Geology (M.S.)

About The Program:

The Department of Earth and Environmental Science offers a two-year M.S. program that includes graduate courses in Geology, weekly graduate seminars, qualifying exams, and research leading to a master's thesis.

Career Options: Graduates secure positions in industry, education, and government, and are accepted into doctoral programs.

Prerequisites for Admission: One year of Physics, Chemistry and Calculus preferred

Areas of Specialization:

Advanced courses and research opportunities are available in:

- Environmental geology, including ecohydrology, energy and land degradation, environmental geophysics, groundwater modeling, ice sheet stability and climate change, Karst hydrology, nanomineralogy, and urban hydrology.
- Geochemistry, including nanomineralogy, paleontology-fossil provenance, planetary geology, and weathering and diagenesis.
- Sedimentary geology and paleontology, including coastal and aeolian dynamics, ichnology, paleontology-fossil provenance, paleopedology and modern soils, planetary geology and impact studies, and Precambrian geology.
- Structural geology, including geothermal energy and geomechanics.

Requirements of Programs:

- **Total Credit Hours**: 30
- **Culminating Events**:
  Comprehensive Examination:
  The purpose of the comprehensive examination is to demonstrate breadth and depth of knowledge in the concepts of geological sciences. The exam has written and oral sections. It is taken when the student completes at least 20 credits.
  Thesis:
  The Department of Earth and Environmental Science requires an original research thesis as the culminating project to earn its master's degree. The thesis is evaluated for both scientific content and writing style by a committee of two faculty members and the thesis advisor. Students are required to defend their theses publicly to the academic community.

Core Courses

Select courses from the following to total 28 credits:

Remote Sensing and GIS – The focus of this class is on remote sensing technologies and geographic information systems. Remote sensing is a dynamic field; new, high-resolution satellites are coming on line almost daily, and there has been an exponential growth in applications of remote sensing data during the past decade, including: mineral exploration, precision agriculture, watershed management, land use classification, military intelligence, and climate monitoring. By the end of the semester you will have a fundamental understanding of the uses and limitations of remote sensing data for environmental applications, and a thorough familiarity with geographic information systems.

Coastal Processes – The course will apply a process geomorphological approach to understanding coastal behavior, including global distribution of coasts, wave and tidal hydrodynamics, nearshore and aeolian sediment transport, and morphological signatures of extreme events.

Structural Geology (Graduate) – The purpose of this course is to train students in the concepts and techniques of structural geology. Students will learn how to collect, analyze, and interpret geologic data drawn from a variety of disciplines pertinent to structural geology and present a cohesive analysis and interpretation of these results. Results are presented as maps, reports, and computer models. A hypothesis driven term project will be conducted by the graduate student on a topic in structural geology. NOTE: This course differs from the undergraduate version EES 4101 through graduate specific laboratory and exam questions, readings, and the term project.

Analytical Methods in Mineralogy – An introduction to the theory and application of X-ray diffraction and spectroscopic techniques for analysis of mineralogical samples. Students will learn the theory underpinning these methods, acquire skills in instrument operation, and apply these skills to research-relevant problems such as phase identification, site occupancy, chemical analysis, and planetary surface studies. Techniques discussed include powder X-ray diffraction, visible, Raman, and infrared spectroscopy, and synchrotron-based X-ray spectroscopic and scattering techniques.

X-ray Crystallography – Generation and use of x-rays for diffraction analysis; Analysis of clays and related minerals by x-ray diffraction; Crystal structure patterns and biogeofunctional groups.

Nanoscience and the Environment – Nanotechnology has developed rapidly in the past decade, yet our knowledge of its environmental impact, particularly regarding the fate and behavior of nanomaterials in the environment, lags far behind. This course will cover a range of topics concerning nanomaterials in the environment, ranging from the unique size-dependent properties of nanomaterials to their applications in environmental remediation. The lab component of this course will include nanomaterial synthesis and characterization; nanomaterial transport, aggregation, deposition, transformation, and persistence in natural settings; environmental applications of nanomaterials; and nanomaterial characterization techniques, particularly electron microscopy.

Ecohydrology – Hydrological and ecological processes are tightly interrelated, with vegetation affecting the hydrological cycle, and hydrologic partitioning of the water budget affecting vegetation dynamics. This course builds on perspectives from ecology, hydrology, and soil science to focus on the emerging, interdisciplinary area of ecohydrology - the science that studies mutual interaction between the hydrological cycle and ecosystems. The first part of the course will deal with fundamental processes controlling the flow of water in the biosphere (in land, atmosphere, soil and plants) and the interactions with ecological processes and human dimensions at different scales. The second part will deal with the implications of ecohydrological feedbacks, covering a broad range of issues including global environmental change, land use change, global desertification/land degradation, urbanization, soil erosion, and the food-energy-water nexus. The concepts and principles discussed in the class will have broad applications ranging from finding innovative solutions to ecosystem degradation and food security, and designing global change responses.

Introduction to Geophysics – An introduction to gravity, magnetic, electromagnetic, and seismic exploration methods. Applications include environmental characterization, oil and mineral exploration, geotechnical engineering, and archeology.

Low-Temperature Geochemistry – Principles of aqueous geochemistry discussed within the framework of geologic processes. One or two field trips.

Advanced Low-Temperature Geochemistry – Study and discussion of topics in aqueous and sedimentary geochemistry.

Glaciology – This course presents the basic physical principles governing natural processes occurring to and within glaciers and ice sheets on Earth, and how they interact with the surrounding environment. The following major topics will be covered during the course: 1) the deformation and flow of ice; 2) energy transfer within ice and energy exchanges with the surroundings; and 3) ice geomorphic processes.

Vertebrate Paleontology and Taphonomy – This course examines vertebrate fossils and their importance for interpreting and reconstructing terrestrial ecosystems. Students will learn the basics of vertebrate skeletal anatomy, interpret transport and depositional histories of skeletal elements and assemblages, and combine this information with geologic data to reconstruct paleoenvironmental settings and paleocommunity associations. Several class sessions will meet off-campus at local museums; one weekend field trip is required.

Electron Optical Techniques – This course will introduce the microanalytical and imaging methods of electron optical instruments such as the Electron Probe Microanalyzer (EPMA) and the Scanning Electron Microscope (SEM). The theory and operation of the instruments will be covered as will the interpretation of images and analytical results.

Sedimentary Petrology – This course explores the basic composition and texture of sedimentary rocks in order to understand depositional environment and provenance. This course focuses on sedimentation mechanics, petrography, and diagenesis. Includes a lab.

Soils and Paleosols – The course is divided into two parts: modern soils and paleosols. The goals of this course are to teach students the fundamentals of modern soil genesis and classification in order to interpret ancient soils preserved in the rock record (paleosols), and to incorporate models of soil genesis into the traditional geology paradigm. Students will be exposed to a combination of laboratory methods and field work.

Quantitative Structural Geo Tectonics – Plate tectonic theory. Structure and geometry of lithospheric plates; mechanisms of divergent, transform and convergent boundaries; subduction;

obduction; mantle plumes; large igneous provinces; large sedimentary basins and Phanerozoic orogenic belts.

Planetary Geology – This course explores the modern and ancient geologic processes on other planets and discusses how studies of other planets can aid us in a better understanding of our Earth. The course will also cover topics such as planetary exploration and astrobiology. Includes a lab.

Geology Seminar – Required of M.A. students. Visiting specialists in a wide variety of geologic fields will lecture and discuss their research.

Independent Study Program – Limited to Geology graduate students with permission from the department.

Graduate Geology Seminar – Advanced seminar course; subject matter varies from semester to semester. The educational objectives of the course are to focus on current issues at the interfaces of geological processes through advanced technological methods of analysis.

Advanced Hydrogeology – This course covers water resources with an emphasis on groundwater. Topics include quantifying groundwater flow, groundwater-surface water interactions, contaminant transport, and a brief introduction to modeling. Problem sets and labs are used to develop specific skills, including field techniques.

Groundwater Modeling – This course offers students a chance to construct models using well known codes such as MODFLOW and other practical tools. The goals of this course are: learn tools for groundwater flow modeling, be able to recognize how to judge models and compare them with reality, and gain computer skills that can be used with a wide variety tools.

Research Course

Master's Thesis Research – Course for master's thesis research. Only intended for students in thesis bearing master's programs. A minimum of one credit is required. This course will confer full-time status at the minimum credit hour registration limit of one credit.

Courses:

Click HERE for more information on the courses below.

- Remote Sensing and GIS
- Coastal Processes
- Structural Geology (Graduate)
- Analytical Methods in Mineralogy
- X-ray Crystallography
- Environmental Nanogeoscience
- Ecohydrology
- Introduction to Geophysics
- Low-Temperature Geochemistry
- Advanced Low-Temperature Geochemistry
- Glaciology
- Vertebrate Paleontology and Taphonomy
- Electron Optical Techniques
- Sedimentary Petrology

- Soils and Paleosols
- Quantitative Structural Geo
- Tectonics
- Planetary Geology
- Geology Seminar
- Independent Study Program
- Graduate Geology Seminar
- Advanced Hydrogeology
- Groundwater Modeling
- High Temperature Reactions
- Regional Geology
- Economics of Geo Ore Deposits
- Teaching of Geology
- Master's Research Projects
- Preliminary Examination Preparation
- Capstone Project
- Master's Thesis Research