Strategic Plan

Department of Geological Sciences

Jackson School of Geosciences

December 8, 2006

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Executive Summary

The Department of Geological Sciences has internationally renowned research programs with notable breadth and depth and strong graduate and undergraduate programs. National rankings over the past decade define our core strengths in traditional areas, such as sedimentary geology and stratigraphy, structural geology and tectonics, hydrogeology, paleontology and geophysics, but in fact the disciplinary breadth of our current faculty ranges well beyond these to include petrology, mathematical theory, experimental and computational geosciences, geobiology, geochemistry, space science, climate science, and energy policy. In addition to our research strengths, both graduate and undergraduate programs are strong and substantial in size. The education and accomplishments of students who complete these programs will continue to be a major asset in our development as the leading geosciences institution in the world. Few peer institutions can claim such an asset. Without doubt, the size and quality of our student body reflects the fact that, for a major research institution, our faculty has an unusually strong commitment to undergraduate and graduate teaching and supervision. Beyond the instruction of our own students, there is a strong sense of responsibility to teach non-scientists to produce an informed and scientifically literate citizenry. This is our mission as a public university, and we embrace it strongly.

To further the Jackson School goal to become the premier research institution, the department's strategy is to grow in new frontier areas while maintaining and strengthening our core programs. Future advances in our science will come from discoveries at the interfaces of traditional disciplines, resulting from interdisciplinary studies on coupling of physical, biological, and chemical processes and interactions among Earth's interior, hydrosphere, biosphere and atmospheric systems. We outline two fundamental Earth Science frontier areas as directions for new interdisciplinary studies. The first is concerned with Earth's near-surface processes, and the second with the origin and evolution of Earth, and processes underway in its interior. New faculty and research staff hires in these two areas will be catalysts for research integration and build strong collaborations between the department and other units within the Jackson School and university. To strengthen our current research and graduate programs and those of new faculty and research scientists, we have identified critical actions that will allow us to attract and retain cutting edge scientists, increase research productivity and impact, become a premier graduate program and develop the research infrastructure needed to be a preeminent research institution.

To bring the department to the forefront of education, student services and student opportunities, we will develop a stronger sense of community and enhance services by creating student-oriented spaces with superior support staff and providing student-oriented experiences, educational opportunities and a superior undergraduate and graduate curriculum. We will also enhance our already strong undergraduate teaching program, while not compromising the department's research mission, and better integrate research scientists from all units of the Jackson School into the overall teaching program.

A truly great college requires more than stellar researchers, outstanding research facilities, superior students, and premier graduate and undergraduate programs. What makes a college exceptional is the fabric and texture of the college that binds it together and creates an environment that nurtures creativity, innovation, collaboration, integration, diversity and leadership. The department is committed to actively participating in developing such a college. We will provide an intellectually stimulating environment where faculty, students and research scientists communicate freely, sharing the joys of discovery and engaging in ongoing scientific debate. Within the department we will develop a culture that nurtures, recognizes, and rewards research accomplishments, supports excellence in teaching, and provide leadership to the larger professional community and society. With the Institute for Geophysics (UTIG) and Bureau of Economic Geology (BEG), we will transform the Jackson School of Geosciences (JSG) into the premier geoscience institution in the world. The plan to achieve this involves three themes related broadly to developing (1) our research profile; (2) services to the student body; and (3) the Jackson School as a great college.

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The Department of Geological Sciences has internationally renowned research programs with notable breadth and depth and strong graduate and undergraduate programs. National rankings over the past decade define our core strengths in traditional areas, such as sedimentary geology and stratigraphy, structural geology and tectonics, hydrogeology and paleontology, but in fact the disciplinary breadth of our current faculty ranges well beyond these. Faculty research now also includes mathematical theory, experimental and computational geosciences, geobiology, geophysics, geochemistry, petrology, space science, climate science, and energy policy, and employs field work throughout the world. This extraordinary diversity reflects the evolution of the Earth sciences over the past several decades, and is a characteristic of most institutions considered our peers in various rankings. In addition to our research profile, both graduate and undergraduate programs are strong and substantial in size. The education and accomplishments of students who complete these programs will continue to be a major asset in our development as the leading geosciences institution in the world. Not all peer institutions can claim such an asset. Building on these strengths, and in cooperation with the Institute for Geophysics (UTIG) and Bureau of Economic Geology (BEG), we aspire to develop to the Jackson School of Geosciences (JSG) to its full potential as a premier geoscience institution

This draft strategic plan addresses three areas related broadly to the developments of: (1) our research profile; (2) the student body; and (3) our role in the Jackson School as a whole. These topics are not independent and some overlap is inescapable. The document is organized by theme; for each theme the strategic goals are presented first and are then followed by an action plan for accomplishing each goal. Goals under each theme are listed in order of priority, and action plans for each goal are presented in order of priority, as much as possible.

Theme 1. The Jackson School at the forefront of research – promoting depth, breadth, and impact.

Strategic Goals - Department of Geological Sciences at the forefront of research:

Our goal is to make the Department a premier academic geoscience research and education organization, in cooperation with the Jackson School and other UT research units and Departments. We will continually and aggressively enhance our research capabilities and impact, while maintaining a balanced commitment to teaching and graduate supervision. To ensure our success in promoting research depth, breadth and impact and to increase our overall stature, we will strengthen our current core programs while growing in new directions via four major goals:

1. Expand the research breadth of the Department: Future advances in our science will come from discoveries at the interfaces of traditional disciplines, resulting from interdisciplinary studies on coupling of physical, biological, and chemical processes and interactions among Earth's interior, hydrosphere, biosphere and atmospheric systems. Because of the remarkable breadth and strength of our department, we are uniquely suited to address such problems but need additional expertise to bridge disciplines and to focus our efforts on two fundamental Earth Science questions. The new hires will be catalysts for research integration and build strong collaborations between the department and other units within the Jackson School and university.

2. Attract and retain cutting edge scientists and increase research productivity and impact: One of the major challenges facing the department is finding a workable balance between research and undergraduate teaching, supervision of M.S. students and administrative work inescapable in such a large program. Not only must we attract and retain cutting edge scientists, but we also must find ways to allow them to be productive and have significant impact once they are hired without compromising our educational mission. We have identified three critical actions - establish a "sabbatical" program, strengthen and expand the postdoctoral program, and develop innovative funding mechanisms for new research.

3. Create a premier graduate program: Central to any world class research institution is a premier graduate program. We will increase the research focus and quality of the graduate program, one of the largest in the country, by further increasing the rigor of admission standards, providing improved research and professional development opportunities, and strengthening our curriculum. Aggressive recruiting of top students will be a high priority. Recognizing the many changes within the Jackson School in recent years, we will comprehensively review admission and support policies, and administration of all aspects of the graduate program.

4. Build, enhance and maintain the research infrastructure needed to be a premier research institution: The essential underpinning of any premier research institution and graduate program is the research infrastructure, including computational capabilities, state-of-the-art instrumentation and facilities, and people dedicated to the running and supporting of the facilities. We will support our many excellent, world-class laboratory facilities and significant collections that serve both research and teaching missions, to insure that they remain state of the art, and an attraction to prospective faculty, scientists, and students. To accomplish this, support will be needed for new instrumentation purchases, lab construction, and staffing, both for new hires, and to maintain and expand capabilities of existing labs. In addition to traditional laboratory instruments, both startup and continuing support will be needed for computational experimentation, with hardware, software, and personnel. Department laboratory and computational facilities development and support will be coordinated with other units of the Jackson School

Theme 1. Action Plan:

Strategic goal #1: Develop new areas of frontier research:

Action Item 1. Address compelling, fundamental scientific questions in the Earth Sciences focused on coupled Earth systems and processes. Our goal is to hire 7-10 new faculty and associated research scientists within the 3 year time frame of this plan, seeking especially interdisciplinary scientists who will be catalysts for bridging disciplines and integrating research within the Jackson School, and beyond. We have a preference for hiring young scientists, but the more important goal is to hire the very best and brightest. Interaction and synergy with UTIG, BEG and Environmental Science Institute (ESI) as well as other research units and departments on campus will be important in this process. Thus, joint appointments are anticipated. We will search with a broad advertisement in each frontier area defined by the following overarching questions, intentionally leaving the specific focus flexible so that we can attract the very best researchers or clusters of researchers over a reasonably short period of time. (See Appendix for expanded descriptions of potential research questions to be used as a hiring guide.) Both areas are of equal priority and build on the department's core strengths but create a new focus for integrated research.

Frontier Area 1: How have life, water, climate, and tectonic processes interacted to shape the evolution of the Earth's surface and near surface over time. We are specifically interested in investigating the interaction and coupling of physical, biological, and chemical processes and feedbacks among the solid Earth, hydrosphere, biosphere and atmosphere systems, not just conducting further independent research on specific processes or systems.

Some examples of scientific questions in this area include: How do living "systems" at both cellular and ecosystem scales influence physical and chemical processes at the Earth's surface and near surface? What is the role of ground water in surface and subsurface ecosystems? How are physical processes and biogeochemical processes coupled at the watershed scale? How does geology and geochemistry influence habitat and competition and the structure of the ecological community? What processes connect the atmosphere, land surface, surface water and groundwater systems on local and global scales? What are the fluxes of C and N across land, subsurface and marine systems on local and global scales? What are the impacts of climate change on the hydrologic cycle, ecosystems, and society? What are the dynamics of land-climate interactions and what are the feedbacks between climate and the land surface? Why do some purely physical systems self-organize into distinctive patterns? How are geologic processes observed on Earth manifested on other terrestrial planets? How are complex Earth surface and atmospheric dynamics reconciled with the rock record, and thus what does the rock record tell us about the past and the future environment? What is the impact of development, changes in land use and climate on the quantity and quality of water resources? Are our water resources sustainable? How do watersheds respond to natural and anthropogenic stimuli? What role can geology and geochemistry play in human health?

We will seek outstanding geoscientists interested establishing an interdisciplinary environment with the following expertise: quantitative geomorphology, geomicrobiology, biogeochemistry, global carbon and water cycle, modeling, shallow/environmental geophysics, watershed hydrogeology, paleoecology, remote sensing, numerical modeling/computational geosciences, climate and paleoclimate dynamics.

Frontier Area 2: How do the core, mantle, lithosphere and surface interact to shape the physical and chemical evolution of the Earth? The goal is to strengthen research in the areas of continental and mantle dynamics and to build upon the significant investments of the National Science Foundation and NASA in observing active margin systems and deeper Earth processes via EarthScope, MARGINS, and other programs, data, and computational methods providing new views of Earth's interior structure and surface deformation. Combining existing Departmental strengths with UTIG, BEG and other campus research units will be a critical element in developing this area. Integral to our success is hiring scientists or clusters of scientists that will focus on interaction and coupling of physical and chemical processes in the core, mantle, and lithosphere, both expanding our program into new areas and creating a critical mass in solid Earth geophysics and geochemistry, significant gaps in our overall core programs.

Some examples of scientific questions in this area include: How does the mantle convect? What are the relative roles of mantle plumes, layered convection, and chemical stratification, and what is the time dependence of convection over Earth's history (i.e. periodic superplume eruptions)? How do energy and material fluxes control mantle convection and plate tectonics? What drives plate tectonics and how has plate tectonics varied with time? How do plate margins deform, evolve and interact? What controlling influence do fluids have on geological processes, including magma movement and volcano deformation, tectonic deformation, metamorphic reactions, mineralization processes, and mantle convection? What are rates of interrelated lithosphere and mantle processes? How are chemical and physical processes acting in the Earth's interior manifested at the surface and how do surface processes affect Earth's interior? What are the effects of Earth processes on climate? How can active tectonic processes and present day plate motion be reconciled with the rock record? New measurements techniques show a strong disconnect between current activity and that recorded in the recent geologic record. Understanding the connection between the two is essential to evaluating deep time and understanding future activity that has tremendous societal implications.

We will seek outstanding geoscientists interested establishing an interdisciplinary environment with the following expertise: geodynamics, fluid dynamics, seismology, remote sensing of active and surface deformation, geochronology, mineral physics, geochemistry, and related studies of the terrestrial planets.

Strategic goal # 2. Attract and retain cutting edge scientists and increase research productivity and impact.

Action Item 1. Establish a "sabbatical" program. We will establish a research leave program that is comparable to sabbatical programs at our peer institutions, in terms of support, duration and frequency, to attract and retain cutting edge scientists as faculty and to allow them to achieve high levels of research productivity and impact. We remain one of the very few research universities without a regular program of sabbaticals, which is a major impediment to pursuit of forefront research. Sabbaticals allow faculty time to concentrate solely on research, to be exposed to and develop new research capabilities, and to recharge their creative abilities without the constant demands of undergraduate and graduate teaching, supervision and administration.

Action Item 2. Expand the postdoctoral program. Post-doctoral scientists are an important element of superior research programs. They increase overall research productivity and support the research environment in which graduate students are engaged. The Jackson School should establish a competitive, open-research-area postdoctoral fellow program to fully support at least 3 fellows each academic year. A goal will be to promote interdisciplinary research, especially within the Jackson School. In addition, the Jackson School should continue to have a strong and sustained program of 50% external funding matches to support postdoctoral scientists working with individual faculty and researchers.

Action Item 3. Support research excellence. The Jackson School will develop innovative funding mechanisms to provide Jackson School scientists a competitive advantage in two ways:

1) Establish a competitive, JSG program that provides seed money (not matching) for research projects to develop preliminary data needed to show feasibility of innovative, risky and new-direction projects. The goal is to improve competitiveness in seeking funds from granting agencies and industry, which commonly require preliminary research and sufficient data to demonstrate the project can be done. This program will provide a catalyst for faculty and research scientists to develop fundable research projects rather than supporting research that is fundable by outside agencies and industry through research initiatives.

2) Establish a funding mechanism for rapid response to transient research opportunities – i.e. tsunamis, volcanic eruptions, earthquakes, floods, etc. for the Jackson School. We have the capability to take advantage of targets of opportunity which will lead to major advances in our understanding or transient geological processes.

Strategic goal #3. Create a premier graduate program

Action item 1. Increase rigor of admission standards for graduate students. The admission policy is critical to the success of the JSG graduate program. The Graduate Admissions and Support committees will evaluate current admission standards and policies and establish a holistic set of minimum criteria for admission to both the M.S. and Ph.D. programs with higher standards for external and internal Ph.D. applicants.

Action Item 2. Foster a greater focus on research excellence. To support the goal that every Ph.D. student publishes in peer reviewed journals, and that every M.S. student prepares work of publishable quality, the Graduate Studies Committee will be encouraged to adopt a M.S. defense within curricular groups, a more prominent and public PhD defense; full support for student publication costs, and competitive best paper awards for student-authored publications. Additionally, a premier graduate program needs world class computational and analytical facilities with sufficient technical and instructional support to facilitate their research regardless of which JSG unit their supervisor is affiliated (covered under Strategic goal #4).

Action Item #3. Strengthen graduate recruiting. We will adopt more aggressive recruiting strategies for top students to compete with our peer institutions, including: prominent advertising of student opportunities in leading geoscience publications and at meetings; invited campus visits of top students early in the admissions and application process coupled with; early support offers regardless of discipline; and a summer intern program for top undergraduate students from around the country to attract them here for graduate study.

Action Item #4. Maintain and strengthen support package. Essential to creating a premier graduate program is recruiting excellent students through an attractive support package. The JSG should continue and expand current practices that provide competitive support packages to all admitted students. Expansion should include opportunities for grant-matching funds for summer support, competitive summer research support, and possibly increasing other aspects of the support package to make it competitive with other top schools. The graduate advisor's staff will annually evaluate competitiveness of offers and make recommendations for adjustments.

Action Item #5. Conduct a comprehensive review of graduate program administration and role of curricular groups. The structure, size, and diversity of the graduate program have changed significantly since we became a School. To assure that it remains at the leading edge of geoscience programs in the nation, and that students are well-served throughout their tenure, the Graduate Advisor will organize a review of the administration of the graduate program, examining the roles and structure of curricular groups and processes of admission, support and advancement to candidacy, and bring recommendations to the Graduate Studies Committee for approval.

Strategic Goal #4. Build, enhance and maintain the research infrastructure needed to be a premier research institution:

Action Item #1: Increase computational and numerical modeling capabilities across the full range of geoscience disciplines. Numerical models of physical, chemical, and biological processes applied to the geological sciences are quickly changing our understanding of Earth dynamics. Studies as diverse as sub- and near surface fluid flow, Earth mantle/core convection, explosive volcanic eruptions, and global climate change tied to atmospheric and oceanic circulation have all been spurred by recent findings that could only come from numerical modeling. Numerical studies have the advantage of both integrating physical, chemical, and biological observations from the field and the lab into coherent predictive models, and providing predictions of system behavior that can be tested by targeted field and laboratory measurements. At present the department excels at gathering and assimilating field and laboratory measurements from myriad geological environments. The full potential of numerical modeling, however, has not been realized at the JSG, despite such research being at the cutting edge of geosciences. To strengthen this expertise within the School we propose that in concert with our searches in the two frontier research directions, we

- Establish cooperative programs with the Institute for Computational Engineering and Sciences (ICES) and Texas Advanced Computing Center (TACC) to bring together U.T. researchers specializing in large-scale computer modeling and simulation and facilitate effective and priority access to the supercomputing facilities. This presents the opportunity to establish a world-class facility to lead the way in "numerical experimental confirmation of hypotheses".
- Develop the infrastructure for community-based, numerical geosciences simulations including hiring of computational experts (professional programmers) to assist the various disciplines in implementing computational and simulation applications of their research projects. This person, or persons, would implement parallel processing, computer simulation and other computational methods for specific geological, geophysical and climate processes. Also essential is staff support that can provide an instructional component so that students can take full advantage of these capabilities.

Action Item #2. Develop and maintain significant instrumentation, research facilities and collections that support research excellence through external funding and matching JSG support. The School should continue current practices of providing matching funds for major equipment purchases of general benefit, including support for startup packages. In addition, the Department, in concert with other Jackson School units, will annually assess needs and opportunities for major facility upgrades and entirely new facilities that may be funded outright. In such cases the goal will be to position JSG scientists to be most competitive in securing additional research funding, and to maintain JSG as the world leader in the geosciences.

Action Item #3. Provide dedicated personnel necessary for the effective use of research facilities by graduate and undergraduate students, postdoctoral scientists and faculty and for effective administration of academic programs. Planning and providing for sustained staff and other support will be an element of all facility development. As a general goal, research facilities should be financially self sustaining, but their dual use in education and research justifies a level of continuing staff, including research scientists, and financial support for service contracts and other expenses. Furthermore, the benefits of certain facilities in strengthening JSG research competitiveness may justify full research scientist, technical staff and financial support, even when educational use is slight. In concert with other JSG units, the Department will provide staff and financial support for individual laboratories and facilities, guided by these issues. The Department will also provide a well organized, enlightened staff and financial support for technical support in electronics, engineering and equipment development, computer systems, machine shop, and administrative aspects grant preparation and administration, all of which are essential elements of a strong research infrastructure.

Theme 2. The Jackson School at the forefront of education, student services, and student opportunities.

The department has strong, vigorous undergraduate and graduate programs and, for a major research institution, a faculty with an unusually strong commitment to undergraduate and graduate teaching and supervision. Moreover, many faculty feel a strong responsibility to teach non-scientists to produce an informed and scientifically literate citizenry. This is our mission as a public university, and we embrace it strongly. We do not intend to sacrifice our educational programs in our pursuit of research preeminence, but instead will be excellent in both teaching and research. Our greatest challenge is to balance the two missions. To make the undergraduate program truly great, we must devote substantially more building space to it and increase the level of student services. Recognizing that the geosciences are changing rapidly, we will review both graduate and undergraduate curricula to ensure that we are offering the best possible education for our students.

Strategic goals - the department at the forefront of education, student services and student opportunities:

1. Develop a stronger sense of community and enhance services by creating student-oriented spaces and providing student-oriented experiences. A vibrant student body needs a central location where they can interact and find help and advice. Such space is a tremendous recruiting tool and provides a focal point for alumni during visits. Currently students have no space conducive to interaction with faculty, research scientists and other students and minimal services needed to ensure success. Our goal is to create spaces that provide a welcoming, community climate and that house combined graduate and undergraduate student services. Additionally we intend to take advantage of our field orientation to create lifetime experiences for our students.

2. Provide a variety of services to help ensure that our undergraduates are able successfully to complete the program. Undergraduates entering the university are usually not prepared for the large, seemingly complex and impersonal nature of the university. Graduate students from small schools often face similar problems. Making significant and difficult decisions on courses and career options without informed advice can cause heartache, extra years of schooling and delayed or destroyed chances. Also, many students though intellectually able to succeed as geology major lack the needed background and training in physics, math and chemistry - even if they have had these classes in high school. Our goal is to provide superior mentoring, counseling, advising and tutoring to help ensure student success.

3. Review and enhance undergraduate and graduate curriculum, educational opportunities and teaching role of research scientists from all units of the Jackson School. As the field of geosciences changes and grows and the composition of our school changes, it is essential that we evaluate our curriculum, degree options and other educational and professional opportunities to ensure that we provide the best possible education for our students. Moreover we have a wealth of expertise within the school that can add significantly to the educational opportunities available for students.

4. Enhance undergraduate teaching program while not compromising the department's research mission. The faculty's strong commitment to undergraduate teaching is at times in direct conflict with our mandate and desire to become a premier research institution. We recognize that the very best teachers are often top researchers that carry their excitement for discovery into the classroom, and we find teaching fulfilling. Our goal is to balance our teaching commitment with our research aspirations.

5. Provide access to high quality education through effective recruiting, financial support and managing program growth and quality. Critical to the success of our undergraduate program is effective recruiting of high quality students with strong math, physics, chemistry and biology skills needed for success in the geosciences. Our goal is to offer sufficient financial support so that all highly qualified students, regardless of economic status, can take advantage of a geoscience education in the Jackson School. Moreover we will actively recruit students from all areas of Texas, especially taking advantage of other JSG programs, such as GeoForce, that engage diverse student populations at the pre-college level.

Theme 2. Action Plan

Strategic objective #1. Develop a stronger sense of community and enhance services by creating student-oriented spaces and providing student-oriented experiences.

Action Item 1. The Jackson School will create an open, inviting student center with attached space that houses combined graduate and undergraduate student services. Combining these will encourage graduate students to mentor the undergraduates, serving as role models and providing peer support.

We will dedicate and renovate space on the second floor of the Geology Building old wing for:

- Undergraduate lounge
- Quiet meeting or group study areas
- Academic advising for graduate and undergraduate students
- Mentoring (peer and professional) for graduate and undergraduate students
- Career Services (selecting a graduate school, summer internships, industry recruiting) for graduate and undergraduate students
- Tutoring
- Offices for graduate and undergraduate student organizations
- Undergraduate computing facilities and IT Help Desk
- Classroom designated for evening social and educational events.

Action Item 2. Create a shared bonding experience to promote future student and student faculty interaction. Shared experiences will help each incoming class develop relationships that will see them through their college years and into their professional careers. Undergraduate students entering the university are easily overwhelmed by the size and seemingly impersonal nature of the school. Overnight fieldtrips and other field experiences are a proven way to promote personal and professional relationships and to create a sense of community among with faculty and other students. At present these come relatively late in the undergraduate program.
We will institute for incoming freshmen a 3- to 4-day retreat in the week before classes begin. The event will include short field trips and selected faculty presentations on research and careers in the geosciences, outdoor activities such as hiking, camping, simple field observations, and sample collection. This plan is supported by a survey of Fall 2006 freshmen indicating most are attracted to the geosciences because of the outdoors aspect. The retreat will be an opportunity for enrolling in student and professional organizations and mentoring by upper-division undergraduates and graduate students

Action Item 3. Establish a yearly (or every other year) field trip course for graduate and top senior undergraduates students. We will organize and sponsor a fieldtrip to some area of the world with fascinating geology. Students will take a combined seminar/lecture course prior to the trip to receive the maximum benefit from the field experience. Such a trip provides an exceptional educational experience for students and provides a bonding experience that will build a sense of camaraderie among the students

Strategic Goal #2. Provide a variety of services to help ensure that our undergraduates are able successfully to complete the program.

Action Item 1. Provide support services for students with dedicated professional staff and space. The department student services staff will be dedicated to providing a comprehensive array of student services and, in support of faculty, to design and implement academic programs of the school. The Student Services staff will be organized under an Associate Chair (reporting to the Department Chairman). The student services staff will be developed from existing staff and new personnel, and will grow in numbers to match growth of the student body. The new student center will house appropriate personnel in offices attached to the student lounge to provide essential services for undergraduate and graduate students in an easily accessible and welcoming manner. Services will include advising and career counseling (for example, undergraduate advisor and undergraduate program coordinator, graduate advisor and graduate program coordinator), computer support (IT support staff), tutors for calculus, physics and chemistry and writing, career services (CV preparation, preparation for interviews, scheduling recruiting and networking with recruiters, maintaining a database), student organization oversight and mentoring by graduate students who have been teaching assistants or who obtained a degree from our program.

Strategic Objective #3. Review and enhance undergraduate and graduate curriculum, educational opportunities and teaching role of research scientists from all units of the Jackson School.

Action Item #1. Review and enhance undergraduate curriculum and educational opportunities. Changes and growth in the field of geoscience, employment opportunities and the advent of the new university curricular reform require a comprehensive review of our undergraduate program and course content. One goal is a stronger and more prominent integration of mathematics, physics, biology, and chemistry in geoscience courses, along with development of analytical and writing skills and integration of research and field elements. An Undergraduate Curriculum Committee will conduct a thorough review of the undergraduate curriculum, making recommendations to the full faculty. The committee will work on a two year cycle to match the publication dates of the University catalog. The committee will consider ways to increase participation of students in fieldwork, research, and study abroad programs, including offering our own mid-year or Maymester courses overseas.

Action Item #2. Review and enhance graduate curriculum and educational opportunities and teaching role of research scientists from all units of the Jackson School. With the field of geoscience expanding both externally and within our school, it is imperative that we review the graduate course offerings and assess whether the current courses support the research and education needs of current and future students and identify additional courses needed to further the research capabilities of our students. We will evaluate, in concert with the rest of the School, effective and beneficial ways of involving JSG researchers in the graduate teaching program and develop and implement a mechanism whereby students can benefit from the expertise available within the entire JSG. The Graduate Curriculum Committee will also review and recommend changes to the Graduate Studies Committee concerning the breadth and content graduate courses, and timing of course offerings to ensure that the all students can complete their coursework in a timely manner and have access to the best possible graduate curriculum and instructors.

Action Item #3. Enhance Honors program and other research opportunities for undergraduates. The department has recently instituted an honors program and is committed to having a rigorous honors curriculum to encourage the top-performing geoscience students. Further participation by faculty and students and modest financial support will enhance the program. Continuous review of the honors program as it develops will be undertaken by the organizers to maximize experience for students. Opportunities for students not in the honors program are provided by research scientists and faculty members willing to sponsor undergraduate research in their labs. Modest financial support for research internships will provide more students with an undergraduate research experience.

Action Item #4. Continue to provide professional development support for graduate students, develop a sense of professionalism among undergraduate students, and prepare both for future professional careers. To fully develop our students as professional scientists, we need to further their professional growth in ways not obtained by classes and research alone. For graduate students, the School should maintain and enhance the current professional development support package to encourage students to present their research at regional, national and international meetings and to participate in professional short courses and field trips. For upper division undergraduates the School should encourage participation at professional society meetings by providing some funding towards travel. The department will encourage all students to join a professional society as a student member to give them a professional orientation, and entry into a lifetime relationship with other scientists. To further prepare students professionally, we will develop opportunities (workshops, outside speakers, or portions of organized classes) to talk about topics of professional interest: ethics, intellectual property, project management, being an entrepreneur, writing grants/abstracts/scientific papers, and presentation skills, for example.

Strategic Goal #4. Enhance undergraduate teaching program while not compromising the department's research mission.

Action Item 1. Provide gifted teachers for undergraduate programs. As new faculty are hired, they will be expected to participate in undergraduate teaching. The net effect will be to reduce overall undergraduate teaching load per faculty allowing cumulatively more research time. At the same time students will benefit from a greater variety of faculty with different geoscience expertise. We also recommend hiring gifted teachers as full time lecturers and rewarding them appropriately (salary, promotion, etc.). In rare cases, top senior graduate students, with recognized excellent teaching skills, may be invited to teach in undergraduate courses (with a faculty mentor, subject to faculty approval).

Action Item 2. Develop and maintain highest quality facilities, equipment and dedicated staff to support our teaching mission. Although our classrooms are all equipped with modern technology needed for effective teaching, they need continual care, maintenance and upgrading. Field equipment essential for our field programs and laboratory facilities for essential classes all require continual upgrading and maintenance. Furthermore the JSG holds significant collections that are basic to different aspects of its teaching and research mission. We must provide both financial support to upgrade and maintain such facilities and equipment and staff support to ensure that teaching collections, equipment and facilities are developed and maintained at the highest level. Furthermore, some of the most influential teachers in our program are the teaching assistants The quality of the undergraduate program depends greatly on having high quality teaching assistants with appropriate expertise. To improve the quality of undergraduate teaching, we will assign our best teaching assistants to undergraduate classes, and decrease the size and number of sections per teaching assistant.

Action Item 3. More effectively evaluate and improve our teaching performance. We will expand the use of instructional assessment methods to evaluate teaching success, especially at the undergraduate level. We will identify important concepts that we require our undergraduates to learn (such as Deep Time, 3-D thinking, and organic evolution) and assess their comprehension. To accomplish this we will make use of campus resources, including the Measurement and Evaluation Center, in designing real-time assessment methods for our faculty and teaching assistants.

Strategic goal #5. Provide access to high quality education through effective recruiting, financial support and managing program growth and quality.

Action Item #1. Develop recruiting strategies for excellent students. The Jackson School will have a formal program for recruiting excellent students, with special emphasis on those with strong math, physics, chemistry and biology skills needed for success in the geosciences. We will actively recruit in high schools (prospective students) from all areas of Texas to increase our diversity and within the University (transfer students). At the earliest opportunity the Jackson School will recruit students already admitted to the University by offering strategic scholarships. Additionally, a freshman scholarship program will be in place by Fall 2007. The Department will provide dedicated staff support to recruit students at both undergraduate and graduate levels.. This staff will also engage the Jackson School in existing University programs that offer outreach to Texas high schools.

Action Item #2. Provide access to education through scholarships and other financial support. The Jackson School will ensure that qualified students have no financial barrier to receiving an education in our department. We will establish an undergraduate support policy that includes a full range of opportunities, including 4-year scholarships based upon academic performance, need based financial aid (in cooperation with the office of student financial services) and summer and other field course support.

Action Item #3. Establish high admission standards and measures of success. As a new college we now have the ability to set our own admission standards for both freshman and transfer students. The Jackson School will establish high admission standards and develop measures of student success for continued scholarship support. We will present our program as an elite and rigorous program—with the goal of attracting the best and ensuring their success. By setting high standards we will manage our growth as the college expands and develops.

Theme 3: The fabric of a great College

A truly great college requires more than stellar researchers, outstanding research facilities, superior students, and premier graduate and undergraduate programs. What makes a college exceptional is the fabric and texture of the college that binds it together and creates an environment that nurtures creativity, innovation, collaboration, integration and leadership. The department is committed to actively participating in developing such a college. We want to become an intellectually stimulating environment where faculty, students and research scientists communicate freely, sharing the joys of discovery and engaging in ongoing scientific debate. Within the department we want to develop a culture that nurtures, recognizes and rewards research while allowing us to successfully fulfill our teaching mission and provide leadership to the larger professional community and society.

Strategic Goals - the department as part of the fabric of a great college

1. Develop a sense of community, collegiality and cohesion that promotes collaboration, research excellence and education.
Without a sense of community, collegiality and cohesion within the department, among the JSG units, and across campus, the synergies that will lead to true greatness will not be achieved. We need to change the way we structure our time and communicate so that we can take advantage of the wealth of opportunities available within the department, school, and university. Research excellence and education both are built on exchange of ideas and knowledge; collaboration only occurs when researchers know each other and their interests. To accomplish this strategic goal, we recommend establishing a world class seminar series and yearly Jackson School Conference, developing shared space that promotes community, and enabling interaction across the wider community.

2. Promote diversity within the Jackson school and provide role models for the next generation of scholars. The student population of the department does not reflect the demographics of the U.S. population at large, a common problem in the geosciences that needs to be rectified for the geoscience profession to remain viable in the future. The faculty demographics don't come close to even our student population's demographics. It is vital to the success of our students that they have a diversity of role models. Moreover, a diverse faculty and student body will promote new ways of thinking and approaching scientific and educational problems. We propose to increase our recruiting activities for minority and lower income students, as outlined under Theme 2 (education), and to increase the diversity of the faculty and research scientists within the department.

3. Provide mentoring and career planning and develop a fair evaluation and reward system for faculty, research scientists and technical and administrative staff. People are the most valuable elements of the department, yet little time and effort is spent on mentoring, future career planning and rewarding based on achievements and merit. Retention of high caliber individuals, promotion, tenure and superior performance, all require well conceived efforts in this regard. We propose a comprehensive change in the manner in which we support, evaluate and reward all departmental employees.

4. Provide geosciences leadership for society and within the professional and international community. We want the world to look to the Jackson School for leadership in the geosciences – whether it is nationally, internationally, or within Texas or for boards, panels, offices, editorships, conference leaders, committees, etc. – we should be providing leaders for the geosciences. For major geoscience issues related to policy and/or society – the community should look to us for solutions. The geosciences needs strong leaders and society needs the input and expertise of geoscientists.

Theme 3. Action Plan

Strategic Goal #1. Develop a sense of community, collegiality and cohesion that promotes collaboration, research excellence and education.

Action Plan 1. Establish a world-class weekly seminar series and yearly Jackson School Conference with associated social function. Stimulating the minds of faculty, research scientists, and students depends on a constant influx of new ideas to the school. We intend to raise the profile of the Jackson School as a major center for presentation of top research ideas and to keep the Jackson School researchers and students knowledgeable about cutting-edge geoscience research. Additionally we will develop an associated social function to provide an excellent forum for researchers and students to interact and discuss science and new ideas, which will lead to more collegiality and collaboration. Specifically we propose to:

- Establish a world-class weekly seminar series with following social function on 6th floor patio. The weekly (or biweekly) seminar will exclusively bring in top caliber outside researchers from all areas of the geosciences to enrich the JSC community. With this as the only formal external presentation during the week within the department, nearly universal attendance is anticipated. Student and faculty presentations will be handled in curricular groups, potentially as defenses for students, as outlined under graduate matters. Additionally we intend to establish video and two way communication links from the Boyd auditorium to the Pickle Research Campus so that all talks given on campus can be viewed remotely but with the ability for active participation.
- Establish an annual prestigious Jackson Conference on different specific cutting edge research topics with associated social functions.

Action Plan 2. Build a sense of community through shared space and technology. The physical layout within the department and distance between JSG units provides an impediment to developing a sense of community. We recommend the following physical and technological solutions:

- Faculty and research scientists need common space for daily informal gatherings where they can interact and discuss their research. We propose that during the renovation of the 2nd floor of the old part of the Jackson building to establish the student center, an appropriate room for lunch/break/informal-meetings be designed for faculty and research scientists. In the meantime we propose to modify existing space (Barrow conference room? 6th floor patio?) to allow for such use. To jumpstart such interaction, weekly or bi-weekly informal lunchtime meetings will be arranged.
- We also recommend a reevaluation of space allocation within Jackson building, particularly the older part, to facilitate collaboration/interdisciplinary research. The new student center will help build a sense of community and collegiality among students, but from a research perspective, we should strive to have students and workspace proximal to supervisors, and where possible have interdisciplinary research teams in adjacent space.
- Physical separation between campus and the PRC have caused increased stress and more commuting as more school-related committees have developed and an increased interest in seminars at the different units has grown. We recommend establishing facilities that permit and facilitate communication between the units of JSG via telecommunication for committee meetings where face to face time is not necessary and for seminars and presentations.

Action Plan 3. Encourage collaboration, cohesion and a sense of community across the school and the campus at large. We need to build a tradition of intra-school social, educational and research-related events that bring all members of the units together and forge interaction with other departments and research units on campus. For example, the Jackson School spring picnic should be revived, and unofficial, informal, off campus gatherings open to everyone after work should occur several times a semester. The seminar series and Jackson Conferences should be widely advertised across campus and a major attempt should be made to encourage attendance from outside the school at both the talks and social functions. These talks should provide a focus for informal discussion and help forge cross-college interactions for which the Jackson School can be at the center.

Strategic Goal #2. Promote diversity within the Jackson school and provide role models for the next generation of scholars.

Action Item 1. Continuously search for top quality female and minority faculty and research scientists. Have ongoing advertisement looking for the very best geoscientists regardless of field and use it for hiring topnotch female and minority geoscientists and for other targets of opportunity. Moreover, a conscious effort should be made to identify top quality candidates and encourage them to apply for frontier research positions, as appropriate, or to this open position advertisement.

Action Item 2. Be willing to hire dual career geoscience couples within the JSG community. A major impediment to hiring many females is the trailing spouse issue. Universities that can offer both members of a couple appropriate level positions have a tremendous advantage in recruiting the best and brightest. We need to be receptive to making offers to qualified couples regardless of discipline. Furthermore, we should we should be open to considering spousal hire requests from other departments as a means of establishing potential future reciprocal arrangements.

Strategic Goal #3. Provide mentoring and career planning and develop a fair evaluation and reward system for faculty, research scientists and technical and administrative staff.

Action Item 1. Mentoring for faculty and research scientists
We propose to set up effective mentoring program for pre-tenure and pre-full professor faculty and pre-senior research scientists. Mentors will be fully aware of promotion and tenure hurdles and priorities and provide help and advice in preparing them for promotion.

Action Item 2. Career planning, evaluation and rewarding of faculty and research scientists
We propose that all faculty and research scientists have a 3-5 year overall career plan that outlines their goals in terms of research, teaching, administration and leadership in the larger community. These plans will allow the chairman to balance the various needs of the department and to ensure that faculty and research scientists are provided the opportunities (and advice) they need to advance their careers. Furthermore we propose that faculty at all stages (from lecturers to full professors) and research scientists are evaluated yearly for salary increases, awards, endowed positions and promotion. Rewards should be based on evaluation of accomplishments over past year as well as over a 3-5 year period with their career plans taken into account. The department will actively promote faculty and research scientists externally by nominating them for appropriate awards, fellowships, etc.

Action Item 3. Mentor and support technical and administrative staff

An effective, enlightened staff is critical to the success of the department. Attracting and retaining excellent staff is of paramount importance. To do so we will establish a well defined career ladder and reward superior performance based on yearly evaluations. We must encourage professional development of these staff persons, for example to include their membership on University academic committees, attendance at professional meetings, enrollment in professional short courses and workshops, etc. Regular staff meetings in a suitable space will promote communication of instructional and research goals, and staff roles and responsibilities.

Strategic Goal #4. Provide leadership for the geosciences within society and within the professional and international community.

Action Plan #1. Provide service to meet societal needs. The department plays a critical role in educating nonscientists and future teachers and in providing industry with a skilled workforce. Specific programs and research are directly relevant to societal issues. To fulfill these missions we intend to:

- Continue to offer large enrollment non-major courses to educate non-scientists about the earth sciences, both those that directly apply to societal issues as well as those that provide first hand understanding of scientific endeavors and principles. With the development of the new university curriculum, we will evaluate the effectiveness of our approved signature course and decide whether to propose modifying others to meet the criteria. In addition, incorporate geoscience related policy and societal issues, such as sustainability, into other courses, as appropriate.
- Take advantage of the opportunity offered by the newly approved Earth and Space Science capstone course that will be offered in Texas High Schools to make a difference in public education as well as effectively recruit undergraduate majors. We will provide teacher preparation in cooperation with UTeach, including accelerating our summer Masters program in geoscience education and encouraging interested undergraduates to pursue the teaching option. We will also work with the Dean's office in their efforts in providing assistance to school districts in meeting the new requirements.
- Maintain strong B.S. degree with a teaching option that trains future middle and high school teachers.
- Maintain a strong M.S. degree that provides industry with a skilled workforce
- Continue to take a leadership role and actively participate in the Center for International Energy & Environmental Policy and the Environmental Science Institute. Plus pursue the connections between research results and implementation of societal relevant research.
- Continue development of community and K-12 outreach efforts such as the JSG and ESI Outreach Lecture Series.

Action Plan #2. Raise visibility and leadership role in the geosciences. We will encourage faculty and research scientists to participate in external affairs (e.g. NRC committees, NSF advisory committees, professional society offices, public policy, etc.) and other professional service (editorships, conference organizers, etc.). The department will also promote its faculty and research scientists by nominating them for significant leadership positions. As appropriate, release time, lessening of internal committee duties, and travel support will be available.

Action Plan #3. Increase international involvement. The department is actively involved in research worldwide and our student population draws from many countries, particularly South and Central America and Southeast Asia. We wish to enhance this international involvement through the following actions:

- Establish program to bring in colleagues from other countries as visiting faculty or fellows.

- Develop exchange programs with universities in specific countries where students can study abroad and faculty can spend time doing research and/or teaching.
- Promote our M.A. degree for students who are already employed overseas but want to increase their knowledge and then return to their former employer.

Appendix: Frontier Areas

The two frontier research areas resulted from an evaluation of six potential areas. Because of the strong overlap and interrelationships that emerged among them, we combined the areas into the two broad, overarching frontier areas. A more detailed discussion of the six potential areas is given below to be used as a further hiring guide.

Frontier Area 1: How have life, water, climate, and tectonic processes interacted to shape the evolution of the Earth's surface and near surface over time.

GeoBiology

GeoBiology is the study of the Biosphere, the interface of Earth and Life at all scales of time and spatial resolution, from single crystals and unicelled organisms, to continental scale ecosystems. GeoBiology is a synthesis of many modern disciplines, including Paleontology, Biogeochemistry, Biomineralogy, Geochemical Ecology, Paleoecology, Micropaleontology, Paleobiology, Paleoecology, Molecular Paleontology, Ecology, Systems Modeling, Informatics, and Astrobiology. Geobiology is the domain of synthetic questions of mutual and basic importance to geologists, biologists, and to the interdisciplinary community concerned with water, energy, and global change. These questions extend deep into Earth history, beginning at the origin of Life 4 billion years ago, and their answers are predictive of what lies ahead for Life on whatever Earth's surface becomes. Questions being asked in the area of GeoBiology include 1) when did life arise on Earth, and how? 2) What is the relationship between the evolution of organisms and the evolution of the Earth's atmosphere and surface? 3) How do living "systems" influence geological processes at both the cellular and ecosystem scales? 4) How does geology and geochemistry influence habitat and competition and the structure of the ecological community? 5) What role does geology/geochemistry play in human health? GeoBiology is embodied today in many diverse agencies distributed widely across academic, applied, and political environments, and whose budgets command billions of federal and private dollars.

GeoBiology at the Jackson School will reflect expansion into new areas from existing core strengths in paleontology and geomicrobiology, within a framework of strength in sedimentology, hydrology, geochronology, computing, and informatics. Our paleontology program is built on the 7th largest vertebrate fossil collection (1 million specimens), and the 5th largest invertebrate collections (4 million specimens), with approximately 40,000 square feet of space distributed across seven buildings on two campuses. The collections are valued at roughly $5 billion, and have supported nearly 200 theses and dissertations and more than 10,000 scientific publications. In addition to the core strength in paleontology we have a new and growing program geomicrobiology and microbial geochemistry. We also benefit from strong programs in the School of Biology, in Ecology, Systematics, and Molecular Biology.

To expand our core into a more comprehensive GeoBiology program, we see three especially promising directions of growth. The first is to add scientists whose interests focus around the early biogenic interactions between Life and the hydrosphere, atmosphere, and solid surface. Second, our traditional core strengths need to be expanded taxonomically, so that JSG is home to expertise on all areas of our collections. These should be field- and collections-based scientists who address issues of geochronology and the history of taxonomic diversity. Third, possibly the most exciting new frontiers of GeoBiology were opened by technological and computing advances. They make possible detailed observations and analyses of organisms at the cellular and molecular levels. They also enable recovery of growing repertoires of biomolecules and isotopes from fossils. Micro-scale biological-geological interactions are now being measured on geological scales of time and space. Expanding our community of geomicrobiologists, microbial geochemists, paleo microbiologists is a target of high priority.

Global Water

Global water, brings together several disciplines that together address fundamental issues of water availability, movement, quality, as well as the role of water in basic geological processes. The water program in the JSG has a foundation of classic geology including geomorphology, structural geology, and sedimentology, while employing hydrology, chemistry, aquatic biology and ecology, microbiology, geophysics, and numerical modeling.

Water resources, including the quantity and quality of water, are a critical issue to meet the needs of people and the environment in Texas and the world for the 21st Century, and to assure adequate potable water we must refine our understanding of the geology of water, and develop new tools to characterize and model water resources. Basic issues that need to be evaluated include quantifying recharge into aquifers and discharge to surface water bodies; understanding the impact of development, or changes in land use and climate on the quantity and quality of water resources, characterizing spatial variability in aquifer properties, improving understanding of coupled processes and biogeochemical cycling at the watershed scale, and the role of ground water in surface and subsurface ecosystems. In addition, the NRC has identified “Grand Challenges” in the environmental sciences relevant to the JSG global water mission, and include questions related to Biogeochemical Cycles; Bio-diversity and Ecosystem Functioning; Climate Variability. Hydrologic Forecasting, and Infectious Disease and the Environment. Current NSF funding opportunities exist via programs in the Ecology of Infectious Disease, Hydrologic Observatories, Biocomplexity, and Microbial Observatory.

The department currently has 3 primary faculty members representing three distinct core areas in water science: physical hydrogeology (Sharp); aqueous and microbial geochemistry (Bennett), and ground-surface water interactions and contaminant hydrogeology (Cardenas). In addition there are three associated faculty members with expertise in isotope hydrology (Banner) and climate science (Yang; Quinn). Together we have an internationally recognized and respected water program that is poised to become the top program in the country capable of tackling the basic challenges in environmental science. The water program personnel have identified two key areas that are current weaknesses in the JSG that require new hires either as faculty or research scientists toward becoming the best water program in the nation:

Shallow/Environmental Geophysics: The evaluation of the hydrogeology of the Earth's uppermost kilometer and, particularly, the shallowest 100 meters (the “Critical Zone”), remains a major challenge. Its resources, the environments it supports, and geologic hazards are critical, while the heterogeneity and location of this zone makes traditional petroleum geology techniques difficult to apply. Expertise is needed in seismic refraction and reflection, EM (frequency and time domains), earth resistivity, airborne geophysics, vadose and phreatic borehole methods, GPR, and gravity. Research and teaching efforts in this area will also overlap with colleagues in geophysics, geochemistry, sedimentology, civil and petroleum engineering, speleology, planetary science, coal and economic geology, climatology, archeology, biology, etc.

Watershed Biogeochemistry: The watershed is a fundamental integrating unit of water-related processes. Hillslope hydrology, soil science, fluvial processes, geology and geomorphology, groundwater flow and ecology all converge to form the character of a watershed. The physical processes affect the cycling of nutrients within watersheds and nutrient export across different reservoirs. The watershed is therefore an excellent scale at which coupled biogeochemical and physical processes can be simultaneously investigated, and the health of our watersheds depends on a thorough understanding of biogeochemical cycles and their dependence on physical processes. Fundamental questions include: What are the important sinks and sources for different nutrients? What are the crucial pathways for these nutrients? How can we quantify sources, sinks and fluxes at multiple scales? How do watersheds respond to natural and anthropogenic stimuli? This area can be extended to include a new hire addressing a global-scale biogeochemical cycles.

Additional hires that would interface with the other related research areas are remote sensing and water cycle faculty hires.

Surficial Processes

The study of surficial processes investigates how physical, chemical and biological processes interact at the interface of the lithosphere with the hydrosphere, atmosphere and biosphere. A study of surficial processes links the traditional fields of sedimentology, geomorphology and stratigraphy with hydrology, climatology, low-temperature geochemistry, soil science and biology. Fundamental scientific questions in surficial processes revolve around: (1) understanding the processes themselves and their interrelationships, (2) the evolution of surface systems in response to external forcing, and (3) new approaches in observing, measuring and modeling. For example, how do air, water, land and life processes interact to shape our environment? Why do some purely physical systems self-organize into distinctive patterns? We know that tectonism has a major impact upon climate, but what is the effect of climate upon tectonism? How is landscape evolution different on Mars versus Earth? Because the surface of the Earth is where humans live, a study of surficial processes must be able to provide the scientific basis for societal, economic and environmental questions arising from human impact on the planet. The study of surficial processes is funded primarily by sources in NSF, DOD, DOE, NASA and Industry.

The Department of Geological Sciences has some of the key aspects of a program in surficial processes, but these have never been unified in any thematic research direction, and essential elements of the program are absent. The historical strength of the Department in stratigraphy/sedimentology has been expanded with new hires with an emphasis on experimentation and modeling. Other existing components include programs in hydrology, paleontology, volcanology, and our embryonic climatic program. Important extra-Departmental components are with ESI and CIEEP, as well as with sister groups within the Jackson School at the UTIG and BEG. Essentially, to build a top-tier program in surficial processes requires the harnessing of existing programs, making key hires to fill gaps, and defining research directions that *cause* the formation of an integrated team of data collectors and synthesizers, theoreticians and numerical modelers.

Two key new faculty hires for almost any direction in surficial processes are individuals in quantitative geomorphology and numerical modeling. Other missing links need to be determined based upon specific research directions within this very broad field. New hires need to improve upon our current ability to use remote sensing technologies, GIS, and data visualization methods, as well as promote novel methods for measuring and modeling surficial processes. New hires need to embrace expanding computational resources, while still being grounded in the reality of the natural world. It is imperative that new hires have a history of (or at least an expressed interest in) working together, and wish to evolve a program conducive for post-doc and graduate student involvement.

Climate

Climate science is trans-disciplinary by definition as it integrates the allied fields of geology, physics, chemistry, biology, atmospheric, oceanic, and computational sciences. The complex nature of the climate system requires advanced numerical modeling techniques to be coupled with modern and geologic observations of the response of the Earth system to climate forcing. Quantitative understanding of the climate system is important because climate science is at the heart of a wide range of significant and societal relevant questions including: 1) what is the nature of past and future climate variability? 2) what are the dynamics of, and feedbacks within, the climate system? 3) how does climate change impact air quality, water resources, ecosystems and society? 4) how do the sources and sinks of carbon respond to, and in turn force, the climate system, and 5) how might extreme climate events and/or abrupt climate change episodes in Earth history provide constraints on global climate change in the future. Climate variability has been identified by the NRC as one of its "Grand Challenges" in Environmental Science and several of the national funding agencies support major programs in climate science.

There is an emerging core strength in climate studies in the JSG including faculty in the department (Banner, Quinn and Yang) and research scientists at UTIG. In spite of the recognized importance of climate studies, however, there is no expertise in the global carbon cycle at UT and the JSG could become the leader in this important field. Research activities in DGS' climate studies group include:

1) global and regional climate modeling addressing land-surface atmosphere interactions on times scales from sub-daily to interannual (Yang).
2) chemical evolution of groundwater and ancient oceans, and the control of changing climate on these processes (Banner); and
3) quantifying climate variability and its uncertainties in the tropical ocean-atmosphere system using marine sedimentary archives such as corals and foraminifera (Quinn).

This research activity has the potential for integration with other strong programs within the department (e.g., hydrogeology; surface dynamics; tectonics and climate) and with other JSG units (e.g., UTIG's climate studies, ice-sheet dynamics, and marine geology and geophysics groups). However, both within the department and across the Jackson School units, research and teaching in climate studies is poorly integrated and an enhanced curriculum in climate studies is needed to train the next generation of leaders in this field. Future investments in this area should focus on bridging gaps and integrating ongoing climate research and education within and external to the Jackson School. Such integration can be facilitated through collaboration with the ESI.

The establishment of a discipline-leading group in climate science requires a series of strategic hires that will provide a critical mass of scientists needed to build a group that is successful in obtaining federal funds to support its research activity, in creating a leading edge curriculum, and in mentoring students who will develop into future leaders in the field. Growth in climate sciences in the DGS should include faculty and/or research scientist hires in the following areas: a) biogeochemist (C, N, P, O, S, and ecosystem modeling, with particular emphasis on the global carbon cycle modeling), b) remote sensing expert studying atmospheric and surface dynamics, c) climate and paleoclimate dynamicist with expertise in data analysis and/or modeling, and d) global water cycle expert.

Frontier Area 2: How do the core, mantle, lithosphere and surface interact to shape the physical and chemical evolution of the Earth?

Lithospheric Dynamics

Recent geological and remote sensing observations and numerical modeling has introduced new views into the dynamics of plate margins that are revolutionizing our understanding of the ways lithospheres interact. Examples include the realization that continental lithosphere may be pulled down into the mantle for up to hundreds of kilometers but then rebound to the surface rapidly; present-day margins are deforming at rates and in directions that could not be imagined from global plate motions; erosion of continental margins may influence uplift and deformation of continental arcs and vice versa and thus control everything from the supply rate of sediment to trenches to global atmospheric circulation and climate; that sediment subducted in the trench may in fact return to the surface in magmas in less than 1 m.y.; extensive erosion of the continental lithosphere by the downgoing slab may be returning huge quantities of sediment to the mantle; volcanoes in active arcs deform almost continuously from influxes and outfluxes of magma and gases and indeed magmas generated in the mantle at margins may rise to the surface in 1000's and possibly only 100's of years; fluids control the kinetics and dynamics of all geological processes and thus prescribe the textures and compositions of minerals, rocks, and magmas. These and other "Earth shaking" discoveries are revolutionizing our views of subduction zone kinematics and rates of tectonic and magmatic processes, which will in turn alter our views of the plate tectonics operate and how continental crust has formed and evolved through geological history. Fundamental questions include: What drives plate tectonics and how has plate tectonics varied with time? How do plate margins deform, evolve and interact? What controlling influence do fluids have on geological processes, including magma movement and volcano deformation, tectonic deformation, metamorphic reactions, mineralization processes, and mantle convection? What are rates of interrelated lithosphere and mantle processes? How are chemical and physical processes acting in the Earth's interior manifested at the surface and how do surface processes affect Earth's interior? What are the effects of Earth processes on climate? How much of the complex active magmatic, volcanic, and plate tectonic processes seen today are preserved in the rock record?

The Department has played a key role in observing and understanding the Earth's crust through research ranging from micro-scale geochemical variations in crystals to macro-scale deformation of colliding lithospheres. Our faculty have generated research funding that has resulted in hundreds of student theses and dissertations, as well as international awards for excellence. Currently our strengths are in examining the geological records of tectonic and magmatic events and kinematics of both past and active continental margins through studies of deformation (Mosher, Cloos, Marrett, Carlson, Gardner, Connelly, Housh, Dalziel, Horton, Wilson, Kyle). We also have one of the most well supported faculties in terms of quantitative geochemical measurements, and have had a strong base of geochronological and isotope geochemistry studies to support our geological observations. Better integration with UTIG will strengthen our research capabilities for observing and interpreting the geological record of plate margins.

Our department strengths puts us in a position to make important strides in incorporating the revolutionizing new views of continental dynamics and to tap into the millions of dollars that the National Science Foundation and NASA are investing in observing active margin systems to interpret how the Earth operates (e.g., *EarthScope*, *MARGINS*). To make the next leap forward, however, to become the world leader in these rapidly developing views of the continental systems, we require additional hires of faculty that can tap into the expanding observational platforms, be they geological, geochemical, remote sensing, or numerical modeling, that are quickly becoming the crux of our measurements of active continental margins. We seek the following faculty hires to fully realize the implications of our geochemical and geological observations.

1) To quantify the kinematics of active margins and to relate those to observations of past plate reconstructions we seek a remote sensing expert to measure and model deformation signals of active magmatic and deformation systems.
2) To explore the rates of volcanic, tectonic, and metamorphic processes we seek to strengthen our core geochronology strengths, which lies mainly in U-Pb zircon dating, by hiring geochronologists using isotopic systems that will greatly expand the timescales that can be dated through the measurement of U-Th disequilibria (tens to thousands to a few millions of years) and laser $^{40}Ar/^{39}Ar$ (thousands to tens of thousands to millions)
3) To explore the controlling influence that fluids have on all geological processes, including magma movement and volcano deformation, tectonic deformational rates, metamorphic reactions, and mineralization processes, we seek a geophysical fluid dynamist to model magma and fluid flow and interactions in fractured and porous media.

To integrate all of our present and future observations into coherent models of how plate margins deform and interact, we seek a lithospheric geo-dynamist to integrate numerical models with geochemical and geophysical observations plate motions and magma generation.

Deep Earth Processes/Dynamics

Study of the Earth's interior is focused on understanding the physical and chemical evolution of the interior of the Earth (e.g. mantle and core) and how this evolution both influences and is shaped by processes occurring at the Earth's surface. Such study is by nature highly interdisciplinary, incorporating aspects of high-temperature geochemistry, petrology, seismology mineral physics and geodynamics. One of the exciting aspects of this area of research is that each of the different sub-disciplines provides a number of powerful constraints on the evolution of the Earth's interior, yet in many instances these constraints appear contradictory. For example, geochemistry provides evidence that large portions of the mantle are chemically isolated from one another which provides a case for strong mantle layering. However, global seismology provides evidence that subducted slabs descend to the core/mantle boundary (e.g. whole-mantle convection). Today there is tremendous effort underway to derive a "Grand Unified Theory" for the Earth's interior that would reconcile the apparent contradictions. NSF has invested a huge amount of money into the study of deeper Earth processes, through programs such as Earthscope, COMPRES, RIDGE, MARGINS, CSEDI and CIG. Fundamental questions include: How does the mantle convect? What are the relative roles of mantle plumes, layered convection, and chemical stratification, and what is the time dependence of convection over Earth’s history (i.e. periodic superplume eruptions)? How do energy and material fluxes control mantle convection and plate tectonics? What drives plate tectonics and how has plate tectonics varied with time?

Many components needed to make a world-class program in this area already exist in the department, such as strong research programs in global seismology (Grand) and mantle geochemistry (Lassiter). The ties to the lithospheric tectonic processes are in place through our well established structural geology and tectonics research programs (Cloos, Mosher, Marrett, Connelly) and strong programs at UTIG and the BEG.

To build a forefront, interdisciplinary research program in this area requires a minimum of hires in two areas:

Mantle Geodynamicist - Geodynamic modeling is where the various constraints provided by geochemistry, seismology, and mineral physics are incorporated into a coherent whole. Geodynamic models both incorporate the constraints provided by the above disciplines and also make testable predictions (e.g. regarding seismic structure or chemical and isotopic heterogeneity in the mantle). Hiring a geodynamic modeler in the department would greatly facilitate communication and interaction between students and faculty engaged in study of the Earth's interior.

Mineral Physicist: Our understanding of the physical and chemical properties of materials at high pressure and temperature is limited, and this limits our ability to develop and test realistic models of the Earth's interior structure and behavior. What is the density or strength of minerals that comprise the lower mantle? Are melts more or less dense than their source at the core/mantle boundary? What are the chemical or thermal diffusivities of high--pressure mineral phases? Significant advances are being made in all these areas utilizing both experimental (diamond anvil, multi-anvil presses) and theoretical (quantum dynamic modeling) tools. The physical properties of mantle materials at high P & T are necessary for "observationalists" like Lassiter and Grand to accurately interpret their data in terms of mantle process.

Further additional hires that would strengthen this program include a high-T geochemist focused on U-Th disequilibria and an additional seismologist utilizing different imaging techniques