Mineral growth and metastability phenomena in melt inclusions from metamorphic rocks

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Small portions of pristine melt with diameters of 2 to 50μm are being increasingly recognized as a rather common occurrence in high-grade garnet from high-grade metamorphic terranes. Studying them delivers crucial chemical information on anatectic melts at depth. Also, they are unique "natural experimental charges" where the behaviour of the silicate melt can be investigated, directly in the natural rocks, under P-T-t conditions which cannot be completely reproduced in the laboratory. Every nanogranitoid case study has consistently shown a H_2O-bearing, silica and alkali-rich melt. However, within the inclusions the melt behaviour on cooling is rather surprising as it shows clear evidence of metastability phenomena commonly ascribed to rapid cooling, a phenomenon not recognized in the metamorphic rocks in which they occur.

Different volumes of identical melt in the same mineral may either crystallize completely or remain partially or completely glassy despite having experienced exactly the same slow cooling path. This is possibly the result of the fact that fluids in small pores can maintain higher threshold supersaturation, up to the point that melt crystallization may be completely inhibited. Even when crystallized, the phase assemblage of these tiny granitoid plutons is often very unusual and appears metastable. Quartz and feldspars are commonly absent and instead cristobalite and/or trydimite substitute for quartz, and kumdykolite and kokchetavite for plagioclase and K-feldspar, respectively. These metastable polymorphs crystallize directly from the melt on cooling, independent of the internal P of the inclusions and from the conditions of melt entrapment. They are probably the result of rapid crystallization due to undercooling of the trapped melt, once again a consequence of the peculiar supersaturated conditions achieved on cooling by a confined melt.