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Lacustrine Paleoseismology in Carinthia, Austria: First steps towards a calibrated postglacial paleo-earthquake record in the Eastern Alps

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In formerly glaciated intraplate regions with low deformation rates and moderate seismicity, long-term paleoseismic records are essential to determine the probability of strong earthquakes and assess the seismic hazard. Lake sediments provide a continuous and high-resolution paleoseismic archive, which can record seismic shaking as mass transport deposits (MTDs), turbidites and soft sediment deformation structures.

Paleoseismological studies carried out on many Swiss, French and Italian lakes, have immensely deepened our knowledge of earthquake distribution and intensity, and improved methodological approaches. In Austria, however, although having experienced several damaging historical earthquakes with epicentral seismic intensities of up to IX-X, lacustrine paleoseismic records do not yet exist. Here, we present the research strategy and preliminary results of a recently started paleoseismological research project in Carinthia, Austria.

Carinthia has experienced several well-documented historical earthquakes in a wide intensity range (V-IX) in 1201, 1348, 1690, 1857 and 1976, with the 1348 event considered to be the strongest historical earthquake in the Alps with an estimated M_w of $\sim$7. We compare these temporally well-spaced earthquakes and the associated sedimentary imprints to calibrate our methodology, i.e. we explore relationships between seismic intensity and the type and size of MTDs, turbidites and sediment deformations. This calibrated paleoseismograph allows us to estimate the intensity of paleo-earthquakes, deduced from long sediment cores in strategically distributed Carinthian lakes (Klopeiner See, Keutschacher See, Weissensee, Ossiacher See, Millstätter See and Wörthersee).

We investigated these lakes of various sizes (1.1 km^2 to 19.4 km^2), physiographies and catchment lithologies with reflection seismics and short ($\sim$1.5 m) gravity cores. The seismic data reveal simultaneous sublacustrine slope failures and turbidites – an evidence of strong seismic shaking – in seismostratigraphic positions most probably ranging from pre-Holocene to very recent times. In Wörthersee, Millstätter See and Weissensee, one interval stands out due to its extensive MTDs and associated megaturbidites, which cover almost the whole basin of each lake. In Wörthersee, several very recent ($<$ 1 ky) events are recorded in both the sediment cores and the seismic data, the latter showing an MTD several metres thick, covering the westernmost part of the lake over a length of 2 km. Cores from Millstätter See and Weissensee reveal finely laminated sediments, enabling dating of frequently intercalated event deposits on a yearly scale. We observed different types of turbidites based on petrophysical, grain size and geochemical data, which may help to distinguish between flood- and earthquake origin of these events. Extending the paleoseismological archive to pre-Holocene times will be achieved by long coring in seismostratigraphically suited positions, which will be carried out in 2018 and 2019.