GEOLOGY & ENVIRONMENTAL GEOSCIENCES

Faculty

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Geology is the natural science that involves the nature and history of Earth, including scientific analysis of environmental problems. The Bucknell geology curriculum engages students with concepts and issues related to Earth and its environments through coursework, field studies and scientific research. A geology degree equips students with analytical skills, problem-solving skills, communication skills, experience in teamwork and solid grounding in field-based science. Geoscience includes diverse subdisciplines, for example natural hazards, natural resources, interactions between environmental materials, non-invasive exploration of earth, history of climate change, engineering geology, and tectonics. At an introductory level, geology coursework provides students with basic knowledge of Earth and its systems and how that knowledge can provide an understanding of potential solutions to environmental problems. Knowledge of Earth, its processes, hazards, history, resources and limitations can be an important component of a liberal arts education and can provide a foundation for advanced work in the discipline.

An undergraduate degree provides the foundation needed for employment or graduate degree specialization. In addition to gaining acceptance to some of the most prestigious graduate programs in the country, recent graduates secured employment in environmental or engineering consulting firms, governmental agencies, oil and gas companies, and educational institutions. Students also have used our courses toward certification as teachers in Earth and space sciences.

At Bucknell University, students majoring in geosciences in either Bachelor of Arts or Bachelor of Science degree programs are expected to take courses to explore the breadth of the science culminating with a common course (GEOL 450 Geosciences Futures). Majors will be introduced to the science by one of the 200-level lab courses and then diving deeper into the science by taking a series of 300-level lab courses that span the complex nature of the earth.

A Bachelor of Science track is appropriate for students who have decided to begin a career in geoscience or pursue a graduate degree in an environmental/economic geoscience profession. Students who elect a Bachelor of Arts track have greater curricular flexibility, allowing for a second major. Recent Bachelor of Arts graduates have attended graduate school or secured employment in geoscience, environmental science, environmental law or policy, education, business, medicine and science writing.

Bachelor of Arts Major in Geosciences

Requires nine GEOL courses and two additional courses (10.5 credits).

Select one of the following courses (1 credit):		
GEOL 203	Physical/Environmental Geology	1
or GEOL 204	Evolution of the Earth	
or GEOL 208	Surface Mapping & Subsurface Imaging	
or GEOL 250	Geology for Engineers	
Select seven GEOL courses 300 level or above with the exception of GEOL 318, GEOL 319, and GEOL 320 (7 credits):		7
GEOL 450	Geosciences Futures	.5
Additional two requirements for the major include (2 credits):		
MATH 201	Calculus I	1
or MATH 216	Statistics I	
PHYS 211	Classical and Modern Physics I	1
or CHEM 205	Principles of Chemistry	
or BIOL 203	Integrated Concepts in Biology Fall	
or BIOL 204	Integrated Concepts in Biology Spring	
BA students are encouraged to take a summer field course in the geosciences, to elect additional courses in science and mathematics, and to participate in independent study research opportunities through GEOL 318, GEOL 319, or GEOL 320.		
Total Credits		**10.5**

Bachelor of Science Major in Geosciences

Requires 11 GEOL courses, six additional courses (16.5 credits), and a supervised research experience.

Select one of the following approved 200-level courses (1.0 credit):		
GEOL 203	Physical/Environmental Geology	1
or GEOL 204	Evolution of the Earth	
or GEOL 208	Surface Mapping & Subsurface Imaging	
or GEOL 250	Geology for Engineers	
The following eight CORE courses are required (7.5 credits):		
GEOL 304	Crystallography-Mineralogy	1
GEOL 305	Introduction to Geochemistry	1
or GEOL 344	Paleoclimatology	
GEOL 309	Sedimentology and Stratigraphy	1
GEOL 314	Structural Geology	1
GEOL 316	Geomorphology	1
GEOL 334	Geophysics	1
GEOL 336	Hydrogeology	1
GEOL 450	Geosciences Futures	.5
Select two additional GEOL 300-level or above electives with the exception of GEOL 318, GEOL 319, or GEOL 320 (2 credits).		2
Additional six requirements for the major include (6 credits):		
GEOL 230	Environmental GIS	1
or GEOL 311	Landscapes in GIS	
or GEOG 204	Applied G.I.S.	
PHYS 211	Classical and Modern Physics I	1
CHEM 205	Principles of Chemistry	1
MATH 201	Calculus I	1
MATH 202	Calculus II	1
CHEM 230	Principles of Chemistry 2	1
or MATH 211	Calculus III	
or MATH 216	Statistics I	
or PHYS 212	Classical and Modern Physics II	
A summer course in field geology is recommended.		
BS students are also required to conduct supervised summer research OR 1 credit of supervised research (GEOL 318, GEOL 319, or GEOL 320) AND present their research in an approved forum.		
Total Credits		**16.5**

To satisfy the Supervised Research Experience, BS students plan and execute a research project supervised by a faculty member during their junior and/or senior year. The following steps and timing based on spring graduation are suggested:

1. Determine your research topic: You are encouraged to consult with multiple, potential faculty research advisers during the fall semester of your junior year and select a project in collaboration with at least one member of the department faculty preferably by the end of the fall semester of the junior year, and no later than the last day of class of the spring semester, junior year.
2. Propose your research project: In consultation with your research adviser, students will develop a written proposal summarizing the research objective, work plan and significance. The research proposal must be completed at a time agreed upon by the student and their research adviser, but no later than the fourth week of classes in the fall semester, senior year.
3. Conduct the research: Research projects are one-semester minimum duration during the academic year or eight weeks minimum duration during the summer. Research may be conducted off-campus under the supervision of an off-campus co-adviser. If the research takes place during the academic year, students must successfully complete GEOL 319 and/or GEOL 320.
4. Disseminate your results: Students must present the results of their work in an approved format by their research adviser and the department chair to successfully complete the Research Experience.

Below is the recommended sequence for the Bachelor of Science major.

First Year

First Semester	Credits	Second Semester	Credits
GEOL Course (approved 200-level)		1 GEOL Core Course	1
MATH 201		1 MATH 202	1

Elective		1 Elective	1
FOUN/RESC		1 Elective	1
		4	**4**

Sophomore

First Semester	Credits	Second Semester	Credits
GEOL Core Course		1 GEOL Core Course	1
GEOL Core Course		1 CHEM 205	1
GIS Course		1 IP	1
Elective		1 Elective	1
		4	**4**

Junior

First Semester	Credits	Second Semester	Credits
GEOL Core Course		1 GEOL Core Course	1
GEOL Core Course		1 CHEM, MATH, or PHYS	1
PHYS 211		1 Elective	1
Elective		1 Elective	1
		4	**4**

Senior

First Semester	Credits	Second Semester	Credits
GEOL 450		.5 GEOL Elective	1
GEOL Elective		1 Elective	1
Elective		1 Elective	1
Elective		1 Elective	1
Elective (0.5 cr)		.5	
		4	**4**

Total Credits: 32

Additional Notes

Independent supervised research experiences are strongly encouraged for all majors by the department. Research opportunities are available through summer research fellowships (e.g. P.U.R. and McKenna Environmental) or Undergraduate Research Courses (GEOL 318, GEOL 319 or GEOL 320).

The department encourages majors (either BA or BS) who are completing independent research experiences and who meet requirements to become candidates for Honors in geosciences. Honors is given to those students who are accepted to the University Honors Program and successfully complete and defend an honors thesis and research presentation in geosciences.

The department attempts to make it possible for students to enroll in study abroad programs. At times this involves changing sequences of recommended courses. Consultation with an academic adviser well in advance is essential.

Courses in all of our degree programs are designed to provide students with many opportunities to practice and develop their writing, speaking, and information literacy skills, consistent with the learning objectives of the College of Arts & Sciences Core Curriculum (CASCC).

Students in our department also satisfy the Culminating Experience component of the College of Arts & Science Core Curriculum (CASCC) by taking GEOL 450 Geosciences Futures, a required course for both B.S. and B.A. majors, in the fall of either their junior or senior year.

A geoscience major is also available in combination with a bachelor of science in engineering in a five-year program.

Students wishing to become certified as secondary school Earth Science teachers should consult with the Department of Education and the chair of the Geology & Environmental Geoscience Department to arrange a plan of study that ensures that all of the requirements for certification will be met.

Students may choose from three **minors** in the area of geoscience:

Geosciences Minor

Requires four courses.

GEOL 203	Physical/Environmental Geology	1
or GEOL 250	Geology for Engineers	
GEOL 204	Evolution of the Earth	1

Select two 300-level geology courses except GEOL 319, GEOL 320	2
Total Credits	**4**

Engineering Geology Minor

Requires four courses.

GEOL 250	Geology for Engineers	1
GEOL 314	Structural Geology	1
Select two 300-level geology courses except: GEOL 319, GEOL 320		2

Environmental Geosciences Minor

Requires four courses.

Select one of the following:		
GEOL 203	Physical/Environmental Geology	1
or GEOL 250	Geology for Engineers	
Select two of the following:		2
GEOL 305	Introduction to Geochemistry	
GEOL 316	Geomorphology	
GEOL 334	Geophysics	
GEOL 336	Hydrogeology	
GEOL 338	Applied Environmental Geomorphology	
Select one 200-level or 300-level geology course except: GEOL 319 or GEOL 320		1
Total Credits		**4**

Majors in Geosciences (B.A. and B.S.) will:

- Meet all of the expectations of students in introductory courses
- Understand core areas of geology and environmental geology, and interpret a wide range of earth processes on different temporal and spatial scales.
- Demonstrate competence in collecting scientific data, including field observation and field and analytical measurements.
- Demonstrate the skills of interpretive analysis and critical thinking with respect to geological problems involving temporal and spatial relationships.
- Make informed decisions on issues of local and global environmental significance based on an understanding of: 1) The interconnectedness of the natural sciences; 2) The linkages of processes and systems that characterize Earth systems; and 3) The interrelationships between humans and natural Earth systems.
- Conduct effective independent and collaborative investigations.
- Execute a formal research project, including the use of primary literature, development of a scientific proposal, collection of new primary data, interpretation of new data, and dissemination of results (B.S. majors only).

Non-majors in Geosciences (meeting laboratory science requirements) will:

- Have a basic understanding of the following: 1) how science works (the scientific method); 2) tectonics; 3) geologic time; 4) Earth materials (e.g. the rock cycle, minerals, critical metals); and 5) climate change.
- Develop an appreciation for the methods of scientific inquiry in geosciences through hands-on laboratory experiences.
- Demonstrate the critical thinking and problem solving skills required in scientific disciplines.

Courses

GEOL 108. When Rocks Attack. 1 Credit.
Offered Either Fall or Spring; Lecture hours:3
Students explore popular depictions of natural disasters to assess their geologic plausibility. Not open to students who have taken GEOL 117 or GEOL 203 or GEOL 250.

GEOL 109. Energy and Natural Resources. 1 Credit.
Offered Either Fall or Spring; Lecture hours:3
Origin, development, and use of natural resources for energy production with an emphasis on petroleum, natural gas, and nuclear energy and their impact on the environment. Not open to students who have taken GEOL 117, GEOL 203, or GEOL 250. Only open to first-years and sophomores.

GEOL 117. Environmental Geohazards. 1 Credit.
Offered Either Fall or Spring; Lecture hours:3
Geologic environmental hazards. Emphasis on hazards recognition and assessment in seminars, and field applications. Topics include: soils, slopes, floods, fans, earthquakes, land use, coastal, and groundwater hazards. Preference given to first-years and sophomores. Not open to Geology majors, except by permission of instructor, or students who have taken GEOL 108 or GEOL 316.

GEOL 201. Earth and the Environment. 1 Credit.
Offered Summer Session Only; Lecture hours:3,Other:2
Earth and the Environment examines the fundamental geological processes that govern how the earth works. The topics include plate tectonics, types of rocks and minerals, the rock cycle, volcanism, seismicity, surface processes and introduction to geologic mapping. Finally, it examines the human impact on the geological environment.

GEOL 203. Physical/Environmental Geology. 1 Credit.
Offered Both Fall and Spring; Lecture hours:3,Lab:4
Introduction to Earth's dynamic systems, plate tectonic processes that make Earth a unique planet, and human interaction with Earth. Geologic factors and limitations that affect use or management of the environment. Not open to students who have taken GEOL 250. Prerequisite: first- or second-year status, others by permission.

GEOL 204. Evolution of the Earth. 1 Credit.
Offered Either Fall or Spring; Lecture hours:3,Lab:4
Introduction to the evolution of life, climate, plate tectonics, and catastrophes through time provides perspective for making decisions about ongoing and future environmental change. Preference given to first-years and sophomores.

GEOL 208. Surface Mapping & Subsurface Imaging. 1 Credit.
Offered Either Fall or Spring; Lecture hours:3,Lab:2
Course is designed for students without prior exposure to geoscience, to learn how to detect subsurface features (walls, roads, groundwater, bedrock). Students learn how to collect geospatial data over the earth’s surface, present/analyze data in a GIS environment. Not open to students who have taken GEOL 230 or GEOL 334.

GEOL 230. Environmental GIS. 1 Credit.
Offered Either Fall or Spring; Lecture hours:4
Geographic Information Systems (GIS) in geologic mapping, environmental monitoring, and hydrologic modeling. Introduction to global positioning, (GPS), environmental databases, spatial analyses, and terrain modeling.

GEOL 250. Geology for Engineers. 1 Credit.
Offered Spring Semester Only; Lecture hours:3,Lab:4
Basic principles, including properties of rocks and soils, hydrology, surface processes, rock mechanics, environmental parameters, geological hazards, and engineering case histories. Not open to students who have taken GEOL 203. GEOL 250 is restricted to first- and second-year civil and environmental engineering students and others by permission.

GEOL 304. Crystallography-Mineralogy. 1 Credit.
Offered Either Fall or Spring; Lecture hours:3,Lab:3
Principles of crystallography and mineralogy; crystal morphology, structure, chemistry, physical properties, genesis, occurrence, and identification of important minerals by various techniques including chemical analysis. Prerequisite: GEOL 203 or GEOL 204 or GEOL 250 or permission of the instructor.

GEOL 305. Introduction to Geochemistry. 1 Credit.
Offered Either Fall or Spring; Lecture hours:3,Lab:4
Composition of natural waters and sediments, basic thermodynamics and kinetics, acid-base and oxidation-reduction reactions, chemical weathering, stable and radioactive isotopes, carbon and nutrient cycles, anthropogenic impacts on geochemical cycles. Prerequisites: CHEM 203 or CHEM 205 or CHEM 207 or permission of the instructor. Crosslisted as GEOL 605.

GEOL 309. Sedimentology and Stratigraphy. 1 Credit.
Offered Spring Semester Only; Lecture hours:3,Lab:4
Principles and techniques of the study of depositional processes and environments. Emphasis on semester-long sedimentary basin analysis project including analysis of Paleozoic outcrops near campus. Prerequisite: GEOL 204.

GEOL 311. Landscapes in GIS. 1 Credit.
Offered Either Fall or Spring; Lecture hours:3,Lab:3
Introduction to GIS applied to studying landscape processes and solving geologic problems, including coastal, volcanic, and desert landscapes, and geologic resource mapping. Course focuses on mastery of basic skills using ESRI ArcGIS software and using geologic spatial datasets. Not open to students who have taken GEOL 230.

GEOL 314. Structural Geology. 1 Credit.
Offered Fall Semester Only; Lecture hours:3,Lab:4
Orientation and geometric analyses of rock structures, kinematics and mechanics of rock deformation at all scales. Prerequisite: GEOL 203 or GEOL 250 or permission of the instructor. Crosslisted as GEOL 614.

GEOL 316. Geomorphology. 1 Credit.
Offered Either Fall or Spring; Lecture hours:3,Lab:4
Physical processes shaping the Earth's surface and evolution of resulting landforms. Emphasis on linkages between landscape components and understanding complex relationships between process and form. Prerequisite: GEOL 203 or GEOL 204 or GEOL 250 or permission of the instructor. Crosslisted as GEOL 616.

GEOL 317. Paleontology. 1 Credit.
Offered Alternate Fall or Spring; Lecture hours:3,Lab:4
Principles of evolution and ecology applied to investigation of ancient life. Emphasis on analysis of field collections of marine invertebrate fossils from Paleozoic outcrops near campus. Prerequisites: (BIOL 203 or BIOL 204) or (GEOL 203 or GEOL 204) and permission of the instructor.

GEOL 318. Undergraduate Research. .5-1 Credits.
Offered Summer Session Only; Lecture hours:Varies; Repeatable
Research course for qualified students in any branch of geology. Prerequisite: permission of the instructor.

GEOL 319. Undergraduate Research. .5-1 Credits.
Offered Fall Semester Only; Lecture hours:Varies; Repeatable
Research course for qualified students in any branch of geology. Prerequisite: permission of the instructor.

GEOL 320. Undergraduate Research. .5-1 Credits.
Offered Spring Semester Only; Lecture hours:Varies; Repeatable
Research course for qualified students in any branch of geology. Prerequisite: permission of the instructor.

GEOL 321. Special Topics in Geology. .5-1 Credits.
Offered Fall Semester Only; Lecture hours:Varies,Lab:Varies; Repeatable
Investigation, report, or discussion on currently significant topics in geology. Prerequisite: permission of the instructor.

GEOL 322. Special Topics in Geology. .5-1 Credits.
Offered Spring Semester Only; Lecture hours:Varies; Repeatable
Investigation, report, or discussion on currently significant topics in geology. Prerequisite: permission of the instructor. Crosslisted as GEOL 622.

GEOL 325. Independent Study. .25-1 Credits.
Offered Both Fall and Spring; Lecture hours:Varies,Other:Varies; Repeatable
Independent study course for qualified students in any branch of geology. Prerequisite: permission of the instructor.

GEOL 334. Geophysics. 1 Credit.
Offered Either Fall or Spring; Lecture hours:3,Lab:4
Introduction to geophysical principles and methods (seismic, gravity, magnetic, electrical, electromagnetic and GPR) applied to both near-surface and solid earth studies. Emphasis placed on active learning by hands-on geophysical data collection focused on environmental and engineering applications. Prerequisites: (One 200-level geology course and MATH 201) or PHYS 211P. Crosslisted as GEOL 634.

GEOL 336. Hydrogeology. 1 Credit.
Offered Either Fall or Spring; Lecture hours:3,Lab:4
Water properties, fundamental flow equations, surface and subsurface flow, well hydraulics, regional flow, and contamination. Prerequisites: GEOL 203 or GEOL 250 and MATH 192 or MATH 201, or permission of the instructor.

GEOL 338. Applied Environmental Geomorphology. 1 Credit.
Offered Alternating Spring Semester; Lecture hours:3,Lab:4
Surviving on a complex and dynamic earth surface. Understanding environmental problems and geologic hazards with geologic principles set in a multidisciplinary framework. Prerequisites: GEOL 316 and permission of the instructor.

GEOL 340. Igneous and Metamorphic Petrology. 1 Credit.
Offered Spring Semester Only; Lecture hours:3,Lab:4
This class examines the mineralogy, petrography, geochemistry, origin and tectonic significance of igneous and metamorphic rocks. Prerequisite: GEOL 304.

GEOL 342. Caves and Karst. 1 Credit.
Offered Either Fall or Spring; Lecture hours:3,Lab:4
Students will learn how karst systems and associated landforms, like caves, form. We will explore the geochemistry and hydrogeology of karst aquifers and other topics using collected data, computer modeling, peer-reviewed literature and group projects. Students will be required to attend at least one of two weekend field trips.

GEOL 344. Paleoclimatology. 1 Credit.
Offered Either Fall or Spring; Lecture hours:3,Lab:4
Course will focus on current questions in paleoclimatology and local paleoclimate history through the production of novel paleoclimate records. Survey of paleoclimate archives and proxies, geological controls on climate, Quaternary glacial cycles, warm periods as analogs for modern climate change, millennial-scale climate oscillations, Holocene and Common Era climate.

GEOL 450. Geosciences Futures. .5 Credits.
Offered Either Fall or Spring; Lecture hours:1.5
Geosciences majors (BS BA) will take this course as their culminating experience. Also appropriate for any student interested in geosciences-related careers or graduate education. Students will explore career and graduate school options in the geosciences by way of guest speakers, resume workshops, alumni contacts and preparation for geologist-in-training certification.