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Landscape evolution of Northern Uummannaq, central West Greenland: differential erosion of a Mesozoic rift flank

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The landscape of the Uummannaq region, central West Greenland, is characterised by high elevation low relief topography and spectacular glacial selective linear erosion, yet the mechanisms controlling the evolution of this landscape remain debated. Initial work has suggested it was caused by episodic tectonic uplift throughout the Late Cenozoic, however, alternative models have inferred it to be the product of more recent isostatic uplift in response to differential glacial erosion.

We present the results of a comprehensive low temperature thermochronological study (apatite fission track and apatite (U-Th)/He) across northern Uummannaq to establish the source of the elevated modern landscape and determine the geological evolution of the area. The use of a dense elevation profile, fragmented (U-Th)/He grain analysis, contemporary modelling techniques related to the diffusion of helium in radiation damaged apatites and additional cosmogenic nuclide ages have allowed the generation of well constrained thermal models that provide strong evidence on how the landscape has evolved.

Joint modelling of the apatite fission track and apatite (U-Th)/He data outlines two significant periods of cooling, in the Mesozoic and Cenozoic respectively. The first (95 $\pm$ 8 °C to 60 $\pm$ 5 °C; 151 $\pm$ 6 Ma to 108 $\pm$ 8 Ma) correlates to the onset of rifting between West Greenland and eastern Canada, suggesting uplift of the hinterland during active rifting, while the second period (56 $\pm$ 15 °C to 0 °C; 34 $\pm$ 6 Ma to 0 Ma) is coeval to the cessation of volcanics in the region implying a cooling response to the unroofing of the lithosphere. Accompanying cosmogenic nuclide ages highlight the extent of lateral and vertical differential erosion in the region during the Last Glacial Maximum suggesting the modern geomorphology is the result of regional glaciation and preferential ice stream development across an uplifted rift flank.

This work highlights how a complex interaction between rift tectonics and surface processes has created a modern topographical anomaly within Northern Uummannaq and adds to our understanding of the post-rift evolution of continental margins and the utility of recent advances of low temperature thermochronology.