Swelling and Texture of Iron-Bearing Smectites Reduced by Bacteria

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Abstract: Microbial reduction of clay mineral structural Fe(III) decreases the swelling of nontronite gels, most importantly at intermediate oxidation states (40 to 80 cmol Fe(II) kg^{-1} clay). The purpose of this study was to establish whether microbial reduction of structural Fe(III) decreased the swelling of other Fe-bearing smectites and to discern the influence that organic compounds of microbial origin (bacterial cells, cell fragments and/or exudates) may have on clay swelling and texture. Structural Fe(III) was reduced by incubating smectite suspensions with either a combination of *Pseudomonas* bacteria or a mixture of anaerobic bacteria. The influence of organics on clay swelling was estimated on smectites suspended in either organic or inorganic media in the absence of bacteria. The gravimetric water content of the reduced clay gels equilibrated at various applied pressures was recorded as a function of Fe oxidation state. Transmission electron microscopy (TEM) was employed to determine the influence of bacteria and type of media on the texture of reduced smectite gels. Reduction of structural Fe(III) by bacteria decreased the swelling pressure of all Fe-bearing smectites. Increased clay swelling, due to the presence of organics (organic medium, exudates or cell fragments), was correlated to the total Fe content, the extent of structural Fe reduction, as well as the initial swelling characteristics of the Fe-bearing smectites. High structural Fe(II) contents (>50 cmol Fe(II) kg^{-1}) resulted in increased attractive forces between clay platelets that decreased clay swelling, even in organic medium suspensions. Microbial reduction resulted in increased face-face association of individual clay layers, forming larger and more distinct crystallite subunits than in nonreduced clay gels. But, perhaps more importantly, microbial reduction of structural Fe(III) resulted in an increased association between crystallite subunits and, thus, an overall larger particle size and pore size distribution, due to the interaction of bacteria ceils, cell fragments and organic exudates.

Key Words: Bacteria • Biological Reduction • Organo-Clay Interactions • Smectites • Structural Iron • Swelling Pressure • Texture

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