# Geology and Geography

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Programs in the department include a major and a minor in geology, a major in environmental geology, a major and a minor in geography, a group minor in environmental studies, as well as majors and minors for teacher education programs. Group majors consisting of geology, chemistry, engineering, or physics are also available.

**GEOLOGY MAJOR**

Geology 151 or 120
Geology 152
Geology 212
Geology 215
Geology 311
Geology 316
Geology 317
Geology 387
Two electives from Geology 251, 304, 312, 313, 322, 386, 390, 395, 396, Geography 221 and 222, or an approved interim course.
Physical Science Senior Capstone Course or Geology 386

**Cognate**
Chemistry 103
Mathematics 143 or 161

Students who desire a B.S. degree must complete a minimum of 58 semester hours of science and mathematics. Students who wish to pursue a career or graduate study in geology and who desire a B.S. degree must complete the minimum requirements of the geology major and should also take the following courses:

Geology 313
Chemistry 104
Physics 133
Physics 134
Math 161 or 132
English 201
Geology Field Methods Course

**ENVIRONMENTAL GEOLOGY MAJOR**

Geology 151 or 120
Geology 152
Geology 215
Geology 304
Geology 311
Geology 312
Geology 317
Geology 387
Geography 221
Geography 222
Environmental Studies 210
Environmental Studies 302
Environmental Studies 385 or Field Course
Environmental Studies 395
Two electives from Chemistry 253, Engineering 306, Geology 212, 251, 316, 322 or Physics 133

**Cognates**
Chemistry 103
Chemistry 104
Mathematics 161 or 143
Mathematics 162 or 132

**GEOLOGY MINOR**

Geology 151 or 120
Geology 152
Geology 215
Three electives from Geology 212, 251, 304, 311, 312, 313, 316, 317, 322, 386, 390, 395, 396, Geography 221 and 222.

**Cognate**
Chemistry 103

**EARTH/ SPACE SCIENCE MAJOR FOR SECONDARY EDUCATION**

Geology 151
Geology 152
Geology 212
Geology 215
Geology 251
Geography/Interdisciplinary 191
Astronomy 211
Astronomy 212
SCES 214
An approved elective

**Required Cognates**
Mathematics 132 or 161
Chemistry 103
One course in college or high school physics

**EARTH/SPACE SCIENCE SECONDARY EDUCATION MINOR**

Geology 151
Geology 152
Geology 251
Geography 191
Astronomy 211
Astronomy 212
SCES 214

**Required Cognates**
Mathematics 132 or 161
One course in college or high school physics

**GEOGRAPHY MAJOR**

Geography 110
Geography 120
Geography 210
Geography 221
Geography 222
Geography 230
Geography 310
Geography 311
Geography 320
Geography 380
Two from Geography 191, 240, 241, 242, 251, 322, 351, 385, 390, 395, Environmental Studies 302, an approved interim course

**Cognate**
Mathematics 143 or Psychology 255

**GEOGRAPHY MINOR**

Geography 110
Geography 120
Geography 210
Geography 230
Geography 320
One approved elective

**GEOGRAPHY ELEMENTARY EDUCATION MAJOR**

Geography 110
Geography 120
Geography 210
Geography 221
Geography 222
Geography 230
Geography 241
Geography 311
Geography 320
At least four semester hours of electives from the approved list, which can be found in the *Teacher Education Guidebook*.

**ELEMENTARY/SECONDARY EDUCATION GEOGRAPHY MINOR**

Geography 110
Geography 120
Geography 210
Geography 241
IDIS 375 (secondary only)
Plus six hours of electives: See *Teacher Education Guidebook* for list of applicable electives

**ELEMENTARY SOCIAL STUDIES GROUP MAJOR**

Students must take two specified courses from each of the following four disciplines: Economics, Geography, History, and Political Science. (Specific course choices are listed in the *Teacher Education Program Guidebook*). In addition, students must complete a sequence of courses from one of these disciplines chosen in consultation with a social studies education advisor. Advisors: D. Miller, D. Howard, and R. Schoone-Jongen History Department.

**ELEMENTARY SOCIAL STUDIES GROUP MINOR**

Economics 221
Economics 222
Geography 110
One course from Geography 210, 230, 310, or 320
History 151 or 152
History 229
Political Science 101
Political Science 202

**ELEMENTARY AND SECONDARY INTEGRATED SCIENCE STUDIES**

Students in the Elementary or Secondary Education Program wishing to major or minor in science should consult the Science Education section of the catalog.

**GROUP MAJORS IN GEOLOGY AND GEOGRAPHY**

A group major meets the needs of some students, particularly those in professional programs. Such group majors require twelve courses, ten of which must be from two departments with no fewer than four from either, with the remaining two courses cho-

sen from a third department. The chairs of the three departments involved must approve such programs.

## MAJORS IN GEOLOGY AND GEOGRAPHY

Students must have completed at least two courses in geology or geography with a minimum average grade of C (2.0) before they may be formally admitted to the major program. The core requirement in the physical sciences may be met by Geography/Geology 120, Geography/IDIS 191, 251, or Geology 151. The core requirement in the natural world category may be met by Geology 151-152.

## COURSES

### Geography

110 **World Regional Geography** (4). F and S. An analysis of the earth's principal culture regions from a geographic perspective: Africa, Europe, Russia, North Africa and Southeast Asia, East Asia, South Asia and Southeast Asia, Australia and New Zealand, Oceania, Carribean, and Latin America. These areas will be examined in the light of several foundational geographic themes: the locational organization of physical and cultural features; society-land relationships; cultural landscapes; and patterns of spatial interaction among and within regions.

120 **Earth Systems** (4). F. This course includes an introductory study of physical systems and historical processes that shape the surface of the earth. Topics include: 1) The physical nature of the earth's surface based on composition of earth materials and the forces that create landforms, 2) weather and climatic systems and their effect on the global distribution of soils and ecological communities, and 3) the oceans. Understanding of earth systems is applied to concepts of stewardship, resource use, and energy consumption. Laboratory. Also listed as Geology 120. Not open to students who have completed Geology 151 or Geology W11.

191 **Introductory Meteorology** (4). S. This course is a study of the atmosphere and the complex processes that control weather and climate. Special attention is given to: The different forms of energy that are operative in the atmosphere and how these control temperature; the various optical phenomena that are observed in the atmosphere; the hydrologic cycle and the mechanisms of cloud formation and precipitation; air pressure and the winds that result from its differences at the surface and aloft; and the formation of air masses and their movement as frontal systems. Human interactions with atmospheric processes will be examined, including the topics of air pollution, hurricanes, tornadoes, ozone depletion, global warming, acid rain, and photochemical smog. Laboratory. Also listed as Interdisciplinary 191. Prerequisite: High school chemistry or equivalent.

210 **Human Modifications of the Global Environment** (3). F. As population and affluence have increased and technology's role has grown, human activities have transformed natural environments around the globe. This course surveys and examines how a wide variety of human enterprises such as agriculture, industry, recreation, and urbanization have had and continue to have far-reaching environmental consequences everywhere on earth. These impacts are assessed by standards such as ecological well being and sustainability, human habitability, and quality of life. Not open to first-year students. Also listed as Environmental Studies 210.

221 **Cartography** (2). F and S. Map design and interpretation with an emphasis upon computer cartographic methods. Course includes portrayal of spatial data and the use of remotely sensed data for cartographic purposes. Lab exercises will focus on practical applications of cartographic principles. Note: *Geography 221 and 222 are taught as two six-week segments in the same semester.

222 **Geographic Information Systems** (2). F and S. Focus on geographic information systems (GIS), a computer method that seeks relationships among map systems and spatial databases. Lab work will develop GIS fluency using the latest version of ArcView software and include experiences merging data from multiple sources and formats. Students will complete GIS projects that are tailored to their disciplinary interests. Note: *Geography 221 and 222 are taught in sequence as two six-week segments in the same semester. Prerequisite: Geography 221 or permission of the instructor based on previous training or experience commensurate with Geography 221.

230 **The Geography of the Global Economy** (3). * F, alternate years. This course traces the geographical and structural evolution of the global economic system. Includes analysis of human interaction with Earth's resources, the impact of distance and relative location on various economic activities, exchange and interaction patterns among places, and theories of uneven development. Prerequisite: Geography 110 or an economics course.

240 **The Geography of Latin America** (3). * S, alternate years. A survey of the geography of Latin America with an emphasis on the region's physical, cultural, and economic diversity and with a particular focus on issues of development and poverty. Emphasis is put on historic migrations, physical resources, and relative location in the understanding of the formation of regional patterns. Not offered 2007-2008.

241 **The Geography of the United States and Canada** (3). * F. This course provides an overview of the geographic forces that shaped this region of North America. These forces include natural processes and the distribution of resources, structures of the market economy, relative location of resources and markets, and the history of migration. These processes are used as a framework for the analysis of the regional economic and cultural patterns of North America with an emphasis on worldview as a formative agent in the creation of this regionalization.

242 **The Geography of Africa** (3). F. A survey of the geography of Africa with a focus on the region's physical, cultural, and economic diversity. Featured emphases include the historical experience of colonialism, challenges of environmental degradation, spatial patterns of forced and voluntary migration, intensification of poverty under structural adjustment programs, and the quest for successful development practices.

251 **Oceanography** (4). * F. This survey course includes: The history of marine exploration; the nature of the ocean floor, including submarine volcanoes, oceanic crust, sea-floor spreading, and marine sediments; coastal geomorphic processes; the properties of seawater; the nature of tides and currents; ecological marine biogeography, including marine plankton, deep-water biota, coral reef communities and estuarine and intertidal marine communities; and stewardship of marine resources. Laboratory; field trips. Also listed as Geology 251. Prerequisites: High school chemistry and sophomore standing.

295 **Special Topics in Geography** (2-3). Prerequisite: sophomore standing.

310 **Urban Geography** (4). * S, alternate years. A study of the spatial organization of cities and systems of cities. Both the internal structure and external relations of cities receive attention. The historic and present-day spatial organization of infrastructure, economic life, social activities, ethnicity, institutions, and politics are examined. Prerequisite: Geography 110 or one social science course.

311 **Geomorphology** (4). * F. The investigation of landforms and the processes which cause them. This course studies the erosional and depositional features resulting from rivers, glaciers, and wind, as well as coastal, gravitational, and weathering processes. Landforms are described and classified from field observations, topographic maps, and aerial photographs. Explanations of the landforms are offered through quantitative modeling of the processes. Laboratory, field trips. Also listed as Geology 311. Prerequisite: Geology 151 or Geology/Geography 120.

320 **Introduction to Cultural Geography** (3). * F, alternate years. An examination of the interactions between culture and nature in pre-agricultural, agricultural, and urban-industrial societies. The course explores the origins, character, content, organization, perceptions, and meanings of cultural landscapes, past and present, large and small. Prerequisite: Geography 110 or permission of the instructor. Not offered 2007-2008.

322 **Coastal Geomorphology** (4) *S, alternate years. This course examines the nature and development of coastal landforms and the processes responsible for change in the coastal zone. Topics include waves, currents, tides, wind, changing sea levels, and the coastal environment of beaches, dunes, estuaries, and rocky coasts. Coastal land use and hazards, shoreline protection, and coastal stewardship will be discussed. Great Lakes

coasts are emphasized. Laboratory and field trips. Prerequisite: Geography/Geology 311. Not offered 2007-2008.

351 **Introduction to Urban and Regional Planning** (3). * F, alternate years. A survey of the practice of urban and regional planning including its theory, history, techniques, issues, and careers. Land use planning and zoning, housing and community development, environmental planning, recreation planning, health care systems planning, transportation planning, historic preservation and urban design, and other subfields are examined within neighborhood, downtown, suburban, regional, and Third World contexts. Prerequisites: Two 200-300 level social science and/or geography courses or department approval. Not offered 2007-2008.

380 **Seminar in the History and Philosophy of Geography** (3). S, alternate years. This course includes a study of significant episodes and crucial issues in the history and philosophy of geography with an emphasis on present-day human geography. The philosophical underpinnings of geography's domains and paradigms are critically examined. This seminar requires geography majors to reflect on integrating their geographical knowledge and fitting this into a Reformed worldview. Prerequisite: Junior or senior standing in the geography program. Not offered 2007-2008.

385 **Internship in Geography** (3). F, S, or SS. This course is an internship involving professional application of the concepts and principles learned as part of the geography program. A student is placed in a government agency, a private firm, or a not-for-profit organization, which builds on previous instruction in the program in an area of applied geography, such as urban and regional planning, mapping, and geographic information systems. Students are assigned a specific project and work under the direct supervision of an employee of the outside agency or firm as well as under the supervision of the instructor. Prerequisites: Senior standing in the geography major or permission of the geography faculty.

390 **Independent Study**. * F, I, and S. Prerequisite: Permission of the department.

395 **Research in Geography** (2). F, I, and S. Field or library research on an approved geographical problem and presentation of the results of this research in a seminar. Open to qualified students by permission of the department.

### Geology

120 **Earth Systems** (4). F. This course includes an introductory study of physical systems and historical processes that shape the surface of Earth. Topics include: 1) The physical nature of Earth's surface based on composition of Earth materials and the forces that create landforms, 2) weather and climatic systems and their effect on the global distribution of soils and ecological communities, and 3) the oceans. Understanding of Earth systems is applied to concepts of stewardship, resource use, and energy consumption. Laboratory. Also listed as Geography 120. Not open to students who have completed Geology 151 or Geology W11.

151 **Introduction to Geology** (4). F and S. This course is a study of the materials and processes of Earth leading to a responsible Christian appreciation for and stewardship of Earth. Topics include minerals and rocks, Earth's interior and surface structure; surface processes producing landforms; geological time and principles for interpreting Earth history; mineral resources and fossil fuels; and geological hazards such as earthquakes, volcanoes, floods, landslides, and groundwater pollution. Laboratory. Not open to students who have completed Geology/Geography 120 or Geology W11.

152 **Historical Geology** (4). S. The first portion of this course traces the development of the study of Earth through the past few centuries, as geology became a true scientific discipline and as its practitioners became convinced of Earth's antiquity. Attention is given to relating views of Earth's history to the Genesis record. During the remainder of the course, evidence for the particulars of earth history, with emphasis on North America, is outlined. Topics include the origin of the Earth and its moon; the origin of continents and ocean basins; rock deformation caused by plate motion and the creation of mountain ranges through history; and sedimentary deposits of intracontinental seas. The laboratory

builds on rock classification and map techniques introduced in Geology 151. Prerequisite: Geology 151 or equivalent.

212 **Structural Geology** (4). * S, alternate years. An analysis of common geological structures such as folds, faults, joints, and foliations; inquiry into the means by which these structures are formed from stresses within the Earth; methods of constructing and interpreting geological maps and cross sections; and introduction to field-mapping techniques. Laboratory, field trip. Prerequisite: Geology 152 or concurrently.

215 **Mineralogy and Optical Mineralogy** (4). F, alternate years. A study of the principles of crystal structure in minerals with emphasis on the silicates. Modes of geologic occurrence of minerals are reviewed. Crystal morphology and mineral identification, including use of petrographic microscope, are emphasized in laboratory. Laboratory. Prerequisites: Geology 151 and Chemistry 103 or concurrently. Not offered 2007-2008.

251 **Oceanography** (4). * F, alternate years. This survey course includes: The history of marine exploration; the nature of the ocean floor, including submarine volcanoes, oceanic crust, sea-floor spreading, and marine sediments; coastal geomorphic processes; the properties of seawater; the nature of tides and currents; ecological marine biogeography, including marine plankton, deep-water biota, coral reef communities, and estuarine and intertidal marine communities; and stewardship of marine resources. Laboratory; field trips. Also listed as Geography 251. Prerequisite: High school chemistry and sophomore standing.

304 **Geochemistry** (3). * F, alternate years. This course studies the Earth's major geochemical systems with particular attention to water and rock systems. Topics include fresh and marine water, including groundwater, mineral crystallization and weathering, organic geochemistry, and the application of geochemistry to forensic pollution studies. Stable and radiogenic isotope systematics are reviewed and applied to geological problems and issues. Prerequisites: Geology 215 or 151 plus Chemistry 104 or permission of the instructor.

311 **Geomorphology** (4). * F. The investigation of landforms and the processes which cause them. This course studies the erosional and depositional features resulting from rivers, glaciers, and wind, as well as coastal, gravitational, and weathering processes. Landforms are described and classified from field observations, topographic maps, and aerial photographs. Explanations of the landforms are offered through quantitative modeling of the processes. Laboratory, field trips. Also listed as Geography 311. Prerequisites: Geography/Geology 120 or Geology 151.

312 **Environmental Geology** (4). * S, alternate years. Use of geologic methods and interpretations in understanding and resolving problems related to the environment. Emphasis is on hydrology (groundwater and surface water), coastal zone problems, soil erosion, landslides, and restoration of disturbed geologic regions. Laboratory. Prerequisite: Geology 311.

313 **Paleontology** (4). * S, alternate years. A study of organisms that once lived on Earth. Includes an examination of the processes of preservation and methods of discovering the structure, habitat, and relationships of those organisms, and a review of their distribution and life history. A broad spectrum of organisms is studied with emphasis on invertebrate animals. Laboratory, field trip. Also listed as Biology 313. Prerequisite: Geology 152 or Biology 242 and 243.

316 **Igneous and Metamorphic Petrology** (4). S, alternate years. An investigation of the generation, ascent, and emplacement of magma and the mineralogy, chemistry, field associations, tectonic setting, and genesis of igneous rocks, as well as investigation of the tectonic setting, field associations, classification, structure and texture, and genesis of metamorphic rocks. Laboratory stresses rock identification and genetic interpretation, particularly with the use of the petrographic microscope. Laboratory. Prerequisite: Geology 215. Not offered 2007-2008.

317 **Sedimentation and Stratigraphy** (4) F, alternate years. This includes the study of the classification and origins of sedimentary rocks with emphasis on the physical, chemical, and biological processes responsible for the origin, deposition, and diagenesis of sed-

iments, with particular attention to modern depositional analogs; an investigation of the use of thin-section petrography in the interpretation of the genesis of sedimentary rocks; and graphical techniques for depicting the geometries of layered sedimentary rocks in outcrop and subsurface. Laboratory; field trip. Prerequisite: Geology 215 or concurrently. Not offered 2007-2008.

322 **Coastal Geomorphology** (4) *S, alternate years. This course examines the nature and development of coastal landforms and the processes responsible for change in the coastal zone. Topics include waves, currents, tides, wind, changing sea levels, and the coastal environments of beaches, dunes, estuaries, and rocky coasts. Coastal land use and hazards, shoreline protection, and coastal stewardship will be discussed. Great Lakes coasts are emphasized. Laboratory and field trips. Prerequisite: Geography/Geology 311. Not offered 2007-2008.

359 **Seminar in Secondary Geology-Earth Science** (3). S. A course in perspectives on, principles of, and practices in the teaching of Geology-Earth Science on the secondary level. This course should be taken concurrently with Education 346. The seminar provides a forum for the discussion of concerns that develop during directed teaching. This course is part of the professional educational program and may not be included in the major or minor in Geology-Earth Science.

387 **Geology as Vocation** (1) F. This course examines geology as vocation as it applies to course participants. Topics cover how to discern God's call, how to identify and pursue future opportunities, and the practices and issues that geologists encounter as they enter their discipline. Lectures, class discussions, short reflection papers and guest participants. Prerequisite: Junior or senior standing in a major concentration in geology or permission of the instructor.

390 **Independent Study**. * F, I, and S. Prerequisite: Permission of the department.

395-396 **Research in Geology** (2-4). * F, I, and S. Field and/or laboratory research on an approved geological problem and presentation of the results of the research in seminar. Open to qualified students by permission of the geology faculty.

### Graduate Courses

520 **Advanced Earth Science**. This course includes consideration of the main ideas which serve as unifying principles in Earth science. Recent discoveries and current research projects are reviewed. The course highlights ideas resulting from studies in Earth sciences which have increased our understanding of the relationship between Earth and its human inhabitants. Topics include applications of geology to environmental problems, contribution of space research to understanding Earth, and the relationship between the results of geological study and teachings of the Bible. Special attention is given to topics and concepts, which can be incorporated into elementary, middle, and secondary school materials and activities. Prerequisite: Geology 120 or permission of the department.

590 **Independent Study**. * F, I, and S.

### May Interim Courses

W50 Big Sky Geology: Montana Field Experience (4) (field version of Geol-151). This course in geology is based in southwest Montana. Southwest Montana offers superb field exposures and is within driving distance of outstanding geological localities including Yellowstone National Park and Craters of the Moon National Monument. This course fulfills the Physical Science core requirement, and emphasizes outdoor, field-based investigation and learning. Students will be introduced to the breadth of geological study leading to responsible Christian appreciation and stewardship of the Earth, including rocks and minerals, landforms and surficial processes, geological hazards, and natural resources. Field activities are an important part of each day and the field experience will complement morning lecture and lab activities. As a graded course, exams will cover lecture and text, and students will be required to complete lab assignments, construct a written field log, and choose a special field project. Not open to students who have completed Geology/Geography 120, Geology 151 or Geology W11.