Expeditionsprogramm Nr. 75

FS POLARSTERN

ANT XXIII/4

ANT XXIII/5

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2. CRUSTAL AND SEDIMENTARY STRUCTURES AND GEODYNAMIC EVOLUTION OF THE WEST ANTARCTIC CONTINENTAL MARGIN AND PINE ISLAND BAY

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Objectives

Since the last glacial maximum the West Antarctic Ice Sheet (WAIS) with a base mostly beneath the present-day sea-level has experienced dramatic volume changes within short periods of time. Studies are urgently required to show how these short-term variations are related to volume changes in the older geological past. Next to the ice drainage basins of the Weddell Sea and the Ross Embayment, Pine Island Bay forms the third-largest outflow area for the West Antarctic ice-shield. The main ice streams from the WAIS into Pine Island Bay flow through the Pine Island and Thwaites Glacier systems, through which most of the glacial-marine sediments onto the shelf of Pine Island Bay and across the continental slope into the deep sea have been transported. Geophysical surveys of the sedimentary sequences and the underlying basement of the shelf and slope of the southern Amundsen Sea, Pine Island Bay and its adjacent continental rise would allow reconstructions of the formation of the tectonic and older sedimentary processes as well as to find out about the history of large-scale glaciation in West Antarctica. Accurate models of the geodynamic-tectonic evolution contain some of the most important parameters for understanding and reconstruction of the palaeo-environment. The following objectives will be addressed during ANT XXIII/4 as part of a cooperative project between the Vernadsky Institute in Moscow (Dr. Gleb Udintsev) and AWI:

- Identification of the boundaries between suspected crustal blocks and volcanic zones in Pine Island Bay. The glacier troughs and Pine Island Bay are thought to have developed along such tectonic boundaries. Heli-magnetic, gravimetric and deep crustal seismic (reflection and refraction/wide-angle) surveys in the Pine Island Bay area will provide the necessary data base.

- During and after separation from the Chatham Rise and Campbell Plateau (New Zealand), the continental margin of Marie Byrd Land developed as a passive margin, probably accompanied by intensive volcanism. The question is whether this volcanism occurred mainly during the rifting process or during post-rift phases, or whether it developed in relation to the West Antarctic rift system. Helicopter-magnetic mapping and deep crustal seismic profiling of the continental margin of Marie Byrd Land will provide data to develop models of the magmatic evolution.

- Recording of the sedimentary sequences across the shelf, slope and the continental rise, using reflection seismics, sub-bottom profiler (Parasound) and swath-bathymetry (Hydrosweep) in order to derive a sedimentation model.

- Mapping of the acoustic basement and its structure with seismic reflection methods to obtain the tectonic geometries and boundary conditions necessary to understand sediment transport and depositional processes.

Work at sea
It is planned to collect seismic, bathymetric and Parasound profiles across the shelf, slope and rise of the continental margin of the southern Amundsen Sea. This will be conducted in conjunction with the project *"The response of Quaternary climatic cycles in the south-east Pacific: development of the opal belt and dynamic behaviour of the West Antarctic Ice Sheet"* (Kuhn et al.) and the project *"Quaternary West Antarctic Deglaciation in the Amundsen Sea Embayment"* (Johnson et al.). The exact location of the profiles will be determined during the expedition with respect to ice conditions.
Closely spaced helicopter-magnetic lines will be flown to cover the area of Pine Island Bay as much as possible for a magnetic map of the region to be compiled. The exact location will be determined during the expedition depending on the ship position and flight conditions.

3. THE RESPONSE OF QUATERNARY CLIMATIC CYCLES IN THE SOUTH-EAST PACIFIC: DEVELOPMENT OF THE OPAL BELT AND DYNAMIC BEHAVIOUR OF THE WEST ANTARCTIC ICE SHEET

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Objectives
The reconstruction of the paleoclimatic and paleoceanographic development of the late Quaternary south polar ocean and adjacent continental areas in high temporal and spatial resolution is the main goal of our long-term study. During this expedition the sedimentary budget of biogenic and terrigenous components and their variability will be investigated. One objective of this leg is to continue the studies of former expeditions to gather more detailed paleoceanographic information on the eastern Pacific sector of the Southern Ocean for reconstruction of the distribution of water masses, frontal systems and sea ice, as well as information on high export productivity areas and their impact on global climate evolution. Thus, it will help us to broaden our understanding of the impact of environmental processes in the Southern Ocean on global climate. The second objective is to investigate the response of the West Antarctic Ice Sheet (WAIS) to Quaternary climatic changes. This ice sheet represents the most instable portion of Antarctic ice. The distribution pattern of the WAIS and its development can be deciphered from the sediment deposition in the study area. Previous investigations indicated that the WAIS collapsed once or multiple times during the past 0.75 million years. However there are also controversial findings. Since marine-geological records of glaciomarine deposition proximal to the WAIS are sparse, the exact timing and boundary conditions for such an event, which would result in a rise of the sea level of 5-6 m, are not yet known. The reconstruction of environmental conditions based on a multiproxy approach (this includes the investigations of sediment composition, microfossil assemblages and isotopic measurement of biogenic components) and its stratigraphic dating should substantially add to the knowledge of the WAIS history and its stability during a possibly warmer climate in the future.

Work at sea
It is planned to recover sub-bottom echosounder information and Quaternary sequences from the farther south-east Pacific (De Gerlache Seamounts) on the transit to the Amundsen