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# Anatomy of a seismic seiche deposit: Traces of the AD 1755 Lisbon earthquake in the sediments of lake Hechtsee (Tyrol, Austria)?

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A seiche can be described as a standing wave oscillating in a closed, or partly closed body of water, for example a lake or fjord. It is called a seismic seiche, if the water oscillation is induced by seismic waves from an earthquake. Provided that the frequency content of the passing seismic waves interferes ideally with the resonant frequencies of the lake, seismic seiches can be generated over teleseismic distances. It is hypothesized that the water movements of a seiche event can generate bottom currents, which lead to remobilization of surface sediments and leave a distinct deposit in the basin depocentre. However, no dedicated studies on seismic seiche deposits have been performed so far.

In this study, we investigate Lake Hechtsee, a small lake (0.28 km2, 57 m depth) located in the Northern Calcareous Alps (near Kufstein, Tyrol, Austria). Historical reports confirm that large waves occurred and inundated the shores of Hechtsee on Nov. 1, 1755, despite windless conditions on the lake. We hypothesize that this seiche phenomena is related to a far-field effect of the Mw8.5-9 Earthquake offshore Portugal, the largest known historical earthquake in Europe, and for which seiches in many lakes and fjords throughout Europe were reported.

To test this hypothesis, we examine the sedimentary infill of lake Hechtsee with 16 short gravity cores (∼50-150 cm), to identify a possible seismic seiche deposit. The cores were investigated with CT-scanning, MSCL, XRF-scanning and laser diffraction particle size analyzer. The sediment cores reveal finely laminated organic-rich sediments, enabling dating of intercalated event deposits. The age model builds on short-lived radionuclides (210Pb, 137Cs), AMS radiocarbon (14C) samples and varve counting and suggests an average sedimentation rate of about 0.04-0.06 cm/yr.

Based on petrophysical, geochemical and grainsize data, different types of turbidites were observed within the sediment cores. These signatures are used to discriminate an earthquake, flood or seiche origin for each turbidite. According to the age model and textural properties, there are two prominent event deposits, which can be associated with seismic seiches of the Lisbon Earthquakes in 1755 and possibly 1761. The lower of this two event deposits consists of three units, each one characterized by abundant organic matter at the base and mud clasts visible on CT images. Spatial trends in deposit thickness and grainsize of each sub-event deposit suggest that remobilized sediments originate from different source areas.

Lake Hechtsee provides an interesting archive for studying processes of far-field effects of big earthquakes such as seismic seiches. However, further studies about seismic seiches on lakes and fjords are necessary to understand their mechanisms and the sedimentological properties of their deposits.