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Experimental study of the P-T stability of phlogopite in metasomatised peridotite with varying H_2O contents in the deep cratonic lithosphere

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Phlogopite is an important metasomatic, hydrous, potassic phase in peridotite from on- and off-cratonic lithospheric mantle. It is significant in petrogenesis of exotic mantle-derived magmas such as micaceous kimberlites, ultramafic lamprophyres, kamafugites, lamproites and olivine basanites[1-6]. Along with other potassic hydrous agents (fluids/melts), phlogopite is a major repository for potassium, H_2O and F in K-enriched peridotitic mantle down to ~200 km or more (≈6 GPa[7-10]).

Although some recent studies delineated phlogopite stability in peridotite at a given bulk H_2O content1[1,8-10,12], we lack experimental investigations close to the limits of phlogopite stability in a model mantle composition enriched in K (i.e. by metasomatic agents) with varying amounts of H_2O over a pressure range of 4-6 GPa, i.e. from ≈120 to 200 km deep. Variations in the $\%H_2O$ available however determine the shape and location of the solidus, and hence the onset of partial melting of a K-enriched mantle enriched[8,13].

Our experimental base composition (HPK2) is fertile peridotite + 0.5wt% K2O. Mixes HPK2-0 and HPK2-13 were prepared by blending powdered high purity oxides or carbonates of Si, Ti, Al, Mg, Cr, Ni, Mn, Ca, Na and K. Mg(OH)2 was included in HPK2-13 to produce a mix with 13wt% H_2O. HPK2-0 is anhydrous. HPK2-0 and HPK2-13 were blended to create 3 additional mixes with identical compositions but varying H_2O contents, nominally 0.2, 2 and 5wt% H_2O. Experiments were run in Au, AuPd or graphite (in Pt) capsules at 4-6 GPa and 1050-1350°C. Run products were analysed by EDS on a SEM.

Experiments crystallized assemblages of olivine + orthopyroxene ± clinopyroxene ± garnet ± rutile ± phlogopite. We define the temperature stability limit of phlogopite in potassic-peridotite between 1200 and 1250°C at 4 GPa and <1300°C at 5 GPa, consistent with interpolation of data from previous lower[1] and higher pressure[14] investigations. We also demonstrate the leaching effect of large excesses of hydrous fluid. Sub-solidus runs with 13wt% H_2O, at P-T conditions within the phlogopite stability field at low $\%H_2O$, are phlogopite and clinopyroxene-free, indicating that hydrous-fluids under these conditions may transport significant Na, K, Ca, Al and other solutes[8,12].

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