THE UNIVERSITY OF
TENNESSEE
KNOXVILLE

Department of Earth & Planetary Sciences

Decadal Academic Program Review 2012-2022

Self-Study

Report completed February 2023

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Section 1. Unit Overview

1A. Unit vision statement, mission statement, and strategic plan

Mission Statement
The Mission of the Department of Earth and Planetary Sciences (EPS) is threefold: i) to prepare our students for life-long learning, leading to enriching and successful careers; ii) to expand the frontiers of knowledge in the Earth and Planetary Sciences and related fields; and iii) to serve the university, government, industry, and people of Tennessee, the nation, and the world. Our departmental mission and vision align with UTK's mission and vision as a flagship land grant institution as explored below in Section 2.

Vision Statement
We are committed to excellence in all aspects of our mission. We strive to expand the boundaries of scientific knowledge, improve student training, and provide outreach in the study of the past, present, and future of Earth, its environments, and other planetary bodies. We are committed to training the next generation of geoscientists and students across UTK programs with curricula designed to meet future workforce needs and using accessible, experiential, and inquiry-based approaches. We seek to improve the number, quality, and productivity of our faculty and students, at all levels, so that we can compete successfully with Top 25 geoscience programs at public institutions across the United States. We are committed to promoting a culture of excellence and inclusion where diversity, professionalism, and cooperation are hallmarks of our department. We are committed to interdisciplinary collaboration and cooperation with faculty, staff, and students across campus, so that the growth and improvement of EPS contributes to the overall advancement of our university and the UTK strategic vision. We see potential for EPS to become an important hub for innovation that connects many diverse groups across campus, including faculty and students in the natural sciences, engineering, agricultural sciences, and social sciences. We strive to promote innovation, collaboration, and service to society within the department and with partners in the university, community, state, nation, and globe. This vision aligns both with the University and the premier Earth Sciences professional organization, the American Geophysical Union, whose vision is "…. a future where scientific discovery continues to be valued and celebrated for its role in advancing human knowledge. …. a future where knowledge of Earth and space sciences are used, in collaboration with advances in natural, physical and social sciences, medicine and engineering, for the benefit and prosperity of people and the planet. For details, see https://www.agu.org/Learn-About-AGU/About-AGU/About/Vision.

Strategic Plan
The Department of Earth and Planetary Sciences' most recent Strategic Plan, GEOMAP 2025, was developed in 2019 after a year of extensive consultation and discussion among faculty, staff and students. The final version of the Strategic Plan is included as Appendix 1.1 and is posted on the website at https://eps.utk.edu/docs/Strategic%20Plan.pdf The Strategic Plan includes clear metrics by which to evaluate success. Progress has been made on many objectives, and efforts to achieve additional identified metrics are continuing. We anticipate updating the Strategic Plan following the APR process.

1B. Important historical events

The Department of Earth and Planetary Sciences (EPS) has been a vital part of the University of Tennessee, Knoxville (UTK) for more than 100 years. Founded in 1907 as the Department of Geology & Mineralogy, the Department joined with Geography as the Department of Geology, Geography and Mineralogy in 1914, then became the Department of Geological Sciences after splitting with Geography in 1967. The Department of Earth & Planetary Sciences was renamed in 2003. Name changes reflect shifting foci.

EPS currently has three major areas of research and teaching emphasis: **geology** (geochemistry and petrology, paleobiology, sedimentation and stratigraphy, structure and tectonics); **planetary geoscience** (spacecraft exploration and remote sensing mission work, planetary petrology, cosmochemistry, Earth analogs); and **environmental geoscience** (aqueous geochemistry, geomicrobiology, hydrogeology, paleoenvironments and paleoclimates). Many faculty participate in more than one of these focus areas.

From its inception, the Department has been part of the College of Arts & Sciences. EPS has introduced over 70,000 undergraduate students to 100- or 200-level courses in the Earth Sciences. It has produced more than 1300 Bachelor of Science (BS) degrees (since 1907), as well as granting more than 600 Masters (MS) degrees (since 1929) and 165 Doctoral (PhD) degrees (since 1959). EPS graduates have gone on to success in academia, federal research laboratories, government agencies, K-12 schools, and a variety of professions with petroleum, mining, environmental consulting, law and engineering companies. Current or recent EPS faculty members are highly productive in their research, have received national honors, are leaders of international scientific efforts, and have served at many levels within the University including Interim Dean, Associate Dean, etc.

As of AY22-23, EPS has 14 full-time tenure-line faculty, two partial appointment faculty (holding tenure in other departments but teaching EPS courses and mentoring EPS graduate students), five non-tenure-track lecturers, four research faculty (most are current or former Oak Ridge National Laboratory scientists), three technicians (only 1.5 are hard-money positions), and four office staff. The number of faculty lines has decreased over the last decade, as some tenure-track faculty lines have not been replaced or replaced by lecturers (all but 1 of whom hold PhDs in geoscience). Most of our introductory courses are taught by lecturers, but most courses for undergraduate majors and graduate courses are taught by tenure-line faculty. Graduate student research is directed by tenure-line faculty, but lecturers share in mentoring undergraduate research and may serve on graduate committees. The Department has had success in gender diversity: 37% of our full-time faculty members are women; building diversity in other dimensions of the faculty has been less successful.

Over the decade, EPS generally has had 100+ undergraduate majors and 40-50 graduate students, although those numbers fluctuated from year to year. The undergraduate geology major currently has four tracks: geology, environmental studies, planetary geoscience, and water science. Nearly 2/3 of undergraduate majors are in the environmental studies track and 1/3 are in geology. The planetary and water science tracks just launched in Fall 2022. The department also includes 30-40 students completing the minor in geology, environmental studies, paleontology, or geochemistry. During the past year, 52% of undergraduate geology majors self-identified as women. Few of our students are from minoritized backgrounds.

Over the past decade, about two-thirds of our graduate students were PhD candidates compared to one-third MS candidates. All of our graduate students have teaching or research assistantships or fellowships.

For the past year, 56% of EPS graduate students self-identified as women. The percentage of graduate students representing minoritized backgrounds has increased in recent years, and the faculty are implementing initiatives to increase diversity further.

In 2017, the Department moved from its former home to a new building designed specifically for sciences. We occupy the top 2.5 floors of Strong Hall, which offers excellent teaching and laboratory space for all our classes and research, as well as sufficient office space for faculty, staff, graduate students, postdocs, and professional visitors. We also have sample processing spaces in the basement, a storage room and a media room on the ground floor, as well as use of large classrooms for introductory classes and dedicated classrooms within the department footprint for our introductory labs and major courses.

More than four decades ago, the Department started an Alumni Advisory Board and initiated a development program. Over the years, the endowments have grown to ~$8 million dollars, among the most successful in the College of Arts and Sciences. These funds complement the budget provided by the College and make all the difference in our recruitment and support of faculty and students, as well as to improve the quality of our teaching and research.

The Department has faced a significant challenge over the past five years, as eight senior and two mid-level, very active, tenure-line faculty retired, died, accepted positions as Associate Deans, or left UTK for other institutions. Among them are a National Academy of Science member, a highly decorated Distinguished Scientist, and a very promising faculty hire lost to a degenerative disease. Although some faculty turnover is expected for a mature program, turnover or loss of more than half the tenure-line faculty in such a short timeframe, including faculty who would be stars in any Earth Sciences program, has been disruptive. However, EPS has made six strong faculty replacement hires, although not necessarily in the same disciplines, in the same time period. All the tenure-line faculty are active in research and mentor graduate students, and almost all currently have grants to support their research programs. Consistent leadership for the Department has also been an issue, as EPS has had four Department Heads in the last five years; that situation has now stabilized with the appointment of a new (5-year) Head in August 2022.

The challenges posed by turnover in faculty and in leadership have been exacerbated by the global COVID-19 pandemic, which required faculty to shift to on-line teaching for a time and adversely affected research programs in the laboratory and in the field. Undergraduate recruitment was severely impacted by the lack of in-person laboratory offerings. Pandemic-related challenges also slowed graduation rates, especially for graduate students, and limited graduate recruiting as the Department prioritized extending financial support to already enrolled students beyond their normal time expectations, rather than admitting new students.

Over the past decade, there have also been changes at higher levels within UTK, notable among them being the intentional and substantial increase in undergraduate enrollment, adoption of a new responsibility-centered budget model, and ongoing reorganization of the College of Arts and Sciences into the divisions of Natural Sciences & Mathematics, Social Sciences, and Arts & Humanities. These changes provide new challenges and exciting opportunities for growth for the Department, but also uncertainty.

1C. Unit structure and administration

The Department is led by the Head who oversees the financial, academic, personnel, and research programs of EPS (see organization chart in Appendix 1.2). The Head is supported by an office staff and

Associated Head. The University and College of Arts and Sciences vest considerable authority in its Department Heads, though EPS operates with a great deal of shared governance, as defined in its Bylaws, as well as using a strong committee structure. Major committees are the Graduate Admissions and Program Committee (GAPC) and the Undergraduate Program Committee (UPC). Other committees include Student Success, Annual Evaluations and Awards, Diversity Council, and Adjunct/NTT Faculty Appointments.

Department Heads are appointed by the Dean, usually following a competitive internal or external search. Head appointments are initially for five years, but can be extended. The current Head (Alycia Stigall) was recruited via an external search and began her appointment on August 1, 2022. The Associate Head (Colin Sumrall) is appointed by the Head and, in EPS, this is usually for a three-year term. The Head and Associate Head remain active in teaching and research, albeit with slightly lighter teaching loads.

Departmental governance is based on our Bylaws (https://eps.utk.edu/docs/bylaws.pdf) and uses a system of standing committees (see Appendix 1.3) that report to the faculty at biweekly or monthly meetings, or as needed, during the academic year. The committees typically make recommendations to the full faculty for discussion, and then tenure-track faculty vote on major decisions. Non-tenure track faculty (lecturers and research faculty) and student representatives participate in the faculty meetings, as they are actively engaged in all departmental issues, except for topics involving personnel, like promotion and tenure.

The Business Manager (Tammy Berry) oversees of the office staff. She frequently consults with the Head, but operates with a reasonably high degree of autonomy. The Lecturer/Teaching Lab Manager (Jacob Benner) coordinates and manages the graduate teaching assistants and the 100-level labs. Three scientific staff members manage labs and report to faculty with oversight of specific facilities.

1D. Demand for program; ranking and recognitions; comparable and aspirational peers

Demand is strong for well-trained graduates in the Geosciences, including across the Earth Sciences, Planetary Sciences, Environmental Studies, and specifically Geology. The US Bureau of Labor Statistics (BLS) projects an overall increase of 4.9% in Geoscience jobs (+32,000 jobs) between 2019 and 2029 versus growth for the overall US workforce at 3.7%. The largest gains will be within professional, scientific, and technical services, much of which is related to environmental geosciences or activities supporting the mining section (https://tiny.utk.edu/geosciencemployment, Fig. 1). Furthermore, the demand for Geoscience positions is projected to occur across the economy (private sector, government, and academia), across salary levels, and at all educational levels. Importantly, this growth combined with upcoming retirements, which are projected to be at 27% of the current workforce, will result in a net deficit of Geoscience talent. Current graduation rates in the US do not come close to meeting this demand, indicating outstanding career prospects for students graduating from EPS degree programs in Geology and Environmental Studies.

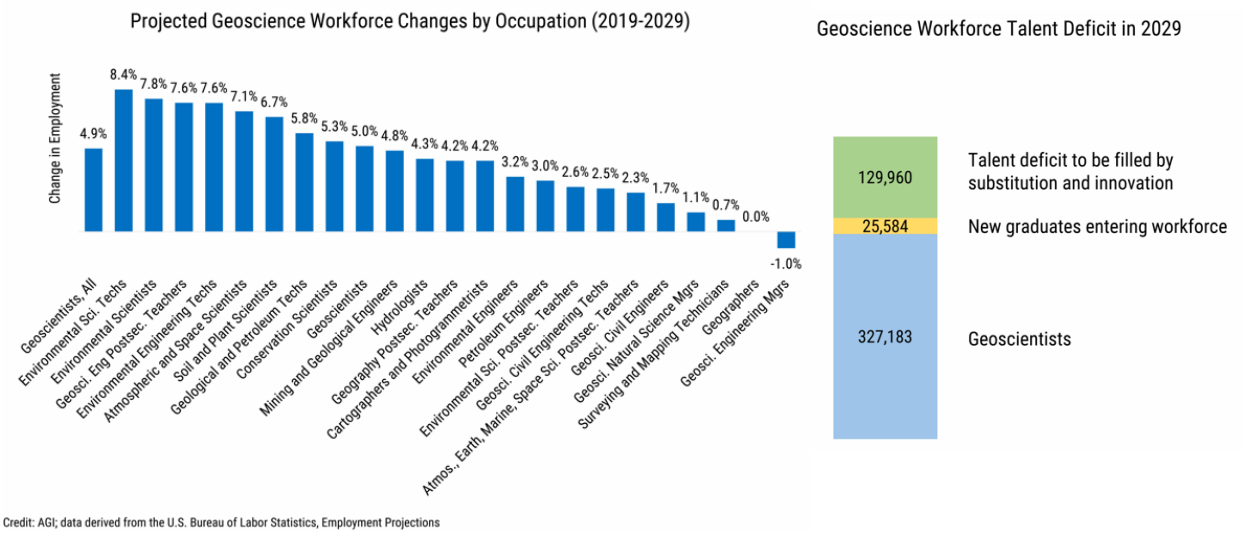


Figure 1. Projected geoscience workforce growth and employment trajectories from 2019-2029. From AGI.

Demand for Geoscience and Environmental Studies programs is expected to remain high at all levels (BS, MS and PhD), but is anticipated to evolve away from the classic "core geology" curriculum within the Geosciences to be more inclusive and provide and skills-based education. The BS degree can lead directly to a job in the Geosciences, but is increasingly viewed as a stepping stone to graduate school or careers in other fields like K-12 education, business, etc. Many of the higher salary/prestige employers, especially in industry and government, hire mainly at the MS or PhD levels. Demand for PhDs in academia is expected to remain strong, partly due to impending retirements and partly because of the multi-disciplinary nature of Geoscience PhD programs, which helps prepare graduates to compete successfully for faculty positions in a variety of different scientific disciplines.

The EPS department is the only program (public or private) in the State of Tennessee that offers a full range BS, MS and PhD degrees over a range of geologic disciplines. The State has twelve public community colleges, only five of which offer any courses in the geosciences (which are only at the introductory level). Among the Geoscience programs in 4-year colleges and universities in Tennessee, seven offer only BS options, and only four currently offer MS degrees in the geosciences, specifically UTK, University of Memphis, and Vanderbilt, with ETSU offering MS degrees in geospatial science and vertebrate paleontology only. The University of Memphis offers a narrowly focused PhD in Geophysics and Seismology, and Vanderbilt University offers a PhD in Earth and Environmental Sciences, which can include geosciences research but is not a PhD in Geoscience. UTK is the *only educational institution within the State of Tennessee* that offers a comprehensive PhD degree, covering a range of Geoscience sub-disciplines, especially Planetary Geology.

The EPS department engages with other stakeholders through outreach and engagement activities through the Space Grant Program, with initiatives to develop broader impacts with local K-12 partners and STEM organizations, and from research exchange and collaboration with Oak Ridge National Laboratory (ORNL). EPS students provide valuable service as interns within local non-profit and government agencies, such as the Tennessee Department of Environment and Conservation and the Tennessee Geological Survey.

National recognition of departmental quality has two main sources: national rankings, by such organizations like the US News and World Report and the National Research Council, and individual national and international recognition of its faculty.

Table 1 compares EPS with geoscience departments in our peer (University of Kentucky) and aspirational (University of Georgia, University of Florida) universities, as well as with our additional aspirational department (University of California at Davis).

In 2010, US News & World Report ranked EPS 89th of 112 programs in Public and Private universities. In 2020, the US News & World Report rankings show EPS rose to 70th, which places us substantially above the University of Kentucky (at 124th), similar to the University of Georgia (tied at 70th), and below both the University of Florida (at 40th) and the University of California at Davis (at 19th).

Since the last Academic Program Review (APR) in 2012, the National Research Council no longer provides direct rankings. Rather, they provide high and low S- and R- rankings. S-rankings are a measure of the strength of the department relative to criteria that scholars say are important. By contrast, R-rankings measure the extent to which a program has similar features to programs that are viewed by faculty as top-notch. Changes to the National Research Council rankings provide the 5th and 95th percentile cut-offs, from which department rankings lie between these cutoffs. Measurement details can be viewed at: https://www.chronicle.com/article/doctoral-programs-by-the-numbers-124722/.

In 2010, the National Research Council ranked EPS 54th out of 140 Earth Science Programs, and 26th out of 78 Earth Science Programs at Public Institutions. In 2020, EPS placed between 48th and 93rd in terms of the criteria deemed important by scholars, and between 30th and 66th in terms of similarity to top-notch departments. If we assume a normal distribution to these placements, then we can infer our ranking to lie at the median of these ranges and a ranking of 70.5 for scholar-based strength (nearly identical to the US News & World Report ranking) and 48th in terms of similarity to top-notch programs. Using such median assessments, the EPS S-ranking are much closer to that of the University of Florida and the University of California at Davis (40 and 70.5, respectively) and substantially better than the University of Kentucky and the University of Georgia (102 and 111, respectively). Despite the recent number of tenure-track faculty in EPS being well below these peer institutions (UTK at 11 in Spring 2022 and 14 in Fall 2022, compared to UK 12; UG 15, UF 18, UCD 23), the strong comparison between EPS and the peer and aspirational programs is notable.

Table 1. Comparisons of rankings between EPS and peer and aspirational institutions.

Earth Science Department	NRC 2020 Rankings				US News & World Report
Institution	S-high	S-low	R-high	R-low	Ranking
University of Tennessee	48	93	30	66	70
University of Kentucky	82	123	62	110	124
University of Georgia	99	124	13	35	70
University of Florida	20	60	37	76	40
University of California at Davis	46	95	52	85	19

Other examples of national and international recognition include the large number of awards received by current EPS faculty, as well as from their leadership roles in national or international organizations, and leadership in journals. These include:

Major Faculty Awards and Recognition (past 10 years)

- National Academy of Sciences Fellow (McSween)
- American Association for the Advancement of Science (Engel, Fedo, Kah, McKay)
- Paleontological Society Charles Schuchert Award (Stigall)
- Paleontological Society Fellow (Stigall, Sumrall)
- GSA Fellows (Engel, Fedo, Kah, Sumrall)
- Geological Society of London Fellow (Fedo)
- AAPG Honorary Member Award (Hatcher)
- American Association of Petroleum Geologists Honorary Member Award (Hatcher)
- Explorers Club Fellow (Engel)
- Karst Waters Institute Karst Award (Engel)
- National Speleological Society Science Award (Engel)
- Union Internationale Spéléologie (International Union of Speleology) Book Prize (Engel)

Leadership Roles in Professional Organizations and Journals (past 10 years)

- Service to Professional Organizations and Agencies
    - International Society of Environmental Biogeochemistry, President (Engel 2020–present)
    - Subcommission on Ordovician Stratigraphy, Officer (Stigall 2020–2024)
    - Southeast Section GSA, President (Sumrall 2019–2021)
    - NSF, NASA, and NRC Review or Advisory Panels (too numerous to count)
- Editors and Associate Editors
    - Associate Editor of *Journal of Geophysical Research Planets* (Thomson, McCanta 2020–present)
    - Associate Editor of *Geochimica et Cosmochimica Acta* (Huang 2010-present)
    - Executive Editor of *Palaeontologia Electronica* (Hembree 2019-2022)
    - Handling Editor of *Palaeontologia Electronica* (Hembree 2015-2019)
    - Associate Editor of *Ichnos* (Hembree 2020-present)
    - Editorial Board *ISME Journal* (Engel 2022–present)
    - Editorial Board *Frontiers in Evolutionary and Genomic Microbiology* (Engel 2010–2016)
    - Principal Editor (Americas), *Geo–Bio Interfaces* (new journal of the Mineralogy Society) (Engel 2022–present)
    - Associate Editor *Journal of Sedimentary Research* (Engel 2004–2015)
    - Co-Editor-in-Chief *Precambrian Research* (Fedo 2013-2014)
    - Associate Editor *Urban Ecosystems* (McKinney 2021-2021)
    - Associate Editor *Frontiers in Ecology and the Environment* (McKinney 2015-2021)
    - Associate Editor *Urban Naturalist* (McKinney 2014-2021)
    - Associate Editor *Evolutionary Ecology Research* (McKinney 2010-present)
    - Editor *Paleontological Society Special Publications* (Sumrall 2017-present)
    - Editor *Structural Geology* (Dunne 2005-2018)
    - Editor *npj Biodiversity* (Stigall 2021-present)
- Conference Organizers
    - GSA, AGU, LPSC Theme Session Chairs (too numerous to count)
    - 2nd Joint International Symposium for Environmental Biogeochemistry and Subsurface Microbiology (Engel, 2023; Banff, Canada)
    - NSF-funded workshop “Microorganisms and Organic Carbon in the Marine Subsurface” (Steen, 2019; Knoxville, TN)
    - SEGSA Co-Chair (Sumrall, 2018; Knoxville, TN

Section 2. Alignment with UTK's Strategic Vision

2A. Educational opportunities: Cultivating the Volunteer Experience

The EPS department is committed to providing outstanding education at all levels. Our faculty and graduate teaching assistants engage in continuing training, considered curricular revision, and application of innovative pedagogical approaches to meet learners where they are help them succeed. For example, EPS faculty recently engaged in retreat organized by the UTK Center for Teaching, Learning, and Instruction to develop robust learning outcomes at the program- and course-level. In this context, the department's philosophy emphasizes curricular development for the 21st century workforce while developing accessible curricula that incorporate inquiry and experiential based learning. This process strengthens student development of transferable skills such as critical thinking, communication, teamwork, and geoscience competencies outlined by Vision and Change in the Geosciences by the American Geosciences institute (see at https://www.americangeosciences.org/change/).

Most of our student credit hours are delivered in the introductory level (100 and 200-level) classroom. Recent innovations in this space include the move to active grading in the laboratories, flipped models of instruction and deployment of active learning in the large classrooms, field trips in select introductory courses, and a focus on content development that connects with societal issues of interest to the students. The outstanding innovation of our faculty at this level has been recognized, such as Jake Benner's recognition as the 2022 College of Arts and Sciences Lecturer Teaching Awardee. Similar pedagogical innovations are included in our major-level courses, such as GEOL 320 Paleobiology and GEOL 310 Mineralogy, which include active learning and innovative research projects.

To address the growing number of our introductory students, and especially the largest group of majors enrolled within the Haslam College of Business, we are seeking to develop new courses, such as GEOL 215 Critical Minerals. This course is scheduled to launch in Spring 2024 and will be highlight supply chain issues and should serve students in other disciplines, as well. To support the new institutional focus in flexible instructional offerings, including online instruction, several introductory courses (e.g., GEOL 202 Earth as an Ecosystem: Modern Problems and Solutions, and GEOL 205 Age of Dinosaurs) have been developed as online courses to meet the needs of students in communities across Tennessee and beyond, including the online BS degree completion (IDP) program. We will seek to expand online offerings in future years to through collaborative MS certificates to increase this impact.

Major and graduate courses often employ project-based learning and include significant field or research components, where appropriate. Recent innovative projects in advanced courses have including projects using real-time Mars rover data, developing podcasts on topics relevant to society, from sinkhole management in urban areas to microbes in extreme environments, or collaboratively synthesizing class projects for peer-reviewed publications. Students in other courses have collected geochemical data and provided recommendations for environmental remediation projects. Other students have engaged in detailed consideration of scientific ethics and diversity work, developed presentation skills through specific coaching and departmental forums, or gained job-seeking and careers advancement skills to pursue academic or national laboratory careers, such as at ORNL. Overall, these unique classroom experiences help students to develop valuable scholastic and career skills while also aiding the local or scientific communities.

2B. Research, scholarship, and creative activity: Conducting Research that Makes Life and Lives Better

Our faculty and students study the past, present and future of Earth, the environment, and planetary bodies. These research foci align directly with the goal that research activities target at making life and lives better, including building a more sustainable, just, and prosperous future. Research in EPS is directly related to understanding and preparing for changes in the modern world and societal impacts. We examine intervals of past climate change, species invasions and mass extinctions, and biotic diversification, all of which provide critical information about the processes and rates of change occurring today and the potential long-term impacts these changes have had on Earth. We examine biogeochemical cycles in modern subsurface environments, like caves and aquifers, as well as in rivers, lakes, volcanoes and oceans to understand primary Earth systems, such as the nitrogen, carbon and sulfur cycles and the pathways of microbial mediation. We examine modern and ancient volcanic and river systems on Earth, Mars, and Venus to constrain the impacts catastrophic events such as major eruptions, impact cratering, and massive floods induce on planetary bodies. We engage in spacecraft mission that can provide information about potential future habitability of Mars and beyond. Elements of these research themes are directly relevant to UTK's four research thrusts, UT-ORII-led UTK/ORNL collaborations, and other major institutional research initiatives. Furthermore, this diverse suite of research develops not only new insights into the past, but critical information about modern environmental issues, geologic hazards, and critical strategic minerals for societal growth, and building a sustainable future for our communities in Tennessee and around the world.

We engage students at all levels in these research themes to expand their ability to explore diverse career trajectories, engage in cutting edge and relevant issues, and develop their own passion as scientists and citizens. Furthermore, the research infrastructure developed within EPS with College and University support is expansive and includes core facilities e.g., Electron Microprobe, upcoming ICP-MS lab), cost centers (i.e., Stable Isotope Lab), and shared facilities (e.g., Geochemistry Teaching Lab, Prep labs, Rock crushing facilities) that are also available to campus and external users, which expands interdisciplinary collaboration and engagement and further expands the mission of EPS to serve the broader community.

Historically, the department has been the home to international research leaders, and presently EPS has a strong record of publication with citation of that work. The mid-career faculty leaders of the department are becoming externally recognized for their work, including three recently elected AAAS Fellows and a number of prestigious geoscience societal awards. Additionally, the tenure-line faculty have had a high participation rate as principal investigators of externally funded projects. Consequently, the department is well positioned to contribute to UTK's Vision goals related to increasing external funding, having greater graduate student research participation, and receiving more external recognition through faculty awards.

2C. Diversity and community: Ensuring Culture where Vol is a Verb

EPS is strongly committed to developing and sustaining a welcoming culture where people of all identities and backgrounds belong and where recognition of diversity and community endures. Our intentions are followed by action. Faculty engage students in expanding their understanding of the world and of their community by incorporating place-based learning within the local community and experiential training in remote locations (including internationally). Faculty engage with a global community of collaborators through their research and bring these perspectives, colleagues, and field locations to their students.

The demographics of EPS mirror the geosciences field overall in terms of limited diversity. In particular, there are currently no African Americans, Asian Americans, or Native Americans/Pacific Islanders represented on the faculty and staff, which is lower than representation within the broader University community. Progress has been made over the past decade to increase gender balance among the faculty, through strategic and targeted opportunity hires. Approximately one-third of the tenure-track faculty self-identify as women. Spousal accommodations have been a particularly important and successful for the recruitment and retention of high-performing women in the department (Kah, McCanta, and Stigall). Providing spousal support has been important for supporting Huang, as well. Our department has LGBTQ+ representation, including graduate students who are leading a nationwide study of LGBTQ+ experiences in the geosciences.

EPS has been actively working to address diversity issues within the department, including attempting to remedy those that are systemic to the geosciences as a whole. During the 2016 mid-year review process, concerns were raised with the Head that treatment of people based on their gender has not always been equal. Many changes were initiated in direct response to this concern, and the Department began a more explicit process to create a culture where everyone is treated equally and respectively, regardless of gender, as well as race or any other distinction. This process continued with the addition of a "Diversity and Inclusion" self-assessment and a "Path Forward" section in the Strategic Plan, which was adopted by the department in 2019. A Diversity Council was added to the department structure and a subset of faculty and students have since been engaging the developing deliverables to improve equity and inclusion via the NSF-sponsored URGE (Unlearning Racism in the Geosciences) program (see https://urgeoscience.org/.

Some of the recent concrete actions that have been taken to help facilitate the goals of increasing diversity, equity, and inclusion are listed below:

- EPS has worked to diversify the Klepser Seminar Series, with significant effort made each semester to include top-quality speakers from different disciplines and, when possible, underrepresented and/or minoritized groups.
- Since Fall 2016, all Faculty are required to complete online Mandatory Reporter training. In Fall 2018, the department implemented the requirement that all graduate students must successfully complete the University's online Mandatory Reporter training, as well.
- Since Fall 2016, all faculty and staff are required to complete the University's STRIDE (Strategies and Tactics for Recruiting to Improve Diversity and Excellence) training prior to participating in job searches. This program specifically addresses implicit bias issues.
- Since Fall 2016, all departmental members have been encouraged to attend Safe Zone training to become more aware and inclusive of all genders and sexualities.
- In Spring 2018, the Head and members of the department's executive committee met with Jennifer Richter and Ashley Blamey from the UTK Office of Equity and Diversity and the Title IV offices, respectively, to discuss gender discrimination concerns among graduate students in EPS.
- In Fall 2018, all faculty, staff, and graduate students were required to attend (as separate groups) a 50-minute Title IX presentation (with Q & A) on gender equity and sexual harassment issues, given by the Office of Equity and Diversity.
- In Spring 2019, all faculty, staff, and graduate students were required to complete online Code of Conduct training.
- Since 2019, EPS has worked to attract diverse faculty to apply for open faculty positions, through targeted advertising on sites such as the Association for Women Geoscientists

(https://www.awg.org/), the National Association of Black Geoscientists (http://www.nabg-us.org/), and others.

- In Fall 2019, EPS created a Diversity Council led by one faculty member, with additional membership and leaderships from one graduate student and one undergraduate student. The Diversity Council is expected to meet regularly to have conversations with, and generate input on, what can be done to accommodate and increase departmental diversity. This position was codified into the department Bylaws and made a regular faculty service assignment.
- In Fall 2020, at the request of the College and University, EPS created a Diversity Action Plan that was filed with the University and included metrics that need to be assessed and reported on annually.
- Since Spring 2021, the EPS website has had a separate "Diversity" tab that lists the department's diversity statement, resources, and an anonymous reporting system.
- In Spring 2021, a subset of faculty and graduate students formed a pod and participated in the nationwide URGE (Unlearning Racism in the Geosciences) program and completed a series of eight deliverables designed to begin addressing issues that are hindering the progress of racial diversity and inclusivity within the discipline broadly and specifically to our department. Refinement of the deliverables is continuing through 2023. The intention is to identify policies and practices that serve as barriers, and then to revise those policies and practices to remove barriers, which should improve inclusivity.
- In Fall 2021, EPS moved to strike the requirement for GRE scores from the admissions process, as studies suggested this was a barrier to admissions for a more diverse graduate student body.
- Continuing work to remove historic barriers to inclusion in the geosciences from our curricula and degree requirements include the launch of new major concentrations that do not require field geology, traditionally completed as a six-week field camp course. Required field courses can be a substantial barrier for non-traditional students and others from minoritized backgrounds. Additional curriculum-based considerations are ongoing.

This platform of mentored self-examination, structured actions and continuing commitments provides a basis for the Department to contribute to the University's transformational goals related to civility, culture and climate. At the same time, the Department is positioned to enhance diversity and inclusion for students, graduate student recruiting and retention, and faculty recruiting and retention, including adopting best practices from UTK and the geoscience profession.

2D. Collaboration, adaptability, and innovation: Making Ourselves Nimble and Adaptable

EPS is committed to engaging a culture of innovation and collaboration within the department and externally to it. Innovative and collaborative research and teaching is highly valued within the department, as it builds value and excellence beyond that which is capable of faculty to achieve working in isolation.

The Geosciences is, by nature, an interdisciplinary enterprise. Our faculty and students explore Earth, the environment, and planetary bodies, often with cross-cutting methods, such as remote sensing technology or geochemical signatures and processes. Because our interests and methods are so diverse, geoscientists are also naturally collaborative. Many of our faculty (or their students) co-publish and write collaborative grants with their EPS colleagues, earth-science-related colleagues in other UTK units, and earth science colleagues at other universities and agencies.

For example, a current course in GEOL 443/543 Sustainable Landscapes is co-taught with a University of Tennessee Institute of Agriculture (UTIA) faculty member, and a newly developed course in Taphonomy GEOL 406/506 will be co-taught with faculty in Anthropology. GEOL 459 Oceanography and GEOL 465 Geomicrobiology are cross-listed with Microbiology, and GEOL 485 Hydrogeology is cross-listed with Civil Engineering, respectively. Our environmental studies, planetary geoscience, and water geoscience major concentrations and new paleontology and geochemistry minors require coursework from other units on campus. Our faculty are also engaged in collaborative efforts on campus, such as the Global Energy Ecosystem Initiative and the Baker Center, as well as within many service roles that serve the larger institutional mission, like our cost center and core lab facilities that serve users across campus, ORNL, and industry.

Furthermore, at a time of significant structural and financial changes in the College and University, along with changes in leadership, the EPS faculty are actively contributing to committees and governance groups engaged with rethinking of the College structure, reformulating the Honors Program, and developing a major UTK Office of Research, Innovation & Economic Development (ORIED) research thrust, Global Energy Systems. As the campus focuses on operational improvements to create nimbleness in this goal of the UTK Strategic Vision, the Department stands ready to partner and adapt.

2E. Connection: Embodying the Modern R1, Land-Grant University

EPS is committed to serving the people of Tennessee and engaging with Tennesseans. Our State has incredibly diverse geology and environments. We explore the geologic structures and mountains on which today's modern landscape is built, study the history of life and events preserved in the sedimentary rocks, and examine the hydrogeology and geochemistry of local rivers and caves. We provide a deep look into the stars and planetary bodies that Tennesseans observe in the night sky. We also have a responsibility to expand the knowledge of our home state and provide new insights on geological issues of societal relevance. We work on problems associated with the contamination of our waterways and soils, the escalating impacts of climate change, from greenhouse gas emissions to global warming, sea-level rise, biodiversity loss, and the spread of invasive species. We contribute to the exploration for and assessment of fossil fuels and critical minerals, and make improvements to our understanding about geological hazards, from earthquakes to volcanic eruptions.

In doing our research, we continuously seek ways to provide educational, experiential learning opportunities, as well as collaborative and synergistic experiences, which can lead to improvements in the lives of Tennessee's citizens and people elsewhere. EPS is committed to educating students and other constituents about the relevance of the geosciences to solving societal issues. We educate students about these issues on campus and reach out to the population of distance learners, an area we hope to expand through both undergraduate degree completion programs and potentially emerging graduate certificate programs. To broaden our reach, we work with distance-learners and collaborate with the Tennessee Geological Survey, the Tennessee Department of Environment and Conservation, and other local industries.

Our faculty and students also engage with community partners though various outreach programs. Notably, the Space Grant Program, administered within EPS, is premier outreach program designed to connect Tennesseans with the University and space education and innovation opportunities for K-12 groups. Our faculty and students deliver content to students at local schools and museums, as well as for programs on campus, including at the McClung Museum and its annual events, such as Darwin Day.

Students also serve as docents to lead school groups in geoscience content. EPS faculty collaborate with Pre-college Research Excellence Programs (https://prep.utk.edu/) on the Tennessee Science Olympiad and Governor's School for the Sciences and Engineering. Faculty collaborae with the UTIA Extension office, exemplified by a recent collaboration that resulted in development of a karst and sinkhole guide, https://extension.tennessee.edu/publications/Documents/W453-A.pdf. Furthermore, we serve as a resource for public inquiries concerning rocks, fossils, and other geological samples like meteorites that are brought to us for identification and information.

Beyond our home state, our faculty engage building connections with other communities to improve the lives of people and to conserve important landscapes. Recent examples include:

- Helping to promote and develop a Geopark to protect and preserve the geologic heritage around Zagora, Morocco.
- Leading local non-profits to conserve and protect Hawaiian lava tubes, and engage local communities to improve cave awareness.
- Leading a MS and PhD student fellowship program for a national non-profit organization.
- Co-leading an international community of scientists to better develop global correlation schemes.
- Participating in an international scientific drilling cruises to better understand volcanic systems and climate change.
- Developing museum displays about faculty research on dinosaur on bone bite marks and cannibalism in Jurassic dinosaur and on the decomposition and fossilization of "Dakota," an *Edmontosaurus* mummy, at museums which serve the communities where the fossils were initially discovered and collected.
- Mentoring graduate students from across Asia, the Middle East, and Europe as part of the Oman Drilling Project science team, in an effort to understand natural CO2 sequestration mechanisms (mineral carbonation), and magmatic processes.

Going forward, the Department-with the support of the College and University-would like to explore building collaborations with more University partners, such as the UTIA Environmental Sciences program and newly renamed department of Natural Resources (with a focus on "living resources", rather than geologic resources), and State partners, such as the Tennessee Department of Energy and Conservation (TDEC). Our Environmental Studies program along with the Sustainability program in Geography are natural partners with UTIA's Environmental Sciences program to create an environmentally focused education, research and engagement strength at UT, particularly if supported by the proposed faculty hiring plan for EPS. The potential for collaboration should be strong here, relating to the UTIA One Health initiative and the ORIED Global Energy Systems initiative, with a strong potential for engagement across the State of Tennessee.

Section 3. Undergraduate programs

3A. Undergraduate academic programs

The EPS department offers a Bachelor of Science (BS) degree in Geology and Environmental Studies (GES), with four concentrations: Geology, Environmental Studies, Planetary Geoscience, and Water Science. We also offer Minors in Geology, Environmental Studies, Paleontology, and Geochemistry (with

concentrations in Solid Earth and Aqueous Earth). The Environmental Studies Major began as an Independent Degree Program (IDP) in 1995. In 2012, Environmental Studies was merged with the existing Geology major to form the new GES degree with a concentration in Environmental Studies. In 2022, we added two new concentrations, Planetary Geoscience and Water Science, both having their initial enrollments in Fall 2022. New Paleontology and Geochemistry Minors also started in Fall 2022.

Courses offered by EPS are under the heading of Geology (GEOL), but can be taken by students in any concentration, as well as by students in other departments (assuming prerequisite courses are met). The current curriculum requirements for all four EPS concentrations are found in Appendix 3.1. They all share some core characteristics. All concentrations require: 1) basic general education courses from the College of Arts & Sciences, 2) several courses in related natural sciences and math, including chemistry, biology, and physics, 3) completion of two introductory lab geology courses from the GEOL 101 (Dynamic Earth), GEOL 102 (Earth, Life, and Time), GEOL 103 (Earth's Environments), GEOL 104 (Exploring the Planets), 4) completion of at least five courses in EPS at the GEOL 300-400 level. Because of the interdisciplinary nature of environmental studies, water science and planetary geoscience, these concentrations require several courses in departments outside of EPS. A field geology course is required by the Geology concentration but not the other concentrations.

The development of two new concentrations and minors was motivated by the recognition that modern Geoscience students pursue a diverse and expanding range of career trajectories. It is our responsibility to provide curricula that can help students succeed in all areas of the Geosciences while also giving them opportunities for more flexibility in the existing degree programs. As our faculty have particular strengths in planetary science, paleontology, and water science, developing the focused curricula also provides students the ability to strengthen their degree programs by engaging in cutting edge research.

3B. Volunteer Core

EPS offers courses at both the introductory (GEOL 100 and 200) and major (GEOL 300 and 400) levels that are included within the Volunteer Core (VolCore), which is the new general education framework. Several additional courses are pending VolCore approval to streamline pathways for our majors and minors to complete these requirements. A recent faculty retreat included discussion of additional courses that may be modified to meet VolCore requirements, particularly for GES majors.

Approved Courses

Natural Sciences (NS)

- GEOL 100 – Earth, Environment, and People
- GEOL 101 – The Dynamic Earth
- GEOL 102 – Earth, Life, and Time
- GEOL 103 – The Earth's Environments
- GEOL 104 – Exploring the Planets
- GEOL 107 – Honors: The Dynamic Earth
- GEOL 108 – Honors: Earth, Life, and Time
- GEOL 202 – Earth as an Ecosystem: Modern Problems and Solutions
- GEOL 202S – Earth as an Ecosystem: Modern Problems and Solutions
- GEOL 203 – Geology of National Parks
- GEOL 205 – Age of the Dinosaurs
- GEOL 207 – Honors: Age of the Dinosaurs

Engaged Inquiries (EI)

- GEOL 206 – Sustainability: Reducing our Impact on Planet Earth
- GEOL 206S – Sustainability: Reducing our Impact on Planet Earth
- GEOL 310 – Mineralogy

Courses under Review

Engaged Inquiries (EI)

- GEOL 205 – Age of the Dinosaurs
- GEOL 210 – Astrobiology

Oral Communication (OC)

- GEOL 453 – Modern and Ancient Soils

Applied Oral Communication (AOC)

- GEOL 444 – Teach the Earth

3C. Course enrollments

EPS strongly contributes to undergraduate education at UTK. Total course enrollments and student credit hour (SCH) production have been steadily increasing following the peak of the COVID-19 pandemic (Spring and Fall 2020) and are at an all-time high (Datapack Tab 8, Fig. 2). The maintenance and expansion of SCH production is a result of strategic deployment of faculty as the department has faced a loss in faculty workforce, as noted earlier in the report (Datapack Tab 16).

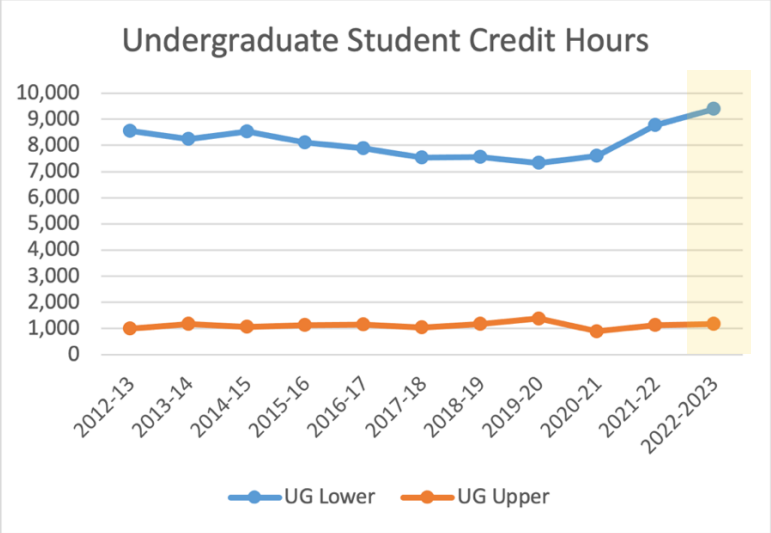


Figure 2. Past ten years of introductory enrollment.

For introductory enrollment growth over the past five years, EPS's growth in SCHs has exceeded the overall rate of growth in the other sciences, College of Arts and Sciences, and the University (Datapack Tab 7). Moreover, at present, EPS instructional faculty generate 670 SCH per instructional faculty member, which is 1.08x the average for Natural Sciences, 1.37x the average across the College broadly, and 1.65x the average for a University faculty member (Datapack Tab 10, 11). During Spring 2023, all introductory courses had maximum capacity enrollments, indicating potential for additional enrollment growth. However, EPS will not be able to offer additional sections of introductory courses, and teach

lecture and laboratory sections, without further increases to faculty and graduate student numbers.

Enrollments and SCHs for upper-undergraduate courses have been generally stable, after a COVID-related decline and rebound in 2020-2021 (Fig. 2). This indicates strong demand for EPS classes even outside of declared majors, as those numbers have been declining somewhat in recent years (Fig. 3). This enrollment is bolstered by our growth in minors in recent years, now between 30-40, and the inclusion of some courses within general education connections packages.

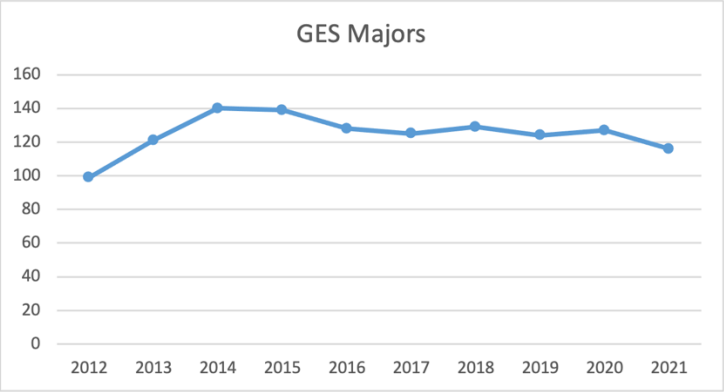


Figure 3. Number of declared Geology and Environmental Studies (GES) majors over the last 10 years.

3D. Recruitment and student demographics

As is typical in the discipline, most GES majors "discover" our program by completing an introductory GEOL course (or transferring from another school as a GES major), rather than enrolling into one of our major concentrations on matriculation as a first year student at UTK. Consequently, we engage in active recruiting mechanisms throughout our introductory courses, including providing career education, information sessions, and direct reach out to high-achieving students. EPS supports our majors through an extensive set of scholarships and awards (Appendix 3.2). We also provide a series of minors to engage students with a primary major in other disciplines, such a paleontology minor to attract Biology and Anthropology students and Geology major to attract Supply Chain students. For students that do enroll as first-time freshman in the GES major, faculty engage with them directly as part of the orientation process, and our program has high rate of retention (Datapack Tab 15).

The number of majors over the last 10 years indicates two patterns (Fig. 3). One pattern is the clear increase of majors following the addition of the Environmental Studies concentration in 2012, with a peak of 139 majors in 2015-16. The second pattern is a slight decline in majors following the peak, to a current count of 117 majors. This same pattern is mirrored in the number of BS degrees awarded (Fig. 4).

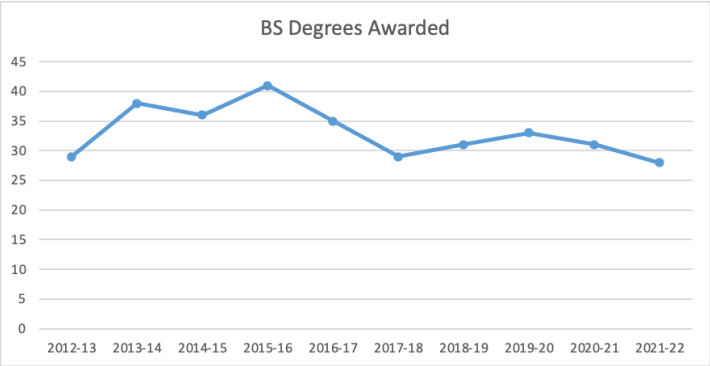


Figure 4. Number of degrees award

The apparent cause of declining EPS majors and degrees is seen in Figure 5 that shows a generally consistent decline in the number of majors in the Geology concentration. This contrasts with the Environmental Studies concentration that shows an increasing number of majors. Both patterns are consistent with national trends (https://tiny.utk.edu/AGIenrollmentrends), reflecting market demand and increased growth in environmental geoscience positions (https://tiny.utk.edu/AGIemploymenttrends) coupled with student interest in societal issues. This apparent shift away from the traditional Geology curriculum was one of the driving motivations for EPS to create the two new concentrations of Planetary Geoscience and Water Science. Notably, both concentrations and total majors show a smalldecline in 2021, which we suspect is a temporary dip related to well-documented COVID-19 pandemic effects on college enrollments, as well as the reduced ability to recruit new students to our "discovery majors" during online-only lab instruction.

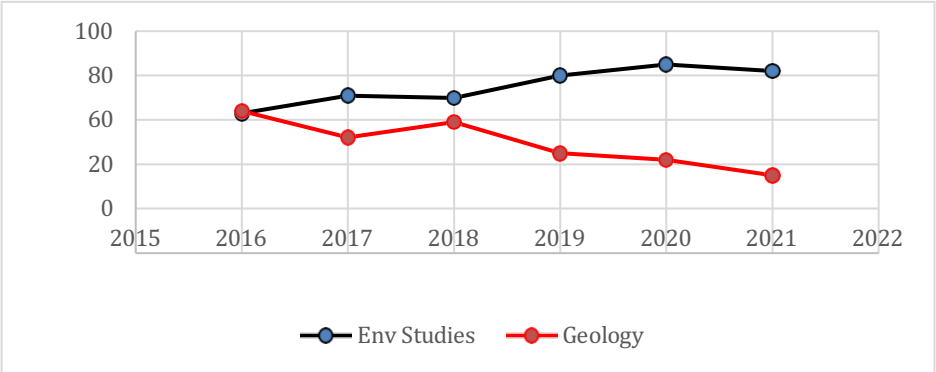


Figure 5. Number of majors in the two concentrations since 2016.

Regarding the demographics of EPS majors, we have observed a consistent increase in the proportion of women, culminating in a current peak of 68% women and 32% men (Datapack Tab 19.A) (Fig. 6). This largely reflects the influence of Environmental Studies which, as seen in Figure 5, consistently has a substantially larger percentage of women than the Geology concentration that rarely exceeds 40% women. On another diversity axis, approximately half of our undergraduates are transfer students from junior college – a number that has been growing since the advent of the Tennessee Promise Program. This is a positive trend in terms of increasing the number of students who are First Generation and come from more diverse backgrounds than have traditionally majored in earth sciences. These data are notable because the geosciences are the least diverse of the STEM disciplines (Bernard & Cooperdock, 2018), not only in gender diversity but also racial diversity.

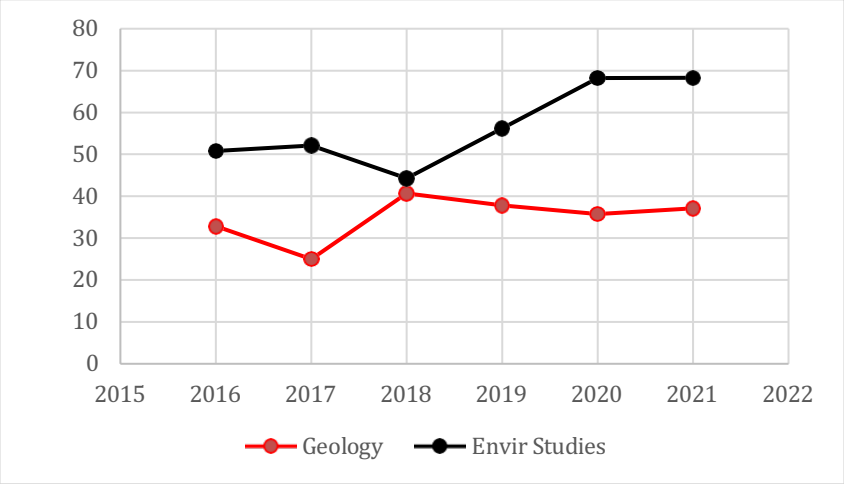


Figure 6. Percentage of women in the two concentrations since 2016.

Regarding racial diversity, EPS demographics show that only 12.5% of our undergraduate population in Fall 2022 identifies with a background other than white/non-Hispanic (Datapack Tab 19A), which is lower than the overall UTK student population of 21.1%.

The EPS faculty are actively engaged in the NSF-sponsored URGE (Unlearning Racism in Geosciences) program and working to identify ways to increase inclusion in our undergraduate programs so that all potential students who are excited about the Earth, environment, or planetary geology will experience a welcoming culture and feel a sense of belonging in EPS. We anticipate growth in major counts as recent and upcoming revisions to the undergraduate curricula address barriers that historically excluded people from diverse backgrounds, such as field camp requirements.

3E. Advising, mentoring, and student success

The undergraduate curriculum in EPS is managed by the Undergraduate Program Committee (UPC), consisting of two co-chairs (McCanta and McKinney) and several other faculty committee members. The UPC is responsible for making curriculum changes each year, advising undergraduate majors and recruiting new majors from incoming freshman and transfer students. Advising duties for incoming students are initially carried out by advisors in the College of Arts & Sciences (CAS), but juniors and seniors are typically advised directly by EPS faculty. The UPC continues working with CAS to build strong relationship and knowledge bases with their advising staff, which can be challenging due to high staff turnover in that office.

Program learning outcomes are listed in Appendix 3.3. These focus on students developing foundational knowledge in geology and environmental studies, the ability to engage effectively in the scientific process from hypothesis generation to data evaluation and final communication of results, and critical thinking and communication skills. The undergraduate curricula for all concentrations support these learning outcomes by providing students with rigorous content knowledge, practical laboratory, field, and research experiences, and training in scientific writing, argumentation, and communication. These learning outcomes are assessed annually via the SACS (Southern Association of Colleges and Schools) assessment report using embedded coursework specific to each concentration. Results of each annual review are shared with all faculty and metrics and pathways for improvement of student learning are

discussed. Support for continued improvement in alignment between learning outcomes and course content is available for faculty including an all-faculty workshop held in December 2022 and follow up conversations.

3F. Teaching, scholarship, and engagement

Quality of instruction is evaluated each year during the annual faculty evaluation process, as well as episodically via peer-review. During the annual review, all student end of course feedback (quantitative and qualitative) is reviewed by the Faculty Evaluation Committee (for tenure-line faculty) and the Head (for all faculty). Peer reviews are provided for all faculty under consideration for promotion or for whom it has been three years since their last evaluation. The peer review committee consists of three faculty members, each of whom observe at least three class sessions and review course materials, who generate a holistic review and set of recommendations for improvement and then share their report with the candidate under review. The Head meets with each faculty member annually to discuss strengths and areas for improvement and consults regularly with faculty on specific teaching and mentoring issues. Faculty are also strongly encouraged to participate in continued pedagogical training and skill set development through the UTK Center for Teaching and Learning Innovation.

Experiential learning is a cornerstone of coursework in EPS and ranges from hands-on learning in class laboratories to active learning of novel datasets collected in the field, lab, or from other sources to independent research or internship opportunities.

All students in the Environmental Studies concentration are required to take at least three hours of GEOL 493 – Independent Study, with an option to take six hours. Similarly, students in the Planetary Geoscience and Water Science concentrations are required to take GEOL 493 or Field Camp. In all cases, the independent study may involve research experience with a faculty mentor although it might also entail an internship or other non- research work experience. Geology concentration students take Field Camp, but often also take GEOL 493 for research experience. Work internships offer a practical experiential learning opportunity that we feel will improve student career opportunities upon graduation. They are highly variable and often tuned to the student's interests and skill set. Some are paid whereas others are volunteer, but all have work hour requirements for the semester.

Thus, undergraduate research is encouraged but not required by any of the concentrations. Even when students complete GEOL 493 for research, they rarely produce a senior thesis or publishable paper. Instead, students often make a presentation, such as a poster at meeting at UTK or at a professional conference. Occasionally, undergraduate students appear as junior authors on a peer-reviewed publication.

Undergraduate majors also have the option of being lab facilitators in our GEOL 101–104 courses. In this role, they assist the GTA's and gain valuable teaching and communication skills and reinforce basic knowledge. This program has proven very popular among the undergraduate students who participate.

3G. Placement

Students graduating from the Geology and Environmental Studies concentrations pursue a wide variety of jobs and careers (Appendix 3.4). It is difficult to track post-graduate placement of undergraduates, but UTK has recently increased efforts to do this and has worked with EPS to improve our data collection.

Data from students graduating from 2018–2022 indicate that 76% of students with known outcomes (72% of students) found employment in geological or environmental fields or continued their education in graduate school following BS degree completion. It is possible that employment demographics for these students are very different than for the students who we were able to track. Still, these percentages are very encouraging, in that our students are using their education in a related field of study or employment.

Section 4. Graduate programs

4A. Graduate academic programs

The graduate program in EPS leads to a Master of Science (MS) or Doctor of Philosophy (PhD) degree in Geology. Both degrees have coursework and independent, original research as part of their requirements. The department also offers a concurrent MS degree for students in the PhD program who do not already possess a MS degree in the geosciences and participates in the three interdisciplinary programs: the Intercollegiate Graduate Statistics and Data Science Program, the Interdisciplinary Graduate Minor in Computational Science, and the Watershed Minor. The specific current curriculum requirements for these programs are outlined in Appendix 4.1.

4B. Course enrollments

Credit hour production for the graduate program has been generally stable over the past decade but has increased during the 2022-23 Academic year (Fig. 7) related to admission of new students with needs for coursework following graduation of many students who were on COVID extensions and revised enrollment expectations for funded students. The higher credit hour production for the graduate program is anticipated to stabilize at this higher value.

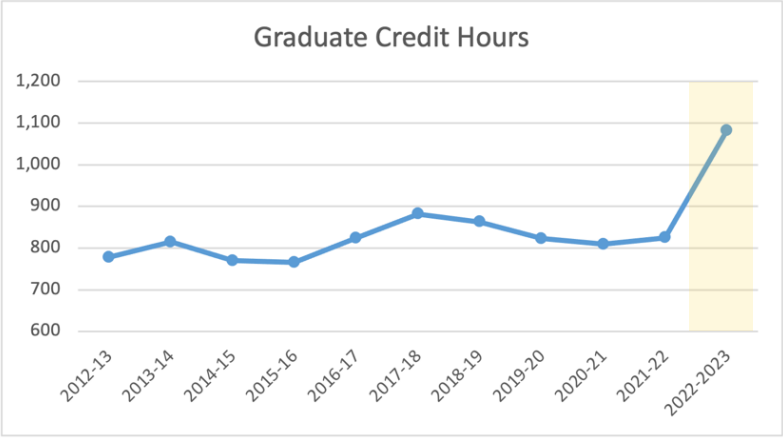


Figure 7. Past ten years of graduate enrollment.

Graduate courses are taught almost exclusively by tenure-line faculty and include a mix of courses including advanced topical courses co-listed for senior level undergraduates (GEOL 500-level courses)

and advanced seminar, communication, and laboratory methods courses offered exclusively for graduate students (GEOL 600-level courses).

EPS graduate courses span the diverse array of faculty teaching and research interests. Through time, the department has self-identified three broad, but synergistic, research areas (geology, planetary geoscience, and environmental geoscience). These topics also define a range of regularly occurring courses that establish advanced, "cornerstone," content essential for modern-day understanding of these topics. Many of these courses represent a mixture of lecture and discussion, with several having substantial field and laboratory components. Faculty also offer more advanced, in-depth courses, commonly in seminar format, to help students develop an understanding of rapidly advancing or emerging topics. Students regularly take courses outside of their research area, including courses in other departments or colleges, which broadens their knowledge base and gives them the opportunity to interact with students pursuing different research interests. Graduate courses typically enroll 6 to 15 students. Examples of recent courses are listed in Datapack 14, 14.A.

4C. Recruitment and student demographics

The department employs multiple approaches for graduate student recruitment. Advertisements are placed with professional societies (e.g., Geological Society of America) and posted on social media and with identity groups to increase exposure to potential candidates. Across time, the most effective recruitment tends to be very personal, with potential advisors contacting their colleagues at other institutions and contacting promising students identified at conferences. Many prospective students contact potential advisors and begin to build working relationships as part of the recruitment process and well in advance of applying. Regardless, all applicants are also asked to identify one or two potential advisors as part of their application package application; with this, faculty can identify and review all potential students who are interested in their programs. Rarely, general student inquiries come to the department and are forwarded to potential faculty advisors. Many prospective graduate students visit campus. Both potential advisors and the department work to cover most or all travel costs for recruiting. Visiting students typically meet with their potential advisors, other faculty members, and current students to get the "full experience" of being in graduate school and in our department.

After faculty advocate for a specific candidate to fill needs of their research group or programmatic goals, the Graduate Admissions and Program Committee (GAPC) reviews applications and ranks the candidates using a holistic review based on previously demonstrated academic excellence and potential for graduate study, as well as programmatic needs. The final decision of which applicants are offered GTA support is decided in a meeting of the full faculty.

Admissions data

Viewing aspects of the graduate student data during the past five years records changes strongly impacted by the effects of the COVID-19 pandemic. Consequently, we also evaluate data across the entire ten-year span since the last APR, where appropriate. In terms of interest in our program, we typically receive most applications for entry in the fall semester, so our discussion focuses on those data. During the first years of the decadal cycle, application numbers continued to rise, almost doubling in number to more than 80 in 2017, then stabilizing to ~70 in subsequent years until more recently (Datapack Tab 23).

Applicant quality remains high. Many applicants have participated in prior independent research. Since 2017, applicants have an average GPA of 3.47 for the PhD program and 3.40 for MS applicants (Datapack Tabs 28 and 29). These values are on par with the average student GPA reported in the previous APR. Admission rate has been approximately 25% for both degree programs in the past five years (Datapack Tabs 26 and 27), with admitted students exhibiting average GPAs of 3.53 and 3.44 for MS and PhD candidates, respectively.

Two aspects of our applicant pool stand out since the last APR. In terms of self-identified gender data collected by the University, the percentage of women applicants has continued to grow. Since 2017, the department regularly receives half, or more, of our applications from women. Likewise for the combined self-identified minoritized (by race, or international student) and unclassified groups, the department continues to receive an increasing number. Up through the Spring 2017 semester, the average number of applicants from these groups was under 12%, whereas since Fall 2017 that average number rose to 17%. Intentional changes to the admission process, such as removing the requirement of GRE scores and more holistic candidate consideration, have been implemented to improve our ability to attract and admit a more diverse pool of outstanding candidates.

The department has 28 Graduate Teaching Assistant (GTA) positions. In most admissions cycles, most matriculating students have an offer of GTA support (which includes stipend, tuition waiver, fee waiver, and health insurance), which is guaranteed for two years for MS and four years for PhD degree seekers. Stipend levels for GTAs are currently $17.1k/year for MS and $18k/year for PhDs. These stipends reflect a recent increase of $2700/year in Fall 2022 with support from the College of Arts and Sciences. The balance of incoming students (~25%) is admitted as Graduate Research Assistants (GRA), which carry the same benefits as a GTA, but whose stipends vary at levels set by their faculty supervisor or arrive with independent funding (e.g., NSF Graduate Fellowship, employment at ORNL, DoD Fellowship, NASA fellowships, etc.). Most faculty members supplement base stipends with “toppings” of summer salary, generally $2–5k/year. The department provides one-time “toppings” from a growing number of departmental fellowships (i.e., Swingle, Shanmugam, Taylor, Garrett, ExxonMobil funds), varying from $1–2.5k/year or from alumni gifts (generally $2–5k/year) (Appendix 4.2). Furthermore, the Graduate School offers competitive campus-wide fellowships for both new and continuing students, which we have been successful at obtaining.

Nevertheless, the overall yield for applicants to accept our offers of a GTA or GRA (or combination) has declined to about 75% (Datapack Tab 23, Fig. 8) since the last APR. This trend is generally driven by the PhD program. From declining student feedback, the primary concern has been related to the rapidly increasing cost of living in Knoxville (e.g., apartments near campus average $1600/month for 2022–2023) relative to the base PhD stipend ($1500/month for 2022–2023). Increasing funding for students has been a pressing matter for the department over the past decade, and positive results have made in endowment funds. However, stipend increases have not kept pace with the rapidly escalating cost of living in Knoxville. Increased investment in graduate salary will be necessary to continue recruiting and then supporting our very best candidates.

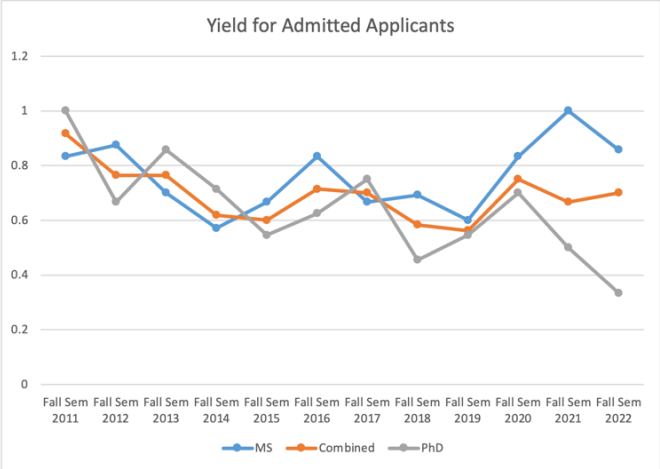


Figure 8. Yield over the past ten years.

Enrollment Data

Among matriculated students over the past decade, the department continues to see an increasing proportion of PhD students relative to MS students, which is in line with our R1 status and goals of increasing the departmental research profile. In 2012, the department had a nearly even ratio of MS to PhD students, whereas in 2022, EPS has two-thirds PhD students (Datapack Tab 1, Fig. 9).

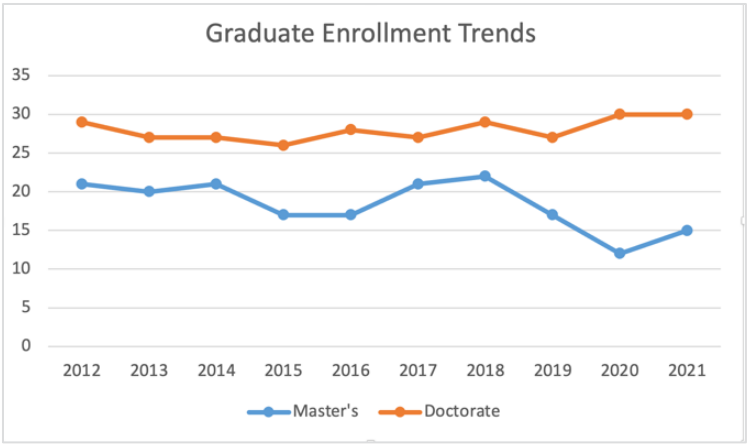


Figure 9. Graduate enrollment by degree over the past 10 years.

That said, our department, like most Earth Sciences departments, highly values the MS degree program because it provides both terminal degrees for those going into some industrial and educational workforce positions and is a credential for those interested in entering a PhD program (including ours). The total number of MS students peaked in the Fall 2018 semester, with a drop off during the pandemic years. Specifically, the department prioritized extending funding for many, especially PhD, students whose progress toward their degrees was delayed (particularly field work and laboratory work at external institutions), rather than admitting MS students. This resulted in accepting fewer students in the past two fall admissions cycles.

As with the total number of applicants, the department has seen a steady increase in the number of enrolled self-identified women students, which has risen to about 60% of the total graduate students from

about 45% in Fall 2014 when data became available (Fig. 10, Datapack Tab 19). The numbers for enrolled members of minoritized groups (including unclassified) sat at about 20% of the total population until the Fall 2016 through Spring 2020 semesters, after which time this number has recently increased to 20% again in Fall 2021 (Fig. 11, Datapack Tab 19).

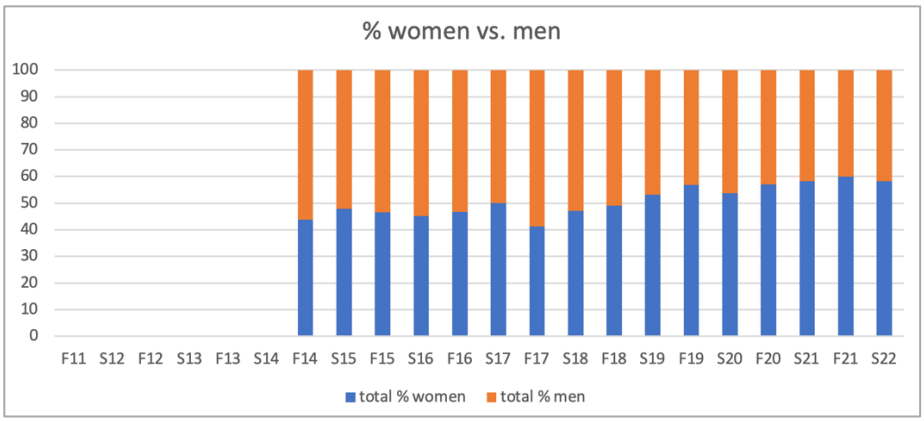


Figure 10. Gender trends since 2014. Prior to 2014, these data were not readily collected by UTK.

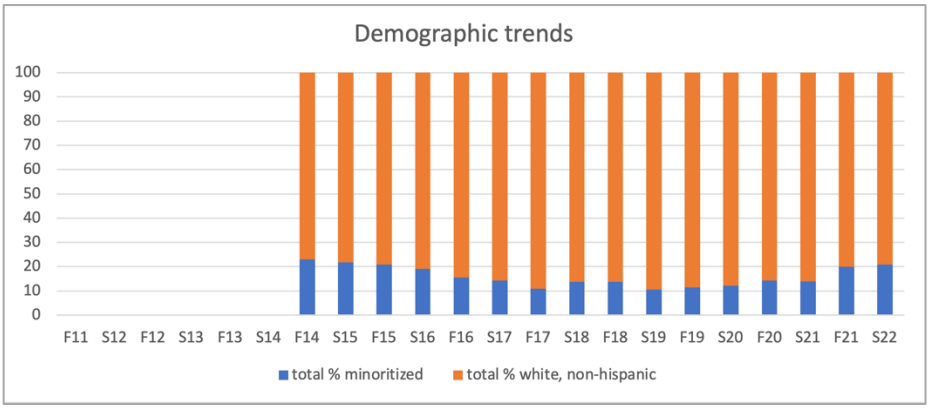


Figure 11. Trends in demographic data since 2014. Prior to 2014, these data were not readily collected by UTK.

The 2017–2022 data show a marked increase in PhD graduates (3.8/year) relative to the 2012–2016 data (2.4/year) and a corresponding decrease in MS graduates (Datapack Tab 4). This is a result of changing from a predominantly MS program to a predominantly PhD program over the past decade. From 2017 to 2022, the average time to completion for the MS degree is 3.3 years and 5.2 years for the PhD degree (Fig. 12). During the past decade, degree completion rates were approximately 90%. We are comfortable that five years is appropriate for a research-intensive PhD, but are trying to take measures to decrease the time required to complete a MS degree. These include providing incentives for MS students to submit their thesis proposals earlier during their degree program at UTK, and making MS students a lower priority for funding extensions once their guaranteed two-year support window has expired, to encourage urgency in completing degree requirements.

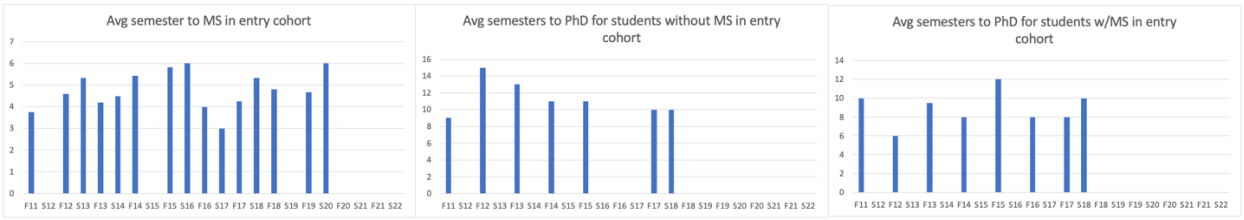


**Figure 12. Time to degree by entry cohort. ***Note most recent cohorts have not completed degrees by time of data collection.

4D. Advising, mentoring, and student success

In almost every circumstance, incoming graduate students are in contact with their potential advisor before they arrive at UTK. Students work closely with their intended major advisor to discuss possible courses for their first semester and to discuss other potential committee members. By the end of a student's first semester or early in the second, the remainder of the committee is selected by the student working in consultation with their major advisor. Students pursuing a MS degree select two committee members in addition to the major advisor, while PhD students need at least three more committee members, one of which must be from an academic unit other that of the student's department. Such committee members are referred to as external members and can either be drawn from other UTK departments or from institutions outside the university. Committee members are selected to bring the necessary research breadth and depth to ensure each student has the necessary mentorship in place to supervise the planned research. The Graduate Program and Admissions Committee (GAPC) reviews each student's thesis/dissertation proposal and committee composition to ensure appropriate scientific supervision.

Thesis or dissertation advisory committees meet at least annually and are responsible for recommending coursework, approving research proposals, scheduling preliminary exams for PhD students, ensuring the student is making adequate progress, and managing defenses for both MS and PhD students. Occasionally, students change supervisors, especially during the first year of their degree. The GPAC works with the student to help find a new supervisor and usually this change can be made quickly and smoothly.

Program learning outcomes are listed in Appendix 4.3. They focus on students developing advanced knowledge in the geosciences necessary to pursue independent research, the development and execution to fruition of a research project, and developing both oral and written scientific communication skills. The curricula for both graduate degrees support these learning outcomes by providing students with rigorous content knowledge, practical laboratory, field, and research experiences, and training in scientific writing, argumentation, and communication. These learning outcomes are assessed annually via the SACS (Southern Association of Colleges and Schools) report using embedded coursework and public defenses of student research. Results of each annual review are shared with all faculty and metrics and pathways for improvement of student learning are discussed. Support for continued improvement in alignment between learning outcomes and course content is available for faculty including an all-faculty workshop held in December 2022 and follow up conversations.

Most of our graduate students spend part of their time as a GTA, where they instruct laboratory sections for predominately GEOL 100- or 300-level courses or assist with instruction in non-lab courses. The departmental GTA Coordinator hosts a GTA training workshop for new and experienced GTAs before the

term starts. Duties and responsibilities are established, then, with the help of experienced GTAs, they discuss effective pedagogy for teaching active laboratories, give sample lab lectures, etc. The GTA coordinator works with students throughout the year to ensure high quality teaching. In every lab section that GTAs teach, they receive student evaluations, which are assessed by Department Head and the GTA Coordinator, to detect possible problems and identify students in need of mentoring. Students are further encouraged to take advantage of opportunities on campus, including the workshops offered by the UTK Center for Teaching and Learning Innovation, to enhance their pedagogical skill sets. About one PhD student per year is given the opportunity to teach a full lecture course at the GEOL 100-level. This is usually done during the summer and the student receives valuable experience, as well as additional pay.

4E. Teaching, scholarship, and engagement

Our goal is to deliver cutting-edge course content, while also preparing students for reality in the work and research world. Many of our courses stress research skills, teamwork, writing, and public speaking. Several courses require that students give conference-style presentations to gain critical speaking skills. One course uses an oral final exam intended to generate the feel of a "preliminary exam" or a question-and-answer session after a scientific conference presentation. Another course focuses on improving job-seeking skills, where students develop a complete job application, such as for an academic career or career in a national laboratory or government agency. Several courses require carrying out mini-research projects and writing up the results in journal format. Two upper division seminar courses have resulted in several student co-authored peer-reviewed journal papers over the past five years. Hands-on experience tends to be a key component of our GEOL 500-level courses. These include instrument-based geochemistry laboratory courses, as well as field-based courses in subjects like structure and tectonics, sedimentary geology, and hydrogeology. Quality of instruction is evaluated annually during the annual faculty evaluation process as well as episodically via peer-review in the same way described in section 3.F of the Undergraduate Program section.

Beyond the classroom environment, our graduate students are very active volunteering as docents at UTK McClung Museum to educate groups of elementary-, middle-, and home- schooled students, plus their teachers and parents. In addition to facilitating K-12 student group visits, EPS students have taken leading roles in organizing the annual Darwin Day celebration at the museum. This two-day festival is held in February, and graduate students lead visitors through a number of table-top demonstrations that increase understanding of the impact of Earth-related processes on their daily lives. Darwin Day is one of the largest and most successful outreach programs hosted by any unit in the University of Tennessee system, and typically brings in 300 to 475 students. During the COVID-19 pandemic, in-person visits were suspended, but UTK, and especially EPS, graduate student coordinators pivoted and developed lessons plans and activity kits that could be dispersed into the community. Graduate students also participate in outreach events at K-12 schools and in the Space Grant outreach program.

Student scholarship forms a critical component of the EPS graduate program. Upon matriculation, students receive a clear and consistent message from faculty mentors and their committee about the importance of personal research productivity, in its different forms, but also as part of the Department's research enterprise. Most students write theses and dissertations in the form of papers for publication. From 2017 to 2022, EPS graduate students improved their total scholarship (i.e., publications, awards, and conference abstracts) relative to the previous five years (2007–2011). This scholarly activity is related to the change to a more PhD-dominated program and the increase in faculty research funds and GRA positions.

Peer-refereed journal publications form one of the key indicators that show a steady rate graduate student scholarly productivity. Our graduate students published 83 papers from 2017–2022 for an average of about 14 papers per year (Fig. 13). By comparison, this represents an increase of 7 publications from the previous APR. Breaking the numbers down by degree, Ph.D. students published about 70% of the total papers, and equate to an average of two publications per graduated Ph.D. student. Master's degree students are also successful, with about 65% of those graduating authoring a publication. Faculty mentor our students to present work in appropriate and often high-profile venues including *Journal of Geophysical Research, Geobiology, Icarus, Paleogeography, Paleoclimatology, Paleoecology, Nature Ecology & Evolution, Geology,* and *Annual Reviews in Earth and Planetary Sciences.*

The steady level of research productivity is also present in the number of presentations given, with our students giving 198 talks and posters from regional to international conferences over the past five years. Common venues for our students include *AGU, GSA, Lunar and Planetary Science Conference,* and specialty conferences. Again, Ph.D. students lead the way, contributing about 74% of the total presentations, and averaging about 5.3 presentations per graduated student, while M.S. students averaged another 1.3. Lastly, our students have been effective at acquiring competitive grants to fund their research and receiving awards that recognize their scholarly achievements including grants from GSA, NASA, AGU, NSF, and the USGS. In sum, all of our students, regardless of degree program, actively contribute to the research enterprise of the department.

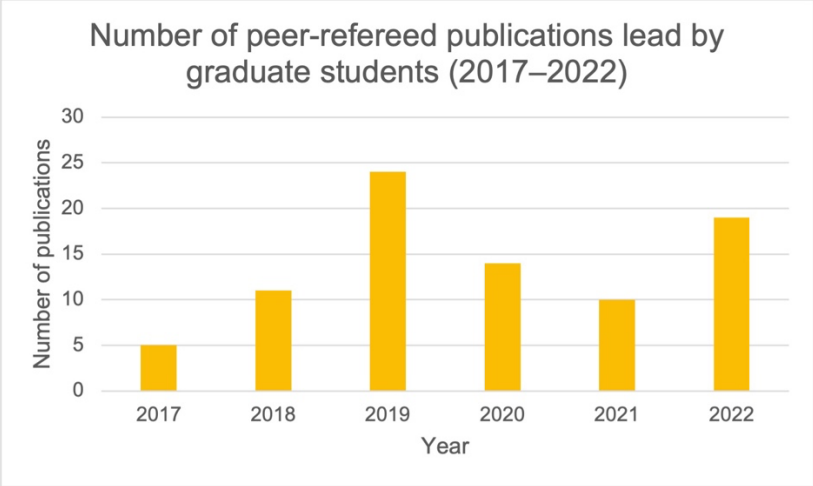


Figure 13. Number of peer-refereed publications per year led by graduate students

Each student is required to attend our weekly department seminar (the Klepser seminar series). This series is supported by an endowment in honor of a former faculty member and brings in prominent scholars with diverse interests from across the country and, occasionally from other countries, to give lectures on their research. During these visits, graduate students are invited to meet personally with the speaker to discuss their own research and/or to take the speaker to lunch or join them for an informal reception after each seminar. The high point of the series occurs once a year, when we bring in a high-profile scholar, including National Academy of Science members, to be the annual Klepser Lecturer who gives a regular lecture and then a follow-up seminar on an advanced research topic of their specialty.

Graduate students are also valued participants in departmental governance. Students are routinely called upon to help us with important department tasks such as faculty searches. Students interview candidates

as a group and then distill their comments, which are delivered to the faculty. We also include a graduate student representative at faculty meetings. These experiences expose our student body to many of the critical functioning aspects of the Department, which gives them the capacity to be fully involved in the learning and governing enterprise.

4F. Placement

The Department offers a broad spectrum of courses that MS students can tailor into groups targeted for employment opportunities in environmental management (e.g., Applied Ground Water Hydrology, Environmental Geology, Principles of Near-Surface Geophysics, Contaminant Hydrogeology), the energy industry (e.g., Sequence Stratigraphy, Ichnology, Applied Geophysics, Siliciclastic Petrogenesis, Carbonate Sedimentology and Geochemistry, Advanced Structural Geology, Petroleum Geology), and other sectors, such as K-12 teaching and government service. The courses, combined with dissertation research and teaching opportunities, can also prepare PhD students for an academic career.

Employment data for graduate students from 2017–2022 are given in Appendix 4.4. Within a short period after completion of their degree, our MS and PhD students enjoy nearly 90% employment in the geosciences or, for some MS students, entry to prestigious PhD programs. Broken down by degree program, 28% of PhD graduates go on to post-doctoral fellowships, after which they commonly seek, and land, academic positions. About 17% of our PhD graduates have gone straight to tenure-line faculty positions, with the remaining 55% are evenly divided between industry (22%) and governmental positions (22%), with the latter category including NASA and federally-funded research centers such as the Jet Propulsion Lab (JPL), Johns Hopkins University/Applied Physics Lab (JHU/APL), and Oak Ridge National Lab (ORNL). Of our M.S. graduates, 46% go directly into industry positions, typically in the environmental or energy sectors, with 17 % currently enrolled in PhD programs. Another 20% of MS recipients go on to government service, including at the municipal, state, and federal levels. No outcome data were available for 11% of PhD and MS recipients.

Section 5. Research and Scholarship

5A. Overview

EPS faculty members have developed strong and diversified research programs that are tightly linked to our graduate program. EPS faculty and students engage in robust research programs that are internationally recognized (and often involve international collaboration or field/lab work) and are sustained by significant external funds. A sample of this diverse research program can be gleaned from the titles of recent publications in the individual faculty profiles in Appendix 6.1.

As noted earlier, our major areas of strength are **geology** (geochemistry and petrology, paleobiology, sedimentation and stratigraphy, structure and tectonics); **planetary geoscience** (spacecraft exploration and remote sensing, planetary petrology, cosmochemistry); and **environmental geoscience** (aqueous geochemistry, geomicrobiology, hydrogeology, paleoenvironments and paleoclimates). The department has long-standing status as a force for planetary geosciences, including mission-based research that

includes remote sensing, petrology and geochemistry, and past and present environmental reconstruction. Recent hires have bolstered the Earth history research sector and the EPS faculty now include seven paleontologically-aligned faculty and represent one of the strongest paleontology programs in the Southeast. The research expertise and output from the environmental geosciences group focus on emerging global and societal concerns that are at the forefront of science, such as understanding methane emissions to climate, characterizing microplastics in the environment, and resolving perturbations to nutrient cycle dynamics and global biodiversity. Recent and upcoming faculty turnover, unfortunately, has weakened departmental research expertise in other core areas, including tectonics, natural hazards, hydrogeology, and climate change, which are vital areas of the Geosciences that each intersect strongly with two or more of our core research areas.

5B. External Funding

Tenure-line faculty are expected to have or be actively seeking external funding as part of their annual expectations in order to garner the funding necessary to conduct field research, sample analysis, and laboratory experiments. In most years, all tenure-line faculty have had at least one grant to support their research. Success in securing external funding is one measure of the overall efforts of our faculty and their maintenance of a reputation for scientific excellence.

Table 2 summarizes grant expenditures over the last decade. Faculty and researchers associated with the Department of Earth and Planetary Sciences have regularly carried between 42 and 73 grants per year (average 3.8 grants per tenure-line faculty/year). Expenditures from these grants averaged $2.5M per year, which is increased over the prior 5 years (as documented in the previous APR), when the number of grants averaged approximately 46 and expenditures averaged just less than $2.0M per year.

Table 2. Grant expenditures from the Department of Earth and Planetary Sciences. *2022 data through July 2022.

Year	Active Grants (# TT Faculty)	Direct Spending	Total Expenditures
2012	69 (17)	$ 1,598,302.66	$ 2,046,705.69
2013	61 (17)	$ 2,204,689.84	$ 3,284,206.09
2014	58 (18)	$ 2,187,115.99	$ 2,781,810.70
2015	73 (16)	$ 1,988,032.43	$ 2,613,413.46
2016	69 (16)	$ 1,767,562.62	$ 2,349,730.09
2017	60 (16)	$ 1,941,139.49	$ 2,639,976.69
2018	60 (15)	$ 1,987,969.24	$ 2,732,236.11
2019	51 (13)	$ 2,280,098.06	$ 2,854,896.37
2020	48 (13)	$ 1,736,920.99	$ 2,230,072.66
2021	42 (11)	$ 1,768,011.77	$ 1,856,175.96
2022*	42 (14)	$ 1,367,451.65	$ 1,782,833.29
AVERAGE	**56**	**$ 1,922,899.21**	**$ 2,512,535.14**

The majority of these grants are from NASA, with individual grants from a variety of programs (e.g., Cosmochemistry, Solar System Workings, Planetary Science and Technology, Mars Fundamental Research, Planetary Data Analysis, Exobiology, and the Apollo Next Generation Sample Analysis programs). In the last decade, we have also had a number of faculty receiving funding to support participation in NASA missions (e.g., Mars Exploration Rover mission, Curiosity Rover mission, Perseverance Rover mission, Dawn Asteroid Orbiter mission, Mars Odyssey mission, and the Lunar Reconnaissance Orbiter mission). Furthermore, faculty receive substantial funding from the National Science Foundation (e.g., Petrology and Geochemistry, Geobiology and Low Temperature Geochemistry, Tectonics, Marine Geology and Geophysics, Systematics and Biodiversity Science, and Sedimentary Geology and Paleontology, GeoPaths as well as cross-disciplinary programs like Dimensions of Biodiversity and Frontier Research in Earth Science). Other funding sources are varied and are outlined in Table 3.

Table 3. Major sources of external funding for EPS faculty

Major sources external funding
NASA (multiple science programs)
NASA (mission specific science)
NSF (multiple science programs)
DOE (multiple science programs)
American Chemical Society
US Geological Survey
National Geographic Society
ORAU and ORNL programs
National Wildlife Federation
Other (IODP, USDA, US Army, NOAA)
Foundations (Keck, Leakey, etc.)

The new faculty hired in 2022 (Huang, Hembree) have already transferred grants to UTK, and their addition (plus Stigall) increases the number of grant-seeking faculty with a track record of funding success. We anticipate increased total grant funding and expenditures as tenure-line faculty numbers rebound in general. We further anticipate new revenues of funding including programs within DOE, NSF, and other agencies and foundations associated with the expansion of societally-relevant environmental and tectonic research related to the new faculty hires proposed in section 6A.

5C. Interdisciplinarity and Collaborations

Research and scholarship in EPS is highly collaborative. Most grants and publications include collaborators in other institutions and many graduate student committees include faculty experts from other institutions. Within UTK, research collaborations are strongest with Ecology and Evolutionary Biology, Physics, and the colleges of Engineering and Education. Faculty also currently collaborate with and are interested in expanding collaborations with scientists at the UTIA, Oak Ridge National Labs.

Section 6. Faculty and Staff

6A. Faculty profiles and demographics

The current faculty of EPS includes a mix of tenure-line faculty, career-track lecturers, and short-term lecturers (known at UTK as teaching post-docs). The current distribution is partly an intentional increase to support expanded teaching capacity and quality (career-track lecturers) and partly a temporary solution (teaching post-docs) to cover teaching needs due to the loss of tenure-line faculty. The department is committed to excellence in research and education, which includes a robust plan to resume the hiring

strategy proposed in the 2019 Strategic Plan and rebuild the research-active tenure-line faculty to a more robust size while maintaining a strong cohort of outstanding career-track lecturers.

Tenure-line faculty

EPS has experienced substantial turnover in tenure-line faculty since the last APR in 2012. At present, the department consists of 14 tenure-line faculty (Datapack Tab 17.A), down from a high of 18 in 2014 (Datapack Tab 16). Over the last decade, the changes include nine faculty hires (Szynkiewicz in 2013, Steen in 2014, McCanta in 2016, Dygert in 2017, Romaniello in 2019, Thomson in 2020, Huang in 2022, Hembree in 2022, and Stigall in 2022), four faculty who left to pursue careers outside of UTK (Baker in 2016, Burr in 2019, Emery in 2019, Romaniello in 2022), and five faculty who retired after long and productive careers at UTK (Labotka in 2014, McSween in 2016, Taylor in 2017, Hatcher in 2018, Perfect in 2021). Two other faculty members (Dunne and McKay) moved from EPS faculty positions to hold full time college-level administrative positions at UTK. One (Steen) transferred their tenure home to Microbiology in 2021 and has announced plans to resign from UTK after the Spring 2024 semester to accept a tenured faculty position at the University of Southern California. Notably, many of these faculty members were not replaced with tenure-line hires, which has resulted in a decline in research faculty numbers and loss of expertise in core areas such as hydrogeology.

Presently, three faculty associated with EPS have tenure homes elsewhere on campus. Drew Steen's tenure resides within the Department of Microbiology with 40% appointment in EPS, and Terry Hazen, a UT-ORNL Governor's Chair, is based in the Tickle College of Engineering and has a 20% appointment in EPS. Elizabeth Herndon is a joint faculty member based at ORNL.

Despite this turnover, we remain a faculty with both strength and diversity across the geosciences, and a commitment to teaching and research in EPS (Table 3; See Appendix 6.1 for Faculty CVs). Two recent hires (McCanta and Dygert) capably fill the shoes of two of the department's prominent retired planetary geoscience faculty (McSween and Taylor) and bring the department new strengths in experimental petrology across a range of temperatures and pressures. Two more hires (Szynkiewicz and Huang) bring scientific and instrumental strength and expertise in isotope geochemistry that provides growing potential for collaboration across our faculty and other departments across campus. Recent hire (Thomson) adds wide-ranging expertise in the planetary sciences, which continues to grow as key senior faculty (sedimentologists Fedo and Kah) have also added the planetary realm to their research profiles. Finally, our newest additions with expertise in marine and terrestrial ecosystems (Stigall, Hembree), who bring new directions to our existing strength in paleontology.

One notable aspect of faculty compensation (Datapack Tab 18) is the significant salary compression among full professors. This faculty cohort is underpaid relative to all peer comparisons whereas the associate and assistant professor cohorts are better compensated. This salary compression is significant at a level that cannot be remedied through the limited discretionary funds allocated within the annual compensation process.

Table 3. Current tenure-track line faculty associated with the Department of Earth and Planetary Sciences

Name	Position	Current Activities
Dygert, Nicholas	Assistant Professor	Igneous Petrology (Earth and Planetary Systems)
Engel, Annette	Professor	Environmental Geochemistry (Geomicrobiology; Cave and Karst Systems)
Fedo, Christopher	Professor	Sedimentary Geology (Siliciclastic Rocks; Stratigraphy; Earth and Mars)
Hembree, Dan	Professor	Sedimentary Geology (Ichnology, Soil Science)
Huang, Shichun	Associate Professor	Isotope Geochemistry (Earth System to Solar System)
Jessup, Micah	Associate Professor	Structural Geology and Tectonics
Kah, Linda	Professor	Sedimentary Geology (Chemical Rocks; Stratigraphy; Earth and Mars)
McCanta, Molly	Associate Professor	Igneous Petrology (Earth and Planetary Volcanology; Meteorites)
McKinney, Michael	Professor	Environmental Science (Sustainability, Invasive Species)
Moersch Jeffrey	Professor	Remote Sensing (Earth and Planetary Systems)
Stigall, Alycia	Professor	Paleontology (Paleoecology, Biogeography, Macroevolution)
Sumrall, Colin	Professor	Paleontology (Systematics; Phylogenetics and Evolution)
Szynkiewicz, Anna	Associate Professor	Isotope Geochemistry (Surface Processes; Earth and Mars)
Thomson, Bradley	Assistant Professor	Geomorphology (Planetary Systems)
Terry Hazen	Governor's Professor (20%)	Environmental Science (Environmental biotechnology); Based in Engineering
Steen, Andrew	Assistant Professor (40%)	Environmental Science (Ocean Sciences; Microbiology), Based in Microbiology
Dunne, William	Professor (Admin)	Associate Dean, Tickle College of Engineering (Structural Geology)
McKay, Larry	Professor (Admin)	Associate Dean, College of Arts and Sciences (Hydrogeology)

At present, our greatest staffing shortfalls lie in the realms of environmental sciences and structural geology and tectonics. Environmental sciences has been impacted by recent retirements (Perfect), moves to college administration (McKay), upcoming resignation (Steen), and potential upcoming retirements (McKinney). Structural geology and tectonics has been decimated by a move to college administration (Dunne), and two retirements (Hatcher and Jessup). These subdisciplines are critical to the future of our department, and it is imperative to expand and retain departmental research capacity in both areas. Environmental sciences remains our fastest growing interest among our undergraduates, and tectonics is the fundamental geologic process that unifies our many subdisciplines of research. To the state of Tennessee, these are key areas have high societal impact, such as by helping to understand the profound impacts of climate change on the hydrologic cycle and other environmental issues like water quality, as well as for predicting geologic hazards and resource distribution or use from mountainous terranes. Hiring in these areas will also provide a robust pathway to increase diversity within the EPS faculty.

As outlined further below, we propose a strategy of one or two faculty hires per year over the next five years with a goal to obtain a department size of 18 tenure-line faculty to maintain robust research programs in these areas. The overall goal for tenure-line faculty size established in the 2012 APR and 2016 mid cycle review was 20 tenure-line faculty. We maintain that number as a long-term goal. However, given the current size of 14 faculty (13 by August 2023), ***we seek to reach a balance 18 tenure-line faculty and four career-track lecturers by the next five year mid-cycle review.*** Furthermore, the current distribution of faculty career ranks is notably slanted toward more experienced faculty. Following the successful application by Dygert for tenure this year, Thomson will be the only remaining Assistant Professor in Fall 2023. The addition of more assistant professors will provide additional energy and vigor within the department.

Lecturers and Adjunct Faculty

Since 2012, EPS has expanded its number of career-track lecturers from one to three (Benner, Drumheller-Horton, Jacobsen). EPS has also hired adjunct faculty or retired faculty (Hatcher) to teach critical courses that could not be covered otherwise. These faculty members are critical members of our faculty and provide outstanding instruction, primarily in the introductory and environmental geoscience courses, along with valuable service and research or outreach contributions. For the past several years, EPS has also included two faculty members in short-term, teaching post-doc roles (presently Robinson and Snyder). These positions are provided as placeholders to EPS to help stabilize instruction due to the departure and non-replacement of tenure-line faculty, such as McKay who moved to CAS administration and Perfect who retired. With the increased demand for EPS introductory courses and projected continued growth in undergraduate enrollment at UTK overall, we propose moving one of these positions (Robinson) to career-track lecturer in Fall 2023.

Although not included within Datapack Tab 18, it is also notable that lecturer compensation is quite low (starting salary of ~$45k) relative to peer institutions. Relatedly, the department has recently lost lecturers (Haile) to other institutions. Our department and our counterparts in the College continue to advocate for increased lecturer compensation.

Demographics and Hiring Plans

Historically, geoscience has been an exclusionary discipline to both women and people of color. The current faculty, however, includes 37% women, including many women in senior positions, which is a comparatively good proportion. As noted above, the geosciences are the least diverse STEM discipline, and our current faculty reflect this historical bias. 17 out of 19 current faculty members (89.5%) identify as white, non-Hispanic (Datapack Tab 20). The faculty are committed to increasing diversity in all dimensions within the department and will seek opportunities to recruit outstanding faculty members from underrepresented groups in future hires by expanding the use of inclusive recruitment practices and seeking colleagues from areas of geoscience that may include more representation from diverse communities.

As noted above, two key areas where tenure-line hires and active research are needed are tectonics and environmental geoscience. Both areas have strong overlap with societal concerns and applied science, areas which research has demonstrated tend to include more diverse geoscientists than other research areas. These areas also have strong overlap with UTK major research initiatives include ONE Health and Global Energy Ecosystems. We seek to growth these areas of significance to modern Earth Systems while maintaining strength in our signature Planetary Sciences program.

Modern Earth Systems education and research involves climate change, societal water needs, societal energy needs, securing and utilization of Earth materials to advance both society and the nation, reducing societal pollution impacts on nature, etc. Focusing on these critical societal issues will enable the department to purposefully collaborate with other UTK programs such as environmental engineering, soil science, environmental biology, computer science because these issue tie to the four major research thrusts of the University:

- **Advanced materials and manufacturing** – identifying, securing and cleanly extracting earth materials for these needs; understanding complex behaviors of earth materials in deformation, and developing manufacturing techniques with earth materials both on and off planet.

- **Human Health and Wellness** – the interaction of people with their environment, particularly in regions such as rural Appalachia has fundamentally affected their health whether it concerns security of water supplies or sources of pollution.
- **Artificial Intelligence Initiative** – Earth Science data sets can be both sparse and have a multitude of contributing parameters, so solving analysis and computational issues for these data sets has value for broad research questions in A.I. and Data Science.
- **Global Energy Ecosystems** – Earth materials have historically sat at the center of societal energy needs, transportation challenges and negative pollution impacts. Which materials are most important changes through time such as at the present with the shift away from Earth-derived carbon-based materials and a greater focus on strategic critical rare Earth materials.

The Department recommends to the College and University that they fill four tenure-line faculty positions over the next few years to support these interdisciplinary research priorities in terms of their interactions with Earth and Planetary systems. The first two would be:

- **Hydrogeology/Water Sciences** – an understanding of groundwater is key to issues of water security, water cleanliness, and understanding the hydrological system of the entire planet. This position would have great opportunities to collaborate with interdisciplinary collaborative research team in Environmental Engineering, UTIA, and even Social Work, while supporting goals in Human Health and Wellness, Global Energy Ecosystems and potentially the A.I. Initiative.
- **Tectonics** – an understanding of Earth movement and the products of such movements like fractures that host water or hydrocarbons, fault-related seismic activity, and the impact of mountain belts, seafloor spreading systems and subduction zones on Earth climate systems relates directly to Global Energy Ecosystems. Tectonically related geologic hazards and structural materials properties relate to Human Health and Wellness and Advanced materias and manufacturing, respecitively. Also, fracture analysis could be quite important for ice lithosphere analysis in the planned NASA mission to Europa, for example.
- **Environmental Impact of Climate Change** – an understanding the impact of climate change on environmental systems is a critical area research that supports the citizens of Tennessee. Climate change impacts include increased flooding, landslides, and other natural hazards, and each of these relate to sustainability questions important to the local community. This research overlaps strongly with Human Health and Wellness, UTIA, A.I. Initiatives as well as collaborative programs related to policy in the Baker Center and sustainability in Geography, Ecology and Evolutionary Biology, and elsewhere.
- **Critical Minerals and Energy Resources** – an understanding of the distribution and properties of mineral resources is critical to developing a modern energy infrastructure. Critical minerals, such as lithium, occur in the bedrock and coal spoil piles of Tennessee. Better understanding these resources connects with strongly with the Global Energy Ecosystems, Advanced Materials and Manufacturing, initiatives in Engineering, and research directions of the Tennessee Geological Survey.

Further, all of these potential faculty hires would be supported by the excellent research facilities in Strong Hall including the ICP-MS, stable isotope, and electron microprobe facilities and would collaborate with other university core facilities on campus.

Specific hiring plans for the next five years to address these needs and accounting for anticipated retirements/resignations and planned university-wide enrollment growth in introductory courses are summarized in Fig. 14.

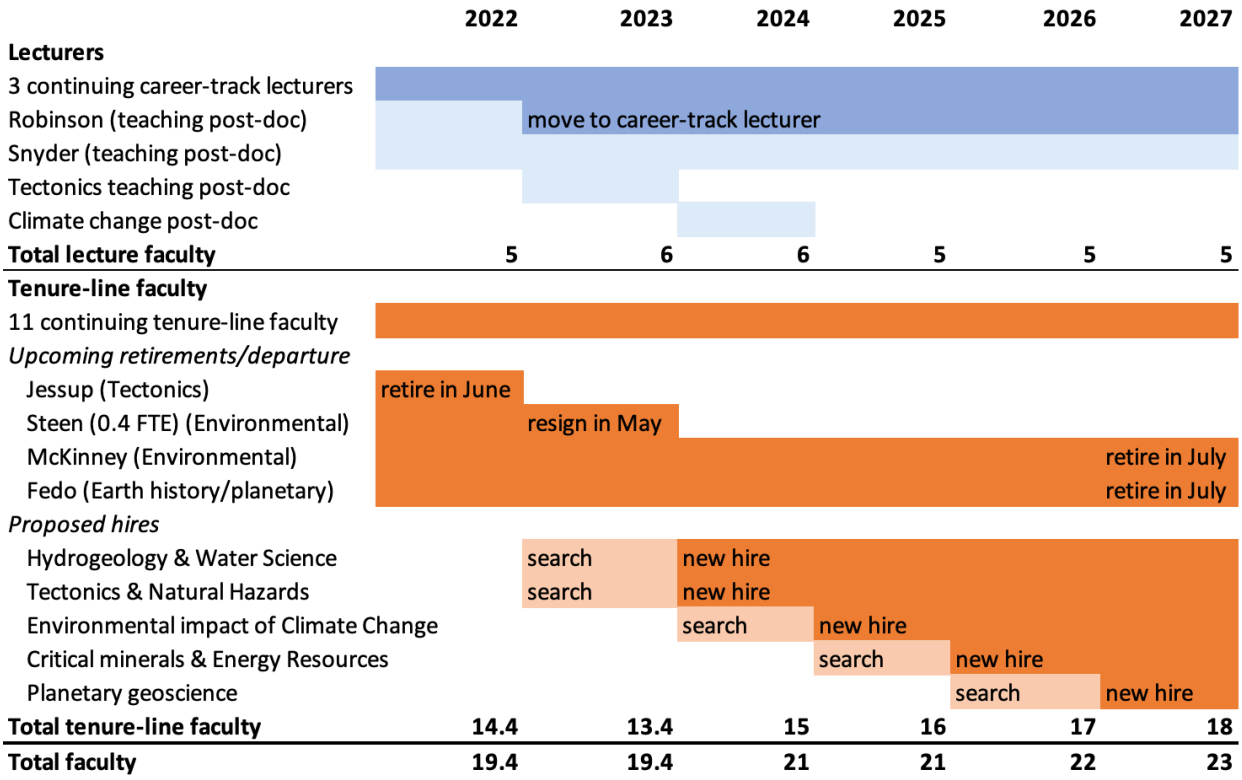


Figure 14. Proposed hiring pathway to a robust research and teaching faculty over the next 5 years.

The department strongly encourages professional development and mentoring opportunities for faculty. Formal programs including Faculty Development Leave (Sabbatical) are available through the University. Additional teaching releases are available through course buyouts. A zero teaching assignment (ZTA) semester is provided to all incoming assistant professors to use during their pre-tenure interval. The department employs a mentoring committee framework to provide career development advice to post-doctoral associates and assistant and associate professors. The College of Arts and Sciences offers a Mentoring Matrix Program that provides opportunities for faculty at all levels to gather with a group of mentors from outside the department. The Office of the Provost provides additional opportunities for leadership development training to faculty at multiple career stages.

6B. Staff profile and demographics

The department includes four administrative staff including a business manager, procurement officer, grants and contracts officer, and an academic support administrator. This represents an increase in one position (i.e., procurement and grants were previously a combined position) since the 2016 mid-cycle review. This increase in administrative support has facilitated greater productivity among faculty and was necessary to ensure full compliance with University and federal guidelines.

There has been considerable staff turnover in the past two years. Two staff members retired, including the former business manager who had served the department for 44 years. One continuing staff member shifted positions from academic to grants administration. Presently, the staff work well together and are efficient managers of departmental administrative business.

The department also includes three technical staff who oversee research labs and instrumentation, specifically the electron microprobe, stable isotope facility, and a geochemistry lab. Only the electron microprobe position and a portion of the stable isotope manager position are funded through the department's base budget. The remaining staff person has been entirely funded by external grants and contracts. The new ICP-MS core facility will also include a staff technician, which will be funded via grants and contracts.

In prior reports, the department has noted that this level of scientific staffing is insufficient to promote maximum scientific output. Notably, other departmental facilities, such as the rock preparation room and Geochemistry Teaching Laboratory, require at least a part-time staff person to maintain the facilities and assist students and other users with their research projects. An increase in technical staff by a full position for EPS would improve stability and access for all departmental and other campus researchers.

There is limited diversity among the current EPS staff. All staff members identify as white/non-Hispanic and our administrative staff are all women. Over the next five-year period, there is potential for staff turnover in EPS due to potential retirements, as one technical and two administrative staff members are likely to reach retirement eligibility. It is also important to note that staff retention is an issue of concern at the university level, partly due to inadequate compensation relative to competing employers. EPS staff are highly valued department members, and we seek strongly to retain their outstanding expertise. It will be critical to replace each of these positions immediately with highly qualified staff members, which provides an opportunity to increase diversity in the unit while supporting the university's diversity goals through inclusive search processes.

6C. Faculty scholarly and teaching activity

Faculty workload varies between tenure-line faculty and lecturers. Faculty expectations are clearly identified in the departmental Bylaws for tenure-line faculty and include teaching an average of 2.5 courses/year, publishing a minimum of two peer-reviewed papers/year, having or actively seeking grant funding each year, and contributing to departmental, university, and societal service as appropriate for rank. Productively is assessed annually against a three-year moving average. Lecturers have variable workloads, with contributions of teaching, research, and service. Standard expectations include four large lecture courses per year, although the number and specific course level varies with department need and specific faculty workloads. Lecturers also have specified departmental service roles that reflect their personal strengths and preferences, and some (Benner and Drumheller-Horton) have research expectations.

All EPS faculty contribute to the teaching mission and are expected to provide outstanding learning experiences for students through classroom learning and/or research mentorship. As noted in Section 3C, the strategic deployment of faculty into high enrollment courses in recent years has resulted in EPS faculty SCH production per person that is higher than typical for other natural science departments, the College as a whole, and much higher than the overall University average (Datapack Tab 10). Tenure-line faculty primarily teach upper division undergraduate and graduate courses, while lecturers teach the majority of introductory courses plus some advanced courses (Datapack Tab 13).

Table 4. Faculty peer-reviewed journal publications. Publication data from World of Science and represents an incomplete, but reprsentative summary. This table includes faculty prior to their hire (pale grey boxes), faculty who have since left the department (dark grey boxes), and faculty who have retired (medium grey boxes). Only current faculty are included in the count of publications per year; total publications includes all research active faculty including retired faculty, ORNL joint faculty, and lecturers. *2022 data through July.

Name	Position	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022*
Baker, Gregory	Former Faculty	2	0	0	0	0	0	0	0	0	0	0
Burr, Devon	Former Faculty	3	4	3	8	2	5	3	1	2	1	4
Dunne, William	Professor (Admin)	0	0	1	1	0	0	2	0	0	0	0
Drumheller, Stephanie	Lecturer	1	1	2	0	2	1	0	2	7	0	2
Dygert, Nicholas	Assistant Professor	0	2	1	2	3	3	1	5	2	5	4
Emery, Joshua	Former Faculty	3	5	7	13	5	7	9	14	19	5	8
Engel, Annette	Professor	3	8	4	3	3	7	0	3	2	1	1
Fedo, Christopher	Professor	2	0	0	3	1	2	1	0	12	4	2
Hatcher, Robert	Retired	1	3	0	0	1	6	0	0	1	0	1
Hembree, Dan	Professor	1	1	7	3	4	4	2	2	1	1	0
Herndon, Elizabeth	Joint ORNL Faculty	0	0	2	9	3	2	5	2	5	5	1
Huang, Shichun	Associate Professor	3	6	5	2	6	6	4	4	6	7	0
Jessup, Micah	Associate Professor	2	2	2	2	2	1	0	3	1	1	2
Kah, Linda	Professor	5	10	8	9	6	5	6	9	8	5	1
Labotka, Theodore	Retired	1	0	0	1	1	0	0	0	0	0	1
Liang, Liyuan	Research Faculty	10	10	10	11	4	2	0	0	0	0	0
Mayes, Melanie	Joint ORNL Faculty	4	6	6	2	2	1	4	11	9	12	2
McCanta, Molly	Associate Professor	1	1	3	4	4	3	1	4	1	0	3
McKay, Larry	Professor (Admin)	5	2	1	1	2	3	3	5	0	0	1
McKinney, Michael	Professor	1	1	2	0	1	0	4	3	2	1	0
McSween, Harry	Retired	20	25	9	19	8	6	11	7	1	3	1
Moersch Jeffrey	Professor	1	4	6	3	1	1	4	1	3	2	1
Perfect, Edmund	Retired	2	7	6	3	3	5	3	8	2	4	0
Riding, Robert	Research Faculty	2	0	7	4	4	2	2	3	4	2	2
Romaniello, Steven	Former Faculty	2	2	4	6	6	6	7	8	3	7	4
Steen, Andrew	Assistant Professor	1	5	3	3	1	2	3	10	5	4	2
Stigall, Alycia	Professor	1	3	8	4	2	3	6	3	3	1	1
Sumrall, Colin	Professor	5	5	1	5	2	5	1	4	6	1	6
Szynkiewicz, Anna	Associate Professor	2	2	2	2	2	1	0	6	2	3	1
Taylor, Lawrence	Retired	4	4	2	2	7	5	2	2	0	0	0
Thomson, Bradley	Assistant Professor	2	0	1	1	2	2	2	1	0	1	0
Total TT Faculty		17	17	18	16	16	16	15	13	13	11	14
Pubs per TT Faculty		4.5	4.8	3.2	4.8	3.2	3.8	2.7	5.3	3.8	3.6	1.7
Total Pubs per Year		66	88	72	84	62	76	66	109	89	76	38

Throughout this period of faculty turnover in the past decade, EPS has continued to produce high quality science. Though a number of our faculty publish books and other media, the most readily quantifiable measure of faculty research productivity is peer-reviewed publications. Table 4 provides publication data from all faculty members active in the department since the previous APR in 2012. When tenure-line faculty with a home appointment in EPS are considered alone, the average number of publications per active tenure-track faculty member per year between 2012-2021 was 4.0 (ranging from 2.7 to 5.3 in individual years), and the total average number of publications for the research-active faculty was 79 (ranging from 62 to 109 in individual years). Our faculty also regularly publish in prestigious scientific journals such as *Nature* (impact factor 49.96), *Science* (impact factor 47.73), *Annual Reviews of Earth and Planetary Sciences* (impact factor 16.30), and the *Proceedings of the National Academy of Sciences* (impact factor 12.78).

The impact factor of published research is commonly quantified in terms of a series of indices (Table 5). The most direct of these idices is the *h*-index, which is defined as the number of papers (n) that each have at least n citations. Another metric is the G2-index, which emphasizes the number of highly cited papers

and is defined as the number of papers (n) that each have at least n^2 citations. Finally, the i10-index, which is defined as the number of papers (n) that each have at least 10 citations, provides an overall measure of the impact of a researcher's work. For this data compilation, we have used data provided from the Clarivate World of Science Core Collection database. Although no single database is capable of capturing a researcher's full output—for instance, most databases do not index individual chapters in books and edited collections, the World of Science Core Collection provides key consistency for exploration of these metrics.

Tenure-track EPS faculty have publication records that range from 9 to 39 years; each of the indices noted above tend to increase through the years with continued visibility of the publications. Across the department, *h*-indices range from 11 to 42 (with an average of 13 for assistant professors, 19 for associate professors, and 27 for professors); G2-indices range from 5 to 11 (with an average of 6 for assistant professors, 7 for associate professors, and 8 for professors); and i10-indices range from 12 to 74 (with an average of 15 for assistant professors, 27 for associate professors, and 45 for professors).

Table 5. Measure of publication impact for tenure-track faculty. Data collected July 2022

Name	Position	First Paper	Years	Pubs	H index	G2 index	i10 index
Dunne, William	Professor	1983	39	43	19	7	27
Dygert, Nicholas	Assistant Professor	2013	9	28	12	5	14
Engel, Annette	Professor	2000	22	56	25	8	38
Fedo, Christopher	Professor	1990	32	71	29	10	46
Hembree, Dan	Professor	2003	19	41	14	5	18
Huang, Shichun	Associate Professor	2007	15	64	28	8	46
Jessup, Micah	Associate Professor	2005	17	36	20	9	27
Kah, Linda	Professor	1996	26	93	42	11	74
McCanta, Molly	Associate Professor	2002	20	37	16	6	21
McKay, Larry	Professor	1984	38	92	32	9	61
McKinney, Michael	Professor	1986	36	78	31	8	53
Moersch, Jeffrey	Professor	1993	29	77	31	11	65
Steen, Andrew	Assistant Professor	2006	16	40	16	7	19
Stigall, Alycia	Professor	2004	18	48	21	6	30
Sumrall, Colin	Professor	1992	30	86	21	6	40
Szynkiewicz, Anna	Associate Professor	2006	16	32	12	5	15
Thomson, Bradley	Assistant Professor	2007	15	17	11	6	12

To benchmark these data, we provide a comparison of these statistics—in particular, the most widely used *h*-index—between tenure-track faculty members in EPS and those that reside within comparable Geoscience departments at the University of Kentucky (UK), the University of Georgia (UG), the University of Florida (UF), and the University of California at Davis (UCD). We note that the first of these (UK) is considered to be a peer institution of the University of Tennessee in terms of budget, total expenditures, and institutional research (cf. https://budget.utk.edu/peer-institutions/), whereas the latter two (UG and UF) are considered aspirational institutions. We have added UCD, whose Geoscience program ranked 19th in the 2023 US News and World Report's ranking of American graduate programs (cf. https://lettersandscience.ucdavis.edu/rankings-distinctions).

Figure 15 shows the results of this analysis in two graphs. The first is a comparison of the *h*-index to the years since first publication, wherein the points that lie lower on the Y-axis record published works that have received fewer citations for the time that they have been in the public sphere. By contrast, points that lie higher on the Y-axis record published works that have received more citations, for the time that they have remained in the public sphere. Regression lines show that EPS has substantially higher citations

than UK (peer) and UG (aspriational), is nearly identical to that of UF (aspirational), yet still lags behind one of the highest-ranked departments in the country (UCD). The second graph compares the H-index to the total number of publications, which denotes a continuation of high-quality research through the years. Here, regression lines shows EPS on a more positive trajectory than our standard peer and aspirational institutions, and places us nearly identical to one of the highest-ranked deparments in the country (UCD).

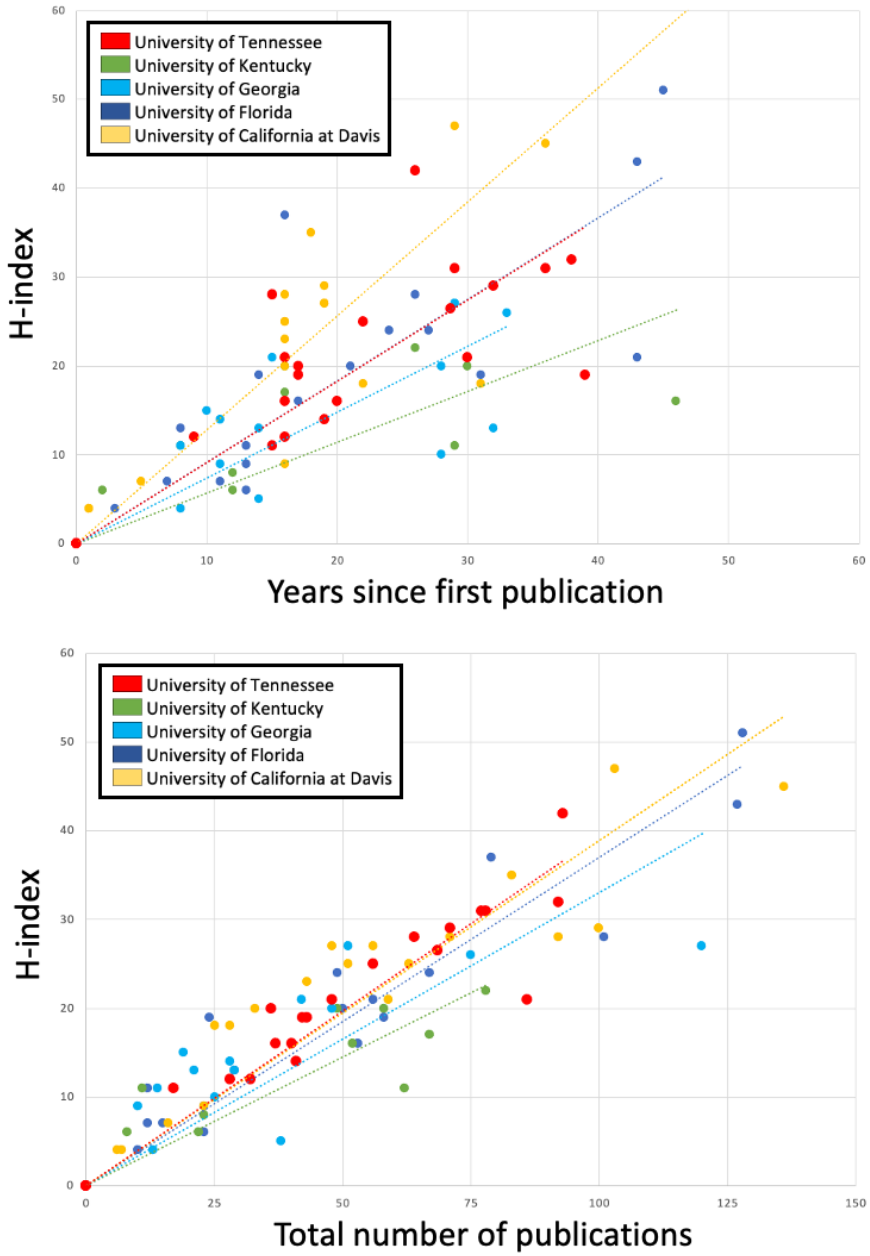


Figure 15. Comparison of publication metrics between UT EPS and some peer and aspirational departments.

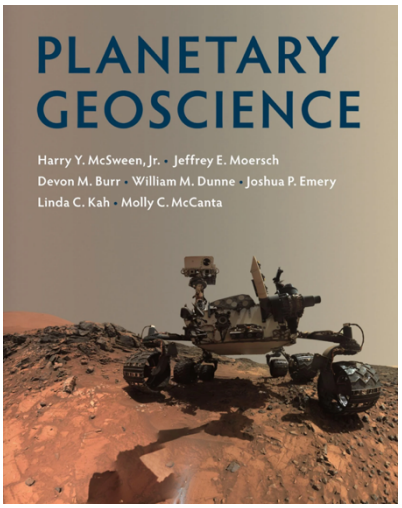
As another indicator of research quality, we show how our graduate and undergraduate students contribute to the scientific outcomes of the department. The expertise of our graduate and undergraduate students is then transferred to the broader economy by their employment in government, industry, and educational realms (See Sections 4, 5). Table 6 shows research active faculty during the

period since the last APR (2012), including a count of their graduate and undergraduate student mentors, a count of their publications, and the percent (and number) of these publications that contained student authors. We see that across the faculty of the Earth and Planetary Sciences, we see an average of 36 publications per faculty from 2012 to 2022, with an average 47% of these (or 16 of the 36 publications) having students as authors. Many of these are PhD students, who are oftentimes first authors on the publications, but the numbers include both MS and BS students as well. It is also worth noting that, prior to the COVID-19 pandemic, the Department of Earth and Planetary Sciences was regularly sending between 10-20 graduate and undergraduate students per year to present their research at one or more of the main geological conferences, including the Geological Society of America Annual Conference, the American Geophysical Union Annual Conference, and the Lunar and Planetary Science Conference.

Table 6. Departmental students and their contributions to department research outcomes. Data collected July 2022

Name	Position	10-Year Publication #	Student Authors %	Student Author #	PhD Students	MS Students	BS Student
Drumheller, Stephanie	Lecturer	20	35	7	0	0	13
Dygert, Nicholas	Assistant Professor	26	15	4	3	3	12
Engel, Annette	Professor	33	73	16	5	7	26
Fedo, Christopher	Professor	32	38	12	7	6	5
Hembree, Dan	Professor	29	55	16	0	11	9
Huang, Shichun	Associate Professor	51	49	25	2	3	9
Jessup, Micah	Associate Professor	20	55	11	4	4	5
Kah, Linda	Professor	77	40	31	8	4	17
McCanta, Molly	Associate Professor	27	30	8	3	6	9
McKinney, Michael	Professor	18	72	13	0	12	20
McSween, Harry	Emeritus Professor	93	30	28	5	3	0
Moersch Jeffrey	Professor	31	77	24	8	4	4
Perfect, Edmund	Emeritus Professor	46	52	24	3	9	0
Steen, Andrew	Assistant Professor	26	65	17	4	4	29
Stigall, Alycia	Professor	33	70	23	0	12	17
Sumrall, Colin	Associate Professor	48	27	13	7	3	11
Szynkiewicz, Anna	Associate Professor	21	43	9	4	5	8
Thomson, Bradley	Assistant Professor	25	12	3	3	1	6
	Yearly Averages	**36**	**47**	**16**	**4**	**5**	**11**

As an additional indicator of both quality of research, collaboration, and commitment to education, in 2019 Cambridge University Press published a textbook on Planetary Geoscience that was authored by 7 faculty of the Department of Earth and Planetary Sciences (McSween, Moersch, Burr, Dunne, Emery, Kah, and McCanta).



This book derived from an upper-level undergraduate course in Planetary Geology (GEOL 380) taught in the Department of Earth and Planetary Sciences and has received strongly positive reviews as it starts to be used by the broader geoscience community.

Reviews includes:

'The first comprehensive textbook on the geological processes that have shaped the extraordinary diversity of planetary and other bodies in the Solar System. With accessible prose and fine illustrations, this will be essential reading for undergraduate courses and a rich resource for readers wanting an up-to-date overview of the latest insights into our neighborhood in space.'

Sanjeev Gupta - Imperial College London

'Planetary Geoscience is at the vanguard in showing how Earth science and planetary science are forever linked by a diversity of processes giving rise to their similarities and differences, with applications almost certainly extending everywhere that planets are found.'

Richard Binzel - Massachusetts Institute of Technology

6D. Faculty curricular vitae

Abbreviated CVs are provided for EPS faculty in Appendix 6.1.

Section 7. Resources and Infrastructure

7A. Budget

The general budget of EPS is shown below (Table 7). In general, the budget has been flat over the past five years. The faculty salary line tracks total faculty numbers. The GTA stipends have remained stable, and the increase in clerical and technical staff reflects only a university-wide program to improve staff compensation. Notably, the operating budget remains essentially the same as it was during the last decadal review ($45,787 in 2011-2012) and has not kept pace with inflation and rising costs.

Table 7. Department of Earth and Planetary Sciences budget over the past five years.

EPS Department Budget					
	FY2017-18	FY2018-19	FY2019-20	FY2020-21	FY2021-22
Faculty Salary	989,453	989,339	1,010,374	1,019,695	1,212,532
GTA Stipends	397,940	384,261	361,136	383,443	404,700
Clerical & Technical Staff	302,518	314,116	326,875	332,538	339,078
Operating Budget	44,508	46,480	46,844	46,846	46,848
Total	1,734,419	1,734,196	1,745,229	1,782,522	2,003,158

The operating budget is supplemented with F&A (overhead) return on grants. In FY2021 the department received approximately $150K in F&A return and half of this (~$75K) was returned to the faculty PI's based on their grant expenditures. All faculty receive an "allotment" of the greater of $1500 or 40% of the overhead return, which can be used for research, travel or items that cannot be directly charged to federal

grants. The remaining ~$75K is utilized as part of our operating budget and is used for things like port charges, office supplies, small equipment, etc. The remainder is used to fund major equipment purchases, start-up packages, etc.

Our final source of revenue are departmental endowments. As noted in Table 8, most of this revenue is used to support students or provide research funds to faculty members. A smaller portion can be used as discretionary funds or are designated for other departmental priorities, such as funding external speakers for the departmental seminar series or equipment for Strong Hall.

7B. Development efforts and other revenue

Over the past four decades, EPS has amassed endowments totaling almost $8 million dollars, ranking among the most successful department development programs at UTK. Much of this development success was led by Larry McKay, who served as department head during the first half of this review period. Almost all of these funds represent gifts from alumni. An approximate breakdown of these endowments (as of Fall 2022) and their purposes are given in Table 8. These funds annually provide critical support for the Department's faculty, graduate and undergraduate students, and activities that would otherwise be impossible. Most faculty hold "chairs" that provide modest funds for their research, and most graduate students receive "fellowship" toppings to GTA stipends. At its Awards Day at the end of the last academic year, EPS presented $38,000 in scholarships and awards to graduate and undergraduate students. And many of the activities of the GeoClub, as well as partial costs associated with student participation in professional conferences, are paid by endowment funds.

Table 8. Endowments in the Department of Earth and Planetary Sciences

Unrestricted Accounts	
5 Funds, market value of $2.83M	Discretionary expenses
Lecture Series Accounts	
2 Funds, market value of $215K	Expenses for invited visiting speakers
Professorships	
13 Funds, market value of $2.75M	Faculty research support and service awards
Graduate Fellowships	
7 Funds, market value of $1.02M	Graduate student recruitment and support
Undergraduate Scholarships	
7 Funds, market value of $1.02M	Academic, research and field camp scholarships
Field Trip Account	
1 Fund, market value of $34K	Support for out-of-region field trips
Not Endowed Funds (from gifts <$25,000)	
8 Funds, totaling $152K	Discretionary expenses, research, travel

The EPS leadership is actively engaged with development initiatives targeted at increasing support for the research and educational mission of the department. Current priorities include development of increased funding to support graduate students as the cost-of-living increases in Knoxville, cultivating funds to support research including faculty managed research endowments, and funding to increase field training for students via department-led excursions.

The department head works closely with the College of Arts and Sciences and the Office of the Chancellor Development team to engage with current and potential donors. In addition, the Department is strongly

supported the by the Department of Earth and Planetary Sciences Advisory Board (AB), an active and engaged group, dedicated to providing external perspectives, advice, recommendations, resources and related assistance as requested by the Department. The AB provides opportunities for alumni and associated supporters to become better acquainted with the activities and accomplishments of the Department, and to use their combined professional experience, expertise, and resources to influence and promote the Department's ongoing success. The AB encourages students to contact its members regarding career and resume advice, or other general mentoring.

The EPS Advisory Board is governed by a Board Charter, informed by the EPS departmental bylaws. The AB is led by a chair, a secretary, and a treasurer. There are six standing committees including: the Executive Committee, Membership Committee, Nominating Committee, Finance Committee, Awards Committee and Mentoring & Outreach Committee, that conduct the Board's business. The AB includes a current student representative and the EPS Head or designee is considered a *de facto* member of the standing committees.

The AB has been instrumental in building Departmental endowments (see Table 8) through both an increased commitment to Departmental success and growth of its membership. At present, the AB consists of 40 members with a steady increase over the past few years. The AB meets in the Department biannually, building strong connections with faculty, staff and students. They listen to student presentations on active research and host a mentorship meeting where students can ask questions and share application materials. Annual contributions from the AB members form a non-endowed fund that is used to help students with need and hardship-related expenses as scholarships.

7C. Space, facilities, and academic support

In summer 2017, EPS successfully moved to a new departmental space in Strong Hall, a state-of-the-art classroom and laboratory building. The new EPS space is approximately 44,000 sq. ft. of adjoining research labs, classrooms and workspace, with student and faculty offices nearby. This is an increase of approximately 30% over the former space. EPS occupies half of the 5th floor and all of the 6th and 7th floors of Strong Hall. Additional research spaces are in the atrium (Visualization Lab), the main floor (Field Equipment Room), and the basement (Rock Rooms for crushing, cutting, polishing, etc.). Further, there are three large and three small conference rooms that are commonly used for collaborative work, including research group meetings and student committees. While the new building has expanded our research, teaching and collaborative spaces, there is some inconvenience related to the inaccessibility of 5th floor from two other floors in EPS. The lack of internal stairway between 5th and 6th/7th floors results in less interaction of 5th floor occupants with the rest of department on 6th/7th floors. In addition, some elements, such as fume hoods, are already experiencing rapid degradation beyond expected for the age of the equipment.

Research

Each faculty member is assigned research space comprised of core labs designated for specialized research and additional open lab spaces are shared among faculty allowing for interactive teaching instructions and interdepartmental collaborations. There are two successful user-base lab facilities

supporting research activities in EPS and beyond. The Electron Microprobe recharge center (supervised by McCanta; https://eps.utk.edu/research/facilities_probe.php) is currently well-supported through user fees, almost all of which are from EPS faculty grants, and a designated departmental technician (Patchen) whose salary is 100% supported by the university. The Stable Isotope Laboratory cost center (supervised by Szynkiewicz; https://eps.utk.edu/research/facilities_isotope.php) provides stable isotope services for research and commercial users and is used by a large number of UTK faculty, postdocs and students, and non-UTK research groups. These services continue bringing sufficient revenue to support 40% of the laboratory manager (Faiia) salary and maintain sufficient surplus to account for repairs and equipment upgrade, and the remaining 60% of the laboratory manager salary is committed by the college (44%) and EPS (16%). Additional larger research lab in EPS is Analytical Geochemistry and Geomicrobiology Laboratory supervised by Engel (https://annettesummersengel.com/analytical-facilities), which also has a laboratory manager (Paterson) with 100% salary supported by Engel's external grants.

Table 9. Laboratory income in the Department of Earth and Planetary Sciences since 2012. These funds have been sufficient to keep these labs running and available to community members.

Year	Stable Isotope	Microprobe
2012	$3,090	$132,150
2013	n/a	$144,750
2014	$14,460	$62,500
2015	$13,816	$78,719
2016	$15,886	$13,370
2017*	$10,868	$33,525
2018	$40,441	$856
2019	$27,491	$14,241
2020*	$22,081	$18,215
2021	$43,221	$13,236
2022	$25,459	$5,086

Note: The Stable Isotope lab was closed between 2012-3/2014 when there was no PI or Technician, and the funding structure of the Microprobe facility was substantially changed in 2016, per changes in university regulations. *In 2017 labs were closed for 3 months during the move to Strong Hall; 2020 operations were impact by the global pandemic. 2022 data only through July.

The most ambitious of the new spaces in Strong Hall is a complex of labs designated as a state-of-the-art ICP-MS core facility (https://eps.utk.edu/research/facilities_ICP-MS.php), with clean rooms, sample preparation space, ventilation, specialized hoods, and instrumentation rooms. During the faculty search and interview process in 2019, it became apparent that significant renovations would be needed to the laboratory spaces in Strong Hall that were meant for ICP-MS core facility. There were clear problems associated with the original clean room laboratory space design and items installed. A faculty search was completed in Spring 2019, which resulted in hiring Dr. Romaniello to lead the ICP-MS facility and enhance UTK-wide teaching and research activities. Dr. Romaniello started in August 1, 2019 and began meeting with designers and architects to renovate the laboratory spaces, with a budget of $1,950,000 ($500,000 from College of Arts and Sciences = and $1,450,000 from Central Administration).

In 2020-21, EPS purchased (through Dr. Romaniello and ThermoFisher Scientific) both a Q-ICP-MS and MC-ICP-MS, as well as autosamplers, computers, peripherals and basic supplies, and a LA system, totaling $1,015,858.55. During the redesign phase throughout 2020, which EPS knew would be lengthy, the recommendation was for Dr. Romaniello to move the Q-ICP-MS and LA system into a different laboratory space on 7th floor, temporarily. The purpose was to get an instrument running, generate data, train students, and begin the process of ramping up the Core Facility. A lab space was identified in Strong Hall

by August 2020 that required minimal renovations to accommodate the iCAP quadrupole setup. However, because of the COVID-19 pandemic and UT Facilities scheduling, the minor renovations (totaling $8,700) did not begin until late 2020 but were completed by December 2020. Because of the unexpected departure of Dr. Romaniello in Summer 2021, this lab space has been empty but reserved for installation of the iCAP Q-ICP-MS and LA system, which was delivered to EPS in February of 2021 and is currently stored in boxes on the 7th floor. The MC-ICP-MS will not be delivered until the clean lab renovations are complete.

In Spring 2022, the new faculty search for ICP-MS position was conducted and resulted in successful hiring of Dr. Shichun Huang to lead the ICP-MS facility in August 2022. Since Dr. Huang's arrival on campus, the planning for renovation and installation have resumed, but with significant delays. The December 2020 renovations to the temporary lab were inadequate to install the iCAP Q-ICP-MS and LA system, and minor additional renovations (around $70,000) are necessary before installation. These are anticipated to be completed and the system ready for installation in late Spring 2023. Because the LA system has been sitting in boxes for over a year, ESL (Elemental Scientific Lasers) has requested a reinspection before installation, which is in progress.

The larger renovation for the clean lab remains a long and unfinished process. When the project went out for bid in 2021, it returned a bid of $500k over budget. This combined with the departure of Dr. Romaniello caused the university to place a hold on the clean room project until a new faculty member could be hired to oversee the project. The university is now seeking approval to reboot the project, which requires a return to architectural phase and will require commitment of additional funds (~$1M) from the central administration due to escalating costs over the past few years. Consequently, the current projected timeline for the full MC-ICP-MS lab completion is late 2024.

Teaching

EPS has several general purpose classrooms capable of being converted into "Scale-Up" flexible teaching spaces. In addition, 150-seat and 250-seat large classrooms and smaller 75-seat and 40-seat classrooms are available to EPS in Strong Hall. The classrooms are specifically designed to emphasize collaborative team learning. Most of the classrooms fit the "flat and flexible" or "flipped" classroom model, meaning the furniture is movable and allows for various types of interactive learning. Tables and chairs and the setup of the classrooms allow the furniture to be easily organized for group work and technology use, and there are multiple spaces that allow for easy student collaboration throughout. EPS uses these classrooms for lab instruction in all 100-level courses and upper-level undergraduate and graduate courses.

Additionally, EPS has a new state-of-the-art Geochemistry Teaching Laboratory for undergraduate and graduate instruction. This classroom is located on the 7th floor of Strong Hall (https://eps.utk.edu/research/facilities_geochemistry.php). Funding from Student Technology Fees, provided by the College of Arts and Sciences, was used to purchase instrumentation and supplies for this laboratory. Currently, the classroom has equipment to train users in the analysis of water samples for dissolved ion and trace metal analyses, in the analysis of atmospheric gases, and in the digestion of solid materials (i.e., soil, rock, bone, shell) for the analysis of trace metals in solution. Additional research capabilities are also possible. The instruments in the classroom and the space are intended to be available for students and/or faculty and staff who would like to conduct independent research. However, the use of this classroom is challenging because of complex instrumentation that requires designated technician support to provide training and support opportunities, but there is no central funding for such support. As a result, only small number of classes has been taught in this classroom by one faculty (Engel) acting

as a supervisor for the teaching laboratory. As noted in the staffing section, there is a need for additional funding to guarantee technical support for the geochemistry teaching laboratory to make it more accessible to broader EPS and UTK community.

Visualization Lab is another interactive EPS classroom located in the atrium. It is a visualization laboratory supervised by Moersch with feeds from NASA's Mission Control Center. The purpose of this classroom was for the Strong Hall visitors to learn more about the ongoing research at UTK and allow EPS faculty members who are working on projects such as the Mars Rover to display video of their projects and allow the public to view the work and ask questions. The impressive space and available technology are used by some faculty for planetary teaching instructions and limited public outreach. EPS graduate students have used this room for live streaming of recent NASA missions (e.g., the landing of Perseverance rover on Mars in spring 2021).

Further, EPS has an outdoor rock garden featuring boulders from around Appalachia that greets visitors of Strong Hall and is also used in interactive instruction for classes in EPS.

Section 8. SOAR analysis

The EPS faculty engaged in a semester-long SOAR (Strengths, Opportunities, Aspirations, Results) analysis during Fall 2022 in preparation for the APR. This process resulted in robust discussion and identification of specific pathways for forward progress and development.

8A. Strengths

EPS faculty are proud of what we have achieved and continue to accomplish as a department. There is a strong sense of teamwork and collaboration that exists and a shared goal toward continuous improvement. Departmental strengths include:

- **Strengthening faculty team.** Although the department lost a number of internationally recognized research leaders over the last decade, it is well positioned for success because of its history of external recognition, quality mid-career faculty members who are coming into the prime of their externally recognized research efforts, a number of high quality recent faculty hires, a group of innovative lecturers supporting student learning and a plan in this review document for faculty growth that aligns and leverages College and University priorities, initiatives and collaborations.
- **Distinctive research productivity.** EPS have a legacy of outstanding research success and a research program on par with some of the best geoscience departments in the country. EPS faculty engage in diverse and mutually supporting research areas. EPS is one of only a handful of programs in the country with a large group of planetary and paleontology faculty. We compete with the best programs in the country for graduate students, plus we are able to strongly diversify our research funding through NASA priorities.
- **Excellent facilities.** Our facilities at Strong Hall and opportunities for collaborative facility use across campus provide outstanding infrastructure. Strong Hall includes sufficient high-quality space to meet all areas of our mission.

- **Strong public interest in the geosciences.** Our research expertise in space science, Earth history/paleontology, and environmental change are highly relevant and inherently interesting to the public. We also have excellent enrollment with wait lists in our introductory courses.
- **Outstanding location.** Our location in east Tennessee provides endless opportunities to provide field training in all areas of the geosciences and environmental studies and is also a great place to live which, helps to recruit faculty and graduate students.
- **Welcoming department culture.** The department has welcoming and friendly culture with doors open to all that is built on a pattern of deliberate and thoughtful efforts particularly over the last five years.
- **Alumni engagement.** The department has a history of engaging its alumni, developing relationships and gaining their confidence with personal and financial support going back to at least the 1970's. As a result, it has one of the strongest set of endowments among the departments in the College of Arts and Sciences.

8B. Opportunities

Given the changing landscape inside and outside of UTK, EPS has many opportunities to succeed and contribute to the college, university, and society.

- **UTK Strategic Vision.** The University has defined metrics related to enrollment growth, a greater variety of instructional modes and approaches, increased number of faculty awards, increased research funding, increased graduate research participation, enhanced culture of civility and inclusion, use of new academic structures and business operations to enhance institutional nimbleness, and a greater role for academic engagement beyond the campus to society, particularly in Tennessee. These selected metrics from the Vision are places where the Department can build success for it and others, as described in this program review document, particularly if the faculty hiring plan is adopted.
- **UTK (ORIED) Research thrusts.** The University has defined four research thrusts and the Departments focus on Earth and Planetary systems fits well into all of them in terms of understanding/manufacturing with earth materials, the impact of Earth systems on human wellness, the sparseness and complexity of data sets for Earth systems as a key test environment for A.I. initiatives, and the role of Earth materials and systems in improving global energy ecosystem. The naturally collaborative approach of Earth scientists who investigate physical, chemical, biological and societal systems, positions the EPS faculty to be key collaborators in these initiatives, growing research expenditures, recognition through publication, student research success and external faculty awards. Again, the proposed faculty hiring plan would greatly facilitate this outcome.
- **Focusing on positive and potential.** Adopting a positive growth mindset allows us to see the good in each other and to seek for the potential when in times of flux. The changes in academic structure within the College of Arts and Sciences can provide new opportunities for enhanced resources, such as grant development support, and increased incentivization for collaboration with new partners. Likewise, the growth in the undergraduate population over the next decade provides the opportunity to engage with a larger number of students –both in the introductory classes and for recruiting more majors in the geosciences.
- **Curricular Revision.** We see tremendous opportunity in curricular revision to meet the needs of 21st century learners, both to provide the best training in geoscience and transferrable skills as well as to enhance our ability to help students to make connections between geoscience and

making positive impacts in the world around them. The lecturer team in EPS has worked to innovatively improve student learning through engagement in our 100- and 200-level courses, which is the primary credit-hour production. Also, we have continued to broaden our instructional and research base to include modern Earth Systems more effectively. These efforts are being leveraged by a moderated kickoff workshop in December 2022 to develop and refine curricula, pedagogy, and instructional environments to meet the needs of the expanding student body. Consequently, we expect to achieve much progress over the next decade.

- **Becoming an exemplar department for inclusion and respect.** Over the last five years, the department has worked purposefully with internal faculty and student leadership and collaboration with external units to improve greatly our culture and demographics. We are poised to build on that foundation particularly with respect to graduate students and faculty members, which are the personnel components of the department where the department has the greatest day-to-day influence and impact. We will identify and work to remove barriers to full inclusion within the geosciences as we continue policy revisions.
- **Building pathways to engage with more people.** We see opportunities to advance our shared diversity and educational access goals by developing more robust relationships with community colleges and HBCUs to attract transfer students and recruit more introductory students to our majors to help build and expand the geoscience workforce of the future.
- **Increasing engagement with the Alumni.** After several years of limited development efforts due to the pandemic and changing departmental leadership, we will re-engage our alumni to increase financial support as well as career development opportunities for our students. Our new department head with development and faculty colleagues have a historically active alumni community with which to build relationships. Initial efforts will include a first geoscience careers night in late February and development trip to Houston in April.
- **Better projecting who we are.** We recognize that the current name of the department, Earth and Planetary Sciences, was appropriate in 2003 but is no longer fully reflective of our work given the growing role for understanding modern and surficial Earth systems and environments. We also recognize that a course prefix of GEOL for courses more diverse than geology can be confusing to students. "I'm going over to EPS to enroll in GEOL 101" is confusing. These branding problems make it challenging for students to find our department, our website (a new website is also a new opportunity on the horizon), and our major programs. Developing a new name, such as Department of Earth, Environmental, and Planetary Sciences, and relabeling courses into title that matches the department name (ex. EEPS)—that is reflective of our current and future plans may be a powerful opportunity to raise our prominence on campus.

8C. Aspirations

EPS faculty are passionate about our role as the department where all aspects of the past, present, and future of the Earth, its environments, and other planetary bodies are studied in a scientific framework. The EPS faculty aspire to outstanding education and training programs in the geosciences with growing enrollment coupled with robust, internationally recognized research program that is appropriately resourced with faculty and graduate students.

- **We aspire to be "the place" on campus that students (and academic advisors) think of for <u>scientific</u> study of the Earth, environment, solar system, and fossils.** We want to be known as the department of the "past, present, and future." We aspire to take a leadership role on campus for scientific study of the Earth and environment including societal impacts such as geologic

hazards, water resources, and climate impacts. Earth science is everywhere. Geoscience is relevant in all aspects of life and is a base on which all other sciences build. We want to spread this message.

- **We aspire to increase the enrollment in our degree programs, especially at the undergraduate level, and to provide opportunities for all Tennesseans.** We want to provide increased opportunities for students, especially first gen to engage with faculty in courses and research.
- **We aspire for our students to develop the skills to thrive and launch into excellent careers.** We aspire to a student experience that is energizing, fun, develops outstanding career outcomes, and includes societal options. We want to train our students in transferable skills and deep content knowledge then connect them with careers and employers.
- **We aspire to belonging, accessibility, justice, diversity, equity, and inclusion.** We want a strong community where all members can bring their authentic selves and feel their contributions matter. We want a to ensure our community includes people of diverse identities, backgrounds, and perspectives.
- **We aspire to expand on our already robust scientific reputation as a department.** We seek to increase external funding, produce impactful high-quality research, engage in interdisciplinary partnerships across campus and foster strong collaboration among faculty within each of our key (and overlapping) research domains of geology, planetary geoscience, and environmental geoscience. We aspire to develop a research infrastructure with our existing lab and new ICP-MS facility that will serve both the UTK community and external constituents.

These aspirations will be particularly facilitated by College and University support for the faculty hiring plan.

8D. Results

The EPS faculty have developed a bold vision for departmental growth and development with goals aligned with the UTK Strategic Vision that will serve our students, the university, the state, and the global communities.

Presently, the Department of Earth and Planetary Sciences is operating at maximum efficiency. Our introductory classrooms are completely full, and we cannot accommodate more students. Our faculty are executing their service obligations to ensure a smoothly functioning department and are highly productive in their research output. However, the current staffing situation is not sustainable. The faculty are overtaxed on service and administrative work (fewer faculty does not reduce total service that needs to be done) which combined with the other constraints leave little time for additional innovation. To capitalize on the exciting opportunities available and reach our departmental aspirations, we need to execute the proposed hiring and an increase in the GTA allotment (to staff the additional introductory course labs). We also require the continued support of the CAS and university leadership in identifying funding for the renovation of clean room to house the MC- ICP-MS.

We can measure our progress on our strengths and realization of opportunities with the following metrics:

- **Grow impact by educating more students, on campus and around Tennessee**
    - Increased teaching of campus students: Student Credit Hour Counts higher than recorded on Datapack Tab 7
    - Growth of the major programs: Major count greater than recorded in Datapack Tab 1

    - Growth in number of curricular collaborations that align with campus partners and the societal impact by modern Earth systems
    - Growth in number of pedagogical initiatives that are deployed in EPS (EEPS) courses and collaborative courses with other UT academic units
    - Increase connection with off-campus Tennesseans through greater student credit hour count produced from online classes and increased outreach activities
- **Revise curricula to provide outstanding skill, content, and career development**
    - Completion of additional departmental retreats and submission of revised curricula
    - Tracking of student career outcomes
    - Establish an exit survey with graduating students and follow up survey one year later, and analyze results
- **Develop a culture of welcoming and inclusion**
    - Increased inclusion: development and deployment of a climate survey
    - Increased diversity: tracking data in blueprint
    - Town hall meetings with students to identify areas for growth and of strength
- **Expand research productivity and recognition**
    - Increase in grant proposals, awards and expenditures
    - Increase in number of collaborative grants/partnerships
    - Increase in number and citation of publications
    - Completion of construction on the clean lab and MC-ICP-MS and LA-ICP-MS labs with growth of a multidisciplinary research initiatives
    - Growth in number of graduate research students and successful placement of students in prestigious career pathways
    - Growth in number of campus-level research collaborations particularly in the context of the four UTK research thrusts
- **Increase departmental recognition on campus**
    - Align department name and class code with department identity
    - Recognized departmental leadership for improving welcoming and inclusive culture through awards and campus communications
    - Increase in faculty awards (on campus)
- **Increase departmental reputation**
    - Increase in external prestigious faculty awards for research and service achievements
    - Improved ranking in US News and World Reports
- **Increase in alumni engagement**
    - Growth in number of active alumni relationships
    - Growth in number of active engagement events
    - Definition of key metrics for success for the EPS (EEPS) Alumni Board
    - Increase in alumni participation in endowment funding

Appendix 1.1 EPS Strategic Plan

GEOMAP 2025

A 5-yr Strategic Plan for the Department of Earth and Planetary Sciences

Prepared by the Tenure-Track Faculty and Adopted on 11-19-19

1. INTRODUCTION

1.1. Overview of the Department

The Department of Earth and Planetary Sciences (EPS) has been a vital part of the University of Tennessee – Knoxville (UTK) for over 110 years. EPS has introduced over 65,000 undergraduate students to the Earth Sciences through its 100- and 200-level course offerings. It has produced over 1,200 Bachelor's degrees (since 1907), as well as granting 547 Masters degrees (since 1929) and 153 Doctoral degrees (since 1959). Our graduates have gone on to success in academia, federal research laboratories, government agencies, K-12 schools, and a variety of industries including oil and gas, environmental consulting, mining, and engineering.

As of August 2019, EPS has 12 active tenured or tenure-track faculty members with majority appointments in the department, 2 with majority appointments in other departments, 2 non-tenure track research faculty members, 1 Oak Ridge National Laboratory (ORNL)-based joint faculty member, 4 lecturers, 2 post-doctoral researchers, 3 laboratory technicians, and 4 office staff, serving approximately 130 undergraduate (UG) majors and 44 graduate students. EPS faculty members strive for excellence in research, teaching and service. Currently, over 90% of active tenured or tenure-track (TT) faculty members have external funding to support their research. Several current or recent EPS faculty members have received national honors. EPS faculty and students have a strong history of service to the University (including two Associate Deans, an Interim Dean, and a Vice-Chancellor for Research), as well as to the broader scientific community (including several past-Presidents of the Geological Society of America, chairs and board members of disciplinary associations, journal editors, and associate editors), and to the public. EPS has a very active and engaged Alumni Board. Endowments, gift agreements and/or bequests to the Department totaled over $7 million as of May 31, 2019.

As a department, we take pride in the breadth of our research exploring the physical, chemical, and biological domains of the Earth and other planetary bodies. This breadth, as well as the strongly interdisciplinary nature of much of our research has led the department to be nationally ranked above many of UTK's peer institutions. In the most recent (2010) National Research Council (NRC) survey of PhD programs in the geosciences, EPS was ranked 30th out of 140 public and private institutions

(http://sites.nationalacademies.org/PGA/Resdoc/), ranking above all of the University's peer institutions, and on par with many of the University's aspirational institutions, including the University of Florida (37th), Purdue (31st), the University of Wisconsin (28th), and Michigan State (27th). US News and World Report rankings from 2018 also recognized the success of our program, with a ranking of 54 out of 124 US Earth Science departments (https://www.usnews.com/best-graduate-schools/top-science-schools/earth-sciences-rankings). This ranking is higher than all but one of the University's peer institutions, and is squarely in the middle of similar departments within the University's aspirational institutions, ranking with the University of Florida (54th) between Michigan State (64th) and Purdue (41st) (see Appendix 8.1 for details).

With a cadre of highly productive faculty and an exceptional home in Strong Hall, EPS is perfectly positioned to help UTK achieve its VolVision 2020 goal of establishing itself as a top-tier public research university. We are proud of our past successes and we are ready to address current and future challenges in order to bring the Department an even brighter future.

1.2. Our Mission

a. To prepare students for enriching and successful careers, as well as life-long learning.
b. To expand the frontiers of knowledge in the Earth and Planetary Sciences and related fields.
c. To serve the university, government, industry, and people of the State of Tennessee.

1.3. Our Values

a. Excellence in research, teaching, and service.
b. A commitment to support all of our students, both undergraduate and graduate.
c. Professionalism, cooperation, respect for individuals, and a commitment to diversity.
d. Alignment of departmental objectives with those of the College, Campus and University System, especially as they pertain to the goals of VolVision 2020.
e. Responsible stewardship of UTK resources and continued self-reliance through the pursuit of external research funding and alumni development support.

2. UNDERGRADUATE PROGRAM

2.1. Background

Degree Requirements

EPS offers a Bachelor's of Science (BS) degree in Geology and Environmental Studies (GES), with concentrations in Geology (GEOL) and Environmental Studies (ES), both with associated honors concentrations and minors. The ES program began as an Interdisciplinary Degree Program (IDP) in 1995. In 2012, it was merged with the existing GEOL BS program to form the new GES degree.

All course offerings in the department fall under the GEOL heading, and can be taken by students in either concentration, as well as by students in other departments. Students in the GEOL concentration take a series of 6 required GEOL courses at the 300-level, 3 elective courses at the 400-level in GEOL, or other disciplines, and a Geology Field Camp. The field camp (minimum 5 credit hours) is not offered by UTK, but students can take it through other institutions, with credit transferred to UTK. Students in the ES concentration are required to take several environmental core courses, 5 GEOL courses at the 300- or 400-level, as well as an internship (GEOL 493), and a set of focus courses (minimum 9 credit hours) in another discipline. The focus requirement can also be fulfilled by taking a minor. ES students are not required to take a field camp.

Retention, Enrollment, and Degrees

One- and two-year full-time, first-time freshman retention rates for GES majors for the period Fall 2013 through Fall 2016 are shown in Fig. 1. In general, these rates are higher than the corresponding UTK-wide averages of 86.0% and 79.3%, for one-year and two-year retention, respectively, over the same time period.

Currently (i.e., Fall, 2019) there are 130 students in the in the GES program, and numbers have varied between 121 and 140 students since 2012 (Table 1). Numbers in the GEOL and ES concentrations have fluctuated substantially since 2012, with the Fall 2019 breakdown being 55 in GEOL and 75 in ES (Table 1). The number of students with no declared concentration has decreased dramatically over time. Currently, there is only one student in honors GEOL and none in honors ES, although several ES students are planning to earn an Honors concentration, but have not formally registered for that concentration. There are currently 10 minors in GEOL and 5 in ES. The number of BS degrees in GES awarded by EPS averages 35 per year (Table 1).

EPS - GES UTK – All degree programs

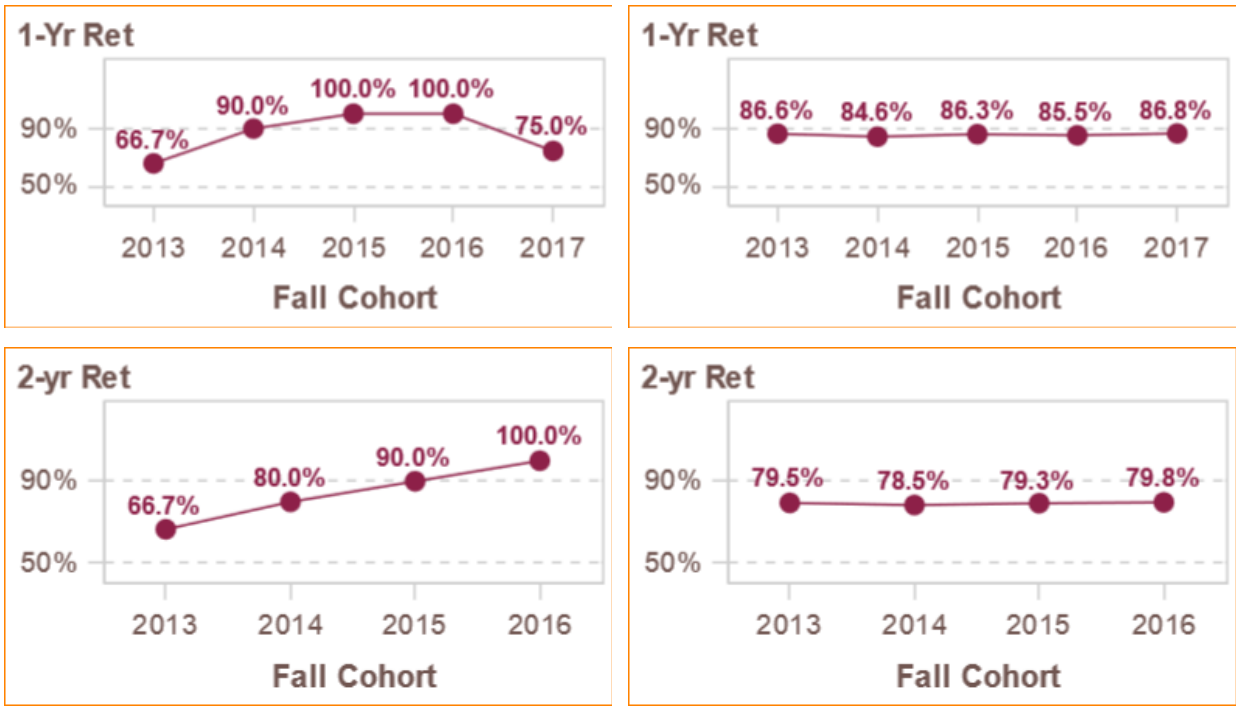


Fig. 1: One- and two-year retention rates for full-time, first-time freshman GES students as compared to those for all degree programs at UTK

Table 1: Undergraduate concentration enrollment and degree production (n/a: data not yet available)

Academic Year	Students in GEOL concentration	Students in ES concentration	Students in GES/ES major but no declared concentration	Total students in EPS UG major	BS degrees in GES awarded
2012/13	65	64	10	139	29
2013/14	64	38	19	121	38
2014/15	58	59	23	140	36
2015/16	51	58	30	139	41
2016/17	63	62	3	128	35
2017/18	51	71	3	125	29
2018/19	n/a	n/a	n/a	129	n/a
2019/20	55	75	0	130	n/a

Time to Completion

Time-to-completion is currently an untracked statistic at the departmental level, and information is not available from the university. It is suggested that EPS begin tracking time-to-completion as part of a proposed exit survey (see section 2.4).

Credit Hours

In Fall 2017, classes at the 100- and 200-level ("lower level") accounted for 4,471 credit hours, while 300- and 400-level courses ("upper level") accounted for 570 credit hours. Based on the average of Fall and Spring enrollments (since there is a pronounced oscillation between semesters), upper-level credit hours have increased ~30% since AY 2009-10, while lower level course credit hours have decreased ~20% (Fig. 2).

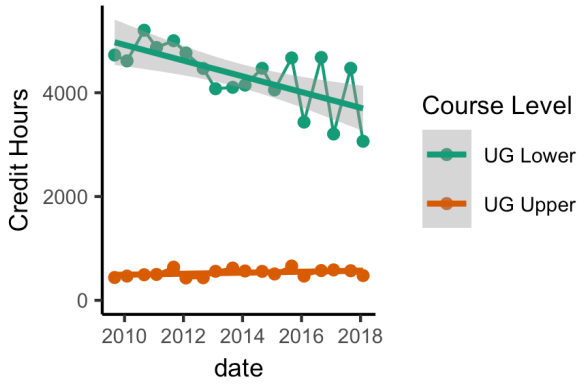


Fig. 2: Undergraduate-level credit hours taught by EPS faculty. "UG Lower" refers to 100- and 200-level courses, "UG Upper" refers to 300- and 400-level courses.

Experiential Learning

At present, 35% of current GEOL students and 8% of ES students have participated in some form of undergraduate research. Undergraduate research is encouraged, but not required by either concentration. Students typically receive course credit (GEOL 493) for research, but rarely produce a senior thesis. Instead, students often make a presentation such as a poster at meeting at UTK or at a professional conference. Occasionally, undergraduate students appear as junior author on a peer-reviewed publication. We have just added GEOL 493R to our undergraduate offerings, to provide a more formal and standardized arrangement for undergraduate participation in research. Undergraduate internships are required for students in the ES concentration, but not for students in the GEOL concentration. These internships offer a practical experiential learning opportunity that we feel will improve student career opportunities upon graduation. They are highly variable and often tuned to the student's interests and skill set. Some are paid whereas others are volunteer, but all have work hour requirements for the semester. We have just added GEOL 493N to our undergraduate offerings, to provide a more formal and standardized arrangement for undergraduate participation in internships.

Student Placement

Students graduating from GEOL and ES pursue a wide variety of jobs and careers. In a recent survey of GES BS graduates (from the past 6 years) job placement data were collected for 49 students. This represents was nearly one quarter of the total GES graduates from 2013 to 2018. Of the 49 BS

graduates, 43% pursued graduate or professional degrees, 37% found employment in geological or environmental fields, and 20% found employment in other fields. The department has no information on the other 161 students who received BS degrees during the survey period. It is possible that their employment demographics are very different from the students we were able to track.

2.2. Challenges and Opportunities

Challenges Related to Campus and College Priorities

VolVision 2020 lists 5 main areas for improvement in undergraduate education. These include: 1) growth in student enrollment, 2) improved quality of incoming students, 3) increased retention and improved 5- and 6-year graduation rates, 4) increased engagement of students in enrichment activities like "experiential learning", study abroad, research, etc., and 5) improved success of students in the job market or in pursuing graduate studies. The strategic plan for the College of Arts and Sciences follows the general trend of VolVision 2020. Several of these issues are have proven to be particularly challenging, as indicated below:

a. Increased emphasis on number of undergraduate majors and student credit hours (SCH). UTK has made growth of the undergraduate student body a top priority for the past ~5 years. This was driven by the need for tuition revenue and to meet the demands of the public and employers. UTK invested substantial sums in recruiting staff and freshman scholarships, leading to growth of the incoming freshman class by 2-4% each year over the past three years. Growth of 2% is expected for Fall 2019 and colleges are struggling to provide space in classrooms and majors for the incoming students. These were the highest priorities for the Dean in budget meetings with CAS departments this year.
b. Increased emphasis on retention and time to completion of UG majors. This is exacerbated by the increase in UG population, especially for programs with extensive pre-requisite requirements and highly specified curriculum.
c. Increased emphasis on experiential learning, study abroad, student research, internships, number of minors or double-majors, etc.

Challenges Related to UG trends in EPS

a. Stagnant numbers of majors in the GEOL concentration. This was indicated as a major concern by the Dean during the Spring 2019 budget meeting.

b. Decrease in SCH's generated in 100- and 200- level GEOL courses, which are primarily populated by non-GES majors. This is due mainly to changes in college and campus level science requirements, but has a negative impact on the department.
c. Increases in number of community college transfer students entering the GES major in EPS. These students make up about half of the incoming GES majors each year (the highest percentage in the college) and many lack important pre-requisites when they arrive at UT, leading to extended time to completion, as well as lower numbers of credit hours taught and students enrolled relative to the number of students graduating.
d. Increased competition from other Science, Technology, Engineering, and Mathematics (STEM) majors on campus. There is a limited pool of UG with the skills and desire to be STEM majors. Recently, the Geography major and the Sustainability IDP have seen strong student growth, likely from the pool of students who might otherwise be GES majors.

<u>Challenges Related to Departmental Culture and Demographics</u>

a. The majority of our faculty focus their UG teaching efforts on the Geology concentration, rather than the ES concentration, even though the majority of our majors are in ES (about 58%). While up to one-half of the credit hours required for the ES concentration are taught outside of the department (18 out of 36 credit hours), the concentration would benefit from a broader base of classes that are attractive to potential ES concentrators. The College sees this is as a serious imbalance.
b. Recent departures of four faculty members (Burr, Emery, Steen (partial) and McKay), with only one hire (ICPMS) in 2019. This will leave EPS with 12 Full Time TT faculty in Fall 2019, which is down from a high of 18 five years ago. It leaves EPS particularly short of TT faculty serving the ES students.

<u>Opportunities for UG Programs in EPS</u>

a. Interest on campus and in the community for interdisciplinary/liberal arts and sciences programs remains strong. This is evidenced by growth in the ES concentration and there may be potential for further growth through better marketing and development of other tracks or concentrations that focus on interdisciplinary topics and/or the liberal arts and sciences.
b. There may be potential for some growth in the Geology concentration, given better marketing and development of new options or tracks. However, GES will be competing for a limited pool of candidates with the interest, abilities and background to be successful in rigorous science courses.

c. The market for jobs and opportunities for graduate studies remains strong for students in both Geology and Environmental Studies.
d. EPS has a strong record of offering experiential learning for UG students. Students in the Geology concentration mainly pursue this through research, lab work and field trips, whereas ES students pursue it mainly through internships.

2.3. Goals

There was general agreement by the Undergraduate Program Committee (UPC) Strategic Planning Sub-Committee on the following goals, which are listed in order of priority:

a. Increase the number of GES majors and the number of GES graduates per year.
b. Increase the quality of the major, especially in key areas related to campus and college priorities. These include:
    i. Increased participation in UG research and internships,
    ii. Increased number of GES majors taking minors in other disciplines,
    iii. Increased number of students pursuing study abroad opportunities,
    iv. Greater diversity and flexibility in major course requirements.
c. Reduce the time to completion for GES majors, especially for students who transfer from community colleges or other institutions.
d. Improve tracking of career/employment pursued by BS grads and provide more effective career mentoring.
e. Increase SCH production per faculty member. This is especially important for upper level courses, because factors leading to decreasing SCH production in lower level courses are largely outside of the control of the department.

2.4. Plans

a. The department will seek to increase student enrollment via two major approaches:
    i. Increase awareness of our majors to incoming UTK students by coordinating with counselors at Tennessee high schools and with Admissions to identify students interested in STEM fields. This plan will be implemented by a new committee.
    ii. Increase the attractiveness of our majors by redesigning our major with new concentration tracks. The redesign will include new concentrations or tracks, potentially including themes such as energy, water resources, and planetary science. These tracks will be crafted to

appeal to students who otherwise would not identify their interests as within geology or Earth and Planetary Sciences. It will also allow students interested in pursuing a more traditional geoscience degree to attain the scientific rigor for them to succeed in graduate school or professional career.

b. Provide incentives and pathways to increased participation in research, internships, and study abroad for students in all concentrations or tracks. This may involve curriculum change.
c. Improve advising and mentoring for students to help with timely completion. Will also consider curriculum change to reduce roadblock courses. May include removing some prerequisites and/or changing some majors courses from required to elective.
d. Introduce annual exit survey for GES majors, to improve tracking of career plans and success.
e. Submit proposals to have more GEOL courses included in connections packages and other college or UTK requirements for non-GES majors. May involve increasing summer and online course offerings.

2.5. Metrics

We will assess the success of the plans outlined in section 2.4 using the following metrics:

a. Increase the number of GES students to 200 per year, representing a ~40% increase over current numbers. The number of GES students receiving BS degrees will increase proportionally.
b. Establish quantitative tracking of students who participate in research, internships and study abroad. The number of students participating in these activities will likely increase over time.
c. Establish quantitative tracking of time-to-completion. Average time-to-completion should decrease, accounting for possible changes in the fraction of transfer students.
d. Receive completed exit surveys for 50% of graduating students.
e. Increase the number of SCH to an average of ~290 per full time equivalent (FTE) per semester, which would be equivalent to our productivity in 2012-13 (i.e., ~5,000 SCH from 17.2 FTE's).

3. GRADUATE PROGRAM

3.1. Self-Assessment

Because Ph.D. students are viewed positively by the College, and can increase publication productivity and grant funding within the department, a goal of previous strategic plans was to increase the number of Ph.D. students in our graduate program. In 2000, approximately 35% of our graduate students were in the Ph.D. program, but by 2011, recruitment efforts attracted more Ph.D. students to our program, and nearly 60% of the graduate students were in the Ph.D. program. There were between 56% and 62% Ph.D. students in the program from 2012 through 2019, with an average of 58%. The

increase in the number of Ph.D. students was achieved with no major change to the overall number of graduate students in the program, at approximately 50-55 students each year (Fig. 3).

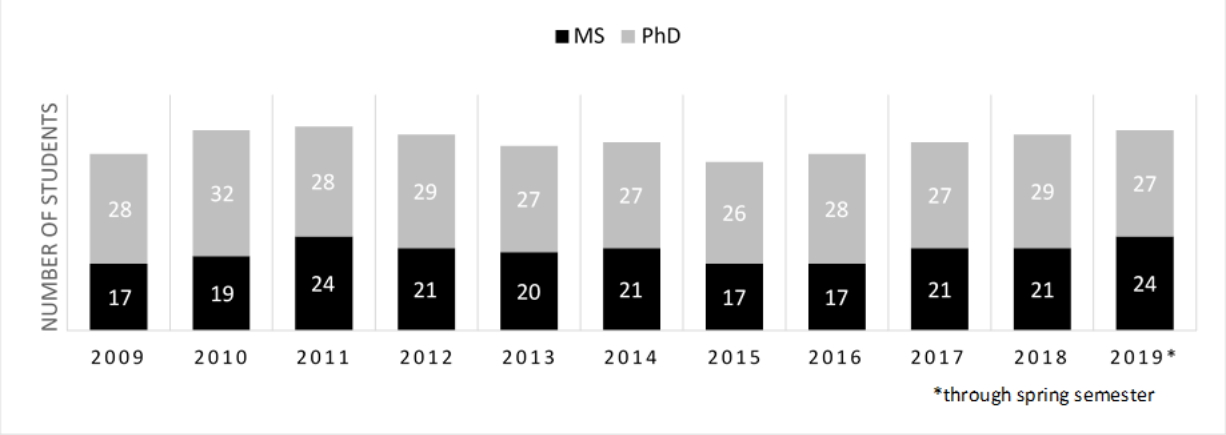


Fig. 3: Number of M.S. and Ph.D. students active in the fall semesters of our graduate programs.

Review of Past Metrics (*previous metrics are listed in italics*)

Based on the Metrics for Success in our 2012 Strategic Plan, over the past 5 years we needed to:

Maintain average Grade Point Average (GPA) for incoming students above 3.7.

This metric was not met when considering only the undergraduate GPA of our incoming students. About 25% of all incoming graduate students in the past 5 years, including those who received a M.S. degree, had an undergraduate GPA at or above 3.7. However, most of the incoming Ph.D. students had higher GPA's for their M.S. coursework, with an average GPA of 3.75, which met the metric.

Increase the number of graduate students from peer-or-above institutions to 60%. This metric is defined to include Top 100 National Universities (UTK ranks 101 by this measure – according to the 2012 Strategic Plan), Top 25 Regional Universities, Top 100 Liberal Arts Colleges and Top 400 World Universities according to US News & World Reports.

During the past 5 years, 19.7% of our incoming graduate students had prior degrees (mostly undergraduate) from UTK. Although we have been able to recruit students into our program from a variety of top-tier institutions, from small liberal arts colleges to large state universities, it became clear that basing a metric like this on an external ranking system is a moving target. Nevertheless, over the past 5 years, only about 25% of our incoming graduate students came from peer-or-above ranked institutions. We need to continue to work on meeting this metric.

Have incoming or existing graduate students receive at least 2 major external fellowships (NSF, NASA, etc.) over the next 5 years.

This metric was exceeded by our existing students but was not met for incoming students. This is because, for the NASA fellowships, as an example, a student needs to already be admitted to the program prior to fellowship submission.

Increase graduate student support to help attract and retain high quality students

a. *Increase the number of Graduate Research Assistants (GRA's) to 13 per year within 5 years (the average number of GRA's in the previous 3 years is 9 per year).*

This metric was met. The average number of GRA's over the past 5 years has been 14 per year, with a range from 13 to 18.

b. *Increase the average M.S. stipend (GRA or Graduate Teaching Assistant, GTA, plus summer salary) to $18K/year (i.e., 60% of the NSF Grad Fellowship stipend).*

This metric was not met, and the base salary for our students is somewhat out of our control. We advocate for raises when we can. The base M.S. stipend remained unchanged until Fall 2018, when all students received a $300 raise, bringing them to $13,800/year. With toppings, the average M.S. stipend currently stands at $16,600. To offset the low base stipends, M.S. students receive "toppings" from various fellowships (e.g., Department, College, and Graduate School) or summer support from their advisors using external grant funds.

Increase the average Ph.D. stipend (GRA or GTA plus summer salary) to $24K/year (i.e. 80% of the NSF Grad Fellowship stipend).

This metric was not met, and the base salary for our students is somewhat out of our control. We advocate for raises when we can. The base Ph.D. stipend remained unchanged until Fall 2018, when all students received a $300 raise, bringing them to $15,300/year. With toppings, the average Ph.D. stipend currently stands at $21,000. To offset the low base stipends, most Ph.D. students receive "toppings" from various fellowships (e.g., Department, College, and Graduate School) or summer support from their advisors using external grant funds.

Increased placement of Ph.D. graduates in prestigious tenure-track faculty positions

a. *Place 3 PhD graduates in tenure-track positions at peer-or-better institutions, defined as Top 100 National Universities, Top 25 Regional Universities, Top 100 Liberal Arts Colleges or Top 400 World Universities.*

This metric was met. We placed four students at nationally ranked peer- or better institutions.

b. *Place a total of 10 Ph.D. graduates in tenure-track positions in 4-year universities or colleges (including the above).*

This metric was met. Overall, 13 of our Ph.D. graduates took tenure-track positions nationally or regionally ranked institutions, and another 3 took faculty positions at non-ranked schools. These graduates represent 57% of all Ph.D. students from our program since 2012.

Decrease the time necessary for M.S. graduates to complete their degrees : ~ 50% of M.S. students should finish within 2 years.

Although we guarantee 2 years of support for our M.S. students, this metric was not met. However, there was a noticeable decrease in the time to M.S. degree completion from 2009 through 2012. But, by 2018, on average, only 10% of the M.S. students finished their degrees within 2 years. The average time for M.S. degree completion is 3.06 years (Fig. 4).

Similarly, there has also been a general decrease in the average time to Ph.D. degree completion since 2009 (Fig. 4), although this was not one of the previous metrics. Overall, we guarantee 4 years of support for Ph.D. students, but only 25% of our Ph.D. students finish in 4 years. Approximately 54% finish within 5 years. Timely graduate degree completion needs to continue to be a focus area for our department.

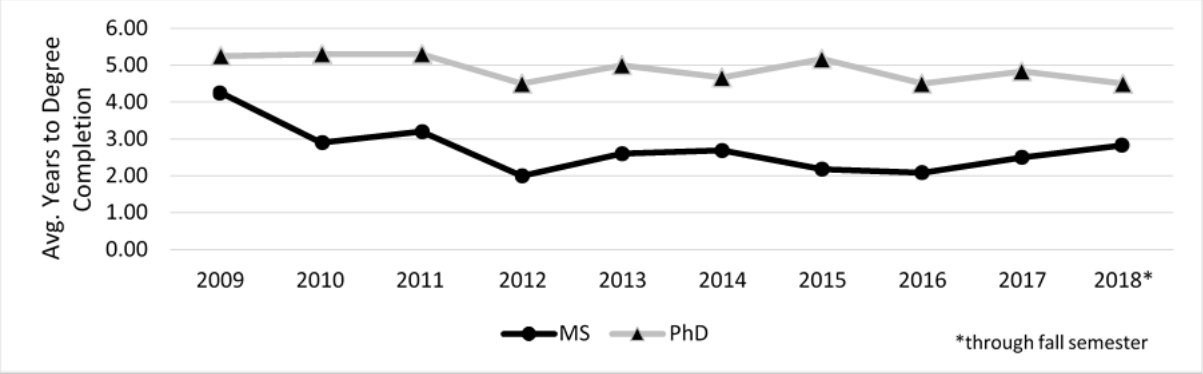


Fig. 4: Average years to M.S. and Ph.D. degree completion since 2009

Increased placement of M.S. graduates in career positions or top Ph.D. programs

a. *Place one-third of M.S. graduates into Ph.D. programs.*

This metric was not met. Only 10% of the M.S. students went into Ph.D. programs.

b. *Place remaining M.S. graduates into career positions in the petroleum industry, government, teaching, etc.*

This metric was met. Roughly <5% of M.S. students did not gain employment within their discipline.

3.2. Gap Analysis

The quality and throughput of our graduate programs needs to increase. At present, we have a few outstanding graduate students and many good ones. There is still room for improvement through better recruiting, more effective mentoring, higher stipends, better achievement recognition, and support for diverse career options and placement. We need to encourage timely degree completion, especially among the M.S. students, and make efforts to improve the requirements for Ph.D. students who enter the program with a B.S. degree so that they can complete their degrees within the current guaranteed funding window. We need to increase the number of students who go on to academic positions and high-salary professional positions (e.g., with major energy and environmental consulting companies).

3.3. Action Plan

We plan to improve the quality and output of the Graduate program through:

a. Greater efforts to recruit and retain top quality graduate students. This will include better advertising, especially at conferences, offering higher stipends or "toppings" using external grant funds and alumni donations, and better organization/support (using EPS development money) of campus visits by recruits.
b. The Graduate Program and Admissions Committee (GAPC) will review and likely revise policies to streamline degree completion for M.S. students and to raise the standards for Ph.D. students. Strategies already implemented include more active enforcement of existing rules on the timely completion of thesis proposals (especially for M.S. students and their advisors), encouraging timely completion of preliminary exams for Ph.D. students, and previously setting a more rigorous pre-graduation publication requirement for Ph.D. students. Moving forward, expectations should continue to be explained and enforced to assist students and advisors.
c. Increased mentoring support for graduate students applying for prestigious research grants, post-doctoral opportunities, faculty positions, and other competitive career opportunities.

3.4. Metrics for Success

a. Increase the quality of incoming graduate students by recruiting top students, as characterized by their undergraduate GPA, undergraduate research experiences, and the quality of their undergraduate programs, as well as potential graduate-level research and experiences.
b. Continue to support existing students applying for major external fellowships (e.g., NSF, NASA, Fulbright, etc.), with the goal of receiving at least 2 successful fellowships over the next 5 years.

c. Increase graduate student stipend support that will help to attract and retain high quality students. GAPC will continue to work with the College and Graduate School to increase student stipends across the board, but will also utilize departmental funds (i.e., from endowments) and from faculty mentors to "top up" salaries, including summer salary. With toppings, the goal is to make graduate student stipends comparable to peer institutions.
d. Decrease the time necessary for degree completion for M.S. and Ph.D. students with or without prior M.S. degrees.
e. Increase placement of M.S. and Ph.D. students into prestigious graduate programs, tenure-track faculty positions, as well as competitive industry, government, and teaching positions.
f. Increase mentoring capacity and effectiveness among faculty advisors by revising documentation and timelines.

4. FACULTY AND RESEARCH

4.1. Self-Assessment

At the time of our last strategic plan in 2012 there were 17 full-time TT faculty. This number was unchanged from the number in 2000. Since then, the number of TT positions has declined to 12 (Fig. 5). The recent losses of Burr, Emery, McKay (to the College), and Steen (60% to Microbiology), in particular, have left the department in a perilous situation. Without a critical mass of TT faculty, our ability to teach and mentor undergraduate and graduate students is coming under strain. Moreover, low faculty numbers decrease our ability to conduct high impact cutting-edge research through external grants from national funding agencies, and serve on committees as needed for the operation of EPS and the College while contributing to the service of professional societies and funding agencies. Without corrective action, the added workload associated with our current state of understaffing will impact the performance of our faculty in terms of annual reviews and promotions as well as the ability of the department to retain faculty.

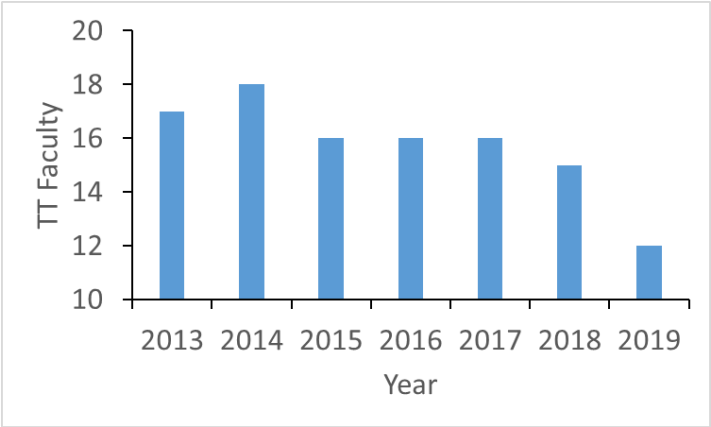


Fig. 5: Full-time tenure track (TT) faculty in EPS in the Fall of each year

The department continues to maintain three basic areas of disciplinary scholarship: Geology, Environmental Science/Studies, and Planetary Science. At the time of our last strategic plan in 2012 there were with ~5-6 faculty members in each area. Now, although the number of TT positions has declined, there is significantly more overlap between areas, with at least 5 faculty working in more than one area. As a result, the current distribution of TT faculty members within each area is ~7 in Geology, ~4 in Environmental Science/Studies, and ~6 in Planetary Science.

External research funding has grown since our last strategic plan. In 2009/10 (when we had 14 TT faculty members), total external grant expenditures were approximately $2.55M ($182K per TT faculty member). In 2017/2018 (when we had 15 TT faculty members, and after two of our most successful grant-winners, Professors McSween and Taylor, had retired), total external grant expenditures were $2.91M ($194K per TT faculty member). This corresponds to an overall increase in external funding of 14% and a per-faculty member increase of 6.6% over a period of 8 years. This shows that EPS faculty members continue to compete successfully—on a per TT faculty member basis—with larger departments such as Physics, Chemistry, and the combined departments of the Division of Biology. In fact, a recent (Oct, 2018) report presented by the CAS Associate Dean for Research and Facilities showed that EPS was the only department in the College in which every TT faculty member was receiving external funding in the past two years (FY 2017 and FY 2018), with the average across the Natural Sciences departments being just under 70% of TT faculty receiving external funding.

4.2. Gap Analysis for Improvement

EPS fully supports the institutional and departmental improvements identified in VolVision 2020, and will act to implement them. Additionally, we have identified several critical gaps between EPS and Top Tier 1 Geoscience departments in other public institutions. These are discussed in the following paragraphs. The focus is on gaps where we see the need and potential for substantial improvements.

Some of these gaps can be addressed using departmental resources, while others will require input from the College of Arts and Sciences and/or UTK upper administration.

The number of TT faculty in EPS (12 as of August 2019) is substantially below that of nearly *all* Tier 1 research geoscience programs in the country. Productive Tier 1 programs typically have 20 to 40 TT faculty members (Appendix 8.1), and these levels are necessary to provide the scientific depth and scholarly output required to gain recognition as a highly successful program. Our small number of faculty limits our net scholarly output, our service footprint, our visibility in the larger geoscience community, and (because of how the metrics are structured) our departmental ranking in publications like US News and World Report. The small number of faculty means that our service burden per faculty member is higher than larger departments, which takes time away from research and teaching. It also means that on average our faculty must teach more introductory and core curriculum courses instead of seminars and upper-level electives that enrich undergraduate and graduate curricula and our research programs.

These issues affect our ability to raise external funding, compounding the challenges we already face as a small department with limited internal research support. Overworked faculty are less likely to engage in department social events or contribute to extracurricular and outreach events. From existing productivity trends on a per-faculty basis it is clear that additional TT positions in critical areas within EPS would be a "good investment" for the College and University. Hiring more tenured and tenure-track faculty would improve undergraduate and graduate-level teaching, help us raise external funds, improve the quality and stature of our research, and the overall climate and culture in the department.

Many Tier 1 medium-sized (~20 TT faculty) research departments (e.g., University of Wisconsin, University of California Davis, University of Minnesota) have supporting technical staff including, technicians, lab managers, and technology specialists (Appendix 8.1). Consequently, faculty at these institutions show higher research productivity than EPS faculty because of the professional technical support. EPS has relatively few professional technical positions relative to typical Tier 1 geoscience programs (Appendix 8.1). EPS currently has 1.44 technician positions supported by the college and 1.00 technician positions supported by external funding. College support includes a 100% funded position for the electron microprobe facility and a 44% funded position for the stable isotope facility, with additional 16% support by EPS. External grants support 40% of a technician position for the stable isotope facility and 100% for the analytical geochemistry and geomicrobiology facility. An additional technician position is anticipated for the new ICP-MS facility, but the level of support from the College is currently unknown.

Currently, the following facilities do not have any technical support: experimental petrology laboratory (which contains machining equipment and high and atmospheric pressure experimental apparatuses), saw/polishing laboratory, and the newly-created geochemistry research undergraduate laboratory in Strong Hall (which contains high-maintenance technical instrumentation including gas and liquid chromatography systems, multiple mass spectrometers, and field equipment for environmental monitoring). Overall, this low level of technical support requires TT faculty members, graduate students, and post-docs (the latter funded on external grants) to carry out time-consuming routine technical tasks in support of laboratory facilities, taking valuable time from conducting cutting-edge research. It also limits our ability to use research-quality laboratories in our graduate and upper level course teaching, and is a significant impediment in our efforts to recruit and retain faculty.

EPS has relatively few postdoctoral researchers and Research Faculty members, compared to Top Tier 1 programs. In the geosciences, especially in planetary geosciences, Research Faculty members and sometimes even postdocs can often support themselves on external grants and add value to the research and graduate mentoring missions of a department.

4.3. Action Plan

4.3.1. New Hires

The department is committed to an aggressive hiring plan in order to return to a critical mass of between 16 and 18 TT faculty by 2025. Between 2016 and 2019, EPS made three outstanding TT faculty hires and one outstanding lecturer hire and we intend to continue this trend. We plan to request one new TT faculty line per year for the next five years. This is in addition to replacing any TT positions vacated by retirement or other departures. If successful this strategy will raise total TT positions in EPS to approximately 17 by 2025. We intend to submit faculty hiring proposals to the College that will highlight the Department's potential to quickly reach Top Tier 1 status, the high productivity of recent EPS faculty hires (including the rapid return on investment from the use of startup funds as seed money for new research initiatives), the international recognition of our research programs, and the high degree of collaboration that EPS faculty have with other departments, colleges, and ORNL.

Tenure-track faculty hiring will focus on the following teaching and research needs and will be guided by cognizance of VolVision 2020 goals to produce an objective recruitment process.

<u>Teaching Needs</u>

With the current small number of TT faculty, the Department's ability to meet its teaching commitments is inadequate. At the present time, the following teaching needs are particularly acute:

a. *Environmental Studies*. The ES program accounts for over half of our majors and yet we only have 4 TT faculty who regularly teach ES courses.
b. *Geophysics / geodynamics*. These subjects are fundamental to the undergraduate and graduate curricula in geology and teaching postdocs have been covering geophysics courses for the past ~5 years.
c. *Introductory-level courses*. The large enrollments in these courses mean that we must rely on lecturers, teaching post-docs, graduate students, and adjunct lecturers, in addition to TT faculty, to teach them.
d. *Core curriculum geology courses*. Most core curriculum courses are taught by a single faculty member every year. These include Structure, Petrology, Mineralogy, and Paleontology. This impacts the quality of the graduate program by limiting the ability of these faculty to offer upper-level electives. Sedimentology and Planetary Science are co-taught or taught by multiple faculty in alternating years; departure of current faculty in these areas could put a similar burden on the remaining instructors of those courses.
e. *Planetary geoscience*. EPS has one of the world's pre-eminent programs for graduate education in planetary geoscience, and approximately 40% of our current graduate student population is working in this area. However, because of recent retirements and departures of key planetary faculty to competing programs (which in itself is a mark of our success), our ability to sustain current levels of teaching and graduate advising, while maintaining quality of the program, is in serious jeopardy.

The teaching needs outlined above can be related to priorities one (Undergraduate Education) and two (Graduate Education) of VolVision 2020. First, a critical number of faculty members in EPS is required to implement the Undergraduate Education goal of improving "academic quality through Experience Learning and innovative new approaches to general education." Second, by having a critical mass of faculty members we can better position ourselves to meet Graduate Education goals such as "Improve recruitment and financial support to attract excellent students" and "Improve graduate student outcomes through focus on career placement and timely completion of degrees."

<u>Research Needs</u>

The quality of our current research programs is internationally recognized; however, our small number of faculty affects department rank and profile. We propose to improve our research impact by:

a. Hiring TT faculty in fields complementary to our existing research strengths. These include Planetary Science, Structure / Tectonics, Deep Time, and Environmental Geoscience. This practice helps departments develop outsized reputations in specific specializations, and it has already served us

well in developing our current reputation. It also ensures the critical mass necessary to support the graduate program, and promotes intradepartmental collaborations as well as group synergy.

b. Hiring faculty in fields with long-term potential to generate significant external research funding. We view research that takes advantage of novel analytical, experimental or quantitative methods, planetary missions, and/or research that crosses traditional disciplinary boundaries as having the highest potential for long-term fundability. We note that current and former faculty have been exceptionally successful raising money through NASA and NSF programs. These faculty members could also pursue collaborative transdisciplinary research.

These research needs can be related to priorities three (Research, Scholarship, Creative Activity, and Engagement) and four (Faculty and Staff) of VolVision 2020. For example, one of the major Paradigm Shifts, “Support Transdisciplinary Research”, aligns with our goal of obtaining new faculty to engage in transdisciplinary collaborative research within the Earth and Planetary sciences, as funded by national funding agencies such as NSF and NASA. In terms of Excellence in Sponsored Research, “Improve Proposal Competitiveness,” the new faculty positions would be in a more competitive place to pursue external funding for collaborative research because of the Department’s emphasis on creating a more supportive environment. Also, a critical number of faculty lines will be needed in order to “Increase Student Research Experiences” through engaging undergraduate students in Experiential Learning as well as graduate student research. As related to Effectiveness and Cost Management, the new Strong Hall facility is a successful example of the goal to “Improve Research Infrastructure” that is an existing foundation for EPS. It is now possible to pursue a hiring plan that can take full advantage of our new cutting-edge facilities for labs, collaborative areas, and teaching. Through the Strategic Direction 2020 for faculty and Staff, EPS is in an excellent position to attract and retain additional competitive faculty lines. Our need to attract excellent faculty members is supported by the Strategic Direction to "actively recruit for top faculty talent on a national level, which will require competitive salary and start-up packages." Also, due to Action Priorities related to Faculty, our department is well placed to recruit and retain excellent new faculty members. In agreement with VolVision 2020, the new hires will be in fields where long-term access to external research funding can be reasonably anticipated. In general, such fields for EPS might include Earth and planetary materials or processes , environment and sustainability, renewable energy, and climate change.

4.3.2.Technical Support

Hiring additional laboratory managers is supported by VolVision 2020 under the Strategic Direction for Faculty and Staff, i.e. "build the staff capabilities required to meet the growing challenges

and complexities of a research intensive university." New laboratory manager positions also fall under Action Priorities for staff. Therefore, we plan to request the following increases in technical support positions over the next 5 years:

1. Request an additional technician position line from the College to support the new ICP-MS laboratory. This position would also support existing rock preparation and saw/polishing facilities.
2. Request equal support of 70% for four technician positions, one in each of our main research facilities: the electron microprobe laboratory, the stable isotope laboratory, the analytical geochemistry and microbiology laboratory (including a newly-created undergraduate geochemistry research laboratory), and the ICP-MS laboratory. This would require a doubling of the College's support, from its current level 1.44 FTE employees to 2.88 FTE employees.

4.3.3.Faculty Mentoring

We plan to improve our faculty mentoring system to better facilitate faculty retention and promotion. Currently, Assistant Professors are assigned a team of three mentors from the tenured faculty, and undergo a thorough mid-term review as prescribed by the University. Associate Professors also have a team of three mentors from the full faculty members. Faculty members requesting promotion to Professor undergo a preliminary review, one to two years in advance of their expected application for promotion, and meet with senior faculty members to discuss strategies for compiling a successful dossier.

It is not clear how successful this team-based approach to mentoring has been, or how frequently the teams meet with their mentees. Therefore, other types of one-on-one mentoring will be explored, including feedback from our recently-implemented enhanced annual evaluation procedure (which involves a committee of three full professors in addition to the Head), that will more clearly define and communicate performance expectations. Any proposed changes to the mentoring process will likely require revisions to our Department Bylaws.

4.3.4.Faculty Development Leaves

Where possible, we plan to make changes in departmental service and teaching assignments so as to encourage applications for Faculty Development Leaves (FDL), which have been relatively rare in EPS. Increased FDL's would allow research-productive faculty to spend more time seeking external funding, carrying out research, and mentoring graduate/undergraduate research. This would also help to achieve the VolVision 2020 objective of pursuing "Transdisciplinary Research." Increasing the number of TT faculty (as outlined in section 4.3.1) is critical to facilitating more FDL's, as it would reduce service and teaching loads.

4.3.5.Post-doctoral Researchers and Research Faculty

We plan to seek additional funding opportunities in NASA, NSF, and other agencies to support Post-doctoral researchers and Research Faculty. The goal is to grow the number of Post-doctoral and Research Faculty appointments in EPS. These positions increase research productivity, the generation of external funding, and collaborations within and external to the department.

4.4. Metrics for Success

a. Increase the number of TT faculty in EPS from 12 to 17 in 2025.
b. Maintain 100% of TT Faculty with at least one externally-funded grant per year.
c. Increase external research expenditures to over $200K per year per TT faculty member in 2025.
d. Have every TT faculty member in EPS publish a 5-year average of at least 2 peer-reviewed journal articles, book chapters, or books per year.
e. Have 100% of TT faculty mentoring at least one M.Sc. or Ph.D. student each year, with at least one graduated student every second year.
f. Increase the number of FDL's taken by TT Faculty from 0.5 per year to 0.75 per year in in 2025.
g. Obtain support from the College for 70% of salary for four technical staff positions.
h. Double the number of Post-doctoral Researchers and Research Faculty in EPS from 4 to 8 in 2025.
i. Have EPS receive at least 1 major professional award for its faculty every other year. This includes AAAS, GSA, or ASA Fellows, as well as Penrose, Miner, Meinzer, Gilbert Awards, etc.

5. DIVERSITY AND INCLUSION

This section of the strategic plan was developed by a departmental subcommittee comprised of both faculty members and graduate students.

5.1. Where We Are Coming From

Although always committed to diversity and inclusion, the Department of Earth and Planetary Sciences (EPS) has not paid much explicit attention to these issues in the past. The only mention of diversity in the last EPS Strategic Plan, dated March 2012, was its appearance as one of the Department's guiding values, i.e., "Professionalism, cooperation, and respect for individuals and for gender/racial/ethnic diversity." There was no specific mention of diversity or inclusion in the EPS mid-cycle self-study document, dated September 2016.

During the 2016 mid-cycle review process, and more recently, some concerns were raised with the Head that the treatment of men and women in the department has not always been equal. The Department is working very hard to create a culture where everyone is treated equally and respectively,

regardless of gender or race or any other distinctions. Some of the recent concrete actions that have been taken to help facilitate this goal are listed below:

a. Since Fall 2016 all Faculty have been required to complete online Mandatory Reporter training,

b. In Fall, 2016, Jennifer Richter from the Office of Equity and Diversity (OED) gave a talk entitled "UTK's sexual misconduct policy and mandatory reporter responsibilities" as part of our Klepser seminar series,

c. In Spring 2018, the Head and members of the department's executive committee met with Jennifer Richter and Ashley Blamey from the OED and Title IV offices, respectively, to discuss gender discrimination concerns among grads in EPS,

d. In Fall 2018, the department implemented the requirement that all graduate students must successfully complete the University's online Mandatory Reporter training,

e. In Fall 2018, all faculty, staff and graduate students were required to attend (as separate groups) a 50-minute Title IX presentation (with Q & A) on gender equity and sexual harassment issues by the Office of Equity and Diversity,

f. In Fall 2018, Suzie Allard, Associate Dean for Academic Programs in the College of Communication & Information, gave a talk on "Mentor-Mentee Relationships" as part of the Klepser seminar series.

g. In Spring 2019, all faculty, staff and graduate students were required to complete online Code of Conduct training.

h. In Spring 2019, the department's chapter of the Association for Women Geoscientists hosted a Diversity Education workshop by UTK's Office of Multicultural Student Life focused on "similarities and differences, inclusion and exclusion, and bias."

5.2. Where We Are Now

At the undergraduate level, the gender distribution of our majors (Fall 2018) is currently 59% male, and 41% female. Excellent progress has been made over the past 5 years in increasing the number of females in the undergraduate program, with the percentage change in female majors increasing by 28%, as compared to a decrease of 9% in male majors over the same time interval (Fig. 6).

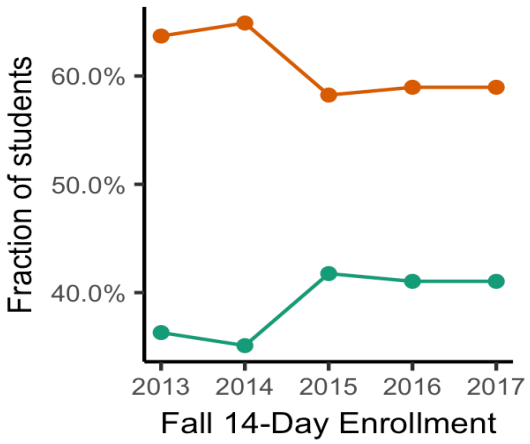


Fig. 6: Students majoring in GES by gender.

In terms of race, 77% of our majors are white, non-Hispanic. African American, Hispanic, and international students currently (Fall 2018) make up 5%, 4%, and 4%, respectively of our undergraduate majors. The fraction of self-identified White students has decreased slightly from 87% in 2013, while other race/ethnicity classes have held roughly steady. Approximately half of our undergraduates are transfer students from junior college – a number that has been growing since the advent of the Tennessee Promise Program. Since 2013, 79-82% of students had in-state status, with the remainder mainly from a few adjacent states.

At the graduate level, the Department has a relatively equal mix in terms of gender (Fig. 7). We also have Lesbian, Gay, Bisexual, Transgender and Queer (LGBTQ) graduate students within the Department who are open regarding their sexual orientation. The graduate student population is dominated by white, non-Hispanics. In Fall 2018 only, 4% of graduate students were international students, and only 1% identified as either African American or Asian. A total of 77% of all graduate applications to the Department over the past 4 years were received from white, non-Hispanic students. Over the same time period, only 11%, 1%, and 8% of graduate applications to the Department came from African Americans, Asians, and Hispanics, respectively.

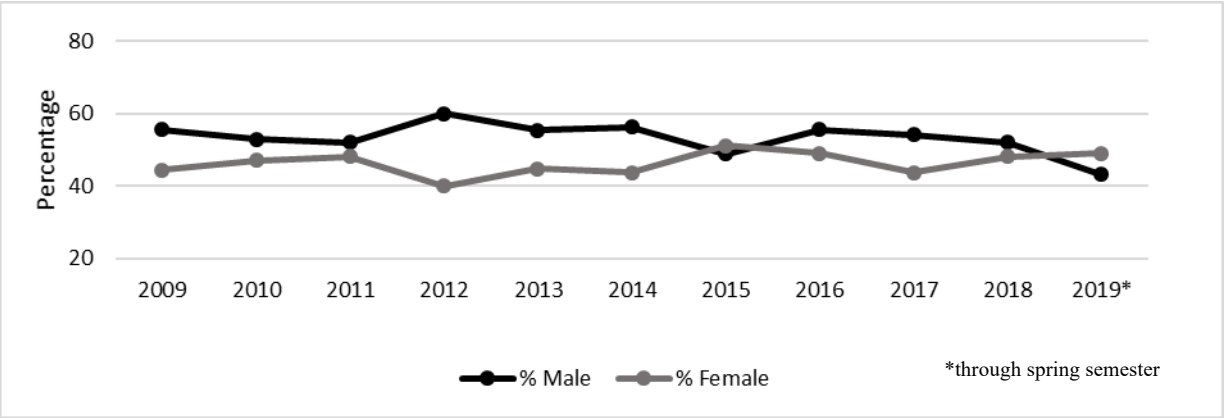


Fig. 7: Percentages of male and female graduate students over time.

Faculty and staff are relatively non-diverse White, other than 8% Hispanic and 8% International. There are currently no African Americans, Asian Americans, or Native Americans represented. Since the last strategic plan, the Department has made some progress, through strategic and target of opportunity hires, in improving the gender balance among faculty, with females now making up approximately one third of active faculty.

5.3. Where We Are Going

In Fall 2019 we created a new Diversity Council led by one faculty member, one graduate student and one undergraduate student. This Council will meet regularly with any interested faculty, staff and students to have conversations with, and generate input on, what we can do to better to accommodate and increase our departmental diversity. The Council is also tasked with developing a diversity component to our website, including creating an anonymous comment mechanism to report perceived diversity-related issues, and coordinating annual Safe Zone training (see below). We recommend that the Department adds these new Diversity Council positions to its Bylaws and formal service assignments.

We plan to continue efforts to eradicate concerns that men and women in the department are not treated equally. To help facilitate this we have developed a departmental position statement on diversity and inclusion, as well as a departmental code of conduct (see Appendices 8.2 and 8.3). We recommend these guidelines be incorporated into the Department's Bylaws, which are currently under revision. Once approved they will be linked to the departmental website with the expectation that all members of EPS will adhere to them.

We will strive to increase diversity among the graduate student population, including gender and underrepresented minorities. We will try to maintain an even gender ratio. Few of our graduate students belong to an underrepresented ethnic minority, which generally matches the national trend for

M.S. and Ph.D. geoscience programs. Although we recognize that the geosciences tend to have the least diversity among STEM disciplines nationally, we would like to increase their representation in EPS. We will work to recruit and retain well-qualified undergraduate and graduate students from diverse, non-traditional, and international backgrounds. Specific goals in this regard include: at least 5% of graduate students with African American, Hispanic, and/or Asian backgrounds, and at least 10% international students. We will continue to make full use of specific College recruiting funds to bring in under-represented minorities for onsite interviews during graduate student recruiting.

To better recognize implicit biases, and to learn how to be inclusive of all genders and sexualities, we plan to offer annual Safe Zone training (https://thesafezoneproject.com/) to all of our graduate students. Graduate students often interact with undergraduate students on a one-on-one basis as teaching assistants. Thus, Safe Zone training of graduate students should also benefit the recruiting and retention of undergraduate students. The Diversity Council will be responsible for coordinating the annual Safe Zone training.

We view the Klepser seminar series as an integral part of graduate education in the department and the speakers as scientific and societal role models. Therefore, efforts will be made each semester to bring in a diverse and inclusive line up of top quality speakers from different disciplines and, when possible, under-represented groups.

We believe that the inclusion of a faculty member from an under-represented group can be a stimulus to recruiting students from minorities, just as the enrollment of females in our undergraduate and graduate programs has increased as the percentage of female faculty has increased. Therefore, we will make explicit efforts to recruit and retain more diverse faculty and staff. Specifically, we will strive to recruit a qualified faculty member from a minority racial group (African American, Asian, Hispanic, or Native American), or one with an openly LGBTQ sexual orientation. To help facilitate this recruiting effort, we will employ targeted advertising on sites such as the Association for Women Geoscientists (https://www.awg.org/) and the National Association of Black Geoscientists (http://www.nabg-us.org/). We will require all faculty members to participate in STRIDE (Strategies and Tactics for Recruiting to Improve Diversity and Excellence) training (https://stride.utk.edu/) to better understand how systemic biases can affect judgement. Additionally, we recommend that all faculty members avail themselves of the Safe Zone training offered to graduate students, to learn how to be inclusive of all genders and sexualities, as well as how to support students with marginalized identities.

5.4. Metrics

We will use departmental data collected by the UPC and GAPC, and well as Academic Unit Statistics available on the University's Office of Institutional Research and Assessment website (https://oiradev2.oira.utk.edu/onlineReporting) to evaluate the success of our specific goals for increasing departmental diversity.

6. ALUMNI RELATIONS AND DEVELOPMENT

6.1. Background (where we are)

The 2012 EPS strategic plan set goals of doubling the total departmental endowment, from $2M to $4M, establishing two new endowed professorships or faculty achievement awards, establishing 10 new term gift agreements (usually 5 year terms) and 5 bequests. The department has achieved all of these goals and more. The market value of EPS endowments at the end of 2018/19 academic year was over $7.0M. Seven new endowed professorships/faculty achievement funds have been created, along with four new graduate fellowships, one new undergraduate scholarship endowment, several special use endowments, and a new discretionary endowment – the Strong Hall fund. Engagement with alumni increased substantially since 2012, resulting in a reinvigorated EPS Advisory Board, which now meets twice a year and sets its own agenda. The Advisory Board is now playing a greater role in student career mentoring and recently established a set of Advisory Board scholarships funded by Board dues. The success in alumni engagement and development since 2012 appears to be the result of the combined efforts of former department head, Larry McKay, college-level development staff, and leaders of the Alumni Board.

6.2. Opportunities and Challenges

It may be difficult to sustain the current high level of alumni engagement and development, especially as key people leave the department or college. The department is experimenting with making greater use of emeritus faculty (McSween) to lead the development effort. This is helpful, but must be supplemented by senior faculty members and/or the departmental head. The department must maintain good engagement with the Advisory Board and be responsive to their suggestions and needs. It is also important that the department become more effective in making annual expenditures from endowments more transparent and showing that these are beneficial to our students and programs.

6.3. Goals for next Ten Years

a. Grow the EPS Advisory Board to at least 30 members. Such a large group will provide a wide variety of insights and assistance for fund-raising.

b. Increase opportunities for the Advisory Board to provide career mentoring for students. This can include more interactions with students at alumni board meetings.
c. Improved plans and oversight for efficient allocation and spending from endowments. This will be the responsibility of the department head, with advice from the college development office.
d. Greater transparency in reporting spending from endowments so that donors can see that their gifts are benefiting our programs, faculty and students. This will be the responsibility of the department head, with advice from the college development office.
e. More frequent nomination of alumni for departmental and college awards. This will be the responsibility of the department head, with advice from the college development office.
f. Continue to encourage giving by alumni, friends, and faculty to increase overall endowment to $10M by 2029.

7. RESOURCES USED

The data presented in this plan were obtained from a variety of sources, including:

a. UTK's Office of Institutional Research and Assessment (OIRA) website: https://oiradev2.oira.utk.edu/onlineReporting

b. UTK Data Central https://data.utk.edu

c. Internal departmental committee, faculty and staff records.

d. The previous EPS Strategic Plan dated March 1, 2012.

The departmental position statement (Appendix 8.2) closely follows that of the Geological Society of America's Commitment to Diversity statement, on which it was modeled. Portions of the Code of Conduct and some of the definitions (Appendix 8.3) and were drawn from the following sources:

a. The Association of American Colleges and Universities

b. The American Association of Public and Land-grant Universities Commission for Access Diversity and Excellence

c. The American Geophysical Union's 2017 Scientific Integrity and Professional Ethics Handbook

d. Guidelines for Faculty, Jackson School of Geosciences

e. Middle Tennessee State University Department Code of Conduct

f. Sumrall Lab Group Code of Conduct, as modified from the Paleontological Society Code of Conduct

g. The Toolik Field Station Code of Conduct

h. The University of Alaska Fairbanks Code of Conduct template

i. Vol Vision 2020

j. Wikipedia

8. APPENDICES

8.1. Departmental Ranking Relative to Peer and Aspirational Institutions

Peer Universities	Univ. Rank	Department	Dept. Rank	TT Faculty	Res. Fac.	Post-docs	Lecturers	Admin. Staff	Lab. Tech.
Virginia Tech	76	Geosciences	28	23	5	–	–	3	5
University of Tennessee	115	Earth and Planetary	54	15	2	2	4	4	2
University of Missouri	129	Geological Sciences	78	12	–	4	–	3	–
University of Nebaska	129	Earth and Atmospheric Sciences	78	22	1	–	1	1	–
University of South Carolina	106	Earth, Ocean and the Environment	90	49	6	4	3	4	–
Louisiana State University	140	Geology and Geophysics	90	22	–	–	1	4	2
University of Kentucky	147	Earth and Environemtnal Sciences	107	12	1	3	2	1	1
University of Alabama	157	Geological Sciences	114	22	1	0	1	3	3
North Carolina State	80	Marine, Earth, and Atmosphere Sci	>124	32	8	14	3	5	5
Auburn University	115	Geosciences	>124	18	1	2	7	2	2
Iowa State University	119	Geological and Atmospheric Sci	>124	22	–	4	–	5	–
Clemson University	66	Env Engineering and Earth Sci	>124	24	6	7	4	7	–
Aspirational Universities	**Univ. Rank**	**Department**	**Dept. Rank**	**TT Faculty**	**Res. Fac.**	**Post-docs**	**Lecturers**	**Admin. Staff**	**Lab. Tech.**
University of Wisconsin	49	Geosciences	15	18	9	13	–	4	8
University of Minnesota	76	Earth Sciences	25	28	31	13	–	7	20
Purdue University	56	Earth, Atmospheric, Planetary	41	35	–	1	–	9	1
University of Tennessee	115	Earth and Planetary	54	15	2	2	4	4	2
University of Florida	35	Geological Science	54	18	1	9	6	2	1
Michigan State University	85	Earth and Environmental Sciences	64	21	5	–	1	4	4
University of Georgia	46	Dept of Geology	90	15	0	1	–	5	1
University	**Univ. Rank**	**Peer Departments**	**Dept. Rank**	**TT Faculty**	**Res. Fac.**	**Post-docs**	**Lecturers**	**Admin. Staff**	**Lab. Tech.**
University of Tennessee	115	Earth and Planetary	54	15	2	2	4	4	2
University of Florida	35	Geological Science	54	18	1	9	6	2	1
University of Houston	171	Earth and Atmospheric Sciences	54	32	22	3	4	9	–
University of New Mexico	187	Earth and Planetary	46	19	10	–	2	4	3
Universit of Hawaii	157	Earth Sciences	41	23	3	–	–	4	2
Purdue University	56	Earth, Atmospheric, Planetary	41	35	–	1	–	9	1
University	**Univ. Rank**	**Aspirational Departments**	**Dept. Rank**	**TT Faculty**	**Res. Fac.**	**Post-docs**	**Lecturers**	**Admin. Staff**	**Lab. Tech.**
Stony Brook University	80	Geosciences	38	19	4	3	1	4	4
Texas A&M	66	Geology and Geophysics	31	38	1	5	2	8	1
Virginia Tech	76	Geosciences	28	23	5	–	–	3	5
UC Davis	38	Earth and Planetary Sciences	24	23	3	9	9	5	5
Rice	16	Earth, Env, and Planetary	24	22	6	12	–	5	2
University of Tennessee	115	Earth and Planetary	54	15	2	2	4	4	2

Rankings from 2018 US News and World Report Rankings (https://www.usnews.com/best-graduate-schools/top-science-schools/). Faculty and staff numbers compiled from institutional websites by Linda Kah in Spring 2019 (note: EPS TT Faculty has since dropped to 12). Peer and aspirational Universities from https://budget.utk.edu/peer-institutions/. Peer and Aspirational Departments selected from 2018 US News and World Report Rankings for US Earth Science departments.

8.2. Draft Position Statement for Inclusion in Departmental Bylaws

The Department of Earth and Planetary Sciences (EPS) affirms its belief in and commitment to diversity, and will continue to develop and promote a diverse community. EPS is dedicated to maintaining an inclusive working environment where differing ideas, abilities, backgrounds, and needs are fostered with opportunities for students, faculty, staff, and visitors from divergent experiences to participate in and contribute to the Department. EPS recognizes that diverse perspectives are important and necessary in teaching, research, and service. Therefore, EPS will strive to ensure that every departmental activity in open to all students, faculty, staff, and visitors regardless of race, sex, creed, age, sexual orientation, national origin, religion, or disability.

8.3. Draft Code of Conduct for Inclusion in Departmental Bylaws

Members of EPS are required to follow the University's general Code of Conduct (https://conduct.tennessee.edu/). Additionally, EPS has established, and seeks to apply, specific code of conduct expectations intended to address ongoing issues within our scientific community that can have profound impacts on our research workplace and on individual lives and careers. The EPS Code of Conduct is a set of principles and practices for professional behavior that governs all EPS students, faculty, staff, and visitors.

Principles

a. Excellence, integrity, and honesty in all aspects of professional work.
b. Professional courtesy, equity, and fairness in working with others.
c. Freedom to responsibly pursue science without interference or coercion.
d. Unselfish cooperation in all department activities.
e. Legal compliance in all aspects of the department's professional activities.

Expectations

EPS is committed to equality, in both opportunity and in treatment, for all of our members and visitors. We will not discriminate on the basis of race, color, national or ethnic origin, immigration status, religion or religious belief, age, marital or parental status, sex, sexual orientation, gender identity or expression, socioeconomic background, disability, veteran status, or any other reason. We will conduct ourselves in a professional manner, in which everyone is treated with dignity and respect.

Faculty and students in EPS are expected to conduct themselves in a lawful manner and uphold University rules and policies. In addition, members of EPS are expected to abide by the departmental

Code of Conduct to foster a learning and research environment in which all members are valued, respected, and celebrated.

EPS follows Ask Once as a behavioral guideline. This guideline is intended to inform behavior among peers, and to provide a simple way to judge harassment for reporting purposes. The Ask Once guideline means you can ask someone out once from your peer group, and if they do not say yes, you cannot ask them out again. Asking out includes hitting on, expressing interest, or making advances. If someone brushes off the advance, does not reciprocate in a positive way, or turns down the advance in any way, it is considered a "no."

Responsibilities

Effective instruction, learning, advising, research, and professional career growth require open communication, ethical professional conduct between all individuals, collegial interactions, and a responsive administration to ensure a positive and successful environment across all levels of the educational endeavor. To ensure a productive environment, all members of EPS are expected to treat one another respectfully and fairly, and serve as role models, upholding the highest ethical and professional standards.

The responsibilities below embody best practices to be used by all members of EPS, including faculty, research scientists, staff, and students. They are intended to provide a heightened awareness of the need to consciously establish effective and productive professional relationships that start with trust, courtesy, two-way communications, and shared expectations.

a. *Conduct:* Members of EPS will act with honesty in the best interests of the department, take full responsibility for the trustworthiness of their research, teaching, and service activities, and treat others with courtesy, equity, fairness, and respect.
b. *Integrity:* Members of EPS will be responsible for the integrity of their contributions to all professional activities related to the department and university.
c. *Public Communication:* Members of EPS, when representing the department, will limit professional comments to their areas of scholarly expertise when engaged in public discussions about the application and importance of scientific knowledge and will clearly distinguish professional comments from their opinions based on personal views.
d. *Environment:* Members of EPS are proactive departmental citizens, responsible for creating and maintaining a safe, open, and professional environment for learning, conducting, and communicating science with integrity, respect, fairness, trustworthiness, and transparency in all endeavors.

e. *Cooperation:* Members of EPS will cooperate unselfishly in shared responsibilities including departmental service assignments, and teaching loads
f. *Power Imbalances:* Members of EPS should be aware of, and sensitive to, the natural power imbalances in working relationships among undergraduate and graduate students, faculty of different ranks, research and departmental staff etc.
g. *Misconduct:* Members of EPS will not engage in discrimination, harassment, bullying, dishonesty, fraud, misrepresentation, coercive manipulation, censorship, or other misconduct. This applies to all professional, research, and teaching environments. See below for further discussion of what constitutes misconduct.
h. *Reporting:* Members of EPS will take responsibility to act or intercede, where possible, to prevent misconduct. Any suspected misconduct, including fabrication, falsification, plagiarism of materials, as well as discrimination, harassment, bullying, or other unacceptable behaviors will be promptly reported following university policy and procedures (see below).

Student-Advisor Relationship

The relationship between a student and the student's advisor(s) is critical to the progression of science and therefore carries extra demands for ethical behavior. Key areas of sensitivity and concern for the advisor include, but are not limited to:

a. Provide an environment that is intellectually stimulating and free of harassment.
b. Be supportive, equitable, accessible, encouraging, and respectful.
c. Recognize and respect the cultural, socioeconomic, religious, marital or parental, sexual orientation, gender identity or expression, and ability of students.
d. Be sensitive to the power imbalance in the student-advisor relationship.
   All students (both undergraduate and graduate) and advisors need to be aware of the responsibilities of the advisor, the student, and the institution in regards to their relationships. All of the guidelines regarding the mentor-mentee relationship described above are also applicable to the graduate-undergraduate student mentor-mentee relationship.

Unacceptable Behaviors

EPS works to maintain an environment that allows science and scientific careers to flourish through the respectful, inclusive, and equitable treatment of others. As outlined above, members of EPS will not discriminate based on the basis of race, color, national or ethnic origin, immigration status, religion or religious belief, age, marital or parental status, sex, sexual orientation, gender identity or

expression, socioeconomic background, disability, veteran status, or any other reason. Additionally, the department opposes all forms of bullying including threatening, humiliating, coercive, or intimidating conduct that causes harm to, interferes with, or sabotages academic activity and careers.

The following behaviors are considered violations of the EPS Code of Conduct and should be reported and addressed, with consequences for the offender. Unacceptable behavior includes, but is not limited to:

a. *Sexual Harassment* such as unwelcome sexual advances, requests for sexual favors, other verbal or physical conduct of a sexual nature, and offensive comments related to gender, gender identity and expression, sexual orientation, physical appearance, race/ethnicity and body size,
b. *Sexual Misconduct* including rape, sexual assault, inappropriate touching, sexual battery, sexual exploitation, coercion, and other forms of non-consensual sexual activity.
c. *Stalking* such as repeatedly following, harassing, threatening, or intimidating including by telephone, mail, electronic communication, or social media,
d. *Patterns of inappropriate social contact* such as requesting / assuming inappropriate levels of intimacy with others,
e. *Dating and Domestic Violence* including emotional, verbal, and economic abuse with or without the presence of physical abuse,
f. *Retaliation* such as withholding employment or academic opportunities or other actions against anyone reporting a violation of this policy (including reporting to any EPS faculty / staff, police, or the Title IX office),
g. *Power-based personal violence* as when an individual asserts power, control, or intimidation in order to harm another. This includes relationship / partner violence, sexual assault, and stalking,
h. Deliberately mischaracterizing a person's gender identity,
i. Gratuitous or off-topic sexual images, comments or behavior,
j. *Microaggression* or unwelcomed behavior against underrepresented groups,
k. *Violating the Ask Once Policy.* It may be appropriate to ask someone out once, but no more than once.

<u>Reporting Options</u>

Individuals at the University have multiple reporting avenues. You can report an incident that you experienced, observed, or were told about, in the following ways:

a. Disclosure to a faculty member (all faculty are mandatory reporters and are lawfully required to share sensitive information with the appropriate offices)

b. Disclosure to the UTK Title IX Office (https://titleix.utk.edu, Phone: 865-974-9600)

c. Disclosure to law enforcement (911)

d. Confidential reporting and support services are offered through the Student Counseling Center (865-974-2196), the Student Health Center (865-974-3135) and the Center for Health and Wellness (865-974-HELP).

Definitions

Diversity can be broadly defined to include all aspects of human difference, including, but not limited to race, gender, age, sexual orientation, religion, disability, social-economic status, and status as a veteran.

Inclusion is the active, intentional, and ongoing engagement with diversity — in the curriculum, in the co-curriculum, and in communities (intellectual, social, cultural, geographical) with which individuals might connect — in ways that increase awareness, content knowledge, cognitive sophistication, and empathic understanding of the complex ways individuals interact within systems and institutions.

Discrimination means unequal or unfair treatment in professional opportunities, education, benefits, evaluation, and employment (such as hiring, termination, promotion, compensation) as well as retaliation and various types of harassment. Discriminatory practices can be explicit or implicit, intentional, or unconscious.

Harassment is a type of discrimination that consists of a single intense and severe act, or of multiple persistent or pervasive acts, which are unwanted, unwelcome, demeaning, abusive, or offensive. Offensive conduct constitutes harassment when: 1) it becomes a condition of opportunity, education, benefit, evaluation, or employment or 2) the conduct is severe or pervasive enough to create a work or educational environment that most people would consider intimidating, hostile, or abusive. These acts may include epithets, slurs, or negative stereotyping based on gender, race, sexual identity, or other categories, as protected by U.S. federal law. Also included are threatening, intimidating, or hostile acts; denigrating jokes and displays; or circulation of written or graphic material that denigrates or shows hostility or aversion toward an individual or a group.

Sexual harassment includes any unwanted and/or unwelcome sexual advances, requests for sexual favors, and other verbal or physical harassment of a sexual nature.

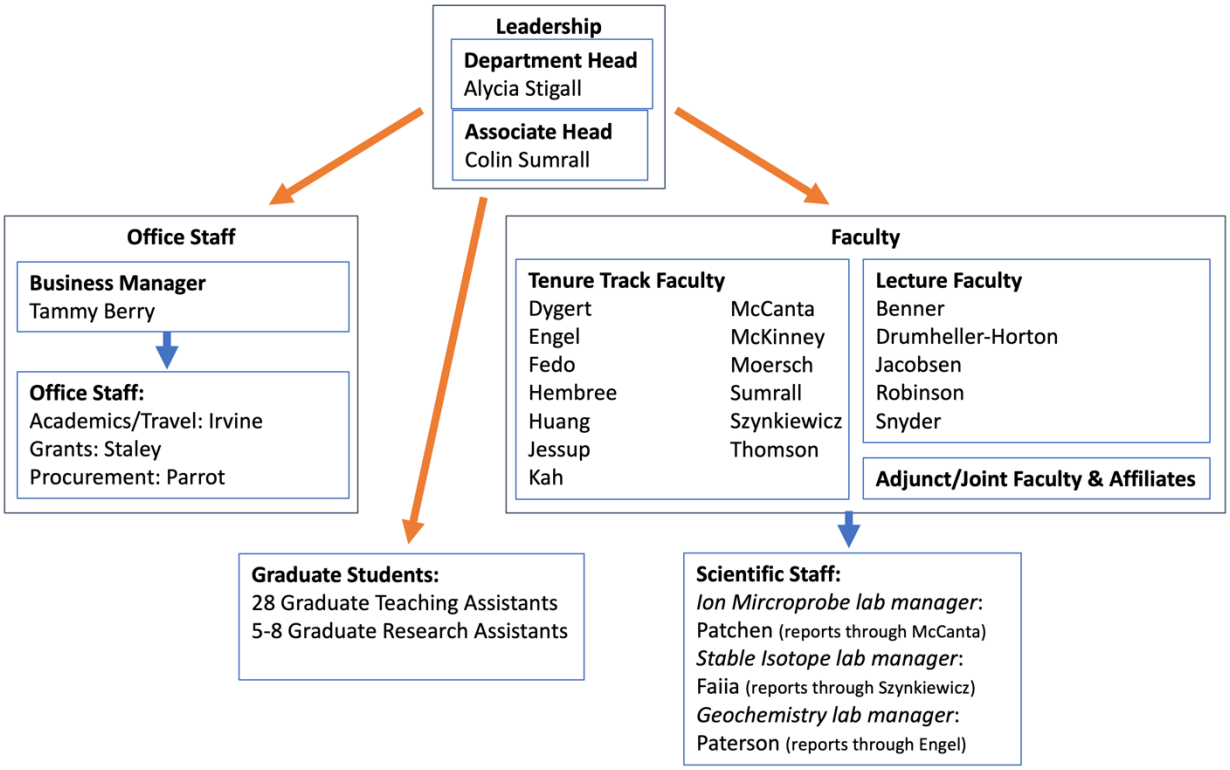
Bullying is the use of force, threat, or coercion to abuse, intimidate, or aggressively dominate others in the professional environment that involves a real or perceived power imbalance. These actions

can include abusive criticism, humiliation, the spreading of rumors, physical and verbal attacks, isolation, undermining, and professional exclusion of individuals through any means.

Microaggression refers to verbal, behavioral, or environmental indignities that intentionally communicate hostile, derogatory, or negative prejudicial slights or insults toward any group.

Title IX Violation is the collective term used for incidents involving discrimination, harassment, sexual harassment, sexual misconduct, stalking, dating violence, domestic violence, and/or retaliation.

Appendix 1.2 EPS Organizational Chart



Appendix 1.3 EPS Committees and Membership

Committee & Coordinator Assignments – Academic Year 2022-23

(Faculty ranks indicated as A: Assistant Professor, O: Associate Professor, P: Full Professor; D: Distinguished Lecturer, L: Lecturer, T: Teaching Post-doc; S: Staff)

Administration

- Head – Stigall[P]
- Associate Head – Sumrall[O]
- Office Staff – Berry[S], Staley[S], Parrott[S], Ballard Berry[S],

Department Standing Committees & Ad-Hoc Committees

- Graduate Admissions & Program Committee
  - Kah[P] (DGS), Thomson[A] (Admissions), Huang[O], Dygert[A]
- Undergraduate Programs and Department Advising
  - Co-Director of Undergraduates - Geology (DUG) – McCanta[O]
  - Co-Director of Undergraduates - Environmental Studies (DUES) – McKinney[P]
  - Members of Undergraduate Program Committee – Benner[D], Hembree[P], Szynkiewicz[O], Jacobsen[L], Snyder[T], Robinson[T]
  - GEOL 100 level course Field Trip Coordinator – Benner[D]
- Student Success Committee
  - Thomson (Chair), Sumrall[O], Dygert[A]
- Adjunct & other Non-TT Faculty Appointments Committee
  - Fedo[P] (Chair), McKinney[P], Moersch[P], Szynkiewicz[O]
- Annual Evaluation & Awards Committee
  - Moersch[P] (Chair), Kah[P], Hembree[P]
- Diversity Council
  - Engel[P] (Chair), Fedo[P], McCanta[O], Steen[A], Paterson[S], Huang[O], grad rep (TBD), undergrad rep. (TBD)

Coordinators & Miscellaneous

- SACS Coordinator – Moersch[P]
- Curriculum Changes & College Curriculum Committee – Hembree[P]
- TN Space Grant Consortium Director –Dygert[A]
- Laboratory Safety Advocate –Patchen[S]
- Webmaster–Jacobsen[L]
- Social Media Coordinator– Drumheller-Horton[L]
- Newsletter Editor – Drumheller-Horton[L]
- Public Display Coordinators – Drumheller-Horton[L], Jacobsen[L]
- Seminar Scheduling – Sumrall[O]
- Course Scheduling – McCanta[O], Stigall[P]
- Alumni Relations & Development – Stigall[P], Sumrall[O]

- Graduate Teaching Assistant Coordinator – Benner[D]
- Institutional Review Board (IRB) Liaison - Jacobsen[L]
- Library Representative – Robinson[T]
- Geoconclave Coordinator – Sumrall[O]
- GeoClub Advisor – Jacobsen[L]
- Awards Day Committee – Sumrall[O] (Chair), Benner[D], Kah[P], McKinney[P], McCanta[O]
- Faculty Development Leave Committee – McKinney[P] (Chair), McCanta[O], Huang[O]

Joint Use Facility Coordinators

- Microscope Lab – Snyder[T]
- Rock Prep Room – Fedo[P] (crushers), Dygert[A] (saws & polishing)
- Computer Lab & Visualization Room – Moersch[P]
- Geochemistry Teaching Lab – Engel[P]
- Microprobe Lab – McCanta[O], Patchen[S]
- XRD Lab – Dygert[A]
- Mass Spec/Isotope Lab – Szynkiewicz[O], Faiia[S]
- ICP-MS Lab – Huang[O]

College/University Service

- Undergraduate Research Advisory Council – Thomson[A]
- University General Education Natural Sciences Committee – Benner[D]
- College Export Control Advisory Board – Kah[P]
- College Budget Committee – Fedo[P]
- College Dean's Advisory Council – Engel[P]
- College Undergraduate Council – Szynkiewicz[O]
- Undergraduate Appeals Committee – Szynkiewicz[O]
- Highly Hazardous Chemical Committee (HHCC)- Huang[O]
- Departmental liaison to the Interdisciplinary Graduate Minor in Computational Sciences – Thomson[A]
- Commencement Assignments
    - Fall: 2022 – Hembree[P], Fedo[P], Huang[O]
    - Spring: 2023 –McKinney[P], Engel[P], McCanta[O]

Peer Teaching Reviews

- Sumrall (Fall, GEOL 370) – Hembree[P] (Chair), Thomson[A], Riding
- Drumheller-Horton (Fall, GEOL 102) – Sumrall (Chair)[O], Robinson[T], Szynkiewicz[O]
- McCanta (Spring, GEOL 320) – McKinney[P] (Chair), Huang[O], Fedo[P]

Faculty Peer Mentors

- Assistant Professor Mentoring Team – Kah[P], Moersch[P]
- Associate Professor Mentoring Team –Engel[P], Hembree[P]
- Post-docs – Hazen[P]

Appendix 3.1 Curricular requirements of undergraduate credentials

Majors offered by the Department of Earth and Planetary Sciences:

Geology and Environmental Studies Major, BS – Environmental Studies Concentration

Corequisites

Students wishing to declare their major in Geology and Environmental Studies should do so at the earliest opportunity.

A. Complete:

- BIOL 260 - Ecology
- BIOL 269 - Ecology Field-Based Laboratory
- ECON 201 - Introductory Economics: A Survey Course *

B. Complete two courses:

- GEOL 101 - The Dynamic Earth *
- GEOL 103 - The Earth's Environments *

C. Select one sequence:

- BIOL 113 - Introductory Plant Biology I *
- BIOL 114 - Introductory Plant Biology II *
- BIOL 115 - Introductory Plant Biology Laboratory

  or
- BIOL 150 - Organismal and Ecological Biology *
- BIOL 160 - Cellular and Molecular Biology *
- BIOL 159 - Skills of Biological Investigation *

  or
- BIOL 158 - Honors: Organismal and Ecological Biology
- BIOL 168 - Honors: Cellular and Molecular Biology *
- BIOL 167 - Honors: Skills of Biological Investigation

D. Select one sequence:

- CHEM 102 - Principles of Chemistry *
- CHEM 103 - Principles of Chemistry Laboratory *
- CHEM 112 - Introduction to Organic and Biochemistry *
- CHEM 113 - Introduction to Organic and Biochemistry Laboratory *

  or
- CHEM 122 - General Chemistry I *
- CHEM 123 - General Chemistry I Laboratory *

- CHEM 132 - General Chemistry II *
- CHEM 133 - General Chemistry II Laboratory *

or

- PHYS 221 - Elements of Physics I *
- PHYS 222 - Elements of Physics II *

E. Select one sequence:

- MATH 123 - Finite Mathematics*
- MATH 125 - Basic Calculus*

or

- MATH 132 - Calculus 1B Infused with Precalculus*
- MATH 142 - Calculus II*

or

- MATH 141 - Calculus I *
- MATH 142 - Calculus II *

or

- MATH 151 - Mathematics for the Life Sciences *
- MATH 152 - Calculus for the Life Sciences *

Concentration Requirements

A. Policy and Writing Skills

Complete:

- AREC 470 - Policy Analysis for Environmental and Natural Resource Management

or

- ECON 362 - Environmental and Natural Resource Policy

- GEOG 345 - People and Environment

or

- SOCI 360 - Environment and Resources

- JREM 451 - Environmental Writing *

B. Environmental Science Core

Complete five courses:

- GEOL 301 - Introduction to Scientific Field Methods and Analysis
- GEOL 310 - Mineralogy *
- GEOL 320 - Paleobiology
- GEOL 340 - Earth Sedimentary Processes
- GEOL 424 - GIS for Geoscientists
- GEOL 425 - Data Analysis for Geoscientists
- GEOL 443 - Sustainable Cities and Landscapes

- GEOL 450 - Landscapes: Earth and Elsewhere
- GEOL 452 - Cave and Karst Geology
- GEOL 454 - Environmental Restoration
- GEOL 455 - Environmental Geology
- GEOL 456 - Global Climate Change
- GEOL 459 - Introduction to Oceanography
- GEOL 461 - Organic Geochemistry
- GEOL 462 - Environmental Aqueous Geochemistry
- GEOL 464 - Water Sustainability and Climate
- GEOL 465 - Geomicrobiology
- GEOL 471 - Applied Geophysics
- GEOL 485 - Principles of Hydrogeology

C. Research or Internship

Complete 3 hours:

- GEOL 493 - Independent Study

D. Environmental Elective Courses

Select 9 additional hours from this list

- AGNR 480 - How to Feed the World
- EEB 304 - Socio-Economic Impact of Plants
- EEB 422 - Landscape Ecology
- EEB 430 - Invasion Biology
- EEB 471 - Aquatic Macroecology and Conservation
- EEB 484 - Conservation Biology
- ESS 326 - GIS/GPS Applications in Agriculture and Environmental Science
- FORS 335 - Principles of Urban Forestry
- FORS 422 - Forest and Wildland Resource Policy
- FORS 423 - Wildland Recreation Planning and Management
- FORS 433 - Urbanization and Urban Soils
- FWF 250 - Conservation
- FWF 315 - Principles of Wildlife and Fisheries Management
- FWF 320 - Human Dimensions of Natural Resources
- FWF 324 - Applied Ecosystem Restoration
- GEOG 206 - Sustainability: Reducing our Impact on Planet Earth
- GEOG 311 - Geovisualization and Geographic Information Science
- GEOG 331 - Natural Hazards
- GEOG 333 - Climate Change and Human Response
- GEOG 436 - Water Resources
- HTM 484 - Critical Sustainable Tourism
- PHIL 346 - Environmental Ethics
- PLSC 280 - Fundamentals of Sustainable Landscape Design
- PLSC 321 - Landscape Plant Identification, Taxonomy and Morphology II
- PLSC 380 - Advanced Sustainable Landscape Design

- PLSC 455 - Advanced Sustainable Landscape Construction
- POLS 410 - Special Topics in Political Science
- POLS 549 - Environmental Policy
- SOCI 363 - Food, Agriculture, and Society
- SOCI 465 - Social Values and the Environment

* Meets Volunteer Core Requirements.

Geology and Environmental Studies Major, BS – Honors Environmental Studies Concentration

Students who have completed five upper-division courses in the Environmental Studies concentration and maintain a cumulative GPA of at least 3.25 are encouraged to pursue an honors concentration. In addition to fulfilling all requirements for their preferred concentration, an honors concentration requires 3 hours of GEOL 491, GEOL 492, or GEOL 493; 3 hours of GEOL 497 during which students will complete written and oral presentation of thesis results; and an additional 9 hours of honors coursework (including honors-by-contract). A GPA of at least 3.25 must be maintained throughout matriculation. Interested students should consult their academic advisor for details.

Geology and Environmental Studies Major, BS – Geology Concentration

Prerequisites

Students wishing to declare their major in Geology and Environmental Studies should do so at the earliest opportunity.

A. Select one sequence:

- CHEM 122 - General Chemistry I *
  and
- CHEM 123 - General Chemistry I Laboratory *

- CHEM 132 - General Chemistry II *
  and
- CHEM 133 - General Chemistry II Laboratory *
  or
- CHEM 128 - Honors: General Chemistry I *
- CHEM 138 - Honors: General Chemistry II *

Note: CHEM 132*-CHEM 133* or CHEM 138* may be taken concurrently with 300-level geology courses.

B. Select:

- GEOL 101 - The Dynamic Earth* and one of these
- GEOL 102 - Earth, Life, and Time*
- GEOL 103 - The Earth's Environments*
- GEOL 104 - Exploring the Planets*

Corequisites

A. Select one sequence:

- MATH 132 - Calculus 1B Infused with Precalculus*
- MATH 142 - Calculus II*

  or
- MATH 141 - Calculus I *
- MATH 142 - Calculus II *

  or
- MATH 147 - Honors: Calculus I *
- MATH 148 - Honors: Calculus II *

  or
- MATH 151 - Mathematics for the Life Sciences *
- MATH 152 - Calculus for the Life Sciences *

B. Select one course:

- EF 151 - Physics for Engineers I *
- EF 157 - Honors: Physics for Engineers I *
- PHYS 135 - Introduction to Physics for Physical Science and Mathematics Majors I *
- PHYS 137 - Honors: Fundamentals of Physics for Physics Majors I *
- PHYS 221 - Elements of Physics I *

C. Select one course(s):

- BIOL 113 - Introductory Plant Biology I *
- BIOL 115 - Introductory Plant Biology Laboratory

  or
- BIOL 150 - Organismal and Ecological Biology *
- BIOL 159 - Skills of Biological Investigation *

  or
- BIOL 158 - Honors: Organismal and Ecological Biology
- BIOL 167 - Honors: Skills of Biological Investigation

Concentration Requirements

Students are encouraged to participate in undergraduate research. A maximum of 3 hours of GEOL 493 may count toward the major.

A. Complete:

- GEOL 310 - Mineralogy *
- GEOL 320 - Paleobiology
- GEOL 330 - Igneous and Metamorphic Petrology
- GEOL 340 - Earth Sedimentary Processes
- GEOL 370 - Earth Structure and Geophysics
- GEOL 380 - Planetary Geoscience

B. Complete at least 5 hours:

- GEOL 440 - Field Geology

C. Select 9 hours:

- 400-level or above GEOL courses

* Meets Volunteer Core Requirements.

Geology and Environmental Studies Major, BS – Honors Geology Concentration

Students who have completed five upper-division courses in the Geology concentration and maintain a cumulative GPA of at least 3.25 are encouraged to pursue an honors concentration. In addition to fulfilling all requirements for their preferred concentration, an honors concentration requires 3 hours of GEOL 491, GEOL 492, or GEOL 493; 3 hours of GEOL 497 during which students will complete written and oral presentation of thesis results; and an additional 9 hours of honors coursework (including honors-by-contract). A GPA of at least 3.25 must be maintained throughout matriculation. Interested students should consult their academic advisor for details.

Geology and Environmental Studies Major, BS – Planetary Geoscience Concentration

Prerequisites:

A. Select one sequence:

- CHEM 122 - General Chemistry I *
- CHEM 123 - General Chemistry I Laboratory *
- CHEM 132 - General Chemistry II *
- CHEM 133 - General Chemistry II Laboratory *

or

- CHEM 128 - Honors: General Chemistry I *
- CHEM 138 - Honors: General Chemistry II *

Note: CHEM 132* or CHEM 138* may be taken concurrently with 300-level geology courses.

B. Take the following introductory courses:

- GEOL 101 - The Dynamic Earth *
- GEOL 104 - Exploring the Planets *

Corequisites:

A. Select one mathematics sequence:

- MATH 132 - Calculus 1B Infused with Precalculus *

or

- MATH 142 - Calculus II *
- MATH 141 - Calculus I *
- MATH 142 - Calculus II *

or

- MATH 147 - Honors: Calculus I *
- MATH 148 - Honors: Calculus II *

or

- MATH 151 - Mathematics for the Life Sciences *
- MATH 152 - Calculus for the Life Sciences *

B. Select one physics course:

- EF 151 - Physics for Engineers I *
- EF 157 - Honors: Physics for Engineers I *
- PHYS 135 - Introduction to Physics for Physical Science and Mathematics Majors I *
- PHYS 137 - Honors: Fundamentals of Physics for Physics Majors I *
- PHYS 221 - Elements of Physics I *

C. Select at least one additional physics, statistics, math or biology course:

- EF 152 - Physics for Engineers II *
- EF 158 - Honors: Physics for Engineers II *
- PHYS 136 - Introduction to Physics for Physical Science and Mathematics Majors II *
- PHYS 138 - Honors: Fundamentals of Physics for Physics Majors II *
- PHYS 222 - Elements of Physics II *
- STAT 201 - Introduction to Statistics *
- STAT 251 - Probability and Statistics for Scientists and Engineers
- MATH 231 - Differential Equations I
- MATH 237 - Honors: Differential Equations I
- MATH 241 - Calculus III
- MATH 247 - Honors: Calculus III
- MATH 251 - Matrix Algebra I
- BIOL 113 - Introductory Plant Biology I *

- BIOL 115 - Introductory Plant Biology Laboratory
- BIOL 150 - Organismal and Ecological Biology *
- BIOL 158 - Honors: Organismal and Ecological Biology
- BIOL 159 - Skills of Biological Investigation *
- BIOL 167 - Honors: Skills of Biological Investigation *

Concentration Requirements:

A. Complete:

- GEOL 310 - Mineralogy *
- GEOL 330 - Igneous and Metamorphic Petrology
- GEOL 340 - Earth Sedimentary Processes
- GEOL 370 - Earth Structure and Geophysics
- GEOL 380 - Planetary Geoscience

B. Complete at least 5 hours:

- GEOL 440 - Field Geology
- External research internships with NASA or similar organizations, or other significant summer research experiences (e.g., extended field work) may satisfy the field camp requirement. Students who engage in such activities are encouraged to consult with their advisor to determine whether it may qualify.

C. Select 12 hours (6 or more at the 400 level or above):

- ASTR 151 - A Journey through the Solar System Lecture *
- ASTR 152 - Stars, Galaxies, and Cosmology Lecture *
- ASTR 217 - Honors: Introductory Astronomy *
- ASTR 218 - Honors: Introductory Astronomy *
- GEOL 210 - Life, the Universe, and Everything
- GEOL 301 - Introduction to Scientific Field Methods and Analysis
- GEOL 424 - GIS for Geoscientists
- GEOL 432 - Geochemical Modeling
- GEOL 450 - Landscapes: Earth and Elsewhere
- GEOL 459 - Introduction to Oceanography
- GEOL 465 - Geomicrobiology
- GEOL 471 - Applied Geophysics
- GEOL 484 - Planetary Geodynamics
- GEOL 490 - Special Problems in Geology
- GEOL 493 - Independent Study
- MICR 475 - Reproducible Data Analysis

  Advanced undergraduates are encouraged to inquire with instructors of 500- and 600-level GEOL courses about the possibility of enrollment. Such courses are normally closed to undergraduates, but may be opened on a case-by-case basis. Enrollment in any 500- or 600-level GEOL course counts toward the 12-credit concentration requirement in C.

* Meets Volunteer Core Requirements.

Geology and Environmental Studies Major, BS – Water Science Concentration

Prerequisites:

A. Select one sequence:

- CHEM 122 - General Chemistry I *
- CHEM 123 - General Chemistry I Laboratory *
- CHEM 132 - General Chemistry II *
- CHEM 133 - General Chemistry II Laboratory *

Or

- CHEM 128 - Honors: General Chemistry I *
- CHEM 138 - Honors: General Chemistry II *

Or

- CHEM 102 - Principles of Chemistry *
- CHEM 103 - Principles of Chemistry Laboratory *
- CHEM 112 - Introduction to Organic and Biochemistry *
- CHEM 113 - Introduction to Organic and Biochemistry Laboratory *

B. Complete two courses:

- GEOL 101 - The Dynamic Earth *
- GEOL 103 - The Earth's Environments *

C. Select one sequence:

- MATH 141 - Calculus I *

AND one of

- MATH 142 - Calculus II *
- PHYS 135 - Introduction to Physics for Physical Science and Mathematics Majors I *
- STAT 201 - Introduction to Statistics *

or

- MATH 151 - Mathematics for the Life Sciences *
- MATH 152 - Calculus for the Life Sciences *

Concentration Requirements:

A. Complete the following:

- GEOL 340 - Earth Sedimentary Processes
- GEOL 424 - GIS for Geoscientists
- GEOL 450 - Landscapes: Earth and Elsewhere
- GEOL 456 - Global Climate Change
- GEOL 459 - Introduction to Oceanography
- GEOL 464 - Water Sustainability and Climate
- GEOL 485 - Principles of Hydrogeology

B. Complete two courses:

- GEOL 301 - Introduction to Scientific Field Methods and Analysis
- GEOL 425 - Data Analysis for Geoscientists
- MICR 475 - Reproducible Data Analysis

C. Complete at least nine hours from:

- CE 391 - Water Resources Engineering I
- CE 494 - Water Resources Engineering II
- CE 495 - Hydrology
- CSM 474 - Environmental Instrumentation and Monitoring
- ESS 424 - Environmental Stormwater Management *
- GEOL 452 - Cave and Karst Geology
- GEOL 455 - Environmental Geology
- GEOL 462 - Environmental Aqueous Geochemistry
- GEOL 466 - Water and Air Pollution
- GEOL 493 - Independent Study
- GEOG 433 - Landform Analysis and Landscape Planning
- GEOG 435 - Biogeography
- GEOG 436 - Water Resources
- JREM 451 - Environmental Writing *

D. Complete two courses:

- ECON 201 - Introductory Economics: A Survey Course *
  or
- ECON 207 - Honors: Introductory Economics *

- ECON 362 - Environmental and Natural Resource Policy
- AREC 470 - Policy Analysis for Environmental and Natural Resource Management

E. Complete at least three hours:

- GEOL 440 - Field Geology
  or
- GEOL 493 - Independent Study (3 credit hours)

* Meets Volunteer Core Requirements.

Minors offered by the Department of Earth and Planetary Sciences:

Environmental Studies Minor

The minor consists of **15 hours**.

Select 9 hours:

- CBE 481 - Green Engineering
- FWF 250 - Conservation *
- FWF 320 - Human Dimensions of Natural Resources *
- GEOG 206 - Sustainability: Reducing our Impact on Planet Earth
- GEOL 202 - Earth as an Ecosystem: Modern Problems and Solutions *
- GEOL 206 - Sustainability: Reducing our Impact on Planet Earth
- JREM 451 - Environmental Writing *
- SOCI 250 - Introduction to Global Studies *

Select one course:

- GEOG 345 - People and Environment
- SOCI 360 - Environment and Resources *
- SOCI 465 - Social Values and the Environment *

Select one course:

- AREC 470 - Policy Analysis for Environmental and Natural Resource Management
- ECON 362 - Environmental and Natural Resource Policy
-

* Meets Volunteer Core Requirements.

Geology Minor

A minor in geology consists of **24 hours**. A maximum of 3 hours of Geology GEOL 493 may be counted toward the minor.

Select two courses:

- GEOL 101 - The Dynamic Earth *
- GEOL 102 - Earth, Life, and Time *
- GEOL 103 - The Earth's Environments *
- GEOL 104 - Exploring the Planets *

Select 6 hours:

- 200-level or above GEOL courses

Select 10 hours:

- 300-400 level GEOL courses

* Meets Volunteer Core Requirements.

Paleontology Minor

A minor in Paleontology consists of **24 hours**. A maximum of 3 hours of GEOL 493 may be counted toward the minor.

Complete:

- GEOL 102 - Earth, Life, and Time *

Select two courses:

- GEOL 320 - Paleobiology
- GEOL 340 - Earth Sedimentary Processes

Select 3 hours from list A and 9 hours from list A or B, must include at least two departments.

List A:

- GEOL 422 - Evolution of Life
- GEOL 423 - Paleoecology
- GEOL 426 - Biospheric Change and the Fossil Record

List B:

- ANTH 483 - Evolutionary Biology for Anthropologists
- ANTH 490 - Primate Evolution
- BIOL 260 - Ecology
- BIOL 280 - Evolution
- EEB 353 - Comparative Vertebrate Biology
- GEOL 459 - Introduction to Oceanography
- GEOL 490 - Special Problems in Geology
- GEOL 493 - Independent Study
- * Meets Volunteer Core Requirements.

Appendix 3.2 Undergraduate scholarships and awards

Scholarships and awards distributed by the Department:

- **Jimmy Walls Award** for performance in introductory geology (100 and 200 level)
  $250 each from Walls Fund (nominated by instructors and chosen by Awards Committee, up to 11 awards)
- **Martin Katzman Scholarship in Environmental Studies**
  $500 each from Katzman endowment (to students majoring in the Environmental Studies Water Science concentrations, selected by Environmental Studies Program Director, 2 awards)
- **Ryan Edwards Environmental Service Scholarship**
  $2000 each from Ryan Edwards Memorial Fund (to students majoring in the Environmental Studies or Water Science concentrations, selected by Environmental Studies Program Director, 2 awards)
- **Don Byerly Field Camp Scholarships**
  $3000 from Byerly Fund (donor selects)
- **Bill Ross Field Camp Scholarships**
  Available funds divided among students attending a field camp, typically ~$1200-1400 per student
- **Student Success Awards**
  Funds provided to students on application to support conference and workshop travel and research expenses (up to $600 per request, selected by Student Success Committee)
- **Otto Kopp Research Awards**
  Funds provided to sophomore and junior students on application to support research expenses ($500, selected by Student Success Committee)
- **Undergraduate Research Grants**
  Funds provided to majors on application to support research expenses (up to $450 per request, selected by Student Success Committee)
- **NASA Space Grant Undergraduate Research Award**
  $250 each from Space Grant account (to majors who participated in undergraduate research chosen by Space Grant Director, 3 awards)
- **Gulley Undergraduate Research Award**
  $500 from Gully endowment (to major who participated in undergraduate research, nominated by faculty, selected by Awards Committee, 1 award)
- **Meritorious Contributions to Diversity, Equity and Inclusion** by undergrad student
  $400 from Walls Fund (nominated by faculty, selected by Awards Committee, 1 award)
- **Undergraduate Professional Promise Award** for students at Junior level
  $400 each from V/J Bibee Fund (nominated by faculty and chosen by Awards Committee, 4 awards)
- **Outstanding Senior Awards**
  $500 each from V/J Bibee and J Bibee Funds (chosen by Director of Undergraduate Studies co-chairs, 2 awards)

Scholarships and awards presented by GeoClub:

- **C H Gordon Award for Professional Promise**
  one student per concentration, chosen by student vote
- **Rock Solid Award**
  one undergraduate student, chosen by student vote
  Student Outreach Award
  one undergraduate student, chosen by student vote

Appendix 3.3 Undergraduate program level student learning objectives

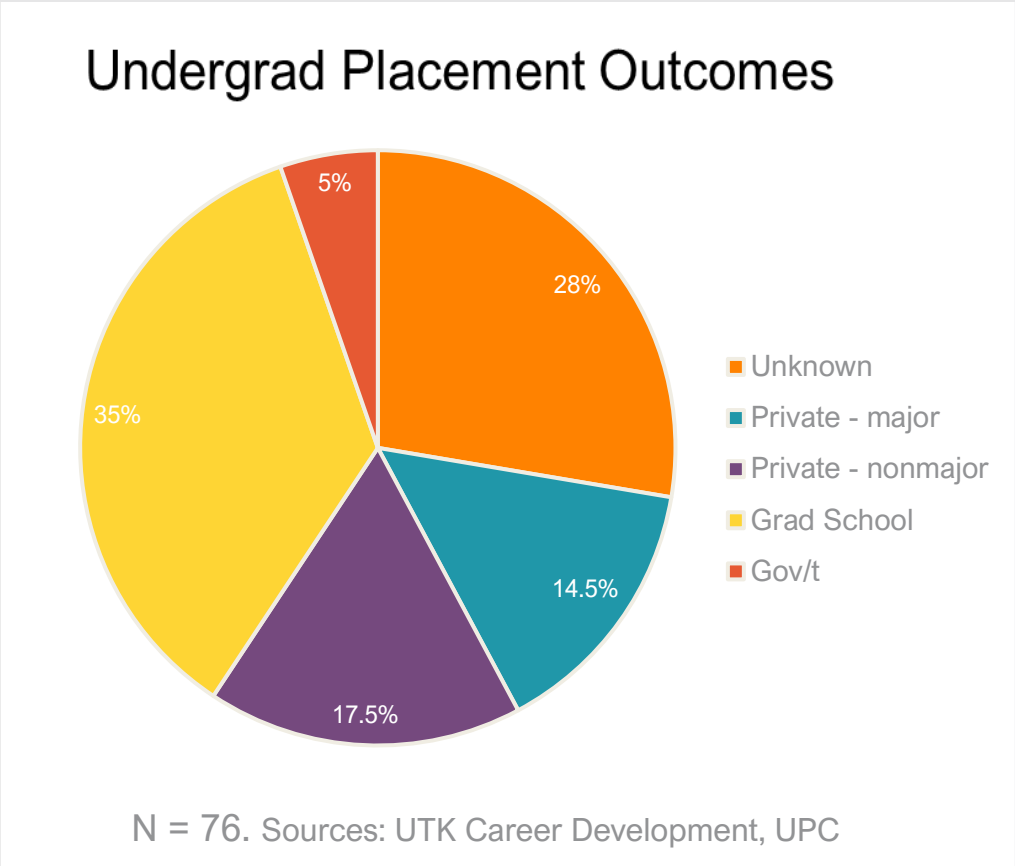
Program Learning Outcomes for the B.S. degree in Geology and Environmental Studies:

- Students will indicate knowledge of basic principles of geology and environmental studies.

- Students will demonstrate the ability to engage in scientific process through the collection and evaluation of data, testing of hypotheses, and communication of results.

- Students will illustrate critical thinking and communication skills necessary to address issues in geology and environmental studies at the core level.

Appendix 3.4 Post-UTK placement of undergraduate majors for the past five years



Results are from students graduating from 2018-2022. These indicate that a substantial proportion (over 35%) go to graduate school. Aside from geology and environmental programs, this includes professional programs such as law and landscape architecture. Private – major (14.5%) refers to jobs in private industry that are directly related to their B.S. major. Most of these are in environmental and geological consulting but also includes science teaching. Private – nonmajor (17.1%) refers to jobs in private industry that are not related to their major. Most of these are retail. The smallest known proportion is government work (5.3%) including city, state and federal jobs; all of these are regulatory and are related to the major. The proportion of unknown outcomes (27.6%) is actually much smaller than past reports because the UTK Office of Career Development has greatly improved our ability to track our graduating students.

Appendix 4.1 Curricular requirements for graduate credentials

Programs Administered by the Department of Earth and Planetary Sciences:

Geology Major, MS, thesis option

Credit Hours Required

- Minimum of 30 graduate credit hours;
- A minimum cumulative 3.00 GPA in all graded graduate coursework.

Required Courses

- GEOL 500 (thesis hours, 6 credit hours)
- 24 credit hours of approved coursework, including
    - GEOL 595 (Seminar) every semester students are in residence unless course or teaching conflicts preclude a student from being present.
    - Students must also enroll in GEOL 596 (Scientific Presentations) one time during their residency.
    - A student may apply a maximum of 2 credit hours of GEOL 595 and 1 credit of GEOL 596 toward graduation.

Additional Course Requirements

- Taking courses from outside the department is encouraged, and are selected in consultation with the advisor and committee.
- Students without a Bachelor's degree in the geosciences may need to take geology courses at the undergraduate level, which may be recommended by the advisor and the Dissertation Committee. These courses supplement the required graduate coursework.

Non-Course Requirements

- Approval of a written thesis proposal.
- Successful oral defense of a written thesis.
- Before receiving an MS degree, students must demonstrate committee-approved proficiency in field-based Earth Sciences, which is typically done by completing an undergraduate field camp or a field-based program of equivalent length and curriculum.

Geology Major, MS, project option, concurrent MS only

Credit Hours Required

- Minimum of 30 graduate credit hours;
- A minimum cumulative 3.00 GPA in all graded graduate coursework.

Additional Course Requirements

- For students enrolled in the PhD program, a concurrent master's degree may be awarded as a 30 credit hour project-based (non-thesis option). To be eligible a student should:
    - not have a prior master's degree in Geology;
    - have successfully completed 30 credit hours of approved graduate coursework;
    - have demonstrated a committee-approved proficiency in field-based Earth Sciences;
    - have a PhD dissertation proposal accepted;
    - have passed his/her preliminary exams; and
    - have at least one first author paper submitted for consideration for publication in a peer-reviewed journal.

Geology Major, PhD

Credit Hours Required

- 72 graduate credit hours beyond the bachelor's degree
- 48 graduate credit hours beyond the master's degree
- A minimum cumulative 3.00 GPA in all graded graduate coursework.

Required Courses

- GEOL 600 (dissertation hours, 24 credit hours)
- A minimum of 24 credit hours of approved graduate coursework beyond that required for the Master's degree (NOTE: a student entering the PhD program with a Bachelor's degree must complete 48 credit hours of approved graduate coursework), to include
    - Enroll in course number GEOL 595 (Seminar) every semester they are in residence unless course or teaching conflicts preclude a student from being present.
    - Enroll in course GEOL 596 (Scientific Presentations) one time during their residency.
    - A student may apply a maximum of 3 credit hours of GEOL 595 and 1 credit of GEOL 596 toward graduation.
    - All PhD students are required to complete a minimum of 9 credit hours of graded approved coursework at the 600-level (this requirement supersedes the University requirement).

Additional Course Requirements

- Taking courses from outside the department is encouraged, and are selected in consultation with the advisor and committee.
- Students without a Bachelor's degree in the geosciences may need to take GEOL courses at the undergraduate level, which may be recommended by the advisor and the Dissertation Committee. These courses supplement the required graduate coursework.

Non-Course Requirements

- Approval of a written dissertation proposal.

- Pass a comprehensive examination. The examination includes both written and oral components in which individuals are tested on their knowledge of their intended research area and related fields. The candidate is expected to be conversant across a wide range of the geological sciences.
    - Students entering the PhD program with a Master's degree must complete the comprehensive examination by no later than the end of the student's third semester.
    - Students entering the PhD program with a Bachelor's degree (but without a Master's degree) must complete the comprehensive examination by no later than the end of the student's fourth semester.
- Oral defense of written dissertation.
    - The written dissertation will demonstrate high-quality, original research by the student.
    - Research results will be presented orally in a departmental seminar open to the public, and will be defended in a private defense restricted to the Dissertation Committee and interested departmental faculty.
- Publication of at least one research paper on the student's dissertation topic (not previous work) in a peer-refereed journal or equivalent outlet is expected prior to the dissertation defense.
- Before receiving a PhD degree, students must demonstrate committee-approved proficiency in field-based Earth Sciences, which is typically done by completing an undergraduate field camp or a field-based program of equivalent length and curriculum.

Additional Information

- The Department of Earth and Planetary Sciences offers students who enter the doctoral program with a Bachelor's degree only the opportunity to earn a Master of Science degree with a major in Geology concurrent to the doctoral degree. For more details see the information given within this catalog for the Geology Major, MS. The current Master's requires a minimum of 30 graduate credit hours and is only for those students who enter the doctoral program who have not earned a prior master's degree in Geology.

Interdisciplinary programs in which the Department of Earth and Planetary Sciences participates but does not administer:

Intercollegiate Graduate Statistics and Data Science Program (IGSDSP)

The Department of Earth and Planetary Sciences participates in the intercollegiate graduate statistics and data science program (IGSDSP). Any student pursuing a master's or PhD with a major in Geology can receive a minor in statistics by completing the appropriate IGSDSP requirements. For additional information, see the description of the statistics minor in the catalog listed under Intercollegiate Graduate Statistics and Data Science Minor or the program's website. The Department of Earth and Planetary Sciences also contributes courses to the IGSDSP program curriculum.

Interdisciplinary Graduate Minor in Computational Science (IGMCS)

The Department of Earth and Planetary Sciences participates in the interdisciplinary graduate minor in computational science (IGMCS) program. Any student pursuing a master's or PhD with a major in geology can receive a minor in computational science by completing the appropriate IGMCS

requirements. For additional information, see the description of the Interdisciplinary Graduate Minor in Computational Science listed under the Department of Electrical Engineering and Computer Science or visit the IGMCS website. The Department of Earth and Planetary Sciences also contributes courses to the IGMCS program curriculum.

Watershed Minor

The Department of Earth and Planetary Sciences participates in the interdisciplinary Watershed Minor for graduate students. Any student pursuing a master's or PhD with a major in geology, who completes the appropriate requirements, can receive a Watershed minor. For additional information, see the description of the Interdisciplinary Watershed Graduate Minor on their website. The Department of Earth and Planetary Sciences also contributes courses to the Watershed program curriculum.

Additional information about all EPS graduate programs is available in the Graduate Catalog:
https://catalog.utk.edu/preview_entity.php?catoid=35&ent_oid=3762&returnto=4806

Appendix 4.2 Graduate scholarships and awards

Scholarships and awards distributed by the Department:

- **Exxon Scholarship**
  $1000 per semester (funding to recruit outstanding graduate student candidates, selected by the Graduate Admissions and Program Committee)
- **Lawrence Taylor Graduate Scholarship**
  $2500 per semester (funding to recruit 2 outstanding PhD students preference for one woman and one planetary geology student, selected by the Graduate Admissions and Program Committee)
- **Walker-Briggs-Shanmugam Graduate Fellowship**
  $500 per semester (funding to recruit outstanding graduate student candidates studying sedimentology or petroleum geology, selected by the Graduate Admissions and Program Committee)
- **George D. Swingle Fellowship**
  $2500 per semester (funding to recruit outstanding graduate student candidates in structure/tectonics/field-based studies, selected by the Graduate Admissions and Program Committee)
- **TW & Claire Garrett Graduate Fellowship**
  $2500 per semester (funding to recruit outstanding graduate student candidates, selected by the Graduate Admissions and Program Committee)
- **Bill O. Ross Graduate Fellowship**
  $2500 per semester (funding to recruit outstanding graduate student candidates, selected by the Graduate Admissions and Program Committee)
- **Professors Honors Fund Scholarship**
  $1000+ per semester (funding to recruit outstanding graduate student candidates, selected by the Graduate Admissions and Program Committee)
- **Graduate Field Camp Scholarships**
  Available funds divided among students attending a field camp, typically ~$1200-1400 per student
- **Excellence in Teaching by GTAs Awards**
  $500 each (nominated by faculty, chosen by Awards Committee, 4 awards from V/J Bibee fund)
- **Geology Colloquium Presentation Awards**
  $400 each from Walls Fund (selected by Geol 596 (Scientific Presentations) instructor, 4 awards)
- **Student Success Awards**
  Funds provided to students on application to support conference and workshop travel and research expenses (up to $600 per request, selected by Student Success Committee)
- **NASA Space Grant Excellence in Outreach**
  $250 each from Space Grant account (chosen by Space Grant Director, 3-4 awards)
- **Meritorious Contributions to Diversity, Equity and Inclusion by grad student**
  $400 from Walls Fund (nominated by faculty, selected by Awards Comm, 1 award)
- **EPS Alumni Advisory Board Award** for outstanding contribution to alumni relations
  $200 from Professors Honors Fund (1 award)
- **Graduate Professional Promise Awards**
  $500 each (nominated by faculty, chosen by Awards Comm, 2 awards from V/J Bibee Fund)

Scholarships and awards presented by GeoClub:

- **C H Gordon Award for Professional Promise**
  one MS and one PhD student, chosen by student vote
- **Rock Solid Award**
  one graduate student, chosen by student vote
  Student Outreach Award
  one graduate student, chosen by student vote

Appendix 4.3 Graduate program level student learning objectives

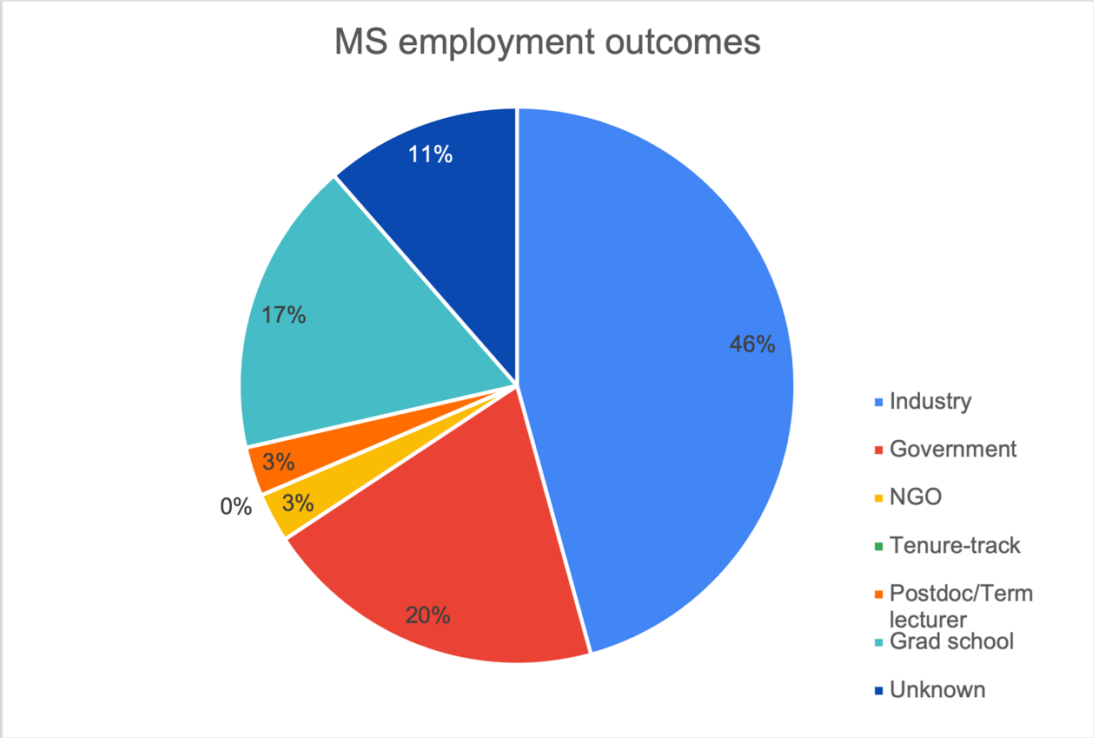
Program Learning Outcomes for the MS Geology program:

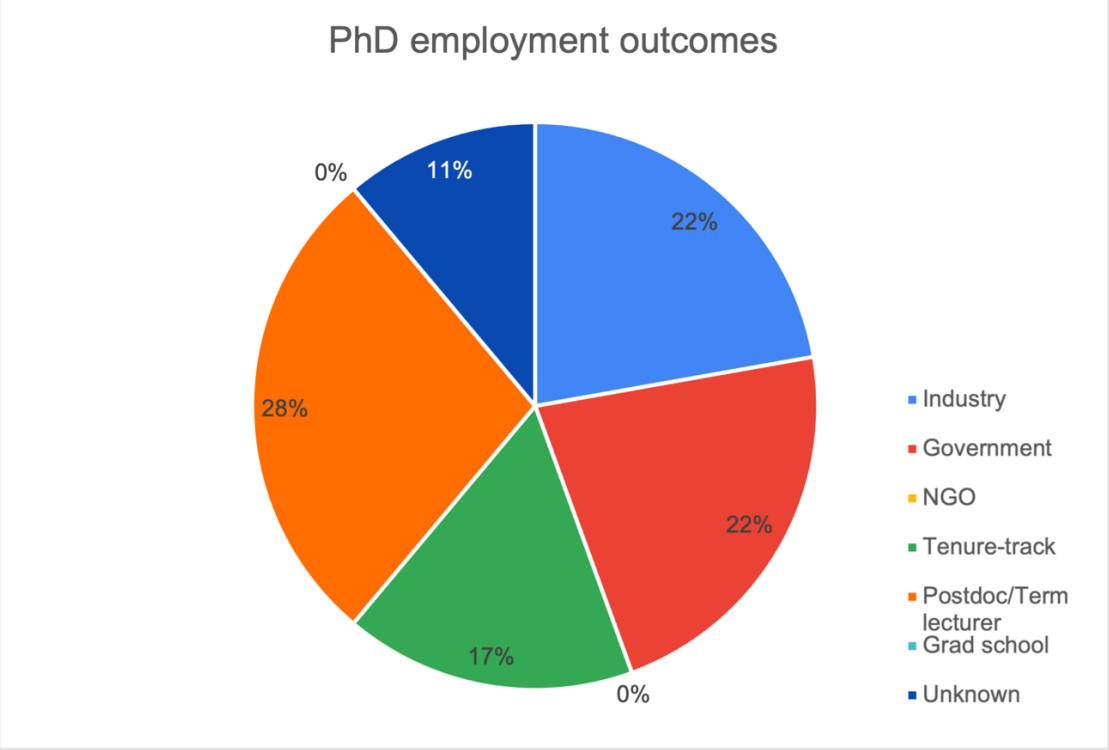
- Students will demonstrate an understanding of the Earth's (and other planetary systems') physical, chemical, and biological systems that reflects the base knowledge necessary for completion of individual research projects in earth and planetary sciences.
- Students will develop a research proposal that has the potential to generate new scientific knowledge.
- Prepare and defend a written scientific thesis that reflects a thorough understanding of the field of research. The thesis should make a substantial contribution of new knowledge to the field.
- Present and defend scientific research in an oral/visual format, which is effective for communicating ideas, methods, and findings to an audience of other student and faculty researchers in the field.

Program Learning Outcomes for the PhD Geology program:

- Demonstrate an understanding of Earth's (and other planetary systems') physical, chemical and biological systems at a level permitting completion of individual research projects in earth and planetary sciences, under the direction of a scientific adviser.
- Students will develop a research proposal that has the potential to generate new scientific knowledge.
- Prepare and defend a written scientific dissertation that reflects a thorough understanding of the field of research.
- Present and defend scientific research in an oral/visual format, which is effective for communicating ideas, methods, and findings to an audience of other student and faculty researchers in the field.

Appendix 4.4 Post-UTK placement of graduate students for the past five years





Appendix 6.1 Abbreviated Curricula Vitae for faculty members

Dunne, William Matthew

Rank: Professor and Associate Dean for Research (Tickle College of Engineering)

Date Hired: August 1988
Date of Last Promotion: August 1995

Program of Study:

Fracture characterization methods and approaches
Formation and deformation within orogenic foreland thrust systems
Roles of fractures in icy lithospheres of satellites of gas-giant planets

Summary of Research Funding Sources:

National Science Foundation; American Chemical Society; Tennessee Department of Transportation; Oak Ridge National Laboratory

Summary of Research Publications:

H-Index via Web of Science: 19
Peer-reviewed publications in last 10 years: 3
Percent first authored in last 10 years: 0%
Percent with student author in last 10 years: 67%

Summary of Mentoring and Management:

Lab Managers in last 10 years: 0
Postdocs in last 10 years: 0
PhD students in last 10 years: 0
MS students in last 10 years: 0
BS students in last 10 years: 0

Highlighted Research Examples:

1. Mauldon M, Dunne WM, and Rohrbaugh MB (2001) Circular scanlines and circular windows: new tools for characterizing the geometry of fracture traces. Journal of Structural Geology, 23: 247-258.
2. Evans MA and Dunne WM (1991) Strain factorization and Partitioning in the North Mountain thrust sheet, Central Appalachians, USA. Journal of Structural Geology, 13: 21-35.
3. Hogan JP and Dunne WM (2001) Calculation of shortening due to outcrop-scale deformation and its relation to regional deformation patterns. Journal of Structural Geology, 23: 1507-1529.
4. Thorbjornsen KL and Dunne WM (1997) Origin of a thrust-related fold: Geometric vs kinematic tests. Journal of Structural Geology, 19: 303-319.
5. Dunne WM et al. (2003) Orthogonal jointing during coeval igneous degassing and normal faulting, Yucca Mountain, Nevada. Geological Society of America Bulletin, 115: 1492-1509.

Other Faculty Highlights:

Continuing instructional role on comparative tectonics of Venus, Earth & Mars; continued service on a number of graduate committees, with meaningful contributions to published work; served as an editor of the Journal of Structural Geology for 13 years ending in 2018; currently working to facilitate faculty research success in the Tickle College of Engineering and across the University as appropriate.

Dygert, Nicholas

Larry and Dawn Taylor Assistant Professor of Planetary Geosciences
Rank: Assistant Professor

Date Hired: August 2017
Date of Last Promotion: N/A

Program of Study:

Using experiments, analyses of natural materials, numerical models, and field observations to understand dynamic processes in planetary interiors and crusts. Petrogenesis and high-temperature geochemistry. Melt migration and melt-rock reaction. Rheological properties of minerals and melts, two phase flow. Silicate and oxide-melt trace element partitioning. Planetary science.

Summary of Research Funding Sources:

NASA (Solar System Workings); NSF (Marine Geology and Geophysics); DOE (Science Alliance)

Summary of Research Publications:

H-Index via Web of Science: 12
Peer-reviewed publications in last 10 years: 26 (16 since hire)
Percent first authored in last 10 years: 38% (25% since hire)
Percent with student author in last 10 years: 15%

Summary of Mentoring and Management:

Lab Managers/Professional Staff in last 10 years: 1
Postdocs in last 10 years: 2
PhD students in last 10 years: 3
MS students in last 10 years: 3
BS students in last 10 years: 12

Highlighted Research Examples:

1. Mouser MD, Dygert N, et al. (2021) Experimental investigation of Mercury's magma ocean viscosity: Implications for the formation of Mercury's cumulate mantle, its subsequent dynamic evolution, and crustal petrogenesis. JGR – Planets, doi:10.1029/2021JE006946.
2. Dygert N. et al. (2020) Experimental determinations of trace element partitioning between plagioclase, pigeonite, olivine and lunar basaltic melts and an fO_2 dependent model for plagioclase-melt Eu partitioning. GCA, doi:10.1016/j.gca.2020.03.037.
3. Lucas M, Dygert N, et al. (2020) Evidence for early fragmentation-reassembly of ordinary chondrite (H, L, and LL) parent bodies from REE-in-two-pyroxene thermometry. GCA, doi:10.1016/j.gca.2020.09.010.
4. Dygert N et al. (2018) Plate tectonic cycling modulates Earth's $^{3}He/^{22}Ne$ ratio. EPSL, doi:10.1016/j.epsl.2018.06.044.

Other Faculty Highlights:

Built and operate an experimental petrology laboratory for conducting high-pressure high-temperature experiments; Active mentor to undergraduate students (some of whom have entered graduate programs at Brown, Harvard, UT Austin, Colorado School of Mines, and Auburn; Currently serving as PI of our NASA Space Grant node and manage an annual outreach budget of ~$90,000, which supports STEM education and undergraduate and graduate research.

Engel, Annette Summers

Donald H. and Florence Jones Professor of Aqueous Geochemistry
Rank: Professor

Date Hired: August 2011
Date of Last Promotion: July 2016

Program of Study:

Prof. Engel conducts field and laboratory research that explores and quantifies the evolutionary, ecological, and geochemical interactions among living organisms (from microorganisms to vertebrates) and their environments through time, including subsurface habitats and coastal settings.

Summary of Research Funding Sources:

National Science Foundation (EAR-Climate, Systematics & Biodiversity Science, Dimensions of Biodiversity, EAGER, Geobiology & Low Temperature Geochemistry); US Army Corps of Engineers; NOAA RESTORE Act Science Program; Cave Conservancy Foundation; Barton Springs Salamander Conservation Fund, Gulf of Mexico Research Initiative (RFP-IV and RFP-I); UTK (SARIF, Institute for a Secure & Sustainable Environment; Student Technology Fee Award)

Summary of Research Publications:

H-Index via Web of Science: 25
Peer-reviewed publications in last 10 years: 33
Percent first authored in last 10 years: 15%
Percent with student author in last 10 years: 72.7%

Summary of Mentoring and Management:

Lab Managers and other Research Staff in last 10 years: 3
Postdocs in last 10 years: 2
PhD students in last 10 years: 5
MS students in last 10 years: 8
BS students in last 10 years: 26

Highlighted Research Examples:

1. Keenan SW and Engel AS (2017) Early diagenesis and recrystallization of bone. Geochimica et Cosmochimica Acta. 196: 209-223. DOI:10.1016/j.gca.2016.09.033.
2. Engel AS, Liu C, Paterson AT, Anderson LC, Turner RE, and Overton, E.B. (2017) Salt marsh bacterial communities before and after the Deepwater Horizon oil spill. Applied and Environmental Microbiology. 83:e00784-17. DOI: 10.1128/AEM.00784-17
3. Engel AS (2015) Microbial Life of Cave Systems. DeGruyter, 335 p. DOI:10.1515/9783110339888
4. Hutchins BT, Engel AS, Nowlin WH, and Schwartz BF (2016) Chemolithoautotrophy supports subterranean food webs and affects regional diversity and long-term stability of stygobiont communities. Ecology. 97: 1530–1542. DOI: doi/10.1890/15-1129.1

Other Faculty Highlights:

Research featured in newspapers and magazines around the world related to new species discoveries in Hawaii and Tennessee. Research recently featured in Nature PBS documentary, Living Volcanoes (2019) and ZDF Enterprises documentary (Germany), “Planet of Volcanoes (2019).

Fedo, Christopher

McSween Chair of Earth and Planetary Sciences
Rank: Professor

Date Hired: August 2005
Date of Last Promotion: August 2013

Program of Study:

Precambrian sedimentology and basin analysis; geochemical signatures of weathering in modern environments; use of geochemistry for determining provenance, paleoweathering, and diagenetic conditions; facies and sequence stratigraphic analysis of siliciclastic deposits; sedimentary petrography; tectonics and sedimentation of rifted margins; geologic mapping; Planetary science, particularly the sedimentology and geochemistry of sediments on Mars.

Summary of Research Funding:

NASA (Exobiology and Evolutionary Biology, and Mars Fundamental Research programs); NASA Mars Science Laboratory mission Participating Scientist program; National Science Foundation (Sedimentary Geology and Paleontology)

Summary of Research Publications:

H-Index via Web of Science: 28
Peer-reviewed publications in last 10 years: 32
Percent first authored in last 10 years: 3
Percent with student author in last 10 years: 38

Summary of Mentoring and Management:

Lab Managers in last 10 years: 0
Postdocs in last 10 years: 0
PhD students in last 10 years: 7
MS students in last 10 years: 6
BS students in last 10 years: 5

Highlighted Research Examples:

1. Muhlbauer JG and Fedo CM (2020) Architecture of a fluvial dominated, wave- and tidal-influenced, pre-vegetation braid delta: Cambrian middle member of the Wood Canyon Formation, southern Marble Mountains, California: J Sedimentary Research, 90: 1011-1036.
2. Muhlbauer JG, Fedo CM (2020) Architecture of a distal pre-vegetation braidplain: Cambrian middle member of the Wood Canyon Formation, southern Marble Mountains, California, USA: Sedimentology, 67:1084-1113.
3. Brengman LA and Fedo CM (2018) Development of a mixed seawater-hydrothermal geochemical signature during alteration of volcanic rocks in the Archean (~2.7 Ga) Abitibi Greenstone Belt, Canada: Geochimica et Cosmochimica Acta, 227: 227-245
4. Fedo CM, McGlynn IO, and McSween HY (2015) Grain size and hydrodynamic sorting controls on the composition of synthetic, analog, basaltic sediments: implications for interpreting martian soils: Earth & Planetary Science Letters, v. 423, p. 67-77.

Other Faculty Highlights:

N/A

Hembree, Daniel

Rank: Professor

Date Hired: August 2022
Date of Last Promotion: August 2018 (at Ohio University)

Program of Study:

My research program involves the interaction of sedimentological and biological processes within the fields of paleopedology and ichnology. I combine these disciplines to study the evolution modern and ancient soils, soil ecosystems, and landscapes as well as to demonstrate the broad environmental, climatic, and ecological applications of paleosols and ichnofossils, especially in evaluating the effect of long-term climate change on terrestrial ecosystems through Earth history.

Summary of Research Funding Sources:

American Chemical Society Petroleum Research Fund; National Geographic Society; W.M. Keck Foundation; Ohio University

Summary of Research Publications:

H-Index via Web of Science: 16
Peer-reviewed publications in last 10 years: 29
Percent first authored in last 10 years: 41%
Percent with student author in last 10 years: 55%

Summary of Mentoring and Management:

Lab Managers in last 10 years: 0
Postdocs in last 10 years: 0
PhD students in last 10 years: 0
MS students in last 10 years: 11
BS students in last 10 years: 9

Highlighted Research Examples:

1. Hembree DI and McFadden CJ (2020) Analysis of climate and landscape change through the Pennsylvanian and Permian Monongahela and Dunkard Groups, Southeastern Ohio, USA. Journal of Sedimentary Environments, 5: 321-353.
2. Hembree DI (2019) Burrows and ichnofabric produced by centipedes: modern and ancient examples. Palaios, 34: 468-489.
3. Catena AM, Hembree DI, Saylor BZ, and Croft DA (2017) Paleosol and ichnofossil evidence for significant Neotropical habitat variation during the late middle Miocene (Serravallian). Palaeogeography, Palaeoclimatology, Palaeoecology, 487: 381-398.
4. Hembree DI, Smith JJ, Buynevich IV, and Platt BF (2017) Neoichnology of semiarid environments: soils and burrowing animals of the Sonoran Desert, Arizona, USA. Palaios, 32: 620-638.
5. Hembree DI (2016) Using experimental neoichnology and quantitative analyses to improve the interpretation of continental trace fossils. Ichnos, 23: 262-297.

Other Faculty Highlights:

Executive Editor Palaeontologia Electronica 2019-2022

Huang, Shichun

Gerald D. Sisk Professorship
Rank: Associate Professor

Date Hired: Aug 2022
Date of Last Promotion: N/A

Program of Study:

High temperature geochemistry and petrology
Metal stable isotope geochemistry
Cosmochemistry

Summary of Research Funding Sources:

National Science Foundation (Petrology and Geochemistry division, Cross-cutting Activities division, Planetary Astronomy division); United States Geological Survey

Summary of Research Publications:

H-Index via Web of Science: 28
Peer-reviewed publications in last 10 years: 51
Percent first authored in last 10 years: 9%
Percent with student author in last 10 years: 49%

Summary of Mentoring and Management:

Lab Managers in last 10 years: 1
Postdocs in last 10 years: 2
PhD students in last 10 years: 2
MS students in last 10 years: 3
BS students in last 10 years: 9

Highlighted Research Examples:

1. Tschauner O, Huang S, Yang S, Humayun M, Liu W, Gilbert Corder N, Bechtel HA, Tischler J and Rossman GR (2021) Discovery of davemaoite, $CaSiO_3$-perovskite, as a mineral from the lower mantle. Science, 374: 891-894, doi:10.1126/science.abl8568.
2. DeFelice C, Mallick S, Saal AE and Huang S. (2019). An isotopically depleted lower mantle component is intrinsic to the Hawaiian mantle plume. Nature Geoscience, 12: 487-492 doi:10.1038/s41561-019-0348-0.
3. Tschauner O, Huang S, Greenberg E, Prakapenka V, Ma C. Rossman G, Shen AH, Zhang D, Newville M, Lanzirotti A and Tait K (2018) Ice-VII inclusions in diamonds: Evidence for aqueous fluid in Earth's deep mantle. Science, 359: 1136-1139, doi:10.1126/science.aao3030.
4. Huang S, Hall PS and Jackson MG (2011) Geochemical zoning of volcanic chains associated with Pacific hotspots. Nature Geoscience, 4:874-878, doi:10.1038/ngeo1263.
5. Huang S., Farkaš J and Jacobsen SB (2011). Stable calcium isotopic compositions of Hawaiian shield lavas: Evidence for recycling of ancient marine carbonates into the mantle. Geochimica et Cosmochimica Acta, 75: 4987-4997, doi:10.1016/j.gca.2011.06.010.

Other Faculty Highlights:

Have served as an Associate Editor for Geochemica et Cosmochimica Acta since 2010.

Jessup, Micah

Rank: Associate Professor

Date Hired: August 2007
Date of Last Promotion: August 2013

Program of Study:

My research interests are in structural geology, metamorphic petrology, and tectonics, with a common theme of the spatial and temporal variability of strain partitioning at different scales and levels in the crust. Through international collaborative research, I integrate my field-and lab-based specialties with thermochronology, geochronology and isotopic geochemistry to test the evolution of orogenic systems.

Summary of Research Funding Sources:

National Science Foundation, National Geographic Society

Summary of Research Publications:

H-Index via Web of Science: 20
Peer-reviewed publications in last 10 years: 20
Percent first authored in last 10 years: 15%
Percent with student author in last 10 years: 55%

Summary of Mentoring and Management:

Lab Managers in last 10 years: 0
Postdocs in last 10 years: 0
PhD students in last 10 years: 4
MS students in last 10 years: 4
BS students in last 10 years: 5

Highlighted Research Examples:

1. Searle MP, Law RD and Jessup MJ (2006). Crustal Structure, restoration and evolution of the Greater Himalaya in Nepal-South Tibet: implications for channel flow and ductile extrusion of the middle crust. Geological Society of London, Special Publication, 268: 355-378.
2. Searle MP et al. (2008) Defining the Himalayan main central thrust in Nepal. Journal of the Geological Society, 165: 523-534.
3. Grambling T.A., Kessup MJ, Newel DL, Methner K, Mulch A, Hughes CA (2022). Miocene to modern hydrothermal circulation and high topography during synconvergent extension in the Cordillera Blanca, Peru. Geology, 50: 106-110.
4. Hiett CD Newel DL and Jessup MJ (2021) ^{3}He evidence for fluid transfer and continental hydration above a flat slab. Earth and Planetary Science Letters, 556: 116722.
5. Jessup MJ, Jangille JM, Diedesch TF and Cottle JM (2019) Sneiss dome formation in the Himalaya and southern Tibet. Geological Society of London Special Publications, 483: 401-422.

Other Faculty Highlights:

N/A

Kah, Linda C.

Kenneth R. Walker Professor
Rank: Professor

Date Hired: January 2000
Date of Last Promotion: August 2012

Program of Study:

Integrating sedimentology, stratigraphy, geochemistry, and paleobiology in understanding the evolution of Earth's Precambrian biosphere, with a focus on marine carbonate-, evaporite-, and chert-bearing successions; Co-Investigator on the Curiosity and Perseverance rover teams investigating habitable environments on Mars and building context for Mars sample return.

Summary of Research Funding Sources:

NASA Mars Science Laboratory mission; NASA Mars2020 mission; American Chemical Society-Petroleum Research Fund; Robert Rex Research Fund.

Summary of Research Publications:

H-Index via Web of Science: 42
Peer-reviewed publications in last 10 years: 77
Percent first authored in last 10 years: 6.5%
Percent with student author in last 10 years: 40.2%

Summary of Mentoring and Management:

Lab Managers in last 10 years: 0
Postdocs in last 10 years: 0
PhD students in last 10 years: 8
MS students in last 10 years: 4
BS students in last 10 years: 17

Highlighted Research Examples:

1. Kriscautzky AK, Kah LC, Bartley JK (2022) Molar-tooth structure as a window into the deposition and diagenesis of Precambrian carbonate. Annual Reviews of Earth and Planetary Sciences, 50: 205-230.
2. Kah LC and Bartley JK (2021). Carbonate fabric diversity and environmental heterogeneity in the late Mesoproterozoic Era. Geological Magazine, DOI: 10.1017/S0016756821000406.
3. Stack KM et al. (2020) Photogeologic map of the Perseverance rover field site in Jezero crater constructed by the Mars 2020 Science Team. Space Science Reviews, 216; 47 pages.
4. Kronyak RE, Kah LC, Miklusicak NB, et al. (2019) Extensive polygonal fracture network in Siccar Point group strata: Fracture mechanisms and implications for fluid circulation in Gale crater, Mars. Journal of Geophysical Research-Planets, 124: 2613-2634.
5. Manning-Berg AR and Kah LC (2017) Understanding Precambrian silicification: constraints from taphonomy and geochemical modelling. Geobiology, 15: 469-483.

Other Faculty Highlights:

Named AAAS Fellow (2021); University Chancellor's Award for Research and Creative Achievement (2015); Named GSA Fellow (2014); Awarded Roger and Beverly Bohanan Faculty Achievement Award (2013). Research on Mars missions widely covered by local press.

McCanta, Molly

Gerald Sisk Associate Professor of Mineralogy and Petrology
Rank: Associate Professor

Date Hired: August 2016
Date of Last Promotion: June 2018

Program of Study:

My research focuses on the record of magmatic conditions (T, P, fO2, pH2O) and eruptive processes contained within minerals and quenched glasses. This information is accessed through experimental investigations of elemental partitioning as a function of magma physical and compositional variables and high-resolution analysis of samples to determine their histories.

Summary of Research Funding Sources:

National Science Foundation (Petrology and Geochemistry division); NASA (Solar System Workings; Planetary Data Archiving, Restoration, and Tools; Planetary Major Equipment and Facilities; Apollo Next Generation Sample Analysis); International Ocean Discovery Program

Summary of Research Publications:

H-Index via Web of Science: 11
Peer-reviewed publications in last 10 years: 27 (20 since hire)
Percent first authored in last 10 years: 33% (30% since hire)
Percent with student author in last 10 years: 26% (30% since hire)

Summary of Mentoring and Management:

Lab Managers in last 10 years: 1
Postdocs in last 10 years: 1
PhD students in last 10 years: 3
MS students in last 10 years: 6
BS students in last 10 years: 9

Highlighted Research Examples:

1. Teffeteller H, McCanta MC, Filiberto J, Treiman AH, Keller L, Cherniak D, Rutherford MJ, and Cooper RF (2022) An experimental study of the alteration of basalt on the surface of Venus. Icarus, doi.org/10.1016/j.icarus.2022.115085.
2. McCanta MC and Dyar MD (2020) Effects of oxidation on pyroxene visible-near infrared and mid-infrared spectra. Icarus, doi.org/10.1016/j.icarus.2020.113978.
3. McCanta MC, Dyar MD, Rutherford MJ, Lanzirotti A, Sutton SR, and Thomson BJ (2017) In situ measurement of ferric iron in lunar glass beads using Fe-XAS. Icarus, 285: 95-102.
4. McCanta MC. Beckett JR, and Stolper EM (2016) Correlations and zoning patterns of phosphorus and chromium in olivine from H chondrites and the LL chondrite Semarkona. Meteoritics and Planetary Science, 51: 520-546.

Other Faculty Highlights:

I have been involved in five NASA future mission proposals in the last five years, including one as deputy PI. Although none have been funded (yet!), all have been reviewed highly and several will likely be proposed again.

McKay, Larry

Jones Professor of Hydrogeology
Rank: Professor and Associate Dean of Research & Facilities, College of Arts & Sciences

Date Hired: January 1993
Date of Last Promotion: August 2004

Program of Study:

Groundwater flow and contaminant transport in fractured clay-rich materials.
Microbial contamination in groundwater and surface water.
Environmental restoration at DOE/DOD sites and former industrial sites in east Tennessee
Paleofloods, paleoclimate and flood risk on the Tennessee River.
Enhancing academic transfer paths for community college students and career planning

Summary of Research Funding:

NSF, GP-IMPACT Program; Electric Power Research Institute, NSF Critical Zone Observatory subcontract from Penn State.

Summary of Research Publications:

H-Index via Web of Science: 27
Peer-reviewed publications in last 10 years: 22
Percent first authored in last 10 years: 0
Percent with student author in last 10 years: 91%

Summary of Mentoring and Management:

Lab Managers in last 10 years: 0
Postdocs in last 10 years: 0
PhD students in last 10 years: 3
MS students in last 10 years: 4
BS students in last 10 years: 2

Highlighted Research Examples:

Paradis, C.J., L.D. McKay, E. Perfect, J. Istok, T.C. Hazen, 2018, Push-pull tests for estimating effective porosity: Expanded analytical solution and in situ application, *Hydrogeology Journal*. Volume: 27 Issue: 1, pages: 437-439.

Vulava, V., S. Vaughn, L.D. McKay, S.G. Driese, L.W. Cooper, F. Menn, N. Levine, G.S. Sayler, 2016, Flood-induced transport of PAHs from streambed coal tar deposits, *Science of the Total Environment*. http://dx.doi.org/10.1016/j.scitotenv.2016.09.222

Knappett, P., L.D. McKay, A. Layton, D. Williams, M. Alam, M. Huq, J. Mey, J. Feighery, P. Culligan, B. Mailloux, J. Zhuang, V. Escamilla, M. Emch, E. Perfect, G. Sayler, K. Matin Ahmed, A. van Geen, 2011, Implications of fecal bacteria input from latrine-polluted ponds to sandy aquifers, *Environ. Sci. Technol.*, vol. 46, No. 3, 1361-1370.

Other Faculty Highlights:

University of Tennessee National Alumni Association, *Outstanding Teacher Award - 2019*

McKinney, Michael

Rank: Professor

Date Hired: September 1985
Date of Last Promotion: September 1999

Program of Study:

I have many research interests, generally focused on sustainability issues. In recent years I have focused on threats to biodiversity and urban ecology, including urban rewilding, green roofs, and invasive species. My field work is focused on land snails and mussels with a special interest in their conservation. My lab work currently focuses on microplastic transport and impacts on ecosystems. I am Editor of the *Urban Naturalist* and Associate Editor for *Urban Ecosystems*.

Summary of Research Funding Sources:

USDA Forest Service; National Wildlife Foundation; One Health Initiative (UT Institute of Agriculture); East Tennessee Development District; UT Institute for Sustainable and Secure Environment

Summary of Research Publications:

H-Index via Web of Science: 31
Peer-reviewed publications in last 10 years: 18
Percent first authored in last 10 years: 33%
Percent with student author in last 10 years: 72%

Summary of Mentoring and Management:

Lab Managers in last 10 years: 0
Postdocs in last 10 years: 0
PhD students in last 10 years: 0
MS students in last 10 years: 12
BS students in last 10 years: 20

Highlighted Research Examples:

1. Welch JG, Sims CB and McKinney ML (2022) Does an urban wilderness promote gentrification? A case study from Knoxville, Tennessee, USA. Sustainabilty, 14: Article 73.
2. Guo Q, Cen X., Song R. McKinney ML and Wang D (2020) Worldwide effects of non-native species on species-area relationships. Conservation Biology. 35: 711-721.
3. McKinney ML and VerBerkmoes A (2020) Beneficial health outcomes of natural green infrastructure in cities. Current Landscape Ecology Reports 5: 35-44.
4. Li D, Olden JD, Lockwood JL, Record S, McKinney ML and Baiser B (2020) Changes in taxonomic and phylogenetic diversity in the Anthropocene. Proceedings Royal Society Biological Sciences, 287: Article number 20200777.
5. McKinney ML, Gladstone N, Lentz J and Jackson F (2019) Land snail dispersal, abundance and diversity on green roofs. PLOS ONE, 14: 2-11.

Other Faculty Highlights:

Lifetime Achievement Award from the UTK Office of Sustainability

McSween, Harry (Hap)

Rank: Chancellor's Professor Emeritus

Date Hired: August 1977
Date of Retirement: July 2016

Program of Study:

Cosmochemistry and meteorite petrology; exploration of the Solar System; geology/geochemistry of Mars via rovers and orbiters; geology/geochemistry and thermal evolution of asteroids via samples and spacecraft; terrestrial igneous and metamorphic petrology/geochemistry

Summary of Research Funding Sources:

NASA Mars Exploration Rovers Science Team; NASA Dawn Asteroid Orbiter Science Team; NASA Mars Odyssey Science Team; NASA Cosmochemistry Program

Summary of Research Publications:

H-Index via Web of Science: 100
Peer-reviewed publications in last 10 years: 93
Percent first authored in last 10 years: 12%
Percent with student author in last 10 years: 30%

Summary of Mentoring and Management:

Lab Managers in last 10 years: 0
Postdocs in last 10 years: 1
PhD students in last 10 years: 5
MS students in last 10 years: 3
BS students in last 10 years: 0

Highlighted Research Examples:

1. McSween HY and Huss GR (2022) Cosmochemistry, 2nd edition, Cambridge University Press, 437 p.
2. McSween HY, Moersch JE, Burr DM, Dunne WM, Emery JP, Kah LC, and McCanta M. (2019) Planetary Geoscience, Cambridge University Press, 334 p.
3. McSween HY, Raymond CA, Stolper EM, Mittlefehldt DW, Baker MD, Lunning NG, Beck AW and Hahn TW (2019) Differentiation and magmatic history of Vesta: Constraints from HED meteorites and Dawn spacecraft data. Geochemistry, 79:125526.
4. McSween HY, Emery JP, Rivkin AS, Toplis MJ, Castillo-Rogez J, Prettyman TH, De Sanctis MC, Pieters CM, Raymond CA, and Russell CT (2018) Carbonaceous chondrites as analogs for the composition and alteration of Ceres. Meteoritics and Planetary Science 53: 1793-1804.
5. McSween HY (2015) Centennial Article: Petrology on Mars. American Mineralogist 100:2380-2395.
6. McSween HY and McLennan SM (2014) Mars. In Treatise on Geochemistry, 2nd edition, vol. 2, pp. 251-300, HD Holland and KK Turekian, eds., Oxford: Elsevier.

Other Faculty Highlights:

Elected to the U.S. National Academy of Sciences (2021)

Moersch, Jeffrey

Rank: Professor

Date Hired: 5/2000
Date of Last Promotion: 8/2013

Program of Study:

Remote sensing on Earth and Mars, with particular emphasis on identification of minerals and substrate behavior via spectral analysis.

Summary of Research Funding:

NASA Mars Exploration Rovers Participating Scientist Program; NASA Mars Odyssey Participating Scientist Program; NASA Mars Science Laboratory Participating Scientist Program; NASA (Planetary Instrument Concepts, Data Analysis Program, Astrobiology Institute, Exobiology Program, Planetary Major Equipment, Astrobiology Science and Technology, Planetary Science and Technology programs).

Summary of Research Publications:

H-Index via Web of Science: 31
Peer-reviewed publications in last 10 years: 31
Percent first authored in last 10 years: 0
Percent with student author in last 10 years: 77

Summary of Mentoring and Management:

Lab Managers in last 10 years: 0
Postdocs in last 10 years: 2
PhD students in last 10 years: 8
MS students in last 10 years: 4
BS students in last 10 years: 4

Highlighted Research Examples:

1. Phillips MS et al. (2021) The Lifecycle of Hollows on Mercury: An Evaluation of Candidate Volatile Phases and a Novel Model of Formation. Icarus, 359.
2. Beddingfield CB, et al. (2021) Martian crater rim thermal inertia variations are a function of degradation state in low dust environments, Icarus, 370.
3. Bishop JL, Bell JF, and Moersch JE, editors (2020) Remote Compositional Analysis: Techniques for Understanding Spectroscopy, Mineralogy, and Geochemistry of Planetary Surfaces, Cambridge University Press.
4. McCarty C and Moersch J (2020) Remote characterization of physical surface properties of Mars using diurnal variations in apparent thermal inertia, Icarus, 345.
5. Tate CG et al. (2019) Mars Science Laboratory Dynamic Albedo of Neutrons passive mode data and results from sols 753 to 1292: Pahrump Hills to Naukluft Plateau, Icarus, 330:75-90.

Other Faculty Highlights:

Has conducted extensive field work and mission simulations in terrestrial analog environments such as Ellesmere and Axel Heiberg islands in the Canadian High Arctic, the Atacama Desert, Altiplano, and Andes of Chile, the Mojave Desert and Death Valley of California, and the Laki and Holuhraun volcanic fields of Iceland.

Perfect, Edmund

Rank: Professor Emeritus (Retired August 2021)

Date Hired: August 2001
Date of Last Promotion: August 2010

Program of Study:

My areas of expertise are Soil Physics, Hydrogeology, and Fractal Geometry. My research interests are mainly focused on the fundamental relations between total porosity, pore shape, pore size-distribution and pore connectivity, and key soil / rock hydraulic properties and processes, such as permeability and spontaneous imbibition. I seek to understand and predict the scale-dependency of these relations through geostatistical analyses and fractal modeling.

Summary of Research Funding:

US Army (Earth Materials and Processes Program); DOE (Office of Science, Biological and Environmental Research Program, Bioenergy Technologies Office); USGS National Geological Storage Assessment Program; UT-ORNL Science Alliance (LDRD and JDRD Programs)

Summary of Research Publications:

H-Index via Web of Science: 37
Peer-reviewed publications in last 10 years: 46
Percent first authored in last 10 years: 7%
Percent with student author in last 10 years: 52%

Summary of Mentoring and Management:

Lab Managers in last 10 years: 0
Postdocs in last 10 years: 1
PhD students in last 10 years: 3
MS students in last 10 years: 9
BS students in last 10 years: 0

Highlighted Research Examples:

1. Horodecky BB, Perfect E, Bilheux HZ, Brabazon JW and Gates CH (2020) Onset dynamics of air-water menisci on rock fracture surfaces. Advances in Water Resources, 146:103754
2. Perfect E, Brabazon JW and Gates CH (2020) Forward prediction of early-time spontaneous imbibition of water in unsaturated rock fractures. Vadose Zone Journal, 10.1002/vzj2.20056
3. Perfect E and Donnelly B (2015) Bi-phase box counting: an improved method for the fractal analysis of binary images. Fractals, 23, 1540010.
4. Perfect E, Cheng C-L, Kang M, Bilheux HZ, Lamanna JM, Gragg MJ and Wright DM (2014) Neutron imaging of hydrogen-rich fluids in geomaterials and engineered porous media: A review. Earth Science Reviews, 129:120-135.
5. Cai J, Perfect E, Cheng C-L and Hu XY (2014) Generalized modeling of spontaneous imbibition based on Hagen-Poiseuille flow in tortuous capillaries with variably shaped apertures. Langmuir, 30: 5142-5151.

Other Faculty Highlights:

Among top 2% of scientists in the world for research citations according to Stanford University researchers (2020, 2021) https://elsevier.digitalcommonsdata.com/datasets/btchxktzyw/3

Steen, Andrew

Rank: Assistant Professor

Date Hired: February 2014
Date of Last Promotion: n/a

Program of Study:

I am interested in how microbes interact with organic matter in Earth's subsurface; understanding how microbial extracellular enzymes, organic matter, and mineral surfaces interact; understanding what physiological traits allow microbes to persist at slow metabolic rates in the subsurface and what influence those traits have on oxidation rates of organic carbon.

Summary of Research Funding Sources:

National Science Foundation (Biological Oceanography, GEOPATHS, Ocean Drilling, eXtreme Science and Engineering Discovery Environment); DOE Biological and Environmental Research; Deep Carbon Observatory, Center for Dark Energy Biosphere Investigations; NVIDIA Corporation.

Summary of Research Publications:

H-Index via Web of Science: 18
Peer-reviewed publications in last 10 years: 26
Percent first authored in last 10 years: 23%
Percent with student author in last 10 years: 65%

Summary of Mentoring and Management:

Lab Managers in last 10 years: 2
Postdocs in last 10 years: 1
PhD students in last 10 years: 4
MS students in last 10 years: 4
BS students in last 10 years: 29

Highlighted Research Examples:

1. Schmidt JM, Royalty TM, Lloyd KG and Steen AD (2021). Potential activities and long lifetimes of organic carbon degrading extracellular enzymes in deep subsurface sediments of the Baltic Sea. Frontiers in Microbiology, 12:702015.
2. Steen AD, Kusch S, Abdulla H, Cakić N, Coffinet S, Dittmar T, Fulton J, Galy V, Hinrichs K-U, Ingalls A, Koch B, Kujawinski E, Liu Z, Osterholz H, Rush D, Seidel M, Sepúlveda J, Wakeham SG (2020). Analytical and computational advances, opportunities, and challenges in marine biogeochemistry in an era of "omics". Frontiers in Marine Science, 7:718.
3. Royalty TM and Steen AD (2019). Quantitatively partitioning microbial genomic traits among taxonomic ranks across the microbial tree of life. mSphere, 4:e00446-19
4. Steen, AD, A Crits-Christoph, P Carini, KM DeAngelis, N Fierer, KG Lloyd, JC Thrash (2019). High proportions of bacteria and archaea across most biomes remain uncultured. ISME Journal 13:3126-3130. doi: 10.1038/s41396-019-0484-y.

Other Faculty Highlights:

I involve middle and high school students from disadvantaged backgrounds in geoscience research. More than 100 students have participated, and 30 have presented the research at conferences.

Stigall, Alycia L.

Jones/Bybee Professor and Head of Earth and Planetary Sciences
Rank: Professor

Date Hired: August 2022
Date of Last Promotion: August 2015 (at Ohio University)

Program of Study:

I investigate the relationship between paleobiogeography, paleoecology, and macroevolution in driving patterns of speciation and extinction in Earth History. My lab uses the fossil record of shallow marine invertebrates to create ecological niche models to constrain the effects of invasive species and environmental change on biodiversity during radiation and mass extinction events.

Summary of Research Funding Sources:

National Science Foundation; UNESCO International Geoscience Programme; Ohio Environmental Education Fund; Ohio Board of Regents; Ohio University

Summary of Research Publications:

H-Index via Web of Science: 21
Peer-reviewed publications in last 10 years: 33
Percent first authored in last 10 years: 52%
Percent with student author in last 10 years: 70%

Summary of Mentoring and Management:

Lab Managers in last 10 years: 0
Postdocs in last 10 years: 0
PhD students in last 10 years: 0
MS students in last 10 years: 12
BS students in last 10 years: 17

Highlighted Research Examples:

1. Stigall AL (2019) The invasion hierarchy: ecological and evolutionary consequences of invasions in the fossil record. Annual Review of Ecology and Evolutionary Systematics, 50: 355-380.
2. Stigall AL, Edwards CT, Freeman RL, and Rasmussen CMØ (2019) Coordinated biotic and abiotic change during the Great Ordovician Biodiversification Event: Darriwilian assembly of early Paleozoic building blocks. Palaeogeography, Palaeoclimatology, Palaeoecology, 530: 249-270.
3. Stigall AL, Bauer JE, Lam AL, and Wright DA (2017) Biotic immigration events, speciation and the accumulation of biodiversity in deep time. Global and Planetary Change, 148: 242-257.
4. Trubovitz S and Stigall AL (2016) Synchronous diversification among Laurentian and Baltic rhynchonelliform brachiopods: implications for regional vs. global triggers of the Great Ordovician Biodiversification Event. Geology, 44: 742-746.

Other Faculty Highlights:

Awarded Charles Schuchert as Outstanding Paleontologist under age of 40 (2016); Paleontological Society Fellow; Professional Excellent Award AWG (2017); Associate Editor for Biodiversity; Co-lead of International Geosciences Programme (IGCP) Project 653 (Ordovician Biodiversification).

Sumrall, Colin D.

Rank: Associate Professor

Date Hired: 8/2012
Date of Last Promotion: 8/2017

Program of Study:

My research involves the early evolutionary history of Echinodermata (marine organisms such as crinoids, sea stars and sea urchins), with expertise in morphological homology, symmetry, and morphological characterization of the extinct taxa; recent focus on the origin, evolution and diversity of Late Paleozoic brittle stars using novel approaches and disarticulated skeletal elements.

Summary of Research Funding Sources:

National Science Foundation

Summary of Research Publications:

H-Index via Web of Science: 21
Peer-reviewed publications in last 10 years: 48
Percent first authored in last 10 years: 31.25%
Percent with student author in last 10 years: 27.3%

Summary of Mentoring and Management:

Lab Managers in last 10 years: 0
Postdocs in last 10 years: 0
PhD students in last 10 years: 7
MS students in last 10 years: 3
BS students in last 10 years: 11

Highlighted Research Examples:

1. Sumrall CD (2017) New insights concerning homology of the oral area and ambulacral system in echinoderms. In, S. Zamora (ed.) Progress in Echinoderm Paleontology, Special issue of Journal of Paleontology. 91, 604-617.
2. Sumrall CD and Zamora S (2018) New data on edrioasteroids from the Upper Ordovician of the Anti-Atlas (Morocco). Special Papers in Palaeontology. 485: 565-577.
3. Deline B, Thompson JR, Smith NS, Zamora S, Rahman IA, Sheffield SL, Ausich WI,. Kammer TW, and Sumrall CD (2020) Evolution and development at the origin of a phylum. Current Biology, 30: 1672-1679.
4. Novack-Gottshall PM, Sultan A, Smith NS, Purcell J, Hanson KE, Lively R, Ranjha I, Collins C, Parker R, Sumrall CD and Deline B. (2022) Morphological volatility precedes ecological innovation in early echinoderms. Nature Ecology and Evolution. 6: 263–272.
5. Sumrall CD (2020) Pan-Echinodermata. p. 641-644 and Echinodermata. p. 645-648. In K de Queiroz, J Gauthier, and P Cantino (eds.) Phylonyms: A Companion Volume to the PhyloCode. Taylor & Francis Group, London.

Other Faculty Highlights:

Fellow of the Geological Society of America (2018); Fellow of the Paleontological Society (2021); participation in phylocode volume, which officially replaces the250 year-old Linnaean Classification of life with the PhyloCode tree-based classification.

Szynkiewicz, Anna

Rank: Associate Professor

Date Hired: August 2013
Date of Last Promotion: August 2020

Program of Study:

M research focus is on surface processes related to water activity on the continental crust. I use a variety of chemical and isotope tracers to understand how water interacts with and moves through rocks. Using this research experience on Earth, I also formulate research questions related to the origin of sulfur-bearing minerals in extraterrestrial environments, specifically on Mars.

Summary of Research Funding Sources:

NASA (Mars Fundamental Research program, Solar System Workings); National Science Foundation (Low-Temperature Geochemistry and Geomicrobiology); Oak Ridge Associated Universities; United States Department of Interior; United States Geological Survey

Summary of Research Publications:

H-Index via Web of Science: 12
Peer-reviewed publications in last 10 years: 21
Percent first authored in last 10 years: 47%
Percent with student author in last 10 years: 43%

Summary of Mentoring and Management:

Lab Managers in last 10 years: 1
Postdocs in last 10 years: 0
PhD students in last 10 years: 4
MS students in last 10 years: 5
BS students in last 10 years: 8

Highlighted Research Examples:

1. Moore RD and Szynkiewicz A (2022) Controls on S mineral formation and preservation in hydrothermal sediments: Implications for the volcanic, aqueous, and climatic history of Gusev crater, Mars. Icarus, 376: 114880.
2. Ende JJ and Szynkiewicz A (2021) Mechanisms of sulfate formation in acidic hydrothermal sites of Iceland, Lassen, Valles Caldera, and Yellowstone: Implications for possible oxidation pathways in martian volcanic settings. Icarus, 368: 114608.
3. Szynkiewicz A and Bishop JL (2021) Assessment of sulfate sources under cold conditions as a geochemical proxy for the origin of sulfates in the circumpolar dunes on Mars. Minerals, 11: 507.
4. Szynkewicz A, Olichwer T, and Tarka R (2020) Delineation of groundwater provenance in Arctic environments using the isotope compositions of water and sulphate. Journal of Hydrology, 580: 124232.

Other Faculty Highlights:

With local artist Shelagh Leutwiler, I presented an art exhibit entitled *The Universe of Clay – Understanding Clay through Science and Art*, with the goal to educate the public about the natural processes of clay formation on Earth and Mars and to facilitate science discovery through art.

Thomson, Bradley

Rank: Assistant Professor

Date Hired: August 2020
Date of Last Promotion: n/a

Program of Study:

My research in geomorphology is focused on understanding the physical processes that have shaped the surfaces of the terrestrial planets, including impact, eolian, fluvial, lacustrine, and volcanic processes. I unravel the complex geologic histories of Mars, the Moon, and Venus using geomorphological analysis and remote data from radar, optical, near-IR, and thermal measurements.

Summary of Research Funding:

NASA (Mars Fundamental Research, Mars Data Analysis, Planetary Mission Data Analysis, Planetary Data Archiving, Restoration, and Tools, Lunar Data Analysis Program); NASA Lunar Reconnaissance Orbiter Mini-RF Science Team; NSF (Petrology and Geochemistry)

Summary of Research Publications:

H-Index via Web of Science: 24
Peer-reviewed publications in last 10 years: 25
Percent first authored in last 10 years: 32%
Percent with student author in last 10 years: 12%

Summary of Mentoring and Management:

Lab Managers in last 10 years: 0
Postdocs in last 10 years: 0
PhD students in last 10 years: 3
MS students in last 10 years: 1
BS students in last 10 years: 6

Highlighted Research Examples:

1. Vanga S, Fassett CI, Zanetti M, Nypaver C, Thomson BJ, and Hirabayashi M (2022) Rock abundance on the lunar mare on surfaces of different age: Implications for regolith evolution and thickness. Geophysical Research Letters, e2021GL096710.
2. Thomson BJ, Bussey DBJ, Neish CD, Cahill JTS, Heggy E, Kirk RL and 6 others (2012) An upper limit for ice in Shackleton crater as revealed by LRO Mini-RF orbital radar. Geophysical Research Letters, 39: L14201.
3. Thomson BJ, Bridges NT, Milliken R, Baldridge A, Hook SJ, Crowley JK and 4 others (2011) Constraints on the origin and evolution of the layered mound in Gale crater, Mars using Mars Reconnaissance Orbiter data. Icarus, 214: 413-432.

Other Faculty Highlights:

I was invited in 2021 to write a review article on Gale crater geology for the Oxford Research Encyclopedia. I used this opportunity to convene a Mars seminar in Fall 2021 with graduate students who were interested in co-authoring the review. We divided up the topic to smaller segments, and I worked with each group to iterate on the manuscript text. At the end, I assembled all of the segments, edited them to harmonize them, and submitted the review in spring 2022.

Benner, Jacob

Rank: Distinguished Lecturer

Date Hired: July 2018
Date of Last Promotion: July 2022

Program of Study:

Research is a small fraction of my role in EPS, but I remain active in the field of ichnology and pedagogy in Earth sciences. My current focus is Late Carboniferous terrestrial ecosystems (New England, USA), including most recently the oldest evidence of endophytic herbivory. Past projects have included glaciolacustrine and shallow marine ecosystems. I have ongoing collaborations with others in EPS focused on the efficacy of new, technology-enabled teaching methods.

Summary of Research Funding Sources:

I have not received funding for research since my hire at UT as a lecturer, but in the past, I have received funding through the American Chemical Society–Petroleum Research Fund, the Paleontological Society, Tufts University, and the Geological Society of America.

Summary of Research Publications:

H-Index via Web of Science: 8
Peer-reviewed publications in last 10 years: 3
Percent first authored in last 10 years: 2
Percent with student author in last 10 years: 2

Summary of Mentoring and Management:

Lab Managers in last 10 years: 0
Postdocs in last 10 years: 0
PhD students in last 10 years: 0
MS students in last 10 years: 0
BS students in last 10 years: 5

Highlighted Research Examples:

1. Benner JS, Knecht RJ and Engel MS (2015) Tonganoxichnus: A revision of the ichnogenus with new material from Massachusetts. Geological Association of Canada, Miscellaneous Publication 9: 31-43.
2. Netto RG, Benner JS, Buatois LA, Uchman A, Mángano MG, Ridge JC, Kazakauskas V and Gaigalas A (2012). Ichnology of Glacial Environments, in Knaust D and Bromley RJ, eds., Trace Fossils as Indicators of Sedimentary Environments. Amsterdam: Elsevier, 64: 960 pp.
3. Knecht RJ, Engel MS and Benner JS (2011) Late Carboniferous paleoichnology reveals the oldest full-body impression of a flying insect. Proceedings of the National Academy of Sciences, 108: 6515-6519.
4. Benner, J.S., Ridge, J.C and Knecht, R.J., 2009. Timing of post-glacial reinhabitation and ecological development of two New England, USA, drainages based on trace fossil evidence. Palaeogeography, Palaeoclimatology, Palaeoecology, 272: 232-239.

Other Faculty Highlights:

Although I do not directly supervise graduate research, I provide mentoring and training as the GTA coordinator. I also coordinate our 100-level courses and lab sections in the undergraduate program.

Drumheller-Horton, Stephanie

Rank: Lecturer

Date Hired: January, 2013
Date of Last Promotion: August, 2020

Program of Study:

My research centers on understanding the interplay of evolution, behavior, and diet of archosaurs (especially crocodylians) through the lens of bone surface modifications and paleopathologies.

Summary of Research Funding Sources:

National Science Foundation (GEOPATHS program), IMPACT, David B. Jones Foundation, The Leakey Foundation, National Geographic Society, Experiment.com

Summary of Research Publications:

H-Index via Web of Science: 9
Peer-reviewed publications in last 10 years: 20
Percent first authored in last 10 years: 50%
Percent with student author in last 10 years: 35%

Summary of Mentoring and Management:

Lab Managers in last 10 years: 0
Postdocs in last 10 years: 0
PhD students in last 10 years: 0
MS students in last 10 years: 0
BS students in last 10 years: 13 (undergraduate research supervisor)

Highlighted Research Examples:

1. Drumheller SK, Adams TL, Maddox H, Noto CR (2021) Expanded sampling across ontogeny in *Deltasuchus motherali* (Neosuchia, Crocodyliformes) reveals ecomorphological niche partitioning and Appalachian endemism in Cenomanian crocodyliforms. Elements of Paleontology, doi: 10.1017/9781009042024
2. Drumheller SK, McHugh JB, Kane M, Riedel A and D'Amore DC (2020) High frequencies of theropod bite marks provide evidence for feeding, scavenging, and possible cannibalism in a stressed Late Jurassic ecosystem. *PLoS ONE*, e0233115.
3. Drumheller SK and Wilberg EW (2020) A synthetic approach for assessing the interplay of form and function in the crocodyliform snout. Zoological Journal of the Linnaean Society, 188: 507-521.
4. Drumheller SK, Vliet KA and Darlington J (2019) Surveying death roll behavior across crown Crocodylia. Ethology, Ecology & Evolution, 31: 329-347.
5. Drumheller SK, Stocker MR and Nesbitt S (2014) Direct evidence of trophic interactions among apex predators in the Late Triassic of western North America. Naturwissenschaften 101: 975-987.

Other Faculty Highlights:

My research has been featured in such venues as National Geographic, Smithsonian Magazine, and museum exhibits in Colorado and North Dakota. I am highly active in outreach, both locally and online through the science communication handle @UglyFossils.

Jacobsen, Robert

Rank: Lecturer

Date Hired: 08/01/2021
Date of Last Promotion: N/A

Program of Study:

Post-Doc in Teaching & Learning Innovation, University of Tennessee, Knoxville (2019)
Ph.D. in Geology, University of Tennessee, Knoxville (2016)
M.S. in Geology, University of Tennessee, Knoxville (2016, concurrent)
B.A. in Geology, Colorado College (2010)

Summary of Research Funding Sources:

N/A

Summary of Research Publications:

H-Index via Web of Science: 5
Peer-reviewed publications in last 10 years: 9
Percent first authored in last 10 years: 33%
Percent with student author in last 10 years: 0%

Summary of Mentoring and Management:

N/A

Highlighted Research Examples:

1. Jacobsen RE and Szynkiewicz A (2022) Planetary Science Education and Public Outreach and through Collaborations with Local Artists. GSA Annual Meeting in Denver, CO.
2. Burr DM, Viviano CE, Michaels TI, Chojnacki M and Jacobsen RE (2022). An explosive volcanic origin identified for dark sand in Aeolis Dorsa, Mars. Geology, 50: 939-943.
3. Burr DM, Jacobsen RE, Lefort A, Borden RM and Peel SE (2021). Geologic Map of the Aeolis Dorsa Region, Mars. US Geological Survey Scientific Investigations Map, 2021.
4. Jacobsen RE, Grambling NL and Skjetne HL (2021) Planetary Science as a Gateway to the Geology Major: In-Person and Online Teaching Resources and Strategies from the Course "Exploring the Planets" at The University of Tennessee, Knoxville. GSA Annual Meeting in Portland, OR, https://dx.doi.org/10.1130/abs/2021AM-370089

Other Faculty Highlights:

Assistant Director for Tennessee Space Grant: In this role, I coordinate programs and funding for education and public outreach at K-12, undergraduate, and graduate levels. Each year, Space Grant support STEM education programs in local schools and museum, research experiences for undergraduate students in geology and aerospace engineering, and at least one Ph.D. fellowship.
Institutional Leader for the Center for the Integration of Research, Teaching, and Learning (CIRTL): CIRTL is a network of 42 R-1 universities committed to advancing STEM education through the professional development of graduate students and postdocs. In this role, I collaborate with the university's office of Teaching & Learning Innovation to promote CIRTL on campus and recruit students to participate in network events.

Hazen, Terry

UTK/ORNL Governor's Chair Professor
Rank: Professor

Date Hired: December 2011
Date of Last Promotion: December 2011

Program of Study:

My lab focuses on basic and applied field microbial ecology as it relates to bioremediation, biofuels, enhanced oil recovery, and water quality. We strive to understand fundamental concepts of systems biology and environmental stress response pathways from the molecular to the ecosystem level to improve our knowledge of biogeochemistry.

Summary of Research Funding Sources:

UTK (Wastewater Based Epidemiology, Institute for a Secure and Sustainable Environmen); National Science Foundation (Engineering Research Center Planning); Department of Energy (National Nuclear Security Administration, Biological and Environmental Research); Norwegian Science Foundation; American Petroleum Institute; BP Exploration & Production

Summary of Research Publications:

H-Index via Web of Science: 60
Peer-reviewed publications in last 10 years: 142
Percent first authored in last 10 years: 8%
Percent with student author in last 10 years: 75%

Summary of Mentoring and Management:

Lab Managers in last 10 years: 2
Postdocs in last 10 years: 7
PhD students in last 10 years: 13
MS students in last 10 years: 5
BS students in last 10 years: 39

Highlighted Research Examples:

1. Couradeau E et al. (2019) Probing the active fraction of soil microbiomes using BONCAT-FACS-Seq. Nature Communications 10:2770-2770.
2. Smith MB et al. (2015) Natural bacterial communities as quantitative biosensors. mBio 6, DOI: 10.1128/mBio.00326-15.
3. Hazen TC, Prince RC and Mahmoudi N (2016) Marine Oil Biodegradation. Feature Article. Environmental Science and Technology 50:2121-2129.
4. Hazen TC et al. (2010) Deep-sea oil plume enriches psychrophilic oil-degrading bacteria. Science 330:204-208.
5. Chivian D et al. (2008) Environmental Genomics Reveals a Single-Species Ecosystem Deep Within Earth. Science 322:275-278.

Other Faculty Highlights:

American Society for Microbiology Award for Environmental Research (2021); Named Fellow of the American Association for the Advancement of Science (2013); Environmental Science & Technology Best Paper Award (2011); Editorial Board mBio (2022-2025).

Herndon, Elizabeth

Rank: Assistant Professor (ORNL Joint Faculty)

Date Hired: November 2019
Date of Last Promotion: n/a

Program of Study:

My research focuses primarily on iron and manganese redox processes and impacts on carbon and nutrient storage in soils and cycling in diverse ecosystems

Summary of Research Funding:

National Science Foundation (Office of Polar Programs); DOE (Early Career Research Program)l ORNL Laboratory (Directed Research and Development)

Summary of Research Publications:

H-Index via Web of Science: 18
Peer-reviewed publications in last 10 years: 12 (since hire)
Percent first authored in last 10 years: 17%
Percent with student author in last 10 years: 33%

Summary of Mentoring and Management:

Lab Managers in last 10 years: 0
Postdocs in last 10 years: 2
PhD students in last 10 years: 1
MS students in last 10 years: 0
BS students in last 10 years: 0

Highlighted Research Examples:

1. Li H, Santos F, Butler K and Herndon E. (2021) A critical review on the multiple roles of manganese in stabilizing and destabilizing soil organic matter. Environmental Science and Technology, 55: 12136-12152.
2. Yazbek, L., Cole, K., Shedleski, A., Singer, D., and Herndon, E. (2021) Hydrogeochemical processes limiting Fe export in a headwater catchment impaired by acid mine drainage. ACS ES&T Water 1(1), 68 – 78.
3. Herndon E. M., Kinsman-Costello L., Di Domenico N., Duroe K., Barczok M., Smith C., and Wullschleger S. D. (2020) Iron and iron-bound phosphate accumulate in surface soils of ice-wedge polygons in arctic tundra. Environmental Science: Processes & Impacts 22, 1475 – 1490.
4. Shaw M., Yazbek L., Singer D., Herndon E. (2020) Seasonal mixing from intermittent flow drives concentration-discharge (C-Q) behavior in a stream affected by coal mine drainage. Hydrological Processes 34(17), 3669-3682.

Other Faculty Highlights:

Awarded DOE Early Career Research Program grant; Postdoctoral researcher Erin Rooney received NSF Postdoctoral Research Fellowship; PhD student Kristen Butler received UT-ORNL Graduate Advancement, Training, and Education (GATE) fellowship to support two years of tuition and salary.

Liang, Liyuan

Rank: Adjunct Professor

Date Hired: 2019
Date of Last Promotion: N/A

Program of Study:

Aquatic chemistry
Contaminant transformation
Environmental chemistry
Groundwater remediation
Toxic metals

Summary of Research Funding:

DOE, Biological and Environmental Research Program
DOE, Environmental Management, Technology Demonstration Program

Summary of Research Publications:

H-Index via Web of Science: 49
Peer-reviewed publications in last 10 years: 59
Percent first authored in last 10 years: 0
Percent with student author in last 10 years: 50

Summary of Mentoring and Management:

Lab Managers in last 10 years: 1
Postdocs in last 10 years: 7
PhD students in last 10 years: 2
MS students in last 10 years: 0
BS students in last 10 years: 3

Highlighted Research Examples:

1. Parks JM, JohsA.; Podar M, Bridou R, Hurt RA, Smith SD, Tomanicek SJ, Qian Y, Brown SD, Brandt CC, Palumbo AV, Smith JC, Wall JD, Elias DA, Liang LY (2013) The genetic basis for bacterial mercury methylation Science, 339:1332–1335 (has received 775+ citations).

2. Gu B, Schmitt J, Chen Z, Liang L and McCarthy JF (1994) Adsorption-desorption of Natural Organic Matter on Iron-oxide: Mechanisms and Models, Environmental Science and Technolology 28: 38-46, (has received 1100+ citations).

3. Erdan H, Zhang Y, Wu S, Wu J, Liang L, He F. (2017) Role of dissolved Mn(III) in transformation of organic contaminants: non-oxidative versus oxidative mechanisms. Water Resources, 111:234-243. (Cited >12 per year).

Other Faculty Highlights:

N/A

Riding, Robert

Rank: Research Professor

Date Hired: 2007
Date of Last Promotion: N/A

Program of Study:

Microbial, algal and reef carbonates.

Summary of Research Funding:

TOTAL S.A.

Summary of Research Publications:

H-Index via Web of Science: 61
Peer-reviewed publications in last 10 years: 30
Percent first authored in last 10 years: 17
Percent with student author in last 10 years: 10

Summary of Mentoring and Management:

Lab Managers in last 10 years: 0
Postdocs in last 10 years: 3
PhD students in last 10 years: 1
MS students in last 10 years: 0
BS students in last 10 years: 0

Highlighted Research Examples:

Riding R (2002) Structure and composition of organic reefs and carbonate mud mounds: concepts and categories. Earth-Science Reviews, 58: 163-231 (has received 530+ citations).

Riding R (2000) Microbial carbonates: the geological record of calcified bacterial -algal mats and biofilms. Sedimentology, 47: 179-214 (has received 1600+ citations).

Riding R (2006) Cyanobacterial calcification, carbon dioxide concentrating mechanisms, and Proterozoic-Cambrian changes in atmospheric composition. Geolobiology, 4: 299-316 (has received nearly 300 citations).

Riding R (2006) Mcrobial carbonate abundance compared with fluctuations in metazoan diversity over geological time. Sedimentary Geology, 185: 229-238 (has received nearly 300 citations).

Other Faculty Highlights:

N/A