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Using nanogranite and glassy inclusions to unravel anatexis in the crustal footwall of the Ronda peridotites (Betic Cordillera, S Spain)

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The application of melt inclusion (MI) studies to migmatites and granulites is a recent, small-scale approach to a better understanding of melting in the continental crust [1]. Being trapped by growing peritectic phases at suprasolidus conditions, these MI represent a window into the pre-peak anatectic history of partially melted terranes, and may provide a wealth of microstructural and compositional information on crustal anatexis [2, 3, 4]. The crustal footwall of the Ronda peridotites consists of an inverted metamorphic sequence with migmatites and mylonites at the top. Mylonites represent strongly deformed former diatexites. To shed light on the nature and mechanisms of melting in the migmatites of the Ojén traverse, a detailed microstructural and geochemical study has been conducted on primary 2-10 μm MI hosted in peritectic garnet of i) metatexites at the bottom of the migmatitic sequence and ii) mylonitic former diatexites close to the contact with the mantle rocks. Both metatexites and mylonites have compositions corresponding to peraluminous greywackes. Phase equilibria modeling shows P–T conditions of equilibration of 4.5–5 kbar and 660–700 °C, and of 820-830 °C and 5.5-6.0 kbar for metatexites and mylonites, respectively. Clusters of MI in the metatexites are rounded and preferentially located at the core of small garnet crystals, whereas these clusters may have a sigmoidal to spiral-like shape in garnets of mylonites. MI show a variable degree of crystallization ranging from totally glassy to fully crystallized (i.e. nanogranites), consisting of Qtz+Pl+Kfs+Bt+Ms aggregates (often modal Kfs > Pl in mylonites). Piston cylinder remelting experiments led to the complete rehomogenization of nanogranites in metatexites at the conditions inferred for anatexis: 700 °C and 5 kbar. Rehomogenized nanogranites in metatexites and glassy MI in mylonites are all leucogranitic, although generally plot away from minimum melt compositions. Systematic compositional variations have been observed between MI in metatexites and mylonites. MI in metatexites show higher amounts of H_2O and Na2O/K2O ratios, lower FeO content, and higher concentrations of those trace elements controlled by feldspars: Sr, Ba. MI in mylonites have higher concentrations of trace elements controlled by Bt (Cs, Rb and FRTE e.g. Zn, Sc) and accessory minerals (HFSE e.g. Zr, U, Th, and LREE). The compositions of MI in metatexites and mylonites are interpreted to record the composition of the anatectic melts produced from a peraluminous greywacke 1) on, and immediately after crossing, the fluid-saturated solidus of this metasedimentary rock, and 2) during syn-kinematic anatexis via biotite dehydration melting at increasing temperature, respectively.

[1] Cesare et al. (2009) Geology, 37, 627-630. [2] Bartoli et al. (2013) Geology, 41, 115-118. [3] Bartoli et al. (2014) EPSL, 395, 281-290. [4] Acosta-Vigil et al. (2010) JPetrol 51, 785-821.