



NEWSLETTER

Message from the Chair

Dear Members of the EES family;

Welcome to our fifth annual installment of the EES newsletter. As you turn the pages you will see that we devote this year's focus to the undergraduate program – and for good reason. Our major has grown to over 80 students and another 23 are declared minors. The Department faces new challenges with a now large and growing major, but these are good challenges to have. We think that there are several reasons for this growth. First and foremost is the world we live in. Energy, natural resources including water, environment, climate, and infrastructure are the top of our societal needs at the national level. Students recognize this and are eager to learn more. EES is the only Department on campus that has deliberately positioned its curriculum to address these national challenges. Increasingly, our society is becoming more urban, more suburban, more sterile, and more distant from the energy, natural resource, and environmental base that lies at the foundation of our economy. You'll either be amused or disappointed to hear that when asked recently where the chemical sedimentary rock that makes up dry-wall comes from, my undergraduate sedimentology class responded “Home Depot”. EES is committed to experiential learning including lab and fieldwork that re-engages the Lehigh student with his or her natural world. Another reason why the major is growing is that students view the curriculum as accessible and interesting. For example, we offer a range of introductory lecture-based courses that have been successful at recruiting majors. Lastly, the students sense a real institutional commitment to the things that EES does because of the Department's central role in conceiving of and being housed in STEPS. What does this growing major mean for us? Well it means that our classes are larger, more sections are required, graduate TAs are stretched thin, and field trips have become quite a bit more expensive. It also means that there is more independent, student-driven research that needs to be mentored. All of this is good, but we need to recognize the fact that we now have an even larger obligation to these undergraduates to help place them in graduate school, industry, or the public sector. You, the readers of this newsletter, are in a position to help with that last goal so I restate my invitation that you become as engaged with the Department as your time allows. The following pages will highlight some of the upcoming spring and summer events that you may wish to participate in including the D. Foster-Hewett lecture series, the Graduate Student Symposium, the undergraduate research symposium, the second Marcellus Shale information panel, and the 38th annual Lehigh field camp. Do not hesitate to browse our website or contact us directly to learn more. With warm wishes to you and your family for the upcoming Holiday Season.

Sincerely,

Frank J. Pazzaglia
 Professor and Chair, EES
 Co-Director, Environmental Initiative

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THIS ISSUE IS DEDICATED TO UNDERGRADUATE RESEARCH IN STEPS



Undergraduate Research

The temperature sensitivity of hydroclimate in Southeastern Alaska: implications for understanding the effects of future climate change

Kevin Barrett, Undergraduate Student

Advisor: Robert Booth

Evidence suggests that warming surface temperatures will lead to changing patterns of precipitation variability, including the intensification and recurrence of drought in some regions. Understanding historical moisture variability is critical for predicting the threat of future drought events. Reliable records of past hydroclimate are lacking from many humid mid-latitude regions, where tree-ring reconstructions of climate variability are limited in sensitivity and age. My research aims to fill one of these critical gaps by reconstructing historical drought variability in southeastern Alaska for the past 3000 years using peatland sediments. The focus of my work will be to reconstruct moisture availability during past periods of known dramatic temperature variability, such as the Medieval Climate Anomaly and the Little Ice Age. Responses of moisture availability to these past changes in temperature will be used to better understand potential future responses of hydrology to ongoing and future warming.

My study site is Fish Creek Bog, which is located outside of Juneau, Alaska, a region where numerous bogs exist and warming temperatures during the past few decades have been particularly dramatic. Bogs are sensitive to moisture variability because the sole water source is from the atmosphere, and they contain a record of past environmental change in the form of waterlogged peat sediments. I will use testate amoebae, a subgroup of moisture-sensitive protozoans that produce decay-resistant shells, to reconstruct the past hydrology of the bog. Modern ecological studies have developed models that allow past water-table depth changes to



Out on the bog (Juneau, Alaska)

be estimated from fossil testate amoeba communities. Radiocarbon dating will be used to develop an age-depth model for the testate amoeba record, so that temporal changes in water-table depth can be reconstructed. The peat record from Fish Creek Bog will be directly compared to the record from another site near Juneau, and proxy temperature records from the region to determine the region's history of moisture variability and assess temperature-moisture relationships.

Undergraduate Research

Provenance of the Perkasio Member Conglomerate in PA-NJ: Implication for a recycled Permian

Kyle Davison, Undergraduate Student

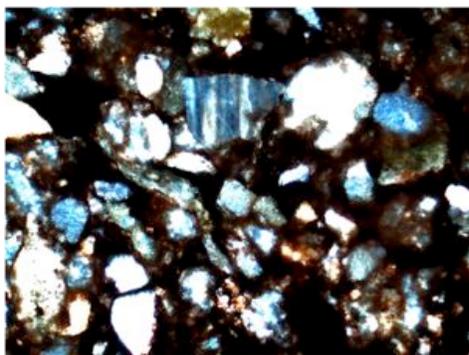
Advisor: Frank Pazzaglia

It has been proposed that the Permian Appalachian Mountains were once the size of the present day Andes. The sediment eroded from these mountains was shed westward into the foreland and constitutes a thick Paleozoic section ending with a coarse, continental Permian molasse. Subsequently, in the late Triassic, rifting led to breakup and opening of the Atlantic Ocean. Sediment from the foreland was recycled back to the east into the rift basins, one of which is the Newark basin that straddles eastern Pennsylvania and New Jersey.

Exposed at Milford, NJ along the Delaware River are coarse conglomerate deposits of variable composition, all contained within the Perkasio Member of the Passaic Formation. Some of these are composed primarily of limestone and granite-clasts the provenance of which matches the adjacent Blue Ridge and Lehigh Valley rocks. However, there are also large volumes of quartzite-clast conglomerates, the provenance of which is enigmatic. My research seeks to understand the origin of these quartzite clast conglomerates and test the hypothesis that they represent recycling of a former, widespread Permian molasse sourced in the Appalachian foreland.



Dipping red strata of the Perkasio Member exposed along the Delaware River north of Milford, NJ.



Petrographic thin section of a sandstone from the Perkasio Member, Milford, NJ.

My analysis involves measuring ~135m of the Milford section in the field and collection of sandstone and gravel throughout for petrographic analysis. The sandstone is subsequently analyzed to determine the light mineral composition using thin sections and heavy mineral composition using an SEM element analyzer. Preliminary results indicate that the conglomerate coarsens up section and the composition of the quartzite clasts changes from gray, to red, to a mixture of gray, red, and limestone and granite clasts. The light mineral fraction shows a more heterolithic assemblage of quartz, feldspar, and lithic fragments at the base of the section in comparison to a more monolithic dominance of quartz up section. Incorporation of the heavy mineral data, now in progress, will be used to determine provenance, weathering/climate conditions during transport and deposition of these conglomerates, and the unroofing sequence of the Newark Basin footwall. I plan to complete this research and present it as a senior thesis at the end of the Spring 2012 semester.

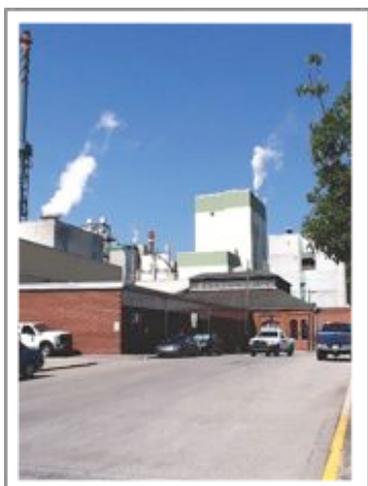
Undergraduate Research

Major Ions within Groundwater and their Relationship to Flow Paths and Lengths through the Geology within Appalachian Basins

Meagan Patrick, Undergraduate Student

Advisor: Steve Peters

Hydrologic and geochemical interactions between groundwater, surface water and strata can give insight into natural and anthropogenic sources of arsenic (As) and chromium (Cr). Coal fired power plants release fly ash, which contaminates nearby streams as seen in Spring Grove, Pennsylvania and Semora, North Carolina. Strata in the area can also affect the water's geochemical signature by adding elements naturally. I have traveled to Spring Grove, Pennsylvania and Semora, North Carolina in which coal fired power plants as well as strata likely contribute to concentrations of arsenic and chromium.



Spring Grove, Pennsylvania



Semora, North Carolina

Strata in the area can also affect the water's geochemical signature by adding elements naturally. I have traveled to Spring Grove, Pennsylvania and Semora, North Carolina in which coal fired power plants as well as strata likely contribute to concentrations of arsenic and chromium.

In this study I have investigated the nature of the arsenic and chromium contaminants. Surface water data collected from streams near Spring Grove and Semora show that both of these contaminants decrease in concentration away from the plants. Water samples also show that As is traveling through water more in dissolved phase. This is significant because it makes the contaminant more available to species than if it were adsorbed onto particles. Cr travels in both phases making it less likely to be ingested.

I will return to both Spring Grove and Semora in order to collect more samples and pursue the preliminary findings. To study the chemistry and inputs of groundwater, I will quantify groundwater flow paths by using Rare Earth Elements (REEs) as a tracer (Johannesson, 1997) and analyzing the concentration of major ions including Ca, Na, Mg, K, Cl, and SO₄. Piper diagrams will then be constructed in order to determine the relative composition of the water samples. This will show signatures of the waters that can then be related to bedrock in the area and will give insight to flow paths through the aquifers. Rock samples will also be analyzed for major ions through acid digestions and will provide further insight into the flow paths.

Undergraduate Research

Determining the Evolution of Sinkholes with the Lehigh Valley

Katherine Spevok, Undergraduate Student

Advisor: David Anastasio

I am investigating the link between Appalachian deformation and ground water flow within the faulted and folded carbonate rocks of the Lehigh Valley in order to gain a better understanding of the sinkholes hazard in this region. When rock deformation and changes in groundwater flow occur together in carbonate-rock terrains the result can impact people and infrastructure through the production of sinkholes. The Lehigh Valley is underlain by carbonate-rock and karst terrain and is highly susceptible to sinkhole development. The geometry and extent of sinkholes and caves is commonly controlled by rock discontinuities, such as bedding, fractures, and faults because they focus the flow of groundwater. Sinkholes develop near the water table as the movement of water along structures causes dissolution and widens the fractures. Within the Lehigh Valley ground water extraction associated with quarrying and increased urbanization drive large fluctuations in the groundwater levels that can flush sediment and enlarge structures that lead to sinkholes.

In order to investigate the deformation I am going into the Kutztown quarry and mapping sinkholes and measuring rock discontinuities. Orientation analysis will determine the relationship between rock fabrics and dissolution in outcrops and in drill cores within and surrounding the quarry. I am also investigating the hydrology around the quarry using historic ground water level data to establish hydraulic conductivity and determine if there are anisotropies in groundwater flow related to bedrock discontinuities. In addition to fieldwork I intend to evaluate a regional LIDAR dataset and to build a GIS coverage of subtle topographic depressions that are associated with sinkholes to evaluate regional trends in sinkhole development. A goal of quantifying the relationship between lithology and rock deformation to sinkholes is to inform a predictive model of where future sinkholes may occur and influence policy decisions.



A clay pocket in the quarry that is evidence of dissolution.

EES Undergraduate Research in Action



(Left) EES undergraduates in the undergraduate ecology class using the binocular microscopes in the new STEPS microscopy teaching lab. TA Travis Andrews (standing) is delivering instructions on microscope use and sample data collection. (Right) EES undergraduate Kyle Davison using the thin-section grinder in the new STEPS Earth materials processing lab



(Left) EES undergraduate Devon Acevedo engaged in her undergraduate research project in the paleoecology lab. (Right) EES TA Matt Bennett running an introductory EES undergraduate lab in the new STEPS multipurpose teaching labs on the 5th floor of the building.



(Left) Meaghan Patrick presents results of her undergraduate research project at the EI-internship colloquium, held in the STEPS concourse in September, 2011.

EES Undergraduate Research in Action



EES undergraduates in the surface processes class at the Ringing Rocks boulder field learning field data collection using a range of high-tech and low-tech devices. Note that the students have orange field transit books and are required to learn how to create and maintain a professional field notebook. The instrument on the tripod is a Sokkia total station that is being used to survey the slope of the boulder field. The instrument in the plastic bag hanging around the neck of the student third from the left is an I-Pad. Increasingly, in courses and during the summer field camp, students are given I-Pads and taught how to use them for real-time GPS-aided mapping and data collection, including annotated photographs.



EES students digging trenches at Island Beach State Park, NJ, during the annual visit to observe and learn about coastal processes.

Faculty Research Highlight

If a lot of trees died in the forest a long time ago, does it matter? Bob Booth argues that it does. Bob, along with his students and collaborators, has been investigating the impact of prolonged droughts on forest and wetland ecosystems in North America.



Bob Booth collecting a peat core from West Virginia in fall of 2011.

Even wet ecosystems can be altered by drought. As part of a recent grant from the National Science Foundation, Bob and one of his PhD students, Alex Ireland, have been examining how prolonged drought affects wetland and aquatic systems. Their work is focused on understanding the history of peatland development within kettlehole ecosystems. They are finding some surprising results. Episodes of peatland expansion in these systems are fast, perhaps within a decade or two, and followed by centuries of relative stasis. Once peatland is established, Bob and Alex predict that a cascade of changes occurs within the ecosystem, influencing species diversity, food-web structure, and biogeochemical processes. Such threshold responses are difficult to predict, and their research is providing a foundation for evaluating the relative sensitivity and vulnerability of ecological systems to future climate change.

Ecological changes of the past clearly do matter. However, not all the forests that Bob studies disappeared long ago. In fact, along with his graduate students and the twenty-six students in his undergraduate ecology class, he has been investigating the outcome of an experiment that was started on Lehigh's own South Mountain a century ago. See the Winter 2012 issue of the Lehigh University Alumni Magazine for the fascinating story of his re-discovery of the Lehigh Arboretum and Experimental Forest Plantation!

Paleoenvironmental archives contain numerous examples of major climatic and ecological changes, and these "natural experiments," can be carefully examined to better understand the causes and long-term ecological implications of extreme climate events. For example, one such natural experiment occurred about 700-years ago. Pollen records from this time indicate that populations of American beech (*Fagus grandifolia*), a characteristic tree species of mesic forests in the northeastern U.S., underwent a rapid decline across a large portion of its range. Coincident with the decline in beech populations, pine and oak species expanded. By using a suite of well-validated tools for vegetation, fire, and climate reconstruction (e.g., pollen, microscopic charcoal, testate amoebae) together at multiple sites, Bob's research group has convincingly demonstrated that a series of multi-decade spanning droughts and wildfires were the primary cause of the dramatic change in forest ecosystems. Drought is not typically viewed as a driver of ecological change in humid portions of North America, but Bob's research is showing that these regions are vulnerable to persistent droughts, severe enough to disrupt forest ecosystems on a regional scale.

Even wet ecosystems can be altered by drought. As part of a recent grant from the National Science Foundation, Bob and one of his



American beech, a late-successional tree species common in north-temperate forests of eastern North America.

Current Graduate Students and their Interests

Leonard Ancuta: My research focuses on understanding how regions of high topography are uplifted in continental interiors. I am studying the Hangay dome in central Mongolia. This broad uplifted dome occupies an area of 200,000^{km}² within the larger Mongolian Plateau. At its interior, the dome is marked by flat-topped peaks over 4000 m. The geology of the Hangay dome is defined by Permian and Jurassic granitoids overlain by sequences of Cenozoic basalts, which were likely erupted coevally with uplift. I am using Ar/Ar geochronology and field relationships of basalts sequences to better understand the timing of widespread volcanism and uplift in the region. I am also using geochemical techniques to determine major- and trace-element and radiogenic isotope compositions (Sr, Nd, Hf, Os, Pb) of the basalts. These geochemical analysis will help elucidate the roll of the mantle in the volcanism. Together these techniques will help me understand when the volcanism occurred and what processes contributed to melt generation; ultimately allowing me to hypothesize what caused the uplift of the Hangay Dome. Advisor: Peter Zeitler

Travis Andrews: The largest ecosystem restoration effort ever attempted, the Comprehensive Everglades Restoration Plan, is currently underway in the Florida Everglades with a central goal of reestablishing pre-drainage (pre-AD 1880) hydrology. I am investigating the ecology of testate amoebae in the Everglades and assessing their potential as paleohydrological indicators, with the goal to use the preserved remains of these organisms to reconstruct pre-drainage hydrology and guide restoration efforts and future water management in the Everglades. Testate amoebae, a group of unicellular organisms, form decay-resistant tests, are preserved in peat, and have been used successfully as hydrological indicators in northern peatlands. However, potential applications in other peatland types, particularly at lower latitudes, has not been well studied. Advisor: Robert Booth

Rachel Baxter: I am studying the effects of sediment loading in mid-sized, mixed-use northeastern streams. I intend to understand suspended sediment provenance and transport in a local stream, Saucon Creek, located in Lehigh and Northampton County, Pennsylvania. First, I am producing a model which correlates turbidity and suspended sediment in order to ultimately calculate suspended sediment flux and transport at particular stream locations during an extended period of time as well as individual flood events. Through a fingerprinting approach, I am using fallout radionuclides ²¹⁰Pb and ¹³⁷Cs to identify the sources of suspended sediment during storm events, in which the two main unconstrained sediment sources in Saucon Creek are (1) the remobilization of legacy sediment and (2) surface sediment. Saucon Creek is listed as an impaired watershed and therefore a TMDL (total maximum daily load) must be performed according to the Clean Water Act. My research will help complete the TMDL and help answer larger watershed management questions. Advisor: Frank Pazzaglia

Matthew Bennett: I am working with old growth forests in Pennsylvania. I am using tree ring records to determine moisture availability in those watersheds. Then using the moisture available for trees to grow, I am developing a stream carbon transport model using Netlogo. This should help determine the carbon transport to neighboring watershed and allow for future modeling efforts to expand the knowledge base of grid to grid communication. Advisor: Frank Pazzaglia

Johanna Blake: I am working towards combining tectonics, geology, geomorphology and geochemistry with regards to arsenic to create a predictive model of arsenic locations. Due to the potential harm of arsenic concentrations above 10 ppb in drinking water, it is important to ascertain source rocks and locations. The Newark Basin, in New Jersey and Pennsylvania, shows elevated levels of arsenic in drinking water in lacustrine and some fluvial lithologies. I suggest that arsenic was deposited in this basin through a process of crustal recycling. Through studying other Mesozoic Rift Basins along the east coast of the United States, I look to show a spatial relationship between crustal recycling, geology, and geochemical processes with regards to arsenic in groundwater. This will ultimately help to find arsenic locations in other areas to avoid high arsenic water for drinking. Advisor: Steve Peters

Lucy Brown: I am using local seismicity to study strain near an actively deforming metamorphic massif within the eastern Himalayan syntaxis. Additionally, I am working on a project that is using the aftershock sequence from the 2010 magnitude 8.8 Maule earthquake in Chile to study the crustal structure in the vicinity where the earthquake occurred. Advisor: Anne Meltzer

Current Graduate Students and their Interests

Christopher Bochicchio: My research is in arctic climatic change over the last 20,000 years, with a particular focus on rapid shifts. I am currently developing high-resolution paleoclimate records from lake sediment cores collected in Alaska over the last two years. My goal is to examine the stability of arctic climate over the last 12,000 as a new phase in earth's orbital cycle began a cooling trend in northern hemisphere summer temperature, by reducing solar energy. Though the decrease in solar energy is constant and gradual, I am looking for evidence that the climate system can readjust rapidly to new environmental conditions in sudden shifts. I am also developing new lab techniques for concentrating pollen from lake sediments and new analytical techniques for global paleoclimate datasets. Advisors: Robert Booth and Zicheng Yu

Jill Burrows: Abandoned mine drainage (AMD) is one of the largest environmental problems facing the recovery of mining impacted environments. Many engineering solutions have been devised to remediate streams including biotic, abiotic, active, and passive systems. Many of these techniques are resource intensive in terms of money, land, and manpower. Once in place, some treatment systems fail to sufficiently decrease the quantity of metals in streams to have any impact on the recovery of waterways. These resource intensive and sometimes unsuccessful methods were created without first thoroughly examining the natural processes in hydrological systems that may have a role in removing Fe such as precipitation rate and stream morphology. I hypothesize that geomorphic and geochemical conditions within streams play an integral role in the precipitation and deposition of Fe from surface waters contaminated by AMD, and will be testing this hypothesis on a variety of natural processes in increasing scales from beakers, to flumes, to natural streams. Advisor: Steve Peters

Michael Clifford: I am studying the geography and timing of past wet/dry periods, focusing on drought events and their ecological impacts by using records obtained from peat bogs found in humid regions of North America that date back 3000 years. The instrumental records of climate are quite short, at about 100 years, and likely do not capture the full range of climatic variability. By using proxy records of climate, we are extending the records of moisture variability at decadal to multi-decadal time scales. Reconstructing the geography of past drought periods of North America will help to elucidate some of the potential linkages, such as ocean and atmospheric influences, which may be associated with drought. I am also examining how these past wet/dry periods influenced the fire dynamics that occurred in pre-settlement forests. Understanding how past moisture fluctuations influenced fire dynamics can lead to better forest management, restoration, and may provide insights into how forest fire dynamics may react to future changes in the moisture regime resulting from global climate change. Advisor: Robert Booth

Nathan Collins: My research focuses on the chemical systematics of metamorphism and its significance within subduction zones. I am examining the carbon isotopic signatures of high- and ultrahigh-pressure mafic/ultramafic suites from the Western Alps and Tianshan Mountains of China. These studies will help to further the understanding of fluid-rock interactions, devolatilization pathways, and carbon cycling into the mantle, mantle wedge, and arc magmas. Advisor: Gray Bebout

Jennie Cook-Kollars: I am studying the changes undergone by sediments during subduction. I am determining the carbon concentrations and isotopic values in marine sediments from a sequence of rocks in Italy that experienced varying degrees of partial subduction before returning to the surface. From these data, I will estimate the amount of carbon that continues into the deep mantle and the amount that is recycled during volcanism. This will contribute to an overall understanding of carbon cycling on the planet. Advisor: Gray Bebout

David Cuomo: I am studying the magnetic properties of sedimentary rocks and working on the development of a relatively new method which uses variations in rock-magnetic properties through sedimentary strata to create time-series that are representative of Earth's past climate. These time-series are used to find periodic changes in the Earth-Sun distance and orientation over time (Milankovitch cycles) and develop high-resolution astrochronologies. Currently I am working on a turbidite system in Spain and black shales from Texas. Advisor: Ken Kodama

Current Graduate Students and their Interests

Chris Dempsey: I am working with Don Morris and Frank Pazzaglia on using Excitation Emission Matrices (EEMs) of dissolved organic carbon (DOC) to determine the source of this organic matter in headwater stream systems. We believe that we can locally calibrate the peaks in EEMs with DOC age and lability. DOC plays a significant role in controlling food chain dynamics in these headwater systems and is understudied in terms of the global carbon cycle. The use of three different land use areas for this project will give us an indication of how watersheds store, process, and transport organic carbon during baseflow and storm event condition. One of these study areas is an old-growth forest site, which may provide insight into how streams functioned prior to large-scale human development. Advisor: Don Morris

Kellen Gunderson: My project documents high-resolution slip histories of two disconnected blind thrust faults in the northern Apennines, Italy to determine (1) if the faults exhibit in-phase unsteady slip behavior and (2) what external factors (if any) influence unsteady slip. The processes responsible for causing unsteady slip behavior on faults are not well understood. One idea is that surface processes modulate unsteady slip on faults. My project is investigating the potential coupling between surface processes and fault slip by documenting fault slip on 10^4 - 10^5 yr time scales, the same scale that surface processes were proved to be unsteady in this region. Advisor: Frank Pazzaglia

Nathan Hopkins: I'm studying surface processes and mechanisms of change in the high arctic using a combination of remote sensing techniques and fieldwork. Through observation and analysis, I hope to shed light on the physical processes of exchange between glacial and proglacial environments and to assess how these processes respond to a changing climate. Our current research area is the Russian arctic archipelago of Severnaya Zemlya, an extremely remote and little explored landscape dominated by several large and highly sensitive ice masses. Advisor: Joan Ramage

Brian Pin-Chin Hsu: I am studying mercury emission mechanism from aquatic system to the atmosphere. Mercury can impair human health through environmental exposure, thus it's important to understand the mercury cycle. By manipulating the light, dissolved organic carbon, halogen, pH, and temperature, I can understand the key factors controlling mercury production under natural conditions and will bridge the gap between the previous researchers' discovery. Advisor: Steve Peters

Stephanie Hunt: High latitude peatlands represent one of the largest biospheric carbon reservoirs, yet the role of peatlands in the global carbon cycle remains intensely debated. My research entails studying peatland carbon and ecosystem dynamics over the past 13,500 years, during which there were a number of well-documented climatic changes. Understanding how peatland ecosystems have responded to past climatic changes in terms of carbon accumulation rates, vegetation changes, and hydrological changes is crucial for understanding how these carbon rich ecosystems might respond to future climatic changes. Using a peat core collected from the Seward Peninsula in Alaska, I am reconstructing carbon accumulation rates, vegetation change, and hydrological changes for the past 13,500 years taking both a regional and local perspective. Advisor: Zicheng Yu

Alex Ireland: I am using glacial kettles in northern Wisconsin and western Pennsylvania as model systems to assess the role of climatic variability in driving abrupt ecosystem state-shifts. I use paleoecological techniques to reconstruct spatiotemporal patterns of peatland encroachment into aquatic portions of kettle basins. Results of this work have linked episodic peatland encroachment events to variability in hydroclimatic conditions. Specifically, severe droughts appear to facilitate peatland invasion of kettle lakes by lowering water levels and exposing substrate for pioneering plant colonization while very little lateral peatland expansion occurs during general moist and climatically stable times. Advisor: Robert Booth

Current Graduate Students and their Interests

Eric Klein: My research involves the study of peatlands, which are among the largest reservoirs of terrestrial carbon (C) in the northern hemisphere. Understanding how this reservoir will respond to climate changes is critical to assessing potential earth-system feedbacks. Specifically, I am studying the response of hydrology and C accumulation of Alaskan peatlands, which make up more than half of the C storage of United States' peatlands, to well-documented climate changes over the past ~1,200 years, such as the Medieval Climate Anomaly and Little Ice Age. I am looking at both regional (i.e., across different Alaskan climate zones) and local (i.e., inter-site variation in potential controls like surficial geology within the same region) scales to understand how these different variables impact peatland response. Results suggest that local controls lead to a heterogeneous peatland response to climate change, even within the same region. However, some northern peatlands could serve as a negative feedback to climate change by sequestering more C as temperatures increase, given sufficient moisture conditions are maintained through hydrological changes. Advisors: Robert Booth and Zicheng Yu

Kristin Lazzeri: My research uses stable isotope geochemistry, mineralogy, and petrology to study the storage of nitrogen in high and low-temperature silicates and glasses. I am investigating part of the nitrogen biogeochemical cycle by determining (1) the extents of the incorporation of nitrogen into high and low-temperature silicates and glasses, as N₂ or as NH₄⁺, (2) whether the isotopic composition of the nitrogen incorporated into these phases can elucidate fluid-rock interactions during their formation, and (3) whether the nitrogen isotope composition of these materials can serve as an indicator of past biological processes. The concentrations and isotopic compositions of N₂ residing in microporous minerals (cyclosilicates, zeolites, and melanophlogite in this study) should reflect nitrogen sources (in many cases ultimately organic), conditions of crystallization, and perhaps fluid-mineral isotopic fractionation. Advisor: Gray Bebout

Julie Loisel: I am interested in high-latitude ecosystem dynamics and their relations to past, present and future climatic changes. The overall goal of my current research is to determine the relative importance of summer temperature and precipitation in controlling peatland carbon dynamics in the climate-sensitive regions of Alaska and southern Patagonia. Peatland ecosystems only occupy 3% of the global land area, but they store about 1/3 of the global soil organic carbon, making them important players in the global carbon cycle. Specifically, my research approach includes (1) quantifying Holocene (past 12 000 years) peat-carbon sequestration rates in these two regions using a network of new peat cores and published datasets, (2) reconstructing past temperature and moisture conditions using new peat-based paleoecological and geochemical analyses, and (3) determining the respective roles of temperature and moisture on peat-Carbon sequestration rates. (https://sites.google.com/a/lehigh.edu/julie_loisel/) Advisor: Zicheng Yu

Erik Mason: I am studying the impacts of past and present climate change on wetlands in Alaska. Using NCAR's Community Earth System Model (CESM), I hope to better understand how orbital parameters during the Early Holocene impacted Alaskan wetlands. Additionally, I will compare these results from the Early Holocene with the present anthropogenic induced CO₂ warming to better understand what the future holds for Alaska's wetlands. Advisor: Ben Felzer

Daniel Minguez: Globally observed excursions of the $\delta^{13}\text{C}$ isotopic anomaly have been interpreted as synchronous and evocative of processes at work on a global scale. One such excursion, the "Shuram" excursion has been observed in Oman, Australia, and California. It is interpreted as a stepwise oxidation of the oceans perhaps following a catastrophic event (global glaciation or bolide impact) and thus a recovery of Earth's marine ecosystem, setting the stage for the Cambrian explosion. However, no confident estimates of time have been proffered for such a recovery, the duration of which is critical to understanding the mechanism by which it happened. To furnish a much-needed high resolution time scale for the "Shuram" excursion, Prof. Ken Kodama and I will employ a magnetic-cyclostratigraphy to rocks in Death Valley, CA containing the event. If successful, we will not only extract a high-resolution (up to ~20ky) time scale, but demonstrate a reliable methodology of extracting high resolution time from rocks nearly 600 my old. Advisor: Ken Kodama

Current Graduate Students and their Interests

Kalin McDannell: I am working with Dr. Peter Zeitler looking at the Hangay Dome in Mongolia to resolve the geodynamics of how this broad, high elevation, low relief intracontinental structure exists and how the continental lithosphere and deeper mantle interact through processes involving uplift and mass transfer in continental interiors. The main question in particular, what is the spatial and temporal evolution of the elevation and landscape of the Hangay? I will be using the low-temperature (U-Th)/He thermochronology of apatite in granitic rocks to constrain the erosional history and place limits on the timing, magnitude, and pattern of any significant exhumation related to the recent (Cenozoic) uplift of the region. Advisor: Peter Zeitler

Ryan McKeon: I am interested in how landscapes evolve, how driving forces of tectonics and erosive processes interact to create the landscapes that we live and play in. For my PhD research here in the Earth and Environmental Sciences Department I am focusing on the Appalachian Mountains, where the current rugged topography we are familiar with bears no spatial or genetic link to past tectonic events. To elucidate the mechanism responsible for the longevity or rejuvenation of this landscape I am working with Dr. Peter Zeitler and Dr. Frank Pazzaglia using low-temperature thermochronology as a means to detect when the current landscape was established. My research suggests that erosion of the Appalachian landscape has been unsteady since the Cretaceous, which corroborates geologic evidence from offshore basins and suggests that our view of the Appalachians being an old and slowly evolving landscape is in need of review. Advisors: Frank Pazzaglia and Peter Zeitler

Jennifer Schmidt: My primary interests are in understanding how mountain belts form and evolve by incorporating field study, geochronology and thermochronology. I am beginning work with Peter Zeitler on a project involving the intercalibration of thermochronometers to better understand their kinetic parameters. Specifically, I am working on K-feldspar $^{40}\text{Ar}/^{39}\text{Ar}$ dating from Little Devil's Postpile in Yosemite National Park. Advisor: Peter Zeitler

Kate Semmens: I study remote sensing of the cryosphere, focusing on detecting snowmelt onset, early melt events, and melt duration via passive microwave sensors for the Yukon River Basin. These data are used to model snowmelt runoff in areas lacking instrumentation. Other research interests include the detection of melt dynamics on icefields, as well as studying the correlation of melt timing and wildfire occurrence and intensity. Advisor: Joan Ramage

Allison Teletzke: My research will document the long-term slip history of a fault in the southwest Spanish Pyrenees. Understanding the timescales on which faults slip has important implications for modeling fault mechanics and evaluating seismic hazards. I plan to model the slip history and determine rates using a paleomagnetic chronology in a section of syntectonic sediments. Last summer I collected samples with David Anastasio, David Cuomo, and two of our Spanish colleagues. I also spent a few weeks working in a paleomagnetic lab at the National Research Center for Human Evolution in Burgos, Spain, and have since been finishing up measurements here at Lehigh. In the end, this study will provide a new age model for the area, and a better understanding of the timescales on which foreland structures deform. Advisor: David Anastasio

Meng Zhao: I am involved in remote sensing of snow and cryosphere. My research focuses on utilizing remotely sensed data to analyze snow melt onset and duration. I am also working on glacierhydrological modelling. I am devoted in analyzing their relationships to climate variables. I mainly use IDL to carry out the research. Advisor: Joan Ramage

EES Field Experiences

Costa Rica

This marks the 14th year that Professors Don Morris and Rick Weisman will be taking students to Costa Rica. In recent years they have been joined by Professor Steve Cutcliffe. Students sometimes refer to the trio as “The 3 Amigos”, no doubt because they are frequently seen roaming the halls of STEPS together in their Mexican caballero outfits!

The Lehigh in Costa Rica program has 2 courses associated with it: EES-42 (The Natural History of Costa Rica) and ES-122 (Sustainable Development: The Costa Rican Experience). Both groups of students travel around Costa Rica together in a 20 passenger “coaster” bus and participate in a variety of adventures centered on natural history and sustainable development. Every year we try to add some new activities and landscapes to our Costa Rican experience. This year we will be bringing students to the Osa Peninsula which has been recognized by the IUCN as a global biodiversity “hotspot”. A biodiversity hotspot (aka Key Biodiversity Area—KBA) is a biogeographic region with a significant reservoir of biodiversity that is under threat from humans. Around the world there are only about 25 areas that qualify under a strict set of criteria. These sites contain nearly 60%



Rhinoceros Beetle (they grow ‘em big in Costa Rica!)

of the world’s plant, bird, mammal, reptile, and amphibian species, with a very high degree of endemism. Because it is recognized as a hotspot, the Osa Peninsula is given a high priority with respect to global-scale conservation efforts and funding. This should be an amazing experience!

This year the program will be in the field from December 26th to January 14th. We are hoping for better weather this year to kick off the trip. Last year’s holiday blizzard made it nearly impossible to escape the Northeast and a number of students were delayed in starting the program. Undergraduates interested in participating in the 2012-2013 program should be aware that scholarships are available and there is a substantial early enrollment discount provided that they register by May 31st. You can contact Prof. Morris or the Study Abroad office in Coxe Hall for more information.

BIOS

Bermuda Institute of Ocean Sciences, “BIOS” (<http://www.bios.edu/>)

The Bermuda Institute of Ocean Sciences (BIOS) hosted several Earth and Environmental Sciences Department people during Summer 2011 through a generous gift from Lehigh alumnus James Stanard ('70). Stanard’s gift supported one EES major (Chase Slavin) and one EES graduate student (Rachel Baxter) to attend the 3-week Microbial Oceanography course during June and July. Chase reported “It was a truly unforgettable experience...students in the program were some of the nicest people that I have ever met...instructors were incredible as well...I probably learned more in this intensive three week course than I would have in an entire semester of lectures”. EES faculty member Bruce Hargreaves (who is serving as the liaison with BIOS) also visited BIOS for 10 days to meet the instructors of the microbial course and the reef ecology course and to explore research opportunities with BIOS scientists (which led to 4 days at sea on the 171-foot RV Atlantic Explorer). We hope that funding for these exciting courses in a subtropical island



venue surrounded by coral reefs and blue ocean will continue to be available in future years. Current funding will support 1-2 additional students for summer 2012 (photos by C. Slavin)



EES Field Experiences

Field Camp 2011

EES successfully completed its 37th field camp campaign in June 2011. The venue was the northern Rocky Mountains with camps and major projects at Pinedale, the Gros Ventre Valley, and Mackay, Idaho. In attendance were 28 students, 10 of whom were from Lehigh, four faculty, and 6 teaching assistants. The 2011 camp was blessed with pleasant weather, excellent staff, engaged students, and not a single flat tire! The snow pack in the Rockies was particularly deep in the spring of 2011 so many rivers and streams were flowing at or near record discharges. This provided an additional opportunity for the students to see the impact of surface processes in action. The 2012 camp will return to the



Rockies with similar numbers of students and staff. We will be inaugurating a new project in southwest Montana that exposes students to mapping in part of the Sevier fold and thrust belt. Student interest in field camp and in Lehigh's camp in particular has been growing as the related issues of energy and environment continue to emerge in the political and economic discussion at the national level. Students perceive that camp is an investment in their professional development, several of whom are pursuing professional licensure. Over the past four years, EES field camp has also been involved in a major educational outreach program financially supported by the gifts of a generous donor. We have successfully integrated middle and high school teachers in the field camp experience so that they can learn the content and then bring it back to their classrooms where they inspire and mentor the next generation of Earth and Environmental Scientists. So far eight teachers have been supported by this program and we hope to continue it for the 2012 camp. As always, camp and students can really benefit from your support directed to the camp or the Vic Johnson scholarship fund. See <http://www.lehigh.edu/~fjp3/fieldcamp/index.html> for more information about the 2012 schedule. All EES alumni are welcome

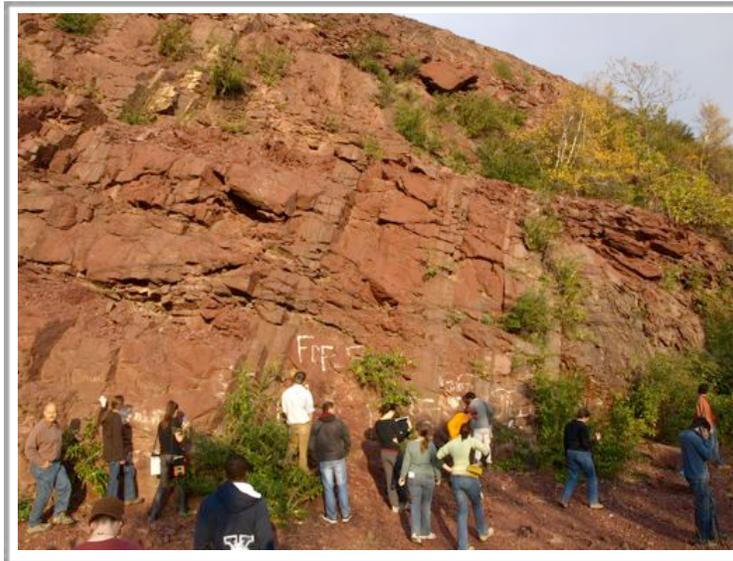
Marcellus Shale Panels

Rapid development of the Marcellus Shale in the Appalachian Basin continues to make news in Pennsylvania and Lehigh University has opened a dialog with the goal of aligning research and scholarship interests with the myriad of resource, technical, environmental, and policy issues that surround the industry. That dialog is facilitated by panel discussions, the first of which was hosted in mid-November and which focused on science and technical topics including fracking. Participating in the November panel was Kristen Carter, M.S. '93, senior geologist for the PA DCNR. The Marcellus Shale gas play will be a part of Pennsylvania's energy portfolio for the foreseeable future and EES will continue to play a leadership role engaged in the unique activities that a University can bring to the discussion, namely education. We are eager to partner with our alumni base in Marcellus educational, research, and scholarship opportunities. Specifically, if there are opportunities for Lehigh graduate and undergraduate students to pursue internships that expose them to the various geologic and geotechnical aspects of shale gas development, we would like to hear about them. Look for the announcements on the Lehigh website for the second panel discussion to be held this spring with a focus on the society, policy, and economics of Marcellus development.

Workshops



In late October, 2011, EES and STEPS hosted a NSF-funded workshop aimed at integrating the EarthScope and GeoPRISMS communities in geologic and geophysical research in eastern North America. These research communities are interested in studying the construction of the Appalachians, rift initiation and evolution, and the modern distribution of earthquakes on the East Coast.



The NSF workshop was preceded by a graduate student colloquium that visited local outcrops, including this excellent one of the Bloomsburg Formation at Lehigh Gap.

Alumni Activity

NASA, SRU's Patrick Burkhart

In June, Patrick Burkhart (Ph.D. Lehigh 1994) now a Slippery Rock University professor of Geology, will land on "Mars." He will step onto a plain of red dust, sand and rock. The only catch is that this "Mars" isn't the fourth planet from the sun, but rather a planetary analogue in the eastern Washington. NASA recruited Burkhart to co-lead a student-research exhibition to the Channeled Scablands where he and a team of 20 undergraduates will study the landscape for similarities to possible landing sites on the real Mars. Pat first visited the Channeled Scablands on an EES field trip lead by Prof. Ed Evenson.



NASA offered Burkhart a consultancy with its Lunar and Planetary Institute Academy, a summer internship program for undergraduate and graduate students. The primary objective of the program is to inspire the next generation of scientists to pursue the technological challenges involved with space exploration. "There are many features on Mars that are similar to where we are going in Washington," and what's really cool is that I am getting a field trip, a stipend and an affiliation with NASA - it's the filet mignon and caviar of opportunities," Burkhart said. Pat has also been working with Ed Evenson and Greg Baker (M.S. Lehigh 1994) in Argentina where they are investigating "Darwin's Boulders" and the glacial history of the southern Andes.

In Memoriam



EES lost a member of its family this past summer with the tragic passing of Kurt Frankel (M.S.'02). Kurt was killed while biking during a vacation in Florida on 02 July, 2011. He was 33 years old. At the time of his passing, Kurt was an Assistant Professor of Geology at Georgia Tech University. During his time at Lehigh Kurt became interested in landscapes and the active tectonic processes that shape them. He was a leader and well-liked among the graduate students, enjoyed all outdoor activities including running, biking, and hiking, was TA for Lehigh Field Camp, and had an infectious smile and deep laugh. He completed his M.S. work on fault-bounded mountain fronts in the southern

and continued to pursue active tectonics and cosmogenic nuclide geochronology research in the western U.S., Turkey, Mongolia, and Italy for his Ph.D. through assistant professorship. His work was making an impact in the geosciences and EES was fortunate enough to have him return as the keynote speaker of the graduate student symposium in February 2011. In addition to his research, Kurt was recognized as an excellent educator, earning a best teacher award at Georgia Tech. Kurt is survived by his wife, Stephanie Briggs, parents Charles '62 and Joanne Frankel, brothers Reed and Todd and their families, and sister Barrett '02. He will be missed by EES, friends, and colleagues who had the honor and pleasure of working with him.

Calendar of Events 2012

- ~ **February 9 & 10** *36th Annual D. Foster Hewett Lecture Series*
Guest lecturers will be, **Hank Frankel** (University of Missouri), **Rob McCaffrey** (Portland State University), **Joann Stock** (Cal Tech), and **Rob Van der Voo** (University of Michigan)

- ~ **February 24** *Grad Student Symposium*

- ~ **May 30 thru July 3** *38th Field Camp*

- ~ **Upcoming Seminars** <http://www.ees.lehigh.edu/EESdocs/seminars.html>
 - January 20 *Adrienne Oakley*, Kutztown University
 - March 16 *John Cottle*, University of California, Santa Barbara
 - March 23 *David Schuster*, University of California, Berkeley
 - April 6 *Ed Rastetter*, Marine Biological Laboratory
 - April 20 *Ron Harris*, Brigham Young University



Let Us Hear From You!

Have you 'checked in' with us lately? We want to hear from EES alum! Please feel free to keep us informed of address changes, and job changes, etc. What have you been doing... what have you done... news that we can share...

And remember to let us know if your mailing and/or e-mail addresses have changed or will be changing.

EES Newsletter
Earth & Environmental Sciences
Lehigh University
1 West Packer Avenue
Bethlehem, PA 18015-3001

Please keep in touch!

Email Laura ljc0@lehigh.edu or Frank fjp3@lehigh.edu or drop us a note!

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: _____

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,
1 W. Packer Ave., Bethlehem, PA 18015-3001