Implication of microbially induced low temperature smectite-illite transformation in Bering Sea Slope sediments

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The smectite-to-illite (S-I) transformation is a diagenetic process that typically occurs in deeply buried sediments at temperatures above 60˚C. Recent experimental studies showed that anaerobic microbial respiration possibly contributes to promote the S-I transformation at room temperature. Nevertheless, the occurrence of low temperature S-I transformation has rarely been observed in natural marine sediments. We evaluated the possibility of naturally occurring microbially induced S-I transformation at temperatures below 40˚C in continental slope sediments of the Bering Sea by examining porewater chemistry, clay mineralogy, and chemical composition of clay minerals measured to ~800 m beneath the seafloor (mbsf) in core samples acquired during Integrated Ocean Drilling Program Expedition 323. In porewater from these cores, chloride concentrations decreased with increasing depth from 560 mM near the seafloor to 500 mM at ~800 mbsf; δ^{18}O increased from 0 to +1.5‰; and δD decreased from −1 to −9‰. These trends are consistent with the addition of water derived from S-I transformation. X-ray diffraction analysis of the clay-size fraction (<2 μm) showed an increase of illite content in the I/S mixed layer with increasing depth to 150 mbsf. This increase may imply the occurrence of S-I transformation. The decrease of Fe^{3+}/Fe^{2+} in the clay-size fraction with increasing depth strongly suggests microbial reduction of Fe(III) in clay minerals with burial, which also has the potential to promote the S-I transformation. Our results imply the significant ecological roles on the diagenesis of siliciclastic clay minerals underlying the high-productivity surface seawater at continental margins.

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