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Relationship between volcanic ash fallouts and seismic tremor: quantitative assessment of the 2015 eruptive period at Cotopaxi volcano, Ecuador

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Abstract

Understanding the relationships between geophysical signals and volcanic products is critical to improving real-time volcanic hazard assessment. Thanks to high-frequency sampling campaigns of ash fallouts (15 campaigns, 461 samples), the 2015 Cotopaxi eruption is an outstanding candidate for quantitatively comparing the amplitude of seismic tremor with the amount of ash emitted. This eruption emitted a total of ~1.2E + 9 kg of ash (~8.6E + 5 m3) during four distinct phases, with masses ranging from 3.5E + 7 to 7.7E + 8 kg of ash. We compare the ash fallout mass and the corresponding cumulative quadratic median amplitude of the seismic tremor and find excellent correlations when the dataset is divided by eruptive phase. We use scaling factors based on the individual correlations to reconstruct the eruptive process and to extract synthetic Eruption Source Parameters (daily mass of ash, mass eruption rate, and column height) from the seismic records. We hypothesize that the change in scaling factor through time, associated with a decrease in seismic amplitudes compared to ash emissions, is the result of a more efficient fragmentation and transport process. These results open the possibility of feeding numerical models with continuous geophysical data, after adequate calibration, in order to better characterize volcanic hazards during explosive eruptions.

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