

# GEOLOGY

The geological sciences play a key role in addressing environmental problems, recognizing and mitigating natural hazards, and procuring natural resources. Furthermore, geoscientists make important contributions to human knowledge in fields as diverse as environmental geology, sustainability, oceanography, planetology, geochemistry, geophysics, plate tectonics and paleontology.

## ABOUT THE PROGRAM

Student-faculty research comprises an important part of the geology program at Hope College. In recent years students and faculty have been engaged in research projects such as:

- Experimental investigations on the remediation of contaminated ground water
- Analyzing trace element chemistry of phosphate minerals
- Working out the geological history of coastal dunes along Lake Michigan
- Making 3D computer models and gigapixel panoramas from digital photos to study dune erosion
- Exploring the effectiveness of biochar as a means to improve poor quality soils
- Investigating antibiotics and hormones in local ground water and surface water
- Uncovering the development of early continental crust in India and Sweden
- Documenting the occurrence and abundance of insects in ground water

Traditionally, the training of geologists has included a large amount of field experience. Hope College is ideally situated to study glacial geology, sedimentology, geomorphology, limnology and environmental issues. To broaden the spectrum of field experience, classes commonly take longer trips to examine the geology of other areas such as the Upper Peninsula of Michigan, the Smoky Mountains of Tennessee, and the Ohio River Valley in Indiana and Kentucky. In addition to these trips, each year the regional geology field trip gives students the opportunity to visit and investigate the geology of a North American region. In the past, regional field trips have gone to the Colorado Plateau; Big Bend, Texas; Death Valley, California; Southern Arizona; New Mexico; and the Bahamas.

We are well-equipped for teaching and research. In addition to petrographic microscopes, the department has a geographic information system (GIS) computer laboratory, X-ray diffractometer, thin section preparation laboratory, ion chromatograph, gas chromatograph, infrared Fourier transform spectrometer, UV-visible light spectrometer and access to a scanning electron microscope.

The study of the Earth is eclectic so geologists must be competent in the other natural sciences and in mathematics. Accordingly, we encourage strong minors in other sciences and composite majors with chemistry and physics.

The Department of Geological and Environmental Sciences has an established reputation of excellence. Many graduating seniors have gone directly to work in environmental consulting firms, mineral resource companies, or the energy industry, while others have been accepted at some of the most prestigious graduate programs in the country, including the California Institute of Technology, University of Chicago, Harvard, Stanford, Princeton and various Big Ten universities.

## MAJORS

### Bachelor of Arts Degree in Geology

The Bachelor of Arts in Geology consists of one of the following sequences of introductory courses:

**Introductory Sequence #1** GES 100 – The Planet Earth, 4 credits and GES 111 – How The Earth Works, 2 credits or

**Introductory Sequence #2** GES 125 - Michigan Field Geology, 4 credits and GES 111 - How the Earth Works, 2 credits

together with the following courses:

- GES 203 – Historical Geology, 4 credits
- 16 total credits of geology courses selected from GES 225, GES 243, GES 244, GES 251, GES 252, Ges 320, GES 351, GES 430, GES 450, GES 453 or GES 295
- GES 341 – Regional Field Study, 2 credits
- One year, 8 credits, of ancillary science – Biology, Chemistry, Engineering, Environmental Science, or Physics

### Bachelor of Science Degree In Geology

The Bachelor of Science in Geology consists of one of the following sequences of introductory courses:

**Introductory Sequence #1** GES 100 – The Planet Earth, 4 credits and GES 111 – How The Earth Works, 2 credits or

**Introductory Sequence #2** GES 125 – Michigan Field Geology, 4 credits and GES 111 – How The Earth Works, 2 credits

together with the following courses:

- GES 203 – Historical Geology, 4 credits
- 24 total credits of geology courses selected from GES 225, GES 243, GES 244, GES 251, GES 252, GES 320, GES 351, GES 430, GES 450, GES 453 or GES 295
- Two semesters of GES 341 – Regional Field Study, 2 credits apiece for a total of 4 credits
- Two years, 16 credits, of ancillary sciences – biology, chemistry, engineering, environmental science, or physics and one year, 8 credits of mathematics (Calculus preferred). Both years of ancillary science need not be in the same science. *Students should choose these courses in consultation with their departmental advisors.*
- Students receiving a Bachelor of Science degree are also required to work on an independent research project with a faculty mentor.

### **Bachelor of Science Degree in Environmental Science**

The Department of Geological and Environmental Science administers three options for the environmental science major, described in detail in the [Environmental Science Major](#) section of the catalog.

### **Geology Chemistry Composite**

The composite major is an alternative to the departmental major. While the composite major seeks to fulfill the same objectives as the departmental major, namely, the ability to engage in intensive, in-depth scholarly inquiry, the composite major allows for special alignment of courses from several departments to fulfill a particular academic or vocational objective. The composite major is just as rigorous as a department major, but it allows the tailoring of an academic program to a field or topic of inquiry other than a departmental field. For additional information, please refer to the [Degree section](#) of the catalog.

### **Geology Education**

In partnership with the Department of Education, the Department of Geological and Environmental Sciences offers a Geology/Earth Science teaching major through the State of Michigan. The Michigan Certification Code requires that prospective high school teachers complete 30 or more credits of courses in geology for a major. Consult with the Department of Education concerning detailed requirements.

### **Geology-Physics Composite**

This was the first composite major established in the sciences at Hope College. Both the geology-chemistry and geology-physics majors have been very successful. Students who graduate with the composite major are in great demand and have been accepted into top graduate schools in the United States. You will find additional information about composites [here](#).

## MINORS

### Environmental Science

The Department of Geological and Environmental Science administers the environmental science minor, which is described in detail [here](#).

### Geology

A geology minor consists of at least 16 credits, not more than half of which may be numbered 203 or below.

### Geology Education

In partnership with the Department of Education, the Department of Geological and Environmental Sciences offers a geology/Earth science teaching minor through the State of Michigan. The Michigan Certification Code requires that prospective high school teachers complete 22 credits in geology for a minor. Consult with the Department of Education concerning detailed requirements.

## COURSES

### GEOLOGICAL/ENVIRONMENT SCIENCE

#### **GES 493 - Independent Study: Geol/Enviro**

Course provides opportunity for a junior or senior to engage in an independent study project in an area in which the student has special interest.

Credits Awarded: 1-4

Terms Offered: As Needed

Prerequisites: Permission of Instructor

### ENVIRONMENTAL SCIENCE COURSES

#### **GES 130 - Introduction to Environmental Science**

This course introduces students to systems thinking, to concepts of the physical world essential for the study of environmental science, and to sustainability as a lens for considering issues of resource production, resource consumption, and generation of waste. Laboratory exercises will explore general scientific principles relevant to study of the atmosphere, oceans, and solid Earth, as well as aspects of resource use in our daily lives. Three lectures and one three-hour laboratory each week. Cross-listed with GEMS 130. No prerequisites.

Credits Awarded: 4

Terms Offered: Fall, Spring

Attribute: Natural Science I with lab (NSL)

#### **GES 211 - Local Environmental Systems**

This course introduces the scientific study of our planet in terms of natural systems, their interactions, and their modification by human activities, on a local scale. Subjects addressed include air pollution modeling, fate and transport of water pollution, contaminant toxicology, human health risk assessment, soil chemistry and degradation, wastewater and drinking water treatment, and land-use assessment. Learning is facilitated by quantitative problem solving and case studies. Three hours of lecture per week.

Credits Awarded: 3

Terms Offered: Fall

Prerequisites: Chem 125 or Chem 131

**GES 213 - Global Physical Systems**

This is the scientific study of physical systems on our planet with a focus on global environmental problems. The course will emphasize analysis of large-scale problems and potential strategies for addressing them. Subjects include biogeochemical cycles, current climate and climate change, human interactions with physical systems, and sustainability.

Credits Awarded: 2

Terms Offered: Spring

Prerequisites: Chem 125 or Chem 131

**GES 215 - Global Change - Humans and Biological Systems**

This course focuses on biological systems and how humans have altered them. Topics include ecosystems, biological diversity, population growth, land-use change, disturbance, and invasive species. We also explore how humans can conserve ecosystems and resources in order to provide for the future human global population.

Credits Awarded: 2

Terms Offered: Spring

Prerequisites: GES 130 or GEMS 130

**GES 220 - Laboratory Methods in Environmental Science**

This laboratory course accompanies GES 211, GES 213 and GES 215. This class will introduce laboratory and field methods necessary to investigate the natural systems which comprise our ecosystem, and the effects of human activities on it. Sampling techniques, field identification, and common methods of chemical analysis for environmental study will be emphasized. Three hours of laboratory per week and one hour of discussion.

Credits Awarded: 2

Terms Offered: Spring

Prerequisites: Chem 127 or Chem 132

**GES 225 - Introduction to Geographic Information Systems**

This course introduces principles and tools for using a Geographic Information System to display and analyze location-based data, along with instruction on where to find freely available data and how to create new datasets. Concepts will include scale, map projections, raster- and vector-based representations of data, and evaluation of spatial relationships between features. Students will receive hands-on instruction with ArcGIS software to learn how to create and analyze maps of any kind of data with a geographic component. Exercises will focus on analysis of real-world datasets to solve problems of local interest.

Credits Awarded: 2

Terms Offered: Spring

**GES 310 - Environmental Public Policy**

This course is an introductory analysis of the economic, scientific and political factors involved in environmental public policy. American environmental management will be viewed in terms of the interplay among economic efficiency, scientific feasibility and the demands of the political process. Topics covered will include federal lands, intergovernmental relations, agency law, comparative institutions, U.S. environmental regulations and technological compliance. This course is team taught by faculty from the Departments of Economics and Business, Geological and Environmental Sciences, and Political Science, so that students are exposed to the interdisciplinary nature of environmental public policy issues. Four hours of lecture per week. Fulfillment of the NSL general education requirement is highly recommended prior to this course.

Credits Awarded: 4

Terms Offered: Spring

**GES 401 - Advanced Environmental Seminar**

This is an interdisciplinary course where students with different academic majors will work in teams to research a local environmental problem. The students will work with faculty members in geological/environmental sciences, biology, chemistry, and possibly other departments in the design of a research project, the collection and interpretation of data, and the making of recommendations. This course is meant to duplicate the process by which scientists work to solve actual environmental problems and is intended as a "capstone" experience for environmental science minors. One two-hour group meeting per week. Additional times to be arranged for consultation, field and laboratory work.

Credits Awarded: 2

Terms Offered: Fall

Prerequisites: GES 211 or GES 212 or GES 220

**GEOLOGY COURSES****GES 100 - The Planet Earth**

This course is an introduction to the scientific study of the planet on which we live. This course emphasizes the study of the major Earth systems (atmosphere, hydrosphere, biosphere, and geosphere) and the interactions between them. Attention is given to environmental change and its implications for our future. This course is one possible introduction to the geology major. Three lectures and one three-hour laboratory each week. One or two Saturday morning field trips are required. Cross-listed as GEMS 157. A student may not receive credit for both GEMS 157/GES 100 and GES 110.

Credits Awarded: 4

Terms Offered: Fall, Spring

Attribute: Natural Science I with lab (NSL)

**GES 104 - Organisms and Environments**

This is the second of a two-semester sequence of courses. The combined courses ("Matter and Energy" and "Organisms and Environments") will satisfy the natural science laboratory general education requirements only for elementary education teacher candidates. The courses will also cover the content that is important for future educators in an integrated inquiry-based format. The content in this recommended course sequence will flow from physical science to Earth/space science to life science topics that students will find themselves teaching in the future. This course will primarily include content from the life and Earth/space sciences, though due to the interdisciplinary nature of many of the topics, physical science topics will also be addressed where appropriate.

**Credits Awarded:** 4  
**Terms Offered:** Fall, Spring  
**Attribute:** Natural Science I with lab (NSL)

**GES 111 - How The Earth Works: An Introduction to Plate Tectonics**

Plate tectonics is a theory that has revolutionized geology, giving the science its first coherent, widely accepted picture of how the whole Earth works. This course is designed to give students a solid understanding of the basic theory, the evidence on which it is based, and its application to subjects as diverse as earthquakes, volcanoes, mountain ranges, precious metal deposits, the topography of the sea floor, and the history of life.

**Credits Awarded:** 2  
**Terms Offered:** Fall

**GES 125 - Michigan Field Geology**

This course is designed as a hands-on introduction to the broad scope of geology using phenomena found within the state of Michigan. Its goal is to give students direct experience with the ways geoscientists ask and answer questions about the Earth. The class begins with a 10-day field trip during which students will travel, camp, and observe and interpret a variety of sedimentary, igneous, and metamorphic rocks and processes that affect them. The course finishes work at Hope College to further understand processes encountered in the field. This course is one possible introduction to the geology major. A 10-day August field trip is required. A student may not receive credit for both GES 100/GEMS 157 and GES 125.

**Credits Awarded:** 4  
**Terms Offered:** Fall  
**Attributes:** ADDITIONAL COURSE FEE (+FEE), Natural Science I with lab (NSL)

**GES 203 - Historical Geology**

This is an introduction to the physical and biological development of the Earth during the last 4.5 billion years. Topics include the formation of the Earth, interpretation of major events in Earth history as preserved in the rock record, and the origin and evolution of life. Three lectures and one three-hour laboratory each week. One weekend field trip is required.

**Credits Awarded:** 4  
**Terms Offered:** Spring  
**Prerequisites:** GES 100 or GEMS 157 or GES 111 or GES 125



**GES 243 - Mineralogy: Earth Materials I**

This course is an introduction to the paragenesis and crystal chemistry of minerals with emphasis on the rock-forming silicates. Laboratory periods will be devoted to the study of minerals in hand samples, as well as exercises designed to help the student understand physical and chemical properties of minerals. Three lectures and one three-hour laboratory per week. One weekend field trip will be required. Students may take Chem 125 or Chem 131 prior to enrollment in or concurrently with the course.

Credits Awarded: 4

Terms Offered: Fall, Even Years

Prerequisites: Chem 125 or Chem 131

Corequisites: Chem 125 or Chem 131

**GES 244 - Petrology: Earth Materials II**

This is a course about mineralogical, chemical, and textural characteristics of igneous, sedimentary, and metamorphic rocks. Their occurrence and petrogenesis will be discussed in terms of rock associations and relevant physical and chemical processes of formation. Laboratory sessions will be devoted to petrographic description, identification, and interpretation of rocks in hand samples and microscope thin sections. A Saturday field trip is required. Three one-hour lectures and one three-hour laboratory per week.

Credits Awarded: 4

Terms Offered: Spring, Odd Years

Prerequisites: GES 243

**GES 251 - Surficial Geology: Earth Structures I**

This is an introduction to the natural processes shaping Earth's surface. Among other topics, the course will stress weathering, landform and soil development, soil mechanics, the influence of running water, moving ice and wind on Earth's surface, and people's interaction with surficial geology. The laboratory will emphasize the use of maps and other geographic images and the course will include an introduction to mapping. Three lectures and one three-hour laboratory each week. Two Saturday field trips will be required.

Credits Awarded: 4

Terms Offered: Fall

**GES 252 - Structural Geology: Earth Structures II**

This is a study of the structures formed by rock deformation, stressing geometric techniques and the concept of strain. The laboratory will emphasize the preparation and interpretation of geological maps and cross-sections. Three hours of lecture and one three-hour laboratory each week. One weekend field trip is required.

Credits Awarded: 4

Terms Offered: Spring, Even Years

Prerequisites: GES 251

**GES 295 - Special Topics in Geology**

A course offered in response to student and instructor interest. Topics are not generally covered in the regular course listings. Course may be taken multiple times if topics are different.

Credits Awarded: 0-4

Terms Offered: As Needed

Prerequisites: Permission of instructor

**GES 320 - Introduction to Petroleum Geology**

This course is an introduction to the applied sub-discipline of geology called petroleum geology. Emphasis is placed on the techniques and strategies used in the modern energy industry to find, extract and produce petroleum hydrocarbons. Topics will include depositional environments, subsurface mapping, seismic interpretation, wire-line logging, reservoir characterization, onshore and offshore leasing, and exploration economics. Student will gain experience working individually and on teams in the evaluation of subsurface data and the development of exploration-related strategies.

**Credits Awarded:** 4  
**Terms Offered:** Spring, alternate years  
**Prerequisites:** GES 100 or GEMS 157 or Eng 100

**GES 341 - Regional Field Study**

This course is a field investigation of the general geology of an area selected by the instructor. One or more hours of lecture will be held each week prior to study in the field. The entire spring vacation or an extended period in the spring or summer will be spent in the field. Courses may be repeated for credit if fieldwork is conducted in different regions.

**Credits Awarded:** 2  
**Terms Offered:** Spring  
**Prerequisites:** GES 100 or GEMS 157 or GES 111 or GES 125

**GES 351 - Invertebrate Paleontology**

This is the study of the fossil record of the history of invertebrate life. Topics include changes in diversity during the Phanerozoic, tempo and mode of evolution, functional morphology, systematics, and paleoecology of the major invertebrate phyla. Three hours of lectures and one three-hour laboratory per week. One or more weekend field trips will be required.

**Credits Awarded:** 4  
**Terms Offered:** Fall, Even Years  
**Prerequisites:** GES 203

**GES 430 - Environmental Geochemistry**

The principles of physical and inorganic chemistry will be applied to geochemical systems of environmental interest. Element recycling and evaluation of anthropogenic perturbations of geochemical cycles will be examined with a strong emphasis on aqueous chemistry. Laboratory exercises will emphasize computer modeling and the analyses of natural waters by a variety of techniques. Three lectures each week. This is a flagged course for the environmental science minor.

**Credits Awarded:** 4  
**Terms Offered:** Spring, Odd Years  
**Prerequisites:** GES 243 or Chem 311

**GES 450 - Hydrogeology**

This is a study of the geological aspects of the water cycle with an emphasis on groundwater. Topics include aquifer testing, groundwater flow, geology of aquifers, water resource management, groundwater chemistry, contamination, and remediation. Emphasis is placed on quantitative problem solving. Three hours of lecture and one three-hour laboratory each week. This is a flagged course for the environmental science minor.

Credits Awarded: 4

Terms Offered: Spring, Even Years

Prerequisites: Permission of instructor

**GES 453 - Sedimentology**

This is the study of the mineralogy, petrology, occurrence, and stratigraphic associations of sedimentary rocks. Thin section examination, textural analysis, and field investigation of sedimentary rocks and unconsolidated sediments will be performed in the laboratory. Three hours of lecture and one three-hour laboratory each week. One or more weekend field trips will be required.

Credits Awarded: 4

Terms Offered: Fall, Odd Years

Prerequisites: GES 203

**GES 490 - Special Problems**

This course is designed to introduce the student to research. A research problem in an area of special interest will be nominated by the student, and approved by a faculty member who will oversee the research.

Credits Awarded: 0-3

Terms Offered: Fall, Spring, Summer

Prerequisites: Permission of instructor

**GES 495 - Study in Geology**

In this course a professor guides students in scholarly readings and discussions focused on a special area of geologic interest.

Credits Awarded: 1-2

Terms Offered: Fall, Spring, Summer

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*Professor of Geology & Environmental Science (1996)*

Ph.D., University of Michigan, 1994

M.S., University of Michigan, 1990

B.A., College of Wooster, 1987

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M.A., Princeton University, 1989

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