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A preliminary evaluation of the tsunamigenic potential of the active faults at the Alboran Basin (westernmost Mediterranean) based on new seismic data

Laura Gómez de la Peña (1), Eulàlia Gràcia (2), Stefano Lorito (3), Alessio Piatanesi (3), Roberto Basili (3), Francesco E. Maesano (3), Fabrizio Romano (3), Manuela Volpe (3), Cristina S. Serra (2), and César R. Ranero (4)

(1) GEOMAR Helmholtz Centre for Ocean Research Kiel, Dynamics of the Ocean Floor, Kiel, Germany (lgomez@geomar.de), (2) Barcelona Center for Subsurface Imaging, Institut de Ciències del Mar, CSIC, Barcelona, Spain, (3) Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy, (4) ICREA at Institut de Ciències del Mar, CSIC, Barcelona, Spain

The Alboran Basin, located in the westernmost Mediterranean, hosts the boundary between the European and African tectonic plates. The deep structure of this basin is poorly constrained by regional tomographic models, and the tsunamigenic potential of individual faults is partly undefined.
Modern data acquired in the area during the last 15 years (e.g., active source seismic data from WESTMED cruise in 2006, EVENT-DEEP cruise in 2010 and TOPOMED cruise in 2011; and passive seismic data from TOPO-Europe and TOPO-Iberia projects in 2009-2010) are fundamental to constrain the crustal thickness and to image the sedimentary and tectonic structure of this area. Results of these surveys allowed us to advance in the characterization of the main active faults in the Alboran Basin (i.e. Carboneras, Al-Idrissi, Yusuf and Alboran Ridge front faults), and to review their tsunamigenic potential.
To estimate the possible tsunamigenic potential for each fault, we followed a two-step workflow. First, we analysed the faults in the area, selecting the potentially most tsunamigenic ones and describing them in detail. We created 3D models of the fault planes, using bathymetric and active and passive seismic data. The dense grid of multichannel seismic data, together with the pre-stack depth-migrated sections and a refraction profile showing the velocity structure across the basin, allowed us to consider for the first time in the area realistic geometry of the major faults. Second, we calculated the possible tsunami scenarios for each fault, using our 3D fault plane models and their simplified rectangular plane version, all with associated seismic parameter estimates. Tsunami simulations were done with Tsunami-HySEA non-linear shallow water GPU-optimised code developed by the EDANYA Group of the University of Malaga, Spain (de la Asunción et al., 2013, Comput. Fluids).
Main preliminary results show that: 1) the Alboran Ridge front fault expresses the highest tsunamigenic potential in the area, being able to generate a tsunami with an offshore maximum wave height > 1 m for a 7.2 Mw earthquake, 2) the strike-slip fault systems have low tsunamigenic potential as expected. However, due to the influence of poorly-constrained parameters in the modelled tsunami scenario, a further characterization of the strike-slip fault systems is recommended. Comparing the tsunami obtained when using the 3D fault plane with those obtained when using the simplified planar versions, we observe systematically different wave propagation patterns with enhanced wave heights.
Collectively, our results show the importance of the fault characterization to improve the definition of the tsunamigenic potential of the tectonic structures in the Alboran Basin and provide an example for applications in other areas. Although the new data allow us to better constrain the fault geometry, there are still other important parameters, such as the rake, that have a relatively large associated uncertainty and has an influence on the resulting tsunami model. This is especially important for strike-slip structures, where rake variation of 10° produces wave-height differences of more than 0.5 m at some offshore points that may translate into non-negligible higher differences due to the amplification when reaching the coast.