

# Department of Geosciences

Chair: *French (Astronomy)*

Associate Professor: *Besancon, Brabander, Hawkins*

Assistant Professor: *Argow*

Lecturer: *Mattison*

Instructor in Geosciences Laboratory: *Gilbert, Waller*

Geoscience is the study of the Earth and all its systems. Interactions between the solid earth, the hydrosphere, atmosphere and biosphere continually reshape the Earth. Geoscientists investigate these interactions using interdisciplinary approaches to address questions related to how the Earth formed, how it evolved over geologic time, and how its continued evolution affects the environment in which we live. Understanding the Earth's many linked systems is increasingly important if we are to make informed decisions about the many critical environmental issues facing humanity, including global climate change, sea-level rise, shortages of drinking water, health hazards posed by materials in our urban environment, and mitigation of threats from earthquakes, landslides, volcanic eruptions, tsunamis, floods and other natural hazards. The Department of Geosciences offers courses on the nature and history of the Earth, the processes that shape the Earth, the impacts those processes have on human populations, and our ability to live sustainably. Student research opportunities complement the program of study.

## Goals for the Major

Geoscience majors will acquire fundamental knowledge and understanding of the Earth, past and present, its internal structure and composition, the internal and surficial processes that shape its evolution, and how earth systems interact to produce the environment in which we live; develop their cognitive and analytical reasoning skills by completing core coursework with field- and lab-centered learning experiences; develop their ability to frame and solve interdisciplinary geoscientific problems; and become more effective communicators of science through repeated opportunities to refine their written, oral, and visual/spatial communication skills.

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## GEOS 101 Earth Processes and the Environment with Laboratory

**NOT OFFERED IN 2009-10. OFFERED IN 2010-11.** The Earth is home to more than six billion people and millions of kinds of animals and plants. Geologic processes both rapid (earthquakes and landslides) and slow (mountain building and sea level rise) are intimately linked with sustaining this diversity of life. This course will examine these and other processes in which the atmosphere, geosphere, and biosphere are linked via the flow of energy and mass. Laboratory and field trips will introduce skills needed to observe and document processes shaping our environment. Problem solving in small groups during class time will foster critical thinking, and classroom debates between larger teams will focus research and communications skills on current issues in geosciences such as building and removing dams, and the science surrounding global climate change.

Prerequisite: Fulfillment of the basic skills component of the Quantitative Reasoning requirement. Not open to students who have taken 102.

Distribution: Natural and Physical Science. Fulfills the Quantitative Reasoning overlay course requirement.

Semester: N/O. Offered in 2010-11. Unit: 1.25

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## GEOS 102 The Dynamic Earth with Laboratory

### Staff

Introduction to geologic processes ranging from microscopic growth of mineral crystals to regional erosion and deposition by water, wind, and ice to volcanism and earthquakes associated with global plate motions. A particular focus of the course will be to better understand the interactions between human activities and the geologic environment. Laboratory and field trips.

Prerequisite: Fulfillment of the basic skills component of the Quantitative Reasoning requirement. Not open to students who have taken 101.

Distribution: Natural and Physical Science. Fulfills the Quantitative Reasoning overlay course requirement.

Semester: Fall, Spring Unit: 1.25

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## GEOS 110 The Coastal Zone: Intersection of Land, Sea, and Humanity with Laboratory

### Argow

This first year course focuses on physical processes that frame ecological and human interactions within the dynamic coastal environment. At local field sites, students will observe, sample, and measure coastal processes in action to answer such questions as: Why do some beaches lose sand, where does it go, and what should we do about it? What are coastal wetlands, and how do they form and function? Field trips will be supplemented by information drawn from popular and scientific literature and media. Students will participate in on-going research to learn how scientific data is generated, analyzed, and applied. Final project involves field and laboratory research on a local coastal issue, including management implications. Weekend field trip required.

Prerequisite: Open to first-year students only. Preference will be given to students considering science majors. By permission of the instructor.

Distribution: Natural and Physical Science

Semester: Fall Unit: 1.25

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## GEOS 111/ES 111 The Yucca Mountain Problem: Where Should We Put Nuclear Waste?

### Besancon (Geosciences)

Choices about disposal of radioactive materials will affect countless future generations. Focusing on the proposed storage facility at Yucca Mountain, Nevada, we will examine the important scientific questions that must be answered for long-term safety of a nuclear repository. Students will learn the scientific principles governing risk assessment, groundwater movement, volcanism, earthquakes, and the groundwater properties of the repository rocks, and how each affects the safety of the proposed containment facility. We will also examine the evidence and methods used to predict how the waste and the containers designed to hold it will behave for long periods. Students will identify key issues and produce small group projects examining some of the scientific issues raised by this controversial proposal. *Students may register for either GEOS 111 or ES 111 and credit will be granted accordingly.*

Prerequisite: Open to first-year students only.

### **GEOS 200 The Earth and Life Through Time with Laboratory**

*Mattison*

How have the Earth and life changed throughout their 4.6-billion-year histories? How do subtle interactions among tectonics, climate, and life alter the world you see? We will examine past events, including sea-level change, mountain building, climate change, and evolution/extinction as recorded in the rock record. Using Wellesley's extensive fossil and rock collections, we will explore changing landscapes and environments through geologic time. Field trips and laboratory exercises provide the students with the opportunity to reconstruct the past.

Prerequisite: 101 or 102  
Distribution: Natural and Physical Science  
Semester: Spring Unit: 1.25

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### **GEOS 201/ES 201 Methods and Problems in Environmental Science with Laboratory**

*Brabander*

Problems in environmental science are inherently multidisciplinary and often require a diverse skill set to analyze and solve. This course will focus on developing a toolbox of skills including field methods, geochemical analysis (natural waters, soils, and other environmental materials), and modeling with a goal of being able to frame and solve environmental problems. Students will conduct semester-long research projects and will present their results in a final poster session. *Students may register for either GEOS 201 or ES 201 and credit will be granted accordingly.*

Prerequisite: One of the following: 101, 102, ES 101 and permission of the instructor.  
Distribution: Natural and Physical Science  
Semester: Spring Unit: 1.25

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### **GEOS 203 Earth Materials with Laboratory**

*Hawkins*

An introduction to the materials—minerals, rocks, magmas, sediments, soils—that make up the Earth, and how those materials influence the processes that operate within and on the surface of the Earth. Emphasis is placed on the geological, chemical and physical basis for understanding the physical properties and chemical composition of minerals, magmas, rocks and soils, and the processes by which these materials form. Lecture and laboratory sessions are integrated to create a studio-style, project-based learning experience.

Prerequisite: 101 or 102  
Distribution: Natural and Physical Science  
Semester: Fall Unit: 1.25

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### **GEOS 205 Vertebrate Paleontology: Revolutions in Evolution**

*Mattison*

From fish to amphibian, "reptile" to mammal, dinosaur to bird, organisms on Earth have adapted to moving continents, climate variations and fluctuating sea levels. Students will piece together the history of vertebrate life using the paleontologist's tools: the fossil record, functional morphology, phylogeny and paleoecology. Two weekend field trips will be required. *Normally offered in alternate years.*

Prerequisite: 101, 102, BISC 111 or permission of the instructor.  
Distribution: Natural and Physical Science  
Semester: Fall Unit: 1.0

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### **GEOS 206 Structural Geology with Laboratory**

**NOT OFFERED IN 2009-10. OFFERED IN 2010-11.** This course will consist of weekly outings to nearby field areas where sedimentary stratification, lava flows and other igneous features, metamorphic foliations, unconformities, folds and faults can be seen in outcrop. Indoor sessions will introduce maps, cross sections and stereographic projection as methods for representing such structures, and establish the physical and tectonic conditions under which they form. Course will conclude with a student-led field trip and written field guide. Rain gear will be necessary. *Normally offered in alternate years.*

Prerequisite: 203 or permission of the instructor.  
Distribution: Natural and Physical Science  
Semester: N/O. Offered in 2010-11. Unit: 1.25

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### **GEOS 208 Oceanography**

*Argow*

Covering 71 percent of the Earth's surface and encompassing 98 percent of Earth's water, the oceans are perhaps the most distinctive feature of our planet. Why does Earth have abundant water? Why are the oceans salty? And what should every Congresswoman know about the largest habitat on Earth? Oceans impact humanity in countless ways, by controlling climate, navigation, and food and mineral resources. Topics include tides, waves, ocean currents, submarine volcanism, tsunamis, ocean basin sediments, marine geology, El Niño events, coral reefs, shoreline processes, coastal engineering, and more.

Prerequisite: One of the following: 101, 102, ES 101, CHEM 105, CHEM 120, PHYS 103, PHYS 104, PHYS 107, ASTR 100 or permission of the instructor.  
Distribution: Natural and Physical Science  
Semester: Spring Unit: 1.0

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### **GEOS 210/ES 210 Hydrogeology—Water and Pollutants with Laboratory**

**NOT OFFERED IN 2009-10. OFFERED IN 2010-11.** Investigation of water supply and use. Principles of surface and groundwater move-

ment and water chemistry are applied to the hydrologic cycle to understand sources of water for human use. Mathematical groundwater models are used to understand groundwater movement and pollutant plumes. Quantity and quality of water and the limitations they impose are considered. Normally offered in alternate years. *Students may register for either GEOS 210 or ES 210 and credit will be granted accordingly.*

Prerequisite: 101 or 102 or permission of instructor.  
Distribution: Natural and Physical Science or Mathematical Modeling  
Semester: N/O. Offered in 2010-11. Unit: 1.25

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### **GEOS 213/ASTR 203 Planetary Geology**

**NOT OFFERED IN 2009-10. OFFERED IN 2010-11.** Spacecraft observations have revealed a breathtaking diversity of geologic features in the solar system, from ancient river valleys on Mars and violent volcanic eruptions on Io to ice fountains on Enceladus and the complex surfaces of comets. From a comparative point of view, this course examines the formation and evolution of the planets and small bodies in the solar system. Topics will include: volcanism, tectonic activity, impacts, and tides. *Students may register for either GEOS 213 or ASTR 203 and credit will be granted accordingly. Normally offered in alternate years.*

Prerequisite: Fulfillment of the basic skills component of the Quantitative Reasoning requirement and any 100-level GEOS or ASTR course.  
Distribution: Natural and Physical Science  
Semester: N/O. Offered in 2010-11. Unit: 1.0

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### **GEOS 219 Geology in New Zealand**

*Hawkins, Besancon*

New Zealand is one of the best localities in the world to observe a wide range of active geologic processes, geologic features, and geomorphology in a small area. The country spans two types of plate tectonic boundaries and the interaction of these plates produces a wide variety of landforms and geological features such as active volcanoes, alpine mountains, complexes of metamorphic and igneous rocks formed deep in the crust, sedimentary rocks deposited in a variety of environments, and active glaciers and associated landforms, river systems and deposits. Students will keep daily field observation notebooks, complete field exercises, give oral presentations in the field and lead group discussion sessions. *Normally offered in alternate years. Subject to Dean's Office approval.*

Prerequisite: 101 or 102 and permission of the instructor.  
Distribution: Natural and Physical Science  
Semester: Wintersession Unit: 0.5

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### **GEOS 220 Volcanoes: Agents of Global and Regional Change with Wintersession Laboratory**

*Besancon, Hawkins*

From Mount Saint Helens to Vesuvius to Krakatau, volcanoes affect global climate, change landscape evolution, and are sometimes the cause of tremendous disasters. Understanding the wide variety of phenomena associated with volcanoes provides a broad perspective on how science can be used to protect lives and further human needs and interests. Using geologic literature, Internet search, and a general text, we will study case histories of volcanoes on earth and in the solar system. Written papers and oral presentations will be important parts of the course. The laboratory is a three-week long Wintersession trip to New Zealand that requires payment of additional fees. *Normally offered in alternate years. Subject to Dean's Office Approval.*

Prerequisite: Permission of the instructor and 101, 102, or ES 101.  
Distribution: Natural and Physical Science  
Semester: Fall Unit: 1.25

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### **GEOS 250 Research or Individual Study**

Prerequisite: Open by permission to students who have taken three Geosciences courses including 101 or 102. This course cannot be counted towards the minimum major in Geosciences.  
Distribution: None  
Semester: Fall, Spring Unit: 1.0

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### **GEOS 250H Research or Individual Study**

Prerequisite: Open by permission to students who have taken three Geosciences courses including 101 or 102. This course cannot be counted towards the minimum major in Geosciences.  
Distribution: None  
Semester: Fall, Spring Unit: 0.5

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### **GEOS 304 Sedimentology with Laboratory**

**NOT OFFERED IN 2009-10. OFFERED IN 2010-11.** Sedimentary rocks cover most of the Earth's present surface. Sedimentology encompasses the study of the origin, transport, deposition and lithification of sedimentary rocks, and is critical to accurate interpretation of the geologic rock record. Observations of modern sedimentary processes illuminate past environments; sedimentary strata record evidence of sea level change, glacial advances and paleoclimate cycles, and preserve the fossil record. Natural resources including groundwater, coal and petroleum are found in sedimentary rocks. Society is impacted by sedimentary processes in popular human habitats including coastlines and flood plains. Discussions, readings and projects build students' familiarity with topics including sediment transport, stratigraphy, and modern and ancient depositional environments. Laboratory exercises and field trips emphasize field methods, rock identification, and data collection, analysis and interpretation. *Normally offered in alternate years.*

Prerequisite: 200, 203, 206 or permission of the instructor.  
Distribution: Natural and Physical Science  
Semester: N/O. Offered in 2010-11. Unit: 1.25

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### **GEOS 308 Wetlands Science with Laboratory**

*Argow*

Wetlands are among the most important environments on Earth, yet are widely undervalued and misunderstood. Wetland science is an exciting, growing field, critical to addressing issues ranging from modern shoreline stabilization to fossil fuel extraction. This course will focus on sediment-water interactions that create and maintain saltwater and freshwater wetland environments, and on the roles played by organisms within the geologic framework. Field trips to nearby wetlands will provide opportunities to make observations, collect samples and develop research questions in consultation with scientists studying and managing wetlands. These will be complemented by laboratory sessions introducing techniques for sample analysis and by relevant readings. Final reports will be submitted to organizations like the National Park Service or National Estuarine Research Reserve System. Two weekend field trips required. *Normally offered in alternate years.*

Prerequisite: 201, 203, 208, or permission of the instructor.

Distribution: Natural and Physical Science

Semester: Fall

Unit: 1.25

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### **GEOS 309 Petrology with Laboratory**

*Hawkins*

This course is an introduction to igneous and metamorphic rocks, processes and environments. Emphasis is placed on the application of geological, chemical and physical principles to the study of rocks in a search for clues to their origin and to the origin and evolution of the Earth (and other planets). A field trip over Patriot's Day weekend is an essential component of the course. Lecture and laboratory sessions are integrated to create a studio-style, project-based learning experience. *Normally offered in alternate years.*

Prerequisite: 203 or permission of the instructor.

Distribution: Natural and Physical Science or Mathematical Modeling

Semester: Spring

Unit: 1.25

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### **GEOS 315/ES 315 Environmental Geochemistry with Laboratory**

*Brabander*

Accurately predicting the fate and transport of naturally occurring toxic elements and anthropogenic compounds in the environment requires a broad set of multidisciplinary skills. This course introduces geochemical approaches, including mass balance, residence time, isotope fractionation, and thermodynamic and kinetic modeling necessary to fingerprint sources of pollutants and track them in water, soil, and plants. These fundamentals will be explored in several classic case studies and in semester-long geochemical research projects conducted by small groups. *Normally offered in alternate years. Students may register for either GEOS 315 or ES 315 and credit will be granted accordingly.*

Prerequisite: One course above the 100-level in two of the following disciplines: Geosciences, Chemistry, Biological Sciences or Environmental Studies; or permission of the instructor.

Distribution: Natural and Physical Science or Mathematical Modeling

Semester: Fall

Unit: 1.25

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### **GEOS 320 Isotope Geochemistry**

**NOT OFFERED IN 2009-10. OFFERED IN 2010-11.** This seminar-style course will use the primary literature to study state-of-the-art techniques in isotope geochemistry. Radiogenic, cosmogenic, and stable isotope systematics will be explored with applications ranging from geochronology, tectonics, fate and transport of pollutants, and the use of isotopes to trace biogeochemical processes. Field trips to Boston area isotope labs and opportunities for collaborative research projects will complement the seminar. *Normally offered in alternate years.*

Prerequisite: 201 and CHEM 205; or GEOS/ES 315 or permission of the instructor.

Distribution: Natural and Physical Science

Semester: N/O. Offered in 2010-11.

Unit: 1.0

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### **GEOS 350 Research or Individual Study**

Prerequisite: Open by permission to juniors and seniors.

Distribution: None

Semester: Fall, Spring

Unit: 1.0

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### **GEOS 360 Senior Thesis Research**

Prerequisite: By permission of department. See Academic Distinctions.

Distribution: None

Semester: Fall, Spring

Unit: 1.0

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### **GEOS 370 Senior Thesis**

Prerequisite: 360 and permission of department.

Distribution: None

Semester: Fall, Spring

Unit: 1.0

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## **Requirements for the Major**

A major in geosciences includes eight geosciences courses (a minimum of eight units of course work), at least six of which must be taken at Wellesley. Entry into the major may be through GEOS 101 or GEOS 102. Four 200-level courses are required, normally to include GEOS 200, GEOS 203 and GEOS 206. Three 300-level courses are required, one of which must be GEOS 304 and one of which may be GEOS 350, GEOS 360 or GEOS 370. Four complementary courses from mathematics, biological sciences, chemistry, physics, astronomy,

or computer science are also required, and two of these must come from the same discipline. The department also recommends that students majoring in geosciences take a geology field course, either the MIT 12.114-12.115 sequence offered in alternate years by MIT or a summer geology field course offered by another institution.

## **Requirements for the Minor**

A minor in geosciences consists of five courses, including GEOS 101 or GEOS 102 and at least one course at the 300 level.

## **Honors**

The only route to honors in the major is writing a thesis and passing an oral examination. To be admitted to the thesis program, a student must have a grade point average of at least 3.5 in all work in the major field above the 100 level; the department may petition on her behalf if her GPA in the major is between 3.0 and 3.5. See Academic Distinctions.

## **Graduate Study**

Students considering graduate school are urged to take two semesters of mathematics, two of chemistry and two of physics. Students will choose an appropriate set of complementary courses with the guidance of a departmental advisor.