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Compositional trends in Ba-, Ti-, and Cl-rich micas from metasomatized mantle rocks of the Gföhl Unit, Bohemian Massif, Austria

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ABSTRACT

Ba-, Ti-, and Cl-rich micas associated with other Ba- and/or Cl-rich minerals in the rock matrix or in garnet and clinopyroxene hosted multiphase solid inclusions (MSI) are observed in mantle-derived garnet pyroxenites. The micas show extremely high variability in chemical composition ranging between Ba-rich phlogopite, chloroferrokinoshitalite, and oxykinoshitalite. Elemental covariation trends in mineral chemical data reveal the principal substitution mechanisms responsible for the observed chemical variability. The substitution $Ba^{2+}Al^{3+} \leftrightarrow K^{1+}Si^{4+}$ associated with either $OH^{1-} \leftrightarrow Cl^{1-}$ or $Ti^{4+}2O^{2-} \leftrightarrow Mg^{2+}2OH^{1}$ links phlogopite to chloroferrokinoshitalite and oxykinoshitalite, respectively, whereas the substitution $Ti^{4+}2O^{2-} \leftrightarrow Fe^{2+}2Cl^{1-}$ links chloroferrokinoshitalite to oxykinoshitalite. The preferred incorporation of Cl in Fe-rich mica and of Ti+O in Mg-rich mica indicates that XFe (Fe_{tot}/Fe_{tot}+Mg) exerts an important control on mica composition. The positive correlation of XFe with Cl led to the formation of possibly the most Cl-rich mica so far described classified as chloroferrokinoshitalite ($XFe_{0.88}$, $Ba_{0.95}K_{0.03}Fe_{2.68}Mg_{0.37}Al_{1.91}Si_{2.01}Cl_{1.98}$) with 10.98 wt% Cl. Substantial substitution of OH^- by Cl^- and O^{2-} in mica, and the presence of Cl-apatite, a rare Cl-rich phosphate goryainovite, and carbonates together with Cl-rich micas indicate high-Cl and -CO_2 activity and low-H_2O activity in metasomatizing fluids or melts that may be classified as Ba-Cl-rich silicocarbonatitic. The coexistence of two micas with distinct compositions close to chloroferrokinoshitalite ($XFe_{0.57-0.77}$, $K_{\sim 0.1}Ba_{0.6-0.8}Mg_{0.7-1.3}Fe_{1.7-2.3}Ti_{0.0-0.1}Si_{2.2-2.3}Al_{1.5-1.7}Cl_{1.2-1.8}$) and oxykinoshitalite ($XFe_{0.19-0.20}$, $K_{\sim 0.3}Ba_{\sim 0.5}Mg_{2.0-2.1}Fe_{\sim 0.5}Ti_{0.2-0.4}Si_{2.4-2.6}Al_{\sim 1.8}Cl_{\sim 0.3}$) suggests that a miscibility gap exists between these two compositions. The exotic mineral assemblage was formed by interaction with metasomatizing fluids or melts whose origin cannot be defined with certainty. They may be derived from crustal or mantle lithologies or from the host garnet pyroxenites. The textural position of the MSI in garnet and their characteristic mineral assemblages indicate that they have been introduced into the garnet crystals under post-peak conditions, possibly during decompression. With this research we document substitution mechanisms in Ba-, Ti-, and Cl-rich micas and shed light on the behavior and composition of fluids or melts at the upper mantle/lower crust interface.

Keywords: Garnet pyroxenite, metasomatism, multiphase solid inclusions, fluids, melts, kinoshitalite; Experimental Halogens in Honor of Jim Webster