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Opening of the north-eastern Atlantic and onshore mountain rise controlled by Fennoscandian deep structure

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Large-scale topography is thought to be mainly controlled by active tectonic processes. Fennoscandia is located far from any active tectonic setting and yet includes a mountain range along its passive North Atlantic margin. Models proposed to explain the origin of these enigmatic mountains are based on glacial isostatic adjustments, delamination, long-term isostatic equilibration, and dynamic support from the mantle, yet no consensus has been reached. We show that topography along the continental margin of Fennoscandia may be influenced by its deep structure. Fennoscandia formed by amalgamation of Proterozoic and Archean continental blocks; using both S- and P-receiver functions, we discovered that the Fennoscandian lithosphere still retains the original structural heterogeneity and its western margin is composed of three distinct blocks. The southern and northern blocks have relatively thin crust (~40-45 km), while the central block has thick crust (~60 km) that most likely was formed by crustal stacking during the Proterozoic amalgamation. The boundaries of the blocks continue into the oceanic crust as two major structural zones of the North-East Atlantic, suggesting that the Fennoscandian amalgamation structures determined the geometry of the ocean opening. We found no evidence for mountain root support or delamination in the areas of high topography that could be related with mountain formation. Instead, our results suggest that both crustal and lithospheric heterogeneity of Fennoscandia along the continental margin might have a control on geodynamic forces that support the rise of Scandinavian mountains.