Characterization of Active Faults Through the Gulf of Guayaquil, Ecuador: implication for the southern boundary of the North Andean Sliver

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Along the Ecuadorian margin, the North Andean Sliver is moving in the northeastward direction due to the oblique subduction of the Nazca plate. The opening of the gulf of Guayaquil is a consequence of this motion. Two principal models compete to explain the opening. One proposes an opening achieved essentially with strike-slip motion along a single major fault through the gulf, the other with a combination of strike-slip and normal faulting on both sides of the gulf. The consequences in term of seismic hazard are very different. A single strike-slip fault model could imply a long fault segment capable of generating large magnitude events. In contrast, a multi-segments composite fault system will give conditions for producing small to medium size earthquakes. The southern Ecuador subduction zone is characterized by the absence of large historical earthquake. Data from the historical and instrumental seismicity for magnitude above 4 show the forearc has a high level of moderate seismic activity within and around the gulf that connects to the crustal seismic activity of the volcanic arc. In contrast, the forearc elsewhere shows very little or no seismic activity between the marine forearc zone and the volcanic arc. Regional and global CMTS data show a large number of mechanisms within the gulf that do not line up on a simple straight fault system. We present new earthquake data from the recently upgraded national seismic network of Ecuador. They provide the first image of SW-NE trending crustal faults stretching in the central part of the gulf and running eastward south of the Puna island. The main seismic belt appears to be discontinuous, made of short length segments with variable trends. The variety of focal solutions also indicates complex faulting. As the shape of this seismic belt is in good agreement with the orientation of the GPS velocity vectors, this new fault zone is readily interpreted as the southernmost segment of the actual NAS boundary. Others seismic clusters are observed parallel to the northern coast of the gulf, indicating active structures eventually accommodating the North-South opening of the gulf through normal faulting. b-value analysis of the main seismic belt seismicity shows high b value (>1) indicating either highly fractured or heterogeneous medium, or/and low stress level within the gulf of Guayaquil. This is again in agreement with a multi-segmented faulting system and also with the lack of large magnitude event in the historical seismic data. A cross-section for the entire seismic belt shows a depth extend of the crustal seismic activity down to 30 km which confirms the seismic belt to be a sliver boundary.