



Carbonated pelites in the upper mantle (8-22 GPa)

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Recycling of crustal materials into the mantle occurs through two different subduction related processes: first, the subducting oceanic crust devolatilizes at least partly, produces a mobile phase (a fluid, melt or supercritical liquid, Kessel et al. 2005) and thus loses part of its main and trace element inventory to the mantle wedge. Whatever has then been spared and left behind, will ultimately mix into the mantle at larger depths. Such mantle heterogeneities are commonly classified by their Pb, Nd, Sr, and Hf isotopy and the so-called EM-I mantle type has an important component of recycled oceanic sediments (Eisele et al. 2002, Stracke et al. 2005, Turner and Foden 2001).

The purpose of this study is, to investigate the composition of melts from dehydrated but not decarbonated pelites at pressures beyond subarc depths. While dehydration at low temperatures may remove all H₂O from a carbonated pelite, carbonate minerals and K-hollandite remain stable and will dominate the fluid-absent melting reaction at high pressures. Such melts are expected to be potassium and carbonate rich and have K₂O >> Na₂O at 3-5 GPa (Thomsen and Schmidt, 2008). When rising into the mantle wedge, they react with the peridotite creating K-metasomatized zones as are at the origin of ultrapotassic magmas (Foley, 1992).

Two isobaric series of experiments at 8 and 13 GPa have been completed on a dry bulk composition and on one with 1 wt% H₂O added. Both sections are similar and produce carbonatite melts first, contrasting the melting behaviour at ≤ 5 GPa where silicate melting occurs before carbonate melting (Thomsen and Schmidt, 2008). At 8 GPa, Ca-carbonate and magnesite coexist at T < 1000°C, but form dolomite at higher temperatures. K-hollandite is present in the dry, phengite in the 1 wt% H₂O composition, both at T < 1000°C. Other subsolidus phases are coesite, kyanite, garnet,

jadeitic clinopyroxene, and rutile. Ca,Mg,Fe-carbonatite melts with approximately 17 wt% K_2O and a $K_2O/Na_2O > 15$ are formed after the breakdown of the K-phase at 1100°C in the 1 wt% H_2O and at 1200°C in the dry composition. The small amount of unquenchable carbonatite liquid at the solidus are difficult to analyze, as quench phases reach from one to the other of each melt pool and reverse sandwich experiments are under way, to better constrain these melt compositions. Nevertheless, at 300°C above the solidus, melt pools are large and easy to measure, the melts still have K_2O/Na_2O near 15. The subsolidus assemblage at 13 GPa consists of Fe-rich magnesite, K-hollandite, garnet, jadeitic pyroxene, stishovite, corundum and a Ti-phase. Melt appears at 1250°C and is a K_2O -, CaO-rich carbonatitic melt with K_2O/Na_2O near 2 coexisting with K-hollandite, and with $K_2O/Na_2O > 7$ at 1450°C after breakdown of K-hollandite. The solidus reaction is $0.65 \text{ mgs} + 0.41 \text{ K-holl} + 0.56 \text{ cpx} + 0.3 \text{ grt} = 0.64 \text{ st} + 0.24 \text{ cor} + 1 \text{ melt}$. Magnesite disappears first near the solidus, followed by the Ti-phase, K-hollandite (1450°C) and stishovite. At 1850°C the only phases still present are kyanite and a few garnet and clinopyroxene crystals.

Preliminary experiments at 22 GPa (1200-1600°C) result in a subsolidus assemblage of garnet+stishovite+corundum+K-hollandite and a Na-rich Ca-carbonate. A decisive change with respect to lower pressures is the absence of jadeite, Na now being repartitioned in small amounts between the other silicate phases (except stishovite). This has direct consequences on melt compositions as Na becomes again incompatible, as this is the case at pressures below 3 GPa. At 1600°C, the Na,Ca,Mg,Fe-carbonatite melt has now a K_2O/Na_2O of 0.2, and coexist with a Ca-ferrite type phase.

These results indicate that (i) ultrapotassic melts are generated from pelites only between 3 and 15 GPa, but not at significantly higher pressures, (ii) that melting temperatures for a carbonated but H_2O -free pelite remain below the mantle adiabat to 22 GPa, and (iii) thus that such melts will invariably form upon thermal relaxation when subducted sediment are incorporated in the mantle.

References

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