Investigation of Microbe Mediated Smectite to Illite Transformation

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Smectite-illite clay minerals are ubiquitous in sedimentary basins. The smectite to illite transformation is approximately concomitant with petroleum maturation during sediment diagenesis, but the relationship between organic matter and clay mineral reactions has yet to be rigorously established. Recent discovery that organic matter can exist in smectite structure suggests that microbes may be responsible for the two parallel reactions. We will investigate microbe effects on the smectite to illite transformation using environmental cell transmission electron microscopy (EC-TEM) and electron energy loss spectroscopy (EELS). We hypothesize that, in anaerobic subsurface environments, microbes can break down the smectite structure through structural Fe(III) reduction, and thus release organic matter, triggering illite formation and organic matter maturation.

I propose to study the microbe-driven smectite to illite reaction through reduction of structural Fe(III) in smectite under diagenetic conditions by both CN32 (mesophilic) and *Bacillus Infernus* (thermophilic). Bacteria will be analyzed for extra-cellular polymers which may play a role in attachment and reduction of Fe(III) in clays. This will serve as our initial focus toward the understanding of cell adhesion to clay surfaces, solubilization of Fe(III) from clays, and ultimate transfer of reducing power from bacterial respiratory systems. EELS will be used to determine iron oxidation state, while EC-TEM will allow viewing of biological systems in their native states. EC-TEM allows for the preservation of delicate biological and mineralogical textures and it is capable of imaging the nanoscale interface between minerals and microbes. This will help to elucidate mechanisms of interaction between minerals and microbes.