

New hazard map of Atacazo-Ninahuilca Volcanic Complex, Ecuador

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Hazard maps constitute a guiding tool for land use planning and emergency response. Quito, the capital of Ecuador, is surrounded by several active and potential active volcanoes, such as Atacazo-Ninahuilca Volcanic Complex (ANVC). The geological record indicates that Plinian eruptions at ANVC have an average Frequency of one event every 2513 ± 193 years with the last eruption dated at 2267 ± 17 years BP. The first hazard map of this volcano was published in 1992 and given the fast development of Quito and new knowledge on the volcano, an update is necessary.

We carried our new hazard assessment based on three main eruptive scenarios: 1) a small eruption with Volcanic Explosivity Index (VEI) of 1 or 2, whose principal volcanic phenomenon is tephra fall; 2) a moderate explosive eruption, VEI 3 or 4 whose hazards include tephra fall, pyroclastic density currents (PDCs) associated to dome collapse and small secondary lahars; and 3) a large explosive eruption, VEI 4 or 5 which including regional tephra fall, long-runout PDCs and large secondary lahars. In our study, the lahar volumes are estimated based on local rainfall patterns and the amount of loose material emplaced during the eruptions and available for remobilization.

We used different methodologies to create the hazard map such as geological mapping of the most recent ignimbrite deposits and numerical simulations for phenomena like dome collapses, tephra falls and secondary lahars. Then, the results of the simulations were validated through detailed field data.

The most hazardous zone potentially affected by tephra fall is located to the west of the volcanic complex, due to the predominant wind direction. Nevertheless, we show that Quito could be affected up to 10 cm of tephra fall in the south and other localities as far as 200 km could be affected by at least 1 mm of tephra. PDCs might affect Pilatón river (close to Alluriquín town) to the west, leaving deposits of at least 30 meters thick; and some other settlements like Tambillo and Cutuglahua to the east of the volcanic edifice could be affected by pyroclastic surges up to few meters due to topography effects. Finally, secondary lahars may reach several towns around the volcano like Alluriquín, Tambillo and the southwest of Quito especially in the rainy season, leaving deposits of variable thickness. These results represent the most probable scenario, while the impacts and affected areas are reduced for the less probable scenarios.

Stakeholders should use the new hazard map of the Atacazo-Ninahuilca volcanic complex in order to correct and adapt land use planning for Quito and its surroundings to avoid human and economic losses during a future eruption.