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Solution calorimetric determination of the enthalpies of formation of NH_4-bearing minerals buddingtonite and tobelite

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ABSTRACT

Enthalpies of solution of the NH_4^+-bearing minerals buddingtonite ($NH_4AlSi_3O_8$ feldspar) and tobelite [$NH_4Al_2(AlSi_3O_{10})(OH)_2$ mica] have been measured in 20.1 wt% hydrofluoric acid (HF) at 50 °C. Utilizing additional HF solution calorimetric data from this laboratory for sanidine, albite, muscovite, paragonite, halite, sylvite, salammoniac, gibbsite, and water, along with enthalpies of formation from Robie and Hemingway (1995) for the same phases, the heats of formation at 298.15 K of buddingtonite and tobelite have been determined to be –3883.9 and –5881.3 kJ/mol, respectively. Entropies of ~247 and ~319 J/(mol·K) for these minerals (298.15 K) have been approximated from various ion-exchange equilibria involving feldspars, micas, and chlorides. Collectively, these data result in 298.15 K Gibbs free energies of formation from the elements of –3579 and –5422 kJ/mol, respectively, for buddingtonite and tobelite, values that differ by 40 to 50 kJ/mol from those given previously by Mäder et al. (1996). The calculated phase equilibria that result from the data of this investigation are reasonable relative to the conditions required to synthesize both buddingtonite and tobelite (Harlov et al. 2001b, 2001c).