

# GEOLOGY

## Overview and Contact Information

The geology major offers students hands-on learning in the classroom, lab, and field. Intermediate and upper-level courses are relatively small and explore geologic materials, physical and biological processes, and earth history and change. We recommend strongly courses in the cognate sciences (biology, chemistry, and physics), as well as calculus and/or statistics.

### Contact Information

**Thomas Millette, Chair**  
**Debra LaBonte, Academic Department Coordinator**

304 Clapp Laboratory  
413-538-2278  
<https://www.mtholyoke.edu/acad/geography>

## Faculty

**This area of study is administered by the Department of Geology and Geography:**

Steven Dunn, Professor of Geology, Teaching Fall Only

Girma Kebede, Professor of Geography

Mark McMenamin, Professor of Geology

Thomas Millette, Professor of Geography; Director of the Geo-Processing Lab

Alan Werner, Professor of Geology

Michelle Markley, Associate Professor of Geology

Serin Houston, Assistant Professor of Geography and International Relations, On Leave 2017-2018

Samuel Tuttle, Visiting Assistant Professor of Data Science

Vivian Leung, Mount Holyoke Fellow; Visiting Instructor in Geology

Sara Hughes, Visiting Lecturer in Geography

Eugenio Marcano, Manager of the Geo-Processing Lab; Instructor in Geology and Geography

## Requirements for the Major

A minimum of 42 credits:

One of the following introductory survey courses:	4
GEOL-103 Oceanography	
GEOL-107 Environmental Geology	
GEOL-108 Precious Drops: The Geology of Groundwater and Fossil Fuels	
GEOL-109 History of Life	
GEOL-131 Introduction to Hydrology: A Data Perspective	
GEOL-123 Methods in Earth Science	2
GEOL-201 Rocks and Minerals	4
GEOL-202 History of Earth	4
GEOL-203 Surface Processes	4

GEOL-224 Paleontology-Stratigraphy	4
GEOL-322 Igneous and Metamorphic Petrology	4
GEOL-333 Structural Geology and Orogenesis	4
8 additional credits in geology at the 200 level or above	8
CHEM-101 General Chemistry (or 4 credits of Advanced Placement Chemistry)	4
<b>Total Credits</b>	<b>42</b>

## Additional Specifications

- Geography, environmental studies, astronomy, and other geology courses in the Five Colleges and from abroad may also apply toward the major as electives or, in some cases, as substitutes for required courses.
- A summer field course may also count for 4-6 credits in geology. No more than 4 credits of independent study (GEOL-295 or GEOL-395) may be counted towards the major.

## Requirements for the Minor

A minimum of 22 credits:

One of the following 100-level geology courses:	4
GEOL-103 Oceanography	
GEOL-107 Environmental Geology	
GEOL-108 Precious Drops: The Geology of Groundwater and Fossil Fuels	
GEOL-109 History of Life	
GEOL-131 Introduction to Hydrology: A Data Perspective	
GEOL-123 Methods in Earth Science	2
12 credits at the 200 level or above	12
4 additional credits at the 300 level	4
<b>Total Credits</b>	<b>22</b>

## Teacher Licensure

Students interested in pursuing licensure in the field of earth science can create a special earth science major and combine this course work with a minor in education. For specific course requirements for licensure in earth science within the field of geology (and related disciplines), please consult your advisor or the chair of the geology and geography department. Further information about the minor in education (<http://catalog.mtholyoke.edu/areas-study/psychology-education/#minortext>) and the Teacher Licensure program (<http://catalog.mtholyoke.edu/areas-study/psychology-education/#teacherlicensuretext>) is available in other sections of the catalog, and consult Sarah Frenette of the psychology and education department.

Licensure also requires a formal application as well as passing scores on the Massachusetts Test of Educator Licensure (MTEL) in both the literacy component and the subject matter component. Copies of the test objectives for the MTEL are available in the Department of Psychology and Education.

Additional information about the Licensure Program, including application materials, can be found on the Teacher Licensure Program website (<https://www.mtholyoke.edu/acad/teach>).

## Course Offerings

### GEOL-103 Oceanography

*Spring. Credits: 4*

Because more than seventy percent of our planet is covered by oceans, the study of marine systems is crucial to our understanding of Earth History and life on the planet. We will examine chemical, physical, geological, and biological processes in the oceans at a variety of scales in time and space. We will explore how the Earth's oceans formed, how they provided the foundations for life, and how they continue to affect weather and climate, stabilize global chemical cycles, erode coastlines and provide access to resources. We will conclude the semester with a discussion of the human impact on the ocean environment including sea level rise, acidification, coral bleaching and over-fishing.

*Applies to requirement(s): Math Sciences*

*A. Werner*

*Advisory: Potential Environmental Studies and Geology majors should consider taking GEOL-123 concurrently with this course.*

### GEOL-107 Environmental Geology

*Fall. Credits: 4*

The only planet known to sustain life, Earth provides all the resources that sustain us, yet at the same time it can be an unpredictable and sometimes dangerous home. Floods, earthquakes, volcanic eruptions, and other natural processes challenge our ingenuity, while we also contend with self-induced problems such as pollution, desertification, and even global climate change. This course examines earth processes, how these affect our lives, and how we can best live with and sustain our environment. May be taken for 200-level credit with permission of instructor.

*Applies to requirement(s): Math Sciences*

*S. Dunn*

*Advisory: Potential Environmental Studies and Geology majors should consider taking GEOL-123 concurrently with this course.*

### GEOL-108 Precious Drops: The Geology of Groundwater and Fossil Fuels

*Spring. Credits: 4*

Are we running out of drinking water? Is fracking safe? When is peak oil? This course is a basic geology course that focuses on two earth materials we use every day: fresh water and fossil fuels. We cover where groundwater is found and why, the depletion and contamination of groundwater, and some major aquifers. We will also explore the formation, worldwide distribution, and extraction of coal, oil, and natural gas. This course introduces students to physical and historical geology, focusing particularly on plate tectonics and sedimentary basins, with attention to current events and illustrations from around the world.

*Applies to requirement(s): Math Sciences*

*M. Markley*

*Advisory: Potential Environmental Studies and Geology majors should consider taking GEOL-123 concurrently with this course.*

### GEOL-109 History of Life

*Fall. Credits: 4*

Life forms have inhabited the surface of our planet for most of its history. Earth, as a result, has a strange geology unlike that of any other known planet. In this course we will examine the interrelations between life processes and Earth's crust and atmosphere, and how these relationships interact to generate the geology of the planet. By means of hands-on analysis of rocks and fossils, we will study the origin and evolution of life, the diversification of complex life forms, the appearance of large predators, and the causes and consequences of oxygenation of the atmosphere.

*Applies to requirement(s): Math Sciences*

*M. McMenamin*

*Advisory: Potential Environmental Studies and Geology majors should consider taking GEOL-123 concurrently with this course.*

### GEOL-123 Methods in Earth Science

*Fall and Spring. Credits: 2*

This course provides a hands-on introduction to earth science and methods in geology. Students will learn the fundamental tools of the trade and explore local geology on field trips. Interactive laboratory work will include projects on groundwater contamination, landfill siting, geologic hazards, and earth materials. Students will also develop skills in reading topographic and geologic maps.

*Applies to requirement(s): Meets No Distribution Requirement*

*V. Leung, P. Taylor, A. Werner*

*Advisory: This is an excellent stand-alone introduction to the geosciences, and also works very well if taken concurrently with any 100-level geology course.*

*Notes: Several field trips are required.*

### GEOL-131 Introduction to Hydrology: A Data Perspective

*Spring. Credits: 4*

Understanding hydrology (the distribution and movement of water at the earth's surface) is critical for resource management and climate modeling. With an eye toward these applications, we will use observational data to explore the components of the water cycle (precipitation, evapotranspiration, soil moisture, and streamflow) and the physical processes that govern them. Lectures and hands-on computer exercises are aimed at students with interests in earth and environmental science or data science. No previous experience is necessary. Students will receive an introduction to statistics, computer programming, data visualization techniques, and available environmental data sources.

*Applies to requirement(s): Math Sciences*

*S. Tuttle*

### GEOL-201 Rocks and Minerals

*Fall. Credits: 4*

In this course you will learn to recognize the common rock-forming minerals and principal rock types, and to understand their origins, properties, associations, and geological significance. Observational skills and hand sample identification will be emphasized in lab and on field trips. Students must have either a one-year high school earth science class or any 100- or 200-level geology course or Geography 107. One or more field trips required.

*Applies to requirement(s): Math Sciences*

*S. Dunn*

*Coreq: GEOL-201L.*

**GEOL-202 History of Earth**

*Spring. Credits: 4*

This course explores the evolution and interaction of life, rocks, oceans, and air during the past 4 billion years of earth history. Some topics covered are: ice ages and greenhouse atmospheres, continental drift, extinctions and radiations of flora and fauna, the early evolution of earth, absolute and relative dating of rocks, and the geologic time scale. Oral presentations and writing assignments focus on the design and testing of earth science hypotheses, critical analysis of recently published research on earth history, and proposal writing. The final exam involves memorization of the geologic time scale and significant events in earth history.

*Applies to requirement(s): Math Sciences*

*Other Attribute(s): Speaking-Intensive, Writing-Intensive*

*M. Markley*

*Prereq: GEOL-123. May be taken concurrently with permission of instructor.*

**GEOL-203 Surface Processes**

*Fall. Credits: 4*

The surface of the Earth is a history book of past environmental change. Every hill and valley, every erosional feature and every deposit is the result of processes acting at the Earth's surface. In this course we study these processes (e.g. glaciers, rivers, slopes, coastlines, arid regions, frozen ground, cave formation, soil development and groundwater) to understand how they work and to understand the resulting landforms and deposits. With this understanding we can then observe different landforms and deposits and infer past processes (environments of deposition). Field work and trips allow students to explore first-hand the processes that have created and modified the Earth's surface.

*Applies to requirement(s): Math Sciences*

*V. Leung, A. Werner*

*Prereq: GEOL-123. Coreq: GEOL-203L.*

**GEOL-210 Plate Tectonics**

*Not Scheduled for This Year. Credits: 4*

Plate tectonic theory explains the origins of volcanoes and earthquakes, continental drift, and the locations of mountain belts and oceans. This course focuses on the geometry of plate tectonics. Topics include mid-ocean ridge systems, transform faults, subduction zones, relative plate motion, earthquake analysis, triple point junctions, and stereographic projection. Work includes individual research projects on active plate boundaries.

*Applies to requirement(s): Math Sciences*

*Other Attribute(s): Speaking-Intensive, Writing-Intensive*

*M. Markley*

*Advisory: Comfort with geometry and trigonometry required.*

**GEOL-224 Paleontology-Stratigraphy**

*Spring. Credits: 4*

This course provides an intensive study of fossils, fossil preservation, relationships between major groups of organisms, depositional environments, sediments, sedimentary rocks, and the processes of sedimentation. We will employ the principles of stratigraphic analysis and correlation to interpret ancient environments and paleoclimate, reconstruct paleogeography, and probe the characteristics of sedimentary basins. Laboratory exercises and field trips will introduce a variety of analytical techniques used to study sedimentary rocks.

*Applies to requirement(s): Math Sciences*

*M. McMnamin*

*Prereq: GEOL-123. Coreq: GEOL-224L.*

**GEOL-227 Groundwater**

*Not Scheduled for This Year. Credits: 4*

The demand for and the contamination of groundwater resources are major environmental concerns. To better understand the dynamics of the groundwater system, we will cover topics including the hydrologic cycle, surface and subsurface hydrology, groundwater resource evaluation, and groundwater geotechnical problems. Students are required to prepare weekly problem sets/labs, a term paper, and an oral presentation.

*Applies to requirement(s): Math Sciences*

*A. Werner*

*Prereq: One 100-level Geology course. Coreq: GEOL-227L.*

**GEOL-240 Geological Resources and the Environment**

*Not Scheduled for This Year. Credits: 4*

This course surveys the geology and exploitation of important mineral deposits and energy resources. We will discuss factors that govern the economics of their production and the environmental implications of their extraction and use.

*Applies to requirement(s): Math Sciences*

*S. Dunn*

**GEOL-241 Topics in Geology****GEOL-241RV Topics in Geology: 'Rivers and Society'**

*Spring. Credits: 4*

In this course, you will think like a river scientist, evaluate societal issues related to rivers, and learn to communicate these points to a general audience. The course is organized around broad topics in river science: river migration, floods, deltas, human water usage, river ecology, and dams. Case studies will include the Yellow River in China, the Mississippi River and Hurricane Katrina, water rights in the southwest U.S. and Mexico, and the Elwha River dam removals in the Pacific northwest (with Skype lectures from Lower Elwha Klallam Tribe scientists).

*Crosslisted as: ENVST-233RV*

*Applies to requirement(s): Meets No Distribution Requirement*

*V. Leung*

*Prereq: Any science, math, or geography course.*

**GEOL-247 Environmental Modeling & Statistics**

*Fall. Credits: 4*

Models are simple representations of the real world, which can be used to convey information, generate and test hypotheses, and make predictions about what will happen in the future. This course introduces students to the art and science of modeling natural systems, as well as their mathematical and statistical foundations. Students will gain experience in asking research questions, creating hypotheses, collecting and arranging data, and designing computer models (in R) to address a variety of environmental problems. This course will include lecture and hands-on computer exercises and is aimed at students with interests in earth and environmental science or data science.

*Applies to requirement(s): Math Sciences*

*S. Tuttle*

*Prereq: One of the following: STAT-140, GEOG-107, GEOL-107, ENVST-200, BIOL-223, or COMSC-101.*

**GEOL-295 Independent Study**

*Fall and Spring. Credits: 1 - 4*

*The department*

*Instructor permission required.*

**GEOL-316 Scanning Electron Microscopy**

*Not Scheduled for This Year. Credits: 2*

Includes theory and operation of the scanning electron microscope and preparation of biological and geological materials for observation. The versatile use of the microscope will be emphasized and will include low magnification, high resolution, and back scattered (reflected) electron modes of operation as well as operation at different pressures. Energy dispersive X-ray microanalysis will be introduced.

*Crosslisted as: BIOL-316*

*Applies to requirement(s): Meets No Distribution Requirement*

*B. Carbajal-Gonzalez*

*Prereq: 4 credits at the 200 level from Biological Sciences or Geology.*

**GEOL-322 Igneous and Metamorphic Petrology**

*Spring. Credits: 4*

This course covers mineralogical and chemical compositions, classification, genesis, and mode of occurrence of igneous and metamorphic rocks, including relationships between rock-forming processes and global plate tectonics; labs involve the study of representative rock suites in hand specimen and thin section, introduction to analytical techniques and in-depth coverage of mineral optics. One or more field trips required.

*Applies to requirement(s): Math Sciences*

*D. Snoeyenbos*

*Prereq: GEOL-201 and CHEM-101. CHEM-101 may be taken concurrently.*

*Coreq: GEOL-322L.*

**GEOL-326 Seminar: Global Climate Change**

*Spring. Credits: 4*

Earth's dynamic climate system is rapidly changing. This course will introduce you to the science behind climate change predictions as they apply to past, present, and future changes in our earth's climate. We will also discuss how, over the course of time, we adapted to these changing conditions with a specific focus on water resources and natural disasters, including floods, droughts, and hurricanes that have been predicted to intensify in response to ongoing climate change.

*Applies to requirement(s): Meets No Distribution Requirement*

*S. Tuttle*

*Prereq: One Geology or Environmental Studies course at the 200-level.*

**GEOL-333 Structural Geology and Orogenesis**

*Fall. Credits: 4*

This course covers the basic techniques of field geology and structural analysis. Lectures concentrate on field techniques, stress, strain, faulting, folding, rock strength, deformation mechanisms, and multidisciplinary approaches to mountain building (orogenesis). Many labs are field trips that involve data collection. Weekly writing assignments focus on presenting original research and distinguishing between observations and interpretations. During the final weeks of the semester, oral presentations emphasize fluency in the published literature of structural geology using a case study from Death Valley, California.

*Applies to requirement(s): Math Sciences*

*M. Markley*

*Prereq: GEOL-123 and GEOL-201. GEOL-201 may be taken concurrently.*

*Coreq: GEOL-333L.*

**GEOL-341 Seminar**

Seminars offer directed study and discussion of one or more selected topics in geology. Topics vary from year to year.

**GEOL-342 Seminar in Geology**

Seminars offer directed study and discussion of one or more selected topics in geology. Topics vary from year to year. Consult the department for information about future seminars.

**GEOL-343 Applied Environmental Geology**

*Spring. Credits: 2*

This 2-credit field-based course focuses on assessing the environmental impact of applied road salt in two local hill towns. Each week we will work to measure stream discharge, stream water quality, and measure soil water and snow bank salinity. Each student will pursue their own independent research project but will work collaboratively with other students in the class.

*Crosslisted as: ENVST-343*

*Applies to requirement(s): Meets No Distribution Requirement*

*A. Werner*

*Prereq: GEOL-123 or ENVST-200.*

*Notes: Half semester.*

**GEOL-395 Independent Study**

*Fall and Spring. Credits: 1 - 8*

*The department*

*Instructor permission required.*

**GEOL-399 Getting Ahead in Geology and Geography**

*Fall. Credits: 1*

This course provides support and mentoring for geology and geography majors as they pursue internships, summer jobs, independent research, and careers. Experiences will include: resume and communication workshops; self-reflection and sharing opportunities for students returning from internships, work experiences, and semesters abroad; guidance on preparing for, selecting, and applying to graduate school; information about careers in education and teacher licensure; and discussion of new research in geology and geography.

*Crosslisted as: GEOG-399*

*Applies to requirement(s): Meets No Distribution Requirement*

*M. Markley, P. Taylor*

*Restrictions: This course is limited to Geography and Geology majors and minors*

*Notes: Credit/no credit grading. Course meets on Fridays after Earth Adventures.*