Mg-Smectite Authigenesis in a Marine Evaporative Environment, Salina Ometepec, Baja California

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Abstract: Formation of authigenic trioctahedral Mg-rich smectite is common in evaporative lake sediments, but was not described previously in modern marine evaporative environments. This study documents formation of authigenic K-rich, Mg-smectite during very early diagenesis in the dominantly siliciclastic Salina Ometepec (Baja California), a large supratidal evaporative sabkha complex near the mouth of the Colorado River. Here, sediment pore waters are exceptionally Mg^{2+}-rich relative to other marine evaporative environments due to suppressed sulfate reduction which limits production of carbonate alkalinity and, hence, carbonate (particularly dolomite) precipitation. Sediment cores were obtained along a five km transect seaward across the hypersaline mud flat to evaluate how these atypical geochemical conditions would affect the clay mineral compositions.

Scanning transmission electron microscopy (STEM) observations show that the smectite from the marine Inlet, near the sediment source, consists of grains of irregular shape that give selected area diffraction (SAED) patterns reflecting dominant turbostratic stacking. Analytical electron microscopy (AEM) analyses indicate that K^+ is the dominant interlayer cation; the mean composition is approximately $K_{0.7}(Al_{3.3}Fe(III)_{0.3}Mg_{0.5})(Al_{0.5}Si_{7.5})O_{20}(OH)_4$. Such smectite is implied to be detrital in part because it is similar to smectite known to be deposited by the Colorado River.

Smectite from the hypersaline mud flat occurs as aggregates of small subhedral pseudohexagonal plate or lath-shaped crystals <-250 nm in diameter; with thicknesses varying between three and ten layers. The SAED patterns reflect substantial turbostratic stacking, but with a greater frequency of interlayer coherency as compared with detrital smectite. Crystals from greater sediment depths are larger and more nearly euhedral. This smectite is dominantly trioctahedral, with mean composition approximately $K_{0.7}(Al_{0.7}Fe(III)_{0.5}Mg_{4.45})(Al_{1.2}Si_{6.8})O_{20}(OH)_4$ (saponitic). This smectite is inferred to be dominantly authigenic in origin.

The X-ray diffraction (XRD) and STEM/AEM data collectively imply that detrital aluminous dioctahedral smectite reacts to form authigenic Mg-rich trioctahedral smectite, driven in part by the high Mg^{2+}/Ca^{2+} ratio of pore waters. Such early-formed Mg-rich smectite may be the precursor for the trioctahedral mixed-layer smectite, corrensite, and chlorite assemblages found in ancient marine evaporative sequences. These results also add to the accumulating evidence that interlayer K^+ in marine smectite is fixed during the earliest stages of marine diagenesis near the sediment water interface.

Key Words: Baja California • Early Diagenesis • Hypersaline Brines • K-smectite • Mg-smectite • Salina Ometepec • Saponite • Trioctahedral Smectite

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