Morphological, Chemical, and Isotopic Evidence for an Early Diagenetic Evolution of Detrital Smectite in Marine Sediments

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Abstract: Mineralogical (XRD), morphological (transmission electron microscopy), chemical (major, rare-earth elements, and scanning-transmission electron microscopy), and isotope (Sr, O, H) measurements were made of marine detrital smectite from shales to study their reactions during early diagenesis. Albian, Aptian, and Palaeogene smectite samples were selected from Deep Sea Drilling Project drill cores taken in the Atlantic Ocean and from outcrops and drill cores from Belgium and northern France. Detrital, fake-like smectite particles seem to have adapted to their depositional environment by isochemical dissolution and subsequent crystallization of authigenic, lath-like particles. The major-element and rare-earth element compositions of both types of particles are similar. The Sr isotope chemistry suggests that the dissolution-crystallization process occurred soon after deposition in an almost closed chemical system. Except for slight changes in the amount of Fe and the oxygen isotope composition, the reaction took place without noticeable chemical exchange with the interstitial or marine environment. Such closed-system recrystallization of clay minerals may be a common diagenetic process if the water/rock ratio is small, as in shales.

Key Words: Chemical composition • Diagenesis • Isotopic composition • Morphology • Smectite • Transmission electron microscopy • X-ray powder diffraction

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