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Weakened lithosphere beneath Greenland inferred from effective elastic thickness: A hotspot effect?

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Geological and geophysical constraints on the structure and tectonic history of Greenland are sparse due to the thick ice cover. The effective elastic thickness (T_e) of the lithosphere provides geophysical information about long-term flexural strength and can be used to constrain thermo-rheological properties of the lithosphere. The coupling of crust and mantle can be inferred using T_e and crust-mantle boundary data. T_e is typically calculated from the spectral analysis of gravity and topography data; variations in T_e are, however, not well resolved in Greenland due to poor constraints on crustal structure and complications due to ice loading. Here we use the global gravity model EIGEN-6C4, together with a new model of the crust-mantle boundary, to obtain a high-resolution T_e map of Greenland. We present the distribution of effective elastic thickness, which together with the Moho map indicates mechanical decoupling of the crust and uppermost mantle beneath southern and central Greenland. The decoupling might be due to the passage of the Iceland hot spot during the last 100 Ma. In contrast, the northern part of Greenland shows a large T_e, implying mechanical coupling between crust and mantle and suggesting the existence of a cold and strong tectonic unit. In a relative sense, the distribution of T_e values is consistent with estimates of lithospheric thickness based on seismic velocity models, indicating a dominantly thermal control of lithospheric structure and evolution.