

Spatiotemporal distribution of distal volcanic-tectonic swarms in the Northern Inter-Andean Valley, Ecuador

A. García^{1,2}, S. Hernandez², M. Plain², M. Ruiz², A. G. Ruiz^{1,3}, G. Viracucha², S. Vaca², L. Troncoso¹, A. Córdova²

¹Universidad Central del Ecuador (UCE), Quito, Ecuador

²Instituto Geofísico, Escuela Politécnica Nacional (IG-EPN), Ap. 17-01-2759, Quito, Ecuador

³The Pennsylvania State University, State College, PA, USA

Between February and April 2016, the National Seismic Network (RENSIG) of the Instituto Geofísico at the Escuela Politécnica Nacional (IGEPN) recorded several swarms of seismic activity near the Imantag parish north of the town of Cotacachi in northern Ecuador. As part of the Inter-Andean Valley, this area is home to a dense concentration of important volcanic (Cuicocha, Imbabura, Chachimbiro) and tectonic (Río Ambi, Otavalo, Billecocha) features, a fact which makes it difficult to determine whether seismicity in the area is of tectonic or volcanic origin. In this study, we reconstruct a detailed spatio-temporal evolution of these swarms in order to establish the physical origins of the source. A subset of 50 events ($M_L \geq 1.5$) were extracted from the local IGEPN catalog and used as templates for a match filter technique (Shelly et al., 2007). This technique was applied to continuous seismic data between January and June of 2016, resulting in the discovery of an additional 392 previously unidentified local events. Body wave arrival times manually picked from this expanded catalog were used to generate relative relocations using the hypoDD software (Waldhauser and Ellsworth, 2000). The 514 analyzed earthquakes ($M_L \leq 2.5$) cluster into two major swarms. The first swarm (<100 events) occurred within the first few days of March, and the second swarm (>300 events) occurred between March 24 and April 13. These swarms are nestled along the eastern edge of the Cotacachi-Cuicocha volcanic complex, with shallow depths (< 4 km) and a broad NNE-SSW trend. The remaining seismicity has more dispersed locations to the southwest of the main swarm and larger focal depths (6 to 15 km). An extensional-faulting (vertical P-axis) composite focal mechanism using first arrival polarities was computed for the event with the most repetitions. This solution disagrees substantially with the regional tectonic stress field determined by Corredor (2003), where a sub-horizontal P-axis dominates instead. The spectral properties of many of the events indicate hybrid (HB) sources with high-frequency onsets transitioning to low-frequency coda. We interpret these results as indicative of distal volcano-tectonic earthquakes, likely caused by changes in the state of stress in the nearby Piribuela, Loma Negra, and/or Cuicocha domes. This study establishes a baseline against which future locations, focal mechanisms, and rates of activity in this area can be compared. Future studies, possibly incorporating GPS, InSAR, and other data, should focus on correlating the seismic activity of these faults with the evolving activity of the potentially active volcanoes of the northern Inter-Andean Valley.

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