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Influence of ice sheet, the Iceland hotspot, glacial erosion, and sediment transport on Greenland's passive margins

Sergei Medvedev (1), Ebbe Hartz (1,2), and Alban Souche (1)

(1) Physics of Geological Processes, Oslo University, Norway (e.h.hartz@fys.uio.no), (2) Det norske oljeselskap, Oslo, Norway

The sub-ice topography of Greenland reveals a particular landform characterized by elevated margins and by a central depression below the sea level. Whereas the central depression may be explained by significant load of the Greenland ice sheet, the origin of the peripheral relief remains unclear. Evidence for uplift is shown by the presence of Mesozoic and Cenozoic marine sediments at an altitude of 1.2 km at the localities of Scoresby Sund (central East Greenland) and Nuusuaq plateau (central West Greenland) and even up to 2 km (Kangerlussuaq region, East Greenland). What are the mechanisms responsible for such relief along a 'passive' margin? We analyze the influence of formation of the ice sheet and carving by glacial erosion on the evolution of the topography along the margins of Greenland. In our numerical experiments, we model topographic evolution and consequent isostatic response backward in time, starting from the actual topography of Greenland and surrounding areas. Our analysis shows that: (1) The heavy ice loading in the central part of Greenland and consecutive peripheral bulging has a negligible effect on amplitude of the uplifted Greenland margins. (2) First order estimates of uplift due to isostatic readjustment caused by glacial erosion and unloading in the fjord systems is up to 1.1 km, explaining marine sediments at that altitude in the Scoresby Sund region. (3) Erosional uplift in the Kangerlussuaq region is less than 700 m, and thus can not explain Cretaceous marine sediments at 2 km altitude in this region. This area, however, is on the Iceland hotspot track, which may explain the excess uplift. (4) The increase of accuracy of topographic data (comparing several data sets of resolution with grid size from 5 km to 50 m) results in increase of the isostatic response in the model. (5) The analysis of mass redistribution during erosion-sedimentation process and data on age of offshore sediments allows us to estimate the timing of erosion along the margins of Greenland. This ongoing analysis, however, requires careful account for the link between sources (localized glacial erosion) and sinks (offshore sedimentary basins around Greenland).