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Sediment core and glacial environment reconstruction – a method review

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Alpine glaciers are often located in remote and high-altitude regions of the world, areas that only rarely are covered by instrumental records. Reconstructions of glaciers has therefore proven useful for understanding past climate dynamics on both shorter and longer time-scales. One major drawback with glacier reconstructions based solely on moraine chronologies – by far the most common –, is that due to selective preservation of moraine ridges such records do not exclude the possibility of multiple Holocene glacier advances. This problem is true regardless whether cosmogenic isotopes or lichenometry have been used to date the moraines, or also radiocarbon dating of mega-fossils buried in till or underneath the moraines themselves.

To overcome this problem Karlén (1976) initially suggested that glacial erosion and the associated production of rock-flour deposited in downstream lakes could provide a continuous record of glacial fluctuations, hence overcoming the problem of incomplete reconstructions.

We want to discuss the methods used to reconstruct past glacier activity based on sediments deposited in distal glacier-fed lakes. By quantifying physical properties of glacial and extra-glacial sediments deposited in catchments, and in downstream lakes and fjords, it is possible to isolate and identify past glacier activity – size and production rate – that subsequently can be used to reconstruct changing environmental shifts and trends. Changes in average sediment evacuation from alpine glaciers are mainly governed by glacier size and the mass turnover gradient, determining the deformation rate at any given time. The amount of solid precipitation (mainly winter accumulation) versus loss due to melting during the ablation-season (mainly summer temperature) determines the mass turnover gradient in either positive or negative direction. A prevailing positive net balance will lead to higher sedimentation rates and vice versa, which in turn can be recorded in downstream lakes. To retrieve these glacial sediments it is necessary to collect sediment cores from the lake bottom. Reading the glacial signal, as preserved in the lake sediments, now includes the application of various methods such as measuring the amount of minerogenic versus biologic matter (typically inferred from Loss-on-ignition (LOI)), grain size analysis (GSA), magnetic properties (MP), geochemical elements (GE), Rare-Earth Elements (REE), Bulk Sediment Density (BSD), but also other techniques such as XRF analyses. Moreover, detailed glacier reconstructions can also be used to assess denudation rates, chemical and physical weathering as well specific glaciological changes.