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Deep Seismic Investigation across the Knipovich Ridge

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1. INTRODUCTION

Mid-ocean ridges (MOR) are responsible for creating new oceanic crust. The oceanic crust, which covers approximately 60% of the Earth's surface, is formed along the MOR system. Ultraslow-spreading mid-ocean ridges can be found in both hemispheres. However, the two most extensive ultraslow-spreading systems are the Arctic Ridge system in the Northern Atlantic Ocean and the Southwest Indian Ridge (SWIR) in the Indian Ocean. The Knipovich Ridge belongs to the first one.

The KNIPSEIS OBS profile provides information on the seismic crustal structure of the Knipovich Ridge and oceanic crust in the North Atlantic. The structure of the oceanic crust generated by the ultraslow-spreading Knipovich Ridge still remains a relatively uninvestigated area compared to the other North Atlantic spreading ridges further south. The complexity of the Knipovich Ridge with its oblique ultraslow-spreading and segmentation makes this end-member of spreading ridge systems an important and interesting ridge to investigate.

This investigation presents an analysis of wide-angle reflection and refraction seismic profile acquired across the ultraslow-spreading Knipovich Ridge and oceanic crust to SE. The profile is performed in frame of the KNIPSEIS Project led by the Institute of Geophysics PAS in collaboration with University of Bergen and Hokkaido University. It was realized in 2019 to study active spreading processes and lithospheric structure of the ridge.

2. RESULTS

The Ocean Bottom Seismometer (OBS) data along a refraction/reflection profile (~280 km) crossing the Knipovich Ridge off the western Barents Sea was acquired by use of RV G.O. Sars on July 24 – August 6, 2019. The seismic energy was emitted every 200 m by an array of airguns with total volume of 80 l. To receive and record the seismic waves at the seafloor, ocean bottom seismometers were deployed at 12 positions with about 15-km spacing in 2 deployments. Seismic energy from airgun shots were obtained generally up to 50 km or even more from the OBSs. Several OBSs revealed clear arrivals beyond 100 km offset.

In general, the seismic records obtained along the KNIPSEIS profile are of good quality allowing detailed wave field analysis and crustal structure modelling to be made. The data obtained, after appropriate processing, were used for two-dimensional *P*-wave seismic modelling. A seismic velocity model of the Earth's crust along the survey profile was obtained. The high quality data recorded allowed modelling even of the layer below the Moho boundary. The model shows a relatively simple structure of the oceanic crust in the south-east direction, consisting of several parallel layers with *P*-wave velocities ranging from 1.95 km/s at the ocean floor to 7.20 km/s at the Moho boundary at a depth of about 12 km. The thickness of the sedimentary layers is up to 4 km with *P*-wave velocities of 1.95, 2.90 to 3.85 km/s. In the Knipovich Ridge area, the crust is thinner, especially for the mid- and lower crust layers. Interestingly, the greatest uplift of the Moho boundary does not occur exactly beneath the Knipovich Ridge axis, but about 30 km to the south-east, where the thickness of the crust has been determined to be only 4 km. In the transition zone between the rift zone and the older (but still young) oceanic crust, an increase in crustal thickness and an extension of the layer with a *P*-wave velocity of 6.7 km/s to a thickness of up to 5 km is determined. Along the whole profile, a layer with a *P*-wave velocity of about 7.1 km/s was found in the lower crust, possibly related to serpentinisation. *P*-wave velocities in the upper mantle were determined to be around 7.9 km/s in the Knipovich Ridge zone and 8.0 km/s beneath the oceanic crust at the south-eastern part of the profile. In the upper mantle, the existence of a seismic boundary approximately replicating the shape of the Moho boundary was also additionally observed, with a *P*-wave velocity shift of 0.1 km/s.

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