Partial melting of ultramafic granulites from Dronning Maud Land, Antarctica: melt inclusions and thermodynamic modelling

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In the Pan-African belt of the Dronning Maud Land, crystallized melt inclusions (MI) occur in garnet from ultramafic granulites hosted in orthogneisses of the Conrad-gebirge. The granulites contain the peak assemblage Amp_1+Grt+Cpx with rare relict Opx, and retrograde Pl+Spl+Opx+Amp_2±Ol±Bt symplectites at contacts between Grt and Amp_1. Garnet contains two generations of MI. $Type_1$ MI are primary, isolated, <10-μm in size, and generally with negative crystal shape. They contain Kml, Kok and Phl, with Qz and Zo as minor phases; glass was identified in one single inclusion. $Type_2$ MI are up to 30 μm, pseudosecondary, and contain Amp, Felds, Zo, minor Mgs, Hl and Opx. A CO_2-rich fluid may be present in $Type_2$ MI.

MI were re-homogenized after heating for 24 h in a piston cylinder at 950°C, 15–24 kbar. The composition of $Type_1$ MI is trachytic with c. 68 wt.% SiO_2, 17–18 wt.% Al_2O_3, K/Na = 3.55 and $H_2O \approx 2.5$ wt.%; Type2 MI are dacitic with K/Na= 0.56 and $H_2O \approx 12$ wt.%.

Thermodynamic modelling of the ultramafite composition in the NCKFMMnASHTO system shows that the peak assemblage Hbl+Grt+Cpx+melt±Bt±Rt, inferred from petrography, is stable at c. 15 kbar and 850–900 °C, and that at these conditions the modelled melt composition is felsic, K-rich and quite similar to that analyzed in $Type_1$ MI.

The thermodynamic modelling, combined with the MI study, supports the interpretation that both melt and garnet are products of the anatexis of the ultramafic boudins at peak conditions, most likely through amphibole and biotite fluid-absent melting, and that the $Type_1$ MI contain the anatectic melt that was present during garnet growth.

The high-silica, K-rich melt composition of $Type_1$ MI, unexpected in an ultramafic source rock, can be explained by the participation of biotite and amphibole as reactants in the melting reaction, and by low melting degrees.