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Evidence of unadulterated mantle-depth, granitic melt inclusions: kumdykolite and kokchetavite crystallized from melt in Bohemian Massif granulites.

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Partial melting under near-UHP conditions of metagranitoids (now HP felsic granulites) at mantle depth in the Orlica-Śnieżnik Dome (Bohemian Massif, Poland) is recorded in small volumes of hydrous melt trapped as primary melt inclusions (MI) in peritectic garnets. When free of cracks connecting the inclusion with the leucocratic matrix, these "nanogranites" ($\leq 50\mu$m inclusion diameter) contain a unique assemblage including kumdykolite, kokchetavite and cristobalite – polymorphs of albite, K-feldspar and quartz, respectively. These usually metastable phases crystallized from the melt (glass?) during rapid exhumation (cm/a) at high T but the crack-free state strongly suggests over-pressuring of the inclusion with respect to the pressure-time path followed by the matrix.
Reports of both kumdykolite and kokchetavite have been mainly from natural rocks equilibrated in the diamond stability field. The precise calculation of the PT path of the MI on cooling and the comparison with previous studies suggests, however, that pressure is not influential to their formation, ruling out the possible interpretation of kumdykolite and kokchetavite as indicators of ultra-high pressure conditions. Experimental re-homogenization of these crack-free nanogranites was achieved using a piston cylinder apparatus at 2.7 GPa and 875°C. These conditions are consistent with the results of geothermobarometric calculations on the host rock, suggesting that no H_2O loss occurred during exhumation as this would have caused a shift of the inclusion melting T toward higher values. Coupled with the absence of H_2O-loss microstructural evidence, e.g. decrepitation cracks and/or vesciculation in re-homogenized nanogranites, this evidence suggests that the nanogranites still preserve the original H_2O content of the melt.
Both experimental and microstructural evidence support the hypothesis that the presence of these polymorphs should be regarded as direct mineralogical criterion to identify former melt inclusions with preserved composition, including H_2O and CO_2 contents, and to infer rapid cooling of the host rocks. Thus the present study provides novel criteria for the interpretation of fluid/melt inclusions in natural rocks, and allows a more rigorous characterization of the nature of metamorphic fluids during deep subduction and their behavior on exhumation.