5. PROCESSES IN CHANNEL SYSTEMS IN THE WESTERN GREENLAND SEA

5.1 Structure and geological processes

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Objectives

In the frame work of the multi-disciplinary research programme ARKTIEF sedimentation processes are studied on geological time-scales (± 1000-2000 years) in a channel system at the East Greenland continental margin. The geological programme aims at

(1) characterizing the larger scale subsurface structure of the channel and the adjacent areas,
(2) mapping the various sedimentary facies, and
(3) sampling surface and near surface sediments for a detailed study of various sedimentological, organic geochemical and micropaleontological tracers which may reflect the various sedimentation processes, in particular gravitative mass transports. Additionally, the history of sediment transport in the channel will be elucidated by analysing sediment cores. These studies will contribute to a better understanding of the recent and past activity of the channel system.

Work at Sea

Bathymetrical survey

The swath sounding system HYDROSWEEP was used during expedition ARK XVII/1 for a bathymetric survey in the study area of ARKTIEF at the East Greenland continental margin. Based on the results of the survey during expedition ARK XVI/1 in 2000 (Krause and Schauer 2001), the adjacent lower continental slope and deep-sea areas were visited to continue the detailed mapping of the course of the channel. Furthermore, selected transects were conducted in the central portion of the system that was studied in 2000 to fill gaps in the bathymetric chart of this area.

Sediment echosouding

The ship-mounted PARASOUND echosounding system of POLARSTERN was in operation during the work in the Greenland Sea in order to characterize the acoustic behaviour of the uppermost sediment layers. The PARASOUND transects were conducted partly perpendicular to the axis of the channel in order to identify lateral variability of sedimentary facies. Furthermore, PARASOUND profiling was used to select coring locations and transects for the OFOS surveys. The data were digitised by two different systems:

(1) the PARASOUND system for simultaneous printing on a chart recorder (Atlas Deso 25), and
(2) by the PARADIGM system (Spiess 1992). For details of the method and standard settings used during the expedition see e.g. Niessen & Whittington (1994).

Bottom sediment sampling
Surface and near-surface sediments were collected in the study area on transects across the channel to sample the various sedimentary environments. A more detailed sampling was done along the OFOS transects in collaboration with the biology group. In order to get undisturbed surface and near-surface sediments, the giant box corer (GKG) with a size of 50x50x60 cm and the multi corer (MUC) with a tube diameter of 10 cm were used. The sampling was routinely done by MUC because of the better recovery of sediment surfaces. Gravity corers (SL) were used to obtain long sediment cores from the channel, the adjacent levees and the deep sea.

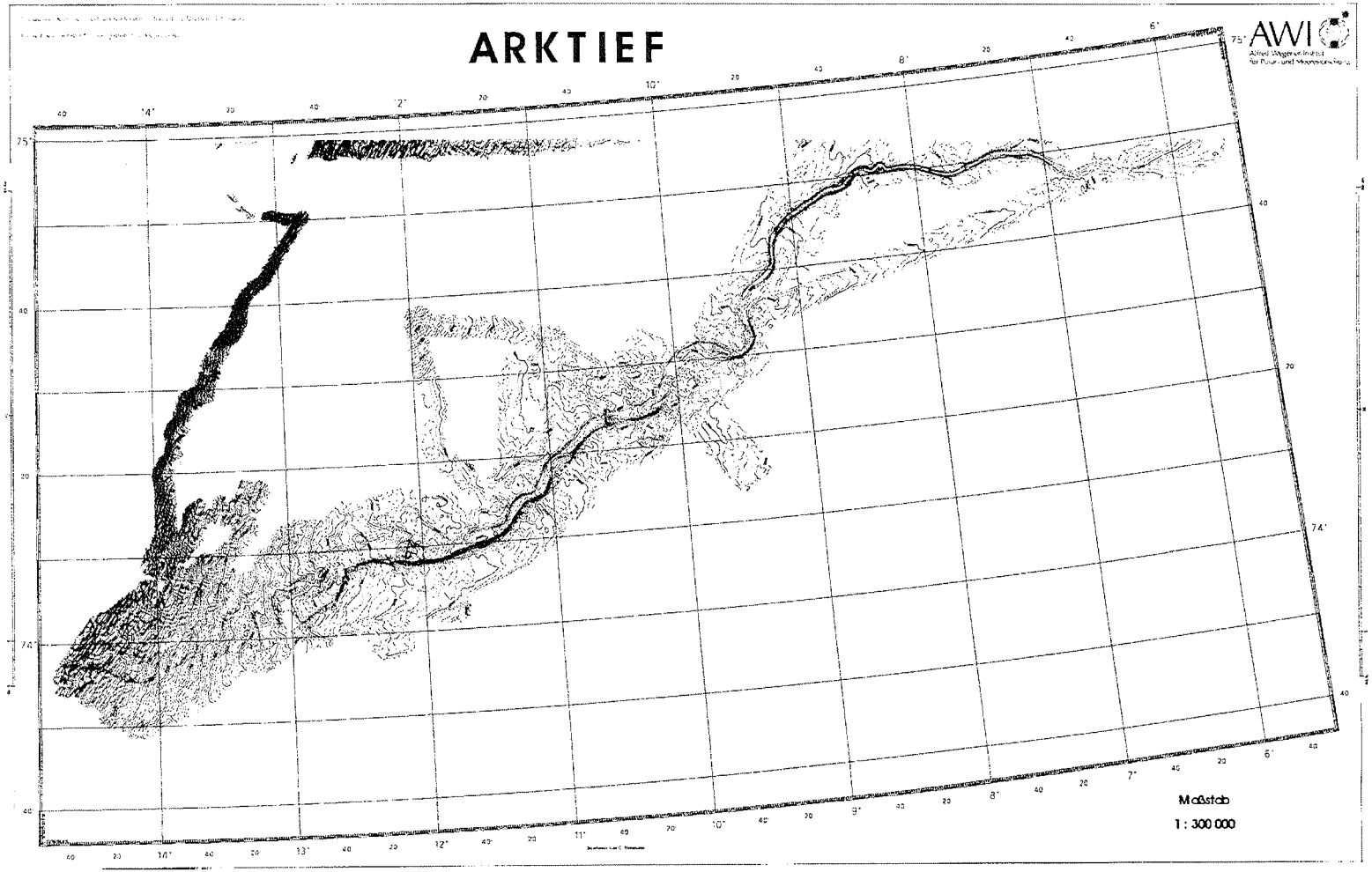
Preliminary Results

Bathymetry of the channel system
A large-scale mapping with the GLORIA long-range side-scan sonar revealed the general pattern of a system with three major channels in the western Greenland Basin (Mienert et al. 1993; Hollender 1996) but only single separate segments of the channel system that were selected for detailed studies in the ARKTIEF project could be mapped. The preliminary results of our bathymetric surveys in 2000 (Krause and Schauer 2001) and in 2001 show that a single channel meanders from the lower continental slope to the abyssal plain over a distance of about 200 km (Fig. 8). The channel was tracked back from the Greenland Basin in ca. 3500 m water depth at ca. 74°45´N and 6°30´W to the continental rise at ca. 74°N and 13°15´W in about 2600 m water depth. Although the severe ice conditions during ARK XVII/1 hampered the survey at the continental slope, the few profiles suggest that there is not a single distinct channel extending upslope. Smaller tributary channels may be found running down slope but further detailed processing of the data is needed to allow a definite interpretation. Along the entire course, this channel system is developed as a single channel that is clearly separated from the other channel systems. East of 6° 30´W distributary channels may have developed as indicated by the GLORIA data (Hollender 1996) but due to time constraints, the transition from the channel to the depositional area could only be studied along a single line when POLARSTERN left the area of operations to Fram Strait. Any larger depositional regions in the distal parts of the channel have not been observed.

Morphology of the channel system
The acoustic penetration was on the average down to a sediment depth of 25 to 40 m, except in the channel bottom and in the continental slope where penetration was usually less than 5 m. The channel system can be tentatively divided into 4 morphological divisions based on morphological and acoustic characteristics.

The upper channel system extends from the continental slope to about 12°W (Fig. 8). The structure of the channel is less distinct than in the middle and lower channel system. A levee extends along the southern margin of the channel but it is almost

Fig. 8: Preliminary bathymetric map of the channel at the East Greenland margin based on HDROSWEEP data obtained during expeditions ARK XVI/1 and ARK XVII/1. Depth contours are at 10 m intervals (Processing of data by C. Hohmann).
Abb. 8: Vorläufige bathymetrische Karte der untersuchten Rinne am ostgrönländischen Kontinentalhang, basierend auf den während der Expeditionen ARK XVI/1 und ARK XVII/1 erhobenen HYDROSWEEP-Daten. Abstand der Tiefenlinien ist 10 m (Datenprozessierung durch C. Hohmann).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indistinct at the northern margin. On the lower continental slope at the westernmost end of the mapped area, the channel is becoming much wider (ca. 10 km), probably ending at a slide headwall. Shallow depressions upslope (<10 m) of the possible headwall may indicate that tributary channels may originate on the upper continental slope. Although the acoustic penetration is low on the continental slope, debris flow deposits are clearly identified in most profiles.

The middle channel system consists of a leveed channel extending from the continental foot to about 9°30'W. Levees are usually well developed at both flanks, the southern one being consistently higher than the northern one giving the channel an asymmetric shape. Some levees stand out clearly by more than 20 m from the adjacent deep-sea plain. The U-shaped channel is incised into the sea floor up to 100 m, but mainly less than 50 m, and is relatively narrow with an average width of ca. 2000 m. The levee deposits usually show a number of distinct parallel acoustic reflectors whereas only one prominent reflector is seen in the channel sections. The channel bottom is relatively even.

The lower channel system is characterized by a symmetric to asymmetric V-shape and the absence of prominent levees. Single cross sections are about 600 to 1000 m wide and the channel is incised up to 50-70 m (max. 150 m) into the sea-floor. The channel floor is relatively rough. Apparently, the channel shallows east of 7°W being in general less than 30-50 m deep and having again a symmetric U-shape. The channel floor is more even than west of 7°W. These observations are only based on few oblique profiles across the channel and these interpretations must be considered as rather tentative. Further HYDROSWEEP and PARASOUND surveys are required because only one relatively narrow stripe of ca. 5000 m width was mapped along the channel.

In the Greenland Basin east of ca. 6°35'W PARASOUND profiles show that the channel widens considerably terminating possibly in larger depositional lobes that have been interpreted from the GLORIA profiles (Hollender 1996). Single lens-shaped bodies with a transparent internal structure comparable to debris flows are possibly indicating sediment deposition related to transport in the channel system. However, further studies in this area are needed to reveal morphological details of this deep-sea depositional environment.

Sedimentary environment along the channel system

Bottom sediment sampling was conducted along the whole channel focussing on the central part of the system. The initial macroscopic analysis of the surface sediments suggests that the composition of sediments in the channel, the adjacent levees and the deep-sea areas is similar. The lack of erosional surfaces and the comparable sediment composition along the course of the channel suggest continuous recent and sub-recent deposition. Only short sediment cores were recovered from the channel floor. Gravity cores did not penetrate into the acoustic transparent layer below the top reflector. The core recovery was usually less than 100 cm indicating that only a thin cover with soft (Holocene?) sediments overlies bedrock. Longer sediment cores were only retrieved from the adjacent levees and the deep sea. Further detailed land-based sedimentological, geochemical and micropaleontological studies as well as analysis of the HYDROSWEEP and PARASOUND records are required to evaluate

the variability of sediments in the study area with respect to sedimentation and transport processes.

References

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5.2 Benthic distribution patterns and turn-over processes

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Objectives

Objectives of the planned biological and biochemical investigations within the ARK-TIEF project are to assess large-scale distribution patterns of benthic organisms in and around channel systems crossing the eastern Greenland continental margin and the deep central Greenland Sea, and to estimate benthic processes within these areas and their relevance for the Arctic Ocean ecosystem. Based on activity and biomass data it might be possible to estimate the frequency and intensity of particle-loaded near-bottom currents within the channels, and to evaluate the quality of the suspended matter. The combination of results from optical surveys assessing distribution patterns of the larger epibenthic fauna with activity and biomass data for small sediment-inhabiting organisms from biochemical analyses will help to determine whether a channel system is "active" or "fossile".

Work at Sea

Small benthic organisms

We hypothesize that the distribution as well as the activity of small benthic organisms are corresponding to the topographic and biochemical features of channel systems in terms of depth and distance to the channel centre. Benthic microbial processes are suspected to be directly connected to the occurrence of meio- and macrofaunal organisms.

Sampling was performed by using a multicorer sampling system, allowing the investigation of an undisturbed sediment surface. A total of 11 stations were sampled in the vicinity of the channel system. Subsamples for abundance, diversity and activity of bacteria and meiofauna, as well as the biogenic sediment compostion were taken using 5 ml and 20 ml syringes with cut off ends (see also section 9). Subsamples were sectioned horizontally in 1 cm-layers and analysed separately to investigate