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Paleoseismology and tectonic geomorphology of the Pallatanga fault (Central Ecuador), a major structure of the South-American crust

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Abstract

The Pallatanga fault (PF) is a prominent NNE-SSW strike–slip fault crossing Central Ecuador. This structure is suspected to have hosted large earthquakes, including the 1797 Riobamba event which caused severe destructions to buildings and a heavy death toll (more than 12,000 people), as well as widespread secondary effects like landsliding, liquefaction and surface cracking. The scope of this study is to evaluate the seismic history of the fault through a paleoseismological approach. This work also aims at improving the seismotectonic map of this part of the Andes through a new mapping campaign and, finally, aims at improving the seismic hazard assessment.

We show that the PF continues to the north of the previously mapped fault portion in the Western Cordillera (Rumipamba–Pallatanga portion) into the Inter-Andean Valley (Riobamba basin). Field evidences of faulting are numerous, ranging from a clear geomorphological signature to fault plane outcrops. Along the western side of the Riobamba basin, the strike–slip component seems predominant along several fault portions, with a typical landscape assemblage (dextral offsets of valleys, fluvial terrace risers and generation of linear pressure ridges). In the core of the inter-Andean valley, the main fault portion exhibits a vertical component along the c. 100 m-high cumulative scarp. The presence of such an active fault bounding the western suburbs of Riobamba drastically increases the seismic risk for this densely inhabited and vulnerable city. To the east (Peltetec Massif, Cordillera Real), the continuation of the Pallatanga fault is suspected, but not definitely proved yet.

Based on the analysis of three trenches, we state that the Rumipamba–Pallatanga section of the PF experienced 4 (maybe 5) Holocene to Historical strong events (Mw > 7). The coseismic behavior of the fault is deduced from the occurrence of several colluvial wedges and layers associated with the fault activity and interbedded within the organic black soil sequence. According to a series of ^{14}C datings, we document that these events occurred during the last 6500 years. The clear deformation of the shallowest layer (^{14}C: 1633 AD) is most likely associated with the 1797 Riobamba earthquake. After retrodeforming one of the 3 trenches, we estimate coseismic vertical throws (0.70 to 0.90 m). Because of bad outcrop conditions, we could not determine the horizontal component of slip and we used the slip vector determined in a previous work with a tectonic geomorphology study.

Assuming this slip vector, we obtain total coseismic offsets between 3.5 and 4.5 m, indicative of earthquake magnitudes around c. Mw 7.5. The estimated recurrence time intervals range between 1300 and 3000 years, indicating an average slip rate of c. 2.5 mm/a for the Rumipamba–Pallatanga section of the fault.

Available in:

Geomorphology, 2015, vol. 237, p. 14-28.

DOI: http://dx.doi.org/10.1016/j.geomorph.2014.02.030

http://www.sciencedirect.com/science/article/pii/S0169555X14001238