Abstracts

Springer

Bulletin of Volcanology

The enormous Chillos Valley Lahar: an ash-flow-generated debris flow from Cotopaxi Volcano, Ecuador

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Abstract

The Chillos Valley Lahar (CVL), the largest Holocene debris flow in area and volume as yet recognized in the northern Andes, formed on Cotopaxi volcano's north and northeast slopes and descended river systems that took it 326 km north–northwest to the Pacific Ocean and 130+ km east into the Amazon basin. In the Chillos Valley, 40 km downstream from the volcano, depths of 80–160 m and valley cross sections up to 337 000 m^2 are observed, implying peak flow discharges of 2.6–6.0 million m^3/s. The overall volume of the CVL is estimated to be ≈3.8 km^3. The CVL was generated approximately 4500 years BP by a rhyolitic ash flow that followed a small sector collapse on the north and northeast sides of Cotopaxi, which melted part of the volcano's icecap and transformed rapidly into the debris flow. The ash flow and resulting CVL have identical components, except for foreign fragments picked up along the flow path. Juvenile materials, including vitric ash, crystals, and pumice, comprise 80–90% of the lahar's deposit, whereas rhyolitic, dacitic, and andesitic lithics make up the remainder. The sand-size fraction and the 2- to 10-mm fraction together dominate the deposit, constituting ≈63 and ≈15 wt.% of the matrix, respectively, whereas the silt-size fraction averages less than ≈10 wt.% and the clay-size fraction less than 0.5 wt.%. Along the 326-km runout, these particle-size fractions vary little, as does the sorting coefficient (average=2.6). There is no tendency toward grading or improved sorting. Limited bulking is recognized. The CVL was an enormous non-cohesive debris flow, notable for its ash-flow origin and immense volume and peak discharge which gave it characteristics and a behavior akin to large cohesive mudflows. Significantly, then, ash-flow-generated debris flows can also achieve large volumes and cover great areas; thus, they can conceivably affect large populated regions far from their source. Especially dangerous, therefore, are snow-clad volcanoes with recent silicic ash-flow histories such as those found in the Andes and Alaska.

Available in:

Bulletin of Volcanology, 1998, vol. 59, no 4, p. 233-244.

DOI: https://doi.org/10.1007/s004450050188

https://link.springer.com/article/10.1007%2Fs004450050188

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