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Experimental study of the system phlogopite-diopside from 3.5 to 17 GPa

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ABSTRACT

On the basis of both natural samples and experimental studies, clinopyroxene is a potential reservoir for potassium in the Earth's mantle. The amount of K partitioning into clinopyroxene depends on the phase assemblage present, the bulk composition, pressure, and temperature. To investigate some of these dependencies, subsolidus and melting phase relations in the system phlogopite-diopside have been studied to 17 GPa. In this system, phlogopite becomes unstable with increasing pressure, breaking down to potassium richterite, which in turn breaks down to another K-bearing hydrous phase (phase X), such that a K-rich phase coexists with clinopyroxene to 17 GPa. Clinopyroxenes contain $\leq$1.3 wt% K_2O in assemblages of phlogopite + clinopyroxene ± olivine ± liquid at 3–5 GPa, phlogopite + clinopyroxene + garnet ± olivine ± liquid at 7–9 GPa, clinopyroxene + garnet + olivine ± potassium richterite ± liquid at 11 GPa, and clinopyroxene + olivine + garnet + phase X at 14 and 17 GPa.

In these assemblages, K is partitioned into hydrous phases or liquid, rather than into the clinopyroxene. By inference, phlogopite (or its higher-pressure breakdown products) is the primary host for K in the mantle (if H_2O is present), and any coexisting clinopyroxene has very low concentrations of K. Conversely, the natural occurrence of clinopyroxene with $>>$ 1 wt% K_2O requires that phlogopite, potassium richterite, or phase X is not stable in the local source environment of such samples.