Geophysical Research Abstracts,
Vol. 10, EGU2008-A-03319, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-03319
EGU General Assembly 2008

Mantle ductile deformation beneath a continental rift: insight from the structural study of the Ronda massif (southern Spain)

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The Ronda peridotites are one of the largest subcontinental mantle exposures in Europe and belong to the Alpujarride nappe complex in the internal Betic (Southern Spain). After an Eocene HP/LT nappe stacking, this complex has suffered a strong extension-related thinning at the Oligocene/Early Miocene time, as well exampled through the Jubrique crustal unit in the western Betic. However, previous structural studies through the Ronda peridotites, which underlie the Jubrique unit, have only attributed their ductile deformations to Oligocene/Miocene compressional events. As a consequence, the ductile history of the Ronda peridotites remains controversial. A structural study was then carried out through the Ronda peridotites and these following tectonic stages were discerned: 1) the formation in the Spinel pressure conditions of a kilometre-scale strain gradient; 2) a partial melting that erases statically a part of this latter; and 3) a newly formed plagioclase-bearing foliation that affects a part of the melted domain. These three stages occur thus during decompression of the peridotites. A subsequent stage 4) is then characterised by the formation of thrusts that cross-cut and fold the plagioclase-bearing foliation. Both the partial melting of the crust just below peridotites and the intrusion of granite dykes occur also during this stage. We proposed therefore the following tectonic history: 1) a narrow continental rift that forms a lithosphere-scale shear zone, along which the Ronda peridotites are unroofed from 70 to about 20 km; 2) an extension-coeval transient uplift of hot asthenosphere that promotes a static partial melting in the core of the rift; and 3) a thermal relaxation

that promotes a strong downward cooling, which isolates a strongly cooled and undeformed Spinel-bearing domain, while the still active syn-rifting deformation affects the hotter domain during plagioclase appearing. The extension occurring during these three events leads to a strong thinning of the lithosphere, which is consistent with the thinned Jubrique crust on top of the Ronda peridotites. Finally, the last tectonic event is 4) a rift inversion, which stacks the much thinned lithosphere according to major thrusts and inserts some still hot peridotite lenses that melt the uppermost underlying crust at 21 Ma. All ductile structures encountered through the Ronda peridotite massif may be therefore related to a narrow continental rift, which occurs during the extensive geodynamic of the Alboran region at the Oligocene/early Miocene time.