Active Tectonics of the Western Mediterranean: GPS Evidence for Roll Back of a Delaminated Subcontinental Lithospheric Slab Beneath the Rif Mountains, Morocco

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In the western Mediterranean, the Alboran domain is caught between North Africa and Iberia at the westernmost limit of the Alpine mountain belt (Figure 1). During the Cenozoic, the Alboran domain, along with the Atlas Mountains, grew thicker in this convergent setting. Later during the Miocene, the Alboran domain stretched and subsided below sea level, accumulating more than 7 km of sediment.

Present-day tectonic processes occur within the context of ongoing, ~NW-SE convergence between Africa and Iberia in the Strait of Gibraltar (4.3 ± 0.5 mm/yr at an azimuth of 116 ± 6° from GPS (McClusky et al., 2003)). However, the location of a discrete Africa-Eurasia plate boundary is equivocal, as evidenced by the distributed seismicity.

Surface deformation in Morocco derived from five years of GPS survey observations of a 22-station network, four continuously recording GPS stations, and four International GPS Service (IGS) stations in Iberia indicate roughly southward motion (~3 mm/yr) of the Rif Mountains, Morocco relative to stable Africa (Figure 1). Motion of the Rif is approximately normal to the direction of Africa-Eurasia relative motion, which is predominantly strike slip, and results in shortening of the Rif and subsequent crustal extension of the adjacent Alboran Sea region. The sense, and the N-S asymmetry of the observed deformation (i.e., no evidence for north-directed shortening in the Betic Mountains north of the Alboran Sea) cannot be easily explained in terms of crustal plate interactions suggesting that dynamic processes below the crust are driving the recent geologic evolution of the western Mediterranean. The model that best fits the observations involves delamination and southward roll back of the African lithospheric mantle under the Alboran and Rif domains (Figure 2).

References:

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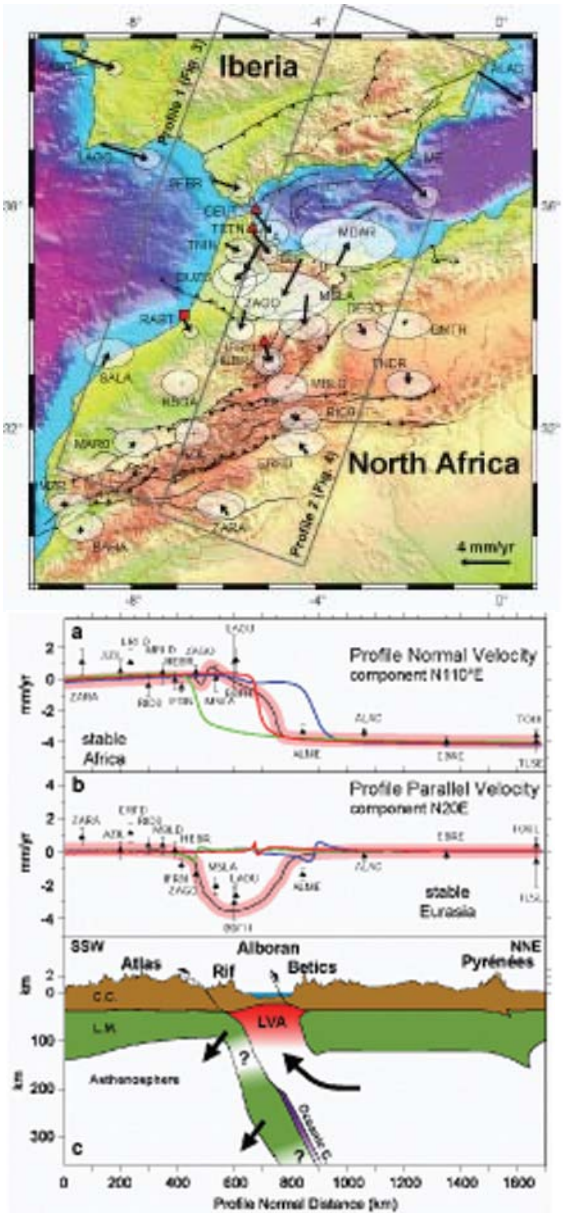

Figure 1. GPS-derived site velocities and 95% confidence ellipses relative to Africa for sites in Morocco and adjacent Iberia. Continuously recording GPS stations in NW Africa indicated by square and triangles.

Figure 2. Profile 2 (eastern profile in Figure 1). a) Component of velocities and 1-sigma uncertainties along the direction of plate motion (normal to profile), b) Component of velocities and 1-sigma uncertainties normal to the direction of plate motion (i.e., parallel to profile). The interseismic deformation predicted by elastic block models is shown for the three main hypothesized plate boundaries (see Fadil et al., 2006 for details). The thick pink line with a thin black line in the center is for a model with a central Rif block as we propose, c) Topography and interpretative cross section along profile. C.C.= continental crust, L.M.= lithospheric mantle. LVA = low velocity and high attenuation anomaly. Oceanic C. = oceanic crust.