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Melting of metapelitic Rocks at ultrahigh Pressure

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Diamondiferous quartzofeldspathic (DQF) rocks, occurring in the Paleozoic complexes of the Kokchetav Massif and the Saxonian Erzgebirge, were originally metapelitic rocks. These rocks were deeply buried either by subduction or by delamination of the lithosphere. At ultrahigh pressure Ca-poor DQF rocks consisted of coesite+kyanite+garnet+Na-clinopyroxene+phengite($\pm$K-feldspar) and were nearly as dense as garnet peridotites. The heating of these rocks during burial caused melting. During ascent and cooling of the melt significant amounts of garnet first crystallized.

In order to better understand the processes of melting and crystallization of such rocks, thermodynamic calculations were undertaken with PERPLE_X (Conolly, 2005) in the system Na_2O-CaO-K_2O-FeO-MgO-Al_2O_3-SiO_2-H_2O. The data set by Holland and Powell (2002) including activity models for the above phases and melt (White et al., 2001) were used to finally obtain contoured P-T pseudosections. In the absence of a hydrous fluid, phengite(+jadeite+coesite) decomposes to form melt+garnet+K-feldspar+kyanite (5 GPa: $\sim$ 1000°C due to experiments; the used thermodynamic data overestimate the melting T). The formed melt is rich in silica and K_2O ($>$ 8 wt.%). With rising T, K-feldspar, clinopyroxene, coesite, and finally (kyanite+) garnet disappear. The melt approaches a granodioritic composition. A melting interval of about 350°C was calculated to form a melt from which 50 % of the total garnet in the DQF rocks can crystallize later. Thus, the maximum T for the DQF rocks of the Erzgebirge (1200°C) and Kokchetav Massif (1150°C) estimated by Massonne (2003) are probably too low. However, the chemical zonation of garnet (e.g., relatively Ca-rich core = restite, Ca-poor mantle crystallized from melt) results, in principle, from the thermodynamic calculations as well. Calculated densities show that a significant melting interval is also required to produce a melt mash with a sufficiently low density allowing ascent.