



Rivers under ice: fluvial erosion beneath decaying ice sheets

John D. Jansen (1), Alexandru T. Codilean (2), Arjen P. Stroeven (1), Derek Fabel (3), Clas Hättestrand (1), Johan Kleman (1), Jon M. Harbor (4), Jakob Heyman (4), Peter W. Kubik (5), and Sheng Xu (6)

(1) Stockholm University, Stockholm, Sweden (john.jansen@natgeo.su.se), (2) University of Potsdam, Potsdam, Germany, (3) University of Glasgow, Glasgow UK, (4) Purdue University, Lafayette, USA, (5) ETH Zürich, Switzerland, (6) Scottish Universities Environmental Research Centre, East Kilbride, UK

The century-long debate over the origins of inner gorges cut within larger valleys that were repeatedly covered by Quaternary glaciers hinges upon whether the gorges are fluvial forms eroded by subaerial rivers, or subglacial forms cut beneath ice. We apply cosmogenic nuclide exposure dating to seven inner gorges along ~500 km of the former Fennoscandia ice sheet margin in combination with a new deglaciation isochron map. We show that the timing of bedrock exposure matches the advent of ice-free conditions, strongly suggesting that inner gorges were cut by channelised subglacial meltwater while simultaneously being shielded from cosmic rays by overlying ice. Given the exceptional hydraulic efficiency required for subglacial meltwater channels to erode bedrock and evacuate debris, we deduce that inner gorges are the product of ice sheets undergoing intense surface melting akin to that currently occurring on the Greenland ice sheet. The lack of postglacial river erosion in our seven inner gorges leads us to propose that channelised subglacial meltwater—boosted possibly by abrupt supraglacial lake drainage—may be a key driver of valley deepening on the Baltic Shield over multiple glacial cycles.