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Kumdykolite, kokchetavite, and cristobalite crystallized in nanogranites from felsic granulites, Orlica–Snieznik Dome (Bohemian Massif): not an evidence for ultrahigh-pressure conditions

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Processes such as fractionation during crystallisation or interaction with younger magmas are commonplace in partially molten rocks, thus the compositions of silicate melts in high grade metamorphic rocks are notoriously difficult to ascertain. These processes change phase chemistry and proportions and therefore hinder reliable use of standard thermobarometric and petrological modelling tools for such rocks. For this reason, tiny remnants of melt trapped in peritectic phases growing during the melting process, nanogranites, have become an important source of information about unadulterated melt compositions. Typically, granitic melts form in rocks of the continental crust at pressures below 1 GPa. However, it has become increasingly recognised that broadly granitic continental crust can also undergo melting during subduction to depths where pressures of >3GPa prevail and where coesite or even diamond are stable phases. Geodynamically, the subduction of continental crust is countered by buoyancy of the upper crust, even when completely transformed to denser, high-pressure minerals. However, the coherence of the down-going plate and the transition between subducton and exhumation appears to be linked to the initiation of melting, and thus weakening of the upper crust allowing it to separate from denser lower crust and lithospheric mantle that can be further subducted. An unusual ultrahigh pressure terrane with deeply subducted granite rocks is the Variscan belt of Europe [1,2]. Here, felsic type-locality granulites are actually eclogite facies rocks incorporating bodies of mantle garnet peridotite and diamond-bearing gneisses. Spectacular evidence for partial melting under near-UHP conditions [3] occurs in the form of primary melt inclusions (MI) in peritectic garnets of metagranitoids from the Orlica–Śnieżnik Dome (Bohemian Massif, Poland). Some melt inclusions exhibit cracks linking them to the matrix and have clearly been modified. However, one type of smaller (≤ 50µm inclusion diameter), crack-free inclusions contains a unique assemblage [4] including kumdykolite, kokchetavite and cristobalite, polymorphs of albite, K-feldspar and quartz, respectively, along with remnants of glass (still preserving a measurable water content). Experimental re-homogenization of these crack-free nanogranites was achieved using a piston cylinder apparatus at 2.7 GPa and 875°C. The rare phases kumdykolite and kokchetavite were originally described from rocks of the world's first documented microdiamond-rich UHP terrane, the Kokchetav Massif in Kazakhstan

(Kumdy Kol being one of the locations), and other reports are predominantly from known microdiamond-bearing complexes. We interpret the occurrence of these metastable phases to result from crystallisation from melt in crack-free inclusions experiencing pressures deviating considerably from those of the host rock (i.e. overpressure) during exhumation i.e. they are not UHP phases. This pressure effect of a rigid garnet host following a decompression path is the same as that responsible also for preserving coesite in eclogites of the same massif [5]. More importantly, however, the survival of these unusual polymorphs and the remnant water-bearing glass are extremely strong evidence for the preservation of a primary, unadulterated melt composition: something that is generally difficult to demonstrate in a standard melt inclusion.

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