Active Subduction as the Driving Force Behind Recent Deformation and Long-Term Seismicity in the Gibraltar – Gulf of Cadiz Region

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The SW Iberia/ NW Morocco region has been the site of strong historical seismicity, most notably the M8.7 Great- Lisbon earthquake of 1 Nov. 1755, (60,000 casualties and a 5-15 m high tsunami). Recent geophysical results reveal an east dipping subduction zone, beneath the Gulf of Cadiz and Gibraltar arc, whose activity remains the subject of debate. Bathymetric data from numerous recent cruises indicate ongoing, widespread deformation as expressed by a fresh, continuous horseshoe shaped deformation front (more than 400 km in length), defining the limit of an elongate accretionary wedge. New high-resolution seismic data across this deformation front, offer evidence of outward vergent thrusting (directed W, NW, and SW). An E-W trending basement high (Coral Patch Ridge) can be seen indenting the deformation front in an asymmetric manner. Analog modeling using granular materials demonstrates how WSW directed tectonic shortening can reproduce this indenter pattern. While regional GPS data confirm an overall NW motion of most Moroccan stations (relative to stable Eurasia) at velocities of 3-4 mm/yr, several stations in the Rif-Betic Alboran region show W to SW motion at velocities ranging from 1-2 to 5-6 mm/yr. The westernmost stations (in particular San Fernando) show the highest velocities. These data require active E-W extension in the W Alboran Sea (confirmed by the current stress field here) and imply W to SW shortening in the Gulf of Cadiz. Together, these data indicate active subduction, with back-arc extension (in the W Alboran Sea) is the driving mechanism for compressional deformation in the Gulf of Cadiz. This supports a subduction fault plane origin as the likely source of the 1755 earthquake. Future research will focus on the activity (surface deformation, GPS displacement vectors, seismicity) of the lateral bounding faults.

Key words: Subduction; seismicity; Gibraltar; Gulf of Cadiz