CLEMSON UNIVERSITY

2011-2012 Academic Year in Review

Chair's Corner

Dear Colleagues and Friends:

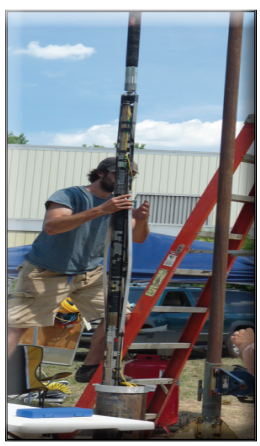
I am very pleased to present you with a brief summary of the accomplishments and activities of our Department during the past academic year. The Department had again another exceptional year. We currently have 182 undergraduate and 120 graduate students working with 20 tenure track faculty members. New research awards, several of which are from keen national competitions, reached $4.5M in the past year, while the research expenditures totaled $2.7M. This is a testament to the hard work and impressive productivity of our talented faculty, students and staff. Dr. Stephen Moysey received the prestigious NSF CAREER award, increasing the number of CAREER award recipients in the Department to five. Dr. Kevin Finneran was named Kavli Fellow of the National Academy of Sciences, a program that recognizes young scientists who are leaders in their field. Dr. Tim Devol was named as the Toshiba Endowed Professor of Nuclear Engineering, a corner stone position in the Department that is responsible for our nationally recognized and unique nuclear environmental engineering and science program. Dr. Annick Anctil joined the Department as our new Environmental Sustainability faculty. Her major research interest is in sustainable energy; in particular, photovoltaics, where she uses life cycle assessment to identify the main issues of current technologies and propose alternative solutions. We organized another very successful Hydrogeology Symposium (20th!) with over 350 attendees and 30 exhibitors. We are also very proud of the accomplishments of our students; several of them have received impressive national awards (e.g., NSF Graduate Research Fellowship, Fulbright Award) and recognitions, some listed on the next page. There are many more accomplishments that I cannot fit in this limited space. Please visit our web page to learn about them. Overall, I cannot be more proud with the exemplary work ethics and productivity of our immensely talented faculty, students and staff.

Tanju Karanfil, Ph.D., P.E., BCEE

Selected Research Projects and Summaries

Degradation of military high explosives and insensitive munitions by mixed biological-abiotic interactions

Dr. Finneran and his students examine the degradation of hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) and the 2,4-dinitroanisole (DNAN) to determine the mixed biological-chemical reactions with iron and extracellular electron shuttling molecules that degrade them in both defined systems and contaminated environmental media in a DOD funded project. The fastest and most complete RDX degradation pathway is via extracellular reduced intermediates. Formaldehyde is the dominant reaction product, and this pH dependent reaction is very fast – with rates on the order of hours between pH 8 and 9. An emerging contaminant, DNAN, also quickly degrades by hydroquinones and Fe(II) via direct reduction. They have coupled these reactions to a phototroph that generates reduced extracellular metabolites, *Rhodobacter sphaeroides*, to use sun energy for generating the reducing equivalents needed to drive the reactions.



Innovative Well Testing Technique to Make CO_2 Storage Safer

Wells deform when fluid, like CO_2, is injected into the subsurface. **Drs. Murdoch** and **Moysey** have a project sponsored by the Department of Energy to evaluate the feasibility of measuring and interpreting these small deformations in deep wells in order to reduce costs and risks during CO_2 storage. The results of poroelastic modeling indicate that casing deformation should be at least a few microns to several tens of microns during CO_2 injection. These are tiny deformations, but they are huge compared to the resolution of downhole tools developed by grad students **Dave Hisz, Glenn Skawski,** and **Johnathan Ebenhack**. Their work has demonstrated new instruments capable of measuring deformations of 0.01 micron in the field. Moreover, the research has developed an innovative sensor capable of measuring displacements in 3D using optical fibers. The picture to the left shows an innovative downhole well testing tool being evaluated in the Newark Basin, New Jersey, in July, 2012.

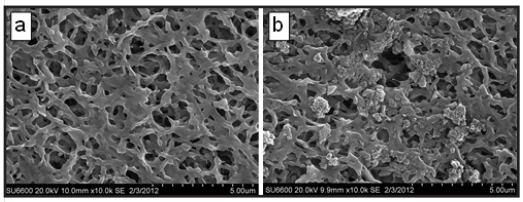
PCBs in the Environment

Graduate student **Tim Sattler** and **Dr. Lee** install a passive air sampler above Town Creek near Pickens, SC. **Tim** is testing his hypothesis that polychlorinated biphenyls (PCBs) are volatilizing from the stream. Previous work by **Dr. Viet Dang (EE&S 2012)** found PCB concentrations above the detection limit in the water column of the creek using polyethylene passive samplers designed to collect dissolved PCBs. **Viet** also measured PCBs extracted from Rhodondendron leaves collected along the banks of the stream, which led to Tim's hypothesis. Seven passive air samplers were deployed in a transect from the stream and up the bank, co-located with the Rhodondendron shrubs from the previous study. **Dr. Lee's** research group is conducting a long-term study of the behavior of PCBs in the ecosystem of the Superfund site that includes Town Creek. The work is supported by funding from EPA and NSF.

Dendritic Polymers as Biocompatible Oil Spill Dispersants

Dr. Ladner's research group is engaged in oil spill remediation research through a STAR grant from the Environmental Protection Agency, in collaboration with Pu-Chun Ke (Physics and Astronomy), Andrew Whelton (University of South Alabama) and Sean Powers (University of South Alabama). The research team is investigating whether dendritic polymers show advantages as oil spill dispersants compared to conventional dispersants like those used in the Deepwater Horizon oil spill in 2010. In a manuscript that is in press for publication the team reports that two kinds of dendritic polymers show strong interactions with oil components and have the potential for good dispersion.

Selected Research Projects and Summaries, cont.



Coupling Small-Particle Adsorbents with Membranes for Trace-Contaminant Removal in Water Treatment

Drs. Ladner, Karanfil and Mefford (MSE) work on a project from National Science Foundation to develop hybrid adsorbent-membrane systems that will allow multiple treatment objectives in a single process (i.e., the control of both small molecular weight contaminants and microbial contaminants. Moving into the future, sustainable water treatment will require low-footprint and low-energy processes, which are the dual objectives of this project.

Ultra-Trace-Level Quantification of α- and β-Emitting Radionuclides with Extractive Scintillating Resin

Drs. Devol and Husson (ChE) work on a grant from the Defense Threat Reduction Agency to develop robust extractive scintillating media and methods for the ultra-trace-level quantification of α- and β-emitting radionuclides in water, sewage and air. Extractive scintillating media concentrate the radionuclide(s) of interest, while serving as a radiation transducer. Next-generation media are being produced by grafting ligand-rich polymers from a robust scintillating core using surface-initiated polymerization. The media will have high analyte capacity, high selectivity, and high sensitivity. A parallel effort is advancing the fundamental understanding and quantification of the parameters affecting the detection sensitivity.

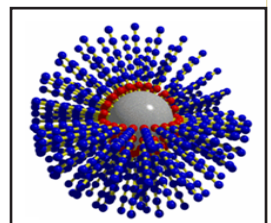


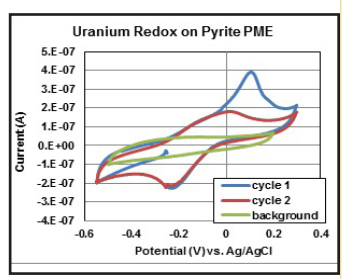
Illustration of the high density of ligand binding sites on a scintillator core following polymerization

Wetlands for treating Energy-Produced Waters

Dr. Castle's research group is involved in characterization of waters produced by energy extraction and utilization and the remediation of these waters for beneficial use. The research focuses on biogeochemical processes in sediments of constructed wetland systems designed for treating energy-produced waters. Using pilot-scale systems, treatment effectiveness is measured for various organic and inorganic constituents in simulated and actual waters. Results of the pilot-scale studies are being applied to a field demonstration project, sponsored by Chevron and USDOE, at a natural gas field in Alabama.

Radionuclide Redox Reactions at Mineral Surfaces

Dr. Shuller-Nickles' research group integrates atomistic simulations with experiments to understand the thermodynamics and kinetics of radionuclide redox reactions at mineral surfaces and in solid phases. Recently, Yi Wen used a powder microelectrode to observe uranyl sulfate oxidation and reduction at a pyrite (FeS_2) surface. The blue anodic peak signifies the oxidation of U^{4+} to U^{6+}, which occurs after preconditioning the sample at -0.25 V for 5 minutes. The red anodic peak signifies the one electron oxidation of U^{5+} to U^{6+} and is observed in the absence of preconditioning.



Nitrosamines in Water

Nitrosamines, a group of compounds classified as probable human carcinogens in water at concentrations as low as 0.2 ng/L, are associated with a 10^{-6} lifetime cancer risk. They are being currently evaluated by EPA for regulations in drinking water. In a Water Research Foundation project, **Dr. Karanfil's** research group investigates the impact of seasonal variations and some climatic events on the occurrence of nitrosamine precursors in drinking water sources, the removal of the nitrosamine precursors at full-scale water treatment plants, the formation of nitrosamine in distribution systems, and the effectiveness of some treatment strategies for nitrosamine control during the seasonal variations and climatic events. In a project funded by the NSF, **Dr. Karanfil's** group also investigates the formation mechanisms of nitrosamines and halonitromethanes in drinking waters.

Particles and Organic Materials in Natural and Engineered Environmental Systems

Dr. Schlautman's research interests fall in the broadly-defined fields of environmental chemistry and geochemistry, physicochemical treatment processes, chemical fate and transport, and water and soil quality. A long-term interest for him has been adsorption reactions on mineral surfaces, particularly those involving naturally-occurring organic matter (NOM) and synthetic polymers. Because NOM is a complex, heterogeneous mixture of substances, **Dr. Schlautman** and colleagues use various strategies to study NOM reactions in environmental systems. One promising approach is the use of spectroscopic and chromatographic techniques to fingerprint and therefore track changes in NOM. Adsorption of NOM and/or polymers on turbidity-causing particles in water can lead to particle stabilization or aggregation and removal, depending on specific conditions. A conceptual model has been developed recently for polyacrylamide (PAM) adsorption and its effects on particle stabilization/flocculation when hardness cations are present in water.

Faculty Awards Recognitions

Stephen Moysey Receives NSF Career Grant

Congratulations to **Dr. Stephen Moysey** for winning a prestigious NSF CAREER grant to support his research project entitled "Advancing the mechanistic understanding of field-scale preferential flow and transport processes in soils using geophysics." The project will use geophysical imaging techniques (electrical resistivity and ground-penetrating radar) to understand how different subsurface flow mechanisms interact to establish preferential flow and transport networks in the vadose zone. This award increases the number of current faculty in EEES who have won NSF CAREER Awards to five.

Kevin Finneran Named Kavli Fellow

Dr. Kevin Finneran, Associate Professor, was named a Kavli Fellow of the National Academy of Sciences (NAS) in May 2012. The Kavli program recognizes young scientists who are leaders in their field, and brings them together in the Frontiers of Science program, which is a collaborative symposium between the NAS and the leading scientific academy of a foreign country. **Dr. Finneran** was invited to speak and become a Kavli Fellow at the German-American Frontiers of Science conference (GAFOS), held May 10-14, 2012 in Potsdam Germany. The Alexander Von Humboldt Foundation is the participating organization in Germany. Kavli Fellows are encouraged to establish overseas research collaborations with counterparts from their respective Frontiers of Science symposia, and the hosting organizations provide funding to initiate these visiting professorships. His presentation "Bioremediation: basic science meeting applied goals" can be viewed at http://vimeo.com/44772026. Information on the Kavli Frontiers of Science Program can be found here: **http://www.kavlifoundation.org/kavli-frontiers-science.**

Tim Devol Named Toshiba Endowed Professor

Dr. Timothy A. DeVol has been named the Toshiba Endowed Professor of Nuclear Engineering, a cornerstone position in a department that is charged with preparing the next generation of nuclear environmental engineers and scientists. The new Toshiba Endowed Professorship was funded as part of a $1.5 million endowment to Clemson University in honor of Toshiba Corporation President and CEO Norio Sasaki. The professorship will be used to maintain and properly equip the departmental world class laboratories with nuclear instrumentation and to enhance the educational experience of all the Nuclear Environmental Engineering and Science (NEES) students in the department. The NEES focus area has two academic programs, Environmental Health Physics and Environmental Radiochemistry. The Environmental Health Physics program is accredited by ABET. There are now 21 MS and PhD students in the NEES concentration. Over the past three years the NEES program has been awarded more than $3.5 million in educational and research grants which help to prepare the next generation of nuclear scientists and engineers. The educational grants are for infrastructure improvements, course development, and student fellowships. The research grants are focused on solving contemporary issues like safeguarding human and environmental health from the nuclear fuel cycle, detection of clandestine nuclear-related activities and cleaning up legacy wastes from the cold war.

Brian Powell Named Sigma Xi Young Investigator

Dr. Brian A. Powell was awarded the Clemson University Sigma Xi Young Investigator of 2011. **Dr. Powell** was recognized at the spring 2012 banquet. This award is given by the Clemson University Chapter of Sigma Xi to the junior faculty member with the most distinguished research record.

Student News and Awards

Muriel Steele, (PhD, EE&S) was selected as one of the recipients of the National Science Foundation 3-year graduate research fellowships (NSF GRF) to students in science, engineering, mathematics, technology, and some social sciences. These are very prestigious awards with a generous support package ($45k/year).

Shanna Estes, (PhD, EE&S) has received the Health Physics Society Fellowship for graduate studies in health physics. The award includes $5,000 to support **Shanna's** graduate work as well as a travel grant to attend the 2013 HPS Annual Meeting in Madison, Wisconsin.

Lauren Harroff, (MS, BE) has received a Fulbright grant to conduct research in Uganda. A member of Clemson's National Scholar Program, **Harroff** earned many accolades for her research, which is centered around the adaptation and application of sustainable biofuels, particularly in international settings. The Fulbright Program is the flagship international educational exchange program sponsored by the U.S. government and was created to increase mutual understanding between the people of the United States and those in other countries.

Jeff Schwindaman (MS, Hydrogeology) has been awarded a DOD SMART scholarship (https://smart.asee.org/) for the coming academic year. The Science, Mathematics and Research for Transformation (SMART) Scholarship for Service Program has been established by the Department of Defense (DoD) to support undergraduate and graduate students pursuing degrees in Science, Technology, Engineering and Mathematics (STEM) disciplines. The program aims to increase the number of civilian scientists and engineers working at DoD laboratories.

David Hahn, (MS, Hydrogeology), was awarded with the National Association of Geoscience Teachers (NAGT) Outstanding Teacher Assistant Award for his outstanding contributions to many of our Geology and Physical Sciences courses. This is a great recognition for **David's** strong commitment to high quality teaching and continuous hard work.

2012 EEES Student Awards

L-R: **Steven Chow,** Clark Lindsay McCaslan Award, Biosystems Engineering; **Lauren Harroff,** Howard H. McKinney Award, Biosystems Engineering; **Alex Baldwin,** Jean G. Stillwell Award, Geology; **Tanju Karanfil,** Department Chair; **Jaclyn Ellerie,** L. G. Rich Water Environment Federation Award; **Kelly Grogan**, Environmental Scholars Award; **Xiaoling Liu,** Environmental Scholars Award; **Meric Selbes,** A. Ray Abernathy Water Environment Federation Award; **Muriel Steele,** Environmental Scholars Award; **Josh Smith,** Thomas M. Logan Geology Award (not pictured).

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EEES Welcomes Dr. Annick Anctil

In August, **Dr. Annick Anctil** joined the EEES department. **Dr. Anctil** received her Ph.D. in Sustainability from the Rochester Institute of Technology in 2011 where she also received her M.S in Materials Engineering (2007) after a B.S. in Materials Engineering from Ecole Polytechnique de Montreal (2005). Prior to joining Clemson, she worked as a Research Associate at the National Photovoltaic Environmental Research Center at Brookhaven National Laboratory where she worked on the environmental impact of large-scale photovoltaic power plants and resource availability of critical metals for solar technologies. **Dr. Anctil's** major research interest is in sustainable energy, in particular photovoltaics, where she uses life cycle assessment to identify the main issues of current technologies and propose alternative solutions. A primary focus of her work is in the environmental impact of nanomaterials and fine chemicals for energy applications, in particular as it relates to reducing the impact of industrial production.

David C. Snipes Hydrogeology Symposium

The 20th Annual Clemson/David S. Snipes Hydrogeology Symposium was held on April 12th at the Madren Center along with field trips on April 11 and April 13. This year's event attracted over 350 attendees–an all-time record! Dr. S. Majid Hassanizade of Utretch University in the Netherlands gave the keynote speech. He talked about the "Transport of Viruses in Partially Saturated Soil and Groundwater". Dr. Hassanizade is the 2012 Darcy Lecturer.

Most attendees hailed from South Carolina; others were others from North Carolina, Georgia, Tennessee, Virginia, and Florida. There were fifty oral and poster presentations given over three consecutive oral presentation sessions. The theme sessions covered these topics: Hydromechanics, Constructed Wetland Treatment Systems, Emerging Contaminants, Groundwater Characterization, Chemical Remediation, Geophysics, Biodegradation, Remediation techniques, and the Clemson Creative Inquiry (CI) undergraduate senior projects. **Dr. Falta** gave a talk on "REMFuel: Remediation Evaluation Model for Hydrocarbon Fuel Sites" and **Dr. Murdoch** discussed "Environmental Implications of Fracking in North Carolina". **Dr. Moysey** moderated the geophysics session. Graduate students giving oral presentations were **Glenn Skawski, Clay Freeman, Johnathon Ebenhack, Dave Hisz, Catherine Ruprecht, David Hahn, Michael Pardue, Alex Beebe, Peter van Heest, Rich Hall, Adam Mangel, Eramus Oware, and Sudershan Gangrade.** Recent graduate **Dan Matz** returned to give a talk about his research in India called "Impact of the Indian Monsoon on Near Surface Electrical Conductivity". Geology undergraduates who presented the results of their senior CI research project included **William Webber, Josh Smith, Ben Douglass, Mathew Creel, Alex Grayson, Colin Phillips, Alexis Jarvis, and Corey Buchanan.** A complete list of presenters and the titles of their talks can be found at:

http://www.ces.clemson.edu/hydro/symposium/speaksched.htm

In addition to the posters, 30 exhibitors from around the US displayed their products and services. After the symposium, a mixer was held at the Geology Museum.

The field trips, led by Scott Brame, Jack Garihan (Furman University, and Tom Goforth (BS, 1968), examined the relationships between soil, plants and geology in the Jocassee gorges area of South Carolina.