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Seismicity at Villarrica Volcano (Chile): Characteristics, origin and implications on wave propagation

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Villarrica Volcano is one of the most active and dangerous volcanoes in Chile. Therefore it is permanently monitored by seismometers. However, in order to insure an effective hazard prediction, the strong influence of local peculiarities in the observation requires a careful and detailed analysis of the targeted volcano.
In early March 2012, we installed a dense local network with 75 stations covering the volcanic edifice, its surroundings and the summit. The data provides new insight into the characteristics of the seismicity as well as the properties of the edifice, that determine seismic wave propagation.
With this contribution we present a collection of results that highlight the strong scattering behavior of the medium and the specific features of low-frequency seimicity at Villarrica.
During nine observation days, we recorded thousands of low-frequency (<5 Hz) events and hundreds of volcano-tectonic (f>5Hz) earthquakes. Waveforms of lf-events are shortest and almost impulsive at stations in close vicinity to the active lava lake while at later stations they evolve into the typical emergent spindle-shape. This phenomenon is likely caused by strong scattering effects. The signals are embedded in a persistent background tremor, which has a similar spectral content as the events. Amplitude-decay location and array analyses both indicate a source region around summit but extended somewhat to the South for tremor and events.
VT-events originate from a region 2-4 km southeast of the summit in depths of 5-0 km b.s.l.. The decay of their vertical peak ground displacement indicates a geometrical spreading associated with body waves and an extremely large damping factor of 0.0556. The latter may again result from strong scattering effects in such a heterogeneous medium as a volcano.
Comparison of array analyses for vt- and lf-events also suggests body wave velocities for vt-events whereas the wavefield of lf-events is dominated by surface waves.
Previous studies reported only rare occurrences of VT-events. The abundance of VT-events in our data may be either attributed to an indeed unusually increased activity of shear-fractures or result from a beneficial instrument positioning.