Crust velocity model and earthquake relocation of the northern Middle Magdalena Valley, Colombia

Abstract

A new crustal waves velocity model was obtained for the northern Middle Magdalena Valley Colombia by a simultaneous hypocenter-velocity inversion. The dataset consists of an earthquakes catalog and complete waveforms containing more than 4 000 events fromFebruary 2014 to March 2016 provided by the Geological Survey of Colombia. We inverted the high-quality hypocenter locations 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 V p/Vs of 1.74. The model calculates the Mohoroviččić discontinuity at 40 km depth. The time station corrections range from -0.03 and 0.89 s to P waves, and from -0.08 to 1.36 s for S waves.

The newly velocity model was employed to relocate the cortical events. First, the Hypocenter algorithm included in the SEISAN package was applied yielding an improvement on the quality of the locations by diminishing the root mean square errors and the hypocenter location errors compared with earlier models. Next, the double differences method was implemented by the HypoDD algorithm to perform more precise event locations finding the most seismogenic region towards the tectonic limits of the Middle Magdalena Valley. Besides, the seismicity of the Wadati-Benioff zone highlights a subducting east dipping slab down-going below 50 km depth, but the association with the Nazca or Caribbean plates is unclear.

On the other hand, we assessed the ongoing stress field of the Middle Magdalena Valley by the integration of earlier data from different sources and moment tensor solutions derived here. The data interpretation suggests that the current crustal deformation is the result of a compressive regime with maximum horizontal stresses varying in direction northwest-southeast to west-east and locally modified by the presence of the fault systems in the deformation fronts of the Cordilleras foothills.

Finally, this contribution might be useful for new crustal modeling and seismicity source studies in the Middle Magdalena Valley, as well as to obtain more precise earthquake locations for the permanent seismic monitoring of the region.