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The Expedition of the Research Vessel "Maria S. Merian" to the Labrador Sea in 2009 (MSM12/2)

Edited by
Gabriele Uenzelmann-Neben
with contributions of the participants

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* Anschrift / Address
Alfred-Wegener-Institut
Für Polar- und Meeresforschung
D-27570 Bremerhaven
Germany
www.awi.de

Editor in charge:
Dr. Horst Bornemann

Assistant editor:
Birgit Chiaventone

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Cruise Report
RV MARIA S. MERIAN Cruise MSM12-2

Reykjavik - Reykjavik
17. June – 13. July 2009
Chief Scientist: Gabriele Uenzelmann-Neben
Captain: Karl Friedhelm von Staa

Gabriele Uenzelmann-Neben
Alfred-Wegener- Institut für Polar- und Meeresforschung
Am Alten Hafen 26
D-27558 Bremerhaven

Tel.: +49 471 48311208
Fax: +49 471 48311271
e-mail: Gabriele.Uenzelmann-Neben@awi.de

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1. Zusammenfassung / Summary

Der Fahrtabschnitt MSM 12/2 vom 17.6. bis 13.7.2009 mit FS Maria S. Merian bestand aus reflexionsseismischen und geologischen Untersuchungen der Eirik Drift, einer Sedimentstruktur südlich Grönlands. Die Eirik Drift dokumentiert seit dem Miozän die Sedimentation vor Südwest-Grönland und bildet so ein Archiv für die Ablagerungsprozesse in diesem Gebiet, die durch den Western Boundary Undercurrent (WBUC), die grönländische Eisbedeckung und den Eintrag aus der Labrador See/Davis Strait geprägt wurden. Eine detaillierte Erfassung und Analyse der Struktur und Zusammensetzung der Eirik Drift mittels seismischer und geologischer Methoden und ein Anschluß an bestehende ODP und IODP Bohrungen (ODP Leg 105 und IODP Expedition 303) wurde benötigt, um Informationen über die Entwicklung des WBUC und Dimension und Ausdehnung/Rückzug des grönländischen Eises zu erhalten. Das reflexionsseismische Programm während der Expedition MSM 12/2 wurde derart gestaltet, dass die Struktur der Eirik Drift bis zum Basement sowie laterale Relokationen der Hauptablagerungsgebiete erfasst wurden. Es wurden insgesamt ~2000 km an hochauflösenden reflexionsseismischen Daten registriert. Parallel zu den seismischen Profilarbeiten wurden bathymetrische und Parasound Messungen durchgeführt. Über die Parasound Registrierungen sind dann signifikante Lokationen für geologische Beprobungen ausgewählt worden, die die Verbindung mit den hochauflösenden seismischen Untersuchungen zu einer Kombination verschiedene Zeitskalen und somit eine entscheidenden schärfen Schärfung des Verständnisses für die Entwicklung des Klimas in dieser Region ermöglichen. An 12 Lokationen wurden geologische Proben genommen.
Ergänzt wurden die seismischen und geologischen Messungen durch 8 CTD Stationen und ADCP Messungen im Gebiet der Eirik Drift.

Cruise leg MSM 12/2 with RV Maria S. Merian, leaving Reykjavik on 17.6., returning to Reykjavik on 13.7.2009, comprised seismic reflection and geological studies of the Eirik Drift, a sedimentary structure south of Greenland. The Eirik Drift has been documenting the sedimentation near southeast Greenland since the Miocene by forming an archive for the depositional processes in this region, which have been shaped by the Western Boundary Undercurrent (WBUC), the Greenland ice sheet and the material input from the Labrador Sea/Davis Strait. A detailed study and analysis of both structure and composition of the Eirik Drift via seismic and geologic methods as well as a correlation with results from ODP and IODP sites (ODP Leg 105 and IODP Expedition 303) was needed to lead to information on the development of the WBUC as well as the dimensions and expansion/retreat of the Greenland ice sheet. Seismic profiles were gathered, which capture the structure of the sediment drift down to basement and lateral relocations of the main depot centres. In total ~2000 km of high resolution seismic reflection data were recorded. Bathymetric and Parasound data were recorded parallel to the seismic profiling. Parasound data were used to pick significant locations for geological sampling. The incorporation of high resolution seismic reflection investigations with geologic sampling results in the combination of

different timescales and much clearer understanding of the evolution of the climate southwest of Greenland. Geological sampling was carried out at 12 locations.
To complement the seismic and geological studies CTD measurements at 8 locations and ADCP measurements across the whole Eirik Drift were carried out.

2. Objectives

During this leg both the palaeo as well as the recent sedimentation processes and oceanographic conditions in the area of the Eirik Drift were studied. Proxies determined at recent and sub-recent samples will enable a better interpretation of IODP data and hence lead to a better reconstruction of the long-term development of sedimentation processes, the glacial history, and oceanographic conditions during the Neogene and Quaternary. We have aimed to solve the following questions:

1) What is the detailed structure of the Eirik Drift? Can we distinguish between contouritic and turbiditic deposition? Do the turbiditic deposits lead to information on the extension (frequency and dimension) of the Greenland ice shield? To answer those questions we needed to gather seismic data across the entire Eirik Drift from the shallower parts into the deep sea. The profiles further had to cover the locations of ODP and IODP sites.
2) Can we reconstruct the development of the Western Boundary Undercurrent (WBUC) in this region? Have modifications in the current system been documented in the sediment transport? In what way did those oceanographic modifications affect the sedimentary sequences? Why did the build-up of the Eirik Drift start with a delay of about 1.1 my relative to the oceanographic modifications (i.e. 4.5 Ma)?
3) Can we identify analogies to the build-up and the creation of sediment drifts on the southern hemisphere? Do chronological matches exist between the Eirik Drift and Drift 7 at the Antarctic Peninsula or the Agulhas Drift in the Transkei Basin? Can we identify global climatic and oceanographic events in those drift systems?
4) Can we detect short-term variations of oceanic currents (NADW), sea-ice extent, surface water productivity, and terrigenous input within the upper 15 m of the sedimentary column (Milankovich and sub-Milankovic cycles)? How do those parameters correlate with instabilities of the Greenland ice shield?

The project comprised geophysical and marin-geological operations in the area of the Eirik Drift (Fig. 2.1). Streamer, airguns, gravity corer, giant box corer, as well as PARASOUND and multi-beam systems were used. Seismic reflection profiles were gathered in order to study the sedimentary distribution in relation to the tectonic and oceanographic evolution (black lines in Fig. 2.1). Those profiles cover the whole Eirik Drift with the transition into the deep sea. Furthermore, the profiles cover the locations of ODP Leg 105 Site 646 and IODP Expedition 303 Sites 1305, 1306, and 1307.

The marin-geological programme concentrated on sampling the near-surface sediments (0-15 m) using giant box corer and gravity corer. Undisturbed sediments not affected by e.g. turbidity currents were sampled. Sample locations were picked based on PARASOUND recordings, which were gathered parallel to the seismic profiling. This saved on ship time. The cores were opened already during the cruise, described and sampled.

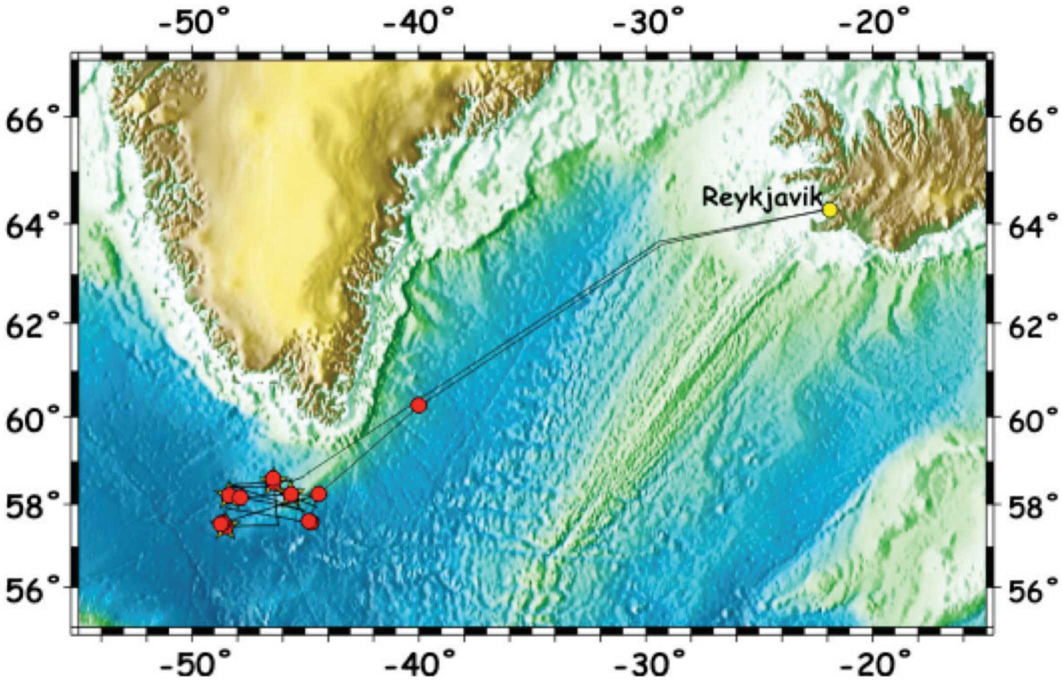


Fig. 2.1: Ship track of RV MARIA S. MERIAN cruise MSM12-2 in the Labrador Sea with locations of seismic profiles (black lines) and geological sampling (red dots) marked.

Fig. 2.2: The scientific party of RV MARIA S. MERIAN cruise MSM12-2 (**Photo Reinhard Müller).**

3. Cruise Itinerary

(G. Uenzelmann-Neben)

date	approx. board time (UTC)	programme and event	weather
17.6.	8:00-22:00	participants go on-board RV Maria S Merian; Loading of containers and streamer winch; unpacking and installation of equipment; safety instructions	fine
18.6.	9:00 departure from Reykjavik	continued installation of equipment; safety procedure	fine; increasing winds
19.6.	13:00-19:30	continued installation of equipment; test of streamer and airguns	rain; medium winds
20.6.		approach to working area	stormy conditions, high swell
21.6	16:00	Multibeam and PARASOUND – start of profiling	stormy conditions; high swell
22.6.	6:08-7:26 8:15 10:13	CTD/rosette sampler; deployment of streamer and airguns; start profile AWI-20090001	medium winds and swell
23.6.		continued seismic profiling	medium winds and swell
24.6.		continued seismic profiling	medium winds and swell
25.6.	10:49 14:32-16:47	end of profile; retrieval of streamer and airguns; CDT/rosette sampler	increasing winds; high swell
26.6.	16:39-	Gravity corer and giant box corer	strong winds and swell
27.6.	-4:14 5:43 7:14	Gravity corer and giant box corer; Deployment of streamer and airguns; start of profile AWI-20090005	decreasing winds; high swell
28.6.		continued seismic profiling	light air; low swell
29.6.	13:35 17:39-19:56 20:14-23:33	end of profile; retrieval of streamer and airguns; CTD/rosette sampler; Gravity corer and giant box corer	fine; low swell

30.6.	1:50-10:29 11:49 13:49	Gravity corer and giant box corer; deployment of streamer and airguns; start of profile AWI-20090007	increasing winds and swell
01.7.		continued seismic profiling	strong winds and swell
02.7.	1:37 5:38-7:19 8:04-12:03 14:50-16:22 16:31-	end of profile; retrieval of streamer and airguns; CTD/rosette sampler; Gravity corer and giant box corer; CTD/rosette sampler; Giant box corer and gravity corer	fine; low swell
03.7.	-1:01 6:09 8:09	Giant box corer and gravity corer; deployment of streamer and airguns; start profile AWI-20090010	fine; low swell
04.7.		continued seismic profiling	fine; low swell
05.7.		continued seismic profiling	medium winds and swell
06.7.	10:41 14:30-16:51 16:57-23:55	end of profile; retrieval of streamer and airguns; CD/rosette sampler; Gravity corer and giant box corer	medium winds and swell
07.7.	7:23-8:54 9:10-10:20	CTD/rosette sampler; Gravity corer and giant box corer	storm; very high swell (10 m)
08.7.		no activity due to extremely bad weather	storm; very high swell (10 m)
09.7.	8:01-10:33 12:15-14:08 14:45-20:12	Gravity corer and giant box corer; CTD/rosette sampler; Multibeam calibration survey; end of scientific programme	medium winds and swell
10.7.		de-installation and packing of equipment; transit to Reykjavik	medium winds and swell
11.7.	16:00	end of multibeam and PARASOUND profiling	medium winds and swell
12.7.	9:00	Pilot on board; enter Reykjavik;	fine; low winds

	-18:00	Packing of equipment	
13.7	9:00 13:00	Unloading of containers and streamer winch; departure of participants	fine; low winds

4. Geological Background

(G. Uenzelmann-Neben, R. Stein)

4.1 Tectonic development since the break-up of Gondwana

During the late Cretaceous (anomaly 27, 63 Ma) rifting commenced in the southern Labrador Sea between the Precambrian blocks of Greenland and the Canadian Labrador and Baffin Islands. Rifting progressed into the northern Labrador Sea during the Paleocene and ceased in the Davis Strait and Baffin Bay in Eocene times (anomaly 20, 45 Ma, Chalmers and Pulvertaft, 2001). Baffin Bay and the Labrador Sea are connected via the Davis Strait. Here, a shallow sill prevents an exchange of deep water masses between the two ocean basins (Srivastava and Arthur, 1989). It is not clear whether Davis Strait ever was deep enough for an exchange of deep water masses.

According to the few studies published, the structure of the Greenland continental margin is extremely variable. Chian and Louden (1992) see no evidence for seismic high velocity zones in the deeper crust of the southern and central Labrador Sea and hence no indications for underplated magmatic layers or intrusions. In contrast to this, seismic studies by Gohl et al. (1991) and Gohl and Smithson (1993) show an up to 8 km thick lower crust farther north, which exhibits extremely high velocities of 7.5-7.8 km/s. This high velocity zone maybe related to the hot spot magmatism postulated for Davis Strait, which is also inferred to have created the volcanic of Davis Strait and Baffin Bay and which is considered to have migrated eastwards towards Iceland (White and McKenzie, 1989).

4.2 Sedimentation and current systems

The circulation of deep water masses in the Labrador Sea interacts closely with the North Atlantic and important global climatic and palaeoceanographic events (Fig 4.1).
ODP Leg 105 Site 646 has been drilled down to a depth of 766 mbsf on the western flank of the Eirik Drift in order to study this (Srivastava et al., 1987; Srivastava et al., 1989). 3 further sites were drilled as part of IODP Expedition 303 (Sites U1305, U1306, and U1307; Expedition 303 Scientists, 2006a; Expedition 303 Scientists, 2006b; Expedition 303 Scientists, 2006c; Expedition 303 Scientists, 2006d). From middle Eocene to late Miocene the basement troughs were filled with sediments. The base of the above lying unit is charactised by a double-reflector R3/R4. This reflector was dated as late Miocene (7.5 Ma) and marks a change in sedimentation rates (Srivastava et al., 1987). This has been attributed to erosion by currents. A modification of the bottom current regime 5.6 Ma led to the formation of reflector R2 (Arthur et al., 1989). Apart from this no current controlled sedimentation could be identified for the late Miocene-early Pliocene.

Strong modifications of the current system occurred at 4.5 Ma (early/middle Pliocene) leading to the formation of a sediment drift. It has been unclear where the nucleus of the drift lies and whether the drift has been continuously built up from e.g. North to South or East to West. These points comprise important hints with respect to direction and intensity of the generating current and a possible recirculation via the Labrador Sea.

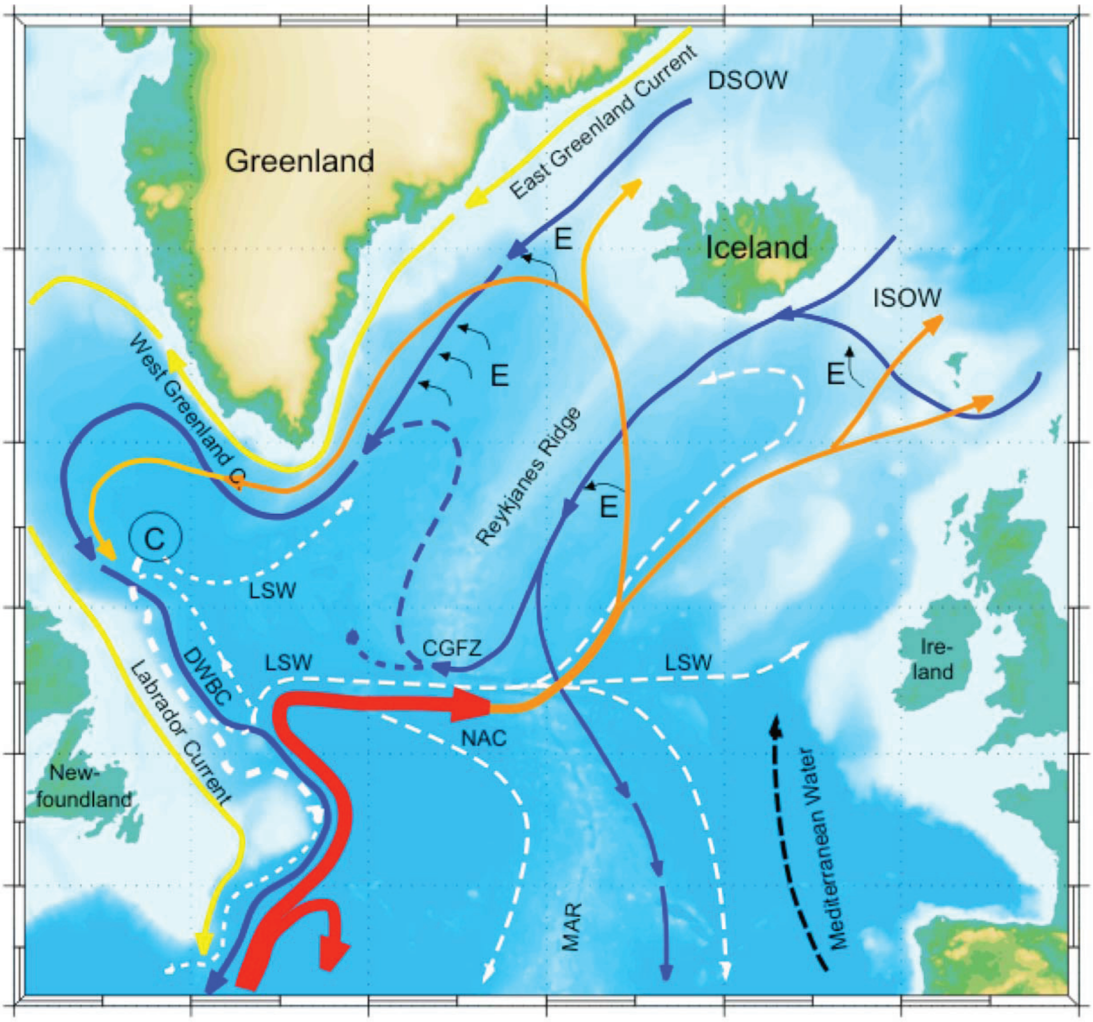


Fig. 4.1: Current system in the North Atlantic, schematic.

4.3 Short-term variation of sea-ice cover, productivity and bottom water circulation

The study of surface samples of ODP Leg 105 Site 646 (0-20m) has shown that the sediments clearly reflect glacial-interglacial cycles in stable oxygen isotope values and the contents of organic matter and dinoflagellates, which is a result of the variability in sea-ice cover and surface water productivity (Aksu et al., 1989; Aksu and Hillaire-Marcel, 1989; Stein, 1991; Stein and Stax, 1991). The low chronological resolution unfortunately did not allow any interpretation with respect to short-term variability of the palaeoenvironment as is being discussed presently (e.g. 1500-year cycles) (Bond et al., 2001). Detailled studies of the grain size distribution (especially the silt fraction) have shown that grain sizes represent strong proxies for the reconstruction of the velocity of the bottom current (Bianchi and McCave, 1999).

4.4 ODP Leg 105 Site 646 and IODP Expedition 303 Sites U1305, U1306, and U1307

Site 646 of ODP Leg 105 and IODP Expedition 303 Sites U1305, U1306, and U1307 have been drilled on the Eirik Drift. This way lithological and geochemical information could be gathered for the sedimentary column down to 766 mbsf (Site 646). The oldest sediments sampled were found to be of late Miocene (8.4 Ma) age (Shipboard Scientific Party, 1987; Shipboard Scientific Party, 2005).

Reflectors R2 and R3/R4 could be drilled at Site 646 in a depth of 520 mbsf and 680 mbsf, resp. Lithological-geochemical parameters show significant changes in temperature, bottom water characteristics and intensity of the deep circulation for these depths (Shipboard Scientific Party, 1987). IODP Expedition 303 Sites U1305, U1306, and U1307 also form a rich archive with respect to environmental changes during instabilities of the ice sheets, to the history of surface and deep currents as well as the Western Boundary Current WBUC, which contributes to the North Atlantic Deep Water NADW (Expedition 303 Scientists, 2006a; Shipboard Scientific Party, 2005)

Down-hole logs exist for ODP Leg 105 Site 646 and IODP Expedition Site 1305 sites. A sonic log is only available for Site 646, but density, porosity and NGR logs have been gathered for both sites. Physical properties were measured for all cores. This way, the seismic data can be correlated with the geological information. Age-depth models via biostratigraphic, magnetostratigraphic and oxygen isotope data further allow a chronological order of the seismic horizons.

5. Scientific Programmes - Preliminary Results

5.1 Seismic reflection profiling

(G. Uenzelmann-Neben, E. Weigelt, T. Eggers, B. Baasch, R. Freibothe, M. Kordanska, B. Liss, A. Obermann)

5.1.1 Methods

The application of seismic methods was the primary operational objective of MSM 12/2 in order to obtain information on the sedimentary distribution in the area of the Eirik Drift. We used a standard multi-channel seismic reflection technique to image the outline and reflectivity characteristics of the sedimentary layers and the structure of the sub-sedimentary basement and lower crust by recording the returning near-vertical wave field. Figure 5.1 illustrates the principles of this technique.

5.1.2 Seismic equipment

5.1.2.1 Seismic sources, triggering and timing

We used a cluster of 4 GI-guns to resolve the sedimentary layers. A single GI-Gun™ is made of two independent airguns within the same body. The first airgun (“Generator”) produces the primary pulse, while the second airgun (“Injector”) is used to control the oscillation of the bubble produced by the “Generator”. We used the “Generator” with a volume of 0.72 litres (45 in^3) and fired the “Injector” (1.68 litres = 105 in^3) with a delay of 33 ms. This leads to an almost bubble-free signal. The guns were towed 30 m behind the vessel in 2 m depth and fired every 10 s (~25 m shot interval).

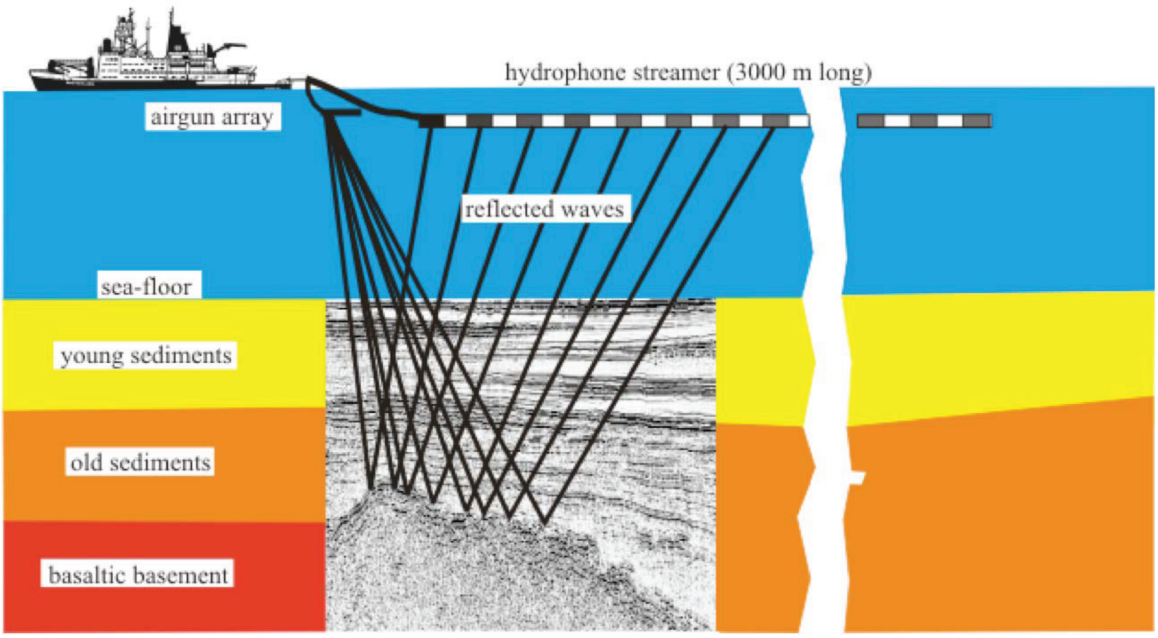


Fig. 5.1: Principle of marine seismic reflection surveying.

Seismic data acquisition requires a very precise timing system, because seismic sources and recordings systems must by synchronised. A combined electric trigger-clock system was in operation in order (1) to provide the firing signal for the electric airgun valves, and (2) to provide the time-control of the seismic data recording. Due to the variable time difference in

the NMEA format of the ship-provided clock and the DVS system, a separate Meinberg GPS clock was used with an antenna mounted on the upper deck. The clock provides UTC date and time (minute and second) pulses.
In accordance with the *Guidelines to Environmental Impact assessment of Seismic Activities in Greenland Waters* provided with the research permit, an observer constantly visually monitored the area in a radius of 500 m around the vessel for possible marine mammal appearance before and during seismic profiling. The seismic operations were interrupted when marine mammals were sighted (see Appendix 6). Airguns were fired with gradually increasing working pressure (ramping up) at the beginning of a profile and after shot interruptions.

5.1.2.2 Multi-channel reflection recording system

For multi-channel reflection data acquisition, a complete digital seismic streamer and recording system was used. The system consists of a large capacity, fully integrated, high resolution marine seismic data acquisition system (SERCEL SEAL™) which is composed of both onboard and in-sea equipment (Fig. 5.2). The streamer is a 240-channel hydrophone array which is coupled to the onboard recorder via a fibre-optic tow leader and a deck lead. The data collected by the hydrophone array is firstly converted from an analogue signal to digital via an A/D converter and then converted to a 24-bit complement format at 0.25 ms sample rate by a DSP. The data is routed to a Line Acquisition Unit Marine (LAUM) at this point, one of these being located every five Acquisition Line Sections or 750 m. The LAUM decimates, filters and compresses the data before routing them through the tow leader and deck lead to the on-board equipment.

The coupling of the streamer with the Control Module (CMXL) is made via the Deck Cable Crossing Unit (DCXU) which also acts as a LAUM for the first 60 channels of the streamer. The CMXL decompresses, demultiplexes and then performs IEEE 32-bit conversion to the data. The data are collected via a network switch and converted to SEGD by the PRM, the PRM being a processor software module used for formatting data to and from the cartridge drives, the plotters and Seapro QC™.

All system parameters can be set through the Human Computer Interface (HCI) which displays the systems activity such as print parameters, log files, high resolution graphic display and test results.

Cable depth keeping was monitored on Digicourse™ software, and adjustment to depths was made with Digibirds™, Model 5010. The Digicourse™ software gives a continuously updated graphical display of depths and wing angles via the Digibirds™ which are situated at 300 m intervals along the streamer.

Fig. 5.2: SERCEL SEAL™ digital multichannel seismic system and the recordings units.

Acquisition Line Section Spec.	
Length	150 m
Channels	12
Phones/group	16
Group length	12.5 m
Sensitivity	20 V/Bar open ended
Capacity	256 µf

Table 5.1: Specification of SEAL system.

The data were recorded with the following parameters (also Appendix 7):

Profile Name	*Active Length*	*Lead-in*	*Record Length*	*Sample Rate*
AWI-20090001	3000 m	191 m	9 s	1 ms
AWI-20090002	3000 m	191 m	9 s	1 ms
AWI-20090003	3000 m	191 m	9 s	1 ms
AWI-20090004	3000 m	191 m	9 s	1 ms
AWI-20090005	3000 m	191 m	9 s	1 ms

AWI-20090006	3000 m	191 m	9 s	1 ms
AWI-20090007	3000 m	191 m	9 s	1 ms
AWI-20090008	3000 m	191 m	9 s	1 ms
AWI-20090009	3000 m	191 m	9 s	1 ms
AWI-20090010	3000 m	191 m	9 s	1 ms
AWI-20090011	3000 m	191 m	9 s	1 ms
AWI-20090012	3000 m	191 m	9 s	1 ms
AWI-20090013	3000 m	191 m	9 s	1 ms
AWI-20090014	2250 m	191 m	9 s	1 ms

Table 5.2: Brief description of seismic recording parameters.

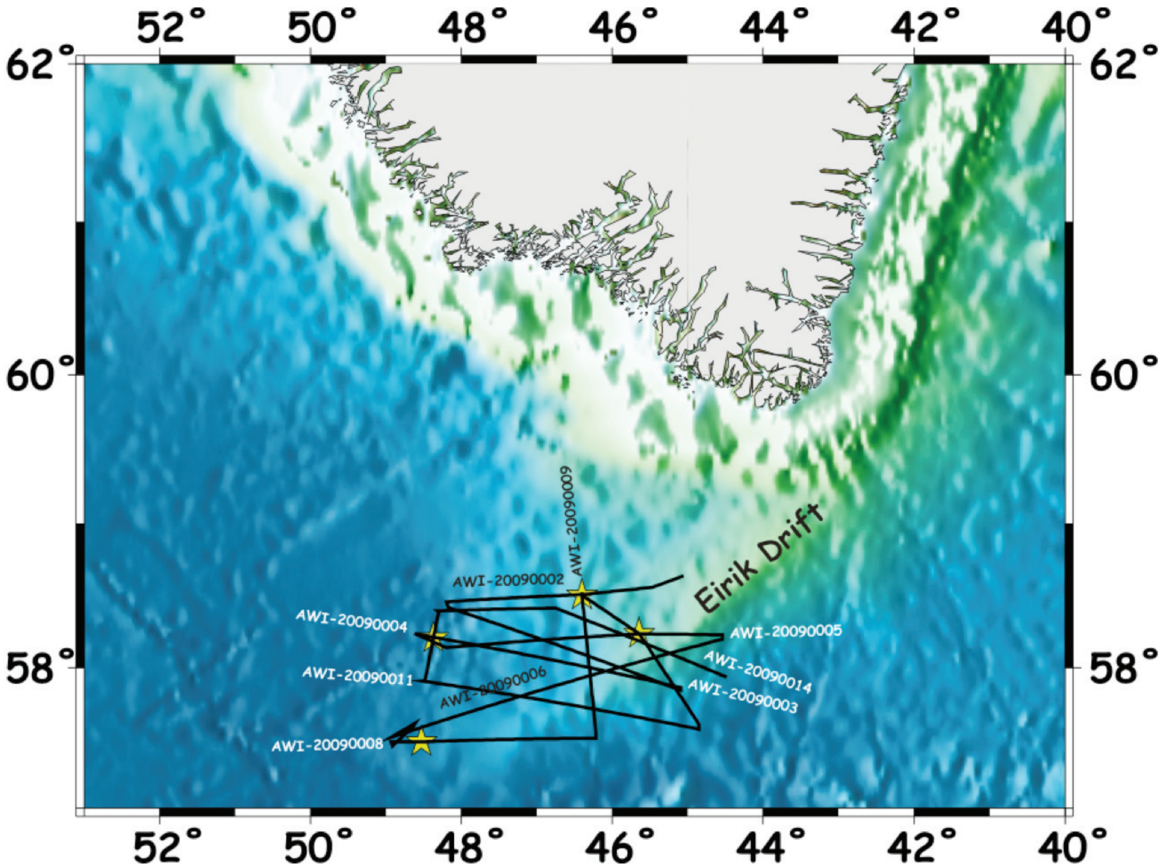


Fig. 5.3: Bathymetric map of the Eirik Drift with locations of the seismic lines in black. Yellow stars show the locations of ODP Leg 105 Site 646 and IODP Expedition 303 Sites U1305, U1306, and U1307.

5.1.3 Preliminary Results

As detailed seismic processing is time-consuming and could not be carried out on board, only a first, preliminary interpretation could be performed on board during the cruise.

The seismic profiles cover the whole area of the Eirik Drift into the adjacent deep sea (Fig. 5.3). The drift itself can be easily recognized in its topographic elevation (Fig. 5.4). It comprises a sedimentary column of up to 2 s TWT (~2 km). The drift is underlain by oceanic basement with several basement highs. Those basement highs are up to 10 km in width and rise 750-1000 ms above the surrounding basement. In the southwestern area of investigation we observed one basement high, which pierced the seafloor (Fig. 5.5). It is assumed that these western basement highs form an elongated basement ridge. The sedimentary column is disturbed in the vicinity of these basement highs. Faults as well as chimneys or pipes indicating gas can be observed in the sedimentary column adjacent to the basement highs. Since the sedimentary layers up to the surface are disturbed (Fig. 5.5) we assume that the magmatic activity is young in age. A quick correlation with information from ODP Leg 105 Site 646 shows that at least the layers up to reflector R2 (late Miocene/early Pliocene, 5.6 Ma, (Shipboard Scientific Party, 1987; Srivastava and Arthur, 1989), in parts even Pliocene layers are affected by the magmatic activity. This is in contrast to the fact that spreading in the Labrador Sea has been identified to have ceased at 45 Ma (anomaly 20, Chalmers and Pulvertaft, 2001).

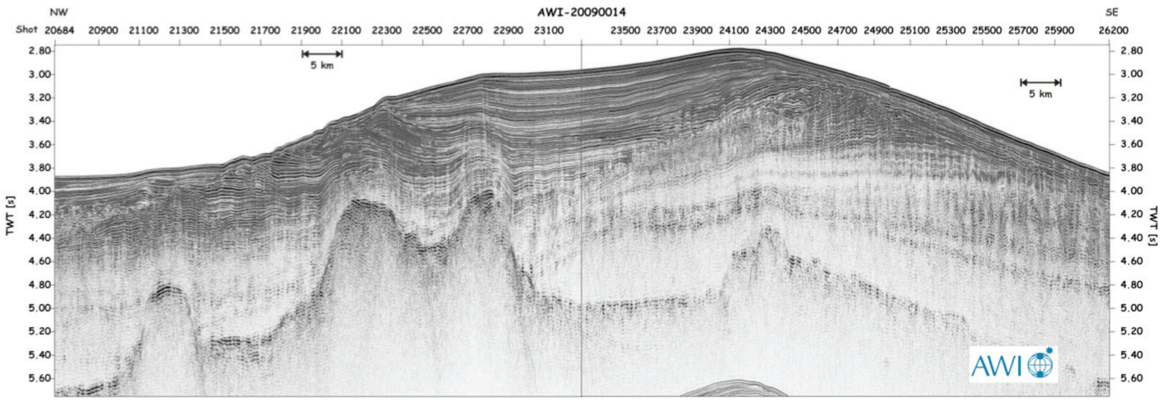


Fig. 5.4: Line AWI-20090014 showing the topography of the Eirik Drift.

Sedimentation appears to have started by filling the basement topography. This lower sedimentary sequence is up to 1 s TWT thick and is characterized by only few weak amplitude reflections. Reflectors R5 and R3/R4 can be identified (Srivastava and Arthur, 1989). On top of this nearly reflection free layer a well layered unit can be observed. Drift build-up appears to have begun with deposition of this unit. We can identify at least three drift bodies: a) one elongate drift body forming the topographic high in the east with the steep flank towards the west, b) a second elongate drift body deposited immediately west of drift body A, also with the steep flank towards the west, and c) an attached drift body on top of drift body B (Fig. 5.6). It appears that the eastern drift A was formed first followed by a shift in the generating current to west. Then, drift B was created. A phase of strong erosion followed, after which the attached drift was deposited on top of drift B. On a few seismic lines we can further distinguish a fourth drift body eastwards of drift A, which shows the steep flank in the east (Fig. 5.7). The current building up the Eirik Drift obviously took a path from the north southwards along the eastern flank of the drift and then was directed northwestwards following the topography of the drift. While its path was relatively stable in the east the formation of several drift bodies in the west points towards a relocation of the current's path there.

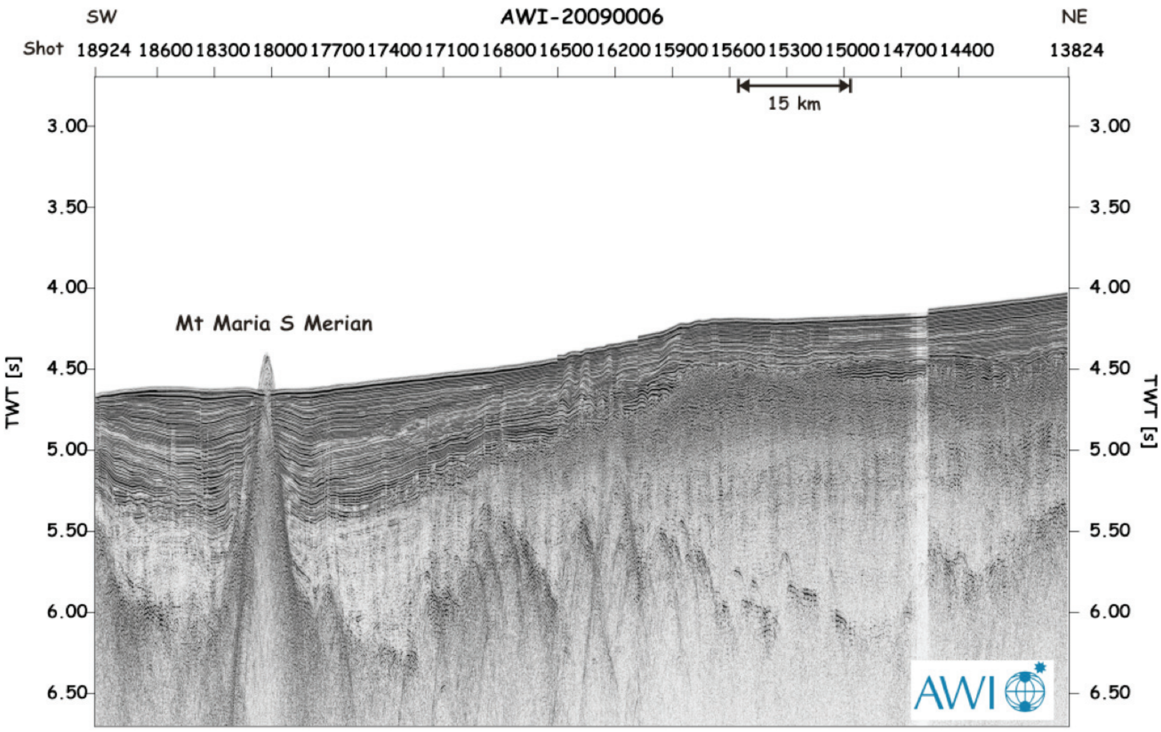


Fig. 5.5: Line AWI-20090006 showing the basement highs in the western part of the Eirik Drift and Mt Maria S Merian.

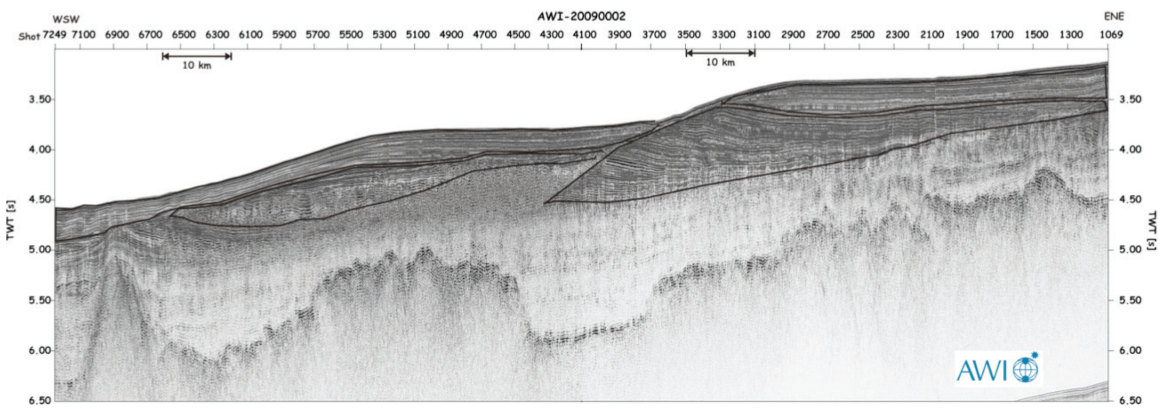


Fig. 5.6: Line AWI-20090002. Note the three different drift bodies forming the Eirik Drift.

5.2 Geology

(R. Stein, F. Niessen, D. Schmidt, D. Naafs, C. Peters, C. Saukel, R. Sommerfeldt)

As outlined in Chapter 4.3, the overall goals of the marine-geological research programme have concentrates on high-resolution studies of changes in palaeoclimate, palaeoceanic circulation, palaeoproductivity, and sea-ice distribution in the Eirik Drift/Labrador Sea area. During MARIA S. MERIAN Expedition MSM 12/2, we focussed our station work on areas of the western and eastern flanks as well as on top of Eirik Drift, including coring at the locations of ODP Site 646 and IODP sites U1305, U1306, and U1307 (Fig. 5.8). Coring positions were collected carefully using the hull-mounted PARASOUND profiling system (see Chapter 5.4 for details) to avoid areas of sediment redeposition (turbidites and slumps) and erosion. Shipboard analyses performed on the sediments and preliminary results are presented below.

5.2.1 Geological sampling and methods applied

In total, geological coring was carried out at 12 stations, using the Giant Box Corer (GKG) and the Gravity Corer (SL) (Table 5.3).

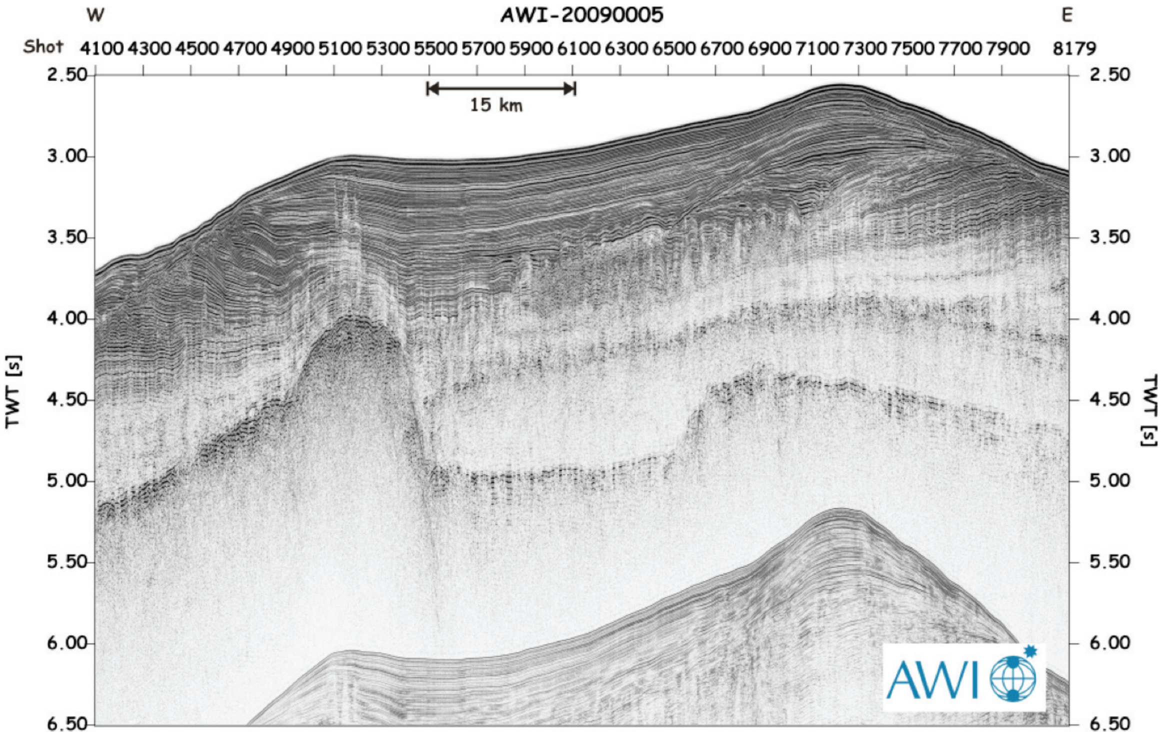


Fig. 5.7: Eastern part of line AWI-20090005.

5.2.1.1 Surface and near-surface sediments

Surface and near-surface sediment sampling was carried out by using a Giant Box Corer. The Giant Box Corer (weight of ca. 500 kg; volume of sample 50*50*60 cm; manufactured by Fa. Wuttke, Henstedt-Ulzburg, Germany) was successfully used 10 times at 10 stations. Twice there was no recovery due to technical problems. Recovery of the GKG cores ranges between ca. 25 and 50 cm. From the Box Corer surface sediments as well as three subcores for sedimentology (AWI), geochemistry (AWI), and foraminifers (Bristol University) and an archive box (AWI) were taken. The following samples were obtained from the surface sediments:

20x10 cm^2 (200 cm^3) Archive (AWI)
10x10 cm^2 (100 cm^3) Org. Geochemistry (AWI) (deep-frozen)
10x10 cm^2 (100 cm^3) Sedimentology (AWI)

10x10 cm^2 (100 cm^3) Foraminifers (Bristol University)
10x10 cm^2 (100 cm^3) Palynomorphs (GEOTOP, Canada)

Photographs of the surface and the sediment section from all GKGs were taken. Lithology was preliminary described visually for all box cores. Colour of surface sediments (0-1 cm) and subcores was described using the Munsell Soil Colour Chart (1954). Sediment slabs for X-radiography were taken as well.

In order to estimate the abundance of sediment components within the sand fraction, selected samples were wet-sieved with a mesh of 63 µm to separate the coarse fraction >63 µm. The coarse fraction was dried at 60°C. The composition of the coarse fraction was estimated using a binocular microscope (see Chapter 5.2.2 for some results).

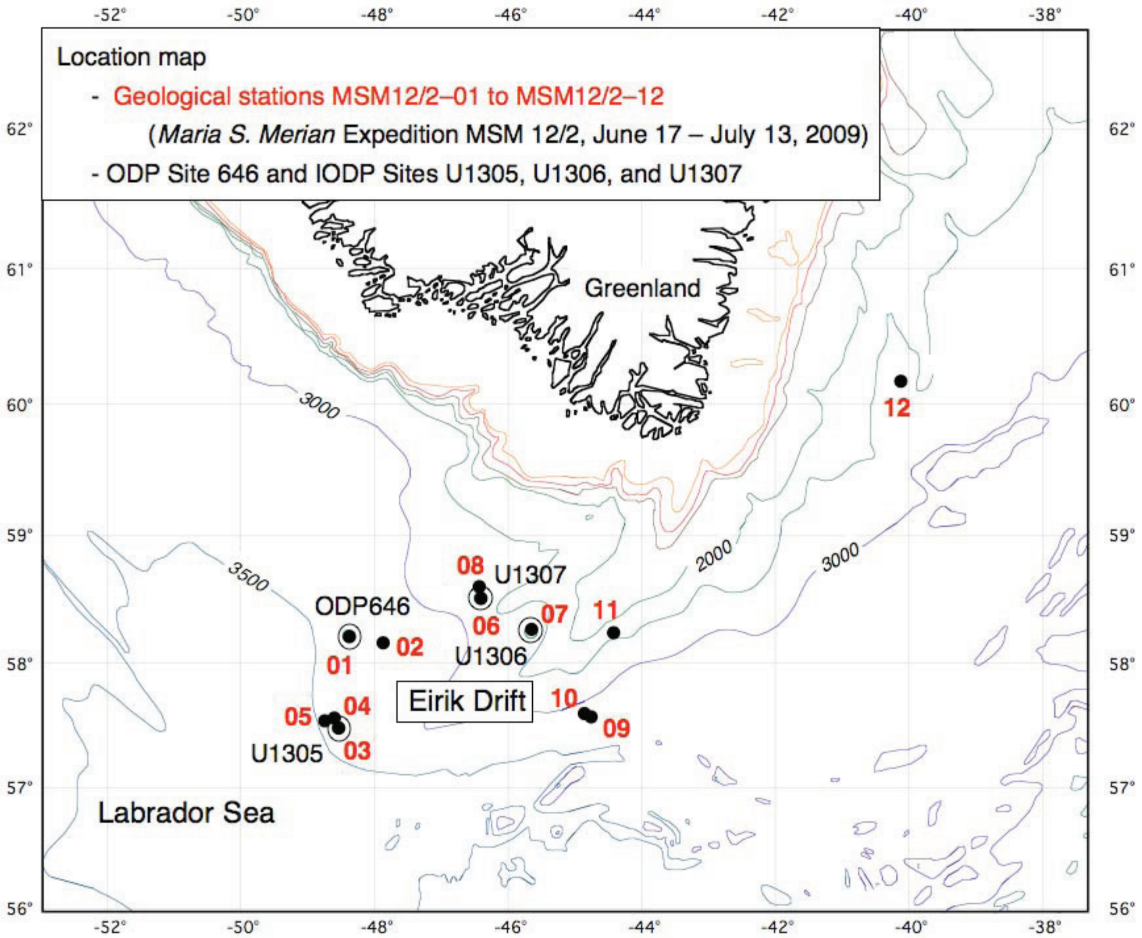


Fig. 5.8: Map showing the location of geological stations carried out during Expedition MSM12/2. In addition, locations of ODP Site 646 and IODP sites U1305, U1306, and U1307 are shown.

5.2.1.2 Long sediment cores

Long sediment cores were taken by the Gravity Corer. The Gravity Corer (GC or "Schwerelot", SL) has a penetration weight of 1.5 t. It was successfully used with variable barrel lengths of 10 or 15 m at all 12 stations. The recovery of the gravity corer varied between about 3 and 15 m (Table 5.3; Fig. 5.9).

All gravity cores were logged before they were opened using the Multi-Sensor Core Logger (MSCL) (see Chapter 5.2.2). After opening, photography were taken from both the archive and working halves. As for the GKG, sediment slabs (250x100x8mm) were taken from all opened cores for X-ray photography. That means, plastic slabs were slowly pushed into the scraped and smoothed sediment surface and carefully removed. These slabs were sealed in a plastic cover and stored for later X-radiography to be done at AWI.

From the archive halves, a visual core description was carried out. Colours were identified using the Munsell Soil Colour Chart (1954). A selected set of sediment cores was sampled for smear-slide analyses. Smear-slides were investigated under the light microscope. Smear-slides description was performed for rough evaluation of grain-size composition, preliminary determination of mineralogical composition (mainly quartz, feldspars, detrital carbonate, etc.) and content of biogenic components (foraminifers, coccoliths, diatoms, sponge spicules). On a few number of samples, a coarse-fraction analysis was carried out.

5.2.1.3 Multi-Sensor Core Logging

Whole-core physical properties provide initial core characterization with a very high vertical resolution. Physical properties can be used to define and interpret stratigraphical patterns, including a comparison with lithology and other properties such as data obtained from sediment color or XRF scanning. In combination with other data down-core pattern of physical properties provide a powerful tool for lateral core correlation. The latter is beyond the scope of this report and will be carried out after the cruise. Physical properties are also useful to link the cores to high-resolution echosounding profiles obtained by PARASOUND thereby aiding the projection of core data from a single spot into larger spatial and temporal scales.

Measurements in the ship laboratory included non-destructive, continuous determinations of wet bulk density (WBD), P-wave velocity (V_P) and magnetic susceptibility (MS) at 10 mm intervals on all cores obtained during the cruise. The Multi Sensor Core Logger (MSCL, GEOTEK Ltd., UK) was used to measure temperature, core diameter, P-wave travel time, gamma-ray attenuation and MS. The technical specifications of the MSCL system are summarized in Table 5.4. The principle of logging cores is described in more detail in the GEOTEK manual “Multi-Sensor Core Logging”, which can be downloaded from the web (http://www.geotek.co.uk). The orientation of the P-wave and gamma sensors was horizontal. Gravity cores (SL) were measured in coring liners including end caps. A data example is given for core MSM-12/2-01 (Fig. 5.10)

Geometry: In order to convert raw data to density, velocity and volume susceptibility the geometry of the cores must be determined. Whereas for the calculation of density and velocity the core diameter (SL) is directly measured at the position of the V_P transducers, volume susceptibility is calculated from the mean core diameter per meter core as measured between the liner caps (see MS below). The distance between the V_P transducers were calibrated using plastic cylinders of known geometry.

WBD was determined from attenuation of a gamma-ray beam transmitted from a radioactive source (^{137}Cs). A beam collimator of 5 mm was used and the beam was focused through the core-centre into a gamma detector. To calculate density from gamma counts, Geotek-MSCL software was used (www.geotek.co.uk), which applies a 2nd order polynomial function to describe the relationship between the natural logarithm of gamma counts per second and the product of density and thickness of the measured material. For calibration the three constants of the equation are determined empirically for each day by logging a standard core consisting of different proportions of aluminum and water as described in Best & Gunn (1999).

Station	Latitude	Longitude	WD (m)	Gear	Pen_SL	Rec_SL	Remarks
MSM12/2-01-01	58.21	-48.37	3450	SL-10	10	9.68	ODP Site 646
MSM12/2-01-02	58.21	-48.37	3451	GKG			ODP Site 646
MSM12/2-01-03	58.21	-48.37	3450	SL-10	10	9.34	ODP Site 646
MSM12/2-02-01	58.16	-47.87	3306	SL-10	10	9.81	
MSM12/2-02-02	58.16	-47.87	3307	GKG			
MSM12/2-03-01	57.48	-48.53		SL-10	10	9.88	U1305
MSM12/2-03-02	57.48	-48.53		GKG			U1305
MSM12/2-04-01	57.56	-48.60	3492	SL-10	10.2	9.96	Mt Merian
MSM12/2-04-02	57.56	-48.60		GKG			Mt Merian
MSM12/2-05-01	57.54	-48.74	3489	SL-15	15	14.94	High-resolution section Holocene
MSM12/2-05-02	57.54	-48.74		GKG			GKG nicht ausgelöst
MSM12/2-06-01	58.51	-46.40	2578	GKG			IODP U1307; GKG nicht ausgelöst
MSM12/2-06-02	58.51	-46.40	2579	SL-10	5	2.97	IODP U1307
MSM12/2-06-03	58.51	-46.40	2579	GKG			IODP U1307
MSM12/2-07-01	58.27	-45.64	2273	GKG			IODP U1306
MSM12/2-07-02	58.27	-45.64	2273	SL-10	10	9.53	IODP U1306
MSM12/2-08-01	58.60	-46.43	2563	GKG			High-resolution section (close to U1307)
MSM12/2-08-02	58.60	-46.43	2563	SL-15	15	14.16	High-resolution section (close to U1307)
MSM12/2-09-01	57.57	-44.75	3275	SL-15	15	14.53	High-resolution section
MSM12/2-09-02	57.57	-44.75	3275	GKG			
MSM12/2-10-01	57.60	-44.85	3193	GKG			
MSM12/2-10-02	57.60	-44.85	3192	SL-15	15	14.18	More condensed section
MSM12/2-11-01	58.24	-44.42	2384	SL-10	10	9.53	
MSM12/2-12-01	60.17	-40.12	2370	SL-15	14	12.75	
MSM12/2-12-02	60.17	-40.12	2370	GKG			

Table 5.3: Locations and gears of geological stations of Expedition MSM 12/2. Penetration and recovery values of gravity cores are listed as well.

V_P: The cores were stored in the laboratory for 24 hours prior to logging in order to let the sediments equilibrate with room temperature. Temperature was measured sporadically by a calibrated PT-100 sensor placed into the sediments near the end of each core section or otherwise in the laboratory. Temperatures ranged between 19 and 21°C. Whole-core P-wave velocities were calculated from the core diameter and travel time after subtraction of the P-wave travel time through the core liner wall (SL), transducer, electronic delay, and detection offset between the first arrival and second zero-crossing of the received waveform, where the travel time can be best detected. This travel-time offset was determined using a SL-liner filled with freshwater (V_p = 1481 m/s). P-wave velocities (V_P) were normalized to 20°C using the temperature logs.

$$V_P = V_{Pm} + 3 * (20 - tm) \qquad \text{(iii)}$$

where V_{Pm} = P-wave velocity at measured temperature; tm = measured temperature.

MS on whole cores was measured in terms of SI units, using Bartington MS-2 meter loop sensors (Table 5.5). The sensor has been calibrated by Bartington and data output is MS (10^{-5}). The meter was set to zero 100 mm before the core reached the MS sensor. After removing the last section of a core from the track, a zero-reading of the MS-2 meter was used to monitor sensor drift. The drift ranged between 0 and +/- 2, which is less than 1 % of the maximum MS measured in the cores. Therefore no drift correction was applied. In order to calculate volume-specific susceptibility data are corrected for loop-sensor and core diameter as follows:

P-wave velocity and core diameter Plate-transducer diameter: 4 cm Transmitter pulse frequency: 500 kHz Pulse repetition rate: 1 kHz Received pulse resolution: 50 ns Gate: 5000 Delay: 0 s
Density Gamma ray source: Cs-137 (1983) Activity: 356 MBq Energy: 0.662 MeV Collimator diameter: 5.0 mm Gamma detector: Gammasearch2, Model SD302D, Ser. Nr. 3043 , John Count Scientific Ltd., 10 s counting time
Magnetic susceptibility Loop sensor: BARTINGTON MS-2C Loop sensor diameter: 14 cm Point sensor: BARTINGTON MS-2F Alternating field frequency: 565 Hz, counting time 10 s, precision $0.1 * 10^{-5}$ (SI) Magnetic field intensity: ca. 80 A/m RMS Krel: 1.63 (SL, 12 cm core-ø), variable for KAL counting time 10 s

Table 5.4: Technical specifications of the GEOTEK MSCL14.

$$MS\ (10^{-6}\ SI) = \text{measured value}\ (10^{-5}\ SI) / K\text{-rel} * 10$$

K-rel is a sensor-specific correction calculated from the diameter of the core over the diameter of the loop sensor as outlined in the Geotek MSCL manual (www.geotec.co.uk). We have used the empirical relationship of relative response to varying core and loop diameters outlined in the MSCL-Manual (www.geotec.co.uk):

$$K\text{-rel} = 4.8566(d/D)^2 - 3.0163(d/D) + 0.6448$$

D is the diameter of the MS-2 meter core loop (140 mm) and d is the diameter of the core.

In addition, for a higher resolution, MS on split cores was measured using the MS-2 meter point sensor. Drift corrections were not applied. Sensor drifts per core were </= 1 and are thus negligible.

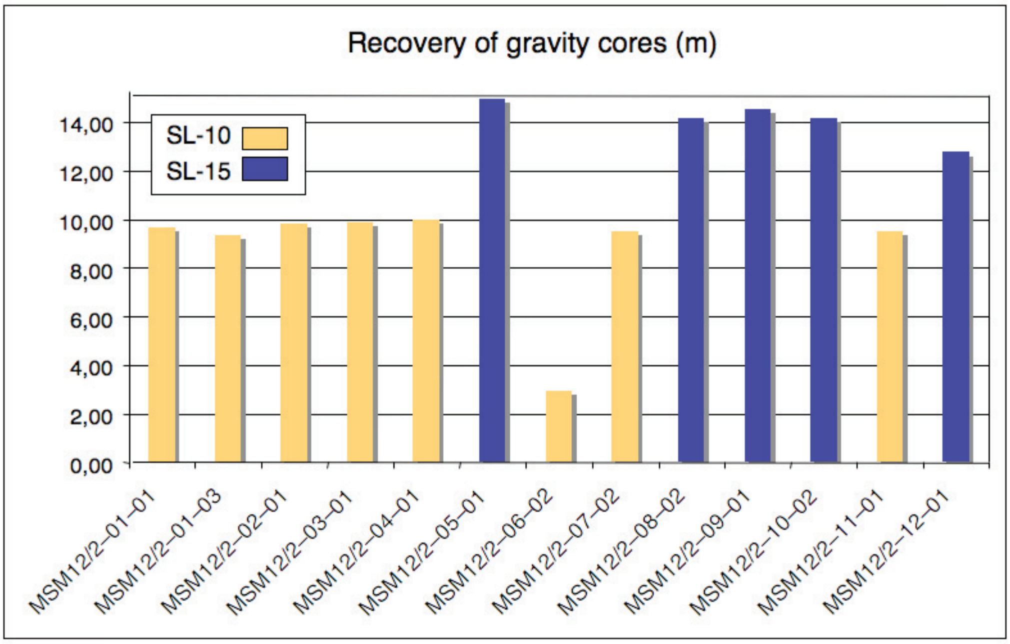


Fig. 5.9: Recovery of the gravity cores (in cm). For location of cores see Figure 5.8.

Core	1	2	3	4	5
MSM12/2-01-01	x	x	x	x	x
MSM12/2-01-03	x	x	x		
MSM12/2-02-01	x	x		x	
MSM12/2-03-01	x	x			
MSM12/2-04-01	x	x		x	
MSM12/2-05-01	x	x			
MSM12/2-06-02	x	x			
MSM12/2-07-02	x	x			
MSM12/2-08-02	x	x			
MSM12/2-09-01	x	x			
MSM12/2-10-02	x	x			
MSM12/2-11-01	x	x			
MSM12/2-12-01	x	x			

Table 5.5: Logging and processing status of cores from MSM-12/2. Logging and processing steps (1 to 5) are outlined in text.

Data acquisition and processing went through several steps:

1. MSCL Raw-data acquisition of whole cores using GEOTEK software.
2. First processing of whole-core data using GEOTEK software. This includes the calculation of core thickness, V_P, WBD and the removal of the liner caps from the depth scale. MS remained in raw-data state (10^{-5} SI).
3. Second processing of whole-core data using software Kaleidagraph. This includes a data quality control on calibration sections logged on top and below the bottom of the

core (20 cm liner filled with water) and a removal of these data from the core. It also includes data cleaning for effects caused by liner caps on V_P and WBD. In addition, MS is converted to volume MS using the average core thickness per core as "d" (see above), and the fractional porosity is calculated from WBD assuming constant grain density of 2.6 g cm^{-3} and constant pore-water density of 1.02 g cm^{-3}.

4. MS raw-data acquisition on split cores using GEOTEK software.
5. First processing of whole-core data using GEOTEK software. This includes the removal of the liner caps from the depth scale. MS remained in raw-data state (10^{-5} SI).

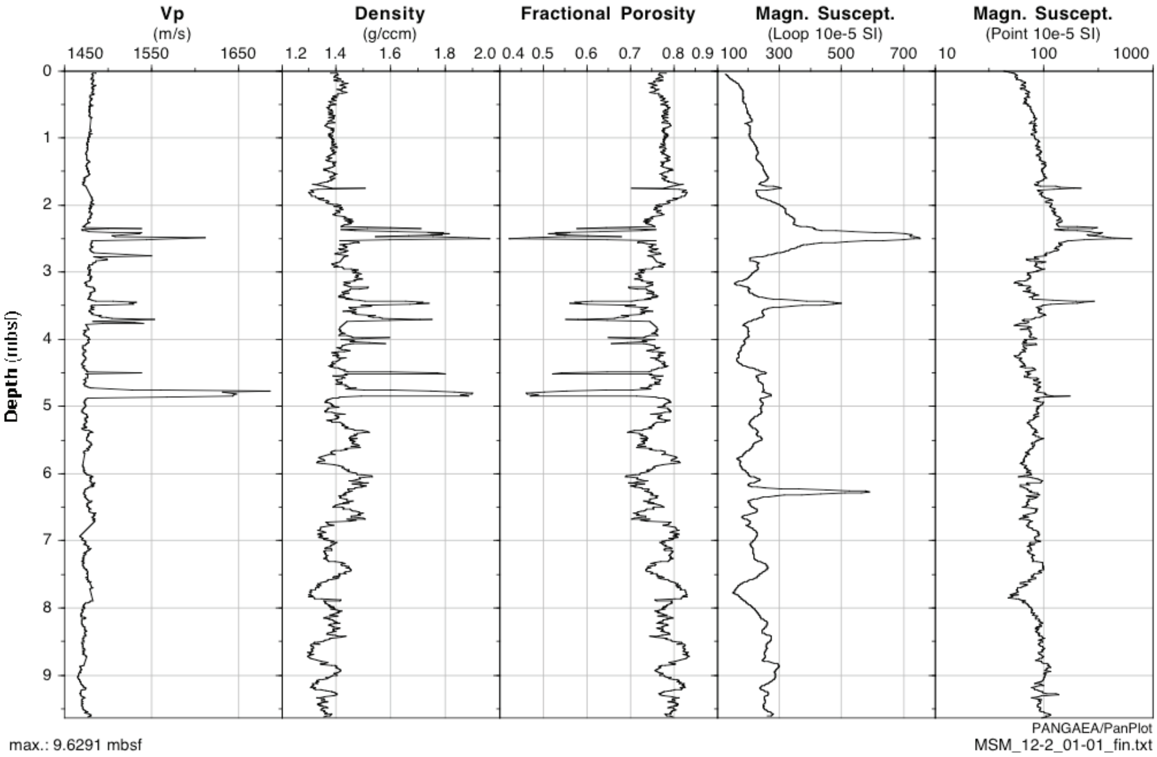


Fig. 5.10: Physical-property logs from core MSM-12/2-01-01. MS data are instrumental data (10-5 SI). Point sensor data are plotted on a logarithmic scale to make small-scale fluctuations not resolved in the loop data better visible.

There was not enough time to carry out full processing for all the cores logged during the cruise. Also, not all of the slit cores were logged and not all of the cores were split. The status of data acquisition and processing is summarized in Table 5.5.

The correlation of loop sensor and point sensor MS is good as demonstrated for cores MSM-12/-01 and 03 (Fig. 5.11). However, a perfect correlation cannot be expected because the loop data is obtained from a larger core volume as the point data so that data from different material are compared. Also the effect of clasts in the core is more pronounced in loop data than in point data, because clasts may have been removed after splitting or are not directly measured with the point sensor. On the other hand, small-scale MS peaks are more pronounced in the point-sensor data because of the better sensor resolution. For this reason it is not straight forward to calculate volume-specific susceptibility from point-sensor data. As an approximation for data conversion it is suggested to use empirical linear regressions according to Figure 5.11 for each core or for the entire data set from the cruise once available. The reasons explained above, the correlation is slightly better if data of the large peaks are removed from the linear regression (Fig. 5.11).

5.2.2 Preliminary results

5.2.2.1 Characteristics of surface and near-surface sediments

The box corers of MS12/2 were recovered in three regions, on the western flank of the drift, on top of the drift and on the eastern flank. The box core sections from sites on the western flank (MSM12/2-01-02, MSM12/2-02-02 and MSM12/2-03-02) can be divided into two major lithologies. At the surface, some gneiss and sandstone dropstones, smooth shelled bivalves, a scaphopod, xenophyophora and a phytodetritus layer were found. The top layer is a light olive-brown sandy silty clay with foraminifers and sponge spicules. The unit is interrupted by olive brown layers with the same lithology. The underlying unit is separated by a sharp contact at 23 cm at Site 01, at 14 cm at Site 02, and at 23 cm at Site 3. The lower unit is an olive gray to gray clay with foraminifers and very abundant bioturbation of non-branching burrows with up to 3 cm long blank worm-linings.

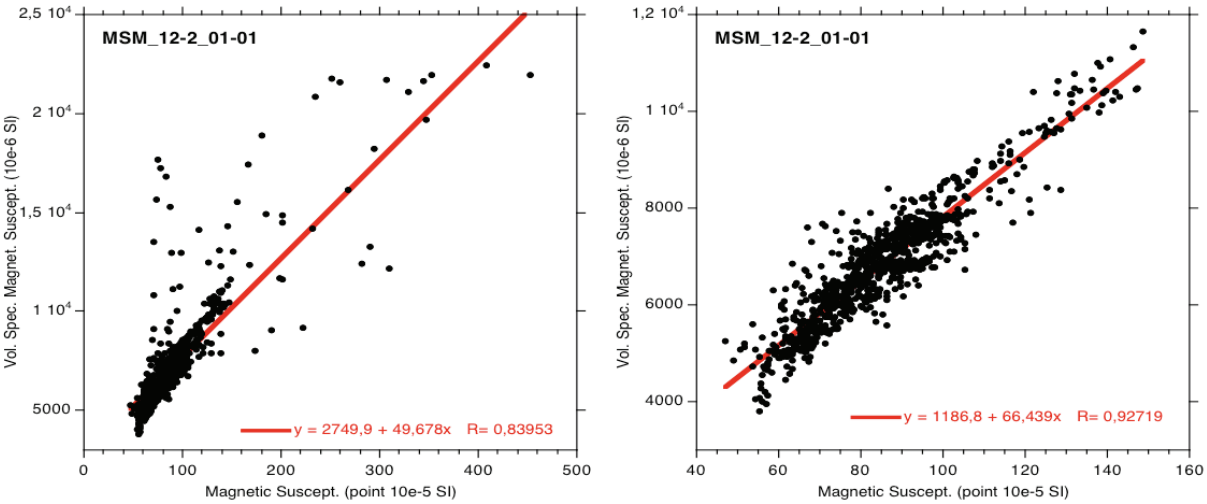


Fig. 5.11: Correlation of MS data measured with a loop sensor and converted to volume-specific MS with MS data measured with a point sensor.

The sand fraction of the top layer is dominated by well-preserved planktic foraminifers, namely *Neogloboquadrina pachyderma* sinistra with a minor contribution of *N. incompta*, *Globigerina bulloides*, *Turborotalia quinqueloba* and *Globigerinita uvula,* a typical fauna for the warm periods of this region. The fauna displays a distinct size bimodality as already described for the IODP Leg 303 sites (Channell et al., 2006). The benthic foraminifers fauna is divers and contains, amongst others, *Epistominella exigua* and *Melonis barleanum*, *Oridorsalis umbonatus*, *Gyroidina soldanii*, *Fursenkiona* spp. and an abundant and diverse agglutinating benthic fauna with *Rhabdammina* spp., *Reophax* spp. and *Trochamina* spp. The darker layer contains abundant *G. bulloides* and the benthic fauna *Pyrgo murhina, Pullenia* and *Cibicidoides wuellerstorfi*. The non-foraminiferal component is dominated by mainly quartz gravel and sponge spicules with accessory ostracods, radiolarians, diatoms and volcanic glass. The lower unit is impoverished in its diversity and just moderately well-preserved, and contains of *N. pachyderma* (s) with *Pullenia* spp. and *Uvigerina* spp..

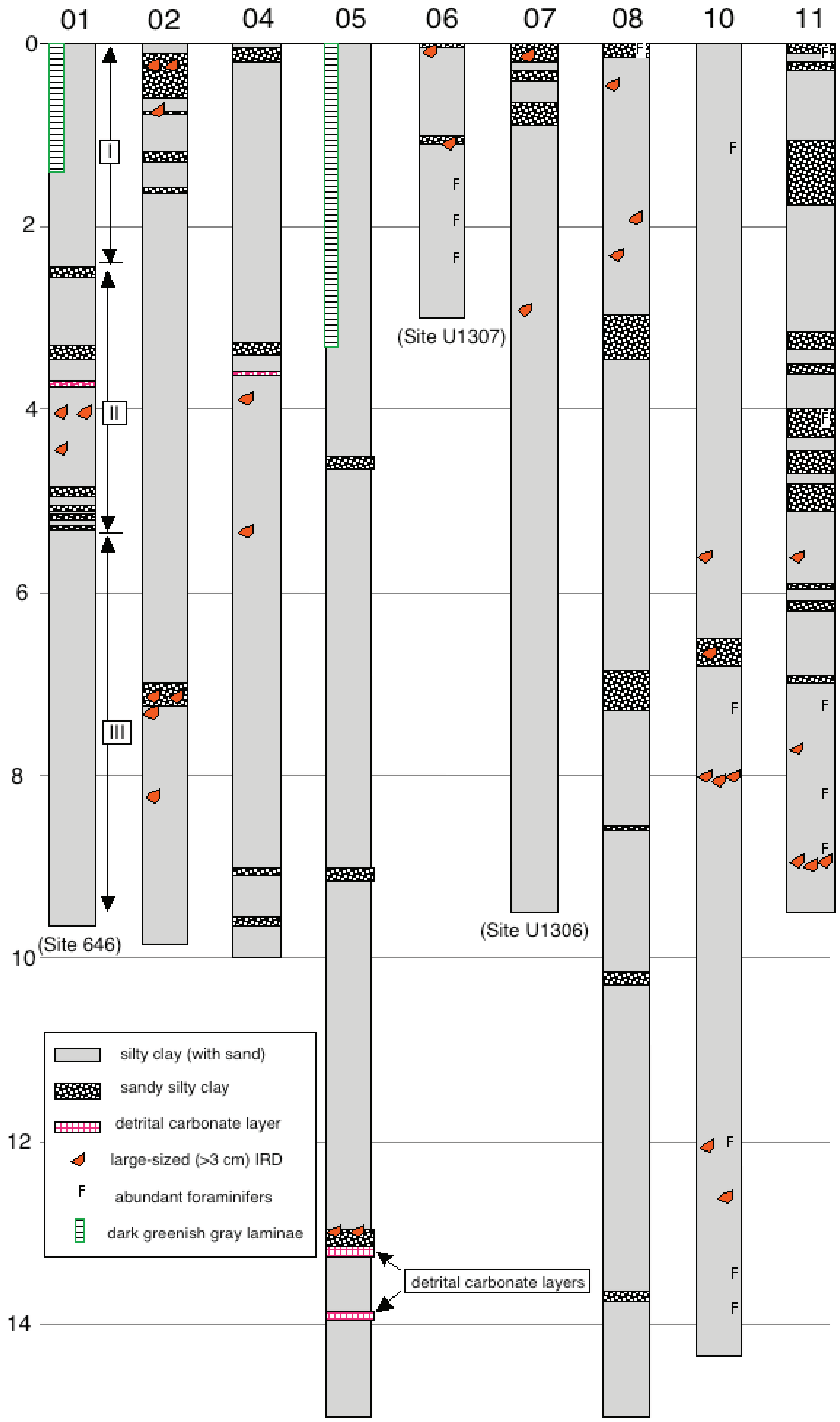


Fig. 5.12: Simplified lithological columns of sediment cores opened and described during expedition MSM12/2. 01 = MSM12/2-01, 02 = MSM12/2-02, etc. At core MSM12/2-1, three lithological units I to III were distinguished.

Site MSM12/2-04-02 is distinctly different from all the other sites in the area. The surface contains some worm burrows, a few manganese coated dropstones and a few small 1cm smooth bivalve shells. The olive brown clay to silty clay at the top is barren of siliceous fossils and small foraminiferal specimens, suggesting dissolution and stronger bottom currents. The fauna consist of *N. pachyderma* (s), *N. incompta* and *T. quinqueloba* suggesting a lack of Holocene deposition. The bottom unit is a dark grayish brown clay, partly finely layered, with *N. pachyderma* and *N. incompta* plus sponge spicules, diatoms, quartz, pyrite, and volcanic glass.

The surface sediments on top of the drift and along the eastern flank are very similar. The surface is covered by abundant manganese-coated dropstones, gravel and pebble size, several of which are colonised by several species of sponges. Benthic foraminifers, e.g. *P. murhina* and *Rhabdamina* spp., are abundant on the surface. Additionally, (sapellid) worms, brittle stars, gastropods, and bivalves were found. Several of the sites are covered by a phyto-detritus layer. The top unit of the box corers consists of an olive brown to light olive brown gravely clay with foraminifers, sponge spicules and volcanic glass. Minor traces of radiolarians and diatoms are present in all the surface samples. The foraminiferal assemblages reflect typical Holocene assemblages with *N. pachyderma* (s), with minor amounts of *N. incompata*, *G. bulloides*, *T. quinqueloba* and traces of *G. glutinata* and one specimens of *Globorotalia scitula.* Site MSM12/2-07-01 contains more sand than gravel. The lower unit is a dark grayish brown to olive brown clay with foraminifers and gravel, partly with larger isolated drop stones and sponge spicules.

Site MSM12/2-06-03 surface shows much larger abundance of dropstones with sizes up to 6 cm. Here, the surface is consolidated and shows signs of bottom currents. The foraminiferal fauna has a very broad range of preservation ranging from well-preserved to moderately well-preserved with Fe coatings, suggesting reworking. The lack of small specimens additionally points towards winnowing. The planktic fauna is dominated by N. *pachyderma* (s) and *N. incompta*, with minor amounts of *G. bulloides*, *G. glutinata*, *T. humilis* and *G*. cf. *umbilicata* the latter suggesting reworking of older material. Reworking is also suggested by the broad range of preservational states at site MSM12/2-09-02. Near the base of this box core at 10 to 20 cm, a large, completely disintegrated volcanic bomb was found.

Site MSM12/2-12-02 is furthest to the north nearest to Iceland. The surface is dominated by volcanic glass with the planktic foraminiferal fauna *N. pachyderma* s and *N. incompta*. Sponge spicules and diatoms are rare in these samples.

5.2.2.2 Main lithologies of long sediment cores

The classification of the major lithologies is mainly based on the visual core description, i.e., sediment colour, structure and grain size. As the number of smear slides from each core is very limited, main lithologies identified by visual core description are mainly terrigenous-type sediments (i.e., silty clay to sandy silty clay), i.e., biogenic components (especially nannofossils) are probably underestimated and – thus – do not appear in the name of the sediment.

The detailed lithological core descriptions of all opened gravity cores are shown in Appendix 8. In general, three main types of lithologies could be distinguished: (1) fined-grained sediments (mainly silty clay) of varying colours, (2) coarser-grained sediments (mainly sandy silty clay and diamicton), and (3) foraminifera-rich silty clays (Fig. 5.12). Occasionally, large-sized dropstones with diameters >3 cm were found. The coarser-grained, more sandy intervals often show fining-upwards cycles. Whereas at cores MSM12/2-01, MSM12/2-05, and MSM12/2-10 the upper 2.5 to >6 m mainly consist of silty clays, at all other cores, i.e., MSM12/2-02, MSM12/2-04, MSM12/2-06, MSM12/2-07, and MSM12/2-11, the uppermost part of the sections are composed of coarser-grained sediments (Fig. 5.12). Cores MSM12/2-03 and MSM12/2-09, located close to cores MSM12/2-05 and MSM12/2-10 and not opened and described yet, do probably show a similar fine-grained lithology in the open part, as supported by the MSCL raw data.

Based on the correlation of the magnetic susceptibility (MS) record of cores MSM12/2-01, MSM12/2-03, and MSM12/2-05 with MS records from ODP Site 646 (Hall et al., 1989) and IODP Site U1305 (Channell et al., 2006) as well as other piston cores from this area (Stoner et al., 1995; Stoner et al., 1996; Turon et al., 1999), it is very probable that the upper fine-grained unit is of MIS 1 (postglacial to Holocene) age. That means, on the other hand, at cores having coarse-grained sediments on top, no (or only very thin) Holocene sediments were recovered.

At Core MSM12/2-01, three lithological units can be distinguished. Units I and III are composed of silty clays with some sand, whereas the intercalated Unit II is characterized by coarse-grained (sandy silty clays and dropstones) sediments (for details see core description in the annex). The coarsed-grained intervals (Fig. 5.12) clearly correlate with distinct maxima in density (Fig 5.10). Based on the very preliminary "age model" (see above), Unit II probably represents the last glacial MIS 2.

5.3 Swath Bathymetry (SIMRAD)

(J. Højdal)

The onboard R/V MARIA S. MERIAN bathymetric swath system comprises of following elements:

Multibeam Echosounder:	Kongsberg Simrad EM-120 12 kHz
Beamsteering sound velocity probe:	AML SV Probe (not functional)
Motion compensation:	Kongsberg Seatex SeaPath 200
Heading/gyro sensor:	Kongsberg Seatex SeaPath 200
Positioning	Primary antenna of Kongsberg Seatex SeaPath 200

Sound velocity profiles were provided by the CTD casts carried out by the participating oceanographer.

5.3.1 Method

5.3.1.1 Operating frequency and coverage sector

The nominal sonar frequency is 12 kHz with an angular coverage sector of up to 150 degrees and 191 beams per ping. During this cruise the swath coverage sector was reduced to 60 degrees on either side during normal sea conditions and to 50 degrees on either side in sea states higher than 4. The beam spacing is normally equidistant with equiangular available (not used on this cruise).

5.3.1.2 Transmission

The transmit fan is split in several individual sectors with independent active steering according to vessel roll, pitch and yaw. This place all soundings on a “best fit” to a line perpendicular to the survey line, thus ensuring a uniform sampling of the bottom and 100% coverage. The sectors are frequency coded (11.25 to 12.60 kHz), and they are transmitted sequentially at each ping. The sector steering is taken into account when the position and depth of each sounding is calculated, as is the refraction due to the sound speed profile, vessel attitude and installation angles. Unfortunately the AML sound velocity probe was defect during the entire cruise with some reduction of the general data quality as the result.

Pulse length and range sampling rate are variable with depth for best resolution. The ping rate is mainly limited by the round trip travel time in the water up to a ping rate of 5 Hz. On the average water depth of approximately 2500 metres in the area of operations the ping rate was experienced to be less than 0.07 p/sec.

5.3.1.3 Transducer arrays

The EM 120 transducers are linear arrays in a Mills cross configuration with separate units for transmit and receive. The arrays are divided into modules. The number of modules used (and hence the beam width) is determining for the actual beam width of the system. The system in use was configured for 2 degrees along track and 2 degrees across track. A combination of phase and amplitude detection is used. The lack of an on-line sound velocity probe did however minimize the benefit of these features.

5.3.2 Processing

Raw data from the Kongsberg data acquisition software (SIS) were imported and converted to CARIS HIPS format. In CARIS the following procedures were followed for each segment of data (each segment is approximately 30 minutes of data acquisition):

A) Preliminary tidal model calculated for nearest known tidestation (Nanortalik/Greenland)

Prediction ATT Nanortalik (3437) Z_0 height 1.380 Time zone - 3		
ATT	g°	H(m)
M2	164	0.880
S2	203	0.380
K1	114	0.190
O1	077	0.110

Table 5.6: Parameters used for computation of tidal model.

B) Refraction correction from nearest obtained position of sound velocity profile.
C) Swath reduction to +/- 60 degrees (to +/- 50 degrees in high sea state)
D) Manual inspection of navigational quality
E) Manual spike editing of individual swaths
F) Export to various standard formats (FAU and XYZ)
G) Export of centre beam positions in customized format as requested by the chief scientist.
H) Area Spline cleaning of XYZ exports in QLOUD area cleaning software.
I) Additional re-exports to FAU/XYZ with patch test alignment values obtain on the last day of the official part of the cruise is still outstanding but expected completed prior to arrival Reykjavik.

5.3.3 Preliminary results

The data has not yet been finally corrected for true tidal model or the complete refraction model, but in "numbers":

Number of "survey line kilometres": 3450 Km
Area covered (overlap has been extracted) 24.450 Km^2

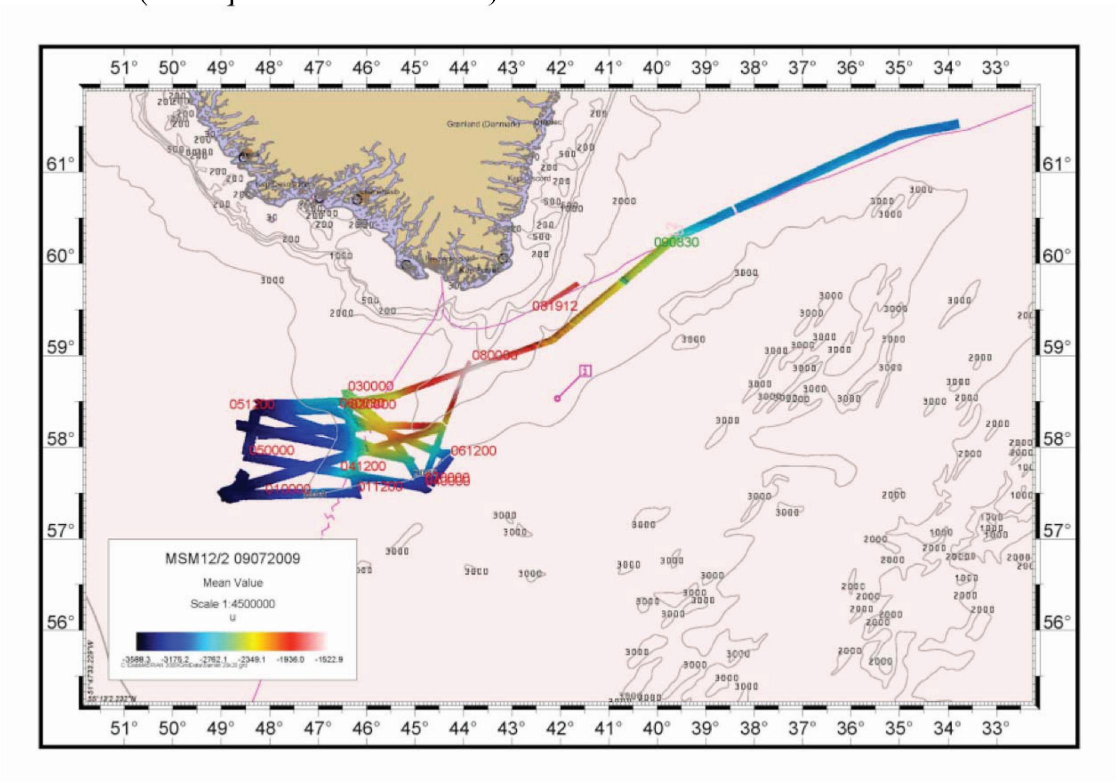


Fig. 5.13: Coverage plot on completion on the 9th of July 2009.

5.4. Marine Sediment Echosounding using PARASOUND

(F. Niessen, B. Slaby, A. Fischel)

5.4.1 Scientific Objectives

Bottom and sub-bottom reflection patterns obtained by PARASOUND characterize the uppermost sediments of the Arctic Ocean in terms of their acoustic behaviour down to about 100 m below the sea floor. This can be used to study depositional environments in space and time, of which the uppermost sediments may also be sampled. The objectives of sediment echosounding during MS-12/2 were:

- to provide the data base for an acoustic facies interpretation of the younger most sediments of the Eirik Drift indicative for different bottom water currents and their spatial and temporal variability, and, thereby,
- to provide a high-resolution counterpart for the uppermost sections of seismic profiles recorded during the cruise,
- to select coring stations based on acoustic pattern and backscatter, and
- to obtain different pattern of high-resolution acoustic stratigraphy useful for lateral correlation over shorter and longer distances thereby aiding correlation of sediment cores retrieved during the cruise.

5.4.2 Technical Aspects and Modes of Operation

RV MARIA S. MERIAN is equipped with a Deep Sea Sediment Echo Sounder PARASOUND (ATLAS HYDROGRAPHIC, Bremen, Germany) DS III-P70 similar to the systems installed on other German RVs such as “Polarstern”, “Meteor” and “Sonne”. An overview about the system set up and operation of “PARASOUND DS III-P70” is given by Niessen et al. (Klages and Thiede, in prep)and Niessen et al. (Schiel, 2009).

The hull-mounted PARASOUND system generates two primary frequencies selectable between 18 and 23.5 kHz transmitting in a narrow beam of 4° at high power. As a result of the non-linear acoustic behavior of water, the so-called “Parametric Effect”, two secondary harmonic frequencies are generated of which one is the difference (e.g. 4 kHz) and the other the sum (e.g. 40 kHz) of the two primary frequencies, respectively. As a result of the longer wave length, the lower parametric frequency allows sub-bottom penetration up to 200 m (depending on sediment conditions) with a vertical resolution of about 0.30 m. The primary advantage of parametric echosounders is based on the fact that the sediment-penetrating pulse is generated within the narrow beam of the primary frequencies thereby providing a very high lateral resolution compared to conventional 4 kHz-systems.

On RV MARIA S. MERIAN, PARASOUND DS III-P70 is controlled by two operator software packages plus server software running in the background. These processes are running simultaneously on a PC under “Windows XP”. (i) ATLAS HYDROMAP CONTROL is used to run the system by an operator. The selected modes of operation, sounding options and ranges used during the cruise are summarized in Table 5.7. A list of abbreviations is given at the end of this chapter. (ii) ATLAS PARASTORE-3 is used by the operator for on-line visualization (processing) of received data on PC screen, for data storage and printing. It can also be used for replaying of recorded data, post-processing and further data storage in different output formats (PS3 and/or SEG-Y). For any further details the reader is referred to the operator manuals of Atlas Hydromap Control (ATLAS_Hydrographic, 2007a) and Atlas Parastore (ATLAS_Hydrographic, 2007b) and some basic descriptions given by Niessen et al. (Schiel, 2009).

Used Settings	**Selected Options**	**Selected Ranges**
Mode of Operation	P-SBP/SBES	PHF, (SHF), SLF
Frequency	PHF SHF SLF	18.75 kHz (41.66 kHz) for testing only 4.166 kHz
Pulselength	No. of Periods Length	2 0.5 ms
Transmission Source Level	Transmission Power Transmission Voltage	100% 159 V
Beam Steering	none	
Mode of Transmisson	Single Pulse Quasi-Equidistant	 Interval 400-1200 ms
Pulse Type	Continuous Wave	
Pulse Shape	Rectangular	
Receiver Band Width	Output Sample Rate (OSR) Band Width (% of OSR)	6.1 kHz 66%
Reception Shading	none	
System Depth Source	Fix Min/Max Depth Limit	Manual Other (EM-120) Controlled Atlas PHF Atlas Parastore
Water Velocity	C-Mean C-Keel	Manual 1500 m/s Manual 1500 m/s
Data Recording	PHF SLF	Full Profile Full Profile

Table 5.7: Settings of PARASOUND operation used on MSM-12/2.

date 2009	From UTC	Until UTC	duration (h)	reason
19.06.	09:33	09:48	0.25	- SPM is in Error State - Driver 'ATLAS PARASOUND DS P70' is not sending telegrams - Runtime Error Program: C:\ProgramFiles\Atlashydro\HydromapControl\AHControl.exe

	11:02	22:06	11.07	Cannot connect to database
20.06.	04:51	05:35	0.73	- W-026 Can't deliver ASD File Service PLF config:2 - W-004 Timeout while waiting for fileserver response
	07:53	08:00	0.12	Parastore not reacting anymore
	10:42 11:40 (?)	12:15	1.55	Echogram Buffer full (Windows error)
	12:33	14:49	2.27	System crash; multiple SPM notifications PS3 reboot DIPS carried out; Status invalid
21.06.	14:27	<5min	0.08	Parastore crash without error message
	14:42	15:53	1.18	- Driver 'DS P70' is not sending telegrams (s.o.) - Runtime error: Termination of: Atlashydro\HydroDBServer\AHServer.exe
	17:32	18:05	0.55	Can't deliver ASD file Service PHF config:2
	20:50	21:18	0.47	PARASOUND crash; PC restart necessary
	23:13	23:31	0.30	Warning: TbfCmd Receive State; Shut down computer repeated more than 6 times
22.06.	01:01	03:43	2.70	PC restart > Switch Power: „Status invalid“
	05:55			Windows crash - not working anymore
24.06.		17:34	59.65	Out of function until date and time given left
	20:11	22:04 (?)	1.88	Remote Operation Bremen
	06:42	07:16	0.57	- Windows error: Parastore discovered a problem and needs to close - FTP error messages
	15:35	16:35	1.0	- Timeout while waiting for PHF data - Parastore crash - no signal; multiple CM recovery action: reconfiguration
	20:25	20:33	0.13	Parastore crash
28.06.	17:38	18:48	1.17	- Warning: SET TBF enable not possible - Data not sent properly to sounder! Try again. If it is not possible to sent the data at all, you have to restart the HYDROMAP SERVER and database process

				- Driver 'ATLAS PARASOUND DS P70' is not sending telegrams - Switch Power: „Status invalid“ after first restart
29.06.	13:43	13:54	0.18	Parastore crash
	20:15			Remote Operation Bremen
30.06.		00:25	4.17	
	14:39	16:17	1.63	- Windows error; Windows data loss during writing of ASD-Files; Timeout while waiting for file service - Driver DS P70 is not sending telegrams - TBF startup problem - HVPM communication error
01.07.	10:25	10:42	0.28	- Driver DS P70 is not sending telegrams - Message: data not sent properly to sounder
	10:47	10:54	0.12	- Timeout while waiting for PHF data - Driver DS P70 is not sending telegrams - SPM recovery
	16:35	16:42	0.12	Parastore closes without error message
	18:05	18:36	0.52	- Parastore closes without error message - no signal after restarting Parastore
03.07.	13:43	18:12	4.48	Windows error
04.07.	14:00	14:08	0.13	Storage Problem
05.07.	21:44			- Windows error: data loss while writing (Temp\SPL C7 could not be saved) - after restart: Parastore: Timeout while waiting for file service response (Windows XP final crash, hard disc failure)
09.07.		04:00	89.0	
sum of time without data			186	Due to system problems without stations
sum of station time			67	According to Table 5.9
sum of operation time			207	Data acquisition and storage
Sum of anticipated operation time			393	Including operation time without stations

Table 5.8: Summary of time windows when PARASOUND data acquisition was not possible due to system failure and repair

Date 2009	From UTC	Until UTC	Gear
22.06.	05:57	08:07	06:00 CTD 08:00 Seismic deployed
25.06.	14:32	17:12	CTD;
26.06.	15:15	22:23	16:15 MSM12/2-01-01 (SL-10) 18:05 MSM12/2-01-02 (GKG) 20:15 MSM12/2-01-03 (SL-10)
27.06.	00:01	04:17	00:05 MSM12/2-02-01 (SL-10) 02:05 MSM12/2-02-02 (GKG)
29.06.	17:37	23:39	MSM12/2-03-01 (SL-10) MSM12/2-03-02 (GKG)
30.06.	00:16	05:18	CTD 01:55 MSM12/2-04-01 (SL-10) 03:25 MSM12/2-04-02 (GKG)
	05:43	10:37	MSM12/2-05-01 (SL-15) MSM12/2-05-02 (GKG) no recovery
02.07.	05:22	12:07	08:03 MSM12/2-06-01 (GKG) 09:27 MSM12/2-06-02 (SL-10; IODP U1307) MSM12/2-06-03 (GKG)
	14:51	19:10	16:30 MSM12/2-07-01 (GKG) 18:10 MSM12/2-07-02 (SL-10)
	22:23		MSM12/2-08-01 (GKG) MSM12/2-08-02 (SL-15)
03.07.		03:52	
06.07.	14:31	20:08	ca. 17:00 MSM12/2-09-01 (SL-15) MSM12/2-09-02 (GKG)
	20:48		MSM12/2-10-01 (GKG) MSM12/2-10-02 (SL-15)
07.07.		00:05	
	07:24	10:21	CTD 09:13 MSM12/2-11-01 (SL-10)
09.07.	07:32	10:49	08:02 MSM12/2-12-01 (SL-15) 09:20 MSM12/2-12-02 (GKG)
	12:13	14:11	CTD

Table 5.9: Summary of time windows when PARASOUND data acquisition was reduced (2 minutes wait time) or system on standby due to vessel on station

5.4.3 Data Acquisition and Management

During MS-12/2 digital data acquisition and storage were switched on in the Irminger Basin on June 19 at 16:19 UTC with full data acquisition from June 20 at 00:00 UTC and had to be switched off after a major system failure on July 5 at 21:38 UTC. Originally profiling was anticipated to continue until station MSM-12/-12 (reached on July 9 at about 04:00). PARASOUND was continuously operating during the period stated above unless acquisition was interrupted by system crashes (Tab. 5.5) or switched to standby or reduced data storage on stations (Tab. 5.6). Acquisition included PHF and SLF data whenever the system was running. Both PHF and SLF traces were visualized as online profiles on screen. SLF profiles (200m depth windows) and online status (in 60s or 120s intervals) were printed on A4 pages.

For the period defined above six different types of on-line data files were stored on hard disc:

- PHF data in ASD format
- SLF data in ASD format
- SLF data in PS3 format
- SLF data in SEG-Y format
- Navigation data and general PARASOUND settings (60s intervals) in ASCII format
- Auxiliary data about ATLAS PARASTORE 3 settings in ASCII format

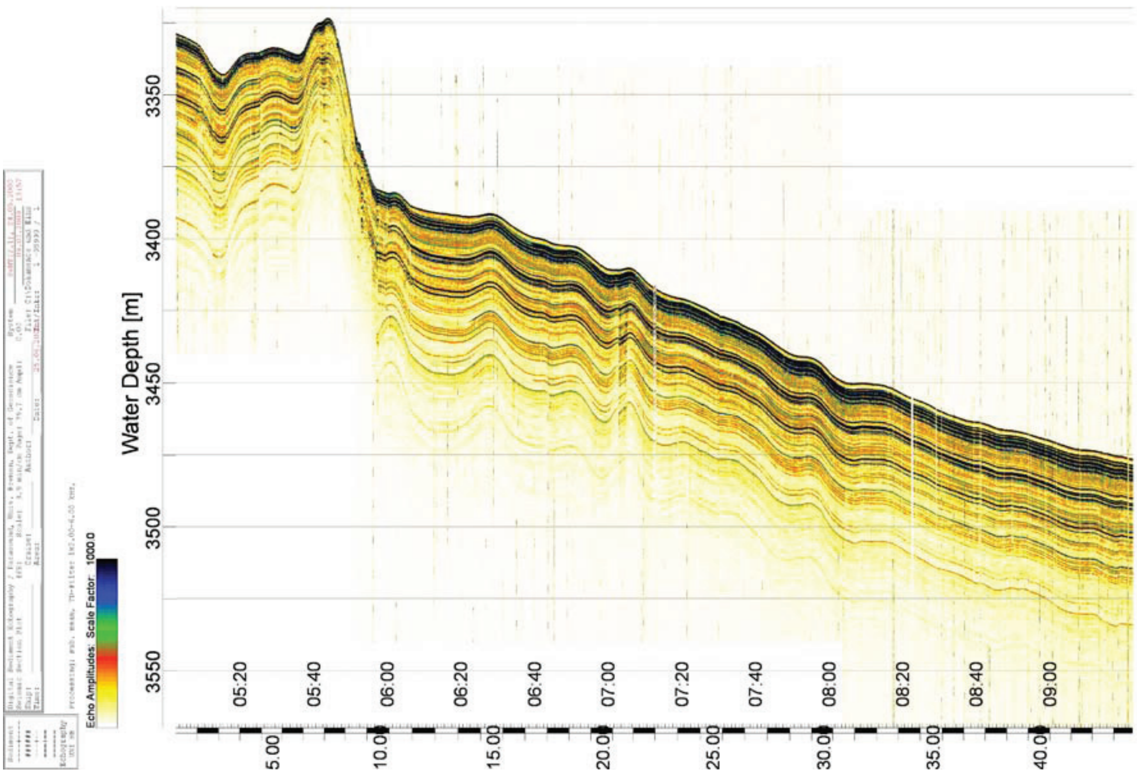


Fig. 5.14: PARASOUND profile with locations of stations MSM-12/2-01 and 02. Horizontal scales are time UTC (upper) and kilometer (lower numbers and bars). Station MSM-12/2-01 and MSM-12/2-02 are at 08:49 and 06:40 UTC, respectively.

All ASD data files stored are automatically packed into "cabinet files" by Atlas software. The files are named according to date and time of recording (containing about five minutes of acquired data per file). Usually cabinet files contain profile data for 10 minutes of acquisition time. The data have been sorted by the operator into folders according to data type and recording dates (0 to 24 hours UTC), copied to one external hard disk via fast USB-board and backed up on a second hard disc. In total 15,659 files in 74 folders of data with a total volume of 117 GB were stored on external discs. These data will be transferred to the AWI data base for being available through PANGAEA (www.pangaea.de).

During the entire period of acquisition the system was operator controlled (watch keeping). Book keeping was carried out including basic PARASOUND system settings, some navigation information, various kinds of remarks as well as a low-resolution hand-drawn bathymetry plot.

Time windows with data of specific interest (geological situations at or near stations) were selected and replayed during the cruise using optimal settings of ATLAS PARASTORE-3 and SeNT (Hanno Keil, MARUM, University of Bremen).

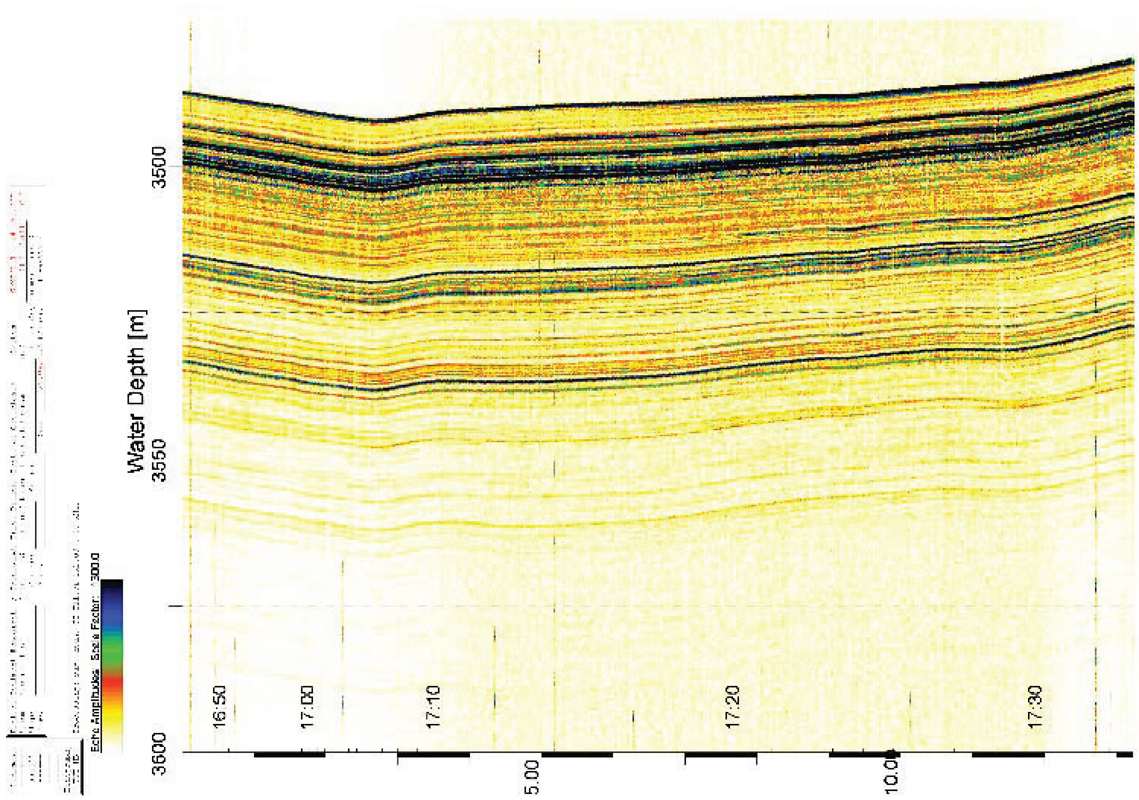


Fig. 5.15: PARASOUND profile with location of station MSM-12/2-03. Horizontal scales are time UTC (upper) and kilometer (lower numbers and bars). Station MSM-12/2-03 is at 17:32 UTC.

In total 28 major problems or system crashes were observed during the cruise. These crashes were caused by failures of ATLAS HYDROMAP CONTROL, ATLAS HYDROMAP SERVER, ATLAS PARASTORE-3, CM and/or SPM (Tab. 5.5). However, the major concern was caused by the PC system software "Windows XP", which led to total failure and partial destruction of the PC's system software three times during the cruise. In the first two cases the internet connection was used for a re-installation and repair of the operator PC remotely carried by ATLAS HYDROGRAPHIC, Bremen, Germany (Tab. 5.5). Prior to remote repairs "Windows XP" could be re-installed on the operator PC by the shipboard staff. On July 5 the third "Windows" crash could not be repaired because it was accompanied by hardware problems (hard disc drive). Almost simultaneously, the second Operator PC located on the bridge broke down due to a similar combination of problems. All crashes caused significant loss of data, which is summarized in Table 5.8. In total a period of 187 hours of data acquisition was lost, which is equivalent to 47 % of the total time, where profiling in the area under investigation was intended to be carried out (station time not included, Tab. 5.5).

5.4.4 Examples of recorded data along the cruise track near geological stations

In the area under investigation the sediments resolved in PARASOUND profiles are well stratified and show evidence of bottom current activity up to the surface. In most locations this is documented in variable thicknesses of sediment packages over relatively short lateral distances. For the coring stations mentioned below the reader is referred to Fig. 5.8.

For example, sediment thicknesses are higher at coring station MSM-12/2-01 (ODP 646) than on top of a topographic feature (MSM-12/2-02) where the units appear to be more condensed (Fig. 5.14). At coring station MSM-12/2-03 (IODP 1305), the upper 75 m of sediments are relatively constant in thickness over longer distances (Fig. 5.15).

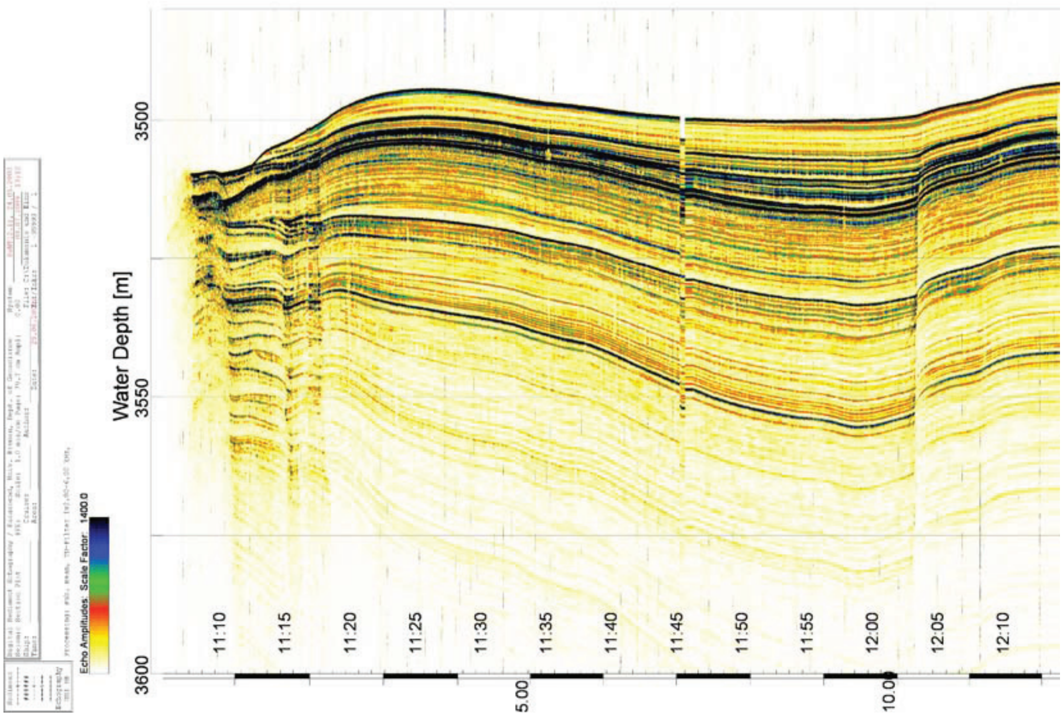


Fig. 5.16: PARASOUND profile with locations of stations MSM-12/2-04 and 05. Horizontal scales are time UTC (upper) and kilometer (lower numbers and bars). Station MSM-12/2-04 and MSM-12/2-05 are at 11:13 and 11:59 UTC, respectively.

The opposite is visible at coring stations MSM-12/2-04 and MSM-12/2-05 (Fig. 5.16). Here, at station MSM-12/2-05, the uppermost sediments were sampled with the highest resolution observed in the entire area under investigation. In contrast, right next to station MSM-12/2-04, this unit lenses out while some underlying units appear to be thicker than at station MSM-12/2-05 only 9 km away. However, those units thicker also lens out but in the opposite direction so that they only occur in the area displayed in Figure 5.16 but nowhere else. The location is close to the sea mount (“MARIA S. MERIAN”) discovered on air gun and multi-beam bathymetry tracks during the cruise. Station MSM-12/2-04 is only 0.5 km away from the feature, which is represented by a data gap in PARASOUND profiles (e.g. Fig. 5.16) due to its steep slope (>> 4°).

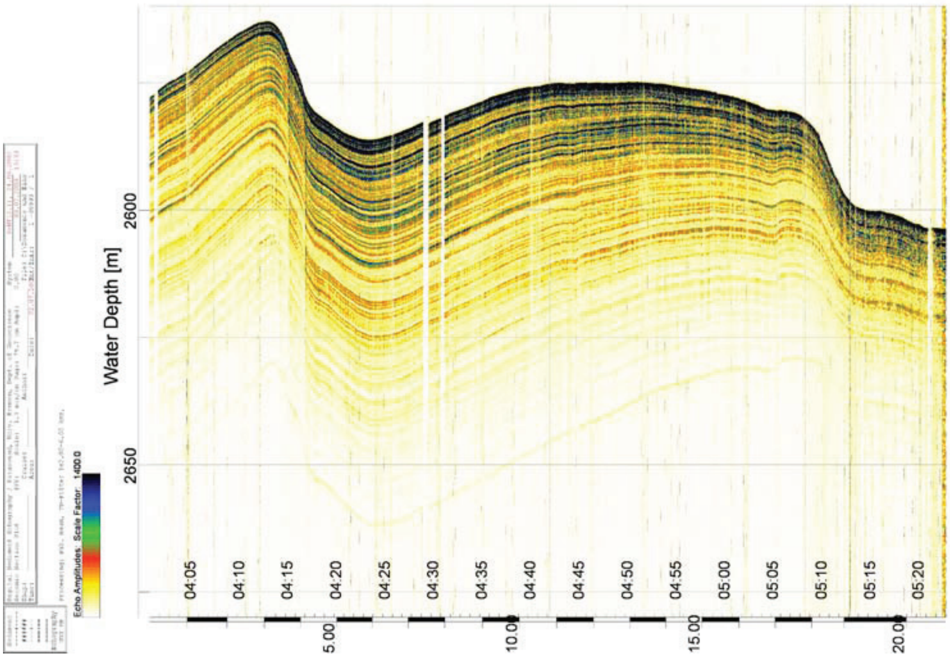


Fig. 5.17: PARASOUND profile with locations of stations MSM-12/2-06 and -08. Horizontal scales are time UTC (upper) and kilometer (lower numbers and bars). Station MSM-12/2-06 and MSM-12/2-08 are at 05:23 and 04:24 UTC, respectively

The more condensed character of the sediments at coring station MSM-12/2-05 (IODP 1307) is clearly documented in PARASOUND data compared to station MSM-12/2-08 some 15km away, where the thickness is higher by a factor of about 2 (Fig. 5.17). At coring station MSM-12/2-07 (IODP 1307) sedimentation rates appear to be higher than in the area 10km to the south of IODP site 1307 (Fig. 5.17). Some differences in sediment thickness are also observed between station MSM-12/2-09 and MSM-12/2-10, where a bathymetric depression and a bathymetric high were sampled over a relatively short lateral distance in the south-east corner of the area, respectively (Fig. 5.18).

Coring site MSM-12/2-11 is located in an area where sediments appear to be condensed (Fig. 5.19). In places at about 10 mbsf, erosion of well-stratified sub-bottom strata is visible in PARASOUND profiles. Core MSM-12/2-11 should have penetrated through this unconformity (Fig. 5.19). The last core of the cruise MSM-12/2-12 is not documented in this report by PARASOUND data, because it was recovered after the final break down of the PARASOUND system. The location was selected from a sub-bottom profiling track of a previous "Polarstern" cruise (ARK-XXIII/2 in 2008).

5.4.5 List of Abbreviations

ASCII	American Standard Code for Information Interchange
ASD	Atlas Sounding Data
C	Water sound velocity
CM	Control Module
mbsf	Meters below Sea Floor
PHF	Primary High Frequency
P-SBP	Parametric Sub-bottom Profiling
PS3	Export format of PARASOUND data
P70	Product version of PARASOUND with 70 kW pulse transmission power
RV	Research Vessel
SBES	Single-Beam Echo-Sounder

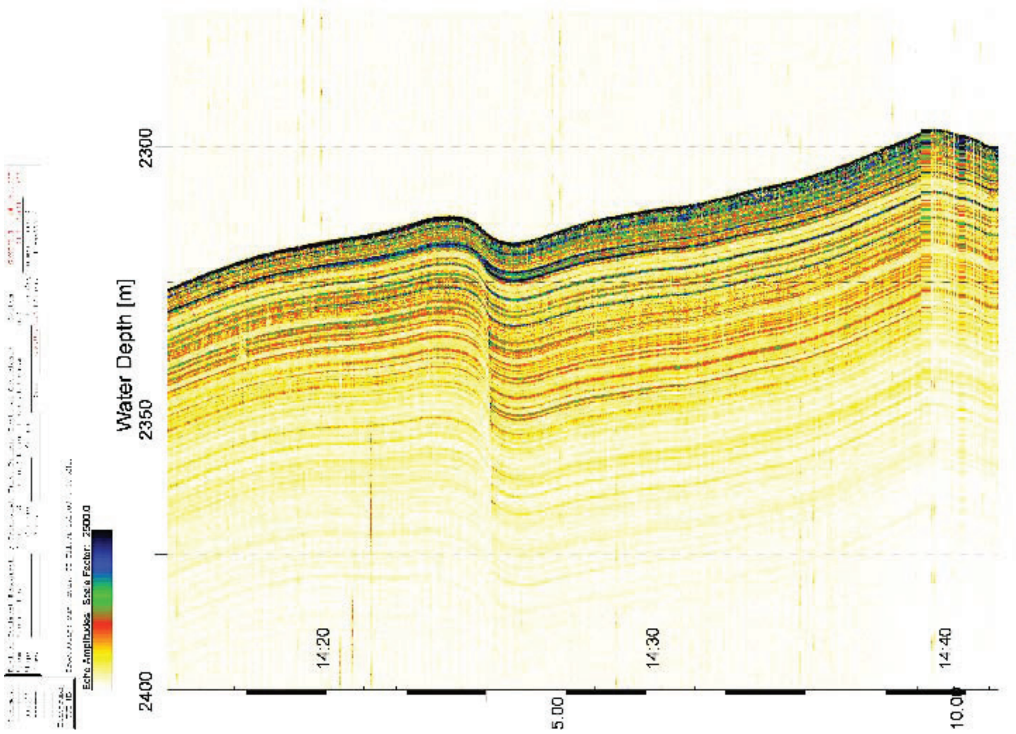


Fig. 5.18: PARASOUND profile with location of station MSM-12/2-07. Horizontal scales are time UTC (upper) and kilometer (lower numbers and bars). Station MSM-12/2-07 is at 14:45 (profiling stopped for station work).

SEG-Y	Society of Exploration Physicists-Standard Format for Seismic Data
SHF	Secondary High Frequency
SLF	Secondary Low Frequency
SM-120	Multi-Beam System (Simrad Echosounder)

SPM Signal Processing Module
USB Universal Serial Board

5.5 CTD System

(A. Müller-Michaelis)

5.5.1 Method

Water masses from different origin regions determine depth profiles in temperature and salinity. The changing hydrographic properties of the water masses in the investigation area result also in different sound velocity depth profiles. The PARASOUND and multi-beam systems use a fixed water sound velocity of 1500 m/s for profiling the sea bottom. To get better results during the MSM12/2 cruise and for the data processing the true sound velocity profiles of different CTD (Conductivity, Temperature, Depth) reference stations are used for the calibration of these acoustic systems. The CTD consists of conductivity, temperature, and pressure sensors. The depth is evaluated by the pressure and the salinity by the conductivity. The CTD is fixed on a frame with an altimeter and niskin bottles for water samples. It is lowered by winch down to approx. 10 m above sea bottom. The profiles are measured and recorded during the down- and the up-cast. For the multi-beam system just the up-casts were used and updated continually during the cruise. Due to problems with the PARASOUND system the fixed sound velocity of 1500 m/s was used during MSM12/2, but the recorded sound velocity profiles can be used for latter post-processing.

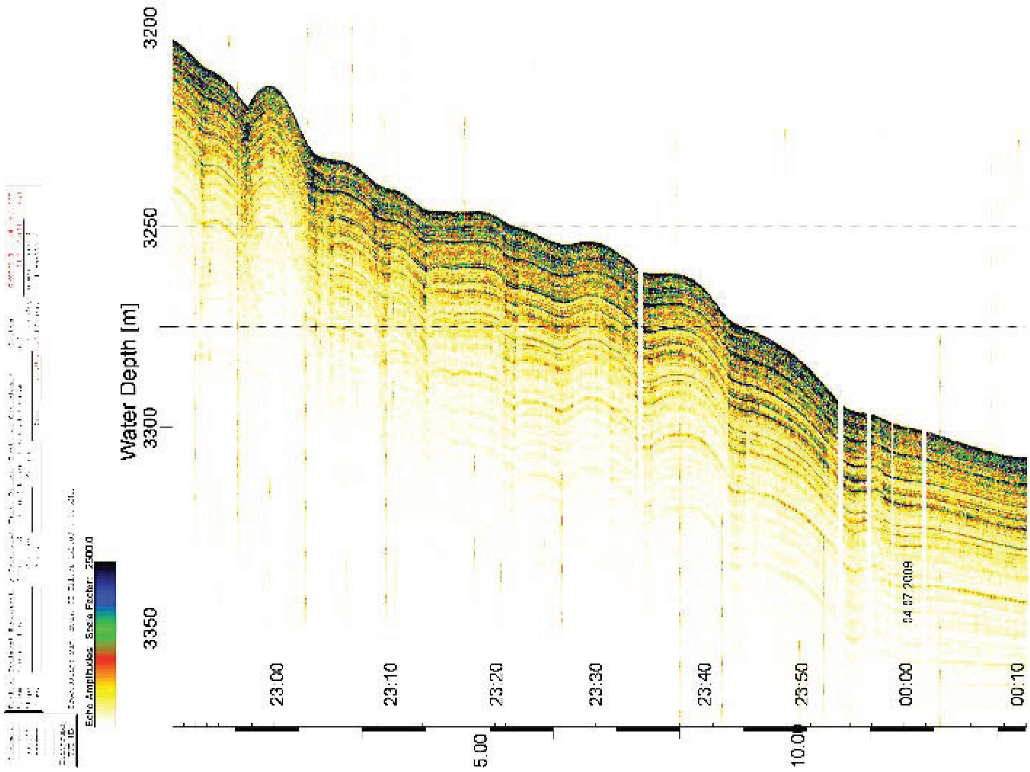


Fig. 5.18: PARASOUND profile with locations of stations MSM-12/2-09 and -10. Horizontal scales are time UTC (upper) and kilometer (lower numbers and bars). Station MSM-12/2-09 and MSM-12/2-10 are at 23:54 and 22:58:30 UTC, respectively.

8 CTD casts were completed on this cruise. The casts were initiated and terminated on deck. 2 water samples were taken per cast for calibration of the conductivity sensor. (The CTD was also used for 47 CTD stations on the MSM12/1 cruise, the salinity of the water samples will be measured by salinometer on the MSM12/3 cruise).

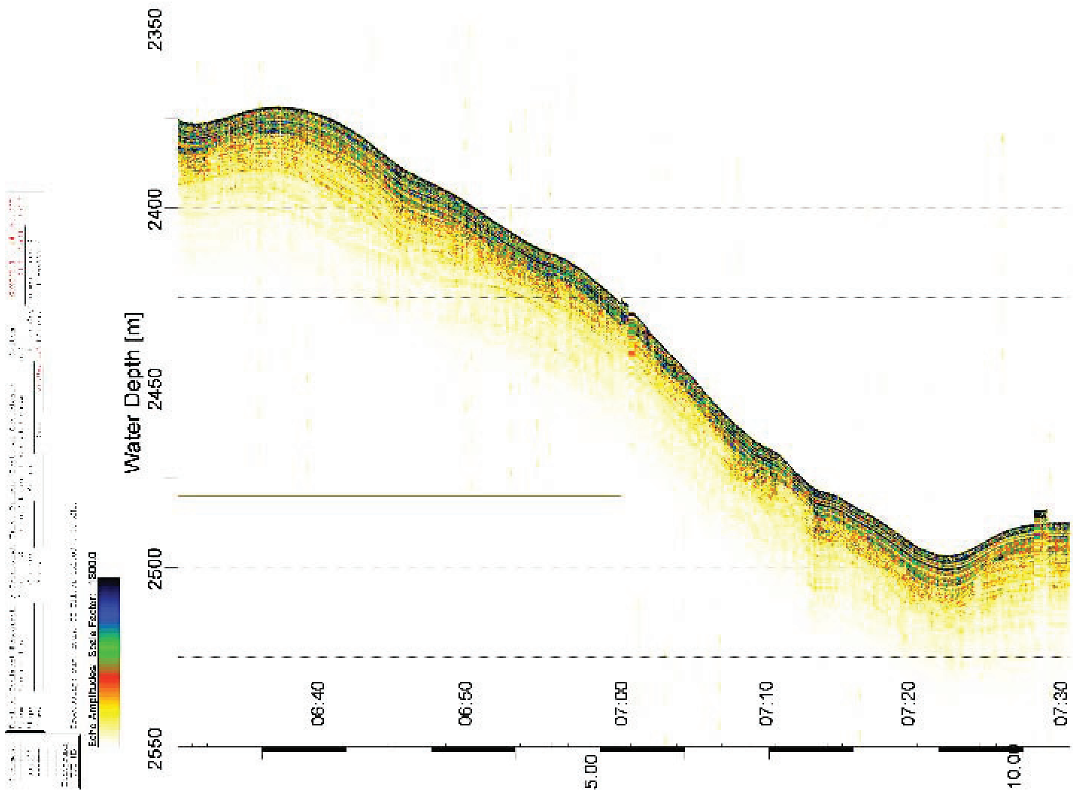


Fig. 5.19: PARASOUND profile with location of station MSM-12/2-11. Horizontal scales are time UTC (upper) and kilometre (lower numbers and bars). Station MSM-12/2-11 is at 06:53 UTC, respectively.

5.5.2 Equipment

12 bottle stainless steel frame configured in the following way:

Seabird 9/11 plus CTD
Seabird 24 position carousel
12 x 5 L Ocean Test Equipment "niskin" bottles
The configuration of IfM CTD-2 was:
Seabird 9+ underwater unit
Seabird 3 P temperature sensor s/n 1526
Seabird 4 Conductivity sensor s/n 1222
Digiquartz temperature compensated pressure sensor s/n 53573
Seabird 5T submersible pump

Seabird altimeter s/n 1119
Seabird 24 position carousel
Seabird 11+ V2 deck unit

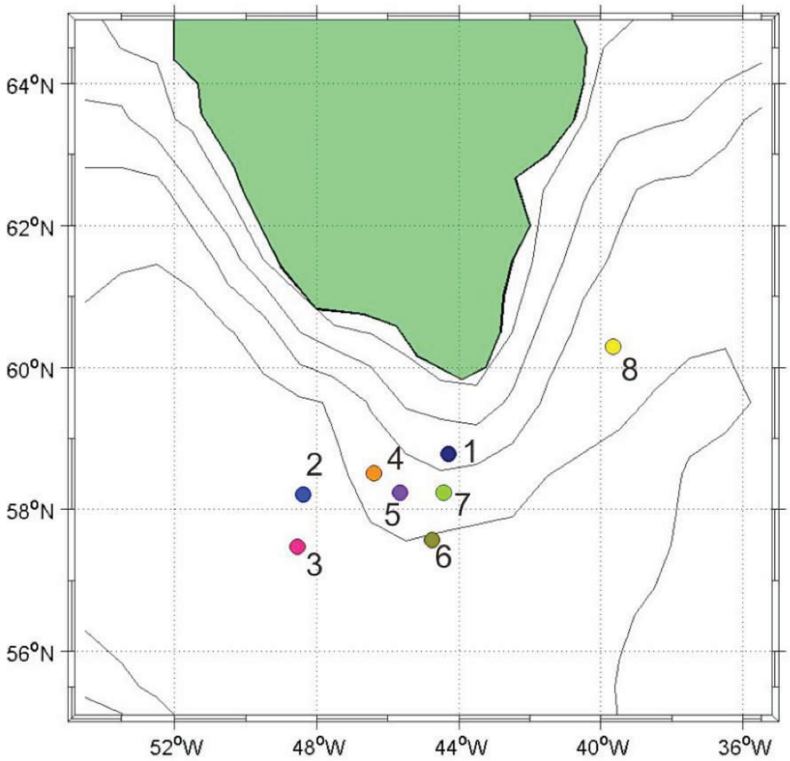


Fig. 5.20: Positions of the 8 CTD stations MSM 12/2.

5.5.3 Preliminarily Results

List of the CTD stations:

Cast No.	Date	Start time	Latitude	Longitude
001	22.06.2009	06:06	58° 46.83’ N	044° 17.41’ W
002	25.06.2009	14:29	58° 12.62’ N	048° 22.16’ W
003	29.06.2009	17:37	57° 28.52’ N	048° 31.81’ W
004	02.07.2009	05:36	58° 30.34’ N	046° 24.05’ W
005	02.07.2009	14:48	58° 14.23’ N	045° 38.54’ W
006	06.07.2009	14:29	57° 34.16’ N	044° 44.73’ W
007	07.07.2009	07:19	58° 14.32’ N	044° 24.87’ W
008	09.07.2009	12:13	60° 17.25’ N	039° 40.14’ W

Table 5.10: CTD station coordinates.

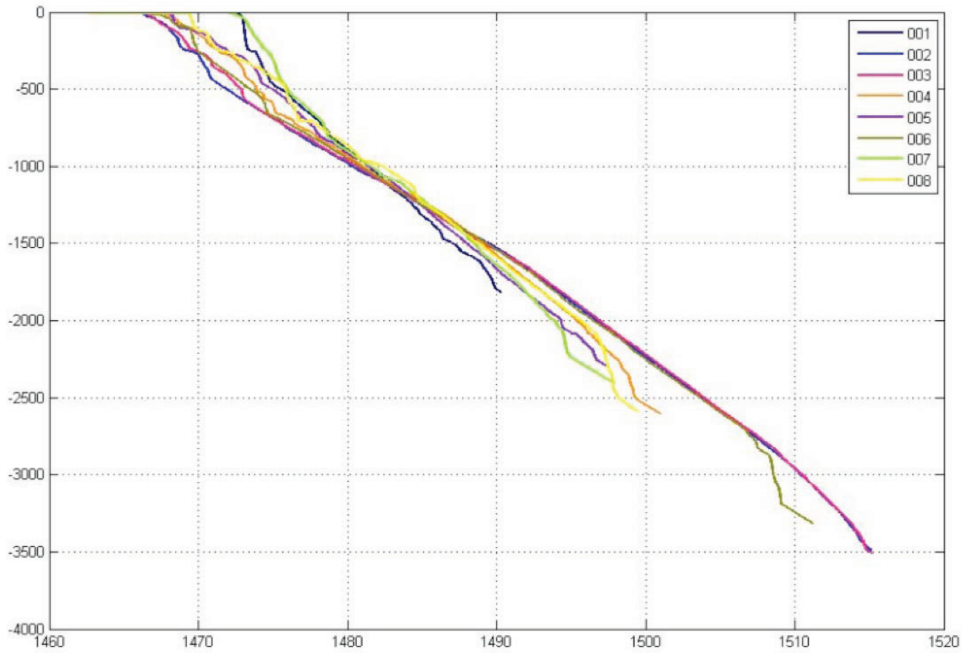


Fig. 5.21: Sound velocity profiles of the 8 CTD stations MSM 12/2.

5.6 ADCP

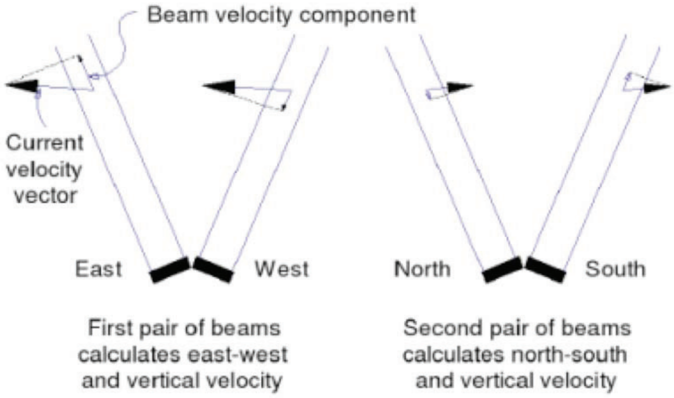
(A. Müller-Michaelis)

5.6.1 Method

The vessel mounted Acoustic Doppler Current Profiler (ADCP) measures the current velocity beneath the ship using the Doppler effect. Four beams of low-frequency acoustic signals are sent into the water column and the echo from suspended scatterers like plankton, faecal pellets etc. are evaluated to receive the velocity along the beam direction as the frequency of (sound) waves is changed by relative motion. The first pair of beams calculates east-west and vertical velocity, the second pair of beams the north-south and also the vertical velocity. The difference between two vertical velocities gives the error velocity. To get the true current velocities beneath the ship, the measured values have to be corrected for the pitch and roll movement of the ship, rotated from the ADCP coordinates to earth coordinates and the ships velocity and the tidal currents have to be subtracted.

5.6.2 Equipment

The ship's ADCP, which has been manufactured by RD Instruments (Poway, Ca., USA), has a working frequency of 75 kHz, ping rate of 0.7 Hz, and is specified for a maximal ship speed of 22 kn. Despite the fact that this instrument is specified for a maximal bottom track depth of 950 m, the operational maximal bottom search depth was set to 500 m. A constant salinity of 35 was utilized to calculate the velocities.



5.6.3 Preliminarily results

The Acoustic Doppler Current Profiler (ADCP) had been running almost constantly during the cruise without any problems.
The measurements were stopped and restarted every 4 to 5 days to keep the file sizes easily processable and to avoid data loss in cases of problems. The Ship's DoLog interferes with the ADCP. It was activated two times during MSM 12/2, June, 19th from 13:30h to 14:00h and on July, 2nd from 02:00h to 03:00h.

List of data files:

File No.	Start date	Start time	End date	End time	Comments
001	18.06.2009	13:20	18.06.2009	13:20	Test
002	18.06.2009	13:20	21.06.2009	10:17	DoLog activated: 19.06.2009 13:30-14:00
003	21.06.2009	10:17	25.06.2009	19:11	-
004	25.06.2009	19:11	29.06.2009	19:15	-
005	29.06.2009	19:15	06.07.2009	16:01	DoLog activated: 02.07.2009 02:00-03:00
006	06.07.2009	16:01	09.07.2009	13:25	-
007	09.07.2009	13:25			

Table 5.11: Details of ADCP recording.

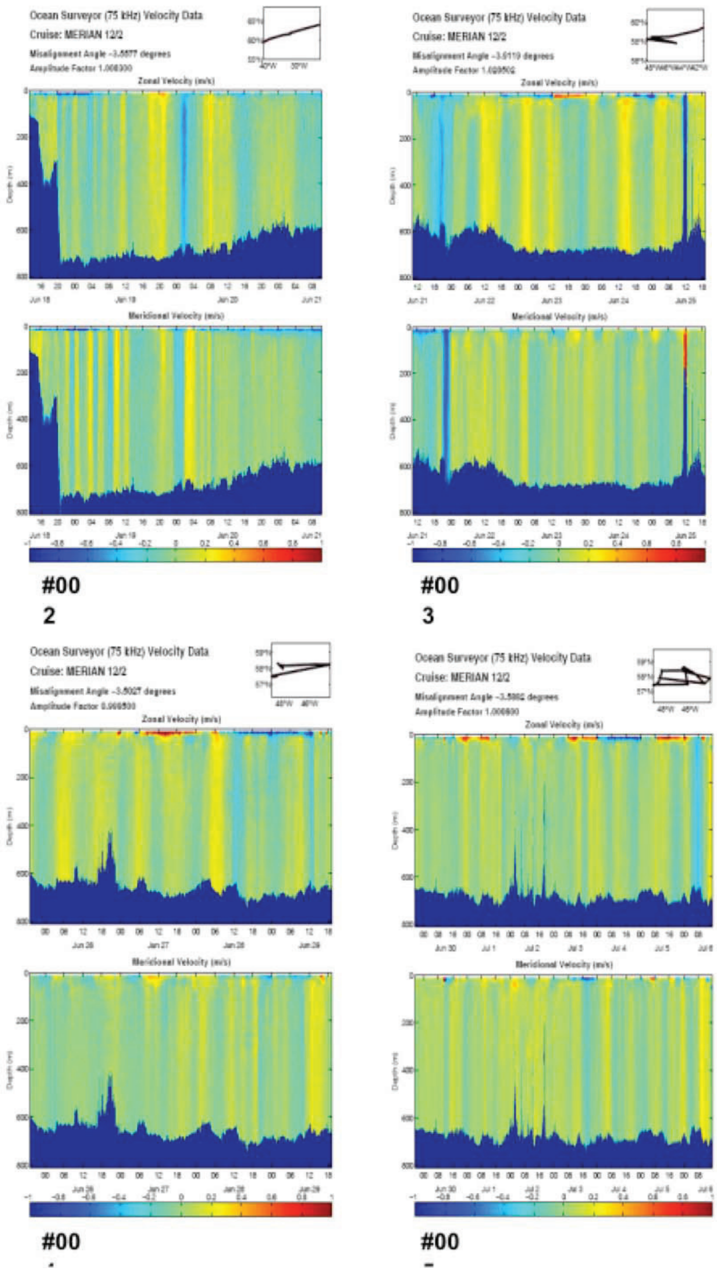


Fig. 5.22: Zonal and meridional velocity time series during MSM 12/2

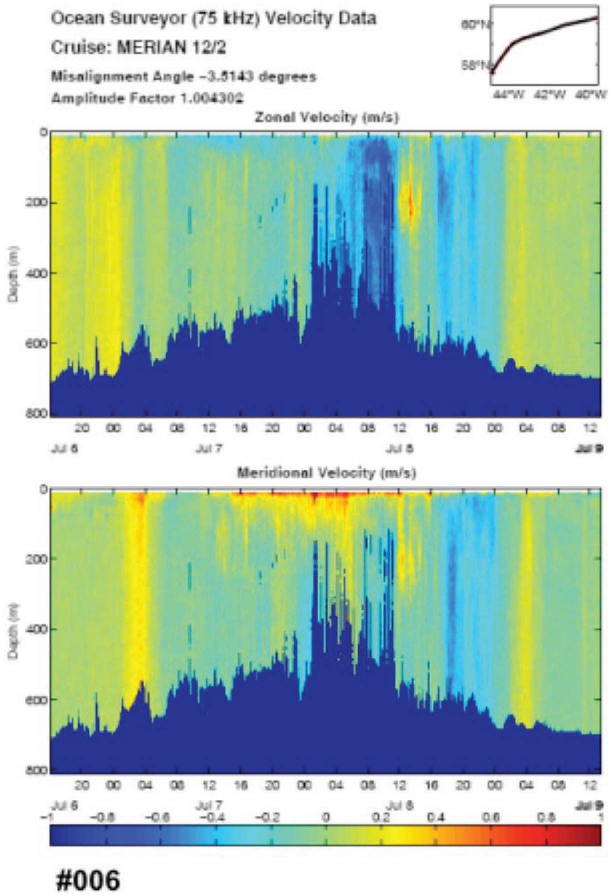


Fig. 5.22: Continued.

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Appendix 1 Teilnehmende Institute/ Participating Institutions

AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung in der Helmholtz-Gemeinschaft Am Alten Hafen 26, D-27568 Bremerhaven, Germany (www.awi.de)
EEL	Exploration Electronics Ltd/ Airbridge Compressors Yarmouth Business Park, Suffolk Rd, Great Yarmouth, Norfolk NR31 0ER, UK (www.exploration-electronics.co.uk)
GEUS	Geological Survey of Denmark and Greenland Øster Voldgade, Dk-1360 Copenhagen K, Denmark (www.geus.dk)
IfM-ZMAW	Institut für Meereskunde, Zentrum für Marine und Atmosphärische Wissenschaften, University Hamburg Bundesstr. 53, D-20146 Hamburg, Germnay (www.ifm.uni-hamburg.de)
Optimare	OPTIMARE Sensorsysteme AG Am Loners 15a, D-27572 Bremerhaven, Germany (www.optimare.de)
Scansurvey	Scansurvey ApS Baldershoej 26a, DK-2635 Ishøj, Denmark (www.scansurvey.dk)
Uni Aarhus	University of Aarhus Department of Earth Sciences Hoegh-Guldbergs Gade 2, DK-8000 Aarhus C, Denmark (www.geo.au.dk)
Uni Bristol	University of Bristol Department of Earth Sciences Wills Memorial Building, Queens Rd, Bristol BS8 1RJ, UK (www.gly.bris.ac.uk)

Appendix 2 Fahrtteilnehmer / Cruise Participants

UENZELMANN-NEBEN, Gabriele	Chief Scientist	AWI
BAASCH, Benjamin	student, Seismics	AWI
EGGERS, Thorsten	Seismics	Optimare
FISCHEL, Andrea	student, PARASOUND	Uni Aarhus/GEUS
FREIBOTHE, Ronald	student, Seismics	AWI
HØJDAL, Jesper	Simrad	Scansurvey
KORDANSKA, Matylda	student, Seismics	AWI
LISS, Barbara	student, Seismics	AWI
MÜLLER-MICHAELIS, Antje	CTD	IfM-ZMAW
NAAFS, Bernhard David	Geology	AWI
NIELD, Mark	compressor technician	EEL
NIESSEN, Frank	PARASOUND, core logging	AWI
OBERMANN, Anne	student, Seismics	AWI
PETERS, Carl	student, Geology	AWI
SAUKEL, Cornelia	Geology	AWI
SCHMIDT, Daniela	Geology	Uni Bristol
SLABY, Beate	student, PARASOUND	AWI
SOMMERFELD, Robert	student, Geology	AWI
STEIN, Rüdiger	Geology	AWI
WEIGELT, Estella	Seismics	AWI
MÜLLER, Reinhard	doctor	Briese

Appendix 3 Besatzung / Ship's Crew

VON STAA, Friedhelm	Master
GUENTHER, Matthias	Chief Officer
BEHNISCH, Holm	1st Officer
MAASS, Björn	2nd Officer
OGRODNIK, Thomas	Chief Engineer
BOY, Manfred	2nd Engineer
RAABE, Rejko	3rd Engineer
STASUN, Oliver	Electrician
WIECHERT, Olaf	Fitter
TOMIAK, Martin	Electronics
MAGGIULLI, Michael	SysOps
KREFT, Norbert	Bosun
ROOB, Christian	SM
VREDENBORG, Enno	SM
ETZDORF, Detlef	SM
PAPKE, Rene	SM
BARON, Heiko	SM
THODE, Marc	SM
BADTKE, Rainer	SM
LORENZEN, Olaf	Motorman
ARNDT, Waldemar	Cook
KROEGER, Sven	2nd Cook
SEIDEL, Iris	Stewardess

Appendix 4 Stationsliste / Station List

Station No.	Date	Time [UTC]	Position Lat	Position Lon	Depth [m]	Gear	Action	Comment
MSM12/639-1	6/21/2009	16:00	59° 10,53' N	42° 9,70' W	2192.4	Multibeam und PARASOUND	start profil	
MSM12/640-1	6/22/2009	6:08	58° 46,83' N	44° 17,40' W	1825.6	CTD/rosette water sampler	surface	
MSM12/640-1	6/22/2009	6:44	58° 46,83' N	44° 17,40' W	1826.3	CTD/rosette water sampler	at depth	SL max 1796 m
MSM12/639-1	6/22/2009	6:50	58° 46,83' N	44° 17,40' W	1827.6	Multibeam und PARASOUND	Information	Techn. Defekt des PS-PC Profile weiter ohne PS
MSM12/640-1	6/22/2009	7:26	58° 46,83' N	44° 17,40' W	1826.7	CTD/rosette water sampler	on deck	
MSM12/640-2	6/22/2009	8:15	58° 46,76' N	44° 17,82' W	1830.6	Seismic reflection profile	Streamer into water	
MSM12/640-2	6/22/2009	9:25	58° 45,86' N	44° 22,52' W	1858.9	Seismic reflection profile	Remark	3175m Streamer ausgebracht
MSM12/640-2	6/22/2009	9:37	58° 45,72' N	44° 23,31' W	1865	Seismic reflection profile	airguns in the water	
MSM12/640-2	6/22/2009	10:13	58° 45,00' N	44° 27,19' W	1894.3	Seismic reflection profile	profile start	Profil AWI 20090001
MSM12/640-2	6/22/2009	10:27	58° 44,68' N	44° 28,91' W	1908.4	Seismic reflection profile	Remark	Unterbrechung wg. Kompressor-Problemen
MSM12/640-2	6/22/2009	10:47	58° 44,25' N	44° 31,27' W	1922.7	Seismic reflection profile	Remark	techn. Probleme behoben
MSM12/640-2	6/22/2009	10:54	58° 44,10' N	44° 32,09' W	1928.8	Seismic reflection profile	Remark	Unterbrechung wg. Kompressor-Problemen
MSM12/640-2	6/22/2009	12:25	58° 42,09' N	44° 42,84' W	1956	Seismic reflection profile	Remark	Beginn Hieven Streamer zur Kontrolle (Lauftiefe nicht korrekt und zu hoher Zug)
MSM12/640-2	6/22/2009	13:45	58° 41,02' N	44° 49,16' W	1979.9	Seismic reflection profile	streamer on deck	Streamerzug zu hoch da Endboje leckge-schlagen & gesunken. Ändern auf gr. Blase
MSM12/640-2	6/22/2009	14:27	58° 40,73' N	44° 50,87' W	1983.3	Seismic reflection profile	Streamer into water	
MSM12/640-2	6/22/2009	15:40	58° 38,98' N	44° 59,46' W	2009	Seismic reflection profile	Remark	Streamer mit 3175m ausgesteckt
MSM12/640-2	6/22/2009	15:47	58° 38,81' N	45° 0,36' W	2017.1	Seismic reflection profile	Remark	Kompressor i.O. - Fortsetzung Profil
MSM12/640-2	6/22/2009	16:07	58° 38,27' N	45° 3,28' W	2057.5	Seismic reflection profile	Remark	Alle 4 Airguns in Betrieb
MSM12/640-2	6/22/2009	18:52	58° 33,62' N	45° 28,12' W	2352.4	Seismic reflection profile	alter course	Neuer Kurs 261°rw
MSM12/640-2	6/22/2009	22:27	58° 30,63' N	46° 2,01' W	2480.3	Seismic reflection profile	alter course	Neuer Kurs 267°
MSM12/640-2	6/23/2009	12:25	58° 28,16' N	48° 14,40' W	3463.8	Seismic reflection profile	alter course	Neuer Kurs 109°
MSM12/640-2	6/23/2009	13:27	58° 25,22' N	48° 10,41' W	3447.5	Seismic reflection profile	Remark	Auf neuem Kurs 109°
MSM12/640-2	6/24/2009	10:12	57° 50,26' N	45° 5,29' W	2702.3	Seismic reflection profile	alter course	Neuer Kurs 281°
MSM12/640-2	6/24/2009	12:08	57° 51,57' N	45° 7,52' W	2652.8	Seismic reflection profile	Remark	Auf neuem Kurs 281°
MSM12/639-1	6/24/2009	21:36	58° 1,19' N	46° 36,36' W	3062.1	Multibeam und PARASOUND	Information	Techn. Defekte behoben, Fortsetzung Profil mit PS
MSM12/640-2	6/25/2009	8:51	58° 12,61' N	48° 22,26' W	3447.2	Seismic reflection profile	alter course	Neuer Kurs 283°
MSM12/640-2	6/25/2009	8:52	58° 12,63' N	48° 22,42' W	3450.6	Seismic reflection profile	Remark	Auf neuem Kurs 283°
MSM12/640-2	6/25/2009	10:49	58° 14,85' N	48° 40,72' W	3475.6	Seismic reflection profile	end of profile	
MSM12/640-2	6/25/2009	11:20	58° 15,33' N	48° 43,54' W	13.4	Seismic reflection profile	array on deck	
MSM12/640-2	6/25/2009	12:32	58° 17,59' N	48° 48,84' W	3485.5	Seismic reflection profile	streamer on deck	
MSM12/639-1	6/25/2009	14:12	58° 13,13' N	48° 25,06' W	3479.6	Multibeam und PARASOUND	profile break	

MSM12/641-1	6/25/2009	14:32	58° 12,62' N	48° 22,17' W	3447.2	CTD/rosette water sampler	surface	
MSM12/641-1	6/25/2009	15:37	58° 12,56' N	48° 22,14' W	3447.8	CTD/rosette water sampler	at depth	Sl max. 3438m, hieven
MSM12/641-1	6/25/2009	16:47	58° 12,56' N	48° 22,15' W	3448	CTD/rosette water sampler	on deck	
MSM12/639-1	6/25/2009	16:47	58° 12,56' N	48° 22,15' W	3448	Multibeam und PARASOUND	continue the profile	
MSM12/639-1	6/26/2009	16:39	58° 12,57' N	48° 22,16' W	3450.6	Multibeam und PARASOUND	profile break	
MSM12/642-1	6/26/2009	16:39	58° 12,57' N	48° 22,16' W	3450.6	Gravity corer	surface	10 m Kernrohr
MSM12/642-1	6/26/2009	17:22	58° 12,57' N	48° 22,16' W	3449.2	Gravity corer	at sea bottom	SL max 3473 m
MSM12/642-1	6/26/2009	17:26	58° 12,56' N	48° 22,16' W	3449.6	Gravity corer	off ground hoisting	
MSM12/642-1	6/26/2009	18:16	58° 12,57' N	48° 22,16' W	3450.1	Gravity corer	on deck	
MSM12/642-2	6/26/2009	18:25	58° 12,57' N	48° 22,16' W	3449.8	Box corer	surface	
MSM12/642-2	6/26/2009	19:08	58° 12,57' N	48° 22,16' W	3454.2	Box corer	at sea bottom	SL max. 3467m
MSM12/642-2	6/26/2009	19:57	58° 12,57' N	48° 22,16' W	3449.1	Box corer	on deck	
MSM12/642-3	6/26/2009	20:12	58° 12,57' N	48° 22,16' W	3450.2	Gravity corer	surface	10 m Kernrohr
MSM12/642-3	6/26/2009	20:53	58° 12,57' N	48° 22,16' W	3447.9	Gravity corer	at sea bottom	SL max 3473m
MSM12/642-3	6/26/2009	20:59	58° 12,57' N	48° 22,16' W	3450.1	Gravity corer	off ground hoisting	
MSM12/642-3	6/26/2009	21:48	58° 12,57' N	48° 22,17' W	3450.9	Gravity corer	on deck	
MSM12/639-1	6/26/2009	21:48	58° 12,57' N	48° 22,17' W	3450.9	Multibeam und PARASOUND	continue the profile	
MSM12/639-1	6/27/2009	0:20	58° 9,48' N	47° 52,43' W	3306.6	Multibeam und PARASOUND	profile break	
MSM12/643-1	6/27/2009	0:20	58° 9,48' N	47° 52,43' W	3306.6	Gravity corer	surface	
MSM12/643-1	6/27/2009	1:14	58° 9,49' N	47° 52,44' W	3305.5	Gravity corer	at sea bottom	Sl max. 3325m, Fz max. 62,8kN
MSM12/643-1	6/27/2009	2:14	58° 9,48' N	47° 52,44' W	3305.7	Gravity corer	on deck	
MSM12/643-2	6/27/2009	2:25	58° 9,48' N	47° 52,44' W	3304.8	Box corer	surface	
MSM12/643-2	6/27/2009	3:17	58° 9,48' N	47° 52,44' W	3306.4	Box corer	at sea bottom	Sl max. 3329m, Fz max. 42,7kN
MSM12/643-2	6/27/2009	4:14	58° 9,48' N	47° 52,44' W	3305	Box corer	on deck	
MSM12/639-1	6/27/2009	5:43	58° 10,32' N	48° 18,76' W	3429.2	Multibeam und PARASOUND	continue the profile	
MSM12/644-1	6/27/2009	5:43	58° 10,32' N	48° 18,76' W	3429.2	Seismic reflection profile	Streamer into water	
MSM12/644-1	6/27/2009	7:09	58° 8,61' N	48° 12,27' W	3408.3	Seismic reflection profile	airguns in the water	
MSM12/644-1	6/27/2009	7:14	58° 8,62' N	48° 11,91' W	3404.5	Seismic reflection profile	profile start	
MSM12/644-1	6/27/2009	23:17	58° 14,22' N	45° 38,96' W	2272.2	Seismic reflection profile	alter course	Neuer Kurs 91°
MSM12/644-1	6/28/2009	6:30	58° 13,96' N	44° 28,42' W	2348.9	Seismic reflection profile	end of profile	Drehen auf neues Profil, neuer Kurs 254°rw
MSM12/644-1	6/28/2009	8:13	58° 11,94' N	44° 32,06' W	2371.1	Seismic reflection profile	profile start	Profil AWI 20090006
MSM12/644-1	6/29/2009	0:08	57° 48,85' N	46° 59,50' W	3114	Seismic reflection profile	Remark	Airgun aus wg. Problemen mit Kompressor
MSM12/644-1	6/29/2009	1:08	57° 47,83' N	47° 5,97' W	3127.7	Seismic reflection profile	Remark	Kompressor repariert
MSM12/644-1	6/29/2009	13:35	57° 29,31' N	48° 57,44' W	3503.7	Seismic reflection profile	end of profile	
MSM12/644-1	6/29/2009	13:53	57° 28,41' N	48° 56,53' W	3502.9	Seismic reflection profile	array on deck	
MSM12/644-1	6/29/2009	15:20	57° 26,10' N	48° 53,70' W	3508.1	Seismic reflection profile	streamer on deck	
MSM12/639-1	6/29/2009	17:39	57° 28,52' N	48° 31,82' W	3466.4	Multibeam und PARASOUND	profile break	
MSM12/645-1	6/29/2009	17:39	57° 28,52' N	48° 31,82' W	3466.4	CTD/rosette water sampler	surface	
MSM12/645-1	6/29/2009	18:43	57° 28,52' N	48° 31,81' W	3465.7	CTD/rosette water sampler	at depth	SL max 3453 m
MSM12/645-1	6/29/2009	19:56	57° 28,52' N	48° 31,81' W	3463.1	CTD/rosette water sampler	on deck	
MSM12/645-2	6/29/2009	20:14	57° 28,52' N	48° 31,81' W	3463.1	Gravity corer	surface	10 m Kernrohr

MSM12/645-2	6/29/2009	20:58	57° 28,52' N	48° 31,82' W	3465.1	Gravity corer	at sea bottom	SL max. 3481m
MSM12/645-2	6/29/2009	20:59	57° 28,52' N	48° 31,82' W	3465.8	Gravity corer	off ground hoisting	
MSM12/645-2	6/29/2009	21:50	57° 28,52' N	48° 31,82' W	3463.7	Gravity corer	on deck	
MSM12/645-3	6/29/2009	21:57	57° 28,52' N	48° 31,82' W	3464.1	Box corer	surface	
MSM12/645-3	6/29/2009	22:03	57° 28,52' N	48° 31,82' W	3464.4	Box corer	information	Abbruch, SL max. 165m
MSM12/645-3	6/29/2009	22:06	57° 28,52' N	48° 31,82' W	3466.2	Box corer	information	Oberfläche, erneut fieren
MSM12/645-3	6/29/2009	22:47	57° 28,52' N	48° 31,81' W	3464.5	Box corer	at sea bottom	SLmax. 3477m
MSM12/645-3	6/29/2009	23:33	57° 28,52' N	48° 31,82' W	3464.6	Box corer	on deck	
MSM12/639-1	6/29/2009	23:33	57° 28,52' N	48° 31,82' W	3464.6	Multibeam und PARASOUND	continue the profile	
MSM12/639-1	6/30/2009	1:50	57° 33,45' N	48° 37,03' W	3491.4	Multibeam und PARASOUND	profile break	
MSM12/646-1	6/30/2009	1:50	57° 33,45' N	48° 37,03' W	3491.4	Gravity corer	surface	
MSM12/646-1	6/30/2009	2:38	57° 33,45' N	48° 37,02' W	3490.5	Gravity corer	at sea bottom	Sl max. 3510m, Fz max. 63,9kN
MSM12/646-1	6/30/2009	3:33	57° 33,45' N	48° 37,03' W	3491.9	Gravity corer	on deck	
MSM12/646-2	6/30/2009	3:42	57° 33,45' N	48° 37,02' W	3491.9	Box corer	surface	
MSM12/646-2	6/30/2009	4:24	57° 33,45' N	48° 37,03' W	3491.9	Box corer	at sea bottom	SL max 3510 m
MSM12/646-2	6/30/2009	5:10	57° 33,45' N	48° 37,02' W	3491.4	Box corer	on deck	
MSM12/639-1	6/30/2009	5:10	57° 33,45' N	48° 37,02' W	3491.4	Multibeam und PARASOUND	continue the profile	
MSM12/639-1	6/30/2009	5:52	57° 32,31' N	48° 44,32' W	3490.9	Multibeam und PARASOUND	profile break	
MSM12/647-1	6/30/2009	5:52	57° 32,31' N	48° 44,32' W	3490.9	Gravity corer	surface	10 m Kernrohr
MSM12/647-1	6/30/2009	6:34	57° 32,31' N	48° 44,32' W	3492.1	Gravity corer	at sea bottom	SL max 3504 m
MSM12/647-1	6/30/2009	6:34	57° 32,31' N	48° 44,32' W	3492.1	Gravity corer	off ground hoisting	
MSM12/647-1	6/30/2009	7:28	57° 32,31' N	48° 44,32' W	3491.5	Gravity corer	on deck	
MSM12/647-2	6/30/2009	7:32	57° 32,31' N	48° 44,32' W	3487.6	Box corer	surface	
MSM12/647-2	6/30/2009	8:14	57° 32,31' N	48° 44,32' W	3490	Box corer	at sea bottom	SL max. 3497m
MSM12/647-2	6/30/2009	8:58	57° 32,31' N	48° 44,32' W	3490	Box corer	on deck	BC hat nicht ausgelöst
MSM12/647-3	6/30/2009	9:03	57° 32,31' N	48° 44,32' W	3491.1	Box corer	surface	
MSM12/647-3	6/30/2009	9:45	57° 32,31' N	48° 44,32' W	3490.6	Box corer	at sea bottom	SL max. 3501m
MSM12/647-3	6/30/2009	10:29	57° 32,31' N	48° 44,32' W	3490	Box corer	on deck	
MSM12/639-1	6/30/2009	10:29	57° 32,31' N	48° 44,32' W	3490	Multibeam und PARASOUND	continue the profile	
MSM12/648-1	6/30/2009	11:49	57° 43,87' N	48° 31,27' W	3444.9	Seismic reflection profile	Streamer into water	
MSM12/648-1	6/30/2009	13:05	57° 39,17' N	48° 34,69' W	3481.9	Seismic reflection profile	Remark	Streamer ausgesteckt, 3190m
MSM12/648-1	6/30/2009	13:10	57° 38,87' N	48° 34,90' W	3492.3	Seismic reflection profile	airguns in the water	
MSM12/648-1	6/30/2009	13:40	57° 36,73' N	48° 36,47' W	3492.9	Seismic reflection profile	alter course	Auf neuen Kurs 225°
MSM12/648-1	6/30/2009	13:49	57° 36,14' N	48° 37,31' W	3491.4	Seismic reflection profile	profile start	
MSM12/648-1	6/30/2009	16:26	57° 26,76' N	48° 54,72' W	3506.1	Seismic reflection profile	end of profile	
MSM12/648-1	6/30/2009	16:48	57° 25,46' N	48° 57,03' W	3534.5	Seismic reflection profile	alter course	Beginn Wendemanöver auf 090°rw
MSM12/648-1	6/30/2009	18:39	57° 28,44' N	48° 55,97' W	3497.7	Seismic reflection profile	profile start	Profil AWI 20090008
MSM12/648-1	6/30/2009	21:13	57° 28,51' N	48° 31,82' W	3466.6	Seismic reflection profile	alter course	Am Wegpunkt IODP 1305, neuer Kurs 089°
MSM12/648-1	7/1/2009	12:06	57° 30,18' N	46° 12,42' W	3156.5	Seismic reflection profile	end of profile	
MSM12/648-1	7/1/2009	12:25	57° 30,20' N	46° 9,51' W	3175.4	Seismic reflection profile	alter course	Beginn Wendmanöver auf rw 354°

MSM12/648-1	7/1/2009	13:26	57° 32,16' N	46° 12,86' W	3107.1	Seismic reflection profile	profile start	Profil AWI-20090009
MSM12/648-1	7/2/2009	1:19	58° 30,22' N	46° 24,00' W	2580.8	Seismic reflection profile	alter course	WP IODP_1307 - KÄ auf rw 358°
MSM12/648-1	7/2/2009	1:37	58° 31,67' N	46° 24,13' W	2566.1	Seismic reflection profile	Remark	Abbruch Profil, Beide Auftriebskörper der Airguns verloren
MSM12/648-1	7/2/2009	2:25	58° 34,90' N	46° 24,36' W	2552.6	Seismic reflection profile	array on deck	
MSM12/648-1	7/2/2009	3:43	58° 39,09' N	46° 26,90' W	2553.2	Seismic reflection profile	streamer on deck	
MSM12/639-1	7/2/2009	5:38	58° 30,34' N	46° 24,05' W	2579.8	Multibeam und PARASOUND	profile break	
MSM12/649-1	7/2/2009	5:38	58° 30,34' N	46° 24,05' W	2579.8	CTD/rosette water sampler	surface	
MSM12/649-1	7/2/2009	6:26	58° 30,34' N	46° 24,05' W	2580.1	CTD/rosette water sampler	at depth	SL max 2569 m
MSM12/649-1	7/2/2009	7:19	58° 30,34' N	46° 24,05' W	2578.3	CTD/rosette water sampler	on deck	
MSM12/649-2	7/2/2009	8:04	58° 30,34' N	46° 24,05' W	2580	Box corer	surface	
MSM12/649-2	7/2/2009	8:37	58° 30,34' N	46° 24,05' W	2577.5	Box corer	at sea bottom	SL max. 2638m
MSM12/649-2	7/2/2009	9:17	58° 30,34' N	46° 24,05' W	2581.1	Box corer	on deck	
MSM12/649-3	7/2/2009	9:26	58° 30,34' N	46° 24,05' W	2578.3	Gravity corer	surface	10 m Kernrohr
MSM12/649-3	7/2/2009	10:00	58° 30,34' N	46° 24,05' W	2579.9	Gravity corer	at sea bottom	SL max. 2591m
MSM12/649-3	7/2/2009	10:00	58° 30,34' N	46° 24,05' W	2579.9	Gravity corer	off ground hoisting	
MSM12/649-3	7/2/2009	10:42	58° 30,34' N	46° 24,05' W	2579.4	Gravity corer	on deck	
MSM12/649-4	7/2/2009	10:52	58° 30,34' N	46° 24,05' W	2579.6	Box corer	surface	
MSM12/649-4	7/2/2009	11:24	58° 30,34' N	46° 24,05' W	2579.3	Box corer	at sea bottom	SL max. 2595m
MSM12/649-4	7/2/2009	12:03	58° 30,34' N	46° 24,05' W	2577.9	Box corer	on deck	
MSM12/639-1	7/2/2009	12:03	58° 30,34' N	46° 24,05' W	2577.9	Multibeam und PARASOUND	continue the profile	
MSM12/639-1	7/2/2009	14:50	58° 14,23' N	45° 38,55' W	2276.1	Multibeam und PARASOUND	profile break	
MSM12/650-1	7/2/2009	14:50	58° 14,23' N	45° 38,55' W	2276.1	CTD/rosette water sampler	surface	
MSM12/650-1	7/2/2009	15:36	58° 14,23' N	45° 38,56' W	2274	CTD/rosette water sampler	at depth	Sl max. 2263m
MSM12/650-1	7/2/2009	16:22	58° 14,23' N	45° 38,56' W	2279.4	CTD/rosette water sampler	on deck	
MSM12/650-2	7/2/2009	16:31	58° 14,23' N	45° 38,56' W	2271.8	Box corer	surface	
MSM12/650-2	7/2/2009	16:59	58° 14,23' N	45° 38,56' W	2274	Box corer	at sea bottom	SL max. 2291m
MSM12/650-2	7/2/2009	17:32	58° 14,23' N	45° 38,56' W	2273.9	Box corer	on deck	
MSM12/650-3	7/2/2009	17:42	58° 14,23' N	45° 38,56' W	2273.8	Gravity corer	surface	10 m Kernrohr
MSM12/650-3	7/2/2009	18:10	58° 14,23' N	45° 38,56' W	2272.4	Gravity corer	at sea bottom	SL max. 2291m
MSM12/650-3	7/2/2009	18:10	58° 14,23' N	45° 38,56' W	2272.4	Gravity corer	off ground hoisting	
MSM12/650-3	7/2/2009	18:48	58° 14,23' N	45° 38,56' W	2273.3	Gravity corer	on deck	
MSM12/639-1	7/2/2009	18:48	58° 14,23' N	45° 38,56' W	2273.3	Multibeam und PARASOUND	continue the profile	
MSM12/639-1	7/2/2009	22:23	58° 36,12' N	46° 25,82' W	2560.1	Multibeam und PARASOUND	profile break	
MSM12/651-1	7/2/2009	22:23	58° 36,12' N	46° 25,82' W	2560.1	Box corer	surface	
MSM12/651-1	7/2/2009	22:53	58° 36,12' N	46° 25,83' W	2561	Box corer	at sea bottom	SL max. 2575m
MSM12/651-1	7/2/2009	23:30	58° 36,12' N	46° 25,83' W	2564.4	Box corer	on deck	
MSM12/651-2	7/2/2009	23:41	58° 36,12' N	46° 25,82' W	2560.5	Gravity corer	surface	10 m Kernrohr
MSM12/651-2	7/3/2009	0:14	58° 36,12' N	46° 25,82' W	2560.1	Gravity corer	at sea bottom	SL max. 2582m, Fz max. 59,0 kN
MSM12/651-2	7/3/2009	1:01	58° 36,12' N	46° 25,83' W	2562.6	Gravity corer	on deck	
MSM12/639-1	7/3/2009	1:01	58° 36,12' N	46° 25,83' W	2562.6	Multibeam und PARASOUND	continue the profile	

MSM12/652-1	7/3/2009	6:09	58° 33,76' N	46° 37,80' W	2705.8	Seismic reflection profile	Streamer into water	
MSM12/652-1	7/3/2009	7:44	58° 31,13' N	46° 27,17' W	2610.4	Seismic reflection profile	airguns in the water	
MSM12/652-1	7/3/2009	8:09	58° 30,34' N	46° 24,01' W	2577.7	Seismic reflection profile	profile start	Profil AWI 20090010
MSM12/639-1	7/3/2009	13:35	58° 15,05' N	45° 40,85' W	2285.4	Multibeam und PARASOUND	Information	erneut techn. Defekt des PARASOUND - PC; Profil weiter nur mit EM120 (MB)
MSM12/652-1	7/3/2009	13:50	58° 14,32' N	45° 38,84' W	2274.7	Seismic reflection profile	alter course	WP IODP_1306 - neuer Kurs 146°
MSM12/639-1	7/3/2009	18:15	57° 55,68' N	45° 15,39' W	2477.3	Multibeam und PARASOUND	Information	PS-PC repariert; PS wieder gestartet
MSM12/652-1	7/3/2009	23:24	57° 35,41' N	44° 47,67' W	3229.3	Seismic reflection profile	end of profile	Kursänderung: Neuer Kurs 280°, Kanonen abgesoffen
MSM12/652-1	7/3/2009	23:39	57° 35,16' N	44° 45,50' W	3240	Seismic reflection profile	Remark	Beginn einholen der Kanonen
MSM12/652-1	7/3/2009	23:48	57° 34,61' N	44° 44,82' W	3257.7	Seismic reflection profile	array on deck	
MSM12/652-1	7/4/2009	0:10	57° 33,16' N	44° 46,16' W	3292.1	Seismic reflection profile	airguns in the water	Airguns nun mit 3 Blasen
MSM12/652-1	7/4/2009	0:44	57° 33,93' N	44° 51,03' W	3235.7	Seismic reflection profile	profile start	Profil AWI_20090011
MSM12/652-1	7/5/2009	0:31	57° 54,44' N	48° 31,76' W	3393.1	Seismic reflection profile	end of profile	Beginn KÄ auf 011°
MSM12/652-1	7/5/2009	1:49	57° 54,19' N	48° 28,90' W	3387.8	Seismic reflection profile	profile start	Profil AWI_20090012
MSM12/652-1	7/5/2009	5:28	58° 12,53' N	48° 22,17' W	3448	Seismic reflection profile	Remark	Passieren Wegpunkt IODP 646
MSM12/652-1	7/5/2009	7:22	58° 21,92' N	48° 18,77' W	3465.4	Seismic reflection profile	end of profile	
MSM12/652-1	7/5/2009	7:50	58° 24,19' N	48° 18,04' W	3465.4	Seismic reflection profile	alter course	Neuer Kurs 089°rw
MSM12/652-1	7/5/2009	9:16	58° 23,81' N	48° 18,75' W	3469.5	Seismic reflection profile	profile start	AWI-2009013
MSM12/652-1	7/5/2009	18:48	58° 24,77' N	46° 48,38' W	2922.1	Seismic reflection profile	end of profile	
MSM12/652-1	7/5/2009	19:07	58° 24,81' N	46° 45,25' W	2913.1	Seismic reflection profile	alter course	Neuer Kurs 112°rw
MSM12/652-1	7/5/2009	19:10	58° 24,81' N	46° 44,77' W	2914.3	Seismic reflection profile	profile start	Profil AWI 20090014
MSM12/639-1	7/5/2009	21:43	58° 20,17' N	46° 22,48' W	2801.1	Multibeam und PARASOUND	Information	erneut techn. Defekt des PARASOUND - PC; Profil weiter nur mit EM120 (MB)
MSM12/652-1	7/6/2009	10:41	57° 56,01' N	44° 28,82' W	2901.6	Seismic reflection profile	end of profile	
MSM12/652-1	7/6/2009	10:56	57° 55,62' N	44° 27,03' W	2928.1	Seismic reflection profile	array on deck	
MSM12/652-1	7/6/2009	12:12	57° 55,36' N	44° 17,40' W	3028.9	Seismic reflection profile	streamer on deck	
MSM12/639-1	7/6/2009	14:30	57° 34,16' N	44° 44,74' W	3275.7	Multibeam und PARASOUND	profile break	
MSM12/653-1	7/6/2009	14:30	57° 34,16' N	44° 44,74' W	3275.7	CTD/rosette water sampler	surface	
MSM12/653-1	7/6/2009	15:35	57° 34,16' N	44° 44,75' W	3273.4	CTD/rosette water sampler	at depth	Sl max. 3279m
MSM12/653-1	7/6/2009	16:51	57° 34,16' N	44° 44,74' W	3272.9	CTD/rosette water sampler	on deck	
MSM12/653-2	7/6/2009	16:57	57° 34,16' N	44° 44,74' W	3274.4	Gravity corer	surface	15 m Kernrohr
MSM12/653-2	7/6/2009	17:38	57° 34,16' N	44° 44,74' W	3274.7	Gravity corer	at sea bottom	SL max 3291 m
MSM12/653-2	7/6/2009	17:39	57° 34,16' N	44° 44,74' W	3274.4	Gravity corer	off ground hoisting	
MSM12/653-2	7/6/2009	18:27	57° 34,16' N	44° 44,74' W	3274.5	Gravity corer	on deck	
MSM12/653-3	7/6/2009	18:34	57° 34,16' N	44° 44,74' W	3273.5	Box corer	surface	
MSM12/653-3	7/6/2009	19:14	57° 34,16' N	44° 44,74' W	3274.5	Box corer	at sea bottom	SL max 3295 m
MSM12/653-3	7/6/2009	19:58	57° 34,16' N	44° 44,74' W	3273.9	Box corer	on deck	
MSM12/639-1	7/6/2009	19:58	57° 34,16' N	44° 44,74' W	3273.9	Multibeam und PARASOUND	continue the profile	

MSM12/639-1	7/6/2009	20:52	57° 36,08' N	44° 51,18' W	3192.3	Multibeam und PARASOUND	profile break	
MSM12/654-1	7/6/2009	20:52	57° 36,08' N	44° 51,18' W	3192.3	Box corer	surface	
MSM12/654-1	7/6/2009	21:31	57° 36,08' N	44° 51,18' W	3196.5	Box corer	at sea bottom	SL max. 3207m
MSM12/654-1	7/6/2009	22:14	57° 36,08' N	44° 51,18' W	3194.9	Box corer	on deck	
MSM12/654-2	7/6/2009	22:25	57° 36,08' N	44° 51,18' W	3197.6	Gravity corer	surface	15 m Kernrohr
MSM12/654-2	7/6/2009	23:07	57° 36,08' N	44° 51,18' W	3195	Gravity corer	at sea bottom	SL max. 3217m
MSM12/654-2	7/6/2009	23:07	57° 36,08' N	44° 51,18' W	3195	Gravity corer	off ground hoisting	
MSM12/654-2	7/6/2009	23:55	57° 36,08' N	44° 51,18' W	3193.6	Gravity corer	on deck	
MSM12/639-1	7/6/2009	23:55	57° 36,08' N	44° 51,18' W	3193.6	Multibeam und PARASOUND	continue the profile	
MSM12/639-1	7/7/2009	7:23	58° 14,32' N	44° 24,88' W	2384.7	Multibeam und PARASOUND	profile break	
MSM12/655-1	7/7/2009	7:23	58° 14,32' N	44° 24,88' W	2384.7	CTD/rosette water sampler	surface	
MSM12/655-1	7/7/2009	8:09	58° 14,32' N	44° 24,88' W	2383.8	CTD/rosette water sampler	at depth	SL max. 2373m
MSM12/655-1	7/7/2009	8:54	58° 14,32' N	44° 24,88' W	2384.5	CTD/rosette water sampler	on deck	
MSM12/655-2	7/7/2009	9:10	58° 14,31' N	44° 24,89' W	2383.4	Gravity corer	surface	10 m Kernrohr
MSM12/655-2	7/7/2009	9:43	58° 14,31' N	44° 24,89' W	2386.7	Gravity corer	at sea bottom	SL max 2405 m
MSM12/655-2	7/7/2009	9:44	58° 14,31' N	44° 24,89' W	2388.6	Gravity corer	off ground hoisting	
MSM12/655-2	7/7/2009	10:20	58° 14,31' N	44° 24,89' W	2382.6	Gravity corer	on deck	
MSM12/639-1	7/7/2009	10:20	58° 14,31' N	44° 24,89' W	2382.6	Multibeam und PARASOUND	continue the profile	
MSM12/639-1	7/9/2009	8:01	60° 10,33' N	40° 7,02' W	2348.9	Multibeam und PARASOUND	profile break	
MSM12/656-1	7/9/2009	8:01	60° 10,33' N	40° 7,02' W	2348.9	Gravity corer	surface	15 m Kernrohr
MSM12/656-1	7/9/2009	8:33	60° 10,34' N	40° 7,02' W	2347.9	Gravity corer	at sea bottom	SL max. 2364m
MSM12/656-1	7/9/2009	8:33	60° 10,34' N	40° 7,02' W	2347.9	Gravity corer	off ground hoisting	
MSM12/656-1	7/9/2009	9:12	60° 10,33' N	40° 7,02' W	2347.8	Gravity corer	on deck	
MSM12/656-2	7/9/2009	9:20	60° 10,33' N	40° 7,02' W	2350.3	Box corer	surface	
MSM12/656-2	7/9/2009	9:50	60° 10,34' N	40° 7,02' W	2347.6	Box corer	at sea bottom	SL max. 2368m
MSM12/656-2	7/9/2009	9:56	60° 10,33' N	40° 7,02' W	2346.9	Box corer	information	Stop hieven, Störung Winde
MSM12/656-2	7/9/2009	10:00	60° 10,34' N	40° 7,02' W	2346.7	Box corer	information	Störung behoben, weiter hieven
MSM12/656-2	7/9/2009	10:33	60° 10,33' N	40° 7,02' W	2347.3	Box corer	on deck	
MSM12/639-1	7/9/2009	10:33	60° 10,33' N	40° 7,02' W	2347.3	Multibeam und PARASOUND	continue the profile	
MSM12/639-1	7/9/2009	12:10	60° 17,21' N	39° 40,16' W	2562.4	Multibeam und PARASOUND	profile break	Unterbrechung der MB-Aufzeichnungen wegen Kalibrierung EM120
MSM12/657-1	7/9/2009	12:15	60° 17,24' N	39° 40,14' W	2563.5	CTD/rosette water sampler	surface	
MSM12/657-1	7/9/2009	13:05	60° 17,24' N	39° 40,14' W	2564.5	CTD/rosette water sampler	at depth	Sl max. 2553m
MSM12/657-1	7/9/2009	14:08	60° 17,24' N	39° 40,14' W	2561.9	CTD/rosette water sampler	on deck	
MSM12/639-1	7/9/2009	14:45	60° 14,83' N	39° 32,73' W	2555.8	Multibeam und PARASOUND	continue the profile	5 Profile zur Kalibrierung des EM 120
MSM12/639-1	7/9/2009	15:31	60° 19,95' N	39° 29,91' W	2697.8	Multibeam und PARASOUND	end of track	KÄ auf Gegenkurs
MSM12/639-1	7/9/2009	15:41	60° 20,01' N	39° 29,88' W	2699.9	Multibeam und PARASOUND	start track	
MSM12/639-1	7/9/2009	16:25	60° 15,08' N	39° 32,66' W	2558.4	Multibeam und PARASOUND	end of track	KÄ zum Parallelprofil
MSM12/639-1	7/9/2009	16:54	60° 15,39' N	39° 38,07' W	2514.5	Multibeam und PARASOUND	start track	
MSM12/639-1	7/9/2009	17:42	60° 20,81' N	39° 35,04' W	2692	Multibeam und PARASOUND	end of track	KÄ auf Gegenkurs

MSM12/639-1	7/9/2009	17:51	60° 20,86' N	39° 35,03' W	2694.7	Multibeam und PARASOUND	start track	
MSM12/639-1	7/9/2009	18:38	60° 15,50' N	39° 38,03' W	2518	Multibeam und PARASOUND	end of track	
MSM12/639-1	7/9/2009	19:16	60° 18,33' N	39° 38,88' W	2603.9	Multibeam und PARASOUND	start track	Querprofil
MSM12/639-1	7/9/2009	20:12	60° 15,68' N	39° 26,91' W	2626.3	Multibeam und PARASOUND	end of profile	

Appendix 5 Beobachtung mariner Säuger / Marine Mammal Observations

date	time	latitude	longitude	info	observation	approx. distance	seismic stop	seismic start	name
19/06/2009	16:59	61°47.61'N	32°52.92'W	start MMSO	-	-	-	-	AMM
19/06/2010	17:37	61°45.08'N	32°51.80'W	start shooting, seismic test (4 airguns)	-	-	-	17:37	AMM
19/06/2009	17:49	61°44.25'N	32°51.32'W	stop shooting (compressor failure), stop MMSO	-	-	17:48	-	AMM
22/06/2009	9:55	58°45.44'N	44°29.09'W	start MMSO	-	-	-	-	DNS
22/06/2009	10:13	58°45.10'N	44°29.00'W	start shooting (4 airguns)	-	-	-	10:13	DNS
22/06/2009	10:27	58°44.65'N	44°29.08'W	stop shooting (compressor failure)	-	-	10:27	-	DNS
22/06/2009	10:47	58°44.23'N	44°31.40'W	start shooting (4 airguns)	-	-	-	10:47	DNS
22/06/2009	10:54	58°44.08'N	44°32.19'W	stop shooting (compressor failure)	-	-	10:54	-	DNS
22/06/2009	15:45	58°38.91'N	44°59.88'W	start shooting (4 airguns)	-	-	-	15:45	DNa
22/06/2009	17:10	58°36.48'N	45°12.71'W	stop & start shooting	Group (approx. 10-15) Pilotwhales ahead, distance < 200m, pass ship on port side [distance > 200m at 17:13h (wait 5 minutes before restart shooting)]	70 m	17:10	17:18	AMM
22/06/2009	20:30	58°32.21'N	45°43.98'W	stop & start shooting	2-3 Hering Whales (Finnwale) pass ship on port side, distance <= 200m	200 m	20:49	20:56	CP
23/06/2009	12:10	58°27.83'N	48°12.35'W	stop & start shooting	Whales, distance < 200m	100 m	12:10	12:20	DNa
23/06/2009	13:07	58°25.89'N	48°13.26'W	stop & start shooting	Whales, distance < 200m	100 m	13:07	13:13	DNa
23/06/2009	15:35	58°21.73'N	47°51.16'W	stop & start shooting	Whales, distance < 200m	< 200 m	15:33	15:39	DNa
24/06/2009	12:58	57°52.39'N	45°15.15'W	stop & start shooting	Whales, distance < 200m	50 m	12:58	13:03	DNa
24/06/2009	17:11	57°56.73'N	45°55.12'W	-	blow of a whale approx. 1000 m ahead, 17:15 blow ahead 1 point port side approx. 500 m, 17:20 blow ahead 3-4 point	> 200 m	-	-	AMM

					portside approx. 700 m				
25/06/2009	5:56	58°09.71'N	47°55.00'W	stop shooting	numerous Pilotwhales	< 200 m	5:56	-	CP
25/06/2009	6:10	58°09.92'N	47°57.37'W	still stopped & start shooting	another small group of whales	< 200 m	still stopped	6:13	CP
25/06/2009	6:53	58°10.65'N	48°04.05'W	stop & start shooting	probably same group of whales (05:56)	< 200 m	6:53	6:57	CP
25/06/2009	7:03	58°10.79'N	48°05.00'W	stop & start shooting	probably same group of whales (05:56 and 06:53)	< 200 m	7:03	7:10	CP
25/06/2009	10:49	58°14.86'N	48°40.87'W	stop shooting, profile end, streamer in, stop MMSO	-	-	10:49	-	DNS
27/06/2009	7:16	58°08.63'N	48°11.70'W	start MMSO	-	-	-	-	AMM
27/06/2009	7:43	58°08.75'N	48°08.23'W	start shooting (4 airguns)	-	-	-	7:43	AMM
27/06/2009	16:25	58°11.85'N	46°43.53'W	-	Group (approx. 10) Pilotwhales ahead 4.5 point port side, distance approx. 400m, pass ship on port side distance approx. 500 m, 16:35h out of sight	> 200 m	-	-	AMM
29/06/2009	5:20	57°41.75'N	47°44.50'W	stop & start shooting	Blow of a whale (grey, big) apprx. 100m ahead 3 point starbord side, 05:22 another blow ahead 2 point starbord side approx. 50 m, 05:25 2 whales 7-8 point starbord side approx. 100m	100 m	5:20	5:31	AMM
29/06/2009	6:41	57°39.89'N	47°56.26'W	stop & start shooting	Group (school) pilotwhales ahad 1 point starbord approx. 150m, pass ship on starbord side approx. 50-150m, 06:48 distance > 200m	150 m	6:41	6:53	AMM
29/06/2009	8:41	57°37.02'N	48°14.13'W	-	5-6 pilotwhales approx. 300m starbord side, disappeared within 5 minutes	> 200 m	-	-	DNS
29/06/2009	13:35	57°29.31'N	48°57.44'W	stop shooting, profile end,	-	-	-	-	DNa

				streamer in, stop MMSO					
30/06/2009	13:05	57°39.17'N	48°34.69'W	start MMSO	-	-	-	-	TE
30/06/2009	13:10	57°38.87'N	48°34.90'W	start shooting	-	-	-	-	TE
01/07/2009	10:29	57°30.03'N	46°27.00'W	stop & start shooting	Group (school) pilotwhales passing on port side <200m, 10:40 same school jumping, 10 min, max. 12-15 individuals distance > 300m, 10:50 same group, increasing distance > 500m, out of sight 10:59	< 200 m	10:29	10:33	DNS
02/07/2009	1:37	58°31.67'N	46°24.13'W	stop shooting, profile end, streamer in, stop MMSO	-	-	1:37	-	RS
03/07/2009	7:45	58°31.12'N	46°27.12'W	start MMSO	-	-	-	-	AMM
03/07/2009	7:57	58°30.75'N	46°25.64'W	start shooting	-	-	-	7:57	AMM
03/07/2009	9:28	58°26.00'N	46°13.48'W	stop & start shooting	small group pilotwhales starbord side approx. 200m	200 m	9:28	9:32	DNS
03/07/2009	15:06	58°08.61'N	45°31.95'W	stop & start shooting	large group (30-40) pilotwhales aft port side, start diving, wait 5 minutes	200 m	15:06	15:11	DNa
03/07/2009	16:41	58°02.31'N	45°23.62'W	stop & start shooting	group (15-20) pilotwhales aft port side following the ship, dissapearing in starboard direction	200 m	16:41	16:58	AMM
04/07/2009	17:12	57°48.24'N	47°24.80'W	-	blow of a whale aft starbord side approx. 1500 m	> 200 m	-	-	AMM
04/07/2009	17:21	57°48.35'N	47°25.89'W	-	group pilotwhales aft approx 3000 m coming closer up to 350 m, stopped, last blows 3000 m, 17:40 out of sight	> 200 m	-	-	AMM
05/07/2009	13:41	58°24.28'N	47°36.81'W	-	group pilotwhales distance > 200m	> 200 m	-	-	DNa
05/07/2009	13:50	58°24.28'N	47°35.51'W	stop & start shooting	group pilot whales	< 200 m	13:50	13:55	DNa
05/07/2009	14:55	58°24.28'N	47°23.07'W	-	group (sei) whales, stay	> 200 m	-	-	DNa

					around until 15:15, distance approx. 400 m				
05/07/2009	17:11	58°24.62'N	47°03.57'W	-	group pilotwhales 5 point port side approx. 2000 m, passing port side closest 500 m, 17:29 out of sight	> 200 m	-	-	AMM
05/07/2009	19:48	58°23.71'N	46°39.27'W	stop & start shooting	group pilotwhales approx. 700m ahead 4 point port side, 19:50 distance < 200m passing port side, 19:53 distance > 200m	< 200 m	19:50	19:56	AMM
06/07/2009	7:14	58°02.43'N	44°58.81'W	stop & start shooting	3 pilotwhales approx. 50 m ahead, disappeared 07:16 on starbord side	50 m	7:14	7:19	AMM
06/07/2009	10:41	57°55.99'N	44°28.72'W	stop shooting, profile end, streamer in, stop MMSO	-	-	10:41	-	DNS

Abbreviations:

AMM - Antje Müller-Michaelis
CP - Carl Peters
DNa - David Naafs
DNS - Daniela Schmidt
RS - Robert Sommerfeldt
TE -Thorsten Eggers

Appendix 6 Seismische Parameter / Seismic recording parameters

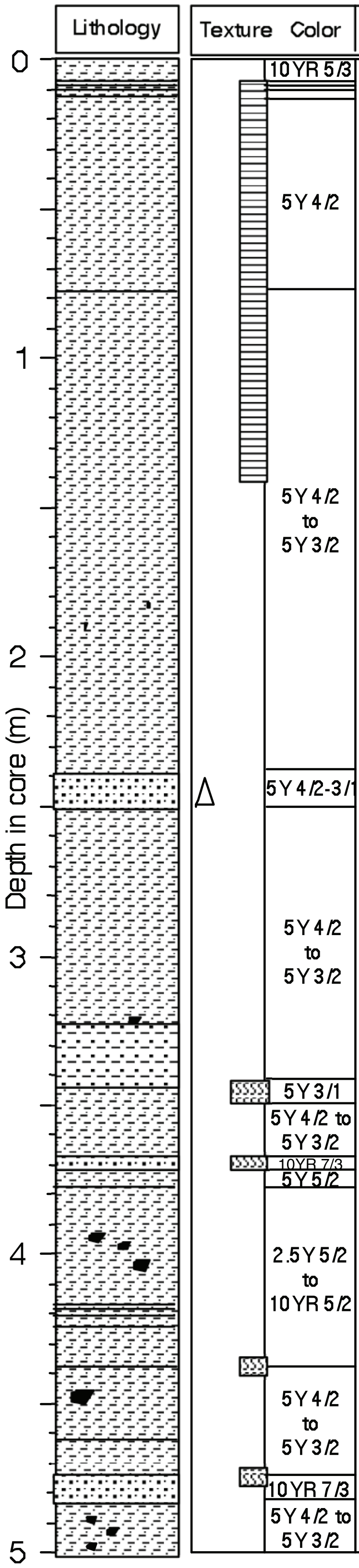
begin			end				length [nm]	airgun configuration	total volume [l]	shot interval [s]	No of shots	field tapes
UTC	lat	lon	date	UTC	lat	lon						
10:13:00/ 16:06:00	58.64	-45.05	22.6.09	18:52:38	58.56	-45.47	14	4 GI-guns	9.6	10	1068	P00080
18:52:38	58.56	-45.47	23.6.09	12:09:38	58.46	-48.2	85.4	4 GI-guns	9.6	10	6180	P00080
13:26:58	58.42	-48.17	24.6.09	10:13:00	57.84	-45.09	103	4 GI-guns	9.6	10	7817	P00080
12:09:20	57.86	-45.09	25.6.09	10:49:00	58.2475	-48.6787	113.6	4 GI-guns	9.6	10	8110	P00080/ P00082
8:00	58.1473	-48.0945	28.6.09	6:26:45	58.2325	-44.4825	116.5	4 GI-guns	9.6	10	8179	P00081
8:13	58.199	-44.5345	29.6.09	13:36:55	57.64857	-48.9558	147	4 GI-guns	9.6	10	1010 0	P00081
13:48:43	57.6026	-48.62114	30.6.09	16:47	57.42337	-48.94505	13	4 GI-guns	9.6	10	1077	P00084
18:38	57.4729	-48.93522	1.7.09	12:23:21	57.50340	-46.16263	88	3 GI-guns	7.2	10	6519	P00084
13:25:50	57.5356	-46.21445	2.7.09	1:34:13	58.5278	-46.402	60	3 GI-guns	7.2	10	4445	P00084
8:08:50	58.5056	-46.40040	3.7.09	23:24:48	57.59	-44.7925	75	3 GI-guns	7.2	10	5556	P00086
00:43:13	57.5650	-44.84871	5.7.09	00:29:07	57.90694	-48.52443	118	3 GI-guns	7.2	10	8741	P00086
1:48:50	57.91	-48.482	5.7.09	7:42:10	58.39239	-48.30316	27	3 GI-guns	7.2	10	2000	P00086
9:16	58.3968	-48.3125	5.7.09	19:08:10	58.41576	-46.75071	48	3 GI-guns	7.2	10	3556	P00086
19:12:30	58.4139	-46.73975	6.7.09	10:40	57.933	-44.4827	75	3 GI-guns	7.2	10	5556	P00086/ P00088

Line	date
AWI-20090001	22.6.09
AWI-20090002	22.6.09
AWI-20090003	23.6.09
AWI-20090004	24.6.09
AWI-20090005	27.6.09
AWI-20090006	28.6.09
AWI-20090007	30.6.09
AWI-20090008	30.6.09
AWI-20090009	1.7.09
AWI-20090010	3.7.09
AWI-20090011	4.7.09
AWI-20090012	5.7.09
AWI-20090013	5.7.09
AWI-20090014	5.7.09

Appendix 7 Kernbeschreibungen / Core descriptions

MSM12/2-01-01 SL Eirik Drift **MSM12/2**

Recovery: 9.68 m 58° 12.57´ N, 48° 22.16´ W Water depth: 3450 m



Description

0 - 7 cm: brown (10YR 5/3) silty clay, some sand dark brown (10YR 3/3) horizons at 3-4 and 6-7 cm

7 - 8 cm: pale brown (10YR 6/3) silty clay

8 - 9 cm: light brownish gray (2.5Y 6/2) silty clay

9 - 12 cm: pale brown (10YR 6/3) to yellowish brown (10YR 5/4) silty clay; 9-10 cm dark brown(10YR 3/3) horizon

12 - 77 cm: olive gray (5Y 4/2) silty clay; more silty, dark greenish gray (5BG 4/1) layers at 20-21,25-26, 29, 32, 33, 39, 41, 44, 50, 51, 53, 55, 60, 67, 68, and 69 cm

77 - 239 cm: olive gray (5Y 4/2) to dark olive gray (5Y 3/2) silty clay (some sand), dark greenish gray (5BG 4/1) laminae between 80 and 150 cm; between 177-195 cm more sandy (sandy silty clay); thin more sandy laminae between 237 and 239 cm; single dropstone (0.3 cm in diameter) at 182 and 189 cm

239 - 251 cm: olive gray (5Y 4/2) to very dark gray (5Y 3/1) clayey sandy silt, fi ning upward; sharp boundary at bottom

251 - 323 cm: olive gray (5Y 4/2) to dark olive gray (5Y 3/2) silty clay, some sand; dropstone (1 cm in diameter) at 321-322cm

323 - 344 cm: olive gray (5Y 4/2) to dark olive gray (5Y 3/2) sandy silty clay, some coarser grains/gravel (-> diamicton?)

344 - 349 cm: very dark gray (5Y 3/1) silty clay, bioturbated

349 - 368 cm: olive gray (5Y 4/2) to dark olive gray (5Y 3/2) silty clay

368 - 371 cm: olive gray (5Y 4/2)and very pale brown (10YR 7/3) (sandy) silty clay (detrital carbonate?); bioturbation

371 - 377 cm: olive gray (5Y 5/2) to grayish brown (2.5Y 5/2) silty clay

377 - 437 cm: grayish brown (2.5Y 5/2 - 10YR 5/2) silty clay, some sand; between 392 and 406 cm more coarse grained; dropstones at 395-397 cm (3 cm in diameters), 398 cm (1 cm in diameter), and 403-406 cm (4 cm in diameter) (-> diamicton?); dark brown laminae at 417, 419, 420, and 424 cm; dark brown horizon at 436-437 cm

437 - 474 cm: olive gray (5Y 4/2) to dark olive gray (5Y 3/2) silty clay, some sand; large dropstone at 447-450 cm (5 cm in diameter); dark greenish gray lamina at 462 cm

474 - 483 cm: very pale brown (10YR 7/3) (sandy) silty clay, towards bottom more coarse-grained (diamicton-type sediment) (detrital carbonate?); sharp boundary at base

483 - 542 cm: olive gray (5Y 4/2) to dark olive gray (5Y 3/2) silty clay to (sandy) silty clay; more sandy at 483-498, 508-516, 522-531, and 535-539 cm; small dropstones at 489, 493, and 498 cm, dropstone at 538 cm

542 - 551 cm: very dark gray (5Y3/1) silty clay; gray mottling (large burrows, strongly bioturbated)

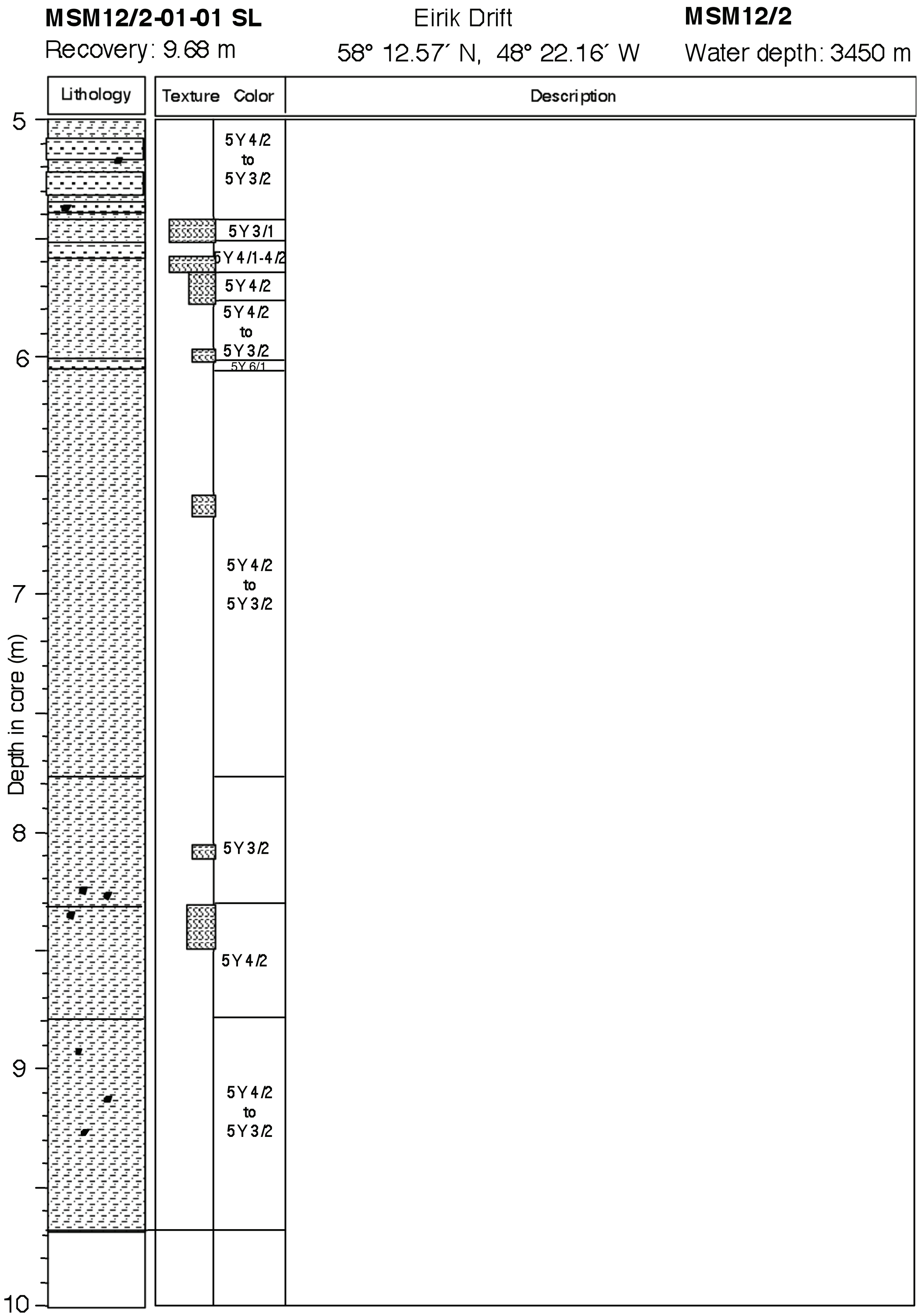
551 - 558 cm: dark gray (5Y4/1) and olive gray (5Y 4/2) (sandy) silty clay

558 - 564 cm: dark gray (5Y4/1) and olive gray (5Y 4/2) silty claystrongly bioturbated

564 -577 cm: olive gray (5Y 4/2) silty clay, mottled/bioturbated

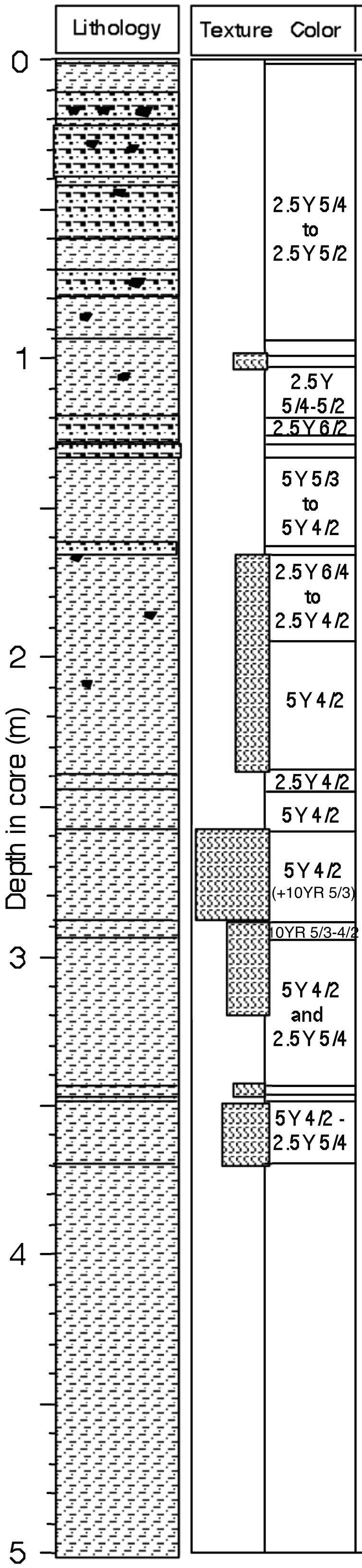
577 - 778 cm: olive gray (5Y 4/2) to dark olive gray (5Y 3/2) silty clay , more silty/sandy at 580-586, 613-616, 640-656, 662-677, and 699-728 cm; 601-605 cm gray (5Y 6/1) (sandy) silty clay, bioturbation at top; dropstone (1cm in diameter) at 644-645 cm; thin dark greenish gray laminae at 726, 728, and 731 cm: moderately to strongly bioturbated (larg-sized burrows) between 740 and 770 cm

778 - 968 cm: olive gray (5Y 4/2) to dark olive gray (5Y 3/2) silty clay, some sand; bioturbated (largte burrows)m at 801-810, 830-850 cm; small dropstones at 824, 827, 835, 893, and 913 cm; dropstone (1 cm in diameter) at 927-928 cm; more silty/sandy at 910-922 cm


MSM12/2-01-01 SL
Recovery: 9.68 m
Eirik Drift
58° 12.57´ N, 48° 22.16´ W
MSM12/2
Water depth: 3450 m
Lithology
Texture Color
Description
5Y 4/2 to 5Y 3/2
5Y 3/1
5Y 4/1-4/2
5Y 4/2
5Y 4/2 to 5Y 3/2
5Y 6/1
5Y 4/2 to 5Y 3/2
5Y 3/2
5Y 4/2
5Y 4/2 to 5Y 3/2
Depth in core (m)
5
6
7
8
9
10

MSM12/2-02-01 SL Eirik Drift **MSM12/2**

Recovery: 9.81 m 58° 09.48´ N, 47° 52.44´ W Water depth: 3306 m

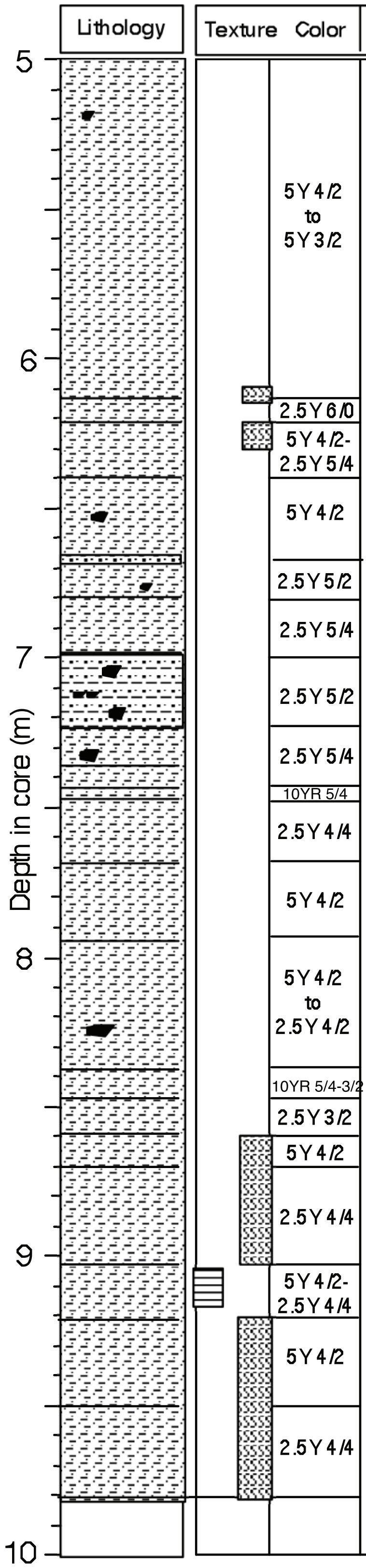


Description

0 - 1 cm: brown (10YR 5/3) silty clay, some sand; some foraminifers
1 - 94 cm: Alternation of light olive brown (2.5Y 5/4) to grayish brown (2.5Y 5/2) silty clay with some sand (at 1-11, 19-22, 39-42, 59-70, and 79-94 cm) and sandy silty clay with abundant mudclasts and dropstones (at 11-19, 22-39, 42-59, and 70-79 cm; -> diamicton): larger dropstones at 17-19 (1cm, 1cm, and 3 cm in diameter), 29 cm (0.5 cm in diameter), 31 cm (0.5 cm in diameter), 43 cm (1 cm in diameter), 75-77 cm (3 cm in diameter), and 86-87 cm (1 cm in diameter)
94 - 119 cm: grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/4) (sandy) silty clay; some very small dropstones, large dropstone at 107-109 cm; at 99-103 cm very dark grayish brown (10YR 3/2) interval, mottled/bioturbated; at 118-119 cm dark brown layer
119 -125 cm: light brown gray (2.5Y 6/2) silty sandy clay (diamiction)
125 - 129 cm: olive gray (5Y 4/2) silty clay; thin dark brown laminae at 125 and 126cm
129 - 132 cm: light brown gray (2.5Y 6/2) silty sandy clay (diamiction)
132 - 162 cm: olive (5Y 5/3) to olive gray (5Y 4/2) silty clay
162 - 164 cm: grayish brown (2.5Y 5/2) sandy silty clay
164 - 194 cm: light yellowish brown (2.5Y 6/4) and olive gray (5Y 4/2) silty clay with some sand; some bioturbation; dropstones at 167-168 cm (1 cm in diameter) and 185-186 cm (1 cm in diameter)
194 - 238 cm: olive gray (5Y 4/2) silty clay, some grayish brown mottling (bioturbation); small dropstone (0.5 cm in diameter) at 209 cm
238 - 245 cm: dark grayish brown (2.5Y 4/2) (sandy) silty clay
245 - 258 cm: olive gray (5Y 4/2) silty clay
258 - 288 cm: olive gray (5Y 4/2) silty clay, strong mottling (10YR 5/3)/bioturbation
288 - 295 cm: brown (10YR 5/3) and dark grayish brown (10YR 4/2) silty clay, some bioturbation
295 - 343 cm: olive gray (5Y 4/2) and light olive brown (2.5Y 5/4) silty clay, upper half mottled/bioturbated
343 - 347 cm: brown (10YR 5/3) to light olive brown (2.5Y 5/4) silty clay, some bioturbation
347 - 349 cm: dark grayish brown (10YR 4/2) silty clay
349 - 370 cm: olive gray (5Y 4/2) and light olive brown (2.5Y 5/4) silty clay, moderately bioturbated
370 - 500 cm: olive gray (5Y 4/2) to dark olive gray (5Y 3/2) silty clay, some sand; at 385-436 and 468-373 cm more stiff and mud clasts

MSM12/2-02-01 SL Eirik Drift **MSM12/2**

Recovery: 9.81 m 58° 09.48´ N, 47° 52.44´ W Water depth: 3306 m



Description

500 - 613 cm: olive gray (5Y 4/2) to dark olive gray (5Y 3/2) silty clay, some sand; at 501-506, 543-553, 565-570, and 575-599 cm more stiff and mud clasts; at 609-613 cm large-sized burrows (bioturbation); drop stone (1.5 cm in diameter) at 518-519 cm

613 - 621 cm: gray (2.5Y 6/0) silty clay (619-621 cm more dark gray - 2.5Y 4/0)

621 - 640 cm: olive gray (5Y 4/2) and light olive brown (2.5Y 5/4) silty clay, mottled/ bioturbated at 621-630 cm

640 - 668 cm: olive gray (5Y 4/2) silty clay, some sand; more sandy (diamicton) at 666-668 cm; large dropstone (3 cm in diameter) at 651-654 cm

668 - 680 cm: grayish brown (2.5Y 5/2) silty clay; dropstone (1.5 cm in diameter) at 676-678 cm

680 - 699 cm: light olive brown (2.5Y 5/4) silty clay

699 - 723 cm: grayish brown (2.5Y 5/2) sandy silty clay; numerous dropstones at 704-706 (2.5 cm in diameter), 712 (2x 0.5 cm in diameter), and 718-720 cm (4 cm in diameter)

723 - 736 cm: light olive brown (2.5Y 5/4) silty clay; large dropstone (4 cm in diameter) at 732-734 cm

736 - 743 cm: light olive brown (2.5Y 5/4) silty clay, mud clasts

743 - 748 cm: yellowish brown (10YR 5/4) silty clay; mud clasts

748 - 768 cm: olive brown (2.5Y 4/4)silty clay, some sand; small dropstones (<0.5 cm in diameter) at 760-761 cm

768 - 794 cm: olive gray (5Y 4/2) (sandy) silty clay

794 - 837 cm: olive gray (5Y 4/2) to dark grayish brown (2.5Y 4/2) (sandy) silty clay; large (6 cm in diameter), well-rounded dropstone at 823 - 827 cm

837 - 847 cm: yellowish-brown (10YR 5/4) and very dark grayish brown (10YR 3/2) silty clay

847 - 860 cm: dark grayish brown (2.5Y 3/2) silty clay

860 - 870 cm: olive gray (5Y 4/2) silty clay; large-sized burrows (gray mottling)

870 - 903 cm: olive brown (2.5Y 4/4) silty clay; some bioturbation

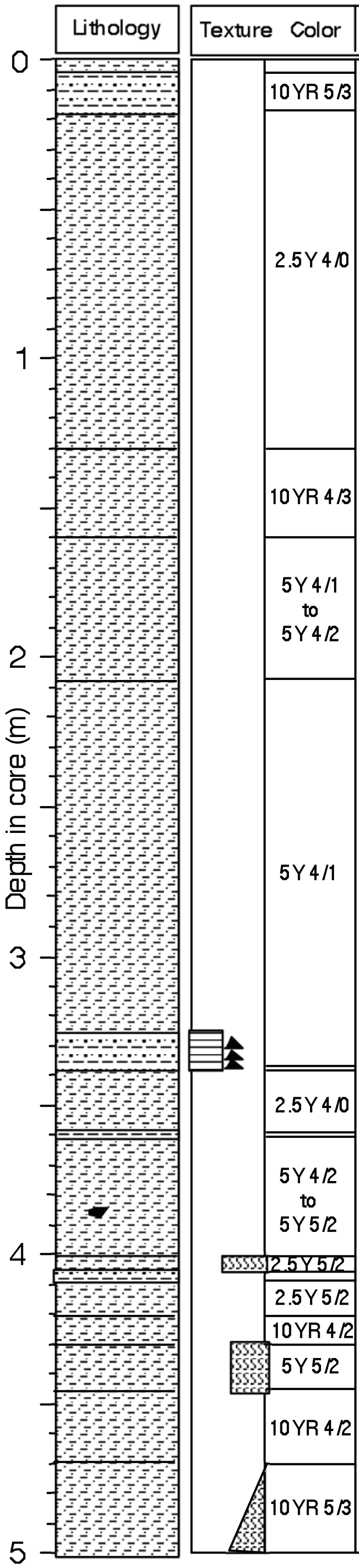
903 - 921 cm: yellowish brown (10YR 5/4) silty clay; very dark grayish brown (10YR 3/2) horizons/layers at 905, 907-908, 913, 914, and 916 cm

921 - 950 cm: olive gray (5Y 4/2) to olive brown (2.5Y 4/4) silty clay; some bioturbation

950 - 981 cm: olive brown (2.5Y 4/4) silty clay, some sand; some bioturbation

MSM12/2-04-01 SL Eirik Drift **MSM12/2**

Recovery: 9.96 m 57° 33.44´ N, 48° 37.02´ W Water depth: 3491 m

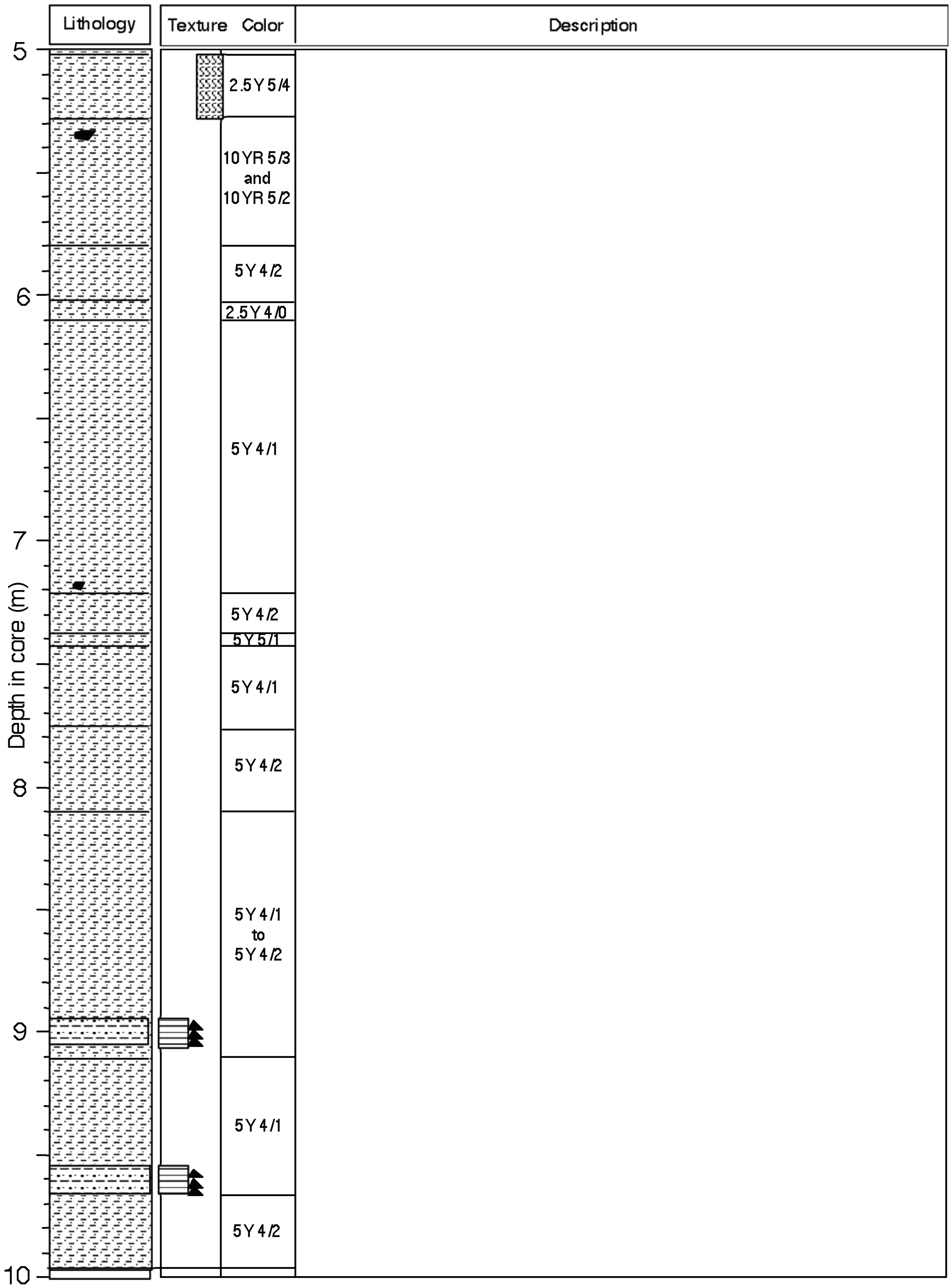


Description

0 - 4 cm: brown (10YR 5/3) silty clay, some sand
4 - 17 cm: brown (10YR 5/3) to dark grayish brown (10YR 4/2) sandy silty clay, laminated; more sandy toward the base
17 - 130 cm: dark gray (2.5Y 4/0) silty clay
130 - 160 cm: brown (10YR 4/3) silty clay
160 - 208 cm: dark gray (5Y 4/1) to olive gray (5Y 4/2) (silty) clay
208 - 309 cm: dark gray (5Y 4/1) (silty) clay
309 - 326 cm: dark gray (5Y 4/1) silty clay
326 - 338 cm: alternation of dark gray (5Y 4/1) sandy silty clay and silty clay (337-338 very dark gray); fi ning upward cycles (-> lamination); sharp contact at base
338 - 359 cm: dark gray (2.5Y 4/0) silty clay
359 - 360 cm: light brownish gray (10YR 6/2) sandy silty clay (detrital carbonate?)
360 - 401 cm: olive gray (5Y 4/2 - 5Y 5/2) silty clay, some sand; large dropstone (4 cm in diameter) at 386-388 cm
401 - 405 cm: grayish brown (2.5Y 5/2) silty clay, some mottling/bioturbation
405 - 408 cm: light brownish gray (10YR 6/2) sandy silty clay
408 - 421 cm: grayish brown (2.5Y 5/2) silty clay
421 - 430 cm: grayish brown (10YR 5/2) silty clay
430 - 445 cm: olive gray (5Y 5/2) silty clay, bioturbated
445 - 470 cm: grayish brown (10YR 5/2) silty clay; some dark brown spekes
470 - 502 cm: brown (10YR 5/3) silty clay, slightly to moderately bioturbated (bioturbation increasing downward); very small black grains
502 - 528 cm: light olive brown (2.5Y 5/4) silty clay, some bioturbation
528 - 580 cm: brown (10YR 5/3) and grayish brown (10YR 5/2) silty clay, some sand; mottled/bioturbated; large dropstone (6 cm in diameter) at 534-536 cm, sediment around: numerous foraminifers
580 - 602 cm: olive gray (5Y 4/2) silty clay
602 - 610 cm: dark gray (2.5Y 4/0) silty clay, some sand; very stiff
610 - 721 cm: dark gray (5Y 4/1) silty clay; thin very dark gray laminae at 666 and 683 cm; dropstone (2 cm in diameter) at 718-719 cm
721 - 737 cm: olive gray (5Y 4/2) silty clay; numerous foraminifers
737 - 742 cm: gray (5Y 5/1) silty clay; numerous foraminifers
742 - 775 cm: dark gray (5Y 4/1) silty clay
775 - 811 cm: olive gray (5Y 4/2) silty clay
811 - 895 cm: dark gray (5Y 4/1) to olive gray (5Y 4/2) silty clay
895 - 905 cm: dark gray (5Y 4/1) to olive gray (5Y 4/2) sandy silty clay, fi ning upward; sharp contact at base
905 - 911 cm: dark gray (5Y 4/1) to olive gray (5Y 4/2) silty clay
911 - 955 cm: dark gray (5Y 4/1) silty clay
955 - 966 cm: dark gray (5Y 4/1) sandy silty clay, fi ning upward cycles (laminations); sharp contact at base
966 - 996 cm: olive gray (5Y 4/2) silty clay

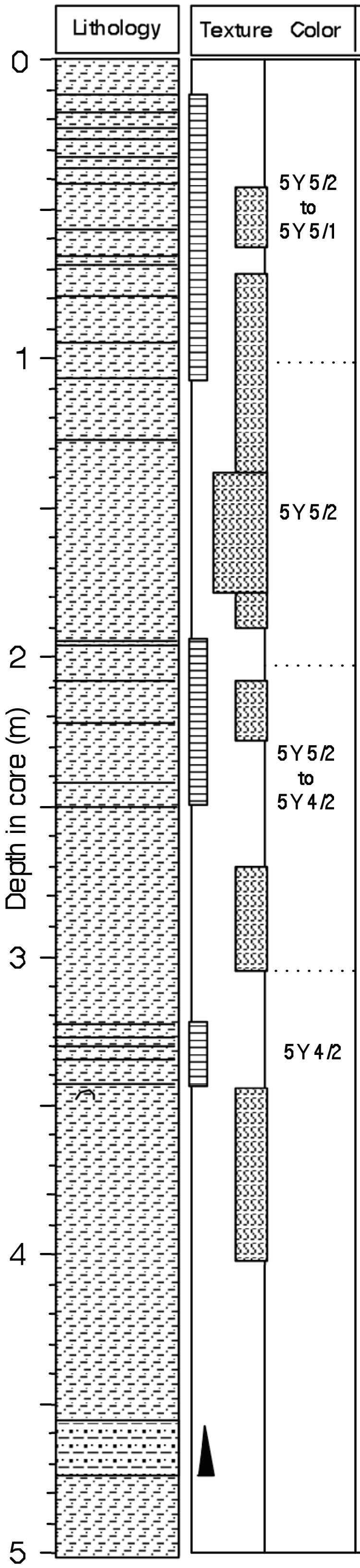
MSM12/2-04-01 SL Eirik Drift **MSM12/2**

Recovery: 9.96 m 57° 33.44´ N, 48° 37.02´ W Water depth: 3491 m



MSM12/2-05-01 SL Eirik Drift **MSM12/2**

Recovery: 14.94 m 57° 32.31´ N, 48° 44.32´ W Water depth: 3491 m



Description

0 - 899 cm: dark gray (5Y 4/1) to olive gray (5Y 4/2) silty clay, some sand; slightly to moderately bioturbated (35-60, 70-190, 210-230, 275-300, 340-405, 610-700, 810-880 cm; small black spots throughout;
Dark greenish gray (5BG 4/1) layers/horizons at 13, 17, 23, 27-28, 32, 35, 41-42, 57-58, 66, 69, 79-80, 94-95, 107, 127-128, 194-195, 208, 222, 242, 250, 323, 327, 330, 334, and 342 cm;
Bivalve shell at 346 cm;
Sandy (fi ne sand) silty clay at 456-473 cm; fi ning upward;
(Sandy) silty clay, olive gray (5Y 5/2) at 600-606 cm; sharp contact at top;
More sandy at 612-616, 627-630, 637-646, and 745-780 cm (?)

899 - 911 cm: olive gray (5Y4/2), dark gray (5Y 4/1) to very dark gray (5Y 3/1) silty sandy clay (906-911) to sandy silty clay; fi ning upward

911 - 990 cm: dark gray (5Y 4/1) to olive gray (5Y 4/2) silty clay

990 - 1011cm: olive gray (5Y 4/2-5/2) sandy silty clay

1011 - 1063 cm: dark gray (5Y 4/1) to olive gray (5Y 4/2) silty clay; at 1114 cm thin sandy layer

1063 - 1101 cm: olive gray (5Y 4/2) silty clay

1101 - 1107 cm: olive gray (5Y 4/2) sandy silty clay; at 1101 and 1102 dark gray, more sandy layers

1107 - 1293 cm: dark gray (5Y 4/1) to olive gray (5Y 4/2) silty clay, some sand

1293 - 1311 cm: olive gray (5Y 4/2-5/2) sandy silty clay; numerous dropstones, three larger ones at 93-94 (1.5 cm in diameter), 98-100 (1.5 cm in diameter), and 105-107 cm (2 cm in diameter), --> diamicton

1311 - 1313 cm: light brownish gray (10YR 6/2) sandy silty clay, some pebbles --> diamicton (detrital carbonate, Henrich Event 1?)

1313 - 1343 cm: olive gray (5Y 4/2) silty clay, some mud clasts

1343 - 1355 cm: olive brown (2.5Y 4/4) silty clay

1355 - 1377 cm: olive gray (5Y 4/2) silty clay; some small dropstones between 1364 and 1377 cm; large dropstone (2 cm in diameter) at 1367-1369 cm

1377 - 1384 cm: olive gray (5Y 4/2) silty clay

1384 - 1391 cm: light brownish gray (10YR 6/2) sandy silty clay, some pebbles --> diamicton (detrital carbonate, Henrich Event 2?); sharp contact at base

1391 - 1413 cm: olive gray (5Y 4/2) silty clay

1413 - 1423 cm: gray (5Y 5/1) to olive gray (5Y 4/2) silty clay

1423 - 1446 cm: dark gray (5Y 4/1) silty clay, some coarser grained; light olive brown spots in upper part (mottling/bioturbation); dropstone (2.5 cm in diameter) at 1443-1445 cm

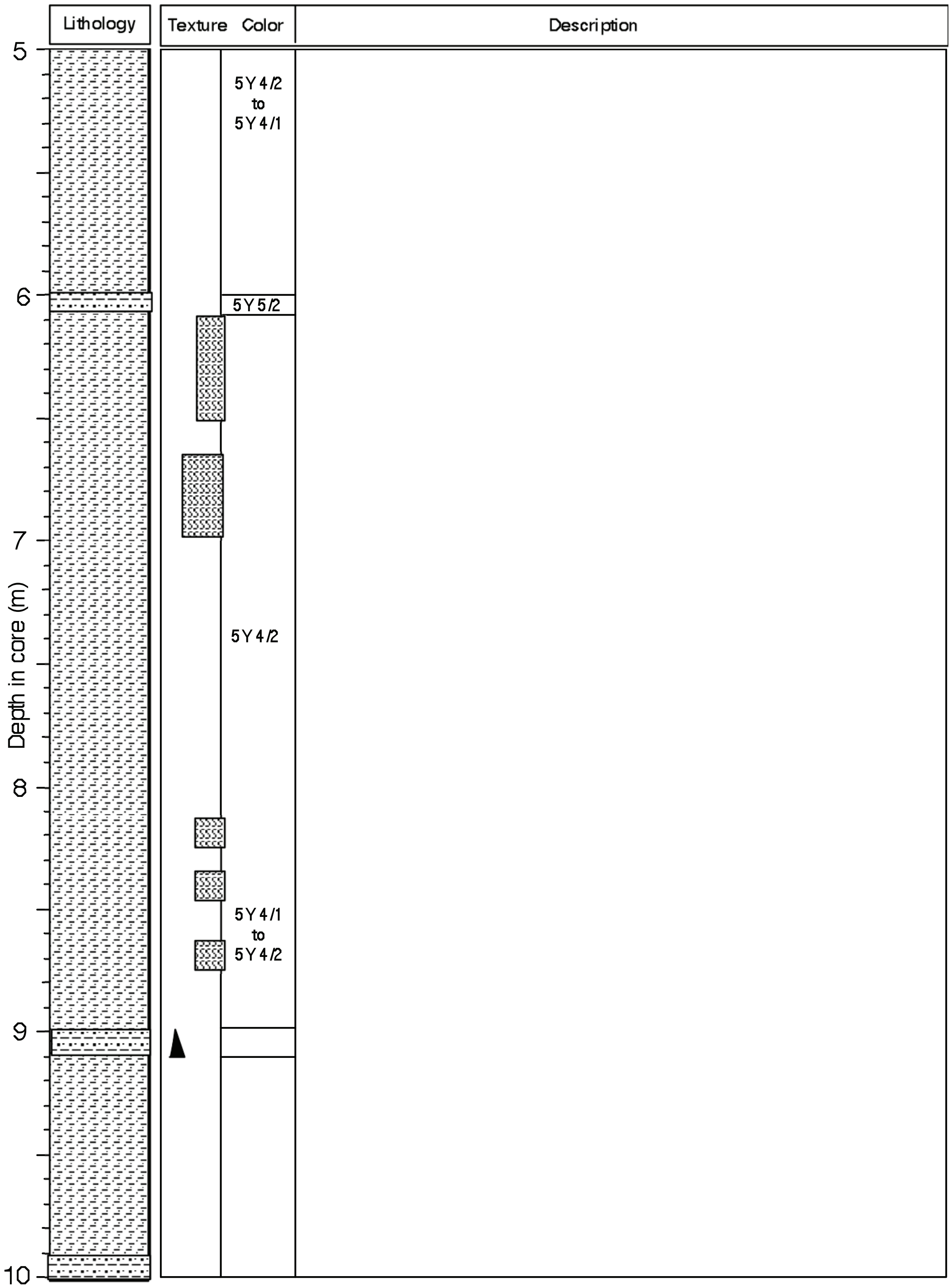
1446 - 1474 cm: dark gray (5Y 4/1) to olive gray (5Y 4/2) silty clay, some bioturbation

1474 - 1479 cm: olive gray (5Y 4/2) and light brownish gray (10YR 6/2) silty clay, some sand; mottled/bioturbation

1479 -1494 cm: dark gray (5Y 4/1) to olive gray (5Y 4/2) silty clay, some large burrows at 1481-1482 cm

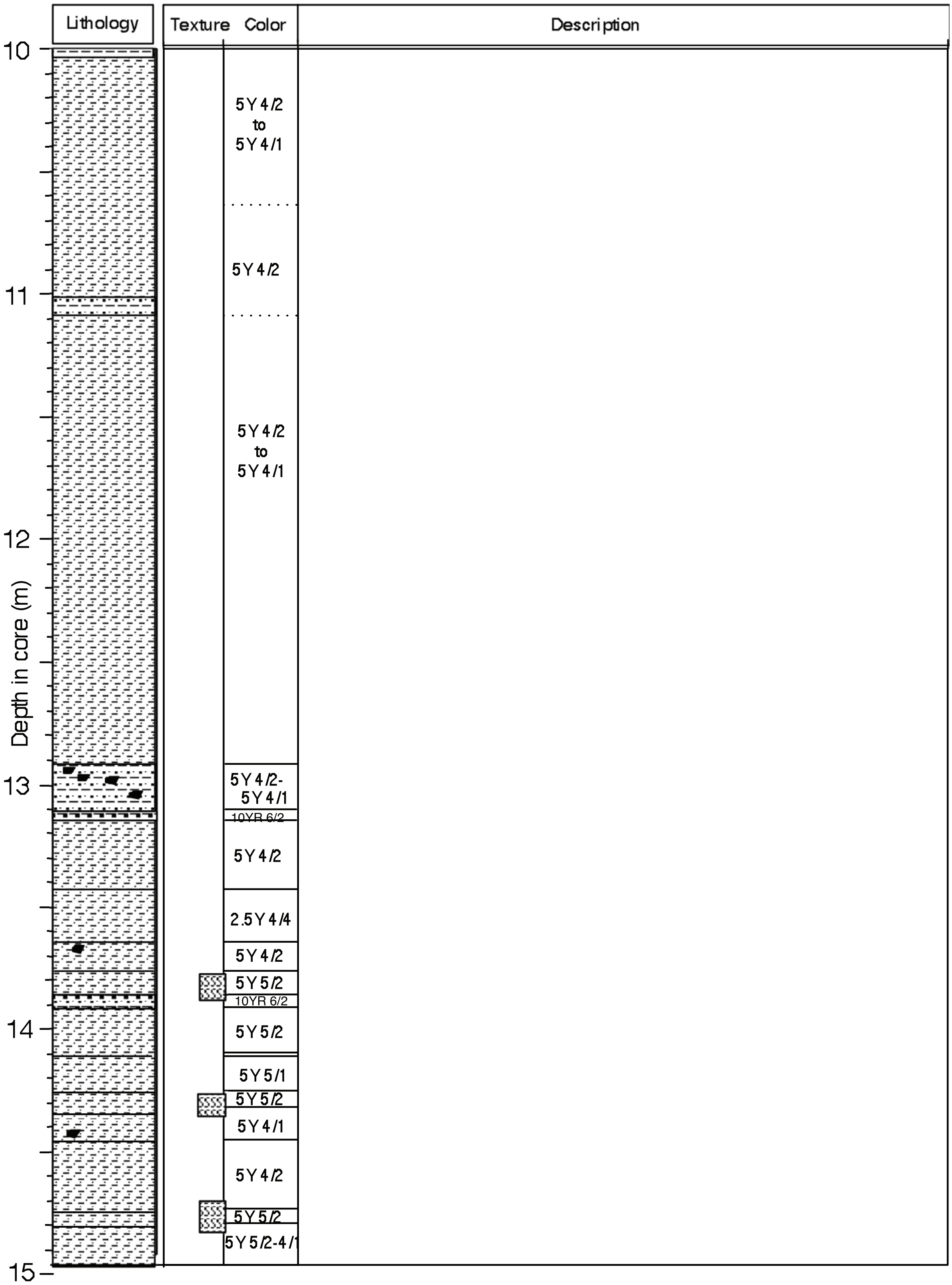
MSM12/2-05-01 SL Eirik Drift **MSM12/2**

Recovery: 14.94 m 57° 32.31´ N, 48° 44.32´ W Water depth: 3491 m



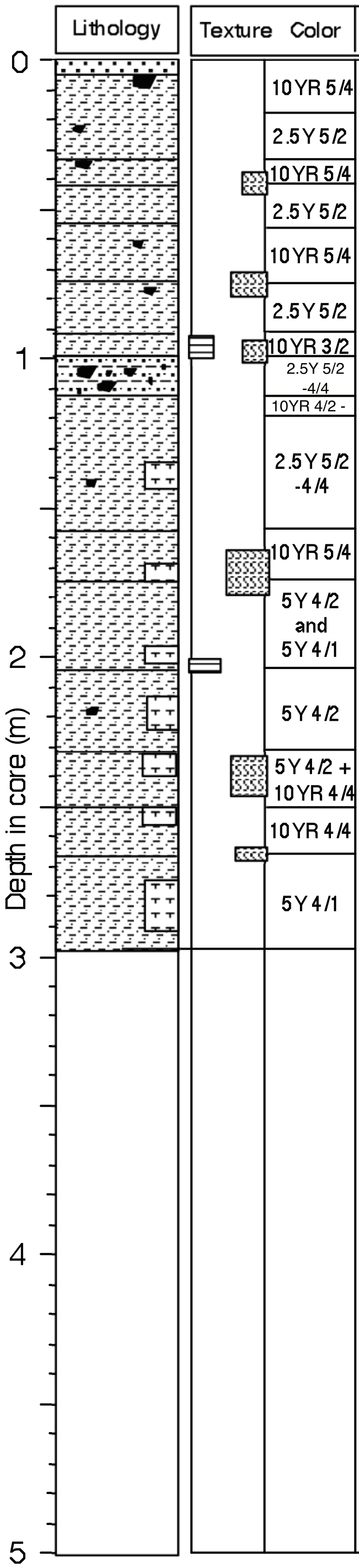
MSM12/2-05-01 SL Eirik Drift **MSM12/2**

Recovery: 14.94 m 57° 32.31´ N, 48° 44.32´ W Water depth: 3491 m



MSM12/2-06-02 SL Eirik Drift **MSM12/2**

Recovery: 2.97 m 58° 30.34´ N, 46° 24.05´ W Water depth: 2579 m



Description

0 - 4 cm: yellowish brown (10YR 5/4) sand

4 - 18 cm: yellowish brown (10YR 5/4) (sandy) silty clay ; large dropstone (4 cm in diameter) at 7-10 cm

18 - 33 cm: grayish brown (2.5Y 5/2) (sandy) silty clay; dropstone (1 cm in diamter) at 23-24cm; mud clasts

33 - 42 cm: yellowish brown (10YR 5/4)) (sandy) silty clay; mud clasts; dropstone (1.5 cm in diameter) at 34-35 cm

42 - 58 cm: grayish brown (2.5Y 5/2) (sandy) silty clay; mud clasts

58 - 74 cm: yellowish brown (10YR 5/4)) (sandy) silty clay; mud clasts; dropstone (1 cm in diameter) at 60-61 cm

74 -91 cm: grayish brown (2.5Y 5/2) (sandy) silty clay; dropstone (0.5 cm in diamter) at 77 cm; yellowish brown mottling

91 - 99 cm: very dark grayish brown (10YR 3/2) silty clay, some sand; upper part lainated; yellowish brown mottling

99 - 112 cm: grayish brown (2.5Y 5/2) to light olive brown (2.5Y 4/4) sandy silty clay; numerous small dropstones, large dropstones (2 cm in diameter) at 105-106 and 110-112 am; abundant foraminifers at 102-104 cm

112 - 120 cm: dark grayish brown (10YR 4/2) and grayish brown (2.5Y 5/2) (sandy) silty clay,

120 - 157 cm: grayish brown (2.5Y 5/2) to light olive brown (2.5Y 4/4) sandy silty clay; mud clasts; dropstone (2 cm in diameter) at 140-142 cm; abundant foraminifers at 134-142 cm

157 - 174 cm: yellowish brown (10YR 5/4) (sandy) silty clay; olive gray (2.5 4/2) lenses/horizons -> bioturbation; lower part abundant foraminifers

174 - 203 cm: dark gray (5Y 4/1) to olive gray (5Y 4/2) sandy silty clay, lower part some lamination and abundant foraminifers

203 - 231 cm: olive gray (5Y 4/2) silty clay; dropstone (1 cm in diameter) at 217-218 cm: abundant foraminifers at 213-223 cm

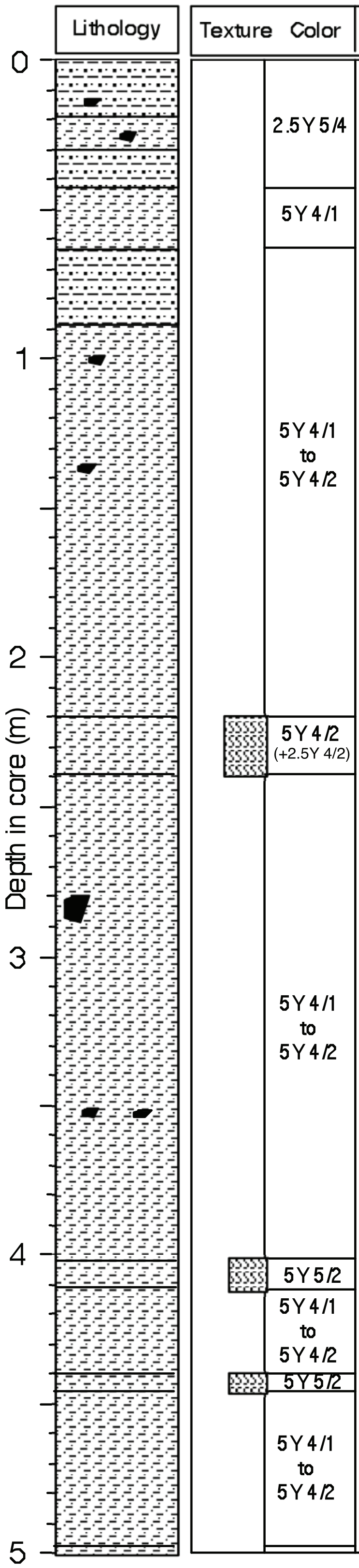
231 - 250 cm: olive gray (5Y 4/2) and dark yellowish brown (10YR 4/4) silty clay; abundant foraminfers ats 231-239 cm

250 - 267 cm: dark yellowish brown (10YR 4/4) silty clay; abundant foramainifers in upper part

267 - 297 cm: dark gray (5Y 4/1) sandy silty clay; abundant foraminifers

MSM12/2-07-02 SL Eirik Drift **MSM12/2**

Recovery: 9.53 m 58° 14.22´ N, 45° 38.56´ W Water depth: 2273 m

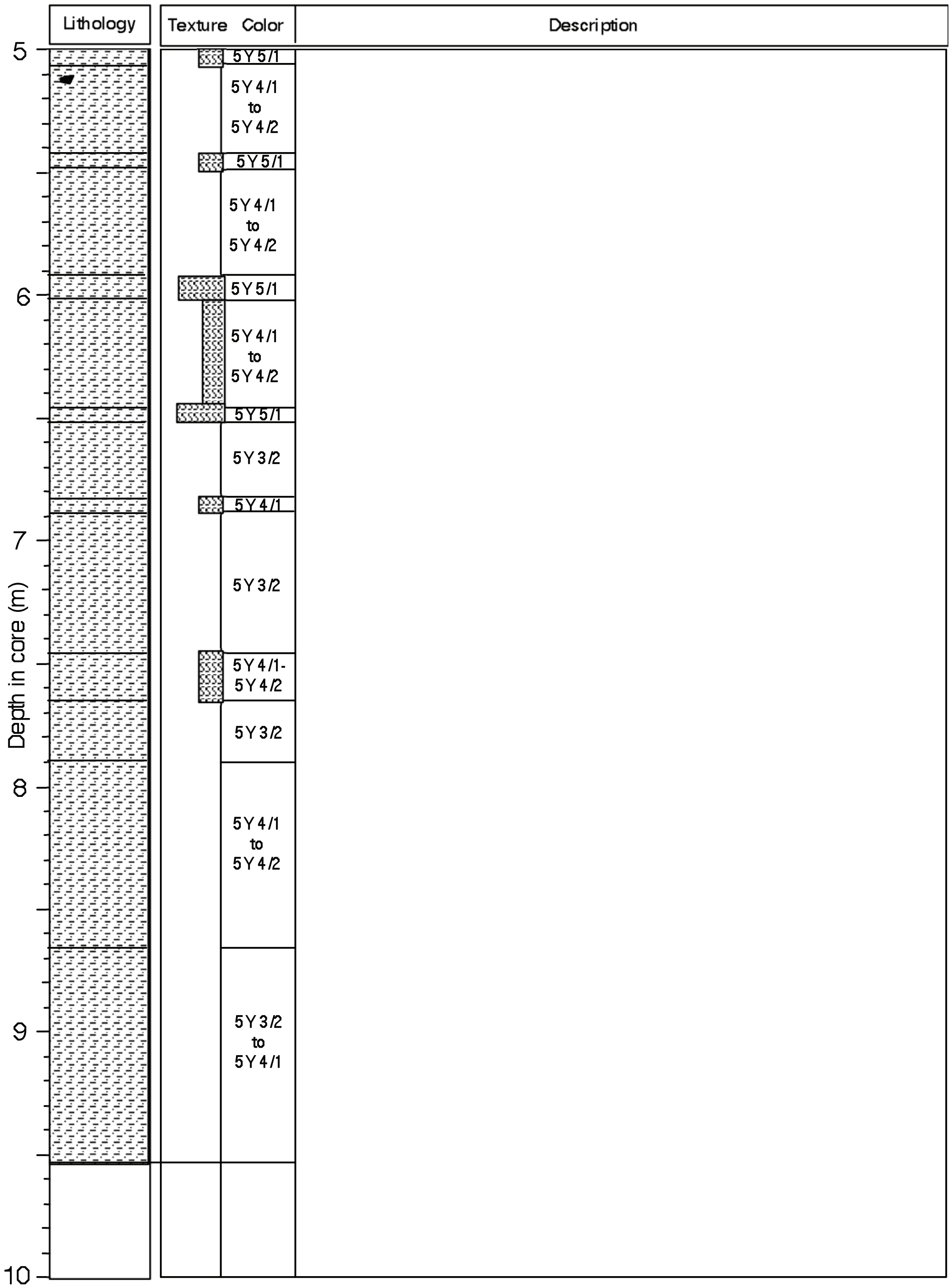


Description

0 - 6 cm: light olive brown (2.5Y 5/4) sandy silty clay with foraminifers
6 - 43 cm: light olive brown (2.5Y 5/4) sandy silty clay, dark brown (10YR 3/3) mottling and layers at 6-11 cm; at 18-30 cm more fi ne-grained (silty clay) dropstones at 13-15 cm (2 cm in diameter) and at 24-25 cm (1 cm in diameter); sharp contact at base
43 - 63 cm: dark gray (5Y 4/1) silty clay; thin more silty layer at 47 cm
63 - 88 cm: olive gray (5Y 4/2) to dark gray (5Y 4/1) sandy silty clay
88 - 953 cm: dark gray (5Y 4/1), olive gray (5Y 4/2), to dark olive gray (5y 3/2) silty clay, some sand;
lighter, more bioturbated intervals at 220-239 cm (olive brown mottling), 402-412 cm (5Y 5/2), 440-445 cm (5Y 5/2), 498-506 cm (5Y 5/1), 542-548 cm (5Y 5/1), 592-602 cm (5Y 5/1), 646-651 cm (5Y 5/1), 682-688 cm (5Y 4/2), and 744-765 cm (5 4/2);
dropstones at 100-102 (2 cm in diameter), 138-140 (2 cm in diameter), 283-291 (8 cm in diameter), 351-353 (2 cm and 1.5 cm in diameter), and 512-514 cm (2 cm in diameter); mud clasts at 164-167 and 333-363 cm

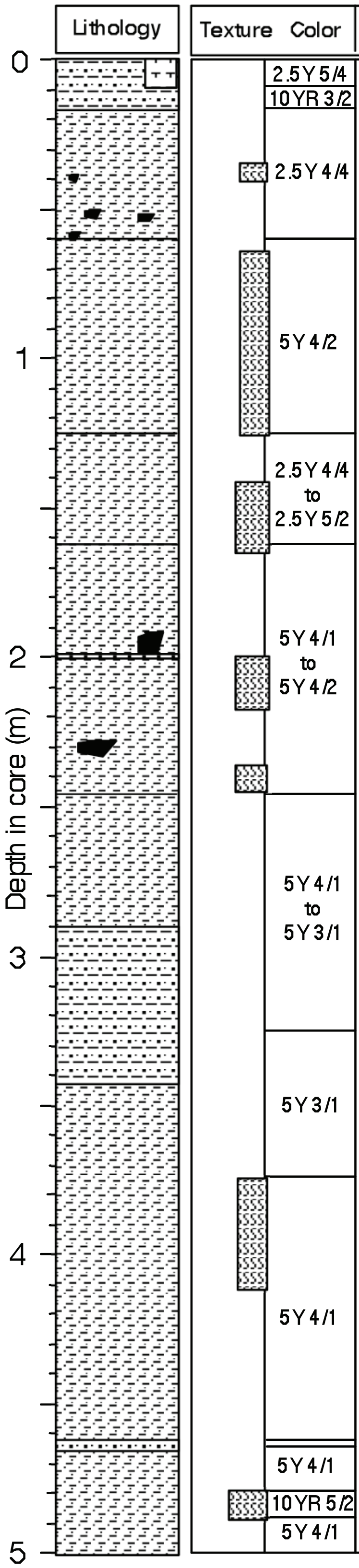
MSM12/2-07-02 SL Eirik Drift **MSM12/2**

Recovery: 9.53 m 58° 14.22´ N, 45° 38.56´ W Water depth: 2273 m



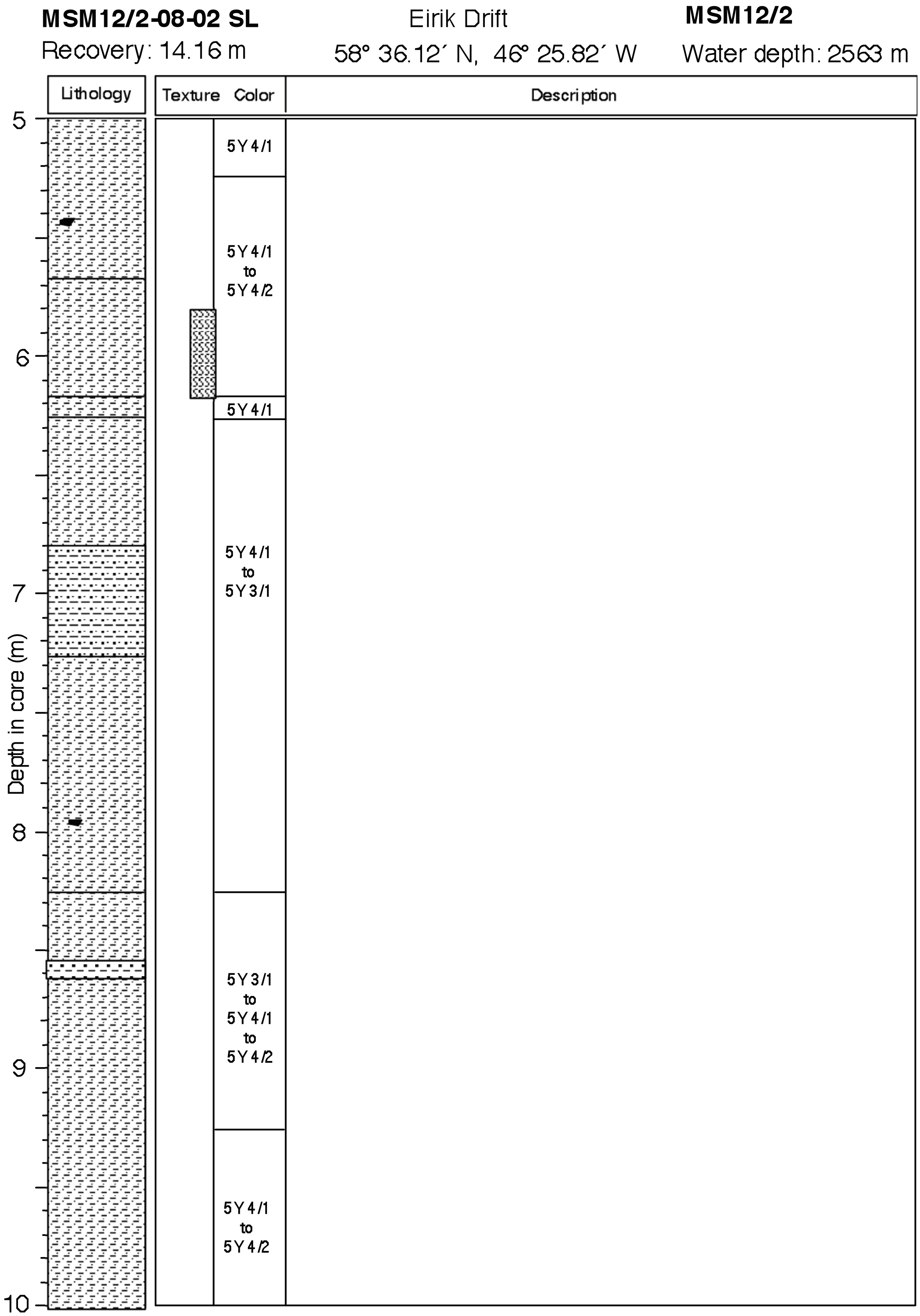
MSM12/2-08-02 SL Eirik Drift **MSM12/2**

Recovery: 14.16 m 58° 36.12´ N, 46° 25.82´ W Water depth: 2563 m



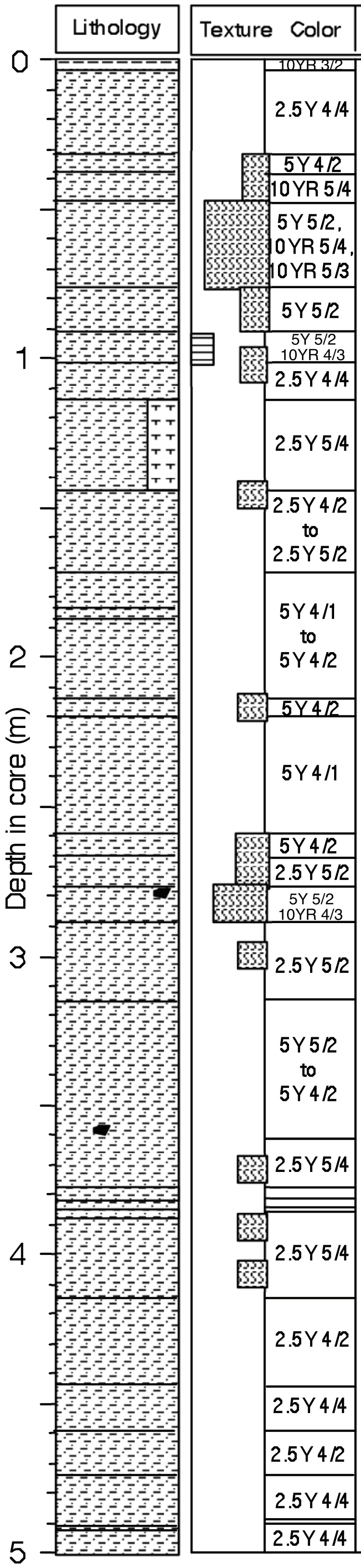
Description

0 - 9 cm: light olive brown (2.5Y 5/4) silty sandy clay with foraminifers
9 - 16 cm: very dark grayish brown (10YR 3/2) sandy silty clay; mud clasts
16 - 25 cm: olive gray (5Y 4/2) silty clay, some sand
25 - 60 cm: olive brown (2.5Y 4/4) (sandy) silty clay; dropstones at 39-40 (1 cm in diameter), 51-54 (3 cm and 2.5 cm in diameter), and 58-59 cm (1.5 cm in diameter)
60 - 125 cm: olive gray (5Y 4/2) silty clay, some sand; mud clasts at 74-84 and 114-125 cm; olive brown at 74-84 and 96-100 cm,slightly bioturbated
125 - 162 cm: olive brown (2.5 4/4) to grayish brown (2.5Y 5/2) silty clay, lower half bioturbated
162 - 246 cm: olive gray (5Y 4/2) to dark gray (5Y 4/1) silty clay, some sand; large dropstones at 191-198 cm (8 cm in diameter) and 229-233 cm (7 cm in diameter); sandy layer at 200 cm; yellowish brown mottling at 198-220 cm
246 - 325 cm: (very) dark gray (5Y 4/1-3/1) (sandy) silty clay, below 290 cm more sandy
325 - 374 cm: very dark gray (5Y 3/1) silty clay, at 325-342 cm more sandy
374 - 526 cm: dark gray (5Y 4/1) (sandy) silty clay; mud clasts at 395-415 and 452 and 462 cm; large burrows (5Y 3/1) at 375-382 cm; at 462-464 cm very dark gray sandy silty clay, mud clasts; at 479-488 cm grayish brown (10YR 5/2) (sandy) silty clay, some bioturbation
526 - 1024 cm: dark gray (5Y 4/1) to very dark gray (5Y 3/1) and olive gray (5Y 4/2) silty clay, some sand; at 580-617 cm brownish mottling/bioturbation; at 567 cm thin very dark gray lamina; mud clasts at 680-726 cm; at 715-725 and 975-981 cm very stiff; dropstones at 542-543 (1 cm in diameter) and 796-797 cm (1 cm in diameter)
1025 - 1038 cm: olive gray (5Y 5/2) silty sandy clay, fi ning upward; sharp contact at base
1038 - 1261 cm: dark gray (5Y 4/1) to olive gray (5Y 4/2) silty clay, some sand; at 1038-1110 cm very stiff; at1050-1055 and 1063-1065 cm grayish brown sandy silty clay; at 1052-1068 cm mottled/bioturbated; at 1160-1170 cm dark gray silty clay; at 1238-1247 cm abundant foraminifers; dark greenish gray (5BG 4/1) layer at 1260-1261 cm; dropstones at 1113-1115 (2 cm in diameter), 1171(0.5 cm in diameter), 1207-1208 (2 cm in diameter), and 1210-1211 cm (1 cm in diameter)
1261 - 1275 cm: olive gray (5Y 4/2) silty clay
1275 - 1282 cm: olive gray (5Y 5/2-4/2) silty clay, some sand; abundant foraminifers
1282 - 1298 cm: dark gray (5Y 4/1) sandy silty clay; sharp contact at base
1298 - 1325 cm: olive gray (5Y 4/2) silty clay
1325 - 1363 cm: dark gray (5Y 4/1) to olive gray (5Y 4/2) silty clay, slightly bioturbated
1363 - 1372 cm: olive gray (5Y 4/2) sandy silty clay; sharp contact at base
1372 - 1416 cm: dark gray (5Y 4/1) to olive gray (5Y 4/2) (sandy) silty clay


MSM12/2-08-02 SL
Recovery: 14.16 m
Eirik Drift
58° 36.12´ N, 46° 25.82´ W
MSM12/2
Water depth: 2563 m
Lithology
Texture Color
Description
Depth in core (m)
5
6
7
8
9
10
5Y 4/1
5Y 4/1 to 5Y 4/2
5Y 4/1
5Y 4/1 to 5Y 3/1
5Y 3/1 to 5Y 4/1 to 5Y 4/2
5Y 4/1 to 5Y 4/2

MSM12/2-10-02 SL Eirik Drift **MSM12/2**

Recovery: 14.18 m 57° 36.08´ N, 44° 51.18´ W Water depth: 3192 m

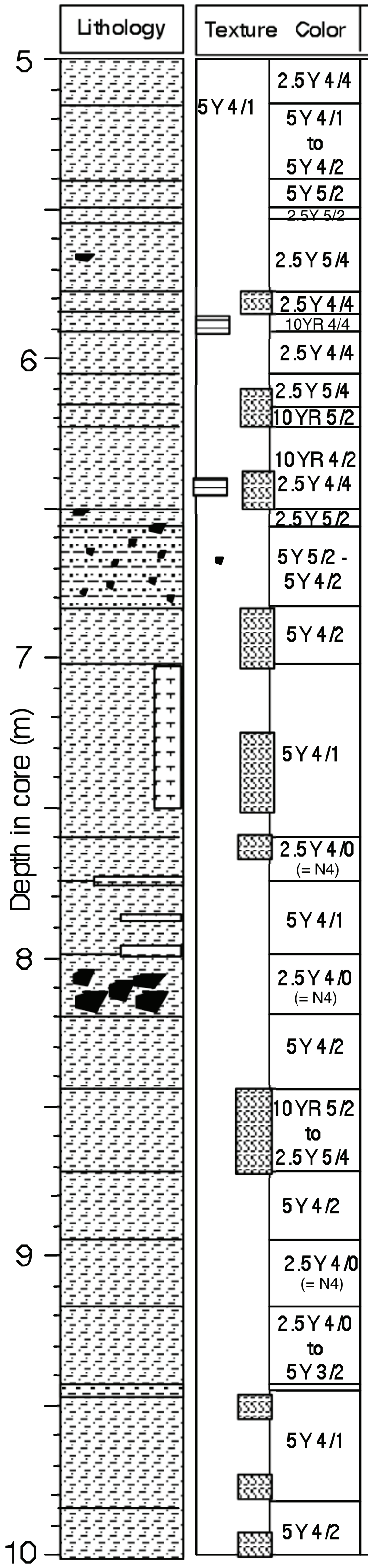


Description

0 - 3 cm: brown (10YR 5/3) (sandy) silty clay, some foraminifers
3 - 32 cm: olive brown (2.5Y 4/4) silty clay, some sand; mud clasts; abundant forams in lower part
32 - 37 cm: olive gray (5Y 4/2) silty clay, some sand; foraminifers; mottled/bioturbated
37 - 48 cm: yellowish brown (10YR 5/4) silty clay, some sand; foraminifers; mottled/bioturbated
48 - 76 cm: olive gray (5Y 5/2), yellowish brown (10YR 5/4), and dark brown (10YR 4/3) silty clay, some sand; foraminifers; strongly mottled/bioturbated
76 - 91 cm: olive gray (5Y 5/2) silty clay with sand; mottled/bioturbated
91 - 101 cm: alternations of olive gray (5Y 5/2) and dark brown (10YR 4/3) silty clay with sand
101 - 114 cm: olive brown (2.5Y 4/4) silty clay, some sand; mud clasts
114 - 144 cm: light olive brown (2.5Y 5/4) silty clay, some sand; abundant foraminifers
144 - 172 cm: grayish brown (2.5Y 5/2) to dark grayish brown (2.5Y 4/2) silty clay, some sand; foraminifers; bioturbated in upper part; mud clasts at 160-172 cm; sharp contact at base
172 - 214 cm: dark gray (5Y 4/1) to olive gray (5Y 4/2) silty clay, some sand; foraminifers; thin very dark gray layers at 183 and 187 cm
214 - 220 cm: olive gray (5Y 4/2) silty clay, some sand; foraminifers; bioturbated
220 - 259 cm: dark gray (5Y 4/1) silty clay, some sand; foraminifers
259 - 267 cm: olive gray (5Y 4/2) silty clay, some sand; foraminifers; bioturbated
267 - 277 cm: grayish brown (2.5Y 5/2) silty clay, some sand; foraminifers; bioturbated
277 - 289 cm: yellowish brown (10YR 5/4) and olive gray (5Y 5/2) silty clay, some sand; foraminifers; strongly mottled/bioturbated; dropstone (2 cm in diameter at 277-279 cm
289 - 315 cm: grayish brown (2.5Y 5/2) silty clay, some sand; foraminifers; slightly bioturbated in middle part
315 - 361 cm: olive gray (5Y 5/2-4/2) silty clay, some sand; some foraminifers; dropstone at 357-358 cm (2 cm in diameter)
361 - 415 cm: light olive brown (2.5Y 5/4) silty clay, some sand; abundant foraminifers (lenses of forams); some bioturbation; gray (5Y 5/1) horizons at 378-380 and 383-384 cm
415 - 515 cm: alternation of dark grayish brown (2.5Y 4/2) and olive brown (2.5Y 4/4) silty clay, some sand; foraminifers; at 491-493 olive gray (5Y 5/2) silty clay

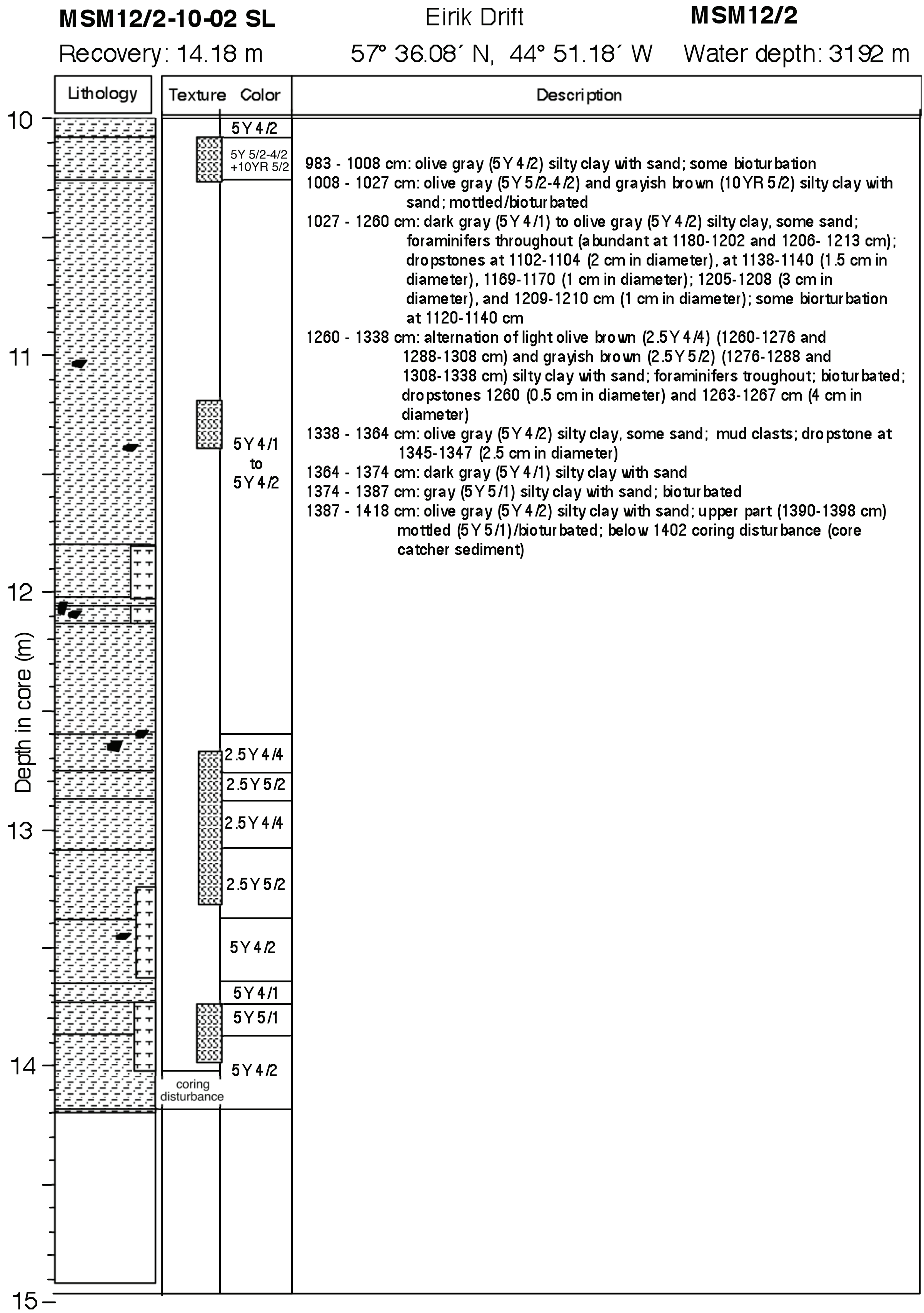
MSM12/2-10-02 SL Eirik Drift **MSM12/2**

Recovery: 14.18 m 57° 36.08´ N, 44° 51.18´ W Water depth: 3192 m



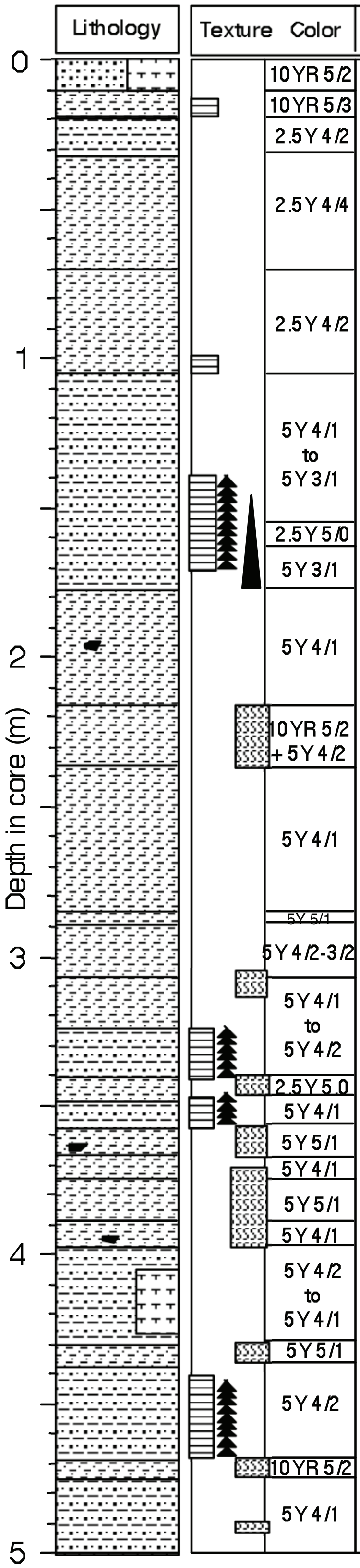
Description

415 - 515 cm: alternation of dark grayish brown (2.5Y 4/2) and olive brown (2.5Y 4/4) silty clay, some sand; foraminifers; at 491-493 olive gray (5Y 5/2) silty clay
515 - 540 cm: dark gray (5Y 4/1) to olive gray (5Y 4/2) silty clay, some sand
540 - 550 cm: olive gray (5Y 5/2) silty clay, some sand
550 - 554 cm: grayish brown (2.5Y 5/2) silty clay
554 - 578 cm: light olive brown (2.5Y 5/4) silty clay, some sand; abundant mud clasts; some small dropstones, large dropstone (4 cm in diameter) at 564-566 cm
578 - 585 cm: olive brown (2.5Y 4/4) silty clay, some sand; bioturbated
585 - 591 cm: dark yellowish brown (10YR 4/4) and light olive brown (2.5Y 5/4) silty clay, some sand; some lamination
591 - 605 cm: olive brown (2.5Y 4/4) silty clay, some sand
605 - 616 cm: light olive brown (2.5Y 5/4) silty clay, some sand; lower part mottled/ bioturbated
616 - 623 cm: grayish brown (10YR 5/2) silty clay, some sand; foraminifers; some bioturbation
623 - 650 cm: dark grayish brown (10YR 4/2) and olive brown (2.5Y 4/4) silty clay, some sand; dark brown laminae; foraminifers; lower part bioturbated
650 - 657 cm: grayish brown (2.5Y 5/2) silty clay, some sand; dropstones at 651-652 (1 cm in diameter) and 657 cm (0.5 cm in diameter)
657 - 683 cm: olive gray (5Y 5/2-4/2) silty clay with sand, numerous small dropstones (diamicton)
683 - 702 cm: olive gray (5Y 4/2) silty clay, some sand; foraminifers; some mottling/ bioturbation
702 - 760 cm: dark gray (5Y 4/1) silty clay with sand; 717-750 bioturbated and abundant foraminifers
760 - 775 cm: dark gray (2.5 4/0 = N4) silty clay with sand
775 - 799 cm: dark gray (5Y 4/1) silty clay with sand; enrichment of foraminifers at 775 cm (thin horizon), 786-788 cm and 795-799 cm
799 - 820 cm: dark gray (2.5 4/0 = N4) silty clay with sand; several very large dropstones (5-8 cm in size) at 807-818 cm; very stiff (diamicton)
820 - 844 cm: olive gray (5Y 4/2) silty clay with sand
844 - 872 cm: grayish brown (10YR 5/2) to light olive brown (2.5Y 5/4) silty clay, some sand; some bioturbation
872 - 895 cm: olive gray (5Y 4/2) silty clay with sand; mud clasts in upper half
895 - 917 cm: dark gray (2.5Y 4/0 = N4) silty clay with sand; very stiff
917 - 943 cm: dark gray (2.5Y 4/0) to dark olive gray (5Y 3/2) silty clay with sand
943 - 944 cm: light brownish gray (10YR 6/2) sandy silty clay horizon (detr. carb?)
944 - 983 cm: dark gray (5Y 4/1) silty clay with sand; some forminifers below 960 cm; upper and lower parts bioturbated
983 - 1008 cm: olive gray (5Y 4/2) silty clay with sand; some bioturbation


MSM12/2-10-02 SL
Eirik Drift
MSM12/2
Recovery: 14.18 m
57° 36.08´ N, 44° 51.18´ W
Water depth: 3192 m
Lithology
Texture
Color
Description
10
11
12
13
14
15
Depth in core (m)
5Y 4/2
5Y 5/2-4/2 +10YR 5/2
5Y 4/1 to 5Y 4/2
2.5Y 4/4
2.5Y 5/2
2.5Y 4/4
2.5Y 5/2
5Y 4/2
5Y 4/1
5Y 5/1
5Y 4/2
coring disturbance
983 - 1008 cm: olive gray (5Y 4/2) silty clay with sand; some bioturbation
1008 - 1027 cm: olive gray (5Y 5/2-4/2) and grayish brown (10YR 5/2) silty clay with sand; mottled/bioturbated
1027 - 1260 cm: dark gray (5Y 4/1) to olive gray (5Y 4/2) silty clay, some sand; foraminifers throughout (abundant at 1180-1202 and 1206- 1213 cm); dropstones at 1102-1104 (2 cm in diameter), at 1138-1140 (1.5 cm in diameter), 1169-1170 (1 cm in diameter); 1205-1208 (3 cm in diameter), and 1209-1210 cm (1 cm in diameter); some biorturbation at 1120-1140 cm
1260 - 1338 cm: alternation of light olive brown (2.5Y 4/4) (1260-1276 and 1288-1308 cm) and grayish brown (2.5Y 5/2) (1276-1288 and 1308-1338 cm) silty clay with sand; foraminifers troughout; bioturbated; dropstones 1260 (0.5 cm in diameter) and 1263-1267 cm (4 cm in diameter)
1338 - 1364 cm: olive gray (5Y 4/2) silty clay, some sand; mud clasts; dropstone at 1345-1347 (2.5 cm in diameter)
1364 - 1374 cm: dark gray (5Y 4/1) silty clay with sand
1374 - 1387 cm: gray (5Y 5/1) silty clay with sand; bioturbated
1387 - 1418 cm: olive gray (5Y 4/2) silty clay with sand; upper part (1390-1398 cm) mottled (5Y 5/1)/bioturbated; below 1402 coring disturbance (core catcher sediment)

MSM12/2-11-01 SL Eirik Drift **MSM12/2**

Recovery: 9.52 m 58° 14.32´ N, 44° 24.88´ W Water depth: 2384 m



Description

0 - 10 cm: grayish brown (10YR 5/2) sand, abundant foraminifers; sharp contact at base

10 - 19 cm: brown (10YR 5/3) (and grayish brown 2.5Y 5/2) silty clay with sand; abundant mud clasts; some lamination

19 - 31 cm: dark grayish brown (2.5Y 4/2) sandy silty clay

31 - 70 cm: olive brown (2.5Y 4/4) silty clay with sand

70 - 105 cm: dark grayish brown (2.5Y 4/2) silty clay with sand; at 95-105 cm some lamination (dark brown); sharp contact at base

105 - 177 cm: dark gray (5Y 4/1) to very dark gray (5Y 3/1) and gray (2.5Y 5/0; 155-163 cm) sandy silty clay; general fi ning upward; middle part (140-167 cm) alternation of coarse (more sandy)/ fi ne (more silty-clayey) sediments = fi ning-upward cycles

177 - 216 cm: dark gray (5Y 4/1) silty clay with sand; dropstone (1.5 cm in diameter) at 195-197 cm

216 - 237 cm: grayish brown (10YR 5/2) and olive gray (5Y 4/2) silty clay with sand; abundant mud clasts; mottled/bioturbated

237 - 285 cm: dark gray (5Y 4/1) silty clay with sand; some mud clasts in upper part

285 - 289 cm: gray (5Y 5/1) silty clay with sand

289 - 308 cm: (dark) olive gray (5Y 4/2-3/2) silty clay with sand; lower part mottled/ bioturbated

308 - 340 cm: dark gray (5Y 4/1) to olive gray (5Y 4/2) sandy silty clay to silty clay with sand; coarse/fi ne alternations with fi ning-upward cycles (325-340 cm

340 - 347 cm: gray (2.5Y 5.0) silty clay with sand, some bioturbation

347 - 357 cm: dark gray (5Y 4/1) to olive gray (5Y 4/2) sandy silty clay to silty clay with sand; coarse/fi ne alternations with fi ning-upward cycles

357 - 367 cm: gray (5Y 5/1) silty clay with sand, bioturbation; dropstone (1.5 cm in diameter) at 363-364 cm

367 - 375 cm: dark gray (5Y 4/1) silty clay with sand; some bioturbation in lower part

375 - 389 cm: gray (5Y 5/1) silty clay with sand, bioturbation

389 - 397 cm: dark gray (5Y 4/1) silty clay with sand, gray mottling (bioturbation); dropstone (2 cm in diameter) at 394-396 cm

397 - 429 cm: olive gray (5Y 4/2) to dark gray (5Y 4/1) sandy silty clay; abundant foraminifers at 405-425 cm

429 - 436 cm: gray (5Y 5/1) silty clay with sand, bioturbation

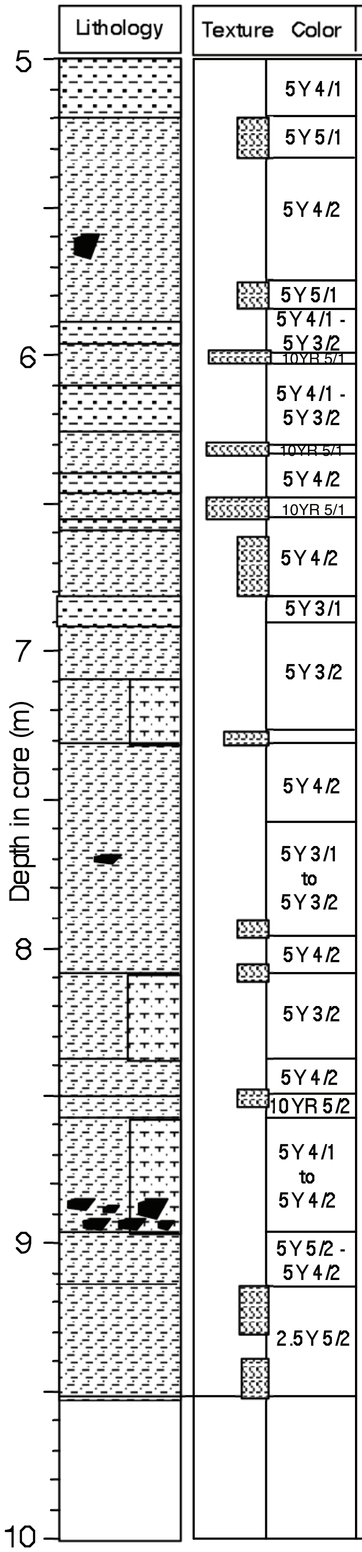
436 - 468 cm: alternations of olive gray (5Y 4/2) sandy silty clay and silty clay with sand (coarse/fi ne fi ning-upward cycles)

468 - 475 cm: grayish brown (10YR 5/2) silty clay with sand; mottled/bioturbated

475 - 519 cm: dark gray (5Y 4/1) sandy silty clay and silty clay with sand; at 489-493 cm some large burrows

MSM12/2-11-01 SL Eirik Drift **MSM12/2**

Recovery: 9.52 m 58° 14.32´ N, 44° 24.88´ W Water depth: 2384 m



Description

475 - 519 cm: dark gray (5Y 4/1) sandy silty clay and silty clay with sand; at 489-493 cm some large burrows
519 - 533 cm: gray (5Y 5/1) silty clay with sand, moderate bioturbation
533 - 575 cm: olive gray (5Y 4/2) silty clay with sand; abundant mud clasts in upper half; large dropstone (8 cm in diameter) at 559-565 cm
575 - 584 cm: gray (5Y 5/1) silty clay with sand, mottled (5Y 4/2)/bioturbated
584 - 658 cm: dark gray (5Y 4/1), olive gray (5Y 4/2) to dark olive gray (5Y 3/2) sandy silty clay to silty clay with sand; intercalated gray (10YR 5/1) intervals, strongly bioturbated (partly 5Y 4/2 with 10YR 5/1 mottling) at 599-603, 630-633, and 648-655 cm
658 - 681 cm: olive gray (5Y 4/2) silty clay with sand; some bioturbation
681 - 691 cm: very dark gray (5Y 3/1) sandy silty clay
691 - 709 cm: dark olive gray (5Y 3/2) silty clay with sand
709 - 731 cm: dark olive gray (5Y 3/2) foraminifer-rich silty clay with sand; 726-731 cm olive gray (5Y 4/2) with grayish brown (10YR 5/2) mottling (bioturbation)
731 - 758 cm: olive gray (5Y 4/2) silty clay with sand
758 - 796 cm: very dark gray (5Y 3/1) to dark olive gray (5Y 3/2) silty clay with sand; some bioturbation at lowermost part; large dropstone (3.5 cm in diameter) at 769-771 cm
796 - 809 cm: olive gray (5Y 4/2) silty clay with sand; some bioturbation at base
809 - 838 cm: dark olive gray (5Y 3/2) foraminifer-rich silty clay with sand, bioturbated at top
838 - 850 cm: olive gray (5Y 4/2) silty clay with sand
850 - 858 cm: grayish brown (10YR 5/2) silty clay with sand; bioturbation around top
858 - 896 cm: dark gray (5Y 4/1) to olive gray (5Y 4/2) silty clay with sand; abundant foraminifers; several large dropstones (2-7 cm in diameter) at 885-893 cm
896 - 914 cm: olive gray (5Y 5/2-4/2) silty clay with sand
914 - 952 cm: grayish brown (2.5Y 5/2) silty clay with sand; some bioturbation

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