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Seafloor deformation in the Gulf of Cadiz and GPS data indicate active WSW motion of the Gibraltar arc

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The tectonically complex Nubia - Eurasia plate boundary near Southern Iberia has stimulated competing geodynamic models. Tomographic and deep-seismic data indicate a small east dipping subduction beneath the Gulf of Cadiz and the Gibraltar arc (Betic and Rif mountain belts), but its activity remains the subject of debate.

Bathymetric data from numerous recent cruises can help resolve this question. A fresh, continuous horseshoe shaped deformation front (more than 400 km in length) is observed, defining the limit of an elongate accretionary wedge. New high-resolution seismic data across this deformation front, offer evidence of active W, NW, and SW vergent thrusting here. An E-W trending basement high (Coral Patch Ridge) can be seen indenting the deformation front in an asymmetric manner and offers constraints on the relative motion between the accretionary wedge and the seafloor to the west. This relation is tested by analog modeling using granular materials. The results indicate WSW tectonic shortening, driven by the motion of an arcuate backstop.

Data from permanent GPS stations provide independent evidence on the regional kinematics and indicate an overall NW motion with respect to Iberia, of NW African stations at velocities of 3-4 mm/yr, generally consistent with large-scale plate kinematic models. However, the 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 indicate active E-W extension in the W Alboran Sea and W SW shortening in the Gulf of Cadiz. Together, these data support active subduction, with back-arc extension (in the W Alboran Sea) and compression in the accretionary wedge (in the Gulf of Cadiz).