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A revised conceptual model for the depositional process of a megaturbidite: evidence for a combination of turbidite amalgamation and seiche influence in Lake Lucerne, Switzerland

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Megaturbidites in lakes have regularly been attributed to seiche events triggered by seismic shaking. Flow-strength fluctuations due to seiching are not only held responsible for the strong ponding geometry of these deposits, but also for grain size and sorting fluctuations at the base of the megaturbidite. However, other studies have ascribed such fluctuations to the amalgamation of synchronously-triggered turbidity currents along different slopes.
Here we study the earthquake-triggered AD 1601 megaturbidite in Lake Lucerne in order to distinguish turbidite amalgamation from a seiche imprint. We retrieved 28 gravity cores along several transects through the megaturbidite across the lake basin and studied them using primarily medical and micro CT scanning, grain-size analysis and Natural Remanent Magnetization (NRM). The analyses allowed to divide the megaturbidite into four units that are, from the bottom: Unit I: the coarse sandy base, which is thickest in the east; Unit II: a strongly ponded silt-to-fine-sand unit with a laminated nature in some of the cores; Unit III: a ponded homogenous mud; and Unit IV: a ponded to draped homogenous clayey mud. While the coarse sandy Unit I usually constitutes the base of the megaturbidite, both core and reflection-seismic data show that it also occurs below some of the landslide deposits that are sourced from the northern slopes. Micro CT analysis of grain orientations on an oriented core shows that most of these coarse sands are sourced from the northeast, but at least one pulse has a different source area. In Unit II, variable orientations of grains and organic matter, strong ponding and poor quality of the magnetic signal (high Mean Angular Deviation; MAD), provide evidence for a very strong seiche influence in this unit. Throughout the ponded Unit III, high MAD and unstable NRM show the persisting influence of the seiche movement. The draping geometry, higher clay content, low MAD and stable NRM in uppermost Unit IV are evidence of deposition under calm conditions, after all currents have ceased. We conclude that the sedimentary imprints of turbidite amalgamation and seiching can be disentangled in the 1601 AD Lake Lucerne megaturbidite. The applied methods will also be applicable to megaturbidites in other lake basins.