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Identifying the annual signal in laminated clastic sediments from a Late Pleistocene lake succession

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A thick (>250m) succession of laminated lacustrine sediments at the Baumkirchen site in the Inn Valley (Austria) indicates the presence of a lake or series of lake phases existing during Marine Isotope Stage 3. The laminations are highly complex, entirely clastic, and vary considerably in thickness and internal structure. Despite high sedimentation rates of 5-6 cm per year indicated by radiocarbon and pollen data, there is no systematic macroscopic annual pattern in the laminations which could be used to develop a high-resolution (varve) chronology. Microscopic investigations of thin sections revealed sub-mm to cm-scale silt layers punctuated by very thin (0.25-2 mm) clay-rich layers spaced semi-regularly between 2 and 8 cm where present. The spacing and small grain size of these thin layers suggests a possible annual process responsible for their formation: rain-out of the fine suspended sediment from the water column during winter, when fluvial discharge into the lake was negligible and its surface was frozen. These potentially annual layers are not reliably identifiable macroscopically, however, analysis of X-ray fluorescence core scan data revealed the layers to be enriched in several heavy metals: most strongly in Zn but also in Pb, Cu and Ni. Possible carrier minerals of these heavy metals are currently being investigated. The radiocarbon chronology (in the short upper section where it is available) and heavy metal peak counting agree within error suggesting the heavy metal enriched clay-rich layers are mostly annual. Available X-ray fluorescence data for 150 m of the section suggest no significant long-term changes in annual layer spacing (i.e. sedimentation rate) from the 5-6 cm average indicated by the radiocarbon data, although there is a high degree of small-scale variation. Preliminary optically stimulated luminescence dates point to the presence of several hiatuses in this succession suggesting a fragmented record containing several lake periods of high sedimentation rates, rather than a continuous record. Local, annually resolved chronologies will open the door to perform high-resolution investigations into rates of change of climate proxies (pollen and biomarkers) across stadial-to-interstadial transitions.