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Crustal structure of the Central-Eastern Greenland: results from the TopoGreenland refraction profile

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Until present, seismic surveys have only been carried out offshore and near the coasts of Greenland, where the crustal structure is affected by oceanic break-up. We present the deep seismic structure of the crust of the interior of Greenland, based on the new and the only existing so far seismic refraction/wide-angle reflection profile. The seismic data was acquired by a team of six people during a two-month long experiment in summer of 2011 on the ice cap in the interior of central-eastern Greenland. The presence of an up to 3.4 km thick ice sheet, permanently covering most of the land mass, made acquisition of geophysical data logistically complicated. The profile extends 310 km inland in E-W direction from the approximate edge of the stable ice cap near the Scoresby Sund across the center of the ice cap. 350 Reftek Texan receivers recorded high-quality seismic data from 8 equidistant shots along the profile. Explosive charge sizes were 1 ton at the ends and ca. 500 kg along the profile, loaded with about 125 kg at 35-85 m depth in individual boreholes.

Given that the data acquisition was affected by the thick ice sheet, we questioned the quality of seismic records in such experiment setup. We have developed an automatic routine to check the amplitudes and spectra of the selected seismic phases and to check the differences/challenges in making seismic experiments on ice and the effects of ice on data interpretation.
Using tomographic inversion and forward ray tracing modelling we have obtained the two-dimensional velocity model down to a 50 km depth. The model shows a decrease of crustal thickness from 47 km below the centre of Greenland in the western part of the profile to 40 km in its eastern part. Relatively high lower crustal velocities (Vp 6.8 – 7.3 km/s) in the western part of the TopoGreenland profile may result from past collision tectonics or, alternatively, may be related to the speculated passage of the Iceland mantle plume. Comparison of our results with the new receiver function studies (Kraft et al., personal communication) suggests the possibility for a massive underplating along the profile.
The origin of the pronounced circum-Atlantic mountain ranges in Norway and eastern Greenland, which have average elevation above 1500 m with peak elevations of more than 3.5 km near the Scoresby Sund in Eastern Greenland, is unknown. Our new results on the crustal structure provide constraints for assessment of the isostatic balance of the crust in Greenland, as well as for examining possible links between crustal composition, rifting history and present-day topography of the North Atlantic Region.