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Evidence of microbially-catalyzed Smectite-to-Illite reaction at low-temperature

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K-nontronite, transient phase of microbially-catalyzed illitization, and dissolution of nontronite at the low-temperature condition (4℃) boosted-up by psychrophilic Fe-reducers has been confirmed for the first time, unlike mesophilic and thermophilic condition. Recently, the microbially induced S-I reaction in a natural environment have been reported, however, there is limited research on the microbe-mineral interaction at low-temperature conditions like cryosphere a reason why microbial cultivation at low-temperature conditions is not easy. However, in the present study, the research on the structural and chemical modification of nontronite was conducted using "psychrophiles" that were growing active at low-temperature (4℃). K-nontronite identified in X-ray diffraction profiles (10Å-shoulder after Li-saturation) and transmission electron microscopic (TEM) analysis (Al/Si=~0.3 with K-saturated) suggest that the initial step of biogenic illitization has been progressed even the temperature is extremely low compared to the conventional diagenetic setting. The increases in Fe, Al, and Si concentration in the supernatant were observed, and the formation of vivianite ($Fe_3(PO_4)_2 \cdot 8H_2O$) which are obvious evidence for the reductive dissolution of nontronite. These results collectively suggest that the microbial respiration of psychrophiles at low-temperature could play an important role in the mineral diagenesis and elemental cycle, particularly the supply of the bioavailable Fe in the cryosphere.