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3D imaging of the internal structure of a rock-cored drumlin using ground-penetrating radar

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One key question linking subglacial bedform analyses to ice dynamics relates to the flux of sediment at the bed. It is relatively easy to measure the upper surface of subglacial sediments either in active contemporary systems (using ice-penetrating radar surveys) or in relict subglacial terrain (using high-resolution digital elevation models). However, constraining the lower surface of subglacial sediments, i.e. the contact between the bedform sediment and a lower sediment unit or bedrock, is much more difficult, yet it is crucial to any determination of sediment volume and hence flux. Without observations, we are reliant on assumptions about the nature of the lower sediment surface. For example, we might assume that all the drumlins in a particular drumlin field are deposited on a planar surface, or that all comprise a carapace of till over a rock core. A calculation of sediment volume will give very different results leading to very different interpretations of sediment flux.

We have been conducting experiments in the use of ground-penetrating radar to find the lower sedimentary surface beneath drumlins near Kirkby Stephen (Northern England), part of the extensive Eden Valley drumlin field. The drumlins comprise diamict overlying a bedrock surface of Carboniferous limestone which outcrops frequently between the drumlins. Here we present the results of a grid survey over one of the drumlins that clearly demonstrate this drumlin comprises a thin carapace of till overlying a stepped limestone bedrock surface. We provide details on the field data acquisition parameters and discuss the implications for further geophysical studies of drumlin fields.