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^{B}Na–^{B}Li solid-solution in A-site-vacant amphiboles: synthesis and cation ordering along the ferri-clinoferroholmquistite–riebeckite join

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ABSTRACT

Amphiboles were hydrothermally synthesized at 500 °C and 4 kbar in the system Li_2O-Na_2O-FeO-Fe_2O_3-SiO_2-H_2O, with nominal compositions along the riebeckite [$\square Na_2Fe^{2+}_3 Fe^{3+}_2Si_8O_{22}(OH)_2$]-ferri-clinoferroholmquistite [$\square Li_2Fe^{2+}_3Fe^{3+}_2Si_8O_{22}(OH)_2$] join, where the exchange vector is $NaLi_{-1}$ at the B-site. Experimental products were characterized by powder XRD and SEM-EDAX, confirming very high amphibole yield along the join (>95%, plus minor quartz). The XRD patterns can be indexed in $C2/m$, and the refined cell parameters show linear variation as a function of composition. For the ^{B}Li end-member, the IR spectrum shows a single sharp main band centered at 3614 cm^{-1}, which is assigned to the FeFeFe-OH-$^A\square$ configuration. With increasing ^{B}Na in the mineral, this band broadens and shifts 4 cm^{-1} to higher frequencies. This effect can be attributed to the change in M4 site occupancy. Minor ^{A}Na (partial solid-solution toward arfvedsonite) is also observed with increasing sodium in the system. Mössbauer spectroscopy confirms the cation distribution provided by IR data, and shows that a small, but significant amount of Fe^{2+} occurs at M4 along the join. Infrared spectroscopy shows that the Li end-member has a very ordered structure, whereas intermediate compositions show local heterogeneities associated with the presence of two different B sites occupied by Na or Li.