Geophysical Research Abstracts, Vol. 7, 09614, 2005
SRef-ID: 1607-7962/gra/EGU05-A-09614

P-T-ε-t retrograde evolution of the Nevado-Filabride complex (Eastern Betics, SE Spain): New insights from in-situ ^{40}Ar/^{39}Ar ages and metamorphic petrology

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The mechanisms and processes by which deep-seated metamorphic rocks of highly extended back arc terrains were transported to the surface, such as Betic Cordillera domes, are still debated (Platt & Vissers, 1989; Lonergan & White, 1997; Martínez-Martínez *et al.*, 2004). In particular, extensional structures alone cannot discriminate between syn- or post-orogenic settings (or both). In order to do so, continuous P-T paths relying on blastesis-deformation relationships (Parra *et al.*, 2001, 2002) must be obtained for samples related to the main exhumation shear zones (e.g. Lister *et al.*, 1984; Jolivet *et al.*, 1994, 1998; Parra *et al.*, 2001, 2002). Texturally controlled *in situ* dating of minerals can then provide the crucial link between ages and textures with high spatial resolution as proposed by Muller (2003). The aim of this paper is to present such an integrated pressure-temperature-deformation-time (P-T-ε-t) approach for the Betic Cordillera domes.

The combination of metamorphic petrology tools and *in situ* laser ^{40}Ar/^{39}Ar dating on phengite (linking time of growth, composition and P-T conditions) enables us to propose a detailed P-T-ε-t path for the still debated tectonometamorphic evolution of the Nevado-Filabride complex (Betic Cordillera, SE Spain). The data show a first isothermal decompression (at c. 550°C) from 20 kbar for the Bédar-Macael unit and 14 kbar for the Calar Alto unit down to approximately 3 kbar for both units at 2.8 mm.yr^{-1}. This first part of the exhumation is followed by a final exhumation at 0.6 mm.yr^{-1}along a HT-LP gradient of $\sim$60°C.km^{-1}. Radiometric ages show that the change from isothermal exhumation to cooling occurred some 18 Myrs ago. The age of the peak of pressure (D1 deformation stage) is not precisely known but we show that it has to be around 30 Ma and possibly older; which is at variance with recent models suggesting a younger age for HP metamorphism.

A large part of the final exhumation is related to late-orogenic extension and the formation of large-scale detachments. The formation of the main ductile extensional shear zone occurred from 18 Ma (D2 deformation stage), and the transition from ductile to brittle shear along the same detachment occurred from 18 Ma to 14 Ma (D3 deformation stage). D2 deformation becomes clearly associated with a top-to-the-west shear sense once the shear zone is well localised, which corresponds to the cluster of ages around 22-18 Ma. The final exhumation, accommodated by brittle deformation, occurred from 14 to 9 Ma and was accompanied from 12 to 8 Ma by the formation of nearby extensional basins (D4 deformation stage).

The duration of the extensional process is approximately 20 Myrs which pleads in favour of progressive slab retreat from $\sim$30 to 8 Ma rather than instantaneous convective removal of thickened crust at 20 Ma. The change in the shape of the P-T path at 22-18 Ma together with the localisation of the main top-to-the-west shear zone suggest that this date corresponds to a change in the direction of slab retreat from southward to westward and to the tearing of the slab suggested by several authors.

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