Reduction of Structural Fe(III) in Smectite by a Pure Culture of *Shewanella Putrefaciens* Strain MR-1

Joel E. Kostka[1,†], Joseph W. Stucki[2], Kenneth H. Nealson[1] and Jun Wu[2]

[1] Center For Great Lakes Studies, University of Wisconsin—Milwaukee, 600 E. Greenfield Avenue, Milwaukee, WI 53204
[2] Department of Natural Resources and Environmental Sciences, University of Illinois, 1102 South Goodwin Avenue, Urbana, IL 61801

[†] Current Address: Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA 31411.
joel@skio.peachnet.edu

Abstract: *Shewanella putrefaciens* is a species of metal-reducing bacteria with a versatile respiratory metabolism. This study reports that *S. putrefaciens* strain MR-1 rapidly reduces Fe(III) within smectite clay minerals. Up to 15% of the structural Fe within ferruginous smectite (sample SWa-1, Source Clays Repository of the Clay Minerals Society) was reduced by MR-1 in 4 h, and a range of 25% to 41% of structural Fe was reduced after 6 to 12 d during culture. Conditions for which smectite reduction was optimal, that is, pH 5 to 6, at 25 to 37 ° C, are consistent with an enzymatic process and not with simple chemical reduction. Smectite reduction required viable cells, and was coupled to energy generation and carbon metabolism for MR-1 cultures with smectite added as the sole electron acceptor. Iron(III) reduction catalyzed by MR-1 was inhibited under aerobic conditions, and under anaerobic conditions it was inhibited by the addition of nitrate as an alternate electron acceptor or by the metabolic inhibitors tetrachlorosalicylanilide (TCS) or quinacrine hydrochloride. Genetic mutants of MR-1 deficient in anaerobic respiration reduced significantly less structural Fe than wild-type cells. In a minimal medium with formate or lactate as the electron donor, more than three times the amount of smectite was reduced over no-carbon controls. These data point to at least one mechanism that may be responsible for the microbial reduction of clay minerals within soils, namely, anaerobic respiration, and indicate that pure cultures of MR-1 provide an effective model system for soil scientists and mineralogists interested in clay reduction. Given the ubiquitous distribution and versatile metabolism of MR-1, these studies may have further implications for bioremediation and water quality in soils and sediments.

Key Words: Clay • Fe(III) reduction • Metal-reducing bacteria • Sediments • Smectite • Soils

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