Electron shuttling capacity of humic substances in reducing aquifers and their potential role in arsenic mobilization

NATALIE MLADENOV*, HARSHAD KULKARNI[1], MATTHEW KIRK[2] AND DIANE MCKNIGHT[3]

[1]*Department of Civil Engineering, Kansas State University, Manhattan, KS (*correspondence: mladenov@ksu.edu)
[2]Department of Geology, Kansas State University, Manhattan, KS.
[3]Institute for Arctic and Alpine Research, University of Colorado, Boulder, CO.

Dissolved organic matter (DOM) is generally thought of as the labile carbon source and electron donor for microbial iron (Fe) and arsenic (As) reduction in reducing aquifers with elevated As concentration. The fulvic acid fraction of DOM is also biogeochemically important in reducing groundwater, and its presence is indicative of additional roles of DOM, such as complexation, sorption, and electron shuttling reactions that may influence the mobility of As. Previously, analyses of inorganic and organic chemistry in reducing groundwater, spanning a wide spatial extent in Araihazar, Bangladesh, uncovered that there were highly significant relationships between dissolved As, Fe, fulvic acid content, aromaticity, and fluorescence properties. We hypothesized that fulvic acids may enhance As mobility by functioning as electron shuttles to accelerate the microbial reductive dissolution of Fe minerals. We tested this hypothesis with electron shuttling experiments using fulvic acids isolated from natural groundwater environments. Preliminary results indicate that fulvic acids and labile DOM added to a natural consortium of microorganisms, including Fe reducers, increased the reduction of Fe(III) mineral to Fe(II) over trials with labile DOM and Fe-reducers alone.