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CHLORINE-POTASSIUM RELATIONS IN HASTINGSITIC AMPHIBOLES

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To metamorphic petrologists like Peter Robinson, amphiboles are “translucent garbage cans” that can provide useful information about its history and formation conditions. A pertinent example of these useful chemical properties is an amphibole’s Cl-content, which can be related to ancient hydrothermal fluids. Chlorine incorporation into amphiboles is not only affected by the activity of Cl in a fluid, but the crystal chemistry of the amphibole as well.

The importance of potassium in forming Cl-rich amphiboles has long been documented in multiple studies of naturally occurring amphiboles. It has been generally accepted that Cl and K are positively correlated. We report here results on synthetic K-Cl hastingsite ($K\ Ca_2\ (Fe_4^{2+}, Fe^{3+})\ (Al_2\ Si_6)\ O_{22}\ (OH, Cl)_2$) that complicate this relationship.

Amphiboles were synthesized from reagent grade materials at a series of conditions designed to yield amphiboles with a wide variety of Cl-content. The syntheses can be divided into two categories: “dry”, at 1-20 kbar and 600-700°C, and hydrothermal, in the presence of initial $FeCl_2$ brines from 0 - 250 molal (0-97wt%) at 3 kbar and 700°C. The synthetic amphiboles were analyzed by electron microprobe (WDS).

Analysis showed a negative correlation at Cl contents <0.4 apfu Cl and a positive correlation between K and Cl at amphibole Cl contents > 0.4 apfu Cl. A plot of Cl vs K for these amphiboles resembles an asymmetric V, with the lowest (0 apfu) and highest (~1.7 apfu) Cl amphiboles both having near ~1 apfu K. Moving toward the middle of the plot, amphibole K-content decreases until it reaches a minimum at ~0.5 K.

There is a negative correlation between K and $^{C}Al + {}^{C}Fe^{3+}$ indicating that the exchange vector $^{A}K{}^{C}Fe^{2+} \leftrightarrow Avac_{-1}(^{C}Al,{}^{C}Fe^{3+})_{-1}$ may be operating. There were also noteworthy trends in the unit cell dimensions among these amphiboles, with the *a* dimension increasing with K and the *c* dimension increasing with Cl. Interestingly, the increase in the *c* dimension as Cl content increases from 0 – 0.4 apfu is counterbalanced by the decrease in the *a* dimension as K content decreases, allowing the unit cell volume to remain nearly constant (941Å^3) up until the threshold Cl content of 0.4 is reached, after which, volume increases with Cl (to a maximum of 961Å^3) and K is positively correlated with Cl. Direct analysis of Fe^{3+} is needed to confirm this exchange vector.

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