



GEOSCIENCES

TEXAS TECH UNIVERSITY

Department of Geosciences

A Pathway to 2025 | Strategic Plan

Making it Possible...



*...supporting research and education
in the solid earth and environmental sciences*

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Purpose and Scope

The University strategic plan, *A Foundation for the Next Century – A Pathway to 2025*, identifies three priorities:

- *educate and empower a diverse student body;*
- *enable innovative research and creative activity and*
- *transform lives and communities through outreach and engaged scholarship.*

This document presents the Department of Geosciences strategic plan in support of the broad vision outlined in the University and the College of Arts & Sciences strategic plans. The first part of this report describes the context and background for planning. The second part of this report describes three strategic initiatives designed to advance the educational and research mission of the department. Lastly, the third part of this report describes how department activities and initiatives support the wider University plan.

Mission Statement

The Department of Geosciences supports research and education in the solid-earth and atmospheric sciences and geography, through an understanding of the physical processes that govern the state and evolution of the earth-atmosphere system, the recognition of the impact these systems have on society, and the interaction between people and the environment. Students graduating from our degree programs will have the knowledge and skills to be strongly competitive in private, academic and government positions. In addition, we provide high-level integrated science literacy to students from other disciplines, so they can become informed decision makers of the future.

Vision Statement

The Department of Geosciences aspires to the highest standards of excellence in all aspects of teaching, research and service. It recognizes that the sub-disciplines of the Geosciences serve as the basis for any fundamental understanding of the Earth, environmental processes, natural resources, and natural hazards. These sub-disciplines include Geology, Geophysics, Atmospheric Science, Geography and GIScience. As such, the department strives to maintain a faculty that is recognized nationally and internationally for their research and teaching contributions. Our goal is to build a foundation for a healthy, long-term scientific enterprise focused on innovation, conveyed to students in classroom and research settings.

Context and Background for Planning

The Department of Geosciences offers academic programs in Geology/Geophysics, Atmospheric Science and Geography. The three disciplines share a common goal of understanding the physical processes that govern the state and evolution of planet Earth, the impact of earth systems on society, and the interaction between people and the environment.

Exploiting Regional Advantage

University priorities and strengths are often related to the physical environment and regional geographic context of the university. We expect the University of Hawaii to have good research programs focused on volcanoes. We expect the University of Idaho to have good research programs focused on potatoes. At Texas Tech, we have world-class academic programs focused on cotton and rural health. So what makes sense for our department?

In our case, we are located on the southern Great Plains – a semi-arid landscape characterized by wind, severe convective storms, occasional tornadoes and frequent dust. The landscape surrounding the university is dominated by agriculture, much of it irrigated from the Ogallala Aquifer, and small rural towns in decline. The Llano Estacado is a prominent feature on the landscape, the Rocky Mountains extend down through central New Mexico; but West Texas is probably best known for some of the most productive oil and gas plays in the world.

For our department, it makes sense that atmospheric science has a good research programs focused on severe storms, wind energy and aerosols (particularly dust). In a similar manner, it makes sense that geography has research programs focused on arid and semi-arid lands and the depletion of the Ogallala Aquifer. Lastly, it makes sense that geology has good research programs focused on issues relevant to the petroleum industry.

Maintaining Discipline Breadth

While it is a beneficial to exploit our regional advantage, at the same time we want to offer our students a broad, high-quality science education. Until the mid-1950's, the Department of Geology was largely dedicated to training students for work in the petroleum industry, rather than providing students with a strong science education. That changed under the leadership of Dr. Wade who suspended the doctoral program from 1954 to 1963 because he believed that the educational program did not have the breadth and depth to justify the granting of a Ph.D.

As a department, it is very natural to align our programs to exploit our regional advantage. At the same time, it is very important to offer our students a broad, high-quality science education. In this regard, we recognize that some faculty research will focus on topics of regional interest, but other faculty research will focus on topics of broader concern within the discipline.

Department of Geosciences - Degree Programs

Atmospheric Science

Minor in Atmospheric Science
Master's in Atmospheric Science
Ph.D. in Geosciences (atmospheric science emphasis)

Geology and Geophysics

Minor in Geology
Minor in Geophysics
Composite Minor in Geosciences
Bachelor Science in Geosciences - Concentration in Geology
Bachelor Science in Geosciences - Concentration in Geophysics
Bachelor Science in Geosciences - Concentration in Environmental Geology
Master of Science in Geosciences
Ph.D. in Geosciences (geology or geophysics emphasis)

Geography and GIScience

Undergraduate Minor in Geography
Undergraduate Minor in GIScience and Technology
Bachelor of Arts in Geography
Master of Science in Geography
Ph.D. in Geosciences (geography emphasis)
Graduate Certificate in Geographic Information Science & Technology

Areas of Research and Education

Atmospheric Science

Severe Storms

- hurricanes, tornadoes, thunderstorms, lightning, boundary layer processes

Wind Energy

- turbulence, boundary layer processes

Human Impacts

- impact on human health
- impact of severe storms

Geology and Geophysics

Earth Materials

- formation and composition of sedimentary, metamorphic and igneous rocks
- geochemical processes and isotope analysis

Structure and History of the Earth

- geophysics and crustal analysis
- tectonic history and geomorphology
- evolution of sedimentary basins
- evolution of life
- new frontiers in space

Applied Geoscience

- energy resources - applications in oil and gas exploration
- mineral resources - applications in mineral exploration
- environmental geoscience - natural hazards and environmental geology

Geography and GIScience

Human Geography and Globalization

- social and cultural geography of the world
- urban geography
- political geography (global studies)
- economic geography (globalization)

Physical Geography and Environmental Science

- climatology (atmosphere)
- hydrology (hydrosphere)
- geomorphology (lithosphere)
- biogeography (biosphere)

Geographic Information Science

- geographic information systems
- remote sensing of the environment
- global satellite navigation systems
- internet mapping and web applications

Human Resources – Permanent Faculty and Staff

Atmospheric Science

Brian Ancell	Associate Professor
Karin Ardon-Dryer	Assistant Professor
Eric Bruning	Associate Professor
Johannes Dahl	Assistant Professor
Sandip Pal	Assistant Professor
John Schroeder	Professor
Chris Weiss	Professor

Geology and Geophysics

George Asquith	Professor (Pevehouse Chair emeritus)
Cal Barnes	Professor
Sankar Chatterjee	Horn professor (0.5 appointment)
Harold Gurrola	Associate Professor
Callum Hetherington	Associate Professor
Juske Horita	Professor
Hal Karlsson	Associate Professor
Tom Lehman	Professor
David Leverington	Associate Professor
Neo McAdams	Assistant Professor
Seiichi Nagihara	Associate Professor
Moiria Ridley	Professor
Branimir Segvic	Assistant Professor
Dustin Sweet	Associate Professor
Paul Sylvester	Professor
Aaron Yoshinobu	Professor

Geography and GIScience

Perry Carter	Associate Professor
Guofeng Cao	Assistant Professor
Jeff Lee	Professor
Kevin Mulligan	Associate Professor & Department Chair
Xiaopeng Song	Assistant Professor
– Linda Jones	Permanent part-time instructor (0.5 percent)
– Lucia Barbato	Permanent part-time instructor (0.75 percent)

Department Staff

Cat Massengale	Unit Business Coordinator (geosciences department)
Debbie Walker	Unit Business Coordinator (atmospheric science)
Hannah Webb	Coordinator
Celeste Yoshinobu	Undergraduate Advisor (geology and geophysics)
James Browning	Senior Technician
Darren Hedrick	Technician (computer and seismic)

Department Strategic Initiatives

The Department of Geosciences has three related strategic initiatives designed to strengthen the research enterprise of the department, the College of Arts & Sciences and the University. Each initiative supports the strategic priorities of the College through enhanced research funding, scholarship and educational opportunities. To realize all three strategic initiatives will require an investment in new faculty lines over the next five years – the pathway to 2025. The department recognizes that new faculty lines represent a significant investment; however, each of the initiatives contributes directly to strategic areas identified by the College.

Permian Basin Research Initiative

West Texas is widely recognized as a world leader in oil and gas production. The Permian Basin Research Initiative seeks to exploit the regional advantage of the university to develop a significant research program focused on the Permian Basin. Coupled with the Midland Core Facility, the purpose of the initiative is to increase the department footprint in the petroleum industry through focused research and scholarship that is applicable to the oil and gas industry.

While many of our current faculty conduct research directly relevant to the petroleum industry (clastic and carbonate sedimentology/stratigraphy, clay mineralogy, biostratigraphy, and isotope geochemistry), the purpose of this initiative is to focus and expand the departmental research capabilities in this area. To develop the initiative, the department supports the acquisition, development and use of the Midland Core facility and we propose three new faculty lines over the next five years, one each in geophysics, geomechanics and biochemistry. Taken together, the main objective is to enhance the department's reputation for research in the broad field of energy resources (oil, gas and wind).

Proposed Investment

- 1) The department requests three new faculty lines as part of a strategic hiring cluster, one in geophysics, one in geomechanics and one in biochemistry. With a pending retirement in the next few years, a replacement position in carbonate sedimentology and stratigraphy would also contribute to this research focus.
- 2) While the department fully supports the acquisition of the Midland Core Facility, it does not have the resources to support the maintenance and operation of the facility. The facility must be maintained by the university with the department and college sharing the cost of operations.

Program Benefits

- 1) The development of a research program focused on issues relevant to the petroleum industry will greatly enhance the potential for research funding and scholarship in the areas of petroleum exploration and extraction.
- 2) The department has a solid reputation for research in wind energy and works closely with the National Wind Institute. By focusing on petroleum resources in this initiative, the department can greatly enhance its reputation in the energy sector as a whole.

- 3) The department's educational program in geophysics is severely constrained by the number of faculty. For a university of our size, having one geophysicist is completely inadequate. Adding a second geophysicist would allow the department to offer a greatly improved academic program in geophysics.
- 4) A position focused on geomechanics would add a new dimension to existing department strengths. As noted above, many of our faculty conduct research directly relevant to the petroleum industry, but rock mechanics is an area of research that has become significant with the revolution in hydraulic fracturing.
- 5) Three new faculty lines in a strategic cluster focused on research relevant to the petroleum industry will enable the department to increase in the number of graduate students in line with the projections outlined in the recent *Growing with Purpose 2025 Enrollment Management Plan*.
- 6) With the Permian Basin Research Initiative coupled to the Midland Core Facility, the core repository will become an important department asset with the enhanced potential of more users.
- 7) The Permian Basin Research Initiative will greatly enhance our standing with alumni in the petroleum industry and thereby enhance the potential for greater giving.

Water Resources Research and Education Initiative

Texas Tech is located in a semi-arid environment with limited water resources to support irrigated agriculture, rural communities and the demands of the petroleum industry. In this situation, there has always been a strong interest in water, largely supported by the Water Resources Center in the College of Engineering and the CASNR Water Center. In the College of Arts & Sciences, there are faculty with an interest in water, but the College has never developed water as a strategic research or educational priority.

The Water Resources Research Initiative will build strategically in the area of water resources. At present, there are faculty members in the department who work closely with the WCoE and CASNR, there are faculty members who have interests in geochemistry as it relates to water, the department has excellent analytical capabilities, and the department hosts the USGS Water Science Resources Center. To build on this interest and expertise, we propose three new faculty lines, one in hydrogeology with a focus on aquifer characterization, one in spatial hydrology/climatology with a focus on GIS applications, and one in precipitation measurement and modeling.

Proposed Investment

- 1) The department requests three new faculty lines, one in hydrogeology as part of the geosciences program, one in spatial hydrology/climatology as part of the physical/environmental program in geography, and one in precipitation measurement & modeling as part of the atmospheric science program.

Program Benefits

- 1) The development of a research program focused on water will greatly enhance the potential for research funding and scholarship in the area of water resources – an area that is currently lacking in the College of Arts & Sciences.
- 2) The initiative will enhance collaboration between the College of Arts & Sciences (Geosciences), the College of Engineering (Water Resources Center) and the CASNR (Water Center). Over the years, this type of collaboration has led to significant funding from federal agencies, especially the USDA.

- 3) The Water Resources Research Initiative also creates the potential for increased collaboration with the Climate Science Center. A large part of future climate change is projected to include significant shifts in precipitation. In this regard, water resources positions in hydrogeology, spatial hydrology/climatology and precipitation modeling can contribute to climate change research in a meaningful way.
- 4) The Water Resources Initiative will also contribute to the development of undergraduate and graduate educational opportunities in geology. Presently, Dr. Will Asquith (USGS) teaches a course focused of surface water hydrology and the new faculty member in hydrogeology will add expertise in the area of aquifer characterization.
- 5) The core of physical geography includes education relevant to understanding the four earth spheres; the lithosphere, atmosphere, hydrosphere, and biosphere. At present, the physical/environmental program in geography only offers a course in geomorphology. The addition of a new faculty member in the area of hydrology/climatology would greatly facilitate the development of a much stronger undergraduate and graduate program with courses in spatial hydrology and climatology (both of which are cornerstones in physical/environmental geography).
- 6) At present, the GIS program in geography is stretched to the limit. The new faculty member with expertise in spatial hydrology and climatology will contribute directly to the GIS program.
- 7) The Atmospheric Science program at Texas Tech is highly-regarded for research in severe storms and modeling atmospheric processes. Yet there is presently no research emphasis on precipitation. With a research focus on the measurement and modeling of precipitation, there are tremendous opportunity for collaborative research that will lead to significant external funding and opportunities for graduate study.
- 8) Three new faculty lines in a strategic cluster focused on water resources will enable the department to increase in the number of graduate students in line with the projections outlined in the recent *Growing with Purpose 2025 Enrollment Management Plan*.
- 9) Water resources is a research theme that transcends all three groups in the department.

Environmental Science Research and Education Initiative

Environmental science has become a well-established discipline in major universities over the past 20 years. At Texas Tech, Environmental Engineering has become as very successful program in the Department of Civil & Environmental Engineering. Yet the College of Arts & Sciences only offers an interdisciplinary non-technical minor in Environmental Studies – and there is no academic program focused specifically on the field of environmental science.

The Environmental Science Initiative will leverage the existing environmental expertise in the department with the new lines in the Permian Basin Initiative and Water Resources Initiative to build strategically in the area of physical/environmental science as part of the geography, geology and atmospheric science programs.

Proposed Investment

1) An academic program focused on Environmental Science will be pursued regardless of any new faculty lines – but the degree of success will be greatly enhanced by the proposed new faculty in other two initiatives. In essence, the Environmental Science Initiative will build on exiting faculty expertise and leverage the proposed new faculty hires in hydrogeology, spatial hydrology/climatology, precipitation measurement & modeling and biochemistry to build the program.

Program Benefits

- 1) The development of research programs focused on environment problems will greatly enhance the potential for research funding and scholarship in the area of environmental science.
- 2) An academic program in environmental science is very attractive to this generation of students. In this regard, we expect to see a significant increase in undergraduate majors and graduate students.
- 3) The environmental science program will be developed as a Bachelor of Science degree which will greatly benefit the physical/environmental side of geography.
- 4) The environmental science program will increase the enrollment in undergraduate atmospheric sciences courses. This is important because atmospheric science is does not offer an undergraduate degree program and the number of atmospheric science minors is limited.
- 5) Environmental science is a research theme that transcends all three groups in the department.

University and College Strategic Priorities

Priority 1. Educate and Empower a Diverse Student Body

i. Improve student success.

The success of an academic program is measured by: 1) the number of students enrolled in a program and 2) the number of students (percent) that complete the program. In this case, the different undergraduate programs in the department have different concerns. Geology programs are very challenging and suffer from a relatively high rate of failure. The DFW rate in required core courses (mineralogy) approaches thirty percent. In contrast, the undergraduate program in geography has a much higher completion rate but the number of majors is low. In a similar manner, the number of minors in atmospheric science is low making it difficult to fill upper-division courses.

To address the low completion rate in geology, minimum GPA requirements were added to the program and a more rigorous introductory Physical Geology course is being required for majors.

With regard to the low number of majors in geography, the program is being revised to: 1) remove old legacy courses, 2) focus on teaching the core courses in the discipline, and 3) develop an environmental science track (or degree program).

With regard to the low enrollment in upper-division atmospheric science courses, this issue is being addressed in the requirements and electives specified in the environmental science program.

ii. Enhance mentoring and advising of students

The Department of Geosciences has an excellent advising staff. To improve advising, we need to promote more interaction between the department advisors and advisors in the College. In addition, our programs need to be designed in way that makes sense to students, are easier to explain and easier to understand.

The department also recognizes the need to encourage more women to pursue a career in the geosciences. At present, females represent only 30% of the students in geology/geophysics and 10% of the students in geography. The Cearley Endowment will certainly help in this area, but we also need to strengthen our outreach to encourage more women in science.

iii. Expand and develop transformative learning experiences

The department offers well-developed signature learning opportunities in all three program areas. The summer field camp in geology, fieldwork in geology courses, GIS courses in geography, the Junction intersession course in geography, and the opportunity for fieldwork at the graduate level in atmospheric science, all provide students with a transformative learning experience. To expand these opportunities, the department will encourage substantive field trips in geography (spring break, summer intersession) and expanded offerings in study-abroad.

iv. Increase semester credit hours (SCH)

Undergraduate student credit hours are critical to the success of the graduate programs in the department insofar as the revenue supports TAs. To increase department revenue, we are developing an online distance-learning section of Physical Geography, which will be offered for the first time in fall 2019. If successful, we hope to expand the online course offerings to include the introductory courses in geology and atmospheric science.

v. Broaden student perspective

Fieldwork, field trips and distant travel are the best way to broaden a student's perspective. The field courses in geology, the addition of field trips in geography, and field research in atmospheric sciences all serve to provide a unique educational experience.

vi. Develop online offerings for summer core curriculum

The online course being developed for Physical Geography can be offered as a core curriculum science in the summer session. Again, if this course is successful, it will provide a model for developing online courses in geology and atmospheric science.

vii. Improve retention and graduation rates

Retention rates in our department is largely a function of student quality and preparedness. Good students who are well prepared in calculus, chemistry and physics tend to do quite well. Students who struggle in the science fundamentals do not. When a student does not do well, our advisors work with the student to find another major – hopefully one in which they can thrive.

viii. Resolve bottleneck and high DFW courses

The bottlenecks in the department are largely the result of too many students for the number of course sections. While we are keenly aware of the problem, it is difficult to address without more faculty or instructor resources. The small number of Ph.D. students in the program limits the availability of GPTIs in geography – and the complexity of teaching upper-division courses in geology limits the number of GPTIs to only a few qualified students near the end of their program.

In a similar manner, the high DFW rate in geology is largely the result of student preparedness and the department is working to address this problem with minimum GPA requirements, active and engaged advising, and a more rigorous introductory course.

Priority 2. Enable Innovative Research and Creative Activity

i. Metrics of research and scholarly activity

The Department of Geosciences uses the standard metrics used in most STEM disciplines; those being the number and value of proposals submitted, total research funding, the number of scholarly publications, and the quality of scholarly journal – all while taking into account the nature of the research, the teaching load and graduate student supervision.

ii. College of A&S strategic research areas

The Department of Geosciences strongly supports three areas that have been identified as College strategic priorities: d) oil & gas and wind energy, e) climate science & policy and f) undergraduate research. The Permian Basin Research Initiative described earlier is designed to build upon the department's existing strength in oil & gas and wind energy. In a similar manner, the Water Resources Initiative and the Environmental Science Initiative can be directly linked to climate science and policy.

With regard to undergraduate research, the department has long supported faculty working with undergraduates. For many years, this research was presented as part of the department's annual Research Day – where posters were presented to highlight the research of undergraduates. In the past few years, however, the requirement of undergraduate research was discontinued owing to the overwhelming number of students. Nevertheless, with the legacy of Research Day, the department maintains a strong culture of cultivating undergraduate research.

iii. Connections for research collaboration

The strategic initiatives put forth in this department plan all promote research collaboration. The Permian Basin Initiative will strengthen ties to the WCoE through petroleum engineering. The Water Resources Initiative will strengthen ties to WCoE Water Resources Center, the CASNR Water Center. Lastly, the Environmental Science Initiative will strengthen ties to Climate Science Center

Priority 3. Transform Lives and Communities through Outreach and Engaged Scholarship

i. Strategic outreach

The Department of Geosciences has a long history of community outreach. Faculty presentations at K-12 schools, museum exhibits and demonstrations, identifying rocks and meteorites, weather forecasting, lightning measurement for football games, public radio spots that highlight research, and many more.

ii. Engaged scholarship

The department has two signature programs that involve engaged scholarship. In the first case, the community fostered the development of the West Texas Mesonet, with many stations established on private land. In turn, data from the West Texas Mesonet are distributed back to the community as regional weather and agricultural forecasts. While the West Texas Mesonet is part of the NWI, faculty in atmospheric sciences have been actively engaged in the development of the network and frequently use the data in their own research.

The second signature program that involves engaged scholarship is YouthMappers. In this case, the program has developed YouthMapper chapters at universities throughout the world. These chapters then train students to map areas of interest from satellite imagery. The main goal is to develop a global network of mappers who can respond to disasters and map areas of extreme poverty in support of relief agencies.