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Carbonatitic melt inclusions in peritectic garnet from the Carlos Chagas batholith: Implications for crustal melting in the Araçuaí orogen, Brazil

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Crustal differentiation is an important process for the production and stabilization of the continental crust. Orogenic events drive crustal differentiation by introducing fertile material for the production of granitic magma into the deep crust. Partial melting (> 800 °C) produces granitic magmas by fluid-absent melting reactions involving the breakdown of micas and amphiboles. Such reactions produce peritectic phases that can trap primary melt inclusions during their growth. The investigation of preserved melt inclusions within peritectic phases provides an excellent opportunity for better understanding of the crustal recycling processes during an orogeny. We report the presence of melt inclusions in garnet from the polymetamorphic Carlos Chagas batholith (CCB), which is a very large body (covering 14,000 km^2) of peraluminous, S-type granite formed during the collisional stage (ca. 585–545 Ma) of the Araçuaí orogeny (ca. 630–480 Ma). The CCB contains large garnet porphyroblasts (5–35 mm), which present numerous inclusions (40–380 μm) of rounded high-Ti biotite, lobate and rounded quartz as well as the accessory minerals ilmenite, rutile, apatite, zircon and monazite. These garnet crystals are the product of fluid-absent incongruent melting of biotite, which also resulted in a significant volume of granitic melt, which has been lost from the system, thereby preserving the peritectic garnet. Phase equilibrium modelling of the garnet-bearing assemblage via Theriak Domino indicates peak metamorphic conditions of 790–820 °C and 9.5–10.5 kbar, i.e. depth of approximately 30 km. For the first time, polyphase inclusions of calcite and rutile have been identified in the peritectic garnet crystals of the CCB.

These inclusions are small (80–180 μm), have a sub-circular shape, low angle terminations and are dark-coloured in transmitted light. Microcracks frequently occur in the garnet crystals, but some polycrystalline inclusions appear to have no association with cracks. Investigation via SEM demonstrated that calcite locally presents euhedral internal faces and rutile occurs commonly as subhedral aggregates or as single crystals surrounded by calcite. This microstructural evidence is interpreted to reflect primary Ti-rich carbonatitic melt trapped as inclusions during peritectic garnet growth. In addition, pseudomorphed granitic melt films are represented by quartz and plagioclase developed along the boundaries of both garnet and euhedral rutile crystals in the matrix, and attest to the presence of the granitic melt produced by biotite incongruent melting during the growth of garnet and rutile.

In combination, this evidence from the CCB appears to record the coexistence of immiscible silicate and carbonate melts during fluid-absent melting of biotite. The carbonate melt is interpreted to reflect anataxis of a carbonate fraction within the metasediments, possibly originating as a carbonate cement between grains in the protolith. In addition, the P–T conditions estimated in this study are in agreement with the findings of re-homogenization experiments for calcite-bearing inclusions hosted in peritetic garnet of migmatites from Oberpfalz [1].

Reference:

[1] Ferrero S et al. (2016) In: *35th International Geological Congress*, abstract