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Lithosphere structure and topography around the North Atlantic Ocean

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Major seismic data acquisition has recently taken place in several areas around the North Atlantic Ocean. Scandinavia has now been fully covered by broad-band seismology with a nominal station spacing of 60 km by the MAGNUS and ScanArray projects. Crustal scale controlled source seismic projects have covered southern Norway and the Polar region. Until recently, seismic surveys in Greenland were only carried out near the coasts, where the crustal structure is affected by oceanic break-up. New data acquisition has provided seismic data in central-eastern Greenland including the ice sheet. The data was acquired by 24 broadband (BB) onshore stations, partly on the ice cap, over a period of 3 years and as a refraction seismic profile on the ice cap by a team of six people during a two-month long experiment in summer of 2011.

We present models of the seismic structure of the upper mantle and crust based on the new data from Scandinavia and Greenland. The crust is approximately 35 km thick with two main layers and relatively low velocity (<6.7 km/s) in southern Norway, even in regions with high topography, whereas it is 45-50 km thick and includes a high-velocity lower crust (>6.9 km/s) in Sweden. Upper mantle velocities are low (~7.9 km/s) in S Norway and high (~8.2 km/s) in Sweden.

In Greenland our crustal model, constrained by seismic refraction and receiver functions, shows a decrease in crustal thickness from ~50 km below the centre of Greenland to ~40 km at the edge of the ice cap and ~20 km at the coast in the eastern part of the study area. High velocity lower crust (Vp 6.8 – 7.3 km/s) is only observed in Central Greenland. Receiver Function inversion indicates relatively low seismic velocities in the upper mantle for this cratonic area and a thin transition zone which indicates high temperatures throughout the lithosphere.

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 Scoresby Sund in Eastern Greenland, is unknown. The abrupt crustal thickening in Scandinavia is related to addition of a high-velocity (and high density) lower crust which is not the case in Greenland, where sharp eastward crustal thinning takes place around the highest mountains. We discuss the implications of these new observations for topography in relation to densities of the crust and uppermost mantle. Our new results on the crustal structure indicate that crustal isostasy alone cannot explain the topographic variation in the region, such that other phenomena, including possible dynamic processes must be active in the area.