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Preserved anatectic melt in ultrahigh-temperature (or high pressure?) felsic granulites, Connecticut, US

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Polycrystalline inclusions occur in felsic granulites from northeastern Connecticut, US (Axler and Ague, 2015). They sit in the core of garnet porphyroblasts formed during peak metamorphism at T >1000°C and P >1 GPa. The investigated inclusions vary from needle-shaped, with length ≤50 microns and few microns across, to isometric with diameter ≤10 microns. They show a rather constant assemblage which includes quartz, phlogopite, biotite and very often a compositionally variable phase. Raman spectroscopy shows the occasional presence of glass and cristobalite (the latter only when quartz is absent). Crystallized phases and the presence of glass suggest that these inclusions formed originally as droplets of melt trapped during garnet growth, likely as result of partial melting of the original metasedimentary protolith. A prominent feature of the garnet is the presence of rutile needles and ilmenite oriented accordingly to the crystallographic planes of garnet. When elongated in shape, also the polycrystalline inclusions are generally oriented according to the same planes, and occasionally contain rutile and /or ilmenite occur as trapped phases.

Re-heating experiments were performed on the polycrystalline inclusions using a piston cylinder apparatus and without adding water to the experimental capsules. Complete re-homogenization was achieved at T 1025-1050°C and P ∼1.7 GPa, confirming that these inclusions are nanogranites (Ferrero et al., 2015). Re-homogenized inclusions contain a peraluminous glass (ASI=1.36) with ≤6 wt% water, confirmed also via Raman spectroscopy. Its average composition is granitic, with K/Na= 4.37 and rather high FeO (3.70 wt%). Both K-rich character and FeO content are consistent with experimental melts generated at T of 900-1000°C and variable P via melting of metasediments.

The investigation of the experimental products furthermore provides novel constraints for the peak conditions (and likely of anatexis) of these granulites. During experiments performed at T 1025-1050°C and P <1.7 GPa melt and garnet interacts forming a new garnet with different composition, thus indicating lack of equilibrium between melt and garnet. Such microstructure is absent in the experiment at P ≥1.7 GPa, suggesting that such P values correspond to the conditions of melting with the simultaneous production of melt and garnet. Such values are more consistent with the water content of re-homogenized inclusions, rather high for melts formed at T>1000°C. Such pressures are remarkably higher than those previously proposed for these rocks, and suggest that they experienced indeed high pressure rather than ultrahigh temperature conditions, a possibility also supported by the widespread presence of pseudomorphs of sillimanite after kyanite.

References

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