Earth Science at Rice University

Message from the chair

The Earth science department at Rice is a community of professors, adjuncts, students, post-doctorates, staff and friends - over one hundred of us - whose primary mission is to educate, communicate and conduct fundamental research on problems of Earth, energy and environment. Our community extends outward to hundreds of alumni, who have gone on to pursue diverse careers, including in academia, the energy industry, environmental consulting, medicine and health, politics, community organizing, teaching, and more. As Earth scientists, we excel in making observations and interpreting complex, open-ended systems. We see the world, because nature is beautifully complex, as an interconnected system, with moving parts that feed and respond to one another. From understanding how interactions between the deep Earth and surface modulate climate to investigating how erosion, soil formation and life shape the surface of the Earth and our immediate environment, we acquire by necessity a unique mind-set through our training and experiences, giving us key advantages in tackling some of the most complex, uncertain and controversial problems facing science and society.

With our flavor of Earth science, we emphasize understanding at a fundamental level. We teach our students to approach all geologic and environmental problems from a process-oriented approach and to consider Earth as a system. We do so by coupling field observations and laboratory analyses with quantitative modeling and experimentation. In Earth Science, we draw on physics, chemistry, math and biology in our investigations of our planet and environment. We have some of the best, award-winning faculty in the world, but what really sets our department apart from others is our ability to work together and generate interdisciplinary projects that could not otherwise be accomplished by any single faculty alone. Our department has become one of the country's most successful leaders in Earth science innovation. We as Earth scientists, especially with the Rice approach, are uniquely poised to tackle the most complex problems facing our society today. One such problem is developing aggressive energy portfolios and economies while at the same time developing programs for sustainable environment and health. There are no easy solutions. Any solution will require the unique skill of looking at the problem as a system of interconnected parts, a skill that is uniquely Rice Earth science.

A diverse research portfolio

We have expertise in deep and surface Earth processes. In deep Earth, we are investigating deep volatile cycling, core formation, the structure and composition of the crust and mantle, mountain building, volcanism, plate motions, basin formation, crust and lithosphere deformation, mantle convection and earthquake physics. We are also growing our expertise in planetary science, including the petrology and geochemistry of meteorites, geodynamics of planetary interiors, and processes of planetary accretion. In the surface Earth, we are tackling problems related to paleoclimate, atmospheric chemistry and dynamics, elemental cycling, weathering, upland and fluvial geomorphology, sedimentology, biogeochemistry, geobiology, stratigraphy, paleo sea-level reconstruction, tempestology, and cryosphere studies.

Our research has appeared in high profile journals like Nature, Science and the Proceedings of the National Academy of Sciences. You may have recently heard about new constraints on the timing of retreat of the Antarctic ice sheet, a new theory on the evolution of atmospheric oxygen, new clumped isotope tracers of biochemical processes, a new understanding of the origin of copper porphyries, how the Caribbean margin evolved, what happens to the Pacific plate after it subducts beneath Japan, the role of carbon in controlling melting in the upper mantle, or how we need to revise our views on the sand budgets in rivers. These came from our faculty and our students.

We are a fundamentally interdisciplinary department, with a number of us leading large, collaborative programs that bring together several scientists here in our department as well as scientists from other departments or other universities. Ongoing multiple principle investigator programs include National Science Foundation-funded projects to investigate carbon and oxygen cycling between the deep Earth and surface environment, sediment transport in the Yellow River in China, lithospheric and crustal structure in slow spreading centers off of Spain, lithospheric stability beneath the western Mediterranean, lithospheric structure in the Columbian Andes, lithospheric structure of east Asia, and the history of ice sheet advance and retreat in Antarctica. Our faculty also lead a million dollar Keck Foundation project to develop biosensors for interrogating biogeochemical processes in soils and sediments. We also play key roles in leading International Ocean Drilling Program expeditions, with the latest one headed to the southwest Pacific to investigate the evolution of subduction zones at a continental margin. We are arguably one of the most interactive and holistic departments in the country.

We have an applied dimension to our research portfolio as well. Some of us are in the business of developing algorithms for handling geophysical data while others develop methods for quantifying the physical, chemical and mineralogical properties of soils and sediments, all of which have implications for the energy and environmental industries. Many of our research projects are also focused on natural resources. These include characterizing and understanding the origin of hydrocarbon source rocks and formation, ore formation, water resources, and sand transport. We have ongoing research in natural hazards, such as understanding the physics of earthquakes and volcanic eruptions, reconstructing the spatial and temporal distribution of hurricanes along the Gulf Coast, and understanding how landslides form. Finally, we have active research on environmental problems, such as delta formation and evolution, river morphology evolution, the chemistry of soils, carbon sequestration in soils, atmospheric pollution and heavy metals in urban waters.

Our research has taken us to all corners of every continent, while others develop numerical models and techniques to simulate geologic processes or develop cutting edge experimental and analytical facilities to push the limits in terms of precision or resolution, allowing us to “see” things we were not capable of a decade ago.

Educating the next generation

We pride ourselves in our teaching. Our classes are small and we try to teach our students about the complex world around us, while at the same time, teaching students how to simplify a complex problem into the key components. We do this by emphasizing the big picture, through field trips across the country, and at the same time, teaching basic technical skills through hands-on learning of computer modeling and laboratory analyses and experimentation. Many of our courses emphasize writing, communication and independent thinking through term papers and oral presentations. As students complete their core classes, they participate in research seminars, where all the topics of discussion are open-ended. Some courses bring together several faculty with different views to tackle a common problem, giving students experience in interdisciplinary research and how science operates. Many of our students participate in undergraduate research, giving them direct access to laboratories. In some cases, these undergraduate research projects have led to first-authored papers. Each year, we send many of our students on to graduate school, some of them winning the much coveted National Science Foundation Graduate Fellowship. Regardless of where our students go in the future, the hard and soft skills they learn here prepare them to be leaders.

Equipping our students for success

Our success in education and research is in part linked to the health of our facilities. Over the last decade, we have increased our analytical facilities through support from the National Science Foundation, Packard Foundation funds, and endowment funds. On the third floor, we now have gas source mass spectrometers, a laser ablation facility coupled to an inductively coupled plasma mass spectrometer, a fourier-transform infrared microscope, a field emission electron microprobe, and an X-ray fluorescence imager. We have the ability to do U/Pb geochronology, traditional stable isotopes, clumped isotopes, and trace and major elements, and speciation in a variety of materials. We also have the ability for elemental mapping at a variety of lengthscales ranging from the centimeter to nanometer scale. On the second and third floors, we have a variety of apparatus for simulating extreme conditions on Earth and other planets, studying the rheology and dynamics of fluids, and characterizing the physical properties of soils. These instruments are utilized by both graduate and undergraduate students.

Where are we going?

We cannot rest on our laurels. Earth science is continually changing, so we must continually adapt and improve to position ourselves for continued success in an unpredictable environment. It is the long vision that matters. Here are some of the initiatives we are currently developing or hoping to embark on in the next year to give you an idea of where we are headed.

A growing and evolving faculty – This past year, we were sad to see Brandon Dugan leave, but we are happy that he is starting new adventures at the Colorado School of Mines. In the meantime, we conducted a successful open search. We received over 300 applications, with our top two applicants accepting our offers. Melodie French will join us in January 2017 from the University of Maryland, where she is an NSF post-doctoral fellow. She is a rock physicist working on material and transport properties of fault-related rocks and sediments. She will enhance our strengths in Earth structure and deformation and our ties to the energy and environmental industries. Mark Torres will join us in September 2017 from Caltech, where he is currently a post-doctoral fellow, working on chemical weathering, geomorphology, and surface cycling of sulfur and carbon.

In addition to Melodie and Mark, we will be conducting another search in the next couple years. We have a number of fields that interest us, including but not limited to geobiology, paleoclimate, mineral physics, environmental science earth history, stratigraphy, cryosphere studies, planetary sciences, tectonics, geophysics, and water resources. In the end, we just want open and creative minds around us.

Bringing industry and academia together – Our previous chair Richard Gordon along with distinguished alumni Ken Abdulah and Ed Biegert established a Rice industry-academia workshop called IRESS (Industry-Rice Earth Science Symposia) to help foster better ties between Rice and industry. Building on the successes of the last three symposia, we have decided to expand the scope and vision of the symposia. Our primary goal is for Rice Earth Science to serve as a think tank, which brings the best ideas from academia and industry, from around the world, to solve challenging scientific problems. Our goal is to serve as the catalyst for cross-disciplinary interactions and eventual collaboration. IRESS 2017 (earthscience.rice.edu/iress), Feb 23-24, will focus on a theme entitled "Interdisciplinary perspectives on the building of a passive margin", and we have already built a list of distinguished speakers, covering topics from continental rifting to new concepts in tectonostratigraphy to sedimentology on Mars. This event will redefine our understanding of passive margin development and is one event you definitely do not want to miss.

Generating an integrative department – One of our goals is to build a more cohesive department. With over one hundred current members in the department, many of whom travel around the world for field work or conferences, it is challenging to have department-wide meetings and activities that keep everyone informed of each other's activities. This becomes even more challenging if we add to this our desire to interface with our alumni and friends. As a first step towards these goals, we implemented last summer a new webpage platform (earthscience.rice.edu) whose content is controlled by all members of the department and no longer requires a webmaster. This webpage is our portal for departmental activities, recent publications, news items, and blogs from our students, updating in real time. In the coming years, we hope to bring the webpage to our alumni and friends, giving them the opportunity to share their own stories and become more engaged with our department.

Experiential learning – Earth science classes are unique in that we consistently work on open-ended problems and provide hands-on experience by sending our students to the field or into laboratories. We have been successful at this, but there is still room to grow. Provided we have enough funds, we hope to expand the field components of several classes. We have developed a new senior honor's thesis program and we are looking to set up internal research funds for such students to execute their ideas. With adjuncts and our faculty, we will be adapting and developing new courses that emphasize working with disparate datasets, seeing Earth as a system, and cultivating teamwork, skills that are useful in academia and in industry. Finally, we are in the midst of developing writing courses to help our students communicate more effectively.

Science communication – In the coming year, we will be hiring a dedicated science writer. The science writer will help promote our department by writing about Earth science research in our department and beyond in layperson terms. We are looking for creative, highly motivated individuals whose mission is to bring science and the process of doing science to the broader community. If you are interested or know of anyone that fits this bill, contact us!

Enhancing our analytical and computational facilities – The strength of a research institution depends on generating great ideas and being able to execute those ideas. Analytical and computational facilities are critical in this sense as they allow us to generate data. Through the writing of proposals to NSF or NASA, we hope to acquire major instrumentation infrastructure that positions our department as a facility where investigators from industry and academia visit. These include quantitative isotopic, elemental and mineralogic imaging facilities, such as secondary ion mass spectrometry and hyperspectral core scanners. Of high priority will be to establish the necessary technical support to operate and maintain our facilities in prime condition for the future.

Career development – Earth scientists in theory have many career options. We will continue to cultivate and enhance our ties with the energy industry. As part of these efforts, we will hold workshops where alums from industry return to share their career paths with our students. We are also interested in getting the perspective of alums who chose to start their own businesses or took career paths not directly related to Earth sciences: medicine, government, art, writing, etc. We are also committed to supporting the careers and initiatives of women in Earth sciences, which has traditionally been a male-dominated field.

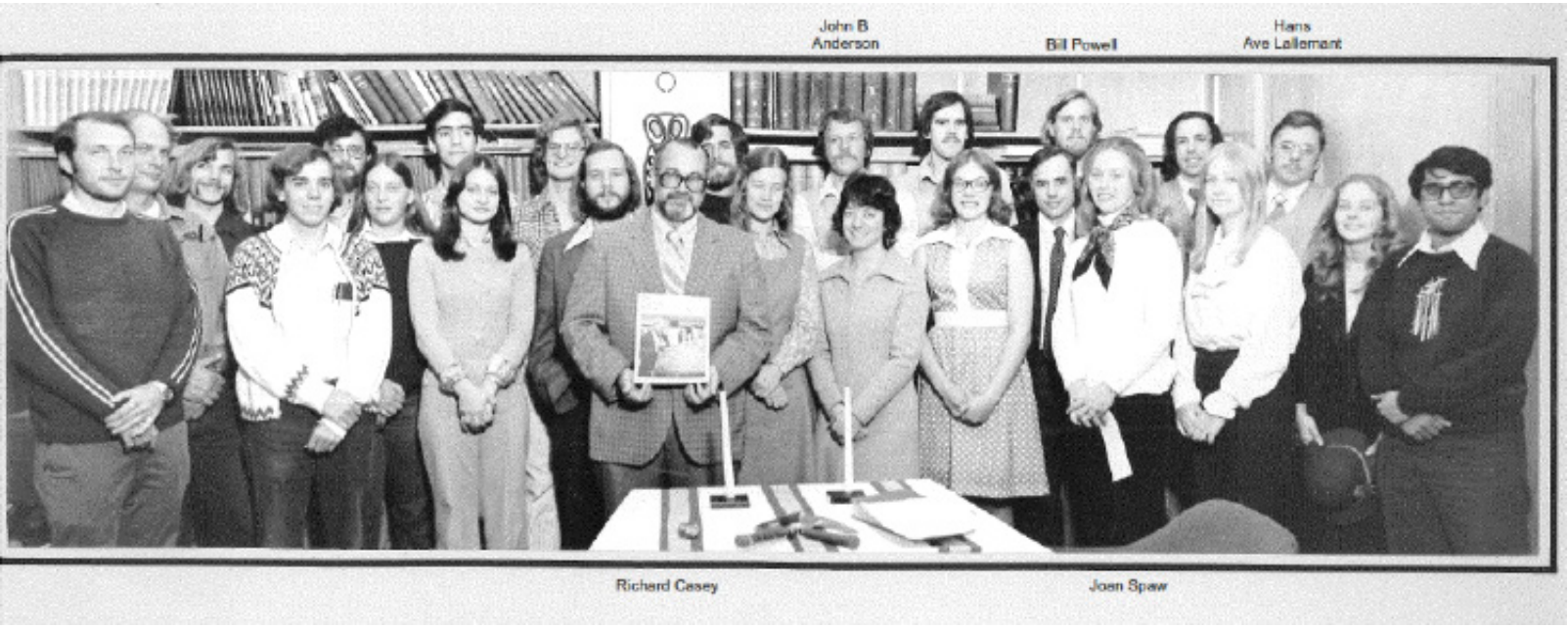
Alumni activities – We will be embarking on a number of Department-sponsored activities over the course of this year, ranging from one day birdwatching trips with Pete Vail to weekend trips led by Andre Droxler out to the Guadalupe Mountains or Texas Hill Country. We will also be experimenting with new alumni trips focused on geology and natural history.

You are part of our community

As you can see, we have set many lofty goals to keep us ahead of the pack. We aim to build an energy-academia think tank, establish new courses for experiential learning, enhance our facilities, expand the size of our departmental faculty and train the next generation of critical thinkers. And we want you to be involved. This takes a variety of forms. You can give to our research, innovation and education funds, existing endowments, or you can establish your own endowment and directly help shape and guide the future of our department. You can also volunteer your time by sharing your experiences with our students and help them navigate their own career paths. Or you can just join us on any of our departmental activities and share with us your experiences and ideas. We are always open to learning new things! Now is the time to join us and help Earth sciences at Rice rise to its full potential.

Sincerely yours

Cin-Ty Lee, September 2016



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