MSM 30 CORIBAR

– Ice dynamics and meltwater deposits: coring in the Kveithola trough –

Western Barents Sea
Tromsø – Tromsø
July 15th – August 16th, 2013

1st Weekly Report – July 15th to 21st, 2013

After a three-day mobilization phase in the harbour of Tromsø which was required for our heavy seafloor drill rig, we departed through the spectacular fjord straight to the North. Our destination was the western edge of the Barents Sea.

MARIA S. MERIAN in the harbour of Tromsø.

During high-glacial times, the entire Barents Sea was thickly covered by the Eurasian ice sheet in which several ice streams carved ca. 300 m deep troughs. These thick glaciers delivered large volumes of sediment and rock debris across the shelf edge towards the continental slope, where in turn massive deposits formed at that time in the form of extended fans, just off the troughs (deposits called *debrites* forming *trough-mouth fans*). With the following climatic warming and the associated rise in sea level, the glaciers started to retreat with intervals of rapid melting interrupted by intervals of stagnation. During this transition to warmer conditions, the ice sheet and particularly its most dynamic element, ice streams, left two types of deposits which we can be used as recorders of past ice extent and climatic conditions:

1. Sediment-loaded suspension plumes drained out of the melting ice caps and settled down at the continental slope (deposits called *plumites* on the *trough-mouth fans*); and
2. Moraine-like ridges (deposits called *tills* forming *grounding-zone wedges*) deposited at the glacier front during each phase of stagnation inside the troughs carved by ice streams.

The target of this cruise is the Kveithola trough located just North of Bjørnøya (Bear Island) at 74°30'N, two-third way between Norway and Svalbard (Spitsbergen). This 90 km long and 10 km wide trough is a relatively small glacigenic structure, which makes it ideal for the purpose of our studies: the smaller the catchment area of the former glacier, the more direct we expect its response to climatic variability.

What makes this cruise special and novel?

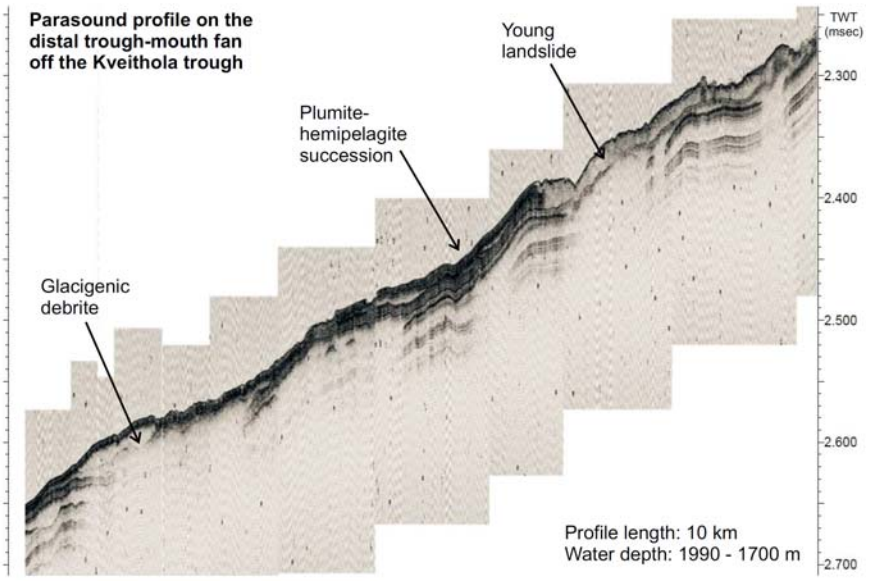
An international group of scientists wants to drill into such ice sheet-related deposits several tens of meters deep into the seafloor. Previous cruises by the partners from Italy, Spain and Norway provided a detailed database concerning the seafloor morphology (bathymetry) and subbottom architecture (seismic and chirp profiles). Many of the important depositional units are, however, buried deeply under younger sediments; deeper than can be recovered by standard coring tools.

The seafloor drill rig MeBo (*Meeresboden-Bohrgerät*), constructed and based at MARUM (University of Bremen) is an in Academia unique drilling device that is able to drill into various types of deposits down to 80 m below seafloor, in up to 2,000 m water depth, and is naturally well-suited for the purpose of this cruise. With the final aim to obtain such long sedimentary records an international group was formed [MARUM / Bremen, OGS / Trieste, CSIC / Barcelona, UiT / Tromsø, GEUS / Copenhagen, AWI / Bremerhaven]. The group acts on the basis of a consortium, rather than a simple collaboration, as each individual partner has separately applied for funding a share of this joint cruise project. This has been one of the initial challenges of CORIBAR: to synchronize the different national funding systems – but finally these efforts have been hundred percent successful.

The main scientific target of this project is to drill into the *trough-mouth fans* and through the *grounding-zone wedges* of the Kveithola trough system in order to reconstruct the dynamics of ice-sheet retreat during deglacial times. The superordinate aim is to decipher the history related to the retreat-steering factors from such deposits: climatic melioration, stepwise rising sea level, palaeoceanographic and ocean current changes as well as the role of seabed topography. In addition, the surrounding shallow shelf banks having acted as material source during glacial coverage, the establishment of the modern shallow-water oceanographic system after disappearance of the regional ice sheet, and the local Holocene history of sea-ice cover in this region shall be investigated.

During this first week, we mainly conducted a program serving as preparation for the seven preselected MeBo drilling sites. Seafloor morphology and the first tens of meters subbottom stratigraphy were profiled with the shipboard multibeam and PARASOUND sediment-echosounder systems.The seafloor surface and first meters of deposits have also been sampled by multicorer, giant box corer, and a 3- to 12-m long gravity corer. These data provide the information needed for a save deployment of MeBo since the 8-tons heavy tool is supposed to be placed on the seafloor for not less than 1.5 days at each site.

Whilst the weather conditions change rapidly from sunny and calm to hazy and wet, the wave conditions remain gracious.



PARASOUND profile across the distal Kveithola trough mouth fan.

We first run a long seismo-acoustic profile along the entire Kveithola trough and half-way down the slope fan, have then crossed the first three drilling stations to obtain a three-dimensional picture, and have sampled these three sites. The coring has worked very well and we received a long core from a grounding-zone wedge at the outer Kveithola trough, and one from 1,700 m water depth showing a thick succession of the Holocene cover. We took a third core from an eroded channel-like scar structure (product of a landslide collapse), which will later serve as a window into deeper strata during MeBo coring, and received a long core with highly consolidated slide material.

We have, moreover, started to extend the already existing high-resolution bathymetric data set in the distal zone of the trough-mouth fan. Numerous landslides characterize the seabed morphology here. The PARASOUND profiles show a series of glacigenic debrite lenses interbedded with plumites and hemipelagic sediments as well as younger landslide bodies at the surface. These sediments are indicative of 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 overall instability of the slope during interglacial times. Finally, we run PARASOUND along two of the channels frequently appearing at the uppermost slope (erosional structures called *gullies*). These gullies are expected to serve as conduits for dense waters and suspended sediments flowing out of the Kveithola trough. To evaluate the role of these gullies in terms of sediment transport, we took two cores from bases (called *thalwegs*) which contained rocky debris and sandy turbidites at the surface.

Currently, MeBo is drilling at a first site in the innermost part of the Kveithola trough where an exceptional sediment body rests on glacial tills; we expect that this well-stratified and 30-m thick succession is not more than 10 thousand years old, thus resolving the Holocene climatic and oceanographic history of this region in outstandingly high temporal resolution.

We have collected exciting material already, all participants are healthy and in good mood, and we are looking forward to receive the first long MeBo core on deck.

Till Hanebuth

Chief Scientist

Kveithola, July 22, 2013, 74°50’N 17°38’ E

Scientists recovering a gravity core meter by meter.