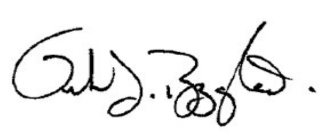
Newsletter December 2010 Issue 4

Department of Earth and Environmental Sciences

Message from the Chair

Welcome to the fourth installment of the EES alumni newsletter. Last year we devoted our newsletter looking back at the foundation of our Department given that it was the final year that we would be in our traditional home of Williams Hall. This year, we look forward as we continue to settle into our new home of the STEPS building. I have more on that below, but here I wish to highlight some of the major EES academic and curricular activities over the past calendar year. As you may know, the University has drafted and adopted a strategic plan that identifies energy, environment, and infrastructure as one of the core areas where it wishes to enhance its intellectual footprint and impact in scholarship. EES figures prominently in that vision and we are working to align with the plan and in the process, better prepare our students for their future careers. Our faculty continue to be recognized for outstanding service to the University and their academic disciplines. Steve Peters was recently tenured and promoted to Associate Professor. Bob Booth was awarded the Frank Hook teaching award for his exemplary instruction in the classroom and mentorship of undergraduate and graduate students. Ken Kodama was recognized at the annual College of Arts and Sciences research dinner for his long and productive contributions to paleomagnetism, tectonics, and cyclostratigraphy. Dean Anne Meltzer has announced she will be stepping down from college leadership and will return to the Department in the Fall, 2011 semester after six years in Maginnes Hall. We welcome her return because it marks the EES faculty finally gaining its full strength after many years of having had several of its faculty serving as leaders of administrative stems and programs. The graduate program continues to have a strong presence on campus and regularly attracts top students nationally and internationally. These students have been similarly recognized for their academic achievements including a best presentation award by Ryan McKeon at an international conference in Scotland, an Exxon-Mobil research grant to Allison Teletzke, and an EPA and NASA PhD graduate fellowship landed by Kate Semmens. The undergraduate program is undergoing rapid growth, a trend perhaps spurred on by the move to the STEPS building. In research our faculty, graduate students, and undergraduates are working on funded projects around the world. These projects will see EES in some pretty exotic places including Patagonia, Alaska, the Yukon, and central Mongolia. The research projects are investigating everything from the causes of climate change, to making predictions of terrestrial ecosystem response to global change, to natural sources of arsenic in ground water, to active tectonics and associated hazards, and orogeny in continental interiors. All in all, it has been a hectic, but productive year and we are thankful that Lehigh continues to weather the economic storms well. We hope 2010 has also been a productive year for you and that you will enjoy a peaceful holiday season and a great start to 2011. As alway, stay in touch and do not hesitate to pay us a visit.

On behalf of the EES faculty, students, and staff family,



Frank J. Pazzaglia
Professor and Chair

STEPS

Finally, after years of planning and building, the summer of 2010 saw the EES Department move from Williams Hall to the new STEPS facility. We are now nearing the end of our first semester breaking in the building and already we can sense a new feel for the Department. First and foremost, the building provides impressive and effective teaching platforms that allow the professor to effortlessly transition from the blackboard, to PowerPoint projection, to a document camera, to fixed posters. The teaching labs are laid out with hand samples that aid in the learning experience and we've high-graded our mineral collection for the numerous display cases in the building. Speaking of our collections, they are safely housed and newly labeled in the basement space saving movable storage. Complementing the teaching spaces are the state-of-the-art research spaces that have been designed to foster synergy and learning across disciplines.

EES students, faculty, and labs mostly occupy the 2^{nd} and 5^{th} floors of the building, with some spill-over to the 1^{st} and 4^{th} floor. Most of the 4^{th} floor of the building is dedicated to biology undergraduate teaching labs whereas most of the 3^{rd} floor is occupied by the environmental engineers of the Civil and Environmental Engineering Department. Chemistry undergraduate teaching labs fill the balance of the building on the 1^{st} and 3^{rd} floors. Our hope is that the mix of faculty and students in the building will lead to research synergy in science, engineering, policy, and economics in the Earth and Environmental Sciences, broadly speaking.

As I mentioned in my welcoming statement, we have seen a pretty dramatic rise in major declarations which might be related to STEPS. Certainly, the facility is a draw for students who are taking advantage of its computer labs and many wide open and comfortable spaces for studying and group projects. The building maintains open hours only second to the library. We welcome visitors frequently and would be happy to show you around if you visit Lehigh in the coming calendar year.

STEPS EES Teaching Lab

New Petrographic Microscope

EES Research

Activities of the Glacial Group
by: Ed Evenson

It has been awhile since I was asked to contribute to the EES Newsletter so I thought I'd use this opportunity to update you on the activities of the "Glacial Group" in your old department. Our efforts have been centered on the research of my last three students Iain Barton (MS), Matt Gentoso (MS) and Sarah Kopczynski (Ph.D.) and my work (along with Claudio Berti and others) on a separate problem in Tierra del Fuego – the origin of "Darwin's Boulders".

Iain's research was conducted in Idaho along the Big Lost River. Here, the retreating Wildhorse Canyon glacier released an ice-dammed lake that resulted in a flood downstream. Iain located all of the large boulders transported by the flood waters, measured their long, intermediate, and short axes and modeled the flood discharge. That flooding event was 218 times as great as the largest historic discharge of the Big Lost. It transported minivan sized boulders over 10 kilometers downstream of the end moraines from which they were derived. Iain is currently a consulting geologist with EMS based in Bethlehem.

Matt Gentoso studied till kinematics, using AMS rock magnetism, in the Weedsport drumlin field of New York. Ken Kodama served as his co-advisor. Matt demonstrated that AMS measured fabrics (carried by microscopic maghemite grains) align almost perfectly with pebble fabrics and the orientations of the drumlins and flutes. This suggests that the "matrix" of the subglacial till (the "deforming bed") is behaving like fault gouge and accreting over time. I am looking for a student to continue this study to see if we can cast light on the origin of streamlined bedforms such as drumlins and flutes. Matt is currently a consulting geologist with AMEC, Plymouth Meeting, PA.

Sarah worked in the Anchorage lowland where she studied the timing and style of retreat of the Matanuska/Knik glacier complex which almost equally shared the lowland. Her work demonstrated that the glaciers coalesced to form the Elmondorf moraine during the Last Glacial Maximum (LGM) but that upon retreat following the LGM the Matanuska lobe stagnated in place while the Knik lobe retreated rapidly by calving making room for the Matanuska to flow into space previously occupied by the Knik lobe. Sarah is currently working as a civilian for the Army studying the glacier shrinkage in Afghanistan.

My "Darwin's Boulders" project (with Claudio Berti, Greg Baker, and Pat Burkhart) has taken us to Tierra del Fuego annually for the last three years. Here we are studying the origin of an elongate group of large, monolithologic granite boulders discovered by Charles Darwin while on the voyage of the Beagle. Darwin thought, and wrote, that the boulders were "ice-rafted" to their position on the Atlantic coast and used them to argue for an ice-rafting as the explanation for many far traveled erratics in South America and Europe. Our investigation demonstrated that Charlie was wrong! The boulders are the result of a large landslide of granite onto the surface of a glacier (Perry Glacier) over in the Andes followed by supraglacial, and strain elongation, across Tierra del Fuego to their present position. If you want a PDF of the GSA TODAY article drop me an email.

Darwin's Boulders at Bahia San Sebastian, Tierra del Fuego

A Big Darwin's Boulder!

EES Research

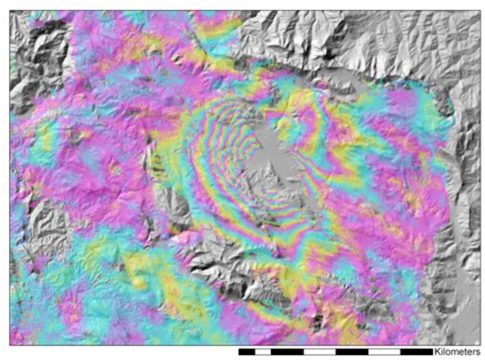
Looking closer from afar...InSAR satellite geodesy and landscape evolution
Claurio Berti, Post-Doctoral Research Associate

How can a 10 m long radar antenna orbiting at about 700 km over our head be helpful in understanding slow movement of the Earth's surface? Well… this is the same question that I asked myself when Frank and Joan offered me the Post-Doc appointment: No way! It turned out that I was wrong, it works great! But let me introduce myself first. I am a geological geomorphologist with broad interests in the evolution of landscapes and their response to tectonic forcing. Landscapes are the result of intermediate to long-term tectonic processes that build topography and the corresponding surface processes that tear them down by erosion. I am most interested in understanding these processes through process geomorphologic research.

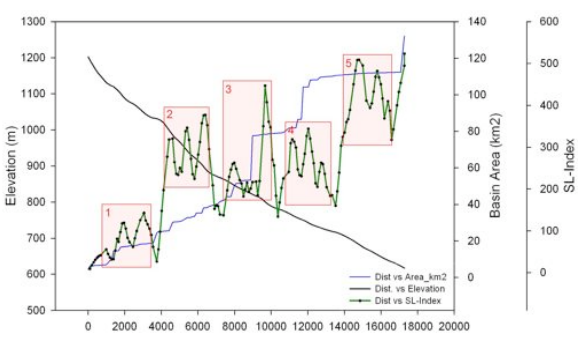
Mapping in the Badlands of South Dakota

The core data that I collect comes from field mapping, stratigraphy, sedimentology, structural geology and tectonic geomorphology, paired with computationally-based analyses of digital topography. The drainage basin, its hydrology, stream network, rates of river incision, and corresponding hillslope processes is the inter-related system that I study. I am particularly interested in the medium time scale response of the landscape to tectonic forcing, investigating the range of processes that act in the transient phase of disequilibrium landscape.

My current post-doc research at the Lehigh University has me deeply involved in InSAR (Interferometric Synthetic Aperture Radar) geodesy, and its range of applicability in landscape evolution studies. As a powerful geodetic tool, InSAR is currently and proficiently used in the study of rapidly deforming landscapes associated with faults or volcanos. In my research, I am interested in integrating the short term signal of deformation detected from advanced InSAR technique (time-series, persistent scatters) with the medium term landscape evolution history inferred by drainage basin tectonic geomorphology and river long profile modeling.



InSAR image of l'Aquila earthquake. Rainbow cycles represents 2.8 cm of displacement in the satellite L.O.S.



River long profile with superimposed Hack SL Index. Clustering of SL index peaks provides clues on the rupture behavior of tectonic elements located in the lover trunk.

Promising results have been achieved in the study of the L'Aquila earthquake in Italy (April 2009), and an advance study proposal for 2 areas in the western US has been recently submitted to NASA for approval and is now under revision.

The objective of this proposal is to characterize the processes of fault rupture unsteadiness and accumulation of interseismic strain by studying a temporal and spatial continuum of rupture behavior. The characteristic time frame of observations of InSAR geodesy of coseismic and interseismic deformation, geodetic geomorphologic record (river terraces) and paleoseismology of a fault scarp are link by stream long profile analyses and integrated in large-scale segmentation history of range-bounding normal faults.

Incorporation of organic nitrogen into silicates: isotopic analyses of melanophlogite, beryl, and cordierite

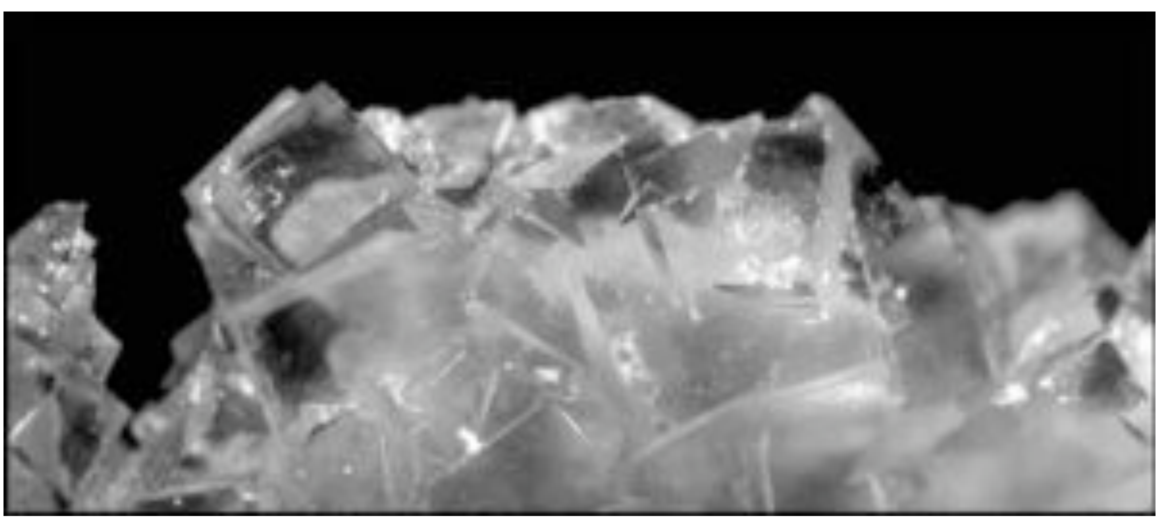
Kristin Lazzeri, Master's Candidate
Advisor: Gray Bebout

The nitrogen isotope system has the potential to trace interactions among Earth's major reservoirs, including the transfer of organic nitrogen into solid inorganic phases. There is still much to be learned about the processes by which organic nitrogen is incorporated and recycled throughout the geosphere, and it may be one key in understanding the evolution of the ancient Earth biosphere.

Relatively few studies have addressed the flux of organic nitrogen into the deeper Earth and the nature of N_2 within silicates is poorly understood. This is partly related to the small quantities of nitrogen in many silicate materials and the only recent advances in low-concentration isotope mass spectrometry. A select few minerals can incorporate various molecules in microcavities, pores, or channels and can be very useful in providing information on the nature of fluid phases present during crystallization and entrapment. We hypothesize that nitrogen isotope signatures within microporous silicate channels can be used to trace the storage and mobility of initially organic nitrogen in Earth's crust and provide information regarding ancient fluid-rock interactions. In particular, the channels of microporous silicates beryl, cordierite, and melanophlogite will be examined for ability to store nitrogen in the crust and the isotopic composition of this nitrogen.

Beryl ($Al_2Be_3Si_60_{18}$) and cordierite ($(Mg,Fe)_2Al_4Si_5O_{18}$) are cyclosilicates with similar structures in which the dominant features are hexagonal rings of SiO_4 tetrahedra stacked above each other. These stacked rings form hollow channels parallel to the c axis where sizable amounts of guest molecules can be stored. Melanophlogite, on the other hand, ($46SiO_2 \cdot 6(N_2,CO_2) \cdot 2(CH_4,CO_2)$) is a natural clathrate compound of silica that is believed to contain quantities organic impurities in its structure (including nitrogen). Melanophlogite is a very rare mineral and is known from only five localities in nature.

Beryl, cordierite, and melanophlogite analyzed in this study are from various collections as well as beryl samples collected in the field during the spring. This study will consist of isotopic and petrographic analysis at EES's Stable Isotope Geochemistry Laboratory.



0.4-mm melanophlogite crystals. (F. Adorni collection and photo)

EES Research (cont'd)

Land use effects on biofilms ability to utilize, process, and transport dissolved organic carbon (DOC) in the fluvial system

Christopher Dempsey, Ph.D. Candidate
Advisors: Don Morris and Frank Pazzaglia

I am interested in studying the lability, transport, and export of dissolved organic carbon (DOC) in fluvial systems in eastern Pennsylvania streams. I have been trying to understand how land use affects DOC lability. Headwater streams are relatively understudied in terms of carbon cycling and human impact. With the ever increasing changes in land use it is important to understand how humans are affecting the environment. It is important to understand how carbon is being used in various ecosystems and whether it is staying in the system (stream), or being lost to the atmosphere (CO_2).

Sampling Location at Alan Seeger Natural Area

Organic carbon is the only energy source for heterotrophic bacteria. In lotic ecosystems, organic carbon is usually most abundant in the form of dissolved organic carbon (DOC). Microbial communities and biofilms in streams act as a critical link between DOC and higher trophic levels. Without the activity of microbial communities, DOC and the energy contained within these compounds, would be transported unused through lotic systems. Heterotrophic microbes are capable of metabolizing a portion of the DOC and converting it into microbial biomass, which can then be consumed by higher trophic levels. This critical link provides energy for lotic systems, not only from autochthonous, but also from terrestrial allochthonous sources.

My study sites for this project are located within Rothrock State Forest near State College, PA. The sites were pre-selected to eliminate variables other than land use. I am interested in how land use affects DOC liability in headwater streams. Part of this research utilizes a pristine forest which may give us some insight into how streams functioned before large scale human settlement and deforestation. The role of carbon cycling in small streams is not well understood in terms of the global carbon budget. In the context of global warming this research is important in understanding how we can effectively manage our streams as carbon sources or sinks.

Collecting water samples

Google Earth image of approximate sampling locations

Another project at the same sites (shown to the left) will try to determine the age of carbon being exported from these headwater sites. This has important implications for land use managers and could play a significant role in carbon sequestration. Organic carbon residence times and ages will be determined to better understand the processes that control the export of carbon on a watershed scale.

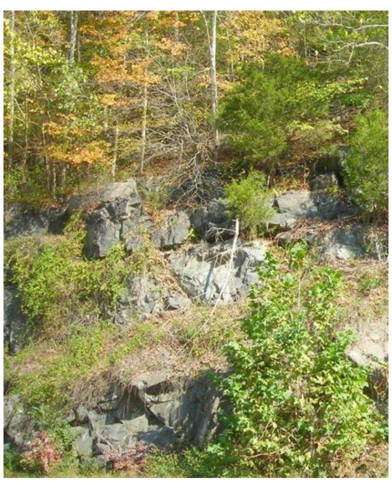
Geologic sources of arsenic in groundwater: Crustal recycling in convergent margins?

Johanna Blake, Ph.D. Candidate
Advisor: Stephen Peters

Exposure of humans to arsenic through drinking water is linked to health problems ranging from stomach pain and circulatory problems to skin, lung, bladder, and kidney cancer. In many areas of the world, arsenic in groundwater is derived from naturally occurring geologic sources. Weathering and desorption of As from geologic formations into groundwater can cause water quality degradation, which is well recognized now in the United States, Argentina, Chile, New Zealand, Taiwan, India, Bangladesh, and other countries.

Working in the aqueous geochemistry lab in the STEPS building

Arsenic is mobilized from crystalline bedrock to groundwater and surface water in two ways: direct mobilization or through crustal recycling. The direct mobilization model has been studied in Northern New England and found to work. The crustal recycling model suggests that Mesozoic rift basins to the south, including the Newark, Gettysburg, and Culpeper Basins, provide a repository for crystalline bedrock to erode and deposit, where it gets recycled. Arsenic in the source rock is transported from the higher elevation to the low points as alluvial fan or lake deposits. These deposits then come into contact with ground water and the arsenic undergoes dissolution and mobilizes.



Lake deposits of the Newark Basin

The goal of this project is to understand the fate and transport of arsenic through an earth system by studying the geochemistry of bedrock, soils, surface water and groundwater. As data is collected from this research, a predictive model will be created to show where arsenic may be in drinking water. Research will begin in the lake deposits of Eastern Pennsylvania in the Newark Basin where some research on groundwater has already been done. Close attention will be made to identifying the lithologies of these lake deposits to aide in identification of similar deposits in the Gettysburg, Culpeper, Barboursville, Richmond, Taylorsville, Dan River, and Deep River Basins. Once comparable lithologic units are identified, rock samples will be collected at outcrops and roadcuts, with attention to finding unweathered material. In particular, the fine grained lake sediments most similar to those in the Newark Basin will likely contain arsenic in grain coatings and cements. Groundwater from private wells and surface water samples will also be collected.

Rock, soil, and water samples will be analyzed in multiple labs throughout the STEPS building. Initial inspection of the rocks will include optical microscopy, scanning electron microscopy, and energy dispersive spectroscopy (SEM-EDS). Subsequent analysis will include crushing and sieving to 200 microns followed by a wet chemical total digest for analysis by inductively coupled plasma mass spectrometry (ICP-MS, Thermo Elemental X-Series, Winsford, UK). Water samples will be tested for As^{3+} and As^{5+} by ion chromatography-hydride generation on an Inductively Coupled Plasma-Mass Spectrometer (ICP-MS).

EES Research (cont'd)

Measuring unsteady faulty in the Northern Apennines

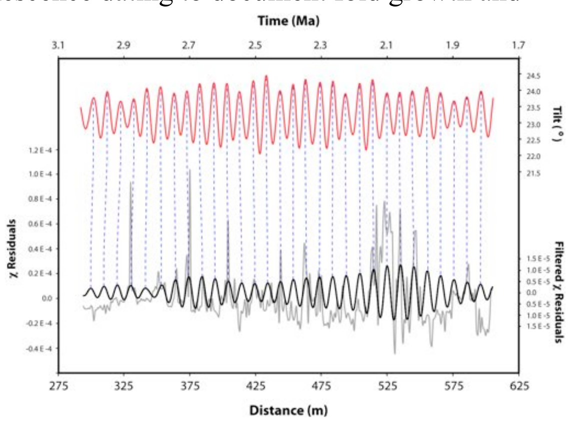
Kellen Gunderson, Ph.D. Candidate
Advisors: Dave Anastasio, Ken Kodama, and Frank Pazzaglia

It has become increasingly apparent that deformation of the Earth's crust does not always occur at a steady rate. These unsteady rates have been observed in systems as wide ranging as entire mountain belts to individual faults, spanning timescales of millions of years to a single decade. What causes unsteady deformation rates, however, remains ambiguous.

Growth strata exposed at the Enza River near Parma, Italy

Our group has been testing the hypothesis that changes in climate over 20 kyr-100 kyr time scales influence unsteady rates of deformation on individual faults in the northern Apennine mountains, Italy. We are integrating multiple methods of geochronology: magnetostratigraphy, cyclostratigraphy, cosmogenic nuclide dating, and optically stimulated luminescence dating to document fold growth and fault slip on disconnected structures at the northern Apennine mountain front. We apply these techniques to rocks that were deposited synchronously with deformation, called growth strata, that are exposed on the flanks of northern Apennine folds.

A problem researchers previously encountered was the inability to measure rates of deformation at the same time scale that climate and surface processes are unsteady. We apply the method of cyclostratigraphy, first developed by stratigraphers, wherein we correlate climatic proxies in the rocks to changes in solar insolation. These changes provide a high resolution metronome giving us 20 kyr- 100 kyr resolution of growth strata deformation. The specific proxy we use in the northern Apennines is magnetic susceptibility, which we have shown to vary with the Earth's axial tilt.



Correlation of magnetic susceptibility to Earth's axial tilt (obliquity)

The most exciting aspect of our work in the Apennine mountains is that it crosses disciplinary boundaries. We are required to integrate geomorphological, geological, geophysical, and geochronological data sets to meet our research objectives. Most importantly, we have had the good fortune of collaborating with an international group of exceptional scientists in a country that never seems to disappoint.

David Anastasio, Kurt Frankel (Georgia Tech), Claudio Berti, and Kellen Gunderson:

wet, cold, and ready for a pasta dinner

The sensitivity of North American kettlehole ecosystems to hydroclimatic variability

Alex Ireland, Ph.D. Candidate
Advisor: Robert Booth

The coming century is predicted to feature enhanced climatic variability, including increased frequency, intensity, and duration of extreme climatic events. Ecologists are faced with the critical challenge of anticipating potentially non-linear ecosystem responses to these changes. However, relatively few observational or experimental datasets exist that are of sufficient temporal depth or resolution to provide a basis for predicting ecosystem dynamics under a rapidly changing climate. In this project, we are addressing this critical data gap by employing paleoecological techniques and using kettlehole ecosystems as models to investigate the potential for climate-induced ecosystem state shifts. Paleoecological datasets that capture past ecosystem responses to enhanced climate variability provide valuable long-term perspectives on the sensitivity of ecosystems to climate-forced state shifts.

Recently, we used a suite of paleoecological analyses at Titus Bog in northwestern Pennsylvania, to test the hypothesis that the development and expansion of floating peatlands in kettlehole basins represents a threshold response to hydroclimate variability. In contrast with expectations of widely accepted conceptual models of gradual autogenic peat mat expansion, our results indicated that peat mat expansion at Titus Bog was highly episodic and occurred in three distinct pulses centered on 800, 650, and 400 cal yr BP. Each of these expansion events coincided with or immediately followed decadal-to-mutlidecadal droughts recorded in regional paleoclimate reconstructions. These patterns indicate that peatland development in kettlehole basins can follow non-linear trajectories, with episodes of rapid advancement triggered by climatic forcing. Future climate changes may increase the likelihood of peatland expansion in kettlehole basins, potentially leading to abrupt changes in adjacent lake ecosystems.

Fallison Bog, Wisconsin. Looking east from the peat mat over the centrally located remnant pond. Preliminary results indicate that large areas of peat mat established around 5000 and 3000 years ago, but that that peat mat has not advanced substantially in the last 1000 years.

We are currently reconstructing the developmental histories of several kettlehole lake – peat systems situated along a gradient of groundwater influence, in northern Wisconsin. This landscape-level study has two primary goals. First, we hope quantify the relative roles of basin morphology and groundwater input in mediating floating peat mat invasion of kettlehole lakes. Second, we plan to assess the biotic and physiochemical responses of the remnant lake ecosystems to peat mat invasion. From these datasets, we hope to formulate an empirically based spatially explicit model of peat mat advancement and a nested system dynamics model of lake system response, capable of reproducing past patterns and predicting potential future changes. This work is of critical importance because of its ability to improve our understanding of ecosystem dynamics within these systems and to improve current conceptual models of the dynamics that occur during rapid externally forced ecosystem state changes.

EES Research (cont'd)

Contrasting patterns of past carbon dynamics in peatlands from Alaska and Patagonia: possible controls of temperature and climate seasonality

Julie Loisel, Ph.D. Candidate
Advisor: Zicheng Yu

The proposed project aims at identifying and understanding large-scale controls on high-latitude peatland dynamics and quantifying Holocene (last 12,000 years) peat-C accumulation rates in Alaskan and Patagonian ecosystems. In this ongoing research, I am providing a long-term perspective on peatland development from these two climate-sensitive, soil C-rich regions to evaluate the effects of climate seasonality on C sequestration. Specifically, I am reconstructing peat accumulation rates for these two regions by using a combination of new peat core collection and analysis as well as syntheses of existing peat data sets, with the goal to compare northern and southern peatlands response to changing climate seasonality. Alaska and Patagonia have been experiencing very different climate seasonality and temperature magnitude over the past 12,000 years due to orbitally-induced insolation changes. About 11,000 years ago, for example, the Earth was closest to the Sun during the northern hemisphere summer, and thus farthest away from the Sun during the southern hemisphere summer. As a result, the intensity of the summer insolation peak was greater in the northern than in the southern hemisphere. Over the past 4000 years, the opposite is true. Therefore, as each precession cycle progresses through time, the insolation intensity is out of phase between the hemispheres. Given that, in terms of incoming solar energy, the precession forcing is the most important of all orbital cycles, this asynchrony can be used as a 'natural experiment' to evaluate the long-term, large-scale role of temperature seasonality on peatland functioning. Overall, a better understanding of large-magnitude insolation controls on peatland C dynamics is critical to improve peatland models and to better forecast the effects of the ongoing and projected climatic changes on peatland C fluxes and their associated feedbacks to the climate. Particularly, the impact of past temperature seasonality and precipitation changes on high-latitude C-rich ecosystems is of particular interest given the ongoing and projected decrease in temperature seasonality in high-latitude regions.

Peat bog, Andorra Valley (Tierra del Fuego, south Argentina)

An Appalachian perspective on long-term landscape evolution and low-temperature theromochronology

Ryan McKeon, Ph.D. Candidate
Advisors: Peter Zeitler and Frank Pazzaglia

Panoramic view of the high, steep, and extremely vegetated ridges of my study area in the Great Smoky Mountains of North Carolina

The Appalachians were constructed through a series of collisional orogenies in the Paleozoic and then torn apart and rejuvenated during Mesozoic rifting that opened the Atlantic Ocean basin. Models predict that mountain ranges should decay away quickly when the tectonic driving forces that built them cease, which makes the persistence of rugged topography and significant relief in the Appalachians difficult to explain in the context of a old and decaying mountain range. The goal of my research is to understand the pace and variability of the development of the Appalachian landscape and in so doing get a sense of the ways in which old landscapes respond to perturbations be them tectonic, climatic, or otherwise.

My research utilizes a specific type of radiometric dating called thermochronology, where the stopwatch starts when the rock cools below a mineral-specific temperature threshold. The ages I calculate, by measuring the concentration of uranium and thorium (the unstable parent isotope) verses helium (the daughter product of radiometric decay) for individual grains of apatite, give me the time elapsed since the rock was last above ~ 60˚C. Uplift and erosion are typically coupled processes which brings new material to the surface to replace that which has eroded, the resultant exhumation of deeper material results in cooling which starts the clock in my apatite grains. However, in the Appalachians the ages I calculate are not as straightforward as those from apatites from regions with a less colorful geologic history. Instead, the scatter I observe in my data is likely signaling some important effects that we have yet to appreciate. Thus, much of my work has been in the laboratory trying to mitigate, or use to my advantage, possible sources of age scatter with the goal of moving the discipline forward and in the process getting a clearer sense for rates and drivers of Appalachian landscape evolution.

In working with my advisors, a curious trend we have found in the Appalachians is that apatites from samples of river sand tend to have less age scatter than samples derived from bedrock. This is counterintuitive because rivers are gathering material from everywhere upstream, whereas bedrock samples are specific to a single outcrop. We think that the journey from bedrock, to hillslope, to river channel culls some apatite grains that are the source of the age scatter and that the ones that survive to become river sediment give more reliable ages. Part of my research in the Great Smoky Mountains has been focused on turning a single steep drainage into a natural laboratory by dating apatites from all parts of the system (bedrock, soils, stream sediment) to address the life cycle of apatite grains and determine where the age scatter modulation occurs. Additionally, I am attempting to calibrate laboratory techniques to mimic the work that nature is doing to fluvial apatites. The goal of this work is to generate reproducible data from Appalachian apatites which can then be interpreted to address the landscape evolution questions that this not so old looking mountain range poses.

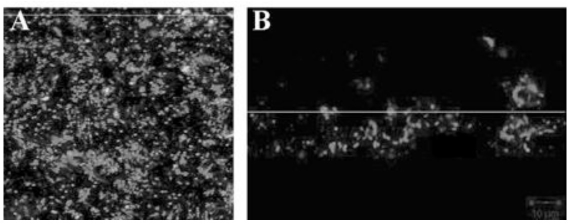
EES Research (cont'd)____________________

The impacts of environmental biofilms on the waterborne pathogen *Cryptosporidium*

Elizabeth Wolyniak, Ph.D. Candidate
Advisors: Bruce Hargreaves (EES) and Kristen Jellison (CEE)

Cryptosporidium is a group of waterborne protozoan parasites that cause a significant gastrointestinal infection. Oocysts (the environmental form of the parasite) are transmitted through fecal contamination of drinking and recreational waters. *Cryptosporidium* is estimated to be found in 55% of surface waters and 17% of drinking water supplies in the United States and remains a threat to water systems because they are small enough (4-8 μm) to pass through filters and resistant to chlorine disinfection. An understanding of how various environmental conditions affect *Cryptosporidium* will aid in more cost-effective water treatment and specific targeting of watersheds where the environmental conditions could support infectious oocysts.

An important consideration, especially when dealing with water treatment, is the formation of biofilms. Biofilms are microbial communities embedded in a polymer matrix that grow attached to surfaces exposed to water (i.e., the slime on rocks in a stream or pond). Biofilms can rapidly accumulate pathogens at densities much higher than water column densities with the potential for loss many months after entrapment. In addition, the biofilm structure can serve as a barrier to harmful environmental conditions, including disinfectant treatments and environmental conditions.



Scanning confocal laser microscopy image of oocysts attached to a biofilm.
(A) Planar view (B) Cross-sectional view

The goal of this project was to understand the dynamics of oocyst attachment and release from biofilms and the ability of biofilms to protect oocysts from damaging solar radiation.

Environmental biofilms were collected from three creeks during all four seasons. Oocysts easily attached to all biofilms within 24 hours during oocyst dosing. When the oocyst supply was removed, the number of oocysts attached to the biofilm decreased to a steady-state level at an average concentration of 2100 oocysts/cm^2. Variation in oocyst attachment between the different biofilm collections (site and time of year) was found to be a function of biofilm surface roughness.

Cryptosporidium oocysts have been shown to be vulnerable to solar radiation. However, when oocysts at depth in a biofilm were exposed to solar radiation, they were found to be significantly more infectious than those with no biofilm protection.

These results concerning oocyst attachment to biofilms are aiding in the development of a method to monitor a watershed for oocysts through the use of biofilms.

Collecting biofilm at Pocono Creek

The flow chamber system used to grow biofilms in the lab

FIELDCAMP 2010

2010 Fieldcamp at Palo Duro Canyon

After 35 years, Lehigh field camp broke with tradition and headed to the southern Rocky Mountains for its 36th consecutive campaign. The camp's core projects were run out of the Jemez Mountains of New Mexico and the Huefano Park region of southern Colorado. Eighteen students, including eleven from Lehigh participated in the camp. Several experiences are noteworthy. These include a kickoff 12-mile hike of Old Rag Mountain in Shenandoah N.P., a night-time tour of Mammoth Caves, threading the needle of tornado alley in Oklahoma, two days in the Canyon Country of Palo Duro, TX, securing a new water supply system for otherwise dry campgrounds, and two days and nights learning about the rise and fall of the Anasazi culture, not to mention sequence stratigraphy, at Chaco Canyon, NM. In summary, the southern Rockies camp proved to be very popular with the students and staff alike and we may adopt it as a permanent alternate year venue. In 2011, we return to the northern Rockies, Wyoming, Yellowstone, the Tetons, and Idaho. The Lehigh field camp remains one of the few, if only cross-country traveling camp and our ability to expose students to such a wide range of geology, hydrology, ecology, and environmental science topics using multiple venues will insure its popularity and sustainability for years to come.

Over the past three years the camp has been able to run an outreach program to high school teachers, bringing them along for part or all of the camp so that they can learn the content, and then bring it back to the grade 7-12 setting. This program has been generously underwritten by an EES alumnus who makes an annual donation to the Vic Johnson Fund. If you are interested in supporting the field camp and any of its various projects, outreach, and scholarship efforts, a donation to the Vic Johnson Fund is a great way to help.

Speaking of Vic Johnson, I have the sad news to report that he passed away this past April at the age of 83. His death was preceded in March of 2010 by the passing of Dave Nelson. Through the fieldcamp and your research, many of you knew of these two very fine gentlemen who were life-long supporters of Lehigh and its students. We are thankful for that support and have communicated our respect and condolences to their respective families.

Costa Rica

“Lehigh in Costa Rica” Anticipates Another Successful Trip

Eighteen students in the “Lehigh in Costa Rica” program have been working hard this fall laying a strong academic foundation for their coursework. At the end of the month, these intrepid explorers will pack their bags and depart for an 18 day field trip to Costa Rica. This will represent the 13th year for this Study Abroad program which was initiated by Profs. Morris (EES) and Weisman (CEE). In recent years Prof. Cutcliffe (STS) has joined the effort. The program began as a study of sustainable development practices in Costa Rica (ES-122). The program has recently expanded and now includes a course on the natural history of Costa Rica (EES-42). This year we are delighted to be joined by EES graduate student Jill Burrows who will be the program’s TA. One of Jill’s tasks this year will be to organize the students to participate in “Lehigh on Location” which features an interactive video blog of our trip. Log in to the Lehigh Portal, find the Lehigh in Costa Rica link, and follow our exploits!

Green tree frog

Students demonstrating the use of pigments derived from plants.

Severe flooding in the Caribbean lowlands made the trip interesting in 2010. It is after all a rain forest!

An invitation to get involved in your Department

The faculty and staff would like to extend an invitation to alumni to stay in contact with EES and to get involved with your Department. Contact us and let us know how you would like to be involved. Some activities and events open to all alumni include:

- The weekly Friday lunch and seminar (11 AM-1:00PM)
- The Graduate Student Seminar (typically the second week in February)
- Undergraduate and Graduate thesis defenses (typically near the end of the semester)
- Graduation (3rd Monday in May)
- Field Camp (see http://www.lehigh.edu/~fjp3/fieldcamp/index.html for the schedule)
- The Department Field Trip and field trips during the semester

Many of the programs we offer in EES that allow us to excel in education and research are made possible by endowed accounts and donations established by alumni. We are always looking to augment our resource base for graduate and undergraduate research, EES Field Camp, faculty development, and/or Departmental labs, equipment, and educational facilities. If you are in a position to donate, please fill out the form below with your gift and send it to us. We will acknowledge receipt as soon as it arrives. Please make your check payable to Lehigh University and we thank you in advance for your consideration and support.

Name: ____

Address: ______________________________________

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Email: ____

I would like to make a donation to support the EES graduate program in the amount of $___________

I would like to make a donation to support the EES undergrad program in the amount of $__________

I would like to make a donation to support Vic Johnson Scholarship in the amount of $_____________

I would like to make a donation to support EES faculty development in the amount of $____________

I would like to make a donation to support Department facilities in the amount of $________________

I prefer to make an unrestricted gift of $___________

Total personal donation $___________

Employer matching gift (if applicable, include employers matching gift form) $ __________________

Grand Total $___________

Send the completed form with your check to:
Laura Cambiotti, Department of Earth and Environmental Sciences, Lehigh University,
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