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Quantification of residual OSL signals in glacifluvial deposits from Jostedalen, Norway

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Temporal constraint of Quaternary ice masses may be facilitated through radiometric techniques including optically stimulated luminescence (OSL) dating. A precondition of OSL dating is that sufficient exposure of sediments to daylight occurs prior to deposition; however some transport processes in glacial settings may preclude this.

Partial bleaching within an otherwise homogeneous sediment system can lead to overestimation of depositional age, whereas heterogeneous bleaching results in sedimentary mixtures with complex luminescence dose histories, leading to ambiguous age estimates. There are laboratory tests to diagnose both scenarios, based on luminescence decay shapes and on dose-distributions, however further understanding of the sedimentary controls on bleaching and mixing in glaciofluvial systems is desirable in order to improve sample selection criteria and confidence in age determinations.

With this in mind a modern analogue bleaching study has been conducted in Jostedalen, Norway, home to the largest ice-cap in mainland Europe: Jostedalsbreen. Its outlet glaciers have been extensively studied over the past 100 years, providing a record of episodic glacial advance and retreat. Although modern analogue studies are often used to determine the suitability of an approach, they are often only applied to a single specific depositional environment. In this study alternatively, modern sediments deposited by the Bergsetbreen outlet glacier have been selected by their depositional pathway mechanism and proximity to the glacial snout, over a range of 0 – 25 km. The overall objective of this research is to identify which glacial sediments it is most appropriate to apply OSL to.

A further challenge encountered when dating quartz from glacial landsystems is that it often has very dim luminescence intensity. The cause of this is unknown; however it can render age determinations, especially in young samples, very inaccurate. Consequently rather than determining absolute ages for the samples analysed, the relative luminescence intensity is instead being examined.

A potentially useful field luminescence tool is the Portable OSL Reader, developed at the Scottish Universities Environmental Research Centre. It provides a simple set of initial screening results to assess the dependence of luminescence intensities on depositional setting. Samples have been analysed using the portable OSL reader in order to determine whether it can provide a meaningful indication of bleaching extent in glacial settings. Samples are currently being analysed using laboratory profiling and conventional OSL preparation, in order to compare the natural intensities of polymineral and unsieved sediment with the SAR measurements of the coarser fractions of prepared quartz sand (180-210μm). Initial results indicate that the most distal samples exhibit the smallest residual signals, and these observations have been made both within the Portable Reader data, and also within SAR screening of the prepared Quartz fraction. The coarse polymineral fraction exhibits much greater luminescence intensity than the coarse quartz fraction which is very dim, however is subject to anomalous fading of charge, and thus requires further investigation before it can be relied upon for accurate residual determination.

Contrast of the residuals between the different catchments analysed indicates that different glaciofluvial environments have very different bleaching characteristics, with the proglacial delta sediments from Nigardsbreen exhibiting a much greater residual charge than those from the Bergsetbreen meltwater channel. Similarly the sandur at Fåbergstølsgrandane exhibits a greater residual charge than sediments obtained from either the meltwater channel at Bergsetbreen or Fåbergstølsbreen. These results indicate that careful consideration of the specific depositional context is vital when using OSL on glacifluvial deposits.