Geophysical Research Abstracts
Vol. 19, EGU2017-13526-1, 2017
EGU General Assembly 2017

Distinguishing megathrust from intraplate earthquakes using lacustrine turbidites (Laguna Lo Encañado, Central Chile)

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One of the main challenges in seismically active regions is differentiating paleo-earthquakes resulting from different fault systems, such as the megathrust versus intraplate faults in subductions settings. Such differentiation is, however, key for hazard assessments based on paleoseismic records. Laguna Lo Encañado (33.7°S; 70.3°W; 2492 m a.s.l.) is located in the Central Chilean Andes, 50 km east of Santiago de Chile, a metropole with about 7,000,000 inhabitants. During the last century the study area experienced 3 large megathrust earthquakes (1906, 1985 and 2010) and 2 intraplate earthquakes (1945 and 1958) (Lomnitz, 1960). While the megathrust earthquakes cause Modified Mercalli Intensities (MMIs) of VI to VII at the lake (Van Daele et al., 2015), the intraplate earthquakes cause peak MMIs up to IX (Sepúlveda et al., 2008). Here we present a turbidite record of Laguna Lo Encañado going back to 1900 AD. While geophysical data (3.5 kHz subbottom seismic profiles and side-scan sonar data) provides a bathymetry and an overview of the sedimentary environment, we study 15 short cores in order to understand the depositional processes resulting in the encountered lacustrine turbidites. All mentioned earthquakes triggered turbidites in the lake, which are all linked to slumps in proximal areas, and are thus resulting from mass wasting of the subaquatic slopes. However, turbidites linked to the intraplate earthquakes are additionally covered by turbidites of a finer-grained, more clastic nature. We link the latter to post-seismic erosion of onshore landslides, which need higher MMIs to be triggered than subaquatic mass movements (Howarth et al., 2014). While intraplate earthquakes can cause MMIs up to IX and higher, megathrust earthquakes do not cause sufficiently high MMIs at the lake to trigger voluminous onshore landslides. Hence, the presence of these post-seismic turbidites allows to distinguish turbidites triggered by intraplate earthquakes from those triggered by megathrust earthquakes. These findings are an important step forward in the interpretation of lacustrine turbidites in subduction settings, and will eventually improve hazard assessments based on such paleoseismic records in the study area, and in other subduction zones.

References

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