

The rhyolitic–andesitic eruptive history of Cotopaxi volcano, Ecuador

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Abstract

At Cotopaxi volcano, Ecuador, rhyolitic and andesitic bimodal magmatism has occurred periodically during the past 0.5 Ma. The sequential eruption of rhyolitic (70–75% SiO₂) and andesitic (56–62% SiO₂) magmas from the same volcanic vent over short time spans and without significant intermingling is characteristic of Cotopaxi's Holocene behavior. This study documents the eruptive history of Cotopaxi volcano, presenting its stratigraphy and geologic field relations, along with the relevant mineralogical and chemical nature of the eruptive products, in order to determine the temporal and spatial relations of this bimodal alternation. Cotopaxi's history begins with the Barrancas rhyolite series, dominated by pumiceous ash flows and regional ash falls between 0.4 and 0.5 Ma, which was followed by occasional andesitic activity, the most important being the ample andesitic lava flows (~4.1 km³) that descended the N and NW sides of the edifice. Following a ~400 ka long repose without silicic activity, Cotopaxi began a new eruptive phase about 13 ka ago that consisted of seven rhyolitic episodes belonging to the Holocene F and Colorado Canyon series; the onset of each episode occurred at intervals of 300–3,600 years and each produced ash flows and regional tephra falls with DRE volumes of 0.2–3.6 km³. Andesitic tephra and lavas are interbedded in the rhyolite sequence. The Colorado Canyon episode (4,500 years BP) also witnessed dome and sector collapses on Cotopaxi's NE flank which, with associated ash flows, generated one of the largest cohesive debris flows on record, the Chillós Valley lahar. A thin pumice lapilli fall represents the final rhyolitic outburst which occurred at 2,100 years BP. The pumices of these Holocene rhyolitic eruptions are chemically similar to those of older rhyolites of the Barrancas series, with the exception of the initial eruptive products of the Colorado Canyon series whose chemistry is similar to that of the 211 ka ignimbrite of neighboring Chalupas volcano. Since the Colorado Canyon episode, andesitic magmatism has dominated Cotopaxi's last 4,400 years, characterized by scoria bomb and lithic-rich pyroclastic flows, infrequent lava flows that reached the base of the cone, andesitic lapilli and ash falls that were carried chiefly to the W, and large debris flows. Andesitic magma emission rates are estimated at 1.65 km³ (DRE)/ka for the period from 4,200 to 2,100 years BP and 1.85 km³ (DRE)/ka for the past 2,100 years, resulting in the present large stratocone.

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