American Mineralogist, Volume 92, pages 114–123, 2007

The density and compressibility of $KAlSi_3O_8$ liquid to 6.5 GPa

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ABSTRACT

The thermodynamic properties of crystalline and liquid $KAlSi_3O_8$ are used to calculate the fusion curve of sanidine to 6.5 GPa. New values for the enthalpy and entropy of fusion of sanidine at one bar and 1200 °C (ΔH_{Tf} = 63.0 kJ/mol, ΔS_{Tf} = 42.8 J/mol-K) are recommended on the basis of improved heat-capacity equations for $KAlSi_3O_8$ crystal, glass, and liquid. On the basis of phase-equilibrium experiments on the congruent melting reaction between 2 and 6.5 GPa, the pressure dependence of the liquid compressibility ($K_0' = dK_0/dP$, where $K_0 = 1/\beta_0$) is constrained to be 12.2 ± 1.0 in a third-order Birch-Murnaghan equation of state (EOS). The metastable, one-bar melting temperature (T_f) is additionally constrained to be 1203 ± 26 °C. Determination of the liquid K_0' allows the density and compressibility of $KAlSi_3O_8$ liquid to be calculated to 6.5 GPa (2.709 ± 0.014 g/cm^3 at 1600 °C). The uncertainty in K_0' of ±1.0 leads to an error in melt density at 6.5 GPa of ±0.52%. With a K_0' = 12.2, the relatively high compressibility of $KAlSi_3O_8$ liquid at 1600 °C (K_0 = 15.8 GPa) drops rapidly with increasing pressure. The dominant mechanism of compression for $KAlSi_3O_8$ liquid between 0 and 6.5 GPa most likely involves topological changes and increases in network connectivity with pressure. It is probable that highly compressible liquids, such as hydrous, silica-rich liquids formed by partial melting of a subducted slab, may have K_0' values that exceed 12 (at pressures ≤6.5 GPa).

Keywords: Sanidine, fusion curve, enthalpy of fusion, topology, equation of state