Seismic activity along a Cretaceous magmatic intrusion in Monchique, SW Iberia

Analdyne Soares¹, Susana Custódio¹, Marta Neres¹,², Dina Vales², and Luís Matias¹

¹Dom Luiz Institute, Faculty of Science, University of Lisbon, Lisbon, Portugal (analdyne_soares1@hotmail.com)
²Instituto Português do Mar e da Atmosfera, Lisbon, Portugal

Iberia, located at the southwestern end of Europe, displays a complex pattern of seismic activity, with most known active faults slipping at low rates (< 1 mm/yr). However, the seismic activity is remarkable, with numerous earthquakes in the historical record proving destructive. The earthquake cluster in mainland Portugal that has a highest rate of seismic activity is very localized (small spatial extent), extends vertically from 5 to 20 km depth and lays on the Monchique late Cretaceous magmatic intrusion, in SW Portugal. This magmatic intrusion forms strong rheological contrast between the intruded magmatic rocks and surrounding Paleozoic rocks. Furthermore, it is the locus of abundant natural water springs. Several pertinent questions remain to be answered concerning earthquakes in Monchique: Are earthquakes in Monchique simply a response to tectonic stresses (given the proximity of Monchique to the EU-AF plate boundary), with the localization of brittle failure in the region facilitated by the rheological contrast between the Cretaceous intrusion and surrounding Paleozoic rocks? Do fluids play a role in facilitating slip in existing fractures? Or, conversely, is the circulation of fluids facilitated by the faulting that results from the rheological contrasts? Are there hazardous faults in Monchique? In this presentation, we re-analyze in detail the seismic data recorded by the regional permanent seismic network, in order to better understand the relationship between seismic activity and igneous intrusion. In particular, we re-locate earthquakes using NonLinLoc and PRISM3D, a 3D velocity model for the region. At a subsequent step, we re-locate earthquakes using HypoDD. We also perform a clustering analysis based on waveform similarity and compute focal mechanisms for the region. The results show that earthquakes align along two main directions, E-W and NNE-SSW, coinciding with surface features of the magmatic intrusion. Focal mechanisms indicate dominantly strike-slip faulting, with the possible fault planes coinciding with the favored directions of earthquake lineations. We investigate the spatio-temporal evolution of seismicity and address possible forcing mechanisms, including tidal forcing.

The author would like to acknowledge the financial support FCT through project UIDB/50019/2020 – IDL and PTDC/GEO-FIQ/2590/2014 - SPIDER.