Characterization of Tectonic - Magmatic Seismic Source at Chiles - Cerro Negro Volcanic Complex (CCNVC)

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The Chiles - Cerro Negro Volcanic Complex (CVCCN) is located in the Western cordillera at the Ecuador – Colombia border. This volcanic complex has shown an anomalous seismic activity since late 2013, with high activity peaks in 2014, specially in October and November with up to 6000 earthquakes per day mostly volcanic-tectonics events. The most important earthquake in this sequence occurred on October 20, 2014 with a 5.7 Mw. In order to obtain a better characterization of the seismic source in the CVCCN area, a new 1D velocity model was computed using 300 earthquakes with magnitudes larger than 3.0 MLv, and high quality of P and S pickings. This model has 8 layers over a semi-space and starts with a Vp = 2.96 Km/s and Vs = 1.69 Km/s highlighting strong variations at 7km with Vp = 5.87 Km/s and Vs = 3.52 Km/s and at 24 km Vp = 6.58 Km/s and Vs = 3.79 Km/s. A value of 1.73 of Vp/Vs was determined, which is a normal for the continental crust. Computed hypocenters with the new velocity model highlighted two sources: one is defined by a concentration of shallow earthquakes on the southern flank of Chiles Volcano, and the second one contains events deeper than 7 km and follows a N-S tectonic structure that crosses the CVCCN and matches the Cauca-Patía fault. This structure obtained with this new model is confirmed by interferograms from Sentinel images after the earthquake MLv 4.2 of September 27, 2019 where a mostly dextral movement is defined. Focal mechanisms were computed for earthquakes larger than MLv 4.0 using waveform inversion (SeisComp3). Most events show ~N-S planes and dextral with inverse component. Focal mechanisms exhibit a Non-Double Couple component (CLVD), which in most of these events is more than 40 percent including the CLVD = 71% calculated for the earthquake of Mw 5.7 on October 20, 2014. This value suggests the presence of a volumetric component that could be induced by magma or fluid movements. This is corroborated by the presence of LP and VLP events inside of the CVCCN system.