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An integrated methodology of micro-CT and thin-section analysis for paleoflow reconstructions in lacustrine event deposits

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X-ray computed microtomography (μCT) is a non-destructive 3D imaging and analysis technique that is increasingly used in geosciences, including the analysis of grains, pores, structures, fluid flow and morphological features. In Quaternary sedimentology, particularly in disciplines that study unconsolidated sediment cores from (glacio)lacustrine environments, μCT scanning of smaller subsamples is proving to be a valuable integration tool to the traditional thin section micromorphology, as it allows visualisation of internal 3D sediment composition, texture and structure at high resolution. We created an integrated methodology of μCT and thin section analysis by developing a 3D-printed subsampler that can effectively (1) extract areas of interest from soft sediment cores, (2) stabilise the unconsolidated "wet" sediment during μCT scanning and (3) allow dehydration and impregnation to be carried out while the sample is in the subsampler, which ensures an undisturbed sample for thin section preparation.

Here we apply our new methodological approach on sediment cores from Alaskan, Chilean and Swiss lakes. Medical X-ray CT scans of sediment cores from these lakes have proven to be valuable for studying seismically, volcanically and climatically induced event deposits. However, higher resolution μCT data with a voxel size of 5 μm is required to isolate individual grains larger than medium silt to determine their grain size, shape and orientation. Subsamples (8.0 x 1.5 x 1.5 cm) of different types of event deposits (turbidites, lahars and avalanches) were extracted from the sediment cores, scanned at the Centre for X-ray Tomography (UGCT, Ghent University) and thin sections were prepared. μCT scanning of the "wet" sediment subsamples allowed 3D characterisation of grains and structures of the original sediment microstructure and radiodensity contrast at high resolution, while the thin sections provided additional mineralogical and high resolution structural 2D information. This detailed analysis of the orientations of mud clasts, silt/sand grains and dropstones (in deposits from historical events) will lead to a better understanding of the relationships between paleoflow direction and grain deposition, and thus improve the reconstructions of past natural hazard events in the study areas.