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The H_2O content of granite embryos

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Quantification of H_2O contents of natural granites has been an on-going challenge owing to the extremely fugitive character of H_2O during cooling and ascent of melts and magmas. Here we approach this problem by studying granites in their source region (i.e. the partially melted continental crust) and we present the first NanoSIMS analyses of anatectic melt inclusions (MI) hosted in peritectic phases of migmatites and granulites. These MI which totally crystallized upon slow cooling represent the embryos of the upper-crustal granites [1, 2, 3]. The approach based on the combination of MI and NanoSIMS has been here tested on amphibolite-facies migmatites at Ronda (S Spain) that underwent fluid-present to fluid-absent melting at $\sim$700 °C and $\sim$5 kbar. Small ($\leq 5\ \mu$m) crystallized MI trapped in garnet have been remelted using a piston-cylinder apparatus and they show leucogranitic compositions. We measure high and variable H_2O contents (mean of 6.5 ± 1.4 wt%) in these low-temperature, low-pressure granitic melts. We demonstrate that, when the entire population from the same host is considered, MI reveal the H_2O content of melt in the specific volume of rock where the host garnet grew. Mean H_2O values for the MI in different host crystals range from 5.4 to 9.1 wt%. This range is in rather good agreement with experimental models for granitic melts at the inferred P-T conditions. Our study documents for the first time the occurrence of H_2O heterogeneities in natural granitic melts at the source region [3]. These heterogeneities are interpreted to reflect the birth of granitic melts under conditions of "mosaic" equilibrium, where the distinct fractions of melt experience different buffering assemblages at the micro-scale, with concomitant differences in melt H_2O content. These results confirm the need for small-scale geochemical studies on natural samples to improve our quantitative understanding of crustal melting and granite formation. The same approach adopted here can be applied to MI hosted in higher-temperature, granulite-facies rocks that represent the parents of many upper-crustal granites. This will result in a better understanding of formation and evolution of granitic magmas.

[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.