

Feldspars in the System K[AlSi₃O₈] - K[FeSi₃O₈]: their Growth and Structural State

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K-feldspars in the system K[AlSi₃O₈] - K[FeSi₃O₈] have been synthesized hydrothermally from oxide mixes together with KOH solution at $P_{\text{H}_2\text{O}} = 1$ kbar and $T = 400$ °C, 500 °C, and 600 °C to investigate their ordering behaviour, the extent of Al,Fe substitution, and the influence of oxygen fugacities on the run products.

In the Ni-NiO buffered runs Fe^{3+} was partly reduced to Fe^{2+} . Abundant growth of Fe-containing mica left the K-feldspar strongly depleted in Fe^{3+} relative to the starting material. In the Cu-Cu₂O runs with their larger oxygen fugacities, growth of delafossite ($\text{Cu}^{1+}\text{Fe}^{3+}\text{O}_2$) took up various amounts of Fe^{3+} resulting in Fe^{3+} contents of the K-feldspars ranging from 20 mol% to 100 mol%.

Considering the discontinuous character of the sanidine-microcline transition in both K-feldspar endmembers, a phase diagram has been calculated from known transition temperatures (480 °C and 704 °C, respectively) and known (7300 J/mol; Hovis, 1988) or derived transition enthalpies (11500 J/mol) yielding a narrow two-phase field separating (Al,Fe)-sanidine from (Al,Fe)-microcline. In the Al-rich part of the diagram, metastable monoclinic K-feldspar persisted in the stability field of microcline, whereas Fe-rich compositions attained the triclinic ordered state. No indication of a miscibility gap was detected.

Pure KAl-feldspars, even after long annealing, kept a high degree of disorder in agreement with predictions from the Mueller rate equation, when using an updated calibration of $\ln(K_d)$ vs. $1/T$: $-\text{RT}\ln(K_d) = 4047(668) - 1.80(47)*T + 10955(929)*Q$.

Structural incorporation of Fe^{3+} leads to faster ordering kinetics. For example, substitution of 27 at% Al by Fe enhances the ordering rate constant at 600 °C by a factor of 170. Further, the observed degree of order increases at increasing Fe contents and decreasing temperatures ruling out ordering in the solid state subsequent to growth. One possibility would be initial growth with the observed degree of order driven by atomic radii effects and the proton concentration in the structure having a larger effect on Fe,Si than Al,Si interchanges. A second possibility would be solution-reprecipitation becoming more effective at increasing Fe contents and increasing deviation of the metastable monoclinic crystals from their (Al,Fe)-sanidine stability fields.

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