The plinian fallout associated with Quilotoa's 800 yr BP eruption, Ecuadorian Andes

Patricia A. Mothes, Minard L. Hall

Instituto Geofísico, Escuela Politécnica Nacional, Quito, Ecuador

Abstract

Large volcanic eruptions at dacitic or rhyolitic volcanoes often generate exceptional volumes of fine ash that mantles an area up to a million km2. These eruptions are characterized by extreme fragmentation of the magma and hence extraordinary dispersal of ash and are categorized as plinian, ultraplinian, or phreatoplinian events. Large-volume co-ignimbrites or co-plinian ashes are often produced by such eruptions. High fragmentation indices of > 90% are attributed to the violent eruption of silicic magma, especially if augmented by fuel-coolant reactions produced when abundant external water interacts with the magma. The present study documents a case where the fine ash (≤ 1 mm diameter) fall deposit related to the plinian phase of the eruption comprises the overwhelming bulk – about 87 wt.% of the eruptive products. This is another example demonstrating the predominance of a widespread, fine-grained, co-plinian ash which follows the initial coarser lapilli fall. Historical eruptions at two other Andean volcanoes Quizapu, (Chile) and Huaynaputina, (Peru), and at Santa Maria, (Guatemala) and Novarupta, (Alaska) produced similar ash fall sequences.

Quilotoa's 800 yr BP eruption, in the Ecuadorian Andes, is an example of a powerful plinian eruption at a small dacitic volcano. It produced a crystal-rich, fine-grained ash layer which mantled an extrapolated ~ 810,000 km^2 with ≥ 1 mm thickness and has a bulk magma volume of about 18.3 km^3. Stratigraphic and petrographic studies, as well as granulometric and density analyses were employed to investigate these eruptive products, particularly the distal co-plinian fall deposits. The eruptive cycle consisted of a phreatomagmatic triggering, the establishment of a powerful sustained plinian column and subsequently partial column collapses, leading to widespread surge and ash flow activity. Quilotoa's 800 yr BP eruption has a (VEI) Volcano Explosivity Index = 6, and generated a maximum column height of about 35 km and a mass discharge rate of ~ 2×10^8 kg/s. In comparison, Pinatubo's 1991 eruption had similar column heights and discharge rates but smaller erupted volumes.

Factors that possibly contributed to the extreme explosiveness and resulting fine-grained ash production include inferred volatile overpressures in the crystal-dominated dacite magma, a rapid eruption onset, a forceful and sustained plinian column, possibly through a crater lake, thus promoting extreme fragmentation of the magma, but without leaving evidence of wet, phreatoplinian-type deposits.

Available in:

Journal of Volcanology and Geothermal Research, 2008, vol. 176, no 1, p. 56-69.

DOI: https://doi.org/10.1016/j.jvolgeores.2008.05.018

http://www.sciencedirect.com/science/article/pii/S0377027308002874