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PERIDOTITE BODIES IN THE W MEDITERRANEAN – TECTONIC SLICES IN AN ALPINE BELT FRAGMENTED BY LATE STAGE EXTENSION AND INHERENT SLAB ROLL-BACK

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ABSTRACT

Integrating a wide range of multidisciplinary data, i.a., seismic tomography features, regional tectonic transport directions and uplift/cooling rates, and ages of subduction/collision, lithospheric extension and slab detachment, suggests a new model for the development of the Alpine belt in the W Mediterranean (Fig. 1; Zeck, 1996; 1997; 1999). The model implies that the backbone of the Alpine orogeny was formed by a composite SW-NE striking Betic-Ligurian subduction system, active until some time before 22 Ma (Fig. 1b). The system which consumed Mesozoic Tethyan oceanic lithosphere was W-ward dipping under the leading edge of Iberia which was drifting E-ward under the influence of the opening of the North Atlantic. Subduction activity was terminated by the formation of the Alpine orogenic belt through collision of Iberian and Betic-Ligurian continental lithospheres. A series of late stage extensional regimes, with local formation of Neogene oceanic lithosphere, in the Valencia Gulf, Provençal-Algerian basin and Tyrrhenian basin, and inherent slab roll-back subsequently have fragmented the original collisional belt (Fig. 1c). This has produced the seemingly erratic distribution of Alpine metamorphic core complexes in the western Mediterranean (Fig. 1a).

Peridotite bodies are present in most of these Alpine core complexes: Betic-Rif, Calabria, Corsica and Liguria. The Ronda peridotites in the Betic-Rif belt are among the best known. These bodies outline the Arc of Gibraltar, and were shown to represent tectonic slices of mantle rocks within the major Alpujárride nappe complex. They reached their present position in three stages (Zeck, 1997). The first covers their travel from great mantle depths to crustal levels, in the order of 150-200 km (pseudomorphed diamonds). The second stage covers induction of peridotite slices in the crustal nappe pile of the Betic-Ligurian subduction zone system. Metamorphic conditions within the peridotite and its envelope at this stage are given by mineral parageneses formed at c. 11-15 kbar and 750-850ºC (Tubia, 1994). Overprinting of these HP parageneses by mainly static LP parageneses (7-3 kbar and 750-850ºC; Tubia, 1994) took place during the third and final stage of emplacement which started after cessation of subduction activity and slab break-off, shortly before 22 Ma as indicated by regional cooling rate studies (Zeck, 1996). Slab-break-off caused lateral convective inflow of high-temperature and low-density asthenospheric material into the widening gap above the sinking lithospheric slab. This may have had a triggering effect on the uplift, but first of all created a HT metamorphic/anatectic regime within the overlying Betic lithosphere leading to thermal weakening in the crustal section promoting tectonic extrusion under the influence of compression between the rigid Iberian and African lithospheric plates. At higher levels, secondary extensional tectonic units, some of which contained peridotite slices, were individualized and displaced over distances of 50-200 km. Extremely high uplift/cooling rates (ca. 500ºC/m.y.; Zeck, 1996) characterise this third stage of peridotite emplacement. Directions of extensional tectonic transport were variable – NW-ward for the Sª Bermeja/Alpujata peridotite body, W-ward for the body at Ceuta and SW-ward for that of Beni Bousera – and define a centrifugal pattern radiating from the central part of the Alborán Sea basin (Fig. 1c).

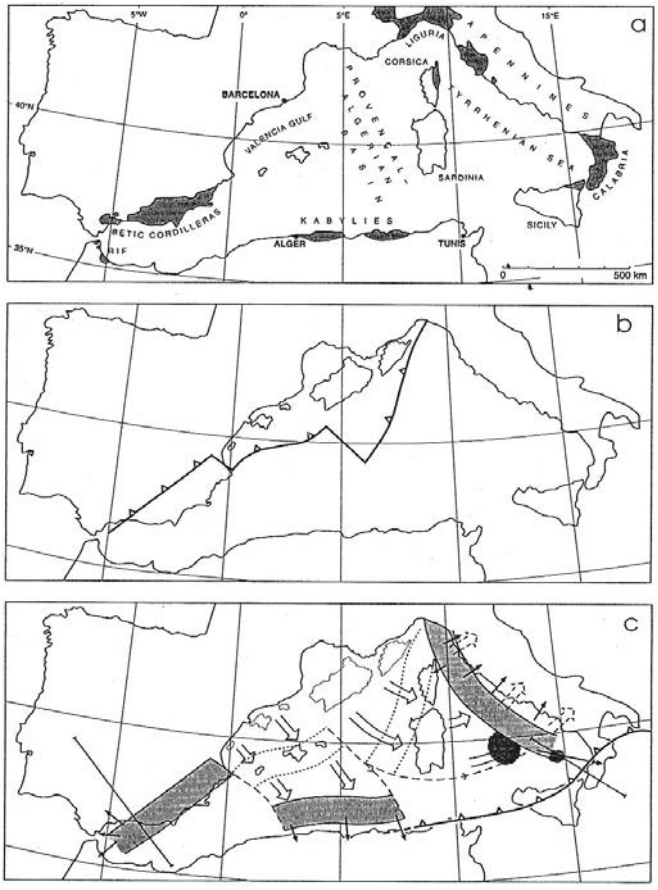

Fig. 1 - From Zeck (1999). Outline of the plate kinematic evolution of the western Mediterranean. (a) Location of metamorphic core complexes (screened) and major geographic entities. (b) Final stage of subduction with Iberian plate colliding with continental Betic-Ligurian lithosphere after Mesozoic oceanic Tethyan lithosphere had been subducted W-wards under E-ward drifting Iberia. The subduction system did not form a smooth, continuous belt; three segments of active subduction were separated by two transform fault zones. (c) Miocene stage of extensional regimes with slab roll-back and local slab detachment involving opening of the Gulf of Valencia, the Provençal-Algerian basin and Tyrrhenian basin, but prior to the latest stage extension in the southern Tyrrhenian basin (Vavilov and Marsili oceanic basins in dark shading) which translated the slab further east (hatched double arrows) towards its present position and assisted in the final emplacement of the Calabria core complex, overriding the E-W trending subduction system (hinge line in bold) accommodating major N-S Europe-Africa convergence.

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