EGU25-11849, updated on 22 Apr 2026
https://doi.org/10.5194/egusphere-egu25-11849
EGU General Assembly 2025
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A complex deposit sequence from a small, southern Cascadia lake suggests a previously unrecognized subduction earthquake immediately followed a crustal earthquake in 1873 CE

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Here, we disentangle a complex disturbance deposit sequence attributed to the ~**M** 7 1873 CE Brookings earthquake from lower Acorn Woman Lake, Oregon, USA, using sedimentological techniques, computed tomography, and micro-X-ray fluorescence. The lower portion of the sequence is derived from schist bedrock and has characteristics similar to a local landslide deposit, but is present in all cores, suggesting that it is the result of high frequency (>5 Hz) ground motions from a crustal earthquake triggered the landslide. In contrast, the upper portion of the sequence is similar to a deposit attributed to the 1700 CE Cascadia subduction earthquake (two-sigma range of 1680-1780 CE): the base has a higher concentration of light-colored, watershed-sourced silt derived from the delta front followed by a long (2-5 cm) organic tail. The soft lake sediments are more likely to amplify the sustained lower frequency accelerations (<5 Hz) of subduction earthquakes, resulting in subaquatic slope failures of the delta front. The upper portion of the 1873 CE deposit, however, has an even higher concentration of watershed-sourced silt as compared to the 1700 CE deposit, which is suspected to be the result of shaking-induced liquefaction of the lake's large subaerial delta. The tail of both the 1873 CE and 1700 CE deposits is explained as the result of flocculation that occurred during sustained shaking. A preliminary literature search suggests that flocculation may occur during low frequency (<4-5 Hz) water motion that is sustained for an extended period of time (~minutes). The subduction interpretation of the upper portion of the 1873 CE deposit is supported by the observation of a small local tsunami offshore and the presence of a possible seismogenic turbidite attributed to the 1873 CE Brookings earthquake in southern Oregon sediment cores.

These results are important to regional seismic hazards for several reasons. Southern Cascadia crustal earthquakes, not previously recognized as a threat in southern Oregon, have the potential to cause damage to infrastructure, including the Applegate dam and buildings and other structures at Oregon Caves National Monument. They also identify a previously unrecognized recent southern Cascadia subduction earthquake. Finally, the close temporal relationship between these two types of earthquakes, not observed elsewhere in the downcore record, may be early evidence of the transition of the Walker Lane belt into a transform fault as predicted.