

Geosciences

Chair of the Department: Charles Fitts, Bailey Hall, Gorham

Professors: Novak, Pollock, Swanson; *Associate Professor:* Fitts; *Laboratory Associate:* Vose

In geosciences, we study the dynamic processes that have affected the history and development of the earth and continue to influence environments on its surface. Geoscience crosses traditional discipline boundaries, incorporating concepts from physics, chemistry, biology, and mathematics in the study of specific areas such as earth structure, history of life, plate tectonics, mountain building, earthquakes, ground water resources, climate, and energy resources. The geosciences curriculum is designed to give the student a solid scientific understanding of our environment using the latest tools and applications in preparation for careers in geology and geo-technical consulting, resource exploration and extraction, environmental issues involving water resources, geologic hazards, research, and government regulatory agencies.

The degree program offers students the flexibility to tailor a sequence of courses to their interests, whether they be in earth materials, large-scale crustal processes, or surficial processes relevant to environmental issues. We offer a strong field- and laboratory-based sequence of courses. We conduct field trips to explore, map, and measure geologic processes throughout Maine and New England. Dedicated laboratories in Bailey Hall include the Sediment Analysis Laboratory, Rock Preparation Laboratory, and X-ray Diffraction Laboratory for mineral identification. The latest digital mapping technologies are available with global positioning system (GPS) and total station surveying equipment that is used in conjunction with the Gorham Geographic Information System (GIS) computer laboratory in Bailey Hall. The Gorham GIS Laboratory offers the latest software for modern spatial analysis and remote sensing of the earth's surface. Geosciences courses integrate our available equipment and technology resulting in a strong field-based, digitally supported degree program.

We also stress and value undergraduate student research and independent study. Faculty expertise offers student research opportunities in many areas including digital outcrop surface mapping, remote sensing using multiple data sources, groundwater resource mapping and modeling, and geoarcheology. Student work is presented at a number of venues including the USM Thinking Matters conference, Maine Water Conference, Geological Society of Maine meetings, and Geological Society of America meetings.

Graduates of the program find that they are well-prepared to start careers in geologic and environmental work, science teaching, or to continue on to graduate school for advanced degrees. Our graduates work for a variety of local geologic consulting firms, Maine's Department of Environmental Protection, and teach science in K-12 schools throughout the state. Similar employment opportunities are available in other states.

More information can be found at the Geosciences Web site: www.usm.maine.edu/geos.

Programs and Requirements

Bachelor of Arts in Geosciences and Bachelor of Science in Geosciences

A minimum of 54 credits are required for the B.A. degree and a minimum of 71 credits are required for the B.S. degree (in addition to the University's Core curriculum requirements). The B.A. and B.S. degrees differ only in the chemistry, physics, and mathematics requirements as listed below. Majors must achieve a 2.0 grade point average and grades of C- or better in all geosciences courses.

Geosciences Course Requirements for both B.A. and B.S. degrees:

All majors must complete at least one introductory lecture and lab, to be selected from among the following courses. Note that an additional introductory lecture course may be applied to the major as three elective credits.

Introductory lecture courses

GEY 100K	Volcanoes, Earthquakes, & Moving Plates
GEY 103K	Floods, Glaciers, and Changing Climate
GEY 105K	Ocean Planet

Introductory lab courses

GEY 101K	Laboratory Experiences in Geology
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GEY 102K	Field Experiences in Geology
GEY 106K	Ocean Planet Laboratory

Introductory lecture/lab course

GEY 109K	Field Geology of Maine
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All majors must complete each of the following foundation courses

GEY 202	Landscape Evolution and Analysis
GEY 203	Mineralogy
GEY 204	Crustal Deformation
GEY 205	Water Resources: Science and Issues

In addition to the above, 20 credits of geosciences (GEY prefix) elective courses are required. Three credits of these may be at the 100 level, and the rest must be at the 200 level or higher. Students are encouraged to also explore relevant courses in other departments, depending on their interest. In particular, GIS courses are recommended for those interested in mapping or consulting, and some chemistry and environmental science courses are relevant to environmental consulting and regulation.

Original research is regarded as a significant component of liberal education. The department encourages a choice of either the Senior Thesis (GEY 490) or Undergraduate Research in Geology (GEY 498) as part of the degree program.

Suggested Geosciences elective courses for students interested in earth materials and resources

GEY 201	Paleogeography and Global Change
GEY 240	X-ray Powder Diffraction Laboratory
GEY 302	Sedimentation and Stratigraphy
GEY 303	Igneous & Metamorphic Rock Origins
GEY 410	Introduction to Geophysics

Suggested Geosciences elective courses for students interested in environmental geology

GEY 110K	Field Studies in Environmental Geology on the Island of Lesbos, Greece
GEY 205	Water Resources: Science and Issues
GEY 207	Atmosphere: Science, Climate, and Change
GEY 208	Environmental Geology
GEY 310	Glacial & Pleistocene Geology
GEY 420	Groundwater Flow and Quality

Suggested Geosciences elective courses for students interested in mapping technologies

GEY 340	Digital Mapping
GEY 360	Field Mapping in the Island Environment: Data Collection to GIS

Non-Geosciences course requirements for the B.A. degree

CHY 113K	Principles of Chemistry I
CHY 114K	Laboratory Techniques I
PHY 111K	Elements of Physics Laboratory I
PHY 114K	Introductory Physics Laboratory I
MAT 120D	Introduction to Statistics OR MAT 152D Calculus A

Non-Geosciences course requirements for the B.S. degree

CHY 113K	Principles of Chemistry I
CHY 114K	Laboratory Techniques I
CHY 115	Principles of Chemistry II
CHY 116	Laboratory Techniques II
PHY 121K	General Physics I
PHY 114K	Introductory Physics Laboratory I
PHY 123	General Physics II
PHY 116	Introductory Physics Laboratory II
MAT 120D	Introduction to Statistics
MAT 152D	Calculus A
MAT 153	Calculus B

Minor in Geosciences

A minimum of 17 credits of GEY courses are required, including an introductory lecture, an introductory lab, and 13 additional credits of GEY electives, 10 of which must be numbered 200 or higher.

GEY 100K Volcanoes, Earthquakes, and

Moving Plates

An introduction to minerals, rocks, and the processes that have continually shaped the earth over hundreds of millions of years of geologic history. The course also explores how the movements of crustal plates generates earthquakes, volcanoes, continental rifting, sea floor spreading, subduction, and continental-scale mountain ranges. For K credit, registration in one of the following: GEY 101K, GEY 102K, or GEY 106K is required; concurrent registration is recommended. Cr. 3.

GEY 101K Laboratory Experiences in Geology

Weekly lab sessions will focus on the basic skills of mineral identification, rock classification, and interpretation of topographic and geologic maps. Field trips to local geologic sites of interest will help illustrate rock types and geologic processes that shape our world. Traditional map, compass, and modern GPS techniques will be utilized. For K credit, registration in one of the following: GEY 100K, GEY 103K, or GEY 105K is required; concurrent registration is recommended Cr 1.

GEY 102K Field Experiences in Geology

This field-based lab experience will stress rock and mineral identification and map interpretation in the study of a series of local field sites. Basic geologic mapping techniques will be used to reconstruct local geologic history and create detailed maps and cross-sections describing many of the spectacular outcrops in the Casco Bay area of coastal Maine. Traditional map and compass and modern GPS techniques will be used. For K credit, registration in one of the following: GEY 100K, GEY 103K, or GEY 105K is required; concurrent registration is recommended. Fall semester only. Cr 1.

GEY 103K Floods, Glaciers, and Changing Climate

This course focuses on the external processes that shape earth's surface, including rivers, groundwater, glaciers, oceans, climate, and landslides. The course will also examine issues such as flood control, water resources, and climate change, where these external processes have large impacts on society. For K credit, registration in one of the following: GEY 101K, GEY 102K, or GEY 106K is required; concurrent registration is recommended. Cr 3.

GEY 105K Ocean Planet

An interdisciplinary look at the science of the ocean, emphasizing connections between land, sea, and atmosphere. Basic concepts in chemistry, geology, physics, and biology are taught as they apply to marine phenomena such as salinity, ocean floor formation, currents, waves, seafloor sediments and rocks, and marine life. Students must have fulfilled the University's minimum proficiency requirements in mathematics. For K credit, registration in one of the following: GEY 101K, GEY 102K, or GEY 106K is required; concurrent registration is recommended. Cr 3.

GEY 106K Ocean Planet Laboratory

Major concepts from GEY 105K are illustrated using hands-on activities. Students perform a variety of tasks designed to promote understanding of scientific methods and data analysis. Classes held in the lab include a range of chemical, physical, and geological exercises. Field trips may involve observing a variety of coastal phenomena including waves, beach formation, rocky shoreline geology, or intertidal zonation. Students must have fulfilled the University's minimum proficiency requirements in mathematics. For K credit, registration in one of the following: GEY 100K, GEY 103K, or GEY 105K is required; concurrent registration is recommended. Cr 1.

GEY 109K Field Geology of Maine

This introductory course uses a field-based approach to understanding earth materials and the processes of crustal deformation, igneous intrusion, and surface erosion. Traditional lectures and labs are combined in a series of weekly field trips to spectacular coastal rock exposures of Casco Bay and southern Maine, where students will learn to recognize and interpret the effects of crustal and surface processes in the context of local geologic history. Traditional map and compass and modern GPS techniques will be used. Summer Session or Fridays during fall semesters. Cr 4.

GEY 110K Field Studies in Environmental Geology on the Island of Lesbos, Greece

This course will consider the basic and applied geology of the eastern Aegean Sea with particular emphasis on the island of Lesbos, Greece. The course is a cooperative effort with the Department of Environmental Studies of the University of the Aegean. Rocks, minerals, and topographic maps will be studied for the purpose of interpreting the bedrock geology, geomorphology, and hydrogeology of the region. Other topics will include remote sensing, aerial geology, tectonics, use of the Brunton compass, waste disposal, coastal processes, and the impact of development. The course will consist of lectures, laboratory experiences, and field trips to many parts of the island. Offered during Summer Session only. Cr 4.

GEY 201 Paleogeography and Global Change

This course examines the diversity of the global rock record to emphasize continental, oceanic, and atmospheric origins and changes. Geochronology, geologic time scale, plate tectonics, and magneto- and biostratigraphy will be significant topics. Laboratories will emphasize invertebrate fossil groups from the late Precambrian to the Pleistocene. Three hours lecture, three hours lab. The course may require one three-day field trip. Prerequisite: completion of a 100-level geoscience lecture and lab. Cr 4.5

GEY 202 Landscape Evolution and Analysis

Students will consider landscapes and the processes that are responsible for their formation. Emphasis will be on the constructive processes of mountain-

building and volcanism and the erosional processes of rivers, glaciers, the sea, and wind. There will be one or two weekend field trips. Two hours lecture, two hours lab. Prerequisite: Any GEY 100-level lecture with lab or permission of instructor. Cr 4.

GEY 203 Mineralogy

The course concentrates on the silicate family of minerals, but also examines non-silicate mineral families. Subject areas covered include crystallography, crystal chemistry, and environments of mineral formation. In one lab each week, students will examine crystals and minerals in hand specimens. In a second lab each week, the rudiments of optical crystallography are introduced and students will examine minerals microscopically. Three hours lecture, two labs each two hours in length. Prerequisite: completion of a 100-level geoscience lecture and lab; CHY 113K and CHY 114K are recommended. Cr 5.

GEY 204 Crustal Deformation

The crustal rocks exposed in coastal Maine are examined. Students learn to recognize, describe, and interpret a wide variety of outcrop-scale structures. In weekly field-based labs, students will use Brunton compasses, manual and digital stereonet, outcrop mapping techniques, GPS and clay deformation devices to analyze the local geologic structure and tectonic history. Prerequisite: completion of a 100-level geoscience lecture and lab. Three hours lecture and four hours lab. Cr 5.

GEY 205 Water Resources: Science and Issues

An introduction to watershed hydrology, including precipitation, evaporation, transpiration, flow in open channels, floods, and subsurface flow. Readings of current domestic and international case studies involving water resource issues are incorporated where appropriate. Prerequisites: PHY 111K or PHY 121K and successful completion of the University's Core requirements in composition (C) and mathematics (D). Cr 3.

GEY 207 Atmosphere: Science, Climate, and Change

Students will be introduced to the physical and chemical processes active in the earth's atmosphere. Specific topics include atmospheric circulation, atmospheric chemistry, climate patterns, storms, natural atmospheric change in recent geologic time, human-induced atmospheric change, and atmospheric pollution. Prerequisite: CHY 113K, CHY 114K. Cr 3.

GEY 208 Environmental Geology

Examines the effect of geological processes and products on human civilization. Specific topics will include earthquakes, volcanoes, landslides, floods, sinkholes, human impact and erosion at the coastal zone, waste disposal, groundwater use and contamination, climate change, energy resources, and mineral resources. Laboratory experiences complement the lecture and will include several field trips to local sites. Three hours lecture, two hours lab. Cr 4.

GEY 240 X-Ray Powder Diffraction

Laboratory

This is an applications laboratory designed for junior or senior level majors in geosciences, or any discipline that requires the characterization and identification of crystalline solids. Students will develop a working knowledge of elementary crystallography, sample preparation and identification using x-ray diffraction. Projects will utilize a series of increasingly complex materials and mixtures, culminating with a narrowly defined research project. Prerequisite: GEY 203 or concurrent or CHY 113K and CHY 114K or concurrent, or permission of instructor. Cr 1.

GEY 302 Sedimentation and Stratigraphy

Students focus on the processes that produce sediments and the mechanisms by which they are eroded, transported, and deposited. By carefully examining the motifs, models, and characteristics found in the sediment composition, texture, and features in modern-day sedimentary environments, clues can be found to understanding the historical sedimentary record. Three hours lecture, three hours lab. Prerequisite: GEY 202 or permission of instructor. Cr 4.5.

GEY 303 Igneous and Metamorphic Rock Origins

An introduction to the diversity and global distribution of igneous and metamorphic rocks. Students will examine the physical conditions and environments where igneous and metamorphic rocks form. Such environments include mid-ocean ridges, island arcs, convergent margins, and intraplate settings. Topics include: styles of volcanic eruptions, intrusive igneous rocks, regional metamorphism, and metamorphic belts. Labs will cover rock identification, computer exercises, and petrographic microscopy. Three hours lecture, three hours lab. The lab and lecture will occasionally be combined into half or full day field trips. Additionally, one weekend field trip will be offered. Prerequisite: GEY 203. Cr 4.5.

GEY 310 Glacial and Pleistocene Geology

Glacial processes, deposits, and the stratigraphy of the Pleistocene epoch. Emphasis on the erosional and depositional features of glacial events in Maine. One, possibly two, weekend field trips. Prerequisite: GEY 202 or permission of instructor. Three hours lecture, two hours lab. Cr 4.

GEY 340 / GEO 340 Digital Mapping

Students are exposed to the latest digital survey gear and integrated techniques with applications in geosciences, geography, and environmental science. Instrumentation includes both static and real time kinematic GPS (global positioning system) and autolock servo-driven electronic total station. Detailed precision survey data are combined with geo-referenced maps and imagery in GIS software. Six hours lecture/lab. Prerequisites: introductory course in GEY, GEO, or ESP and additional 200-level course in any of the above areas. Cr 4.5.

GEY 360 Field Mapping in the Island**Environment: Data Collection to GIS**

The coast of Maine provides a unique laboratory for teaching geologic and environmental mapping, data compilation and data management. In this course students are trained and equipped to use kayaks as the platform from which to conduct survey work for the preparation of small-scale high-resolution analytical maps of natural, historical, and archaeological phenomena. Field techniques used include topographic surveying, global positioning system (GPS) operation, and field mapping of geological and geographical features. Minimum impact methods are used throughout. Laboratory techniques used include air-photo interpretation, traditional cartography and geographic information system (GIS) operation. The course culminates in the completion of a portfolio of maps and a GIS database covering the area surveyed. Offered during Summer Session only. Prerequisite: junior/senior standing or permission of instructor. May be repeated for credit. Cr 6.

GEY 400 Cooperative Education in Geosciences

Students have opportunities to relate academic knowledge and practical job experience. Arrangements can be made with various agencies, businesses, and industries to employ qualified students. The student's work should be in a field related to geoscience. Approval is on an individual basis, depending on the nature of the job and specific work assignments. Evaluation is typically done through a written report that summarizes the work experience, with input from the employer and a faculty advisor. Prerequisite: junior/senior standing or permission of instructor. May be repeated for a maximum of 6 credits. Cr 1-6.

GEY 410 Introduction to Geophysics

Students investigate the mechanics of earth's structure and dynamics, as well as applications of geophysics to resource exploration and environmental investigation. In the context of both plate tectonics and applied geophysics, specific topics include magnetism, seismology (earthquake seismology, seismic refraction, seismic reflection), gravity, and

heat flow. Prerequisites: MAT 152D and PHY 121K or permission of instructor. Cr 3.

GEY 411 Environmental Geophysics

Students will become familiar with the most common geophysical field methods used in all phases of environmental investigations, including data collection, data processing, report preparation, and public presentation. Field and lab exercises are incorporated to provide hands-on experience in the methods, and to introduce students to common geophysical instrumentation. Prerequisites: GEY 100K and GEY 410. Cr 4.

GEY 420 Groundwater Flow and Quality

A survey of groundwater processes covering the following topics: water balance, basic fluid mechanics, groundwater flow equations, flow to wells, flow in various geologic environments, groundwater quality, and groundwater contamination. Some case studies will be included. Prerequisite: a 100-level GEY lecture course, CHY 113K (may be taken concurrently), MAT 152D, and PHY 111K or PHY 121K, or permission of instructor. Three hours lecture, two hours lab/recitation. Cr 4.

GEY 490 Senior Thesis

The student develops an in-depth research paper about an original research theme. A thesis topic is chosen in consultation with a faculty advisor in the semester prior to registration. May be repeated for a maximum total of 6 credits. Prerequisite: senior standing and permission of instructor. Cr 3-6.

GEY 498 Undergraduate Research in Geology

Students have the opportunity to work independently or as research assistants to Geoscience faculty conducting original geologic research. Research may involve analysis of geologic samples or data, field mapping, or literature review. The topic is chosen in consultation with a faculty advisor in the semester prior to registration. May be repeated for a total of 6 credits. Prerequisite: permission of the instructor. Cr 1-3.