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Experimental data on the Tschermak substitution in Fe-chlorite

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ABSTRACT

Iron chlorite with compositions intermediate between the two end-members daphnite [$Fe_5Al_2Si_3O_{10}(OH)_8$] and Fe-amesite [$Fe_4Al_4Si_2O_{10}(OH)_8$] were synthesized from gels, under f_{O_2} conditions defined by the solid oxygen buffer Fe-FeO. The unit-cell parameters and volume of chlorite with Si-content ranging from 2.3 to 2.7 were calculated. A least-squares fit of these data yields $V^0_{\text{Fe-ames}} = 213.06$ cm^3 and $V^0_{\text{daph}} = 216.50$ cm^3. The molar volume of daphnite is similar to that estimated by Vidal et al. (2001), but the volume difference between Fe-amesite and daphnite is too low. The experimental data were also fitted for reasonable values of $V^0_{\text{Daph}} - V^0_{\text{Fe-ames}}$ and $V_{\text{FeMg-1}}$, with linear (ideal) or non-ideal volume models involving a positive excess volume. With these models we obtain V^0_{Daph} between 216 cm^3 and 217.49 cm^3, and $V^0_{\text{Fe-ames}}$ between 209 and 211.35 cm^3.

Equilibration experiments involving chlorite with almandine-hercynite/fayalite or chloritoid-hercynite/fayalite provide data on the chlorite composition as a function of T and P at temperatures between 420 and 520 °C and pressures between 3 and 20 kbar, at f_{O_2} buffered by the assemblage Fe-FeO. Initial Si-rich and Si-poor chlorite compositions converged in most cases toward an equilibrium composition during the experiments. The results show that the Si-content of chlorite is sensitive to temperature for the various divariant assemblages. The most definitive results, obtained for the assemblage chlorite-almandine-fayalite, were used to estimate $H^0_{\text{fFe-amesite}}$ and the Al-Fe Margules parameter for the various sets of daphnite and Fe-amesite molar volumes constrained from the synthetic chlorites. The results indicate that $H^0_{\text{fFe-amesite}} = -7616 \pm 3$ kJ and $W^{\text{G}}_{\text{AlFe}} \sim -10$ kJ.