Active deformation and seismsmogenic characterizaton of secondary faults in the Alboran Sea constrained by high-resolution bathymetry and seismic

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Abstract

Recent advances in seafloor and subsurface imaging allow accurately mapping and characterizing the kinematic pattern and the style of deformation of submarine faults with unprecedented detail to better assess seismic and tsunami hazards in coastal areas. The Alboran Sea is a Neogene basin generated by crustal extension associated with the subduction in the Gibraltar Arc. At present, several fault systems absorb part of the strain related to the NW-SE convergence (4-5.5 mm/yr) between the African and Eurasian plates. Consequently, the Alboran Sea shows a significant seismic activity. New high-resolution bathymetric and seismic data reveal the presence of poorly known pervasive fault systems in the central part of the Alboran Sea, the Averroes Fault (AF) and the North Averroes Faults (NAFs). These are secondary fault systems located between two large active faults, the Carboneras and Yusuf/Alboran Ridge faults, and represent a hitherto unrecognized seismogenic potential. The WNW-ESE trending AF and NAFs, which may have evolved since the Lower Pliocene (4.57 Ma), are subvertical right-lateral strike-slip active faults since: a) are offsetting the Quaternary sedimentary units and deforming the seafloor; and b) produce a right-lateral displacement of the northwestern margin of the Alboran Channel and across the Adra Ridge North. Given that the AF and NAFs have formed in a continental crust and that are located in a zone surrounded by some of the main active faults in the Alboran Sea, we postulate that these fault systems have been developed into a distributed dextral strike-slip shear zone with the local bulk shear striking approximately N90º. Considering their surface length they could generate earthquakes with magnitudes (Mw) between 6.3 and 7.2, but reaching 7.6 when AF and Yusuf Fault are linked. The high resolution bathymetry map has allowed us measuring lateral offsets produced by the AF and NAFs. Assuming that these displacements have been accumulated during the last 4.57 Ma, the calculated lateral slip rate for AF is approximately1.5 mm/yr and range between 0.2 and 0.4 mm/yr for the NAFs. Our results evidence the importance of the kinematic and seismogenic characterization of secondary fault systems to better comprehend earthquake and tsunami hazards.