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Ice sheet scale subglacial meltwater conduit dimensions and processes: insights from 3D morphometry of a large sample of eskers

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Meltwater exerts an important influence on ice sheet dynamics and has attracted an increasing amount of attention over the last 20 years. However, the active subglacial environment remains difficult to study mainly due to its inaccessibility. Understanding of the dimensions, pattern, and extent of subglacial meltwater conduits at the ice sheet scale is limited to relatively sparse observations. We address this gap by using the geomorphological record of Quaternary ice sheets as a proxy to quantify the dimensions and pattern of subglacial conduits at the ice sheet scale. We present the results of a high-resolution (2 m), large sample (n>50,000) study of three-dimensional esker morphometry at sample locations in SW Finland and Nunavut, Canada. Detailed mapping of esker crestlines and outlines permits the quantification of a number of parameters, including: length, width, height, cross-sectional area, volume, sinuosity, cross-sectional symmetry, and uphill/downhill trends. Whilst the dimensions of eskers reflect depositional processes as well as simply the size of the parent conduit, they nevertheless offer a powerful tool for understanding the size and shape of meltwater conduits and the configuration of subglacial drainage systems across large areas (entire ice sheets), and over long periods of time (from years to thousands of years) in both high spatial and temporal resolution. The results may be used to: (1) inform numerical models of subglacial meltwater drainage, (2) inform process models of esker formation, and (3) provide a dataset of esker morphometry against which other features may be compared (e.g. sinuous ridges on Mars).