Sediment distribution of the Greenland Sea and the Fram Strait

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Recent drilling in the Norwegian Sea (Leg 104) has established that 1) the inflow of warm Atlantic water of the Norwegian Current has responded to glacial-interglacial climatic changes of the northern hemisphere since 2.56 Ma (Jansen et al. 1987), and 2) that repeated sediment layers with a significant contribution of coarse, ice-rafted terrigenous debris document more than 26 phases of ice cover of varying duration during this time span (Jansen et al. unpublished). Because input of saline Atlantic water is an important element of deep and bottom water formation in the modern Norwegian-Greenland Sea (see recent discussion by Swift (1986)), fluctuating Atlantic water inflow and sea-ice cover may be expected to have caused large-scale changes in deep water circulation over the past 2.5 my.

The recent sediment distribution of the Greenland Sea and the Fram Strait, both regions where deep water is formed under modern oceanographic conditions, is investigated in order to assess the influence of the modern oceanographic regime on sediment accumulation and to see how this pattern changed during the Pleistocene. Data used in this study are 3.5 kHz profiles from water depths greater than 1,000 m, courtesy of the Alfred-Wegener-Institut für Polar- und Meeresforschung (POLARSTERN), the U.S. Naval Research Laboratory (HAYES), and Lamont-Doherty Geological Observatory (VEMA). Acoustic penetration is variable, but averages approximately 30 msec. Assuming an average sound velocity in sediment of 1,600 m/sec, 30 m/sec corresponds with a sediment thickness of 24 m. Sedimentation rates most likely range between 1–4 cm/1,000 y for the upper few meters (e.g. Kellogg 1980; Botz et al. pers. comm. 1987). Extrapolation of these rates over a sediment section of 24 m corresponds to a time interval of 2.4 to 0.6 Ma, spanning glacial-interglacial cycles.

In the Boreas Basin, the upper portion of the sedimentary section consists of many conformable reflectors. Acoustic transparency is up to 50 m/sec. This type of acoustic character was interpreted by Damuth (1978), through correlation with sediment cores, to represent bedded sediment with little silt or sand and uniform accumulation, not disturbed by bottom currents or mass flows. In water depths exceeding 3,200 m, two deep transparent layers are observed at approximately 20 m/sec subbottom (Fig. 1). These layers appear to be deposited by some sort of large-scale gravity influenced flow because they infill a large portion of the deepest part of the Boreas Basin (Fig. 1).

Greenland Basin sediment characteristics are quite different. As noted previously by Damuth (1978), large regions of the western basin consist of hyperbolic returns or prolonged reflectors, and migrating sediment waves occur along the southwestern basin margin. Erosional channels, with truncated reflectors along the channel walls, are also observed along the western basin margin. These sediment disturbances record influence of recent mass flow and contour current activity, in marked contrast to the recent uniform accumulation of the Boreas Basin. Mass flows may be expected to be more common in the western Greenland Basin because of numerous transverse

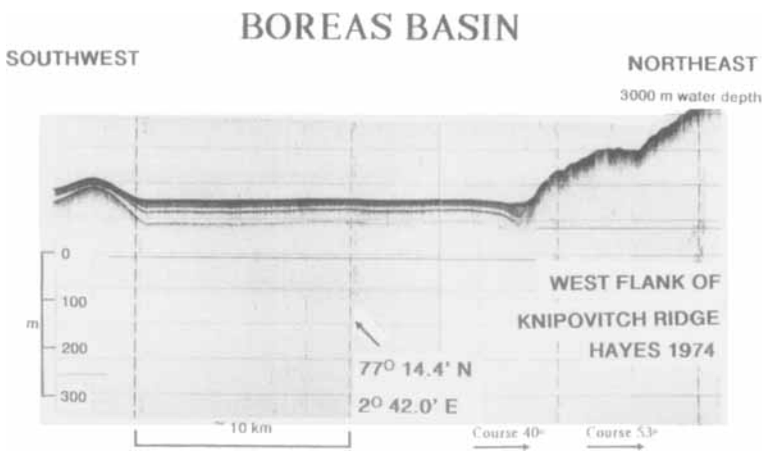

Fig. 1. Section of 3.5 kHz profile obtained by the HAYES in 1974 in the Boreas Basin along the west flank of the Knipovitch Ridge. An upper series of conformable reflectors is underlain by two deep transparent layers in deeper parts of the basin. Sweep is one second. Data courtesy of the U.S. Naval Research Laboratory.

channels on the East Greenland continental shelf, while there is a large bank on the shelf west of the Boreas Basin. Transverse channels are thought to be formed by glacial erosion, and can act as sediment conduits, especially when the sea level is lowered during glacial periods.

Migrating sediment waves are usually interpreted to reflect steady, sediment-laden flows (e.g. Flood & Shore unpublished). Greenland Basin sediment waves occur at approximately 3,300 m in the Arctic Ocean Deep Water/Greenland Sea Deep Water regime (Koltermann 1987). The waves affect at least the upper 35 m/sec of the sedimentary section. If a sedimentation rate of 5 to 10 cm/1,000 yr is assumed, these deposits could have accumulated over the past 0.6 to 0.3 my.

In the Fram Strait to the north, the western Svalbard margin also shows signs of bottom current activity and slumping. In particular, a large sediment lens occurs at 1,300 m water depth. This lens appears to have been formed because of several factors: erosion/nondeposition in shallower water depths (<1,200 m) – seen as prolonged surface reflectors and decreased spacing between subbottom reflectors – and slumping below 1,500 m water depth. Some slump scars along the western Svalbard margin extend to the surface, indicative of recent slumping, while other scars are observed deeper within the sedimentary section.

Evidence of current-controlled deposition is not found in the limited data analysed to date along the East Greenland margin on the western side of the Fram Strait. Here the upper sedimentary section consists of conformable layered reflectors, while at about 10 m/sec subbottom lenses of transparent sediments occur in depressions along and at the base of the slope. These accumulations of transparent material are most likely mass flow deposits.

The central part of the Fram Strait has a complicated topography due to a series of transform zones, ridges and nodal basins. Regions with fairly flat topography have recent sediment accumulations similar to those observed in the Boreas Basin: many conformable reflectors with about 40 m/sec acoustic penetration. Mass flows are observed as hyperbolic reflectors along the deep flanks of some topographic highs.

In conclusion, although sediments in the southwestern region of the Greenland Basin and the eastern Fram Strait show evidence of influence by bottom current activity, the predominant pattern of recent sediment accumulation appears to be uniform deposition. Recent slumping occurred along the western Svalbard margin in the Fram Strait and possibly in the Greenland Basin. In the past, mass flows occurred both along the East Greenland and western Svalbard margins of the Fram Strait, and several large-scale apparently gravity-influenced deposits were formed in the Boreas Basin. Future work will focus on correlating acoustic character and reflectors to recently obtained and well-dated sediment cores, in addition to deep-towed side-scan sonar surveying of regions with sediment disturbances.

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