U. S. Department of Energy Office of Science
Subsurface Biogeochemical Research

Subsurface Biogeochemical Research Annual Meeting
April 30 - May 2, 2012
Wardman Park Hotel
Washington, DC

Sunday, April 29		
5:00–7:00 pm	**Evening Registration – *Thurgood Marshall Northeast***	
Monday, April 30		
7:00–8:00 am	**Registration – *Thurgood Marshall Northeast***	
8:00–9:20 am	**Welcome and Introductory Comments**	
	8:00–8:20 am	Gary Geernaert, Director Climate and Environmental Sciences Division
	8:20–8:50 am	David Lesmes (DOE-CESD) ***SBR Program Update***
	8:50–9:05 am	Dan Stover (DOE-CESD) ***TES Program Update***
	9:05–9:20 am	Susan Gregurick (DOE-BSSD) ***Systems Biology Knowledgebase Update***
9:20 am– 12:00 pm	***New Frontiers for Subsurface Biogeochemical Research: Scientific Grand Challenges***	
	9:20–10:05 am	Philippe van Cappellen, University of Waterloo ***Elemental Biogeochemical Cycles in Subsurface Environments***

	10:05–10:35 am	**Break**
	10:35–11:20 am	Evan DeLucia, University of Illinois ***Scientific Grand Challenges for Understanding the Role of Soil Systems in Sustainable Feedstock Production***
	11:20–11:40 am	Bill Riley, Lawrence Berkeley National Laboratory ***Challenges for Understanding and Modeling Carbon and Nutrient Cycling and Microbiological Processes in Terrestrial Ecosystems – Part I***
	11:40 –12:00 pm	Eoin Brodie, Lawrence Berkeley National Laboratory ***Challenges for Understanding and Modeling Carbon and Nutrient Cycling and Microbiological Processes in Terrestrial Ecosystems – Part II***
12:00–2:00 pm	**Buffet Lunch and Presentation** Speaker: Todd Anderson, Director, Biological Systems Science Division	
2:00–5:30 pm	**Breakout Sessions** ***New Frontiers for Subsurface Biogeochemical Research***	
2:00–5:30 pm	***Breakout Session 1: Elemental Biogeochemical Cycles in Terrestrial Environments*** **Session Chairs:** Harry Beller (LBNL), Liyuan Liang (ORNL), and John Zachara (PNNL) **Panelists:** Derek Lovley (University of Massachusetts), Francois Morel (Princeton University), Tim Scheibe (PNNL), Jeremy Smith (University of Tennessee), Anne Summers (University of Georgia), and Philippe van Cappellen (University of Waterloo) **Objective:** The EMSP/NABIR/SBR programs have defined the state of fundamental science in contaminant biogeochemistry and metal/radionuclide fate and transport over the past 10 years. Seminal impacts to this scientific area have been made by many publications, the development of multidisciplinary approaches, and the performance of sophisticated field studies of unique character. While previous research has focused on the subsurface environment, elemental cycling facilitated by biosphere-metal interactions occurs more broadly in terrestrial environments including soil, groundwater, and freshwater sediments. Biosphere-metal interactions critically	

	affect all ecosystems and respond in a dynamic manner to climatic and other environmental changes on all scales. Scientific understanding of these diverse, complex, and far-reaching processes, together with their rates, interactions, and impacts, is uneven. The intent of this session is to identify impactful scientific grand challenges (GCs) in elemental biogeochemical cycling (e.g., S, Fe/Mn, Si, trace elements, etc.) in terrestrial environments to guide future research. **Content:** A panel and audience discussion will identify fundamental scientific grand challenges (GC) in elemental biogeochemistry and multidisciplinary approaches to resolve them. Environments to be considered include soils, the vadose zone, groundwater, the groundwater-river mixing zone, and the hyphoreic zone. The focus will be on elemental cycling challenges that involve coupled microbiologic, hydrologic, and geochemical processes and that require a combination of molecular, mechanistic, and systems-scale approaches for comprehensive resolution and environmental prediction. The session will also consider responses of elemental biogeochemical cycling to climatic and other dynamic environmental changes. Discussions will identify two to three impactful grand challenges, example environments where they could be evaluated, balances between fine-scale and systems-scale research, and new modeling approaches that might be required.
2:00–5:30 pm	***Breakout Session 2: Toward an Integrated, Process-Level View of Biogeochemical Cycling and Carbon Flow within Terrestrial Systems*** **Session Chairs:** Baohua Gu (ORNL), Susan Hubbard (LBNL), and Alan Konopka (PNNL) **Panelists:** Jon Chorover (University of Arizona), Evan DeLucia (University of Illinois), Mary Firestone (UC Berkeley), TC Onstott (Princeton University), and Bill Riley (LBNL) **Objective:** Managed and natural terrestrial ecosystems are critically important for sustaining life. The interactions between the solid, aqueous, and biological components of ecosystem soils and underlying sediments regulate the geochemical fluxes of most life-critical elements, control the production of food and biofuel feedstock, and regulate greenhouse gases. Despite decades of research on carbon cycling in terrestrial ecosystems and the clear importance of these systems for bioenergy and climate change, a predictive understanding of the physical, chemical, and biological interactions that occur across scales and through various linked compartments of the system (atmosphere-plant-soil-vadose zone-groundwater-surface water) remains elusive. The lack of understanding hinders our ability to predict and optimize ecosystem behavior, both under current and future environmental conditions.

	BER has the potential to advance such a predictive understanding through the linkage of the SBR, Terrestrial Ecosystem Science (TES), Climate Science, and BSSD programs. Recognition of the hierarchical nature and complex interactions between system components, innovative multi-disciplinary approaches, sophisticated new instrumental platforms and "omics" technologies, and multi-scale mechanistic models developed through SBR research on contaminant biogeochemistry have great potential to advance a process-level understanding of biogeochemical cycles and carbon fluxes within terrestrial ecosystems. Such understanding is required for improved predictions and ultimately for sustainable management of natural and managed ecosystems. This breakout session will explore grand challenges that leverage SBR multi-process expertise to questions of how biogeochemical cycles coupled to hydrological fluxes impact carbon dynamics in multi-compartment terrestrial systems. **Content:** The breakout session will identify research grand challenges (GCs) related to developing a predictive understanding of the biogeochemical basis (broadly defined) of carbon cycling; carbon storage, transformation, and sequestration; and C exchange and redistribution in complex, multi-compartment terrestrial systems. The GCs will involve coupled processes; explicitly consider the range of space and time scales relevant to energy and environmental sustainability; have field relevance and linkage; be complementary to research directions in TES; and benefit from the research perspectives and approaches developed collectively by the SBR community including environmental "omics," molecular spectroscopy and analysis, multi-process modeling, and field characterization, monitoring, and experimentation. Deliberations will refine candidate GCs to a few examples and identify associated (i) science questions to guide scale-specific studies, (ii) molecular- to field-scale experimental and monitoring approaches that might be applied, (iii) ecosystem field site characteristics desirable for performing impactful science, and (iv) opportunities for the development of robust, process-level biogeochemical models of carbon cycling in multi-scale terrestrial systems. The session will conclude with an important discussion on how process-level models of biogeochemical cycles could contribute to improved management of ecosystem-level carbon fluxes and transformation rates.
2:00–5:30 pm	***Breakout Session 3: Subsurface Biogeochemical Processes Associated with Energy Production, Usage, and Storage*** **Session Chairs:** Scott Brooks (ORNL), Jim Fredrickson (PNNL), and Carl Steefel (LBNL) **Panelists:** Rick Colwell (Oregon State University), Li Li (Penn State University), George

	Redden (INL), and Ken Williams (LBNL) **Objective:** Many energy-related activities perturb the biogeochemistry of the subsurface or are themselves influenced by biogeochemical processes. A prime example is the design of geological nuclear waste repositories, where the impact of biogeochemical processes on far-field radionuclide transport will be substantial. Microbially-enhanced hydrocarbon recovery (MEHR) is another example in which perturbation of the subsurface microbiological and biogeochemical environment is used for energy extraction purposes. More knowledge is also needed of how greenhouse gas fluxes are modified by biogeochemical processes in the subsurface; the release of methane from methane hydrates due to global warming is now treated as a purely physical/hydrological process but is likely to be far more complex. Another example involves the leakage of geologically stored CO_2 into drinking water aquifers, where acidification may significantly alter the biogeochemical status and where toxic metals may be potentially mobilized. The objective of this breakout session is to address the question of how energy production, usage, and storage of byproducts can impact the biogeochemistry of the subsurface, as well as to consider how the ambient or perturbed biogeochemical environment can impact the energy production and storage schemes. **Content:** The breakout session will identify fundamental biogeochemical grand challenges associated with the production, usage, and storage of energy in the subsurface. While these topics have been addressed by applied DOE programs for improving process efficiencies, a firm scientific underpinning for understanding the full system behavior is lacking. An overall goal is to identify cross-cutting fundamental science issues or knowledge gaps associated with multi-scale, biogeochemical reactive transport whose resolution could advance safe extraction, isolation, or storage technologies. The breakout will consider the far-field impacts of biogeochemistry on the effective design of geological nuclear waste repositories, the effects of enhanced gas recovery and carbon sequestration on subsurface microbiologic communities and their biogeochemical function, and perturbations to the subsurface as a result of inadvertent hydrocarbon releases. The effect of biogeochemistry on carbon fluxes in the deep subsurface (as distinct from the soil environment) as related to climate change will also be addressed. A desired outcome is the identification of fundamental biogeochemical research topics applicable to multiple emerging DOE mission areas.
6:00–8:30 pm	***Poster Session I – Thurgood Marshall Southwest***

Tuesday, May 1

8:00–10:00 am	**Plenary Session I – *Thurgood Marshall Northeast***	
	8:00–8:20 am	Robin Gerlach, Montana State University ***Mixing-, Reaction-, and Transport-Controlled Microbial Activity and Carbonate Mineral Precipitation in Porous Media***
	8:20–8:40 am	Gemma Reguera, Michigan State University ***Extracellular Reduction of Uranium via* Geobacter *Conductive Pili as a Cellular Protective Mechanism***
	8:40–9:00 am	Derek Lovley, University of Massachusetts ***New Biological Paradigms Emerging from Bioremediation Research***
	9:00–9:20 am	Eric Roden, University of Wisconsin ***Microbial Oxidation of Insoluble Fe(II)-Bearing Minerals Relevant to the Hanford 300 Area and Other Subsurface Environments***
	9:20–9:40 am	David Richardson, University of East Anglia ***Exploring the Biology of Microbe-to-Mineral Electron Transfer at Nanometer Resolution***
	9:40–10:00 am	Kevin Rosso, Pacific Northwest National Laboratory ***Molecular Structure and Electron Transfer in Microbial Cytochromes***
10:00–10:30 am	**Break**	
10:30 –12:30 pm	**Poster Session II – *Thurgood Marshall Southwest***	
12:30–1:30 pm	**Boxed Lunch**	

1:30–5:30 pm	**Plenary Session II – *Thurgood Marshall Northeast***	
	1:30–1:50 pm	Kim Hayes, University of Michigan ***Impact of Iron Sulfide on the Oxidative Dissolution of Reduced Uranium***
	1:50–2:10 pm	Paul Tratnyek, Oregon Health and Science University ***Technetium Reduction and Long-Term Sequestration by Iron/Iron-Sulfide Nanoparticles***
	2:10–2:30 pm	Yu Yang, Auburn University ***Coupling Microscale Processes with Macroscale Migration for Actinides: From Dissolution and Reduction of Crystals to Column Transport***
	2:30–2:50 pm	Kathy Nagy, University of Illinois at Chicago ***On the Stickiness of Mercury(II) to Soil Components and EFPC Soils***
	2:50–3:10 pm	Anne Summers, University of Georgia ***Bacteria in the Global Mercury Cycle: From Y-12 to Clean Coal and Beyond***
	3:10–3:30 pm	Jeremy Smith, University of Tennessee ***Simulations of Mercury: Inside and Outside the Bacterial Cell***
3:30–4:00 pm	**Break**	
4:00–5:30 pm	***New Insights for Subsurface Microbial Ecology***	
	4:00–4:30 pm	Chris Marx, Harvard University ***Evolution and Modeling of Synthetic Microbial Communities***
	4:30–5:00 pm	Jill Banfield, University of California at Berkeley ***Novel Organisms and Pathways Contribute to Coupled Carbon and Geochemical Cycling in Complex Subsurface Microbial Communities***

	5:00–5:30 pm	Tim Scheibe, Pacific Northwest National Laboratory ***Complex Challenges in Science-Based Predictive Simulation: From Fundamental to Field Scales***
6:00–8:30 pm	**Poster Session III – *Thurgood Marshall Southwest***	

Wednesday, May 2

8:00–9:30 am	**Plenary Session III -** ***IFRC Presentations***	
	8:00–8:20 am	Baohua Gu, Oak Ridge National Laboratory ***Oak Ridge-IFRC Science Talk***
	8:20–8:50 am	Scott Brooks, Oak Ridge National Laboratory ***Accomplishments and Remaining Challenges***
	8:50–9:10 am	Xingyuan Chen, Pacific Northwest National Laboratory ***Hanford-IFRC Science Talk***
	9:10–9:40 am	John Zachara, Pacific Northwest National Laboratory ***Accomplishments and Remaining Challenges***
	9:40–10:00 am	Steve Yabusaki, Pacific Northwest National Laboratory ***Old Rifle-IFRC Science Talk***
	10:00–10:30 am	Phil Long, Lawrence Berkeley National Laboratory ***Accomplishments and Remaining Challenges***
10:30–11:00 am	**Break**	
11:00 am–12:30 pm	**Plenary Discussion**	

	11:00–11:20 am	Report Out: Breakout Session 1
	11:20–11:40 am	Report Out: Breakout Session 2
	11:40–12:00 pm	Report Out: Breakout Session 3
	12:00–12:30 pm	Discussion
12:30 pm	**Final Announcements and Adjourn**	