California State University, Fresno
College of Science & Mathematics
Earth & Environmental Science Seminar
Wednesday, February 7, 2006 - 5:00 - 6:00 PM
Smittcamp Alumni House
Relaxed Parking: Lot V 4:30 – 7:00 PM (Shaw & Woodrow Ave)
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Kinematics of an arcuate orogen: the Betic-Rif arc and the Alboran back-arc basin, western Mediterranean

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The Betic-Rif arc is one of the tightest arcs on Earth, and it surrounds an extensional back-arc basin that formed coevally with the arc. The arc comprises a thin-skinned external fold and thrust belt of Miocene age, which formed around the periphery of the exotic Alboran Domain as it moved relatively westwards between the converging African and Iberian plates. The Alboran Domain includes the remains of a Paleogene contractional orogen that underwent extensional collapse coevally with the formation of the thrust belt. Restoration of structural sections, together with kinematic and paleomagnetic analysis, shows that the Alboran Domain moved ~ 250 km W relative to Iberia and Africa during the Miocene. The convergence direction on the Iberian side was between 310° and 295°, and on the African between 235° and 215°: the difference reflects Africa-Iberia relative motion. Extension of the Alboran Domain during westward motion modified the geometry of the arc: additional components of displacement were transferred into the external thrust belt along a series of strike-slip shear zones, which allowed the limbs of the arc to rotate, extend and tighten, and created variations in the amounts and directions of shortening. The northern limb of the arc rotated clockwise by 25° during this process, and the southern limb rotated counterclockwise by about 55°. Oblique convergence on the limbs resulted in additional vertical-axis rotations of thrust sheets as they formed.

Miocene extension of the Alboran Domain thinned an pre-existing accretionary orogen as much as 50 km thick to between 5 and 10 km thickness, creating a stack of extensional allochthons separated by NE-directed sub-horizontal detachment faults. Extension was so extreme that the sub-continental mantle was locally exposed. Overlying crustal rocks show an apparently coherent metamorphic zonation from high-pressure granulite facies rocks at the peridotite contact to unmetamorphosed rocks 5 km higher in the structural sequence. PT paths from the peridotite and its crustal envelope indicate decompression with increasing temperature to shallow depths, and thermochronological data reveal that cooling was extremely rapid in the interval 21.2-20.4 Ma. Thermal modeling suggests that an asthenospheric heat source at an initial depth of about 70 km is required to explain

heating during exhumation, which may therefore have been triggered by the removal of most of the lithospheric mantle beneath the orogen.

Subduction of the leading edge of the Iberian margin beneath the advancing edge of the Alboran Domain caused eclogite-facies metamorphism at about 17 Ma. Rapid exhumation, completed by 10 Ma, created a large metamorphic dome beneath the previously extended and now overthrust Alboran Domain, bounded by an extensional detachment with predominantly W-directed shear sense.