

Stress tensor analysis of the 1998–1999 tectonic swarm of northern Quito related to the volcanic swarm of Guagua Pichincha volcano, Ecuador

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Abstract

The phreatic activity and the subsequent dacitic dome growth in 1998–1999 at Guagua Pichincha volcano, Ecuador, were associated with two seismic swarms: one located in the northern part of Quito (population: 1,500,000) and another one, just below the active volcano, about 15–20 km SW from the first one. Quito swarm tectonic events have high frequencies (from 1 to 10–15 Hz). We registered more than 3200 events (among which 2354 events of $1.4 \leq M_L \leq 4.2$) between June 1998 and December 1999 at the –2- and –17-km depth. The volcanic events below the Guagua Pichincha caldera have high (from 1 to 10–15 Hz) and low (less than 3 Hz) frequencies. Approximately, 130,000 events were registered between September 1998 and December 1999 at the +2.4- and –3.5-km depth. Here, we study the stress tensors of these two swarms deduced from the polarities of P first motions and compare them to the regional stress tensor deduced from CMT Harvard focal mechanisms. The Quito swarm stress tensor is relatively close to the regional stress tensor (the σ_1 axis was oriented N117°E close to the N102°E direction of the plate motion found by the GPS measurement, and σ_3 is nearly vertical). The difference may be due to the action of the closely active Guagua Pichincha volcano. The Guagua Pichincha stress tensor is very different from the regional tectonic one. The σ_1 axis of the volcano is oriented N214°E, almost perpendicular to the σ_1 of the swarm of Quito and σ_3 is almost horizontal. Even if these two tensors are different, they can be explained in a more general tectonic scheme. The almost horizontal direction of σ_3 just below the volcano is compatible with an extensional horizontal direction that may be expected in the shallow extrados part of a compressional region and consistent with an opening of the top of the Guagua Pichincha volcano. The movement of the fluids (magma, gas and/or groundwater) produced by the closely active Guagua Pichincha volcano seems to have an influence in the acceleration of the generation of seismic events.

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