Microbially induced Smectite-to-Illite reaction

*Tae-hee Koo[1], Jinwook Kim[1]

1. Department of Earth System Sciences, Yonsei University, Seoul, Korea

Microbial Fe-reduction in smectite structure plays a significant role in illitization accompanying with the structural/chemical modification of smectite, closely linked to the physico-chemical properties of clays, Fe-liberation, water chemistry, elemental cycles, and fault behavior. Especially current researches exploring microbial diversity in the Nankai Trough fault and the influence of illitization on fault behavior emphasize the significance of the microbially induced smectite-to-illite reaction. The dissolution of smectite induced by microbial respiration of Fe in the structure of smectite is a major process that promotes illitization, however direct evidence of K-fixation and K-nontrontie/illite formation is not clearly understood.
The present study demonstrates evidence of biotic illitization during the reductive dissolution of nontronite (NAu-1) associated with microbial Fe-respiration, by the microscopic/spectroscopic measurements of progressive modification in morphology, structure, and elemental composition of bio-reduced nontronite as well as aqueous chemistry in the supernatant as incubation time increased. Fe-reducing bacteria (FeRB), *Shewanella Oneidensis* MR-1 was inoculated in M1 medium with nontronite (NAu-1) less than 0.2 micron as an electron acceptor and Na-lactate as a sole electron donor at 30 degree-Celcius in the anaerobic chamber. The pH was buffered with potassium-phosphate buffer at pH 7.0 and 8.0 for optimum condition for microbial growth and illite formation.
The progress of bio-reduced nontronite reaction can be explained as follows: altered nontronite (AN) with a scouring surface texture →K-nontronite (KN) with frayed edges →euhedral lath shaped illite. A progressive morphology change in bio-reduced nontronite corresponded to an increase in Al/Si and K/(K+2Ca) that ranged between 0.13 to 0.28 and 0.16 to 1.0, suggesting the biotic reductive dissolution of nontronite and neoformation of illite.
The changes in oxidation state of structural Fe and its consequences on the petrophysical properties of clay minerals during the illitization may modify the fault behavior and geological environments.

Keywords: smectite-to-illite reaction, Microbial Fe reduction, Fault property

