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The northern Uummannaq Ice Stream System, West Greenland: ice dynamics and and controls upon deglaciation

Timothy Lane (1), David Roberts (1), Brice Rea (2), Colm Ó Cofaigh (1), Andreas Vieli (1,3)

(1) Department of Geography, Durham University, Durham, UK (t.p.lane@durham.ac.uk), (2) Geography and Environment, School of Geosciences, University of Aberdeen, Aberdeen, Scotland, (3) Department of Geography, University of Zürich, Zürich, Switzerland

At the Last Glacial Maximum (LGM), the Uummannaq Ice Stream System comprised a series coalescent outlet glaciers which extended along the trough to the shelf edge, draining a large proportion of the West Greenland Ice Sheet. Geomorphological mapping, terrestrial cosmogenic nuclide (TCN) exposure dating, and radiocarbon dating constrain warm-based ice stream activity in the north of the system to 1400 m a.s.l. during the LGM. Intervening plateaux areas ($\sim$ 2000 m a.s.l.) either remained ice free, or were covered by cold-based icefields, preventing diffluent or confluent flow throughout the inner to outer fjord region. Beyond the fjords, a topographic sill north of Ubekendt Ejland prevented the majority of westward ice flow, forcing it south through Igdlorssuit Sund, and into the Uummannaq Trough. Here it coalesced with ice from the south, forming the trunk zone of the UISS.

Deglaciation of the UISS began at 14.9 cal. ka BP, rapidly retreating through the overdeepened Uummannaq Trough. Once beyond Ubekendt Ejland, the northern UISS retreated northwards, separating from the south. Retreat continued, and ice reached the present fjord confines in northern Uummannaq by 11.6 kyr. Both geomorphological (termino-lateral moraines) and geochronological (14C and TCN) data provide evidence for an ice marginal stabilisation at within Karrat-Rink Fjord, at Karrat Island, from 11.6-6.9 kyr. The Karrat moraines appear similar in both fjord position and form to 'Fjord Stade' moraines identified throughout West Greenland. Though chronologies constraining moraine formation are overlapping (Fjord Stade moraines – 9.3-8.2 kyr, Karrat moraines – 11.6-6.9 kyr), these moraines have not been correlated. This ice margin stabilisation was able to persist during the Holocene Thermal Maximum ($\sim$7.2 – 5 kyr). It overrode climatic and oceanic forcings, remaining on Karrat Island throughout peaks of air temperature and relative sea-level, and during the influx of the warm West Greenland Current into the Uummannaq region. Based upon analysis of fjord bathymetry and width, this ice marginal stabilisation has been shown to have been caused by increases in topographic constriction at Karrat Island. The location of the marginal stillstand is coincident with a dramatic narrowing of fjord width and bed shallowing. These increases in local lateral resistance reduces the ice flux necessary to maintain a stable grounding line, leading to ice margin stabilisation. This acted to negate the effects of the Holocene Thermal Maximum. Following this stabilisation, retreat within Rink-Karrat Fjord continued, driven by calving into the overdeepened Rink Fjord. Rink Isbræ reached its present ice margin or beyond after 5 kyr, during the Neoglacial. In contrast, the southern UISS reached its present margin at 8.7 kyr and Jakobshavn Isbræ reached its margin by 7 kyr. This work therefore provides compelling evidence for topographically forced asynchronous, non-linear ice stream retreat between outlet glaciers in West Greenland. In addition, it has major implications for our understanding and reconstruction of mid-Holocene ice sheet extent, and ice sheet dynamics during the Holocene Thermal Maximum to Neoglacial switch.