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Active tectonics and deformation partitioning in the Gibraltar Arc

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In the Western Mediterranean there is a considerable debate on the meaning of the seismicity distribution; if it delimitates the African-Eurasian plate boundary and if crustal versus lithosphere mantle seismicity could correspond to linked or decoupled processes. The character, nature, and distribution of the active deformation processes in the Gibraltar Arc are still far to be established, and they should be known to really understand the current geodynamics of the westernmost Mediterranean, as well as, to discriminate among competing geodynamic hypotheses.

In the Gibraltar Arc we have integrated different data sources to delimitate key aspects to constrain the current geodynamics of the region. Firstly, we have conducted an interactive geophysical modelling to obtain the most suitable lithosphere configuration (crustal and lithosphere mantle thickness) that explain the current topographic elevation. Secondly, with this lithosphere model, we have estimated the rheological stratification and characteristics of the crust (e.g., depth of the brittle-to-ductile transition, BDT) to compare with a refined distribution of the crustal seismicity. And thirdly, we have completed a map with the location of active faults and a comprehensive study of the present-day stress field by integrating different stress indicators.

It results that most of the crustal seismicity (>17%) is placed close to the BDT depth. Active fault structures seem to connect in depth with scatter seismic swarms in the brittle, upper crust, and merge into the BDT. These results suggest collectively that the BDT represents a decoupling horizon that conditions the mode of deformation. Active faulting and present-day stress-field depict a complex strike-slip (left-lateral) fault zone that crosscut obliquely the Gibraltar Arc concentrating most of the current deformation along the Africa-Eurasia plate boundary.