Stanford EARTH

SCHOOL OF EARTH, ENERGY & ENVIRONMENTAL SCIENCES

REPORT TO DONORS

Photo by Stacy Geiken.

Message from the Dean

Dear Friends,

It is my great pleasure to present this special Report to Donors about the research and teaching of the Stanford School of Earth, Energy & Environmental Sciences during the 2014-15 academic year.

In our first-ever annual Report to Donors we highlight some of the cutting-edge work coming out of our departments and programs, special initiatives funded through the Stanford Earth Fund, and key efforts to educate the next generation. We also illuminate our plans to accelerate our impact in four critical challenge areas.

Our people, our programs, and the planet we share are at a turning point. Building on the successes of our faculty, students, and alumni over many years, we are embarking on an ambitious initiative that will allow us to accelerate research, education, and problem solving aimed at meeting the resource needs of future generations while sustaining our environment.

As the scope and urgency of Earth-related challenges grow, so does our mandate. I hope you will join with us in this effort to realize our fullest potential for teaching and learning, discovery and problem solving, and securing the wellbeing of our own and future generations.

I am so grateful for what you have already helped us to accomplish. What we do today will determine the world in which our children and grandchildren live. Thank you for your support and for your continuing interest in our work.

Pamela A. Matson
Chester Naramore Dean
Richard and Rhoda Goldman Professor in Environmental Studies

Discover. Educate. Influence.

Focus

Departments, Programs, and Centers

On the scientific forefront for decades, our faculty have been among the first to identify complex planetary processes and problems and to engage in interdisciplinary approaches to solutions. From this position of leadership, we see that we can—and must—do more to addresses the Earth resource and environmental challenges with the highest stakes for human wellbeing.

The departments, programs, and centers in which our faculty and students work form the foundations of the school and the positions of strength from which we address those high-stakes challenges.

DEPARTMENTS

The **Department of Earth System Science** (ESS, formerly Environmental Earth System Science) is co-led by Scott Fendorf, the Terry Huffington Professor, and Eric Lambin, the George and Setsuko Ishiyama Provostial Professor. ESS works to understand, predict, and respond to human-caused environmental change at local to global scales. Faculty and students investigate the complexity of the global system, including the interactions, synergies, and feedbacks that link oceans, atmosphere, land surfaces, and freshwater systems. Studying the planet as a singular, highly interactive system, faculty and students evaluate the interactions among chemical, biological, and physical processes across Earth's surface. A targeted list of focus areas for the year include working to fill intellectual gaps in the natural science approaches to Earth system science, venturing further into the emerging areas represented by human-environment interactions, and enhancing the core curriculum for graduate students. There are 51 students engaged with faculty around these issues.

Led by Tony Kovscek, the Keleen and Carlton Beal Professor in Petroleum Engineering, the **Department of Energy Resources Engineering** (ERE) continues its work on the design of processes for energy production and transformations, and the long-term storage of energy byproducts such as carbon dioxide. Work in other key areas includes research on clean energy conversions, geothermal engineering, energy systems modeling and optimization, marine energy systems, large-scale solar, and other renewable energy resources. ERE continues its focus on research and teaching covering traditional petroleum engineering disciplines and frontier energy-related areas including clean energy conversions and carbon capture and storage, while maintaining its leading-edge research in geothermal reservoir

***Above**: Chris Field, the Melvin and Joan Lane Professor in Interdisciplinary Environmental Studies, and professor of Earth system science, was, from 2008 to 2015, co-chair of Working Group II of the United Nation's Intergovernmental Panel on Climate Change (IPCC), which focused on both the socio-economic and natural effects of climate change and humanity's options for adapting to them. Photo by Patrick Freeman.*

engineering (ERE is home to one of the longest running technical meetings on renewable geothermal energy in the world, hosting its 40th Stanford Geothermal Workshop in 2015.) The department and the school celebrated the appointment this year of former dean Lynn Orr as Undersecretary for Science and Energy at the U.S. Department of Energy. There are 114 students engaged with faculty around these issues.

The **Department of Geological Sciences** (GS), led by Associate Professor Jon Payne,* continues its critical study of Earth materials and Earth processes, and how they have changed over the planet's 4.56 billion-year history. Research in GS addresses the chemical and physical properties of minerals and rocks (at pressures from the surface to the core), as well as soils, sediments, and water; the formation and evolution of Earth and other planets; the processes that deform Earth's crust and mantle and that shape Earth's surface; the stratigraphic, paleobiological, and geochemical records of Earth history including changes in climate, oceans, and atmosphere; present-day, historical, and long-term feedbacks between the geosphere and biosphere; and the origin and occurrence of our natural resources. A newly expanded focus on geobiology complements existing strength in sedimentary geology, structural geology and tectonics, mineralogy, petrology, Earth surface processes, and field geology. Another new program addresses the technical and scientific basis for the disposal of high-level nuclear waste. There are 70 students engaged with faculty around these issues.

**Payne succeeded Gordon Brown, the Dorrell William Kirby Professor, as department chair in September 2015.*

The **Department of Geophysics** (GP), led by Professor Howard Zebker, integrates geology, mathematics, and physics, using laboratory experiments, computational and theoretical modeling, remote imaging, and direct observation in order to understand how the Earth works. Research topics include measuring crustal deformation, high-resolution imaging, studies on the feasibility of carbon sequestration, earthquake source studies and hazard analysis, and radar remote sensing of the Earth. Study of the cryosphere is a new direction for the department and the school, as is a program under development to study induced seismicity in the context of the growing role of shale gas. A new consortium—the Stanford Center for Induced and Triggered Seismicity—has 21 industry sponsors supporting research addressing the hazard and potential of the natural gas revolution enabled by horizontal drilling and hydraulic fracturing. There are 86 students engaged with faculty around these issues.

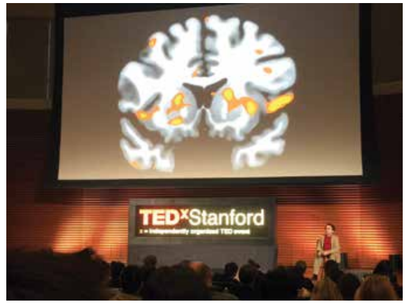
***Top, left**: Claire Duncan Trombadore (B.S '85 Geo) and her husband, Tom (AB '83 Hum Bio), visit with Richard Nevle, deputy director of the Earth Systems Program, during Reunion Homecoming. Photo by Stacy Geiken. **Top, right**: Roland Horne, the Thomas Davies Barrow Professor and professor of energy resources engineering, talks with multimedia producer Miles Traer in the video, Geothermal Research Unlocks the Clean Energy Beneath Your Feet, which can be viewed on the school's YouTube channel. Professor Horne is also director of the Geothermal Program Affiliates. **Bottom, right**: George L. Harrington Professor and professor of geophysics Rosemary Knight at Moss Landing, California, with videographer Kurt Hickman (Stanford News Service) filming a video about her work on saltwater intrusion into aquifers along the Monterey Coast. Photo by Stacy Geiken.*

***Right**: Lucas Oliver Oswald (center), coterminal master's degree student in the Earth Systems Program, is studying agriculture and science communication. Lucas is interested in coffee and its economic potential for small farmers in the developing world; his work focuses on simplifying the coffee supply chain to bring more value to producers. Families like the one he visited in Guatemala (shown at right) are dependent on income from coffee. Photo by Lucas Oliver Oswald.*

Alex Blanchette, a PhD candidate working in Professor Simon Klemperer's crustal geophysics group, is the **2015-16 Stanford-USGS Fellow**. The Stanford-USGS Fellowship was established 30 years ago with the support of alumni, friends, and faculty to recognize and facilitate the research collaboration between Stanford and the U.S. Geological Survey. Recipients of the fellowship embody that ongoing collaboration: Alex is working with Walter Mooney of the U.S. Geological Survey on a project to evaluate and mitigate volcano and seismic hazards in Saudi Arabia.

PROGRAMS

Led by Kevin Arrigo, the Victoria and Roger Sant Director and Donald and Donald M. Steel Professor, the **Earth Systems Program** (ESys) is in its 23rd year as Stanford's interdisciplinary, undergraduate, environmental science major. The program continues to teach and encourage independent investigations around complex environmental problems caused by human activities in interaction with natural changes in the Earth system. Students use natural and social sciences along with policy analysis to study some of the most pressing environmental problems we face; the the program offers courses in the fundamentals of biology, calculus, chemistry, geology and physics, as well and economics, policy, and statistics, and interdisciplinary core courses focused on social and environmental systems. A new co-terminal MA degree in environmental science communication will train the next generation of articulate environmental communicators, and a new sustainable food and agriculture track complements the popular land systems track. Other tracks in the program are anthrosphere; biosphere; oceans; and energy, science, and technology. There are 139 students engaged with faculty around these issues.



***Above**: Nik Sawe, PhD candidate in E-IPER, was a speaker at 2015 TEDx Stanford. His work adapts neuroeconomics—the study of financial decision-making in the brain—to environmental applications: from consumer responses toward eco-labeling, to how we value natural resources, and what motivates us to protect threatened ecosystems. Watch Nik's talk at https://tedx.stanford.edu/2015/nik-sawe.*

The **Emmett Interdisciplinary Program in Environment and Resources** (E-IPER) continues to train scholars and leaders to understand the natural and human environment and to develop novel paths to sustainability under the leadership of Peter Vitousek, the Skyes Family Director and Clifford G. Morrison Professor in Population and Resource Studies. The PhD program continues to be highly competitive, with more than 115 applications for 8 places. Just over half of PhD graduates are in academic positions; others are employed in government, NGOs, and private companies. E-IPER's MS program offers joint degrees for business, law, and medical students. Interest areas include clean tech and energy, and land use and agriculture. Key areas of focus for the year included pursuing a targeted communications strategy to inform and recruit a more diverse applicant pool, and efforts to more actively engage E-IPER's more than 120 alumni. E-IPER's 39 PhD and 44 MS students have an opportunity to interact with 115 affiliated faculty from all seven schools at Stanford.

Student numbers are approximate, given some fluctuation throughout the year.

CENTERS

The **Stanford Center for Computational Earth and Environmental Sciences** (CEES) integrates Earth science and computer science to build capacity in computational methods for the Earth and environmental sciences, and to enable new growth in areas where computational activities already exist. The three units of CEES—research, high-performance technical computing, and education—work together to increase the connections between applied mathematics and the Earth sciences. Combining a strong focus on scientific applications with state-of-the-art hardware and computational methods, CEES is pushing forward the frontiers of computational geoscience and engaging computer scientists and architects to design software and hardware better suited for Earth and environmental science problems. The **Computational Geoscience Program** (CompGeo) offers a master's degree to provide students the skills and knowledge required to develop efficient and robust numerical solutions to Earth science problems using high-performance computing. CompGeo is a joint enterprise between the School of Earth, Energy & Environmental Sciences and the Institute of Computational and Mathematical Engineering (ICME). Professors Biondo Biondi and Hamdi Tchelepi co-direct CEES; Associate Professor and Senior Associate Dean for Educational Innovations Margot Gerritsen directs ICME.




Accelerating Our Impact

Today, more than 1 billion people have inadequate access to energy, water, and food.

As the world population continues to grow to over 9 billion this century, demand for these resources will increase. These needs must be met in spite of obstacles posed by climate change—including extreme weather events, sea level rise, and water limitations—and in ways that sustain our planet's environment and resources for future generations.

The Stanford School of Earth, Energy & Environmental Sciences is in a unique position to make an essential contribution as the global community rises to this challenge. On the scientific forefront of these issues for decades, our faculty have been among the first to identify complex planetary processes and problems and to engage in interdisciplinary approaches to solutions. From this position of leadership, we see that we can—and must—do more to address the Earth resource and environmental challenges with the highest stakes for human wellbeing.

To that end, we are engaged in an ambitious, $110M initiative that will allow us to accelerate research, education, and problem solving aimed at meeting the resource needs of people while maintaining a safe and sustainable planet.

The initiative will drive educational innovations and leverage our strengths to advance research in four areas of particular concern to humanity: *Securing the Energy Future, Climate Solutions, Reducing Disaster Risks,* and *Food and Water Security*. Its success will depend on our ability to align many of the strengths of our faculty and students around these challenges. It will also require investments in new faculty to complement our existing expertise, new educational programs to train students for leadership in an increasingly complex world, and new infrastructure—most significantly, a new 21st-century building for transformative learning and research.

SECURING THE ENERGY FUTURE

How can we develop new approaches and technologies to allow a future in which energy is abundant, efficient, and produced in a sustainable and responsible way?

Today, fossil fuels—coal, oil, and gas—provide most of the world's power; they are the critical ingredients for almost everything we do. New advances in gas and oil production offer the promise that the rapidly growing demand for energy in the coming decades can be met while slowing and replacing the consumption of coal, the fossil fuel resource with the greatest negative environmental and health impacts.

Our scientists and engineers, leaders of Stanford's cross-school efforts on energy, are world-renowned for their research and discovery related to oil, gas, and geothermal energy as well as carbon capture and storage techniques. We are also known for our methods and measures for reducing greenhouse gas emissions and water resource impacts. We stand out for our long-term concern with producing resources efficiently and with the minimum negative impact.

FACULTY LEADERS: **Sally Benson**, professor of energy resources engineering, co-director of the Precourt Institute for Energy, and director of the Global Climate and Energy Project; **Mark Zoback**, the Benjamin M. Page Professor and director of the Natural Gas Initiative

OPTIMIZING NATURAL GAS

Major advances in natural gas production have fundamentally changed the energy outlook in the United States, thrusting this resource into the global spotlight as a potential enabler of a low-carbon energy future.

"Natural gas can play a critically important role as a transition fuel."

The Natural Gas Initiative (NGI), launched in February 2015 by Stanford Earth and the Precourt Institute for Energy, engages faculty across the university to carry out research needed to ensure that natural gas is developed and used in ways that are economically, environmentally, and socially optimal. Ten diverse research projects are currently being carried out by Stanford faculty associated with the Natural Gas Initiative.

"If developed in an environmentally sustainable manner, globally abundant natural gas resources will enable large-scale fuel switching for electrical power generation," says geophysics professor Mark Zoback, director of NGI. "This will dramatically reduce greenhouse gas emissions and air pollution in many countries, while enhancing energy security and economic growth. In this context, natural gas can play a critically important role as a transition fuel on the path to a decarbonized energy future."

Initiative

CLIMATE SOLUTIONS

Our climate is already changing. Stanford Earth faculty are working to evaluate causes and consequences and to develop new approaches for both limiting the extent of change and increasing the resilience of communities.

Human energy and land use are undeniably altering Earth's climate, most prominently through emissions of greenhouse gases and particulates, and through alteration of the land surface. Climate change, in turn, is affecting other Earth processes, making the critical 21st-century challenges of providing food, water, and energy to a growing human population much more difficult.

Stanford Earth faculty are renowned for their research and role in the public dialogue about climate change. We work across disciplines—and at the interface of atmosphere, ocean, land, and ice systems—to characterize climate change as well as to develop potential responses and outcomes that matter to people.

FACULTY LEADERS: **Noah Diffenbaugh**, associate professor of Earth system science; **Chris Field**, the Melvin and Joan Lane Professor in Interdisciplinary Environmental Studies and professor of Earth system science

GREATER CLARITY FOR CLIMATE DATA

Climate scientist Noah Diffenbaugh and statistician Bala Rajaratnam, both professors of Earth system science, teamed up to utilize cutting-edge statistical approaches to improve the reliability of scientific conclusions about global warming and climate change.

"These aren't projections of 100 years in the future. Our research suggests that global warming is playing a role right now."

Using appropriate statistical methods and developing new tools well suited to the geosciences, they showed that global warming is very likely increasing the probability of extreme weather events such as intense monsoon rains in India and droughts in California. In September 2015, they revealed evidence that an apparent pause, or "hiatus," in the rate of global warming was an artifact of the older statistical methods.

"In using these advanced statistical techniques to combine climate observations with model simulations, we've been able to better understand global warming, climate change, and individual extreme events," says Diffenbaugh. "These aren't projections of 100 years in the future. These are events that are more extreme than any in the observed record, and our research suggests that global warming is playing a role right now."

REDUCING DISASTER RISKS

Thousands of lives and billions of dollars have been lost in recent natural disasters such as the 2010 Haiti and 2015 Nepal earthquakes and the 2011 Tōhoku earthquake and tsunami. Geohazards have shaped and reshaped the planet for millennia. Now climate change is adding to the threats, even as urban centers are expanding and more people are living in vulnerable locations.

How can we use new Earth- and satellite-based sensors and advances in computation to provide insights into natural hazards and illuminate potential approaches to protecting vulnerable populations?

Stanford Earth is viewed around the world as one of the foremost centers for natural hazards science. We are recognized for our long history of engagement as well as our range of cross-disciplinary expertise and the breadth of the hazards on which we focus. We seek to understand these Earth processes—what causes them, how to predict where and when they will happen—but we also seek to reduce the risks to human wellbeing, especially in increasingly populated and vulnerable cities worldwide.

FACULTY LEADERS: **Greg Beroza**, the Wayne Loel Professor; **Jenny Suckale**, assistant professor of geophysics

ARE ECOSYSTEMS A TSUNAMI DEFENSE?

Conventional wisdom holds that a natural buffer of vegetation can help protect coastal communities from some of the damage wrought by tsunamis, hurricanes, and extreme storm surges.

Communities around the world are planting vegetation along coastlines and counting on it for protection.

In an attempt to address these risks, many of which have been exacerbated by climate change, communities around the world are planting vegetation along coastlines and counting on it for protection. Whether and under what conditions this strategy works, however, has not been established.

An interdisciplinary group of Stanford scientists has launched an effort to learn more. Led by Jenny Suckale, assistant professor of geophysics, and involving faculty from across the university, this approach will combine ecosystem services analysis with highly computational biophysical models of wave dynamics, fluid flow, and more to provide knowledge for informed decision making.

POWER = WATER = FOOD IN SUB-SAHARAN AFRICA

A Stanford team is demonstrating that an energy-related innovation—in this case, solar-powered drip irrigation technology—can improve the nutritional status of entire regions.

"The gains in nutrition and income impact families, villages, and the entire market area."

A considerable portion of sub-Saharan Africa's rural population is considered "food insecure," surviving on less than $1 per person per day and without reliable access to plentiful, nutritious food. In many farming villages in Benin, the growing season is very short—only three to six months of rainfall. Until now, unforgiving topography and lack of access to reliable, affordable energy has made irrigation to extend the growing season impractical.

The team, led by Professor Roz Naylor, found that villages receiving cost-effective solar irrigation systems are able to increase their production of crops such as tomatoes, okra, peppers, eggplants, and carrots, which are high not only in nutrition, but also in market value. The benefits of irrigation are thus shared more widely. "The gains in nutrition and income impact families, villages, and the entire market area," says Naylor.

FOOD AND WATER SECURITY

How can we feed and provide adequate access to clean water for a growing population in the context of climate change–related uncertainties?

The challenge of feeding a population that is expected to grow in both size and consumption in the coming decades looms large. The availability of water—largely used for food production—is likewise an enormous challenge, made more difficult by the droughts and declining soil moisture associated with climate change.

Our faculty includes biophysical scientists and resource economists who study food resources, food security, and agricultural sustainability as well as scientists who study, monitor, and evaluate changes in groundwater and land systems. Our scientific leadership and deep investment at the intersection of these issues sets Stanford Earth apart from other schools and universities that simply study agriculture, food policy, water, or climate change.

FACULTY LEADERS: **Rosemary Knight**, the George L. Harrington Professor; **Rosamond Naylor**, the William Wrigley Professor; and director of the Center on Food Security and the Environment

Alumni, Friends, and Volunteer Engagement

Our school and the university value alumni involvement. Your knowledge and expertise are tremendous assets that can benefit the community. Whether you are a recent graduate looking to build upon connections made as a student, or have a long relationship with the school and are seeking new ways to continue your relationship, we have opportunities to stay connected and engaged.

The newly created **Alumni Council** met on campus for the first time in April 2015. Tasked with advising the dean on the school's alumni programs and services, members were recruited across decades and degree programs to serve three-year terms. The council will contribute to the design of alumni activities and advise on how best to engage alumni in the life of the school. Jake Covault (BS '04, PhD '08 GES) is the current chair.

The School of Earth, Energy & Environmental Sciences **Advisory Board** is composed of members from industry, government, and other academic institutions. These volunteers meet annually to review the school's programs, goals, and academic opportunities and advise the dean. John Moragne (MS '83 AES, MBA '86) is the current chair.

The **Petroleum Investments Committee** is made up of volunteers who use their expertise in the energy industry to manage producing oil and gas royalties and other energy-related assets on behalf of the school. These volunteers find direct investment opportunities, recommend investment managers, and provide outright financial support.

Council, board, and comittee appointments are by invitation to ensure diversity by class, geography, and industry experience and to meet the needs of each group.

For other volunteer opportunities including Stanford Alumni Mentoring and Stanford Alumni Association groups and official clubs, visit the alumni page at earth.stanford.edu.

***Top, right**: Stanford School of Earth, Energy & Environmental Sciences Alumni Council. Left to right, front row: Osman Apaydin (MS '98 PE), Rajiv Lulla (MS '99 PE), Jason Dunford (BA '10 Hum Bio, MS '12 ESys), Dean Pamela Matson, and Lily Cheng (BS '06, MS '10, ESys). Left to right, middle and back rows: Alumni Relations Director Astrid Thompson, Tom Parsons (MS '90, PhD '92 GP), Hari Mix (BS '08 GES, PhD '14 EESS), Jake Covault, chair (BS '04, PhD '08 GES), Associate Dean Steve Graham (MS '74, PhD '76 Geo), Meredith Lopuch (BS '99 Bio, AB '01 Econ, MS '01 ESys), Catherine Chang (MBA '12, MS '13 E-IPER), and Erin Craig (BS '85 GP). **Bottom, right**: Advisory Board members on a field trip to the O'Donohue Family Stanford Educational Farm. Left to right: Ashok Belani (BS '88 PE); Patrick Archie, director, O'Donohue Family Stanford Educational Farm; Amy Balsom, senior associate dean, finance and administration; Dean Pamela Matson; Terry Huffington (BS '77 Geo); Brad Mills (BS '77, MS '79 Geo); Kai Anderson (BS '93 Geo, PhD '98 GES); Lisa Cirenza (BS '85 AES, AM '87 Int'l Policy Studies); James Illich (BS '84 PE); Rebecca Vogel, assistant vice president for development; Martha Roberts (BS '04, MS '06 ESys); and Chuck Katz (AB '69 Art).*

Terry Huffington at her farm in Steamboat Springs, Colorado. Photo by Tania Coffey.

Terry Huffington, '77

Geologist, farmer, advisor, philanthropist

When she left Stanford with her geology degree, Terry Huffington never imagined that she would someday call herself an organic farmer.

Huffington was always active outdoors—hiking, backpacking, rock climbing—but before she and her husband acquired the Colorado property that would become Elkstone Farm, she knew nothing about growing. "Soil was just dirt that was in the way of looking at the rocks below," she says. Elkstone Farm now grows organic produce for sale to the local market and Huffington is a veteran of the region's Community Agriculture Alliance Advisory Board.

A petroleum geologist with a Harvard MBA, Huffington led her own international oil and gas exploration company in Houston, Texas, until the late 1990s. For more than 20 years, she has been an active advocate and ambassador for Stanford Earth, advising three consecutive deans and serving on the school's advisory board. From 2013 to 2015, she co-chaired an alumni task force convened by Dean Pamela Matson to advise the school on strategic directions.

Huffington is a longtime leader in the Houston-area Stanford alumni community and has held a number of volunteer roles for the university, including as a member of The Stanford Challenge Steering Committee. For her volunteer efforts on behalf of the school and university, Huffington received the Stanford Associates Governor's Award in 2014.

Dean Matson says Huffington's professionalism, experience, and generosity have played an important role in strengthening Stanford and the school. "I have depended on her perspective because, in her own career, Terry has worked across the range of things we work on in the school—from oil and gas to agriculture and sustainability," she says.

Now well into her second career as an organic farmer, Huffington defines her mission in terms of stewardship, and she takes a similar approach to her philanthropy. In 2007, she endowed a professorship to help build the school's expertise in land use and management. Her foundational support for the school's highest priorities also includes a key gift to build the sustainable "green" barn at the O'Donohue Family Stanford Educational Farm.

Huffington feels strongly that, as a leading producer of objective scientific research, Stanford has a special role to play in guiding the conversation on Earth and its resources and environment.

"Stanford is in a position to help dispel myths and get the facts out," she says. "People won't always agree, but if you can get to the point where disagreements are based not on the facts, but on the interpretation, that is incredibly valuable."

Established by the School of Earth, Energy & Environmental Sciences, with the generous support of Laura and Kevin (MBA '87) O'Donohue, the O'Donohue Family Stanford Educational Farm sits on 6 acres near Stanford's historic Red Barn, and is the university's new hub for teaching, research, and demonstration of innovation in small-scale sustainable agriculture. Photo by Stacy Geiken.

Inspiring Future Generations

SUMMER UNDERGRADUATE RESEARCH IN GEOSCIENCE AND ENGINEERING (SURGE)

Each summer, a diverse group of students from universities and colleges across the country—and sometimes the world—comes to Stanford for eight weeks of intense research that helps prepare them for admission to graduate school. The program takes underrepresented minority scholars from any area of science, technology, engineering, and mathematics (STEM) who are interested in pursuing graduate study in the Earth sciences, and helps prepare them for admission into graduate schools in the Earth sciences. Since 2011, SURGE has hosted 73 scholars. Ninety-three percent of the program's alumni have gone on to graduate school or careers in the Earth sciences, including programs at MIT and Stanford. The 2015 SURGE cohort is pictured left. Photo by Jerry Wang.

HIGH SCHOOL INTERNSHIP PROGRAM

High school interns explore Earth's ancient past preserved in the fossil record with Stanford School of Earth, Energy & Environmental Sciences Director of Outreach Education, Jennifer Saltzman (far right). Each of the 32 high school students participating in last summer's program joined a lab to participate in an ongoing research project. Working closely with faculty, laboratory managers, and graduate students, they conducted hands-on and computational research across a wide variety of topics, including paleoclimate studies, agriculture, and microbiology. "Educating the next generation to understand how the Earth works is critical to society's future ability to manage the planet's environmental resources," said Saltzman. "We see high school students as future leaders in this area just like our undergraduate and graduate students." Photo by Joanne Ma.

Educate

TEACHER EDUCATION

High school teacher Monica Sircar (Everest Public High School, Redwood City) marvels at a simple demonstration of fluid dynamics and convection cells as part of the Understanding Global Change Workshop. Twenty-five teachers attended the July 2015 workshop, co-sponsored by the Stanford School of Earth, Energy & Environmental Sciences and the University of California Museum of Paleontology. They engaged with experts on the life systems of the planet, including the hydrosphere, climate, biosphere, nutrient cycles, and geosphere. Teachers came away from the workshop better able to answer their students' questions about the changing planet. "The workshop's goal is to deepen teachers' understanding of how to most effectively teach the Earth sciences," said Jennifer Saltzman, director of outreach education at Stanford Earth and co-organizer of the workshop.
Photo by Jennifer Saltzman.

GEOKIDS

Eight hundred first and second graders are introduced to the work of geologists every year through the Geokids Program. Student volunteers lead a morning of fun and engaging activities for students on field trips from local schools, who record their observations in field books during hands-on educational activities focusing on minerals, rocks, fossils, and soil.
Photo by Emilie Peck.

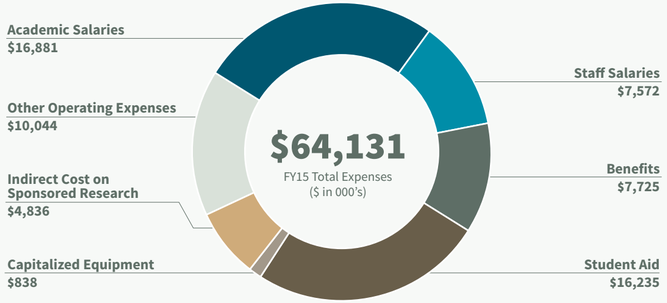
Financial Overview

Our ability to expand our efforts to educate the next generation of leaders and conduct pioneering research depends on many kinds of resources—including financial ones. Currently, annual gifts from our alumni and friends provide funding that we can use immediately to support school programs and the dean's top priorities. In addition, restricted endowment funds support fellowships and faculty in significant ways.

SUPPORT FOR THE SCHOOL'S ANNUAL EXPENSES COMES FROM THESE SOURCES:

- grants and contracts
- affiliate program and other income
- annual gifts
- university general funds
- endowment and investment income

SCHOOL EXPENSES FOR 2014-15 TOTALED JUST OVER $64M:



As stewards of the School of Earth, Energy & Environmental Sciences, and in order to accelerate our impact, we must make an investment to set in motion the school's next period of evolution. After a decade spent implementing our 2005 Strategic Plan, we are now ready to embark on an ambitious agenda to accelerate progress on some of the critical challenges of our age.

Discover

Investing in Our Future

To expand our impact, the School of Earth, Energy & Environmental Sciences is pursuing an ambitious $110M initiative that will allow us to accelerate research, education, and problem solving aimed at meeting the resource needs of people while maintaining a safe and sustainable planet. The initiative includes major investments in a new center and in new faculty to complement our existing expertise.

***Above**: Our new building will provide the headquarters and convening space the school now lacks. Concept rendering by EHDD.*

EARTH, ENERGY & ENVIRONMENTAL SCIENCES BUILDING

A new center for Earth, Energy & Environmental Sciences will serve as the hub for the school's activities and provide 21st-century facilities for transformative learning and research. The new center will help us align expertise around our critical challenge areas and provide flexible nexus areas to maximize interdisciplinary research and education. In addition to offices, laboratories, and collaborative workspaces, the center will provide state-of-the-art imaging and computational facilities for new data analytical approaches. A boost to our educational efforts at every level, the center will provide flexible technology-enabled teaching spaces far more conducive to innovative pedagogy than our current facilities.

NAMED ENDOWED PROFESSORSHIPS

Endowed professorships are the primary tool with which the dean can attract and retain world-class faculty and shape the school's identity. Each new endowed chair allows the dean to recruit a senior, tenured faculty member who has already demonstrated leadership and can immediately bring additional prestige and experience to the school's academic community.

NAMED ENDOWED FACULTY SCHOLARS

Faculty scholars are young and mid-career faculty members who can stretch the boundaries of their disciplines to define new research paradigms. Faculty scholar awards recognize the contributions and promise of these faculty, bringing them prestige and encouragement to build on the base upon which the school's reputation will rest in the coming decades.

For more information about these and other naming opportunities, please call 650.498.0613.

***Above**: From left: Astrid Thompson, director of alumni relations and annual giving; Dean Pamela Matson; Professor Rosemary Knight; Professor Lou Durlofsky; senior events planner Eryn Mills, at* Earth Matters Houston.

Stanford Earth Fund

Annual gifts to the Stanford Earth Fund from alumni and friends are essential to the success of our teaching programs and research enterprise. As a primary source of unrestricted dollars, these gifts provide the dean with the flexibility to answer the school's most pressing challenges and to pursue promising new opportunities for which no other funding exists. The Stanford Earth Fund has an immediate impact: Each year, gifts provide vital funding to people and programs in areas of critical growth. The school's departments and programs benefit from this support, which seeds the research efforts of our newest faculty, helps build and improve teaching and research facilities, and promotes student programs that create well-rounded graduates with global experience. The collective power of annual giving—to the Stanford Earth Fund or another designation of your choice—ensures funding for the school's highest priority: supporting our students and faculty.

The Stanford School of Earth, Energy & Environmental Sciences acknowledges and thanks all those who support our programs. To acknowledge our lead donors, we have established new donor recognition levels*:

Leadership Circle:	$1,000 - $4,999
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Thank you for your investment in our efforts every year—your gift, at any level, matters.

Bill Dickinson (1931-2015) greeting Jon Claerbout, the Cecil H. and Ida M. Green Professor of Geophysics, Emeritus, at the School of Earth, Energy & Environmental Sciences diploma ceremony on June 14, 2015, when he received the school's first Distinguished Alumni Award. The award was established to recognize highly significant, long-lasting contributions to the civil, government, business, or academic communities by school alumni. Dickinson, a key figure in the plate tectonic revolution of the 1960s and 1970s, held three degrees from the school: BS '52 PE, MS '56 and PhD '58 Geo. He passed away on July 21, 2015 in Nuku'alofa, Tonga, on the eve of his field research season there. Photo by Stacy Geiken.

HANNAH BEUTLER, SU '16, teaching assistant for the Sophomore College course *In the Age of the Anthropocene: Coupled Human-Natural Systems of Southeast Alaska*. Hannah helped students learn how to do a Forest Service stream restoration analysis for salmon habitat health. The students measured and collected data for stream pool size and depth, as well as log and wood presences. The learning activity was part of a module in which students learned about the importance of salmon in the southeast Alaskan communities, environment, and economy, as well as the dangers facing salmon populations. Photo by Rob Dunbar, the W.M. Keck Professor, who taught the course.

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