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New crustal focal mechanism solutions for Bolivia: mapping the transition from Subandean compression and Altiplano extension

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In the last three years we improved the Bolivian seismic network and collected data to get a better knowledge of the stress regime in the country and to improve the fault plane solution database. Taking advantage of our new broadband data in combination with open data from international agencies like IRIS, USP, GFZ and others we determined 10 new focal mechanism solutions using different techniques (first arrival polarities, regional and teleseismic waveform modeling). The solutions are compared with the geological context of the country. The subduction process between Nazca and South America Plates is the main source of the regional stresses, plateau uplift and the resulting local seismicity. There are six geomorphological provinces in Bolivia. From west to east: the first one is the Western Cordillera (WC), then the Altiplano Plateau (AP), followed by the Eastern Cordillera (EC), the Inter Andes (IA), eastern the Sub Andes (SA) and finally the Cratonic Basin (CB). The shallow seismicity (less than 50 km deep) is related to this division. Intermediate earthquakes (depths from 100 to 350 km), and deep earthquakes (500 to 650 km depth) occur in the Nazca slab. Most of the shallow seismicity is located at the transition from Eastern Cordillera to Inter Andes and Sub Andes, near the Bolivian Orocline (a major change of structural direction from NW-SE to N-S). However, there is also evidence that at the Altiplano region some potentially active shallow geological faults trigger seismicity.

We analyzed the best recorded events in the last few years to get 10 new focal mechanisms in Bolivia, a significant increase of the previously compiled 20 solutions. The solutions show consistency with the geological context and the expected stress regime. For the Altiplano specifically in the Oruro Department, we computed two new solutions (one near San Martin town, the other near Oruro city, all showing strike – slip faults with EW to NE-SW compression and NS to NW-SE extension. Between the AP and EC we found a strike – slip solution for LLoja Earthquake located at La Paz Department. In the EC, just west of the Bolivian Orocline (also known as Boomerang) we found two not well constrained solutions: one normal and the other strike – slip,. Four seismic events are located between the IA – SA region: two near Cochabamba show thrust faults (located ate the changing direction of the Bolivian Orocline) with NE-SW P axes, two near Santa Cruz are strike – slip faults with E-W P axes. In the SA region in Southern Bolivia (Tarija) we found a thrust solution with NW-SE P axis. Finally, in the northern region of the Amazon craton, we found a thrust solution(the first one for that region) with ENE-WSW P axis.

These 10 new solutions, together with the previous 20 solutions from the literarure, show that the stress regime in Bolivia is characterized mainly by thrust and strike-slip faults which are related to the crustal deformation due to the subduction process. The following pattern can be recognized: along the Inter-Andean and Sub-Andean belts thrust faults predominate with compressional stresses varying from SW-NE, north of the Orocline, to E-W south of the Orocline.