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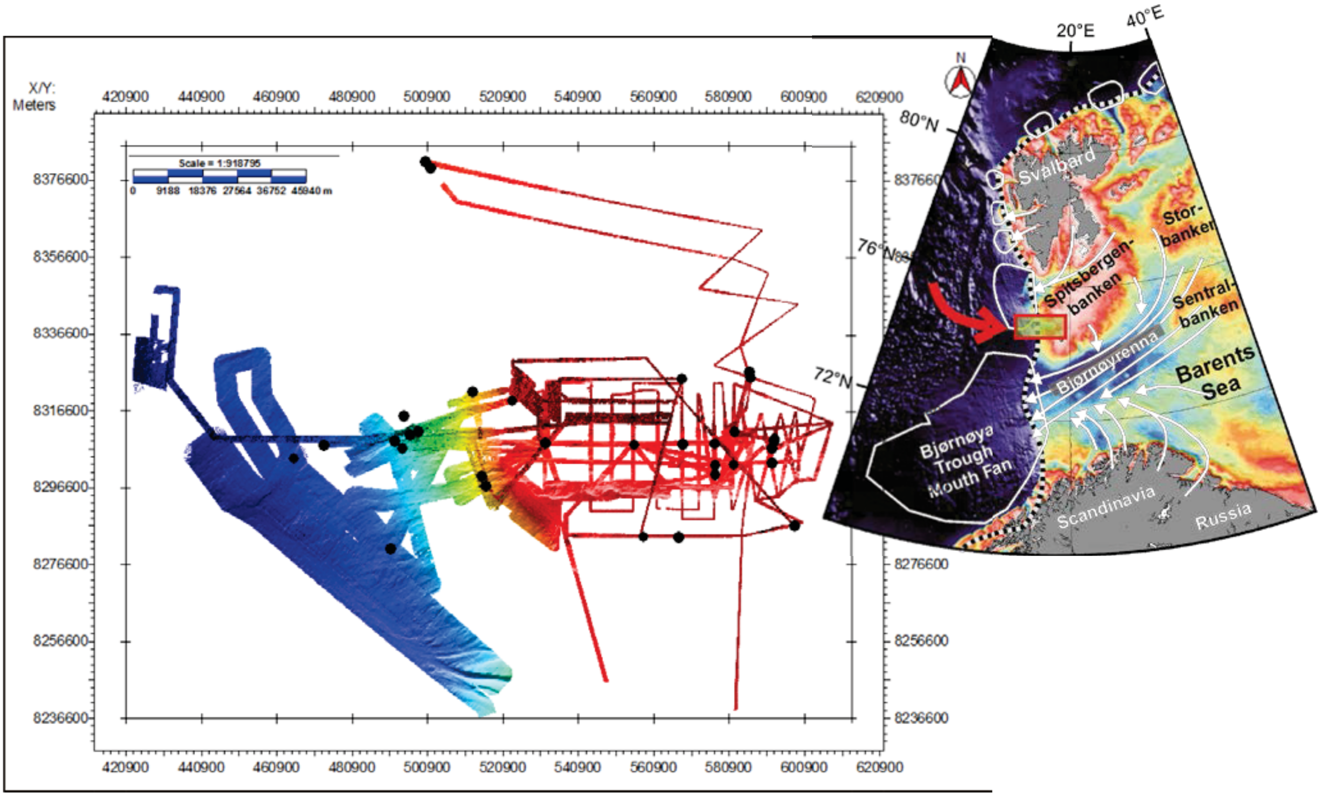
Short Cruise Report
RV Maria S. Merian – MSM 30
Tromsoe - Tromsoe
July 16, 2013 - August 15, 2013
Chief Scientist: PD Dr. Till Hanebuth
Captain: Matthias Günther



Objectives

The rate of ice-sheet retreat across polar continental shelves, ice-stream collapses and their relationships to short-term sea-level changes during deglacial periods are a matter of debate. However, if the associated catchment area and ice reservoir of an ancient ice-stream system were locally restricted, the deposits which typically formed have sensitively record these ice advance and retreat dynamics as a result of climatic variability. Rapid deglacial climatic changes in the northern Atlantic realm have forced the local ice stream of the *Kveithola Trough in the western Barents Sea* and the regional sea-ice cover to respond sensitively and rapidly. This ice dynamics is assumed to have left particular footprints in the form of various glacigenic deposits:

1. The continental-slope deposits (Trough Mouth Fan systems, TMF) recorded these deglacial ice dynamics sensitively by the formation of plumite (meltwater suspension plume deposits) successions but have also interacted with the ocean-current system. We want to understand the mechanisms of generation and dispersal patterns of sediment-laden meltwater discharges and investigate the sedimentation and stability dynamics on glacially influenced continental slopes in response to the cyclic glacier-induced sediment deposition. Further, we want to analyze the palaeoceanographic and climatic changes since MIS 5 (6?), concentrating on glacial-interglacial and shorter-term millennial variability.
2. Variations in meltwater discharge, ice-stream dynamics, and sea-level rising were related to the deglacial ice sheet retreat history and are recorded by the ice-margin deposits (Grounded-Zone Wedge systems, GZW) inside the Kveithola trough. We want to reconstruct the chronology of the deglaciation stages of the Svalbard/Barents Sea Ice Sheet for developing the conceptual understanding of ice-stream dynamics as well as in the context of rapidly changing climatic and environmental conditions since the last glacial maximum.
3. The nearby shallow continental shelf which must have acted as the local material source for the ice-stream delivered sediments. Confined depocenters are expected, thus, to contain information on these processes and the connection between the surrounding bank areas and the trough itself. We want to understand the formation dynamics of such shelf depocenters and to use these deposits as environmental archives for environmental changes and for the backtracking of material sources, pathways and the driving forces leading to sediment dispersal.
4. The sea-ice history is closely linked to the climatic variability with strong impact on the marine productivity and deep-water formation processes. We want to reconstruct former sea-ice positions and their dynamics, and to assess the climate-model credibility in simulating high-latitude ocean and sea-ice processes by verifying simulations under palaeo-boundary conditions with sea-ice proxy reconstructions.

Main intention of this international project between the collaborative institutions – MARUM (Bremen), OGS (Trieste), CSIC (Barcelona), UiT (Tromsø), GEUS (Copenhagen) and AWI (Bremerhaven) – was to obtain sediment cores of the exceptional length of up to 70 m with the MARUM owned seafloor drill rig MeBo, flanked by an intense sediment-acoustic and conventional coring program.

Narrative

During the first week, we mainly conducted a program serving as preparation for the seven pre-selected MeBo drilling sites. Seafloor morphology and the first tens of meters subbottom stratigraphy were profiled with the shipboard multibeam and PARASOUND echosounder systems.The seafloor surface and first meters of deposits were sampled by multicoring, giant box coring, and 3- to 12-m deep gravity coring. Beside their own scientific value, these data were thought to provide information for a save deployment of MeBo.

Whilst the weather conditions changed rapidly from sunny and calm to hazy and wet, the wave conditions remained always calm. We first run a long seismo-acoustic profile along the entire Kveithola trough and half-way down the slope fan. Then, we run cross-profiles at these stations to obtain a three-dimensional picture, and have sampled these three sites afterwards. The coring worked very well and we received a long core from the oldest grounding-zone wedge at the outer Kveithola trough, and one from the associated *trough-mouth fan* at 1,700 m water depth. We took a third core from an eroded channel-like slide-scar structure at the fan, a structure which should serve as a window into deeper strata during MeBo coring, and received a long core with highly consolidated slide material.

Since MeBo had a number of technical issues to solve, we started to extend the already existing high-resolution bathymetric map of our CORIBAR partners in the distal zone of the trough-mouth fan. Numerous landslides characterize the seabed morphology in that area. The PARASOUND profiles show a series of glacigenic debrite lenses interbedding plumite and hemipelagic sediments, and younger landslide bodies at the surface. These deposits illustrate the large amount of debris supplied by the Kveithola ice stream during glacial periods, the significant activity of meltwater plumes during the deglaciation phase and the widespread slope instability during interglacial times. Finally, we run PARASOUND profiles along two of the channels which appear frequently at the uppermost slope and are expected to serve as conduits for dense waters and suspended sediments coming out of the Kveithola trough. To evaluate the role of these gullies in terms of sediment transport, we took two cores from their thalwegs which contained rocky debris and sandy turbidites at the surface.

The second week of our cruise was a successful performance with regard to our scientific objectives, the prime target of our program – to drill down long sediment cores with MeBo – could, however, still not be put into practice. During the early stage of drilling at the first site, a severe failure occurred in the hydraulic system of the drill rig. It was turned out that the required cleansing of this system could not be achieved on board. With three weeks of cruise time still ahead, we decided to return to Tromsø at the end of weekend for repairing the hydraulics with land-based support. The permission for this stay in the harbour came within two working days. In the meantime, we continued our research survey and finished first the preparation program for the MeBo drilling sites inside the Kveithola Trough. At the outer edges of two grounding-zone wedges we received long, fine-grained sediment cores from the area-draping Holocene cover.

We used two consecutive nights to cover the drift deposit at the innermost part of the trough by a dense grid of PARASOUND profiles. We cored across this drift at four stations afterwards with the aim to receive material from the high-accumulation center (best temporal resolution), from the margin with reduced accumulation rates (deepest look back into the past) and the marginal moat (current velocity). We also mapped the sedimentary infill of a 50-km long, structurally controlled channel located north of the trough, which is supposed to re-direct shelf bottom currents towards the drift deposit.

In respect to our contingency plan, we went next to the mouth area of the neighbouring Storfjorden Trough. The previous cruise of our Spanish collaboration partners has shown that some tills are covered by younger sediments here, thin enough for gravity coring. First physical property measurements on the two cores we took indicated that we penetrated these deposits which will able us to estimate the former ice coverage thickness. Finally, we run a number of parallel multibeam lines at the toe of the Kveithola trough-mouth fan to extend the edges of the already existing high-resolution bathymetric map generated by our Spanish, Italian and Norwegian partners during preceding cruises.

The third week began with the stay in the harbor of Tromsoe from Monday to Thursday, where two hydraulics specialists from Germany and the MeBo technicians have repaired the hydraulic system of MeBo. We arrived back in our study area on Friday night. New technical complications have, however, continued to hamper the successful deployment of MeBo. We, thus, took sediment surfaces and gravity cores along two transects with seven stations in total on the bipartite sediment drift body located in the innermost part of the Kveithola Trough. The northward diverging structural channel was sampled through three gravity cores since its filling can directly be correlated to the trough's drift and we expect additional information on the regional oceanographic conditions and sediment dispersal pattern from these deposits. We run a grid of PARASOUND profiles across this area during the nights. The aim was to take sediment cores along a transect in the sense of *offset coring* (contigency plan) allowing to receive material from different successive units of the drift. Thus, such a composite core would in parts replace one long MeBo core.

During the remaining nine days, we have deployed MeBo five times. The first two sites were located at two successive grounding-zone wedges (GWZ) inside the Kveithola Trough. Drill-ing depths were 35 and 40 m penetrating the 20-m thick glaci-marine surface unit and the underlying tills of the GWZs. Both operations had to be stopped when the drilling advance came to a standstill due to the stiffness of the tills. Nevertheless, a GWZ was at least successfully drilled by a scientific group for the first time. The material retrieved (though the core recovery was limited due to the fact that high-pressure drill-hole flushing was required) allows an inside into the formation processes behind such glacigenic bodies.

We deployed MeBo at two further stations at the Kveithola trough mouth fan (TMF). The target was the continuous succession of various types of TMF-characteristic deposits (hemipela-gites, plumites, glacigenic debrites, landslide deposits) allowing the reconstruction of the fan formation history and of the ice-sheet dynamics on longer time scales. Two drilling attempts had to be aborted due to technical failures. A third was located inside an erosional channel-like scar structure which we wanted to use as a geological window into much deeper, thus older strata (back into the Eemian times or older). After having inter-penetrated a 20-m thick debritic landslide unit which covers these old successions, the flush water fully drained away into the underlying, much softer hemipelagic deposits. The thick landslide material had, however, a rather sticky consistency and that the bore rods stucked.

In addition to these MeBo deployments, we sampled seabed sediments and took sediment cores at 11 stations during this week. The shallow-shelf areas north and south of the Kveithola Trough host small depression fills and various types of moraine deposits which we have drilled with a vibro corer, providing ground-truthing to our numerous PARASOUND lines across the area. We also have completed a depth transect from the trough's mouth down to the TMF's toe at 2,000 m water depth, collecting surface sediments for palaeoceanographic studies. We received two sediment cores, especially taken for the analysis of regional methane fluxes. Profiling surveys performed during the nights extended the bathymetric map of the study area significantly, in particular run along the trough's northern and southern margins, around the trough's mouth, and at the TMF's toe. Thus, we are able now to understand the sub-recent as well as ancient processes in detail which have and had control on sediment dispersal as well as on slope instability.

Acknowledgements

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We also would like to thank Captain Matthias Günther and his crew for the great cooperation and communication during the entire cruise with its frequently arising new challenges.

List of Participants

#	Given name	Name	Duty on Board	Institution
1.	Till J.J.	Hanebuth	Chief Scientist	MARUM
2.	Markus	Bergenthal	MeBo	MARUM
3.	Andrea	Caburlotto	Geolab	OGS
4.	Sebastian	Dippold	MeBo	Bauer
5.	Ralf	Düßmann	MeBo	MARUM
6.	Tim	Freudenthal	Chief MeBo	MARUM
7.	Tanja	Hörner	Geolab	AWI
8.	Kai	Kaszemeik	MeBo	MARUM
9.	Steffen	Klar	MeBo	MARUM
10.	Hendrik	Lantzsch	Deck	GeoB
11.	Jaume	Llopart	Deck	CSIC
12.	Renata G.	Lucchi	Geolab	OGS
13.	Line S.	Nicolaisen	Wet lab	GEUS
14.	Kees	Noorlander	MeBo	MARUM
15.	Giacomo	Osti	Deck	UiT
16.	Asli	Özmaral	PARASOUND	GeoB
17.	Michele	Rebesco	Geolab	OGS
18.	Uwe	Rosiak	MeBo	MARUM
19.	Anna	Sabbatini	Wet lab	PUM
20.	Werner	Schmidt	MeBo	MARUM
21.	Adrian	Stachowski	MeBo	MARUM
22.	Roger	Urgeles	Geolab	CSIC

AWI Alfred-Wegener-Institute for Marine Polar Research, Bremerhaven, Germany.
Bauer Firma Bauer, Germany.
CSIC Institute of Marine Sciences, CSIC, Barcelona, Spain.
GeoB Dept. of Geosciences, University of Bremen, Germany.
GEUS Geological Survey of Denmark and Greenland, Copenhagen, Denmark.
MARUM Center for Marine Environmental Sciences, University of Bremen, Germany.
OGS National Institute for Oceanographic and Geophysic Sciences, Trieste, Italy.
PUM Dept. of Environm. and Life Sciences, Polytechnical University of Marche, Arcona, Italy
UiT Department of Geology, University of Tromsö, Norway.

Station List

Site (GeoB)	#	Gear	Date 2013	Latitude (°N)		Longitude (°E)		WD (m)	Rec. (cm)
17601	1	MUC	07-17	74	51,532	16	5,822	375	
17601	2	GBC	07-18	74	51,532	16	5,816	385	
17601	3	GC	07-18	74	51,532	16	5,817	384	509
17601	4	MeBo	07-18	74	51,532	16	5,840	380	0
17601	5	GC	07-18	74	51,532	16	5,818	370	537
17601	6	MeBo	08-08	74	51,317	16	5,498	380	4060
17602	1	GBC	07-19	74	52,039	14	43,969	1491	
17602	2	GC	07-19	74	52,040	14	43,964	1496	286
17602	3	GC	07-19	74	52,041	14	43,957	1488	456
17602	4	MeBo	08-09	74	52,035	14	43,577	1512	1210
17602	5	MeBo	08-11	74	52,187	14	42,538	1530	2110
17603	1	MUC	07-19	74	51,000	14	48,088	1430	
17603	2	GBC	07-19	74	51,002	14	48,084	1432	
17603	3	GC	07-19	74	51,002	14	48,091	1430	990
17603	4	MeBo	08-12	74	50,999	14	48,047	1440	740
17604	1	MUC	07-20	74	36,953	14	41,745	1797	
17604	2	GC	07-20	74	36,957	14	41,732	1798	632
17605	1	GBC	07-21	74	47,091	15	31,265	767	
17605	2	GC	07-21	74	47,090	15	31,269	775	285
17605	3	GC	07-21	74	47,089	15	31,270	771	405
17606	1	GBC	07-21	74	45,691	15	33,280	778	
17606	2	GC	07-21	74	45,691	15	33,280	778	438
17607	1	MUC	07-22	74	50,744	17	38,353	301	
17607	2	GC	07-22	74	50,738	17	38,351	302	829
17607	3	MeBo	07-22	74	50,741	17	38,318	300	1011
17607	4	GBC	07-22	74	50,714	17	38,274	296	
17607	5	GC	07-22	74	50,714	17	38,273	296	920
17607	6	MeBo	08-04	74	50,748	17	38,359	300	1356
17608	1	MUC	07-23	74	50,857	17	20,855	306	
17608	2	GBC	07-23	74	50,858	17	20,853	305	
17608	3	GC	07-23	74	50,858	17	20,854	299	819
17609	1	GBC	07-23	74	51,043	16	54,354	315	
17609	2	GC	07-23	74	51,041	16	54,332	315	626
17609	3	MUC	07-23	74	51,039	16	54,360	316	
17609	4	MeBo	08-03	74	51,045	16	54,319	315	270
17609	5	MeBo	08-06	74	51,026	16	54,208	320	3555
17610	1	MUC	07-25	75	30,985	15	0,530	389	
17610	2	GC	07-25	75	30,986	15	0,530	391	349
17611	1	GC	07-25	75	30,115	15	3,401	384	225
17611	2	MUC	07-25	75	30,113	15	3,410	385	
17612	1	MUC	07-26	74	46,446	17	37,737	291	
17612	2	GC	07-26	74	46,447	17	37,729	285	0
17612	3	GBC	07-26	74	46,442	17	37,729	290	
17612	4	GC	08-03	74	46,459	17	37,741	287	270
17613	1	MUC	07-26	74	47,741	17	37,887	294	

17613	2	GC	08-03	74	47,737	17	37,886	298	294
17614	1	MUC	07-26	74	47,642	18	8,743	284	
17614	2	GC	07-26	74	47,644	18	8,754	291	796
17615	1	GBC	07-26	74	50,935	18	10,939	330	
17616	1	MUC	07-26	74	58,831	15	26,524		
17617	1	MUC	07-27	74	49,432	13	49,005	2006	
17618	1	MUC	02-08	74	47,712	17	47,911	298	
17618	2	GC	02-08	74	47,711	17	47,918	296	812
17619	1	MUC	08-04	74	49,637	18	9,271	297	
17619	2	GC	08-04	74	49,639	18	9,277	296	550
17619	3	GC	08-04	74	49,638	18	9,278	296	682
17620	1	GBC	08-04	74	50,740	18	10,530	335	
17620	2	GC	08-04	74	50,741	18	10,523	339	491
17621	1	GBC	08-04	74	52,258	17	49,420	327	
17621	2	GC	08-04	74	52,258	17	49,421	327	576
17621	3	GC	08-04	74	52,259	17	49,422	330	786
17622	1	MUC	08-04	74	59,689	17	59,589	159	
17622	2	GC	08-04	74	59,691	17	59,587	160	434
17623	1	GBC	08-04	75	0,458	17	58,839	151	
17623	2	GC	08-04	75	0,459	17	58,847	150	442
17624	1	MUC	08-08	74	57,564	15	48,237	392	
17624	2	MUC	08-08	74	57,561	15	48,217	393	
17624	3	GBC	08-11	74	57,564	15	48,196	390	
17625	1	GBC	08-08	74	53,281	14	56,535	1350	
17625	2	GC	08-08	74	53,281	14	56,537	1349	364
17626	1	MUC	08-09	74	51,336	14	5,159	1894	
17627	1	GBC	08-09	74	52,940	14	52,184	1397	
17627	2	GBC	08-09	74	52,941	14	52,185	1403	
17627	3	GC	08-09	74	52,941	14	52,186	1400	474
17628	1	MUC	08-09	74	55,486	14	48,989	1347	
17628	2	GC	08-09	74	55,481	14	48,987	1342	720
17629	1	GBC	08-10	74	37,798	17	57,749	131	
17629	2	VC	08-10	74	37,803	17	57,754	127	493
17630	1	GBC	08-10	74	37,908	17	16,889	149	
17630	2	VC	08-10	74	37,909	17	16,888	150	160
17631	1	GBC	08-10	74	38,122	16	57,774	173	
17631	2	VC	08-10	74	38,123	16	57,777	174	506
17632	1	GBC	08-10	74	59,985	17	21,780	169	
17632	2	GC	08-10	74	59,984	17	21,780	170	236
17633	1	GBC	08-13	74	51,855	14	44,658	1475	
17633	2	GBC	08-13	74	51,854	14	44,659	1478	
17633	3	GC	08-13	74	51,854	14	44,655	1482	575
17634	1	GBC	08-13	74	51,877	14	44,380	1494	
17634	2	GC	08-13	74	51,876	14	44,582	1485	604