Evolution of Illite/Smectite from Early Diagenesis through Incipient Metamorphism in Sediments of the Basque-Cantabrian Basin

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Abstract: Prograde evolution of illite/smectite occurring in an unusually-thick (8000 m) sequence of Mesozoic-Cenozoic sediments in the Basque-Cantabrian Basin, Spain, has been studied using XRD and TEM/AEM. The sediments, which are only slightly tilted, cover the range from smectite to illite, and the most deeply buried ones are unique in that they span the range from diagenesis through low-grade metamorphism (anchizone), with no apparent overprinting due to tectonic deformation.

Pelites are absent from the shallow section, but smectite occurs in marls as high-charge, K-dominant and low-charge, K-poor anastomosing arrays of layers. At intermediate depths, authigenic clay is identified largely as R1 I/S, coexisting with packets of R>>3 I/S (nearly pure illite), where illite-like and smectite-like layers can be identified by contrast in TEM images, which is consistent with XRD data. The authigenic clay of the deepest samples consists of illite with no or almost no expandable layers, which occurred as packets with layers largely subparallel to bedding, K-deficient composition in comparison with muscovite, $1M_d$-like SAED patterns, and 100 Å mean packet thickness. There is no evidence of deformation stress-induced, non-bedding-parallel clays in the deepest samples. Detrital micas with either a phengite-rich or a phengite-poor composition range dominate the phyllosilicate fraction of all the samples. Detrital micas show no changes over the diagenesis/metamorphism range and appear to have behaved as if isolated from authigenic clays.

Authigenic clays occur as bedding-subparallel packets that evolved during passive burial metamorphism through dissolution/crystallization of less-evolved clays. Where illite-like and smectite-like layers can be identified, TEM images imply a discontinuous series in which packets of R1 I/S (50% I) transform to packets of nearly-pure illite, that is, an Ostwald-step-rule-like sequence. Such immature illite remains unmodified with further burial, and is apparently the potential predecessor of stress-induced, highly-evolved mica of higher-grade, tectonically-deformed pelites.

Key Words: Basque Cantabrian Basin • Diagenesis • Illite • Smectite

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