Focal mechanism of intermediate depth earthquakes in the Alboran Sea (Western Mediterranean)

Carolina López-Sánchez¹, Elisa Buforn¹, Maurizio Mattesini¹, Simone Cesca², Juan Vicente Cantavella³, Lucia Lozano³, and Agustín Udías¹

¹Fac. CC. Físicas, Universidad Complutense de Madrid, Spain
²GFZ German Research Centre for Geosciences Potsdam, Germany
³Spanish Seismic Network, Instituto Geográfico Nacional, Madrid, Spain

One of the characteristics of the seismicity in the Ibero-Maghrebian region is the occurrence of intermediate depth earthquakes (50<h<100 km), their largest concentration located at the western part of the Alboran Sea, with epicenters following an NNE-SSW alignment. In this study, we have relocated over 200 intermediate depth earthquakes (M≥3) occurred in this region in the period 2000-2020, using a non-linear probabilistic approach (NonLinLoc algorithm) together with a recent regional 3D tomography lithospheric velocity model for the Alboran-Betic Rif Zone. Maximum likelihood hypocenters confirm the NNE-SSW distribution in a depth range between 50 and 100 km. We have determined the focal mechanisms of 26 of these earthquakes with magnitudes (mb) greater than 3.9. We first derived focal mechanisms using the P-wave first motion polarity method and then performed a moment tensor inversion, using a probabilistic inversion approach based on the simultaneous fit of waveforms and amplitude spectra of P and S phases. We performed an accurate resolution study, by repeating the inversion using different 1-D velocity models and testing different moment tensor (MT) constraints: a full moment tensor, a deviatoric moment tensor and a pure double couple (DC). Misfit values are similar for different MT constraints. Most solutions have a non-DC component larger than 30%. This may be due to the tectonic complexity of the region and the use on the inversion of 1-D Earth model. The DC components obtained from the inversion show different orientations of the nodal planes. A first group of events to the northern part with epicenters inland on south Spain have horizontal tension axes in NE-SW direction. A second group of earthquakes with epicenters off-shore, but close to the Spanish coast, presents near-vertical pressure axes. The third group, formed by deeper earthquakes, with epicenters on the center of the Alboran sea have dip slip focal mechanisms of either normal or reverse motion with planes either vertical or dipping 45° plane oriented in NNE-SSW direction, approximately the same orientation as the alignment of their epicenters. The distribution of these intermediate depth earthquakes and their focal mechanisms evidence the seismotectonic complexity of the region related with a possible subduction.