

GEOG 491, 492 Research (2 credits)

GEOG 493, 494 Research (4 credits)

See the description of these courses at the beginning of the “Curricula” section of this catalog.

GEOG 495, 496 Individual Study (2 credits)

GEOG 497, 498 Individual Study (4 credits)

See the description of these courses at the beginning of the “Curricula” section of this catalog.

## Geology (GEOL)

College of Arts and Sciences

Department of Geology

Hickson (chair), Lamb, Theissen

Geologists study the Earth, not as a static lump of rock, but as a dynamic, changing system with a long, deep, and rich history. The science of geology focuses on the processes that have sculpted and continue to shape the planet and its life. The Department of Geology seeks to provide a solid foundation in the Earth sciences for its majors, preparing them for a variety of career paths.

The geology curriculum has been designed to provide students with a solid core, but with sufficient flexibility to allow students with particular interests to pursue a more customized program. At the heart of this program is the field laboratory experience, a fundamental and basic component of a St. Thomas geoscience degree. Department faculty emphasize the fact that geology must be learned in the field and as a result offer field laboratory experiences in all courses that extend from a short afternoon trip to a multi-week field course on field methods and regional geology. Majors will visit many of the geologically significant localities throughout the upper Midwest as part of their program.

### Major in Geology (B.A.)

*Four credits from the following:*

GEOL 110 Geology of the National Parks (4 credits)

GEOL 111 Introductory Physical Geology (4 credits)

GEOL 113 The Earth’s Record of Climate (4 credits)

GEOL 114 The Science of Natural Disasters (4 credits)

GEOL 115 Environmental Geology (4 credits)

*Plus:*

GEOL 211 Earth Materials (4 credits) *or* GEOL 310 Environmental Geochemistry (4 credits)

GEOL 260 Regional Geology and Field Methods (4 credits)

GEOL 320 Sedimentology and Stratigraphy (4 credits)

GEOL 340 Fundamentals of the Lithosphere I (Petrology) (4 credits)

GEOL 360 Fundamentals of the Lithosphere II (Structural Geology) (4 credits)

GEOL 430 Advanced Earth History (4 credits)

*Plus twelve credits from the following (four credits of which must be at the 400-level):*

GEOL 130 Earth History (4 credits)

GEOL 211 Earth Materials (if not chosen above) (4 credits)

GEOL 220 Oceanography (4 credits)

GEOL 252 Earth Surface Processes and Geomorphology (4 credits)

GEOL 310 Environmental Geochemistry (4 credits) (if not chosen above)

GEOL 410 Hydrogeology (4 credits)

GEOL 460 Advanced Field Methods (4 credits)

GEOL 494 Research (4 credits)

*Note:* GEOG 321 Geographic Information Systems and geology courses offered at Macalester College may fulfill one of these courses with permission of chair

### Allied requirements

MATH 113 Calculus I (4 credits)

*or*

MATH 108 Calculus with Review I (4 credits) *and* MATH 109 Calculus with Review II (4 credits)

*Plus one of the following sequences:*

CHEM 111 General Chemistry I (4 credits) *and* CHEM 112 General Chemistry II (4 credits)

PHYS 111 Introduction to Classical Physics I (4 credits) *and* PHYS 112 Introduction to Classical Physics II (4 credits)

CHEM 111 General Chemistry I (4 credits) *and* PHYS 111 Introduction to Classical Physics I (4 credits)

*For students wishing to pursue careers in paleontology, geobiology, or geomicrobiology:*

BIOL 201 Diversity and Adaptation (4 credits) *and* BIOL 202 Genetics and Population (4 credits)

Biology may be substituted for one of the CHEM/PHYS sequences with permission of chair

## Geology

*Strongly recommended for students considering graduate study:*  
additional courses in the allied sciences and mathematics

### **Major in Geology (B.S.)**

*Four credits from the following:*

GEOL 110 Geology of the National Parks (4 credits)  
GEOL 111 Introductory Physical Geology (4 credits)  
GEOL 113 The Earth's Record of Climate (4 credits)  
GEOL 114 The Science of Natural Disasters (4 credits)  
GEOL 115 Environmental Geology (4 credits)

*Plus:*

GEOL 211 Earth Materials (4 credits) *or* GEOL 310 Environmental Geochemistry (4 credits)  
GEOL 260 Regional Geology and Field Methods (4 credits)  
GEOL 320 Sedimentology and Stratigraphy (4 credits)  
GEOL 340 Fundamentals of the Lithosphere I (Petrology) (4 credits)  
GEOL 360 Fundamentals of the Lithosphere II (Structural Geology) (4 credits)  
GEOL 430 Advanced Earth History (4 credits)

*Plus twelve credits from the following (four credits of which must be at the 400-level):*

GEOL 130 Earth History (4 credits)  
GEOL 211 Earth Materials (if not chosen above) (4 credits)  
GEOL 220 Oceanography (4 credits)  
GEOL 252 Earth Surface Processes and Geomorphology (4 credits)  
GEOL 310 Environmental Geochemistry (4 credits) (if not chosen above)  
GEOL 410 Hydrogeology (4 credits)  
GEOL 460 Advanced Field Methods (4 credits)  
GEOL 494 Research (4 credits)

Note: GEOG 321 Geographic Information Systems and geology courses offered at Macalester College may fulfill one of these courses with permission of chair

### **Allied requirements**

MATH 113 Calculus I (4 credits) *or* MATH 109 Calculus with Review II (4 credits)  
MATH 114 Calculus II (4 credits)  
CHEM 111 General Chemistry I (4 credits)  
CHEM 112 General Chemistry II (4 credits)  
PHYS 111 Introduction to Classical Physics I (4 credits)  
PHYS 112 Introduction to Classical Physics II (4 credits)  
MATH 303 Statistics for the Applied Sciences (4 credits) *or* QMCS 220 Statistics I (4 credits)

*For students wishing to pursue careers in paleontology, geobiology, or geomicrobiology:*

BIOL 201 Diversity and Adaptation (4 credits) *and* 202 Genetics and Population (4 credits)  
Biology may be substituted for one of the CHEM/PHYS sequences with permission of chair

Depending on a student's interest and career goals, substitutions may be made for other advanced courses in Biology, Chemistry, or Physics for certain listed courses, in consultation with the geology department chair.

### **Teacher Licensure**

Elementary Education with a Co-major in Science and Mathematics for Elementary Education  
Elementary Education with a Specialty in Science (5-8)  
Co-major in Science (5-8) – Earth and Space Science (9-12) and a Co-major in Secondary Education  
*See Education.*

### **Minor in Geology**

*Four credits from the following:*

GEOL 110 Geology of the National Parks (4 credits)  
GEOL 111 Introductory Physical Geology (4 credits)  
GEOL 113 The Earth's Record of Climate (4 credits)  
GEOL 114 Natural Disasters (4 credits)  
GEOL 115 Environmental Geology (4 credits)

*Plus four credits from the following:*

GEOL 211 Earth Materials (4 credits)  
GEOL 310 Environmental Geochemistry (4 credits)  
GEOL 320 Sedimentology and Stratigraphy (4 credits)

*Plus:*

GEOL 340 Fundamentals of the Lithosphere I (Petrology) (4 credits)

*Plus eight credits from the following:*

GEOL 130 Earth History (4 credits)

GEOL 211 Earth Materials (4 credits) (if not chosen above)

GEOL 220 Oceanography (4 credits)

GEOL 252 Earth Surface Processes and Geomorphology (4 credits)

GEOL 260 Regional Geology and Field Methods (4 credits)

GEOL 310 Environmental Geochemistry (4 credits) (if not chosen above)

GEOL 320 Sedimentology and Stratigraphy (4 credits) (if not chosen above)

GEOL 360 Fundamentals of the Lithosphere II (Structural Geology) (4 credits)

GEOL 410 Hydrogeology (4 credits)

#### **GEOL 102 Origins and Methods (4 credits) (GEOL 110, 111, 114, 115)**

A study of the basic concepts of geology that were first developed by James Hutton in the late 18th century and their application today. This is an introductory science course specifically designed to reduce the mystique that often is associated with the scientific method. Following Hutton's example, the student will focus on the materials which make up the Earth and on the geologic processes that operate on these materials. Offered in January term.

NOTE: Students who receive credit for GEOL 102 may not receive credit for GEOL 110, 111, 114, or 115.

#### **GEOL 110 Geology of the National Parks (4 credits) (GEOL 102, 111, 114, 115)**

This course introduces fundamental geologic concepts, processes and materials using examples from the national parks. Emphasis is placed on the specific geologic materials, natural processes, landforms and sequence of events responsible for the outstanding scenery in selected U.S. national parks. Laboratories will include study of the rocks common to the national parks; analysis of geomorphic, topographic and geologic maps of the national parks; and field studies of local sites. Lecture and two laboratory hours per week.

NOTE: Students who receive credit for GEOL 110 may not receive credit for GEOL 102, 111, 114, or 115.

#### **GEOL 111 Introductory Physical Geology (4 credits) (GEOL 102, 110, 114, 115)**

A study of the Earth's properties; the formation and classification of minerals, rocks, ore deposits, and fuels; and the nature and origin of the Earth's surface and interior. Emphasis will be placed upon a changing Earth, and the geologic processes operating at the surface and in the interior. Lecture and two laboratory hours per week.

NOTE: Students who receive credit for GEOL 111 may not receive credit for GEOL 102, 110, 114, or 115.

#### **GEOL 113 The Earth's Record of Climate (4 credits)**

Climate change is a pressing issue for all of humanity, yet we cannot understand modern climate change without an awareness of the Earth's natural climate variability over the billions of years of geological time. In this course we will first explore modern climate and the controls on it; then focus on the methods used to understand how climate has changed over recent and distant geological time; explore the factors and theories that explain changes in the Earth's climate system; and finally analyze human-induced climate changes in light of the past geological evidence. Labs will focus on the analysis of climate data and geological evidence for changes in climate. This course fulfills the second-level Computer Competency requirement in the core curriculum.

#### **GEOL 114 The Science of Natural Disasters (4 credits) (GEOL 102, 110, 111, 115)**

This introductory geology course focuses on how and why natural disasters occur, as well as on their effects and how scientists study them. The course will examine internal and external Earth processes and in particular how these processes impact humans. Course emphases will be upon the principles underlying natural disasters such as earthquakes, volcanic eruptions, landslides, floods, coastal processes, and extinctions. We will use case studies of recent and historic events to understand these natural processes.

NOTE: Students who receive credit for GEOL 114 may not receive credit for GEOL 102, 110, 111, or 115.

#### **GEOL 115 Environmental Geology (4 credits) (GEOL 102, 110, 111, 114)**

This course emphasizes the interactions between humans and their environment, focusing on those processes and issues that are fundamentally geological in nature. Early in the course, students will be introduced to basic geoscience concepts and principals, the scientific method, plate tectonics, and Earth materials (rocks and minerals). The remainder of the course will focus on specific topics at the interface between humans and their environment, including volcanic and earthquake hazards, human impacts on the hydrological cycle, surface and groundwater contamination, climate and the carbon cycle, nuclear waste storage, soil erosion, non-renewable resources, and slope stability.

NOTE: Students who receive credit for GEOL 115 may not receive credit for GEOL 102, 110, 111, or 114.

#### **GEOL 130 Earth History (4 credits)**

The course introduces fundamental geologic concepts while examining the major tectonic, chemical and biological events that shaped the Earth through time. It will include a study of fossils, sedimentary structures, depositional environments, radiometric dating techniques, and other tools geoscientists use to interpret the past. Throughout the course global events will be studied but focus will be on the North American continent.

#### **GEOL 211 Earth Materials (4 credits)**

Earth's materials record the vast history of the earth, help us understand current earth processes and are vital to our daily living. By the end of this course, you will be able to identify many common Earth materials and their compo-

## Geology

nents, describe how they formed, state where on or in Earth they typically form, and describe their economic and environmental importance. We will travel to the Badlands and Black Hills, SD, to collect data from several field sites for analysis during the rest of the semester.

Prerequisite: one of GEOL 102, 110, 111, 113, 114 or 115

### GEOL 220 Oceanography (4 credits)

The Earth's surface is dominated by vast oceans known for the beauty of their wildlife and waters. The oceans are also increasingly recognized for their critical importance to the functioning of the Earth's climate system and for their endangered natural resources. For example, the ocean-atmospheric climate phenomenon known as the El Niño Southern Oscillation has gained household name recognition for its global impact on the weather, economy, and public health. In this course we will explore the physical, chemical, and biological processes that characterize the oceans. Students will develop research and analytical skills by making observations and interpretations of oceanographic processes using data, demonstrations, and field experiences.

Prerequisite: one of GEOL 110, 111, 113, 114, 115, 130, or permission of the instructor

### GEOL 252 Earth Surface Processes and Geomorphology (4 credits)

This course emphasizes the physical processes that are responsible for shaping the Earth's surface. The qualitative description of landforms is pursued, in light of student's newly-gained analytical and quantitative understanding of processes. The labs focus on techniques used by geomorphologists to characterize landforms, soils, and the processes that shape, including: air photo interpretation, analysis of digital topographic data, experimental simulation of landforms evolution, and field techniques in geomorphology. This course fulfills the second-level Computer Competency requirement in the core curriculum.

Prerequisite: one of GEOL 102, 110, 111, 113, 114 or 115

### GEOL 260 Regional Geology and Geological Field Methods (4 credits)

The field is geology's laboratory. this course is an introduction to the major concepts of geology, as well as the methods of field geology. Students will learn how to collect, synthesize, and analyze geological data in the field. Techniques will be taught in the context of the regional geology of an area so students will gain a critical appreciation of a geological terrain outside of their usual experience. Students will spend 2-3 weeks in the field examining geological structures, modern-day faults, modern processes that shape the Earth's surface, and examining the ancient record of past climate and environments preserved in the rock record. Student teams will learn basic techniques and instruments of geological mapping and rock description, how to recognize geological structures like faults and folds, ways to interpret the evolution of the Earth from sedimentary, igneous, and metamorphic rocks, and to link surface processes with the rock record. Offered in January-term.

Prerequisite: one of GEOL 102, 110, 111, 113, 114, 115, or permission of instructor

### GEOL 295, 296 Topics (2 credits)

### GEOL 297, 298 Topics (4 credits)

The subject matter of these courses will vary from year to year, but will not duplicate existing courses. Descriptions of these courses are available at [www.stthomas.edu/registrar/onlineschedule/](http://www.stthomas.edu/registrar/onlineschedule/).

### GEOL 310 Environmental Geochemistry (4 credits)

Environmental geochemistry is a growing and dynamic field in geology which explores past and present environments for their chemical characteristics and environmental quality. In this course we will explore the applications of chemistry to solve geological and environmental problems, with an emphasis on freshwater environments. Students will get hands-on field and laboratory experience investigating Minnesota rock formations and lake sediments using several different geochemical methods.

Prerequisite: one of GEOL 110, 111, 113, 114, 115; and CHEM 111 or permission of instructor

### GEOL 320 Sedimentology and Stratigraphy (4 credits)

Sedimentology is the study of sediment, particularly focusing on how it is transported and deposited. Stratigraphy emphasizes the analysis of sedimentary strata, the layers of sedimentary (and some volcanic) rocks that cover about three-quarters of the Earth's surface. Sedimentary rocks illuminate many of the details of the Earth's history: effects of sea level change, global climate, tectonic processes, and geochemical cycles are all recorded in the sedimentary strata of the Earth. This course will cover basics of fluid flow and sediment transport, sedimentary structures and textures, and – forming the bridge between modern landforms and ancient rocks – depositional sedimentary environments.

Prerequisite: one of GEOL 110, 111, 113, 114, 115; GEOL 211 recommended

### GEOL 340 Fundamentals of the Lithosphere I (Petrology) (4 credits)

This is the first course in a year-long sequence that covers the fundamentals of petrology and structural geology in a global tectonic framework. The course begins with a discussion of plate tectonics and then examines each of the major plate settings and their boundaries. It will include the formation of igneous, sedimentary and metamorphic rocks. Labs will include hand specimen identification and the use of the petrographic microscope. The course will also examine the conditions of rock deformation and the typical structural features of each tectonic setting. Labs will cover structural geology techniques including recognition and analysis of features in the field and in hand samples. In the fall semester the focus will be on the petrology of the mantle and lithosphere as well as divergent margins. In the

spring semester, the focus will be on convergent margins. There will be several field trips as part of this course, ranging from 1-4 days, in the early fall and late spring.

Prerequisites: one of GEOL 110, 111, 113, 114 or 115; GEOL 211 and 320 or permission of the instructor

#### **GEOL 360 Fundamentals of the Lithosphere II (Structural Geology) (4 credits)**

Continuation of GEOL 340.

Prerequisite: GEOL 340

#### **GEOL 410 Hydrogeology (4 credits)**

This course focuses on groundwater and how geology influences its recharge, movement, storage, and withdrawal. The course will cover basic concepts of surface- and subsurface water flow, aquifer properties, well testing, heterogeneity in aquifers, groundwater chemistry and contamination, the role of groundwater in geological processes, and regional groundwater systems. Examples, labs, and projects will focus on groundwater in Minnesota and its immediate surroundings.

Prerequisite: one of GEOL 110, 111, 113, 114 or 115; GEOL 360 recommended

#### **GEOL 421 Geophysics (4 credits)**

Fundamental principles of geophysical methods commonly used for subsurface exploration, including: gravity, magnetic, seismic and electrical measurements. Emphasis on field procedures and interpretation techniques used for geologic investigations. Lecture and three laboratory hours per week.

Prerequisite: GEOL 360

#### **GEOL 430 Advanced Earth History (4 credits)**

This course serves as a senior capstone experience in the geology major. Using the tools and concepts from previous coursework—including geochronology, plate tectonics, and other Earth processes—students will examine in-depth some aspect of Earth history. The specific subject matter and focus of this course will vary from year to year, and will be chosen based on input from the students in consultation with the instructor. Some examples of topics include: Precambrian tectonics of the Great Lakes region; Global Mesozoic tectonics; Sedimentary basins and basin analysis; or the Phanerozoic amalgamation of Asia.

Prerequisite: C- or better in GEOL 260, 320, and 340

#### **GEOL 460 Advanced Field Geology (4 credits)**

In this course, students will use skills developed in the introductory field methods course, Geology 260, to tackle more complex geologic problems. We will spend 3 weeks in the field mapping in an area that is more structurally complicated and learning additional techniques not introduced in the first course. Students will have the option of starting a research project and collecting data to be analyzed and written up in the following semester. Students not choosing this option will complete a field project during the course.

Prerequisites: GEOL 260 and permission of the instructor

#### **GEOL 475, 476 Experiential Learning (2 credits)**

#### **GEOL 477, 478 Experiential Learning (4 credits)**

See the description of these courses at the beginning of the “Curricula” section of this catalog.

#### **GEOL 483, 484 Seminar (2 credits)**

#### **GEOL 485, 486 Seminar (4 credits)**

See the description of these courses at the beginning of the “Curricula” section of this catalog.

#### **GEOL 487, 488 Topics (2 credits)**

#### **GEOL 489, 490 Topics (4 credits)**

The subject matter of these courses will vary from year to year, but will not duplicate existing courses. Descriptions of these courses are available at [www.stthomas.edu/registrar/onlineschedule/](http://www.stthomas.edu/registrar/onlineschedule/).

#### **GEOL 491, 492 Research (2 credits)**

#### **GEOL 493, 494 Research (4 credits)**

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### **German (GERM)**

See Modern and Classical Languages

### **Greek (GREK)**

See Modern and Classical Languages