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Active faulting and earthquakes in the central Alboran Sea

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Central Alboran Sea constitutes a key area to analyze the relationships between active tectonic structures and moderate seismicity. The heterogeneous crustal layered structure and the propagation of the deformation along the fault zones are key features to relate active faults and seismic hazard. The NW-SE oblique convergence between Eurasian and African plates determines the broad band of tectonic deformation and seismicity along the Alboran Sea basin (westernmost Mediterranean). The Betic-Rif Cordilleras are connected through the Gibraltar Arc and surround the Alboran Sea formed by thinned continental crust. This basin is filled since the Neogene by sedimentary and volcanic rocks. Central Alboran Sea is now undergoing shortening and is mainly deformed by a system of conjugated WNW-ESE dextral and NE-SW sinistral faults with recent activity formed by indenter tectonics related to a heterogeneous crustal behavior. In addition a NNW-SSE normal fault set and large ENE-WSW folds deform the central and northern Alboran Sea. These structures support a present-day N160°E maximum compression and orthogonal extension. In this setting, most of the recent seismicity is concentrated along a NNE-SSW zone that extends landward from Campo de Dalias (SE Spain) to Al Hoceima (Morocco). The Campo de Dalias 1993-1994 seismic crisis reached up to magnitudes Mw= 5.3, while the Al Hoceima area was affected by seismic crisis of 1994 (May 26, Mw=5.6) and 2004 (Feb 24, Mw= 6.4). The main active fault related to the 2004 earthquakes, even that it was a vertical NNE-SSW oriented fault and focal depth was 6 km, did not reach the surface probably due to the presence of a mechanically layered crust. The main active surface faults located in Al Hoceima area (the NNE-SSW transtensional sinistral Trougout fault zone) extended northwards towards the NE-SW sinistral Al Idrissi Fault that intersects the Alboran Sea and are connected with the normal NNW-SSE Balanegra Fault zone. Although these active faults determine most of the seismicity of the central Alboran Sea, the seismic crisis that occurred since January 2016, reaching Mw= 6.3 is located in a region westward of Al Idrissi Fault, underlining the relevance of growth of new faults to determine the seismic hazard of the region. Earthquake focal mechanisms support that the main active fault has a NNE-SSW orientation, similar to Al Idrissi Fault zone. Maximum magnitude suggests a surface rupture length of at least 12 km and a subsurface rupture of 20 km. Propagation of a new fault is more efficient to accumulate elastic deformation, and to produce highest magnitude earthquakes than already formed faults. This new fault is connected probably in deep crustal levels with the blind sinistral fault responsible of the 2004 Al Hoceima earthquake. The tsunami hazard of the region should be consequence of both seabottom displacement due to fault activity and co-seismic submarine landslides. The INCRISIS cruise, scheduled by May 2016, will provide evidences of seabottom effects of this seismic crisis.