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Large-scale distribution, pattern and morphology of subglacial meltwater corridors

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The character and evolution of the subglacial drainage system is a key control on ice-sheet dynamics. However, the inaccessibility of contemporary ice-sheet beds means the subglacial hydrological system is poorly resolved. An alternative approach is to use meltwater landforms formed on the beds of past ice sheets to reconstruct subglacial meltwater pathways over large spatial and temporal scales. This approach has been facilitated by the release of high resolution datasets (e.g. Arctic DEM), which allows evidence of subglacial meltwater transport to be identified at unprecedented levels of detail and scale.

This study focusses on subglacial meltwater corridors (SMCs); features characterised as elongated tracts of 'rough' or hummocky terrain which stand out from the surrounding smooth and streamlined bed. While these features have been identified before (e.g. St-Onge, (1984); Rampton et al., (2000); Peterson et al., (2017)), their distribution over ice-sheet scales as well as the mode of the hydrological system which they represent and the amount of time they took to form has yet to be determined.

Here, we present an automated approach for rapidly identifying and mapping the distribution, pattern and morphology of SMCs beneath the former Laurentide and Fennoscandian ice sheets from high-resolution digital elevation models. To test the extraction accuracy our results are compared to detailed manual mapping. Our results indicate that SMCs are widespread and more common than initially thought. SMCs are typically found in areas of subglacial till and are often associated with other subglacial meltwater features such as eskers and tunnel valleys. In terms of spatial organisation, SMCs appear to exist within clusters and individuals within each group exhibit a high degree of parallel conformity. Detailed mapping reveals information about their individual morphology; SMCs can vary in width, spacing, length and sinuosity both within and between clusters and display a range of relief (negative and positive) and definition (sharp and 'blurred' boundaries). This combination of methods will help contextualise meltwater drainage beneath contemporary ice sheets and will help better understand the impact of increased ice melt on ice sheet dynamics.

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