

Terra Firma

FALL 2017 NEWSLETTER

Supporting Science Education in Our Community



Sarah Roberts, a second-year PhD student, had heard of the Planetary Geosciences Institute (PGI) during her short time at UT, but did not really know much about it.

“It wasn’t until Professor Larry Taylor asked me to attend the Tennessee Space Grant Consortium meeting in his place that I learned how much this group does in our community,” Roberts says.

Established in 1993, the goal of PGI is to educate East Tennessee K-12 teachers, students, and the general public about the importance of planetary sciences and engineering. PGI is comprised of EPS faculty, staff, and students, as well as international collaborators.

With funding from the Tennessee Space Grant, PGI provides support for the Space Science outreach program that Paul Lewis, from the UT Department of Physics and Astronomy, runs. Leading up to the total solar eclipse in August, Lewis focused his programming on the exciting and rare event in the East Tennessee area.

“Paul Lewis is an incredibly active man who hosts activities through the year to educate K-12 kids in all things space related,” Roberts says. “Last year he organized visits to schools, civic groups, churches and other organizations, state and national parks, and other public events, which were attended by over 7,500 people.”



PGI also supports The Muse Knoxville, a museum designed to inspire and empower generations at the intersection of science and art. It has Knoxville’s only public access planetarium, and last year, PGI provided funding to upgrade their computer and software systems to accommodate new space programs.

“We also sponsored a team of students from Bearden High School to participate in the Human Exploration River Challenge at the Space and Rocket Center in Huntsville, Alabama,” Roberts says. “In February, we sent 10 students to the Kennedy Space Center to see the launch of their Student Spaceflight Experiments Program project to the International Space Station. The students had the opportunity for a private tour of the Space Center, which Larry Taylor coordinated.”

For over 20 years, PGI has provided support for UT’s Basic Aerospace Education STEM Workshop, which is designed to enable teachers to bring STEM education activities into their classrooms. During the workshop, teachers get to fly with the Tennessee Air National Guard on a refueling mission, fly with the Civil Air Patrol, and build and launch model rockets.

PGI also provided support to the Knoxville K-12 school system to develop their space related curriculum and gave two scholarships to minority students to pursue space-related studies.

“I was not aware that PGI was involved in so many activities happening around me,” Roberts says. “I now realize the importance of educating the public, especially our youth, about space and science in general. Now that I know there are more opportunities for outreach available to me, I want to do more to educate people about science and get them excited about the research I love.”

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MIKE MCKINNEY

Department Head
Earth & Planetary Sciences

A YEAR OF **Transition**

The fall term of 2017 brings new leadership, new faces, and a new building for EPS. I am honored to step into the role of department head – a position Larry McKay served in for eight years. Larry successfully led the department through a period of great change, culminating in our move to Strong Hall. He steps down to focus on teaching and enhancing his hydrology research program. I look forward to working with an outstanding group of faculty, staff, and students.

Our EPS family grew this year. We welcome Nick Dygert, our new petrologist, whose wide-ranging interests include the study of planetary evolution. Iftekhar Alam is our new teaching post-doc. He brings a broad background in geophysics, which he will be teaching in addition to basic introductory classes.

We have also had our share of loss. Sadly, Professor Larry Taylor passed away September 18. Larry was fiercely devoted to this department and a powerful presence. His wit and strong opinions are legendary. As a faculty member for nearly a half century, he mentored many graduate students and was a major factor in the growth of our planetary geology program, now one of the largest in the country. I have admired his generosity and disarming honesty and will miss him greatly, as will many others in our department.

On a happier note, we finally made the move to Strong Hall! Our offices are on the top three floors and have a terrific view of campus, the Sunsphere, and other downtown vistas. The move, however, was not easy. It's amazing how much "stuff" accumulates in a geology department over the course of many decades.

Of course, not everything has changed. Melody Branch, our business manager who keeps the department functioning, celebrated her 40th year at UT. We continue to have a strong undergraduate program with a geology track led by Colin Sumrall and an environmental studies track led by Drew Steen. Our graduate program continues to attract high-quality students with diverse interests from cave snails to asteroids.

In the spring, we are honored to host the regional meeting of the Southeast Geological Society of America, which has kept several of our faculty busy with organizing symposia and field trips. We hope to see quite a few alumni at the meeting. Speaking of alumni, we now have our strongest advisory board ever, thanks to the hard work of Professor Larry McKay and alumni leaders including Tom Cronin ('80, '83) and Mike Allison ('84).

Please stay in touch. Please drop me, or your former mentors or professors, an email. We'd love to learn what you are up to today!

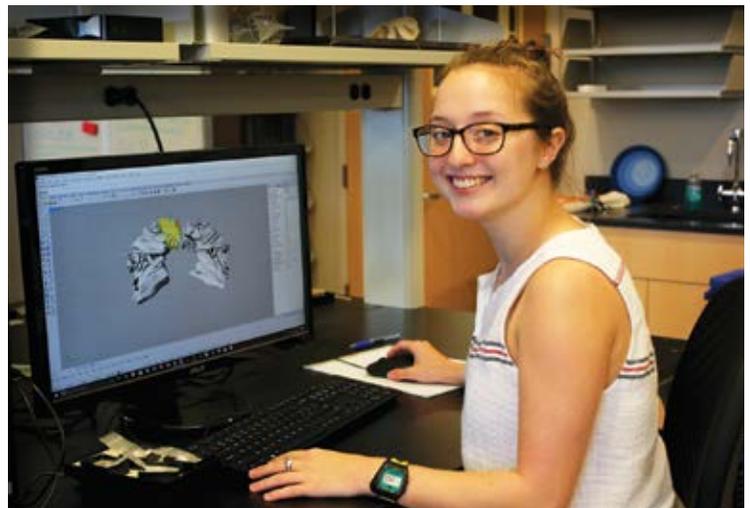
All the best,
Mike McKinney

Internal Morphology of Extinct Echinoderms

Logan Qualls is an enthusiastic senior with a keen analytical mind. She has participated in independent research projects in paleontology and geochemistry and for the past two and a half years, she has conducted research with graduate student Jennifer Bauer. Her research objective is to digitally reconstruct the internal respiratory structures of blastoids, which possess complex fold-like respiratory structures that are not well understood. The external expression of these structures provide the basis for taxonomic classification.

In order to recreate these structures, Logan created 3-D models that can be digitally manipulated to examine otherwise small, overlooked morphological details.

Logan presented the most recent models at the 2017 GSA Southeastern section meeting. Results imply that the evolutionary history of this extinct group is better



understood with the incorporation of internal morphological data. Additionally, these anatomical models can aid in efforts to further analyze phylogenetic relationships and to simulate functional morphology. Logan and Jennifer are preparing the project for publication submission in early spring.



Studying Cave-Obligate Land Snails

Nick Gladstone is interested in land snails, which are instrumental as indicators in soil and groundwater contamination monitoring programs.

Cave-obligate species should likewise provide valuable information on the health, conservation, and management of caves and other subterranean ecosystems. A major problem regarding the utilization of these organisms, however, is researchers hypothesize that many morphologically identical species, particularly in subterranean environments, consist of multiple, unrecognized cryptic species. The misidentification of species can have significant impacts on biodiversity assessments and subsequent conservation management. Further, although morphologically identical, these cryptic species can differ in their environmental tolerances and genetic plasticity leading to the misdiagnosis of environmental impacts on these fauna.

Using modern molecular techniques, the goal of Nick's research is to conduct the first phylogeographic study of cave-obligate land snails in North America to better understand their phylogenetic relationships, species boundaries, and biogeography. This research will not only advance our understanding of taxonomy within the genus *Helicodiscus*, but will provide a platform for future phylogeographic studies of this and other cave-obligate land snail genera.

Preservation of Proterozoic Microbial Mats

As a chemical sedimentologist, **Ashley Berg** is interested in understanding ancient oceans and ecosystems, particularly during the Mesoproterozoic Era. Primary and early diagenetic minerals, such as carbonate, chert, and evaporite minerals, are capable of preserving their original chemistry and can provide information used to infer the chemical composition and redox state of the oceans. These mineral phases also commonly preserve organic matter, or precursors of organic matter, which can provide information about the microbial community and the metabolisms present at the time of lithification, providing insight into what the ecosystem and biosphere were like at the time of deposition.



Ashley investigates the potential for peritidal chert to preserve ancient depositional environments. Throughout the Meso- and Neoproterozoic, chert deposits in these environments precipitated during early diagenesis from seawater enriched in dissolved silica and record textural evidence of mineral precursors and microfossils.

In an effort to understand the origin of these chert deposits, Ashley used a geochemical model to determine which mineral phases were capable of precipitating from Proterozoic seawater. The results of the model agree with previously published hypotheses that silica gel may be responsible for the preservation of the exceptional microfossils. The model also implies that primary carbonate and silica phases are capable of precipitating from the same fluid, which matches the fabrics observed in thin section.

Ashley is also performing a taphonomic assessment of the mat fabrics and individual microfossil morphology to describe the preserved complexity of the microbial mats. It will also help to identify processes that occurred prior to and potentially because of silicification, exquisitely preserved the morphology of these microbial mats and may indicate that these samples are good candidates for the preservation of organic geochemical preservation.

Oxidative Processes on Earth and Mars



Terrestrial analogs provide a means to understand processes that once occurred on other planets, such as Mars. Graduate student **Jessica Ende** uses Iceland as a terrestrial analog for sulfate formation on Mars, a process that is poorly understood.

High concentrations of sulfur, mainly in the form of sulfate, have been found on the Martian surface. The mechanism by which reduced sulfur was oxidized to sulfate, however, is unknown. One hypothesized location for sulfate formation on Mars is volcanic hydrothermal systems.

To better understand how sulfate formed in terrestrial hydrothermal systems, Jessica collected water, sediment, and gas samples from mud pots, hot springs, and fumaroles in northern and southern Iceland during the summer of 2016 for geochemical and isotopic analyses. Ultimately, the results of this work will be used to make implications about the geochemistry of past hydrothermal systems and test the validity of hydrothermally produced sulfate on Mars.

In addition to field work, Jessica uses laboratory experiments to understand the kinetics of reduced sulfur oxidation, a process that is not currently quantified or well understood. The results of this work will provide much needed information on the rate of reaction of hydrogen sulfide oxidation. Collectively, Jessica's work will provide insight into oxidative processes on both Earth and Mars.

IN OTHER NEWS

We have a [LinkedIn](#) page - **University of Tennessee Earth and Planetary Science Alumni** - which will serve as a forum and point of contact for EPS students and alumni. *Please consider joining!*

Five graduate students attended the annual AAPG meeting in Houston. We hosted an alumni/student mixer, and two EPS students landed internships while networking at the convention.



Investigating Planetary Interior and Crust Evolution

NICHOLAS DYGERT, new assistant professor, grew up in Washington State and gained an appreciation for the natural sciences backpacking and climbing in the Cascades and Olympics. His research focuses on improving our understanding of the processes that shape the evolution of planetary interiors and crusts, and their expression in the rock record.

Nicholas' interest in geology started at the University of Rochester when he participated in field research on the Bolivian Altiplano, the largest high-altitude plateau outside Tibet. The team crisscrossed the plateau and its foothills collecting fossils and surface waters with a goal of understanding when and how quickly the Altiplano rose to its present day altitude of 11-13,000 feet. Off track in the middle of nowhere, the research team came across a compelling and unstudied crater that, according to local legend, was formed by meteorite impact. Fascinated, Nicholas returned to the site the following year to sample and map, which ultimately developed into an honors thesis. The excitement of conducting independent exploratory field research in a remote high altitude environment hooked Nicholas on geology for good. He hopes to motivate UT undergraduates by facilitating their own inspirational research experiences.

After spending two years in industry, Nicholas enrolled in the geology PhD program at Brown University, where he studied the physicochemical evolution of the lunar and terrestrial models. Nicholas arrived in Tennessee after finishing up a departmental postdoctoral fellowship at the Jackson School of Geosciences at the University of Texas at Austin, where he focused on numerical modeling and synchrotron-based experimental techniques. He is building a lab where he will run experiments at pressure-temperature conditions ranging from those in Earth's middle crust up to those in Earth's upper mantle. His lab, coupled with the one atmospheric gas-mixing lab Molly McCanta is building, will make UT a powerhouse in experimental petrology.



Adding up the Miles for Research

Whether it is keeping track of her bird life-list, national parks visited, or research miles traveled, Professor **ANNETTE ENGEL** loves counting things. She is fascinated with geochemical and biological processes that occur in the dark, not only in caves, but also hidden inside animals or buried within marine sediment.

With research grants from NSF, the Cave Conservancy Foundation, the Gulf of Mexico Research Initiative, and the NOAA Restore Act program, Engel has spent an average of 50 to 100 days in the field each year in caves or dynamic coastal marine systems. She logged over 7,000 miles in vehicles in 2016 and nearly 5,000 miles in 2015.

This year has been a big travel year for Engel, who was the closing plenary conference speaker at the International Society for Aquatic Microbial Ecology meeting in Zagreb, Croatia. She will speak about the importance of exploration as a plenary speaker at the International Society for Subsurface Microbiology meeting in Rotorua, New Zealand. In Sydney, Australia, at the International Congress of Speleology meeting, she spoke about cave research findings from Tennessee, Kentucky, and Israel.

Engel did not do all of this research alone. Students also logged many of these hours and miles. Their dissertation and thesis topics spanned the study of organic matter cycling in cave and groundwater ecosystems to the effects of oil on coastal marsh ecosystems, the microbial role in bone diagenesis, and chemosymbiosis between marine clams and bacteria. Undergraduate students have also been involved, traveling to Kentucky or throughout Tennessee to conduct various cave projects, or traveling to San Salvador and the Bahamas as part of a class on field methods in coastal environments.



A Diamond in the Rough: Remembering Larry Taylor

Professor Lawrence A. Taylor passed away September 18, just after his 79th birthday and following his recent retirement after 46 years of service on the UT faculty. Larry was founder and director of the Planetary Geosciences Institute and was named a University Distinguished Professor in 2004.

He was a consummate scientist and indisputably the department's most prolific faculty member ever, with a staggering 542 publications in peer-reviewed scientific journals. Much of his research focused on the petrology and magmatic evolution of the Moon, stemming from his involvement with the Apollo program early in his career. Major contributions include the discovery of the oldest mare basalts and the role of liquid immiscibility in the lunar magma ocean. He also made significant contributions to the evaluation and use of resources on the Moon and Mars. He held six patents for engineering processes such as microwave paving of roads using lunar regolith. His terrestrial research also helped elucidate the nature and composition of the Earth's mantle by studying rocks formed at great depths and the diamonds that they carry. Much of that work was done in collaboration with Russian colleagues, analyzing kimberlites to which no other Americans had access. His research garnered recognition from all over the world.

Larry taught numerous geology courses and introduced generations of students to his favorite

research instrument, the electron microprobe. He directed seven master's and eight PhD students and supervised 41 postdoctoral associates. He was UT's point man for the Tennessee Space Grant Consortium and did lots of outreach for the public and local schools. Larry was always an aggressive proponent for the department. It is a much stronger program because of his many contributions. The electron probe laboratory in our new building will be named in memory of Professor Taylor, and his generous contribution has also funded the Larry Taylor Professorship.

His long-time colleague Hap McSween remembers Larry as being like what he studied – a diamond in the rough.

“Like a diamond brought to the Earth's surface, he was never really in equilibrium with his surroundings,” McSween says. “He was forged under harsh conditions – he relished telling of being raised as a child in a neighborhood bar. He was hard – on his students and postdocs, on his friends, on department heads. He was uncut, never subtle, but his honest clarity sparkled. Despite his flaws, which all diamonds have, he was nearly indestructible, almost to the end.”

Larry, and his wife Dawn, had a constant presence in the department that will surely be missed.

SE GSA Comes to Knoxville

The UT Department of Earth and Planetary Sciences will host the Southeast Section meeting of the Geological Society of America April 12-13, 2018, at the Knoxville Convention Center. Linda Kah, Annette Engel, Colin Sumrall, and Bob Hatcher are part of the committee planning the programs and field trips and have done a fantastic job soliciting proposals for topical sessions, symposia, and field excursions that will make this meeting one for the record books.

Theme sessions range from seismic hazards and chemostratigraphy to tectonics and planetary geology. Field trips associated with the meeting include trips to look at various tectonic settings, Ordovician stratigraphy, and more. The keynote speaker is Robert Hazen, senior staff scientist at the Carnegie Institution's Geophysical Laboratory and Clarence Robinson Professor of Earth Sciences at George Mason University.

Two symposia will honor the career of UT faculty.

“Longstanding Problems and New Ideas About the Structure and Tectonic Evolution of the Southern Appalachians and Other Mountain Belts” will honor the career of Robert D. Hatcher Jr., and “From Diamonds to the Moon: Advances in the Understanding of Planet Formation” will honor the career of Lawrence August Taylor. The Flynn Creek Crater field trip will also be in Taylor's honor.

Alumni and friends are invited to attend the symposia and an evening visit to tour the new Strong Hall facility. This will be a great opportunity to see our new setting as we look to the future to advance our teaching and scientific endeavors. Learn more at tiny.utk.edu/SE-GSA.

Alumni Spotlight

Wesley Diehl Honored for Professional Achievement

Wesley Diehl ('82) received the College of Arts and Sciences Alumni Professional Achievement Award during the alumni awards luncheon September 22. Diehl earned his MS in geoscience and wrote his thesis on the depositional environments and paleoecology of carbonate rocks in the Ordovician Martinsburg Formation.

Diehl went to work for Exxon immediately after he defended his thesis and started out mapping and drilling oil well prospects. He arrived at Exxon just before the oil crash of the mid-1980s and worked his way up through the highly competitive organization.

"A highlight was drilling a 4,500 barrel a day oil well in South Florida," he says about that period of his career. "That was exciting."

In 2007, he was promoted to senior geologic advisor, overseeing 50 operations geologists across 17 cities in developing some of the company's largest international oil and gas reservoirs in an efficient and environmentally safe manner. During that time, ExxonMobil drilled several successful world-class prospects in Russia, Nigeria, and Ghana. He retired in 2016 after 34 years in the oil and gas industry.



Diehl credits his time at UT with providing him with the strong fundamental geologic skills that paved the way for his future career.

"Working on my thesis allowed me to analyze mounds of data and come up with multiple viable interpretations," he says. "Most importantly, it allowed me to be able to communicate those interpretations to my committee."

Until his retirement, Diehl returned to the university annually to recruit students, often giving departmental presentations on career opportunities in the oil and gas. In 2011, Diehl and his wife Cindy established a Faculty Achievement Award fund, which provides support for the department's most highly productive faculty members.

Strong Hall Fund Exceeds Expectations

Thanks to the support of our alumni and friends, we met our goal of raising \$1M for the Strong Hall Fund!



Major donors received recognition through naming of classrooms and labs. The two largest lecture halls are named after **Professor Jimmy Walls**, who taught at UT for 47 years. The "soft rock" teaching lab and the undergraduate teaming rooms are named after alumnus **Bill Ross** ('60). The microprobe lab was named in memory of **Professor Larry Taylor**. Other named rooms include **Roger** ('72, '75) and **Bev Bohanan** Microscope Teaching Laboratory and the **Kula Misra** Conference Room. We're planning to continue the Strong Hall campaign and hope to have additional gifts and named rooms.

Alumni donors and award recipients of all kinds will be recognized in a display planned for the reception area in front of the department office. Visit eps.utk.edu to find out more about the Strong Hall Fund and our grand opening in Strong Hall.

From all of us in the department, **thank you for your support!**

Transforming the EPS Advisory Board



Our advisory board has made great strides in the past two years. Members of the board wrote a Charter, which defines its structure and goals. They set up an Advisory Board Fund, which can be used to support initiatives to help students and faculty. There are currently 18 members on the board. They meet (in-person or online) twice a year. Overall, this is probably the most active board in the history of our department.

Visit the EPS website to learn more about the new and exciting direction our advisory board has planned for the future!

**DEPARTMENT OF EARTH
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GIVING OPPORTUNITIES

Your contributions, no matter what size, play a critical role in supporting academic achievement and research by students and faculty.

Will you help us meet our goal?

STRONG HALL FUND We've achieved our initial goal of \$1M in gift commitments, but there is still a need to increase the size of the fund, which supports fellowships, travel, equipment, etc.

HARRY Y. McSWEEN RESEARCH FUND Former students and colleagues of Emeritus Prof. Hap McSween are encouraged to donate to this fund. It will be used for awards to support student and faculty research projects.

If you would like more information about any of these funds or would like to discuss a major gift or bequest, please contact Professor Larry McKay, at lmckay@utk.edu or 865-974-7782 or Deloris Mabins, College Development, at dmabinsa@utk.edu or 865-974-3816. Donations can be mailed to EPS, with check payable to the UT Foundation, or can be made online at eps.utk.edu under the heading of "Give to Earth and Planetary Sciences."



Your gift counts more than ever! We sincerely thank the many alumni and friends who so generously support the Department of Earth and Planetary Sciences.

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