



Bedrock properties and glacial erosion: hardness and joint spacing, abrasion and plucking

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Subglacial erosion beneath glaciers occurs predominantly by abrasion and plucking, producing distinct erosional forms. The controls on the relative importance of abrasion vs. plucking are poorly understood. On the one hand, glacial conditions (such as ice velocity, ice thickness and water pressure) that favour or suppress cavity formation are thought to favour plucking or abrasion respectively. Conversely, bedrock properties (such as hardness and joint spacing) are also known to control landforms and the processes that form them, but this has rarely been analysed quantitatively.

In this study we compare landforms and bedrock properties of two different rock types (sandstone and quartzite), at the bed of a palaeo-ice stream near Ullapool in NW Scotland. The boundary between the two rock types is at right angles to the westward palaeo-ice flow, and palaeo-glacial conditions on both rock types were similar. We report quantitative parameters for bedrock properties (Schmidt Hammer hardness and joint spacing) and use morphometric parameters to analyse the landforms.

Torridon sandstone is soft but thick-bedded and with a wide joint spacing. Erosional bedforms include roche moutonnées with smoothed tops and concave stoss-sides, whalebacks and elongate p-forms, indicating a high proportion of abrasion over plucking. Cambrian Quartzite is hard, but thin-bedded and with a small joint spacing. Erosional landforms are angular to subangular with abundant plucked lee faces, suggesting a high proportion of plucking over abrasion. Hardness and joint spacing thus exert a strong control on subglacial erosional landforms and the mechanisms that formed them: where palaeoglaciological conditions are similar the bedrock properties represent the main control. Consequently, palaeoglaciological conditions can only be inferred from glacial erosional landforms if the effects of bedrock properties of the substrate are considered.