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Identifying palaeo-ice streams on hard beds: mapping erosional glacial bedforms in NW Scotland

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Most ice sheet flow occurs on hard beds, yet few studies have used erosional glacial bedforms to reconstruct spatial variability in flow and glaciodynamic processes on bedrock-dominated palaeo-ice sheet beds. Owing to a lack of digital terrain models at sufficiently high resolution (<1 m), we use field survey techniques to map subglacial bedforms within a ∼250 km2 area of hard crystalline bedrock in a landscape of "areal scour" around Loch Laxford in NW Scotland. The bedrock bedforms range from plastically moulded (p-forms) and wholly abraded forms, to stoss-lee forms and plucked surfaces all on an outcrop scale (1-100 m). We devise a 5-zone classification system to map, in a GIS, the presence, absence and abundance of glacial erosional forms within 624 (500-m square) grid cells. We then use these erosional bedform zones, along with known glaciological relationships to interpret the spatial and altitudinal pattern of palaeo-ice sheet processes and glacier dynamics in this part of NW Scotland. Our interpretation highlights the strong vertical thermal zonation on mountains and the spatial variation in ice-deformation rate and velocity transition associated with the onset of ice streaming. Consequently, we define the Laxfjord ice stream tributary – a feeder to the Minch palaeo-ice stream in NW Scotland. Finally, we suggest that this new mapping approach could be performed in other deglaciated shield-rock provinces to examine, more widely, the subtle erosional signatures preserved within areas traditionally thought to represent ice sheet "areal scour".