School of Natural Sciences and Mathematics

Department of Geosciences

Department Faculty

**Professors:** Carlos L. V. Aiken, John F. Ferguson, John W. Geissman, William I. Manton, George A. McMechan, John S. Oldow, Robert J. Stern

**Professors Emeritus:** David E. Dunn, Richard M. Mitterer, Emile A. Pessagno Jr., Dean C. Presnall, Robert H. Rutford

**Associate Professors:** Thomas H. Brikowski

**Associate Professor Emeritus:** James L. Carter

**Senior Lecturers:** William R. Griffin, Ignacio Pujana

Objectives

The basic objective of the Department of Geosciences Graduate Program is to provide students with a broad fundamental background in geosciences as well as an in-depth emphasis in a particular specialty.

The Master of Science degree (thesis option) is designed for students desiring research experience in a specific area of the geosciences. This degree will prepare the student for professional employment in the energy, mining, or environmental industries or government, as well as those seeking a doctoral degree. The Master of Science degrees (non-thesis options) are designed for students who are employed or seek employment in the energy, mining, or environmental industries, and the industrial application of Geospatial Information Sciences (GIS).

The Doctor of Philosophy degree in Geosciences emphasizes basic research in one of the specialties in geosciences and is designed to prepare students for advanced positions in the energy, environmental or mining professions in industry or government, or for positions in academia.

The Doctor of Philosophy degree in Geospatial Information Sciences (GIS) is supported by the Department of Geosciences, the School of Economic, Political and Policy Sciences, and the School of Engineering and Computer Science. The degree reflects geospatial information science origins at the confluence of work in multiple disciplines. The degree focuses on advancement of the technology, its associated theory, and the enhancement of its applications. Graduates of this program will be well suited to advanced positions in the geospatial technology industry and academic positions.
Facilities

Departmental research facilities include: digital imaging petrographic microscopes, rock preparation and mineral separation facilities, electronics shop and machine shop. Separate research facilities for computing, hydrology, thermal ionization mass spectrometry, geophysics and paleomagnetism/rock magnetism are described below.

Computing Facilities

The Geosciences Department has a large number of networked Windows/PC and Unix/Linux workstations in several laboratories accessible to the students and faculty. A number of laser printers are available, including a color printer. A large format HP 2500CP printer/plotter is available for creating maps and posters. A variety of software licenses are supported for GIS, remote sensing, image processing, geophysical data processing, graphics and visualization. Large scale computing is supported by two state of the art Linux clusters, one with 32 and one with 192 64-bit cores, and 30 terabytes of disk. A GeoWall visualization facility permits immersive interaction with 3-D data and is supported by high-resolution 3D HDTV visualization systems.

Hydrology Laboratory

Field equipment for measuring ground and surface water flow and chemistry, including borehole bailers, electric water level meter, FlowProbe hand-held flow meter, Hach DREL 2010 Basic Water Quality Lab (field spectrophotometer, pH and salinity meters), and YSI-85 DO/salinity/conductivity meter. Software for modeling water flow and transport, including general interfaces GMS and WMS, Hydrus-2D (unsaturated flow and transport), TOUGH2 and Tetrad (2-3D multiphase flow and transport), and many public-domain models. Hardware and software for visualizing model results, including Windows and Linux workstations.

Geochemical Laboratories

A Perkin-Elmer 6100 DRC ICP-MS is used for determining concentrations of a wide range of elements in materials. A Finnigan MAT 261 equipped with 9 collectors and a secondary electron multiplier is supported by Class 100 clean room facilities with sub-boiling acid distillation apparatus, micro- and semi-microbalances, and vessels for pressure decomposition of refractory silicates. Studies focus on using the evolution of Sr, Nd and Pb as indexes of petrogenetic processes, geochronology, environmental Pb, and evolution of marine Sr.

Geophysics Facilities

Geophysical research is supported by two Scintrex CG-5 gravimeters; a variety of surveying instruments including a Nikon theodolite and data collector, a TOPCON GPT 3005LW total station electronic distance meter and theodolite, two Laser Atlanta Advantage CI reflectorless laser rangefinders, a Riegl LMP 3800 laser scanner and a Riegl LSM Z620 laser scanner, seven dual frequency Leica Viva RTK GPS systems, three dual frequency Topcon HyperLite RTK GPS systems (6 receivers), nine dual frequency Leica SR9500 GPS receiver systems with choke-ring antennas, a Trimble GeoXT GPS system, a Trimble GeoHT GPS system and GPS post-processing software.
including Leica SKI, Trimble Pathfinder Office and BERNESE. A Geometrics proton-procession total field magnetometer system, An AGI SuperSting R1/IP DC resistivity and induced polarization system is available for near surface electrical conductivity mapping. Seismic and radar equipment include a Geometrics 48-channel floating point seismic acquisition system with Betsy, hammer, and explosive sources for shallow to deep exploration; and pulse EKKO IV, 1000 and PRO ground penetrating radars.

Paleomagnetism and Rock Magnetism Laboratory

The newly completed Paleomagnetism and Rock Magnetism laboratory, including a low magnetic field induction space designed and constructed by Dr. Gary Scott of Lodestar Magnetics, is about 2,600 sq. feet in footprint, and includes an attached sample preparation/wet chemistry laboratory, equipped with a fume hood, and an attached meeting/office space area for graduate and undergraduate students. The laboratory includes all non-magnetic furniture and cabinetry installed by Dr. Gary Scott and colleagues in the low magnetic field space. The workhorse instrument for all remanence measurements is a 2G Enterprises Model 760R horizontal access, three measurement axis (DC SQUID) superconducting rock magnetometer, equipped with DC SQUIDS and superinsulation. A fully automated specimen handling system is interfaced with an online alternating field (AF) demagnetizer capable of reaching peak inductions of 160 mT, allowing for automated demagnetization of specimens. We have initiated the purchase of a new, pulse-cooled magnetometer from 2G Enterprises, with anticipated delivery in early 2013. AGICO JR-5 and AGICO JR-6 spinner magnetometers allow for the remanence measurements in both automated and static mode. Thermal demagnetization is conducted using Shaw (MMTD), and three ASC (TD48) furnaces, a Schonstedt (TSD-1), as well as a home built large-volume, three heating zone furnace capable of heating/cooling in an inert atmosphere. A large-volume furnace is capable of conducting long-term, elevated temperature magnetic viscosity experiments in a controlled atmosphere. The laboratory includes two ASC impulse magnetizers, with the full range of coil sizes. Two home built impulse magnetizers capable of peak DC induction of 1.3 T and 3.4 T and a horizontal Curie balance for measuring saturation magnetization as a function of temperature in an inert atmosphere. An additional, home built impulse magnetizer, capable of reaching about 9 T, is currently being tested. Two ASC D-2000 AF demagnetizers provide peak field values of 200 mT and are capable of imparting anhysteretic remanent magnetization (ARM) and partial ARM with DC fields up to 1.0 mT. A D-Tech coil interfaced with an externally tuned Schonstedt GSD 1 AF demagnetizer also allows for AF demagnetization and ARM acquisition. Chemical demagnetizations are carried out in a fume hood environment in the laboratory. The leaching and drying of specimens is carried out in a field-reduced environment (less than 300 mT) in the fume hood. Kappabridge KLY-3S, KLY-4S, and MFK1-FA automated susceptibility systems allow bulk and anisotropy of magnetic susceptibility measurements to be made in both static and automated modes. The KLY-3S and MFK1-FA susceptibility units are interfaced with a CS-4 furnace assembly for measuring susceptibility as a function of temperature in an inert atmosphere. The laboratory also has over ten sets of mu-metal shields of different volumes and geometries, to provide very low magnetic field environments for different purposes. We are equipped for all aspects of field sampling and specimen preparation, including four complete sets of drilling equipment and three dual bladed trim saws. An Olympus BX51TRF-5 transmitted light/ reflected light microscope, equipped with a dedicated DP72, 12.8 mp digital camera. A Princeton
Instruments AGM/VSM, equipped with a high temperature furnace assembly, acquired by the Physics Department in 2010, has been transferred to the Geosciences Department, and a space remote from the Paleomagnetism Laboratory houses the magnetometer and internal water chiller system. The Physics Department at UT Dallas maintains a Quantum Designs Magnetic Property Measurement System and this is available for use by the PI and students. The UT Dallas Paleomagnetism Laboratory has dedicated field vehicle.

Admission Requirements

The University's general admission requirements are discussed on the Graduate Admission page (catalog.utdallas.edu/2013/graduate/admission).

Applicants are typically expected to take the GRE General Test (Verbal, Quantitative, and Analytical Writing). A combined score of no less than 300 on the Verbal and Quantitative portions of the exam is advisable based on our experience with student success in the program. In addition, students should complete and submit a Supplemental Geosciences Application Form which can be obtained from the Geosciences Department Office by mail (ROC 21, The University of Texas at Dallas, 800 W. Campbell Road, Richardson, TX, 75080, USA), telephone (972-883-2401), or email the Geosciences Department.

Entering students are expected to have completed the equivalent of the University's BS degree in Geosciences, including courses in physics, mathematics and chemistry. Students whose undergraduate training is in a science other than geology or geophysics are admitted to the program when their previous course work complements or supports their intended research interests. Deficiencies in the undergraduate background of admitted students will be address through a sequence of four required graduate courses. It is understood that the minimum course requirements for the intended degree, as specified below, apply to well-prepared students.

Degree Requirements

The University's general degree requirements are discussed on the Graduate Policies and Procedures page (catalog.utdallas.edu/2013/graduate/policies/policy).

Additional requirements are specified below for each degree.

Graduate Certificate in Remote Sensing

15 hours

The Remote Sensing Certificate is supported by the Department of Geosciences and the School of Economic, Political and Policy Sciences.

The American Society for Photogrammetry and Remote Sensing (1997) defined remote sensing as the art, science, and technology of obtaining reliable information about physical objects and the environment, through the process of recording, measuring and interpreting imagery and digital representation of energy patterns derived from non-contact sensor systems.
Remote sensing is a powerful set of software and hardware, computer-based techniques for extraction and presentation of information represented by raster and vector spatial data acquired via non-contact sensors. It provides reliable and cost-effective means of studying the environment for protection, natural resources management and urban planning. Government and non-government organizations continuously seek qualified professionals to use remote sensing for a wide range of applications.

Prerequisites and Admission

- BS or BA Degree. Competence in personal computers, especially Windows-based, is expected.
- Application for admission to UT Dallas Graduate School as "non-degree or degree seeking"
- Only BS or BA transcripts are needed. No GRE score or reference letters are needed for non-degree seeking students.
- Online registration is at: www.utdallas.edu/admissions

Course Requirements

The Graduate Certificate in Remote Sensing is obtained by completing 15 hours of courses. Students must complete the following courses:

- **GEOS 5325** Remote Sensing Fundamentals
- **GEOS 6381** or **GISC 6381** Geographic Information Systems Fundamentals
- **GEOS 5326** or **GISC 7365** Remote Sensing Digital Image Processing
- **GEOS 5329** or **GISC 7366** Applied Remote Sensing
- **GEOS 7327** or **GISC 7367** Remote Sensing Workshop

Master of Science in Geosciences

36 hours minimum

Thesis Option

All students seeking the Master of Science degree (thesis option) must satisfactorily complete the following requirements (a minimum of 36 graduate semester hours):

- **GEOS 5315** The Earth: An Overview
- **GEOS 5330** Geospatial Applications in Earth Science
- **GEOS 5375** Tectonics
- **GEOS 5387** Applied Geophysics

A minimum of 15 hours of additional graduate courses.
A minimum of nine semester hours of thesis research including GEOS 8398 Thesis and submit an acceptable thesis.

In addition to the above requirements, students seeking the MS degree (thesis option) must submit, no later than the second semester of enrollment, an acceptable degree plan and a research proposal to their supervising committee. Upon completion of the thesis research, the MS degree candidate will publicly defend the thesis.

Non-Thesis Option

All students seeking the Master of Science degree (non-thesis option) must satisfactorily complete a minimum of 36 graduate semester hours including the specified Geosciences courses below.

- **GEOS 5315** The Earth: An Overview
- **GEOS 5330** Geospatial Applications in Earth Science
- **GEOS 5375** Tectonics
- **GEOS 5387** Applied Geophysics

A minimum of 21 hours of additional graduate courses, to be selected in consultation with the graduate advisor.

Research: An 8000 level, 3-hour research course.

In addition to the above requirements, students seeking the MS degree (non-thesis option) must submit, no later than the second semester of enrollment, an acceptable degree plan.

Master of Science in Geospatial Information Sciences

30 hours minimum

The Master of Science in Geospatial Information Sciences (MGIS) is a professional program that is offered jointly by the School of Economic, Political and Policy Sciences and the School of Natural Sciences and Mathematics. The program focuses on the use of Geographic Information Systems (GIS) and associated technologies such as remote sensing and global positioning systems for managing spatially referenced information. Students are provided with the concepts underlying GIS, the skills for implementing GIS projects in public and private sector organizations, and the ability to use GIS in pure or applied research in substantive areas. Prospective students should apply using established procedures to either Geosciences or the School of Economic, Political and Policy Sciences depending on their background.

For the Master's degree in Geospatial Information Sciences, beginning students are expected to have completed college Mathematics through Calculus and at least one programming or computer applications course or possess equivalent knowledge. Students must have the equivalent of GISC 6381 Geographic Information Systems Fundamentals and GISC 6382 Applied GIS, or they must take these
courses at UT Dallas in addition to the 30 credit hours required for the MGIS. Additional details of the curriculum can be found under "Master of Science in Geospatial Information Sciences," in the School of Economic, Political and Policy Sciences section of the catalog.

Doctor of Philosophy in Geosciences

75 hours minimum beyond the baccalaureate degree

All students seeking a Doctor of Philosophy degree in Geosciences must satisfactorily complete the following requirements (75 graduate hours minimum).

- **GEOS 5315** The Earth: An Overview
- **GEOS 5330** Geospatial Applications in Earth Science
- **GEOS 5375** Tectonics
- **GEOS 5387** Applied Geophysics

A minimum of 18 hours of additional Geosciences graduate courses to be specified by the student's research supervisory committee and the graduate advisor.

A minimum of 36 hours of additional graduate courses or research.

A minimum of nine semester hours of thesis research including **GEOS 8399** Dissertation and submit an acceptable dissertation.

In addition to the above course requirements, students seeking the PhD degree must submit an acceptable degree plan and research proposal describing the intended project to be completed for the dissertation. Students entering with a Master's should complete this proposal in the third semester; students entering without a Master's have until the fourth semester. An oral qualifying examination covering the broad background and detailed knowledge relating to the student's specialization and research proposal will be held in the same semester that the proposal is submitted. After satisfactory performance on the Qualifying Examination, the student will complete and publicly defend the dissertation.

Also, see the University's general degree requirements. Please note that more detailed instructions for Geosciences Graduate students are given in the "Guidelines for Graduate Students - Geosciences" that is available in the office of the Department Head.

Doctor of Philosophy in Geospatial Information Sciences

75 hours minimum beyond the baccalaureate degree

The Doctor of Philosophy in Geospatial Information Sciences is an advanced degree offered jointly by the School of Natural Sciences and Mathematics, the School of Economic, Political and Policy Sciences and the Erik Jonsson School of Engineering and Computer Science. Geospatial information is a
unifying theme across a wide range of disciplines and the unique organization of this program permits a diverse range of expertise to the prospective student. The PhD in GIS is intended to go beyond the MS in GIS degree in terms of analysis, the creation of new technology and the novel application of geospatial information technology. This program will prepare students for leadership positions in academy, industry or government.

Individual students can concentrate in particular discipline areas. The Geosciences component focuses on remote sensing and mapping technologies, including global positioning satellite and three-dimensional laser ranging based data capture as well as other imaging technologies. In particular, these methodologies are applied to geological, hydrological, and environmental problems associated with the physical Earth.

It is expected that students will enter this program with diverse educational backgrounds. Applicants may have Bachelors, Masters or other advanced degrees in any relevant field including computer science, economics, engineering, geography, geology, information system management, resource management, geographical information science, and possibly others. At least a Bachelors degree from an accredited (or equivalent) institution with an undergraduate/graduate grade point average of 3.25 or better is required. A GRE score of 300 or higher for the combined quantitative and verbal components is desirable. Fluency in written and spoken English is required. Please see detailed degree requirements under "Doctor of Philosophy in Geospatial Information Sciences," listed in the School of Natural Sciences and Mathematics section of the catalog.