

# 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 approach to Earth science education has also been at the vanguard, with a longstanding focus on engaging all students in the research enterprise and new approaches including immersive international experiences, an increased emphasis on authentic data, and public outreach around natural hazards.

Our goal for the next five years is to continue and expand this proud tradition by focusing on two key objectives: ensuring that we remain strong in fundamental areas of the geosciences in the face of key retirements, and establishing the Department as a center of excellence in the geosciences of the *Anthropocene*, the new geologic era in which humans are acting as a global, geologic force. 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 global water cycle and other components of 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 *sustainable 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 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, in 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 1990’s and 2000’s. 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. 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. Strategic hiring will solidify our core while establishing PSU as the leader in the geosciences of the *Anthropocene*. 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 governmental laboratories 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.

## **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) and potential renovation of the basement of Deike that affect Geosciences directly and indirectly; and
- 9) initiation of a new capital campaign at Penn State.

External factors include:

- 1) recognition of humans as a geological force;
- 2) continued growth in online education;
- 3) exponential growth in Earth observations at all scales (big data needs);
- 4) increased emphasis on relevance to society of the research the government funds;
- 5) a national focus on water, energy, and natural resource needs that is likely to be reflected in University initiatives, including a response to the PSU Water Task Force;
- 6) very low national success rates 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, as reflected in our #1 ranking in geology, #2 in geochemistry, and #6 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 and give examples of research areas that could fulfill those objectives.

### **Strategic Priority 1: Establish PSU as a global leader in Geoscience of the Anthropocene**

#### *Action Items*

- A broad and strategic hire in human-induced changes to the global water cycle and other Earth systems that 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
  - 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, wastewater injection and energy production are exposing fundamental questions about fluid flow and rock-water interaction in Earth's subsurface.
  - 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 Anthropocene timescales: studies of landscape or ice-sheet response to human forces, induced seismicity and volcanism, hydrate destabilization, etc.; or

- Observing Earth at scales from the microscopic to the global using modern instrumentation, satellites, and the mining of big datasets.
- A broad and strategic hire that builds 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 Priority 2: Strengthen links with industry and government**

### *Action Items*

- Initiate tenure-track hires in industry-related disciplines linked to INGAr
  - Sedimentary Geology
  - Reflection Seismology
  - Petrophysics
- Secure funding for laboratory enhancements in support of INGAr and other industry-oriented research programs.
- With the help of the Departmental Alumni Advisory Board, develop a "Strategy for Engaging Industry"
- Develop closer collaborations with the United States Geological Survey through
  - Collaboration on issues related to water;
  - 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.
- Develop stronger ties with other national laboratories through collaborative research and graduate internships.
- Improve management of software donation, installation, license management, and training.
- Improve communication about student internship and research opportunities at national labs.

### **Strategic Priority 3: Fill key positions in the geosciences of the solid Earth**

#### *Action Items*

- Strategic hires could include diverse candidates working in the following fields, as examples, that connect Earth surface to its interior and build collaborative ties with existing faculty:
  - Crustal genesis: One thrust that would unite many subprograms is the origin of continental and oceanic crust.
  - Global Seismology: A big-data, high-performance computing, EarthCube, cyberscience-oriented hire in this high-impact field would complement existing strengths and expected growth through INGAr in geophysics.
  - Basin analysis: 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: 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. Either of the first two positions listed above could be filled by a geoscientist with a planetary science research emphasis.

### **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 and computing support, including centralization of analytical facilities and establishment of cost-recovery mechanisms.

## **Strategic Priority 5: Strengthen partnerships and leverage transdisciplinary opportunities within the College and across the University**

- Continue working with PSIEE, EESI and the Water Task Force to craft a University-wide Water Initiative.
- Fully engage with EME/INGaR through 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 INGaR-related facility enhancements..
- Develop a sustainable model for technical and computing support.
- Produce the “Strategy for Engaging Industry”

#### ***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 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 education.

### **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.
- Explore the creation of a position for a 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 courses that exploit the state-of-the-art infrastructure provided by the *Pulse of the Earth*.
- Build endowment and gift support, particularly for undergraduate field trips.
- 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.
- Strengthen our alumni network through better tracking of graduates through their evolving careers, holding regional gatherings in major metropolitan hubs, and utilizing social media to better advantage.
- Establish an annual career symposium for undergraduates to participate in panel discussions with alumni, discussing the plethora of careers available 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 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.
- Work with EMS-affiliated faculty members and DUS advisors at the Commonwealth Campuses to increase awareness of and preparation for Geoscience baccalaureate programs.

**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 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.

**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.
- Expand 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. 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. Training new K-12 teachers is one area of impact. We are poised to develop an Integrated Undergraduate/Graduate program with the departments of Astronomy and Astrophysics and Curriculum and Instruction whereby students can get a degree in Geosciences, Earth Sciences, or Planetary Sciences and then proceed to post-baccalaureate certification in Earth and Space Sciences through the College of Education. The significance of faculty involvement in this and other outreach efforts will increase in the near future as NSF is tightening accountability of *Broader Impacts*.

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.

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.

### **Strategic Priority 1: Expand local Earth Science outreach**

#### *Action item:*

- Better integrate and coordinate activities with the NSF-funded Earth and Space Science Partnership.
- Consider inviting other local school districts to participate in SRR.
- 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.

## **Accomplishing These Goals**

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

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 seed grants to faculty for preliminary data collection, travel, workshops, etc. in anticipation of proposal writing.

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 governmental offices and laboratories.

## **Assessing Success**

### **Strategic Performance Indicators**

We will gauge the success of our strategic initiatives using a variety of metrics. There is considerable expertise on campus to assist us in this task, and we will avail ourselves of it: Dutton e-Learning Institute, Schreyer Institute for Teaching Excellence, and the Office of Planning and Institutional Assessment. We will work with these groups and others, using existing databases such as EIS, SIMS, etc. to monitor trends in strategic performance indicators. For research and graduate education, these include research expenditures, number of publications and citation rate, stipend support for graduate students, success in faculty hiring initiatives, diversity of the faculty and graduate student populations, and the successful placement of students placed in academia, industry, government, and national laboratories. For undergraduate education, we will monitor student enrollments, average GPAs (outside of Geosciences) of our majors, average SRTEs of our faculty, minority enrollments, and endowment and gift funds (largely, but not exclusively benefitting undergraduate education).

We will immediately establish and maintain the data and graphs necessary to monitor trends in these performance indicators (including providing the historical perspective of the last several years of data where available). We will establish a scorecard, to be completed annually, that lists the measures, evaluates whether we are above, at, below, or far below our targets, based on numerical scores and target scores. And as necessary we will take corrective action.

Overall, we will consider this strategic planning exercise successful if we not only have achieved the goals we identified herein but also identified new initiatives not anticipated but discovered because our “antennas were up” as a consequence of developing and implementing this plan.

### **Learning Outcomes Assessment**

As the Geosciences Department develops new courses and novel ways of teaching them, we also recognize that we have a concomitant responsibility to assess their effectiveness. Our department has been at the forefront in introducing innovative methods of delivering course content, such as online instruction and “flipped” classroom techniques, and we are committed to developing metrics to appraise them. The SRTEs have served as the traditional measure for educational success, but student surveys capture only a narrow window of the undergraduate and graduate learning spectrum.

In order to go beyond the students’ own perceptions of how well they have learned, we have developed additional devices to assess our pedagogical accomplishments. These have included: 1) Evaluation rubrics for the final and most complex mapping exercise in the summer field camp, in which students must synthesize and apply the concepts learned over three to four years of coursework;

2) A comprehensive, faculty-wide appraisal of student performance in the oral and written parts of the senior thesis, which is a capstone experience required of all Geosciences and Geobiology BS students; 3) A final examination in Earth Sciences fluency administered to all graduating seniors.

The ACUE Assessment Coordinating Committee has rated our department's past analysis of its assessment data as exemplary, and for the future we will continue to develop innovative measures of student success. This effort will be aided by our participation in InTeGrate, a 5-year, NSF-sponsored STEP center that promotes the development of pre- and post-testing assessments as integral to the creation of new STEM courses. In addition, our department is now partnering with the American Geosciences Institute in its nation-wide exit surveys of seniors in the Earth Sciences to extract the first complete dataset of post-graduate career paths.