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Ice-dammed lakes of Scandinavia - a key to the pattern and chronology of the final decay of the Scandinavian Ice Sheet

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Here we present the use of ice-dammed lake-related landforms and sediments for reconstructing the final phases of decay of the Scandinavian Ice Sheet.

In the late stages of the deglaciation, extensive glacial lakes were dammed between the easterly retreating Scandinavian Ice Sheet and the water divide within the mountains to the west. Using high-resolution airborne LiDAR-data, shorelines and other landforms relating to these ice-dammed lakes have now been discovered over larger areas and in greater numbers than previously known, opening a treasure trove of palaeoglaciological information of vast potential for reconstructing the final decay phase of the Scandinavian Ice Sheet.

The geomorphological imprint of the ice-dammed lakes is of particular importance in northern Scandinavia, as geological evidence pertaining unequivocally to the final ice sheet decay is sparse. Its interpretation is complicated since the ice sheet is thought to have mainly been cold-based during final decay, inhibiting sliding at the ice-bed interface and limiting the construction (or destruction) of landforms indicative of the changing shape and flow of the ice sheet. Furthermore, dated sediment sequences marking the onset of ice-free conditions are woefully few in northern Scandinavia. Likewise, available cosmogenic nuclide exposure dates provide high age uncertainty and inadequate geographical cover, leaving the timing and location of final ice sheet decay still elusive.

Using examples from northern and central Scandinavia, we show that ice-dammed lakes are an intricate part of the deglacial dynamics and show how mapping and dating them offer a solution to these problems. Even with a frozen ice-bed interface, surface melting and meltwater drainage creates landforms unequivocally associated with ice sheet decay: drainage channels, dammed lake shorelines, and deltas. Meltwater drainage routes and ice-dammed lakes are therefore powerful tools for reconstructing a disintegrating ice sheet; a ponded lake reveals the location of its

requisite ice-dam, and drainage pathways reveal ice-free conditions. A dated sequence of ice-dammed lake sediments can therefore constrain both ice and lake coverage at that time for a much larger area than the dated site itself. Furthermore, the extent of different ice-dammed lake stages and their requisite ice-damming positions enables the pattern of ice margin change to be traced, and the relative age of ice-marginal positions determined using cross-cutting relations. The shorelines' present-day tilts are also used to inform patterns and magnitudes of postglacial isostatic uplift, information otherwise lacking from the continental interior but of particular importance for modelling former ice sheet volumes and understanding the crustal response to ice sheet loading. Reconstructing the extents and timing of ice-dammed lakes and the study of related landforms and deposits can therefore greatly improve our understanding of the final decay of the Scandinavian Ice Sheet and provide potential analogues for the predicted future behaviours of modern ice sheets.