Geophysical Research Abstracts
Vol. 20, EGU2018-13830, 2018
EGU General Assembly 2018

Using the sedimentology of distal glaciolacustrine varve sediments to understand changes in former proglacial lake systems.

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Glaciolacustrine sediments formed in proglacial lakes represent a key archive for reconstructions of past environmental and climate change. Perhaps most important are annually-laminated (varve) sediments, as these deposits facilitate precise estimates of the rates and duration of palaeoenvironmental events, through counts of successive annual layers, and detailed analysis of their internal structure. Critically, such sediments are one of only a few environmental archives to provide insights into the dynamics of abrupt climate events and resolve weather and climate at a season timescale. However, in (palaeo)lakes characterised by low biological productivity, it can be difficult to discern a 'true' varve structure. Instead, independent-age determinations are required to corroborate the seasonal cycle of sedimentation. This is possible in lakes where varve sedimentation extends to the present-day, but in the palaeolake systems this is often not the case, and more reliance is placed on robust, process-based sedimentological models to evaluate potential varve structures.

Glaciolacustrine varves range in thickness from >1000 mm in ice-proximal areas, to <1 mm in ice-distal locations. A variety of analytical techniques are available to examine the detailed sedimentary structures preserved at these different scales, with micromorphological techniques, such as thin section analysis, essential for robust analyses of the fine sediment structures (<25 mm thickness) typical of the more distal parts of glaciolacustrine basins. Typical glaciolacustrine varves are composed of texturally-distinct couplets comprising (i) a coarse sediment component (very fine sand and silt) deposited during the melt season, and fine sediment component (very fine silt and clay) that settles during the non-melt season. At the microscale, these couplets can exhibit a complex range of sedimentary structures, which are not recognisable with the naked eye, and reflect variations in the nature and/or frequency of sediment-laden meltwater pulses to the lake basin during the melt season, either from (i) the glacier margin; (ii) nival melt streams from the immediate catchment; (iii) precipitation events; and (iv) stochastic slump or surge deposits resulting from one-off events.

This talk uses observations made from a range of former glaciolacustrine basins (e.g. NW Europe, Patagonia) to outline protocols for the recognition of complex varve microfacies, how it might be possible to use varve microfacies to distinguish between the relative contribution of glacier-fed sediment as opposed to nival inputs and their differentiation from non-annual (irregular) sediment structures. This should enable improved understanding as to the drivers of varve thickness variations in palaeo-glacier lakes.