What do you see as the strengths of CECG?
For over a dozen years, CECG has gathered scientists across Penn State to study chemical problems within the earth system. The Center has sponsored exploratory research among faculty and students across colleges, connected scientists with instrument capabilities in the chemical area, and supported the innovative, student-run Environmental Chemistry Student Symposium (ECSS) since its start in 1996 — one of only a few such efforts in the country. The greatest impacts from the interdisciplinary CECG links are successful proposals that have led to training and PhDs in new areas - for instance, 20 students trained in BRIE (Biogeochemical Research Initiative for Education) and more recently, CEKA (Center for Environmental Kinetics Analysis). These put participating scientists and the students who graduate at the cutting edge of earth and life science discovery. Breadth also is one of our strengths. With the common “language” of chemistry, we cover engineering activities and chemistry in four colleges—Eberly College of Science (ECOS), College of Earth & Mineral Sciences, College of Agricultural Sciences and College of Engineering.

What are the center’s outreach goals?
There are a couple of main goals for the next several years of CECG. With a re-charged faculty group on the Steering Committee—more junior faculty—we aim principally to find new research projects at interfaces within the earth system. “Find” means “fund,” so a primary goal is success with appropriate opportunities to which we are writing proposals. A second goal is expanding our mission beyond our own campus. We hope to host 3-5 outside universities at next spring’s ECSS. This will enrich scientific exchange and, it is anticipated, lead to jointly funded projects. If an extended ECSS works, it could become “the” environmental conference for the mid-Atlantic area.

What are the center’s greatest challenges?
Visibility on campus, perhaps. There are many ‘environmental’ programs and activities. We want every student and faculty member who would benefit from participation in CECG—whether using shared facilities, participating in seminars or ECSS—to know we are here.

What are your long-range goals for the center both in terms of the university community and the greater scientific community?
New educational and training programs, an extended ECSS, and greater attention to data archiving and data mining across all environmental chemistry activities at PSU are the main ones. It is noteworthy that given expected center “lifetimes” within the University, CECG is stronger than ever after 12 years. This is a credit to its leadership as well as the energy of 100+ participants (see the website for a listing of Affiliates and Facilities: http://www.essc.psu.edu/CECG/).
CECG Summer Fellowships Support

In summer 2008, CECG awarded four fellowships in support of environmental research. This year’s recipients were Daniel Hummer, Daniel Jones, Daniel Silverman, and Michelle Williams-Tober. The following is based on reports that each submitted.

Daniel Hummer’s summer research yielded a new discovery that he has submitted as a letter to Physical Review Letters. A graduate student in geosciences, Hummer discovered that the summed energies of titanium oxide surfaces is always much less than the total calculated surface energy of a whole nanoparticle—suggesting that the junctions between crystal faces contributes their own surface energy. This new influence on nanoparticle stability could have broad ramifications for environmental science and nanotechnologies.

Dan Jones used his CECG Fellowship to study the phylogeny, diversity and metabolic processes of microorganisms in highly acidic formations known as “snotites.” Curious whether certain classes of genes are over-expressed in the snotite environment, the graduate student in geosciences annotated the snotite metagenome and compared it to other microbial communities. He also identified several metabolic pathways, specifically those for carbon and nitrogen fixation and for sulfur oxidation. He then cultured snotite microorganisms in order to verify that the microbes could oxidize different forms of sulfur and fix both carbon and nitrogen.

The only undergraduate to receive a CECG Fellowship, Daniel Silverman gained valuable laboratory experience, learning techniques critical for studying enzymes that impact the global environment. More specifically, the biochemistry and molecular biology major used gene-cloning techniques and heterologous expression to produce large amounts of polyhistidine-tagged acetate kinase from Methanosarcina thermophila and then purified the enzyme by affinity chromatography.

Michelle Williams-Tober’s CECG Fellowship underscored the field and laboratory work that she needed to complete for her master’s degree in ecology. Her field work included sampling stream and ground water from 13 headwater wetland sites in the Upper Juniata watershed; taking soil samples at 16 plots; and installing nitrogen-collecting resin bags below the soil surface at the same plots. These samples were then analyzed for pH, soil organic matter, NO₃⁻ and NH₄⁺ concentrations. Williams-Tober is now working on the statistical analyses of the variables and discovering significant relationships between wetland conditions and vegetative and soil variables.

Stay tuned for CECG’s 2009 Summer Fellows nomination request.

Macalady Goes “Underground” in Search of Sulfur-Loving Microbes

Until five years ago, Jenn Macalady had focused her research above ground—on the thousands of microorganisms in soil. But then an Italian colleague introduced her to microbial mats growing in caves near his home, and Macalady went underground. Now, Macalady’s research takes her as much as 600 meters below the surface into sulfidic caves.

Caves that formed due to sulfur cycling have been found on all continents but not all have the microbial communities that hang from cave walls and resemble slime. These “snotite” communities depend upon sulfuric acid production, and that production has ceased in some caves like the Lechuguilla/Carlsbad complex in New Mexico. So Macalady travels mostly to Italy for her research. The downside to the trans-Atlantic jaunts: Descending into those caves involves a lot of rope work and waiting, she says.

Snotite communities are far simpler than soil communities with a gram of snotite containing only from 5 to 10 species. That is the result of the caves’ highly acidic environment—in some, the pH can measure as low as 0.

But that lack of biodiversity is a plus for researchers like Macalady. Because snotite communities have such few species, researchers are able to connect each species with specific processes like nitrogen fixation or acid production. Making these connections brings the ecological rules governing the whole microbial ecosystem into view.

Even more significant, says Macalady, snotites may provide clues to how microorganisms evolved in the past and how they are evolving today. So far, snotite communities across the globe contain microbes that are less related genetically than their near-identical ecological niches would predict. This means that the physical barriers between sulfide caves maintain isolated populations that are likely evolving into new species.

Next up: Using microsensors to measure interactions between the cave microbes and geochemical conditions that change seasonally. This data will be able to be retrieved remotely.

An assistant professor of geosciences, Macalady received her Ph.D. in soil science from the University of California Davis. Her research interests include geomicrobiology of cave formation, astrobiology, microbial role in weathering and soil processes and ecological interactions in microbiologically dominated ecosystems.

Macalady works with colleagues at Penn State, the University of Vermont and the Max Planck Institute of Marine Microbiology. Her research is supported by NASA and the National Science Foundation.
Environmental Chemistry Student Symposium - 2008

The symposium was held on March 28-29, 2008, and was held in the Forest Resources Building. Dr. Patrick Hatcher of Old Dominion University was the keynote speaker. Undergraduate and graduate students from 11 different departments participated in the 11th Annual Environmental Chemistry Student Symposium.

About 60 students participated in the event which included poster and oral presentations and a photography contest. Departments represented included: crop and soil sciences; chemistry; wildlife and fisheries sciences; geosciences; ecology; environmental engineering; microbiology; and chemistry.

Douglas Call, an M.S./Ph.D. graduate student in environmental engineering, received the Overall Oral Presentation Award for his research involving the production of hydrogen gas using microbial electrolysis cells (MECs). Call’s work demonstrated that hydrogen recoveries are possible at rates of 78 percent to 96 percent with MECs lacking membranes. This opens the door to more simple and more cost-effective MEC designs.

Charles Jones, a Ph.D. student in chemistry, was awarded the Overall Poster Presentation Award for his research on the role of formic acid in cloud droplet formation. Researchers have determined that formic acid has the ability to bind to water on the molecular scale more easily than water binds with itself. The results from this study may help scientists better understand how organic acids might play a larger role than previously thought in the cloud chemistry of our atmosphere.

More than 30 faculty members from multiple departments participated as judges. The annual event is supported by the Eberly College of Science and the College of Earth and Mineral Sciences through the Center for Environmental Chemistry and Geochemistry, The Penn State Institutes of Energy and the Environment, The College of Agricultural Sciences, and The College of Engineering.

Save the date for next year’s ECSS which is slated for March 27-28, 2009.

ECSS Winners of Poster Sessions

**Ag and Soil Sciences**
Mike Castellano (CROP & SOIL)
Maina Martir Torres (SOIL SCI)

**Chemistry**
Rebecca Sanders (CHEM)
Christin Palombo (CHEM)

**Environmental Engineering**
Rachel Wagner (ENviron ENG)
Alessia Eramo (ENviron ENG)

**Meteorology & Others**
Jennifer Williams (GEOSC)
Keith Price (WILDLIFE & FISH)

**Biogeochemistry & Microbiology 1**
Daniel Jones (GEOSC)
Mary Kay Lupton (SOIL SCI)

**Biogeochemistry & Microbiology 2**
Rebecca Grimme (CHEM)
Aaron Diefendorf (GEOSC)

**Undergraduate Poster Session**
Melissa May (ENVIron RES MNGMT)
Michael Skowronski (CHEM)

ECSS Oral Presentation Winners

**Biology and Molecular Biology**
Heidi Albrecht (GEOSC)
Christopher Ross (ECOL)

**Agricultural Soil Science and Geochemistry**
Daniel Hummer (GEOSC)
Ashlee Dere (SOIL)

**Environmental Engineering and Ecology**
Yi Zuo (ENVIron ENG)
Jennifer McElhoe (ENVIron ENG)

ECSS Photography Contest

1st place - Rachael O’Patchen, Undergrad (MICRO)
2nd place - Ziming Zhuang, Graduate (IST)
3rd place - Beth Herndon, Graduate (GEOSC)

CECG Briefs

Keep the date open for the Annual CECG Wine and Cheese Event which is scheduled for Feb. 5, 2009, at the Nittany Lion Inn in the Fireside Room. The keynote speaker this year will be Dr. Alison A. Campbell, Director of the Environmental Molecular Science Lab (EMSL) of DOE’s Pacific Northwest National Lab.
The Center for Environmental Chemistry and Geochemistry is supported by the Eberly College of Science, the Earth and Environmental Systems Institute, the Department of Meteorology, and Penn State Institutes of Energy and the Environment.

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