Baltic Sea Paleoenvironment Expedition

In September 2013, the *Greatship Manisha* left Kiel, Germany, with 17 scientists from Expedition 347 Baltic Sea Paleoenviornment onboard to begin coring and logging operations at nine sites offshore Denmark and Sweden. Led by Co-chief Scientists Thomas Andrén, School of Natural Sciences, Technology and Environmental Studies at Södertörn University, Sweden, and Bo Barker Jørgensen, Center for Geomicrobiology at Aarhus University, Denmark, the offshore Science Party and ESO staff spent 50 days coring the sediments in six sub-basins of the Baltic Sea Basin. Situated in the heartland of past Scandinavian Ice Sheet advances and retreats the coring sites have been subject to repeated glaciations and preserve unique geological, microbiological and environmental archives. These records will enable investigation of the environmental history and microbiological evolution of the Baltic Sea region over the last 140,000 years, from the beginning of the Eemian interglacial through the Last Glacial Maximum to the present day.

Scientific goals

1. Climate and sea-level dynamics of Marine Isotope Stage (MIS) 5, including onsets and terminations;
2. Complexities of the last glacial, MIS 4 - MIS 2;
3. Glacial and Holocene (MIS 2 - MIS 1) climate forcing;
4. Deep biosphere in Baltic Sea Basin (BSB) sediments.

The expedition set out to recover sediment sequences spanning the time period from MIS 5 to the present day at the highest possible resolution. In order to meet this aim, nine sites were drilled during the expedition. The geographic distribution of the sites aimed to register the in- and out-flows from the Baltic Sea Basin, as well as the sediments deposited within the basin itself.

Dates: 12 September - 1 November 2013
Platform: *Greatship Manisha*
Deepest hole: 229.6 m
Number of boreholes: 30
Number of cores: 798
Core recovery: 1622.76 m (91.45%)
http://www.ecord.org/expedition347

Climate, sea-level and ice-sheet change

It is envisaged that the transect of drilled sites, from west to north east and from south to north, in this repeatedly glaciated and environmentally dynamic region will provide new scientific insights in a variety of research fields.


Greatship Manisha on station during Exp. 347..

Examples include regional and global issues on the timing and forcing of rapid climate and sea-level changes; mechanisms behind hypoxia-driven processes in intracontinental sea basins, and reconstruction of the glacial history of the Scandinavian Ice Sheet and its interaction with the climate system. The paleoenvironmental information will be relevant on a semi-continental scale, due to the fact that the Baltic Sea drains an area four times its size.

Biogeochemical Processes

The drilled sites will also give new insight into the controlling mechanisms for prokaryotic communities and underlying biogeochemical processes in the seabed. New data will show how the highly variable environment has affected the phylogenetic diversity of the microbial communities and which biogeochemical processes predominate today in the deep glacial and interglacial deposits.

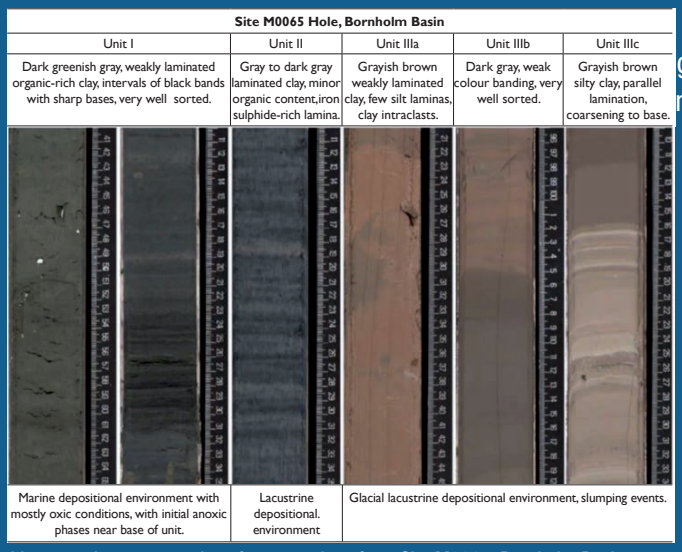
IODP
INTERNATIONAL OCEAN DISCOVERY PROGRAM

ECORD
EUROPEAN CONSORTIUM FOR OCEAN RESEARCH DRILLING

Scientific results

During the 50-day long offshore phase aboard the *Greatship Manisha* and the Onshore Science Party held at the Bremen Core Repository in February-March 2014, the scientists analysed the cores to gain a deeper understanding of the palaeoenvironmental evolution of the Baltic Sea Basin through the last glacial cycle.

The lowermost part of the cored sequences taken in the Little Belt and near Anholt Island revealed biostratigraphic indications of possible MIS 5 age, and sufficient material was collected to perform optically stimulated luminescence dating. Further laboratory investigations and dating are required, but it is likely that a deeper understanding of MIS 5 will be forthcoming. Also, material from these sites and others in Hanö Bay and Bornholm Basin are expected to provide information on conditions within the Baltic Sea Basin during parts of MIS 4 - MIS 2.



Line-scan image examples of core sections from Site M0065, Bornholm Basin

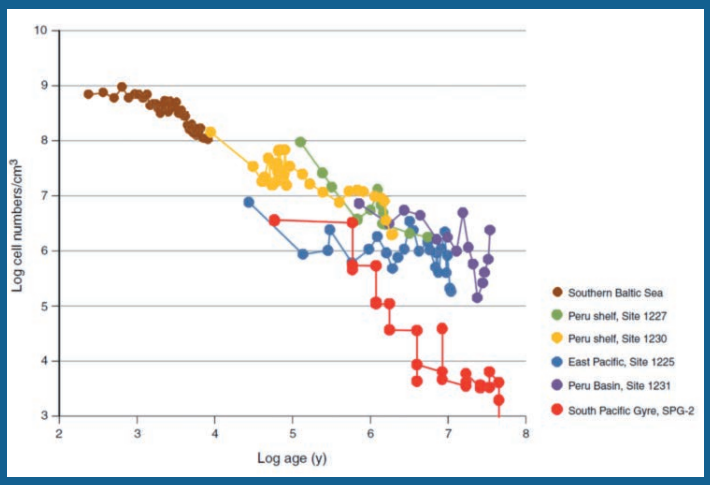
and will provide new general understanding of the behaviour of the Scandinavian Ice Sheet during MIS 2. The sequences from Little Belt and near Anholt Island may also contribute to this knowledge. The cored sequences from the Ångermanälven River estuary will give new insights into the late Holocene history of the northern part of the Baltic Sea Basin.

An unexpected long Holocene sequence from the Little Belt, together with an extremely expanded Holocene sequence from Landsort Deep, will allow high-resolution reconstructions of climate response and other external forcing mechanisms, and new knowledge on how the anthropogenically unaffected

The Expedition Team at the Onshore Science Party in Bremen.

ecosystem responded. The Holocene sequence from the Landsort Deep is laminated and may allow us to reconstruct annual-scale environmental changes during the last ~8000 years.

Four sites in the Little Belt, near Anholt Island, Landsort Deep and Bornholm Basin were selected for the study of the deep biosphere and how the buried microbial communities responded to major shifts in the Baltic Sea environment in the past and to varying lithologies and geochemical stratification in the present. Microbial cell counts are generally extremely high, particularly in the organic-rich Holocene deposits younger than ~8000 years that yielded the highest microbial abundances yet recorded by IODP *(below)*. Samples were taken offshore for microbiological analysis from dedicated holes, and were shipped during and after the expedition to laboratories around the world and, based on the many novel ideas and techniques that will be applied, important new information on microbial life in the deep biosphere is expected.



Distribution of microbial cells in the seabed. The double-logarithmic plot shows examples of cell numbers per cubic centimeter and how these decrease with the age of the sediment. Cell counts from the Baltic Sea, 108–109 cells/cm³, are compared to data from the Pacific Ocean where counts drop below 104 cells/cm³ in the oldest sediments of the most nutrient poor area, the South Pacific Gyre. Modified from Jørgensen (2012).

April 2017 - credits: ECORD/IODP, Dominique Weis and Volker Diekamp, MARUM.

For further reading

- Andrén T, Jørgensen BB and Cotterill C and the Expedition 347 Scientists, 2015. Proc. IODP, 347: College Station, TX (Integrated Ocean Drilling Program). doi:10.2204/iodp.proc.347.2015
- Expedition 347 Scientists, 2014. Baltic Sea Basin Paleoenvironment: paleoenvironmental evolution of the Baltic Sea Basin through the last glacial cycle. IODP Prel. Rept., 347. doi:10.2204/iodp.pr.347.2014
- Jørgensen BB, 2012. Shrinking majority of the deep biosphere. PNAS, 109, 40, 15976-15977. doi:10.1073/pnas.1213639109
- D'Hondt S et al, 2004. Distributions of microbial activities in deep subseafloor sediments. Science, 306(5705):2216-2221. doi:10.1126/science.1101155