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Geomorphological and sedimentological evolution of a lake basin under strong volcano-tectonic influence: The seismic record of Lago Calafquén (south-central Chile)

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Abstract

The Chilean Lake District is a geodynamically active area located at the foot of the Andean cordillera and permanently influenced by the Chilean active continental margin. The study area is prone to steady mass movements that are triggered by active volcanism, strong earthquakes and climatic forces. On the glacial-born lake Lago Calafquén high-resolution seismic investigation was performed to select suitable coring sites for sedimentary analyses, to revise the existing bathymetry and to integrate the lake bottom topography into the geomorphological context of the surroundings. The sub-bottom profiling reveals a complex structure of the lake floor, which results in a division into an eastern and a central sub-basin. The eastern basin encompasses the deep basin plain which is a depositional area for dense suspension-loaded underflows. The morphology of the basement of the central sub-basin is affected by large landslides. Large rock-slope failures of debuttressed sidewalls fill the primary lake floor of the southern side covered by more than 40 m of sediment. A high-resolution seismic analysis of the sedimentary infill reveals deposits and structures of large mass movements and turbidites, obviously triggered by strong earthquakes. Incidents related to rebound effects by isostatic uplift are also considered to provoke remarkable magnitudes that trigger mass movement processes in the central sub-basin. Furthermore, volcanic impact frequently interrupts normal lacustrine sedimentation of the sediment succession by deposition of tephra layers. The serialized geodynamic impacts on Lago Calafquén cause severe damage to the sedimentary archive. Thus, suitable coring sites for palaeoenvironmental reconstruction should be selected carefully.
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1. Introduction

The subduction processes along the active continental margin of Chile cause destructive earthquakes and steady volcanism that strongly affect the Chilean Lake District. As a consequence of these coupling processes the area is prone to large landslides and related mass movements, which result in a sudden reshaping of topography and the subsurface (cf. Siebert, 1984; Keefer, 1999; Korup, 2005). Volcanic eruptions trigger rock and debris avalanches, as also reported from the 1980 Mt. St. Helens eruption, for example (Voight et al., 1981; Wieczorek, 1996), cause seismic shocks that affect (sub)surface structures and (re)activate faults and slides at various scales (Waldron, 1967; Belousov and Belousova, 1996). Furthermore, deposition of loose tephra accelerates erosion processes and favours the development of debris flows during intensive rainfalls. Seismic processes of any kind cause deformation of the subaerial and lacustrine sediments in the Chilean Lake District. Thus regolith or blankets of volcanic ash may be liquefied, giving rise to further landslide activity. Mass movements and soft sediment deformation have been triggered by earthquakes with magnitudes of $M_w = 5–7$ in the sediments of European alpine lakes (e.g. Siegenthaler et al., 1987; Beck et al., 1996;

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