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Kilometer-scale, late Miocene and early Pliocene surface uplift in East Greenland: tectonic forerunners for the build-up of the Greenland Ice Sheet

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The tectonic origin of late Neogene uplift along NE Atlantic margins has been questioned. Evidence for these movements – such as the recent denudation of mountain ranges and abundant, late Cenozoic coarse sediment near them – has been explained as a result of climate change (Molnar and England, 1990). Identification of the causal relationship between uplift, tectonics and climate deterioration during the late Neogene thus critically depends on defining temporal relation between these events.

We have previously argued that the elevated plateaux in East and West Greenland are the result of three tectonic phases of uplift and erosion (Bonow et al., 2014; Japsen et al., 2014). A late Eocene phase of uplift led to formation of a Palaeogene erosion surface near sea level. Uplift of this surface in the late Miocene led to formation of a lower, Neogene surface by incision below the uplifted Palaeogene surface. Finally, a Pliocene phase led to incision of valleys and fjords below the uplifted Neogene surface, resulting in mountain peaks reaching 3.7 km and 2.1 km a.s.l. in East and West Greenland, respectively.

Data from West Greenland only provide broad constraints on the timing of the Pliocene phase, and we have not yet been able to define the timing of this phase firmly in the east. Here we present new apatite fission-track data from East Greenland that clearly constrain the timing of late Miocene and early Pliocene events of uplift and exhumation. It is thus clear that the final phase of Cenozoic tectonic uplift preceded the onset of large-scale glaciations in the late Pliocene to Pleistocene.

Solgaard et al. (2013) showed that the the build-up of the Greenland Ice Sheet could not initiate in the case of the low-lying and almost flat topography in Greenland prior to the two phases of late Neogene uplift. Furthermore, these results showed that Early Pliocene uplift led to the final formation of the present-day, high coastal mountains in East Greenland that provided anchoring points during the build-up of the Greenland Ice Sheet over the period leading up to the Pleistocene (Solgaard et al., 2013). Tectonic processes thus underpinned the build-up of the Greenland Ice Sheet (Steinberger et al., 2015).

The three uplift phases in Greenland overlap in time with similar events in North America and Europe and correlate with changes in plate motion. The much higher elevation of East Greenland compared to West Greenland suggests active support in the east from the Iceland plume. These observations indicate a connection between mantle convection, changes in plate motion and vertical movements along passive continental margins.

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