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Holocene tectonic, sedimentary, and erosive processes in a volcanic-dammed intramontane lacustrine basin: Lago Laja, Chile

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Lago Laja is located near the drainage divide of the south-central high Andes at 37˚S. The active Antuco volcano, adjacent to the lake, forms a natural dam confining the Laja intramontane basin. We use field observations, lake reflection-seismic profiles, bathymetry, and remote sensing data to reconstruct the late Quaternary erosion and sedimentation history of the Laja basin and to document the existence of an active fault system that runs parallel to the volcanic arc, the Lago Laja fault system (LLFS).

Activity of the Antuco volcano started at $\sim$124 ka with formation of the basaltic edifice, which dammed the catchments forming the intramone Laja basin and lake. At 7.1 cal ka BP, a caldera-collapse event of the Antuco opened the Laja's dam generating an outburst megaflood and emptying the lake. Fluvial systems advanced into the former lake eroding the poorly-consolidated lacustrine sediments. Subsequent Late Holocene post-caldera lavas dammed the Laja's outflow generating the present-day lake and renewed lacustrine sedimentation. The fluvial erosion episode is recorded in a regional unconformity, which is well observed in seismic profiles and thus represents an excellent structural marker to quantify fault activity. A post-7.1 ka lacustrine drape covers the erosional surface.

Normal faults of the LLFS cut the $<$7.1-ka-old still-water lacustrine drape, 6.3-ka pyroclastic deposits, Holocene alluvial fans, and late Pleistocene volcanics. We divide the LLFS in three segments based on fault geometry, width, and slip magnitudes. The underwater faults of the central segment in the lake's deepest part have the maximum

Holocene vertical slip rate of 2.8$\pm$0.3 mm/a. Since 7.1 ka, the LLFS accounts for $\sim$0.7% of arc-normal extension at an average rate of 1.2 $\pm$ 0.6 mm/a and strain rate of $\sim 10^{-14}$ s^{-1}. Pyroclastic deposits of the Chillan volcano in the northern segment yield a vertical slip rate of 1.0 $\pm$ 0.05 mm/a.

We interpret soft-sediment deformation layers in an exposed late Pleistocene glacio-lacustrine sequence as seismites, which evidence M$>$6 paleoearthquakes. This is in agreement with magnitudes expected from Holocene surface ruptures.

The Main Cordillera at $\sim$37˚S is a large-scale pop-up structure uplifted by Quaternary thrusting along both its foothills. In this light, we interpret extension in the axial and highest part of the Andes as incipient gravitational collapse in response to surface uplift and crustal thickening. Thermal weakening due to elevated heat flow in the vicinity of the volcanic arc and post-glacial lithospheric rebound have probably contributed to the arc-limited collapse and late Quaternary acceleration of deformation rates.