Geophysical Research Abstracts
Vol. 21, EGU2019-16237, 2019
EGU General Assembly 2019

Tsunamigenic risk associated to vertical offset in transcurrent fault termination (Westernmost Mediterranean)

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The Mediterranean Sea has one of the longest records of tsunami and represents the 10.1 percentage distribution of tsunami in the world's oceans and seas. The Alboran Basin (Westernmost Mediterranean) is tectonically active as it is suggested by recent earthquakes triggered by several faults, mostly located in the central zone, and formed due to the tectonic indentation in a context of convergence between Africa and Eurasia plates. One of these active faults is the Averroes fault, a NW-SE dextral transcurrent structure with vertical offset at its termination, which is analysed to test its tsunamigenic potentiality. While the propagation of tsunamis by normal or reverse faults is well simulated by numerical models, those generated by structures as the Averroes fault, has not received the interest of the scientific community attention. Through a multidisciplinary approach that involves morphological, seismic stratigraphy, and physical and numerical modellings, we test the generation of tsunamis or the subsequent inundation by the Averroes fault.

The bathymetric and seismic analysis point to the Averroes fault has a maximum vertical offset of 5.4 m. The crustal deformation at the sea bottom surface generated by a given earthquake hosted in the Averroes Fault has been computed using the Coulomb 3.3 code, where calculations are done using the Okada's 1992 approach, assuming an elastic halfspace with uniform elastic properties. Computed deformation pattern is characterized by an uplifting lobe (footwall block) and a subsiding lobe (hanging wall block). The Mw for this event is 7.03. The tsunami wave propagation generated by the seafloor deformation has been modelized with the Tsunami-HySEA (HySEA stands for Hyperbolic Systems and Efficient Algorithms).

The tsunami modelling shows three main wave fronts directed towards the NW, NE and S, being the most affected areas the Campo de Dalias (Almeria) and Malaga, located to the north of the Averroes Fault in the Spanish coast. The maximum wave heights reach about 3 m in the Averroes fault area, and about 2.5 m in the Campo de Dalias and Malaga coasts. The time arrivals are 15' for the first case and about 25' for the last.

The results of this work contribute to increase the number of tsunamigenic sources to be considered in the Alboran Sea. Although transcurrent structures have not been considered by their kinematics as potential triggers of tsunamis, here we demonstrate that the vertical offset at their terminations may generate destructive tsunamis. In addition, in the case of the Alboran Sea, those tsunamis would represent rapid-onset hazards, with time arrivals too short for alert systems, in a densely populated coast that increases during tourist arrivals during the spring and summer periods. This study also highlights the need to review the tsunamigenic potential hazards for similar strike-slip faults with vertical offsets in other seas and oceans.