



Multi-proxy analysis of annually laminated sediments from two neighboring lakes in South-Central Chile: a continuous activity record of Villarrica Volcano for the past 600 years

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Lake sediments contain valuable information about past volcanic and seismic events that affected the lake and its catchment, and provide unique records of the recurrence rate and magnitude of such events. This study uses a multi-lake and multi-proxy analytical approach to obtain reliable and high-resolution records of past natural catastrophes from c. 600 year old annually-laminated (varved) lake sediment sequences extracted from two lakes, Villarrica and Calafquén, in the volcanically and seismically active Chilean Lake District. Using a combination of μ XRF scanning, microfacies analysis, grain-size analysis, color analysis and magnetic susceptibility, we detected and characterized four different types of event deposits (EDs) (lacustrine turbidites; tephra-fall layers; run-off cryptotephras; lahar deposits) and revised the eruption record for Villarrica Volcano, which is unprecedented in its continuity and temporal resolution. Moreover, lahar deposits in lacustrine sediments were described for the first time. Time series analysis shows 112 eruptions with a Volcanic Explosivity Index (VEI) ≥ 2 in the last c. 600 years. Also deposits of eruptions from the more remote Carrán-Los Venados Volcanic Complex, Mocho-Choshuenco, Quetrupillán and Lanín or Huanquihue volcanoes were identified in the studied lake sediments. The last VEI ≥ 2 eruption of Villarrica Volcano occurred in AD 1991. We estimate the probability of the occurrence of future eruptions from Villarrica Volcano, and statistically demonstrate that the probability of a 21-year repose period (anno 2012) without eruptions is $\leq 1.9\%$. This new perspective on the recurrence interval of eruptions and historical lahar activity will help improve volcanic hazard assessments for this rapidly expanding tourist region.