From the Caledonides to the East Greenland mountains and the Scandes

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The post-Caledonian development of Greenland and Fennoscandia has been a subject of much dispute. Here we review our studies of the post-Caledonian development of Greenland, Fennoscandia and adjacent regions based on apatite fission-track analysis (AFTA) and stratigraphic landscape analysis (SLA). AFTA defines episodes of cooling (exhumation) while SLA provides a relative denudation chronology. Integrating these results with the geological record, we were able to produce a coherent history of both positive and negative vertical crustal movements.

Late Carboniferous, Middle Triassic and Middle Jurassic exhumation affected the entire study area (with some time variations) and correlate with rifting episodes during the breakup of Pangea. The uplifts and consequent erosion led to formation of peneplains, in particular a mid-Jurassic peneplain now exposed along the Atlantic margins of East Greenland and Scandinavia.

Mid-Cretaceous exhumation affected wide parts of the study area and coincided with the inversion of the Sorgenfrei-Tornquist Zone. It resulted in tilting of the mid-Jurassic peneplain along the future Atlantic margins and in formation of a peneplain across wide areas in Fennoscandia. This episode may be linked with changes in the relative motion between the European and African plates.

End-Eocene exhumation interrupted subsidence following earliest Eocene break-up in the North-East Atlantic and resulted in formation of a peneplain across all of Greenland (the Upper Planation Surface, UPS), whereas the effects in Scandinavia were minor. This episode coincided with a major plate-tectonic change in the North-East Atlantic.

Early Miocene exhumation affected only Fennoscandia and is attributed to intraplate stress transmitted across the Eurasian plate. The exhumation resulted in formation of a peneplain, of which remnants are preserved in southern Norway (east of the highest mountains, including Hardangervidda), in southern Sweden (the South Småland Peneplain) and offshore Norway as the base-Miocene unconformity.

Late Miocene exhumation affected Greenland, Svalbard and the Barents Sea but not Fennoscandia. The uplift initiated the formation of Greenland's coastal mountains by raising the UPS and to incision below it led to the development of the Lower Planation Surface, LPS, on both margins of Greenland. This episode correlates with changes in the absolute motion of the North American Plate.

Pliocene uplift – amplified by the isostatic response to incision of valleys below the peneplains – raised all margins in the region with maximum elevations reached in coastal areas close to Iceland. This suggests dynamic support from the Iceland Plume.

The spatial and temporal extent of these episodes is well defined, allowing speculation regarding their origin as above. Geodynamic modelling is required to understand the underlying processes, offering the potential reward of new insights into the workings of the planet.

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