

# 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

**Michelle Markley, Chair**  
**Debra LaBonte, Academic Department Coordinator**

304 Clapp Laboratory  
 413-538-2278

<https://www.mtholyoke.edu/academics/find-your-program/geology>  
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## Learning Goals

Students majoring or minoring in geology learn about the dynamic processes and history that shaped our planet and provide us with the resources and natural environments on which we rely. This is a fascinating field of study that also prepares one for outstanding employment opportunities. Our courses are designed to achieve the following learning goals:

- Develop observational and quantitative skills appropriate for field, laboratory, analytical, and modeling methods of geoscience inquiry.
- Develop sophisticated and nuanced reasoning skills to evaluate multiple working hypotheses, integrate earth science data gathered at different spatial and temporal scales, and critically assess data, ideas, and methods from the published literature.
- Become an effective communicator, able to ask interesting questions, collaborate with peers, and engage thoughtfully and respectfully in discussion; to write about scientific observations and interpretations using appropriate vocabulary and style; and to orally and graphically present data, ideas, and methods from your own research and from published literature.
- We encourage geology majors to be informed about ideas and methods within the cognate sciences of biology, chemistry, physics, and math and statistics.
- Geology majors will understand the importance of earth processes and materials in shaping the history and future of humanity.

## Faculty

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

Michelle Markley, Professor of Geology

Mark McMenamin, Professor of Geology, On Leave 2024-2025

Alan Werner, Professor of Geology, Teaching Fall and Spring

Serin Houston, Associate Professor of Geography and International Relations

Marsha Allen

Dinko Hanaan Dinko, Assistant Professor of Geography

Kinuyo Kanamaru, Visiting Assistant Professor in Geology

Shaina Sadai, Visiting Assistant Professor in Geology and Geography

Claire Pless, Visiting Assistant Professor in Geology

Caroline Loomis, Visiting Instructor in Geology and Geography

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

## Requirements for the Major

A minimum of 36 credits:

Code	Title	Credits
<b>32 credits in geology</b>		
8 credits in geology at the 100 level or above		8
16 credits in geology at the 200 level or above		16
8 credits in geology at the 300 level		8
<b>4 credits in chemistry</b>		
CHEM-150 (or 4 credits of Advanced Placement Chemistry)		4
<b>Total Credits</b>		<b>36</b>

### Additional Specifications

- No more than 4 credits of independent study (GEOL-295 or GEOL-395) may be counted towards the major.
- 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.

## Requirements for the Minor

A minimum of 20 credits:

Code	Title	Credits
One 100-level geology course		4
12 credits in geology at the 200 level or above		12
4 additional credits in geology at the 300 level		4
<b>Total Credits</b>		<b>20</b>

## Teacher Licensure

Students interested in pursuing licensure in the field of earth and space 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 and space 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. Students interested in pursuing teacher licensure should set up an initial advising session with Sarah Frenette, Five College Teacher Licensure Coordinator and director of the Early Childhood/Elementary Teacher Licensure Program, by the middle of the sophomore year in order to

identify course work in the major and in the arts and sciences necessary for licensure.

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.

Additional information about the Licensure Program, including application materials, can be found on the Teacher Licensure Program website (<https://www.mtholyoke.edu/academics/find-your-program/teacher-licensure/>).

## 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*

### GEOL-105 Introduction to Geology Change'

#### GEOL-105CC Introduction to Geology: 'Climate Change'

*Fall. Credits: 4*

This course is about past, present, and future global climate and environmental change. We will discover how the climate system works, how the climate has evolved over geologic time, and what might be in store for us in the future - as human population grows, landscapes are modified and greenhouse gas concentrations increase in our atmosphere. We will study some of the biggest climate events in Earth's history and will come to appreciate how rapid changes currently underway compare to the natural range and pace of climatic variability. The course will provide students with an up-to-date assessment of 1) how the climate system works, 2) to what extent humans are causing climate change, 3) what the consequences of those changes might be, and 4) what can be done to mitigate the most adverse effects of those changes.

*Applies to requirement(s): Math Sciences*

*K. Kanamaru*

*Coreq: GEOL-105CCL.*

### GEOL-107 Environmental Geology

*Not Scheduled for This Year. 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*

*The department*

### GEOL-116 Art in Paleontology

*Not Scheduled for This Year. Credits: 4*

Paleontological art brings ancient organisms back to life. In this course we will consider the role that "PaleoArt" itself plays as a mode of scientific discovery. Beginning with an analysis of the pioneering paleoart of Charles R. Knight, we will examine how paleoartists have uncovered key information about prehistoric life well in advance of its recognition by the scientific community. In a collaborative class project, we will identify the best and most representative works for a possible display somewhere on campus. For individual final class projects, students may choose between a research paper and presentation, and their own paleontological artwork in any visual medium. For the latter, students will be able to utilize resources of the Fimbel Maker and Innovation Lab.

*Applies to requirement(s): Math Sciences*

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

*M. McMEnamin*

### GEOL-126 The Cambrian Explosion

*Not Scheduled for This Year. Credits: 4*

The origin of animals was arguably the most important event in earth history. In this course we will review the history of earth, learn basic geology, and then examine the problem of the origin of animals by studying Mount Holyoke College's superb and unique collection of Proterozoic and Cambrian fossils. The emergence of animals has been called the Cambrian explosion. We will examine what this means for our understanding of evolution as we evaluate hypotheses proposed to explain the relatively sudden appearance of more than half of known animal phyla during the Cambrian event.

*Applies to requirement(s): Math Sciences*

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

*M. McMEnamin*

*Notes: May be taken for 200-level credit with permission of instructor.*

### GEOL-133 Mass Extinction, Dinosaurs and Ecological Recovery

*Not Scheduled for This Year. Credits: 4*

Beginning in Precambrian time over a half billion years ago, mass extinctions have periodically decimated earth's biota and left the biosphere in ruins. For example, both the Permo-Triassic and the End-Cretaceous mass extinctions reshaped life on earth and initiated new geological eras. In this course we will examine why mass extinctions occur and study the ways in which the biosphere recovers from mass extinction events. We will also evaluate the claim that we humans are causing a mass extinction and examine proposals regarding the steps we might take to hasten biospheric recovery.

*Applies to requirement(s): Math Sciences*

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

*M. McMEnamin*

*Prereq: Any one course in Biology, Chemistry, Environmental Studies, Geology, or Physics.*

**GEOL-137 Dinosaurs**

*Not Scheduled for This Year. Credits: 4*

The first dinosaur fossils to be recognized in North America, footprints of the creatures, were found in South Hadley. The very first dinosaur species described by a woman researcher, and one of the most ancient dinosaur species in the United States (*Podokesaurus holyokensis*), was discovered close to the Mount Holyoke campus. In this course we will learn the main types of non-avian dinosaurs, compare them to other ancient and modern vertebrates, assess their relationship to birds, debate their physiology (cold-blooded or warm blooded?), examine the ecology of the world they inhabited, and by means of field work, rock drilling and excavation, resume the search for a new specimen of *Podokesaurus*. To complete the final project, students will select a dinosaur species and study its geological age, geographic distribution, environmental preferences, ecological roles, feeding and reproductive strategies, and body form as they review the history of attempts to reconstruct their adopted dinosaur.

*Applies to requirement(s): Math Sciences*

*Other Attribute(s): Speaking-Intensive*

*M. McMenamin*

**GEOL-141 Making the Past: Geosciences in the Makerspace**

*Not Scheduled for This Year. Credits: 4*

The great German paleontologist Dolf Seilacher once remarked that "drawing enforces careful observation." As a consequence, Seilacher drew all of the illustrations for his influential scientific publications. Taking Seilacher's insight into three dimensions, in this course we will utilize Mount Holyoke's Makerspace to reconstruct ancient organisms. Studies have shown that well-crafted reconstructions of ancient creatures contribute substantially to improved scientific interpretation of their functional morphology, behavior and paleoecological role(s). We will use Makerspace resources, Pixologic's Sculptis, 3D printing and other tools to improve our understanding of the morphologies and activities of ancient organisms, while gleaning information derived from the rock record to analyze their ancient morphologies and behaviors.

*Applies to requirement(s): Math Sciences*

*M. McMenamin*

**GEOL-201 Rocks and Minerals**

*Spring. 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.

*Applies to requirement(s): Math Sciences*

*C. Pless*

*Coreq: GEOL-201L.*

*Advisory: Students must have either a one-year high school earth science class or any 100- or 200-level Geology course or GEOG-107.*

**GEOL-202 History of Earth**

*Fall. 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: the geologic time scale, significant events in earth history, ice ages and greenhouse atmospheres, continental drift, extinctions and radiations of flora and fauna, the geology of the anthropocene, and absolute and relative dating of rocks. Oral presentations and writing assignments focus on the design and testing of earth science hypotheses, and critical analysis of recently published research on earth history.

*Applies to requirement(s): Math Sciences*

*M. Markley*

*Prereq: One 100-level Geology course.*

**GEOL-203 The Earth's Surface**

*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 (i.e. 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: One 100-level Geology course.*

**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*

*M. Markley*

*Prereq: Any 100-level Geology course.*

*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 explores 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, and radiation and health. Writing and reading assignments focus on science communication for a general audience.

*Applies to requirement(s): Math Sciences*

*M. Markley*

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

**GEOL-224 Sedimentology**

*Not Scheduled for This Year. Credits: 4*

Sedimentary rocks provide us with repositories of fresh water, hydrocarbons, and other critical raw materials, as well as geological evidence for the history of planet earth. This course will introduce students to the study of sedimentary rocks and their environments of deposition, with a focus on the varied processes of sediment accumulation. We will employ the principles of stratigraphic analysis and correlation to interpret ancient environments, paleoclimate, and paleogeography, and use these tools to probe the characteristics of sedimentary basins. Field trips will introduce a variety of analytical techniques used to study sedimentary rocks.

*Applies to requirement(s): Math Sciences*

*M. McMenamin*

*Prereq: Any one course in Biology, Chemistry, Environmental Studies, Geology, or Physics.*

**GEOL-229 Hydrology and Hydrogeology: Hydrological Cycle, Surface, and Groundwater Movement***Spring. Credits: 4*

This course will introduce students to water science where we investigate the hydrological cycle, water distribution on the earth's surface and subsurface at the continental and catchments scale. We will study atmospheric processes such as precipitation, evapotranspiration, and surface runoff to understand how it affects the quantity and quality of potable water availability. Students will learn and practice introductory level groundwater calculations which are mathematical equations that describe the flow and storage of water.

*Applies to requirement(s): Math Sciences**The department***GEOL-295 Independent Study***Fall and Spring. Credits: 1 - 4**The department**Instructor permission required.***GEOL-321 The Science of Paleontology***Not Scheduled for This Year. Credits: 4*

Our understanding of the fossil record is critical for today, as it helps us to comprehend the current state of the planet and its inhabitants. Using a variety of tools and techniques, this course will provide you with a one semester apprenticeship in paleontological science. We will examine the morphology, evolution, survivorship, paleogeography and ecological relationships of ancient organisms. Our subjects will include plants, invertebrate animals, and vertebrate animals, with examples ranging from the Precambrian to the Pleistocene. We will address quantitative questions in paleontology by means of Excel and R Studio.

*Applies to requirement(s): Math Sciences**M. McMenamin**Prereq: Two college-level science courses.***GEOL-322 Petrology***Fall. Credits: 4*

This course covers mineralogical and chemical compositions, classification, genesis and mode of occurrence of igneous and metamorphic rocks. The structure of the course is a lab course, focusing on the methodology and analytical techniques used to study rock specimens.

*Applies to requirement(s): Math Sciences**C. Pless**Prereq: GEOL-201.***GEOL-326 Climate Change: Polar Places and Spaces***Not Scheduled for This Year. Credits: 4*

Earth's polar environments have undergone rapid change during the 21st century and scientists have generated important new data and made groundbreaking insights (<https://tinyurl.com/45u7h9x7/>). Using real data, diverse material types, and a range of activities, we have been selected to "Beta-test" education modules designed to teach polar science and polar exploration. Every module uses a combination of 360-degree interactive environment(s), GIS, and other materials to provide students with authentic scientific data and the opportunity to dive into the field experience. According to the PolarPass website, "Each module explores a specific theme, provides a series of units within that theme to walk students through discovery. Learning activities are designed to enhance students' geospatial skills and support development of a sense of polar place, even without traveling to these exciting environments." Note: this is an upper-level climate science course that will involve using real climate and proxy data to better understand past and present climate change. Human dimensions of climate change although incredibly important are not the focus of this course.

*Applies to requirement(s): Math Sciences**A. Werner**Prereq: GEOL-203 or ENVST-200.***GEOL-333 Structural Geology and Orogenesis***Spring. 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). Weekly writing assignments focus on presenting original research and distinguishing between observations and interpretations.

*Applies to requirement(s): Math Sciences**M. Markley**Prereq: 8 credits from Geology including GEOL-201.***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-342CC Seminar in Geology: 'Global Effects of Climate Change'***Not Scheduled for This Year. Credits: 4*

Climate change is shifting the historical climate due to temperature increases and changing weather patterns. Historical monitoring of atmospheric gases has shown that anthropogenic contributions since the Industrial Revolution are the leading causes. Today, the effects of climate change vary by location and are most visible in weather patterns, where some locations are becoming wetter or dryer. The global temperatures of land surfaces and oceans have increased over time, and these shifts have also directly affected biodiversity and human activity. This discussion-based seminar aims to cover peer-reviewed articles on the effects of climate change in different regions of the world.

*Applies to requirement(s): Math Sciences**Other Attribute(s): Speaking-Intensive, Writing-Intensive**The department**Prereq: 8 credits in the sciences.*

**GEOL-342DV Seminar in Geology: 'Death Valley Field Course'**

*Not Scheduled for This Year. Credits: 4*

This seminar will cover selected topics on the geology of Death Valley region, California. We will meet for two hours per week up until spring break, then embark on a nine-day field trip to Death Valley National Park, March 2021. A participation fee is required. Students will be responsible for researching particular topics and presenting a final report.

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

*The department*

*Instructor permission required.*

*Prereq: Two Geology courses.*

**GEOL-342EA Seminar in Geology: 'Sea Level Science'**

*Fall. Credits: 4*

Climate change is currently causing sea levels to rise globally. How and why does sea level change over time? What is driving the current acceleration in sea level rise and what might happen in the future? How does earth structure and gravity impact regional sea level change? In this course we will discuss the science of how and why sea level changes, how sea level rise is impacting coastlines around the world, and what can be done to address it. This discussion-based seminar will cover peer-reviewed articles on sea level dynamics and interactive datasets.

*Applies to requirement(s): Math Sciences*

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

*S. Sadai*

*Prereq: 8 credits in the sciences.*

**GEOL-342TR Seminar in Geology: 'Trees: Climate and Dendrochronology'**

*Spring. Credits: 4*

Trees are everywhere, and they are remarkable record keepers of climate/environmental information. Dendrochronology is the study of tree rings to understand the age of trees, past climate patterns, and environmental change. In this course, students will learn that the growth of a tree is a delicate interaction based on many factors including regional climate patterns and environmental conditions. This course will demonstrate that science is accessible to a broad audience through sample collection, laboratory processing, data analysis, creation/testing of hypotheses, and presentation to that audience.

*Applies to requirement(s): Math Sciences*

*K. Kanamaru*

*Prereq: Students who completed any combination of a minimum of two courses in Geology, Geography, or Environmental Studies.*

**GEOL-342WA Seminar in Geology: 'Water Issues Worldwide'**

*Not Scheduled for This Year. Credits: 4*

Potable water is in much higher demand worldwide because of climate change. This seminar discusses research publications about the problems contributing to current water insecurity. Lectures will focus on assigned weekly readings that discuss each issue, case studies in multiple countries, and the analytical methods used for analyses. In addition, students will be required to complete weekly written assignments and a research project where they will apply the gained knowledge. The structure of this course will be beneficial to students who plan on attending graduate school in the STEM fields.

*Applies to requirement(s): Math Sciences*

*The department*

*Prereq: 8 credits in the sciences.*

**GEOL-395 Independent Study**

*Fall and Spring. Credits: 1 - 8*

*The department*

*Instructor permission required.*