



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

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Abstract

Renewed seismic activity of Cotopaxi, Ecuador, began in January 2001 with the increased number of long-period (LP) events, followed by a swarm of volcano-tectonic (VT) earthquakes in November 2001. In late June 2002, the activity of very-long-period (VLP) (2 s) events accompanying LP (0.5–1 s) signals began beneath the volcano. The VLP waveform was characterized by an impulsive signature, which was accompanied by the LP signal showing non-harmonic oscillations. We observed temporal changes of both the VLP and LP signals from the beginning until September 2003: The VLP signal gradually disappeared and the LP signal characterized by decaying harmonic oscillations became dominant. Assuming possible source geometries, we applied a waveform inversion method to the observed waveforms of the largest VLP event. Our inversion and particle motion analyses point to volumetric changes of a sub-vertical crack as the VLP source, which is located at a depth of 2–3 km beneath the northeastern flank. The spectral analysis of the decaying harmonic oscillations of LP events shows frequencies between 2.0 and 3.5 Hz, with quality factors significantly above 100. The increased VT activity and deformation data suggest an intrusion of magma beneath the volcano. A release of gases with small magma particles may have repetitively occurred due to the pressurization, which was caused by sustained bubble growth at the magma ceiling. The released particle-laden gases opened a crack above the magma system and triggered the resonance of the crack. We interpret the VLP and LP events as the gas-release process and the resonance of the crack, respectively.

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