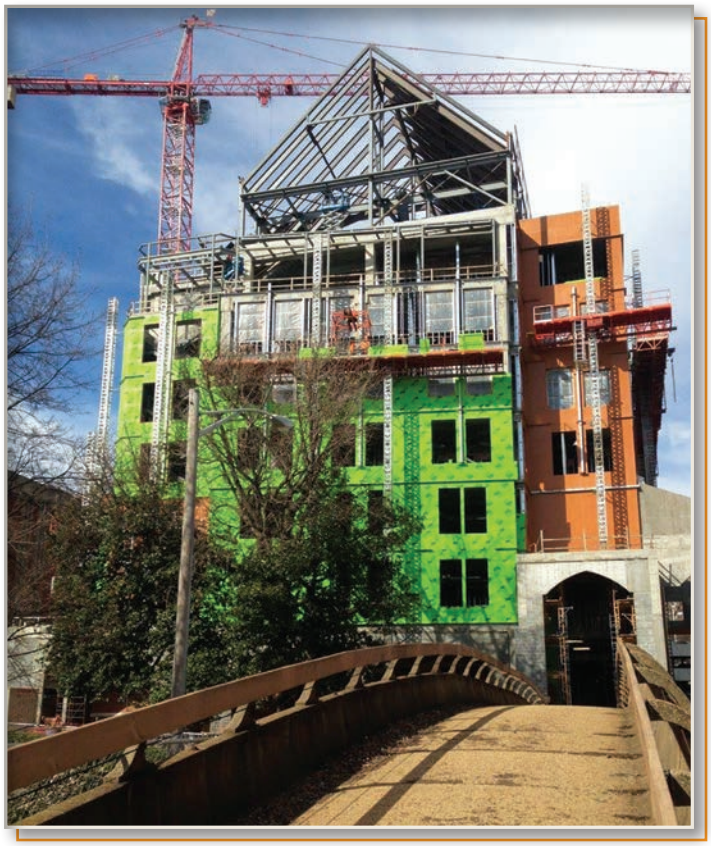
EARTH & PLANETARY SCIENCES

Terra Firma

FALL 2016 NEWSLETTER



Growing Stronger by the Year

It's been an exciting year at the University of Tennessee!

There is a frenzy of activity across campus with many new construction projects, including Strong Hall (our new home), the Mossman biology building, the new University Center, a parking garage, several dormitories, and lots of landscaping. Our campus looks better than ever, which helps make it a great place to study and teach.

I'm very excited about moving into our new space in Strong Hall next summer. The building will contain all of the Department of Earth and Planetary Sciences, along with the Department of Anthropology, and some teaching labs for chemistry and biology. I toured the building a few weeks ago, and it's very impressive. Our students and faculty will have the use of state-of-the-art teaching and research facilities, with plenty of space for growth. I'm looking forward to our grand opening next fall (date to be announced later). I hope lots of alumni will be able to join us.

It's also been a great year for students and faculty. We have 140 undergraduate majors, split equally between geology and environmental studies. We have 45 graduate students, with about a third in the master's program and two-thirds working on a PhD. Our students are winning lots of awards and having success in the job market, including receiving tenure-track appointments at major universities, such as Arizona State University.

Our faculty members have also been highly productive, with lots of grants and awards, including Josh Emery and Linda Kah, who received Chancellor's Awards for research, Annette Engel being elected to the Explorer's Club, and Anna Szynklewicz receiving the Oak Ridge Associated Universities Ralph E. Powe Award. We've had some major changes in the faculty, with the retirement of Hap McSween this past summer, the retirement of Larry Taylor next summer, and the hiring of a new planetary petrologist, Molly McCanta.

I'm pleased to say that we've also had great support from our alumni and friends. The Strong Hall fund is almost two-thirds of the way to our goal of $1 million in gifts or bequest commitments. I hope we'll reach our goal for this important departmental support fund before our grand opening next fall. We've also received several major gifts from one of our faculty, Larry and Dawn Taylor, who created the Lawrence A. Taylor Professorship in Planetary Geosciences. This was awarded to Associate Professor Josh Emery, who is rapidly becoming one of the world's leading experts in the origin and geologic properties of asteroids and comets.

It's great to work with such dedicated faculty and devoted students!

-**Larry McKay**, Department Head

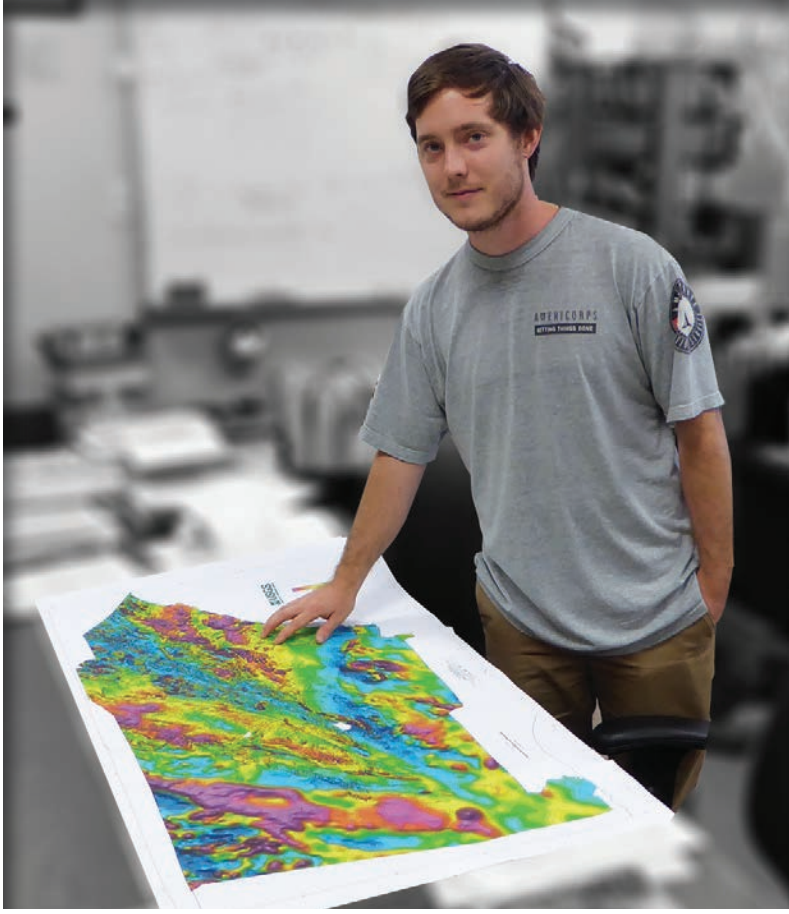
what's inside:

UNDERGRADUATE
student features

UNDERSTANDING MESOZOIC FAULTS

Aaron Stubblefield is an inquisitive senior who finds creative ways to engage in research. While working on an independent research project, Stubblefield impressed Associate Professor Micah Jessup with his detailed microstructural investigation of mean kinematic vorticity using samples from the Cordillera Blanca Peru. Using Mathmatica, he found creative ways to plot his data and received an honorable mention award in the physical sciences category for his EUReCA poster in spring 2016, which showed the results from his research project.

Stubblefield didn't slow down over the summer. Instead, he worked with Robert Hatcher, distinguished scientist and professor of structural geology and tectonics, on a senior research project interpreting the aeromagnetic data of structures beneath the Coastal Plain in South Carolina. From his images, he has restored a left-lateral fault in the area that overprints a large system of late Paleozoic right-lateral faults. This got Stubblefield wondering if there were similar faults elsewhere in the eastern United States. He hypothesized that the fault may be part of a system of early Mesozoic left-lateral strike-slip faults that formed prior to the breakup of supercontinent Pangea and opening of the Atlantic. Stubblefield co-authored a paper with Hatcher and two USGS scientists and presented it at the latest GSA annual meeting in Denver in September, which is quite a high honor for an undergraduate student.



TAGGING THE ASIAN CLAM

The Asian clam was introduced in the United States in the 1930s and is now the most widespread non-native bivalve mollusk in North America. Its expansion impacts native bivalves in several ways, including competing for resources and disturbing natural habitats. However, surprisingly little is known about the way it populates areas and the rate at which it accomplishes its takeover. Tommy Cianciolo, a senior in the Department of Earth and Planetary Sciences, developed a project using passive induced transponders (PIT) tags to measure the rate and direction of movement of the Asian clam in two of Knoxville's urban streams: Pistol Creek and Beaver Creek.

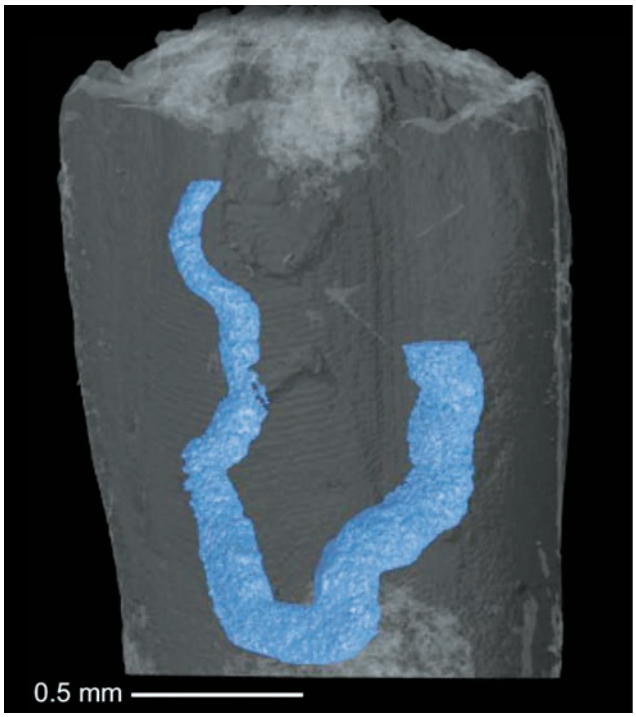
Because of its extremely high population densities and water filtration rates, the Asian clam has greatly altered water regimes in many watersheds, causing drastic ecological impacts and resulting in millions of dollars of economic harm. Through his research, Cianciolo hopes to have a better understanding of how this invasive clam gets around, specifically how fast individuals move up and down streams and waterways. Unlike native mussels, the Asian clam does not use fish as larva hosts. Instead, they rely on passive dispersal. Cianciolo's study will also provide key information about the use PIT tags, influence of tag size, and recovery rates, which can help inform future studies of non-native species and their effect on native ecosystems.

FILTER FEEDERS IN THE HOLSTON RIVER

Freshwater mussels are a viable and practical method of ascertaining the health of a body of water. Due to their ability to filter feed, these creatures are one of the prime species most directly affected by changes, either chemical or physical, in a given water system. Located just northeast of Knoxville, the Holston River is recognized as a waterway readily dealing with effects of agricultural runoff, excess amounts of *E. coli*, the presence of mercury, habitat alteration, and siltation. Among these previously documented anthropogenic effects is the possible effect the Cherokee Dam has had on the local waterway since its construction in 1941.

Ashley Slater, a graduate student studying hydrology and environmental geology, is interested in understanding these possible anthropogenic effects have in relation to time and is looking to freshwater mussels to give her the answers by determining the age of the mussels in Holston River. In order to analyze the growth rings of seven different species of mussels, Slater processed acetate peels, a thin slice in the shell, of each specimen collected. She will be able to separate the growth rings of each species into individual years and use these for subsequent analysis in relation to historical trends in water quality. Slater's analysis will primarily focus on the possible ecological effects of the dam and subsequent anthropogenic factors listed in the Clean Water Act under section 303(d), which requires states to submit lists of waters too polluted or otherwise degraded to meet water quality standards.

Photo taken by Todd Amacker during a field excursion in search of mussels.



EXPLORING EXTINCT ECHINODERMS

Jen Bauer, a graduate student with an interest in paleontology, traveled to the Paul Scherrer Institut in Villigen, Switzerland, to work on a collaborative echinoderm project with Colin Sumrall, assistant professor of paleobiology at UT, and European colleagues using the Swiss Light Source (SLS), which produces photon beams of high brightness. X-ray techniques (CT scanning, synchrotron imaging, MRI) provide an output image that shows differences in density between fossil matrix material. The team's primary objective was to visualize the internal anatomy of extinct echinoderms. Because these animals secrete a calcite skeleton, attempts to visualize the internal structures become very difficult due to the minor difference in density. Images produced by the SLS also allow for the reconstruction of a high-resolution external model of the specimen as well. The team was allotted 72 hours of time on the beamline and imaged approximately 85 echinoderm specimens. The SLS allows for propagation-based phase-contrast synchrotron radiation X-ray tomographic microscopy, which is a technique capable of distinguishing fine density differences that are unattainable from other non-destructive imaging techniques.

Fascination with Himalaya Continues to Build

Micah Jessup, Associate Professor

Since his first trip to the Himalaya, Micah Jessup's fascination with the processes of mountain building continues to motivate him as he enters his 10th year at the University of Tennessee. Jessup is an associate professor in the Department of Earth and Planetary Sciences. His field-and laboratory-based research interests integrate structural geology, metamorphic petrology, geochronology, and geochemistry. Jessup's current research group has two main foci: deformation and metamorphism of the middle crust within the Himalaya, as well as faulting and fluids in the Peruvian Andes.

Over the summer, Jessup enjoyed his 11th research expedition to the Himalaya. Ongoing convergence between India and Asia maintains the highest mountain range in the world. Rocks exposed in the Himalaya can test the timing and conditions of metamorphism and deformation in convergent orogens. An NSF grant to collect samples in the northwest Indian Himalaya and southern Tibet funded two PhD students, Tim Diedesch ('16) and Jackie Langille ('12), and one MS student, Kyle White ('14).

Jessup's research interest in the Peruvian Andes is founded on three research expeditions. The Cordillera Blanca is bounded by an active normal fault that is exhuming rocks in the highest elevation in the Peruvian Andes. Rocks were exhumed in the last five million years. These record processes at different temperatures and differential stress can be used to estimate the conditions of deformation. PhD candidate Cam Hughes joined two research trips to Peru to begin her NSF-funded project. Hughes and Jessup mentored several undergraduate students, including Aaron Stubblefield and Tami Banks, using rocks from this range. Spring water issuing out of the detachment was collected with a collaborator, Dennis Newell at Utah State University, which became the foundation for Jessup's most recent NSF grant on fluids and faulting in this area of flat-slab subduction.

A faculty-development leave for the spring 2016 gave Jessup the opportunity to explore some new research interests. Hosted by Professor Mike Searle, Jessup was a visiting professor in the Department of Earth Sciences at the University of Oxford. Daily interactions with faculty, graduate students, and post docs invigorated him, and he gave two seminars: one on the Himalayas and one on the Andes.

An invitation be a guest lecture for a field trip to northwest Scotland gave Jessup the opportunity to see one of the birthplaces of thrust faulting on outcrops standing tall above endless bogs. Funding from his Sickafoose faculty achievement award helped make this trip possible. Jessup appreciates the opportunity to focus on research during his faculty development leave and looks forward to exploring these new research ideas with a fresh perspective.

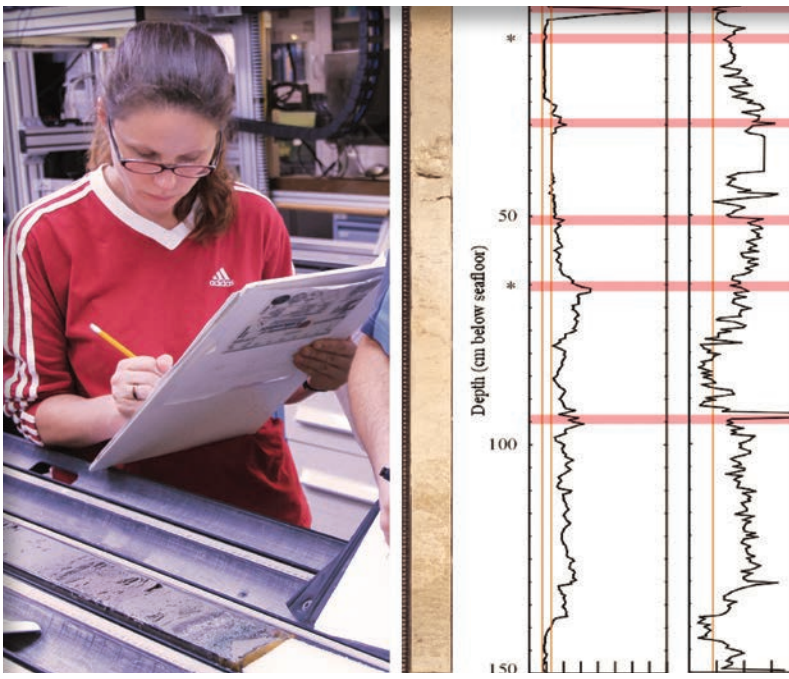
Finally, Jessup is excited to report that all of his former graduate students are employed:

- Tim Diedesch ('16) teaches at Georgia Southern.
- Jackie Langille ('12) is an assistant professor at UNC, Asheville.
- Kyle White ('14) is employed at an environmental consulting company in California.
- Remy Leger ('13) and Ching Tu ('08) both work for Schlumberger.
- Donnie Hicks ('13) is an environmental scientist in New York.
- Liz Lee ('11) remains in her position with ExxonMobil.

New Faculty, New Lab Provide New Research Opportunities

Molly McCanta, associate professor of petrology and planetary geoscience, is the newest addition to the Department of Earth and Planetary Sciences. She is excited to be starting at UT and looks forward to the move into Strong Hall next summer, which will allow her to build a lab to the specifications she needs as an experimental igneous petrologist.

Using a new 1-atmosphere gas mixing lab, McCanta will be able to investigate the partitioning behavior of different trace elements (e.g., P, Fe3+, Cr, V) in melts and minerals under different conditions. This information helps constrain conditions that rocks experienced during crystallization. Along with her colleagues, McCanta is working on calibrating analytical techniques to measure some of these elements in situ, allowing for data resolution that is currently unavailable. They have begun applying the new calibrations to materials from mid-ocean ridges to the Moon.



Left: JOIDES Resolution logging the core as it came up. Right: One section of core from off the coast of Montserrat with the tephra identification spectral parameters plotted along core. Red bars identify cryptotephra layers.

McCanta is also setting up a visible/shortwave infrared spectrometer to search for volcanic tephra layers in deep sea sediments to identify cryptotephra layers (layers that are not visible to the naked eye). This work is a continuation of work from an Integrated Ocean Drilling Program (IODP) expedition she took to the Lesser Antilles in 2012. The cores they collected are the deepest in the region by over 100 meters and expand the record of subduction back nearly 4.5 million years. The data mined from the tephras in these cores is used to inform more accurate hazard assessments for residents of the region and to provide a better understanding of arc processes.

Hap McSween Retires

In July 2016, Chancellor's Professor **Hap McSween** retired after 39 years of service to the department and UT. During his long career he taught petrology to hundreds of undergraduate geology majors and numerous graduate students. He also mentored the research of 26 master's students, 20 PhD students, and 16 postdocs.

Additionally, McSween served as department head and interim Dean of the College of Arts and Sciences, positions he occupied twice over his career at UT.

For the early part of his career, Professor McSween's two-pronged research included igneous and metamorphic rocks of the Southern Appalachians and meteorites. During the last several decades, he focused on meteorites and planetary exploration. He was a participant on an Antarctic expedition to collect meteorites. McSween has been a co-investigator on four Mars spacecraft missions and an asteroid orbiter mission. The research efforts of McSween and his group have been recognized by prominent awards from the Meteoritical Society, the American Geophysical Union, and the National Academy of Sciences, as well as by UT's President's Award, Chancellor's Medal, and selection as Macebearer. He was also named the Southeastern Conference Universities Professor of the Year in 2013. He recently completed a term as the elected president of the Geological Society of America, the first planetary geologist to hold that position. In 2016, McSween received the Chancellor's Medallion.

In retirement, Hap expects to continue to be involved as a planetary researcher and NASA advisor. He also plans to write several books.

UT Husband-Wife Alumni Solve Two-Body Problem, Among Others

For the first time in four and a half years, alumni Craig Hardgrove ('11) and Cara Thompson ('11) live in the same city, which solves the infamous two-body problem that often comes up when spouses are both in academia.

Hardgrove and Thompson, who received PhDs in 2011 from UT's Department of Earth and Planetary Sciences, both went to SUNY Stony Brook University in New York for their postdoc work. Craig, whose background is in geology and physics, studied planetary remote sensing with an emphasis on understanding volatiles in terrestrial planets. Cara started her NSF postdoctoral fellowship and continued to study Ordovician oceans, which was her focus while in graduate school. She used a new technique called boron-isotopes to help constrain changes in the pH during Ordovician climate change.

The duo traveled from New York to California after finishing up their postdoc work in 2012. Craig took a position as assistant staff scientist at Malin Space Science Systems in San Diego where he worked operations for the Curiosity Rover color cameras. Cara joined the Earth Science Department at Santa Monica College and was awarded tenure in June 2016 after four years of teaching.

As part of the NewSpace Initiative, Craig established partnerships with several small commercial space businesses to develop new types of planetary instrumentation for NASA. He leveraged those relationships and partnered with several companies to propose a new type of a small spacecraft mission to NASA, which was selected for flight. Craig now serves as the principal investigator for the Lunar Polar Hydrogen Mapper (LunaH-Map) mission to map hydrogen within permanently shadowed craters at the Moon's south pole using a tiny spacecraft, instrument, and propulsion system, which are all packaged into a craft the size of a shoebox.

In January of 2016, Craig became assistant professor in the School of Earth and Space Exploration at Arizona State University, (ASU), and in August, Cara started as an assistant clinical professor at ASU West.

Both Craig and Cara credit their experiences at UT for helping to prepare them for the paths they are on.

> "One of the most important elements of my graduate education at UT was becoming familiar with the NASA proposal process," said Craig, who received the 2015 Young Alumni Award. "I was able to contribute and write several NASA proposals and won a graduate fellowship, which supported my research for last several years of my dissertation work."

Cara credits her career preparation at UT to the combination of working in labs, conducting field work, opportunities to present at professional conferences, and her dissertation advisor, Linda Kah, professor, UT Department of Earth and Planetary Sciences.

"These experiences provided me with the grit I needed to work through challenges, as well as memorable experiences I can share with my students," said Cara. "One of the most valuable skills I acquired as a graduate student at UT was writing. Thanks to Kah's guidance and editing during my dissertation, my writing improved immensely."

Thanks to the opportunities they had as graduate students at UT, Craig and Cara are forging their paths at ASU and laying the foundation to provide knowledge and guidance for students into the future.

Alumni Spotlight

Mineral Named after UT Alumna Julie Paque

Having a mineral named after you is a very rare honor.

A newly described mineral, paqueite (a calcium-titanium-aluminum silicate), owes its name to Julie Paque (BS '79). In 1984, Paque first chemically analyzed this phase in a refractory inclusion in the Allende meteorite. This very large, carbonaceous chondritic meteorite fell in Mexico in 1969 and has been extensively studied thanks in part to the timing of its fall with relation to the launch of the Apollo space program and associated laboratories.

While Paque's chemical analysis set the grain apart, a new mineral cannot be officially named until both its composition and crystal structure are determined. At the time, the grain was simply too small for X-ray analysis using the available techniques.

Major advances in chemical and structural analysis of minerals have occurred over the intervening years. In 2007, Chi Ma, a senior staff scientist at Caltech and director of the Division of Geological and Planetary Sciences, started turning these nanomineralogical methods to Allende samples. His research uses electron backscatter diffraction on the scanning electron microscope to determine the structure of minerals. To date, he and his colleagues have characterized 15 new minerals in the Allende meteorite alone. While formally describing these new minerals, Ma chose the name paqueite, in honor of its initial discoverer and Caltech colleague, Julie Paque.

Paque, a research scientist at Caltech, is studying trace elements in melilite in Ca-Al-rich inclusions from the Leoville meteorite and the size distribution and rimming characteristics of chondrules from a wide variety of unequilibrated meteorites.

Field Trips, Seminars, and UT Student Support

This year, members of the Knoxville Gem and Mineral Society (KGMS) traveled to Georgia in search of trilobites, agates, and kyanite; to North Carolina to find corundum; and to various localities in Tennessee for plant fossils, wavellite, geodes, and crinoid stems. Ties between KGMS and UT run deep, with students and faculty members and volunteers participating in events ranging from research presentations and field trips to the organization's annual Knoxville Gem, Mineral, and Jewelry Show. At the end of every spring semester, representatives from the KGMS present UT students in the Department of Earth and Planetary Sciences with scholarships. And rock hammers.

KGMS is a nonprofit, educational, and scientific organization. Members have a diverse educational and vocational background, but all share a love of collecting and examining minerals, rocks, and fossils. The group is active in philanthropy as well, providing scholarships through UT, but also ETSU and the Southern Appalachian Science and Engineering Fair for grade school students.

KGMS always welcomes new members, volunteers, and seminar presenters. Learn more at their webpage : **knoxrocks.org**.

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Giving Opportunities

We rely on the generous financial support of our alumni and friends. 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? *Contributions can help us support:*

STRONG HALL FUND We're two-thirds of the way to achieving a goal of $1M in gift commitments for this general purpose fund, which is used for 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 Larry McKay, EPS Head, at lmckay@utk.edu or 865-974-5498 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 & Planetary Sciences. Gifts can be designated to the fund you prefer and will be most gratefully received.

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