Colby

GEOLOGY

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If you are interested in planet Earth—how it developed its present features and what may happen to it in the future, how it functions as a complex physical and chemical system and why we should care, where life originated and how and why our planet supports us, how the environment works and how what we do affects the world around us—a major in geology may be right for you.

The Department of Geology possesses extensive rock, mineral, and fossil collections as a basis from which to investigate Earth, a state-of-the-art powder X-ray diffractometer (XRD) for determining mineral identities, various geophysical instruments, research-grade stereo and petrographic microscopes, and Logitech-equipped rock preparation. The department houses the College's scanning electron microscope (SEM) equipped with energy dispersive X-ray flourescence, as well as specialized equipment for student and faculty research. Additional research equipment, shared with other departments in the Division of Natural Sciences, includes a C,H,N,O, S elemental analyzer and the *Colby Compass*, a research boat equipped with an array of instrumentation from which real-time environmental analyses and studies can be conducted.

Colby's setting provides an intriguing and exciting area for field study, allowing students to integrate field and laboratory experiences. Students are encouraged to work on independent and honors projects in which they develop ways of actively examining and interpreting observational data. Majors are expected to undertake and complete independent research as part of their undergraduate training, and such opportunities are offered routinely during the summer by departmental faculty at Colby and abroad.

Fieldwork is an integral part of many courses and introduces students to various aspects of local and regional geology. Multi-day off-campus trips also are scheduled regularly to localities and areas of particular geologic interest, such as the Hartford Basin of Connecticut, the Mohawk Valley or Catskill Mountains of New York, the classic Joggins and Brule localities in Nova Scotia, and late Paleozoic rocks of New Brunswick. The department also provides off-campus international experiences, including study in Bermuda.

The department offers two major programs and a minor for students with different interests. The point scale for retention of the major applies to all courses taken in the major; no requirement may be taken satisfactory/unsatisfactory. Students should consult regularly with their advisor in selecting courses appropriate for meeting their goals of post-graduation employment or graduate studies.

Requirements for the Major in Geoscience

Geology 141 or 146; four fundamental core courses that include 225, 231, 251, and 254; two geology elective courses (that are 200-level or higher and may include one course in mathematics, physics, chemistry, or biology), three credits of Geology 391, and three hours of independent study (491, 492, or 493); Mathematics 122; Chemistry 141; and one additional laboratory science course in chemistry, biology, or physics.

Requirements for the Major in Geology

This curriculum is designed for those students interested in pursuing a pre-professional degree program. The requirements are Geology 141 or 146; four core courses that include 225, 231, 251, and 254; four geology elective courses (numbered 200-level or higher and may include a course in mathematics, physics, chemistry, or biology), three credits of Geology 391, and three hours of independent study (491, 492, or 493); Chemistry 141; one two-semester sequence of chemistry, physics, or biology; Mathematics 122. Students should consult one of the major advisors in the first and second years regarding election of languages and other Colby required courses.

Requirements for Honors in Geology

This program involves a substantial research component in the student's senior year, with no fewer than six hours of credit elected in research activities. The honors program involves presentation of a research proposal to a faculty committee early in the fall semester, the submission of a mid-term progress report, and the draft of introductory sections before January. Satisfactory progress will result in Geology 483 credit and allow the student to register for Geology 484. Successful completion of an honors research project, and the major, will enable the student to graduate "With Honors in Geology." Students who wish to pursue a more intensive research agenda should consider the Senior Scholars Program.

Requirements for the Minor in Geology

A minor in geology is available to students majoring in other disciplines who also desire an introductory understanding of the geosciences. Minor programs will be tailored to the needs of individual students; course selection should be done only after consultation with the minor advisor. Requirements are Geology 141 or 146, and four geology courses selected from courses numbered 225 and above.

Course Offerings

[GE111] Geology of National Parks Using America's National Parks as a venue, students will learn how the North American continent has evolved over vast amounts of time as it has been subjected to a variety of geologic processes. In the national park setting students will investigate these processes and learn how they have shaped what exists today and why each park has been set aside as sanctuary. Via the parks, students will be exposed to the scientific method and how geologists study the Earth, its materials and its processes. Beyond the geology, they will also appreciate the history of selected parks, how they came to be, and their impact on society. *Three credit hours.* **N**

[GE112] Exploring the Physical Earth The geosciences include study of the Earth, its formation, its history, processes that continue to shape it today, and our interaction with it. Students learn: (1) how Earth processes operate, why certain processes are common in some areas and not others, and how they shape our environment, human history, and interactions; (2) the methods we use to understand these processes and impacts; (3) the origin of Earth resources and how these are and have been used by various cultures; and (4) how natural-resource allocation affects national policies and international relations. *Prerequisite:* Junior or senior standing. *Four credit hours.* **N**

GE115f Extinction: Earth's Lessons Students will learn the processes responsible for the fossil record; evolution and evolutionary theory; the use of paleontological data to understand ecological response to climate change, perturbation, and extinction mechanisms; and how deep time lessons scale to a planet dominated by man. They will gain a conceptual framework for how to acquire, analyze, and assess deep time biodiversity trends; increase their written and oral communication skills; develop constructive critical thinking and argumentation; and learn the fundamentals of discovery, evaluation, and use of appropriate resources. *Prerequisite:* First-year standing. *Four credit hours.* **N,W1** GASTALDO

[GE127] Deep Time Africa A project-based curriculum designed to accomplish, simultaneously, several objectives. Students will increase their understanding of, and sophistication in, geological problem solving by using textbook and pertinent primary resources to study the effects of Witwatersrand gold, mass extinction, diamonds, and human evolution on resource and environmental aspects of South African society. Development of individual and group skills in oral and written communication after synthesizing conceptual and empirical data obtained from geoscientific sources. *Four credit hours.* **N**

[GE129] Geology of Islands Explores the geological and biological origins of islands as physical entities. Students will come to appreciate the many diverse processes that create and maintain islands, as well as the significance of islands in the world around us, including their influence on surrounding marine environments and how they are in turn influenced by those marine environments. The Galapagos Islands in particular have played a pivotal role in the development of scientific thinking since the 19th century, and they will be a focus of study. Part of the three-course Integrated Studies 129 cluster, "Islands in the Sun." *Prerequisite:* Concurrent enrollment in Biology 129 and English 129. (Elect IS129.) *Four credit hours.* **N**

GE141fs Earth and Environment The geosciences encompass the study of the Earth, its formation, its history, the processes that continue to shape it today, and our interaction with it. Students learn (1) how Earth processes operate, how they shape the environment we live in, and how they can affect people; (2) where Earth resources come from, the impacts of using these resources, and how we can reduce these impacts; and (3) the methods we use to understand these processes and impacts. Additionally, the course improves students' critical-thinking and data-analysis skills. Students who have already received credit for GE141 cannot subsequently receive credit for GE151; students taking GE151 in January, however, are not barred from subsequently taking GE141 for credit. *Four credit hours.* **N,Lb** REYNOLDS, SULLIVAN

GE146fs Deciphering Earth History The Earth's history, from galactic and planetary origins through today. Major concepts include basic plate tectonics, geologic or "deep" time, fossils, sedimentary systems, and evolutionary theory. Students will gain insight into the interrelated nature of the biological, chemical, and physical world and the ways in which the planet and its environments have changed and operated over the past 4.6 billion years. Designed for those with no prior geologic background. Lecture and laboratory. Credit cannot be earned for both this course and Geology 142. *Four credit hours.* **N,Lb** NELSON, RUEGER

[GE151] Introduction to Volcanoes and Volcanology Volcanoes have been critical in the formation of the Earth, our atmosphere, and oceans and remain integral factors in the lives of billions around the globe. Students learn (1) how Earth processes operate, how volcanic processes shaped local, regional, and global environments, and how they affected human history and will affect humankind in the future; (2) methods scientists use to understand these processes and impacts; and (3) that despite potential destruction of human infrastructure, volcanic eruptions produce benefits too. Students who have already received credit for GE141 cannot subsequently receive credit for GE151; students taking GE151 in January, however, are not barred from subsequently taking GE141 for credit. *Three credit hours.* **N**

GE153j Meteorology Using text and real-time data, students discover how the basic principles of meteorology are used to understand weather systems and learn how to forecast weather patterns using these principles. A field trip allows those enrolled to interact with working meteorologists and discuss how forecasts are made for the public and private sectors. Students present their own meteorological research efforts, demonstrating their understanding of the principles and practices presented during Jan Plan. Satisfies the non-lab science requirement. *Three credit hours.* **N** EPSTEIN

GE225s Mineralogy Introduces students to the methods geologists use to identify minerals and the geologic environments in which they form. Students will gain experience using the petrographic microscope, powder X-ray diffractometer, and scanning electron microscope to identify major rock-forming minerals. Students will develop interpersonal, critical-thinking, and communication skills that enable them to discuss the chemical and physical processes controlling mineral formation. Concepts learned serve as the foundation for subsequent upper-level geology courses. *Prerequisite:* Geology 141, 142, or 146, and Chemistry 141 (may be taken concurrently). *Four credit hours.* SULLIVAN

GE231f Structural Geology Structural geologists study the geometry of geologic structures such as faults and folds, how these structures form, their significance to the geologic history of an area, and their relationship to plate-tectonic motions. Enables students to (1) evaluate a suite of geologic structures to draw conclusions about their formation and significance, (2) apply basic structural-analysis techniques to solve problems in a variety of geoscience disciplines, and (3) develop the three-dimensional thinking skills needed to evaluate subsurface geology using two-dimensional, surficial data sets. Aims to improve students' graphical and written communication skills and data collection and recording skills. *Prerequisite:* Geology 141, 142, or 146. *Four credit hours.* SULLIVAN

GE251f The Record of Life on Earth Using original research as an educational platform, students learn how to acquire and assess scientific data, to reference and synthesize primary literature, and to justify their arguments and conclusions in both written and oral forms. Provides a greater understanding of the processes responsible for a fossil record, its classification, the use of these data in evolutionary theory, the dynamics of individuals and populations or organisms over space and time, and the application of paleontological data to understanding ecological response to climate change, perturbation, and extinction mechanisms. *Prerequisite:* Geology 141, 142, 146 or one year of biology. *Four credit hours.* GASTALDO

GE254s Principles of Geomorphology Geomorphology is the study of the Earth and all its surficial expression and the continuing evolution of the planet as climate-dictated surface processes seek to remold the underlying solid Earth. Students learn the processes at work in the breakdown of rocks into soils and how mountains, valleys, and all the other myriad landforms of the Earth originated, at a range of scales from millimeters to tens of kilometers. Through understanding of the processes at play in these origins, interpretations of the origin of extraterrestrial landforms becomes possible as well. *Prerequisite:* Geology 141, 142, or 146. *Four credit hours.* NELSON

[GE279] Geology of Bermuda Students will learn how the island of Bermuda, subjected to a variety of geologic processes, has evolved over the past two million years. They will be exposed to the scientific method and how geologists study the Earth, its materials, and its processes. During field and laboratory observations, students will investigate how organisms, including humans, and sedimentary processes have shaped Bermuda; how sediment is formed, moved, consolidated, and lithified; and the interrelationships between geology and biology. They will gain an appreciation of the complexities of living on an island and the anthropogenic impacts on a fragile ecosystem. *Prerequisite:* Geology 131, 141, 142, or 146. *Three credit hours.*

[GE331] Plate Tectonics Primary-literature-synthesis course that guides students through the topic of plate tectonics from the development of the theory to some modern-day theories on crustal growth and plate-boundary processes. Students will be able to (1) piece together a broad-scale interpretation of the evolution of a plate boundary using data and interpretations gleaned from the primary scientific literature and (2) use basic thermochronologic, geophysical, geological, and geospatial data sets to interpret plate boundaries. Improving students' verbal and written communication skills while providing an experience in accessing, reading, and assimilating scientific literature. *Prerequisite:* Geology 231. *Four credit hours.*

[GE332] Igneous and Metamorphic Petrology Teaches students to identify igneous and metamorphic rocks and to understand the physical and chemical processes responsible for their formation. Students learn how to use and evaluate a variety of data sets, and they develop skills using a petrographic microscope and the Scanning Electron Microscope (SEM). They also develop interpersonal, critical-thinking, and communication skills that enable them to discuss petrologic processes in the broader geologic context of tectonic setting. *Prerequisite:* Geology 225. *Four credit hours.*

[GE334] Mountain Belts The anatomy and analysis of collisional mountain belts. Students will learn to (1) piece together a broad-scale interpretation of the evolution of a collisional mountain belt using data and interpretations gleaned from the primary scientific literature and (2) apply modern microstructual and macrostructural techniques used to understand the deformation history of mountain belts. Also aims to improve oral and written communication skills and provide experience in accessing, reading, and assimilating scientific literature. Previously offered as Geology 398. *Prerequisite:* Geology 231 *Four credit hours.*

[GE342] Past Terrestrial Ecosystems Ecosystems on Earth that we now take to be self-evident are a product of their very recent evolution in response to climate change, ecological perturbation, and changing geographies. Earth's terrestrial environment was dramatically different in the deep past, with an array of non-analogue assemblages distributed across landscapes within different continental configurations and climatic patterns. This project-based course is designed to investigate several of these states through geologic time using primary literature. Readings, presentations, and synthetic papers will provide for a

comprehensive understanding of critical intervals of Earth history on the journey to our present world. *Prerequisite:* Geology 251 for geology majors; Biology 164 for biology majors. *Four credit hours.*

[GE354] Glacial and Quaternary Geology An understanding of the causes of glaciation, mechanics of glacier formation, flow and transport, the resulting sedimentary facies and landforms (both erosional and depositional), and the history of glaciation on a North American and global scale. Students delve into the professional literature to understand the broad outline of what is known of the glacial history of Maine; multiple field trips are taken to key localities where students can experience and study sites and features covered in readings and classroom discussions. *Prerequisite:* Geology 254. *Four credit hours.*

GE356s Sedimentation and Stratigraphy A workshop designed to teach students how to apply sedimentary rocks to interpret Earth's stratigraphic record, and develop a fundamental understanding of sediments and resulting rock types found in Earth's sedimentary successions. Use of these classification schemes builds a knowledge of process-based models that reflect features found in common environments in which these sediment types occur. Models are applied to select examples in the stratigraphic record in which physical and remote-sensed (petrophysical) data are introduced and used to interpret past Earth conditions. Students will be able to evaluate the sedimentary rock record over space and time using presently accepted approaches and models. *Prerequisite:* Geology 225. *Four credit hours.* GASTALDO

GE361f Topics in Geochemistry Uses lecture and primary literature to provide a quantitative skill set students can use to evaluate geologic processes on Earth, Moon, Mars, or asteroids. Radiogenic isotopes, stable isotopes, and trace elements are used to unravel salient problems in geology, such as the chemical evolution of the Earth through geologic time. Laboratory component emphasizes data analysis for multiple geochemical systems using computer-based programs. Students will learn to read, critique, and discuss primary literature as it applies to a variety of geochemical problems. Previously offered as Geology 397 (fall 2009). *Prerequisite:* Geology 225. *Four credit hours.* REYNOLDS

GE372f Quaternary Paleoecology Directed research. Students will extract and learn how to identify pollen, plant macrofossils, and insect remains from a fresh research site. Students will gain an understanding of the usefulness of these organic remains in recent sediments to understand past environments and past climates, using what is known of modern ecological requirements of organisms to reconstruct the environment that existed at a site when a particular suite of sediments was deposited. Other groups of organisms may be covered if they are found and time allows. Techniques and skills developed are applicable in paleobiology, geology, and archeology. *Prerequisite:* Geology 142 and Chemistry 141; Geology 251 or Biology 271 is recommended. *Four credit hours.* NELSON

GE391fs Geology Seminar Paper discussions and presentations from invited guest lecturers on topics of current interest in all areas of the geosciences. Majors must complete three seminars during their course of study. Nongraded. *One credit hour.* REYNOLDS, SULLIVAN

GE483f, 484s Senior Honors Project A culminating, research-intensive experience in which students engage in an original project with the expectation that results will be of significantly high caliber to warrant publication after review by committee. The final written report will be in a selected journal format, and project results will be presented formally in a professional context. Students should consult with major advisors during their junior year to learn about on-campus and off-campus opportunities and experiences that can be used in preparation for undertaking an honors program. *Prerequisite:* Permission of the instructor. *Three or four credit hours.* FACULTY

GE491f, 492s Independent Study A culminating, independent research experience that involves the application of skills learned in both field- and laboratory-based course work prior to enrollment. Each student will undertake an original investigation into some aspect of a geosciences problem at various scales. A final written report (see requirements for Honors in Geology option) and formal presentation in a professional context result in the successful completion of this course. Students should consult with major advisors during their junior year to learn about on-campus and off-campus opportunities and experiences that can be used in preparation for independent study. *Prerequisite:* Permission of the instructor. *One to four credit hours.* FACULTY

[GE493] Problems in the Geosciences Pre- and post-Colonial vegetation changes in central Maine. Are modern forests comparable in composition to those of 1,000 years ago? Investigation of the changes in vegetation from late pre-Colonial times through forest clearing, farming, and post-World War II farm abandonment and forest regeneration, based on pollen analysis of sediments from selected basins. *Prerequisite:* Geology 372. *Four credit hours.*