EARTH & PLANETARY SCIENCES

Terra Firma

FALL 2020 NEWSLETTER

Responding to COVID-19

Last spring was a whirlwind for EPS instructors, especially among undergraduate courses. The decision to keep students off campus after spring break was wise, but it came with uncertainty regarding exactly how we would make the shift to online course delivery. We did it through a mix of recorded and synchronous online lectures, demonstrations, and labs via Zoom, and heavy use Canvas to deliver quizzes, exams, and content in order to limp out of the semester.

In early summer, it was clear the novel coronavirus was not going to disappear by the fall semester, so we got to work early to prepare. We learned in spring that online and hybrid (part online, part in-person) teaching formats needed more work and careful planning if they were to be successful and achieve our learning goals. University administrators were engaged in a massive planning effort of their own as they attempted to prepare for the safe return of residential students in fall. If EPS intended to offer courses, it required that we fully understood the rapidly evolving landscape of policies and procedures meant to keep all Vols safe.

One of the university's strategies that played a role in EPS course planning was to identify the top-15-credit-hour courses first year students took and focus on getting those instructors and courses in shape to teach in online or hybrid modes with technologies that were unfamiliar to many. The First Year Course Academy was an online "boot camp" for UT instructors to get them up to speed with available online educational technology. Jake Benner, senior lecturer, participated on behalf of Geology 101 and received access to third-party educational consultants that assisted in the development of a new online version of the course. He shared resources with other instructors, which allowed them to take special care in developing communications, plans, and pacing to ease these students into this very different semester.

In our 100-level courses, we made the decision to take all lab exercises online. Several GTAs and instructors took advantage of the wealth of 3D models available through Sketchfab and Gigapan and made a massive effort to scan our own objects for use in our courses. To connect students more directly with rocks and minerals in 101, we made more than 450 lab kit boxes that contained a full suite of minerals, rocks, testing equipment, and a few other items that students will use to complete the labs during their synchronous Zoom times. GTAs and instructors worked tirelessly to create the kits and get them distributed to students prior to the beginning of the rock labs.

Upper division courses took a varied approach to teaching during COVID. In paleobiology courses, we either digitized specimens or located 3D models to fulfill all of the requirements of those labs. In other courses it was impractical to transition to digital format, and so are working in a fully face-to-face (F2F) teaching mode with students spaced widely in the teaching room, with full personal protective equipment, using assigned microscopes and seats for the whole semester. Instructors record all lectures in case a student needed to view them from quarantine. Other courses are simulcast with half of the students in the classroom and the other half watching live on Zoom, which enables the students to distance themselves appropriately while maintaining the personal connection we seek to create in the classroom.

Each professor, instructor, and teaching assistant put in a monumental effort to prepare for all the possible interactions among students in order to mitigate the spread of the virus. Now the focus is on implementing our strategies in the classroom and re-training students to the "new normal" of office hours on Zoom, exams administered remotely, and wearing those masks at all times!

what's inside:

A Look Back at Departmental Developments

Message from Ed Perfect, Interim Department Head

ED PERFECT

Greetings! I hope this newsletter finds you and your family healthy and continuing to thrive, despite the uncertainty of the global pandemic. I am writing this message as the department's new leader. Mike McKinney, who guided the department for the past three years, stepped down in May of this year. I am getting ready to retire, but have agreed to lead the department on a temporary basis, while we conduct an external search for a new head who can provide longer-term leadership. In his time as head, Mike made some positive and lasting changes to our culture and administrative structure, including a renewed emphasis on excellence in undergraduate teaching, the inclusion of input from senior faculty in the annual evaluation process, and the establishment of a diversity council.

The past academic year had some significant developments for the department. In addition to the change in leadership, we approved a new strategic plan and successfully navigated the first few months of the COVID-19 pandemic. The strategic plan, which outlines our vision for the department over the next five years, represents the output of a group effort conducted throughout the fall 2019 semester. The complete plan is posted on our website if you would like read it in detail. The plan calls for an aggressive hiring strategy to increase our tenure-line faculty (currently at 13, which is considerably lower than a high of 18 in fall 2014). It also calls for significant efforts to increase departmental diversity and inclusion, which was further emphasized by the killing of George Floyd in May. In response to that terrible event, the department came together and wrote a powerful diversity statement, which you can read on our website at eps.utk.edu.

Of course, the other major development was when COVID-19 necessitated us switching from in person classes to finishing up the semester fully online. It was quite an adjustment, but I am proud of our faculty and students for making the best out it. Online teaching continued into the summer, and we had to offer a special online course to enable several of our geology majors to graduate when their field camps were cancelled due to the virus. The summer also ushered in another new phenomenon: virtual thesis and dissertation defenses.

Finally, we had our first virtual alumni advisory board meeting over Zoom. Through all of this, the advisory board have been extremely generous with their time and gifts to EPS. Members of the board stepped in at short notice to make emergency financial support available to some of our undergraduate and graduate students impacted by the pandemic.

Please stay in touch and feel free to send any of us an email. We all really enjoy staying connected with our graduates.

Best wishes to you and your families,
Ed Perfect

FACULTY SPOTLIGHTS

Bradley Thomson, a new assistant professor in EPS, originally hails from California. Part of his family moved to the west coast during the Gold Rush era, so an interest in geology is baked into his DNA. His research focuses on planetary surface processes and geomorphology, specifically on understanding the nature and timing of processes that have shaped the surfaces of the terrestrial planets (Mercury, Venus, Earth, Moon, and Mars). His past work includes Mars landing site studies and radar characterization of lunar permanently shadowed regions.

These shadowed regions near the lunar poles are cold in addition to being dark, and they remain targets of high exploration interest as well as scientific interest as they likely host the largest, most easily accessible deposits of water-ice outside of Earth's gravity well.

Prior to joining the UT family, Thomson has held research appointments at a number of institutions, including as a member of the NASA postdoctoral program at the Jet Propulsion Lab, as a senior staff scientist at the Johns Hopkins University Applied Physics Lab, and as research faculty at Boston University.

"I am honored to transition to a new role as an assistant professor," Thomson said. "The fact that 'Planetary' is in the name of our department affirms that for Vols, one planet is not enough."

Thomson continues to participate in active planetary missions. He is a co-investigator on the mini-RF radar instrument on the lunar reconnaissance orbiter (LRO). He was renewed for an additional four years as a co-I starting in 2020 as part of LRO's fourth extended science mission.

Thomson and his wife, EPS Associate Professor Molly McCanta, live with their two kids and two cats in the Fourth and Gill neighborhood of Knoxville.

Estifanos Haile joined UT as a postdoctoral teaching associate in fall 2019. He was excited to teach GEOL 103: Earth's Environments and GEOL 485: Hydrogeology during the fall semester. He was also thrilled to be able to put together new material for the course GEOL 466: Water and Air Pollution, which was offered for the first time in the 2020 spring semester. Teaching courses at the 100- and 400-level has allowed him to see the growth in students taking courses in the department from eager first-years to skilled upper-class students ready to embark on their next challenge.

Haile completed his undergraduate degree in geology from Addis Ababa University in Ethiopia, his MS in hydrogeology from the Royal Institute of Technology in Sweden, and his PhD in geology from the University of Kentucky. His research interests include characterization of hydrogeologic frameworks (hydrostratigraphy, structural features, and hydraulic properties), delineating groundwater flow systems, and groundwater-surface water interactions through field data collection, interpretation and numerical modeling.

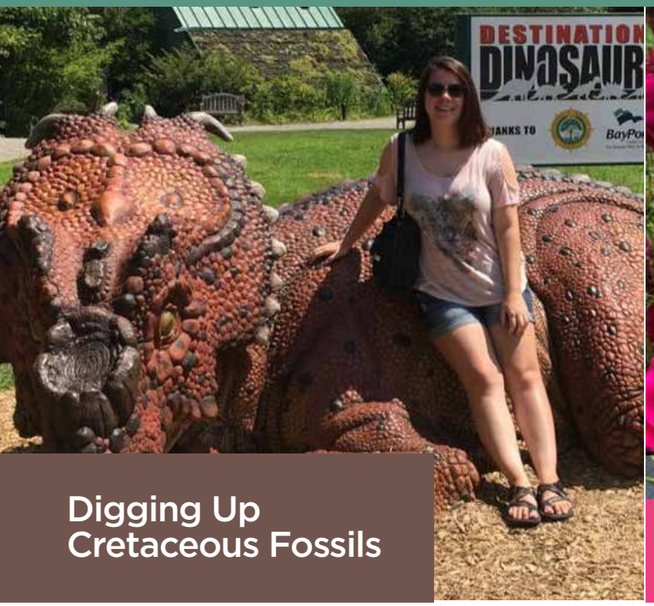
Iftekhar Alam is an applied geophysicist, with a primary focus on engineering, environmental, forensic, and exploration fields of studies. Alam has been using a range of geophysical tools to understand the material physical, mechanical, and electrical properties. For these applications, he focuses on seismic, ground penetrating radar (GPR), and resistivity methods. Currently, he is working on three active projects, which include the field applications of GPR and seismic modeling.

He is working with Joanne Devlin and Giovanna Vidoli at the UT Forensic Anthropology Center (FAC) to develop an effective GPR approach to detect buried clandestine bodies, a project two of his former students, James Atkins and William Piwonka, worked on before they graduated. As part of this program, Alam helps FAC with GPR data analysis and modeling to consult Tennessee Bureau of Investigation. He participates in a training session as an instructor for the FBI evidence recovery team two times a year.

Alam is also working on seismic velocity modeling to estimate rock/soil mechanical properties using medium velocities derived from surface seismic data, which is not always possible to replicate the exact field scenarios in lab experiments.

"This is the most informative among all the physical properties," Alam said. "One of the main challenges in geophysical modeling using field data is noise quantification and finding a threshold between noisy and interpretable data for modeling. I am working on developing a series of synthetic seismic models to replicate field scenarios as closely as possible and its corresponding resolution to accurately interpret anomalies to determine the degree of heterogeneity."

Alam has also started to look at some lunar penetrating radar data from the Chang'E-3 lunar exploration mission. His initial goal is to develop some migrated models to interpret structural features then to perform a full waveform inversion for improved imaging.

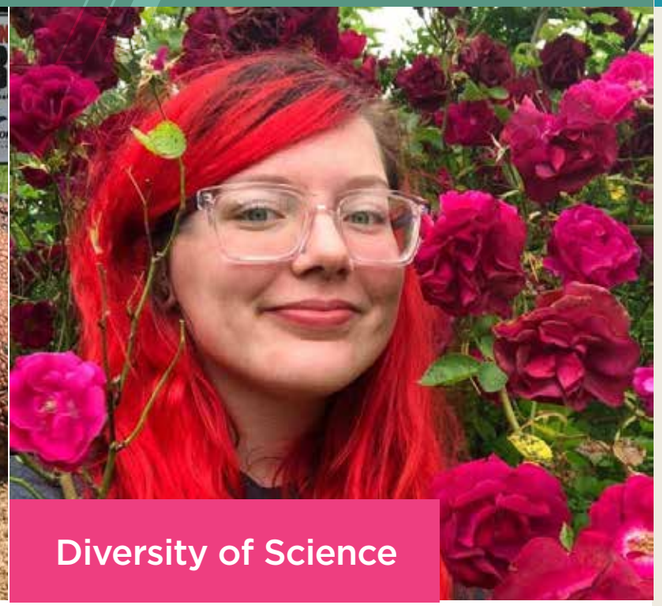


Digging Up Cretaceous Fossils

The Arlington Archosaur Site in Dallas-Fort Worth is a treasure trove of middle Cretaceous fossils, which fill in a key gap in our knowledge of North American biodiversity. The materials, however, provide paleontologists with a challenge. The low energy waters of the ancient deltaic system disarticulated any skeletons deposited there, which jumbled bones from different animals together and spread elements from single individuals far and wide. Piecing together these hundreds of intermixed puzzles can be long, arduous work, but so far, Stephanie Drumheller-Horton and a team of researchers have identified multiple taxa from the site, including two new species of crocodile relatives: *Deltasuchus* and *Scolomastax*.

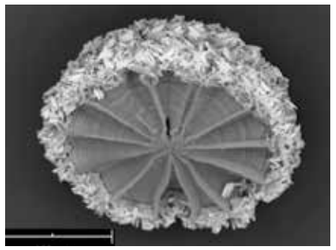
To reconstruct these specimens, Drumheller-Horton recruited undergraduate **Hannah Maddox**, who is a major in the Department of Ecology and Evolutionary Biology and a minor in EPS, to generate three dimensional models of each element and assemble those models into more complete reconstructions. Using the department's 3D surface scanners and the computer program Blender, Maddox pieced together skulls of a large adult *Deltasuchus* and a nearly complete sub-adult. These models provided evidence that the snout shape of these croc-relatives changed with growth and development, a pattern seen in modern crocodylians and one that also tracks shifts in diet from juveniles to adult apex predators.

Maddox will be presenting the results of this study as an online poster at the Society of Vertebrate Paleontology's virtual annual meeting. She is a coauthor on another SVP abstract, exploring where *Deltasuchus* fits in the crocodyliform tree of life, and on a manuscript describing the entire *Deltasuchus* project, which is currently undergoing peer review.



Diversity of Science

One of the best things about our department is the diversity of our science. **Maggie Hinkston**, an undergraduate student majoring in physics and astronomy, with a minor in biology, is participating in undergraduate research in EPS. Hinkston shares a story familiar to many of us in the earth and planetary sciences. Her love of math and physics brought her to her major at UT, but as she became more familiar with the idea of astrobiology—the search for potential life elsewhere in the universe—she wanted to learn more.



Hinkston is now deep into her new research, which involves better understanding of the process of biomorph formation. Biomorphs are mineralized features that form abiotically, but which can easily be mistaken for biogenic structures. In the world of astrobiology, understanding the conditions under which biomorphs form is critically important. Imagine receiving images from a remote lander on a different planet and seeing structures that had similarities to what you might see when visiting Yellowstone and observing microbial structures mineralized by hot spring fluids. Imagine the difference in headlines: "Life on Mars!" vs "Minerals on Mars."

At Eureka, UT's undergraduate research competition in April, Hinkston showed the morphology of biomorphs could change dramatically depending on the pH of the starting solution. Hinkston is continuing her work this fall as she starts her hunt for graduate programs in astrobiology.

Reconstructing History

Tennessee's climate is changing, with average annual rainfall increasing annually by five percent from the first half of the 20th century. Increases in annual precipitation, more severe extreme precipitation events, and more urbanization has led to flooding becoming more severe in Tennessee. Catastrophic floods cause major economic losses, loss of human lives, and greatly impact our society. One of the main uncertainties in flood risk control and management is the lack of long-term records to estimate the stage of extreme floods with high return periods. In addition, not all river basins have instrumentation to measure flood stage levels. Paleoflood hydrology uses geological, geomorphological, hydrological, and botanical evidence to reconstruct past flooding frequency and magnitude before human observation. Working with Larry McKay from EPS and Sally Horn from geography, docoral student **Paula Perilla-Castillo** is using sedimentary sequences from cut bank soil profiles located in the Tennessee River on the Chickamauga Reservoir to reconstruct the paleofloods that occurred during the past 6,000 years.

Surveying the Tennessee River by boat, Perilla-Castillo found evidence of past flood regimes as alternating layers of granular sediments overlying buried soils in cut banks, which are evidence of periods of stability in between major flood regimes. Paleoflood deposits can provide information on depositional environment, increases in depositional energy, and history of the development of floodplains. Perilla-Castillo collected soil samples to perform multiple analyses to determine the suitability of cut banks to help reconstruct the flooding history of the Tennessee River. The results of the analyses show clear evidence of paleofloods and paleosols deposits, which make cut bank soil profiles important repositories of information that can help to reconstruct the flooding history of the river.

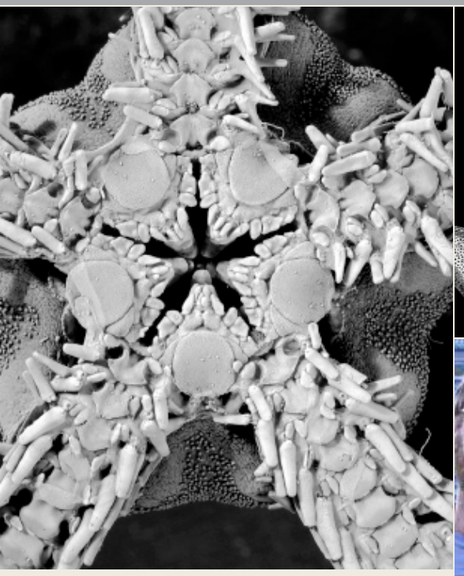
Understanding the Surface of Venus

The surface of Venus is quite different from Earth, with temperatures near 500°C, atmospheric pressure of 90 bars, and atmospheric composition predominantly CO_2. Under conditions that foreign, it is likely that geomaterials behave in a different manner than that observed on Earth. Working with Professor Molly McCanta and scientists at Johnson Space Center, **Hannah Teffeteller**, who recently defended her master's thesis, has been studying these alteration pathways in basaltic glasses experimentally produced under Venus conditions.

High resolution analytical techniques, including transmission electron microscopy and Rutherford backscatter spectroscopy, have shown that glass is rapidly altered via cation migration on timescales of hundreds of years suggesting that, unless recently erupted, the volcanic surface of Venus is likely to have been significantly compositionally altered. Several recent studies have suggested that current volcanic activity may be present on Venus and this study presents one way to assess that hypothesis. With several Venus missions proposed for future flight, it is imperative that our understanding of the planet's surface is complete to ensure that returned data can be placed in the proper context.

To read more about student spotlights from EPS, please visit us online at **eps.utk.edu/newsletter**.

FACULTY RESEARCH



Understanding the Diversity of Fossil Echinoderms

Colin Sumrall and his lab group continue to work on understanding the diversity of fossil echinoderms in the Paleozoic. His student, Maggie Limbeck, has been working on how the morphology of an echinoderm group called paracrinoids changed throughout their evolutionary history. Last fall, Limbeck accompanied him to the European Echinoderm Conference in Moscow, Russia, to present her research and participated in a field trip to the classic Ordovician sections near St. Petersburg.

Two of his students, Aidan Sweeney and Timothy Paton, have been working on various groups of early stemmed echinoderms. Sweeney has been investigating functional morphology in the stem of a group of mobile echinoderms called glyptocystitoids. Her work involves understanding how the construction of these fossils facilitates flexibility and using these parameters to test the feasibility of proposed life postures in a simulated flow tank. Paton has been investigating the evolutionary history and biogeography of two closely related groups called hemicosmitoids and coronoids. These groups show unusual patterns of diversity between localities in North America, Europe, and Africa.

Nick Smith has begun a project to understand the diversity of brittle stars through time. These animals readily fall apart upon death and making it difficult to document their presence. Initial work shows that they are much more diverse than previously thought and has extended the range of several brittle star groups up and down section. Ryan Roney finished his work on Cretaceous sea urchins from South America while employed as the curator of geology at the Tellus Museum of Natural History in Cartersville, Georgia. His work is expanding our understanding of these animals in areas of the world where they are poorly documented.

There have been some amazing ranged extensions in the past two decades, where major groups were thought to have gone extinct only to be discovered at a single locality, sometimes a hundred million years later with nothing in between. Sumrall has been looking at the record of disarticulated echinoderm skeletal elements collected from shale washings to search for this missing record. Initial work has been very promising with the discovery that edrioasteroids, brittle stars, and sea cucumber fossils are relatively common in the Mississippian and Pennsylvanian, even though articulated specimens are few and far between.

Researching Water Activity on the Continental Crust

As a geologist specializing in stable isotope geochemistry, **Anna Szynkiewicz** research focus is on surface processes related to water activity on the continental crust. She uses a variety of chemical and isotope tracers to understand how water interacts with and moves through rocks, how much dissolution takes place, and from where pollutants in rivers and groundwater are sourced. This allows Szynkiewicz to determine and quantify the relationships between water chemistry (quality) and climate, as well as to elucidate human impact on water. Results of her research projects have led to understanding the extent of acid rain impact in mountain catchments of Eastern Europe, sources of salinity in American Southwest and coastal aquifers of northern Mexico, and sources of methane in hydraulically fractured areas of Central Appalachia. Conceptual models resulting from this work, such as those exploring the origin of water salinity in southern New Mexico and west Texas, are helpful in implementing effective strategies to combat decreasing water quality resulting from global warming and increases of land use for agriculture, particularly in semi-arid region.

Using her research experience from studying hydrological and geochemical processes on Earth, Szynkiewicz also formulates research questions related to the origin of sulfur-bearing minerals in extraterrestrial environments, specifically on Mars. These minerals provide a gateway for understanding water history and the potential for life. She also works to determine whether imprints of life—and its interaction with the sulfur system—are preserved in these rocks and how we could find *life signature* with instruments sent to Mars.

Investigating the Evolution & Behavior of Archosaurs

Stephanie Drumheller-Horton is a vertebrate paleontologist who has taught in the department since 2013. This fall, she joins EPS on a full time basis to continue teaching undergraduate courses. Her ongoing research centers on the evolution, ecology, and behavior of archosaurs (birds, crocodiles, and everything in between, including dinosaurs, though she typically leans more croc and less bird). She is particularly interested in how bone surface modifications can inform these questions, placing much of her research under the umbrella of taphonomy. Her most recent research has ranged from helping identify new species of crocodiles from the famous hominin-bearing sites of Kenya and Ethiopia, to exploring the effects of ontogeny on diet in crocodile-relatives from Texas, to describing the oldest evidence for cannibalism in theropod dinosaurs from Colorado.

She is also working on an NSF-funded project to generate physical and virtual geoscience lesson kits and distribute them at little to no cost to area K-12 teachers in partnership with the McClung Museum and the Knox County Public Library System, a project that has only become more topical during the COVID-19 outbreak.

An Appreciation for Trace Fossils

Jake Benner joined EPS in fall 2018 from Tufts University in the Boston area where he worked for 16 years as a lecturer in earth and ocean sciences. In 2019, Benner was promoted to senior lecturer at UT. His responsibilities in EPS are to teach 100-level courses (including 101, 102, and 103); to coordinate lab-teaching activities across the 100-levels; and to train and supervise graduate teaching assistants. He serves on the EPS Undergraduate Program Committee and the University Natural Science General Education Committee.

He likes to stay plugged-in to happenings in GEO-ed by actively participating in NAGT activities whenever possible. Benner's scientific interests lie in fossil behavior, or trace fossils, an appreciation he honed with Tony Ekdale at the University of Utah, where he obtained his master's degree. He has published in that field on fossils from Ordovician, Carboniferous, Mesozoic, and Quaternary marine, lacustrine, and terrestrial paleoenvironments over the years, mostly with the assistance of undergraduate students. Of great interest is an exquisite Pennsylvanian trace fossil Lagerstätte left behind in Massachusetts on which he plans to resume work when the time is available. Benner hopes he will find sites of interest a little closer to his new home as he gets to know the surroundings

Inspiring the Next Generation of Scientists & Engineers

Robert Jacobsen wears many hats in the department and around the university. As a post-doctoral research associate in EPS, he teaches at the introductory-level and assists the Tennessee Space Grant Consortium. This semester, Jacobsen is teaching Exploring the Planets. In this course, students learn to use Earth's geology to understand the geology of our solar system.

"Students wonder at the biggest of space, as well as their smallness," Jacobsen said. "I'm grateful to play a role in these learning experiences."

Teaching in EPS is complemented by his work in the university's office of Teaching & Learning Innovation where he specializes in evidence-based teaching practices in STEM and leads programs for graduate students and postdocs. The goal is to help participants become more authentic and effective instructors. Finally, the Tennessee Space Grant Consortium exists to support STEM learning opportunities at UT and in the community. Each year, he coordinates funding for undergraduate research, which was exactly how Jacobsen got involved in geology. In the community, he meets with STEM education leaders to identify resources needed to inspire the next generation of scientists and engineers.

EPS ADVISORY BOARD UPDATE

Our EPS Advisory Board continues to grow and thrive. Members provided scholarship and emergency funds to many EPS students during the first half of 2020, about a third of which were awarded to six students (undergraduate and graduate) who qualified for emergency hardship awards due to COVID-19 complications (lost jobs, being furloughed, etc.). Many thanks to those in EPS who recognized the need for a second round of awards, and to those who made additional contributions to the Advisory Board Scholarship Fund!

Read more updates from our advisory board online at **tiny.utk.edu/eps-advisory2020**.

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GIVING OPPORTUNITIES

We rely on the generous financial support of our alumni and friends. Your contributions, no matter what the size, are essential to the vitality and financial security of the department.

This year we are asking for contributions to the Earth and Planetary Sciences Enrichment Fund, specifically to assist undergraduate and graduate students experiencing financial hardships and/or delays in their programs due to the ongoing COVID-19 pandemic. Your gifts to this fund will be used to provide financial support to our students in the form of emergency stipends.

Donations can be mailed to EPS, with check payable to the UT Foundation. You can also donate online at eps.utk.edu.

Have you ever thought about setting up a departmental endowment? It is easier than you might think. An endowment is a gift with earnings that go to support students, faculty or programmatic activities as designated by the donor.

If you would like to discuss setting up a departmental endowment, please contact Professor Edmund Perfect, at eperfect@utk.edu or 865-974-5499. You can also contact Andrew Sheehy, executive director of development for the college, at asheehy@utk.edu or 865-974-2365.

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