The timing of fjord formation and early glaciations in North and Northeast Greenland

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The timing and extent of early glaciations in Greenland, and their co-evolution with the underlying landscape remain elusive. In this study, we explore the timing of fjord formation in Northeast and North Greenland, between Scoresby Sund (70°N) and Independence Fjord (82°N). By determining the timing of fjord formation, we can improve our understanding of the early history of the Greenland Ice Sheet in these regions. We use the concept of geophysical relief to estimate fjord erosion volumes and calculate the subsequent flexural isostatic response to erosional unloading. The timing of erosion and isostatic uplift is constrained by marine sediments of late Pliocene-early Pleistocene age that are now exposed on land between ~24 and 230 m a.s.l. The late Pliocene-early Pleistocene sediments themselves attest to a time of limited ice cover in Greenland, with temperatures as much as 6-8 °C higher than present (e.g. Bennike et al., 2010).

We find that the northern Independence Fjord system must have formed by glacial erosion since the deposition of the marine late Pliocene-early Pleistocene sediments at ~2.5 Ma, in order to explain the current elevation of the sediments by erosion-induced isostatic uplift. In contrast, fjord formation in the outer parts of southward Scoresby Sund commenced prior to the Pleistocene, most likely in late Miocene, and continued throughout the Pleistocene with fjord formation progressing inland. Our results suggest that the inception of the Greenland Ice Sheet began in the central parts of Northeast Greenland before the Pleistocene and spread to North Greenland only at the onset of the Pleistocene.

References: