American Mineralogist, Volume 85, pages 1209–1216, 2000

The dissolution of hectorite: In-situ, real-time observations using atomic force microscopy

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ABSTRACT

The dissolution of individual hectorite (a trioctahedral smectite) particles has been observed at molecular scales in acidic aqueous solution with atomic force microscopy (AFM). A new sample preparation technique was used to attach nanometer-sized hectorite particles to a mica substrate. The reactive surface area of individual hectorite particles was identified and its change during a dissolution experiment was quantified. The dissolution of hectorite under pH 2 conditions takes place exclusively at the edge surfaces. In contrast, the basal surface is completely unreactive within the investigated time scale of several hours. The short edges of the hectorite laths were found to react somewhat more quickly than the long edges. The edge surface area represents 1.5–3.3% of the total surface area. The total surface area has been determined from the actual particle dimensions derived from AFM data to be 730 m^2/g. The dissolution rate normalized to the reactive edge surface area (ESA) has been determined to be 7.3×10^{-9} mol hectorite/(m^2-s), which represents a total surface area (TSA) normalized dissolution rate of 1.9×10^{-10} mol hectorite/(m^2-s). The ESA/TSA ratio increases by about 15% within 1 h exposure to a pH 2 aqueous solution at 22 °C.