

THERMODYNAMIC PROPERTIES OF ALUMINOSILICATE MELTS

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The results of experimental studies on aluminosilicate-H₂O systems, including igneous-rock melts, have led to the development of an internally consistent thermodynamic model that can be used to calculate phase equilibria in compositionally complex systems of petrological interest. The model rests on the discovery in the system NaAlSi₃O₈-H₂O that $a_w = k [X_w^m]^2$ for values of $X_w^m \leq 0.5$, where a_w and X_w^m are the activity and mole fraction of H₂O in the melt, respectively, and k is an analogue of a Henry's law constant for a dissociated solute. The $[X_w^m]^2$ term is interpreted, consistent with other data, to indicate that H₂O dissolves in aluminosilicate melts by reaction with bridging O²⁻ to produce 2 OH⁻, coupled with an exchange of H⁺ for a cation that provides charge balance on the tetrahedrally coordinated Al³⁺.

The solubilities of H₂O in melts of granite, andesite, and basalt composition, when recast

on an equimolar basis with NaAlSi₃O₈ in accordance with the solution model, are all identical within experimental error. This implies that k is independent of silicate composition in this range. Moreover, by application of the Gibbs-Duhem relation and the properties of exact differentials, it is found that the silicate components in these melts, properly defined on the basis of 8 O²⁻, mix in accordance with Raoult's law. Therefore, $a_i^{hm} = X_i^{am} [1 - X_w^m]^2$, where a_i^{hm} is the activity of silicate component $[i]$ in the hydrous melt, relative to pure anhydrous liquid $[i]$ at the same P and T , and X_i^{am} is the mole fraction of $[i]$ in the anhydrous melt of the same silicate composition. This mixing behavior of silicate components appears to hold over the composition range basalt to rhyolite, but probably will not hold for Si- and Al-poor mafic melts owing to their high content of nonbridging O²⁻.

HIGH-PRESSURE STUDIES OF ELECTRICAL CONDUCTIVITY VARIATIONS THROUGH THE MELTING POINT OF BASALTS

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The present d.c. electrical conductivity (σ) studies have been carried out on inhomogeneous samples from the Joides Leg 37 332A and B drill sites at $P=20-55$ kbar. below the melting point, the slopes of σ versus T curves ($\epsilon \approx 0.9-1.4$ eV) are similar to those for homogeneous basalt reported by Presnall *et al.* (1972) but are shifted towards higher σ values. However, the beginning of melting of the inhomogeneous samples, instead of being signaled by an immediate sharp increase in σ , is marked by premonitory decreases in σ over a T interval as wide as 500°-600°C. This is attributed

to partial melts, based on localized phase equilibria reflecting the sample inhomogeneity. Initially isolated melts disrupt the solid phase contiguity and thus reduce σ . Local field reductions due to Na⁺, Ca²⁺ ion exchange between different plagioclase fractions are discussed. A sharp increase in σ occurs as soon as isolated melts merge into a common contiguous liquid. Formation temperatures of a contiguous melt-phase at 40 kbar vary between 1730 and 1920°C with pressure coefficients of 8.3-24.5°C kbar⁻¹. Values of $2.2-9.5 \times 10^{-1}$ [Ωcm]⁻¹ for the liquids at 2080°C are some-

what lower than extrapolated from Presnall's curve. The wide freezing interval ($>250^{\circ}\text{C}$) increases with P and, in agreement with earlier work, σ remains high on cooling below T_{liq} but recovers slowly with time depending on P .

REFERENCE

- PRESNALL, D. C., SIMMONS, C. L. & PORATH, H. (1972): Changes in electrical conductivity of a synthetic basalt during melting. *J. Geophys. Res.* 77, 5665-5672.

OXYGEN AND SILICON DIFFUSION-CONTROLLED PROCESSES IN SILICATE GLASSES AND MELTS

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In silicates the mobility of the network-former species (i.e., oxygen and silicon) is rate-determining for mass-transport phenomena such as reaction kinetics, crystallization kinetics, and viscous flow. The techniques for measuring silicon and oxygen diffusion are

briefly outlined. The mechanisms of network-former diffusion are discussed and an approach is given to estimate the ratio of silicon and oxygen diffusivity on the basis of the extent of covalency in the Si-O bond.