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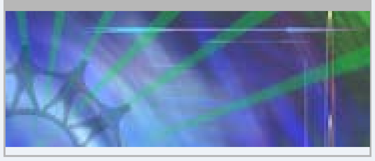

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Award Abstract #0955639

CAREER: Fundamental cell-mineral-redox interactions in the sulfur system

NSF Org:	EAR Division of Earth Sciences
Initial Amendment Date:	June 10, 2010
Latest Amendment Date:	June 10, 2010
Award Number:	0955639
Award Instrument:	Continuing grant
Program Manager:	Marilyn L. Fogel EAR Division of Earth Sciences GEO Directorate for Geosciences
Start Date:	June 15, 2010
Expires:	May 31, 2012 (Estimated)
Awarded Amount to Date:	$189920
Investigator(s):	Gregory Druschel Gregory.Druschel@uvm.edu (Principal Investigator)
Sponsor:	University of Vermont & State Agricultural College 85 SO. PROSPECT ST. BURLINGTON, VT 05405 802/656-3660

NSF Program(s):	GEOBIOLOGY & LOW TEMP GEOCHEM, EDUCATION AND HUMAN RESOURCES
Field Application(s):	0000099 Other Applications NEC
Program Reference Code(s):	OTHR, 9150, 1187, 1045
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ABSTRACT

Greater understanding of redox-active elements like sulfur and iron are key in the processes that affect problems such as ocean transitions through deep time, sour gas and oil evolution, hydrothermal chemistry and the origins of life, the supply of iron to the sea, industrial desulfurization, agricultural sulfur cycling, and metal mobility. Microorganisms have been a potentially important part of sulfur cycling for billions of years (Johnston et al., 2005; Mojzsis et al, 2007), yet many of the fundamental interactions between microorganisms and elemental sulfur are not understood. Advancing our understanding of how these systems behave requires delving into the detailed interactions between cells (bacterial, archaeal, and eukaryotic), minerals (especially nanoparticles), and water chemistry (especially redox speciation).

Intellectual Merit: Elemental sulfur occurs as bulk and nanoparticulate phases and can be utilized by microorganisms for all 3 major catabolic paths through use as an electron acceptor, donor, or essentially both in the case of disproportionation. Dissolved sulfur species also interact with elemental sulfur, and those species can additionally react with metals, most importantly iron. Microorganisms must solubilize elemental sulfur in order to metabolize it, but this mineral is fundamentally different from other minerals where microbe-mineral interactions have been well studied, such as iron oxide minerals (for example Hernandez and Newman, 2001; Childers et al., 2002; Burgon et al., 2003; Lovley, 2008; Newman, 2008). Solubilizing elemental sulfur can be accomplished through interaction with organic ligands or through interactions with other sulfur species to form new soluble intermediates such as polysulfides. Investigator proposes to develop a combined in situ analytical capability to investigate sulfur speciation and elemental sulfur mineralogy in field and laboratory tests to address the following hypothesis: The size and surface character of elemental sulfur is a key component controlling sulfur cycling in biotic and abiotic reactions in many environments.

Broader Impacts: Advances in fundamental cell-mineral-redox interactions in the sulfur system provide an opportunity to integrate some exciting educational experiences to engage stakeholders and professionals in health, policy, and legal fields with research goals that will yield transformative insights of value to the broad study of sulfur-based microorganisms and element cycling through time and in environmentally relevant systems. Sulfur species and minerals are importantly affected by a number of known organisms, but the level of detail proposed for elemental sulfur particle size/character and redox speciation has never been applied. When comparing the wealth of information that has come from years of investigating detailed iron oxide-microbe interactions (Newman, 2008), a detailed investigation of fundamental microbe-mineral-redox interactions involving sulfur may yield critical new insights. The application of the knowledge gained through these investigations of the sulfur system can be applied to broader thinking about similar cell-mineral-redox interactions that affect problems of human health. This opens an opportunity to advance the training of scientists to communicate results with the non-scientific public, and provide training to the medical professionals, policymakers, and legal professionals that utilize mineralogical, geochemical, and microbial information in addressing problems such as asbestos mineral exposure, groundwater arsenic contamination, and selenium toxicity. A series of classes and professional workshops will be developed, alongside a series of learning modules illustrating fundamental cell-mineral-redox interactions, to engage students and professionals in hands-on experiences of how geochemical, mineralogical, and microbial data is gathered, assessed, evaluated, and debated to arrive at reliable information. The participation of stakeholders in the practice of scientific data collection, evaluation, and debate integrated with the training of scientists with better communication skills represents not only an advance in the preparation of scientists, but an advance also in preparing professionals who will work with those scientists.

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