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High-resolution characterization of individual flood deposits

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In most fluvial landscapes rivers transport sediments within and across catchments throughout the year. During flood events the capacity and competence of the river manifolds, and consequently more sediment are eroded and transported within the catchment. Whenever such sediment-laden rivers reach lakes, sediments are deposited at rate much faster than background sedimentation. For this reason alone, lakes can provide exceptionally rich archives of paleofloods. Flood sediments carry information not only about frequency variability through time, but also about source area(s), the time of the deposit (on a seasonal scale), as well as the evolution of the flood. In order to scrutinize the information that can be extracted from such pristine lake records we have developed an approach where high-resolution data are compared to high-precision measurements of selected samples. More specifically, data from high-resolution X-ray fluorescence (XRF) scanning (Itrax) and magnetic susceptibility (Bartington MS2 point sensor) can potentially provide information on annual to decadal resolution. These fast and effective surface scanning methods are subjected to well-known uncertainties, which can impact the interpretation of individual layers.

To overcome this challenge – and obtain the highest possible precision and resolution – precise quantitative analysis of discrete flood layers using magnetic hysteresis measurements and First-order reversal curves (FORCs) as well as conventional X-ray fluorescence spectrometer (Philips PW1404) have been conducted. FORCs are obtained with an Alternating Gradient Force Magnetometer and have exceptional high sensitivity (1 x 10–11 A m2) that allows samples smaller than 200 milligrams to be measured. This means that sediments representing a band of less than a couple of millimeters in the lake sediment cores can be sampled without notable contamination from adjacent non-flood sediments, and analyzed with a high degree of precision (analytical error $\pm 2\%$).

Analyses are carried out on a well-documented lake sediment flood-archive from Meringsdalsvatnet in Southern Norway, which is proven to contain the sedimentary imprint of over hundred floods during the last ca. 10 000 years, including well-known historical events. Preliminary results indicate only minor changes in magnetic mineralogy throughout the record, but notable changes are seen in saturation magnetization, which reflects variations in concentration of the ferromagnetic mineralogy. When these results are compared to corresponding concentration of iron (Fe) and rubidium (Rb) it becomes evident that the core contains two statistical populations, which may indicate two contrasting flood systems. There are at least three potential explanations for this pattern: (1) a dual source area; (2) different mechanisms that trigger floods (spring snowmelting versus intense summer rainstorms); (3) the magnitude of the floods, which influences the sedimentary composition; or 4) a combination of the above.