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The seismogenic zone of Cadiz - Gibraltar subduction and the source of the 1755 Lisbon earthquake and tsunami

E. Thiebot (1) and M.A. Gutscher (1)
(1) CNRS, IUEM, Univ. Bretagne Occidentale, Plouzane, France

The Great Lisbon earthquake of 1755, with an estimated magnitude of 8.7 is the stongest earthquake in European history and killed 60,000 people. It produced a 5-15 m high tsunami, the largest ever recored in the Atlantic Ocean. Recent geophysical results reveal an east dipping subduction zone, beneath the Gulf of Cadiz and Gibraltar arc, with signs of recent activity. As 11 out of the 12 M8.5 earthquakes in the past 100 years occurred in subduction zones, the Cadiz-Gibraltar subduction is a very strong candidate for the 1755 event.

Signs of continued tectonic activity in the accretionary wedge include: numerous active mud volcanoes (indicating active dewatering processes), images of folding and thrusting from high-resolution seismic profiles and the seafloor morphology, which shows a basement high (Coral Patch Ridge) actively indenting the deformation front. The results of deep seismic profiles (multi-channel and OBS) are presented, indicating a shallow eastward dip of the top basement and decollement interfaces in the Gulf of Cadiz. They image the 12-15 km thick accretionary wedge as an eastward thickening unit of low p-wave velocity sediments, overlying thin crust, likely oceanic in nature. These data provide constraints on the 3-D geometry of the subduction fault plane.

Thermal modeling indicates a potential seismogenic zone with a downdip width of 200 km. The absence of instrumentally recorded subduction interface earthquakes suggests a possibly locked zone (like Nankai or Cascadia). Available sedimentological data indicate a recurrence interval of about 1500-2000 yrs for great earthquakes in the Gulf of Cadiz region. This is consistent with a co-seismic slip of 10 m and available data on the subduction velocity of 5-6 mm/yr. Numerical modeling of the 1755 tsunami also suggests a strong contribution from the subduction fault plane.