Depth**
66° 11.090'S	66° 11.090'S	546 m
Longitude Start	**Longitude End**	**Ice Conditions**
120° 30.239'E	120° 30.239'E	1/10

CTD Bottle Plan

Niskin	PRESSURE (DB) Planned	Rev.	Actual	Comments
1	BOT		534.6	
2	BOT		534.8	
3	500		500.1	
4	500		500.3	
5	400		400.1	
6	400		400.3	
7	300		300.3	
8	300		300.5	
9	150		150.6	
10	150		150.5	
11	80		80.5	
12	80		80.3	
13	35		35.3	
14	35		35.1	
15	5		4.7	
16	5		4.7	
17				
18				
19				
20				
21				
22				
23				
24				

Comments:

TSG1 = 33.193 CTD 33.240

New primary CT cables

NBP1402 CTD CAST LOG

RVIB Nathaniel B. Palmer

Cast # 11	**Station** 33	**Observer** B. Stork
GMT Start Date 054 23 FEB 2014	**GMT End Date** 24 FEB	**Data File** nbp1402011.hex
GMT *Start Archiving* **Time** 1735	**GMT End Time** 0027	**Config. File** nbp1402.xmlcon
Latitude Start 66 10.025 S	**Latitude End** 66 10.025' S	**Water Depth**
Longitude Start 120 38.156 E	**Longitude End** 120° 38.159' E	**Ice Conditions**

CTD Bottle Plan

Niskin	PRESSURE (DB) Planned	Rev.	Actual	Comments
1				
2				
3				
4			NO BOTTLES -	
5				
6				
7			PICKING locs for pumps	
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				

Comments: AT pump SITE, Close to JPC 27

Mod errmcnt:
DT

NBP1402 CTD CAST LOG

RVIB Nathaniel B. Palmer

Cast # 12	Station 38	Observer B. BJORK
GMT Start Date 25 Feb 2014	GMT End Date 25 FEB 14	Data File
GMT *Start Archiving* Time 0020	GMT End Time 00:59	Config. File NBP1402.xmlcon
Latitude Start 66 23.269' S	Latitude End 66° 23.257' S	Water Depth 665
Longitude Start 119 44.65' E	Longitude End 119° 44.910' E	Ice Conditions open water near ice edge

REPLICATED CTD Bottle Plan

Niskin	PRESSURE (DB) Planned	Rev.	Actual	Comments
1	662			
2	662			
3	550			
4	550			
5	400			
6	400			
7	250			
8	250			
9	120			
10	120			
11	50			
12	50			
13	5			
14	5			
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				

Ph .15
K .25
MR 0.63
3H .47
N .40
B .35

Comments:

Mod impact:
DN:

NBP1402 CTD CAST LOG

RVIB Nathaniel B. Palmer

Cast #	Station	Observer
Ø13	58	S. BLACKMAN
GMT Start Date	**GMT End Date**	**Data File**
FEB 25 2014	FEB 25, 14	nbp1402013.HEX
GMT Start Archiving Time	**GMT End Time**	**Config. File**
12:19	12:58	nbp1402.xml/con
Latitude Start	**Latitude End**	**Water Depth**
66° 29.102' S	66° 29.102' S	60°
Longitude Start	**Longitude End**	**Ice Conditions**
120° 19.950' E	120° 19.950' E	Ø

CTD Bottle Plan

Niskin	PRESSURE (DB) Planned	Rev.	Actual	Comments
1	BOT		596.4	
2	BOT		596.4	
3	500		500.0	
4	500		500.0	
5	400		399.8	
6	400		399.8	
7	250		250.5	
8	250		250.4	
9	110		109.8	
10	110		109.8	
11	50		50.2	
12	50		50.2	
13	5		5.0	
14	5		5.0	
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				

Comments:

BOT. CONTACT DID NOT GO OFF.

NBP1402 CTD CAST LOG

RVIB Nathaniel B. Palmer

Cast #	Station	Observer
Ø14	60	S. Brackman
GMT Start Date	**GMT End Date**	**Data File**
05 Mar 2014	05 Mar 2014	nbp1402014.Hex
GMT *Start Archiving* Time	**GMT End Time**	**Config. File**
0355	0435	NBP1402.xmlcon
Latitude Start	**Latitude End**	**Water Depth**
66 30.388'S	66°30.386'S	500
Longitude Start	**Longitude End**	**Ice Conditions**
120° 29.191'E	120° 29.191'E	Ø

CTD Bottle Plan

Niskin	PRESSURE (DB) Planned	Rev.	Actual	Comments
1	490		488	
2	490		488	
3	450		450.4	
4	450		450.4	
5	400		400.2	
6	400		400.1	
7	330		330.0	
8	330		330.0	
9	290		289.2	
10	290		289.3	
11	220		219.9	
12	220		219.9	
13	160		159.8	
14	160		159.8	
15	100		99.8	
16	100		99.8	
17	70		69.8	
18	70		69.8	
19	50		49.6	
20	50		49.6	
21	25		24.9	
22	25		24.8	
23	5		5.2	
24	5		5.1	

Comments: chla MAX – 50m TMAX 100m
ml 70m
Tmin
320
340 mCDW intr

NBP1402 CTD CAST LOG

RVIB Nathaniel B. Palmer

Cast # 15	Station 41	Observer R. Bjork
GMT Start Date 05 Mar 14	GMT End Date 05 Mar 14	Data File
GMT *Start Archiving* Time 1340	GMT End Time 14:20	Config. File
Latitude Start 66 07.74 S	Latitude End 66° 7.723' S	Water Depth 580
Longitude Start 120 27.84 E	Longitude End 120° 27.848 E	Ice Conditions open water

CTD Bottle Plan

Niskin	PRESSURE (DB) Planned	Rev.	Actual	Comments
1	570			
2	570			
3	510			
4	510			
5	450			Benthic Tmax
6	450			
7	400			
8	400			
9	300			
10	300			
11	200			
12	200			
13	150			
14	150			
15	75			
16	75			
17	40			
18	40			
19	25			
20	25			
21	5			
22	5			
23	5			
24	5			

Tash OK
Bat: 5278

Comments: chla Tmax 80m ML 60m
Tmin 190
Benthic Tmax 450m 0.64
Mod error: DT: 0 UT: 0
clean trace

CTD Log Sheet

Cruise: **NBP 1402**

Cast #	Date	Julian day	GMT Time	Station	Latitude	Longitude	CTD file name	Water Depth	Operator/comment
1	2/6/14	37	Ø2Ø7	5	67 5.606 S	145 13.38 E	nbp1402ØØ1.HEX	1350 m	S. Blackman
2	2/10/14	41	1319	8	66 03.759	120 03.0112	nbp 1402 002.HEX	500m	B.Bjork
3	2/11/14	42	1456	9	-66.3607	119.8619	NBP 1402 003.	677	"
4	2/12/14	43	2117	12	66 22.02	120 00.565	NBP1402004.	626	B "
5	2/16/14	47	2330	18	66 21.74	119 19.81 E	NBP 1402 005	840	"
6	2/17/14	48	0332	19	66 23.3175	119 13.871 E	NBP1402006	877	S. Blackman
7	2/17/14	48	1450	20	66 25.15	118 57.58	007		
8	2/18/14	49	1522	22	66 34.0	119 13.0 E	NBP1402 008	696	BB
9	2/20/14	51	1020	?	66 53.564	119 25.054 E	NBP1402009	1100	S. Blackman
10	2/21/14	52	0344	27	66 11.090 S	120 30.239	NBP1402010	546	S Blackman
11	2/23/14	54	1735	33	66 10.03	120 58.16	NBP1402 11		B. Bjork
12	2/25/14	56	0020	38	66 23.129	119 44.65	NBP140212	665	B. Bjork
13	2/25/14	56	1219	42 58	66 29.1025	120 19.950 E	nbp140213	608	S. Blackman
14	3/5/14	64	0355	60	66 30.380 S	120 29.191 E	AT T3 MOORING .7mi SE	500	S. Blackman
15	3/5/14	64	1340	61	66 07.74	120 27.50	AT STA 57 SITE w/ MEGACORE, PUMPS	580	BB
16									
17									
18									
19									
20									

11. CTD bottle logs

Bottle Log		NBP14-02	CTD: 001
Lamont-Doherty Earth Observatory Columbia University	Date: 14/02/06		Station: 5

START								
END								
ROS#	Pressure	Oxygen	Temp	DIC	O-18	Salinity	Bottle ID	Remarks
1	1334	✓451	-0.9		✓	✓A1		
2	1334	LEANNE,	Amelia					
3	1000	✓450	-1.3	✓✓	✓	✓A2		
4	1000							
5	910	✓449	-1.6	✓		✓A3		
6	719	✓448	-1.8	✓		✓A4		
7	606			✓	✓			
8	455	✓455	-1.7	✓		✓A5		
9	450							
10	300	✓453	-1.7	✓	✓	✓A6		
11	300							
12	200	✓454	-1.7	✓		✓A7		leaky air vent
13	200							
14	150	✓452	-1.6	✓✓		✓A8		
15	150							
16	100	~~✓~~		✓		✓A9		No leash
17	100							
18	60	✓458	-1.6	✓		✓A10		
19	100							
20	40	✓457	-1.5	✓	✓	✓A11		Broken leash
21	20			✓				
22	20	LEANNE,	Amelia					
23	4	✓456	-1.0	✓	✓	✓A12		
24	sfc	LEANNE,	Amelia					
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								

chl max ~20 m

Bottle Log		NBP14-02	CTD: 002
Lamont-Doherty Earth Observatory Columbia University	Date: 14/02/10		Station: 8

START	01 07 local							
END								
ROS#	Pressure	Oxygen	Temp	DIC	O-18	Salinity	Bottle ID	Remarks
1	Bot	487 ✓	00.000	✓	✓	✓	A13	
2	BoT							
3	450	486 ✓	0.6		—	✓	A14	
4	450							
5	420	444 small bubble	-0.3	✓	✓	✓	A15	
6	420							
7	380	484 ✓	-1.2			—	A16	
8	380							LEAKER
9	300	491 490 ✓✓	-1.2 -1.0	✓	✓	✓✓	A17/A18	
10	300							
11	300			✓	✓			
12	200	489 488 ✓✓	-1.0 -0.9	✓		✓✓	A19/A20	
13	200							
14	200			✓				
15	100	495 ✓	-0.9		—	✓	A21	
16	100							
17	60	494 ✓	-0.9	✓		—	A23	
18	60							
19	40	493 ✓	-1.0	✓		—	A24	
20	40							
21	40							
22	SFC	492 ✓	-1.1	✓		—	A22	
23	SFC							
24	SFC							
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								

Bottle #8 leaked

Bottle Log		NBP14-02	CTD: 3
Lamont-Doherty Earth Observatory Columbia University		Date: 14/ /	Station:

ROS#	Pressure	Oxygen	Temp	DIC	O-18	Salinity	Bottle ID	Remarks
START								
END								
1								
2								
3								
4		NO BOTTLES						
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
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31								
32								
33								
34								
35								
36								

Bottle Log		NBP14-02	CTD: 004
Lamont-Doherty Earth Observatory Columbia University	Date: 14/02/12		Station: 12

ROS#	Pressure	Oxygen	Temp	DIC	O-18	Salinity	Bottle ID	Remarks
START								
END								
1	620	✓ 473	0.0	✓	✓	✓	H1	Bottom Leak
2	620							
3	~~600~~ 600	✓ 472	-0.1			✓	H2	
4	600							
5	550	✓ 474	-0.2	✓		✓	H3	Bottom Leak Air Vent Leak
6	~~550~~		NO TRIP					
7	450	✓ 475	-1.2	✓		✓	H4	Bottom Leak Air Vent Leak
8	~~450~~		LEAK					
9	400	✓✓ 479 478	-1.4 -1.2	✓	✓✓	✓✓	H5 H6	
10	400							
11	350	✓ 477	-1.4			✓	H7	Bottom Leak
12	350							
13	300	✓✓ 426 483	-1.4 -1.1	✓	✓	✓✓	H8 H9	
14	300							
15	200	✓ 482	-1.2			✓	H10	Bottom Leak
16	200							
17	110	✓ 481	-1.2			✓	H11	Bottom Leak
18	110							
19	60	✓ 480	-0.3	✓		✓	H12	
20	60							
21	40			✓				
22	40							
23	SFC			✓				
24	SFC							
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35		ALKS NOT POISONED						
36								

Bottle Log		NBP14-02	CTD: 005
Lamont-Doherty Earth Observatory Columbia University	Date: 14/02/16		Station: 15

ROS#	Pressure	Oxygen	Temp	DIC	O-18	Salinity	Bottle ID	Remarks
START								
END								
1 r	840	✓ 448/452	-0.4	—		✓ H13,	H14	
2	690	✓ 456	-0.4			✓ H15		
3	500	✓ 449	-1.7			✓ H16		
4 r	400	✓ 454/451	-1.4			✓ H17,	H18	
5	300	✓ 450	-1.6			✓ H19		
6	250	✓ 453				✓ H20		
7	200	✓ 458	-1.7			✓ H21		
8	40	No	Samples		NOW AIR			
9 r	40	✓ 451/45				✓	H22, H23	
10	10	—			—	—		
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
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32								
33								
34								
35								
36								

Bottle Log		NBP14-02	CTD: 006
Lamont-Doherty Earth Observatory Columbia University	Date: 14/02/17		Station: 19

ROS#	Pressure	Oxygen	Temp °C	DIC	O-18	Salinity	Bottle ID	Remarks
START								
END								
1 bottom	870	✓ 495	-0.2	✓		✓	I1	
2	850	✓ 491	-0.2	✓✓		✓	I2	
3	850							
4	750	✓ 487	-0.3	✓		✓	I3	bottom leak
5	600	✓ 494	-1.2	✓		✓	I4	
6	450	✓ 490	-1.7	✓		✓	I5	bottom leak
7	450							
8	250	✓ 486	-1.6	✓		✓	I6	bottom leak
9	120	✓ 493	-1.7	✓		✓	I7	
10	40	✓ 489	-1.1	✓✓		✓	I8	
11	25							
12	25							
13	10	✓ 444	-1.3	✓		✓	I9	
14	10							
15								
16								
17								
18								
19								
20								
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34								
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36								

Bottle Log		NBP14-02	CTD: 7 007
Lamont-Doherty Earth Observatory Columbia University	Date: 14/02/17		Station: 20

START								
END								
ROS#	Pressure	Oxygen	Temp	DIC	0-18	Salinity	Bottle ID	Remarks
1	890	✓ 483	-0.4	✓	✓	✓ I10		
2	890	LEANNE		Amelia				
3	800	✓ 479	-0.4	✓		✓ I11		
4	800							
5	700	✓ 475	-1.2	✓		✓ I12		
6	700							
7	600	✓ 482	-1.2	✓		✓ I13		
8	600							
9	520	✓ 478	-1.2	✓		✓ I14		
10	520							
11	450	✓ 474	-1.0	✓		✓ I15		
12	450							
13	410	✓ 481	-1.4	✓		✓ I16		
14	410			Amelia				
15	300	✓ 477	-1.4	✓		✓ I17		
16	300			Amelia				
17	200	✓ 472	-1.4	✓		✓ I18		bottom leak
18	200							
19	110	✓ 480	-1.4	✓	✓	✓ I19		
20	110							
21	50	✓ 476	-0.9	✓		✓ I20		
22	50		CHL MAX - for LEANNE			/	Amelia	
23	10	✓ 473	-1.4	✓		✓ I21		
24	10	LEANNE		Amelia				
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								

Bottle Log		NBP14-02	CTD: 008
Lamont-Doherty Earth Observatory Columbia University		Date: 14/02/18	Station: 22

START								
END								
ROS#	Pressure	Oxygen	Temp	DIC	O-18	Salinity	Bottle ID	Remarks
1	700	✓ 448	-0.2	✓		✓	67	
2	700	LEANNE						
3	600	~~	~~	POSSIBLE	MISTRIP	— —		
4	600	✓ 452	-0.2	✓		✓	613	Bottom Leak ✓
5	400	✓ 456	-1.4	✓		✓	619	
6	300	✓ 449	-1.4	✓		✓	I24	
7	200	✓ 454	-1.4	✓		✓	I23	
8	60	LEANNE						
9	10	✓ 450	-1.2	✓		✓	I22	
10	10 x	LEANNE						
11								
12	x	leaking from Bottom						
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
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31								
32								
33								
34								
35								
36								

Mooring M3

Bottle Log		NBP14-02	CTD: 9
Lamont-Doherty Earth Observatory Columbia University	Date: 14/02/19		Station:

START								
END								
ROS#	Pressure	Oxygen	Temp	DIC	O-18	Salinity	Bottle ID	Remarks
1 bot	1097	497 ✓	-1.3	✓	✓	✓ C1		
② bot	1097	4	Amelia					
3	1000							leak
4	1000	491 ✓	-1.3	✓ ✓	✓	✓ C2		
5	800							leak
6	800	✓ 495	-1.1	✓	✓	✓ C3		
7	650	✓ 490	-1.1	✓	✓	✓ C4		
8	650		Amelia					
9	500	✓ 494	-1.1	✓	✓	✓ C5		
10	500							
11	350	✓ 484	-1.4	✓	✓	✓ C6		
12	350							
13	200	✓ 488	-1.3	✓	✓	✓ C7		
14	200		Amelia					
15	120	✓ 492	-1.2	✓	✓	✓ C8		
16	120		Amelia					
17	80							
18	80							
19	50	✓ 458	-0.6	✓ ✓	✓	✓ C9		
20	50							
21	7	✓ 451	-0.6	✓	✓	✓ C10		
㉒	7		Amelia					
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								

Bottle Log		NBP14-02	CTD: 10
Lamont-Doherty Earth Observatory Columbia University		Date: 14/02 / 21	Station:

START								
END								
ROS#	Pressure	Oxygen	Temp	DIC	O-18	Salinity	Bottle ID	Remarks
1	535							
2	535	✓ 483	-0.1	✓	✓	✓ C11		
3	500							
4	500	✓ 479	0.0	✓✓	✓			
5	400							
6	400	✓ 475	-0.4	✓	✓	✓ C12		
7	300							
8	300	✓ 482	-1.2	✓	✓	✓ C13		
9	150							
10	150	✓ 478	-1.4	✓	✓	✓ C14		
11	80							
12	80	✓ 474	-1.5	✓	✓	✓ C15		
13	35							
14	35	✓ 481	-1.3	✓	✓	✓ C16		
15	5							
16	5	✓ 477	-1.3	✓	✓			
17								
18								
19								
20								
21								
22								
23								
24								
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31								
32								
33								
34								
35								
36								

Bottle Log		NBP14-02	CTD: 12
Lamont-Doherty Earth Observatory Columbia University		Date: 14/02/25	Station: 38

ROS#	Pressure	Oxygen	Temp	DIC	O-18	Salinity	Bottle ID	Remarks
START								
END								
1	662							
2	662	√√448, 452	0.0, 0.11			√√G1, G2		
3	550							
4	550	√√456, 450	0.0, 0.1			√√G3, G4		
5	400							
6	400	√√454, 449	-1.3, -1.1			√√G5, G6		
7	250	~~√√458, 455~~						dribbler from spigot.
8	250	√√458, 453	-1.1, -0.7			√√G8, G9		leaking badly from bottom end cap.
9	120							
10	120	√√457, 484	-1.2, -1.0			√√G10, G11		
11	50							
12	50	√√455, 451	-1.2, -1.0			√√G14, G12		
13	5							
14	5	√√480, 476	-1.2, -1.0			√√G15, G16		
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								

Bottle Log		NBP14-02	CTD: 13
Lamont-Doherty Earth Observatory Columbia University	Date: 14/02/25	Station:	

START								
END								
ROS#	Pressure	Oxygen	Temp	DIC	O-18	Salinity	Bottle ID	Remarks
1	603		AMELIA					
2	603	✓ 473	-0.2		✓	✓ G23		
3	500		AMELIA					
4	500	✓ 488	-0.2		✓	✓ G22		BH. leaking
5	400							
6	400	✓ 492	-1.2		✓	✓ G21		
7	250		AMELIA					
8	250	✓ 495	-1.6		✓	✓ G20		
9	110							
10	110	✓ 490	-1.3		✓	✓ G18		BH. leaking
11	50		AMELIA					
12	50				✓	✓ G17		
13	5		AMELIA					
14	5	✓ 494	-1.5		✓	✓ G24		
15								
16								
17								
18								
19								
20								
21								
22								
23								
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26								
27								
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↑ Replicate for ~~both~~ comparison of 2 methods (TAMUG & DOMACK)

Bottle Log		NBP14-02	CTD: 14
Lamont-Doherty Earth Observatory Columbia University		Date: 14/03/05	Station: 60
AT T3 Mooring site			

START								
END								
ROS#	Pressure	Oxygen	Temp	DIC	O-18	Salinity	Bottle ID	Remarks
1	490							
2	490	484/455	-0.4/-0.3			H1, H2		
3	450							
4	450	451/457	-0.5/-0.4			H3, H4		
5	400							
6	400	453/458	-1.1/-1.1			H5, H6		
7	330							
8	330	450/454	-1.6/-1.5			H7, H8		
9	290							
10	290	449/448	-1.6/-1.5			H9, H10		
11	220							
12	220	452/456	-1.7/-1.4			H11, H12		
13	160							
14	160	489/444	-1.5/-1.5			H13, H14		
15	100							
16	100	486/493	-1.5/-1.3			H15, H16		
17	70							
18	70	487/491	-1. -1.5/-1.3			H17, H18		
19	50							
20	50	494/490	-1.5/-1.4			H19, H20		
21	25							
22	25	495/492	-1.5/-1.4			H21, H22		
23	5							
24	5	488/473	-1.4/-1.3			H23, H24		
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								

Bottle Log		NBP14-02	CTD: 15
Lamont-Doherty Earth Observatory Columbia University		Date: 14/03/05	Station: 61

ROS#	Pressure	Oxygen	Temp	DIC	O-18	Salinity	Bottle ID	Remarks
START								
END								
1	570	LEJEUNE						Virus
2	570	477	+0.1			A1		
3	510							
4	510	479	+0.2			A2		bottom cap leaking
5	450							Vin
6	450	483	+0.4			A3		
7	400							
8	400	478	0.0			A4		
9	300							
10	300	482	-1.0			A5		bottom cap leaking
11	200							Vin
12	200	475	-1.2			A6		
13	150							
14	150	472	-1.0			A7		bottom cap leaking
15	75							
16	75	481	-0.7			A8		
17	40	LEJEUNE						
18	40	474	-0.5			A9		
19	25							
20	25	468	-0.3			A10		
21	5							VIRUS
22	5	480 / 476	0.0 / 0.6			A11, A12		
23	5	LEJEUNE						
24	5							
25								
26								
27								
28								
29								
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31								
32								
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34								
35								
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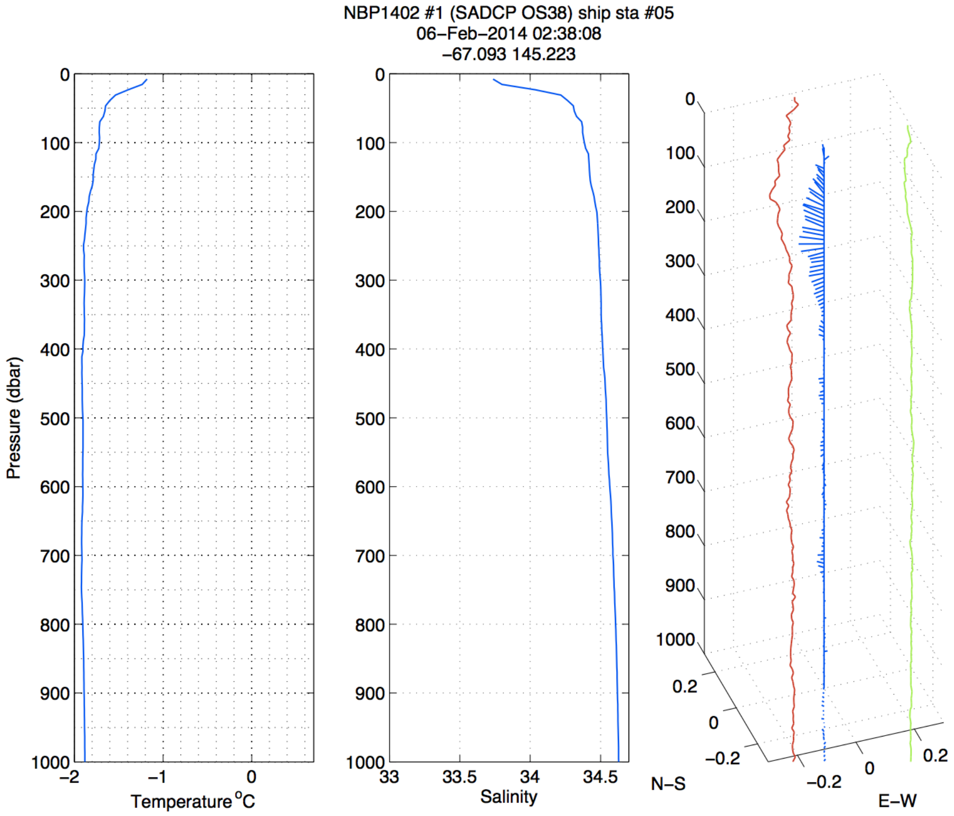
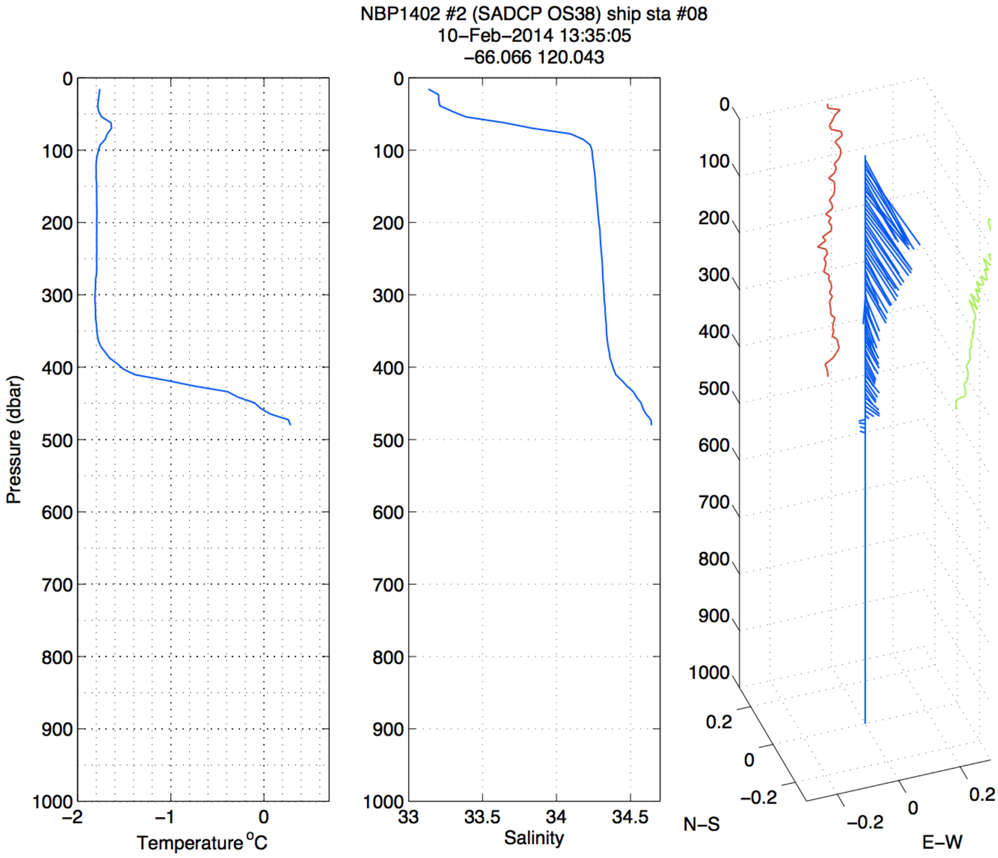
12. LADCP profiles

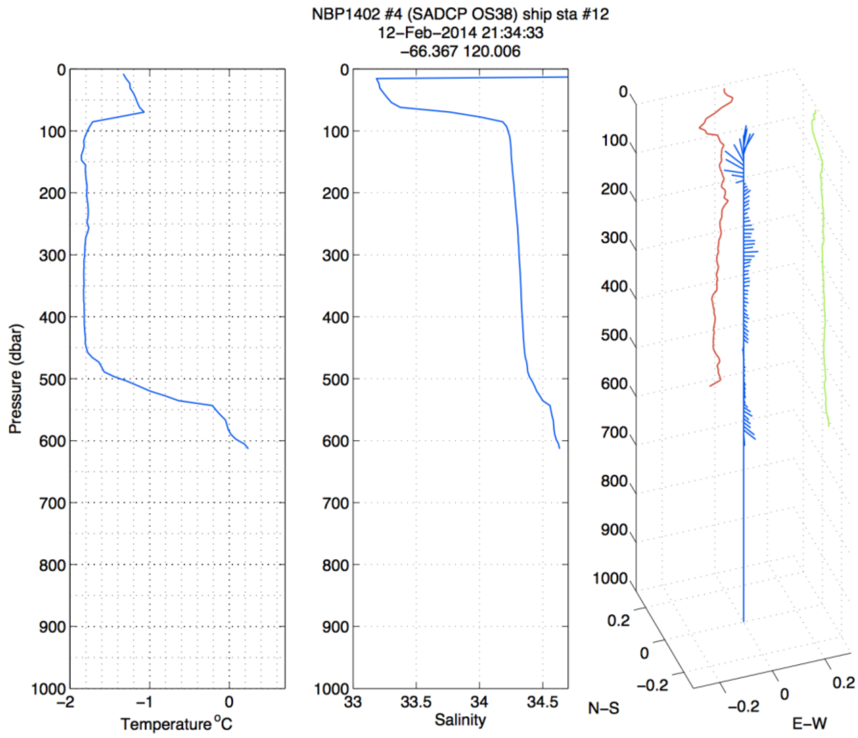
Appendix – Lowered ADCP profiles

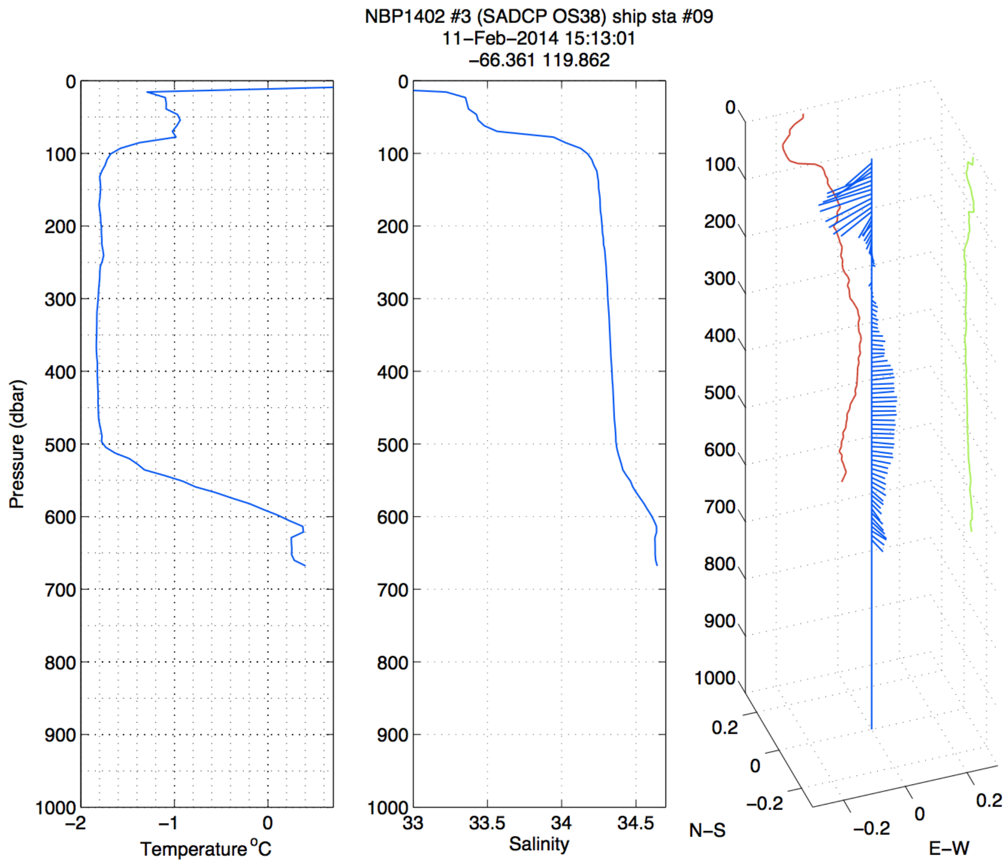
Left panel – CTD temperature at each 8-meter LADCP level
Middle panel – CTD salinity at each 8-meter LADCP level
Right panel – LADCP profiles of N-S (green) and E-W (red) velocity, with the resulting vectors at each 8-m level.

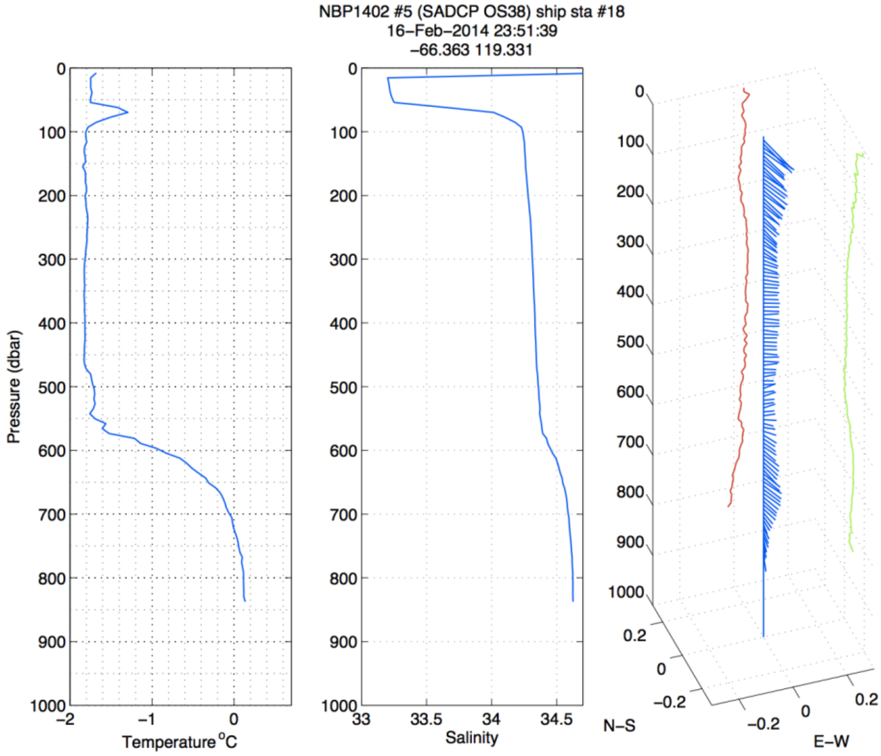
In all cases, the direction has been corrected for the local magnetic declination.

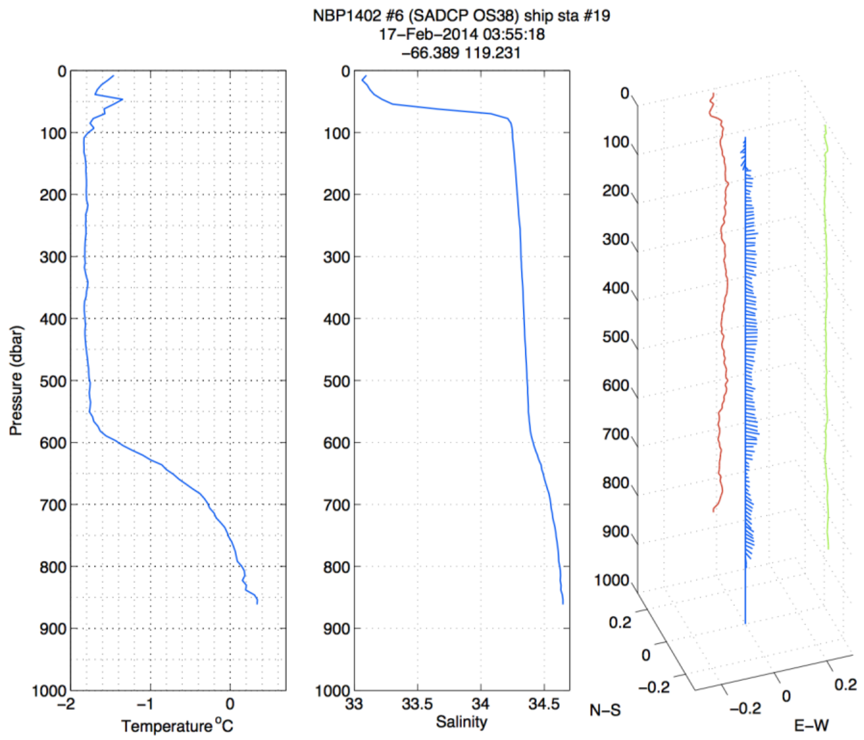

NBP1402 #1 (SADCP OS38) ship sta #05
06–Feb–2014 02:38:08
–67.093 145.223
Pressure (dbar)
Temperature °C
Salinity
N–S
E–W

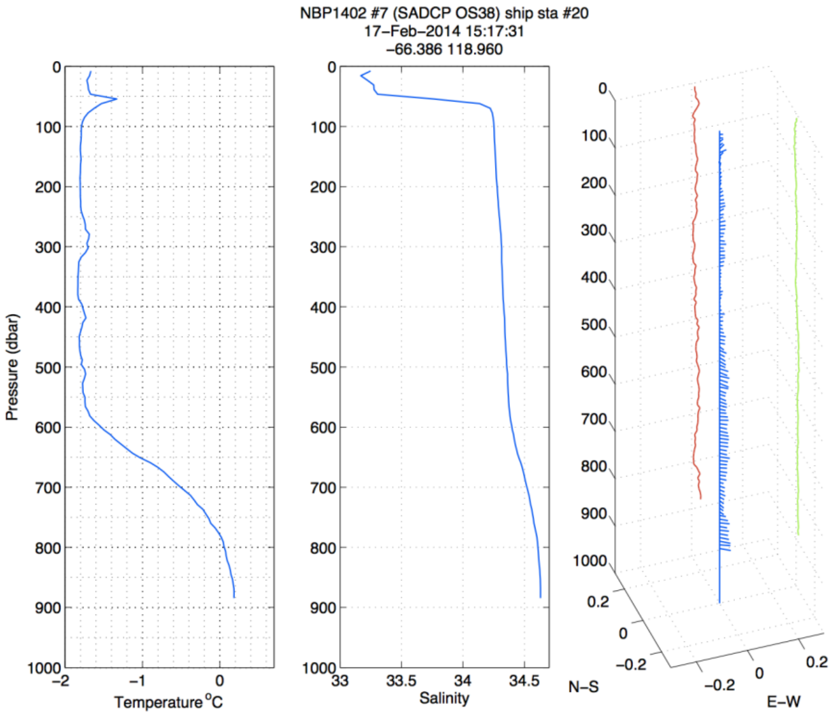

NBP1402 #2 (SADCP OS38) ship sta #08
10–Feb–2014 13:35:05
–66.066 120.043
Pressure (dbar)
Temperature °C
Salinity
N–S
E–W

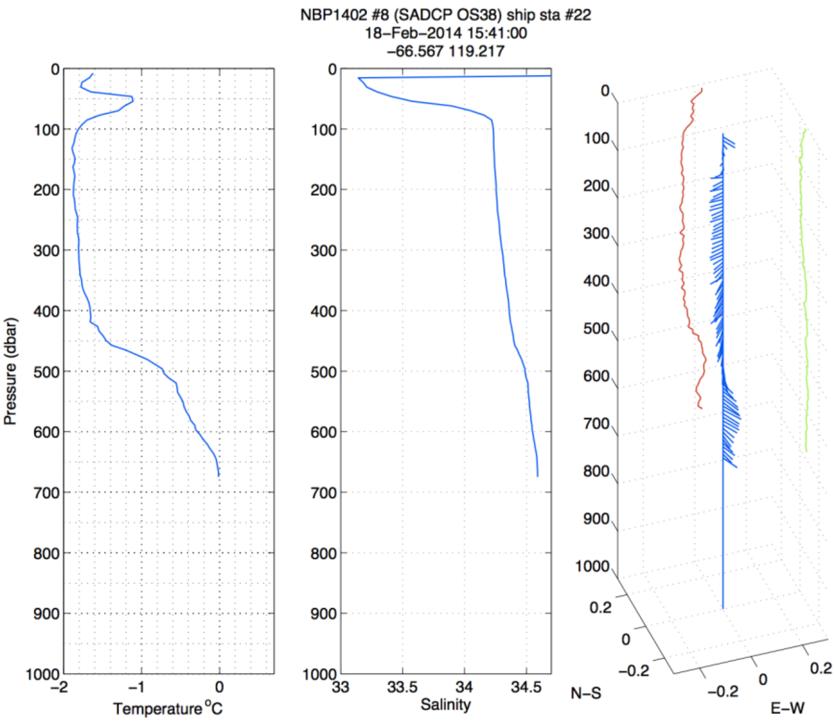

NBP1402 #4 (SADCP OS38) ship sta #12
12−Feb−2014 21:34:33
−66.367 120.006
Pressure (dbar)
Temperature °C
Salinity
N−S
E−W

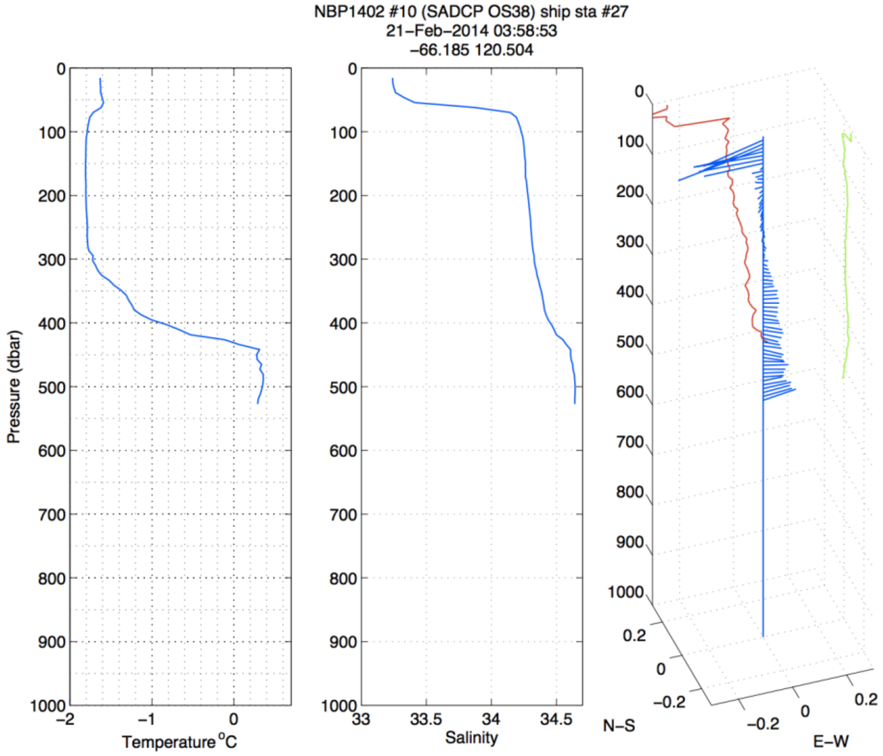

NBP1402 #3 (SADCP OS38) ship sta #09
11−Feb−2014 15:13:01
−66.361 119.862
Pressure (dbar)
Temperature °C
Salinity
N−S
E−W

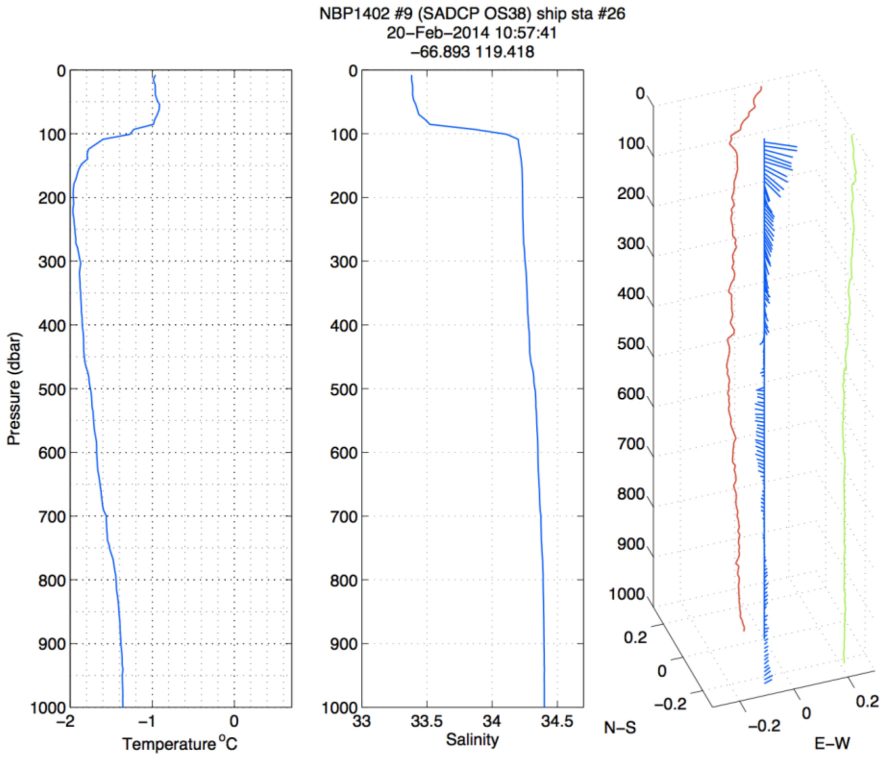

NBP1402 #5 (SADCP OS38) ship sta #18
16−Feb−2014 23:51:39
−66.363 119.331
Pressure (dbar)
Temperature °C
Salinity
N−S
E−W

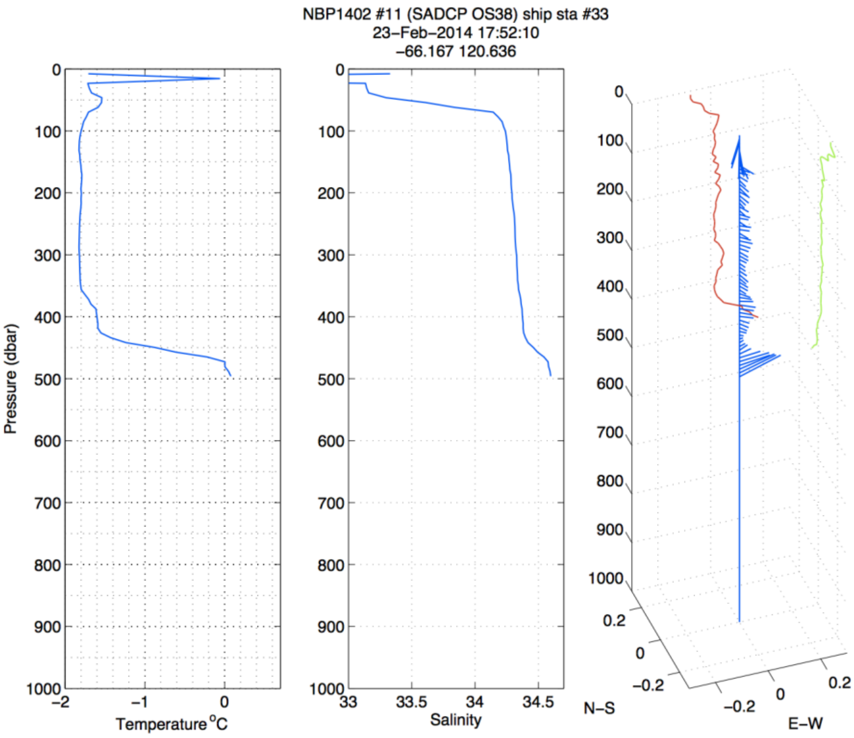

NBP1402 #6 (SADCP OS38) ship sta #19
17−Feb−2014 03:55:18
−66.389 119.231
Pressure (dbar)
Temperature °C
Salinity
N−S
E−W

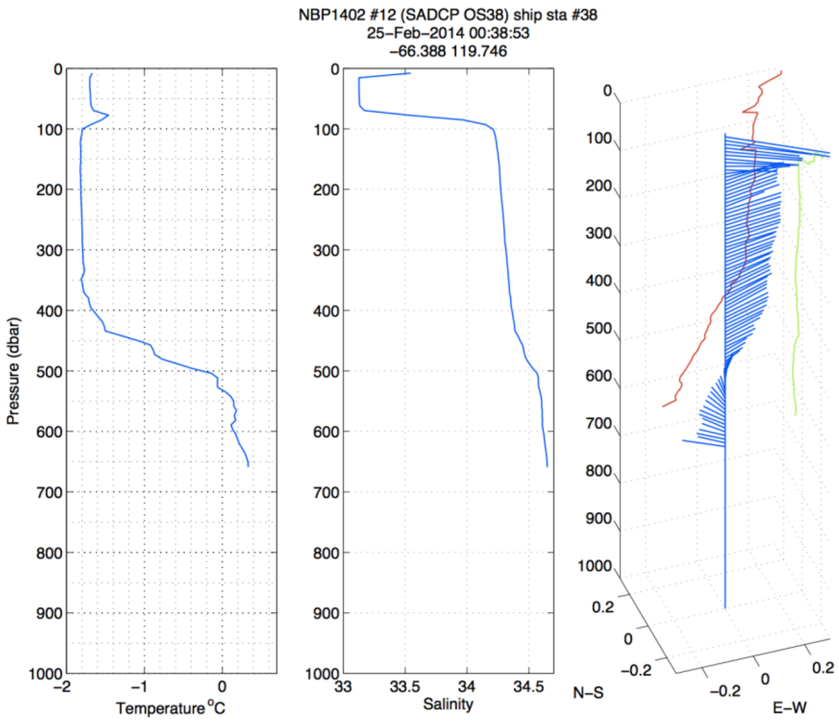

NBP1402 #7 (SADCP OS38) ship sta #20
17–Feb–2014 15:17:31
–66.386 118.960
Pressure (dbar)
Temperature °C
Salinity
N–S
E–W

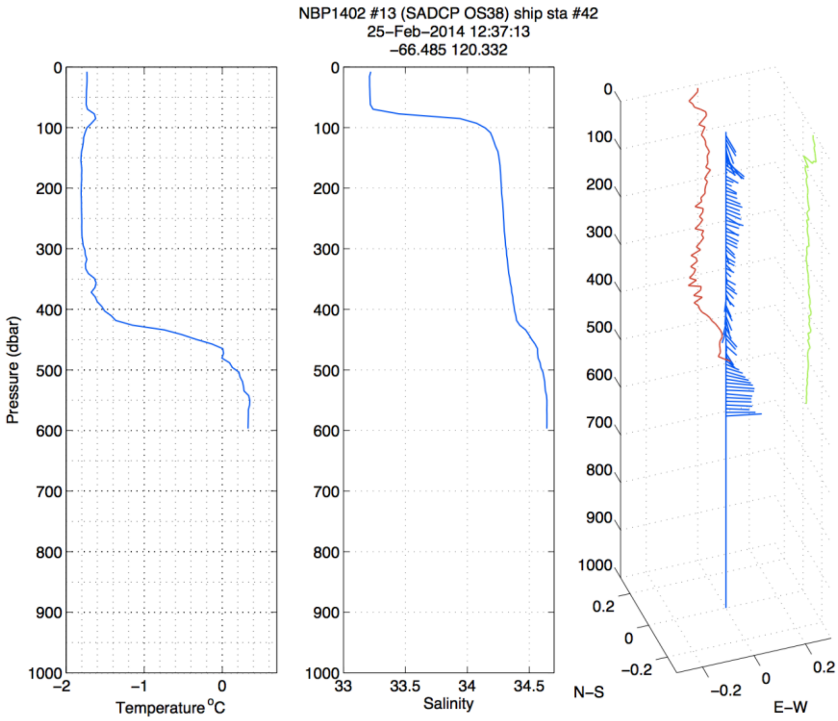

NBP1402 #8 (SADCP OS38) ship sta #22
18–Feb–2014 15:41:00
–66.567 119.217
Pressure (dbar)
Temperature °C
Salinity
N–S
E–W

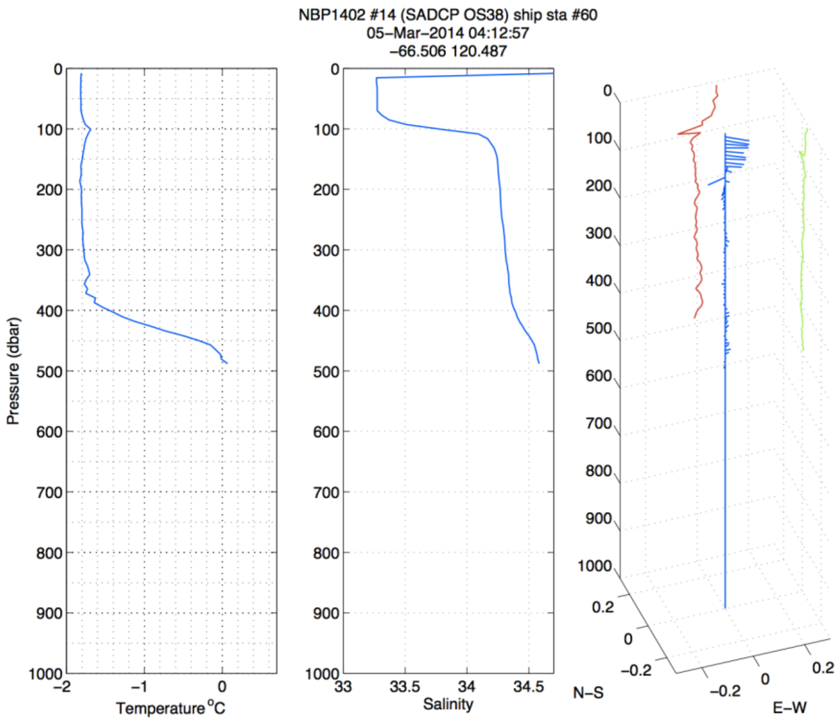

NBP1402 #10 (SADCP OS38) ship sta #27
21−Feb−2014 03:58:53
−66.185 120.504
Pressure (dbar)
Temperature °C
Salinity
N−S
E−W

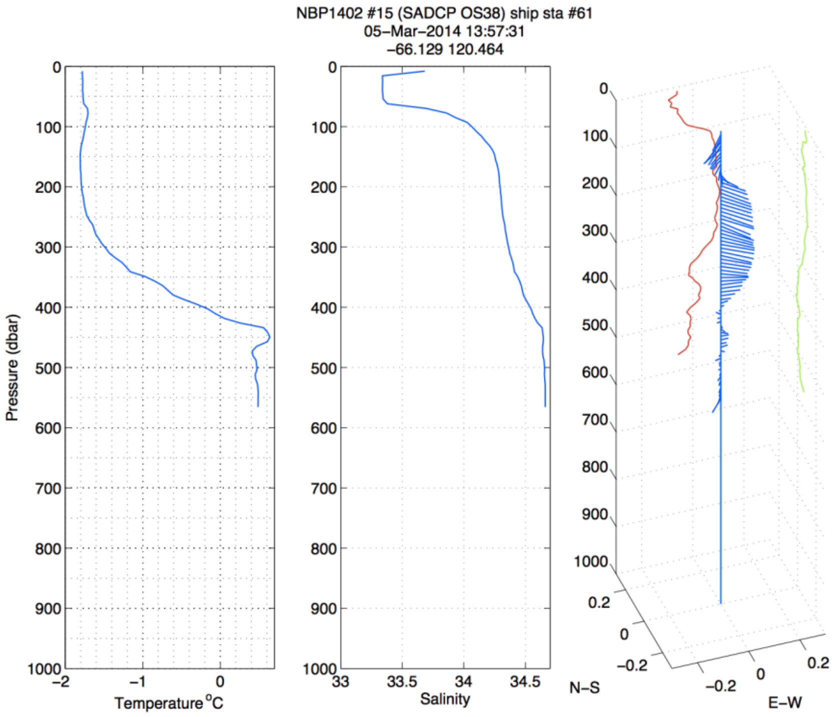

NBP1402 #9 (SADCP OS38) ship sta #26
20−Feb−2014 10:57:41
−66.893 119.418
Pressure (dbar)
Temperature °C
Salinity
N−S
E−W


NBP1402 #11 (SADCP OS38) ship sta #33
23–Feb–2014 17:52:10
–66.167 120.636
Pressure (dbar)
Temperature °C
Salinity
N–S
E–W


NBP1402 #12 (SADCP OS38) ship sta #38
25–Feb–2014 00:38:53
–66.388 119.746
Pressure (dbar)
Temperature °C
Salinity
N–S
E–W


NBP1402 #13 (SADCP OS38) ship sta #42
25−Feb−2014 12:37:13
−66.485 120.332
Pressure (dbar)
Temperature °C
Salinity
N−S
E−W


NBP1402 #14 (SADCP OS38) ship sta #60
05−Mar−2014 04:12:57
−66.506 120.487
Pressure (dbar)
Temperature °C
Salinity
N−S
E−W


NBP1402 #15 (SADCP OS38) ship sta #61
05–Mar–2014 13:57:31
–66.129 120.464
Pressure (dbar)
Temperature °C
Salinity
N–S
E–W

13. Jamin's appendices

Appendix A, Vendor Specifications for GT-2A

Measurement range 9.75 to 9.85 m/sec
Dynamic range +/- 1,000 Gals

Drift per day (corrected) < 0.1 mGals

RMS error in gravity anomaly estimation
(static mode up to 12 hours on bench)
RMS error 0.6 mGals

Attitude limits
roll +/- 45
pitch +/- 45

Operating temp +5 C to +50 C

Power
operating 150 W at 27Vdc
standby 50 W at 27Vdc

Weight (with base) 153.5 kg

Dimensions console 400 x 400 x 600 mm
Dimensions base 600 x 300 mm

Service life 30,000 hours

Error in gravity anomaly estimation (RMS)
0.01 Hz cut-off 0.6 mGals
Lease Pricing:

- $2350 per day while the meter is running
- $500 per day when the meter is on standby

GT2M calculates in a real time four optimal gravity anomaly estimations with different time delays relatively current time **Td**, equal to **Tvc, Tvc+150 c, Tvc+450 c, Tvc+750** by using suboptimal smoothing gravimetrical five order filters. **Tvc** value is entered from CDU. GSE readings are the input for these gravimetrical filters. These readings are formed and corrected by using a task **Input information forming.** The readings contain Eotvos correction based on GPS data and a normal value of gravity calculated by using Gelmert formula minus 14mgal:

Gg=9.78030(1+0.005302 sin^2(F) – 0.000007 sin^2(2F))-0.00014 m/sec^2, where **F**-local latitude

Below you can see formulas for filter time constant calculation **Tf**,
by using averaging time **Tave** and a half wave space resolution of a gravimeter **R** and **Td** :

Tf = Td/(1+√5) ≈ Td/3.24
Tave = Tf ·2π ≈ (Td/3.24) · 6.28 ≈ 1.94 Td
R = (Tave·V) / 2 ≈ 0.97 Td·V, где V- vessel speed.

dG values from channels with time constants Tvc and Tvc+450sec in a binary form are recorded into G-file instead fine and coarse channels respectively. dG values from channels with time constants with Tvc+150sec and Tvc+750sec are recorded into a K-file instead fine and coarse channel respectively. K-file structure is identical to G-file.
In purpose to convert binary **G and K** files in text files (to process them by Geosoft) a converter program **mCONV_c4.exe**. is used. Operator has to put the program **mconv_c4.exe** to the directory where **G и K** files have to be converted are located. Any other G and K files must not be in this directory. The output data of the program m**CONV_c4.exe** is a file with the same name but it begins from a letter **M** and extension **.grv: M*.grv.**
NOTE: the program **mCONV_c4.exe** operates in **Windows (32 bit)** only**.**

Tvc value becomes equal to 150sec automatically when gravimeter is in operating mode. (if Tvc<100sec – no readiness for measurements is flagged).
The table presents values of Tf, Tave and R for Td = 150 sec and vessel speed 5 knots (2.5 м/sec).

dG columns (after conversion)	Time constant Tf	Averaging time Tave	Half wave space resolution R
First (Td = 150 sec)	46 sec	290 sec	363 m
Second (Td = 300 sec)	93 sec	582 sec	727 m
Third (Td = 600 sec)	186 sec	1164 sec	1455 m
Fourth (Td = 900 sec)	279 sec	1746 sec	2182 m

G, K & M – files content
After converting of binary G and K files to ASCII – codes (by means of the mconvert.exe program)
Every line begins from a line header (**HEADER**) and data line header (**GRV**)**.** Then a data itself follows separated by commas.
The first line of a file is a header and looks like shown below:
HEADER,Nplg=10,Ngls=11,Date=10.03.2004,Time=00:06,K=359.9,V=0.0,Tvk=30.0,Serial=22802,*6E

Where:
HEADER - is a header identifier;
Nplg - survey area number;
Ngls - survey number;
Date - system current date (dd.mm.yyyy);
Time - system current time (hh:mm);
К - vessel heading in the beginning of file recording (degrees);
V - vessel speed in the beginning of file recording (knots);
Tvk - time of constant delay (sec);
Serial - gravimeter serial number;

The next lines are data lines and looks like:

GRV,0001,020604,000631,+60.00000,+0.00000,-0.00,-0.00,+0.00,+0.0,0,0000,999999,*5C
Every data line of G-file contains a header (**GRV**), 11 parameters and a check sum. (Table 1).

Table 1. G-file parameters with extension .grv after conversion by using a program mconvert.exe

№	Parameter	Units
1	**№**	-
2	**Date**	dd.mm.yy
3	**Tgrn**	hh.mm.ss
4	**F**	degrees
5	**L**	degrees
6	**dG**	mGal
7	**dGh**	mGal
8	**DGetv**	mGal
9	**Z..**	Gal
10	**FlgG**	-
11	**SY**	Hex
12	**Heh**	m

where:

№ line number

Дата Current Greenwich time

Tgrn GPS Greenwich time (hh,mm,ss.dd),

F current latitude

L current longitude

dG, dGh free air anomaly relatively formula of normal gravity *, calculated by using gravimetrical filters with averaging time **Tave=(6.28/3.24)Tvk** and **Tave=(6.28/3.24)(Tvk+450c)** respectively. **dG** value delays relatively current time on a value equal to **Tvk**. **dGh** value has time delay relatively current time equal to **Tvk+600c**

dGetv current Eotvos correction

Z.. maximum vertical acceleration for the last record period;

FlgG prohibition to use **dG** values because vertical channel disturbance caused by Z range exceeding;

SY gravimeter current status (Table 3);

Heh sonar readings. If sonar is not Heh=999999.

***** Gelmert formula minus 14 mgal.

$$Gg=9.78030(1+0.005302 \sin^2(F) - 0.000007 \sin^2(2F))-0.00014 \text{ м/с}^2$$

Table2. . K-file with extnsion .grv after conversion by mconvert.exe

№	Parameter	Units
1	**№**	-
2	**Date**	ddmmyy
3	**Tgrn**	hhmmss
4	**F**	degrees
5	**L**	degrees
6	**dG**	mGal
7	**dGh**	mGal
8	**DGetv**	mGal
9	**Z..**	Gal
10	**FlgG**	-
11	**SY**	Heh
12	**Heh**	m

here

dG, dGh free air anomaly calculated by using gravimetrical filters with averaging time **Tave=(6.28/3.24)(Tvk+150 sec)** and **Tave=(6.28/3.24)(Tvk+750sec)** respectively. **dG** value has time delay relatively current time equal to **Tvk+150 sec**, **dGh** value has time delay = **Tvk+750 c**

Table 3. M-files parameters with extension .grv after conversion by mconv_c4.exe

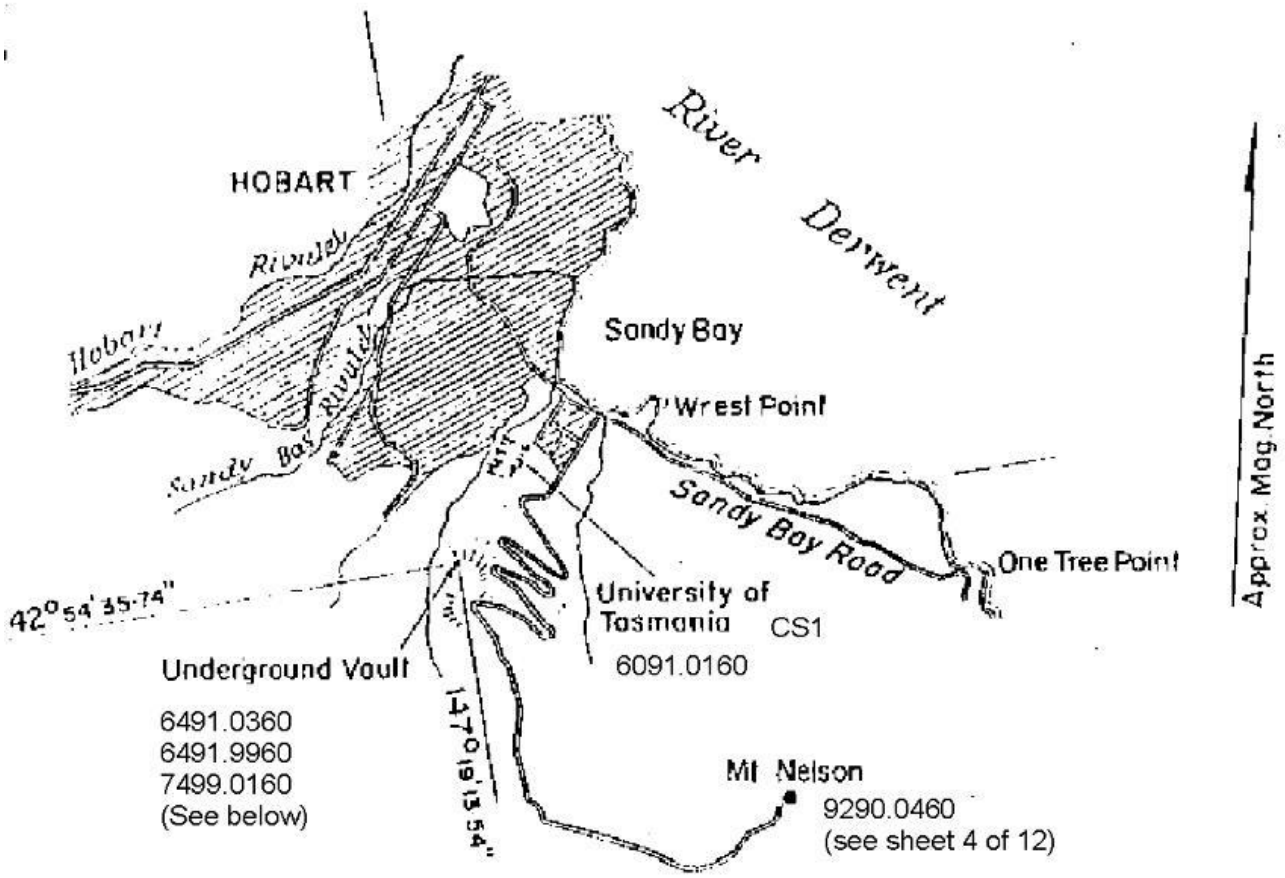
№	Parameter	units
1	**№**	-
2	**Date**	ddmmyy
3	**Tgrn**	hhmmss
4	**F**	degrees
5	**L**	degrees
6	**dG_Tvk**	mGal
7	**dG_Tvk+150**	mGal
8	**dG_Tvk+450**	mGal
9	**dG_Tvk+750**	mGal
10	**DGetv**	mGal
11	**Z..**	Gal
12	**FlgG**	-
13	**SY**	Heh
14	**Heh**	m

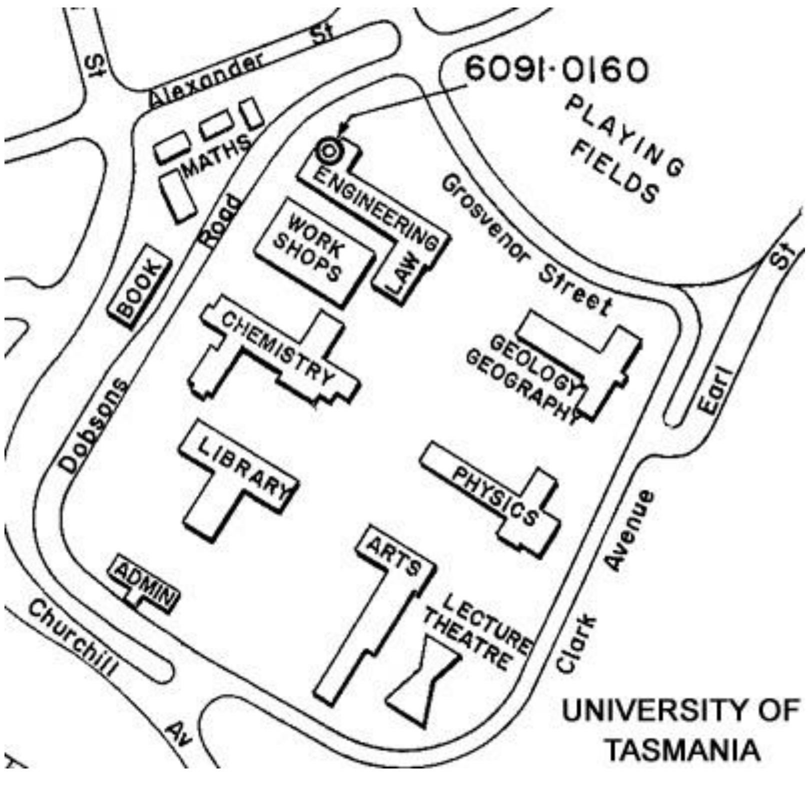
помощью гравиметрических фильтров с в

where

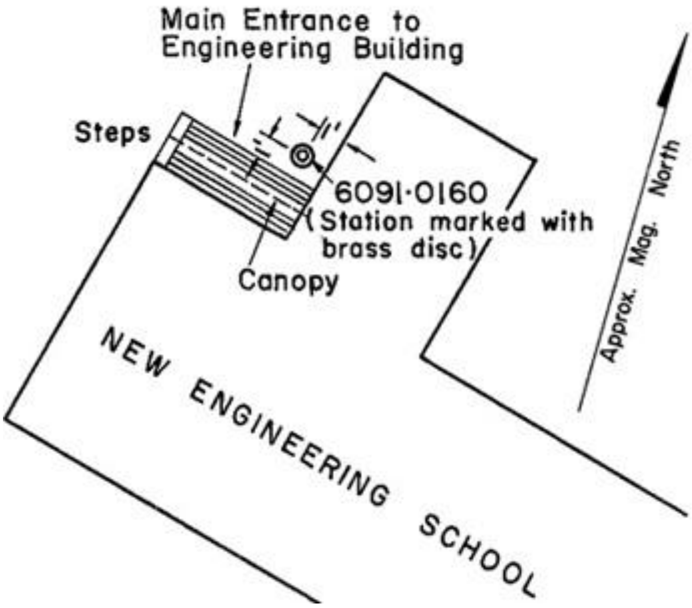
dG_Tvk+i

Appendix C – Gravity Ties
AFGN Station: 1960910160 University of Tasmania





HOBART CALIBRATION STATION NO. 1
University of Tasmania



Pre-Cruise Gravity Ties:

Location	Value	Year	Geode	Source	JCK Difference	JCK Pier Value		TL Difference	TL Pier Value	
Elizabeth St Pier	980437.25	1992	?	GA Report	0.93	980438.18		0.78	980438.03	
Elizabeth St Pier	980437.17	2007	AAGD07	AFGN	0.93	980438.10	-0.08	0.78	980437.95	-0.08
Elizabeth St Pier	980450.52?		?	Palmer	0.93	980451.45	13.27	0.78	980451.30	13.27
U Tas	980444.27	1969	?	Thesis	6.74	980451.01	12.83		980451.01	12.98
U Tas	980431.00	1992	?	GA Report	6.74	980437.74	-0.44		980437.74	-0.29
U Tas	980430.92	2007	AAGD07	AFGN	6.74	980437.66	-0.52		980437.66	-0.37
						980438.14			980437.85	

0.130612245

Operator: James Kinsey (jkinsey@who.edu)

Value Used for tie	980437.99

Post-Cruise Gravity Tie #1

Gravity Tie Spreadsheet

The fields outlined in BLUE MUST BE FILLED IN for this spreadsheet to operate properly.
The automatically calculated values show up in the green, shaded fields.

Date: 16-March, 2014 Reference Code Numbers:
Location: Hobart, Tasmania
Station: AFGN Station: 1960910160 Uni of Tasmania
Latitude: 42.90217 S
Longitude: 147.32655 E
Elevation: 20.22 meters
Gravity: 980430.922 mgal

	Value	Time (GMT)
Ship's meter before gravity tie (Filt Counts)	25024.9	4:16
Ship's meter after gravity tie (Filt Counts)	25024.9	6:17
Average	25024.9	
Ship Gravimeter's Calibration Constant	4.99407055	
Corrected ship's meter (Digital Gravity)	124976.1	

	Value	Time (GMT)
Ship's meter before gravity tie (serial, RVDAS)	n/a	n/a
Ship's meter after gravity tie (serial, RVDAS)	n/a	n/a
Average (for comparison check only)	n/a	

Portable Gravimeter Interval Factor: 1.00943 From Table 1 of Model G #807 Meter

Station	Value	Time (GMT)	Temp	Date	OBS mgal, averaged
Pier measurement 1	4044.16	4:57	53	March 16, 2014	
Pier measurement 2	4044.05	5:03	53	March 16, 2014	4082.22
Pier measurement 3	4044.04	5:05	53	March 16, 2014	
Average	4044.08				
Station measurement 1	4037.18	5:35	53	March 16, 2014	
Station measurement 2	4037.24	5:39	53	March 16, 2014	4075.28
Station measurement 3	4037.22	5:41	53	March 16, 2014	
Average	4037.21				
Pier measurement 4	4044.25	6:03	53	March 16, 2014	
Pier measurement 5	4044.10	6:08	53	March 16, 2014	4082.33
Pier measurement 6	4044.22	6:12	53	March 16, 2014	
Average	4044.19				

Gravity Bias from last tie: 855459.4
Drift since last tie: 2.40

OBS Differences

Station to Pier (1, 2, & 3 averaged)	6.93
Station to Pier (4, 5, & 6 averaged)	7.04
Averaged Differences	6.99
Gravity at pier	980437.91
Elevation of pier above gravimeter, meters	
Earth differential gravity, mgal/meter	0.3
Gravity at ship's gravimeter	980437.91
Gravity Bias (Offset for RVDAS)	855461.79

Comments

Operator: Jamin Greenbaum, jamin@utexas.edu

Note about Elevation of Pier: If pier is below the ship's gravimeter, this value is negative. If above positive.

Gravity Tie Spreadsheet

The fields outlined in BLUE MUST BE FILLED IN for this spreadsheet to operate properly.
The automatically calculated values show up in the green, shaded fields.

Date: 16-March, 2014 — Reference Code Numbers:
Location: Hobart, Tasmania
Station: AFGN Station: 1960910160 Uni of Tasmania
Latitude: 42.90217 S
Longitude: 147.32655 E
Elevation: 20.22 meters
Gravity: 980430.922 mgal

	Value	Time (GMT)
Ship's meter before gravity tie (Filt Counts)	25024.9	4:16
Ship's meter after gravity tie (Filt Counts)	25024.9	6:17
Average	25024.9	
Ship Gravimeter's Calibration Constant	4.99407055	
Corrected ship's meter (Digital Gravity)	124976.1	

	Value	Time (GMT)
Ship's meter before gravity tie (serial, RVDAS)	n/a	n/a
Ship's meter after gravity tie (serial, RVDAS)	n/a	n/a
Average (for comparison check only)	n/a	

Portable Gravimeter Interval Factor: 1.00943 — From Table 1 of Model G #807 Meter

Station	Value	Time (GMT)	Temp	Date	OBS mgal, averaged
Pier measurement 1	4044.25	6:03	53	March 16, 2014	
Pier measurement 2	4044.10	6:08	53	March 16, 2014	4082.33
Pier measurement 3	4044.22	6:12	53	March 16, 2014	
Average	4044.19				
Station measurement 1	4037.28	7:05	53	March 16, 2014	
Station measurement 2	4037.31	7:06	53	March 16, 2014	4075.36
Station measurement 3	4037.28	7:07	53	March 16, 2014	
Average	4037.29				
Pier measurement 4	4044.27	7:39	53	March 16, 2014	
Pier measurement 5	4044.29	7:40	53	March 16, 2014	4082.42
Pier measurement 6	4044.29	7:41	53	March 16, 2014	
Average	4044.28				

Gravity Bias from last tie: 855459.4
Drift since last tie: 2.43

OBS Differences

Station to Pier (1, 2, & 3 averaged)	6.97
Station to Pier (4, 5, & 6 averaged)	7.06
Averaged Differences	7.01
Gravity at pier	980437.94
Elevation of pier above gravimeter, meters	
Earth differential gravity, mgal/meter	0.3
Gravity at ship's gravimeter	980437.94
Gravity Bias (Offset for RVDAS)	855461.82

Comments

Operator: Jamin Greenbaum, jamin@utexas.edu

Note about Elevation of Pier: If pier is below the ship's gravimeter, this value is negative. If above positive.

Appendix D – Towed magnetometer information

MARINE MAGNETICS SeaSPY TOWED MAGNETOMETER

GENERAL DESCRIPTION

RUGGED

Smart connector
The SeaSPY connector is a custom brass underwater connector that supports a tonne of towing force. A PVC nose cone protects it from side impacts, while maintaining a streamlined tow body.

Sleek Design
SeaSPY's sleek design resists snags. The inexpensive and field replaceable tailfins are the only protruding element and they are designed to snap off should they ever get snagged on rocky outcroppings.

Reliability
The SeaSPY towfish is made of ¼" super strong fiberglass coated with a 'bumper' layer of polyurethane for extra shock absorption. Should even a drop of water penetrate the towfish, a leak detector warning appears on your screen to inform you. In the event of a breach, the SeaSPY's electronics module is encased in a polycarbonate housing with 'O' ring seals for another layer of security. The sensor itself is suspended on shockmounts to ensure the quality of your data isn't influenced even if you drag SeaSPY along the sea floor.

A quick glance self diagnostic LED system on the isolation transceiver can save hours of frustration. If all connections are hooked up properly, a status LED will glow green. If there's a problem with one of the connections, it will glow yellow. If there's a short somewhere, it will glow red and the transceiver will safely shut down the output power in microseconds. A blue LED flashes with every mag reading.

Better Data

Worldwide Operation with No Restrictions
SeaSPY will collect accurate data no matter where you are or in which direction you are surveying.

Highest Absolute Accuracy
SeaSPY Overhauser sensors have the highest absolute accuracy of any magnetometer: 0.1nT. The repeatability between SeaSPY sensors is also unmatched at better than 0.01nT.

The benefits to the user are four-fold
1. Targets will not be missed because they fall between mismatched survey lines.
2. Reduces post-processing. Competing technologies require the user to collect tie lines in order to level the data set (match-up inaccurate survey lines).
3. There will be no variation introduced in the data by slight course changes during a survey line.
4. A magnetic map of an area will look the same, regardless of direction in which the survey lines were conducted.

Stable Time
The clock used in the SeaSPY electronics module is accurate to 1ppm throughout the entire temperature range, (as opposed to 100ppm found in competing magnetometer systems) so it will be accurately time stamped to sync with diurnal correction (base station) information.

Maintenance Free Sensors
SeaSPY sensors don't degrade with time, so you'll get the same quality data after 10 years of use as you did the first time you used it. In addition SeaSPY sensors contain no consumable parts, so you won't have to replace anything, like the expensive lamps that wear out in optically pumped mags.

Overhauser Effect
SeaSPY is a pulsed Overhauser magnetometer that measures the ambientmagnetic field using a specialized branch of nuclear Magnetic Resonance technology, applied specifically to hydrogen nuclei.

Ease of Use

Ultra Low Power Consumption
A SeaSPY system only requires 1W standby and 3Wmaximum. As a result, SeaSPY can run for days directly from a 12V or 24V vehicle battery.

No temperature effect on accuracy
SeaSPY works equally well in cold, deep waters as tropical waters, starting instantly on power-up without requiring warm up. And data collected at –40°C will be identical to data recorded at +60°C.

Integrate with side scans and other plaforms
An easy all in one solution to integrate SeaSPY with side scans. A single 10m tow cable is terminated with everything you need. No modifications to your magnetometer or gradiometer are required. Simply swap out your tow cable for the integration cable and you are ready to go.

Best of all, your accessories, including power supply, are still compatible. The integration maintains the basic system integrity of each product, ensuring they can both run independently as well as together.

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Email: rental@oceanscan.co.uk, Website: www.oceanscan.co.uk

Accredited to BS EN ISO 9001:2000

MARINE MAGNETICS SeaSPY TOWED MAGNETOMETER

SeaSPY Towfish includes

- Depth rating 1000m (1500psi), 3000m (5000psi), 6000m, (9000psi) customer specified.
- Overhauser Sensor
- Electronics module containing all of the driving electronics and Larmour counter
- Leak detector to let you know if even a drop of water penetrates the towfish
- 4 lead weights to increase the weight of the towfish and to prevent it from rotating. To adjust the weight you can remove or add additional weights in the field.
- SeaLINK data acquisition and GPS logging software for Windows.

Tow Cable

The cable is made up of one twisted pair of conductors,a Vectran strength member, water block and yellow polyurethane jacket. Length determined by customer.

Isolation Transceiver

Dimensions: 11 x 6 x 3 cm
Weight: 130 g

RS-232 cable

Battery Clip Cable or Power Supply

The power supply accepts any AC line power, from 100-240VAC and 50/60 Hz to provide conditioned and clean 24V DC power. Weight 165g

Options

- Pressure Sensor
- Altimeter
- Transponder
- SideScan integration
- Depth options: 3000m, 6000m
- Extension cables
- Change the weight of the towfish with additional weights
- Deck cable
- Termination kit
- Winches

SPECIFICATIONS

Operating Zones	NO RESTRICTIONS SeaSPY will perform exactly according to spec throughout the entire range.
Absolute Accuracy	0.1nT
Sensor Sensitivity	0.01nT
Counter Sensitivity	0.001nT
Resolution	0.001nT
Dead Zone	NONE
Heading Error	NONE
Temperature Drift	NONE
Power Consumption	1W standby, 3W max
Timebase stability	1ppm, -45ºC to +60ºC
Range	18,000nT to 120,000nT
Gradient Tolerance	Over 10,000nT/m
Sampling Range	4Hz – 0.1Hz
External Trigger	By RS-232
Communications	RS-232, 9600bps
Power Supply	15VDC-35VDC or 100-240VAC
Operating Temperature	-45ºC to +60ºC
Temperature Sensor	-45ºC to +60ºC, 0.1 step

Towfish

Towfish Length	124 cm
Towfish Diameter	12.7 cm
Towfish Weight in Air	16 kg
Towfish Weight in Water	2 kg

Tow Cable

Conductors	Twisted pair
Strength Member	Vectran
Breaking Strength	2,500 kg
Outer Diameter	1 cm
Bending Diameter	16.5 cm
Weight in Air	125 g/m
Weight in Water	44 g/m
Outer Jacket	Yellow Polyurethane
Cable Termination	Field Replaceable

Floatation Cable

Conductors	Twisted pair
Strength Member	Vectran
Max Working Load	2,500 kg
Outer Diameter	1.9 cm
Bending Diameter	25 cm
Weight in Air	272 g/m
Weight in Water	-20 g/m
Outer Jacket	Orange Polyurethane
Cable Termination	Field Replaceable

Marketed By

Oceanscan Limited reserve the right to alter or amend any published specification without notice.

14. Biological stuff from Leanne

Appendix 1 Armand. Location data, basic properties and samples taken from all underway, rosette CTD, Phytoplankton net and Megacore water samples. Images of species identified can be found in Appendix 4 Armand.

Station	Latitude degrees	Longitude degrees	Sea surface fluorometry µg/L (mg/m3)	SST (°C)	JD	CTD Bottle firing	CTD Depth of sample	CTD Bottle Fluro (in Volts (avg))	DNA (2L Sterivex filter)	Flow Cytometry (8L Cell trap)	2mL Syringed in cryotube ?	Isoprenoid GF/F filters (Normal & Precomb.)	No. Liters on each filter	Lugols bottle (mL)	Sieved/Net Sample (20 or 50 um)	Microscopy record	No. Photos (unedited)
Test 1	-50.9668	147.6375	0.75	9.61	31				n	n	n	n		0	50	y	0
Test 2	-51.8023	147.718	1.37	8.3	31				n	n	n	n		0	50	y	0
Transit 1a	-51.8242	147.7226	1.39	8.14	31				y	n	n	n		0	n	n	0
Transit 1b	-51.9033	147.7372	0.9	6.85	31				n	y	n	n		0	n	n	0
Test 3	-54.2980	147.7071	0.58	5.25	31				n	n	n	n		0	50	y	0
Transit 2a	-55.0618	147.6646	0.7	3.82	32				n	y	n	n		0	n	n	0
Transit 2b	-55.0618	147.6646	0.83	4.16	32				y	n	n	n		0	n	n	0
Transit 3	-55.2970	147.644	0.74	4.99	32				n	n	n	y	4	0	n	n	0
Test 4	-55.8011	147.5739	1.23	4.07	32				n	n	n	n		0	20	y	4
Transit 4	-56.3103	147.4595	1.34	2.23	32				y	y	n	n		0	n	n	0
Test 5	-56.3228	147.4569	1.36	2.25	32				n	n	n	n		100	20	y	13
Transit 5	-58.2613	147.0752	0.47	2.39	32				y	y	n	y	2.8	100	20	y	75
Transit 6	-62.1444	146.1675	0.66	2.31	33				y	y	n	y	2.85	100	20	y	108
Transit 7	-64.0272	145.6387	0.8	1.31	34				y	y	y	y	2	100	20	y	77
Transit 8	-65.5977	145.1369	0.3	-0.47	34				n	n	n	y	4	0	n	n	0
Transit 9	-65.8772	144.8979	0.18	-1.67	34				y	y	y	n		100	n	n	0
Transit 10	-66.2586	145.5138	1.01	-1.46	35				y	y	y	n		100	20	y	108
Transit 11	-66.7194	145.6996	4.65	-1.41	35				y	y	y	y	2	100	20	y	60
Transit 12	-67.0156	145.0357	1.64	-1.56	35				y	y	y	y	3	100	n	n	0
Pnet-001	-67.0935	145.2231	1.74	-1.13	37				n	n	n	y	0.03	200	50	y	66
CTD-001-002	-67.09344	145.22314		-1.8641	37	2:37:49	1316.948	0.0449	n	n	n	y	3	200	n	n	0
CTD-001-022	-67.09344	145.22316		-1.3618	37	3:19:32	20.608	0.1738	n	n	n	y	2	200	n	n	0

Station	Latitude degrees	Longitude degrees	Sea surface fluorometry µg/L (mg/m3)	SST (°C)	JD	CTD Bottle firing	CTD Depth of sample	CTD Bottle Fluro (in Volts (avg))	DNA (2L Sterivex filter)	Flow Cytometry (8L Cell trap)	2mL Syringed in cryotube ?	Isoprenoid GF/F filters (Normal & Precomb.)	No. Liters on each filter	Lugols bottle (mL)	Sieved/Net Sample (20 or 50 um)	Microscopy record	No. Photos (unedited)
CTD-001-024	-67.09344	145.22314		-1.0346	37	3:21:55	1.982	0.0814	n	n	n	y	2	200	n	n	0
Transit 13	-65.7286	145.0161	0.52	-1.68	38				n	n	n	y	3	100	20	y	74
Transit 14	-65.7716	143.1459	0.8	-1.57	38				n	n	n	y	3	100	20	y	110
Transit 15	-64.9936	127.9817	0.82	-1.23	40				y	y	y	y	3	100	20	y	76
Transit 16	-65.3876	120.7925	2.42	-0.45	40				y	y	y	y	2	100	20	y	101
Transit 17	-65.792	120.2672	4.96	-1.67	41				y	y	y	y	2	100	20	y	92
CTD-002-002	-66.0655	120.04429		0.29	41	13:35:19	482.806	0.0561	y	y	y	y	2	200	n	n	0
CTD-002-018	-60.0677	120.03843		-1.66	41	13:51:22	60.048	0.066	y	y	y	y	2	200	n	n	0
CTD-002-024	-66.0861	120.03741		0.80	41	13:54:02	0.796	0.1163	y	y	y	y	2	200	n	n	0
Transit 18	-66.677	119.5338	3.39	-1.26	42				y	y	y	y	2	100	20	y	134
CTD-004-002	-66.36698	120.00609		0.2551	43	21:33:59	614.021	0.0554	n	n	n	y	2	200	n	n	0
CTD-004-020	-66.36698	120.0061		-1.1326	43	21:55:22	59.919	0.1453	n	n	n	y	2	200	n	n	0
CTD-004-024	-66.36698	120.0061		-1.3225	43	21:58:12	0.128	0.1716	n	n	n	y	2	200	n	n	0
Transit 19	-66.8456	117.9427	2.84	-1.68	44				y	y	y	y	2	100	20	y	62
Transit 20	-66.8721	118.2455	3.16	-1.21	45				n	n	n	y	2	100	20	y	71
Transit 21	-66.8558	117.8445	1.14	-1.58	46				n	n	n	y	2	100	20	y	78
Transit 22	-66.4628	120.0437	2.43	-1.15	47				n	n	n	y	2	100	20	y	96
Transit 23	-66.362	119.3293	1.46	-1.57	47				n	n	n	y	2	100	n	n	0
CTD-005-001	-66.36324	119.32957		0.1702	47	23:51:48	831.295	0.0544	n	n	n	y	1	200	n	n	0
CTD-005-005	-66.36346	119.33066		-1.8168	48	0:08:01	299.892	0.0505	n	n	n	y	2	200	n	n	0
CTD-005-008	-66.36364	119.33104		-1.7544	48	0:15:36	39.909	0.0973	n	n	n	y	2	200	n	n	0
CTD-005-010	-66.36368	119.33094		-1.71	48	0:17:42	9.824	0.0843	n	n	n	y	2	200	20	y	100
CTD-006-001	-66.38864	119.23118		0.3413	48	3:55:32	861.385	0.051	n	n	n	y	1.4	200	n	n	0

Station	Latitude degrees	Longitude degrees	Sea surface fluorometry µg/L (mg/m3)	SST (°C)	JD	CTD Bottle firing	CTD Depth of sample	CTD Bottle Fluro (in Volts (avg))	DNA (2L Sterivex filter)	Flow Cytometry (8L Cell trap)	2mL Syringed in cryotube ?	Isoprenoid GF/F filters (Normal & Precomb.)	No. Liters on each filter	Lugols bottle (mL)	Sieved/Net Sample (20 or 50 um)	Microscopy record	No. Photos (unedited)
CTD-006-007	-66.38864	119.23118		-1.8014	48	4:11:37	444.994	0.0525	n	n	n	y	2	200	n	n	0
CTD-006-012	-66.38864	119.23118		-1.6028	48	4:25:18	24.411	0.1746	n	n	n	y	2	200	n	n	0
CTD-006-014	-66.38864	119.23116		-1.5243	48	4:26:57	9.853	0.1764	n	n	n	y	2	200	n	n	0
Transit 24	-66.4515	118.7429	1.94	-1.76	48				n	n	n	y	2	100	20	y	78
CTD-007-002	-66.38574	118.95972		0.1809	48	15:17:27	885.246	0.0527	n	n	n	y	2	200	n	n	0
CTD-007-022	-66.38566	118.95992		-1.4264	48	15:44:50	49.537	0.1054	n	n	n	y	2	100	n	n	0
CTD-007-024	-66.38566	118.95992		-1.7033	48	15:46:01	9.652	0.1067	n	n	n	y	2	200	n	n	0
CTD-008-002	-66.56682	119.21744		-0.0088	49	15:41:13	674.973	0.0528	n	n	n	y	2	200	n	n	0
CTD-008-008	-66.5668	119.21744		-1.2467	49	15:59:58	59.267	0.0692	n	n	n	y	2	200	n	n	0
CTD-008-010	-66.5668	119.21744		-1.6924	49	16:01:34	9.225	0.1644	n	n	n	y	2	200	n	n	0
Transit 25	-66.883	119.4367	3.76	-0.83	51				n	n	n	y	2	100	20	y	88
CTD-009-002	-66.89272	119.41758		-1.3338	51	10:58:29	1083.476	0.0489	n	n	n	y	2	200	n	n	0
CTD-009-020	-66.89273	119.41758		-0.96	51	11:30:42	49.343	0.1708	n	n	n	y	2	200	n	n	1
CTD-009-022	-66.89272	119.41757		-1.0002	51	11:32:34	7.119	0.1696	n	n	n	y	2	200	n	n	2
Transit 26A	-66.1848	120.504	1.21	-1.51	52				n	n	n	y	2	100	20	y	108
CTD-010-001	-66.18482	120.50396		0.2916	52	3:56:33	528.699	0.0554	n	n	n	y	2	200	n	n	0
CTD-010-013	-66.18484	120.50396		-1.6235	52	4:13:27	34.849	0.0939	n	n	n	y	2	200	n	n	0
CTD-010-015	-66.18482	120.50398		-1.6244	52	4:15:03	4.76	0.0634	n	n	n	y	2	200	n	n	0
Transit 26B	-66.1843	120.5025	1.73	-1.46	52				n	n	n	y	2	100	20	y	100
Transit 27	-66.4057	119.6943	2.12	-1.56	56				n	n	n	y	2	100	20	y	135
CTD-012-001	-66.38782	119.74772		0.3327	56	00:39:03	654.742	0.0545	n	n	n	y	2	200	n	n	0
CTD-012-011	-66.38762	119.74852		-1.6965	56	00:57:01	49.622	0.0545	n	n	n	y	2	200	n	n	0
CTD-012-013	-66.38762	119.7485		-1.6943	56	0:58:58	4.899	0.1042	n	n	n	y	2	200	n	n	0

Station	Latitude degrees	Longitude degrees	Sea surface fluorometry µg/L (mg/m3)	SST (°C)	JD	CTD Bottle firing	CTD Depth of sample	CTD Bottle Fluro (in Volts (avg))	DNA (2L Sterivex filter)	Flow Cytometry (8L Cell trap)	2mL Syringed in cryotube ?	Isoprenoid GF/F filters (Normal & Precomb.)	No. Liters on each filter	Lugols bottle (mL)	Sieved/Net Sample (20 or 50 um)	Microscopy record	No. Photos (unedited)
Transit 28A	-66.4837	120.3324	1.88	-1.55	56				n	n	n	y	2	100	20	y	12
Transit 28B	-66.488	120.3401	1.97	-1.59	56				n	n	n	y	2	100	20	y	86
CTD-013-001	-66.48504	120.33249		0.3312	56	12:37:50	596.371	0.0517	n	n	n	y	2	100	n	n	0
CTD-013-011	-66.48504	120.3325		-1.7382	56	12:55:30	49.654	0.115	n	n	n	y	2	100	n	n	0
CTD-013-013	-66.48502	120.33252		-1.7457	56	12:57:35	5.017	0.1101	n	n	n	y	2	100	n	n	0
MC45	-66.3979	120.5893			57				n	n	n	y	2	100	n	n	0
Tranist 29	-66.7769	119.1292	1.94	-1.68	58				n	n	n	y	2	100	20	y	62
Transit 30	-66.7667	118.8843	2.38	-1.74	60				n	n	n	y	2	100	20	y	107
Transit 31	-66.5661	119.7248	2.67	-1.78	60				n	n	n	y	2	100	20	y	17
Transit 32	-66.1842	120.5034	1.15	-1.67	63				n	n	n	y	2	100	20		
Transit 33	-66.2432	119.9993	1.54	-1.76	63				n	n	n	y	2	100	20		
Transit 34	-66.5014	120.4566	1.75	-1.71	64				n	n	n	y	2	100	20		
CTD-014-001	-66.50644	120.4865		0.0011	64	4:13:08	487.976	0.0542	n	n	n	y	4	200	n	n	0
CTD-014-017	-66.50644	120.48652		-1.7936	64	4:30:39	69.02	0.1018	n	n	n	y	2	200	n	n	0
CTD-014-021	-66.50644	120.48652		-1.8134	64	4:33:19	24.597	0.1143	n	n	n	y	2	200	n	n	0
CTD-014-023	-66.50644	120.48652		-1.8107	64	4:34:36	5.141	0.0993	n	n	n	y	2	200	n	n	0
CTD-015-001	-66.12894	120.46404		0.4867	64	13:57:56	563.233	0.0505	n	n	n	y	4	200	n	n	0
CTD-015-017	-66.12874	120.46414		-1.7756	64	14:17:03	39.942	0.1129	n	n	n	y	2	200	n	n	0
CTD-015-023	-66.12874	120.46414		-1.7778	64	14:20:08	5.097	0.1049	n	n	n	y	2	200	n	n	0
MC61-1	-66.1282	120.4638			64				n	n	n	y	2	200	n	n	0
MC61-2	-66.1282	120.4638			64				n	n	n	y	0.35	100	n	n	0
Transit 35	-66.2472	119.6297	0.72	-1.77	65				n	n	n	y	2	100	n	n	0
Transit 36	-66.27	119.6728	1.57	-1.78	65				y	n	n	y	2	100	20		

Station	Latitude degrees	Longitude degrees	Sea surface fluorometry µg/L (mg/m3)	SST (°C)	JD	CTD Bottle firing	CTD Depth of sample	CTD Bottle Fluro (in Volts (avg))	DNA (2L Sterivex filter)	Flow Cytometry (8L Cell trap)	2mL Syringed in cryotube ?	Isoprenoid GF/F filters (Normal & Precomb.)	No. Liters on each filter	Lugols bottle (mL)	Sieved/Net Sample (20 or 50 um)	Microscopy record	No. Photos (unedited)
Transit 37	-66.0897	120.7648	0.46	-1.71	66				y	n	n	y	2	100	n	n	0
Transit 38	-65.9669	120.9442	0.94	-1.76	66				y	n	n	y	2	100	n	n	0
Transit 39	-65.8155	120.9524	1.05	-1.72	66				y	n	n	y	2	100	20		
Transit 40	-65.7661	120.7375	2.5	-1.79	66				y	n	n	y	2	100	n	n	0
Transit 41	-65.2572	120.7086	4.64	-1.08	67				y	n	n	y	2	100	20		
Transit 42	-64.7851	121.5143	4.12	-0.08	67				y	n	n	y	2	100	n	n	0
Transit 43	-64.5941	121.8255	4.92	0.64	67				y	n	n	y	2	100	n	n	0
Transit 44	-62.7678	124.7037	2.34	2.24	67				y	y	y	y	2	100	n	n	0
Transit 45	-60.9392	127.4147	1.09	3.42	68				y	y	y	y	2	100	n	n	0
Tranist 46	-59.5875	129.3219	0.96	2.92	68				y	n	n	y	3	100	n	n	0
Transit 47	-59.1348	129.9464	0.41	3.96	69				y	n	n	n	0	100	n	n	0
Transit 48	-59.0777	130.0235	0.41	4.38	69				y	y	y	y	3	100	20		
Transit 49	-56.7437	133.0914	0.89	5.44	69				y	n	n	y	3	100	n	n	0
Transit 50	-56.3998	133.5307	0.79	5.73	69				y	n	n	n	0	100	n	n	0

Appendix 2 Armand. Summary of Microscopy Observations. Note: Not quantitative and preliminary identifications made at x10 or x40 magnification. Key: D = dominant, x= present, ?= compares with. Test samples do not represent a full survey of organisms present.

Station ID.	Test 1	Test 2	Test 3	Test 4	Test 5	Transit 5	Transit 6	Transit 7	Transit 10	Transit 11	Pnet-001	Transit 13	Transit 14	Transit 15	Transit 16	Transit 17	Transit 18	Transit 19	Transit 20	Transit 21	Transit 22	Transit 24	Transit 25	Transit 26A	Transit 26B	Transit 27	Transit 28A	Transit 28B	Transit 29	Transit 30	Transit 31
Species encountered																															
Actinochilus actinocyclus							x			x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x
Actinocyclus curvatulus	x	x									x				x													x			
Actinocyclus spp.									x																						
Asteromphalus hookeri		x	x		x	x		x	x	x	x	x	x			x				x	x	x	x	x	x	x	x	x	x	x	x
Asteromphalus hyalinus							x	x	x		x	x			x	x	x				x	x	x	x	x	x		x	x	x	x
Asteromphalus parvulus				x		x	x	x						x	x	x	x		x	x	x	x				x					x
Azpeitia tabularis						x		x																							
Banquisia bankseii				x	x																							x			x
Chaetoceros (Hyalochaete)		x	x		x	x	x	x	x	x	x	x	x		D	x	x	x	x	x	x	x	x	x	x	x		x		x	x
Chaetoceros (Phaeoceros)		x		x	x		x	x	x	x	x	x	x	x	D	x	x	D	x	x	x	x	x	D	D	D	x	D	D	x	x
Chaetoceros atlanticum				x	x		x		x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	D		D
Chaetoceros convolutus							x	x					x		x																
Chaetoceros criophilum										x											x	x	x	D	x	D	x	x	D		x
Chaetoceros curvisetus															x	x	x	x					x	x	x	x				x	
Chaetoceros dicheata		x	x	x	x		x		x	x	x		x	x			x	x	x	x	x		x		x	x		x	x		x
Chaetoceros peruvianus		x	x				x																	x		x					

Station ID.	Test 1	Test 2	Test 3	Test 4	Test 5	Transit 5	Transit 6	Transit 7	Transit 10	Transit 11	Pnet-001	Transit 13	Transit 14	Transit 15	Transit 16	Transit 17	Transit 18	Transit 19	Transit 20	Transit 21	Transit 22	Transit 24	Transit 25	Transit 26A	Transit 26B	Transit 27	Transit 28A	Transit 28B	Transit 29	Transit 30	Transit 31
Chaetoceros resting spores																										x					
Corethron inerme				x			x				x				x	x					x	x		x						x	
Corethron pennatum	x	x	x	x	x	x	x	x	x	x	x	x	A		A	x	x	x	x		x	x	x	x	x	x	x	x	x	A	x
Coscinodiscus argus									x																						
Coscinodiscus asteromphalus									x	x			x	x	x		x				x	x	x					x	x	x	x
Coscinodiscus bouvet										x																					
Coscinodiscus sp.			x							x								x	x	x		x		x	x	x	x	x	x	x	x
Cylindrotheca spp.		x		x	x	x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x
Dactyliosolen antarctica		x	x	x	x	x	x	x		x	D		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Entomoneis cf. *kufferathii*									x	x		x		x	x		x	x		x	x	x	x	x	x				x		x
Entomoneis cf. *kjellmanii*												x	x					x						x							x
Entomoneis sp. (small)												x	x	x	x		x	x			x	x	x	x	x	x		x	x		
Eucampia antarctica v. *antarctica*				x	x		x						?		x	x															
Eucampia antarctica v. *recta*									x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x
Fragilariopsis curta						x		x	x	x	x	x	x	x	x	x	x	x	D	D	x	x	x	x	x	x		x	x	x	x
Fragilariopsis cylindrus		x							x				D	x	x	x	x	x				x	x						x		x
Fragilariopsis kerguelensis	x		x	x	x	x	x	x		x		x	x		x	x	x	x						x	x	x					
Fragilariopsis linearis															x	x		x				?									
Fragilariopsis pseudonana							x	x	x			x	x		x	x															
Fragilariopsis rhombica/separanda		x		x			x	x	x		x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x
Fragilariopsis ritscherii							x	x						x	x										x			x			

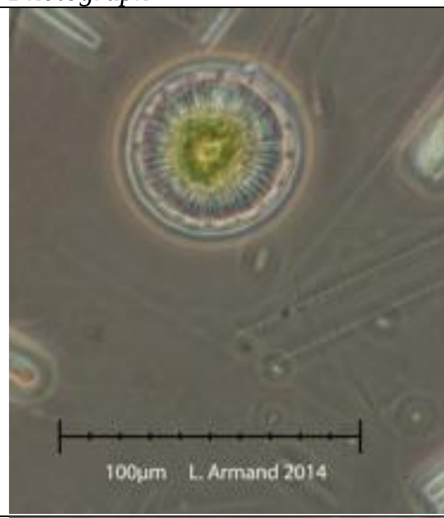
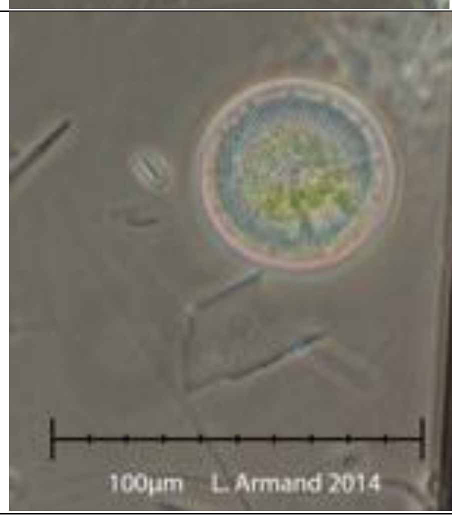
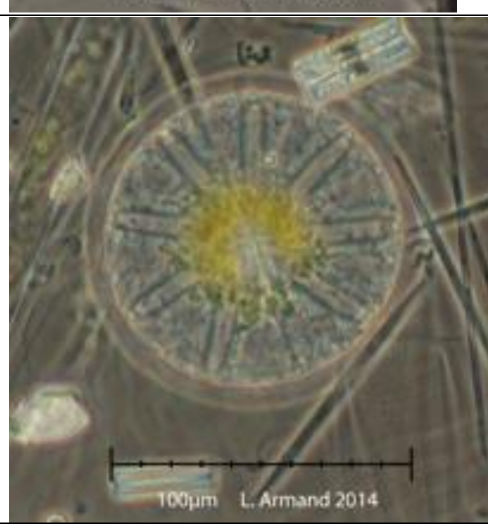
Station ID.	Test 1	Test 2	Test 3	Test 4	Test 5	Transit 5	Transit 6	Transit 7	Transit 10	Transit 11	Pnet-001	Transit 13	Transit 14	Transit 15	Transit 16	Transit 17	Transit 18	Transit 19	Transit 20	Transit 21	Transit 22	Transit 24	Transit 25	Transit 26A	Transit 26B	Transit 27	Transit 28A	Transit 28B	Transit 29	Transit 30	Transit 31
Fragilariopsis sublinearis/obliquec.													x		x				x	x	x		x								x
Fragilariopsis spp.					x	x		x	x	x	x	D	x	x	x	x	x	D	D	D	x	D	x	x	x	x		x	x	x	x
Guinardia cylindrifomis				x	D	x	x	x			x		x		x	x			x		x	x	x	x	x	x		x	x	x	x
Guinardia cf. *tubiformis*					D	x	x	x	x	x	x	x	x		x				x					x		x					
Leptocylindrus sp.					x	x	x	x																							
Navicula spp.		x							x			x	x	x	x		x		x	x		x		x	x			x	x	x	x
Nitzschia spp. (large)				x			x									x	x														
Nitzschia spp. (small)				x																											
Odontella weissflogii									x	x		x	x		x	x	x	x	x	x	x	x	x	x	x				x	x	x
Pinnularia quadratarea var. *constricta*														x																	
Pleurosigma cf. *antarcticum*														x								x		x	x	x		x		x	x
Porosira spp.										x											x	x	x	x	x						x
Proboscia alata			x	x			x	x				x								x										x	
Proboscia inermis			x	x		x			x	x				x					x				x		x	x		x	x	x	x
Proboscia truncata		x					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	A	x	x	x	x	x		x
Pseudo-nitzschia spp.	x	x	x	x	x	x	x	x	x	x	D	D	D	x	x	x	x	x	x	x		x	x	x	x	x			x		x
Rhizosolenia ant. f. *semispina*					x	x	x	x		x		x		x	x	x				x	x	x		x	x	x		x	x	x	x
Rhizosolenia bergonii		x	x																												
Rhizosolenia chunii			x	x	x		x		x	x	x	x	x	x	x		x			x	x	x	x	x	x	x			x	x	x
Rhizosolenia polydactyla f. *poly.*			x			x	x																							x	
Rhizosolenia simplex		x	x							x	x			x	x	x	x			x	x	x	x	x						x	x
Rhizosolenia spp.									x		x		x					x	x	x	x			x						x	x
Stellarima microtrias									x		x	x	x		x	x	x	x	x	x	x	x	x	x		x		x	x	x	x

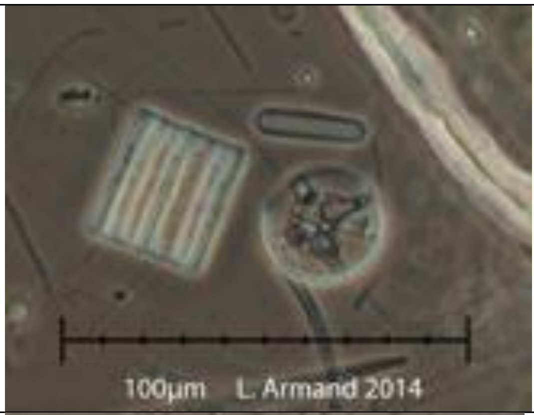
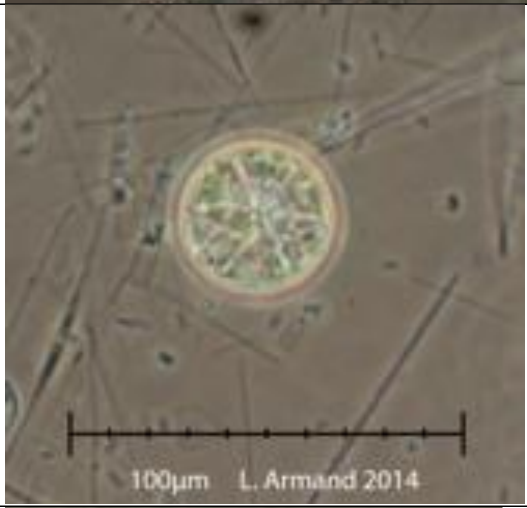
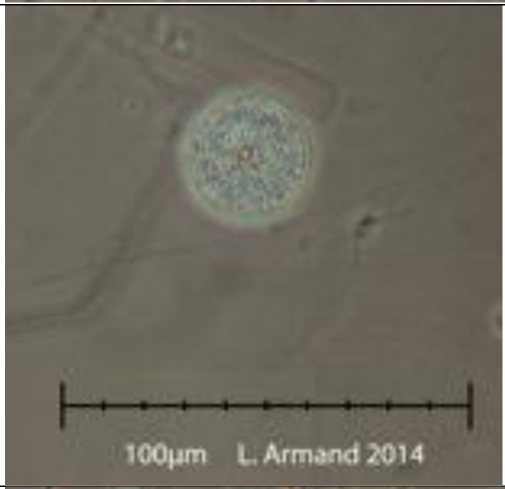
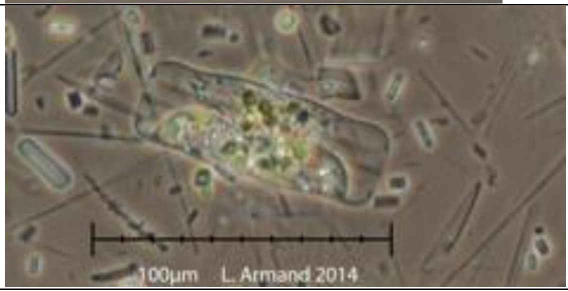
Station ID.	Test 1	Test 2	Test 3	Test 4	Test 5	Transit 5	Transit 6	Transit 7	Transit 10	Transit 11	Pnet-001	Transit 13	Transit 14	Transit 15	Transit 16	Transit 17	Transit 18	Transit 19	Transit 20	Transit 21	Transit 22	Transit 24	Transit 25	Transit 26A	Transit 26B	Transit 27	Transit 28A	Transit 28B	Transit 29	Transit 30	Transit 31
Thalassionema nitz. v. *lancelotata*		x				x																									
Thalassiosira gracilis var. *gracilis*								x					x	x	x	x					x	x	x	x	x						
Thalassiosira lentiginosa		x		x	x	x	x	x	x					x	x	x	x				x			x	x			x	x	x	x
Thalassisosira lineata group										x								x								x		x		x	
Thalassiosira oliverana						x							x		x	x								x	x	x					
Thalassiosira spp. large		x	x						x	x	x	x	x	x	x	x	x			x	x	x	x	x						x	x
Thalassiosira spp. small		x	x	x					x	x			x	x		x		x	x		x		x	x					x		x
Thalassiosira tumida			x	x		x	x			x		x		x	x	x	x			x	x	x	x	x		x		x	x	x	x
Thalassiothrix spp.	x	x		x	x	x	x	x	x	x	D	D	x	x	x	x	x	x		x	x	x	x	x	x	D	x	D	x	x	D
Tropidoneis spp.				x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	?	x	x	x	x		x	x	x	x

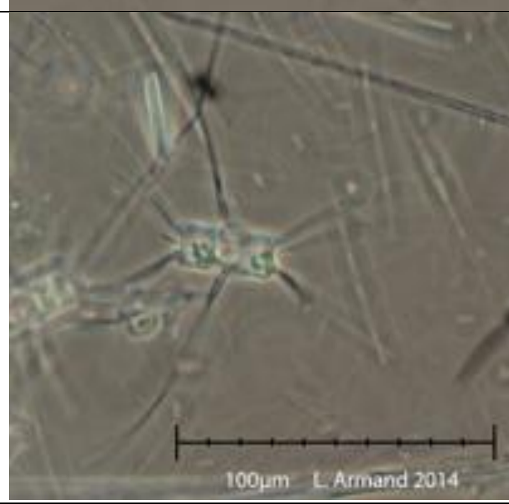
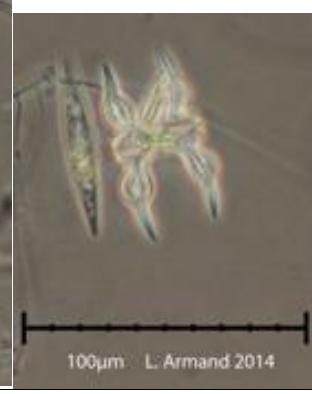
Appendix 3 Armand. Summary of Microscopy Observations - Zooplankton. Note: Not quantitative and preliminary identifications made at x10 or x40 magnification. Test samples do not represent a full survey of organisms present. Key: x = present, ?= compares with.

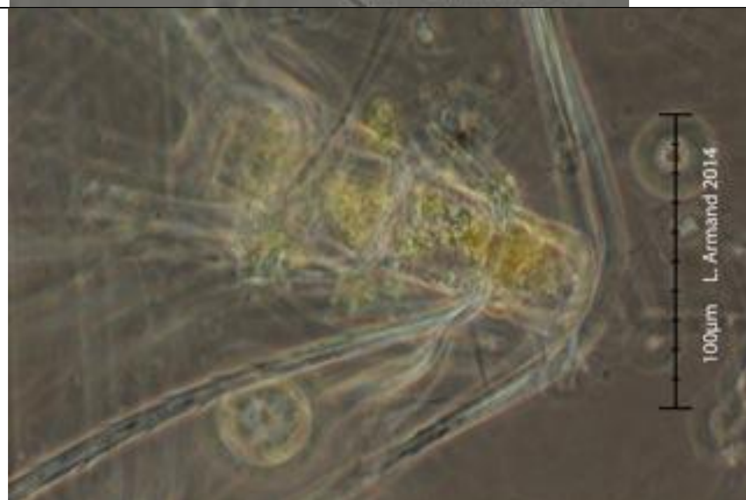
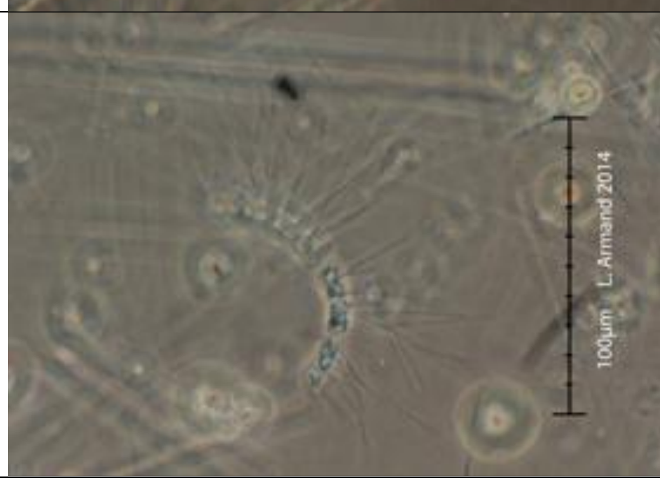
Station ID.	Test 1	Test 2	Test 3	Test 4	Test 5	Transit 5	Transit 6	Transit 7	Transit 10	Transit 11	Pnet-001	Transit 13	Transit 14	Transit 15	Transit 16	Transit 17	Transit 18	Transit 19	Transit 20	Transit 21	Transit 22	Transit 24	Transit 25	Transit 26A	Transit 26B	Transit 27	Transit 28A	Transit 28B	Transit 29	Transit 30	Transit 31
Copepod juveniles	x	x										x		x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x
Faecal pellets	x	x					x			x		x		x	x	x	x	x			x				x		x	x	x	x	x
Pteropods	x						x													x	x		x	x							x
Tintinids	x	x			x	x				x		x		x	x	Many	Many	x	Many		x	x	x	x	Many	x	x	x	x	x	x
Dinoflagellates	x	x	x	x					x	x									Many		x	x		x	x	x		x	x	x	x
(Ceratium)				x			x								x		x			x				x							
(Protoperidinium)				x	x					x				x				x	x		x			x							
(Dinophysis)					x										x	x		x					x								
(other - small)								x	x	x		x		x	x	x	x	x			x										x
Acantharian		x	x																												
Radiolarians		x					x													x			x		x	x				Rare	?
Dictyocha speculum				x	x	x	x	Many	x	x	x	x		x	x	x	x	x			x	x		x	x	x		x	x	x	x
Forams			x				x		Pink													x	x	x	x						
Phaeocystis			?				?					x					x														
Aggultinated org.							x									x					x		x								
Other orgs.							x			x		x				x	x				x					x					x

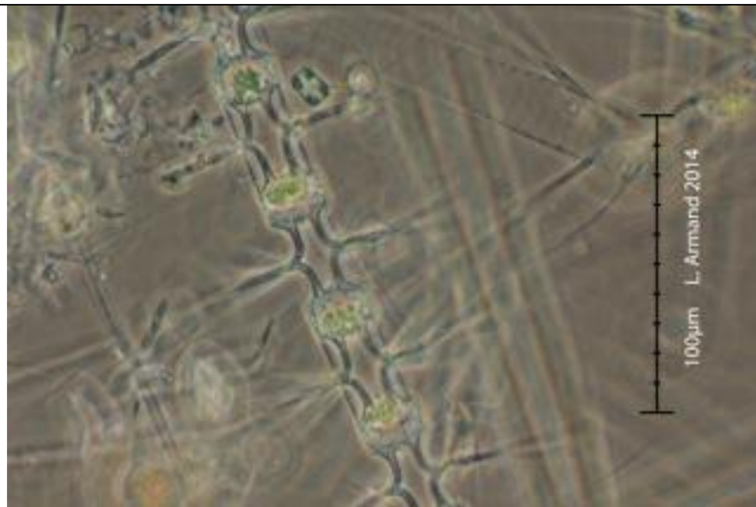
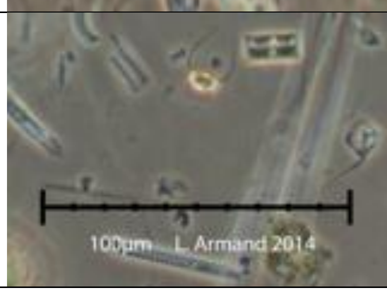
Appendix 4 Armand. Quick guide to diatoms observed and listed during NBP14-02
Underway water sampling with a 20µm mesh sieve.
Please note that the images are in low resolution so as to reduce the size of the file, thus they are best viewed on a screen. If you require high resolution images please contact Dr Leanne Armand (leanne.armand@mq.edu.au). A full photographic database will be publically available in 2014.

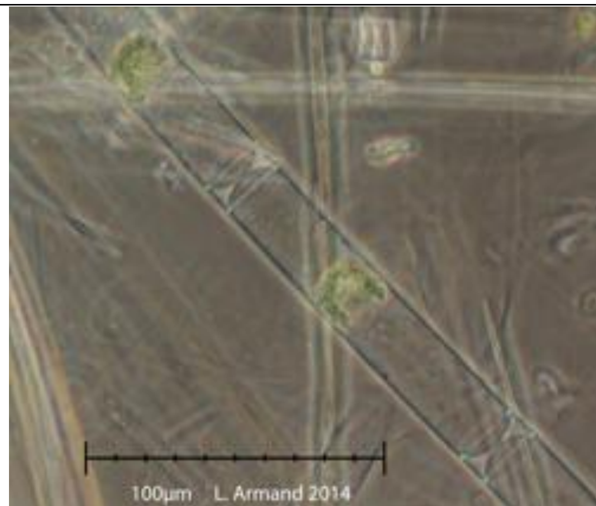
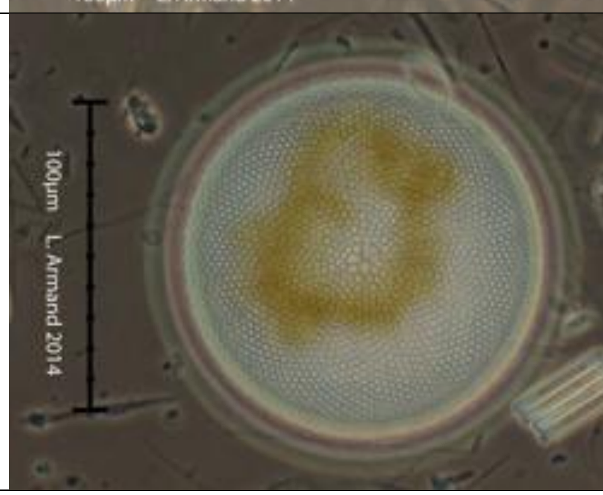
Diatom species	*Photograph*
Actinochilus actinocyclus	
Actinocyclus curvatulus	
Asteromphalus hookeri	

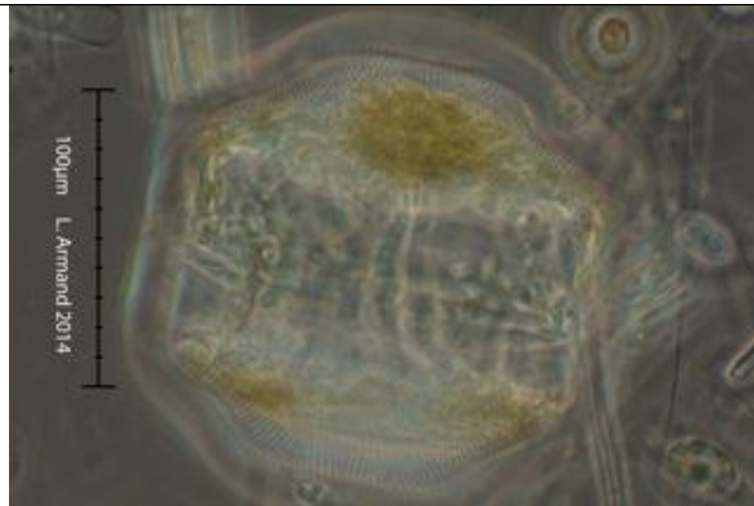
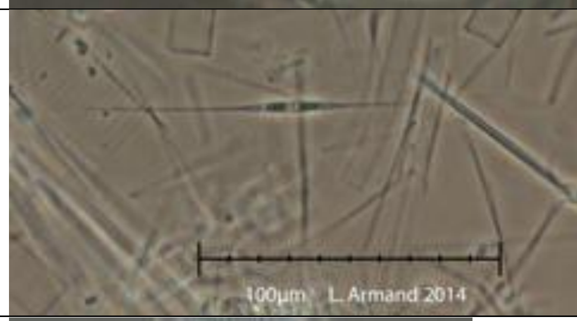
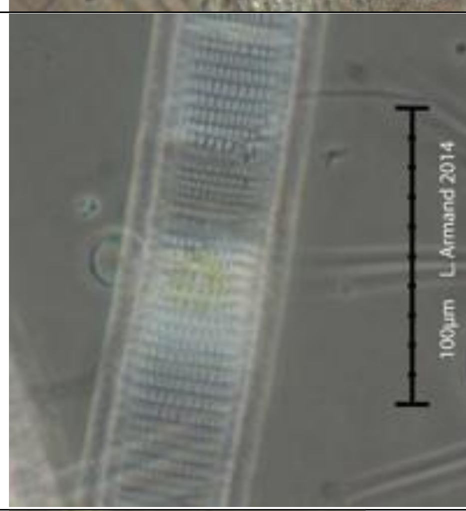
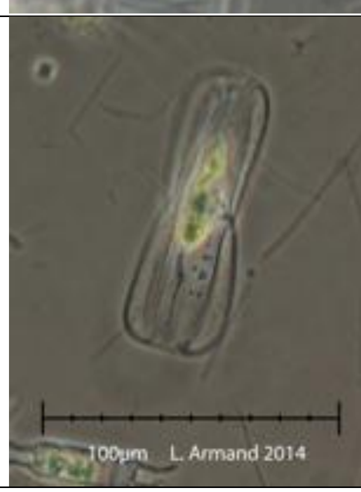
Asteromphalus hyalinus	
Asteromphalus parvulus	
Azpeitia tabularis	
Banquisia bankseii (Part of *Tropidoneis* group)	

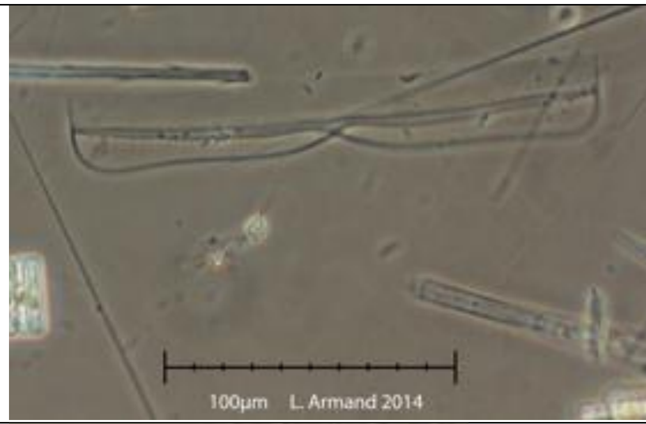
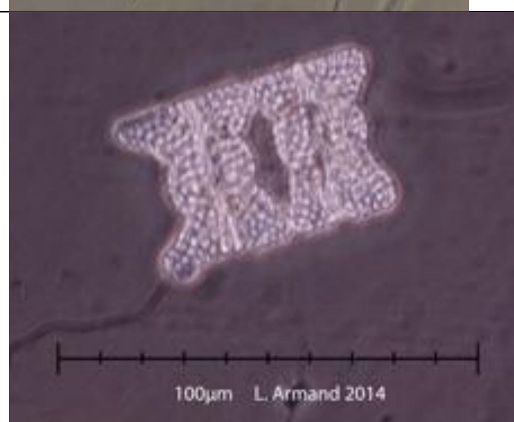
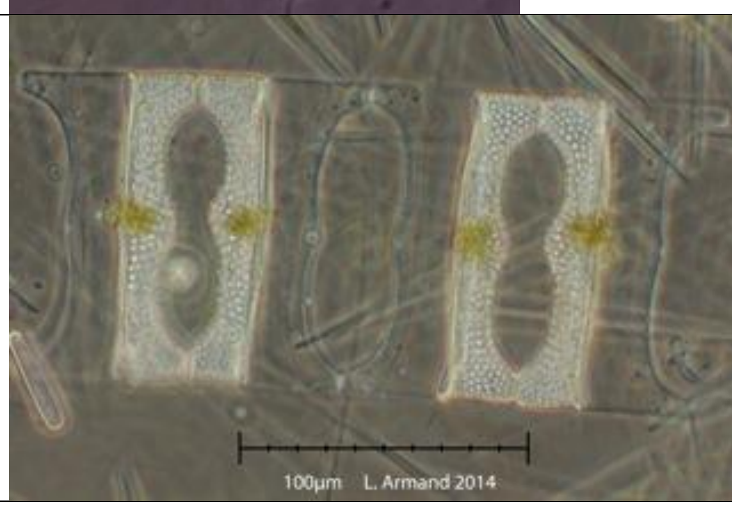
Chaetoceros (Hyalochaete)	
Chaetoceros (Phaeoceros)	
Chaetoceros atlanticum	 

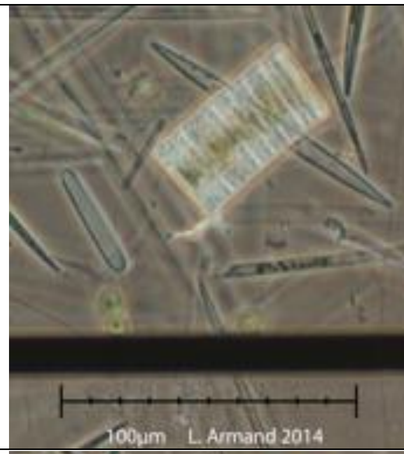
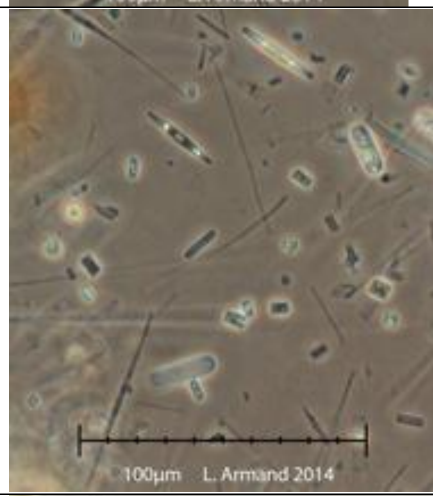
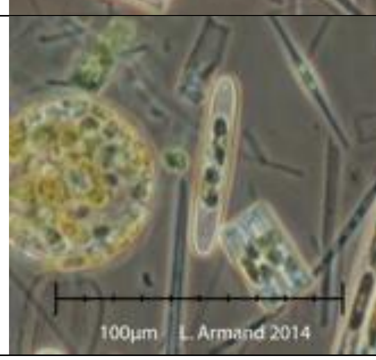
Chaetoceros convolutes (*forma trisetosa* Brunel 1970)	
Chaetoceros criophilum	
Chaetoceros curvisetus	

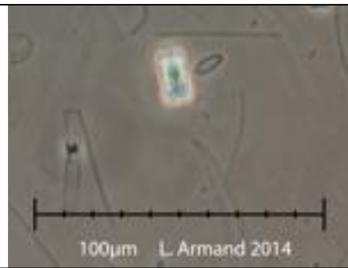
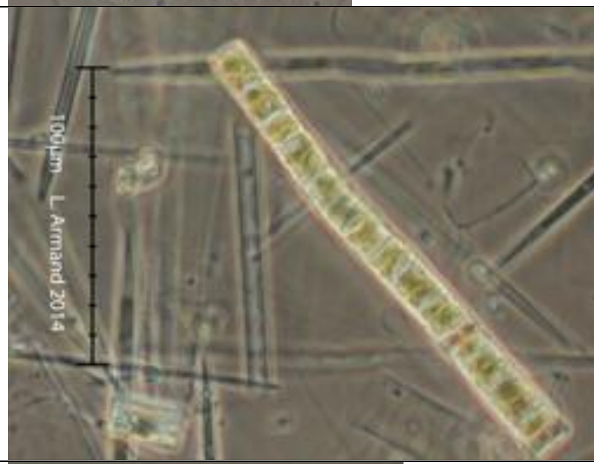
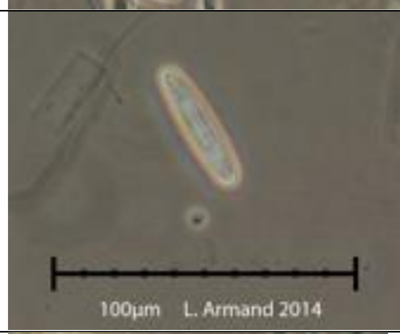
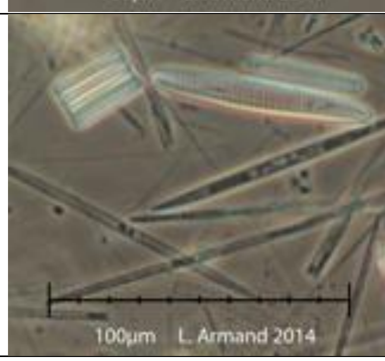
Chaetoceros dicheata	
Chaetoceros peruvianus	
Chaetoceros resting spores	

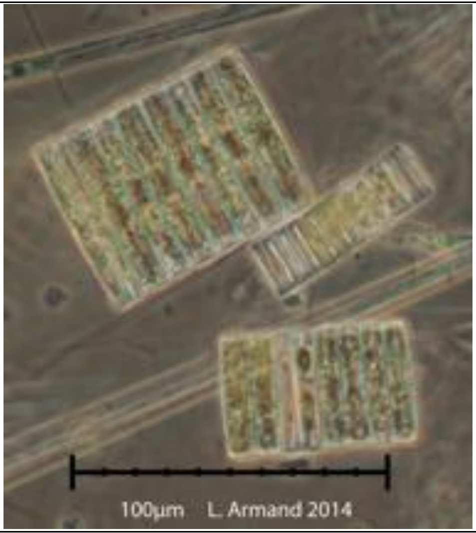
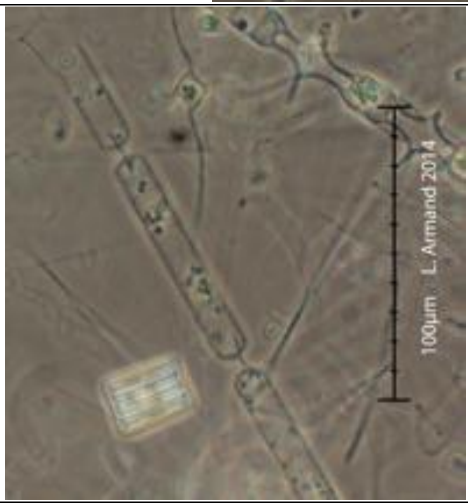
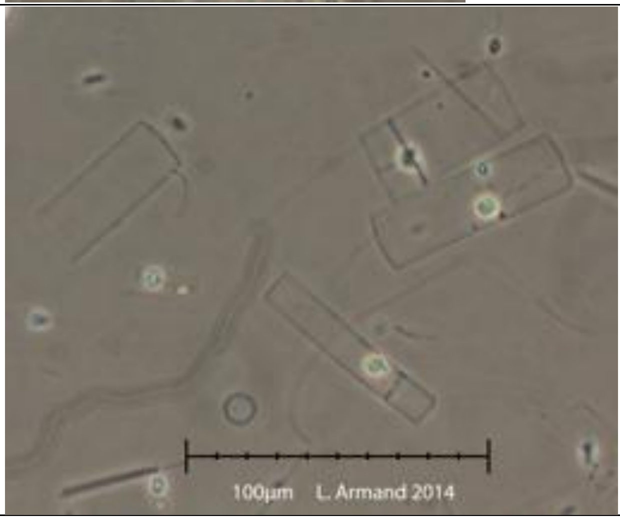
Corethron inerme	
Corethron pennatum	
Coscinodiscus asteromphalus	

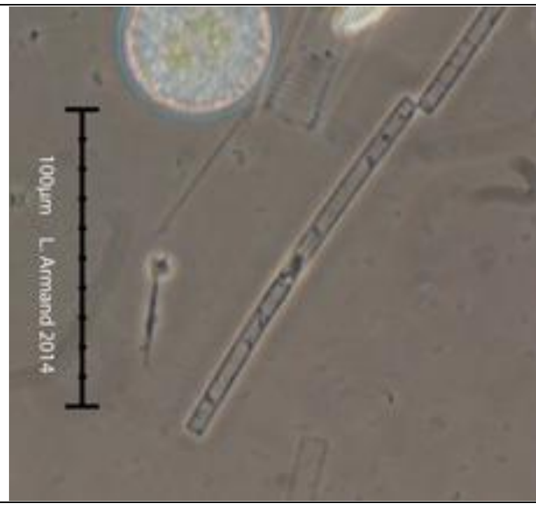
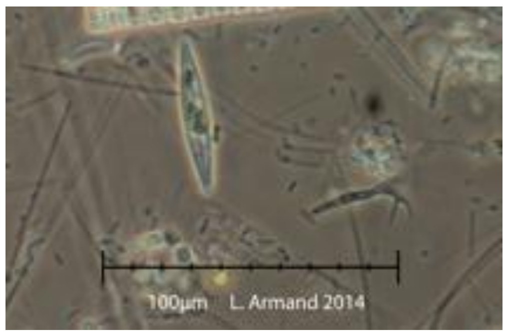
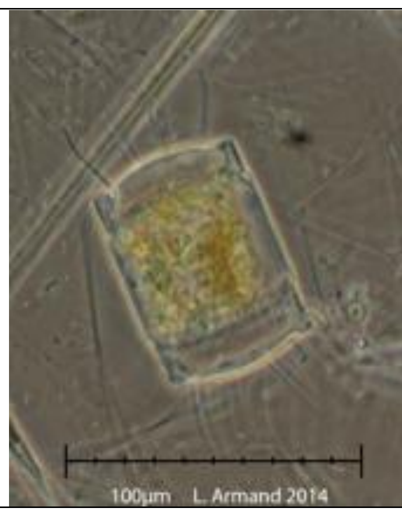
Coscinodiscus bouvet	
Cylindrotheca spp.	
Dactyliosolen antarctica	
Entomoneis cf. *kufferathii*	

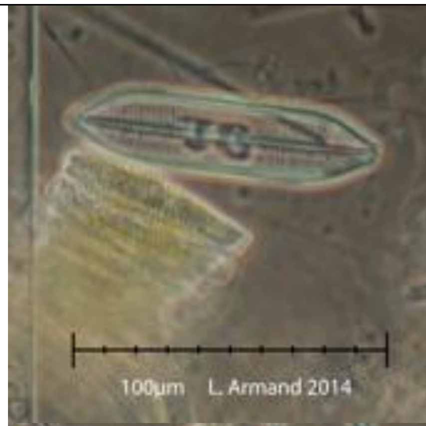
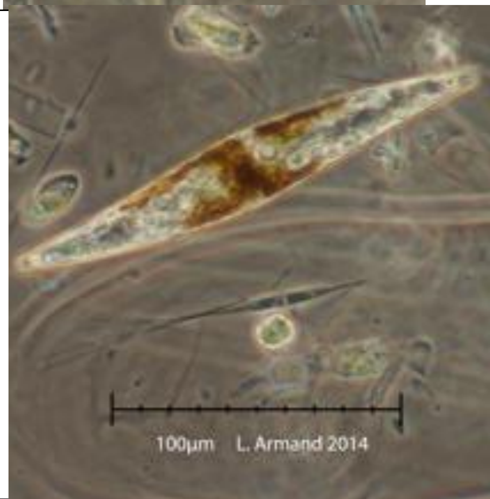
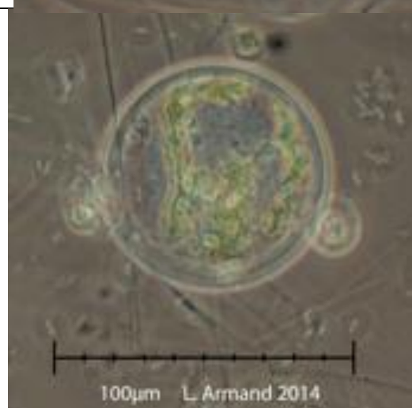
Entomoneis cf. *kjellmanii*	
Entomoneis sp. (small)	
Eucampia antarctica v. *antarctica*	
Eucampia antarctica v. *recta*	

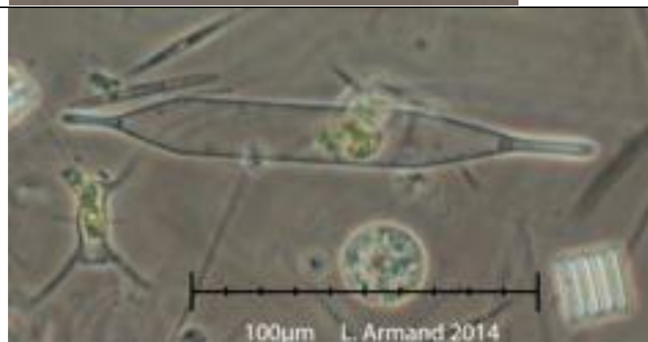
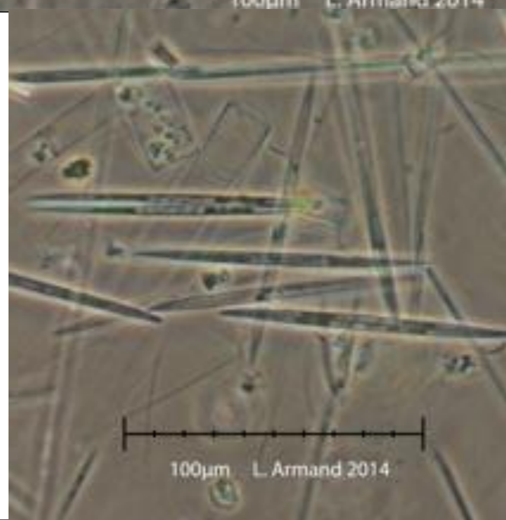
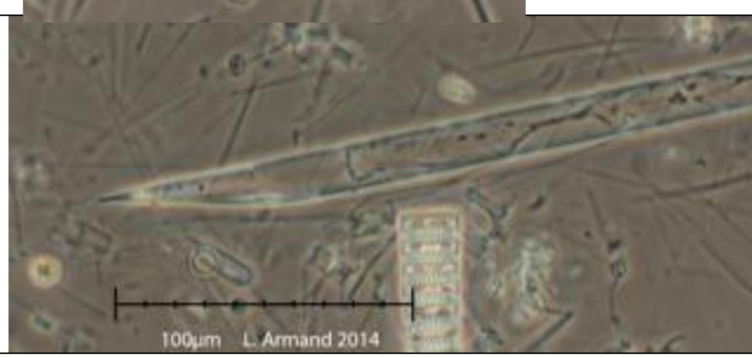
Fragilariopsis curta	
Fragilariopsis cylindrus	
Fragilariopsis kerguelensis	
Fragilariopsis linearis	

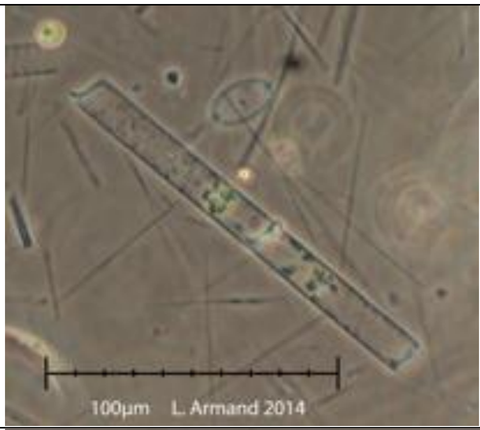
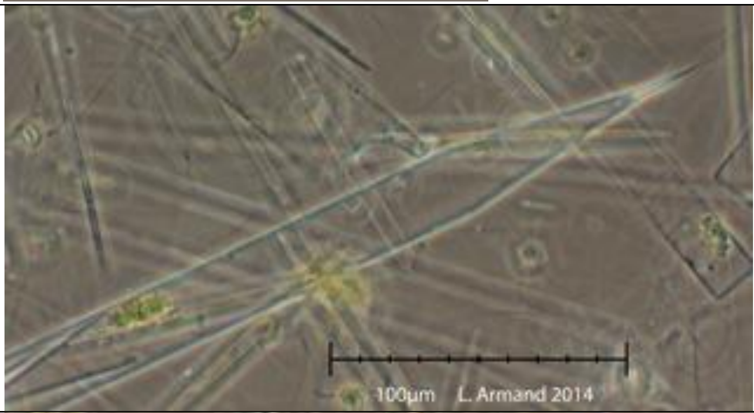
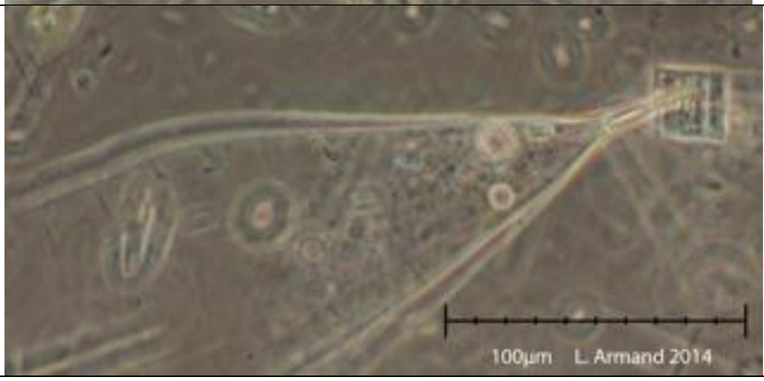
Fragilariopsis pseudonana	
Fragilariopsis rhombica/separanda	
Fragilariopsis ritscherii	
Fragilariopsis sublinearis/obliquec.	

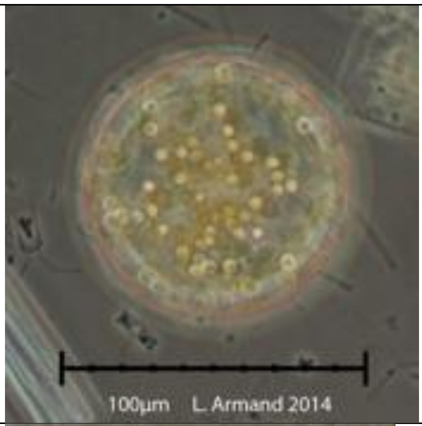
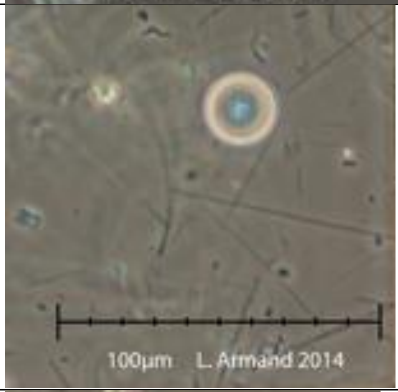
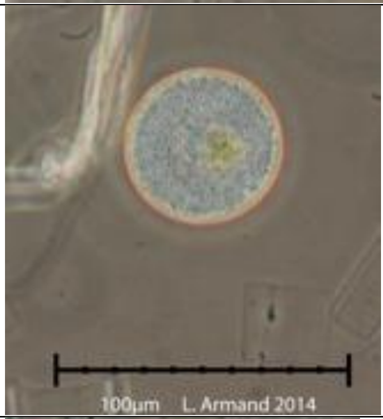
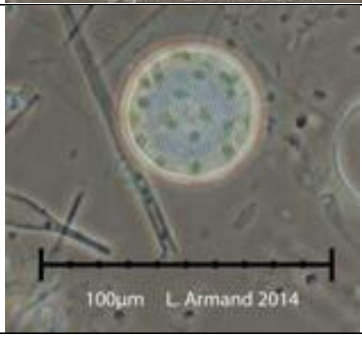
Fragilariopsis spp.	
Guinardia cylindrus	
Guinardia cf. *tubiformis*	

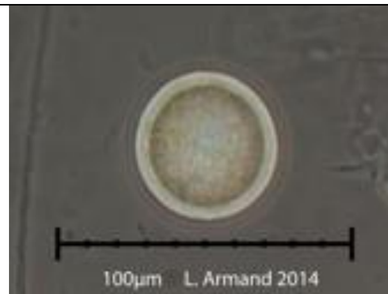
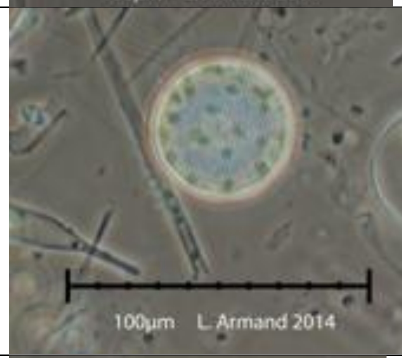
Leptocylindrus sp.	
Navicula spp.	
Odontella weissflogii	

Pinnularia quadratarea var. *constricta*	
Pleurosigma cf. *antarcticum*	
Porosira spp.	
Proboscia alata	

Proboscia inermis	
Proboscia truncata	
Pseudo-nitzschia spp.	
Rhizosolenia ant. f. *semispina*	

Rhizosolenia chunii	
Rhizosolenia polydactyla f. *poly*.	
Rhizosolenia simplex	
Rhizosolenia spp.	

Stellarima microtrias	
Thalassiosira gracilis var. *gracilis*	
Thalassiosira lentiginosa	
Thalassisosira lineata group	

Thalassiosira oliverana		
Thalassiosira spp. Large		
Thalassiosira spp. Small		
Thalassiosira tumida		

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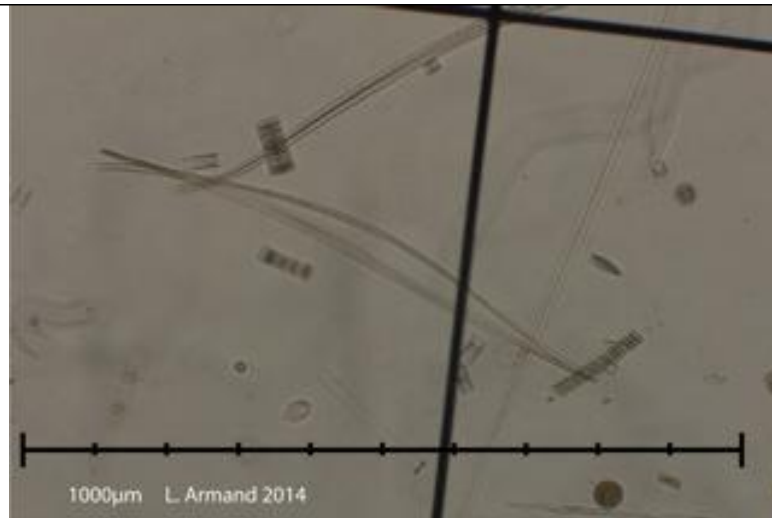
<tr><td>Thalassiothrix spp.</td><td>
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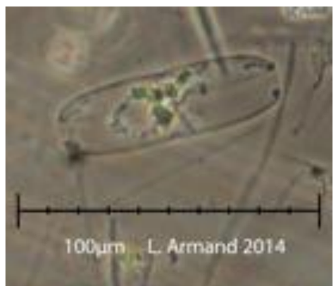
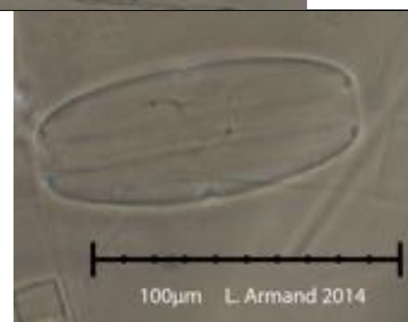
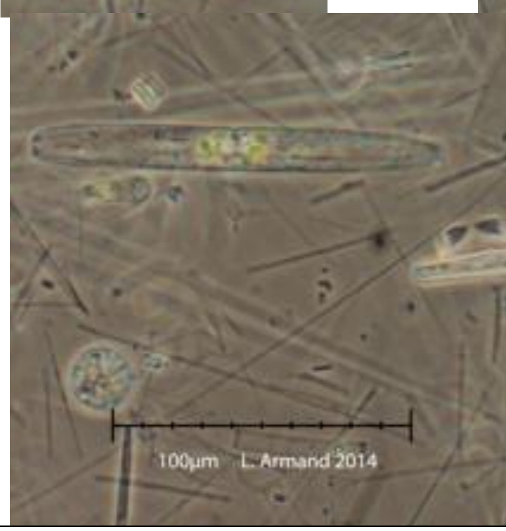
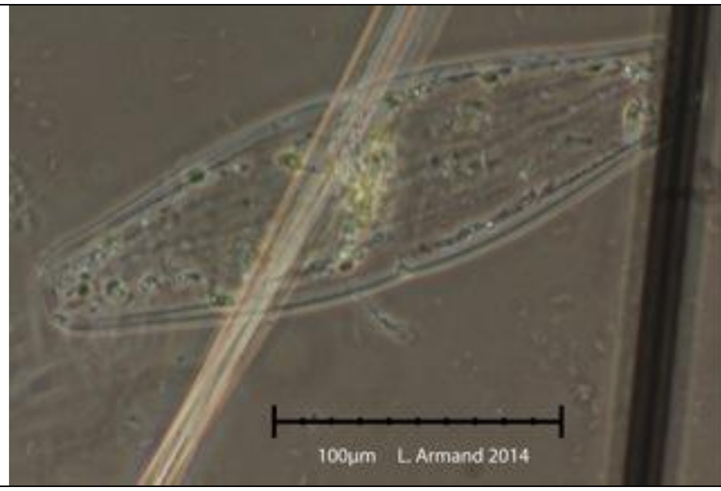
<tr><td>Tropidoneis spp.</td><td>




</td></tr>
</table>

	100µm L. Armand 2014

Appendix 5 Armand. Sediments samples returned to Macquarie University for future diatom analysis.

Sample ID	Date collected (d/mm/yr)	Latitude	Longitude	Seafloor depth (m)	Multicore Tube No. (if relevant)	Downcore depth from surface (cm)
MEGACORE SEDIMENTS						
MC-45	26/02/14	66°11.0042	120°29.995	538	10	1-2
MC-45	26/02/14	66°11.0042	120°29.995	538	10	2-3
MC-45	26/02/14	66°11.0042	120°29.995	538	10	3-4
MC-45	26/02/14	66°11.0042	120°29.995	538	10	4-5
MC-45	26/02/14	66°11.0042	120°29.995	538	10	5-7
MC-45	26/02/14	66°11.0042	120°29.995	538	10	7-9
MC-45	26/02/14	66°11.0042	120°29.995	538	10	9-11
MC-45	26/02/14	66°11.0042	120°29.995	538	10	11-13
MC-45	26/02/14	66°11.0042	120°29.995	538	10	13-15
MC-45	26/02/14	66°11.0042	120°29.995	538	10	15-17
MC-45	26/02/14	66°11.0042	120°29.995	538	10	17-19

Sample ID	Date collected (d/mm/yr)	Latitude	Longitude	Seafloor depth (m)	Multicore Tube No. (if relevant)	Downcore depth from surface (cm)
MC-45	26/02/14	66°11.0042	120°29.995	538	10	19-21
MC-61	5/03/14	66°07.691	120°27.826	579	6	1-2
MC-61	5/03/14	66°07.691	120°27.826	579	6	2-3
MC-61	5/03/14	66°07.691	120°27.826	579	6	3-4
MC-61	5/03/14	66°07.691	120°27.826	579	6	4-5
MC-61	5/03/14	66°07.691	120°27.826	579	6	5-6
MC-61	5/03/14	66°07.691	120°27.826	579	6	6-7
MC-61	5/03/14	66°07.691	120°27.826	579	6	7-8
MC-61	5/03/14	66°07.691	120°27.826	579	6	8-9
MC-61	5/03/14	66°07.691	120°27.826	579	6	9-10
MC-61	5/03/14	66°07.691	120°27.826	579	6	12-14
MC-61	5/03/14	66°07.691	120°27.826	579	6	10-12
MC-61	5/03/14	66°07.691	120°27.826	579	6	14-16

Sample ID	Date collected (d/mm/yr)	Latitude	Longitude	Seafloor depth (m)	Multicore Tube No. (if relevant)	Downcore depth from surface (cm)
MC-61	5/03/14	66°07.691	120°27.826	579	6	16-18
MC-61	5/03/14	66°07.691	120°27.826	579	6	18-20
MC-61	5/03/14	66°07.691	120°27.826	579	6	20-22
MC-61	5/03/14	66°07.691	120°27.826	579	6	22-24
MC-61	5/03/14	66°07.691	120°27.826	579	6	24-26
MC-61	5/03/14	66°07.691	120°27.826	579	6	26-28
MC-61	5/03/14	66°07.691	120°27.826	579	6	28-30
MC-61	5/03/14	66°07.691	120°27.826	579	6	30-32
MC-61	5/03/14	66°07.691	120°27.826	579	6	32-33
SMEAR SAMPLES						
KC-9	11/02/14	66°21.644	119°51.714	645		0
KC-9	11/02/14	66°21.644	119°51.714	645		20
KC-9	11/02/14	66°21.644	119°51.714	645		21

Sample ID	Date collected (d/mm/yr)	Latitude	Longitude	Seafloor depth (m)	Multicore Tube No. (if relevant)	Downcore depth from surface (cm)
KC-9	11/02/14	66°21.644	119°51.714	645		156
KC-9	11/02/14	66°21.644	119°51.714	645		205
KC-14	13/02/14	66°52.3709	118°14.399	641		16
KC-14	13/02/14	66°52.3709	118°14.399	641		6
KC-14	13/02/14	66°52.3709	118°14.399	641		15
KC-14	13/02/14	66°52.3709	118°14.399	641		0
KC-14	13/02/14	66°52.3709	118°14.399	641		87
KC-14	13/02/14	66°52.3709	118°14.399	641		124
KC-14	13/02/14	66°52.3709	118°14.399	641		208
KC-14	13/02/14	66°52.3709	118°14.399	641		252
KC-14	13/02/14	66°52.3709	118°14.399	641		265
KC- 20	17/02/14	66°23.145	118°57.583	895		0

Sample ID	Date collected (d/mm/yr)	Latitude	Longitude	Seafloor depth (m)	Multicore Tube No. (if relevant)	Downcore depth from surface (cm)
KC- 20	17/02/14	66°23.145	118°57.583	895		15
KC- 20	17/02/14	66°23.145	118°57.583	895		38
KC- 20	17/02/14	66°23.145	118°57.583	895		84
KC- 20	17/02/14	66°23.145	118°57.583	895		85.5
KC- 20	17/02/14	66°23.145	118°57.583	895		96
KC- 20	17/02/14	66°23.145	118°57.583	895		97
KC- 20	17/02/14	66°23.145	118°57.583	895		109
KC- 20	17/02/14	66°23.145	118°57.583	895		138
KC- 20	17/02/14	66°23.145	118°57.583	895		141
KC- 20	17/02/14	66°23.145	118°57.583	895		179
KC-27A	21/02/14	66°11.0912	120°30.2390	545		30
KC-27A	21/02/14	66°11.0912	120°30.2390	545		47
KC-27A	21/02/14	66°11.0912	120°30.2390	545		56

Sample ID	Date collected (d/mm/yr)	Latitude	Longitude	Seafloor depth (m)	Multicore Tube No. (if relevant)	Downcore depth from surface (cm)
KC-27A	21/02/14	66°11.0912	120°30.2390	545		112
KC-27A	21/02/14	66°11.0912	120°30.2390	545		139
KC-27A	21/02/14	66°11.0912	120°30.2390	545		144
KC-27A	21/02/14	66°11.0912	120°30.2390	545		165
KC-27A	21/02/14	66°11.0912	120°30.2390	545		196
KC-27A	21/02/14	66°11.0912	120°30.2390	545		204
KC-27A	21/02/14	66°11.0912	120°30.2390	545		216
KC-27A	21/02/14	66°11.0912	120°30.2390	545		226
KC-27A	21/02/14	66°11.0912	120°30.2390	545		239
KC-27A	21/02/14	66°11.0912	120°30.2390	545		245
KC-27A	21/02/14	66°11.0912	120°30.2390	545		259
KC-27A	21/02/14	66°11.0912	120°30.2390	545		264
KC-27A	21/02/14	66°11.0912	120°30.2390	545		272
KC-27A	21/02/14	66°11.0912	120°30.2390	545		280

Sample ID	Date collected (d/mm/yr)	Latitude	Longitude	Seafloor depth (m)	Multicore Tube No. (if relevant)	Downcore depth from surface (cm)
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		0.0
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		0
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		4
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		38
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		59
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		72
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		90
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		131
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		142
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		155
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		159
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		164
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		173

Sample ID	Date collected (d/mm/yr)	Latitude	Longitude	Seafloor depth (m)	Multicore Tube No. (if relevant)	Downcore depth from surface (cm)
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		182
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		199
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		201
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		206
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		224
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		244
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		252
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		264
KC-27B	21/02/14	66°11.0907	120° 30.2385	547		271
KC-42	25/02/14	66°28.889	120°20.2725	610		0
KC-42	25/02/14	66°28.890	120°20.2726	610		60
KC-42	25/02/14	66°28.891	120°20.2727	610		62
KC-42	25/02/14	66°28.892	120°20.2728	610		95

Sample ID	Date collected (d/mm/yr)	Latitude	Longitude	Seafloor depth (m)	Multicore Tube No. (if relevant)	Downcore depth from surface (cm)
KC-42	25/02/14	66°28.893	120°20.2729	610		96
KC-42	25/02/14	66°28.894	120°20.2730	610		108
KC-42	25/02/14	66°28.895	120°20.2731	610		156
KC-42	25/02/14	66°28.896	120°20.2732	610		189
KC-42	25/02/14	66°28.897	120°20.2733	610		242
KC-42	25/02/14	66°28.898	120°20.2734	610		256
KC-42	25/02/14	66°28.899	120°20.2735	610		267.5
KC-42	25/02/14	66°28.900	120°20.2736	610		281
JKC-53	4/03/14	66°11.0568	120°30.1483	539		0.0
JKC-53	4/03/14	66°11.0569	120°30.1484	539		0
JKC-53	4/03/14	66°11.0570	120°30.1485	539		27
JKC-53	4/03/14	66°11.0571	120°30.1486	539		58
JKC-53	4/03/14	66°11.0572	120°30.1487	539		77

Sample ID	Date collected (d/mm/yr)	Latitude	Longitude	Seafloor depth (m)	Multicore Tube No. (if relevant)	Downcore depth from surface (cm)
JKC-53	4/03/14	66°11.0573	120°30.1488	539		135
JKC-53	4/03/14	66°11.0574	120°30.1489	539		164
JKC-53	4/03/14	66°11.0575	120°30.1490	539		197
JKC-53	4/03/14	66°11.0576	120°30.1491	539		224
JKC-53	4/03/14	66°11.0577	120°30.1492	539		238
JKC-53	4/03/14	66°11.0578	120°30.1493	539		244
JKC-53	4/03/14	66°11.0579	120°30.1494	539		282
JKC-53	4/03/14	66°11.0580	120°30.1495	539		288
JKC-53	4/03/14	66°11.0581	120°30.1496	539		309
JKC-53	4/03/14	66°11.0582	120°30.1497	539		332
JKC-53	4/03/14	66°11.0583	120°30.1498	539		364
JKC-53	4/03/14	66°11.0584	120°30.1499	539		393
JKC-53	4/03/14	66°11.0585	120°30.1500	539		399
JKC-53	4/03/14	66°11.0586	120°30.1501	539		413

Sample ID	Date collected (d/mm/yr)	Latitude	Longitude	Seafloor depth (m)	Multicore Tube No. (if relevant)	Downcore depth from surface (cm)
JKC-53	4/03/14	66°11.0587	120°30.1502	539		423
JKC-53	4/03/14	66°11.0588	120°30.1503	539		452.5
JKC-53	4/03/14	66°11.0589	120°30.1504	539		474
JKC-53	4/03/14	66°11.0590	120°30.1505	539		506
JKC-53	4/03/14	66°11.0591	120°30.1506	539		519
JKC-53	4/03/14	66°11.0592	120°30.1507	539		520
KC-57	4/03/14	66°07.7321	120°27.8403	583		0
KC-57	4/03/14	66°07.7322	120°27.8404	583		37
KC-57	4/03/14	66°07.7323	120°27.8405	583		63
KC-57	4/03/14	66°07.7324	120°27.8406	583		69
KC-57	4/03/14	66°07.7325	120°27.8407	583		83
KC-57	4/03/14	66°07.7326	120°27.8408	583		92
KC-57	4/03/14	66°07.7327	120°27.8409	583		109

Sample ID	Date collected (d/mm/yr)	Latitude	Longitude	Seafloor depth (m)	Multicore Tube No. (if relevant)	Downcore depth from surface (cm)
KC-57	4/03/14	66°07.7328	120°27.8410	583		130
KC-57	4/03/14	66°07.7329	120°27.8411	583		144
KC-57	4/03/14	66°07.7330	120°27.8412	583		179
KC-57	4/03/14	66°07.7331	120°27.8413	583		188
KC-57	4/03/14	66°07.7332	120°27.8414	583		193
KC-57	4/03/14	66°07.7333	120°27.8415	583		210
KC-57	4/03/14	66°07.7334	120°27.8416	583		219
KC-57	4/03/14	66°07.7335	120°27.8417	583		227
KC-57	4/03/14	66°07.7336	120°27.8418	583		237.5
KC-57	4/03/14	66°07.7337	120°27.8419	583		253

15. Cooperative mooring plan

APPENDIX 15

US-Australian Cooperative Mooring Program, East Antarctica

Agreement between US NBP1402 Science Team and Steve Rintoul, CSIRO and approved by NSF OPP, Scott Borg and AAD, Nick Gales, September 2013

Scientists from the US and Australia participating in research cruises along the East Antarctic margin in the summers of 2014 and 2015 propose a cooperative program for one-year deployment of an array of moored instrumentation that will maximize the scientific return from integrated physical oceanographic measurements and sediment flux collection. Despite space-based platforms that indicate accelerating mass loss of the Totten Glacier System (Sabrina Coast, ~114-122°E), little is known about this part of the Antarctic continental margin, from very few available oceanographic measurements of any kind. The limited physical data profiled close to the continental shelf break indicate the presence of Modified Circumpolar Deep Water within a thick bottom layer, but these measurements are over 100 km northeast of Totten Glacier terminus (Williams et al., 2011). If the measured Modified Circumpolar Deep Water has access to Totten Glacier through one or more troughs, it is possible that ocean forcing explains the recently observed mass loss.

Several research vessels are scheduled to be working in the Totten region during the 2013/14 and 2014/15 field seasons, including the RVIB *NB Palmer* (NBP1402) and the *Aurora Australis*. NBP1402 will be dedicated to the project "Collaborative Research: Totten Glacier System and the Marine Record of Cryosphere - Ocean Dynamics," lead PI and chief scientist, Amy Leventer, and work on the *Aurora Australis* will be led by Steve Rintoul (*AAS Project 4131: Southern Ocean circulation and water mass formation in a warming world*) during austral summer 2014-2015, a year after NBP1402.

We propose to take advantage of this scheduling to deploy a suite of five moorings during the *Palmer* cruise in austral summer 2013-2014, for recovery one year later during the *Aurora Australis* cruise in austral summer 2014-2015. We hope that acquisition of longer term data sets will result in enhanced scientific documentation and understanding of the Totten Glacier System region and that a cooperative mooring program will help forge a strong and lasting collaborative relationship between the US and Australian Antarctic Programs.

Specifically:

1. During NBP1402 we propose the deployment of 3 Australian moorings and 2 US moorings. Critical to our plan is to select Totten mooring sites that maximize combined scientific value with likelihood and ease of recovery, thus giving strong consideration to the regional history of sea ice distribution and extent, and with having multiple recovery opportunities. Likely regions for the long-term mooring array deployment include the trough in front of Totten Glacier and the trough to the west of the Dalton Iceberg Tongue. In addition to prevailing sea ice conditions, the location of specific mooring sites will also be based on inspection of oceanographic and bathymetric data collected on NBP1402 (Figure A, NBP1402 primary field area).

2. Our intention is to recover all five Totten moorings, USAP and Australian, during the 2014/2015 austral summer *Aurora Australis* cruise. A second option is their recovery during Frank Nitsche's *NB Palmer* cruise to the East Antarctic margin during early 2015.

3. In addition, three Australian moorings (blue triangles, Figure B) are currently deployed in the western outlet of the Mertz-Ninnis Trough. The *RV Tangaroa* was unable to recover these moorings during this past austral summer 2013. Since NBP1402 science plans include work in this area (red circles, Figure B, enlarged view of Figure D), if sea ice conditions permit, we will attempt to recover these Australian moorings during NBP1402.

For the US team, no additional equipment funds are needed, however a supplement may be submitted for funds to work on the data. The plan outlined above will be accommodated within the already allotted cruise time during NBP1402; we are not requesting any additional ship days.

16. Weekly reports

APPENDIX 16

WEEKLY REPORTS

NBP1402 weekly report #1 January 29 – February 6, 2014

The first week of science has been completed successfully for cruise NBP1402. Transit from our departure port of Hobart and equipment testing and setup occupied much of the first week of the cruise. Unseasonably hot weather while in port made stowing all the mooring and other gear on board doubly challenging for the ASC staff.

A major task for the NBP1402 team during the port call was installation of two gravimeters that are new to the Palmer. The first, a marine BGM-3, was installed in the NBP's gravity closet to replace the Lacoste and Romberg unit that had sailed for many years before experiencing trouble prior to the cruise. Given the new installation of the vessel gravimeter and the critical nature of potential fields acquisition on the cruise, the team chose to add a second gravimeter to the project that had recently been used by Co-PI Blankenship's team for airborne gravimetry in the Totten Glacier/Sabrina Coast region of Antarctica. Both meters were installed without incident and have had no issues with data acquisition. A gravity tie was made from the NBP's dock in Hobart to an absolute gravity station located on the University of Tasmania campus.

We departed Hobart with all decks full of gear, arranged with great care and planning on the part of ASC, so as to minimize crane operations at the other end of the transit. Our port call also included a reception at the Governor's Residence and a welcome by the Tasmanian Polar Network; many thanks to the Australians for their wonderful hospitality.

As a general overview for the week, we transited, starting January 29, directly to the Mertz region, ~145°E, for the most efficient transit given the currents, and to spare us a longer transit through potentially very rough seas. In the Mertz region we were able to address a subset of proposal objectives, and to shakedown all of our equipment. After completing 48 hours of science in the Mertz region, we are now headed to the Totten Glacier, ~120°E, with an estimated arrival some time on February 10.

Physical Oceanography (B Huber and A Orsi)

During the transit we deployed 10 buoys on behalf of USAP investigator Ignatius Rigor. The buoys drift at the surface measuring air temperature and pressure, and sea surface temperature, reporting these data by satellite at frequent intervals. A drogue attached to the buoy ensures that it follows the near surface currents, so the ARGOS data telemetry system provides positions for deriving average surface currents in addition to allowing frequent reporting of the temperature and pressure data. The deployments were aided by the enthusiastic support of our cadre of students. Ten additional buoys will be deployed along our homeward transit back to Hobart in March.

With invaluable help from the ASC marine and electronics technicians our Lowered Acoustic Doppler Current Profiler (LADCP) system was mounted on the CTD/rosette frame and thoroughly tested prior to its first use in the deepest part of the deep trough fronting the remains of the Mertz glacier tongue. Our first and only CTD/LADCP cast thus far has given us the opportunity to work some of the bugs out of our set up, water sampling and processing procedures, but more importantly it has also yielded data in a previously unsampled part of the ocean that had until recently been covered by the Mertz glacier tongue.

One new tool that we have been using on this cruise is an underway CTD (uCTD), a system that has not been used on the NB Palmer before. During the port call, ASC tech support diligently found the optimal operational location, and welded into place and constructed fitting plates for the uCTD's massive pedestal. To familiarize ourselves with operation of the uCTD, we carried out a series of casts at different cruising speeds, during our approach to the shelf. A total of 18 casts were successfully completed the within the Mertz region. An operational protocol has been drafted to best take advantage of the multiple benefits of uCTD surveying and profiling of physical properties in the Southern Ocean. Of particular interest to this experiment is the use of uCTD in conjunction with multibeam mapping, as already proved by the high-quality of our first week data sets.

Marine Geology and Geophysics (E Domack, S Gulick, and A Leventer, A Shevenell)

In the Mertz area, we collected 4 seismic lines in total (~ 70 nm); our goal was to evaluate the Mesozoic and Cenozoic history of the Mertz region, using a higher resolution system (~3 m vertical resolution, 12.5 m horizontal resolution) than has been used previously in this region. We shot our first line from north to south, with deviation for a large iceberg, and ending on the Cretaceous basement high to the south. When we were over basement, as indicated by the Knudsen CHIRP, we turned to starboard and shot west-northwest to cross existing seismic lines. At this point we looped back over ourselves, an outside turn to port, to form a crossing line. These data, and the line crossings, provide insight into longstanding questions regarding the climate history of East Antarctica identified in our proposal, and will provide supporting information for the IODP, with a potential future drill site in the Mertz region.

Operationally, during ice breaking, we initially tried towing the UTIG 100 m long streamer with a tail buoy. After losing the buoy rapidly to a growler, the ASC marine technicians rigged up a drogue that would tow beneath the surface. The four seismic lines were acquired using this drogue which seemed to be fine despite small amounts of ice present. For NBP1402-01 and NB1402-02, the dual 45/45 GI gun source with a hot spare was towed 5 m from the streamer where the center of the source was located at approximately channel 4 of the 24 channel streamer. However, the katabatic winds at the southern end of NGP1402-02 required greater spacing between guns and streamer to avoid cross over in the rougher sea state. Therefore during the turn between NBP1402-02 and NBP1402-03, we moved the streamer 1.2 m farther to port. Therefore the near offset for all four lines was +9.375 m and the lateral offset was 5 m for the first two lines and 6.3 m for the latter two. Data were recorded at 0.5 ms for 2.5 s throughout.

Given the rapidly processed seismic data, we were able to choose dredge sites that avoided overly thick "glacial" sediment cover, based on the expected proximity of the strata to the seafloor. We completed five dredges which concentrated on the reflectors near the seafloor, below and above the high amplitude reflector (Eocene-Oligocene boundary?). These dredges, plus the three dredges from NBP01-01, provide excellent information on the nature of the strata to be encountered by future drilling efforts. We succeeded in getting seabed outcrop samples from the E-O strata which appear to consist of the juxtaposition of ferruginous, poorly sorted, gravelly sandstones and sandy conglomerates. We also feel that we collected representative sedimentary rocks from below and above the "outcropping reflector". Currently we are sorting and cataloging the rocks as we make the transit to the Totten area.

Within the limitations of sea ice and time allocated to the Mertz region, one objective that we were unable to accomplish was Jumbo Piston Coring a site identified in our proposal.

Operationally, two issues were noted during our first week. First, we are unable to have live printing capability from the newly installed upgraded Knudsen sub-bottom profiler, a capacity that is critical to on the spot decision-making for selecting core sites. After a great deal of troubleshooting by IT staff, and back-and-forth communication with the Knudsen company, the problem has been determined to be a software issue that needs to be addressed by Knudsen. We have developed a “work-around” system that allows us to print files every hour, a non-optimal process. Finally, of major concern are the four multibeam crashes that have occurred. We have contacted Kongsberg regarding the error message received and have implemented their recommendations.

Marine Mammal Observations (A Walters and T Snow)

Marine mammal observations (MMO) were successfully carried out for both icebreaking and seismic operations during the first week aboard the Palmer. Observations for icebreaking took place during transit through thick ice cover (50%) to and from the Mertz Glacier survey area on the 4th and 7th February, respectively. Observations for seismic operations occurred on the 4-5th February in the survey area. To facilitate icebreaking observations, members of the science party were trained and utilized as observers. A pre-operations training session was carried out by the two PSVO's for all science members on the 3rd February. The MMO icebreaking training included a comprehensive overview of: a) the IHA guidelines for icebreaking, b) the species authorized and level of takes), c) the species taxonomy, physical and behavioral characteristics, and identification cues (conducted by the lead PSVO, Andrea Walters), and d) monitoring and recording methods, including how to calculate distance to animals using reticule binoculars and record weather and visibility conditions. To record observations for icebreaking and seismic operations, an on-line recording system (Elog) was successfully created and used by all observers (http://elog.nbp.usap.gov/MMO-Sighting-Behavior+Log/). This electronic database will be used for the duration of the cruise and will be used to track daily and cumulative take on the Palmer.

Biological work (L Armand)

Biological work on board the NB Palmer is focused on the diatoms recovered from sea surface waters to assist with understanding species distributions, ecology and life cycle stages (where observed). Sampling has been focused on three main threads of investigation:

1. Cell distributions in surface waters are being evaluated during the cruise from underway surface water samples that are sieved to concentrate diatoms, followed by observational microscopy under an inverted phase microscope.
2. Cell concentrates for single cell analysis are being conducted as a link to diatom observations.
3. Water samples from the uncontaminated seawater system have been collected for highly branched isoprenoid analysis, in an attempt to help ground truth the source and variability of dienne and trienne isoprenoids from the surface waters of the Southern Ocean. Samples have been taken from both in and out of the sea ice.

That's all for the first week of NBP1402,

Many thanks to all on board for all the hard work, and a successful first week of science,

Amy Leventer

NBP1402 Weekly Report #2 February 7 – February 15, 2014

After completing work in the Mertz polynya region, NBP1402 began our transit to the Moscow University Ice Shelf – Totten Glacier System. On the way, we sampled at a locality on the mouth of the Mertz-Ninnis Trough, on February 7. We finally arrived at the Totten Glacier - Moscow University Ice Shelf region on February 10. We entered the Moscow University Ice Shelf polynya from the eastern side, along 120 E longitude, after only a few hours of breaking through the loose pack ice. Our work in the open water of the polynya has been dedicated to initial reconnaissance of this previously un-mapped and unsampled region. Accomplishments so far include: development of a swath bathymetric map of the sea floor and a 3.5 kHz record of the sub-surface stratigraphy, collection of > 70 nm of Multichannel seismic data, collection of a suite of physical oceanographic measurements, recovery of several sediment cores, completion of a yoyo camera deployment and deployment of our first temporary mooring.

We continue to watch the satellite imagery to see if we will be able to access the eastern edge of the Totten Glacier. We made one attempt so far, just a short 4 hour transit through a mix of open water and pack ice, but were unable to reach the Totten itself due to the presence of extremely consolidated pack ice and multi-year fast ice.

We note that we are facing severe problems with the multibeam system. The multibeam has crashed 52 times so far, a significant and potentially fatal problem for our scientific objectives of mapping a previously unexplored area of the sea floor, and testing the role of bottom topography on physical oceanographic processes. We are very thankful for help from Kathleen Gavahan and Caroline Lavoie, our multibeam experts, and from IT and ET support staff, Scott Walker, Sean Drabant, Sheldon Blackman and Barry Bjorck – all have put in long hours troubleshooting and re-booting the system.

Marine Geology and Geophysics (E Domack, S Gulick, A Leventer, A Shevenell, A Post)

1. Dredging operations: Coral hard grounds are now recognized as important constituents of Antarctic benthic communities and while their distributions are still being investigated they seem to be focused in areas where very cold, saline outflows are concentrated at the mouth of trough mouth fans, shelf breaks, and around shallow headlands. Because of this they seem to occur fortuitously at the frontal boundaries of shelf and slope water masses. As such they can serve as useful paleoceanographic indicators as they fix calcite over time spans of at least a few hundred years.

For these reasons we collected two short dredges which recovered coral and coral rubble on the mouth of the Mertz-Ninnis Trough, Eastern Wilkes Land. A large basket dredge was used for both transects 7A and 7B. The lower transect extended over a distance of 90 m and a depth range of 707 to 692 m. The upper transect, at 669 to 616 m, collected over a distance of 200 m. Several specimens of *Errina antarctica,* in excess of 20 cm in length were recovered from the upper transect, as well as significant dead coral stems and pieces which seem to carpet the immediate down-slope area of the live growth. If growth rates similar to those observed elsewhere apply here we may have captured a continuous time series of water mass properties that extends to about 1000 years!

2. Multibeam and Knudsen Data: Initial coverage of the inner portion of the Sabrina Coast continental shelf, in the region of the Moscow University Ice Shelf, has revealed a complex set of glacially carved and eroded seascapes (including subglacial meltwater channels) with constructional grounding line wedges and lineated to corrugated subglacial surfaces. What is surprising is the close juxtaposition of all the features in small area of the shelf -- where normally such features are organized across broad regions in other Antarctic shelves. So far we have found these features to be more or less carpeted by a uniform drape of glacial marine silty clay which varies very little in thickness, usually about 3 m. Striking observations of superimposed ice flow directions are indicated as well as several sets of recessional morainal bank constructs -- both of which indicate a complex glacial and deglacial history.

3. Coring Operations: Three kasten cores, a jumbo gravity core and jumbo piston core (JPC) have been recovered so far, allowing an initial evaluation of the sediment drape observed in the 3.5 kHz record. The silty clays are virtually devoid of coarse ice rafted debris, but are rich in diatom frustules. Profiles of magnetic susceptibility can be correlated between cores across the southern border of the study region.

Our first JPC was deployed and recovered in conditions of heavy ice cover and with a drift of between 0.1-0.2 knots. Excellent coordination between the ECO bridge and ASC back deck crews allowed us to set up and deploy while drifting, triggering the JPC with precision locating as we drifted over our selected site.

4. Multichannel Seismic Work: Seismic reflection operations were conducted in the Moscow University Ice Shelf region during week 2 of the expedition. We acquired 71 nm of high-resolution, multichannel data in the form of three profiles. Line 5 headed approximately southwest and crossed greater than 1.5 s of dipping sedimentary strata overlain at a slope break by a morainal bank and then crossed onto topographic rough basement for the remainder of the profile. Line 6 was oriented to the northwest and imaged entirely basement, resulting in a change of plans. Line 7 was then acquired back to the northeast and succeeded in crossing out of the basement terrane and imaged the dipping reflectors with several erosional surfaces and two prominent morainal banks. Numerous smaller features of glacial orogen visible on the bathymetry data and the Knudsen data were also imaged at a lower resolution vertically on the seismic data.

Operationally, no problems occurred with navigation or the streamer during the seismic profiling. Gun 1 successfully shot throughout the survey, while Gun 2 again had syncing errors due to blowing its blast phone off near shot 12940 over the exposed basement portion of the line. We switched to Gun 3 (the hot spare), which shot throughout the remainder of Line 5 and all of Line 6 (<5000 shots) before failing on Line 7 as we reached the basement sediment contact. For the remainder of Line 7 we acquired data with only Gun 1.

After some discussion, it was determined that the blast phone issue could be solved by using lock title on all screws holding in the blast phones (and solenoids). The failure of Gun 3 after so few shots was likely the below freezing conditions it was subjected to without being fired or having no-tox antifreeze delivered to it for a number of hours prior to being used as the hot spare on Line 5. Strategy for future deployments is to hit all guns with no tox prior to placing them on the bridles and then to test fire all three guns in succession after ramp up to ensure they are all ice free at the start of operations.

5. Yoyo Camera: A yoyo transect was run at Station 10 for 0.5 nm to coincide with the location of the short-term oceanographic mooring. The transect revealed a mixed benthic community, consisting of abundant infauna, mobile feeders (such as brittle stars and urchins) and some sessile suspension feeders (gorgonians, bryozoa, sponges and anemones). Marine snow was visible from the surface waters to the bottom, and diatom mats were widely distributed on the seafloor. This indicates high production in the surface waters of the polynya and low current flow at depth. Low sedimentation, as indicated on the sub-bottom profile, suggests that pelagic sedimentation to this environment is scavenged quickly by the benthic community.

Links to Aerogeophysical data (J Greenbaum)

Recent aerogeophysical survey flying in the area along the Sabrina Coast had detected deep bathymetric lows extending from at least the mid-continental shelf to the Totten Glacier grounding line in an area undergoing significant glacier mass loss. This past week the NBP fought its way through multiyear ice into the edge of the airborne grid, providing an opportunity to verify the existence and significance of the canyons. Before getting turned back by thick ice, the first of these large canyons was found and the water properties within were measured, data that may help understand why the glaciers in that area of the coastline are changing so rapidly.

In total, the NBP crossed three of the aerogeophysical lines and sailed in other areas where the aircraft did not fly. Together, these datasets provide a high-resolution view of the seafloor from the NBP complemented by the broad seafloor shape in un-navigable areas provided by airborne data.

Physical Oceanography (A Orsi and B Huber)

During the first week of work inside the shelf break off Sabrina Coast we have managed to fit 43 Underway CTD casts along cruise tracks established for the optimal entrance and during multibeam combing of specific areas. Four uctd casts were occupied in stationary mode in front of the westernmost segment reached by the Palmer in front of the Totten Glacier. The first short-term mooring (M1) was deployed along the eastern flank of an apparent main path of inflow of slope waters. Three CTD/LADCP with rosette bottle casts have been carried out, including one at the M1 site. Water samples have been collected for analysis of salinity and dissolved oxygen, oxygen isotopes, and for filtering for plankton and viruses. Monitoring of the underway ADCP is carried out while underway. The ADCP and LADCP so far have revealed little structure in the currents along our tracks, with the exception of a hint of recirculation in one corner of the survey that may bear further investigation as our sampling plans evolve.

Marine Mammal Observations (A Walters and T Snow)

Marine mammal observations (MMO) took place for icebreaking and seismic operations during the second week aboard the Palmer. Observations for icebreaking occurred during transit through 50% ice cover to and from the Moscow University Ice Shelf and Totten Glacial survey areas. Observations for seismic operations took place in the open water region of the Moscow University Ice Shelf. Members of the science party and the two dedicated MMOs conducted visual observations (2 hourly watches) for icebreaking operations during day and night. Crabeater, Weddell and Leopard seals were sighted hauled out and on the sea ice and only a small number of animals (6%) entered the water upon passing of the vessel. A total of 225 sightings for icebreaking operations have been recorded thus far on the Elog database. The two dedicated MMOs, Andrea and Tasha, successfully conducted visual observations for seismic operations over two 16 hour, daylight periods (4 hourly watches) in the open water region of the Moscow University Ice Shelf. No take has been recorded thus far for seismic operations.

Biological Work (L Armand)

This report encompasses the traverse from the Mertz Glacier across to the Totten region and into the Totten Polynya off the Moscow University Ice Shelf. A total of 9 sampling events were completed during the last week, which includes six inline water stations, two CTD stations and one Kasten core. CTD water samples were taken for isoprenoid, Cell DNA isolation and microscopy for both CTD's (002 and 004), however due to the lack of additional appropriate sampling filters no Cell DNA water samples were taken from CTD 004. Kasten core diatom smear slide analysis was under taken on KC09 (length 2.05m). A report of diatom observations and photographs of voucher specimens at five individual levels was produced and posted.

In summary, this has been an excellent week of work, facilitated by calm weather and strong support from our ASC and ECO shipmates. We are fortunate to be working in a completely new area of the Antarctic margin!

We appreciate the strong collaborative effort by all on board,

Amy Leventer

NBP1402 Weekly Report #3 February 16 – February 22, 2014

Our third week of work has been dedicated to working in the Moscow University Ice Shelf polynya. Work includes a combination of continued reconnaissance of this previously un-mapped and unsampled region and detailed work in areas of specific interest as guided by accumulated data. Accomplishments so far include: additional development of a swath bathymetric map of the sea floor and a 3.5 kHz record of the sub-surface stratigraphy, with a focus on eastern and southern regions, nearer to the Dalton Ice Tongue and ice shelf front respectively, collection of another ~70 nm of Multichannel seismic data, collection of a suite of dredges, and kasten and jumbo piston cores, a single yoyo camera deployment, collection of physical oceanographic measurements including uCTD and rosette CTD data, shipboard and lowered ADCP data, deployment of the second of the two US temporary moorings and one US long-term mooring, and deployment of two of the three Australian long-term moorings.

As during week #2, we keep an eye toward the west, watching the satellite imagery to evaluate access to the Totten Glacier. Cloudy skies have limited the clear imagery that could help us pick a route west. With two weeks of science time remaining, we will continue to work the Moscow University Ice Shelf polynya and hope for a break. Daily weather forecasting information provided by the TAS AntForecasters, Jane Golding and Michelle Hollister, has proven to be invaluable in operational planning, especially as we experience late season storms, with sustained winds > 50 knots.

On a very positive note, we are grateful that our multibeam crash problems seem to have been solved by the replacement of the second BSP board.

Marine Geology and Geophysics (E Domack, S Gulick, A Leventer, A Shevenell, A Post)

Multichannel seismics:
During week 3 we acquired an additional, nominally 16-hour seismic survey in the Moscow University Ice Shelf area. This survey was ~65 nm in length and included Line 8 which was a strike line in front of the primary morainal bank imaged on Line 7, Line 9 which cross obliquely back to south of this moraine, Line 10 which cross the morainal bank in the dip direction and attempted to reach the next moraine to the northeast, Line 11 that was shot westerly when Line 10 had to be cut short due to ice, Line 12 which was shot southeasterly intended to serve a strike line on the crest of the northern moraine, and Line 13 that was shot southwesterly down the slope towards the topographic low area where basement is close to the surface. The southern moraine and its immediately adjacent sedimentary products were well imaged including the megascale lineations superimposed on large morainal banks. We continue to observe regional erosional surfaces at the base of the moraine and these surfaces coming close to the seafloor on the slope flank between the southern and northern moraines. These allow for reflective packages within the sub-moraine sedimentary strata, which dip seaward, to be accessed within a few meters in places of the seafloor. These sites were targeted for first dredging and later coring to establish the age of these older units.

Operationally, the use of lock tite on the screws and no-tox in the air chambers during setup were very successful. No issues during this survey occurred due to blast phone attachment or gun problems due to freezing. In addition to putting no-tox in the guns before hanging them on the bundles, we also took turns shooting with each of the three guns once in the water before acquiring the survey using guns 1 and 2. On the turns we would temporarily fire gun 3 instead of gun 2 just to keep the hot spare ice-free and in good working order should it be needed. The hard plastic, round tail buoy float also proved a success as it you slip around or under bergy bits or growlers without catching and putting stress on the streamer.

Marine geology:
After evaluating the remarkable seismic stratigraphy provided by the UTIG team, we conducted a set of three dredges across areas of outcropping strata at the seafloor. These dredges recovered the usual assortment of ice rafted crystalline rocks but also an abundance of partly weathered mudstone, diatomite, and diamictite lithologies -- in sufficient abundance and character to confirm our interpretation of seafloor outcrop of sedimentary units. We then configured the

ship's Jumbo Piston Core with a single 3 m barrel and special cutter nose and deployed the core at four selected locations along our dredge and seismic reflection sections. We recovered semi-lithified diatom bearing siltstones of fresh character along with a cemented poorly sorted sandstone. The material recovered is more than adequate to provide biostratigraphic information on age, if appropriate microfossils are present. We plan to continue this mode of operation to acquire stratigraphic samples at other key seafloor "outcroppings"in our study area.

The morphology of the seafloor continues to reveal a wide variety of unusual bedforms of both erosional and depositional character, some of which have never been reported from the Antarctic continental shelf. These include:
1) unusual grounding zone wedges which stack in broad sweeping sets, which for lack of a better term we refer to as "feather moraines"
2) parabolic dune forms, and
3) parallel 2-Dimensional mega waves.

In the coming days we plan to further investigate these seafloor features with bottom camera surveys and short strategic gravity cores.

Finally, with regard to coring, we successfully recovered our first long JPC, at a site initially identified on our first approach into the Moscow University Ice Shelf polynya. Reprocessing of the Knudsen chirp data suggested the possibility of 12-15 meters of acoustically transparent sediment in a small (450m x 200 m) North-South oriented basin. The Marine Geophysics and Geology groups used the chirp data to pinpoint kasten and jumbo piston coring targets. Upon arrival, we deployed and recovered a 3-meter kasten core, which we had rigged to encounter a slightly opaque reflector at the seafloor. During deployment, the DAS winch screen froze several different times, including during entry into the sediment. Operations were shifted from the DAS screen to the LCI90; however, there appeared to be an offset between the two screens.

The initial kasten core (KC-27A) did not recover the sediment water interface, but revealed beautifully laminated diatomaceous oozes and muds throughout the 2.95 m recovered, similar to sequences observed on the Antarctic Peninsula (e.g. Palmer Deep) and along the East Antarctic Margin (e.g. Adelie Drift, Iceberg Alley, and the Mac.Robertson Shelf). A second kasten core was rigged with less weight, deployed, and recovered. The sediment water interface was intact and KC-27B recovered 2.71 m of diatom oozes and muds. Comparison of key diatom beds and MS profiles between the two cores indicate 35 cm was lost at the top of KC-27A. Cores were sampled using a standard sampling scheme. In addition to standard sampling, we sampled for DNA, which will enable us to develop a molecular probe to understand past fluctuations in warm circumpolar deep water. Fresh sedimentary material and strict sampling protocols are required for this type of study, which is not possible using archived material. We also sampled individual diatom layers. Shipboard visual inspection of sediments indicates the presence of carbonate microfossils throughout the upper 3 m of sediment.

We repositioned the ship over the thickest sedimentary sequence in the basin (13-15 m as estimated from the chirp data) and rigged for a 5-barrel jumbo piston core. While rigging, we deployed a rosette CTD, which suggested the presence of relatively warm mCDW in the basin. The rCTD was followed by an extremely successful JPC deployment, during which 13 m of sediment was recovered. The shipboard MS profile suggests an expanded deglacial to Holocene sedimentary sequence was recovered.

Bottom photography:
We have achieved one more successful yoyo transect, at a depth of 895 m within the major trough in the western part of the study area. The transect coincided with one of the short-term oceanographic moorings and a kasten core site. Abundant marine snow was observed in the water column, with extensive diatom drifts on the seafloor. The fauna was dominated by brittle stars, with sea urchins and polychaete tubes also common. The seafloor was heavily burrowed, possibly by crustaceans that were occasionally observed at the head of the burrows. Diversity and biomass were relatively low throughout, with the occasional occurrence of sessile epifauna

such as bryozoans, sponges and anemones. These were most often associated with dropstones.

Links to Aerogeophysical data (J Greenbaum)

Over 2800 line kilometers of simultaneous dual-instrument underway gravity data have been recorded in the Sabrina Coast area (in addition to the 4,300 km acquired in transit). After two weeks of exploration, these data cover an area approximately 100 km by 130 km, offering an additional geophysical complement to the multibeam. A preliminary analysis of the free air and bouguer anomalies provide some insight into the bedrock to sediment transition that has been noted in initial analysis of the multibeam data. A noticeable negative bouguer anomaly is apparent near the Dalton rise where seismic data were acquired. A comparison of the two gravimeters reveal similar features, providing confidence in the dual-instrument setup but interesting differences are apparent that warrant further inspection.

Physical Oceanography (A Orsi and B Huber)

Activity during week three was brisk in spite of challenging weather and rapidly evolving ice conditions. Four moorings were deployed, with rosette CTD/LADCP casts at each site, plus with casts at 3 additional stations. Underway CTD (uCTD) casts were made at selected sites and as opportunities allowed. The combination of uCTD, rosette / CTD / LADCP and underway acoustic Doppler current profiler (ADCP) is proving to be a potent tool for developing a broad view of the circulation in the western Totten embayment, while also allowing resolution of some potentially key areas of inflow of modified circumpolar deep water (mCDW) into the southern reaches of the embayment. A short uCTD and CTD/LADCP line along the Moscow University Ice shelf front shows a water column devoid of significant mCDW, unlike stations occupied to the north that present well developed bottom layers of mCDW of varying thickness and temperature. One mooring was deployed just north of the ice shelf to examine the possible seasonal nature of the along-shelf flow and any potential flow into or emanating from the sub-ice shelf cavity.

The ship-mounted ADCP runs continuously, and from that data an overview of the circulation is slowly emerging. ADCP data are somewhat compromised by heavy ice and bad weather but the frequent collection of data along the closely spaced multibeam and seismic survey tracks will allow us to formulate reasonable average views of the flow patterns that prevailed during our cruise.

Australian Moorings (M Rosenberg)

The first two of the trio of Australian moorings were successfully deployed. The first was sited on the eastern flank of the partially mapped depression/trough feature, to measure proposed inflow of slope waters to the multiple glacier system. The second was placed further “upstream”, around the region of high sedimentation at the northeast end of the work area. Each mooring includes a bottom mounted upward looking ADCP, and a string of thermosalinographs (SBE37’s). A gyroscope package, deployed along with each mooring attached separately to the anchor base, was successfully recovered at each site. Data from the gyroscope gives the landing orientation of the bottom mounted ADCP – this orientation is required for reliable measurement of current direction so close to the south magnetic pole. Intended recovery of the moorings is from the *Aurora Australis* in the 2014/15 season.

Both Australian mooring deployments were anchor first, and operations for these moorings, as for the US moorings, were smooth and trouble free due to the solid and professional work of the deck MT’s, winch/A-frame operators on the main deck/O1 deck/aft control, and ship handlers on the bridge.

Biological Work (L Armand)

Eight transit water samples from the intake water line (Transit stations 20 to 26A) were filtered for the isoprenoid study and diatom community composition. All but two stations have full microscopic analysis completed and voucher specimens photographed.

Six CTD water samples were collected for isoprenoid and microscopy from three depths equivalent to the surface, chlorophyll maximum and deepest intervals sampled (CTDs 005 to 010). No Cell DNA water samples were taken from these CTDs due to lack of appropriate filters. Full microscopic analysis was completed from CTD 005 and voucher specimens have been photographed.

Kasten core diatom smear slide analysis was under taken on KC027A (length 2.71m). A report of diatom observations and photographs of general views (x10) from 22 visual diatom bloom layers has been produced and posted. The results of the smear slide analysis suggest that mat forming layers are principally formed by the species *Thalassiothrix antarctica*, and only one layer represented a bloom of other genera (*Corethron pennatum* and *Rhizosolenia* sp.). Samples for smear slide analysis for an additional three KC cores have been taken but are yet to be observed and reported on (KC14, 20 and 27B). Smear slide analysis of two semi-lithified clasts have also been undertaken to ascertain the age of dredged and Jumbo piston-cored sediments.

Marine Mammal Observations (A Walters and T Snow)

Marine mammal observations (MMO) took place for icebreaking and seismic operations during the third week aboard the Palmer. Observations for icebreaking occurred over 5 days (Monday-Friday) as we searched for open water regions along the Sabrina Coast survey area. Observations for seismic operations took place in open water in the northeast corner of the survey area on Sunday, 23rd February. Members of the science party and the two dedicated MMOs conducted visual observations (2 hourly watches) for icebreaking operations during day and night. During icebreaking operations, both crabeater and Weddell seals were sighted. Nearly all animals, apart from a single crabeater seal (5% of total take), remained hauled out and on the sea ice upon passing of the vessel. Visual observations for seismic operations were successfully conducted (by the two dedicated MMOs, Andrea and Tasha) during a 16-hour, day light period. The first take for seismic operations was recorded during this time, with five crabeater seals encountered on passing ice floes within the take (full mitigation) zone. Four of the five seals entered the water upon passing of the vessel (80% of total take). No source mitigation action (shutdown) was required during seismic operations. To date, 227 sightings have been recorded for icebreaking operations, including whales (unidentified), crabeater, Weddell and leopard seals, and 2 sightings (crabeater seals) have been recorded for seismic operations.

We've had a great week science, making use of our first storm to multibeam the southern part of our field area, and taking advantage of the redistribution of sea ice by the winds to access some previously inaccessible regions. A heartfelt thanks to our ASC and ECO shipmates, without whom we could not accomplish our scientific goals.

Amy Leventer

NBP1402 Weekly Report #4 February 22 – March 7, 2014

During our last ~2 weeks of work, we have continued our interdisciplinary focus on the Moscow University Ice Shelf polynya, trying to decipher the short and long term history of this very complex part of the Antarctic margin. Our survey region has expanded, with a dedicated effort (1) to define oceanic circulation patterns, pathways, and processes, (2) to link modern oceanography to the sediment record, (3) to utilize strategic coring to understand depositional processes and histories of features observed via surface swath and sub-surface mapping, (4) to understand controls on the flow of sub-glacial meltwater, and (5) to map out the geologic evolution of the Sabrina Coast, as imaged via Multichannel seismic data acquisition.

The ice fronting the Totten Glacier withdrew sufficiently to warrant a third attempt to gain access to the glacier front, if only for a brief period. However, we have learned that ice conditions change rapidly with changes in intensity and direction of the wind. Unfortunately, on route, increasingly difficult ice conditions prevented our westward progress and we returned to the polynya.

Marine Geology and Geophysics (E Domack, A Shevenell, C Lavoie, S Gulick, A Leventer)

1. During this time we completed multibeam mapping of the juncture of crystalline bedrock with the sedimentary strata of the continental shelf. This mapping was done in order to resolve the nature of bedrock channels which appear to serve as subglacial meltwater conduits during times of expanded ice sheet cover. The channel networks are complex, reflect structural character of the crystalline rocks (i.e. joints, faults, and contrasts in rock type), and range in depth from hundreds to over a thousand meters. It is important to establish the geometry of these features in order to understand how subglacial melt water sculpted and was/is conveyed towards the margin, as offshore features give evidence for periodic outbursts of flowing water of a considerable magnitude. We feel we have sufficiently characterized this seafloor terrain with an extended multibeam survey, despite continual problems with the Kongsberg EM120 multibeam system.

In the sedimentary terrain, we continued to work with the UTIG group to help define the geologic evolution of the margin, which is quite remarkable from other Antarctic margins. The diversity of seismically imaged deposystems and association with a multitude of new types of seafloor morphologies has had us continually discussing various interpretations while the data stream evolves. It is quite exciting science—challenging, but exciting. One of the clearest things we have observed is that the margin has indeed preserved a continuum including: non-glacial, partly glaciated, to fully glaciated depo- and erosional systems. We suspect that this is due to the rather pronounced subsidence history that this margin has experienced in combination with its juxtaposition at the seaward end of the Aurora subglacial basin. To this end we have continued our strategic selection of single barrel jumbo piston cores to acquire samples of strata that outcrop on the seafloor. Two such samples were acquired below and above a prominent fluvial deltaic complex that lies in the part of the section deposited just prior to any evidence of glacial processes. We also completed the multibeam mapping and added a pair of gravity cores on the top of two moraine complexes that resemble feathers on a bird wing (feather moraines); these cores were acquired in order to characterize the physical properties and till rheology, aspects that will help us to understand the depositional processes leading to the development of these rather unique features.

Our earlier discovery of “mega-dune” bed forms at 600 m water depth was followed up with a bottom camera survey and a Smith-McIntyre grab. We recovered well-sorted medium to coarse-grained sand, which appears to blanket the seafloor with a surficial scattering of ice rafted boulders (all heavily encrusted with epifaunal organisms). Subsequent short core efforts also revealed that the sand is interbedded with mud in the near subsurface. Hence, the “sand plains basin” appears to have a more complex history of sand deposition and dune formation than we had originally supposed. This type of seafloor appears to be even more extensive in other basins, those that were partly imaged and which lay farther seaward on the continental shelf.

We continue to work on correlations amongst our growing number of jumbo piston cores and kasten cores using physical properties and lithofacies descriptions. There appears to be a systematic succession of lithofacies related to alternating biogenic vs. fine grained siliciclastic deposition along with a rather “sand-rich” facies transition from glacigenic (till) deposits. We are confident, based on the number of foraminifers observed in Holocene sediments from the region that we will be able to date the deglacial transition within the inner shelf based upon the cores we have collected. However, relating the detailed chronology of the complex of “feather moraines” to a firm absolute time scale will be more challenging due to the multitude of surfaces—far too many for us to core in the time available.

Several larger and more typical morainal bank systems have also been mapped yet they similarly provide rather unique signatures including a spectacular bank collapse and slide block terrains wherein large portions of the grounding zone crest has detached and slid seaward by several kilometers producing a rubble field and glide block terrain in the downslope (seaward) direction. The causal mechanism(s) for this instability are being discussed.

2. We successfully completed two interdisciplinary water column to sediment sampling stations in the northeast region of the polynya. At these stations, we used a suite of sampling devices to characterize the physical oceanography, water column properties, and surface to deep sedimentation. Such studies will enable ecologic investigations, paleoceanographic proxy development, and will enable us to improve understanding of how and why sediment is deposited at each site. We were originally drawn to the locations for jumbo piston coring because the Knudsen 3.5 KHz data revealed 8 to 14 meters of sediment at each site. The geophysics team worked closely with the marine geology team to identify precise coring targets. At Station 27 (~540m), we collected two 3 m kasten cores (2.9 and 2.7 m) comprised of laminated diatomaceous ooze and mud; the second core recovered an intact sediment water interface. These deployments were followed by the deployment and recovery of a 13 m Jumbo Piston Core (JPC). Five days later, we returned to the same site and deployed a rosette CTD, two McLean pumps, and a Megacore. The rosette CTD was intended to characterize the physical oceanography of the region and revealed warm modified Circumpolar Deep Water at depth. ADCP data revealed a local recirculation feature associated with the local bottom topography. The McLean pumps were then deployed for three hours at 480 m (core of mCDW) and at 25 m (surface) to filter large volumes of mCDW and surface water at 0.2□m for DNA/RNA and geochemical analyses of viruses, archaea, and phytoplankton in the water column as well as those associated with each water mass. The deep pump achieved minimum flow and shut down after pumping ~50 L. The surface pump pumped 380 L before reaching minimum flow, and shutting down. Upon recovery, filters were removed and stored at -80°C. Upon completion of pumping, we deployed a megacore and recovered 11 tubes with 35cm of sediment in each tube. Megacores were subsampled for DNA, foraminifers (samples between 0 and 10 cm were stained with a Rose Bengal and 3.8% formalin solution for 36 hours), diatoms, sedimentology, radiocarbon, ^{210}Pb, and organic geochemistry. Several days later, we returned to the site for a third time and recovered a 5.0 m jumbo kasten core with an intact sediment water interface. This core enabled us to extend the DNA/RNA sampling downcore to 5 m; this type of sampling must be conducted immediately upon recovery and samples are immediately frozen and kept at -80°C. Because of the low temperatures required for preservation, sediment DNA/RNA analyses cannot be conducted on the JPCs that are stored at 4°C and opened upon arrival at Florida State.

At the second water column to sediment station, we collected an 8.76m jumbo piston core and a 2.5 m long kasten core that also revealed a sequence of laminated diatom oozes and muds and an intact sediment water interface. We then conducted a rosette CTD and discovered the warmest water at depth in the polynya (~450m). We also deployed a megacore and recovered 12 tubes of sediment (37 cm each) with excellent sediment water interfaces; one tube included a small fish. The megacores were subsampled using the same approach as described above. Following the megacore deployment, the McLean pumps were deployed for 3 hours at depths of 450m and 25m to collect particulate matter associated with the mCDW and surface waters, respectively. The deep pump pumped 380 L before reaching minimum flow rate and shutting down. The surface pump pumped 180 L before reaching minimum flow and shutting down. Filters were removed and stored at -80°C for future analyses.

3. We acquired an additional 266 nm of seismic reflection data. All of these lines used the new operational protocols in terms of minimizing the times the guns were on deck in the cold temperatures, use of no-tox in advance of deployment, and firing gun 3 a few times on the turns. Additionally the adjustments on the mount for the blast phone on gun 2 proved stable. These changes were so successful that we had no failures of guns 1 or 2 for the all of these profiles. All of these profiles continued to be acquired with a 5 s shot rate, sampling interval of 0.5 ms, and record length of 2.5 s.

Lines 14 through 18 were acquired to image the more eastern area closer to the Dalton Ice Tongue. Lines 14 and 15 crossed from the older sedimentary section across the deeper embayment that leads to the western glacial trough and onto outcropping basement. Line 16 was shot from shallower water southwest towards the deeper area. A brief loss of communication with the geode resulted in a loss of a few shots and duplicate shot point numbering requiring ~2/3 of the profile to be named 16a. Line 17 was a longer line across sedimentary older sedimentary sequence and the region of shallow eroded features that may be dune-like features before turning back west across a moraine lying closer to the ice tongue. A surprising result was a clearly imaged delta complex on this profile within the dipping older strata. This last line was Line 18 which was acquired first west and then southeast and thus during processing was broken in 18 and 18a. All of these lines showed a significantly more eroded seafloor with little till and virtually absent Holocene strata in this eastern area.

Lines 19-25 were acquired to first cross our existing profiles within the older strata and then turn north to cross one of the large moraines including an area of intriguing topography originally thought to be crenulations and then continue northwards into an area of newly opened ice well north on the shelf. Line 19 was westerly followed by Line 20, which was southeasterly to link to Line 21 that was the long northern line. The unusual topography turned out to include evidence of slump scars consisting of till where slump blocks, also consisting of till, were observed in the bathymetry to the west of the line. Alone Line 21 we continued to observe the deeper dipping strata getting progressively younger as we proceeded northwards. Within the upper younger strata there were 2-3 erosional surfaces that were clearly both glacial in orogen and dipping northwards along with the underlying older strata; these glacial surfaces were distinctly different in scale, facies, and dip from the overlying regional unconformity and moraines and till that make up the seafloor related features. Within the northern part of the shelf more difficult ice cover resulted in Lines 22-25 being shot eastward then looped back southwestward and then crossed back west. Both Lines 22 and 25 cross an ~2 km wide glacial trough the tended northwards towards the shelf edge.

During Julian Day 57, four hours of daylight were available for seismic operations during which Line 26 was acquired to cross previous lines in a westerly direction but farther north than previous crossing lines had been acquired. This line was acquired to cross over one of the delta features in the subsurface and end by crossing a potential buried glacial moraine observed on Line 21. The next morning seismic operations resumed with the acquisition of Lines 27 to the northeast crossing Line 21 a little farther south within the region of slump blocks and then turning northwest along Line 28 crossing Line 21 within a region where the till was thinner. While acquiring this line, a new ice image was transmitted to the ship that showed the region to the west of all our previous profiles was ice-free. Thus Line 29 was acquired southward keeping about 1 nm from the ice edge and this line reached to the entrance to the deeper western glacial trough. Line 29 showed three clear back-stepping moraines, the southernmost one of these was the edge of a “feather moraine”. When ice was too thick to proceed farther south, Line 30 was acquired back east across the thickest till adjacent to the deeper contact with basement within which numerous glacial surfaces were observed.

The final seismic survey was undertaken during our transit out of the polynya and included Lines 31-35. At the start of Line 31 we had two marine mammal shutdowns, both for less than 7 minutes. The first was due to a seal on an ice floe and the second due a seal in the water, but neither were in the water within the 100 m radius when the guns were operating. Line 31 crossed 18a and Line 21 heading northwest to provide an additional tie line and then due to ice was forced to turn northwards on Line 32. We then turned east on Line 33 when a ship-wide power outage occurred. The repairs and safety checks on the power outage resulted in missing the critical data to cross Line 21 at the northernmost moraine on that line. Therefore we chose to circle back west during marine mammal observations and re-drive to the east on Line 33a. Once we crossed Line 21 and unable to proceed farther east due to ice from the Dalton Ice Tongue, we turned northwards on Line 34. This line showed parallel reflectors within the moraine and the underlying dipping reflectors continuing to young towards the shelf edge. We chose for our last line, Line 35, to drive northwest and were able to continue until the edge of the moraine associated with the Dalton system.

Sea bottom photography (A Post)

We have completed a further 8 seafloor camera transects, over a range of environments and depths from within the polynya region. These provide us with the first information about the habitats and seafloor communities on this Antarctic shelf. Regions of highest benthic biomass and diversity are associated with harder substrates. Dropstones provide a haven for dense and varied benthic assemblages, in the midst of what are otherwise often relatively depauperate surrounds. Areas of basement outcrop are also densely inhabited, dominated by various species of sponge and bryozoans. We used the camera transects to investigate the morphological features revealed by the multibeam and chirp data. We did 2 transects across what appear to be relict dune features, a transect along a drumlin at the contact between basement and the sedimentary basin and a transect up the face of a moraine. Further analysis of these transects will be done to determine modern vs relict sedimentary processes, and to investigate the imprint of the glacial morphology on the nature of the benthic communities.

Links to Aerogeophysical data (J Greenbaum)

Over the past week the NBP doubled the total line kilometers of scalar magnetics data acquired by the project in the Sabrina Coast area. These new data were collected during seismic operations using the NBP's towed system. Although the data require final processing the preliminary results indicate notable changes in magnetic intensity where the continued underway gravimetry dataset reveal column-averaged density variations, as well. Acquiring magnetics data in ice-choked areas like this is difficult because the sensor uses a 300m-long cable to maintain adequate distance from the electromagnetic noise of the vessel. Despite this, the 610 km of scalar magnetics data acquired in the survey area at least partially samples most of the region. In total, 5,230 km of dual-instrument gravimetry data were collected over the Sabrina Coast continental shelf. The compiled Free Air Disturbance and Bouguer Anomaly data reveal a notable density variation in the bedrock along the Dalton Ice Shelf, low-density material near the Dalton Rise, and interesting high-density regions in between. Notably, the UTIG and CMG Ops-provided GT2M gravimeter has produced exceptional data with less than 1 mgal crossover error and 765m spatial resolution after just preliminary processing. The southern extent of the NBP's coverage connects to existing ICECAP airborne geophysical data that used the same gravimeter and magnetics sensors over what the NBP's multibeam system reveals to be exposed bedrock along the calving front of the Dalton Ice Shelf.

Physical Oceanography (A Orsi, B Huber, M Rosenberg)

With time for data collection drawing to a close, the past 13 days have been dedicated to deploying the remaining two year long moorings, recovering one short term mooring and attempting recovery of the second; refining our emerging view of the complicated circulation of the polynya region, and integrating our findings with the other science groups.

Temporary mooring M1 was recovered and yielded full records for all deployed instruments. A clear tidal signal is evident, and so too is an event that we have tentatively identified as a strike by a passing ice berg. Mooring M2 stubbornly remained covered by ice. Three visits were made to the site when the available imagery indicated at least a chance that we might be able to recover the mooring. Unfortunately, recovery was impossible, so M2 has been reluctantly left in place to be recovered next year by the R.V. I.B. *Aurora Australis*.

Two year-long moorings were deployed – the CSIRO mooring T3 (ADCP with SBE Microcat recorders) and a sediment trap mooring deployed in conjunction with E. Domack and A. Leventer of the MGG group.

The initial idea for the last Australian mooring was for an outer shelf deployment, with the hope of targeting both a bathymetric trough feature, and outflow water. Given the uncertainty of finding either of these within the accessible area north of the ice, the plan was changed and the mooring was instead deployed inside the polynya on an assumed inflow path between the two previously deployed Australian moorings, and at the confluence of isobaths running from the northwest and from the north. Additional weight was given to this chosen location after interesting findings from underway CTD work the previous day.

The deployment was anchor first, smooth and trouble free, and the separate gyroscope package was successfully recovered after 2 hours on the bottom. This final deployment completed the Australian mooring program for the cruise, and in each case good alignment data were obtained from the recovered gyroscope package, thus giving the landing orientation of the bottom mounted ADCP at each location. Mooring recoveries a year from now are keenly anticipated.

Three conical single collector traps on the sediment trap mooring are complemented by a CTD with transmissometer, an SBE microcat to record temperature, pressure and salinity, and an SBE39 temperature-pressure recorder. Changing sea state and ice conditions dictated that we deploy the moorings anchor first. This required an on the fly redesign of the sediment trap mooring, and a new, smaller anchor provided by the ASC marine technicians and ECO deck crew. Many thanks to them for providing an essential element on such short notice! As usual, the deployments went smoothly thanks to skillful support from the ASC and ECO staff.

Since the last weekly report we collected about one fourth (28%) of the total number of CTD profiles (131) from the new underway system installed on the Palmer for this cruise. A series of four short synoptic transects revealed much detail of the currents structure and water mass stratification along the path of the Antarctic Coastal Current. Rapid cross-current CTD sections were able to effectively capture the strong nature of this southward-flowing boundary current, all the way from its entrance to the continental shelf off Sabrina Coast near the shelf break, to its westward turn near the eastern end of the Moscow Ice Shelf. As many as 15 consecutive stationary CTD profiles were accomplished within 11 hours on 3 March, and only 4 hours were needed to finish 8 casts on 7 March. Thus, the unique advantages of this system allows us to resolve a wealth of physical oceanographic features with unprecedented detail, when purposely-designed sampling strategies like those used during the last three days of this cruise (28 CTD casts) are applied.

Our final five rosette CTD/LADCP casts allowed us to provide water samples for calibration of the CTD as well as samples for diatoms, virus sampling, oxygen isotopes, and alkalinity with dissolved inorganic carbon (for E Shadwick, ACECRC [Antarctic Climate and Ecosystems Cooperative Research Centre]) We also took the opportunity to attach the three underway CTD probes to the rosette on several occasions for intercalibration. Water samples for calibration of the CTD salinity and oxygen were collected and analyzed on board. The work load for collecting and analyzing the samples was handled by two groups: Mark Rosenberg, Jamin Greenbaum and Natalie Zielinski managed the salinity samples, and Bruce Huber and David Gwyther managed sampling and titrating on 147 samples, to measure oxygen concentration in water collected by the CTD. For most members of both teams, the sampling and analyses were new experiences, and we thank Amy Westman the ASC MLT for her patience and support in helping us with the analytical equipment. Thanks too to Chris Landon (RSMAS) for his prompt replies to queries about the automated Winkler titration system.

Working so close to the magnetic pole causes problems with the magnetometers used in current meters to determine the instrument headings. A prototype intertial measurement package was deployed on four the CTD/ADCP casts to test the feasibility of the method for correcting the ADCP compasses in compensation for the weak horizontal component of the Earth's magnetic field in the region. We had been granted some extra internet bandwidth in support of this testing to allow the transfer of the rather large data files to Lamont-Doherty, where they could be analyzed by A. Thurnherr, the system designer. We are very pleased to report that the preliminary assessment is positive. A separate report will be forthcoming to describe the method and the test results.

The ship ADCP system performed well throughout the cruise. We have found that the highest quality data were obtained during the seismic lines. In examining the ADCP /seismic tracks, we have found evidence of small recirculation features, most notably near station 27 as noted in the section above describing the water column to sediment activities. While the broad features of the circulation in the basin can be guessed at from the distribution of water properties, the addition of repeated ADCP sections helps us identify what may be important small-scale circulation features often associated with changes in the bottom topography. The processed ADCP data available during the cruise is useful for planning and guidance, but substantial post-cruise processing of the data will be needed to eliminate artifacts and noise from ice breaking and wave/bubble interference.

Biological Work (L Armand)

An additional ten Transit water samples from the intake water line (Transit stations 26B to 37) were filtered for the isoprenoid study and to document the diatom community composition. Stations 36 and 37 were also sampled for DNA using STERIVEX filters made available from a study now completed (thanks to M. Breitbart/A.Shevenell). Due to poor weather and ice breaking activities microscopy was not possible on many occasions, therefore six surface water samples still require examination. 20µm sieve sampling of the intake water line will cease on exit to the Southern Ocean, although Lugol's preserved water sampling will continue.

An additional 13 CTD water samples were collected for isoprenoid and microscopy from three or four depths equivalent to the surface, deepest interval and region of highest subsurface maximum (CTDs 012 to 015).

Kasten core diatom smear slide analysis was under taken on KC027A (length 2.96m). A report of diatom observations and photographs of general views (x10) from 21 visual diatom bloom layers has been produced and posted. Samples for smear slide analysis for an additional three KC cores have been taken but are yet to be studied (KC42, 53 and 57).

Two megacore sampling events allowed for the sampling of the overlying water (seafloor water) to be sampled (MC 45 and 61). Bulk overlying water from four mega cores was collected on each occasion and 4L was filtered (i.e. 2 x 2L on two types of GF/F filters) for isoprenoid analysis. An additional 200mL of the bulk overlying water was preserved with acid Lugols for future microscopic analysis. A third sample of overlying water from a single Megacore (MC61 tube 5) was filtered for isoprenoid analysis (2 x350mL) and microscopy (100mL + lugols), to aid as a comparison to the bulk sample from the same event. Finally, sediment samples for collaborative diatom analysis were collected from a single Megacore at both events (MC45 tube 10 and MC61 tube 6).

Sample collection from the underway intake water line will continue on the return transit journey to Hobart, however microscopic analysis will be completed on the remaining previously collected 20µm sieved samples and then cease. All other microscopy will be performed in the home laboratory on the acid Lugol's collected water samples.

Marine Mammal Observations (A Walters and T Snow)

Marine mammal observations (MMO) took place for seismic operations during the fourth and final week aboard the Palmer. Operations occurred over three consecutive days (5, 6 and 7th March) in the open water region of the Moscow University Ice Shelf survey area. Both cetacean and pinniped species (minke whales, n=2 and crabeater seals, n=2) were sighted and recorded as take during operations on the 5th March, while only pinnipeds were recorded as take during operations on the 6th (crabeater seals, n=7) and 7th March (crabeater seals, n=1, Weddell seals, n=2 and unidentified seals, n=1). Nearly all seals, apart from a single Weddell seal (14% of total pinniped take) were hauled out and on the sea ice upon passing of the vessel. Source mitigation action (shutdown and avoidance manoeuvres) was required during seismic operations on the last day (7th March), with Weddell seals encountered on a passing ice floe (n=1) and in the water (n=1) within close proximity of the vessel and airguns. The seals remained in the 100 metre exclusion zone for less than 1 minute each time, with both animals observed exiting the exclusion zone. Overall, a total of 240 take were recorded for icebreaking operations, including whales (unidentified and minke whales), crabeater, Weddell and leopard seals, and a total of 15 take (including minke whales, crabeater, Weddell and unidentified seals) and 2 shutdowns were recorded for seismic operations.

With appreciation for the opportunity we've had to explore the Sabrina Coast, and with thanks to all involved in NBP1402 – scientific party, ASC support staff led by MPC Eric Hutt, and ECO crew members led by Captain Sebastian Paoni. The success of this project is a reflection of the hard work, long hours, and positive spirit of our team.

All the best from 60°south,

Amy Leventer