

Geophysical Research Abstracts
Vol. 15, EGU2013-5799, 2013
EGU General Assembly 2013
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Seismotectonics of the Gulf of Cadiz and Horseshoe Abyssal Plain – active faulting in continental and oceanic mantle

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In the area to the west of the Gibraltar Arc the plate boundary between Africa and Iberia is poorly defined. The deformation in the area is forced by the slow NW-SE convergence of 4 mm/yr between the oceanic domains of Iberia/Eurasia and Africa and is accommodated over a 200 km broad tectonically-active deformation zone. The region, however, is also characterized by large earthquakes and tsunamis, such as the 1969 $M_w=7.9$ Horseshoe Abyssal Plain earthquake and the November 1, 1755 Great Lisbon earthquake with an estimated magnitude of $M_w\sim 8.5$. The exact location of the source of the 1755 Lisbon earthquake is still unknown. Recent work, however, may suggest that the event occurred in the vicinity of the Horseshoe fault, an oblique thrust fault. Further, the area is marked by the presence of compressive structures with a roughly NE-SW orientation and E-W trending, segmented, crustal-scale, strike slip faults that extend from the Gorringe Bank to the Gibraltar arc in the eastern Gulf of Cadiz, which were called “South West Iberian Margin” or SWIM faults. The fault system may mark a developing Eurasia-Africa plate boundary. Two local seismic networks were operated in the area. First, within the framework of TOPOE-EUROPE, a network of 24 ocean bottom seismometers (OBS) monitored the seismicity between January and July 2010 in the northern Gulf of Cadiz to the north of 36°N between $9^\circ 30'\text{W}$ and $\sim 7^\circ\text{W}$. The second network operated between April and October 2012 14OBS in the vicinity of the Horseshoe fault between 10°W to 11°W , and $35^\circ 50'\text{N}$ to $36^\circ 10'\text{N}$. Recordings from the both deployments were supplemented by land stations operated in Portugal and the Gibraltar Arc. The networks provided in the order of 100 locale earthquakes occurring with the networks. In the Gulf of Cadiz, the two largest events of $M_w\sim 3.6$ where thrust faulting events occurring in the vicinity of the Portimao Bank. With a depth of 40-50 km these events, among others, occurred within the continental mantle. Earthquakes in the Horseshoe occurred at even greater depth, at 40-60 km, either in oceanic or unroofed continental mantle. The large source depth observed in the Horseshoe Abyssal plain supports the interpretation that large catastrophic earthquakes, like the Great Lisbon earthquake of 1755, may indeed occur in the area.