

Major and trace element compositions of partial melts of hydrous pyroxenites and their relationship to volcanism and mantle evolution

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Melting experiments on pyroxenites rich in the hydrous minerals phlogopite (PHL) and K-richterite (KR), some including 5% of the accessory phases ilmenite, rutile or apatite, have been conducted at 15 and 50 kbar to characterise the compositions of initial melts in the continental lithosphere. K-richterite melts rapidly and completely within 50°C of the solidus ($\approx 1000^\circ\text{C}$ @ 15kbar; $\approx 1200^\circ\text{C}$ @ 50 kbar), resulting in lamproitic melt compositions dominated by the chemical components of KR. Melts of mica pyroxenites without KR are richer in CaO and Al₂O₃. The presence of accessory phases produces melts exceptionally rich in TiO₂ and/or P₂O₅, unlike any melts seen at the Earth's surface.

Melting temperatures for CPX+PHL+KR mixtures are close to cratonic geotherms at depths >130km so that minor perturbations of the stable geotherm may rapidly lead to 20% melting. These melts are mobile and effective agents of mantle metasomatism at temperatures well below the melting point of anhydrous peridotite. Trace element analyses of melts indicate that both Ti-oxides and apatite are essential in the source to reproduce the enriched trace element patterns of lamproites: apatite for the REE and Ti-oxides for Nb, Ta, Zr and Hf. CPX+PHL+KR mixtures have higher bulk partition coefficients for all of the first row transition elements except zinc, with both PHL (9.2) and KR (12) having D_{Ni} comparable to olivine.

Flow-through experiments in which a lamproite melt similar to those produced in the current experiments was reacted with peridotite demonstrated that the melt loses its lamproitic chemistry after reaction with peridotite [1]. The occurrence of lamproites at the surface therefore requires channelled flow that prevents reaction with peridotite.

The presence of orthopyroxene in hydrous pyroxenites assists the production of melts with high K₂O/Na₂O with higher normative leucite contents. These rocks are expected to be common in subduction channels as products of reaction between subducted sediments and peridotite [2]; melts of this composition may be an indication of the involvement of subducted sediments in the source.

[1] Foley, S.F., Pertermann, M. (2021) *Geosciences* 11, 432.

[2] Sekine, T., Wyllie, P.J. (1983) *Journal of Geology* 91, 511-528.