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The Plio-Quaternary activity of the Yusuf Fault System (Alboran Sea; Westernmost Mediterranean): From 3D deep structure to seafloor geomorphology

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The identification and seismic characterization of the active structures in the Alboran Sea (westernmost Mediterranean) are essential to evaluate better the exposure of the South Iberian Peninsula and Maghreb coasts to different natural hazards. The Alboran Sea accommodates part of the present-day crustal deformation related to the NW-SE convergence (4-5 mm/yr) between the African and Eurasian plates. The area is characterized by low to moderate magnitude instrumental seismicity. However, large earthquakes ($I > IX$ and $M > 6.0$) have occurred in this region in historical and recent times (i.e., 1522 Almeria, 1790 Oran, 1910 Adra, 1994 and 2004 Al-Hoceima or 2016 Al-Idrissi earthquakes). The dextral strike-slip Yusuf Fault System (YFS) is one of the largest active faults in the Alboran Sea and its seismogenic and tsunamigenic hazard needs to be characterized. The fault system trends WNW-ESE and has a length of ~150 km. Using multi-scale bathymetric (ranging from m to cm) and seismic data and different morphological and seismic analysis tools (i.e., slope or relief image maps), we have imaged and characterized the fault system. The analysis of this dataset reveals that the YFS is a complex structure composed of an array of strike-slip faults. The 3D structural model shows that most of the identified faults reach up and offset the seafloor and the Upper Quaternary sedimentary units. The current morphology of the seafloor is a consequence of the Plio-Quaternary tectonic evolution that have resulted in the formation of a large pull-apart basin, which is deeper than the surrounding areas, a topographic ridge, an elongated depression and morphologic lineaments following its trend. The dataset also images several submarine landslides scars, mainly on the steeper slopes surrounding the pull-apart basin. In addition, the analysis of ultra-high resolution data acquired along the Yusuf lineament with AUV has revealed the presence of a series of en-echelon scarps with heights ranging from few centimeters to less than 10 meter. Seismic profiles across these scarps show that they are related to different fault strands of the YFS that are offsetting the seafloor, possibly because of an earthquake occurred in historical times.