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Crustal structure, and topographic relief in the high southern Scandes, Norway

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Resolving the uplift history of southern Norway is hindered by the lack of constraint available from the geologic record. Sediments that often contain information of burial and uplift history have long since been stripped from the onshore regions in southern Norway, and geophysical, dating methods and geomorphological studies are the remaining means of unraveling uplift history. New constraints on topographic evolution and uplift in southern Norway have been added by a recent crustal scale refraction project. Magnus-Rex (Mantle investigation of Norwegian uplift Structure, refraction experiment) recorded three ∼400 km long active source seismic profiles across the high southern Scandes Mountains. The goal of the project is to determine crustal thickness and establish whether these mountains are supported at depth by a crustal root or by other processes. The southern Scandes Mountains were formed during the Caledonian Orogeny around 440 Ma. These mountains, which reach elevations of up to ∼2.5 km, are comprised of one or more palaeic (denudation) surfaces of rolling relief that are incised by fluvial and glacial erosion. Extreme vertical glacial incision of up to 1000 m cuts into the surfaces in the western fjords, while the valleys of eastern Norway are more fluvial in character. Climatic controls on topography here are the Neogene - Recent effects of rebound due to removal of the Fennoscandian ice sheet and isostatic rebound due to incisional erosion. However, unknown tectonic uplift mechanisms may also be in effect, and separating the tectonic and climate-based vertical motions is often difficult. Sediment and rock has been removed by the formation of the palaeic surfaces and uplift measurements cannot be directly related to present elevations. Estimates so far have indicated that rebound due to incisional erosion has a small effect of ∼500 m on surface elevation. Results from Magnus-Rex indicate the crust beneath the high mountains is up to 40 km thick. This thickness implies that the high elevations of the southern Scandes Mountains are not entirely compensated by an Airy type of isostatic model, and other mechanisms for uplift and sustained topographic relief must be in effect. Moreover, there is an observed lateral offset between the highest mountains and the thickest crust beneath the southern Scandes indicating that the Moho topography is modulated by the flexural strength of the lithosphere. We relate new crustal thickness measurements to observed topography to quantify how much of the present elevation of the southern Scandes Mountains can be accounted for by crustal thickness alone. This new understanding of crustal structure can be used to help separate the climatic and tectonic effects on landscape evolution of the southern Scandes Mountains.