

# 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

Alan Werner, Chair  
Rhodaline Forjuvor, 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

Girma Kebede, Professor of Geography

Mark McMenamin, Professor of Geology

Thomas Millette, Professor of Geography

Alan Werner, Professor of Geology

Michelle Markley, Associate Professor of Geology

Serin Houston, Assistant Professor of Geography and International Relations

J. Michael Rhodes, Five College Professor of Geosciences

Samuel Tuttle, Visiting Assistant Professor of Data Science

## Requirements for the Major

A minimum of 42 credits:

One of the following introductory survey courses:	4
GEOL-100 Physical Geology	
GEOL-101 Environmental Geology with Lab	
GEOL-103 Oceanography	
GEOL-107 Environmental Geology	
GEOL-108 Precious Drops: The Geology of Groundwater and Fossil Fuels	
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
Total Credits	42

## 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-100 Physical Geology	
GEOL-101 Environmental Geology with Lab	
GEOL-102 History of Life with Lab	
GEOL-103 Oceanography	
GEOL-107 Environmental Geology	
GEOL-108 Precious Drops: The Geology of Groundwater and Fossil Fuels	
GEOL-123 Methods in Earth Science	2
12 credits at the 200 level or above	12
4 additional credits at the 300 level	4
Total Credits	22

## 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-100 Physical Geology

*Not Scheduled for This Year. Credits: 4*

Humans are intimately connected with and dependent upon the physical environment. We have only been present on the Earth for a brief span, but we try to understand how the Earth has evolved since its formation over four billion years ago. Our knowledge of the Earth is critical, not only for reconstructing its history, but also for helping us to understand issues relevant to our lives, such as the availability of natural resources, pollution, climate change, and natural hazards. In this course, we will perform a general survey of the physical Earth. In classroom, lab and field, we will examine rocks and minerals of which the solid Earth is composed, processes that generate the Earth's landforms, natural hazards associated with those processes, and geologic time.

*Applies to requirement(s): Math Sciences*

*M. Markley*

*Restrictions: This course is limited to First-year and Sophomore students.*

*Coreq: GEOL-100L.*

### GEOL-101 Environmental Geology with Lab

*Not Scheduled for This Year. Credits: 4*

The only planet known to sustain life, Earth provides all the resources that sustain us, yet 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. The labs cover selected geologic topics including methods for recognizing and interpreting environmental hazards, and developing strategies to address environmental problems.

*Applies to requirement(s): Math Sciences*

*S. Dunn*

*Coreq: GEOL-101L.*

### GEOL-102 History of Life with Lab

*Not Scheduled for This Year. Credits: 4*

Life forms have inhabited the surface of our planet for most of its history. Earth, as a result, has a unique geology that is unlike that of any other planet. In this course we will examine the interrelations between life processes and Earth's crust and atmosphere and how they work together to create the geology of the planet. Using both the rock and fossil record, we will study the origin and evolution of life, the history of continents and oceans, and the diversification of complex life forms. Laboratory and field trips will emphasize identification and analysis of sediments, rocks, and fossils.

*Applies to requirement(s): Math Sciences*

*M. McMenam*

*Coreq: GEOL-102L.*

### 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: Environmental Studies and Geology students 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*

### 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*

### 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. McMenam*

**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, and it augments all the 100-level geology courses. Students will learn the fundamental tools of the trade and explore local geology on field trips. Interactive laboratory work will include projects on groundwater quality, 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*

*S. Dunn, M. Markley, P. Taylor*

*Advisory: Any 100-level geology course (may be taken concurrently)*

*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*

*A. Werner*

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

**GEOL-210 Plate Tectonics**

*Fall. 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-211 Uranium**

*Not Scheduled for This Year. Credits: 4*

From the A-bomb to zircon, uranium has revolutionized humanity's destructive potential and wisdom about time. Uranium is the planet's heaviest naturally occurring element, and it transforms by both radioactive decay and nuclear fission. This course uses computer modeling to explore these two transformations and what we make of them, specifically: the age of the earth, high-precision dating of recent geologic and climate events, nuclear power, nuclear weapons, plutonium production, and the uniquely long-term challenge of nuclear waste disposal and storage.

*Applies to requirement(s): Math Sciences*

*M. Markley*

*Prereq: 1 course in Chemistry, Geology, Math, or Statistics.*

**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. McMenamin*

*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**

*Spring. 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-295 Independent Study**

*Fall and Spring. Credits: 1 - 4*

*The department*

*Instructor permission required.*

**GEOL-316 Scanning Electron Microscopy**

*Fall. 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**

*Not Scheduled for This Year. 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): Meets No Distribution Requirement*

*S. Dunn*

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

*Coreq: GEOL-322L.*

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

*Not Scheduled for This Year. 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*

*The department*

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

**GEOL-333 Structural Geology and Orogenesis**

*Not Scheduled for This Year. 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-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: Course meets on Fridays just after the 'Earth Adventures at Lunch' talks.*