

Strategic Plan 2014-2019

Executive Summary

The Department of Geosciences and the College of Earth and Mineral Sciences are internationally recognized as the bellwether of the latest trends in investigating Earth as a system. With other forward-looking geoscience departments, we have redefined the scope of traditional geology to span from Earth's deep interior to the outer reaches of the habitable zone around distant solar systems, while retaining the unique perspective of deep time that geologists have utilized for centuries. Our trailblazing approach to earth science education has had a longstanding focus on engaging undergraduates in the research enterprise with new methods involving immersive international experiences, active learning and outreach.

Our goal for the next five years is to continue and expand this proud tradition by ensuring that we remain strong in fundamental areas of the geosciences in the face of key retirements, and expanding our research and teaching emphases in areas of key societal relevance. To achieve this goal we will:

- 1) hire a diverse cadre of new faculty in strategic areas that build our expertise in *human-induced changes to the Earth system* and in using *lessons from the past to inform future decision-making*;
- 2) expand our expertise in *solid-earth geoscience* to address pressing societal need for geoscientists skilled in *responsible use of natural resources* and *evaluation of natural hazards and associated risks*;
- 3) establish ourselves and the College as the most student-*success*-centric program and college at Penn State;
- 4) strengthen links with *industry and national laboratories* through Institute for Natural Gas Research (INGaR) hires and through expanded partnerships;
- 5) enable *innovation and discovery* in geosciences research and teaching by modernizing our research and teaching laboratory facilities, infusing intellectual vitality into the Department with a visiting and postdoctoral scholars program, and striving to streamline the administrative burden on faculty;
- 6) retain our *agility to both create and respond to opportunities* within the University (and elsewhere) that may deviate from this strategic plan but leverage funding and positions to achieve our broadest objectives.

Introduction

Nearly twenty years ago, and with great prescience, the College of Earth and Mineral Sciences established the Earth System Science Center to “formulate and foster a science of the Earth system.” (Dutton, Fall, 1985 EMS Bulletin). The Department of Geosciences participated fully in this new center, with several co-funded faculty hires that focused departmental research and education on interactions between Earth surface processes and climate, and on the geologic record of global change in Earth’s distant past. Our early and skillful entry into the emergent field of Earth system science established Penn State and its Department of Geosciences as leaders in the interdisciplinary study of the Earth.

Today, the issues that motivated this broadening of the scope of our areas of expertise beyond traditional geology have only become more pressing. At the same time, the need for geoscientists, well trained in the investigation and exploration of Earth’s interior, has intensified. This parallels the demand for precious metals, petroleum, and other natural resources, and the dramatic cost to society of natural disasters such as earthquakes (and associated tsunamis) and volcanic eruptions. Frankly, as we begin our quest to develop faculty expertise in Earth system science relevant to issues of global change, we have lost (or will soon lose through retirement) expertise in the more traditional but highly relevant areas of solid-earth geosciences. We are not alone in this transformation; most U.S. geoscience departments de-emphasized solid-Earth geosciences in the 1990s and 2000s. Yet, as the NRC report “Emerging Workforce Trends in U.S. Energy and Mining Industries, A Call to Action” (NAS, 2013) emphasizes, the current pipeline of students prepared for careers in “Earth Resources Science and Engineering” is grossly inadequate to meet workforce needs in the coming decade. The petroleum, metal, and rare earth extractive industries along with their regulatory counterparts are blossoming like never before with the collective economic impact undoubtedly at historic levels. Regaining faculty capacity in these areas is essential to meet this need, as is attracting a larger and more diverse student body to the geosciences.

To retain our leadership position in U.S. geoscience research and education, we need to maintain our strength in interdisciplinary Earth system science while addressing the challenges and opportunities that recent and anticipated retirements have on the complexion of our faculty. Technological advances in research instrumentation, computation, and online education provide opportunities for us to contribute new knowledge and expand the impact and quality of our educational offerings. Closer collaborations with industry and government labs will provide a more seamless transition for our students to promising careers, an alternative source of research funding in an era of diminishing government support for research, as well as a source of funds for establishing state-of-the-art teaching and research laboratories. In summary, strategic hiring will establish PSU as the leader in both traditional “solid earth geosciences” and “earth systems sciences.”

Factors affecting the Department of Geosciences in the Next Five Years and Beyond

This strategic plan has been developed with awareness of a host of internal and external factors that provide challenges to and opportunities for the accomplishment of the goals we describe herein.

Internal factors include:

- 1) a university budget increasingly being driven by tuition revenue;
- 2) continued growth in student demand for flexibility in class scheduling and online course availability;
- 3) swelling enrollments in geosciences and in other majors we serve through required coursework, especially those offered by the Department of Energy and Mineral Engineering;
- 4) decline in the proportion of female students as our undergraduate enrollment grows (a national phenomenon);
- 5) need for infrastructure and laboratory improvement for education and research;
- 6) increased requirements for faculty (compliance, trainings, committee work) and corresponding reduction in time for intellectual and creative pursuits;
- 7) anticipated retirements in sedimentary geology (2), geochemistry (1), and structural geology (1) with significant impact on oil and gas industry research and education;
- 8) renovations to adjacent buildings (Steidle, Hosler) that affect Geosciences directly and indirectly; and
- 9) initiation of a new capital campaign at Penn State.

External factors include:

- 1) continued growth in online education;
- 2) exponential growth in Earth observations at all scales (big data needs);
- 3) increased emphasis on relevance to society of the research the government funds;
- 4) a national focus on water, energy, and natural resource needs;
- 5) recognition of humans as a geological force;
- 6) decreasing success rates nationwide for proposals at NSF, NASA and DOE;
- 7) opportunities for funding from industry and foundations.

Our strategy is to address these factors and find a path that turns problems and pressures into opportunities and successes.

Goal 1: Promote excellence and innovation in research and graduate education

The Department of Geosciences is considered one of the top geosciences research and graduate programs in the country. The 2014 US News and World Report of Earth Sciences graduate programs ranked Penn State, No. 1 in Geology, No. , as reflected in our #1 ranking in geology, #2 in geochemistry, and No. #6 in Earth Sciences overall in Earth science graduate programs by US News and World Reports (<http://grad-schools.usnews.rankingsandreviews.com/best-graduate-schools/top-science-schools/geology-rankings>). We benefit from a relatively large, disciplinarily diverse faculty who are leaders in their disciplines, and are constantly seeking ways to combine their skills to reveal Earth's deepest secrets. Many of the faculty are at the peak of their academic careers; we need to ensure that no obstacle exists between them and their research and educational goals. At the same time, we must recognize that the long-term health of the Department demands that we continue to bring in outstanding new faculty who will become the next generation's respected leaders. Below we list strategic hiring priorities (**not** in rank order) and give examples of research areas that could fulfill those objectives.

Strategic Priority 1: Establish PSU as a global leader in geoscience Education and Research

Action Items

- Strategic hiring that build on our department's strength in *using lessons from Earth's past to manage our future* could include geoscientists working in:
 - Environmental dynamics of a warm planet: The sedimentary archive provides unique access to proxies and biogeochemical insights into warm-climate conditions. Particularly relevant is the application of state-of-the-art geochemical tools to the sedimentary record needed to validate models of climate and ocean dynamics during warm periods; or
 - Biotic responses to a changing world: Understanding how organisms and ecosystems responded to past shifts in climate can help predict future biotic change and inform conservation efforts. This scientist could study marine or terrestrial ecosystems and investigate how species respond to environmental change over a range of temporal scales.
- Strategic hiring in human-induced changes to Earth systems would complement our current strength in surface processes but focus the emphasis on human time scales and impacts, in areas such as:
 - Global-scale fluxes of water mass and/or hydrologic response to

environmental change: Addresses fundamental questions about water resources and continental-scale fluxes (i.e. hydrologic cycle), and their response to natural and anthropogenic forcings; or forces

- Sustainable sedimentary systems: Understanding sediment-transport dynamics provides a key avenue for connecting information from the stratigraphic record to sustainable landscape engineering. This scientist could study sediment-transport processes in an effort to, for example, reconstruct coastal dynamics from sedimentary deposits and predict future changes to coastal systems; or
- Earth dynamics on human timescales: studies of landscape or ice-sheet response to human forces, induced seismicity, hydrate destabilization, etc.; or
- Observing Earth at scales from the microscopic to the global using modern instrumentation, satellites, and the mining of big datasets; or
- Impact of water production and waste storage on groundwater and the subsurface environment: These topics address the rapidly growing need to understand how water usage impacts the availability and quality of drinking water. At the same time, waste water injection and energy production are exposing fundamental questions about fluid flow and rock-water interaction in Earth's subsurface.

Strategic Priority 2: Fill key positions in the geosciences of the solid Earth

Action Items

- Strategic hiring in the geoscience of the solid Earth
 - Crustal genesis: The current deficits in Solid Earth geochemistry offer the department a chance to move in a bold, new direction that could have strong links to geophysics faculty as well as other research thrusts in the department. One thrust that would unite many subprograms is the origin of continental and oceanic crust.
 - Coupling deep-Earth and Earth-surface processes: The field of basin analysis helps integrate and leverage existing department strengths, particularly connections among solid-Earth and Earth-surface dynamics. This scientist could use the sedimentary record to understand how Earth's surface drives and responds to mantle geodynamics, or how basin evolution influences fluids, fault mechanics, and stratigraphic heterogeneity.
 - Planetary geology/planetary interiors: With years of funding for the

Penn State Astrobiology Research Center from NASA, and with the Department of Astronomy emerging as a leader in extrasolar habitable planet detection, Penn State has the opportunity to become a leader in planetary science through a collaborative effort involving the Departments of Geosciences and Astronomy. Geoscientists who image (seismologists) or analyze (petrologists) Earth's deep interior also investigate the evolution and structure of other planets. A focus on solid-Earth geoscience thus could contribute to a growing planetary science presence at Penn State and ultimately justify the establishment of a formal Planetary Science program.

Strategic Priority 3: Strengthen links with industry and government

Action Items

- Develop an industry and government engagement strategic plan
- Initiate tenure-track hires in industry-related disciplines linked to *INGaR*
 - Sedimentary Geology (including basin analysis)
 - Petrophysics
 - Reflection Seismology
 - Impact of energy production on seismic hazard: Understanding the role of fluid injection and dynamic stressing associated with human activities and natural processes on induced seismicity and earthquake triggering.
- Secure funding for geomechanics lab enhancements in support of INGaR.
- Develop closer collaborations with the United States Geological Survey through
 - Support for graduate students through USGS partnerships;
 - *Pulse of the Earth* student engagement activities; and
 - exploration of an on-campus presence of USGS scientists, e.g., isotope geochemists who could contribute to the maintenance and support of instrumentation.
- Improve management of software donation, installation, license management, and training.
- Improve communication about student internship and research opportunities at national labs.

Strategic Priority 4: Maintain and enhance excellence by enabling the Geosciences research enterprise

Action Items

- Reduce administrative burdens on faculty. Work with staff to develop technology and databases to streamline paperwork.
- Develop a Post-Doctoral Scholars program. This includes developing a coordinated effort to support and enhance the experience of existing post docs as well as developing a department-wide post-doc position. Funding from industry or endowment.

- Invest in infrastructure (research laboratories).
- Develop a sustainable model for technical support, including centralization of analytical facilities and establishment of cost-recovery mechanisms.

Strategic Priority 5: Strengthen partnerships and leverage transdisciplinary opportunities across the University

- Continue working with PSIEE and the Water Task Force to craft a University-wide Water initiative.
- Fully engage with INGaR with faculty hires (see above) and other mechanisms of participation.
- Work through SCRiM and the Sustainability Institute to create initiative in Sustainability and Risk Analysis including new faculty positions.
- Coordinate establishment of a Center for Marine Science and Technology, including close collaboration with the Applied Research Laboratory.

Timeline for Major Objectives, Goal 1

Academic Year 2014-2015

- Initiate search for INGaR position 1.
- (Dependent on retirement) Initiate first “Solid Earth” search.
- Establish agreement with USGS.
- Secure funding from central administration for laboratory renovations to accommodate Hosler relocations and geomechanics laboratory enhancements.

Near Term (2015-2017)

- Establish funding for named postdoctoral position.
- Initiate search for INGaR position 2.
- (Dependent on retirement) Initiate “*Lessons from Past*” search.
- (Dependent on new position from Water Initiative) Initiate “human-induced” search.

Longer Term (2015-2019)

- (Dependent on retirement) Initiate second “Solid Earth” search.
- As opportunities arise through new initiatives, including Sustainability and Risk Management, respond strategically.

Goal 2: Become the most student-*success*-centric program at PSU

The College of Earth and Mineral Sciences established itself early on as the most student-centric college at PSU, with the most visible demonstration being the Ryan Family Student Center. This emphasis has boosted enrollments, built a sense of community among EMS undergraduates and, with the help of tutors in the Ryan Center, likely improved our students' academic success. Substantial effort needs to be put into evaluating and supporting the success of our undergraduates as post-graduates and the career tracking of our graduates to measure that success. We propose a series of strategic initiatives aimed at better preparing our students for lifelong success in what may be a variety of careers.

The emphasis over the next five years will be on undergraduate program reform. Our graduate program has been undergoing a review over the last few years and will continue to be evaluated in terms of its effectiveness in recruiting, retention, and success of our graduate students. Nevertheless, it is our opinion that emphasis needs to be placed on undergraduate education and improving the quality and efficiency of classroom instruction.

Strategic Priority 1: Construct the best pedagogic framework for providing a modern education in geosciences and a support structure that prepares students for lifelong success

Action Items:

- Reform Geosciences as an umbrella major with options in Geology, Geophysics, Geochemistry, Geobiology, and Hydrology.
- Consider broadening our current requirement for senior thesis to include *Pulse of the Earth* outreach activities, internships, and participation in University and nationwide competitions.
- Create a position for a well-vetted Professor-of-Practice, an industry or government scientist who would teach courses (hydrology, oil and natural gas, environmental consulting) from a professional perspective for students.
- Assess as we innovate by including controls in new course design to gauge level of success and by surveying undergraduate experience in collaboration with AGI initiative.
- Continue to develop active-learning courses that exploit the state-of-the-art infrastructure provided by Pulse of the Earth (Room 240).
- Develop a clearer understanding of the careers our students are finding, how those evolve with time, and how we might better prepare our students for lifelong success.
- Consider an annual alumni career symposium for undergraduates to participate in panel discussions with alumni discussing various careers in the geosciences

Strategic Priority 2: Take advantage of novel venues for delivery of instructional content without sacrificing benefits of discipline-specific approaches

Action Items:

- Expand our successful efforts in online Earth science instruction through additional introductory-level courses, especially as summer offerings.
- Provide new bridges for transfer students from the Commonwealth Campuses through online core courses (e.g., Geosc 203) and upper-level courses (see last action item under Strategic Priority 1 above).
- Enable faculty to systematize course content through web-based approaches.

Strategic Priority 3: Enhance the undergraduate research experience both within and outside programmatic coursework

Action Items:

- Modernize lab equipment and infrastructure for experiment- and specimen-based courses by establishing a dedicated Undergraduate Facilities fund.
- Hire a Laboratory Manager responsible for teaching students how to use equipment and developing and maintaining laboratory activities and their attendant equipment and supplies for our laboratory-based courses; or
- Appoint a cohort of Head Teaching Assistants from among the graduate population with heightened responsibilities for undergraduate instruction and commensurate remuneration.
- Develop additional team-centered research projects based in the *Pulse of the Earth* facility.
- Incentivize high-level students to perform independent research through the provision of travel funds and summer stipends.
- Reemphasize the importance of teaching in the tenure review process

Strategic Priority 4: Increase the excellence and diversity of our undergraduate majors

Action Items:

- Work with the Science Education Adviser at PDE and with leadership of PSTA and PAESTA to invigorate study of Earth Science in Pennsylvania middle and high schools.
- Ensure financial support for the 3+2 Fort Valley State University program.
- Support EMS initiatives in increasing professionalism through enhanced instruction in Geosc 496/494W.
- Empower undergraduate majors to develop and implement community-building and outreach programs.
- Appoint one professor each year to focus on recruitment through presentations at Pennsylvania high schools and science events in lieu of one 3-credit course, with special focus on under-represented groups and utilizing our contacts through PAESTA.

Timeline for Major Objectives, Goal 2

Academic Year 2014-2015

- Initiate revisions to Geosciences undergraduate majors.
- Experiment with a Professor of Practice to teach Geosc 452.
- Launch the *Pulse of the Earth* student engagement initiative.
- Hire lab manager / head TA to oversee teaching laboratories.

Near Term (2015-2017)

- Expand online courses that reach out to the Commonwealth campuses and minority serving institutions.
- Secure funding for teaching laboratory renovations.
- Engage PAESTA and pursue strategic high-school recruiting.

Longer Term (2015-2019)

- Explore new pedagogic approaches to geosciences education, including flipped classes, additional online courses.

Goal 3: Increase diversity in the Department of Geosciences

The Department strives to recruit, support and fully engage a diverse student body, staff and faculty, and maintain a collegial work place and a supportive environment that values and promotes openness and inclusiveness in all aspects of Departmental activities. The Department seeks to address underrepresentation of minorities in the Geosciences by supporting and enhancing existing diversity programs within the Department, as well as fostering the development of innovative, new programs.

Activities for enhancing the diversity of the Department and the geoscience workforce more broadly include the following.

Strategic Priority 1: Recruit and retain a diverse student body

Action items:

- In collaboration with the EMS Office of Educational Equity, expand our AfricaArray program by developing a *bridge program* linking undergraduate students in our partner minority-serving institutions with our undergraduate and graduate degree programs at PSU.
 - Develop online content that would benefit both our minority-serving institution (MSI) partners and Commonwealth campus students.
 - Negotiate an agreement with the MSIs that would allow their students to take the online courses without paying additional tuition.

- Expand Button-Waller or other College support to facilitate the matriculation of promising but underprepared minority students in our M.S. program.
- Promote diversity awareness and support the overall Departmental effort by appointing a *Director or Associate Head for Diversity* who would
 - Coordinate fundraising for diversity programs;
 - Demonstrate and highlight the pipeline and successes of minority students;
 - Administer diversity programs within the Department, where appropriate;
 - Mentor and advise both undergraduate and graduate underrepresented minority students ;
 - Establish a peer support network for underrepresented minority students within the Department.
- Empower undergraduate majors to develop and implement community-building and outreach programs.
- Provide long-term monitoring and support of diverse students, particularly those in the SEEMS and Button-Waller programs.
- Identify and benchmark successful programs elsewhere to keep informed about best practices.
- Support faculty outreach to high schools, with the possibility of teaching buyout (see above).
- Support summer programs for science teachers from areas of Pennsylvania with a high population of underrepresented minority students.

Strategic Priority 2: Recruiting and retaining a diverse faculty and staff:

Best practices:

- Conduct broad searches;
- Establish best practices for faculty mentoring;
- Promote diversity-focused postdoc programs.

Timeline for Major Objectives, Goal 3

Academic Year 2014-2015

- Hold workshop on establishing bridge programs with MSIs.
- Assign faculty member as diversity director.

Near Term (2015-2017)

- Establish bridge program.
- Establish funding for named postdoctoral position (see goal 1) with emphasis on diversity–building.

Longer Term (2015-2019)

- Ensure that diversity of department exceeds diversity of PSU (undergraduate and staff/faculty) and national pools (graduate students, postdocs and faculty).

Goal 4: Support outreach programs that emphasize and enhance the relevance of geosciences research and education

The relevance of the geosciences provides boundless opportunities for outreach. In fact, communication of our science via outreach is critical to develop an informed and scientifically literate citizenry. The stakes are especially high at the K-12 level where we need to build interest in the geosciences in order to recruit the next generation of geoscientists. The significance of outreach efforts will increase in the near future as NSF is poised to tighten accountability of *Broader Impacts*.

The Department's flagship outreach program, *Shake Rattle Rocks* (SRR) reaches every fifth grader, approximately 500 students, in the State College Area School District each year. The event runs over three days and involves hands-on activities in a number of different labs in the department. Teachers use SRR as a basis for earth science education back in the classroom.

Our faculty and students are involved in a great deal of outreach in our local community and beyond with school visits, teacher workshops and interaction with the media. Growing distance educational programs freely available through the College of Earth and Mineral Sciences Open Educational Resources Initiative also constitute vital outreach.

Strategic Priority 1: Expand local Earth Science outreach

Action item:

- Invite other local school districts to participate in Shake Rattle and Rocks.
- Participate in the Nittany Mineralogical Society's Junior Education Day that attracts 250 students.

Strategic Priority 2: Utilize the *Pulse of the Earth* facility for departmental outreach

Action items:

- Include information on local geology, links to the EMS museum website and to online courses, as well as examples of educational activities for teachers.
- Incorporate this activity into the Pulse of the Earth student engagement initiative.
- Partner with the Pennsylvania Council of Professional Geologists (PCPG) that has similar goals for enhancing secondary education in the earth sciences to spark interest in geoscience careers.

Accomplishing these goals

The pages above have laid out an ambitious set of goals for the near future of the Department of Geosciences. Our ability to accomplish these goals depends on a combination of prioritization, reallocation of internal resources, leveraging of department resources with College and University co-funding, and fundraising activities coordinated with College and University development officers.

Concerning internal resource reallocation, we will take the following steps to facilitate the strategic plan:

- Consolidate our various majors into one major with a number of options;
- Prioritize the strategic hires listed here when positions become available through retirement or departure;
- Consolidate our research instrumentation into shared facilities with cost-recovery mechanisms established that provide funds for technical support;
- Provide significant funds through Research Incentive Fund return to faculty for preliminary data collection, travel, workshops, etc. in anticipation of proposal writing.

We will continue our tradition of bridge-building across campus to create or respond to relevant initiatives that bring new resources into the department.

Finally, we will devise a more intelligent approach to fundraising, especially in our interactions with industry but with alumni and other donors as well. At present our industry fundraising is distributed and uncoordinated, successful but sometimes at cross-purposes, and thus perhaps not fully effective. We will work with the Office of Corporate and Foundation Relations and the College's Development and Alumni Relations offices to develop a clear understanding of the entry points into the various companies and agencies supporting our educational and research activities, and where and with whom our contacts (and alumni) reside in the various companies and government offices.