



Tungurahua Volcano, Ecuador: structure, eruptive history and hazards

Minard L Hall ^a, Claude Robin ^b, Bernardo Beate ^c, Patricia Mothes ^a, Michel Monzier ^{a, d}

^a Instituto Geofísico, Escuela Politécnica Nacional, P.O. Box 1701-2759, Quito, Ecuador

^b Institut de Recherches Pour le Développement (IRD, ex-ORSTOM), UR 6, OPGC, 5 Rue Kessler, 63038, Clermont-Ferrand, France

^c Departamento de Geología, Facultad de Geología, Minas y Petróleos, Escuela Politecnica Nacional, P.O. Box 1701-2759, Quito, Ecuador

^d Institut de Recherches pour le Développement (IRD, ex-ORSTOM), UR 6, A.P. 17-11-6596, Quito, Ecuador

Abstract

Tungurahua, one of Ecuador's most active volcanoes, is made up of three volcanic edifices. Tungurahua I was a 14-km-wide andesitic stratocone which experienced at least one sector collapse followed by the extrusion of a dacite lava series. Tungurahua II, mainly composed of acid andesite lava flows younger than 14,000 years BP, was partly destroyed by the last collapse event, 2955±90 years ago, which left a large amphitheater and produced a ~8-km³ debris deposit. The avalanche collided with the high ridge immediately to the west of the cone and was diverted to the northwest and southwest for ~15 km. A large lahar formed during this event, which was followed in turn by dacite extrusion. Southwestward, the damming of the Chambo valley by the avalanche deposit resulted in a ~10-km-long lake, which was subsequently breached, generating another catastrophic debris flow. The eruptive activity of the present volcano (Tungurahua III) has rebuilt the cone to about 50% of its pre-collapse size by the emission of ~3 km³ of volcanic products. Two periods of construction are recognized in Tungurahua's III history. From ~2300 to ~1400 years BP, high rates of lava extrusion and pyroclastic flows occurred. During this period, the magma composition did not evolve significantly, remaining essentially basic andesite. During the last ~1300 years, eruptive episodes take place roughly once per century and generally begin with lapilli fall and pyroclastic flow activity of varied composition (andesite+dacite), and end with more basic andesite lava flows or crater plugs. This pattern is observed in the three historic eruptions of 1773, 1886 and 1916–1918. Given good age control and volumetric considerations, Tungurahua III growth's rate is estimated at ~1.5×10⁶ m³/year over the last 2300 years. Although an infrequent event, a sector collapse and associated lahars constitute a strong hazard of this volcano. Given the ~3000 m relief and steep slopes of the present cone, a future collapse, even of small volume, could cover an area similar to that affected by the ~3000-year-old avalanche. The more frequent eruptive episodes of each century, characterized by pyroclastic flows, lavas, lahars, as well as tephra falls, directly threaten 25,000 people and the Agoyan hydroelectric dam located at the foot of the volcano.

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