

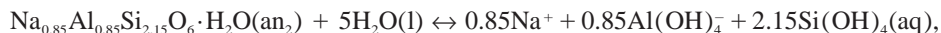
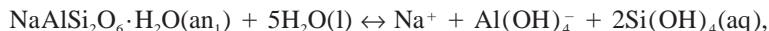
Solubility and stability of zeolites in aqueous solution: I. Analcime, Na-, and K-clinoptilolite

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ABSTRACT

The solubilities of analcime and clinoptilolite were determined in dilute, weakly alkaline, aqueous solutions below 300 °C and at vapor-saturated pressures. Analcimes used in this study were from Mont St. Hilaire, Quebec (an₁, Si/Al = 2.02) and Wikieup, Arizona (an₂, Si/Al = 2.55); clinoptilolite samples were from Castle Creek, Idaho (Si/Al = 4.50). The effects of alkali content (Na,K) on clinoptilolite solubility were determined by using cation-exchanged varieties of the Castle Creek material (cp₁, cp₂). In neutral to weakly alkaline solutions, the dominant solubility-controlling reactions of these zeolites are



and



The logarithm of the equilibrium constants of these reactions were fit to the function: $\log K = A + BT + C/T + D \log T$. At 25 °C, $\log K_{25}$ values for the Mont St. Hilaire analcime, Wikieup analcime, Na-clinoptilolite, and K-clinoptilolite are -16.1, -15.0, -26.5, and -28.1, respectively. These data were combined with the thermodynamic properties of the aqueous (aq) species $\text{Si}(\text{OH})_4$, $\text{Al}(\text{OH})_4^-$, Na^+ , K^+ , and liquid water (l) to determine standard Gibbs free energies of formation as a function of temperature. Values of ΔG_f° at 25 °C and 1 bar for the Mont St. Hilaire analcime and Wikieup analcime are -3089.2 and -3044.4 kJ/mol, respectively. The ΔG_f° values for hydrous Na-clinoptilolite and K-clinoptilolite, respectively, are -6267.9 and -6107.4 kJ/mol at 25 °C and 1 bar. The solubility data reported here, and results obtained from previous calorimetric studies, indicate that the aluminosilicate frameworks of analcime and clinoptilolite are stabilized by an increase in Al content.