

Geological Sciences

Faculty

William S. Bartels, chair and professor of geological sciences, and Arnold G. Langbo Trustees' Professor. A.B., 1977, Rutgers College; M.S., 1981, Ph.D., 1987, University of Michigan. Appointed 1986.

Beth Z. Lincoln, professor. A.B., 1973, Smith College; Ph.D., 1985, University of California, Los Angeles. Appointed 1981.

Timothy N. Lincoln, professor. B.S., 1972, University of Massachusetts, Amherst; Ph.D., 1978, University of California, Los Angeles. Appointed 1981.

Carrie A. Menold, instructor. B.S., 1999, University of Michigan; Ph.D. candidate, University of California, Los Angeles. Appointed 2006.

Christopher M. Van de Ven, assistant professor. B.S., 1997, University of Wisconsin; Ph.D., 2003, Stanford University. Appointed 2004.

Thomas I. Wilch, associate professor. B.A., 1987, Macalester College; M.S., 1991, University of Maine; Ph.D., 1997, New Mexico Institute of Mining and Technology. Appointed 1998.

Introduction

Geology is the study of the earth, the processes that shape it and the materials of which it is composed. Geology gives students an understanding of the world around them, an appreciation for the length and events of earth history, and the knowledge to help them make informed decisions about environmental concerns.

The Geological Sciences Department offers majors in **geology** and in **earth science**. There are two tracks available through the **geology** major-- the first is designed for students intending to enter graduate school and/or continue on as professional geologists (TRACK G); the second is intended for students who do not plan to pursue graduate studies (TRACK L). Track L is also ideal for students who plan to combine a major in geology with a major in another science.

The **earth science** major is designed primarily for students in the secondary education program. It is also appropriate for students who have an interest in the earth sciences but plan to pursue careers in other fields. It may be combined with a second major in another field outside the sciences.

The **geology** curriculum provides students with a strong undergraduate preparation for more specialized training at the graduate level or for on-the-job training by industries and government agencies.

The science of geology depends upon basic principles in physics, chemistry, biology and mathematics. A number of courses in these areas are required as cognates for the **geology** or **earth science** major.

[Geological Sciences Department Web site](#)

Career Opportunities

Albion College geology graduates are successful in obtaining interesting and well-paying jobs. Many of these jobs are with petroleum and metal exploration companies, but the current job market boom is in the area of water resource and environmental management. Other geology graduates have been employed by numerous consulting firms; by research institutes; by state geological surveys and the U.S. Geological Survey; by universities and colleges as geology professors and by secondary schools as earth science teachers.

Over one-half of our graduates have chosen to continue geology studies at major universities and have obtained master's or doctoral degrees in geology before beginning their careers.

Special Features

Three National Science Foundation grants to the department have established sophisticated geographic information systems (GIS), inductively coupled argon plasma (ICP) spectrometry and x-ray fluorescence (XRF) spectrometry laboratories. Another NSF grant has provided electronic mapping tools, including global positioning receivers and base stations, laser ranging equipment and an electronic total

station for precise fieldwork.

The newly constructed Dow Instructional Laboratory houses a Sedigraph 5100 particle size analyzer, Franz magnetic separator, Rigaku miniflex X-ray diffractometer, CEM Mars 5 microwave digestion system and Nikon research-grade petrographic microscope with heating/freezing stage.

Our other laboratories are also well-equipped and include: new binocular and petrographic student microscopes (along with a color video microscopy unit with microcomputer link for image analysis), equipment for cutting and polishing rocks and a petrographic thin section machine; a stream table, flume, wave tank, current velocity meter and water analysis system; exploration seismograph, resistivity apparatus and a magnetometer. Department collections include over 6,000 rock and mineral specimens, over 10,000 fossil specimens and more than 2,000 specialized maps.

The computer laboratory for GIS and digital map analysis includes a Windows 2000 server (with over 470 Gb of storage holding thousands of maps and images), 12 Windows XP workstations (each with its own digitizing tablet), a large digitizing table, a color flatbed scanner, two inkjet printers, two laser printers, and a link to the E-size color printer/plotter, in the nearby Dow Analytical Laboratory. Software for creating, manipulating and analyzing spatial data and images (maps, aerial photos and satellite imagery) includes ArcGIS 9 (ArcInfo and ArcView), and Idrisi-Kili-manjaro.

Our analytical facilities include a JY 38S ICP spectrometer with a Cetac 5000AT ultrasonic nebulizer, a Rigaku 2100 wavelength dispersive XRF spectrometer, a fluxy automatic fluxer, and rock crushing and grinding equipment. This equipment allows us to undertake analysis of a wide range of materials, including rocks and natural solutions, for most elements from trace (parts per billion) to major (%) levels. Students in both introductory and advanced courses use the equipment, and it supports advanced environmental and geological research projects.

Field study is important in geology, so the department maintains an active field program. Each spring students and faculty participate in a regional geology seminar and subsequent 10-day field trip; recent trips have been to Great Britain, Iceland, Canada, Alaska, Hawaii, Arizona and New Mexico, New England, the Ozarks, the Northern Appalachians and the Smoky Mountains. Local field trips are sponsored by the student-run Geology Club. In addition, the Geology Department operates a summer field program in Wyoming, Montana and South Dakota. Students from Albion and many other colleges and universities attend this camp each summer for training in geologic mapping and field research.

Independent study is available to all majors in their junior and senior years. Students may work on an individual laboratory or field problem within the scope of their background and write reports on the findings. Outstanding seniors may carry out honors work in geology or may take part in work that supports faculty research. A local chapter of Sigma Gamma Epsilon, an earth science honorary, is active on the Albion campus.

Requirements for Major in Geology

- There are two tracks through the geology major. Both require nine geology courses, a field work experience, participation in all departmental colloquia during the junior and senior years, and cognate courses (four or three depending on the track).

TRACK G--designed for the student who plans to pursue graduate studies in some aspect of geology or become a professional geologist, or both.

TRACK L--designed for the student who would like to major in geology, but who does not plan to enter graduate school.

COMMON CORE
required for both tracks
Geol 101: Introductory Geology
Geol 103: Introduction to Earth History
Geol 201: Structural Geology
Geol 203: Mineralogy
Geol 204: Introductory Petrology
Geol 205: Sedimentation and Stratigraphy

TRACK G--At least three additional units, including either Geology 208 or Geology 209 plus two electives at the 300-level. A minimum of four cognate courses including Chemistry 121 and 123 and two of the following: Mathematics 141, 143; Physics 115, 116, 167, 168; Biology 195, 210. Students intending to enter graduate school should be aware that most graduate programs require at least one semester of both calculus and physics in addition to chemistry. In addition, many graduate programs require advanced study (senior- or graduate-level) in a cognate science. Students with specific interests in geology may want to pursue completing appropriate minors in the fields of mathematics, physics, chemistry or biology.

Track G majors are required to complete a departmentally-approved independent research project, and are encouraged to complete a senior thesis.

TRACK L--At least three additional units of geology at the 200-level or above, at least one of which must be at the 300-level. Three

cognate courses selected from: Chemistry 121, 123; Biology 195, 210; Physics 115, 116; Mathematics 141, 143, 171, 210.

Requirements for Minor in Geology

- Five units in geology, including Geology 101 and 103 plus three other geology courses at the 200- or 300-level selected in consultation with and approved by the department. Normally, Geology 211 and 311 will not count toward completion of the minor.
- Completion of a field experience equivalent to one-half unit.
- All courses for the minor must be taken for a numerical grade.
- Departmental Colloquia: All geology minors are required to attend Departmental
- Colloquia regularly and to participate once each semester for two semesters.

Requirements for Minor in Environmental Geology

- Six units in geology, including Geology 101, 202, 208, 216; one unit selected from 306, 307 or 312; one unit selected from Geology 104, 106, 111, 115, 211, or ENVN 102, or a one-unit equivalent of approved independent research (Geology 412, Geology 411 taken twice, or a summer research experience). Note: This minor may not be elected by geology majors.
- All courses for the minor must be taken for a numerical grade.

Requirements for Minor in Geographic Information Systems (GIS)

- Five units in geology, including 111, 211, 311 and two units of research-based directed study or one unit each of research-based directed study and a GIS-related internship, selected in consultation with and approved by the department.
- All courses for the minor must be taken for a numerical grade, except those offered only on a credit/no credit basis.

Requirements for Minor in Paleontology (for Geology Majors)

- Six units, including Biology 195, two units from Biology 216, 225, 227 or 237, Geology 208, 314, and a one-unit equivalent of approved independent research (Geology 412, Geology 411 taken twice, or a summer research experience), selected in consultation with and approved by the department.
- All courses for the minor must be taken for a numerical grade.
- Geology majors completing a minor in paleontology must take Geology 209 and Geology/Biology 309 as part of the geology major requirements or as electives beyond the major requirement.

Requirements for Minor in Paleontology (for Biology Majors)

- Six units, including Geology 103, 205, 209, Biology 309, and two units from Geology 101, 111 or 211, 208, or a one-unit equivalent of approved independent research (Geology 412, Geology 411 taken twice, or a summer research experience), selected in consultation with and approved by the department.
- All courses for the minor must be taken for a numerical grade.

Requirements for Minor in Paleontology (for Majors Except Biology and Geology)

- Six units, including Geology 103, 205, 209, 309, Biology 195, and one unit from Biology 216, 225, 227, 237, or a one-unit equivalent of approved independent research (Geology 412, Geology 411 taken twice, or a summer research experience), selected in consultation with and approved by the department.
- All courses for the minor must be taken for a numerical grade.

Requirements for Major in Geology With Secondary Education Certification

- Nine units in geology and the completion of all other requirements as outlined above in the section "Requirements for Major in Geology." Track L or Track G may be elected.
- Physics 105.
- Demonstrated mathematics proficiency at the Mathematics 125 level.
- Completion of all other requirements for teacher certification in earth science, including professional education courses.

- Geology 104 and 115 (taken as electives outside the major).

Requirements for Major in Earth Science

This program is intended for students who do *not* intend to pursue a career in geology.

- Eight units in geology, including: 101 and 103; 201, 203 or 205; 216; one 300-level elective; and three other geology courses, two of which must be at the 200-level or higher. These may *not* include Geology 210, summer field camp or a directed study. Geology 202, 208 or 306 may be substituted for 216 with departmental approval.
- Two cognate courses in mathematics, chemistry, physics and/or biology; may include Physics 105 and one of the courses listed under Track L (above).

Requirements for Major in Earth Science With Secondary Education Certification

- Nine units in geology, including 101, 103, 104, 115, and five other geology courses at the 200-level or higher (one must be at the 300-level), selected in consultation with, and approved by, the department. These may not include Geology 210, summer field camp, or a directed study.
- Completion of all other requirements as outlined below in the section "Requirements for All Students Majoring in Geology or Earth Science."
- Two cognate courses including Physics 105 and one course selected from those listed under Track L (above).
- Demonstrated mathematics proficiency at the Mathematics 125 level.
- Completion of all other requirements for teacher certification.

Requirements for Minor in Earth Science With Secondary Education Certification

- Six units in geology, including Geology 101, 103, 104 and 115 and the completion of all other requirements as outlined above in the section "Requirements for Minor in Geology."
- Physics 105.
- Demonstrated mathematics proficiency at the Mathematics 125 level.
- Completion of all other requirements for teacher certification.

Requirements for All Students Majoring in Geology or Earth Science

- All students completing a major in geology or earth science must satisfy a field work requirement equivalent to one unit of study. This requirement may be fulfilled by summer research, internship or work experiences, academic year directed studies, completion of Geology 210 or 314, other suitable field experiences approved by the faculty (such as field trips sponsored by GSA), or some combination of the above.
- A maximum of one geographic information systems course (Geology 111, 211 or 311) may be counted toward the major.
- Departmental Colloquia: All geology and earth science majors are required to attend Departmental Colloquia regularly and to participate once each semester for four semesters.
- The geology units and the required cognate courses must be taken for a numerical grade. Students considering a geology major are urged to complete the cognate units as early as possible in their Albion career.
- After completing three or four geology courses or at the end of their junior year, majors are urged to attend either the Albion summer field camp in the Rocky Mountains or a similar summer geology field course offered by another college or university. This experience is required by most graduate schools before entering a graduate program and is required by many industries and institutions employing geologists.

Courses

A modest lab fee may be charged in some courses.

101 Introductory Geology (1) Fall, Spring

A survey course designed for liberal arts students covering many aspects of physical geology, the study of active earth processes. Labs illustrate lecture materials and the techniques used by geologists. Two field trips. Complements the material covered in Geology 103; either course can serve as an introductory course in geology. *Staff.*

103 Introduction to Earth History (1) Fall, Spring

A survey course designed for liberal arts students and covering many aspects of historical geology, the study of evolving environments and life forms on earth. Labs utilize fossils, rock samples, maps and field trips to illustrate techniques used by historical geologists. Complements the material covered in Geology 101; either course can serve as an introductory course in geology. *Staff.*

104 Earth Resources and the Environment (1) Fall, Spring

Without earth resources, civilization would not exist. Gold, diamonds, water, oil, building materials--all of our material resources ultimately are derived from the earth. This course will examine the origin and geologic occurrence of these materials, and discuss the environmental implications of their utilization. No laboratory. *Staff.*

106 Earthquakes, Volcanoes and Other Geological Hazards (1) Fall, Spring

A review of the geological hazards which affect our lives, property and the environment. Emphasis will be on the origin and prediction of such hazards, as well as ways to minimize their effects. In addition to earthquakes and volcanoes, this course will cover landslides, floods, meteorite impacts, and stream and coastal erosion. No laboratory. *Staff.*

111 Modern Maps and Geographic Information Systems (1) Fall

An introduction to the elementary principles, techniques and utility of geographic information systems (GIS), as well as related concepts and techniques involved in creating and using digital maps. Shows how maps (particularly computer-generated maps) can help in displaying and analyzing spatial data, modeling processes and making decisions. Lecture and laboratory. Some prior computer experience is helpful, but is not required. *Van de Ven.*

115 Oceans and Atmosphere (1) Spring

Describes the world's oceans and atmosphere and considers how they interact with one another, and with humans. Topics include the geological evolution of the ocean basins, ocean-atmosphere circulation patterns, ocean currents, climate and weather patterns, storms and weather fronts, paleo-oceanography and the history of climate, and the chemical composition of the oceans. Emphasizes the role of the oceans in mediating global climate, global change, global dispersal of pollution and other environmental concerns. No laboratory. Offered in alternate years. *T. Lincoln.*

201 Structural Geology (1) Spring

Prerequisite: Geology 101.

Study of stress-strain relationships and behavior of materials, with particular reference to recognition and interpretation of rock structures. Laboratory work includes methods of solving structural problems and the use of geologic maps and cross-sections to interpret sequences of events in complex structural regions. Alternate years--offered 2006-07. *B. Lincoln.*

202 Ground Water (1) Fall

Prerequisite: Geology 101 or 103.

The geophysical and geochemical aspects of ground water, with an emphasis on the consequences of human intervention. Alternate years--offered 2007-08. *T. Lincoln.*

203 Mineralogy (1) Fall

Prerequisite: Geology 101.

Crystallography, crystal chemistry, physical properties and the occurrence of rock forming minerals, with particular emphasis on the silicate minerals. Laboratory emphasizes hand-specimen identification of minerals. Alternate years--offered 2006-07. *Clark.*

204 Introductory Petrology (1) Spring

Prerequisite: Geology 203.

Hand specimen and microscopic identification of minerals and rocks. Recognition and classification of all varieties of igneous, metamorphic and sedimentary rocks. Laboratory. Emphasis on use of the petrographic microscope. Alternate years--offered 2006-07. *Clark.*

205 Sedimentation and Stratigraphy (1) Fall

Prerequisite: Geology 103; or Geology 101 and permission of instructor.

An examination of the processes and principles that control the accumulation and lithification of sediments, based on examples of recent environments and ancient rock sections in many parts of the world. Laboratory emphasizes map-reading skills and methods for studying recent and ancient sediments and rocks. Alternate years--offered 2007-08. *Bartels.*

208 Geomorphology (1) Spring

Prerequisite: Geology 101 or permission of instructor.

Geologic processes operating at the earth's surface and the landforms they produce. Includes the study of soil formation, river processes, glaciers, wave action, wind, groundwater and their related landforms. Field trips. Laboratory includes analysis of aerial photographs, topographic maps and experiments with flume and wave tank. Alternate years--offered 2006-07. *Wilch.*

209 Geochronology and Paleontology (1) Spring

Prerequisite: Geology 103, or Biology 195, or permission of instructor.

The study of fossils and their use in geology and biology, focusing on invertebrate animals. Laboratory emphasizes relationships between groups and to sedimentary environments and correlation. Offered in alternate years. *Bartels.*

210 Regional Field Geology (1/2) Spring

Prerequisite: Geology 101 or 103, or permission of instructor.

A field study of the structure and stratigraphy of selected geologic provinces. During the second half of the spring semester the class will meet once a week to discuss readings related to the geology of the field study. The field study itself will last for eight to ten days typically beginning the day after commencement in May. *Staff*.

211 Remote Sensing and Geographic Information Systems (1) Spring

Prerequisite: Geology 111 or permission of instructor.

An introduction to the elementary principles, techniques and utility of remotely sensed imagery and image interpretation, especially when used in conjunction with Geographic Information Systems (GIS). Shows how digital maps created from, or utilizing, digital imagery from airplanes, space shuttles and satellites can help in displaying and analyzing spatial data, modeling processes and making decisions.

Laboratory emphasizes the use of remote sensing and GIS in a variety of environmental applications. Lecture and laboratory. Alternate years--offered 2006/07. *Van de Ven*.

216 Environmental Geology (1) Fall

Prerequisite: Geology 101 or 103, or permission of instructor.

A study of selected environmental hazards such as earthquakes, volcanic activity, flooding, avalanches, water depletion and pollution. Study includes land use planning and case histories involving environmental law. Laboratory uses maps, aerial photos and geologic data in the analysis and control of environmental hazards and in land use planning. Laboratory and field trips. Alternate years--offered 2006-07. *Wilch*.

301 Engineering Geology (1) Fall

Prerequisite: Permission of instructor, and Geology 101 or Physics 115 or Physics 167.

Provides an understanding of earth processes, geologic hazards and earth materials through study of the responses of water, rocks and soils to loads from natural and human processes. Includes the mechanics of rocks and soils, remediation of natural conditions, influence of water on human structures and rocks/soils, and assessing and modeling slope stability. Lecture, laboratory and field trips.

Van de Ven.

302 Geophysics (1) Spring

Prerequisite: Geology 101 or permission of instructor.

The study of the physics of the earth, its gravitational and magnetic fields, heat flow, seismicity and internal structure. The geophysical aspects of plate tectonics will be stressed. Offered as needed. *B. Lincoln*.

306 Glaciers and Climate Change (1) Fall

Prerequisite: Geology 101.

Covers the dynamics of glacier flow, origin of glacial features, events of the Pleistocene Epoch with emphasis on the Great Lakes area, Earth's climate history, causes of ice ages, recent and future climate change. Lecture, laboratory and field trips. Alternate years--offered 2007-08. *Wilch*.

307 Geochemistry (1) Spring

Prerequisite: Geology 203 or Chemistry 121.

The application of chemical principles to the study of the earth with emphasis on environmental geochemistry. Topics include the distribution of chemical elements within the earth, rock weathering, the chemistry of natural solutions, surface chemistry and the behavior of contaminants in the environment. Laboratories involve both field and laboratory techniques and rely heavily on state-of-the-art instrumentation, including optical emission and x-ray fluorescence spectroscopy and ion chromatography. Offered as needed. *T. Lincoln*.

309 Vertebrate Paleontology (1) Fall

Prerequisite: Geology 103 or Biology 195.

The fossil record, evolution, morphology, adaptation and paleobiogeography of fish, amphibians, reptiles, birds and mammals. The interactions of vertebrates with ancient floras, climates and plate configurations will be emphasized. Alternate years--offered 2006-07.

Lecture and laboratory. Same as Biology 309. *Bartels*.

310 Igneous and Metamorphic Petrology (1) Spring

Prerequisite: Geology 204 or permission of instructor.

Genesis and occurrence of igneous and metamorphic rocks, with emphasis on the behavior of magmas during cooling, the origin of crystalline rocks and the physicochemical theories of metamorphism. Includes thin-section study of igneous and metamorphic rocks, interpretation of phase diagrams and graphical interpretation of petrochemical data. Offered as needed. *Clark*.

311 Advanced Geographic Information Systems (1) Spring

Prerequisite: Geology 111 or permission of instructor.

The study of the more advanced capabilities of Geographic Information Systems (GIS). Emphasizes spatial modeling and analysis using GIS software such as ArcView GIS. Topics include map algebra, point pattern analysis, network analysis, grid analysis and 3-D surface analysis. Students learn how to use these and other GIS tools for decision-making, model building and the effective use of maps. Lecture and laboratory. Alternate years--offered 2007-08. *Van de Ven*.

312 Geology of Metallic Mineral Deposits (1) Spring

Prerequisite: Geology 204 or permission of instructor.

The nature, origin and global distribution of important metallic resources. Exploration and resource evaluation techniques. Physical and chemical principles applied to the study of the genesis of ore deposits. Laboratory study of ore suites from major mineral deposits.

Principles and applications of reflected-light microscopy stressing creative interpretation of ore textures. Offered as needed. *T. Lincoln.*

391, 392 Internship (1/2, 1) Fall, Spring

Offered on a credit/no credit basis. *Staff.*

401, 402 Seminar (1/2, 1) Fall, Spring

Prerequisite: Geology 101 or permission of instructor.

Critical evaluation of current topics in geology as determined by student and staff interest. Recent topics have been regional geology, engineering geology, paleoecology and volcanology. *Staff.*

411, 412 Directed Study (1/2, 1) Fall, Spring

Staff.

Summer Session

The following courses are offered in the summer session in South Dakota and Wyoming.

314 Field Methods (2)

Prerequisites: Geology 201, 204, 205 (or their equivalents) or permission of instructors.

Experience in geologic mapping is stressed. Field work is done in sedimentary, metamorphic and igneous rocks. Includes three weeks in northwest Wyoming and Montana, and two weeks in the Black Hills of South Dakota. *Staff.*

412 Directed Study (1)

Prerequisite: Three courses in geology, one of which must be an advanced course related to the research topics.

Directed independent study and research related to field problems in the areas of petrology, geochemistry, geophysics, structural geology, stratigraphy or economic geology of the region. Time is arranged with the instructor. *Staff.*