The 17th Annual Environmental Chemistry and Microbiology Student Symposium

March 28-29, 2014
The Pennsylvania State University
University Park, PA
The 17th Annual Environmental Chemistry and Microbiology Student Symposium (ECMSS) at Penn State University is proudly presented by the Center for Environmental Chemistry and Genomics (CECG), the Environment and Natural Resources Institute (ENRI), the Engineering Energy and Environment Institute (E3I), Penn State Institutes of Energy and the Environment (PSIEE), the Office of Educational Equity in the College of Earth and Mineral Sciences, and the Student Association of Environmental Science and Engineering (SAESE).

Cover photo:

First Place Winner of the ECMSS Photo Contest: Mark Ullery

Green River Overlook, Canyonlands National Park, Utah. Over hundreds of millions of years, sedimentary deposits and uplift have shaped the Colorado Plateau, while the Green and Colorado Rivers have eroded a path through it, creating the sheer walls and deep canyons visible today. Harder igneous rock deposits, formed when magma rose through cracks generated when the plateau was uplifted, were exposed after the surrounding sedimentary layers eroded forming the Abajo Mountains, visible in the distance.
Table of Contents

Welcome Letter .................................................................1

ECMSS Featured Keynote Speakers

   Dr. David Sedlak, UC-Berkley ...........................................2
   Dr. Markus Buehler, MIT ..................................................3
   Dr. Richard Alley, PSU .....................................................4

Symposium Itinerary ........................................................5

Overview of Student Presentation Sessions ..........................7

Poster Presentation Abstracts .............................................9

Oral Presentation Abstracts ..............................................29

Environmental Chemistry and Microbiology Resources @ Penn State ..............................38

Published Works from Past ECMSS Presenters .........................65

Acknowledgements from the ECMSS Co-Chairs ..........................68
Welcome!

The organizing committee of the 2014 Environmental Chemistry and Microbiology Student Symposium (ECMSS) welcomes you to Penn State University’s main campus in University Park, PA. ECMSS (formerly ECSS) is a long standing tradition at Penn State that brings together graduates, undergraduates, and faculty members engaged in environmentally-relevant research, with this year marking the 17th consecutive year of the event. ECMSS is entirely organized by an interdisciplinary graduate student committee, whose members, over the years, have worked to provide a unique, enriching opportunity to the environmental science and engineering community at Penn State.

This year, the ECMSS organizing committee is honored to host three keynote speakers, including Dr. David Sedlak (University of California, Berkley), Dr. Markus Buehler (Massachusetts Institute of Technology), and Dr. Richard Alley (The Pennsylvania State University). Additionally, we are proudly hosting 56 student presenters from Penn State as well as several regional universities. Our Penn State participants include students from the Departments of Ecosystem Science and Management, Plant Pathology and Environmental Microbiology, Entomology, Animal Science, and Food Science in the College of Agricultural Sciences; the Departments of Meteorology, Geosciences, and Materials Science and Engineering in the College of Earth and Mineral Sciences; the Departments of Agricultural and Biological Engineering, Civil and Environmental Engineering, and Chemical Engineering in the College of Engineering; the Departments of Chemistry, Biochemistry and Molecular Biology, and Biology in the Eberly College of Science. Additionally, we are pleased to welcome several students from Lock Haven University, Cornell University, and Millersville University.

The ECMSS organizing committee has spent months preparing for this year’s event, which would not be possible without the generous support of our sponsors. We would like to recognize and thank the Center for Environmental geoChemistry and Genomics (CECG), the Environment and Natural Resources Institute (ENRI, part of the College of Agricultural Sciences), the Penn State Institutes of Energy and the Environment (PSIEE), the Engineering Energy and Environment Institute (E²I) of the College of Engineering, the Office of Educational Equity in the College of Earth and Mineral Sciences, Penn State’s Student Association of Environmental Science and Engineering (SAESE), and the University Park Allocation Committee (UPAC). Funding for monetary awards was generously donated by the Departments of Plant Pathology & Environmental Microbiology, Chemistry, Meteorology, Agricultural & Biological Engineering, and Ecosystem Science & Management.

We thank you for joining us for this year’s ECMSS, and encourage you to enjoy the keynote addresses as well as the student poster and oral presentation sessions. Additionally, we hope you will take the opportunity to forge new connections and gain new insights into other disciplines by communicating with your fellow environmental scientists and engineers. We appreciate your participation this year, and invite you to continue to be a part of the Environmental Chemistry and Microbiology Student Symposium for years to come.

Regards,
The 2014 ECMSS Graduate Student Organizing Committee
The 17th Annual ECMSS Keynote Speakers

Dr. David Sedlak

Professor of Civil and Environmental Engineering
Director, Institute for Environmental Science and Engineering
University of California-Berkeley

Biography

David Sedlak is the Malozemoff Chair Professor in the Department of Civil and Environmental Engineering at the University of California at Berkeley, where he is co-Director of the Berkeley Water Center and Deputy Director of the NSF Engineering Research Center for the Reinvention of Urban Water Infrastructure (http://www.renuwit.org). Much of Dr. Sedlak’s current research addresses the fate and transport of organic contaminants in wastewater-impacted waters. This research has included investigations of the fate of steroid hormones in surface waters, control of the formation of the potent carcinogen NDMA in advanced water reclamation facilities and the transformation of pharmaceuticals in effluent-dominated surface waters and engineered treatment wetlands. Dr. Sedlak has served on numerous government advisory panels including the National Research Council’s Committee on Water Reuse and the EPA Science Advisory Board. He also is an Associate Editor for the American Chemical Society journal, Environmental Science & Technology.

Trace Organic Contaminants and the Fourth Water Revolution

Abstract: Throughout history, the expansion of cities has necessitated the development of new approaches for managing the urban water cycle. Fundamental changes in water systems usually occur abruptly, as society recognizes that existing technologies are no longer able to achieve the goals of protecting public health and assuring a reliable source of water. Population growth, climate change and under-investment in existing assets are currently creating conditions that are conducive to a fourth revolution in urban water systems. In many cases, the need to create water supplies that are less susceptible to droughts will require the exploitation of sources that currently are not considered fit for potable use (e.g., wastewater effluent, urban runoff). Furthermore, a growing recognition of the impacts of trace organic contaminants on aquatic ecosystem is leading to calls to rethink municipal wastewater treatment and stormwater management. Advanced treatment systems and actively managed natural systems provide an option for removing chemical contaminants from these water sources. By considering examples of regions where water systems are undergoing transformation, insight can be gained into the environmental chemistry research needed to support the transition to more resilient and effective urban water infrastructure.

Photo Credit: http://www.ce.berkeley.edu/~sedlak/
Dr. Markus J. Buehler

Professor of Civil and Environmental Engineering
Director, MIT-Germany Program
Massachusetts Institute of Technology

Biography

Dr. Buehler is the Department Head of Civil and Environmental Engineering at MIT and is the Principal Investigator at the Laboratory for Atomistic and Molecular Mechanics (LAMM). His research interests include materials science of natural, biological and synthetic materials with a specific focus on materials that provide mechanical functions such as bones and collagen. Dr. Buehler has published over 200 peer-reviewed articles, as well as several books and book chapters. He is distinguishing himself early in his career in the materials science field, having been awarded The Mineral, Metals and Materials Society (TMS) Robert Lansing Hardy Award, the National Science Foundation CAREER Award, the United States Air Force Young Investigator Award, the Navy Young Investigator Award, and the DARPA Young Faculty Award. Dr. Buehler has also received the Presidential Early Career Award for Scientists and Engineers (PECASE), the highest honor presented by the United States government to young researchers, and also shared the Alfred Nobel Prize in 2009.

Bioinspired materials: From chemistry to functionality, for sustainability

What if we could design materials that integrate powerful concepts of living organisms – self-organization, the ability to self-heal, and an amazing flexibility to create astounding material properties from abundant and inexpensive raw materials? This talk will present a comprehensive review of bottom-up analysis and design of materials for various purposes – as structural materials such as bone in our body or for lightweight composites, for applications as coatings, and as multifunctional sensors to measure small changes in temperature or stress. These new materials are designed from the bottom up and through a close coupling of experiment and powerful computation as we assemble structures, atom by atom. Materiomics investigates the material properties of natural and synthetic materials by examining fundamental links between processes, structures and properties at multiple scales, from nano to macro, by using systematic experimental, theoretical or computational methods. We review case studies of joint experimental-computational work of biomimetic materials design, manufacturing and testing for the development of strong, tough and mutable materials for applications as protective coatings, cables and structural materials. We outline challenges and opportunities for technological innovation, exploiting novel concepts of mathematics based on category theory, which leads to a new way to organize hierarchical structure-property information. Altogether, the use of a new paradigm to design materials from the chemistry scale up plays a critical role in advanced manufacturing, providing flexibility and efficiency.

Photo Credit: https://cee.mit.edu/buehler
Dr. Richard Alley

Evan Pugh Professor of Geosciences
The Pennsylvania State University

Biography

Dr. Alley is a current Evan Pugh Professor of Geosciences and the Earth and Environmental Systems Institute at Penn State and is a leading research scientist in regional and global climate change as well as glaciology. He received his Ph.D. in Geology from the University of Wisconsin-Madison in 1987, and has contributed vastly to knowledge on abrupt climate change, ice sheets and glaciers, and measurement of ice-core sample properties for paleoclimatic studies. Dr. Alley has been called on to testify before numerous governmental committees and participated in the 2007 Nobel Peace Prize winning Intergovernmental Panel on Climate Change Fourth Assessment. Dr. Alley has contributed to well over 200 refereed publications including several books, one of which recently supplemented a 2012 PBS TV mini-series he hosted called “Earth – The Operators’ Manual.” Dr. Alley was elected to the National Academy of Sciences (NAS) in 2008, and is among a select group honored with the 2014 Arthur L. Day Prize and Lectureship by the National Academy of Sciences.

Abstract: A remarkable suite of chemical, biological, physical and isotopic indicators supplies a surprisingly clear picture of the history of Earth's climate and of the factors that cause it to change. Perhaps surprisingly, amid the complexity of wobbling orbits, brightening sun, drifting continents, and more, CO2 emerges as the most important influence, confirming the importance of human influence on carbon cycling.
Symposium Itinerary

Friday, March 28
2:00-4:00pm  Registration, Presentation Upload, and Poster Setup
4:00-5:00pm  **Opening Keynote Address, Dr. David Sedlak (UC-Berkeley)**
              “*Trace Organic Contaminants and the Fourth Water Revolution*”

5:00-6:00pm  Poster Session I (with catered dinner)
6:00-7:00pm  Poster Session II (with catered dinner)

Saturday, March 29
8:00-9:10am  Late Registration and Breakfast
9:10-9:20am  Opening Remarks
9:20-10:05am Oral Presentation Session I

<table>
<thead>
<tr>
<th>Time Slot</th>
<th>Last Name</th>
<th>First Name</th>
<th>Presentation Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:20-9:35a</td>
<td>Smyth</td>
<td>Christopher</td>
<td>Application of the Alternative Host Hypothesis Elucidates Potential Virulence Genes in <em>Pseudogymnoascus destructans</em></td>
</tr>
<tr>
<td>9:35-9:50a</td>
<td>Brandt</td>
<td>Leah</td>
<td>Microbial diversity within the Okinawa backarc basin subvent biosphere</td>
</tr>
<tr>
<td>9:50-10:05a</td>
<td>Boettger</td>
<td>Jason</td>
<td>Kinetic Isotope Effects in the CO₂ Hydration/hydroxylation Reaction: Implications for ¹³C and ¹⁸O Isotopic Signatures in Corals</td>
</tr>
</tbody>
</table>

10:10-10:20am Break
10:20-11:20am Oral Presentation Session II

<table>
<thead>
<tr>
<th>Time Slot</th>
<th>Last Name</th>
<th>First Name</th>
<th>Presentation Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:20-10:35a</td>
<td>Sihvonen</td>
<td>Sarah</td>
<td>The Impact of Chemical Processing on the Ice Nucleation Ability of Common Ice Cloud Nuclei</td>
</tr>
<tr>
<td>10:35-10:50a</td>
<td>Peng</td>
<td>Xin</td>
<td>Biologically Renewable Soil Nitrogen: Simulation of BSC Dynamics after Applying Cyanobacteria to Agricultural Soil</td>
</tr>
<tr>
<td>10:50-11:05a</td>
<td>Reed</td>
<td>Andra</td>
<td>Impacts of Sea Level Rise, Tropical Cyclones, and Storm Surge on Coastal Inundation in New York and New Jersey</td>
</tr>
<tr>
<td>11:05-11:20a</td>
<td>Rutt</td>
<td>Kaitlin</td>
<td>The impact of mesoscale circulations on boundary layer evolution and air quality during DISCOVER-AQ.</td>
</tr>
</tbody>
</table>

11:20am - 11:35am Break
11:35am-12:35pm  
**Featured Keynote Address, Dr. Markus Buehler (MIT)**

“Bioinspired materials: From chemistry to functionality, for sustainability”

12:35-1:15pm  
Catered Lunch

1:15-2:15pm  
Oral Presentation Session III

<table>
<thead>
<tr>
<th>Time Slot</th>
<th>Last Name</th>
<th>First Name</th>
<th>Presentation Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:15-1:30p</td>
<td>Coban</td>
<td>Hasan Bugra</td>
<td>Enhanced Submerged Phytase Fermentation with <em>Aspergillus ficuum</em> by Optimization of Process Conditions for Batch and Fed-batch Fermentations</td>
</tr>
<tr>
<td>1:30-1:45p</td>
<td>Zuroff</td>
<td>Trevor</td>
<td>Insights into <em>Clostridium phytofermentans</em> Biofilm Formation: Aggregation, Micro-colony Development and the Role of Extracellular DNA</td>
</tr>
<tr>
<td>1:45-2:00p</td>
<td>Xiong</td>
<td>Boya</td>
<td>Integrating membrane separations with acidogenic digestion of lignocellulosic biomass for enhanced productivity</td>
</tr>
<tr>
<td>2:00-2:15p</td>
<td>Kashima</td>
<td>Hiroyuki</td>
<td>Nitrate Respiration Versus Electrode Respiration: Facultative Nitrate Reduction by Current-Producing Biofilms in a Bioelectrochemical System</td>
</tr>
</tbody>
</table>

2:15-2:25pm  
Break

2:25-3:25pm  
Oral Presentation Session IV

<table>
<thead>
<tr>
<th>Time Slot</th>
<th>Last Name</th>
<th>First Name</th>
<th>Presentation Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:25-2:40p</td>
<td>Ling</td>
<td>Florence</td>
<td>Sorption of Contaminant Lead (Pb) with Triclinic and Hexagonal Birnessite</td>
</tr>
<tr>
<td>2:55-3:05p</td>
<td>Yesavage</td>
<td>Tiffany</td>
<td>Chemical Weathering and Fe Isotope Fractionation in Regolith Overlying a Diabase: Fe Cycling at the Bedrock/Regolith Interface in Pennsylvania</td>
</tr>
<tr>
<td>3:05-3:20p</td>
<td>Harouaka</td>
<td>Khadouja</td>
<td>Determination of a Ca Isotopic Biosignature in Microbially Mediated Gypsum Precipitates</td>
</tr>
</tbody>
</table>

3:20-3:35pm  
Coffee Break

3:35-4:35pm  
**Closing Keynote Address, Dr. Richard Alley (PSU)**

“Reading the dial on the biggest control knob: A short history of 4.6 billion years of Earth’s climate”

4:35-5:30pm  
Awards Ceremony and Concluding Remarks

5:30-6:15pm  
Poster Removal
## Overview of Student Presentation Sessions

**Poster Session I (Friday 5:00-6:00pm)**

<table>
<thead>
<tr>
<th>Poster No.</th>
<th>Last Name</th>
<th>First Name</th>
<th>Presentation Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ajeng</td>
<td>Laing</td>
<td>Beatrice</td>
</tr>
<tr>
<td>2</td>
<td>Atyeo</td>
<td>Sara</td>
<td>Callaghan</td>
</tr>
<tr>
<td>3</td>
<td>Bardsley</td>
<td>Sarah</td>
<td>Callaghan</td>
</tr>
<tr>
<td>4</td>
<td>Bogale</td>
<td>Haikel</td>
<td>Coban</td>
</tr>
<tr>
<td>5</td>
<td>Callaghan</td>
<td>Jake</td>
<td>Coban</td>
</tr>
<tr>
<td>6</td>
<td>Franklin</td>
<td>Allison</td>
<td>Franklin</td>
</tr>
<tr>
<td>7</td>
<td>Grettenberger</td>
<td>Ian</td>
<td>Franklin</td>
</tr>
<tr>
<td>8</td>
<td>Keyes</td>
<td>Nicholas</td>
<td>Grettenberger</td>
</tr>
<tr>
<td>9</td>
<td>Locke</td>
<td>Nicholas</td>
<td>Keyes</td>
</tr>
<tr>
<td>10</td>
<td>Mansor</td>
<td>Muammar</td>
<td>Locke</td>
</tr>
<tr>
<td>11</td>
<td>Ng</td>
<td>Xwei Fun</td>
<td>Mansor</td>
</tr>
<tr>
<td>12</td>
<td>Perry</td>
<td>Alexandra</td>
<td>Ng</td>
</tr>
<tr>
<td>13</td>
<td>Ramos</td>
<td>Laura</td>
<td>Perry</td>
</tr>
<tr>
<td>14</td>
<td>Saia</td>
<td>Sheila</td>
<td>Ramos</td>
</tr>
<tr>
<td>15</td>
<td>Tsao</td>
<td>Leah</td>
<td>Saia</td>
</tr>
<tr>
<td>16</td>
<td>Ullery</td>
<td>Mark</td>
<td>Tsao</td>
</tr>
<tr>
<td>17</td>
<td>Wasilko</td>
<td>Nathan</td>
<td>Ullery</td>
</tr>
<tr>
<td>18</td>
<td>Zhang</td>
<td>Liang</td>
<td>Wasilko</td>
</tr>
<tr>
<td>19</td>
<td>Zuroff</td>
<td>Trevor</td>
<td>Zhang</td>
</tr>
<tr>
<td>20</td>
<td>Zuroff</td>
<td>Trevor</td>
<td>Zuroff</td>
</tr>
<tr>
<td>Poster No.</td>
<td>Last Name</td>
<td>First Name</td>
<td>Presentation Title</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------</td>
<td>------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>21</td>
<td>Alstadt</td>
<td>Valerie</td>
<td>Heterogeneous Chemistry of Aged Mineral Dust</td>
</tr>
<tr>
<td>22</td>
<td>Altaf</td>
<td>Muhammad</td>
<td>Understanding the Structure of Organic Aerosol through Cavity Ring-Down Spectroscopy and Transmission Electron Microscopy</td>
</tr>
<tr>
<td>23</td>
<td>Baier</td>
<td>Bianca</td>
<td>‘Direct Measurements of Ozone Production Rates in Houston, TX</td>
</tr>
<tr>
<td>24</td>
<td>Balashov</td>
<td>Nikolai</td>
<td>Long-term Ozone Variability in San Joaquin Valley, CA</td>
</tr>
<tr>
<td>25</td>
<td>Edwards</td>
<td>Rebecca</td>
<td>Quantifying Iron Mineral Redox Properties to Estimate Contaminant Fate</td>
</tr>
<tr>
<td>26</td>
<td>Fine</td>
<td>Aubrey</td>
<td>The Persistence of a Set of Biomolecules Along a Vertical Decomposition Gradient in a Temperate Forest Surface Soil</td>
</tr>
<tr>
<td>27</td>
<td>Guarriello</td>
<td>Felicia</td>
<td>Chemical Dynamics Driving NO$_2$ in the Lower Troposphere at Rural Sites During DISCOVER-AQ: A Comparison Between and Inland Wintertime Site and a Coastal Summertime Site</td>
</tr>
<tr>
<td>28</td>
<td>Haines</td>
<td>Joshua</td>
<td>Aging of Laboratory Proxies for Organic and Mineral Dust Aerosol</td>
</tr>
<tr>
<td>29</td>
<td>Halliday</td>
<td>Hannah</td>
<td>Preliminary VOC Analysis from Porterville, CA During the 2013 NASA DISCOVER-AQ Campaign</td>
</tr>
<tr>
<td>30</td>
<td>Jansen</td>
<td>Kevin</td>
<td>Effects of Acid Treatment on Ice Nucleation Ability of Mineral Dust</td>
</tr>
<tr>
<td>31</td>
<td>Joshi</td>
<td>Prachi</td>
<td>Heavy Metal Release and Incorporation by Siderite (FeCO$_3$) in Soils and Sediments</td>
</tr>
<tr>
<td>32</td>
<td>LaFemina</td>
<td>Nikki</td>
<td>Diffusion and Conduction of Lithium Cations in Poly(Ethylene Oxide) Based Sulfonate Ionomer</td>
</tr>
<tr>
<td>33</td>
<td>Mina</td>
<td>Odette</td>
<td>Assessing The Presence of Endocrine Disrupting Compounds in Vernal Pools</td>
</tr>
<tr>
<td>34</td>
<td>Serino</td>
<td>Michelle</td>
<td>Trace Gas and Particle Measurements Made at Rural Sites During DISCOVER-AQ: A Comparison of Trends Between Sites</td>
</tr>
<tr>
<td>35</td>
<td>Stager</td>
<td>Jennifer</td>
<td>Applications of a Larger-scale MFC for Wastewater Treatment and Power Production</td>
</tr>
<tr>
<td>36</td>
<td>Teachout</td>
<td>Angelo</td>
<td>Determination of the Soil Dispersivity Coefficient using Tracer Analysis at the Living Filter</td>
</tr>
<tr>
<td>37</td>
<td>Veghte</td>
<td>Daniel</td>
<td>Relationship of Particle Composition to the Deactivation of Heterogeneous Ice Nucleation of Ambient Aerosol in Ulaanbaatar, Mongolia</td>
</tr>
<tr>
<td>38</td>
<td>Weitzman</td>
<td>Julie</td>
<td>Quantifying the Nitrogen Retention Capacity of Legacy Sediments and Relict Hydric Soils</td>
</tr>
<tr>
<td>39</td>
<td>Xiong</td>
<td>Boya</td>
<td>Integrating Membrane Separations with Acidogenic Digestion of Lignocellulosic Biomass for Enhanced Productivity</td>
</tr>
</tbody>
</table>
Second Place Winner of the ECMSS Photo Contest: Jiang Ming

**Poster Session I**

**Isolating Potential N\textsubscript{2}-fixing Microorganisms in Biological Soil Crusts for the Development of Biofertilizers**

Ajeng Laing, Beatrice \textsuperscript{a}* and Bruns, Mary Ann\textsuperscript{b}

\textsuperscript{a}Huck Institutes of the Life Sciences, The Pennsylvania State University  
\textsuperscript{b}Ecosystem Science and Management, The Pennsylvania State University  
*Corresponding author: baa5181@psu.edu

**Abstract:**  
Modern agriculture involves intensive use of industrially fixed nitrogen (N) fertilizers, but low N use efficiency results in only about half of applied N taken up by crops. Enhanced use of biological N\textsubscript{2} fixation can reduce the need for industrially fixed N, while lowering energy consumption and minimizing negative environmental impacts of N loss. We propose that biologically fixed N has longer retention time in soil than industrially fixed N, because it enters soils via microbial cells and plant tissues, which must first die and undergo decomposition before NH\textsubscript{4}\textsuperscript{+} is released and nitrified. To develop a renewable “bio”-alternative as a partial substitute for industrial fertilizers, we are investigating biological soil crusts (BSCs) containing complex communities of N\textsubscript{2}-fixing bacteria and other organisms as possible sources of soil N. In this project, we sampled crusts from Rock Springs Agronomy Farm and isolated local strains of N\textsubscript{2}-fixing microorganisms using BG-II medium. The sequences of 16S rRNA and 18S rRNA genes of these microorganisms were analyzed. The potential contribution of free-living N\textsubscript{2}-fixing microorganisms to soil fertilization makes their management a great prospect for sustainable agricultural practice.

**Acyl Carrier Protein: A Novel Factor in Fire Blight Disease Development**

Atyeo, Sara\textsuperscript{a}, Lee, S.A.\textsuperscript{a}, Lehman, B.\textsuperscript{a}, Sinn, J.B.\textsuperscript{a}, Pfeufer, E.E.\textsuperscript{a}, and McNellis, T.W.\textsuperscript{a}

\textsuperscript{a}Department of Plant Pathology & Environmental Microbiology, The Pennsylvania State University  
*Corresponding author: smk417@psu.edu

**Abstract:**  
*Erwinia amylovora* is a gram-negative bacterium that causes fire blight, an economically important disease of Rosaceous plants including apple and pear. We screened mutants for a loss of symptom development on immature apple fruit. One such mutant was unable to produce one of its acyl carrier proteins (ACP), which are involved in the production of fatty acids. In some bacterial species, these proteins have been shown to be involved in disease development. The acp mutant produced reduced symptoms on apple tree shoots, particularly in the fall when trees are less susceptible to fire blight. It also showed decreased growth on host flowers, a natural point of entry in fire blight infections. The metabolism and most of the known virulence systems of the acp mutant appeared normal; however, the acp mutant was much more sensitive to H\textsubscript{2}O\textsubscript{2} than the wild-type. The production of reactive oxygen species (ROS) like H\textsubscript{2}O\textsubscript{2} can be an important defense mechanism for plants, so this increased sensitivity to ROS stress suggests that the acp mutant may be less virulent because it is less able to survive host immune responses. These results suggest that acp may be a novel virulence gene involved in fire blight disease development.
Comparing Populations of Epiphytic Bacteria in Pennsylvania’s Organic and Conventional Stone Fruit Orchards as it Relates to Bacterial Spot Management

Bardsley, Sarah* and Jimenez-Gasco, Maria del Mar**
*Department of Plant Pathology and Environmental Microbiology, The Pennsylvania State University
**Corresponding author: jimenez-gasco@psu.edu

Abstract:
Bacterial spot of stone fruit (caused by Xanthomonas arboricola pv. pruni) remains the most important bacterial disease of peach and nectarine in the eastern United States. Bacterial spot has also greatly hindered the establishment of organic stone fruit orchards in the eastern US because this disease is not easily managed on highly susceptible, consumer preferred, stone fruit cultivars. Despite that, no bacterial spot was found in two organic peach orchards in Adams County, PA. In contrast, regular applications of the antibiotic oxytetracycline have been used to manage bacterial spot in conventionally managed orchards. This amount of antibiotic use exerts a strong selective pressure on bacterial populations to support the growth of antibiotic resistant bacteria. The overall goal of this research is to understand the consequences of intensive antibiotic applications. The specific objectives of this research were to monitor and identify populations of bacterial epiphytes in organic and conventional stone fruit orchards, including bacterial epiphytes resistant to the antibiotic oxytetracycline. Bacteria growing on oxytetracycline amended media were recovered from six conventional and two organic stone fruit orchards. Comparisons were made between the overall bacterial populations obtained from organic and conventional orchards, based on morphological characteristics. Bacterial populations from organic and conventional orchards were completely different. Gram positive bacterial colonies and yeasts predominated populations recovered from the two organic orchards while the majority of bacterial colonies recovered from the conventional orchards were Gram negative.

Investigation of the regulatory network that controls expression of MSHA pilus genes

Bogale, Haikel N.*, Verma, Subhash C.*, and Miyashiro, Tim*
*Department of Biochemistry and Molecular Biology, The Pennsylvania State University

Abstract:
Symbiotic relationships are an essential part of life. The symbiosis between the bioluminescent bacterium, Vibrio fischeri, and the Hawaiian bobtail squid, Euprymna scolopes, is a particularly well-characterized example of a two-partner symbiosis. The squid shelters V. fischeri in a specialized structure called the light organ and uses the bacterial bioluminescence for their nocturnal activities. Although this model relationship is characterized very well, the role of the Mannose-Sensitive Hemagglutinin (MSHA) pil in the squid-vibrio symbiosis is unknown. Previous studies have demonstrated that the MSHA pilus is important in the pathogenicity of Vibrio cholerae, which is a close relative of Vibrio fischeri and the causative agent of cholera disease. We have conducted a transposon-mutagenesis screen in V. fischeri to identify regulatory components that control the expression of the mshC and mshC2 genes, which give rise to the MSHA pilin proteins. By screening over 100,000 colonies, we isolated two V. fischeri mutants with altered expression of mshC genes. Sequencing of the corresponding mutations revealed that the transposon insertions were within nagC, which encodes a transcription factor important for V. fischeri to initiate symbiosis with E. scolopes. Our gene expression experiments show that NagC down-regulates mshC and up-regulates mshC2. DNA-binding assays involving purified NagC have shown that NagC directly regulates mshC. Our experiments provide insight into how non-pathogenic Vibrionaceae use MSHA pilus to interact with a host.
Searching for Ancient Microbial Life: A Novel Geomicrobiological Study of Enhydro Agates

Callaghan, Jake D.*, Chelsy B. Morrow*, Loretta D. Dicksonb, and Joseph P. Calabrese**

aDepartment of Biological Sciences, Lock Haven University, Lock Haven, PA 17745
bDepartment of Geology and Physics, Lock Haven University, Lock Haven, PA 17745
*Corresponding author: jcalabre@lhup.edu

Abstract:
A novel search was conducted for ancient microbial life trapped inside void water of enhydro agates, which are obloid-shaped nodules composed of banded microcrystalline to cryptocrystalline quartz. These unique rocks are believed to have formed 60-40 million years ago from groundwater percolating through cooling volcanic rock. Based on this geological condition, it is hypothesized that any microbial life forms would preferentially be categorized as thermophilic chemolithoautotrophs. An Energy Dispersive X-ray (EDX) was employed to analyze the chemical composition of the interior of the enhydro agates. This study aims to isolate and identify any possible microbes existing within void water by aseptically drilling into agates and extracting samples for chemical and biological analyses. Immediately following extraction of void water; direct microscopy revealed the presence of small (~1 μm), cocci and diplococci forms exhibiting movement not characteristic of Brownian motion. Our preliminary evidence to support the existence of microbes includes: Direct microscopy of enhydro agate water; simple and differential cell-staining techniques; DNA evidence; and application of various culturing methodologies based on EDX results. Currently we observe microbial growth from all extracted water samples in both chemoautotrophic defined enrichment media and on a nonselective complex medium supplemented with olivine. Scanning electron microscopy (SEM) of cultures indicate the presence of two distinct morphology types from two different agate specimens.

Conversion of Phenylalanine to Phenylpyruvic Acid by Microbial Fermentation

Coban, Hasan B.*, Demirci, Ali*, Patterson, Paul H., and Elias Ryan J.

aDepartment of Agricultural and Biological Engineering, The Pennsylvania State University
bDepartment of Animal Science, The Pennsylvania State University
cDepartment of Food Science, The Pennsylvania State University
*Corresponding author: axd29@psu.edu

Abstract:
Phenylpyruvic acid (PPA) is an alpha keto acid, which is produced by deamination of phenylalanine. PPA has the potential to be used in monogastric animals' diets to prevent excessive nitrogen accumulation in the manure and adverse effects on the environment. PPA is also used as a flavor enhancer in the food industry and for kidney patients' diets to decrease urea accumulation in the body. However, high production costs are limiting the use for these applications. Also, PPA productions have been usually studied in shake-flask fermentations with small working volumes and without any optimizations. Therefore, this project was undertaken to enhance PPA production in bioreactors. Firstly, microorganism selection was performed and Proteus vulgaris was determined to be the best strain for PPA production among four evaluated. Growth parameters (temperature, pH, and aeration) and concentrations of important medium ingredients (glucose, yeast extract, and phenylalanine) were optimized in 2-L bioreactors by using Box-Behnken design. As a result, the optimum temperature, pH, and aeration levels were determined to be 34°C, 5.12, and 0.5 vvm, respectively. Also, optimum concentrations of glucose, yeast extract, and phenylalanine were determined as 119 g/L, 3.68 g/L, and 14.84 g/L, respectively in the fermentation medium. Under these optimum conditions, 1349 mg/L PPA was produced by Proteus vulgaris in bioreactor, which means about a 3-fold improvement in PPA production compared to shake flask fermentations (358 mg/L PPA). This study clearly showed that this is an enhancement of PPA toward commercial production.
Presence of Antibiotics and Antibiotic Resistance at Penn State’s Living Filter

Franklin, Alison M. a, Andrews, Danielle M. a, Watson, Jack E. a, and McLain, Jean E. b
aDepartment of Ecosystem Science and Management, Pennsylvania State University
bDepartment of Soil, Water and Environmental Science, University of Arizona, Tucson, AZ
*Corresponding author: amy125@psu.edu

Abstract: Trace levels of pharmaceuticals and personal care products in wastewater effluent have purportedly been linked to recent increases of antibiotic resistance in clinical settings. This potential association calls for well-controlled studies to analyze antibiotics and antibiotic resistance in the environment to evaluate impacts on susceptible organisms. This study’s first objective was to determine concentrations of antibiotics in influent, effluent and groundwater at Penn State’s Living Filter, a site irrigated with effluent since the 1980’s. Early analysis of effluent samples using quadrupole time-of-flight mass spectrometry identified four antibiotics of interest: sulfamethoxazole (SMX), trimethoprim (TMP), ofloxacin (OFL), and lincomycin (LIN). Concentrations of SMX, TMP, OFL, and LIN in water samples were quantified using liquid chromatography linked to a tandem mass spectrometer. In all samples, SMX was most abundant with 712 ng/L in influent, 563 ng/L in effluent and 70-85 ng/L in groundwater. Although TMP, OFL and LIN are present in influent, quantities in effluent are significantly lower, and none are detectable in groundwater. Due to continuous exposure to low levels of antibiotics, soil bacteria at the Living Filter may have altered resistance. This study’s second objective was to analyze antibiotic resistance in soil bacteria at the Living Filter compared to natural resistance. Soil bacterial isolates were subjected to serial dilutions of antibiotics to determine resistance levels at specific break points. In addition, quantities of two sulfamethoxazole resistance genes, sul1 and sul2, were enumerated by quantitative PCR. Data trends show that bacteria at the Living Filter may possess increased resistance to synthetic antibiotics.

Does increasing crop genotypic diversity help manage abiotic and biotic stress?

Grettenberger, Ian a and John Tooker a*
Department of Entomology, The Pennsylvania State University
*Corresponding author: tooker@psu.edu

Abstract: With a changing climate, crop fields will soon face new challenges. In some regions, changes in temperature and precipitation patterns will likely lead to an increased threat of drought. In addition, crop pests respond to changes in climate and increased temperatures will lead to pest outbreaks in some areas. These abiotic and biotic stressors together will jeopardize crop production and food security. A promising tactic to manage these stressors and maintain crop productivity is to increase crop intraspecific (i.e. genotypic) diversity. Evidence from both agricultural and natural systems has demonstrated that intraspecific plant diversity can influence arthropods, increase plant productivity, and increase system stability. We increased genotypic diversity and intraspecific plant-plant interactions within a wheat model system by increasing variety diversity. Our low diversity treatments consisted of monocultures of a single variety, while high diversity treatments contained all possible three-variety mixtures chosen from a pool of five varieties. We performed a greenhouse experiment using bird cherry-oat aphid (Rhopalosiphum padi) to determine the influence of genotypic diversity and water stress on pest performance. Diversity reduced the total offspring produced by reducing the rate of offspring production. Thus far, our results appear to indicate that genotypically diverse variety mixtures hold potential to diminish the influence of climate change by improving pest management and ecosystem resilience. Our results also build upon a growing body of evidence demonstrating the ecological importance of intraspecific diversity.
Electrochemical Methods to Probe Competition Between *Pseudomonas aeruginosa* and *Staphylococcus aureus*

Keyes, Nicholas*a* and Regan, John*a*

*a*Department of Civil and Environmental Engineering, The Pennsylvania State University

Corresponding author: Nak165@psu.edu

Abstract:

*Pseudomonas aeruginosa* and *Staphylococcus aureus* are two of the most prevalent and resilient species of infectious bacteria. Both possess a suite of antibiotic resistances and are of wide significance, from infected wounds on the battlefield to sufferers of cystic fibrosis in the hospital. These two species are frequently found together in infection, and their presence together enhances one-another’s virulence. Because of this, investigating the interaction between these two species is of paramount importance.

*Pseudomonas aeruginosa* secretes several redox active mediators, most notably pyocyanin. This mediator has a number of purposes, but primarily serves as a shuttle when electron acceptors are not readily available. In this capacity, pyocyanin forms reactive oxygen species on contact with oxygen, which affects host cells and competing bacteria. Using pyocyanin as a judge of the inherent competition occurring between *Pseudomonas aeruginosa* and *Staphylococcus aureus*, we can detect this mediator in real-time using electrochemical techniques and probe the relationship and effects these two species have upon one another.

Identification of Polyphosphate-accumulating Bacteria in Agricultural Watershed Soils and Biofilms Subject to Anaerobic/Aerobic Cycles

Locke, Nicholas*a*, Saia, Sheila*b*, Walter, Todd*b*, Carrick, Hunter*c*, Buda, Anthony*d*, and Regan, John*a*

*a*Department of Civil and Environmental Engineering, The Pennsylvania State University

*b*Department of Biological and Environmental Engineering, Cornell University, Ithaca, NY

*c*Department of Biology, Central Michigan University, Mt. Pleasant, MI

*d*United States Department of Agriculture

*Corresponding author: nal5082@psu.edu

Abstract:

Polyphosphate accumulating organisms (PAOs) have a unique phosphorus metabolism driven by anaerobic/aerobic cycles. Intracellular polyphosphate (poly-P) molecules are hydrolyzed during anaerobic conditions, releasing phosphate ions to the environment, and then poly-P is re-created from ortho-P monomers during aerobic or nitrate reducing conditions. Previous research has focused on PAOs in a wastewater treatment context, identifying the dominant species in enhanced biological phosphorus removal (EBPR). Anaerobic/aerobic cycles in soils and benthic biofilms create conditions that mimic the EBPR process, and hydrologic models in agricultural watersheds suggest a biological mechanism for P uptake and release that agree with PAO activity, yet there is little information characterizing bacterial PAOs in the environment. Molecular identification techniques previously developed in EBPR studies are being used to identify PAOs in natural settings subject to wetting/drying cycles that create microenvironments to mimic the EBPR process. Fluorescent in-situ hybridization probes developed from bacterial PAOs identified in EBPR activated sludge will be applied to soil and benthic biofilm samples to compare similarities. Preliminary analysis of agricultural watershed samples suggests that bacterial PAOs similar to those found in EBPR exist in the environment.
**Achromatium oxaliferum**: A Giant Sulfur Bacteria that Precipitates Intracellular Calcite and Sulfur

Mansor, Muammar*<sup>a</sup>, Fantle, Matthew*<sup>a</sup>, and Macalady, Jenn*<sup>a</sup>

*Department of Geosciences, The Pennsylvania State University
*Corresponding author: muammar10@gmail.com

**Abstract:**
Discovered nearly 100 years ago, little is still known about these giant bacteria due to our inability to cultivate them in the laboratory. They are easily distinguishable in natural samples due to their large size (10-100µm) and the presence of calcite and sulfur inclusions that can make up >70% of its cytoplasmic volume. *Achromatium* constitute only 1% of total bacteria at the sediment-water interface; however, they may easily exceed 90% of the total bacterial biovolume. Their prevalence in sulfidic waters and the presence of intracellular sulfur granules imply that they are sulfur-oxidizers. As such, they likely play a major role in nutrient cycling of sulfur, carbon, and calcium in current and past sulfidic environments. In addition, the potentially tight biological control on precipitation of calcite inclusions may result in isotopic, elemental and mineralogical biosignatures that are relevant to astrobiology and the fossil record on Earth.

Here, we detailed new field observations on *Achromatium* that were re-discovered at Warm Mineral Spring, FL. We employ cutting-edge techniques to hand-pick single cells for future analyses that include Raman spectroscopy, metabolic pathway prediction via flow-through reactors, genome sequencing and isotopic measurements of Ca and S.

**Identification of Transcriptional Regulators of tfoY in Vibrio fischeri**

Ng, Xwei Fun*<sup>a</sup>, Sun, Yan<sup>a</sup>, and Miyashiro, Tim<sup>a</sup>

*Department of Biochemistry and Molecular Biology, The Pennsylvania State University
*Corresponding author: xqn5006@psu.edu

**Abstract:**
Natural transformation is the process whereby a bacterial cell takes up and incorporates exogenous DNA into its genome. The presence of chitin induces natural transformation in *Vibrio fischeri* and this process requires two transcription factors: TfoX and TfoY. In our research, we focused on studying the expression of *tfoY* and more specifically how its expression is regulated. We introduced a *tfoY* transcriptional green fluorescent protein (GFP) reporter plasmid into a transposon-mutant library of *Vibrio fischeri* and screened for mutants exhibiting GFP fluorescence levels different than the wild-type cells. From 44,680 colonies, we identified 31 mutants with altered *tfoY* expression. Using *tfoY* transcriptional reporter plasmid which also constitutively expresses mCherry, we determined the expression level of *tfoY* in each mutant in culture by measuring the ratio of GFP/mCherry. We have determined by sequencing the transposon insertion site in 8 mutants. Our data showed that one of the mutants that up regulated the *tfoY* expression had transposon insertion in a *VF_0806*, which encodes the transcriptional repressor NagC. We will continue to determine the transposon insertion sites in the mutants to understand the regulatory control of *tfoY* in *V. fischeri*.
Novel genes Identified Impacting \textit{qsrP} Expression in \textit{Vibrio fischeri}

\textbf{Perry, Alexandra*}, Verma, Subhash C.*, Snellings, Dan*, and Miyashiro, Tim**

*Department of Biochemistry and Molecular Biology, The Pennsylvania State University

*Corresponding author: tim14@psu.edu

Abstract:

Quorum sensing describes the process by which bacteria can coordinate certain group behaviors in accordance with cell densities. The marine bacterium \textit{Vibrio fischeri} uses the canonical LuxR-LuxI quorum-sensing system to regulate luminescence within its natural squid host, \textit{Euprymna scolopes}. The quorum sensing regulated protein QsrP is also controlled by the LuxR-LuxI system and is one of the most abundant proteins \textit{Vibrio fischeri} produces inside of the squid light organ. However, the function and the role of QsrP within this mutualistic symbiosis remain unknown. A green fluorescent protein reporter fused with the promoter region of \textit{qsrP} was introduced into a transposon-mutant library of \textit{V. fischeri} to screen for mutants with altered \textit{qsrP} expression. Of the 120,000 colonies screened, 25 mutant strains with increased levels of \textit{qsrP} expression were isolated. To test whether the mutations affect the quorum-sensing network, luminescence level of each mutant was measured in response to exogenous N-3-oxohexanoyl-homoserine lactone, the signaling molecule synthesized by LuxI. The resulting luminescence levels varied significantly among the mutants, with 20 mutants brighter than wild-type cells, two mutants dimmer than wild-type cells, and three mutants comparable to wild-type cells, suggesting the presence of LuxR-dependent and LuxR-independent mechanisms to regulate \textit{qsrP} expression. The mutant strains were sequenced to determine the location of the transposon in the \textit{V. fischeri} genome. Sequencing results of 22 strains returned sixteen unique insertions located in seven different genes. Taken together, the results have identified novel genes that impact \textit{qsrP} expression in \textit{V. fischeri}.

The \textit{argD} Gene is Indispensable for \textit{Erwinia amylovora} Bacterium to Cause Fire Blight Disease in Apples

\textbf{Ramos, Laura*} and \textbf{McNellis, Timothy*}

*Department of Plant Pathology and Environmental Microbiology, The Pennsylvania State University

*Corresponding author: lsr5068@psu.edu

Abstract:

Fire blight is the most important bacterial disease of apple and pear worldwide. The causal agent of the disease is \textit{Erwinia amylovora} and is named one of the top 10 bacterial plant pathogens in the world based on scientific and economic importance. Since the 1980’s, scientists have been looking for the genes in \textit{E. amylovora} that help the bacteria to cause fire blight in apples and pears. Some of these genes have been identified, but scientists cannot fully understand the process of disease yet. A better understanding of the pathogen will lead us not only to comprehend better the disease process but also help manage it. We have identified one novel indispensable gene for \textit{E. amylovora} to cause fire blight disease in apple, \textit{argD}, which is involved in the production of the amino acid arginine. The \textit{E. amylovora} with a mutation in the \textit{argD} gene does not cause disease in apple. This study showed that \textit{E. amylovora} cannot get sufficient arginine from the host, which means that ArgD protein could be a suitable enzyme to target for disease control. Furthermore, the \textit{argD} complementation plasmid was highly stable in the \textit{argD} mutant growing in the host even in the absence of antibiotic selection. Therefore, the \textit{argD} complementation plasmid represents a potentially useful biotechnological tool for expression of genes in \textit{E. amylovora} growing inside the host, without the concern about losing the plasmid because of no antibiotic selection. These findings will be put into the larger context of fire blight genetics research.
Phosphorus Mobility in the Landscape: First Steps to Linking Hydrology and Microbiology

Sheila Saia*, Nicholas Lockeb, John Reganb, and Todd Waltera
aDepartment of Biological & Environmental Engineering, Cornell University, Ithaca, NY
bDepartment of Civil & Environmental Engineering, The Pennsylvania State University
*Corresponding author: sms493@cornell.edu

Abstract:
Microbiological techniques (e.g. epi-fluorescent microscopy and PCR) are making it easier to tease out the influence of specific microorganisms on nutrient transport. Polyphosphate accumulating organisms (PAOs) are often used in wastewater treatment plants (WWTP) to remove excess phosphorus (P) from effluent water. PAOs have also been identified in natural settings but their ecological function in the environment is not yet known. In this study, we conducted laboratory experiments to test the hypothesis that PAO mediated P release and uptake in the natural environment (i.e. stream biofilms) would behave similarly to PAO mediated P release and uptake in WWTPs (figure 1). Specifically, we hypothesized that PAOs in natural environments would release and accumulate P during anaerobic and aerobic conditions, respectively. To test our hypothesis, we collected stream biofilms from Cascadilla Creek in Ithaca, NY. We then altered the oxygen conditions of half the containers by bubbling in air (aerobic conditions) for 12 hours and then N2 gas (anaerobic condition) for 12 hours for 3 cycles (2 replicates each). The remaining containers were bubbled with air for the entire experiment (2 replicates). Every 12 hours we analyzed samples for soluble reactive P (SRP), temperature, dissolved oxygen, and pH. Results of SRP over the course of the experiment support our hypothesis that anaerobic and aerobic stream conditions may impact PAO mediated P release and uptake, respectively in natural environments. Based on the results of these experiments, we hope to draw attention to the importance of microbiological controls on P mobility in freshwater ecosystems.

Using Culture-Independent Methods to Obtain a Pure Culture of a Sulfur Oxidizing Bacterium

Tsao, Leaha, Mansor, Muammara, Ajeng Laing, Beatriceb, and Macalady, Jennifer*a
aDepartment of Geosciences, The Pennsylvania State University
bHuck Institutes of Life Sciences, The Pennsylvania State University
* Corresponding author: jlm80@psu.edu

Abstract:
The Frasassi Caves are an Italian cave system formed by the dissolution of calcium carbonate walls with sulfuric acid. Due to the presence of sulfide in cave stream water as well as oxygen in both the atmosphere and percolating meteoric water, a rich microbial community exists at the air-water interface. *Thiobacillus baregensis* is an abundant sulfur oxidizing bacterium in cave streams that may aid in the production of sulfuric acid for cave development. Although *T. baregensis* has been successfully cultured in the laboratory, a pure culture has not yet been obtained. Fluorescent in-situ hybridization (FISH) and metagenomics have been employed to learn about the bacterium’s metabolic properties in order to obtain a pure culture. Semi-quantitative measurements with FISH have revealed that greater abundances of *T. baregensis* do not correlate with sulfide concentrations, oxygen concentrations, or sulfide to oxygen ratios. Furthermore, metagenomic results suggest that the bacterium is capable of oxidizing multiple reduced sulfur species and reducing nitrate. While FISH and metagenomics have been used to understand some of the bacterium’s metabolic capabilities, a pure culture is necessary to allow for direct experimentation on the microbe and to learn more about its metabolic properties. Future work will therefore focus on obtaining an axenic culture of *T. baregensis* to understand its contribution to cave formation.
Comparison of Complex and Ideal Substrate Performance in High-throughput and Bench Scale Microbial Electrolysis Cells (MECs)

Ullery, Mark L.* and Logan, Bruce*
*aDepartment of Civil and Environmental Engineering, The Pennsylvania State University,
*Corresponding author: mlu112@psu.edu

Abstract:
Wastewater treatment and hydrogen production are both energy intensive processes that are highly dependent on fossil fuels. MECs are bioelectrochemical systems that recover energy during wastewater treatment by utilizing exoelectrogenic microorganisms to break down organic material and produce hydrogen. These systems could be used to lower energy demands and greenhouse gas emissions associated with wastewater treatment and hydrogen production by utilizing organic matter in a variety of waste streams. High strength effluents, like those found in industrial and agricultural settings, have shown potential for efficient energy recovery in MECs, but are highly variable and process dependent. Typical wastewater evaluation metrics, including COD and BOD, measure aerobic oxidation and do not accurately reflect energy recovery potential in anaerobic MECs. Cheap, high-throughput mini MEC reactors have been used previously to evaluate treatment potential, but they have not been directly compared to larger bench scale reactor architectures, where gas production can be more easily evaluated. In this presentation we summarize performance data taken in both mini and cubic MEC reactors with various complex and ideal substrate to provide a better understanding of the relationship between these architectures and their utility for evaluating treatment performance in MECs using complex, real world effluents.

Impact of fliY Regulation on Colonization of the Squid Light Organ by Vibrio fischeri

Wasilko, Nathan*, Verma, Subhash*, and Miyashiro, Tim*
*a Department of Biochemistry and Molecular Biology, The Pennsylvania State University
*Corresponding author: npw5041@psu.edu

Abstract:
The symbiosis established between the Hawaiian bobtail squid, Euprymna scolopes, and the marine bacterium, Vibrio fischeri, enables the study of bacterial populations within a host environment. Bacterial transmission in the squid-vibrio symbiosis is horizontal, i.e., juvenile squid hatch from their eggs un-colonized and acquire symbionts from the surrounding seawater. This feature allows the initial steps of bacterial colonization to be studied within the lab. We have discovered that the gene fliY is heterogeneously expressed both within and between isogenic populations of V. fischeri inside of the squid light organ. The fliY gene encodes a cystine-binding protein and is conserved in many species of Vibrios. We hypothesized that this heterogeneous pattern of fliY expression is required for Vibrio fischeri to colonize the squid light organ. The expression of fliY varies significantly during growth in culture, with cultures of high cell density displaying elevated levels of fliY. Using a fliY promoter reporter plasmid, we conducted a transposon mutagenesis screen to isolate mutant colonies displaying altered levels of fliY expression. Mutant colonies isolated thus far have displayed increased levels of fliY expression relative to wild-type cells. We will be comparing fliY expression of mutants to wild-type cells, as well as conducting squid colonization experiments with the isolated mutants. The use of the squid-vibrio symbiosis to examine fliY expression will provide insight of the regulatory systems in bacterial populations within a host environment.
Anolyte Recirculation: An Alternative to Phosphate Buffer in Single-Chamber Air-cathode Microbial Fuel Cells

Zhang, Liang* and Regan, Johnb
aCollege of Power Engineering, Chongqing University
bDepartment of Civil and Environmental Engineering, The Pennsylvania State University
*Corresponding author: kobezhang2000@hotmail.com

Abstract:
Microbial fuel cells (MFCs) are an emerging technology with the potential for coupling waste treatment and energy production. However, most MFC research is conducted with a phosphate-buffered medium that would not be compatible with a waste treatment application. The present study investigated an anolyte recirculation design strategy as an alternative to phosphate buffer in single-chamber air-cathode MFCs to enhance proton transfer while avoiding phosphate release into the environment. Two MFCs with a floating air-cathode were operated under either buffer (MFC-B) or buffer-less (MFC-BL) condition in a recirculation mode. It was demonstrated that MFC-BL operated with a 50 Ω external resistance in recirculation mode (1.0 ml min⁻¹) had a 27% lower power (9.7% lower maximal power) but a 64% higher coulombic efficiency (CE) compared with MFC-B, suggesting a feasible approach for future MFC application. With increased recirculation rates, MFC-B showed a decreased voltage output, batch time, and CE resulting from increased oxygen transfer into the anode. In MFC-BL, increasing the flow rate within a low range significantly enhanced proton transfer, resulting in a higher voltage output, a longer batch time, and a higher CE. Above this range, increased flow rates also decreased the batch time and CE of MFC-BL due to excess oxygen transfer into the anode. MFC-BL showed a maximal power of 1.32 mW and CE of 16.6% at a flow rate of 0.35 ml min⁻¹.

A Comprehensive Approach to Engineering Microbial Consortia for Lignocellulosic Biofuels Production

Zuroff, Trevor R.a, Barri Xiques, Salvador b and Curtis, Wayne R.a*
a Department of Chemical Engineering Department, The Pennsylvania State University
b Industrial Engineering Department, ETS IQS Barcelona, Barcelona, Spain
*Corresponding Author: wrc2@psu.edu

Abstract:
A symbiotic microbial consortium was developed which improves conversion of both cellulose and lignocellulose (switchgrass) to ethanol. The cellulolytic mesophile, Clostridium phytofermentans, and a cellodextrin fermenting yeast, Saccharomyces cerevisiae cd1-1, cooperate based on diffusion of oxygen into the culture medium. Oxygen acts to inhibit the growth of the obligate anaerobe, C. phytofermentans, but when provided a soluble carbon source from C. phytofermentans hydrolysis of cellulose, the yeast metabolizes oxygen relieving the inhibitory effect. This cooperative behavior results in a stable, controllable consortium which improves the conversion of both cellulose (two-fold increase) and lignocellulose (50% increase) to ethanol. This consortium was specifically designed as a solution for achieving consolidated bioprocessing (CBP) or the simultaneous biological enzyme production, hydrolysis and fermentation of lignocellulose to biofuel. This poster focuses on the comprehensive approach taken to understand, control and apply this microbial consortium to CBP of lignocellulose. This involved understanding the microscopic structure of biofilms (surface attached microbial communities) formed on the cellulose surface, modeling the kinetics of cellulose degradation and consortium function and applying the consortium to high-intensity cellulose and lignocellulose fermentations. This work sets the stage for more advanced microbial systems for economically efficient and environmentally friendly production of fuels and chemicals from plant biomass.
Heterogeneous Chemistry of Aged Mineral Dust

Alstadt, Valerie\textsuperscript{a}, Kubicki, James\textsuperscript{b}, and Freedman, Miriam\textsuperscript{c}
\textsuperscript{a} Department of Chemistry, The Pennsylvania State University
\textsuperscript{b} Department of Geosciences, The Pennsylvania State University

Abstract:
Mineral dust is a prevalent atmospheric species due to natural sources such as the Gobi and Sahara deserts. During the course of atmospheric transport, mineral dust interacts with chemical species such as sulfuric acid, present in part due to pollution plumes. Reactions with sulfuric acid can cause surface changes in the mineral and affect the mineral’s later heterogeneous chemistry in the atmosphere. This study addresses what happens to exposed and unexposed minerals when additional trace gas species are encountered. We investigated plain and sulfuric acid treated kaolinite and the changes in surface species when acetic acid was added. Kaolinite was exposed to sulfuric acid and then samples of plain and treated kaolinite were exposed to acetic acid and analyzed via Diffuse Reflectance Infrared Fourier Transformed Spectroscopy (DRIFTS). DRIFTS indicates that the formation of an aluminum sulfate hydrate and the loss of silicon and aluminum in the treated mineral alters the adsorption of acetate on the surface. To characterize the interactions of acetic acid with kaolinite, we have modeled acetate adsorption on kaolinite using Density Functional Theory (B3LYP/6-31G(d,p) basis set). Modeling reveals that multiple structures are responsible for our DRIFTS spectra and the relative amount and nature of each type of bonding as shifts with previous sulfuric acid exposure, which causes changes in the intensity and peak positions in the DRIFTS spectra. We will discuss the implications of our results for the heterogeneous chemistry of aged mineral dust.

Understanding the Structure of Organic Aerosol through Cavity Ring-Down Spectroscopy and Transmission Electron Microscopy

Altaf, Muhammad\textsuperscript{a} and Freedman, Miriam\textsuperscript{a,*}
\textsuperscript{a} Department of Chemistry, The Pennsylvania State University
\textsuperscript{*Corresponding author: maf43@psu.edu}

Abstract:
One area of research in which the atmospheric chemistry community has taken a great interest is in organic aerosol and its importance in anthropogenic and biogenic emissions. Currently, we do not have a clear understanding of aerosol structure. Particle structure plays an important role in the formation of aerosols and can affect the energy balances of the atmosphere through the aerosol direct and indirect effect. In addition to this, particle morphology can affect heterogeneous chemistry in the atmosphere and mass accommodation coefficients (a parameter which determines the transfer rate of gases into aqueous droplets) for organic aerosol loading levels, which impact human health. In order to better understand the structure and optical properties of organic aerosol at the submicron scale, we use spectroscopy, microscopy, and computational methods. We have characterized laboratory generated aerosol particles composed of ammonium sulfate mixed with pimelic acid, succinic acid, or 1,2,6-Hexanetriol. We have observed a core-shell morphology for 1,2,6-Hexanetriol, and a partially engulfed morphology for pimelic acid and succinic acid. Pimelic and succinic acid also have a size dependence of morphology. From the spectroscopy data, we observe that the extinction cross sections of core-shell and partially engulfed particles are approximately equal. By using a combination of the aforementioned techniques, the goal is to figure out the physical chemistry behind the structure and the phase separation that occurs in organic aerosol. We will discuss the impact of organic aerosol structure which will ultimately have implications on climate, heterogeneous chemistry, and mass accommodation.
Direct Measurements of Ozone Production Rates in Houston, TX

Baier, Bianca*a, Brune, William*a, Miller, David*a, Martins, Douglas*a, and Lefer, Barry*b

*aDepartment of Meteorology, The Pennsylvania State University  
bDepartment of Earth and Atmospheric Sciences, University of Houston, Houston, TX  
*Corresponding author: bcb5065@psu.edu

Abstract:  
Ambient ozone is a well-known pollutant found in or nearby urban areas that can have adverse health effects on humans and the environment. Air chemistry modeling is used to locate ozone production sources, to test the Environmental Protection Agency’s (EPA) ozone mitigation strategies, and to forecast high ozone episodes. However, it is proving difficult to accurately depict ozone production, P(O₃), due to model uncertainties and inconsistencies between modeled and measured species.

Testing of model output and chemical mechanisms can be achieved with a direct comparison to measured P(O₃) in order for the EPA to devise efficient ozone reduction standards. Recent developments to the Pennsylvania State University Measurement of Ozone Production Sensor (MOPSv2.0) improve upon the MOPSv1.0 component limitations, measurement techniques, and the flow through the instrument chambers.

Two MOPSv2.0s have been built and deployed to Texas in September 2013 for NASA’s DISCOVER-AQ field campaign where they retrieved ozone production rate (P(O₃)) measurements in Houston, TX and in Smith Point, TX. These P(O₃) measurements provide insight into local ozone source locations and ozone production sensitivity regimes in the Houston, TX area, and provide the first direct calculations of ozone advection rates. This first deployment demonstrates the potential for the MOPSv2.0 to determine where air quality model output and chemical mechanisms succeed and fail, and to aid in the design of air quality standards for mitigating ozone pollution in urban areas.

Long-term Ozone Variability in San Joaquin Valley, CA

Balashov, Nikolai*a and Thompson, Anne*a,b  
aDepartment of Meteorology, The Pennsylvania State University  
bNASA/Goddard Space Flight Center, Greenbelt, Maryland 20771  
*Corresponding author: nvb5011@psu.edu

Abstract:  
San Joaquin Valley (SJV) in California contains some of the most polluted air in the United States. Using the data from several local air quality monitoring stations we analyze a long-term variability of the surface ozone, a secondary air pollutant, in the region. To understand the nature of the long-term surface ozone variability in SJV we use clustering technique called Self-Organizing Maps (SOMs). We apply SOMs method to surface ozone diurnal profiles during the ozone seasons (May 1st through September 30th) from 1980 to 2013. Severity of an ozone season significantly depends on the meteorology of the season. In our work we are trying to determine the effects of climate variability, affecting meteorology of SJV, on the long-term ozone variability. Preliminary results indicate the following years to be ozone favorable in SJV: 1984, 1987, 1988, 1989, and 1996, 2000-2003, 2006, 2008, 2012 and 2013. A more detailed investigation regarding these results is in progress.
Quantifying iron mineral redox properties to estimate contaminant fate

Edwards, Rebecca\textsuperscript{a} and Gorski, Christopher\textsuperscript{b}\textsuperscript{*}
\textsuperscript{a}Department of Civil and Environmental Engineering, The Pennsylvania State University
\textsuperscript{b}*Corresponding author: gorski@engr.psu.edu

Abstract:

The Environmental Protection Agency (EPA) estimates at least 126,000 contaminated groundwater sites exist in the United States, requiring a minimum of $200 billion to remediate using current technology. One prospective solution that could significantly reduce treatment cost is to use iron minerals already present in the ground to transform contaminants \textit{in situ}. Effective use of this approach requires the ability to predict rates and extents of contaminant transformation reactions. To date, iron redox processes have proven to be both experimentally and conceptually difficult to study. Experimentally, iron oxide suspensions do not reach equilibrium with electrodes used to measure thermodynamic values. Conceptually, reactions involving iron oxides and dissolved iron(II) are complex and can include processes such as sorption, interfacial electron transfer, and secondary mineralization.

Here we demonstrate that experimental challenges can be overcome using mediated electrochemical techniques. We measured standard reduction potential values of two commonly occurring iron oxides, goethite and hematite, as a function of pH and dissolved iron(II) concentration. These values agree well with those estimated in previous works. Current experiments are investigating the reversibility of interactions between iron oxides and dissolved iron(II). Measuring these redox properties is an important step towards estimating contaminant fate. Future work will test whether these values can be used to accurately predict contaminant fate.

The Persistence of a Set of Biomolecules along a Vertical Decomposition Gradient in a Temperate Forest Surface Soil

Fine, Aubrey K.\textsuperscript{a,b}, Schmidt, Michael P.\textsuperscript{a,b}, and Martínez, Carmen Enid\textsuperscript{a,b}
\textsuperscript{a}Department of Ecosystem Science and Management, The Pennsylvania State University
\textsuperscript{b}Department of Crop and Soil Sciences, Cornell University, Ithaca, NY
Corresponding author: akf140@psu.edu

Abstract:

Temperate forests generally feature levels of primary production that exceed decomposition, facilitating the accumulation of an organic (O) horizon concentrated at the soil surface above the underlying mineral soil. The traditional focus of C dynamics in such systems has been on these organic surface reserves; however, the majority of terrestrial C is actually stored in the soil as soil mineral-associated forms at depths below 30 cm (Batjes, 1996). The O horizon, which collectively includes organic materials along a continuum of living to highly decomposed, functions as a transformative, biogeochemical barrier between the presumed stronger stabilizing mechanisms active in the mineral subsoil and inputs of OM concentrated near the soil surface. An incomplete understanding of the fate of organic inputs during the decomposition and humification processes in the O horizon currently limits the advancement of efforts to accurately estimate the C sequestration potential of these terrestrial ecosystems, including both surface and subsurface pools. In order to further elucidate these complex processes, a series of biomolecule extractions will be performed on surface soil (O\textsubscript{i}, O\textsubscript{e}, and O\textsubscript{a}, and A horizon) samples collected from a hemlock-dominated site located in Stone Valley Forest in central Pennsylvania. UV-Vis spectrophotometric methods to determine concentrations of five biomolecules, including chlorophyll, protein, DNA, chitin, and polyphenols, have been refined for soil extracts high in matrix interference arising from humic substances, allowing improved biomolecule isolation and subsequent quantification. Hypotheses and preliminary data of the concentrations of these biomolecules, along with supplementary C-XANES spectra, will be presented with depth and varying degree of decomposition.
Chemical Dynamics Driving NO2 in the Lower Troposphere at Rural Sites During DISCOVER-AQ: A Comparison Between and Inland Wintertime Site and a Coastal Summertime Site.

Guarriello, Felicia\textsuperscript{a}, Stein Zweers, Deborah\textsuperscript{b,d}, Clark, Richard\textsuperscript{c}
\textsuperscript{a}Department of Earth Sciences, Millersville University,
\textsuperscript{b}Atmospheric Chemistry and Dynamics (614), NASA Goddard Space Flight Center
\textsuperscript{c}Department of Earth Sciences, Millersville University
\textsuperscript{d}Royal Netherlands Meteorological Institute (KNMI)

Abstract: DISCOVER-AQ is a NASA funded field project aimed at gathering air quality data to better understand the links between pollution near the ground where people live and breathe and pollution higher in the troposphere. These projects take place at various sites including the agricultural, inland site of Huron, CA (January – February 2013) and coastal Smith Point, TX (September 2013).

The data from these two sites, an inland wintertime site and a coastal summertime site, can be compared to learn more about the chemical dynamics that drive near-surface nitrogen dioxide concentrations. A comparative description is given for the various constituents of the NO2 budget measured at each site along with relevant meteorological parameters and net surface radiation. Initial results from ground and aircraft data at Huron, CA suggest that NOy species may play an important role in understanding the day-to-day and diurnal variations in near-surface NO2 at this site. Additional measurements that will be made on the ground at Smith Point, TX will allow us to investigate the role of NOy in even greater detail. We present unique near-surface NO2 datasets measured during different seasons at two locations and describe and evaluate the unique atmospheric chemical dynamics at each site. Such information can lead to improved knowledge of the air quality for different spatial regimes. This can, in turn lead to increased awareness and improvements in human health.

Aging of Laboratory Proxies for Organic and Mineral Dust Aerosol

Haines, Joshua\textsuperscript{a} and Freedman, Miriam\textsuperscript{a*}
\textsuperscript{a}Department of Chemistry, The Pennsylvania State University
\textsuperscript{a*}Corresponding Author: maf43@psu.edu

Abstract: The effects of aerosol particles on our climate system are currently the largest source of uncertainty in climate models. One way aerosol particles affect the climate is through the indirect effect, which characterizes cloud-forming ability, and thus indirectly alters the amount of radiation that influences regional climate. By improving our understanding of the ways in which aerosol particles affect our climate, atmospheric models can be made much more accurate and rendered more useful to predicting future climate. An aspect of aerosol particles that needs more study is the ways in which these particles are aged throughout our atmosphere. We specifically investigate the effect of sulfuric acid and nitric acid on the chemical and physical properties of mineral dust proxies. Once aged with acid, these mineral dust particles could exhibit altered indirect effect behavior. Thus far, gas-phase nitric acid has shown significant ability to alter the composition of calcite and montmorillonite mineral dust samples. Another process through which aerosol particles can influence the climate is heterogeneous chemistry. The second half of this research investigates the formation of organic coatings on mineral dust aerosol particles. The coating efficiency, along with the thickness of the organic coatings, can alter the types of heterogeneous reactions that occur on the surface of the particle. Thus far, ammonium sulfate has been shown to accept an organic coating of palmitic acid at high coating efficiency. Together, these projects will help to define how atmospheric aging processes affect aerosol particles and our climate.
Effects of Acid Treatment on Ice Nucleation Ability of Mineral Dust

Jansen, Kevin*, Alstadt, Valerie, and Freedman, Miriam

*Department of Chemistry, The Pennsylvania State University
*Corresponding author: ktj5036@psu.edu

Abstract:
Aerosol particles are transported into the atmosphere when wind lifts mineral dust particles from dry soil samples. Due to the formation of sulfuric and nitric acid in the atmosphere from industrial emissions, mineral dust particles can interact with acids and potentially undergo structural changes. Depending on the structural changes, the ability of mineral dust to interact with water can vary, potentially affecting the ice nucleation and cloud formation properties of mineral dust. In order to understand the interaction between water and acid-treated mineral particles, samples of kaolinite and montmorillonite were individually treated with varying concentrations of sulfuric and nitric acid. Contact angle measurements between water and mineral samples were taken to understand the interactions during ice nucleation. It was found that for both kaolinite and montmorillonite samples, the acid treatment of the minerals increased the measured contact angle. In addition, it was found that the treatment of minerals with more concentrated acids resulted in higher contact angle measurements. We conclude that minerals that undergo acid treatment appear to be more hydrophobic than untreated mineral samples; by increasing the hydrophobicity of mineral samples, the ice nucleation and cloud formation properties of mineral dust are subsequently reduced as well.

Heavy metal release and incorporation by Siderite (FeCO₃) in soils and sediments

Joshi, Prachi and Gorski, Christopher A.

*Department of Civil and Environmental Engineering, The Pennsylvania State University
*Corresponding author: gorski@psu.edu

Abstract:
Heavy metals, such as lead and chromium, are often present in groundwater in trace concentrations. The fate and bioavailability of these heavy metals in the environment is often controlled by natural occurring iron (Fe) minerals via sorption and incorporation processes. Previously, uptake of heavy metals was assumed to take place primarily during mineral formation. However, recent studies have shown that when Fe minerals are exposed to dissolved Fe(II), they may undergo extensive recrystallization reactions that lead to heavy metal repartitioning into and from the mineral structure. This process has been attributed to the presence of a redox gradient between the aqueous Fe(II) and structural Fe(III) in common iron minerals. We propose that the recrystallization process is driven by trace metal disequilibrium between the solution and solid phases. To test this hypothesis, we are examining the reaction between aqueous Fe(II) and siderite (FeCO₃), a common Fe(II)-bearing mineral found in nature, using radiolabeled ⁵⁵Fe isotope tracer experiments. By tracking radiolabeled ⁵⁵Fe in this system, we are measuring the rate and extent of mineral recrystallization and the associated trace metal partitioning. The results of our experiments will lead to better understanding of the relationship between trace metal concentration and Fe mineral recrystallization, and enable more accurate prediction of heavy metal contaminant partitioning and mobility in soils and sediments.
Diffusion and Conduction of Lithium Cations in Poly(Ethylene Oxide) Based Sulfonate Ionomer

LaFemina, Nikki H.*, Roach, David J.*, Chen, Quanb, Colby, Ralphb, Mueller, Karl T.a,c,*

aDepartment of Chemistry, The Pennsylvania State University
bDepartment of Materials Science & Engineering, The Pennsylvania State University
cPacific Northwest National Laboratory,
*Corresponding author: ktm2@psu.edu

Abstract:
Conventional polymer electrolyte batteries have higher energy densities, are safer, and more environmentally friendly than traditional lead-acid batteries, but still have the problems of solvent leaking, electrode polarization, and cell degradation due to the ability of both the anion and cation to move. Recent work has begun to utilize single ion conducting polymers, or ionomers. In these systems, the anion is covalently attached to the polymer backbone, which eliminates any anion diffusion. Solvent leaking is minimized because the lithium cation is dissolved within the polymer matrix. One of the main limitations with ionomer systems is the relatively low room temperature ionic conductivity. In order to determine the relationship between lithium motion with respect to the polymer structure and conductivity, the diffusion of the lithium cation through the polymer matrix was studied by \(^{7}\)Li solid state nuclear magnetic resonance spectroscopy (NMR). The model samples chosen for these experiments were poly(ethylene oxide)-based sulfonate ionomers with varying ion content and varying molecular weight of the poly(ethylene oxide) spacer. \(^{7}\)Li self-diffusion coefficients were determined using a pulse-field gradient stimulated echo pulse sequence and compared to results obtained from dielectric relaxation spectroscopy (DRS). Comparison between the NMR and DRS data suggests that lithium diffusion is controlled by the ionic state within the polymer matrix (single ions, ion pairs, triple ions and ionic aggregates). Therefore, future experiments will vary the polymer backbone and identity of the ions to probe the change in diffusion coefficient with the introduction of steric constraints on the ionic motion.

Assessing The Presence of Endocrine Disrupting Compounds in Vernal Pools Across a Human Gradient

Mina, Odette*, Gall, Heathera, Carlson, Bradleyb, and Langkilde, Tracymb

aDepartment of Agricultural and Biological Engineering, The Pennsylvania State University
bDepartment of Biology, The Pennsylvania State University
*Corresponding author: oom5021@psu.edu

Abstract:
The goal of this research is to understand the impacts of agricultural land use on the occurrence of emerging contaminants in vernal pools. Endocrine disrupting compounds (EDCs) are introduced into the environment through various sources including pharmaceuticals and personal care products used by humans. These products contain chemicals that are known to be EDCs and that persist in treated wastewater. In addition to human sources of EDCs, veterinary pharmaceuticals and hormones are given to livestock to increase growth and reduce disease. The land application of human and animal wastes and pesticides to agricultural fields inadvertently introduces EDCs into the environment. EDCs are then transported to vernal pools receiving surface water runoff from nearby agricultural fields receiving wastewater irrigation, manure application, and pesticides. These EDCs have the potential to alter the function of the endocrine systems of amphibians that develop in these vernal pools.

Seven vernal pools in Centre County, PA have been identified for this study. Three pools are within a catchment that receives wastewater effluent irrigation, three pools are located in agricultural areas that receive unknown pesticide and fertilizer applications, and one pool is located within a catchment that receives dairy manure applications.

The water quality data presented at this meeting will include the preliminary data for estrogens, pesticides and their metabolites, nutrients and pH, collected from each of the seven sites in October 2013. This preliminary data will be used to design studies to assess impact of animal and human waste applications to water quality in vernal pools.
Trace Gas and Particle Measurements Made at Rural Sites During DISCOVER-AQ: A Comparison of Trends Between Sites

Serino, Michelle\textsuperscript{a*}, Mazzuca, Gina\textsuperscript{a}, Stein Zweers, Deborah\textsuperscript{b}, and Clark, Richard\textsuperscript{a}
\textsuperscript{a}Department of Earth Science, Millersville University, Millersville, PA
\textsuperscript{b}Goddard Space Flight Center, NASA, Greenbelt, MD

Abstract: The NASA DISCOVER-AQ field projects aim to characterize regional air quality in both the horizontal and vertical dimensions. The campaigns feature several key measurement sites including the rural locations of Huron, CA from January-February 2013 and Smith Point, TX during September 2013. To meet campaign objectives, it is essential to continuously observe trace gases, aerosols, and meteorological variables at ground sites. These variables were measured using EPA-standard trace gas analyzers for NO/NO\textsubscript{2}/NO\textsubscript{x} and O\textsubscript{3} (ppb), a nephelometer for backscattering and total scattering coefficients (m\textsuperscript{-1}), and a flux tower for near surface meteorological parameters. The trace gas analyzers and the nephelometer recorded data in one-minute averages, while the flux tower recorded data in five-minute averages.

Comparisons were made between the California and the Texas trace gas and scattering measurements. Based on observations made at the California site, NO/NO\textsubscript{2}/NO\textsubscript{x} generally vary similarly on a given diurnal cycle, with a peak in NO\textsubscript{x} during late afternoon (PST), while O\textsubscript{3} peaks during mid-afternoon. Conversely, scattering coefficients dip during late morning, rapidly increase mid-day, dip again during late afternoon, and increase once more during late night. A discussion of day-to-day variability at each site is given and linked to local meteorological conditions and synoptic-scale changes. Linking the overall meteorological conditions to the trace gas and aerosol concentrations can lead to identification of local and regional source regions. This information can inform regional air quality policy, aid the mitigation of regional air pollution, and improve the overall health of the population in that area.

Applications of a Larger-scale MFC for Wastewater Treatment and Power Production

Stager, Jennifer\textsuperscript{a}, Zhang, Xiaoyuan\textsuperscript{a}, and Logan, Bruce E.\textsuperscript{a*}
\textsuperscript{a}Department of Civil and Environmental Engineering, The Pennsylvania State University
\textsuperscript{*}Corresponding author: bel3@engr.psu.edu

Abstract: Microbial fuel cells (MFCs) use exoelectrogenic bacteria to break down organic matter and generate electricity as well as treat wastewater. MFCs can vary in size and configuration, but many studies utilize a smaller reactor body with either one or two chambers. Studies using larger scale reactors are necessary to improve system efficiency, performance, and to understand chemical oxygen demand (COD) removal kinetics before implementation in domestic wastewater treatment facilities. Such a technology could serve as a practical method for wastewater treatment while also offsetting energy costs at wastewater treatment facilities. In this presentation we will summarize the performance results of a larger-scale, single chamber, multi-brush anode MFC operated with wastewater under batch and continuous flow conditions. Performance was evaluated based on power output, COD removal, and removal kinetics.
Determination of the Soil Dispersivity Coefficient using Tracer Analysis at the Living Filter

Teachout, Angelo*®, Jack Watson®, and Danielle Andrews®
®Department of Ecosystem Science and Management, The Pennsylvania State University

Abstract:
There is an increasing need for improved modeling of the movement of pharmaceutical compounds through soil profiles. As such, a field study at the Penn State’s Living Filter (a land application site for treated wastewater effluent as a form of tertiary wastewater treatment) was conducted to determine the soil’s dispersivity coefficient through tracer analysis, as part of an ongoing pharmaceutical field research project. This soil parameter is a measure of the amount of dispersion that occurs when a chemical is transported by water through the soil. Three sampling locations (three replicates) were selected within each of the forested and cropped areas of the Living Filter. Each replicate was associated with a spray-head along the same lateral and was located 6-9 m from its corresponding spray-head depending on where maximum applied irrigation occurs. A 2.5% potassium bromide (KBr) solution was used as the tracer as Br does not interact with soil exchange sites and is therefore suited as a tracer of water movement. The KBr solution was directly applied to each sampling location and once applied, the soil was spray irrigated with wastewater effluent for 12 hours. Rain gauges were used to collect irrigation application amounts at each sampling location. After irrigation, soil samples were collected to a maximum depth of 50 cm (60 cm at one location) for a total of 13 depth increments. To obtain Br concentrations, soil water extractions were performed and extracts were filtered and analyzed with a Lachat®. STANMOD – CXTFit2 was used to estimate transport parameters.

Relationship of Particle Composition to the Deactivation of Heterogeneous Ice Nucleation of Ambient Aerosol in Ulaanbaatar, Mongolia

Veghte, Daniel P.®, Schill, Gregory b, Hasenkopf, Christa A. b, Tolbert, Margaret A. b, and Freedman Miriam A.®
®Department of Chemistry, The Pennsylvania State University
bCIREs and Department of Chemistry and Biochemistry, University of Colorado, Boulder, Colorado
®Corresponding author: maf43@psu.edu

Abstract:
Ulaanbaatar, the capital city of Mongolia, is one of the least studied, highly polluted cities in the world with an average annual PM$_{2.5}$ concentration of 63.0 μg m$^{-3}$. Particulate matter under 2.5 μm is important because it can enter the lungs causing respiratory and cardiovascular ailments. In Ulaanbaatar, there are large amounts of mineral dust from arid soils along with soot from coal burning for heat, factories, and power plants, resulting in an intricate mixture of aerosol particles. We have collected bimonthly airborne particulate samples for 10 months. Transmission Electron Microscopy (TEM) with Energy Dispersive X-ray Spectroscopy (EDS) was used to study the shape, morphology, and the elemental composition of the particles. The critical ice saturation ratios ($S_{ic}$) were measured for the onset of deposition mode ice nucleation in the supermicron fraction. The samples contain large amounts of soot, sulfate, and mineral dust particles. A larger amount of aging is seen during the winter as indicated by the presence of sulfur. A correlation is seen between an increase in the sulfur content of the particles and the deactivation of deposition mode ice nucleation. It has been shown in laboratory studies that deposition mode heterogeneous ice nucleation is suppressed in samples aged with sulfuric and nitric acid, but this study is the first to show a correlation between aging and ice nucleation suppression for field samples. The study of the composition of the particles and their ice nucleation activity is important for Ulaanbaatar to address regional pollution and health concerns.
Quantifying the Nitrogen Retention Capacity of Legacy Sediments and Relict Hydric Soils

Weitzman, Julie N.a* and Kaye, Jason P.a
aDepartment of Ecosystem Science and Management, The Pennsylvania State University
*Corresponding author: jnw142@psu.edu

Abstract:
Eutrophication is the leading cause of impairment in surface waters in the US. While eutrophication is often attributed to contemporary nutrient pollution, there is growing evidence that past practices, like the accumulation of legacy sediment behind historic milldams, are also important. Our goal was to determine how NO$_3^-$ is cycled through the soil of a legacy sediment strewn stream before and after soil drying. We extracted 10.16cm diameter intact soil columns that extended ~40cm into each of the three significant soil layers at Big Spring Run in Lancaster, Pennsylvania (surface soil, legacy sediment, and buried relict hydric layer). Isotopically labeled nitrate ($^{15}$NO$_3^-$) was added to columns, which were then air-dried and subsequently rewet with N-free water to quantify the loss of $^{15}$NO$_3^-$ from the different layers. We found the highest initial $^{15}$N retention in the legacy sediment (29±6%) and buried relict hydric soil (25±5%) layers, with significantly lower retention in the surface soil (10±1%) layer. As expected, rewetting dry soil resulted in $^{15}$N losses in all layers, with the greatest losses in the buried relict hydric soil, followed by the legacy sediment and surface soil layers, respectively. The $^{15}$N remaining in the soil following the sequential leaching events post-drought was highest in the legacy sediment, intermediate in the surface soil, and lowest in the buried relict hydric soil. Higher $^{15}$N retention in the stable soil N pool following sequential leaching suggests that legacy sediments may immobilize some NO$_3^-$, reducing its losses to nearby stream waters.

Integrating membrane separations with acidogenic digestion of lignocellulosic biomass for enhanced productivity

Xiong, Boya*, Kumar, Manishb, and Richard, Toma*

aDepartment of Agricultural and Biological Engineering, The Pennsylvania State University
bDepartment of Chemical Engineering, The Pennsylvania State University
*Corresponding author: trichard@psu.edu

Abstract:
During acidogenic digestion, lignocellulosic biomass is anaerobically converted into carboxylic acids which serve as reactive intermediates for downstream lignocellulosic biofuel production. Accumulation of carboxylic acids during digestion negatively impacts microbial activity and overall digestion performance. Therefore, acid removal during digestion has the potential to improve system performance. This work evaluated 1) Nanofiltration (NF) membrane separation of acidogenic digestion liquor derived from hot water pretreated willow, with a goal of separating carboxylic acids while retaining sugars; and 2) the integration of separation with digestion, including proof of concept for a membrane bioreactor, with effectiveness evaluated by the digestion yield and conversion rate. The effects of pH and feed pressure on acid and sugar rejection were investigated with 10 day old digestion liquor using two commercial Nanofiltration membranes. Results indicated optimal operation was at pH 3 and 87 psi, achieving low rejection (0%-20%) of lactic, formic and acetic acid, and 90% rejection of xylose. Most carboxylic acids could be recovered by NF except butyric acid, presumably due to intermolecular interaction of butyric acid with the complex compounds in the digestion liquor. To investigate the integration of separation with digestion, the acids were separated by short term NF from the digestion liquor every five days. Retentate was recycled back into the digestion with addition of water to maintain the solids loading rate. This study provides preliminary engineering design using actual lignocellulosic biomass material to develop a membrane bioreactor that appears a robust and scalable process for carboxylate platform of lignocellulosic biofuel production.
Once a sleeping farming village, Wengen has been transformed into a holiday resort over the past 200 years. At an altitude of 1,400 metres, it can bear rich vegetation during the summer and provide abundant snow for winter resort. However, due to the massive increase in recreational facilities and activities, there is an alarming decline in biological diversity in terms of wildlife at the Wengen resort. Global warming and air pollution in Zurich and Brussels also affected the amount of ice cover at Wengen. Environmental conservation projects should be planned accordingly to restore wildlife and their habitats and to adapt to climate change.
Application of the Alternative Host Hypothesis Elucidates Potential Virulence Genes in *Pseudogymnoascus destructans*

**Smyth, Christopher**<sup>a,b,*</sup>, **Schlesinger, S.**<sup>b</sup>, **Overton, B.**<sup>b</sup>, and **Butchkoski, C.**<sup>c</sup>

<sup>a</sup>Department of Plant Pathology and Environmental Microbiology, The Pennsylvania State University  
<sup>b</sup>Biology Department, Lock Haven University, Lock Haven, PA  
<sup>c</sup>Pennsylvania Game Commission, Bureau of Wildlife Management  
*Corresponding author: cws187@psu.edu*

Abstract:  
After its arrival in the United States in 2006, the causative agent of White Nose Syndrome, *Pseudogymnoascus destructans* (*Pds*), has decimated bat populations in North America, leading to the death of over 6 million individual bats spanning 7 species. Evidence suggests that this fungus is new and invasive to North American cave ecosystems, accidentally being introduced from Europe where records of it growing on bats pre-date 2006. *Pds* does not, however, cause the same mortality rates in Europe as seen in North American species. Coevolution has been hypothesized as a probable explanation for the differences in mortality. The Alternative Host Hypothesis, developed by Casadevall et al. (2003) to explain mammalian diseases caused by Environmental Pathogenic Fungi (EPF), offers a different perspective on the potential origin and ecology of this fungus. By growing *Pds* on the moss, *Polytrichum commune*, *in vitro*, we found that the fungus has the ability to survive and reproduce without a bat host. Then, theoretically applying the Alternative Host Hypothesis to *Pds*, we elucidated several potential dual use virulence genes. Dual use virulence genes develop through selective environmental pressures, such as predation by other microbes, and are fortuitously pre-adapted for pathogenic functions when inside the mammal host. If *Pds* fits the definition of an EPF, it would suggest that *Pds* has the ability to grow and reproduce in cave environments when its mammalian host is absent. To the knowledge of the author, this is the first time potential virulence genes have been identified in *Pds*.

Microbial diversity within the Okinawa backarc basin subvent biosphere

**Brandt, Leah**<sup>a,*</sup> and **House, Christopher**<sup>a</sup>

<sup>a</sup>Department of Geosciences, The Pennsylvania State University  
*Corresponding author: ldb163@psu.edu*

Abstract:  
The marine subsurface biosphere has become an area of intense biogeochemical investigation because it represents a significant portion of Earth’s living biomass and, thus, influences global geochemical processes. Isolated beneath the surface for up to hundreds of meters of sediment, microbial life is far removed from sunlight, strong oxidants, organic inputs, and other nutrients. Yet, microbial communities take advantage of the limiting and, often, unfavorable conditions. The survival of microbial ecosystems in strained and extreme environments is appealing to understanding the controls and limits of life.  
The Integrated Ocean Drilling Program (IODP) Expedition 331 to the Okinawa backarc basin provided an opportunity to recover sediments from a hydrothermal vent system within a continental margin setting. The drilling site of interest is located 450 m east of an actively venting hydrothermal vent. The surface sediments are approximately 5°C, while the temperature below increases at an estimated rate of 3°C/m due to a subsurface migration of hydrothermal fluid. There is also evidence below 10 m of hydrothermal alteration of clays. Therefore, this particular drilling site is ideal for investigating shifts in microbial communities as a function of increasingly restrictive, high-temperature conditions with depth. Sequences from amplified regions of the 16S rRNA gene were analyzed from a number of samples spanning the top 20 m of sediment. The sequence data indicate 1) the potential limits of the biosphere, 2) a community involved in the anaerobic oxidation of methane, and 3) a possible high temperature adapted niche within the deeper horizons.
Kinetic Isotope Effects in the CO$_2$ Hydration/hydroxylation Reaction: Implications for $^{13}$C and $^{18}$O Isotopic Signatures in Corals

Boettger, Jason* and Kubicki, James*

*Department of Geosciences, The Pennsylvania State University
*Corresponding author: jdb488@psu.edu

Abstract:
Paleoclimate proxies based on isotopic fractionation in biogenic calcium carbonate minerals constrain paleotemperatures and aid in assessments of the current rate of anthropogenic global warming. Corals and some other calcifiers tend to display $\delta^{13}$C and $\delta^{18}$O in disequilibrium with surrounding waters (so-called “vital effects”), introducing potential errors to paleoproxies. Some research attributes vital effects to slow isotopic exchange during the hydration reaction between CO$_2$ and H$_2$O in the semipermeable membrane-bound calcifying space (“kinetic” vital effect model).

We present atomistic simulations to elucidate the potential contribution of kinetic vital effects to non-equilibrium C and O isotope fractionation in the skeletons of calcifiers. The model utilizes density functional theory and transition state theory to evaluate isotopologue-specific reaction rates for CO$_2$ hydration and hydroxylation. Model accuracy is tested against experimental reaction rates and equilibrium fractionation factors. More accurate results are obtained when using more H$_2$O molecules in the CO$_2$ hydration shell, highlighting the importance of accurately modeling the local chemical environment around the reactive species and suggesting the usefulness of cluster-based models. Results will be compared with periodic models which do not use clusters but instead simulate small numbers of molecules in a repeating superstructure. These results are consistent with previous computational models which achieve ~1‰ accuracy in $\delta^{18}$O$_{CO_2\leftrightarrow H_2O}$ once >15 H$_2$O molecules are included in the hydration shell. These ab initio models will show whether or not the kinetics of hydration and hydroxylation reactions can account for vital effects in calcifiers, or whether other models are necessary to account for non-equilibrium fractionation.

Oral Presentation Session II

The Impact of Chemical Processing on the Ice Nucleation Ability of Common Ice Cloud Nuclei

Sihvonen, Sarah K.*, Murphy, Kelly A.*, Mueller, Karl T.*, and Freedman, Miriam A.*

*Department of Chemistry, The Pennsylvania State University
*Corresponding author: maf43@psu.edu

Abstract:
Mineral dust aerosol serves as a nucleus for ice particles in clouds, thereby affecting climate. However, the nature of mineral dust active sites for ice nucleation is poorly understood. During atmospheric transport, mineral dust aerosol encounters and reacts with trace atmospheric gases, including sulfuric acid, which affects its ice nucleation ability. This research aims to understand changes to reactive surface sites after acid processing. Two types of common clay minerals found in mineral dust, montmorillonite (swelling clay) and kaolinite (non-swelling clay), were explored. The minerals were exposed to various concentrations of aqueous sulfuric acid in order to mimic atmospheric processing. The samples were reacted with a probe molecule, (3,3,3-trifluoropropyl)dimethylchlorosilane, that selectively binds to non-hydrogen bonded Q$^3$ silicon hydroxyl sites located on mineral edges. Attachment to these sites was quantified by counting the hydroxyl groups via $^{19}$F magic angle spinning (MAS) NMR. The bulk structure of the sample was also analyzed using X-ray diffraction (XRD). The kaolinite samples demonstrated an increase in hydroxyl groups with acid concentration, which was most pronounced with 1.0 M sulfuric acid. For the montmorillonite samples, the increase in hydroxyl groups with acid concentration was more subtle. Our results indicate that the proportion of mineral edge site hydroxyl groups increases with exposure to acid. XRD analysis of treated minerals indicates no change to the structure of kaolinite, but montmorillonite becomes enriched in silicon. These results indicate that acid exposure produces more mineral edge sites that can nucleate ice, which has important implications for cold cloud formation.
Biologically Renewable Soil Nitrogen: Simulation of BSC Dynamics after Applying Cyanobacteria to Agricultural Soil

Peng, Xin\textsuperscript{a} and Bruns, Mary Ann\textsuperscript{b}
\textsuperscript{a}Intercollege Graduate Degree Program in Ecology, The Pennsylvania State University
\textsuperscript{b}Department of Ecosystem Science and Management, The Pennsylvania State University
*Corresponding author: xup102@psu.edu

Abstract: Cyanobacteria are the main communities that are capable of nitrogen fixation in biological soil crusts (BSCs). Therefore, they are pioneers of BSC succession and have a great potential to be applied as a biological amendment to increase soil fertility in agricultural systems. Based on the community matrix analysis for three main components of BSCs communities – cyanobacteria, green algae and moss, here a stochastic succession model is established to simulate the microbial dynamics of BSCs after the artificial application of cyanobacteria in both till and no-till maize cultivating system, using a 10-year daily soil condition data. Based on the model simulation, BSC communities are self-renewable after cyanobacterial application, and can contribute a significant amount of the total maize nitrogen requirement for each growth season.

Impacts of Sea Level Rise, Tropical Cyclones, and Storm Surge on Coastal Inundation in New York and New Jersey

Reed, Andra J.\textsuperscript{a*}, Mann, Michael E.\textsuperscript{a}, Emanuel, Kerry A.\textsuperscript{b}, Lin, Ning\textsuperscript{c}, and Kemp, Andrew C.\textsuperscript{d}
\textsuperscript{a}Department of Meteorology, The Pennsylvania State University
\textsuperscript{b}Department of Earth, Atmospheric, & Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA
\textsuperscript{c}Department of Civil and Environmental Engineering, Princeton University, Princeton NJ
\textsuperscript{d}Department of Earth and Ocean Sciences, Tufts University, Medford, MA
*Corresponding author: axr5145@psu.edu

Abstract: In a changing climate, future inundation of the United States Atlantic and Gulf coasts will depend on sea level rise as well as tropical cyclones and their resultant storm surges. Using an interdisciplinary approach that combines tropical cyclone simulations, storm surge models, and proxy sea level records, we perform a first order approximation to determine the effect of rising sea level on storm surge heights in New York City. Distributions of storm surges at the Battery in New York City, combined with sea level rise for the region, are compared for the pre-anthropogenic era (before AD 1800) and anthropogenic era (AD 1800 - present). Results from this initial assessment indicate that the means of the pre-anthropogenic era and anthropogenic era distributions are different at the 99% confidence level. This provides a good proof of concept for how these types of simulations may be used in the future, not only for New York City, but also for other coastal areas.
The impact of mesoscale circulations on boundary layer evolution and air quality during DISCOVER-AQ.

Rutt, Kaitlin*, Charnick, Michael, Uribe, Ricardo, Prebish, Christopher, Ntonados, Evan, Markiewicz, Joseph, See, Timothy, Guarriello, Felicia, Serino, Michelle, Buzanowicz, Megan, McCormick, Jordan, Vivola, Jean, and Nielsen, Megan
Department of Earth Science, Millersville University, Millersville, PA
*Corresponding author: karutt@millersville.edu

Abstract:
The NASA DISCOVER-AQ (Deriving Information on Surface conditions from Column and Vertically Resolved Observations Relevant to Air Quality) provided the opportunity to observe the influence of mesoscale circulations on the structure and evolution of the boundary layer and their associated effect on the air quality and aerosol trends within two urban airsheds. A network of ground-based instruments, soundings, and aerostat profiles captured significant modifications to BL structure as sea and bay breeze fronts, thunderstorm outflow boundaries, weak synoptic-scale fronts, and recirculation events impacted the region. The Millersville University Atmospheric Research and Aerostat Facility (MARAF) was used to obtain high vertical resolution profiles of the lower BL. A high load capacity aerostat carrying a tethersonde for conventional meteorological variables, O3 and NO/NOX criteria gas monitors and particle size distribution for air quality documented details of BL evolution to 500 m, while the NASA P3B aircraft spiraled above with a suite of instruments. Acoustic sodar provided continuous measurements of wind, virtual temperature and turbulence parameters. BL and aerosol layer depth was determined by an MPL4 micropulse Lidar, along with 4 m flux measurements of heat, momentum, moisture, CO2, and net radiation. A case study was done to analyze sea-bay breeze interaction with a 200-plus ppbv O3 plume downwind of Houston, TX. These observations show a complex BL response to transformational air mass interactions.

Oral Presentation Session III

Enhanced Submerged Phytase Fermentation with Aspergillus ficuum by Optimization of Process Conditions for Batch and Fed-batch Fermentations

Coban, Hasan Bugra* and Demirci, Ali*
*Department of Agricultural and Biological Engineering, The Pennsylvania State University
*Corresponding author: axd29@psu.edu

Abstract:
Phytase breaks down phytate, which causes malnutrition by binding divalent ions, amino acids, and proteins in animals. Additionally, phytate causes excessive phosphorus accumulation in the manure, which has negative effects on the environment such as changing flora and fauna. In order to prevent the negative effects of phytate, phytase enzyme must be produced efficiently. However, the current solid-state productions of phytase cannot meet the demand. Therefore, this study aimed to increase the phytase activity in submerged fermentations by selecting the best microbial strain, optimizing process conditions such as temperature, pH, and aeration as well as medium composition such as glucose, phytate, and CaSO4 and performing batch and fed-batch fermentations. As a result, Aspergillus ficuum (NRRL 3135) was selected as the most productive strain among four evaluated. In batch fermentations optimum temperature, pH, and aeration were determined as 33°C, 4.5, and 0.9 vvm, respectively. Phytase activity was measured as 2.27 U/ml under these conditions, which was 2-fold higher compared to shake-flask fermentation results. Also, optimum glucose, phytate, and CaSO4 concentration in the fermentation medium were determined as 126 g/L, 14 g/L, and 1.1 g/L, respectively and phytase activity increased to 3.45 U/ml under these conditions. Furthermore, fed-batch studies showed that 60 g/L of glucose and 10 g/L phytate addition at 96th hour of fermentation enhanced activity to 3.87 U/ml and 4.82 U/ml, respectively. This study clearly showed that this is an enhancement of phytase toward commercial production.
Insights into *Clostridium phytofermentans* biofilm formation: aggregation, micro-colony development and the role of extracellular DNA

Zuroff, Trevor R.*, Gu, Weiminb, Fore, Rachel L.a, Leschine, Susan B.c, and Curtis, Wayne R.a*

aDepartment of Chemical Engineering, The Pennsylvania State University
bDepartment of Microbiology, University of Massachusetts, Amherst, MA
cDepartment of Veterinary and Animal Sciences, University of Massachusetts, Amherst, MA
*Corresponding author: wrc2@psu.edu

Abstract:

Biofilm formation is a critical component to the lifestyle of many naturally occurring cellulose-degrading microbes. In this work, cellular aggregation and biofilm formation of *Clostridium phytofermentans*, a cellulolytic anaerobic bacterium, was investigated using a combination of microscopy and analytical techniques. Aggregates included thread-like linkages and a DNA/protein-rich extracellular matrix when grown on soluble cellobiose. Similar dense biofilms formed on the surface of the model cellulosic substrate Whatman #1 filter paper. Following initially dispersed attachment, micro-colonies of roughly 500 mm diameter formed on the filter paper after six days. Enzymatic treatment of both the biofilm and cellular aggregates with DNase and proteinase resulted in significant loss of rigidity pointing to the key role of extracellular DNA (eDNA) and proteins in the biofilm structure. A high-throughput biofilm assay was adapted for studying potential regulators of biofilm formation. Various media manipulations were shown to greatly impact biofilm including repression in the presence of glucose but not the β1→4)-linked disaccharide cellobiose, implicating a balance of hydrolytic activity and assimilation to maintain biofilm integrity. Using the micro-titer plate biofilm assay, DNase and proteinase dispersed approximately 60 and 30% of mature biofilms, respectively, while RNAse had no impact. This work suggests that *C. phytofermentans* has evolved a DNA/protein-rich extracellular matrix complementing its cellulolytic nature and that biofilm behavior is controlled by density-dependent quorum sensing-like mechanisms. These insights add to our current understanding of natural ecosystems as well as strategies for efficient bioprocess design.

Integrating Membrane Separations with Acidogenic Digestion of Lignocellulosic Biomass for Enhanced Productivity

Xiong, Boya*, Kumar, Manishb, and Richard, Tom*a

aDepartment of Agricultural and Biological Engineering, The Pennsylvania State University
bDepartment of Chemical Engineering, The Pennsylvania State University
*Corresponding author: trichard@psu.edu

Abstract:

During acidogenic digestion, lignocellulosic biomass is anaerobically converted into carboxylic acids which serve as reactive intermediates for downstream lignocellulosic biofuel production. Accumulation of carboxylic acids during digestion negatively impacts microbial activity and overall digestion performance. Therefore, acid removal during digestion has the potential to improve system performance. This work evaluated 1) Nanofiltration (NF) membrane separation of acidogenic digestion liquor derived from hot water pretreated willow, with a goal of separating carboxylic acids while retaining sugars; and 2) the integration of separation with digestion, including proof of concept for a membrane bioreactor, with effectiveness evaluated by the digestion yield and conversion rate. The effects of pH and feed pressure on acid and sugar rejection were investigated with 10 day old digestion liquor using two commercial Nanofiltration membranes. Results indicated optimal operation was at pH 3 and 87 psi, achieving low rejection (0%-20%) of lactic, formic and acetic acid, and 90% rejection of xylose. Most carboxylic acids could be recovered by NF except butyric acid, presumably due to intermolecular interaction of butyric acid with the complex compounds in the digestion liquor. To investigate the integration of separation with digestion, the acids were separated by short term NF from the digestion liquor every five days. Retentate was recycled back into the digestion with addition of water to maintain the solids loading rate. This study provides preliminary engineering design using actual lignocellulosic biomass material to develop a membrane bioreactor that appears a robust and scalable process for carboxylate platform of lignocellulosic biofuel production.
Nitrate Respiration Versus Electrode Respiration: Facultative Nitrate Reduction by Current-Producing Biofilms in a Bioelectrochemical System

Kashima, Hiroyuki and Regan, John**

*Department of Civil and Environmental Engineering, The Pennsylvania State University
*Corresponding author: jregan@engr.psu.edu

Abstract:
Bioelectrochemical systems (BESs) involve microbes exchanging electrons with an electrode and are of interest to combine wastewater treatment and renewable energy production. In this application, they are beginning to be designed for integrated nitrogen removal to offer a sustainable wastewater treatment technology. Since some exoelectrogenic (i.e., electrode-reducing) bacteria, which are central to BES performance, can also facultatively reduce nitrate, understanding their facultative metabolisms is important to develop reliable nitrogen-removal strategies in BESs. The goal of this research is to understand the critical conditions controlling these facultative metabolisms for an exoelectrogenic nitrate reducer, Geobacter metallireducens. We hypothesized that these facultative metabolisms are controlled by nitrate concentration in bulk solution, biofilm thickness, and also bioavailability of the anode electrode as determined by electrode potential via the Nernst equation.

Results showed that the critical nitrate concentration that triggered significant BES performance decrease was a function of electrode biofilm thickness but not electrode potential. This indicates that these alternative metabolisms were controlled by availability of nitrate, which is a function of nitrate concentration in bulk solution and its diffusion into an electrode-reducing biofilm. Electron recovery through the external circuit decreased as a function of nitrate dose due to electron-acceptor substrate competition, and nitrate-induced suspended biomass growth decreased the quality of treated water. In addition, nitrate reductase enzyme activity of electrode-reducing cells in the absence of nitrate indicated a unique metabolic feature of these electrode-reducing biofilms. These results provide important fundamental information about facultative nitrate versus electrode reduction in BESs.

Oral Presentation Session IV

Sorption of Contaminant Lead (Pb) with Triclinic and Hexagonal Birnessite

Ling, Florence*, Heaney, Peter*, and Post, Jeffrey*

*Department of Geosciences, The Pennsylvania State University
**Department of Mineral Sciences, NHB 119, Smithsonian Institute, Washington D.C.
*Corresponding author: ftl102@psu.edu

Abstract:
In the United States, over 300 Superfund sites on the Superfund National Priorities List suffer from lead contamination. In natural environments, manganese oxides such as birnessite have a strong affinity for Pb, possibly due to its layered structure and high cation exchange capacity. Time-resolved x-ray diffraction (TR-XRD) was used to examine the sorption of Pb with triclinic and hexagonal birnessite in a series of flow-through experiments with and without 0.1 M lead nitrate solution at pH 3. At pH 3 in the absence of Pb, triclinic birnessite transformed into hexagonal birnessite after ~3 hrs. During this transformation, Mn atoms in the octahedral sheet moved into interlayer sites. In the presence of Pb, triclinic birnessite transformed into a hexagon-like phase after ~6 hrs. Pb was found in the interlayer, causing turbostratic disorder. We interpret these results using the model of sequential delamination. During the transformation from triclinic to hexagonal birnessite, Pb entered the interlayer, forcing the layers to expand and replacing Mn at their usual positions. As the layers resettled, the lone pair electrons on Pb created a turbostratically disordered structure. Surprisingly, hexagonal birnessite showed subtle, if any, transformation in the presence of Pb after 6 hrs. However, seven-day batch experiments with 0.1 M lead nitrate solution at pH 3 indicated a change in the ratio of the (1 0 0) to (1 0 -1) peak, suggesting that Pb had replaced Mn in the interlayer of hexagonal birnessite. Chemical analysis of solutions for 7-day batch experiments showed that hexagonal birnessite sorbed more Pb than triclinic birnessite.
A Study of Biomolecule Adsorption onto Ferrihydrite: Building the Foundation of Organo-Mineral Associations in Soil

Schmidt, Michael$^{a,b,*}$ and Martínez, Carmen Enid$^{a,b}$

$^a$Department of Ecosystem Science and Management, The Pennsylvania State University
$^b$Department of Crop and Soil Science, Cornell University, Ithaca, NY

*Corresponding author: ms2958@cornell.edu

Abstract:

Competitive adsorption between a vast profile of organic molecules in the soil solution is a molecular level process that has implications on carbon stabilization in soils. Fundamental concepts regarding the competitive adsorption process and how it influences the formation of stable organo-mineral associations in soils remain unclear. This work attempts to clarify the competitive adsorption process by investigating the interaction of two structurally distinct biomolecules with a model ferrihydrite surface. The behavior of laccase, a protein, and DNA, a nucleic acid, at the aqueous oxide interface was probed using an in-situ ATR-FTIR approach. ATR-FTIR was used to simultaneously probe reaction rates and structural rearrangements associated with the adsorption reactions. Results suggest both DNA and laccase readily adsorb to ferrihydrite. A pseudo-first order kinetic model yielded adsorption rate constants of 0.0485 and 0.0784 min$^{-1}$ for DNA and laccase, respectively. Upon adsorption to ferrihydrite, spectroscopic evidence suggests that both DNA and laccase undergo structural rearrangement. Spectra of adsorbed laccase exhibit distortion of amide I and II bands, indicating conformational change in adsorbed material. Adsorbed DNA shows a shift in backbone phosphate group vibrational energy when compared to free DNA. This is indicative of strong interaction between the DNA backbone and the ferrihydrite surface, suggesting a conformational change in the backbone of adsorbed DNA. Preliminary work further exploring organo-mineral interactions will be briefly highlighted as well, showing possible experimental extensions of this work.

Chemical Weathering and Fe Isotope Fractionation in Regolith Overlying a Diabase: Fe Cycling at the Bedrock/Regolith Interface in Pennsylvania

Yesavage, Tiffany$^{a,*}$, Stinchcomb, Gary$^a$, Sak, Peter$^b$, Fantle, Matthew$^a$, Kasznel, Alexander$^b$, and Brantley, Susan$^a$

$^a$Department of Geosciences, The Pennsylvania State University, University Park, PA
$^b$Department of Earth Sciences, Dickinson College, Carlisle, PA

*Corresponding author: tay120@psu.edu

Abstract:

The goal of this study is to understand changes in mineralogy, chemistry and Fe isotope signatures in a 4-m thick Pennsylvania regolith profile underlain entirely by rocks of basaltic composition (diabase). We document important chemical and isotopic reactions taking place in the deep regolith at the bedrock/regolith interface. While total Fe is largely retained in the lower portion of the profile, Fe(II) is oxidized in the lowermost 30 cm of the profile. Elevated concentrations of amorphous Fe are observed both toward the surface of the profile and at depth near the bedrock/regolith interface. Similar trends in a Puerto Rico quartz diorite soil highlight the process of spheroidal weathering, which may release Fe(II) that is rapidly oxidized in the profile and precipitated as amorphous Fe oxides. $\delta^{56}$Fe values of bulk samples show very little variation with depth, whereas $\delta^{56}$Fe values of amorphous Fe are isotopically depleted both in the upper meter and near the bedrock/regolith interface. Although we cannot rule out biological mechanisms, we attribute isotopically light Fe at depth largely to kinetic isotope effects during the rapid abiotic precipitation of Fe(III) to form Fe oxides. In addition to Fe chemistry, we are interested in changes that occur in pore-water chemistry in the deeper B and C horizons. Elevated concentrations of DOC, Fe and Al near the Bt/BC horizon are consistent with preferential flowpaths, likely resulting from the lower hydraulic conductivity of the underlying BC horizon.
Determination of a Ca Isotopic Biosignature in Microbially Mediated Gypsum Precipitates

Harouaka, Khadouja*, Mansor, Muammar*, and Fantle, Matthew*

* Department of Geosciences, The Pennsylvania State University
* Corresponding author: kuh121@psu.edu

Abstract:
Gypsum (CaSO\textsubscript{4} \cdot 2H\textsubscript{2}O) precipitation experiments were carried out in Ca rich media, inoculated with S oxidizing bacteria Acidithiobacillus thiooxidans, and S\textsuperscript{0} as the reduced S source. Microbial oxidation of S\textsuperscript{0} increases SO\textsubscript{4} concentration in the media until it becomes oversaturated with respect to gypsum. An abiotic and a killed control were also run, wherein the reaction proceeded by the addition of 1M H\textsubscript{2}SO\textsubscript{4}. Experiments lasted ~51 days; the solutions were sampled every 2-4 days for Ca and SO\textsubscript{4} concentrations, pH and cell density. The final precipitates were imaged via SEM to determine average aspect ratios. The Ca isotopic compositions (δ\textsuperscript{44/40}Ca) of the solutions and crystals were measured. Isotopic fractionation factors (Δ\textsuperscript{44}Ca = δ\textsuperscript{44}Ca\textsubscript{crystal} - δ\textsuperscript{44}Ca\textsubscript{solution}) were -1.26±0.06 to -1.23±0.04‰ in the biotic experiments, and 0.94±0.21‰ and 0.85±0.17‰ in the killed and abiotic controls, respectively, which implies a biological isotope effect of ~0.4‰. Log precipitation rates (µmol/h), determined from Ca concentration profiles, were similar between the biotic experiments (-0.03±0.3 - 0.24±0.3) and the abiotic (0.09±0.5) and killed (0.18±0.3) controls, indicating that the isotope effect was independent of rate. Crystals from the biotic experiments and the killed control had smaller average aspect ratios (12.6±10.7 - 14.0±21.5) than the abiotic control (39.2±30.0); while saturation states just prior to precipitation were 2.7 - 2.8 in the biotic experiments, and 1.7 and 1.5 in the killed and abiotic controls, respectively. These observations suggest that the presence of living microbes can indirectly fractionate Ca isotopes by inhibiting gypsum nucleation, possibly though the formation of a Ca-organics complex reservoir.
Environmental Chemistry and Microbiology
Resources at Penn State

1. Center for Environmental geoChemistry and Genomics (CECG)
2. Penn State Institutes of Energy and the Environment (PSIEE)
3. Engineering Energy and Environment Institute (College Engineering)
4. Environment and Natural Resources Institute (College of Agricultural Sciences)
5. Earth and Environmental Systems Institute (EESI)
6. Environmental Engineering Group
7. Kappe Environmental Engineering Labs
8. Student Association of Environmental Science and Engineering
9. Agricultural Analytical Services Laboratory
10. Department of Chemistry
11. Department of Energy and Mineral Engineering
12. Nittany Atmospheric Trailer and Integrated Validation Experiment (NATIVE)
13. NMR Spectroscopy Facility
14. Proteomics and Mass Spectrometry Core Facility
15. Materials Characterization Laboratory
16. Shared Fermentation Facility
17. Metabolomics Core Facility
18. Microscopy and Cytometry Facility
19. Genomics Core Facility
The Center for Environmental geoChemistry and Genomics (CECG) was established in 1997 to generate and facilitate research and education in the area of fundamental environmental chemistry and biogeochemistry on the Penn State campus. Instituted by Dr. Pat Hatcher in the College of Earth and Mineral Sciences (EMS), the CECG, now directed by Dr. Jenn Macaldy, encourages participation of faculty, staff, and students from across the campus, including all Colleges and Penn State Institutes of Energy and the Environment (PSIEE). At present, the CECG is supported by The Eberly College of Science (ECOS), PSIEE, The College of EMS, the Department of Meteorology, and the Earth and Environmental Systems Institute (EESI).

As an interdisciplinary center with the goal of promoting analytical and computational research for solving fundamental environmental chemical questions, we are involved in the following activities:

1) Enhancement of the visibility of the excellent personnel engaged in environmental research and education on campus through CECG activities and our website.
2) Establishment of a fund for the invitation of environmental speakers and for sponsorship of environmental conferences.
3) Funding for Penn State graduate and undergraduate research through the CECG summer research awards program. Recipients of the 2012 Summer Fellowships include:
   - Jason Boettger, Department of Geosciences, Graduate student
   - Jennifer Boulay, Department of Biology, Graduate student
   - Mansor Muanmar, Department of Geosciences, Graduate student

4) Continued sponsorship of the annual Environmental Chemistry and Microbiology Student Symposium showcasing undergraduate and graduate student research.
5) Sponsorship of Research Initiation Grants (RIGs) to fund proposals submitted by those conducting research in the area of environmental chemistry on campus.
6) Promotion of analytical and computational facilities on campus for environmental research through web page information and funding.
7) Support for new initiatives related to environmental chemistry.

For more information regarding CECG, please visit our website or contact Debbie Lambert at lambert@essc.psu.edu.
Penn State Institutes of Energy and the Environment

http://www.psiee.psu.edu

Penn State Institutes of Energy and the Environment (PSIEE) is the central coordinating structure for energy and environmental research, education, and outreach at Penn State. Organized under the Office of the Vice President for Research, PSIEE brings together more than 500 extraordinary faculty, staff and students. PSIEE is directed by Professor Tom L. Richard (trichard@psu.edu); with Associate Director Chunshan Song, and Assistant Directors Elizabeth Boyer, Nancy Franklin, and Denice Wardrop. They are assisted by an Executive Committee (with Deans of participating Colleges), a Coordinating Committee (with representatives from participating Colleges and Research Institutes, and Centers across the campuses), and an Advisory Committee (of external experts).

PSIEE promotes interdisciplinary research, education, and outreach via a range of activities:

- Hiring of new faculty into areas of strategic importance and opportunity;
- Monitoring of relevant funding opportunities and communicating them to researchers;
- Communicating with government and non-governmental research sponsors;
- Supporting small grant opportunities for collaborative research in strategic priority areas;
- Providing financial support & matching funds to Penn State faculty toward the development of large-scale, interdisciplinary research proposals;
- Promoting Penn State's energy and environmental capabilities through web sites, listserves, e-newsletters, events, and outreach activities.
- Hosting campus-wide colloquia, seminars, visitors, and post-doctoral fellows;
- Synthesizing information about graduate and undergraduate degree programs at Penn State, and offering an intercampus Environmental Inquiry minor degree program.

Some recent interdisciplinary PSIEE initiatives transforming research at Penn State include:

- Recruitment of 50 faculty members as part of University-wide environmental (25) and energy (25) hiring initiatives.
- Coordination among affiliated environmental & energy institutes across the campus, such as the Environment & Natural Resources Institute; the Earth & Environmental Systems Institute; the EMS Energy Institute; the Engineering Energy & Environmental Institute; the Rock Ethics Institute; and the Sustainability Institute.
- Facilitating major research awards such as the: Energy Efficient Buildings Hub (toward better energy efficiency for commercial buildings); Center for Lignocellulose Structure and Formation (toward understanding of biomass energy sources); Northeast Woody/warmseason Biomass Consortium (expanding use of woody plants and other renewable crops as energy solutions); Battery and Energy Storage Technologies Center (toward improved energy storage); Critical Zone Observatory (toward understanding coupled physical, chemical, and biological processes that affect vegetation, soils, bedrock, & water in the environment); and the Sustainable Climate Risk Management Network (scholars around the world coordinating knowledge and tools to help address the challenges of climate change).
- Hosting the Pennsylvania Water Resources Research Center, a member of the National Institutes of Water Resources, facilitating water sciences research, education, and outreach across the state of Pennsylvania in a unique federal-state-academic partnership.
• Managing campus-wide analytical and experimental facilities for shared use, including a water quality lab and an environmental isotopes & metals lab.

Some PSIEE resources for environmental chemistry and microbiology students:

• View information about environmental research on campus, and a listing of campus-wide environmental majors, minors, and faculty via our website: http://www.psiee.psu.edu

• Check out our comprehensive calendar of upcoming energy & environmental events happening all across the campus: http://www.psiee.psu.edu/news/calendar.asp.

• Subscribe to our listserv to be informed about happenings and opportunities in Energy & the Environment on the Penn State campus: http://www.psiee.psu.edu/news/listserv.asp.

• Interested in water? Join the Penn State student chapter of the American Water Resources Association, sponsored by PSIEE. Contact Sarah Tzilkowski (ssg5034@psu.edu).

• Take a tour of our Water Quality or Isotopes & Metals shared-use laboratory facilities; see http://www.psiee.psu.edu/research/labs_facilities.asp. We provide methods training and have great rates for students. We can help you analyze air, rock, soil, water, or biological samples!

Laboratory for Isotopes and Metals in the Environment
• Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)
• Inductively Coupled Plasma - Mass Spectrometry (ICP-MS)
• Multiple Collector Inductively-Coupled Mass Spectrometry (MC-ICP-MS)
• Elemental Analyzer- Isotope Ratio Mass Spectrometer (EA-IRMS)
• Cryogenic Vacuum Distillation System

For more information, contact Sue Brantley (brantley@eesi.psu.edu)

Water Quality Lab:
• PerkinElmer AAAnalyst 800 Atomic Absorption Spectroscopy
• Mettler Toledo DL15 Potentiometric Titrator for Endpoint Titrations
• Radiometer TIM865 TitraLab: acid neutralizing capacity
• Dionex ICS-3000: Ion Chromatography for fluoride, chloride, nitrate, sulfate, bromide
• Shimadzu TOC-VCPP: carbon/total nitrogen analyzer
• YSI 3200 conductivity meter
• Beckman 360 pH meter
• Milestone’s DMA-80 Direct Mercury Analyzer
• SEAL AQ2 Automated Advanced Discrete Analyzer: ammonia, silica, phosphorus
• Solids Analysis: Total, Settleable, Total Dissolved, Total Suspended
• 2100N Hach Turbidimeter
• Picarro L2130-i Analyzer: Oxygen 16/18, Deuterium/Hydrogen

For more information, contact Karol Confer (kec1@psu.edu)
The Engineering Energy and Environmental Institute (E3I) is the name of the College of Engineering’s (COE) institute that has activities in energy and environment. It is a part of the Penn State Institutes of Energy and the Environment (PSIEE). Both the E3I and PSIEE originally included only environmental activities, but both now accommodate activities in research, education and outreach in both energy and environment topics (see the E3I Mission Statement, available online).

In the world that we live in today, there are infinite opportunities for engineers to engage in activities that will help solve local and global energy and environmental issues. Activities in the COE include addressing existing energy and environmental challenges through forward-looking activities aimed towards avoiding future environmental problems and developing new energy technologies. The main focus of the E3I is to stimulate new innovations in environmental and energy research. The E3I helps to provide increased visibility of the Penn State engineering programs working in these important areas, and engender new research directions that will stimulate innovations in technologies relating to the energy and the environment.

You can find out what research engineers are doing related to energy and environmental topics in the COE by browsing our E3I website. We provide links to pages that summarize environmental and energy activities by department, and links to researchers in these departments that describe their energy and environmental research. You can download a copy of our report "Engineering for the Environment" that contains a broader vision of the research that engineers perform to study and improve our environment.

Engineers will make the difference in solving environmental and energy problems and helping to promote and create an environmentally-sustainable society that produces energy in beneficial ways. We encourage you, through the links and information provided through the E3I website, to learn about our activities and to help us make a difference in these important topics.

Bruce Logan
Director, Engineering Energy and Environmental Institute
blogan@psu.edu
http://www.engr.psu.edu/ce/enve/logan.htm
Penn State’s Environment and Natural Resources Institute (ENRI) falls under the College of Agricultural Science, which is dedicated to leadership in environmental research and education with the mission of improving understanding and management of living systems, landscapes, and human-environment interactions towards the objective of sustaining and enhancing ecosystem services and human well-being. The College's investments in environmental engineering, natural, and social sciences, and commitment to multidisciplinary study of coupled human and natural systems, exemplify a 21st century model for environmental research, education, and outreach in accordance with the Land Grant Mission.

The College of Agricultural Science is a leader in disciplines ranging from basic environmental biology, chemistry, and engineering to environmental economics and sociology. ENRI Supported Centers at Penn State include the Agriculture and Environment Center, the Biomass Energy Center, the Center for Climate Risk Management, and the Energy and Environmental Economics and Policy Initiative. Current areas of research include mechanisms, management, and policies for invasive species, infectious human and animal disease, carcinogenesis, biodiversity, air and water pollution control, land use and cover dynamics, and adaptation to climate change.

College of Agricultural Science and ENRI Supported Centers at Penn State include the following:

- Agriculture and Environment Center, which works to enhance the communication and integration of science to inform policy and improve and build partnerships that benefit working landscapes across Pennsylvania (http://extension.psu.edu/aec/about).
- Biomass Energy Center, whose mission is to coordinate and facilitate research and outreach across the university, building teams to address the complete value chain of biomass energy systems (http://www.bioenergy.psu.edu/).
- Center for Climate Risk Management (CLIMA), which works to analyze scientific, economic, and ethical questions related to climate change risk assessment (http://www.clima.psu.edu/).
- Initiative for Energy and Environmental Economics (EEEP), with the goal of promoting policy-relevant economics research that lies at the boundary between energy systems and environmental management and the development of quantitative tools to address decision challenges in these areas (http://www.eesi.psu.edu/research/eesi-centers/eeep.shtml).

For more information concerning research and outreach activities of the College of Agricultural Science, please visit http://agsci.psu.edu/ or the ENRI website at www.enri.psu.edu.
The Earth and Environmental Systems Institute (EESI) is one of the nation’s leading institutes in earth and environmental sciences research. Its diverse and world-renowned faculty members are engaged in interdisciplinary, innovative and collaborative research on some of the most compelling problems and issues of our time. EESI is part of the College of Earth and Mineral Sciences (EMS) and the Penn State Institutes of Energy and the Environment (PSIEE). EESI is affiliated with PSIEE, the central coordinating structure for energy and environmental research, education, and outreach at Penn State.

EESI faculty and researchers are primarily associated with the departments of Geosciences, Meteorology and Geography, all of which have top-ranked graduate programs. Penn State's Geography graduate program is ranked #1, according to the National Research Council (1995), while the University's Earth Sciences program is sixth in the nation, according to 'U.S. News and World Report' (2010). Within Earth Sciences, the University ranks 3rd in geochemistry, 3rd in geology and 8th in paleontology. Meteorology has one of the best-known atmospheric science programs in the U.S., but this field is not officially ranked by any organization.

Vision

EESI will build an extraordinary community of people who cross boundaries to understand the earth system, how it affects people, and how people affect it.

Mission

EESI's mission is comprised of four interrelated elements:

1. To encourage interdisciplinary examination of the links between Earth’s chemical, physical, and biological processes from atomic to global scales by supporting faculty and student research on earth sciences and environmental issues;
2. To facilitate the modeling and manipulation of data in new and innovative ways through EESI's Environmental Computing Facility;
3. To facilitate dissemination of research findings through publications, presentations, web pages, workshops, seminars, testimony to public agencies, and advice to public and private organizations and agencies; and
4. To develop innovative, interdisciplinary research and education programs that benefit internal and external stakeholders, including the Penn State community, the Commonwealth, scientific communities, and federal and state science agencies and organizations.

Outreach

EESI's faculty work actively to communicate research findings to both academic and practitioner audiences. This is accomplished via publications, presentations, and web sites that are often designed and executed after consultation with the Institute’s outreach support groups and with the Center for Environmental Informatics.

Staff members can assist faculty and students in developing new and innovative approaches to the creation and dissemination of environmental information resources, and facilitate their delivery to individuals, communities, and organizations within the Commonwealth, the nation, and the world; and provide graphic and cartographic design, WWW design, GIS, remote sensing, and data resources services.
Environmental Engineering

www.engr.psu.edu/ce/area_environmental_group.html

Environmental Engineering focuses on the improvement of environmental quality through design, including: the treatment of surface water, groundwater, wastewater, soil, and air; the management of wetlands and watersheds; the treatment and disposal of solid & hazardous wastes; the production of renewable energy; and the design of “green” products. The Penn State Environmental Engineering (EnvE) program has specific strengths in biological processes for energy production, biogeochemistry of metals and radionuclides, bioremediation of hazardous contaminants, physical/chemical processes for contaminant removal, conventional water and wastewater treatment, and green product design.

The EnvE research program is supported by projects of over $20 million dollars funded by the National Science Foundation, the National Institutes of Environmental Health Sciences, the Department of Energy, the Environmental Protection Agency, the American Water Works Association Research Foundation, and many other federal, state, and local agencies, as well as by various industries. The majority of this research is conducted in the Kappe Environmental Engineering Laboratories housed within the Sackett Building on the Penn State, University Park campus.

For more information, visit the website or contact:

Professor in Charge of Graduate Programs
William Burgos
(814) 863-0578
bburgos@psu.edu

Graduate Staff Assistant
Judy Heltman
(814) 863-3085
jle5@psu.edu
The Kappe Environmental Engineering laboratories at Penn State cover an area of approximately 16,000 sq. ft., including a 2,000 sq. ft. laboratory at the University Wastewater Treatment Plant (less than one mile from the Department of Civil and Environmental Engineering).

**Analytical Chemistry:**

We have many instruments that can be used to detect trace quantities of chemicals. There are seven gas chromatographs available in the labs. Two are equipped with autosamplers: (Agilent 6890 GC with FID and TCD detectors; Agilent 6890 GC with Headspace autosampler and FID detector); one equipped for pyrolysis (Hewlett-Packard 5890 Series II / JHP-22 Curie Point Pyrolyzer); and four used with manual injection (three SRI Model 310 with TCD detector and one SRI 8610B with FID, TCD and Hall detectors). For detecting low concentrations of aqueous species, we have two ion chromatographs with autosamplers (Dionex DX-500 for gradient elution and DX-120 for isocratic ion separations), and a high performance liquid chromatograph with autosampler (Shimadzu HPLC with Photodiode Array Detector). Ion chromatography is particularly useful for anions for which no other rapid analytical technique exists. We can measure trace metals in solid or liquid samples by atomizing the sample in the atomic absorption spectrophotometer with flame and graphite furnace (Shimadzu AA-6601F). We also have a carbon / nitrogen analyzer with autosampler (Shimadzu TOC-VCSN / TNM-1), and two UV spectrophotometers (Shimadzu UV-1601 with multiport adaptor and computer interface). Concentrations of radioactive compounds in liquids can be measured using our scintillation counter (LKB Wallac 1217 Rackbeta). For highly specific analysis of uranium VI in water we have a Kinetic Phosphorescence Analyzer (Chemchek KPA-11).

Many other types of analytical equipment are available. For example, thermogravimetry is the measurement of the mass of a sample as the temperature increases. This technique is useful for determining sample purity and water, carbonate, and organic content, and for studying decomposition reactions. We have a thermogravimetric analyzer (Cahn TG-131), an accelerating rate calorimeter (CSI), a Supercritical Fluid Extractor (ISCO SFX 2-10), and a thermal reactivation furnace (Applied Test Systems 3210). We have a variety of equipment useful in water treatment studies, including an ozone Analyzer (Dasibi Environmental Corp 1008-HC), a UV lamp advanced oxidant generation system, a computer-aided titrimeter, a COD and anion analyzer and spectrophotometer (Hach DR 2000 and COD reactor), and two membrane filtration systems: a reverse osmosis unit (Desal) and a ceramic cross flow membrane apparatus (MSC Liquid Filtration Corp.). Various electrochemical measurement devices are also used in microbial fuel cell research, such as potentiostats and data loggers.

**Microbiology:**

Many of the research projects in the department involve microbes, and we are fortunate to have several microscopes and other pieces of equipment that are particularly useful in doing microbial research: a Zeiss Axiophot microscope, an Olympus BH-2 and an Olympus BX61, all with image analysis and epifluorescence capabilities.

Much research in the department involves anaerobic microorganisms. We have an autoclave, three anaerobic chambers (two dual chambers) with temperature controlled oxygen detectors, and both anaerobic and aerobic respirometer systems.
Other equipment useful in microbiological studies includes: six walk-in environmental chambers (three each 4 C and 30 C); three laminar flow hoods for sterile microbiological work (Biosafety Class II); a real-time PCR thermocycler and detection system (Bio-Rad iCycler iQ); an Electrophoresis imaging system (Bio-Rad ChemiDoc); a DGGE system (Bio-Rad DCode); two fermentors capable of operating in batch or chemostat mode with mixing and temperature control (Virtis Corp.), and one which can also measure dissolved oxygen; three centrifuges capable of handling various-sized samples; and a biological oxidizer (R.J. Harvey OX500 14C).

**Particle Analysis:**

The Kappe Labs have numerous pieces of equipment that can be used for particle characterization and/or particle sizing, including a Coulter Counter Multisizer 2 (resistance-type) with computer interface, a Coulter PCA 2. These types of counters have been used in research projects to characterize the dimensions of fractal aggregates, groundwater colloids, bacteria, and iron colloids. We also have a Malvern Zetasizer Nano ZS for measuring particle size, the potential or surface charge of colloids, and absolute molecular weight of polymers and proteins. For characterizing surface area and pore size of microporous carbons, we have Porosimetry Units (Micromeritics ASAP 2000/2010) with density functional theory pore analysis software.

To learn more about the types of research going on in the Kappe Labs, visit the Environmental Engineering group webpage ([http://www. engr.psu.edu/ce/area_environmental_group.html](http://www. engr.psu.edu/ce/area_environmental_group.html)).
Student Association of Environmental Science and Engineering

The Student Association of Environmental Science and Engineering (SAESE) is a newly founded Pennsylvania State University registered student association since 2012. The aim of SAESE is to foster interactions between graduate and undergraduate scientists and engineers engaged in environmentally relevant research. Current club members of SAESE include graduate and undergraduate students, postdoctoral fellows and staffs, and faculty members in Pennsylvania State University.

SAESE started to host the keynote speaker sections in the annual Environmental Chemistry and Microbiology Student Symposium (ECMSS) since 2013, with the founding supports from both Graduate Student Association (GSA) and Center for Environmental geochemistry and Genomics (CECG).

In the future, SAESE will be involved in the following activities:

1) Continue hosting the keynote speaker sections in the annual Environmental Chemistry and Microbiology Student Symposium (ECMSS);
2) Hosting seasonal academic seminars inviting professors and scientists present their research related to environmental science and engineering;
3) Establishing the SAESE website as an information platform for environmentally relevant academic activities and news.

For more information regarding the Student Association of Environmental Science and Engineering (SAESE), please contact:

Daniel Veghte  
President, Student Association of Environmental Science and Engineering  
dov5041@psu.edu

Michael Shreve  
Vice President, Student Association of Environmental Science and Engineering  
mjs697@psu.edu

Hiroyuki Kashima  
Treasurer, Student Association of Environmental Science and Engineering  
hvk5121@psu.edu

John M. Regan  
Faculty Advisor, Student Association of Environmental Science and Engineering  
jregan@engr.psu.edu
The Agricultural Analytical Services Testing Laboratory at Penn State conducts numerous tests for environmental and agricultural materials. Fee-based testing is available to all university faculty, staff and students as well as to the general public. The laboratory testing programs include those for soils, plants, manure, compost, soilless media, biosolids, drinking water, pond water, and irrigation water. All testing methods performed in the laboratory are based on standard referenced procedures. A complete listing of the laboratory testing programs and test packages available is provided on the laboratory web site.

In addition to the standard analyses performed in each of the laboratory programs, the laboratory also performs specialized analysis on research samples upon request. Instrumentation available at the laboratory includes two ICPs (Varian 730 ES), two Environmental Express automated digestion units, two Elementar Vario Max N/C analyzers, two Labfit robotic pH measurement systems, Milestone Mercury Analyzer, Seal Discrete Analyzer and Orion specific ion meters.

Individuals interested in the services available at Agricultural Analytical Services Laboratory should visit the web page or call (814) 863-0841 for prices or more information. Specific questions and comments should be addressed to Dr. Ann Wolf, Director of Agricultural Analytical Services Laboratory, at the phone number provided above or by email (amw2@psu.edu). Researchers or scientists interested in tests not mentioned should contact Dr. Wolf to discuss the possibility of having specific analyses performed.
The discipline of chemistry plays a central role in solving the mysteries of environmental phenomena. The modern world demands clean and efficient production of energy and materials, improved predictions of effects of human activities upon climate, and heightened awareness of the value of land, air, and water resources. "Green chemistry" approaches to manufacturing minimize waste generation; and efficient processes for waste recycling, sequestration, and destruction are needed more than ever. The development of more sensitive and information-rich analytical tools is needed to measure environmental chemicals, probe their dynamics, explore the mechanisms by which they disrupt biochemical processes, and predict the fate and toxicity of pollutants. The Penn State Department of Chemistry plays a leading role in training tomorrow's environmental leaders in all of the above areas through interdisciplinary research and instructional programs. The Department also houses shared technology resources, such as the Penn State NMR Facility, which are available to researchers throughout the Penn State system.

**Environmental Research in the Department of Chemistry**

Several faculty in the Department of Chemistry conduct pioneering fundamental research with important environmental applications. Research interests of some of the faculty are described below. For updated information, please visit our web pages at [http://www.chem.psu.edu/](http://www.chem.psu.edu/).

**Harry R. Allcock**: The Allcock research group is involved with the design, synthesis, and fabrication of membranes and hydrogels that may be useful in environmental research. These materials fall into two categories – (1) membranes designed to capture toxic metal ions such as lead, cadmium, and uranium; and (2) hydrogel particles and membranes that immobilize enzymes or cells for detoxification of organic pollutants.

**A. Welford Castleman**: The Castleman group is striving to bring new understanding to the study of nanoscale materials by employing high technology molecular beams, flow reactors, ultrafast lasers, and sophisticated new mass spectrometer techniques. Two facets of research pertain to environmental chemistry. In the first, aqueous clusters are used as prototypical aerosol particles or cloud droplets to investigate heterogeneous processes of atmospheric significance. In a second line of research, the group is investigating mechanisms of hydrocarbon and other small molecule reactions with transition metal oxides as a contribution toward understanding how various catalytic processes may contribute to pollution abatement.

**Miriam A. Freedman**: The Freedman group investigates atmospheric aerosol chemistry using spectroscopic and surface science techniques. Aerosol-radiation and aerosol-cloud interactions are two leading uncertainties in accurate modeling of Earth’s climate system. The Freedman group studies aerosol particles using ultrahigh vacuum techniques to investigate models of aerosol interfaces, microscopy techniques for single particle studies, and cavity ring-down spectroscopy to measure optical properties. Their overall goal is to develop a more complete understanding of aerosol physical and chemical properties by correlating measurements acquired at length scales ranging from molecular to macroscopic.
Thomas E. Mallouk: Professor Mallouk and his students are interested in artificial photosynthesis, separations, chemical sensing, molecular electronics, environmental remediation, and fuel cell electrochemistry. Their approach involves the synthesis of materials that contain both molecular and solid state components. They have recently developed supported forms of zero-valent iron that are good reducing agents for certain environmental contaminants, such as chlorinated hydrocarbons, heavy metal ions and TcO$_4^-$-ions. They are also developing liquid-liquid extraction techniques for the isolation of Cs$^+$, a problematic component of high level nuclear waste, as inorganic salts that can be safely vitrified.

Karl T. Mueller: The Mueller group develops both theoretical and experimental aspects of high-resolution solid-state nuclear magnetic resonance (NMR) spectroscopy. One focused goal of the Mueller group is to increase the utility and power of NMR as a tool for environmental research. Zeolites, amorphous solids, and other inorganic materials are being examined as reactive materials and sequestering agents useful for remediation of hazardous waste sites. In collaborative work with researchers in the College of Information Sciences and Technology, new cyber-based tools for interdisciplinary environmental analyses are also being developed.

Scott Phillips: The Phillips group is using organic chemistry to create exceedingly inexpensive diagnostic devices that provide all of the functions typically obtained with instruments (i.e., selectivity, sensitivity, quantitative measurements, and clearly displayed information), but using only organic reactions on a piece of paper. Their goal is to devise chemistry that forms the basis for disposable diagnostic devices for use in detecting pollution in water. They also are developing materials that respond to environmental signals by changing shape, function, and/or surface properties. One aspect of this work includes the design and synthesis of environmentally–friendly plastics that disappear when they come in contact with a certain environment (e.g., the ocean).

Ayusman Sen: The Sen group is engaged in several environmental projects. One involves the selective oxidation of alkanes. The lower alkanes, such as methane and ethane, are the least reactive and most abundant of the hydrocarbon family with known reserves equal to that of petroleum. Thus, the selective oxidative functionalization of these alkanes to higher value chemicals is of great practical interest. The current technology for the conversion of alkanes to useful products involves high temperature, multi-step, processes. The direct, low temperature, conversion of the lower alkanes would be far more attractive from an economical standpoint. The Sen group is also involved in developing catalytic processes for the low temperature conversion of biomass to fuels and value-added chemicals. With diminishing reserves of fossil fuel, the production of liquid fuels and chemicals directly from biomass is of great current interest. Carbohydrates, such as mono and polysaccharides and cellulose, typically constitute 50-80% of plant biomass. Existing technologies to biomass-derived products are typically energy intensive multi-step processes. They are investigating one-step catalytic processes for biomass conversion.
John and Willie Leone Family Department of Energy and Mineral Engineering

http://www.eme.psu.edu/

Please, visit our website for the most complete and updated information about our programs and facilities or contact us at 110 Hosler Building, University Park, PA 16802-5000, Phone: 814-865-3437, Fax: 814-865-3248, EME@ems.psu.edu
The Nittany Atmospheric Trailer and Integrated Validation Experiment (NATIVE) is a mobile atmospheric chemistry and meteorology research facility (Fig. 1). The trailer contains in-situ trace gas instrumentation to measure the concentration and temporal variability of EPA-regulated atmospheric pollutants such as ozone (O3), reactive nitrogen oxides (NOy), sulfur dioxide (SO2) and carbon monoxide (CO). The objectives of the research facility include providing ground-validation measurements for satellites, investigations of pollutant production and transport, air quality monitoring and educational outreach for the community. NATIVE also has a ground station to launch ozonesondes that measure vertical profiles of ozone in addition to profiles of temperature and relative humidity. The trailer has been utilized in a variety of different research initiatives in North America including places such as Las Tablas, Panama; Yellowknife, Canada; Beltsville, Maryland and Hampton, Virginia (Fig. 2). When not on deployment, NATIVE continuously samples near Rock Springs, PA, 10 minutes from Penn State’s University Park campus.

For more information on NATIVE and to view data, please visit our website (listed above) or contact:

Douglas Martins at dmartins@psu.edu
423 Walker Building
University Park, PA 16802
Nuclear Magnetic Resonance Spectroscopy Facility

http://www.chem.psu.edu/directory/nuclear-magnetic-resonance-spectroscopy

The primary mission of the Penn State NMR Facility is to make NMR spectroscopy available to students, postdoctoral fellows, and faculty of the University and of the surrounding Central Pennsylvania community for the advancement of their research. Student training, spectrometer maintenance, spectrometer upgrades, spectrometer repair, and scientific NMR consultation are corollary activities that support this mission.

The Facility, located in the basement of the Chemistry Building, is equipped with ten superconducting NMR spectrometers operating in both liquids and solids mode. The spectrometers range from 7 Tesla (300 MHz 1H frequency) to 20 Tesla (850 MHz 1H frequency). On site Ph.D. and technical staff are ready to facilitate data acquisition; enabling NMR applications for those without advanced training.

Spectrometers and Capabilities

Three high field spectrometers: Bruker AV-III-500, Bruker AV-III-600, Bruker AV-III-850. These spectrometers are housed in the Lloyd Jackman NMR Facility (made possible in part through a gift from Bruker Biospin). All three are equipped with TCI single axis gradient cryoprobes (1H/13C/15N/2H) with enhanced sensitivity for 1H and 13C. These instruments are heavily used for biological NMR 2D and 3D experiments. In particular, most standard spin relaxation experiments have been implemented. All high field spectrometers are available for small molecule experiments scheduled through Dr. Benesi.

Our facility has invested heavily in developing methods for 13C-direct detection on the TCI cryoprobes, enabling high field heteronuclear direct-detection spectroscopy for both (synthetic) small molecules and biomolecules. For help with INADEQUATE or similar spectra, please contact Dr. Benesi. For help with biomolecular 13C-detection, please contact Prof. Showalter.

High field solids and imaging

In addition to its primary liquids capability, the AV-III-850 is equipped for static and MAS solid state NMR. In solids mode, the AV-III-850 allows high sensitivity and high resolution observation of many quadrupolar nuclei, making it especially useful for MQMAS and QCPMG experiments. Probes capable of measuring multiple common nuclei, including aluminum, make this instrument ideal for materials research applications.

Finally, the AV-III-850 is equipped with high power amplifiers and high power triple axis pulsed field gradients for imaging and translational diffusion measurements. Ultra-high gradient strengths enable truly unique high-resolution imaging capabilities. The microimaging probe converts to a diffusion probe for liquid state diffusion applications with excellent resolution and slow diffusion (ca. < 1 x 10^-14 m^2 sec^-1) capabilities.
**Three solid state spectrometers:** Tecmag 300, Bruker AV-300, Chemagnetics/Varian Infinity 500. All are equipped for standard solid state NMR experiments such as MAS, CPMAS, CPTOSS, Quadrupolar Echo, etc. Users requiring exotic nucleus capability are encouraged to contact Dr. Benesi.

**Four medium field liquid state spectrometers:** Two DPX-300's, one AV-360, and one DRX-400. These are equipped for broadband and multinuclear NMR. The DRX-400 has an inverse broadband probe with triple axis gradients that is optimized for gradient enhanced 2D experiments (HMQC, HMBC, DQF-COSY, NOESY). All four spectrometers are available for overnight scheduling to enable 2D and variable temperature research.

**Training and Courses**

Basic training for experimental liquid state NMR is provided by NMR "superusers" in the student or postdoc's research group. Users gain access to perform their own NMR experiments by passing a short NMR test with the Director or NMR Spectroscopist. Solid state NMR training is obtained by hands on setup of solid state NMR experiments with the Director or NMR Spectroscopist. Graduate level academic courses in Theoretical NMR and Biological NMR are offered on an alternating every-other-year schedule by the Director and other expert faculty NMR spectroscopists.

All NMR spectrometers of the facility are available to users who have been trained in their use and tested by the Director or NMR Spectroscopist. The Director and NMR Spectroscopist are also available to assist all users with their NMR experiments and in the interpretation of their data.

Director: Dr. Emmanuel Hatzakis, 865-0941, euc15@psu.edu, 008 Chemistry Building

NMR Spectroscopist: Dr. Wenbin Luo, wul17@psu.edu, 10 Chemistry Building

Senior Research Support Associate: Mr. John Lintner, 863-1182, lintner@chem.psu.edu, 014 Chemistry Building

Hours: 24 hours a day, 7 days a week
Proteomics and Mass Spectrometry Core Facility

http://www.huck.psu.edu/facilities/proteomics-mass-spectrometry-up/

The Proteomics and Mass Spectrometry Core Facility (PMSCF) is a Penn State system-wide core resource with a primary mission of providing molecular mass spectrometry support for research in chemistry, the life sciences, and the materials sciences. The PMSCF offers modern capabilities for characterization of a broad range of materials including synthetic substances, volatile chemicals, natural products and biological molecules including proteins, nucleic acid oligomers, carbohydrates, and metabolites. Recent instrumentation acquisitions have broadened the Core capability in supporting proteomics and metabolomics research.

The PMSCF is under the oversight of the Huck Institutes of the Life Sciences. We are located in 3 Althouse Laboratory. With the involvement and assistance of the Center for Environmental geoChemistry and Genomics and other colleges and institutes, it has evolved into a facility with enhanced abilities to support characterization of substances in a broad molecular weight range, including polar pollutants and secondary metabolites, lipids, proteins, peptides, oligonucleotides, and various natural and synthetic polymers. The Proteomics and Mass Spectrometry Core Facility houses state-of-the art equipment for preparation and MS analysis of samples coming from researchers in proteomics and metabolomics, synthetic chemists, veterinary and agricultural scientists, and molecular biologists, to name a few.

The Facility is currently equipped with a Thermo LTQ Orbitrap Velos mass spectrometer with a Dionex UltiMate 3000 nano-LC sample introduction system. This instrument is used primarily for proteomics analyses in conjunction with the Thermo proprietary bioinformatics package, Proteome Discoverer 1.3. An Applied Biosystems 3200 Q-Trap triple quadrupole/linear ion trap mass spectrometer equipped with electrospray ionization and atmospheric pressure chemical ionization sources enables qualitative and quantitative analyses of non-volatile compounds with various polarities. Two Waters TOF mass spectrometers, GCT and LCT are used for accurate mass analyses of small, volatile and non-volatile molecules.

Auxiliary equipment includes 2-D PAGE equipment, gel imager, robotic spot cutter for proteomics work; microplate reader, and Speed Vac concentrator.

The Proteomics and Mass Spectrometry Core Facility staff is capable of providing both collaborative support and fee-based service to the Penn State research community. We offer decades of combined expertise in sample preparation, MS analysis, and experimental design. Our enthusiastic and friendly team members include Tatiana Laremore (tnl1@psu.edu), Phil Smith (pbs13@psu.edu), and James Miller (jrm112@psu.edu).
The Materials Characterization Laboratory

A Collaborative Shared User Facility

http://www.mri.psu.edu/facilities/mcl

The Materials Characterization Lab (MCL) is a fully-staffed, user research facility at Penn State’s Materials Research Institute that offers researchers convenient and affordable access to a wide-range of state-of-the-art analytical instrumentation and services.

Services offered include:

- **Electron & Ion Microscopy** (TEM, SEM, ESEM, FE-SEM, EDS, OIM, FIB)
- **Electron Spectroscopy** (XPS, Auger)
- **X-ray Scattering** (XRD, SAXS)
- **Molecular Spectroscopy** (FT-IR, UV-Vis, Raman)
- **Physical Property Determination** (dielectric properties, powder characterization, thermal analysis)
- **Materials Processing** (sintering furnaces, sputter coating, sample preparation, machine shop, cold isostatic press)
- **Surface Analysis** (AFM, SPM, Profilometer)

**Analytical services**

MCL offers complete sample preparation, analysis, interpretation, report writing and consultation on over 20 different tools. For a complete list and description of the services available through MCL, please visit our website.

**Training services**

All of the analytical tools are available for hands-on use by students and faculty; training is available by appointment throughout the year. Short courses and workshops are held periodically for more intensive educational opportunities.

**Fees**

Instrumentation is available for low hourly fees payable with a Penn State budget and fund number. Separate fees are charged if you require assistance from one of our staff members. Our rates are kept low with financial support from the Materials Research Institute.

**Getting Started**

It is very easy for researchers from Penn State, other universities, and industry to get started using the analytical instrumentation and services. Please contact Josh Stapleton, Operations Manager, 814-863-2224, jjs366@psu.edu, to discuss your analytical needs or visit our website for more information.

**Where we are located**

University Park campus: Millennium Science Complex Building
Administrative office phone number: 814-865-2328.
The Shared Fermentation Facility

http://www.huck.psu.edu/SFF

The Shared Fermentation Facility provides bioprocessing services for microbial cell growth, protein production, cell separation and disruption, and biomass treatment/biofuel fermentation. The facility is supported by the Huck Institutes of the Life Sciences and is located in the basement of Fenske laboratory on the University Park campus.

Features
- Recirculating reverse-osmosis purified water system with facility-wide taps
- Filtered air handling systems
- Two Bio-safety cabinets
- Three autoclaves

Equipment

Fermentors
- Sixfors (six x 500ml research console) A multiple, parallel bioreactor system for up to 6 small vessels
- BioFlo (1 to 5 liter autoclavable benchtop)
- 30 liter Micros (20 l working volume)
- MPP80 80 liter (60 l working vol.) Two units
- 150 liter (110 l working volume)
- 300 liter (230 l working volume)

Centrifuges
- Sharples T-1-P lab-scale continuous flow centrifuge
- Sharples AS-16-VB continuous flow centrifuge

Disruption equipment
- Microfluidics M-110EH microfluidizer
- Dyno-Mill KDL flow-through bead mill

For more information, contact:
Mark Signs
Director, Shared Fermentation Facility
The Huck Institutes of the Life Sciences Penn State University
57 Fenske Building
University Park, PA 16802
Phone: 814-863-6455
Email: mws6@psu.edu
Services and instrumentation

The Facility has two hybrid Quadrupole Time-of-Flight (Q-TOF) tandem mass spectrometers, an AB SCIEX 5600 Triple TOF with a Shimadzu Prominence UFLC, and a Waters Synapt G2-S with a Waters Aquity UPLC. These instruments are used for liquid chromatography-mass spectrometry (LC-MS) based global profiling of the metabolites present in biofluids and tissue extracts. A triple quadrupole mass spectrometer (Waters Xevo TQ-S with a Waters Aquity UPLC) is used for LC-MS based targeted analysis and for validation and accurate quantitation of compounds identified in the global profiling approach.

AB SCIEX 5600 TripleTOF

Uniquely integrates comprehensive qualitative exploration, rapid profiling, and high-resolution quantitation workflows on a single platform, combining the highest sensitivity detection, high-resolution with at least 5X better acquisition speed, and stable ~1ppm mass accuracy over days of acquisition

Waters SYNAPT G2-S

Featuring Stepwave™ technology and the high resolution QuanTof™ mass analyzer, the SYNAPT G2-S MS provides the highest sensitivity and selectivity for very challenging qualitative and quantitative applications. The Lockspray system provides routine sub-ppm mass accuracy.

Waters Xevo TQ-S

A benchtop QTof mass spectrometer with StepWave and QuanTof technologies for scientists who need to confidently identify, quantify and confirm unknown compounds in complex samples — the Xevo G2-S QTof features IntelliStart technology, an intuitive interface that automates routine tasks and ensures reproducible UPLC/MS data of the highest quality.

Licensed software provided by the Metabolomics Core Facility for data analysis

Markerview™

- Designed for metabolomics and protein/peptide biomarker profiling applications, used to review data acquired on all AB SCIEX mass spectrometers and to determine up- and down-regulation of endogenous compounds in complex samples.
- With statistics capabilities including Principal Components Analysis and t-tests, can be used to mine data resulting from classified and non-classified experiments.
**MarkerLynx™ Application Manager**

- Processes complex multivariate data from LC/MS, LC/MS/MS, metabolomic studies.
- Performs 3-dimensional peak integration, data set alignment and incorporates multivariate statistical tools.
- Principal Components Analysis is applied to the processed data sets, allowing visualization of biochemical patterns and identification of potential biomarkers responsible for variations in the data set.

**TargetLynx™ Application Manager**

- Automates sample data acquisition, processing and reporting for quantitative results.
- Incorporates a range of confirmatory checks that identify samples that fall outside user-specified or regulatory thresholds.
- Used to quantify and confirm both LC/MS & LC/MS/MS and GC/MS & GC/MS/MS data.

**SIMCA-P for Multivariate Data Analysis**

- Able to process very large data sets, and offers a variety of data analysis and data visualization capabilities, including Orthogonal Projection to Latent Structures (OPLS).

**MassFrontier™**

- Used for interpretation and management of mass spectra of small molecules.
- Provides comprehensive spectral data and fragmentation mechanism knowledge management facilitating metabolite identification and structural elucidation.

**Location:**

**Metabolomics Core Facility**
319 Life Sciences Building
Phone: 814-867-4641
Microscopy and Cytometry Facility

http://www.huck.psu.edu/facilities/microscopy-cytometry-up

The Facility is specialized in four clusters – optical microscopy, electron microscopy, histology and flow cytometry – equipped with confocal microscopes, research fluorescence microscopes, transmission- and scanning electron microscopes, flow cytometers and a cell sorter, and whose research staff is engaged in experimentation, training, project collaboration and consultation.

Electron microscopes
- FEI Tecnai G2 Spirit BioTwin
- JEOL JEM 1200 EXII
- JEOL JSM 5400

Flow cytometers
- Coulter FC500
- BD Cytopeia Influx
- BD Fortessa LSRII
- Coulter XL-MCL
- Bio-Rad Bio-Plex 200

Fluorescence and confocal microscopes
- Olympus Fluoview 300
- Olympus Fluoview 1000
- Olympus BX60 (digital scope)
- Olympus BX61 (materials scope)

Laser-capture microdissection
- Zeiss PALM MicroBeam IV laser-capture microdissection system

Accessory equipment

SEM sample preparation
- Bal-tec CPD-030 Critical Point Dryer
- Bal-tec SCD-050 Sputter Coaster

TEM sample preparation
- EMS 820 Microwave Sample Processor
- EMS 950X Turbo Evaporator and film thickness monitor
- Leica Ultracut UCT Microtome
- Reichert-Jung Ultracut E Microtome
- RMC5160 Automatic Tissue Processor
- Leica EM UC6 Microtome with Leica EM FC6 Cryo-attachment
- Leica Knife Maker
- Leica Automatic Freeze-Substitution System
- Leica CPC Cryofixation System

**Histology**

Histology and immunohistochemistry at light microscopic level are performed with automated systems for processing, embedding, and staining:

- Shandon Citadel 2000 paraffin processor
- Shandon Histocenter II embedding unit
- Shandon Gemini Varistainer
- Shandon Cryostat
- Shandon Finesse paraffin microtome
- Leica 2040 paraffin microtome

**Optical Microscopes**

- Olympus BX51 fluorescence light microscope with attached Jenoptik ProgRes CFscan CCD Research camera.
- Zeiss Axiovert inverted fluorescence light microscope with attached Jenoptik ProgRes CFscan CCD Research camera.
- Olympus BX50 research light microscope
- Olympus SZ-PT dissecting microscopes with attached SPOT II RT digital camera
- Olympus SZ-ST dissecting microscope
- Several educational brightfield microscopes

**Flow Cytometry Software**

- FlowJo Software
- FCS Express

**Locations:**

**Microscopy and Histology Lab**
N-032 Millennium Science Complex
Phone: 814-863-0294

**Flow Cytometry Lab**
W-124A Millennium Science Complex
Phone: 814-863-2762
Genomics Core Facility

http://www.huck.psu.edu/facilities/genomics-up/services-and-instrumentation

Services and Instrumentation:

1. Microarray analysis
   a. RNA analysis: The Genomics Core Facility at University Park performs differential expression analysis experiments using microarrays as a service. The customer must provide the facility with high quality total RNA and the facility will perform sample labeling, microarray hybridization, scanning, and data acquisition. Raw data is provided to the customer for analysis as the core does not provide data analysis services. The core facility currently supports the use of the Affymetrix and NimbleGen commercial microarray platforms, and will provide guidance in choosing the platform that best fits your project.
   b. DNA analysis: The Genomics Core Facility at University Park has the instrumentation to perform microarray applications involving DNA such as CGH, SNP analysis, and ChIP-chip, but does not routinely perform these assays.

2. Next-generation sequencing
   a. DNA sequencing
      i. Targeted resequencing
      ii. Whole genome resequencing
      iii. Chromatin immunoprecipitation (ChIP-Seq) analysis
      iv. Methylation analysis
   b. RNA sequencing
      i. Whole transcriptome
      ii. miRNA/small RNA
      iii. degradome
      iv. RIP-Seq
      v. de novo transcriptome sequencing

3. Real-time qPCR for DNA and RNA quantification

4. Sanger sequencing
   a. Regular sequencing: standard plasmid and PCR products as well as BACs and cosmids
   b. High-throughput sequencing: 96-well plate submissions

5. Genotyping
   a. VNTRs: VNTR alleles can be determined by Fragment Analysis on the 3730 XL DNA Sequencer.
   b. SNP determination: SNPs can be determined by several techniques, including standard Allelic Discrimination (Taqman Assays), Open Array Technology, and High Resolution Melt Curve Analysis.

Research instruments hosted by the Genomics Core Facility at University Park:

- Affymetrix GeneChip Scanner 3000 7G: Used to scan Affymetrix cartridge microarrays
- Affymetrix GeneChip Fluidics Station 450: Used to wash and stain Affymetrix GeneChip microarrays
- Affymetrix GeneChip Hybridization Oven 640: Used to hybridize Affymetrix GeneChip microarrays with mixing by rotation
- Molecular Devices GenePix 4000B: Used to scan NimbleGen microarrays
- Roche NimbleGen Hybridization System 4: Used to hybridize NimbleGen microarrays
- Life Technologies Ion Personal Genome Machine: Ideal for sequencing small genomes or PCR products
- Roche GS 454 FLX+: Ideal platform for metagenomics and de novo small genome sequencing
- Applied Biosystems 7300 Sequence Detection System: Platform for detection and quantification of nucleic acid sequences
- Applied Biosystems 7900HT Fast Real-Time PCR System: The acknowledged gold standard in real-time PCR
- Applied Biosystems OpenArray Real-Time PCR Instrument and AccuFill System: Best combination of convenience, flexibility, throughput, and cost-effectiveness for mid-density genotyping, and gene expression and digital PCR studies
- Applied Biosystems 3730XL
- Illumina HiSeq 2500: This next-generation sequencing instrument produces medium-length reads and can be used for a variety of applications.
- Illumina MiSeq: This instrument is essentially a small version of the HiSeq 2500

Location:

Genomics Core Facility
407 Chandlee Lab
Phone: 814-867-4067
Published Works from Past ECMSS Presenters

The following list includes student research previously presented at ECMSS (or ECSS, since 2008) that has subsequently been published. If you have published an article and would like to have it included in future abstract volumes, please visit the ECMSS website and email your citation(s) to the current ECMSS Co-Chairs.


Acknowledgements

This year’s ECMSS has been made possible by the hard work of various individuals and organizations at Penn State. We would like to acknowledge their effort, guidance, and sponsorship, which has been instrumental in ensuring the continued success of the symposium.

ECMSS is funded in large part by the Center for Environmental geoChemistry and Genomics (CECG). We express our gratitude to the Center and its executive committee, including Director Dr. Jenn Macalady, for their continued support of the event.

Additional sponsors of the 17th Annual ECMSS include the Environment and Natural Resources Institute (ENRI, part of the College of Agricultural Sciences), the Penn State Institutes of Energy and the Environment (PSIEE), the Engineering Energy and Environment Institute (E3I), and the Office of Educational Equity in the College of Earth and Mineral Sciences. Additionally, we would like to thank Penn State’s Student Association of Environmental Scientists and Engineers (SAESE) and the University Park Allocation Committee (UPAC) for contributing financial support to help sponsor this year’s visiting keynote speakers.

Funding to support this year’s monetary awards for outstanding student presentations and contest winners has been generously donated by the following departments at Penn State, which have made it possible for us to again continue providing student awards:

- Plant Pathology and Environmental Microbiology
- Meteorology
- Agricultural and Biological Engineering
- Chemistry
- Ecosystem Science and Management
- Earth and Environmental Systems Institute

We would like to express our gratitude to the ECMSS keynote speakers, Dr. David Sedlak, Dr. Markus Buehler, and Dr. Richard Alley, for participating in our event and sharing their expertise with the ECMSS audience. We are honored to host such distinguished guests, and very much appreciate the work of all those who made their involvement possible.

We also wish to thank those faculty and staff members who participated in the symposium as judges this year. Presentation judging is an invaluable service that allows students to gain experience in presenting their research and in receiving constructive feedback on their work in a friendly, yet competitive, environment.

The ECMSS co-chairs and the student organizing committee wish to thank Debra Lambert for her administrative assistance, which again proved instrumental in helping with the logistics of organizing this year’s event.

Special thanks go to previous ECSS/ECMSS Co-Chairs, Daniel Veghte, Michael Shreve, and Claudia Rojas, who have been kind enough to provide continued guidance to the 2014 ECMSS organizing committee. We would also like to thank Hiroyuki Kashima, Treasurer of SAESE, for his work in securing UPAC funding.
Finally, the ECMSS co-chairs wish to thank all of the dedicated graduate students that volunteered to serve on the symposium organizing committee:

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract book</td>
<td>Valerie Alstadt</td>
</tr>
<tr>
<td>Audio/Visual</td>
<td>Juan Antonio Raygoza Garay</td>
</tr>
<tr>
<td>Judging Coordinator</td>
<td>Jared Wright</td>
</tr>
<tr>
<td>Judging Coordinator</td>
<td>Brittney Nagle</td>
</tr>
<tr>
<td>Photo and T-shirt Contest</td>
<td>Siyang Hao</td>
</tr>
<tr>
<td>Publication List</td>
<td>Tania Galindo Castañeda</td>
</tr>
<tr>
<td>Publicity</td>
<td>Christopher Smyth</td>
</tr>
<tr>
<td>Publicity</td>
<td>Hao Kuang</td>
</tr>
<tr>
<td>Secretary</td>
<td>Shauna Kay Rainford</td>
</tr>
<tr>
<td>Website</td>
<td>Andrew Kreider</td>
</tr>
<tr>
<td>Undergraduate Outreach</td>
<td>Emily Woodward</td>
</tr>
<tr>
<td>Off-campus Outreach</td>
<td>Prachi Joshi</td>
</tr>
<tr>
<td>Hospitality/Event Setup/Food</td>
<td>Doug Whalen</td>
</tr>
</tbody>
</table>

We hope you have enjoyed attending the 17th Annual ECMSS, and that you will continue to join us in future years.

Sincerely,

Aubrey Fine and Ryan Stauffer, Co-Chairs
2014 ECMSS Organizing Committee