

Rate and style of ice stream retreat constrained by new surface-exposure ages: The Minch, NW Scotland

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Chronologically constrained studies of former ice-sheet extents and dynamics are important for understanding past cryospheric responses and modelling future ice-sheet and sea-level change. As part of the BRITICE-CHRONO project, we present new geomorphological and chronological data from a marine-terminating ice stream system in NW Europe that operated during the Late Weichselian Glaciation. A suite of 51 cosmogenic-nuclide exposure ages from ice sheet moraines and glacially transported boulders constrain the maximum extent of the ice sheet on the continental shelf (~ 28 ka BP) and its subsequent retreat, between ~ 27 and 16 ka BP, into a large marine embayment (ca. 7000 km²; the Minch, NW Scotland). Recently acquired swath bathymetry and acoustic sub-bottom profiler data reveal several large transverse grounding-zone wedges up to 40 m thick and 5 km wide with diagnostic acoustic-facies architecture. These seabed sediment wedges mark former quasi-stable positions of grounded marine-terminating ice-stream fronts; their size and thickness suggest long-lived stillstands of the order of centuries. Statistically significant clusters of exposure ages from glacial deposits on islands and intervening headlands shed important new light on the age of these marine grounding-zone wedges and, by inference, the rate and timing of Minch palaeo-ice stream retreat. We find strong evidence for episodic ice stream retreat on the continental shelf between ~ 28 -24 ka BP, in the outer Minch between ~ 24 -22 ka BP, and in the central Minch between 22-18.5 ka BP. In contrast, final ice stream deglaciation (< 18 ka) across the deepest parts of the inner Minch embayment, was probably rapid and uninterrupted – with the ice sheet margin at or close to the present-day coastline in NW Scotland by 16.1 ka BP. It is hoped that these results will form the empirical basis for future ice-sheet modelling of this dynamically sensitive sector of the British-Irish Ice Sheet.