Ocean Bottom Seismic Survey in the Knipovich Ridge area (KNIPSEIS)

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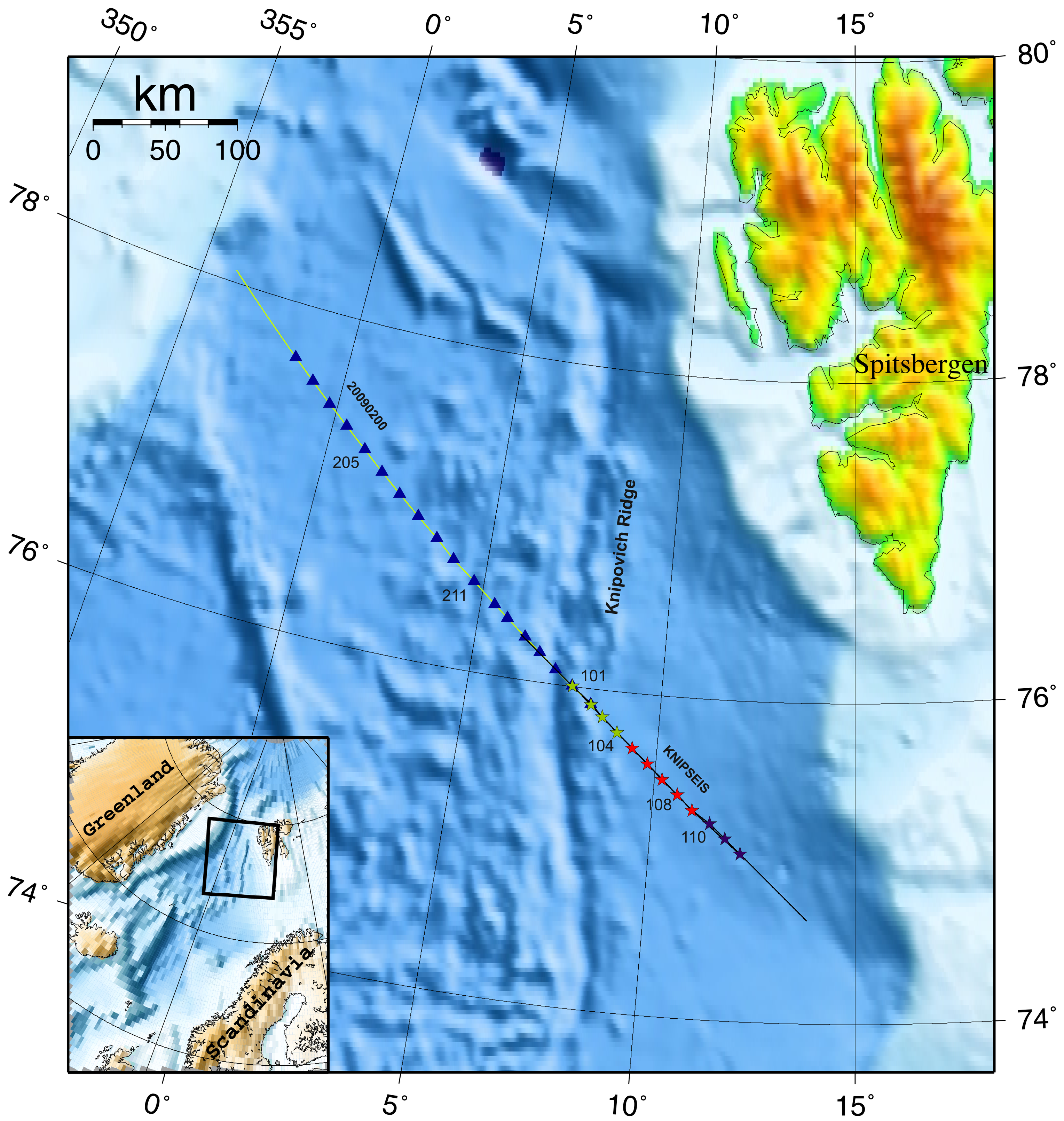
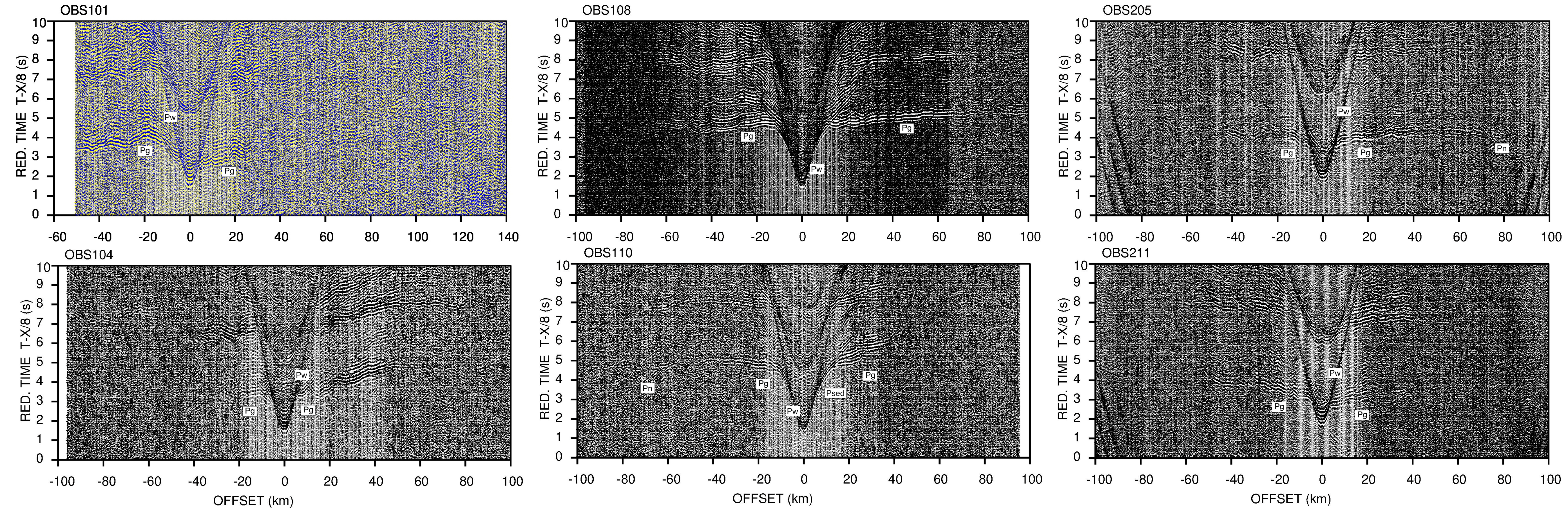
ABSTRACT

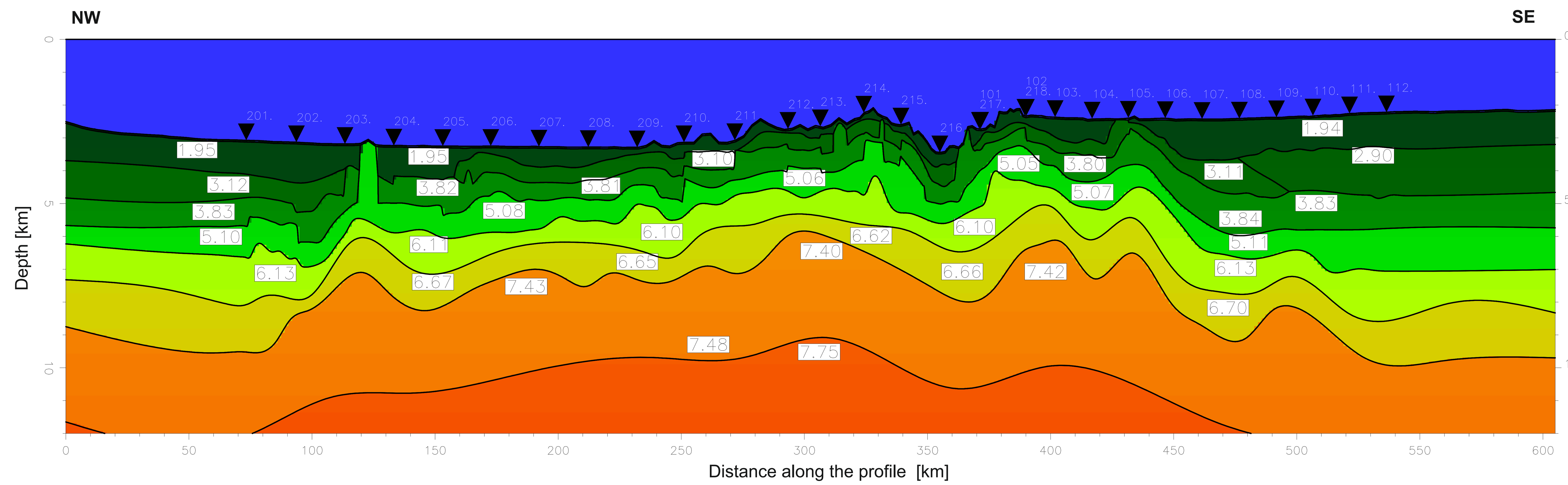
The active spreading processes at ultraslow spreading mid-ocean ridges are still poorly explored because the main representatives, the Arctic Ridge System and the Southwest Indian Ridge (SWIR) lie in regions with difficult working conditions.
The structure of the oceanic crust generated by the ultraslow-spreading Knipovich Ridge still remains relatively uninvestigated 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 challenging ridge to investigate. The aim of this work is to better understand the lithospheric structure beneath the rare ultraslow-spreading ridges, using as example the Knipovich Ridge along its spreading direction. Ultraslow spreading ridges are characterized by a low melt supply. At spreading rates below 20 mm/y, conductive cooling effectively reduces the mantle temperature and results in less melt produced at larger depths. Ultraslow spreading ridges, namely the Arctic ridge system with the Gakkel Ridge, Lena Trough and Knipovich Ridge and the Southwest Indian Ridge (SWIR), therefore greatly differ in their morphology from faster spreading ridges. 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 project partners are University of Bergen, Institute of Geophysics, Polish Academy of Sciences, and Hokkaido University. The acoustic energy was emitted every 200 m by an array of air-guns 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. All the stations were recovered and correctly recorded data. Clear seismic energy from airgun shots were obtained up to 50 km from the OBSs. The profile provides information on the seismic crustal structure of the Knipovich Ridge and oceanic and continental crust in the transition zone. With this survey we have to some extent overlapped the previously performed profile 20090200 by Hermann & Jokat (2013). Together, they constitute one joined transect crossing the Knipovich Ridge from the American to the European plate. Seismic record sections were analyzed with 2D trial-and-error forward seismic modeling.



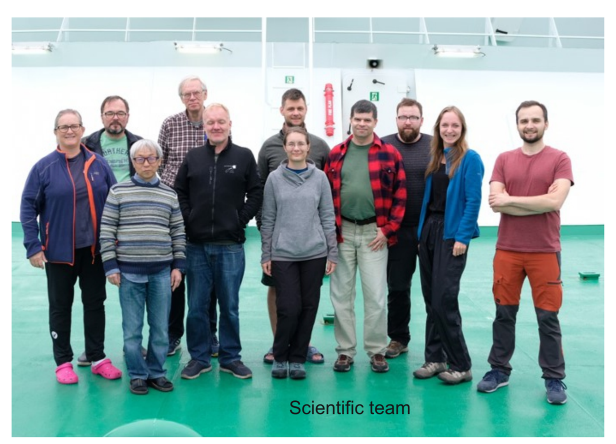
Localization of the transect. 20090200 profile: triangles - German OBSs, light line - airgun shooting. KNIPSEIS profile: light green stars - Polish OBSs (1st deployment), red stars - Norwegian OBSs (one long deployment), dark blue stars - Polish OBSs (2nd deployment), black line - airgun shooting. Numbers mark OBSs which raw record sections are shown.



Examples of seismic record sections from OBSs marked on the map. Sections from OBS101-110 was recorded along KNIPSEIS profile. Sections from OBS205-211 are from 20090200 profile. Reduction 8 km/s, filter 4-20 Hz. Hydrophone component, vertical component for OBS 108.



Preliminary two-dimensional model of P-wave velocity in the crust and upper mantle derived by forward modelling using the SEIS83 package (Červený and Pšenčík, 1983). P-wave velocities in km/s are shown in white boxes. Black lines represent velocity discontinuities (interfaces). Labelled black triangles show positions of OBSs.



Equipment:

The wide-angle data were acquired with **seismic receivers** deployed at the sea bottom. Two kinds of ocean bottom seismometer stations (OBS) were deployed along the acquisition profile KNIPSEIS: short-period Japanese construction's OBSs without hydrophone took positions 105-109 for both deployments (University of Bergen) and Guralp Liber semi-broadband (60 s) OBSs with a hydrophone were located at 101-104 positions for the first deployment and 110-112 for the second deployment (Institute of Geophysics PAS).

Seismic source: 4 x BOLT LL 1500 airguns of 1200 cu.in, total volume 4800 cu.in., depth 12 m, shot interval ~200 m (University of Bergen).

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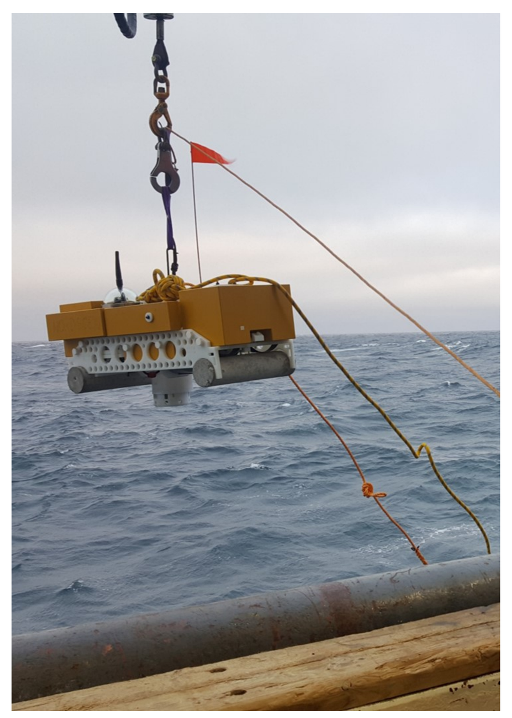

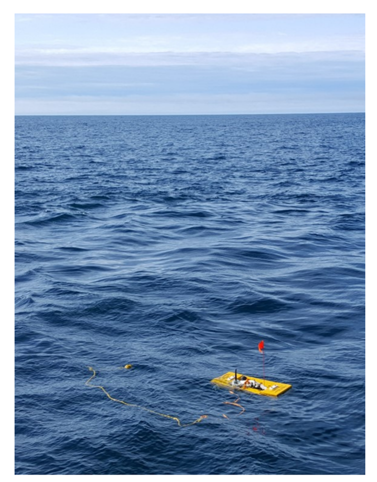

OBSs: short-period (above), Guralp Liber semi-broadband (right)

ACKNOWLEDGEMENTS

Captain John Gerhard Aasen, the crew, and scientific staff are greatly acknowledged for excellent work, dedication, and enthusiasm during the data acquisition. The KNIPSEIS cruise was funded by University of Bergen. Polish works in the project and this presentation was funded by the National Science Centre, Poland according to the agreement UMO-2017/25/B/ST10/00488.

The public domain Generic Mapping Tool (GMT) software (Wessel and Smith, 1991; Wessel and Smith, 1998; Wessel et al., 2013) has been used for preparation of selected maps and figures. Seismic Unix (Cohen and Stockwell, 2000) was used for seismic data processing.

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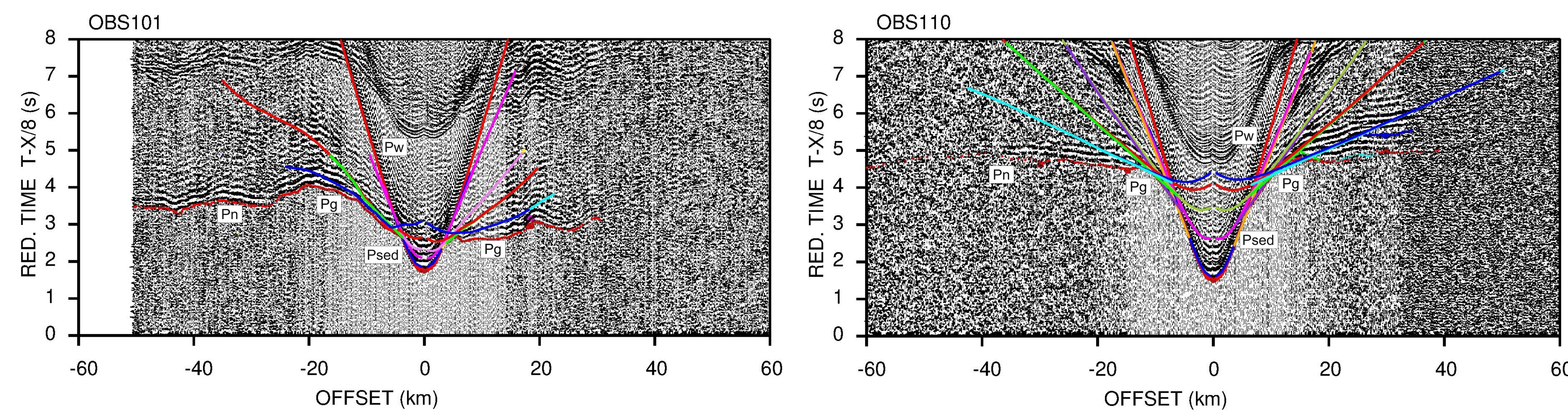

Examples of normalized seismic record sections with modelling along the KNIPSEIS profile, reduction velocity 8 km/s.

References

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