Course Catalog

Geosciences

Faculty

Kurt Knesel, Ph.D., Visiting Assistant Professor
Glenn Kroeger, Ph.D., Associate Professor
Dan Lehrmann, Ph.D., Gertrude and Walter Pyron Professor of Geosciences
Diane Smith, Ph.D., Imogene and Harold Herndon Professor of Geology
Benjamin Surpless, Ph.D., Professor
Kathleen Surpless, Ph.D., Professor; Chair
Brady Ziegler, Ph.D., Assistant Professor

Overview

The department of Geosciences offers two degrees, a Bachelor of Arts in Earth Systems Science and a Bachelor of Science in Geosciences. The Bachelor of Arts program prepares students interested in careers or disciplines that require a fundamental understanding of Earth systems (e.g., environmental science, secondary education, law, geography). This BA program offers flexibility, allowing students to pursue intensive study in other disciplines. The Bachelor of Science program offers two concentrations to prepare students for graduate work in geosciences or for entry-level positions in geosciences and related fields. The Geosciences BS with a concentration in Geology serves the student interested in a traditional, broad-based foundation in geosciences, and the Geosciences BS with a concentration in Environmental Geosciences serves the student interested in addressing environmental issues of the 21st century.

Requirements

- Departmental requirements: Bachelor of Arts Degree in Earth Systems Science (ESYS)
- Departmental requirements: Bachelor of Science Degree in Geosciences
- The Minor
- Honors in Geosciences
The Major

Departmental requirements: Bachelor of Arts Degree in Earth Systems Science (ESYS)

The requirements for the degree of Bachelor of Arts with a major in Earth Systems Science (a minimum of 46 credit hours) are:

I. Required courses in geosciences:
   A. One of GEOS 1303, GEOS 1405, GEOS 1406, 1307, or 1409.
   B. GEOS 2400, 2402, and 2403.
   C. GEOS 3101.
   D. GEOS 3120 is required for junior majors. Trip expenses, including transportation, must be paid by each student.
   E. GEOS 4320 is required for senior majors.

II. At least 14 additional upper division hours in geosciences; no more than 3 hours of Directed Studies or Thesis may be applied to this upper division hour requirement.

III. 12 additional credit hours from the following courses: ANTH 2310; BIOL 1311 and 1111; BIOL 2312 and 2112; BIOL 3434; BUSN/ECON 2301; CHEM 1318 and 1118; CHEM 2319 and 2119; CHEM 3432; MATH 1311; MATH 1312; MATH 1320; MATH 2308; CSCI 1320; CSCI 1321; PHYS 1309 or 1311, and 1111; PHYS 1310 or 1312, and 1112.

IV. University requirements: completion of all other required elements of the Pathways curriculum and at least 120 credit hours.

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Bachelor of Science Degree in Geosciences

The requirements for the degree of Bachelor of Science with a major in Geosciences (a minimum of 56 credit hours) are:

I. Required courses in geosciences:
   A. One of GEOS 1303, GEOS 1405, GEOS 1406, 1307, or 1409.
   B. GEOS 2400, 2402, and 2403.
   C. GEOS 3101.
   D. GEOS 3120 is required for junior majors. Trip expenses, including transportation, must be paid by each student.
   E. GEOS 4320 is required for senior majors.
I. Geosciences and cognate courses to complete one of the following concentrations:

A. **Geology Concentration:**
   1. GEOS 3401; GEOS 3422 or GEOS 3423.
   2. MATH 1311; MATH 1312 or MATH 1320 or MATH 2308.
   3. CHEM 1318 and 1118.
   4. PHYS 1309 or 1311, and 1111; PHYS 1310 or 1312, and 1112.

B. **Environmental Geosciences Concentration:**
   1. GEOS 3408 and GEOS 3411.
   2. MATH 1311; MATH 1312 or MATH 1320 or MATH 2308.
   3. CHEM 1318 and 1118.
   4. At least 8 credit hours from the following list: BIOL 1311 and 1111; CHEM 3432; PHYS 1309 or 1311, and 1111; PHYS 1310 or 1312, and 1112.

I. At least 10 additional upper division hours in geosciences; no more than 3 hours of Directed Studies or Thesis may be applied to this upper division hour requirement.

It is strongly recommended that students take an accredited and departmentally approved summer field geology course.

I. **University requirements:** completion of all other required elements of the Pathways curriculum and at least 120 credit hours.

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### The Minor

**Requirements**

The requirements are at least 18 hours of geoscience courses including GEOS 2400 and at least 9 hours of upper-division geoscience courses.

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### Honors in Geosciences or Earth Systems Science

**Requirements**

Six hours of Thesis credit, GEOS 4395 and 4396, must be completed over two semesters. Students may enroll for thesis credit only with the permission of the thesis director. A formal written thesis proposal must be submitted to
the geosciences Chair before the end of the fourth week of classes during the first semester of enrollment for thesis credit. Achievement of Department Honors will be determined by the quality of the thesis research, the written and oral presentations, and satisfaction of University requirements.

Courses

GEOS-1303 Volcanology
The study of volcanoes with emphasis on volcanic morphology, eruptive mechanisms, rock types, and magmatic properties and processes. Volcanoes will be examined in the context of plate tectonic theory. Natural resources produced by volcanic processes and geologic hazards associated with volcanism will be discussed. (Offered every other year.)

GEOS-1405 Oceanography
An inquiry-based introduction to the geologic, chemical, physical and biologic aspects of the Earth's oceans. Topics include plate tectonics, seawater composition, waves, tides, currents, marine habitats and ecosystems and global climate change. Approximately one half of the course meeting times will be data analysis, laboratory or field activities. Field trip required; field trip costs must be paid by each student. (Offered every year.)

GEOS-1406 History and Evolution of Life
An inquiry-based study of major events in the history and evolution of life. Topics include fundamentals of earth systems, the origin of life, mechanics of evolution, diversification of life, the invasion of land, innovation of flight, mass extinctions, evolution of mammals, primates and hominids, and how human activity may affect the future of life. Three class hours each week, three full-day field trips, and out of class projects including analysis and synthesis of data gathered on field trips. Field trips are required; field trip costs must be paid by each student. (Offered every Spring)

GEOS-1307 Geology, Resources, and Environmental Issues of China and Southeast Asia
A survey of the basic geology, natural resources and environmental issues of China and southeast Asia. The fundamental geologic context of China and southeast Asia will be presented in the context of plate tectonics, Earth system processes and Earth history. A large part of the course will be in seminar format. Discussion topics will focus on the unique geological features of China and southeast Asia, the geology of hydrocarbon, metallic and non-metallic resources, and the unique environmental challenges China and southeast Asia face as a result of rapid economic development.

GEOS-1409 Earth’s Environmental Systems
An inquiry-based examination of the interaction of the Earth’s natural systems and the role that humans play in determining the evolution of those systems. Topics include plate tectonics, solid earth processes and resources, surficial physical and chemical processes, energy resources, and global climate change. Field trips required; field trip costs must be paid by each student. (Offered every year.)
GEOS-2400 Solid Earth Processes
An intermediate-level, inquiry-based study of the fundamental geological materials and processes of the Earth. Topics include plate tectonics, geophysical studies of the subsurface, mineral properties and formation, rock properties and formation, volcanic processes and landforms, earthquake processes, geologic map interpretation, cross section construction, and relative and absolute age dating. Three class hours and three laboratory hours each week. Field trips are required; field trip costs must be paid by each student. (Offered every year). Prerequisites: One lower division GEOS Course or fulfillment of the Natural Sciences Approach of the Pathways curriculum.

GEOS-2401 Earth History
A study of the significance of time as reflected in the rock and fossil record, with emphasis on understanding geological processes within a time framework. An analysis of time concepts, stratigraphic principles, and the fundamentals of sedimentary geology including the historical development of geological concepts and the recognition and reconstruction of ancient environments. Laboratory: study of minerals, rocks, and fossils; interpretation of surface features and time relationships through the use of topographic and geologic maps, cross sections, correlation diagrams, and aerial photos. Three class hours and three laboratory hours a week. Field trips are required; field trip costs must be paid by each student. Prerequisites: GEOS 2400

GEOS-2402 Earth Surface Processes
The course delves into the processes that shape our planet’s dynamic surface. At their most fundamental, these processes are controlled by force, the transport of mass, and the transmission of energy on the surface of our planet. In addition to geoscience concepts, we will apply principles of physics, biology, chemistry, and mathematics in order to understand the short- and long-term evolution of landscapes, soil systems, and groundwater systems. (Offered every Spring.) Prerequisite: GEOS 2400

GEOS-2403 Earth Materials
An introduction to the classification, identification, and formation of minerals, rocks, and soil. Students in the course will be able to evaluate the processes responsible for the origin of minerals and rocks in solid earth and surficial systems, and to appraise the role of minerals and rocks in the Earth system and society. The laboratory emphasizes methodologies and techniques used to identify and classify common minerals and rocks in hand specimen and thin section. Weekend field trip required; students are responsible for field trip expenses. Three class hours and three laboratory hours per week. (Offered every year.) Prerequisite: GEOS 2400

GEOS-3400 Earth Materials
An introduction to the origin, classification, and identification of minerals and rocks, including topics related to crystal systems and structures, bonding, mineral chemistry, the nature of magma, solidification of magma, magma genesis and evolution, types of metamorphism, metamorphic mineral reactions, metamorphic zones and facies, determination of metamorphic grade, and the importance of mineral and rock resources to society. The laboratory emphasizes methodologies and techniques used to identify and classify common minerals and rocks in hand specimen and thin section. Three class hours and three laboratory hours per week. (Offered every year.) Prerequisite: GEOS 2400
GEOS-3401 Structural Geology
A study of the mechanics of crustal deformation in the context of plate tectonics. An introduction to the descriptive, kinematic, and dynamic analysis of structures such as folds, faults, joint systems, and foliation. Emphasis on the application of structural cross-sections, stereonet analysis, graphical techniques, and computer applications to problems involving stress and strain of earth materials. Three class hours and three laboratory hours per week. Field trips required; field trip costs must be paid by each student. (Offered every Fall.) Prerequisite: GEOS 2402 or GEOS 2403.

GEOS-3402 Paleontology
A study of invertebrate fossils, their classification, morphology, and geologic history. Also included will be an introduction to the principles of paleontologic investigation and their application to the study of geology. Three class hours and three laboratory hours a week. Prerequisite: GEOS 2402.

GEOS-3307 Planetary Geology
An introduction to the geologic processes that operate on the surfaces and within the interiors of rocky ice-rich objects in the Solar System. Earth analogues, remote sensing, and the latest results from the robotic planetary exploration are used to investigate the origin and geology of the solar system. Topics include nebular materials and processes in the early solar system, orbital dynamics, meteorites and impact cratering, formation and evolution of lithospheres and atmospheres, volcanism and tectonics, weathering phenomena, planetary environments, space missions and the data sets they collect. Prerequisite: GEOS 2400.

GEOS-3309 Tectonics
Study of the tectonic processes of the Earth with emphasis on the historical development of tectonic theory and current research in tectonics. Topics include: geophysical and geochemical characterization of the Earth’s interior, plate kinematics and dynamics, earthquake mechanisms, the nature and origin of continental crusts and margins, and the relationship between tectonics and rock-forming processes. Prerequisite: GEOS 2403 or GEOS 3400.

GEOS-3310 Global Climate Change
An intermediate-level study of the fundamental science of global climate change. Topics include an introduction to the global climate system, a review of the fundamentals of energy transfer between earth systems, investigation of the geologic evidence of natural climate change, and evidence for anthropogenic climate change. The course will also delve into the present and future impacts of climate change on natural systems and human activities, and students will investigate potential viable solutions to global climate change. (Offered every other year.) Prerequisites: One lower division GEOS course.

GEOS-3411 Hydrogeology
This course will focus on the fundamentals of groundwater, including groundwater recharge, movement, and storage. Basic concepts covered will include aquifer properties, groundwater flow, aquifer heterogeneity, well monitoring and sampling, chemical evolution of natural groundwater, and an introduction to contaminant fate and transport. The laboratory component of this course will involve data collection, manipulation, and analysis, as well as the use of physical and computational models to simulate groundwater flow and aquifer properties. Field trips are required; field trip expenses must be paid by each student. Prerequisites: GEOS 2400. Recommended: CHEM
1318 and CHEM 1118. (Offered every other year.)

GEOS-3412 Applied Geophysics
An introduction to the use of physical principles and measurements in the study of the Earth's subsurface, with an emphasis on applications in environmental science, engineering, mineral exploration and archeology. Topics include Fourier analysis, seismic waves in elastic media, refraction tomography, reflection seismology, multichannel analysis of surface waves, gravity, electrical resistivity and ground penetrating radar. Three class hours and three laboratory hours per week. Field trips are required; field trip expenses must be paid by each student. (Also listed as PHYS 3412.) Prerequisite: PHYS 1310 or 1312 (may be taken concurrently).

GEOS-3315 Iceland - Its Unique Geological, Economic and Cultural History
This course will expose students to the unique economic, geologic, and cultural history of Iceland. The economic aspects will focus on the role of financial markets and monetary institutions in economic booms and crashes using Iceland as a case study, possible solutions to public good problems such as the Icelandic fishing quota, business practices which often prioritize protection of the environment and social responsibility, and the role of international trade in development of a small country. The geological history will emphasize Iceland's plate tectonic setting, volcanism, glacial history and related hazards, geothermal energy, and the effects of climate change. The cultural portion will explore the fundamental role of literature in a country with virtually no illiteracy, and the role of the sagas in the transmission of culture, language, and the law in the country with the oldest parliament in the world. (Also listed as BUSN 3315, ECON 3315, INTL 3315, and PLSI 3315.) (Offered every third year.)

GEOS-3319 Field Geology in China
Field study of the evolution of sedimentary basins and mountain belts in China. Emphasis on developing observational and interpretative skills in the field. Additional goals are to gain an appreciation of Chinese culture, language and history by working together with Chinese students and studying a variety of sites of historical and cultural importance. Students interested in geosciences, environmental studies, anthropology, and Chinese languages and cultures are encouraged to apply. Prerequisites: One course in geology, consent of instructor.

GEOS-3101 Geosciences Seminar
Attendance and participation in departmental seminars. Grade is based on participation, completion of assignments, and attendance. Course may be repeated up to 3 times. Pass/Fail only. (Offered every year.)

GEOS-3120 Majors' Field Trip
Field study of selected areas in Texas and surrounding regions: emphasis on developing observational and interpretative skills in the field. May only be taken on a pass-fail basis. Field trip costs must be paid by each student. May be taken twice for credit. Prerequisite: Departmental major or by invitation of the department.

GEOS-3408 GIS and Remote Sensing
An introduction to computer-based mapping and spatial data analysis used in earth and life sciences and environmental monitoring and management. Topics include: digital representation of data and images; cartographic principles and the use of GPS; raster and vector based geographical information systems (GIS);
geostatistics, kriging, and visualization of geospatial data sets; acquisition and analysis of multispectral remote sensing data, including principle component analysis and classification techniques. Three class hours and three laboratory hours a week. (Offered every year.) Prerequisites: Completion of both the Natural Sciences and the Quantitative Reasoning approaches within the Pathways curriculum.

GEOS-3421 Environmental Geochemistry
A study of the geochemical processes that occur at or near Earth's surface and their application in solving geologic and environmental problems. Topics emphasized will include elemental cycling, thermodynamics, kinetics, acid-base equilibrium, and redox reactions. Prerequisites: CHEM 1318 and GEOS 2400 or consent of instructor.

GEOS-3422 Sedimentology and Stratigraphy
The identification, description, and interpretation of sediments, sedimentary rocks, and sedimentary strata; an introduction to the principles of stratigraphy and of sedimentary processes as they relate to modern depositional systems and their ancient analogs. Emphasis will be place on the interpretation of depositional systems and sequence stratigraphy. Three class hours and three laboratory hours a week. Field trips are required; field trip costs must be paid by each student. Prerequisites: GEOS 2401 and 3400.

GEOS-3423 Basin Analysis
Application of stratigraphic concepts to the study of basin evolution and the environmental history and geometry of sedimentary rock successions. Emphasis will be placed on tectonic evolution of basins, principles of stratigraphic correlation, carbonate depositional systems, sequence stratigraphy, event stratigraphy, stratigraphic modeling, and hydrocarbon systems. Laboratory experiments with outcrop sample suites, core and subsurface geophysical data sets. Three class hours and three laboratory hours per a week. Field trips required; field trip costs must be paid by each student. Prerequisites: GEOS 2402 or GEOS 2403.

GEOS-3-90 Directed Studies - Junior Level
Individual work under supervision. Credit may vary. Prerequisites: Major or minor standing and consent of project supervisor.

GEOS-3-91 Special Topics
An in-depth study of a topic in geosciences that is otherwise not covered in existing courses. May be repeated for credit on different topics. Prerequisite: Consent of instructor.

GEOS-3-92 Internship
An off-campus internship in professional geoscientific practice. Internships may be arranged with businesses, nonprofit institutions and government agencies and must be supervised by a faculty member. Geoscientific field work, laboratory work or analysis must be conducted during the course of the internship. May be repeated for a maximum of 3 credit hours. May only be taken on a Pass/fail basis. Prerequisites: Prior written approval of the supervising faculty member and departmental permission.

GEOS-4001 Senior Comprehensive Examination
Geosciences and Earth Systems majors with senior standing will take a comprehensive exam. Students will be required to attend a one-hour meeting held early in the Spring semester. The exam will be administered on a Saturday in February. May only be taken on a pass/fail basis. Prerequisites: Departmental major and senior standing.

GEOS-4-90 Directed Studies - Senior Level
Individual work under supervision. Credit may vary. Prerequisites: Major or minor standing and consent of project supervisor.

GEOS-4320 Geosciences Senior Capstone Seminar
A synthesis of concepts and topics from the Geosciences curriculum. Students will integrate concepts from multiple geologic disciplines to understand the geologic evolution of western North America, with particular emphasis on the region to be explored during the Majors’ Field Trip. (Offered every Spring.) Prerequisite: Senior standing in Geosciences

GEOS-4395 Thesis Research
Student research conducted under the supervision of a Trinity University faculty member leading to written communication of the research in thesis format. Course enrollment requires planning with the thesis director during the Junior year. A written thesis proposal must be submitted to the department. Prerequisites: Senior standing and acceptance by a thesis director.

GEOS-4396 Thesis Research and Presentation
A continuation of student project begun in GEOS 4395. Students are required to write and defend their thesis according to University guidelines set forth in this Bulletin. An oral presentation of the thesis will be made to the students and faculty of the department. Prerequisite: GEOS 4395.