

## **Thermochemical study of calcium zeolites—heulandite and stilbite**

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### **ABSTRACT**

Calorimetric measurements were made on natural samples of heulandite having the composition  $\text{Ca}_{0.86}\text{Na}_{0.37}\text{K}_{0.06}\text{Al}_{2.14}\text{Si}_{6.86}\text{O}_{18}\cdot 6.1\text{H}_2\text{O}$  and stilbite  $\text{Ca}_{1.01}\text{Na}_{0.12}\text{Al}_{2.12}\text{Si}_{6.88}\text{O}_{18}\cdot 7.27\text{H}_2\text{O}$  both from the same locality (Nidym River, E. Siberia, Russia). Enthalpies of formation and hydration were studied by calorimetry in lead borate solvent at 975 K. The enthalpies of formation from oxides and elements at 298 K of heulandite are:  $-238.7 \pm 4.9$  kJ/mol, and  $-10656.3 \pm 8.6$  kJ/mol, and of stilbite are  $-232.0 \pm 8.3$  kJ/mol and  $-11017.9 \pm 10.9$  kJ/mol respectively. The integral hydration enthalpies including the enthalpies of phase transitions during heulandite and stilbite dehydration are  $-209.4 \pm 5.9$  kJ/mol and  $-229.2 \pm 7.4$  kJ/mol at 298 K, respectively. The molar Gibbs free energies of formation for idealized calcium-sodium and pure calcium heulandites and stilbites were calculated by combining these new calorimetric data with thermodynamic quantities from the literature. Equilibrium temperatures for the reaction:  $\text{Ca-stilbite} = \text{Ca-heulandite} + \text{H}_2\text{O}$ , calculated on the basis of these thermodynamic data, agree with experimental phase equilibria.