



Can small earthquakes help understand lithospheric deformation in slowly deforming regions? A case study from Portugal, western Europe.

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Portugal lies on the south-westernmost tip of Europe, next to the boundary between Eurasia and Africa. The slow oblique convergence between Iberia and Nubia is accommodated along a broad region of diffuse deformation rather than along a single plate boundary. Individual faults have low loading rates, which results in long time intervals between earthquakes. Mainland Portugal lays on stable continental crust, however it has been repeatedly affected by moderate to high magnitude earthquakes in historical times, including some of the largest earthquakes in stable continental crust on the European historical catalog. The adjacent offshore also presents interesting seismicity, being the source region of the largest European historical earthquake (the 1755 Lisbon earthquake), and with a number of earthquakes occurring on old and cold lithospheric mantle, down to ~ 60 km.

The seismicity of mainland Portugal and its adjacent offshore has been repeatedly classified as diffuse. In this paper we show that although the plate boundary south of Portugal is diffuse, in that deformation is accommodated along several faults rather than along one long linear plate boundary, the seismicity itself is not diffuse, just grossly mislocated in current catalogs. When carefully re-located, earthquakes collapse into well-defined clusters and alignments. This work presents a contribution to understanding the Portuguese seismo-tectonics by analyzing the location of small earthquakes occurred between 1961 and 2013 in mainland Portugal and adjacent offshore. Earthquakes occurred between 2010 and 2012 were recorded by a dense broadband seismic deployment, and their locations show a significant improvement with respect to previous locations. New maps of seismicity show clustering and alignments, both onshore and offshore, which allow for a new interpretation of the regional seismo-tectonics.

We conclude that the study of small earthquakes using dense seismic deployments is one of the few powerful tools to study lithospheric deformation in slowly deforming regions, such as western Iberia.