Dehydration of Synthetic Hydrated Kaolinites: A Model for the Dehydration of Halloysite(10 Å)

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Abstract: Several hydrates can be synthesized from well-crystallized kaolinites; of importance to the present work are a 10-Å hydrate (called the QS-10 hydrate), an 8.6-Å hydrate, and two kinds of partially dehydrated mixed-layer hydrates. One kind is a series of unstable materials with d(001) varying continuously between 10 and 8.6 Å, and the other kind is stable with d(001) approximately centered at 7.9 Å. The 10- and 7.9-Å phases have been observed in halloysites by many workers using X-ray powder diffraction, and the 8.6-Å phase has been seen by others in selected area electron diffraction photographs. Infrared spectra reveal additional similarities between the synthetic hydrates and both halloysite(10 Å) and partially dehydrated halloysites. Because of these similarities, the synthetic hydrates can be used to develop a model for the dehydration of halloysite (10 Å).

Previous work on the 10- and 8.6-Å hydrates identified two structural environments for the interlayer water. In one, the water is keyed into the ditrigonal holes of the silicate layer (hole water), and in the other, the water is more mobile (associated water). Both types are found in the QS-10 hydrate and halloysite(10 Å), whereas only hole water occurs in the 8.6-Å hydrate. In the QS-10 hydrate, stronger hydrogen bonding between hole water and the clay makes the hole water more stable than the associated water. This difference in stability is responsible for a two-step dehydration process. The first step is the loss of associated water which results in a material with d(001) = 8.6 Å. This stable hydrate must be heated to temperatures near 200 ° C to drive off the remaining hole water. The less perfect structure of halloysite and its common curvilinear morphology reduce the difference in stability between hole and associated water molecules, so that when halloysite(10 Å) dehydrates, loss of hole water and associated water overlaps, and the d-spacing goes directly to 7.2 – 7.9 Å.

Key Words: Dehydration • Halloysite • Hydrite • Kaolinite • Water

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