Mineralogical and Morphological Evidence for the Formation of Illite at the Expense of Illite/Smectite

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Abstract: The conversion of smectite to illite by way of a mixed-layer illite/smectite (I/S) series was found to be the major depth-related reaction in clay-mineral assemblages from two cored sedimentary sequences in the Rocky Mountains. The I/S reaction occurred in both interbedded sandstone and shale of Upper Cretaceous and lower Tertiary age in the Green River basin, Wyoming, and in chalk and chalky shale of the Upper Cretaceous Niobrara Formation, Denver basin, Colorado. As the proportion of illite layers in I/S increased with depth in these rocks, the amount of I/S in the clay fraction decreased, and the amount of discrete illite increased. Scanning electron microscopy revealed that the morphologies of highly expansible, randomly interstratified I/S clay (samples from shallow cores) exhibited no distinctive intergrowth or overgrowth textures. In deeply buried rocks containing highly illitic, ordered I/S and abundant discrete illite, however, fibers or laths of illite were formed on earlier I/S substrates. Less commonly, I/S of low expandability shows morphological features of both smectite and illite whereby rigid laths of illite appear to have formed diagenetically from the wall surfaces of I/S honeycombs. This combined morphology suggests some dissolution and reprecipitation (or some reorganization) of materials from the I/S substrate as the substrate was transformed into a more illitic mixed-layer day.

These data suggest that some I/S clay was destroyed by the selective cannibalization of smectite layers in I/S to provide the components needed to make a more illitic I/S. Moreover, discrete illite and other minerals apparently were formed during the reaction. Also, coarser mineral phases, such as potassium feldspar and detrital micas, may not have been required to supply the chemical components in the reaction. The observations provide an explanation for late diagenetic I/S reactions that occurred in restricted or relatively closed geochemical systems, as in early cemented rocks having extremely low permeability and little or no potassium feldspar.

Key Words: Diagenesis • Illite • Illite/smectite • Morphology • Scanning electron microscopy • X-ray powder diffraction

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