A time-transgressive perspective of glacial erosion and meltwater beneath the Eurasian ice sheet

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The efficacy and controls governing glacial erosion over geological timescales are intricately linked yet remain poorly understood and contended. By assimilating geophysical data with modelling of the Eurasian Ice Sheet - the third largest Quaternary ice mass that spanned 49°N - 82°N - we decipher its erosional footprint during the last ~110 ka glacial cycle. Our results demonstrate extreme spatiotemporal heterogeneity in erosion with short-term rates ranging from 0 - 5 mm a^{-1} , and a net volume equating to ~130,000 km^3 of bedrock excavated to depths of ~190 m. A hierarchy of environmental controls ostensibly underpins this signature: lithology, topography and climate, though it is basal thermodynamics that ultimately regulates erosion, which can be variously protective, pervasive, or, highly selective. A notable signature of this thermomechanically regulated erosional footprint is an increase in the intensity of erosion across upland areas of Fennoscandia and within troughs in the Barents Sea during the last deglaciation compared to the long-term mean. New meltwater landforms mapped from multibeam bathymetry data collected in the Central Barents Sea capture insight into the evolving nature of the subglacial environment of the Barents Sea ice sheet as it thinned and collapsed; the apparent abundance of basal meltwater, which we interpret was increasingly being supplemented by inputs from supraglacial melting, likely contributed to elevated erosion of the sedimentary substrate and the mobilisation of subglacial sediments during the latter stages of deglaciation.