

# GEOSCIENCES

## Departmental Guidelines

*Students who matriculated prior to the Fall of 2021 may choose to graduate with a Geosciences (GEOS) degree. Students who matriculated after 2021 please see the Earth & Environmental Sciences (EESC) degree requirements.*

*Former GEOS courses now carry the EESC departmental designation. Any Geosciences major who matriculated prior to fall of 2021 must work closely with the department to ensure that they are meeting all requirements appropriately.*

In the Department of Geosciences we investigate the Earth in the broadest sense: how it formed, how it evolved and continues to evolve, how Earth systems interact to produce the environment in which we live, and how present and future changes may affect the habitability of Earth. The central goal of the department is to educate students about the nature and history of the Earth, the processes that shape the Earth, and the impacts those processes have on human populations.

An understanding of the Earth is an important component of global citizenship. Many critical environmental issues face humanity, including global climate change, water shortages, loss of arable land, natural hazards such as earthquakes and flooding, and the availability of petroleum and other energy resources. Citizens and professionals with training in the geosciences will contribute to addressing these and other problems, while increasing opportunities for humans to live sustainably on the Earth.

The department provides non-majors with a basic knowledge of the Earth and Earth processes that will serve their needs as future citizens and community leaders. Geoscience majors and minors develop a strong background in the geosciences in preparation for employment opportunities in fields such as environmental science, geotechnical engineering, exploration for natural resources, geologic research, environmental law, and earth science teaching. Many geoscience graduates continue their training in graduate school; others enter the work force directly.

## Faculty

Associate Professor Erik Klemetti, Chair

Professor David H. Goodwin; Associate Professor Matthew C. Jungers, Assistant Professors Anjali M. Fernandes, Chelsea Mackaman-Lofland

### Program Coordinator

Heather Whitehead

View faculty profiles and contact information (<https://denison.edu/academics/geosciences/contacts/>)

## Geosciences

*Students who matriculated prior to the Fall of 2021 may choose to graduate with a GEOS degree. Students who matriculated after 2021 please see the EESC degree requirements. Former GEOS courses now carry the EESC departmental designation. Any Geosciences major who matriculated prior to fall of 2021 must work closely with the department to ensure that they are meeting all requirements appropriately.*

There are two possible paths to the bachelor's degree in Geoscience: a Bachelor of Science in anticipation of advanced study in the Geosciences, or a Bachelor of Arts for those who seek a less specialized course of

study. Earning a B.A. degree does not preclude a professional career in the Geosciences, although admission to some graduate programs may require completion of additional science and mathematics courses.

A student may graduate with a **B.S. degree** by taking

Code	Title
One 100 level introductory geoscience course e.g.:	
GEOS 111	Planet Earth
GEOS 112	Special Topics in the Geosciences
GEOS 114	Special Topics in the Geosciences
two foundation courses:	
GEOS 210	Historical Geology
and	
GEOS 211	Rocks & Minerals
six elective GEOS courses, at least three of which must be at the 300 level;	
GEOS 380	Geoscience Senior Seminar
and a geoscience field course	
GEOS 400	Field Course
Required additional science courses are four courses from:	
CHEM 131	Atoms and Molecules: Structure and Dynamics
CHEM 132	Organic Structure and Reactivity
CS 111	Discovering Computer Science: Scientific Data and Dynamics
BIOL 210	Molecular Biology and Unicellular Life
BIOL 220	Multicellular Life
BIOL 230	Ecology and Evolution
MATH 135	Single Variable Calculus
MATH 145	Multi-variable Calculus
MATH 220	Applied Statistics
and	
PHYS 121	General Physics I
PHYS 122	General Physics II
or	
PHYS 125	Principles of Physics I: Quarks to Cosmos
PHYS 126	Principles of Physics II

Students who want to pursue graduate study in the geosciences are strongly encouraged to take additional math and science courses beyond this minimum requirement.

Students seeking a **B.A. degree** must take one 100 level introductory geoscience course (see above); two foundation courses (see above); six elective GEOS courses, at least three of which must be at the 300 level; and GEOS 380 - Geoscience Senior Seminar. One cognate science course may be substituted for a 200 level elective GEOS course.

Both B.S. and B.A. students are required to pass a comprehensive exam, administered early in the second semester of the senior year.

Note that most upper level geoscience courses are offered in alternate years. Therefore careful schedule planning is important, especially if one pursues a semester of off-campus study.

## Earth and Environmental Sciences Minor (formerly Geosciences)

To minor in the Geosciences, a student must take one 100 level introductory geoscience course, GEOS 210 - Historical Geology, GEOS 211 - Rocks & Minerals and three additional Geosciences courses at the 200 or 300 level.

### Additional Points of Interest

Geosciences has a long tradition of field trips during the fall and spring semester. Recent trips include Hawaii, coastal Maine, Arizona & Utah, the Bahamas, Death Valley, the Great Smoky Mountains and the Adirondacks.

Abundant student research opportunities are available, including working with faculty in the field or laboratory. Student employment opportunities within the department include working as teaching and laboratory assistants, and assisting in developing and maintaining departmental collections.

The C.L. Herrick Geological Society is an active, student-run organization, which coordinates guest lectures and social events throughout the academic year.

### Courses

#### GEOS 111 - Planet Earth (4 Credit Hours)

An introduction to the study of the Earth: how it formed, how it evolved, how Earth systems interact to produce the environment in which we live, how geologists interpret rocks and how humans use earth resources. Laboratory exercises include learning to identify and interpret minerals and rocks, using topographic maps to understand landscapes and landscape processes, and examining volcanic and earthquake hazard and mitigation. This course is designed as an introductory course in the geosciences for both science and non-science majors. Fulfills the Q (Quantitative Reasoning) GE requirement.

#### GEOS 112 - Special Topics in the Geosciences (4 Credit Hours)

Current topics include: Rare Earth - Building a Habitable Planet. What does it take to build a planet that harbors intelligent life? Are habitable planets common in the Universe, or is Earth the only one? In this course we will examine the development of planet Earth in light of the hypothesis that conditions necessary for a habitable planet are extremely rare in the universe. While emphasizing geology, this examination will involve us in aspects of biology and paleontology, astronomy and astrogeology, philosophy and even theology. Laboratory exercises will allow hands-on investigation of rocks, fossils, geologic maps, and other data important to our understanding of the development of planet Earth. This course is designed as an introductory course in the geosciences for both science and non-science majors. Fulfills the R (Oral Communication) GE requirement.

#### GEOS 114 - Special Topics in the Geosciences (4 Credit Hours)

Current Topics include: Climate Change - Cool Science on a Hot Topic. Global warming constitutes one of the most controversial issues you, and society at large, will face in the future. At the center of this debate lies the question, "Are we responsible for the recent increase in global temperature, or is this trend part of the natural variability in the climate system?" To evaluate these possibilities, we will examine the geologic record of climate change and the processes responsible for these variations. While the majority of our discussions will focus on geology, we will also touch on elements of oceanography, meteorology, biology, paleontology, as well as policy and politics. By the end of this course you will be able to make informed decisions about the climate change issues we are certain to face in the future. This course is designed as an introductory course in the geosciences for both science and non-science majors and to fulfill the Q (Quantitative Reasoning) GE requirement.

#### GEOS 115 - Special Topics in Geosciences (4 Credit Hours)

This course provides a venue to explore different topics in Geosciences at the introductory level.

#### GEOS 199 - Introductory Topics in Geosciences (1-4 Credit Hours)

A general category used only in the evaluation of transfer credit.

#### GEOS 200 - Environmental Geology (4 Credit Hours)

A broad survey of the geologic aspects of environmental issues, emphasizing human interactions with the geologic environment. Topics include geologic hazards, such as earthquakes, landslides and flooding; global water supply and water quality issues, especially groundwater contamination and remediation; and global environmental change, with emphasis on climate change and global warming. This course fulfills the W overlay requirement.

**Prerequisite(s):** A 100-level course taught by GEOS faculty.

#### GEOS 210 - Historical Geology (4 Credit Hours)

A survey of the geologic history of planet Earth. Major topics include global climate history, paleogeography, history of life, and tectonic development and evolution of the North America continent. Lab exercises focus on description and interpretation of sedimentary rocks and environments, and the history of biological evolution.

**Prerequisite(s):** A 100-level course taught by GEOS faculty.

#### GEOS 211 - Rocks & Minerals (4 Credit Hours)

An introduction to the minerals and rocks that make up the Earth, and how those materials influence the processes that operate within and on the surface of the planet. The framework of the course is the geological, chemical and physical basis for understanding the composition and physical properties of minerals, magmas and rocks, and the processes by which these materials form. An emphasis is placed on examining the interplay between earth materials, society and the environment.

**Prerequisite(s):** A 100-level course taught by GEOS faculty.

#### GEOS 215 - Special Topics in Geosciences (4 Credit Hours)

This course provides a venue to explore different topics in Geosciences at the intermediate level".

#### GEOS 222 - Geographic Information Systems I (2 Credit Hours)

This course is an introduction to the concepts and uses of Geographic Information Systems (GIS) with particular application to environmental issues. The course consists of laboratory exercises on GIS data structures and sources of data, on the use of specific GIS tools, and on practical applications of GIS to real-world tasks. The student will gain skills in spatial data analysis, map generation, and data presentation using ArcGIS software. After successful completion of this course, students who wish to develop advanced GIS skills may enroll in ENVS/GEOS 223.

**Crosslisting:** ENVS 222.

**GEOS 223 - Geographic Information Systems II (2 Credit Hours)**

This course is intended to give the student experience with advanced GIS applications. The focus will be on novel analyses of spatially explicit data pertaining to real-world environment issues.

**Prerequisite(s):** GEOS 222 or ENVS 222.

**Crosslisting:** ENVS 223.

**GEOS 234 - Applied GIS for Earth and Environmental Sciences (4 Credit Hours)**

Geographic Information Systems (GIS) allow the organization, analysis, and display of large and varied collections of spatial information. Earth and environmental scientists are increasingly relying on the tools and methodologies of GIS to solve complex problems ranging from the intersection of rising sea level with coastal communities to the mapping and mitigation of landslide hazards in mountain communities. In this course, we will conduct a series of applied projects investigating Earth systems and environmental problems. Each project will include hands-on downloading of data, data processing, developing workflows in ArcGIS, mapmaking and data visualization, and communicating results in written reports. By the end of the term, students will apply the skills learned over the semester in an independent research project. No prerequisites.

**GEOS 240 - Earth Resources (4 Credit Hours)**

This course examines the Earth resources that humans exploit, including (but not limited to) energy, metals, and soil, from both geologic and societal perspectives. We will study: (1) the geologic processes that form these deposits and control their distribution; (2) the methods used to extract the resources and; (3) environmental impact of extraction and resource use. We will also scrutinize the effect on society of the resource, including conflict, labor, sustainability and class issues. The course will combine lab activities, scientific discussion and readings from academic literature, popular media, and activist propaganda. The end result will be the ability to bring together the science of Earth resources with the broader human context of resource exploitation. This course fulfills the P (Power & Justice) GE requirement.

**Prerequisite(s):** A 100 level course taught by GEOS faculty or consent of instructor.

**GEOS 270 - Oceanography (4 Credit Hours)**

This course will provide students with an introduction to the world's oceans. Topics will include: the sea floor and its sediments; the physical properties and chemistry of seawater; ocean circulation; waves and tides; life in the seas; and environmental issues and concerns facing the oceans today. By the end of this course students will have explored many of the basic concepts in modern oceanography, and should be able to integrate new concepts and data into their developing knowledge of the Earth.

**GEOS 275 - Geology of the Solar System (4 Credit Hours)**

In this course, you will discover the wide variety of geologic processes at work across the planets, moons, asteroids and comets of our solar system. We will examine the missions and instruments used to observe extraterrestrial objects, the data collected and how to use it to unravel the geologic history of distant areas and what conditions are needed to support life outside Earth. In the end, you will design your own mission to investigate another piece of the solar system. This course will be a mix of class lecture and activities, labs and presentations/discussions with readings from academic publications, popular media and books. Fulfills the R (Oral Communication) GE requirement.

**Prerequisite(s):** A 100-level course taught by GEOS faculty.

**GEOS 299 - Intermediate Topics in Geosciences (1-4 Credit Hours)**

A general category used only in the evaluation of transfer credit.

**GEOS 300 - Geomorphology (4 Credit Hours)**

We will investigate how Earth's topography reflects the response of surface processes to shifts in tectonic, climatic, and human influences. Our study of landscape evolution will focus primarily on hillslopes (creeping soil to catastrophic landslides), rivers (gullies to bedrock gorges), and glaciers (alpine cirques to Midwest moraines) always with a focus on quantifying how the shapes of landforms reflect process. Labs and class activities will require a blend of fieldwork, introductory mapping and data analysis using ArcGIS, and simple numerical modeling. Frequent, short critical writing responses to primary literature will refine both writing skills and our engagement with the forefront of process geomorphology. This course fulfills the W overlay requirement.

**Prerequisite(s):** Any 100-level course taught by GEOS faculty or consent of instructor.

**GEOS 308 - Biodiversity Through Time (4 Credit Hours)**

An introduction to the study of fossil invertebrates with emphasis on preservation, taphonomy, diversity trajectories through geologic time, evolutionary mechanisms, extinction, paleobiology and paleoecology. Special emphasis will be placed on using fossils to interpret ancient depositional environments. Labs will introduce the student to the major invertebrate phyla commonly preserved in the geologic rock record.

**Prerequisite(s):** GEOS 210 or BIOL 230.

**GEOS 311 - Structural Geology (4 Credit Hours)**

Study of the deformation of the Earth's crust. How and why rocks deform; geometry and interpretation of folds, faults, and rock fabrics; regional tectonics and mountain building. Labs emphasize interpretations of geologic structures in hand specimens, outcrops and geologic maps; and includes opportunities for geologic field mapping and a weekend field trip to the Appalachian fold and thrust belt.

**Prerequisite(s):** GEOS 210 or GEOS 211 or consent of instructor.

**GEOS 312 - Petrology and Volcanology (4 Credit Hours)**

This course examines the processes that produce magma and metamorphic at high temperature. It also explores volcanism and the hazards produced by eruptions. We will employ the reasoning and approaches used to understand petrology including petrography, geochemistry, data analysis and modeling. Key topics include high-temperature isotopes and thermodynamics, formation of magmas in different tectonic settings, the physical processes of volcanism, hazards posed by volcanic activity and using metamorphic reactions to assess the tectonic history of rocks. We will explore petrology and volcanology through labs, primary literature, research projects and group assignments.

**Prerequisite(s):** GEOS 211 or consent of instructor.

**GEOS 313 - Environmental Hydrology (4 Credit Hours)**

This course explores the processes that transfer water between the various reservoirs of the hydrologic cycle. Working mostly at the watershed scale, we will study the balance between precipitation, evapotranspiration, and runoff by drawing on both field methods and the analysis of hydrologic datasets using Geographic Information Systems (GIS). We will study the flow of surface water through natural and engineered rivers, and the flow of groundwater through shallow soils and deep aquifers. Throughout the course, we will strive for an applied approach to Hydrology that explicitly links key concepts to the management of water resources.

**Prerequisite(s):** A 100-level course taught by Geoscience faculty or ENVS 102 or consent of instructor.

**GEOS 314 - Sedimentology & Stratigraphy (4 Credit Hours)**

This course is an introduction to sedimentary processes and sedimentary rocks. The course will cover three major areas: (1) physical sedimentology (how sedimentary rocks are formed); (2) depositional systems (where sedimentary rocks are formed and how they differ from place to place); and (3) stratigraphy (how sedimentary rocks are used to solve geological problems). Labs will expose students to sedimentary rocks under the microscope, in hand sample, and in the field.

**Prerequisite(s):** GEOS 210 or GEOS 211 or consent of instructor.

**GEOS 333 - Stable Isotopes in the Environment (4 Credit Hours)**

Light stable isotope analysis has become a nearly ubiquitous component of (paleo)environmental research. Stable isotopes of Hydrogen, Carbon, Nitrogen, Oxygen, and Sulfur have been used to integrate, indicate, record, and trace important physical and biological processes operating at or near Earth's surface. This course will focus on how stable isotope systems can be used to study (paleo)climatology and (paleo)oceanography, hydrology, pollution, biogeochemical cycling, metabolism, photosynthesis, and (paleo)ecology.

**Prerequisite(s):** GEOS 210 or GEOS 211.

**GEOS 340 - Special Topics in Geosciences (4 Credit Hours)****GEOS 361 - Directed Study (1-4 Credit Hours)**

Individual readings and laboratory work in a student's field of interest within the Geosciences.

**GEOS 362 - Directed Study (1-4 Credit Hours)**

Individual readings and laboratory work in a student's field of interest within the Geosciences.

**GEOS 363 - Independent Study (1-4 Credit Hours)****GEOS 364 - Independent Study (1-4 Credit Hours)****GEOS 370 - Global Tectonics (4 Credit Hours)**

A study of geologic and tectonic processes at the global scale. Major topics include plate tectonic theory and development, topography and geology of the sea floor, plate geometries and processes at plate margins, volcanic arcs, collisional orogenies and mountain building, and the influence of tectonic processes on earth history.

**Prerequisite(s):** GEOS 210 or GEOS 211 or consent of instructor.

**GEOS 380 - Geoscience Senior Seminar (1 Credit Hour)**

This course is designed to help majors apply what they have learned throughout their undergraduate careers to a real-world issue or topic in the geosciences. The seminar will meet weekly with all members of the Geoscience faculty. The seminar topic will be selected by the entire geosciences faculty. Both students and faculty will be responsible for presenting summaries of weekly readings, although the majority will be presented by students. The course will be organized and administered by the department chair. Geoscience majors with senior standing or permission of instructor.

**GEOS 399 - Advanced Topics in Geoscience (1-4 Credit Hours)**

A general category used only in the evaluation of transfer credit.

**GEOS 400 - Field Course (4-8 Credit Hours)**

A B.S. major in Geosciences must register for an approved summer field course offered by any one of a number of universities. Upon the successful completion of the course, the student receives credit transferable to their record at Denison.

**GEOS 401 - Selected Topics in Geoscience (2-4 Credit Hours)**

An advanced seminar or problem-oriented course which involves a semester-long investigation of such topics as field techniques in geosciences, advanced structural geology, geochemistry, or geomorphology.

**GEOS 402 - Selected Topic in Geography (2-4 Credit Hours)**

An advanced seminar or problem-oriented course which involves a semester-long investigation of a global perspective in such issues as ocean resources and territorial rights, population growth, and food needs.

**Prerequisite(s):** A 200-level course or permission of instructor.

**GEOS 451 - Senior Research (4 Credit Hours)****GEOS 452 - Senior Research (4 Credit Hours)**