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H_2O contents of granitic melts produced at the onset of crustal anatexis: constraints from experimental re-melting of nanogranite inclusions in garnet from Ronda migmatites (S Spain)

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Crustal anatexis and melt extraction produce S-type granitic magmas in the upper crust and granitic leucosomes in migmatites, promoting the chemical differentiation of the continental crust and affecting its rheology. H_2O plays a significant role during anatexis, constraining melting conditions and reactions, as well as granitic magma production, composition and migration (Sawyer et al., 2011). Despite the significance of crustal anatexis for the evolution of the Earth, to date there are no available methods to directly analyse the chemical composition, including the nature and concentration of the dissolved volatile species, of natural anatectic melts, particularly at the onset of crustal anatexis.

Here, using a novel and cutting edge approach in crustal petrology [the study of nanogranites in migmatites; Cesare et al., 2011; Ferrero et al., 2012] and taking advantage of a new experimental method for their re-melting, we demonstrate that it is possible to directly determine the H_2O content of granitic melts during their formation in the source region, rather than after the magmas have separated from its source.

We use as an example a migmatite from the Betic Cordillera (S Spain). Piston cylinder re-melting experiments led to the complete re-homogenization of nanogranites hosted in peritectic garnet at conditions (700 °C, 5 kbar) close to those inferred for anatexis, maintaining the original fluid concentration in the melt. After re-melting and quenching, glasses have been analysed by Raman spectroscopy, providing the primary H_2O content of the earliest melts produced in the migmatites. Our data indicate that S-type granites produced at Ronda are mainly H_2O-undersaturated even at low degree of melting and suggest that peraluminous leucogranitic melts formed at low temperature (~700 °C) may not be as wet and of low viscosity as previously considered, implying much greater rock strength and much longer timescales for melt extraction at Ronda and, in general, through the metasedimentary continental crust.

Cesare et al. (2011): Journal of Virtual Explorer, 38, paper 2; Ferrero et al. (2012): Journal of Metamorphic Geology, 30, 303-322; Sawyer et al. (2011): Elements, 7/4, 229-233.