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Using CT scans to count varves in lake sediments. Application to Lake Sagtjernet, southeastern Norway

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Annually laminated sediments, also called varves, are valuable natural archives to reconstruct past environments and climate. Until now, the most common and reliable procedure to count varves has been to produce overlapping thin sections of the entire sediment sequence and counting in the microscope — a process that can take months to complete. Replacing this laborious method has been a long ongoing process within the varve community, and a task that we now may be getting with advancements in analytical tools. This study assesses the use of CT scanning to produce varve chronologies, applying it to the ferruginous sediments of Lake Sagtjernet in southeastern Norway — the first non-glacial varved lake sediment sequence in Norway continuously covering the last 4300 years.

Microfacies analyses of the sediments show that the varves are formed by cyclical deposition of iron and manganese. Oxygen measurements through 2013-2014 show permanent anoxic bottom waters while the seasonal turnover only reaching a depth of c. 6 m (out of a total 12 m depth). Combined with measurements of iron from the water column (highly enriched in the bottom waters) we suggest to classify Lake Sagtjernet as a ferruginous meromictic lake.

Varve counting on CT scans resulted in a 4300-year chronology, which we compared to an independent radiocarbon chronology (based on 17 ^{14}C dates, radionuclide and ^{210}Pb analyses). Our results show that all of the varve ages fall within the 95% confidence interval of the radiocarbon chronology. However, some sections of the sediments with lower concentrations of iron and manganese illustrate vague boundaries between laminae in the CT scans — increasing age uncertainties in the chronology. These age uncertainties can be reduced by using XRF scanning or thin sections in parallel with CT scans to evaluate the boundaries. Based on these results, we conclude that CT scanning is a fast and non-destructive method for producing varve chronologies.