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PERIPHERAL GLACIERS AT LOW ELEVATIONS: CLIMATE INSIGHTS FROM THE SCANDINAVIAN ICE SHEET

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Peripheral glaciers (PGs) are small glaciers that exist independently of larger ice masses and, owing to their relatively small size, are highly sensitive indicators of climatic change (Barr and Spagnolo, 2015). Across northern Norway, low-elevation cirque and valley glaciers preserve an important archive of glacier activity during and following retreat of the Scandinavian Ice Sheet, yet the chronology of these landforms remains poorly constrained. Previous regional mapping identified almost 1,000 cirques within northern Scandinavia, including over 500 below 300 m a.s.l., suggesting that glacier activity at unusually low elevations was considerably more extensive than previously recognised (Oien et al., 2022). However, it remains unclear whether these glaciers represent the final stages of Scandinavian Ice Sheet retreat or subsequent phases of independent peripheral glacier activity. A QRA Small Grant supported ten days of fieldwork across the Lofoten Islands to investigate this question through detailed geomorphological mapping, Schmidt Hammer (ScH) relative-age dating, and targeted cosmogenic nuclide sampling.

Field investigations examined 22 moraine systems distributed across four principal sites: Juvikdalen, Kjerkegarden, Eidesbakken, and Unstad. These localities preserve exceptionally well-defined sequences of terminal and recessional moraines formed by peripheral cirque and valley glaciers occupying remarkably low elevations between 29 and 380 m a.s.l. and situated between approximately 2.5 and 78 km beyond the mapped Younger Dryas ice margin (Stroeven et al., 2016). Schmidt Hammer (ScH) measurements (Shakesby et al., 2006) were collected from all 22 moraines, establishing the first regional relative-age dataset for low-elevation peripheral glacier moraines in the Lofoten Islands. The resulting rebound values provided preliminary relative-age estimates for each moraine sequence and were used to identify representative landforms for subsequent cosmogenic nuclide sampling (Ivy-Ochs and Kober, 2008).

Juvikdalen is a series of moraine ridges extending from a hanging valley towards the valley floor. The outer moraine yielded lower ScH rebound values (~30) than the inner moraine sequence (~45), indicating an older landform and suggesting multiple phases of glacier occupation following deglaciation. Similar patterns were observed at Kjerkegarden (~40-44) and Eidesbakken (~43), where adjacent valleys preserve exceptionally well-developed recessional moraine complexes (Fig. 1). The nested moraine sequences identified within these valleys are exceptionally well preserved and record successive stages of glacier retreat within individual catchments. LiDAR-derived topography, combined with field observations and Schmidt Hammer measurements, clearly demonstrates multiple recessional moraine ridges preserved within adjacent valleys. The morphology of these landforms, together with their spatial relationship to the regional deglaciation pattern, indicates they were formed by small, topographically constrained glaciers rather than by the retreating Scandinavian Ice Sheet itself. At Unstad, located approximately 78 km beyond the Younger Dryas ice-sheet margin, ScH measurements (~45) identified a further distinct phase of peripheral glacier activity despite the moraine's considerable distance from the former ice-sheet margin. Similarly, the Kjerkegarden, Eidesbakken and Unstad moraine systems all produced internally

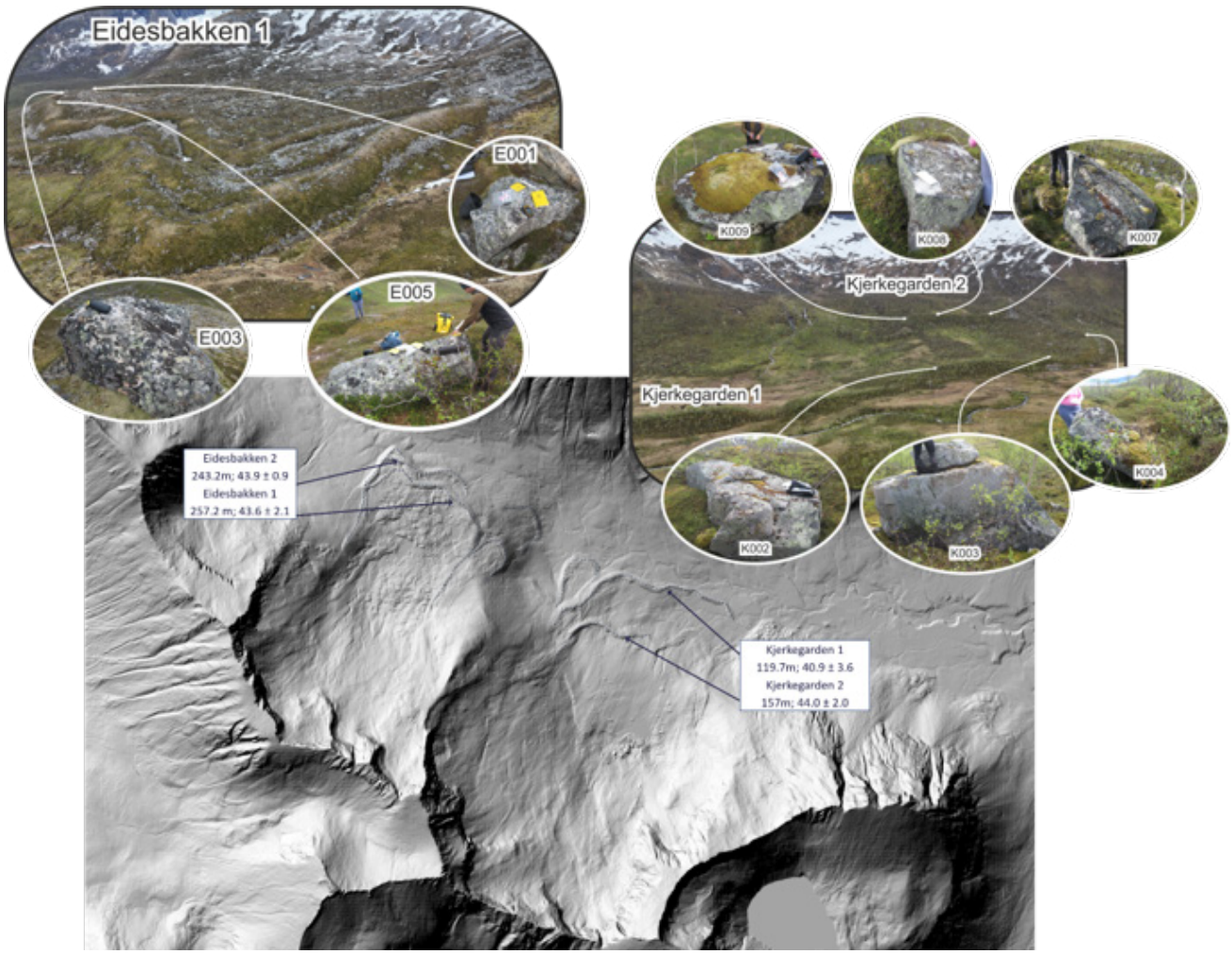


Figure 1: LiDAR-derived topography of the Eidesbakken and Kjerkegarden moraines, highlighting nested recessional moraine sequences, along with elevations, ScH rebound values and field photos of the moraines and numbered sampled boulders.

consistent ScH rebound values, allowing preliminary relative-age estimates to be established despite their differing elevations and distances from the Younger Dryas limit. Although definitive chronologies await cosmogenic exposure dating, these preliminary results suggest that several low-elevation glaciers remained active following regional deglaciation and may record glacier persistence or early Holocene reactivation rather than direct Scandinavian Ice Sheet retreat alone.

Schmidt Hammer results were subsequently used to select representative moraine systems for cosmogenic nuclide sampling. During the field campaign, 20 boulder samples were collected from seven moraines, providing the first regional dataset for absolute dating of low-elevation peripheral glacier moraines in the Lofoten Islands. These samples will be processed at the Scottish Universities Environmental Research Centre (SUERC) under a Natural Environment Isotope Facility (NEIF) grant awarded in July 2026.

The QRA Small Grant enabled the first systematic regional investigation of low-elevation peripheral glacier moraines within the Lofoten Islands and generated an extensive new geomorphological and relative-age dataset. The preliminary results demonstrate that exceptionally low-elevation glaciers persisted across the region following retreat of the Scandinavian Ice Sheet and that these landforms preserve a previously underutilised archive of glacier fluctuations during the Late Glacial-Holocene transition. By combining detailed geomorphological mapping with relative-age dating and targeted cosmogenic sampling, this project provides the foundation for establishing the first chronological framework for peripheral glacier activity in the Lofoten Islands and will improve reconstructions of Scandinavian Ice Sheet retreat and subsequent environmental change.

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