The Hydrothermal Transformation of Sodium and Potassium Smectite into Mixed-Layer Clay

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Abstract: The transformation of sodium and potassium smectite into mixed-layer clay was followed in hydrothermal kinetic experiments. Glasses of beidellite composition and the Wyoming bentonite were used as starting materials. Temperatures ranged between 260 and 490 ° C at 2 kbar pressure, and run times ranged between 6 hr and 266 days.

The course of the reactions was found to be strongly affected by interlayer chemistry. When potassium was the interlayer cation, increasing reaction produced the series: randomly interstratified illite/smectite-ordered interstratified illite/smectite-illite. This sequence is equivalent to that formed in shales during burial diagenesis. With interlayer sodium and temperatures above 300 ° C an aluminous beidellite (Black Jack analog)-rectorite-paragonite series was realized. The difference between these two diagenetic families is discussed. Below 3 ° C sodium beidellite formed randomly interstratified mixed-layer clay much like potassium beidellite, except that a higher layer charge was required to produce sodium mica-like layers. The higher charge resulted from sodium's higher hydration energy. The difference in hydration energy between potassium and sodium may account for the fixation of potassium rather than sodium in illite during burial diagenesis.

The appearance of ordered interlayering in mixed-layer phases is also related to interlayer chemistry. Ordering formed in sodium clays at high expandabilities, whereas it never appeared in the potassium clays above approximately 35% expandable. The appearance of ordering may be partly related to the polarizing power of the mica-like layers.

Phase diagrams, constructed from the kinetic experiments and from the composition and occurrence of natural clays, are presented for the systems paragonite and muscovite-2 quartz-kaolinite-excess water. This study also reports the first synthesis of a Kalkberg-type mixed layer clay.

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