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A seismicity boundary in the low-strain region of Alentejo, south Portugal

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Mainland Portugal lays on a stable continental setting characterized by low strain rates (convergence velocities < 1 mm/yr). However, the region has been the source of documented moderate magnitude earthquakes. The Alentejo region (south Portugal) presents belts of high epicenter density, the two main ones being (1) the Viana do Alentejo cluster in the south and (2) the NW-SE oriented Arraiolos alignment in the north. The latter appears as a sharp transition between a nearly aseismic area to the north and a seismically active area to the south.

Active fault studies based on geological observations have not identified tectonic features able to explain the observed seismicity patterns. Our objective is to contribute to the understanding of the deformation pattern in south Portugal. Several hypotheses need to be addressed: (1) Are those clusters the expression of a broad region of distributed deformation?; (2) Do they mark structures that might have the potential to generate moderate magnitude events?

We use a high-quality dataset recorded by a temporary array deployed in the area to produce a robust image of earthquake locations and to compute focal mechanisms. Newly detected events match well the previously identified earthquake alignments. The local network provides good control of the focal depths. We observe a spatial variation in the depth distribution. The Arraiolos alignment seems to produce deeper earthquakes than the Viana do Alentejo cluster. Earthquake locations inferred using 1D and 3D velocity models show a persistent concentration of seismicity at middle to lower crust depths (15 - 30 km) in the SE section of that alignment. We also present relocation of instrumental seismicity for the period (1970-2016).

Previous studies show that a strike-slip faulting regime dominates mainland Portugal. IPMA (Instituto Português do Mar e da Atmosfera) routinely computes focal mechanisms for earthquakes with reported local magnitudes of 3.5 or greater using the permanent network. However, little is known about small-scale faulting in mainland Portugal. The temporary deployment allowed us to model waveforms of small earthquakes (ML < 3.0) at relatively high frequencies (1.0 - 2.0 Hz). We computed focal mechanisms for ML > 1.5 events. We tested the stability of moment tensor solutions using two velocity models. Minimal diferences in focal plane orientations were observed. The results show a tendency for both strike-slip and reverse faulting.

We discuss the small-scale fault structure of the Alentejo region taking into account other relevant geological and geodetic data.

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