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High-pressure, halogen-bearing melt preserved in ultrahigh-temperature felsic granulites of the Central Maine Terrane, Connecticut (U.S.A.)

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Abstract

Inclusions of relic high-pressure melts provide crucial information on the fate of crustal rocks in the deep roots of orogens during collision and crustal thickening, including at extreme temperature conditions exceeding 1000 °C. However, discoveries of high-pressure melt inclusions are still a relative rarity among case studies of inclusions in metamorphic minerals. Here we present the results of experimental and microchemical investigations of nanogranitoids in garnets from the felsic granulites of the Central Maine Terrane (Connecticut, U.S.A.). Their successful experimental re-homogenization at ~2 GPa confirms that they originally were trapped portions of deep melts and makes them the first direct evidence of high pressure during peak metamorphism and melting for these felsic granulites. The trapped melt has a hydrous, granitic, and peraluminous character typical of crustal melts from metapelites. This melt is higher in mafic components (FeO and MgO) than most of the nanogranitoids investigated previously, likely the result of the extreme melting temperatures—well above 1000 °C. This is the first natural evidence of the positive correlation between temperature and mafic character of the melt; a trend previously supported only by experimental evidence. Moreover, it poses a severe caveat against the common assumption that partial melts from metasediments at depth are always leucogranitic in composition.

NanoSIMS measurement on re-homogenized inclusions show significant amounts of CO_2, Cl, and F. Halogen abundance in the melt is considered to be a proxy for the presence of brines (strongly saline fluids) at depth. Brines are known to shift the melting temperatures of the system toward higher values and may have been responsible for delaying melt production via biotite dehydration melting until these rocks reached extreme temperatures of more than 1000 °C, rather than 800–850 °C as commonly observed for these reactions.

Keywords: High-pressure granulites, anatexis, nanogranitoids, carbon, halogens, piston cylinder; High-Grade Metamorphism, Anatexis, and Granite Magmatism