Hydrosweep and Seabeam Measurements during the AMORE Expedition to Gakkel Ridge

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Gakkel Ridge in the Arctic Ocean was the object of an international expedition in the summer of 2001. This region is of particular geoscientific interest because of its extremely slow spreading rates and the variety of morphologic forms that are produced in this tectonic environment. Therefore, the multibeam bathymetric measurement system was of particular importance to the scientific goals of the cruise.

The system aboard RV POLARSTERN is a Hydrosweep DS 2 and has, compared with Seabeam 2112 aboard the USCGC HEALY, the following technical characteristics:

	Hydrosweep DS 2	Seabeam 2112
Frequency	15.5 kHz	12 kHz
Number of beams	59	121
Opening angle	90 - 120°	up to 120°
Accuracy	0.5 - 1% of water depth	< 0.5 % of water depth
Refraction correction	automatic	automatic

The data collected include depth, sidescan (2048 values per scan), and backscatter information on each of the 59 beams. At midcruise, 4460 km of multibeam bathymetry swath had been collected on POLARSTERN.

A particular technical challenge during this effort was the coordination and combination of data sets from different systems, including Seabeam 2112 data from the USCGC HEALY, and interferometric bathymetric data from the SCICEX project. The SCICEX data were not available in digital form for the production of combined grids, but only as printed maps. The latter data set has the advantage of extensive areal bathymetric coverage, but the disadvantage of inertial navigation instead of GPS and significant measurement uncertainties compared to traditional multibeam bathymetric systems.

In order to produce working maps for the expedition, we gridded the raw Hydrosweep and Seabeam data with a spacing of 150 m, producing plots with 50 m contour intervals. Also freely available Polarstern data from previous cruises were used to determine the navigation shifts for the SCICEX data. The new maps were placed over the SCICEX charts on a light table to calculate graphically for a given locality the magnitude of the correction to be applied to SCICEX coordinates to locate morphologic features on the ocean floor in improved coordinates.

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Overview

AMORE (Arctic Mid Ocean Ridge Expedition) was the first international scientific cooperation of two icebreaking research vessels in high latitudes and was realized from the 31st of July to the 7th of October 2001.
The cruise of "*RV Polarstern*" and "*USCGC Healy*" started in Tromso, Norway, and lead the two ships to the Gakkel Ridge in the Arctic Basin and the North Pole . Figure 1.1 visualizes the cruise track of "*Polarstern*" in the International Bathymetric Chart of the Arctic Ocean (IBCAO).

Gakkel Ridge is the slowest spreading mid ocean ridge in the world (~1cm/year) and therefore of particular geoscientific interest. The valuable multibeam sonar data collected include position, depth, sidescan and backscatter information and are of prime importance in order to study the variety of morphologic structures which are formed in this tectonic system.

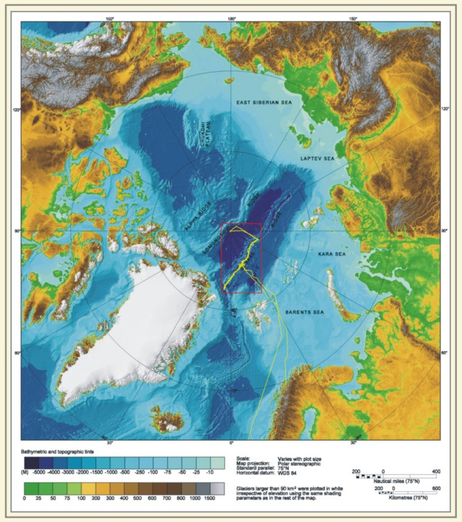


Fig. 1.1 Cruise Track and Area of Interest

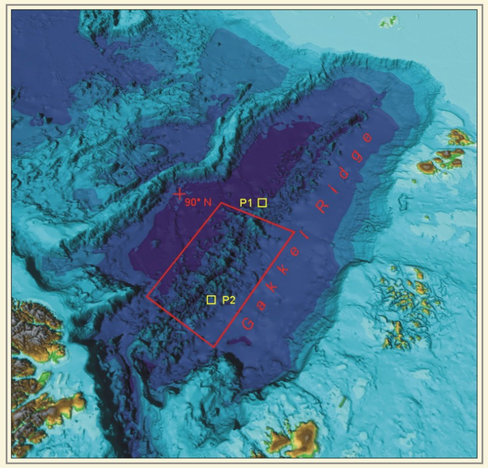


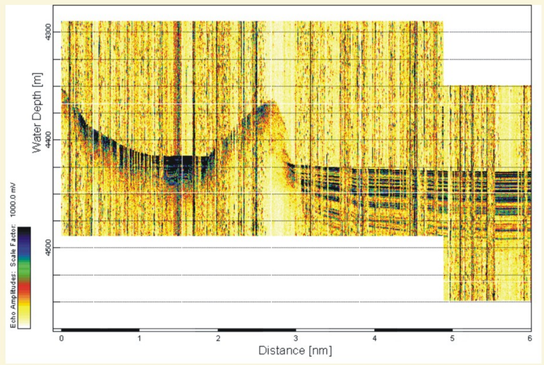
Fig. 1.2 Arctic Basin and Gakkel Ridge

Technical characteristics of the multibeam sonar systems aboard *"Polarstern"* and *"Healy"*

	Hydrosweep DS 2	*Seabeam 2112*
Frequency	15.5 kHz	12 kHz
Number of Beams	59	121
Opening Angle	90 - 120°	up to 120°
Accuracy	0.5% of water depth	0.5% of water depth
Refraction Correction	cross-fan, CTD/XBT measurements	CTD/XBT measurements
Navigation	Global Positioning System (GPS)	Global Positioning System (GPS)

During the entire cruise the sub-bottom profiling system *PARASOUND* was operated in order to explore sediment coverage on the seafloor.
Figure 2.1 shows a region with different sediment layers (reflectors) which had been accumulated in a deep sea basin surrounded by a seamount.
Figure 2.2 represents a part of the western Gakkel Ridge with quickly changing seafloor topography and only small amounts of sediment upon the oceanic crust.

Sediment Echography



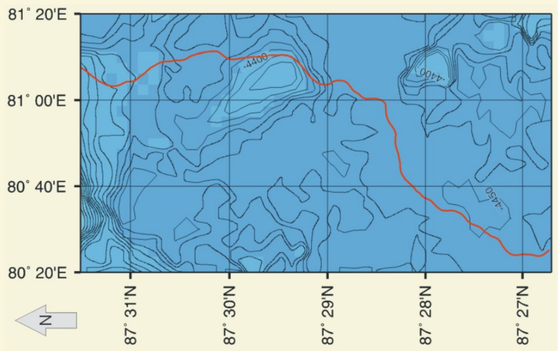
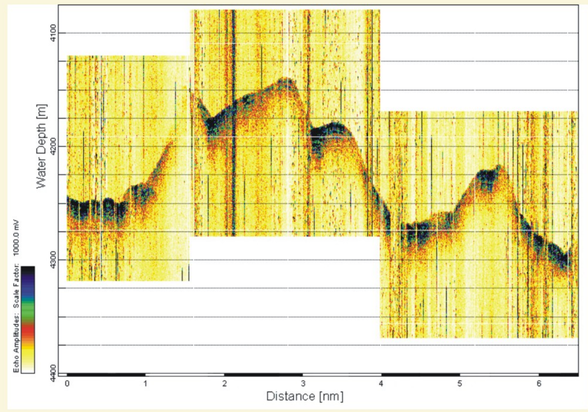


Fig. 2.1 Parasound Area P1



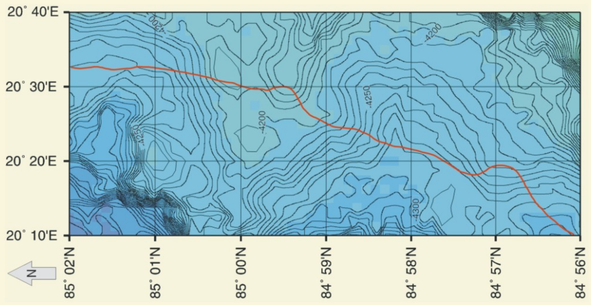


Fig. 2.2 Parasound Area P2

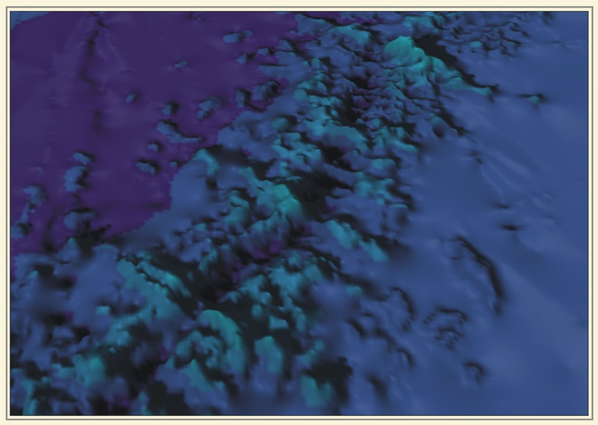


Fig. 1.3 IBCAO Bathymetry of the western Gakkel Ridge (Grid Cell Size: 2.5 x 2.5 km^2, Projection: polar stereographic)

Digital Terrain Models

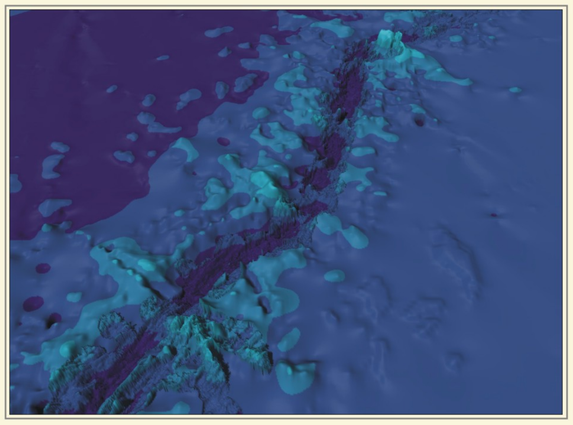


Fig. 1.4 Bathymetry updated from *AMORE* in the same area (Grid Cell Size: 0.5 x 0.5 km^2, Projection: polar stereographic)

The multibeam data are utilized to determine Digital Terrain Models (DTM) as basis for contour line plotting, 3D-visualization, and for the calibration of SCICEX/SCAMP bathymetry. Figure 1.3 and 1.4 demonstrate the difference between the 'old bathymetry', taken from the IBCAO (Vol.1, 2001) and the 'new bathymetry', updated from *AMORE*. Two distinct submarine mountain ranges cutting nearly perpendicular the Gakkel Ridge are visible (height exaggeration: 6).

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