

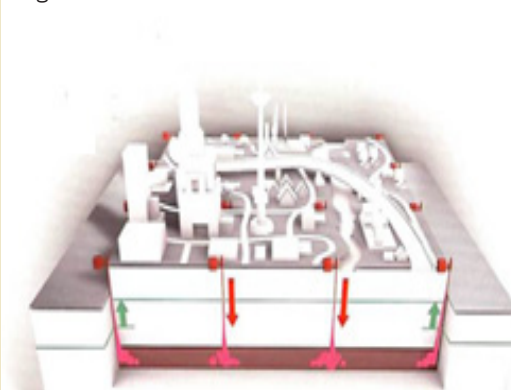
Three Faces of Fracking

Some people view hydraulic fracturing, or fracking, as a godsend that brings jobs and security, but others see it as a disaster that contaminates the environment and disrupts communities. These opposing views have fueled a controversy that has made this once arcane technique a household word, but these



Hydraulic fracture created in Piedmont residual soils by former graduate student **Jim Richardson**

are not the only perspectives on fracking. Long before it was mentioned by Barack Obama in the State of the Union address, fracking was investigated by Clemson researchers as a technique for improving the remediation of contaminated water and soil. The physics of the process used to create massive fractures at great depth scales down can be applied to modest fractures at shallow depth where it enables innovative environmental techniques. These methods and their applications are a long-standing research topic of **Dr. Larry Murdoch** and his students. Hydraulic fractures have been used to improve the effectiveness of nearly all in-situ remediation methods, and it has enabled some techniques that would have otherwise been infeasible, like injection of solid reactive compounds.



Schematic of concept to raise ground elevations by injecting solids into hydraulic fractures. From GEO, 8 Aug, 2010.

The versatility of the hydraulic fracturing technique has inspired a new innovation aimed at protecting cities from catastrophic flooding. The approach is to inject solids into flat-lying hydraulic fractures to raise the ground surface above the level of flood waters. The concept was developed by Murdoch in collaboration with Leonid Germanovich at Georgia Tech, resulting in a process called Solid Injection to Raise Ground Elevation (SIRGE). The SIRGE concept has attracted media attention recently (<http://blogs.clemson.edu/discovery/2012/11/21/sirge-an-alternative-for-protecting-cities-from-flooding/>) after hurricane Sandy exposed the widespread vulnerability of the Atlantic coast to flooding.



Vertical hydraulic fracture filled with rhodamine dye in glacial till. From former graduate student **Chapman Ross**, now at Geosyntec



The department is increasing our social media presence. Check us out on LinkedIn, Facebook and Twitter. Direct links are available on the EEES website.

Faculty Profile



Dr. Kevin Finneran, Assoc. Professor, joined the Department of Environmental Engineering and Earth Sciences at Clemson in 2010. Prior to Clemson, he received a BS degree in Environmental Sciences at Rutgers University and a PhD in Microbiology at the University of Massachusetts at Amherst. He then worked at GeoSyntec Consultants as an Environmental Microbiologist for just under three years, and then joined the faculty in Civil and Environmental Engineering at the University of Illinois. Dr. Finneran was an early developer of technologies for fuel oxygenate (MTBE) bioremediation in anoxic subsurface environments for the American Petroleum Institute, and uranium remediation strategies for DOE facilities with uranium mill tailings piles. He investigates MTBE bioremediation and broadly metal/metalloid remediation, but his focus has shifted to investigate coupled biological and chemical reactions and their role in bioremediation as well as biofuel production. His recent projects include the role of iron biogeochemistry in explosives and chlorinated solvent biodegradation, photobiology in biodegradation, and bio-hydrogen/bio-butanol hyper-production in fermentative bacteria using extracellular electron shuttling compounds. Dr. Finneran was recently named a Kavli Fellow of the National Academy of Sciences (NAS). The Kavli program recognizes young scientists and engineers who are regarded as leaders in their respective fields of research. He was inducted into the fellows program in May of 2012 at the NAS/Alexander von Humboldt Foundation sponsored conference in Potsdam, Germany.

Chair's Corner

Dear EEES alumni and friends:

I would like to take this opportunity to wish you a happy and safe Holiday Season and a prosperous New Year. I am pleased to report that the state of the Department is strong. We had another exceptional year. In this newsletter, we present a brief summary of our accomplishments and activities. We currently have 182 undergraduate and 120 graduate students working with 20 tenure track faculty members. New research awards 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 faculty, students and staff. Dr. Stephen Moysey received the prestigious National Science Foundation (NSF) CAREER award, which is the most prestigious award in support of junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education and the integration of education and research. There are currently five CAREER award recipients in the Department. 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 Toshiba Endowed Professor of Nuclear Engineering, a cornerstone position in the Department responsible for our nationally recognized and unique nuclear environmental engineering and science program. Dr. Annick Antil 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 very proud of the accomplishments of our students; several of them have received impressive national awards, some listed on the next page. There are many more accomplishments that will not 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 talented faculty, students and staff. We appreciate your continuous support and generous donations to the Department. They provide important resources, especially for students, during these challenging economical times. THANK YOU! Please visit us if you happen to be around the Clemson area, and keep us informed about the events and accomplishments in your life.



Tanju Karanfil, Ph.D., P.E., BCEE
Professor and Chair

New Faculty



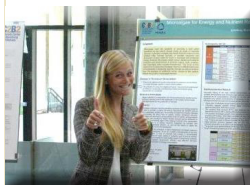
Dr. Annick Antil joined the EEES department in August of 2012. **Dr. Antil** received her PhD in Sustainability from the Rochester Institute of Technology in 2011 where she also received her MS in Materials Engineering (2007) after a BS in Materials Engineering from Ecole Polytechnique de Montreal (2005). 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. Antil'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.

Student News and Accomplishments



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.

Lindsey Burton (Senior, BE) was selected as one of twenty students across the nation to participate in the C2B2 Colorado Center for Biorefining and Biofuels undergraduate research experience this past summer. The program is a joint collaboration between the National Renewable Energy Laboratory and the state of Colorado. Lindsey worked with Dr. Tzahi Cath at Colorado School of Mines on the treatment of wastewater using conventional biological processes and novel wastewater treatment processes utilizing algae. The algae were then cultured on the wastewater to remove toxic ammonia as well as grow for potential lipid extraction for the production of biofuels.



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.



Peng Xie (MS, EE&S), **Jaclyn Ellerie** (MS, EE&S), and **Dr. David Ladner** attended the American Water Works Association (AWWA) Annual Conference and Exhibition in Dallas, TX, in June. Peng gave a platform presentation entitled, "Sinusoidal- and Helical- Flow Spacers for Fouling Mitigation and Energy Reduction in RO Desalination." Jaclyn gave a platform presentation entitled, "Adsorptive Carbon Coatings for Ultrafiltration Membranes." Peng also gave a presentation entitled, "Status of Drinking Water in China," during a special session on global water issues. Dr. Ladner moderated a Universities Forum session during the conference.



April Gillens (PhD, EE&S) was selected to attend lunch with Dr. Sigfried Hecker, the former director of Los Alamos National Laboratory and a former negotiator for the US with North Korea while participating in an internship at Lawrence Livermore National Laboratory.

Dr. Hecker is interested in ongoing work in the area of nuclear forensics that **April** is involved with. This work is supported by the Department of Homeland Security through research projects in our Nuclear Environmental Engineering and Science Focus area.

Meric Selbes (PhD, EE&S) and **Dr. Tanju Karanfil** attended Gordon Conference on Disinfection By-Products held at Mount Holyoke College in Massachusetts. Meric presented his PhD work at the poster session. The title of presentation was "Importance of Tertiary Amine Structure on NDMA Formation and Effect of Background Matrix and Chloramine Species." **Dr. Karanfil** served as the Discussion Leader of the session entitled "Methods to Identify DBPs."



Alumni News



Recent Biosystems Engineering graduate **Lauren Harroff (MS, BE, 2012)** 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. She volunteered with the Pendleton Place Children's Center, participated in peer mentoring with the Calhoun Honors College and worked with Engineers Without Borders. 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.

Dr. Andrew Sowder (PhD, EES, 1998) was a co-organizer for the Gavan-Olin Medal Symposium in honor of Sue B. Clark, former adjunct faculty member of the department and currently Regents Professor of Chemistry at Washington State University. She was honored with the award by the American Chemical Society for her distinguished work in radiochemistry. **Kelly Grogan (PhD, EE&S, 2012)** and **Brian Powell (PhD, ESE, 2004)** and current EEES faculty member presented during the award symposium.





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Dr. Timothy A. DeVol named Toshiba Professor



Congratulations to **Dr. Timothy A. DeVol** who 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 Corp. 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.

In 1980, **Dr. Robert A. Fjeld** was hired into the position and initiated the NEES focus area in the department. The NEES focus area has two academic programs, Environmental Health Physics and Environmental Radiochemistry where Dr. DeVol along with Drs. Powell and Shuller-Nickles form the critical mass of faculty with nuclear expertise. The Environmental Health Physics program is accredited by the Applied Science Accreditation Commission of Accreditation Board for Engineering and Technology, Inc (ABET) The average number of M.S. and Ph.D. students pursuing the NEES concentration has been ~14 per year over the past 5 years. There are currently 21 M.S. and Ph.D. students within the NEES concentration. The NEES research and educational activities

are centered around the South Carolina Commission on Higher Education approved Center for Nuclear Environmental Engineering Sciences and Radioactive Waste Management.

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.

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.

