Source process of very-long-period events accompanying long-period signals at Cotopaxi Volcano, Ecuador

Indira Molina[1]; # Hiroyuki Kumagai[2]; Alexander Garcia-Aristizabal[1]; Masaru Nakano[3]; Patricia Mothes[1]

[1] Instituto Geofisico, Escuela Politecnica Nacional, Ecuador; [2] NIED; [3] USGS

We observed VLP events accompanying LP signals associated with renewed seismic activity of Cotopaxi Volcano, Ecuador. The VLP waveform was characterized by an impulsive signature at the event onset, which was accompanied by the LP signal showing an incoherent oscillation. We observed temporal changes of both the VLP and LP signals, in which a harmonic signature gradually appeared in the LP signal and became dominant over the VLP signal. The Sompi spectral analysis of decaying harmonic oscillations in the tails of the LP waveforms showed frequencies between 3.0 and 3.5 Hz, with Q values significantly larger than 100. Assuming possible source geometries, we applied an inversion method to constrain the source mechanism and the location of the largest VLP event. Our inversion, together with particle motion analyses of the VLP signals, indicated that the volumetric changes of a sub-vertical crack located beneath the northeastern flank of the volcano (at a depth of 2-3 km above sea level) is the most probable source of the VLP event.

The sub-vertical crack may represent an intruded magmatic dike, manifested by the increased VT activity preceded by the VLP/LP activity and deformation data. A release of gases with small magma particles may have occurred due to the pressurization, which was caused by sustained bubble growth at the magma ceiling. The pressure inside the magma decreased in response to the release of particle-laden gas. The pressure drop in the magma recovered due to the growth of tiny bubbles contained in the magma. We interpret the VLP events as the volumetric changes associated with the release of particle-laden gas and subsequent pressure drop and recovery in the magma. The LP events can be interpreted as the resonance of a crack above the magma system, which was triggered by the release of particle-laden gas. At the beginning of the VLP/LP activity, the LP source region above the magma system consisted of a dendritic system of cracks so that the LP waveforms displayed complex incoherent oscillatory signatures. Repetitive injections of particle-laden gas gradually formed a single crack in the source region and generated the LP events with simple harmonic oscillatory signatures. We emphasize that limited observation data can be useful to quantify the VLP and LP sources as demonstrated by this study.