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The effects of grinding on the structure of a low-defect kaolinite

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ABSTRACT

Numerous studies have demonstrated the presence of at least two distinct kaolinites in individual kaolinite samples, one a low-defect material and the other a moderate- to high-defect material. Other studies have shown that some kaolinites contain the lowest-defect material in the coarsest size fractions whereas others contain the lowest-defect kaolinite in the finest fractions. In an attempt to clarify possible mechanisms for producing such kaolinite samples, we have used powder X-ray diffraction to study the effects of mechanical grinding on the nature of layer stacking in the >40 μm fraction of the American Petroleum Institute kaolinite standard no. 9 from Mesa Alta, New Mexico. This material is relatively rich in a low-defect kaolinite. Hand grinding for 10 min plus grinding under acetone for up to an additional 34 min in an automatic agate grinder produced significant changes in its diffraction pattern. However, further dry grinding in a ball mill for 10 min produced material that was almost totally disordered, based on measures such as the Hinkley index. The diffraction patterns of the wet-ground materials showed evidence of increasing disorder that could be modeled best as a physical mixture of low- and high-defect material, consistent with a physical mixture of the original ordered phase with varying amounts of a highly disordered material. Disorder in the high-defect kaolinite is caused by the interstratification of normal kaolinite layers with their enantiomorphs. Contrary to expectations, grinding of kaolinite does not produce a progressive increase in disorder for all of the crystallites present in a sample. Instead, grinding apparently creates increased amounts of a disordered kaolinite that coexist with relatively unaffected material. There is no evidence for the occurrence of an intermediate disordered phase. Contrary to previous reports, disorder caused by physical stress does not include random layer displacements of $\pm b/3$.