8th International Symposium
on Andean Geodynamics
(ISAG)

Velocity structure and ongoing tectonic deformation of the northern Middle Magdalena Valley, Colombia

F. Muñoz[1, 2], T. Planès[1], M. Lupi[1]

[1]*University of Geneva, Switzerland*

[2]*Ovservatorio vulcanológico y sismológico de Costa Rica, Heredia, Costa Rica*

A multi-proxy methodology revealed new insights about the velocity structure and tectonic deformation of the northern Middle Magdalena Valley in Colombia (MMV). The dataset consists of the earthquake catalog and complete waveforms containing more than 4 000 events from February 2014 to March 2016 provided by the Geological Survey of Colombia. Two comparative velocity models were derived to evaluate the behavior of the seismic wave at cortical and sub-cortical depths. Firstly, a one-dimensional velocity model obtained by simultaneous hypocenter-velocity inversion implying 1 148 P and S phase arrivals in the closest 19 stations. The new velocity model consists of six layers at depths of 2, 6, 20, 30, 40 and 100 km with P wave velocities of 4.0, 5.7, 6.5, 6.7, 7.6, 8.13 and 8.2 km/s respectively and Vp/Vs of 1.74. The relocation of the events shows a diminishing of the root mean square errors and the hypocenter location errors compared with earlier models. Secondly, preliminary results of an ambient noise tomography reveal the velocity variations of S waves by the inversion of more than 300 Green's functions and the group velocity evaluated from 8 to 20 s. The S velocity variations indicate a sedimentary cover over the MMV ranging from 2 to 10 km approximately. An irregular Moho interpreted along the region varying between 35 and 42 km deepening to the east. Anomalies of high velocity are observable towards the Central Cordillera and the San Lucas Range in agreement with the presence of crystalline rocks which compound these geological features. On the Eastern Cordillera, the velocity anomalies tend to be lower towards the mid part and slightly increase to the north and the south corresponding to the sedimentary sequence and crystalline basement that compound this range.

Finally, we assessed the ongoing stress field of the Middle Magdalena Valley integrating earlier data from different sources and moment tensor solutions derived in this study. The findings suggest that the current deformation is the result of a compressive regime with maximum horizontal stresses varying in direction northwest-southeast to west-east and locally modified by local fault systems in the deformation fronts of the Cordilleras foothills.

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