

GEOLOGY

College of Natural Sciences and Mathematics

Program Description

Geology is the study of the earth, its environments, and its history. It is an interdisciplinary science that combines geological observations and concepts with those of biology, chemistry, physics, and mathematics. Its goals are to study rocks, minerals, fossils, and energy and water resources, and to understand geologic principles and processes that shape the earth and its environments.

The Sacramento State Geology program has three objectives:

1. to encourage students to think scientifically,
2. to provide students with the knowledge base to make progress in geology after leaving Sacramento State, and
3. to teach students basic skills such as using a petrographic microscope and field equipment, how to construct a geologic map, and how to write a technical geologic report.

The BA degree program is designed as a shorter, more flexible preparation for some geology jobs, earth science teaching in high school (see Teaching Credential), and jobs such as park naturalist, environmentalist, geologic planning specialist, or in geology-related businesses. The BA degree can be used in dual-track majors combining geology with biological sciences, chemistry, physics, or engineering.

The BS degree program is designed to be the best possible preparation for advanced work in geology in graduate school or for professional employment as a geologist. The Geology program offers a strong background in the major areas of geology including: mineralogy, petrology, paleontology, stratigraphy, structural geology, field mapping, hydrogeology, and report writing.

Special Features

- Among the greatest attractions for studying geology at Sacramento State is the University's location in a dynamic geologic environment; just 70 miles to the west is the San Francisco Bay Area and the San Andreas fault. About equidistant to the east is the magnificent Sierra Nevada mountain range. The active geology faculty conducts field trips in almost every course in the Geology major, providing excellent opportunities for students to learn field skills and to apply classroom knowledge to field situations.
- A small student/teacher ratio, plus a rigorous course of study, contributes to the excellent reputation of the Sacramento State Geology Department with employers and graduate schools. Contact the Department office for assistance in obtaining a faculty advisor.
- The Geology Department operates the largest on-campus well field in the nation, with twenty engineered wells for teaching and student research. The well field is complemented by a comprehensive collection of state-of-the-art geophysical and hydrological field equipment.
- The Geology Department shares Placer Hall with the United States Geological Survey (USGS). Students benefit from this unique collaborative enterprise between a university and a federal agency because of the educational, research, and employment opportunities provided by the combined scientific and educational resources of the Geology Department and the USGS.

- Students interested in marine geology may take courses at Moss Landing Marine Laboratories at Moss Landing, CA, 180 miles from the Sacramento State campus. The labs and available courses are described under the Marine Sciences section of this catalog. A program including Moss Landing courses may be formulated with a Geology advisor. Such a program usually requires living in or near Moss Landing for one or more semesters.

Career Possibilities

Geologist · Geophysicist · Groundwater Geologist · Oil and Gas Geologist · Mineralogist · Paleontologist · Marine Geologist · Environmental Geologist · Photogeologist · Seismologist · Consulting Geologist · Soils Engineer · Land Use Planner · Volcanologist · Astrogeologist · Geochemist · Economic Geologist · Mining Geologist · Hydrologist · Government Geologist · Coal Geologist · Glacial Geologist · Vertebrate Paleontologist · Geology Professor · Earth Science Teacher

Contact Information

Tim Horner, Department Chair
 Stacy Sinz, Administrative Support Coordinator
 Placer Hall 2003
 (916) 278-6337
www.csus.edu/geology (<http://www.csus.edu/geology>)

Faculty

CORNWELL, KEVIN J.

EVANS, DAVID G.

HAMMERSLEY, LISA

HAUSBACK, BRIAN P.

HORNER, TIMOTHY

PAUKERT, AMELIA

SHIMABUKURO, DAVID

SKINNER, STEVEN

WAGNER, AMY

Undergraduate Programs

BA Degree in Geology

Units required for Major: 51-54
 Minimum total units required for BA: 120

Required Lower Division Courses (21-24 Units)

CHEM 1A	General Chemistry I	5
GEOL 5	Geology Of Mexico	4
or GEOL 10 & 10L	Physical Geology Physical Geology Lab	
GEOL 12	Historical Geology	3
GEOL 12L	Historical Geology Lab	1
MATH 26A	Calculus I for the Social and Life Sciences	4 - 7
or MATH 29 & MATH 30	Pre-Calculus Mathematics Calculus I	
PHYS 5A	General Physics: Mechanics, Heat, Sound	4

or PHYS 11A	General Physics: Mechanics	
Required Upper Division Courses (30 Units)		
GEOL 100	Mineralogy	4
GEOL 102	Igneous and Metamorphic Petrology	4
GEOL 103	Sedimentology/Stratigraphy	4
GEOL 110A	Structural Geology and Tectonics	4
GEOL 110B	Structural Geology Field	1
GEOL 111A	Field Geology	2
GEOL 111B	Field Techniques	2
Select at least 9 units of the following:		9
GEOL 105	Paleontology	
GEOL 112	Geophysics For Geologists	
GEOL 114	Volcanology	
GEOL 120	Surficial Processes	
GEOL 121	Geology of California	
GEOL 123	Geochemistry	
GEOL 125	Metallic Ore Deposits	
GEOL 127	Hydrogeology	
GEOL 150	Computer Mapping in Geology	
GEOL 171	Petroleum Geology	
GEOL 190A	Geology and Tectonic Development of California Seminar	
GEOL 193C	Engineering Geology	
GEOL 198A	Senior Research Preparation	
GEOL 198B	Senior Research Project	
Total Units		51-54

Note: Attendance at 16 colloquia, verified by faculty signature, is required.

BA Degree in Earth Science



Units required for Major: 62-68

Minimum total units required for BA: 120

Required Lower Division Courses (37-38 Units)

Select one of the following introductory Geology lecture-lab combinations:		4
GEOL 5	Geology Of Mexico	
GEOL 7 & GEOL 8L	Natural Disasters Earth Science Lab	
GEOL 8 & 8L	Earth Science Earth Science Lab	
GEOL 10 & 10L	Physical Geology Physical Geology Lab	
<i>Each of the remaining courses as follows:</i>		
ASTR 4B	Introduction to Stars, Galaxies, and Cosmology	3
ASTR 6	Astronomical Observation Laboratory	1
BIO 1 & BIO 2	Biodiversity, Evolution and Ecology Cells, Molecules and Genes	9-10
or BIO 7	Introduction to the Science of Biology	
CHEM 1A	General Chemistry I	5
or CHEM 6A	Introduction to General Chemistry	
GEOL 12	Historical Geology	3
GEOL 12L	Historical Geology Lab	1
MATH 26A	Calculus I for the Social and Life Sciences	3

PHYS 5A & PHYS 5B	General Physics: Mechanics, Heat, Sound General Physics: Light, Electricity and Magnetism, Modern Physics	8
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Required Upper Division Courses (26 Units)		
GEOG 111	Elements Of Meteorology	3
GEOL 103	Sedimentology/Stratigraphy	4
GEOL 111A	Field Geology	2
GEOL 111B	Field Techniques	2
GEOL 130	Oceanography	3
Select 6 units from the following:		6
GEOL 105	Paleontology	
GEOL 110A	Structural Geology and Tectonics	
GEOL 114	Volcanology	
GEOL 120	Surficial Processes	
GEOL 121	Geology of California	
GEOL 140	Geology and the Environment 	
GEOL 184	Geological Field Trip	
Select 6 units not taken previously from the following:		6
ANTH 124	Environmental Archaeology	
ANTH 151	Human Paleontology	
ENGL 120P	Professional Writing 	
GEOG 113	Climate ¹	
GEOG 116	Global Climate Change	
GEOG 117	Landforms	
GEOG 161	California's Water Resources	
JOUR 131	Column and Review Writing	
PHIL 125	Philosophy Of Science	
RPTA 153	Environmental Interpretation and Outdoor Education	
Select 3-5 other upper-division geology courses with permission of instructor		
Total Units		63-64

¹ Indicates courses recommended for students wishing to prepare for CSET Exam for teaching high school science.

BS Degree in Geology

Units required for Major: 64

Minimum total units required for BS: 120

Note: Additional units may be required to meet the Sacramento State foreign language requirement.

Required Lower Division Courses (25 Units)

CHEM 1A	General Chemistry I	5
GEOL 5	Geology Of Mexico	4
or GEOL 10 & 10L	Physical Geology Physical Geology Lab	
GEOL 12	Historical Geology	3
GEOL 12L	Historical Geology Lab	1
MATH 30	Calculus I	4
PHYS 5A	General Physics: Mechanics, Heat, Sound	4
or PHYS 11A	General Physics: Mechanics	
PHYS 5B	General Physics: Light, Electricity and Magnetism, Modern Physics	4

or PHYS 11B	General Physics: Heat, Light, Sound, Modern Physics	
Required Upper Division Courses (39 Units)		
GEOL 100	Mineralogy	4
GEOL 102	Igneous and Metamorphic Petrology	4
GEOL 103	Sedimentology/Stratigraphy	4
GEOL 110A	Structural Geology and Tectonics	4
GEOL 110B	Structural Geology Field	1
GEOL 111A	Field Geology	2
GEOL 111B	Field Techniques	2
GEOL 188	Advanced Geologic Mapping	6
Select at least 12 units from the following:		12
GEOL 105	Paleontology	
GEOL 112	Geophysics For Geologists	
GEOL 114	Volcanology	
GEOL 120	Surficial Processes	
GEOL 123	Geochemistry	
GEOL 125	Metallic Ore Deposits	
GEOL 127	Hydrogeology	
GEOL 150	Computer Mapping in Geology	
GEOL 171	Petroleum Geology	
GEOL 190A	Geology and Tectonic Development of California Seminar	
GEOL 193C	Engineering Geology	
GEOL 198A	Senior Research Preparation	
GEOL 198B	Senior Research Project	
Total Units		64

Note: Attendance at 16 colloquia, verified by faculty signature, is required.

Minor - Geology

Total units required for Minor: 18

GEOL 10	Physical Geology	3
GEOL 10L	Physical Geology Lab	1
GEOL 12	Historical Geology	3
GEOL 12L	Historical Geology Lab	1
Select 10 units of upper division courses in Geology electives		10
Total Units		18

Students wishing a Geology minor must contact a Geology advisor before beginning upper division work in Geology.

Subject Matter Program (Pre-Credential Preparation)

Geology majors who intend to pursue a teaching credential must complete the science subject matter program which is described in this catalog. Successful completion of this program fulfills the subject matter competence requirement and qualifies students to enter the teaching credential program in the College of Education. The Science Teaching Credential allows graduates to teach all four of the sciences (Geoscience, Biology, Chemistry, and Physics) at the General Science level in 7-12 grades, and Geoscience at an advanced level in high school.

Currently there is a great need for K-12 teachers educated in science. Changes in State Board of Education Standards and increasing interest

in earth and space sciences has created significant demand for students with this credential. Geology majors who have an interest in teaching should contact the credential advisors in the Geology Department (Dave Evans or Judi Kusnick).

Graduate Program

The graduate program in Geology offers coursework, fieldwork experience, and research that will lead to a Master of Science degree in Geology. It allows students who successfully complete the program to upgrade their educational qualifications and advance to doctoral programs or professional positions that require an in-depth knowledge of hydrogeology, environmental geology, and geologic hazards. The University's location in the state capital provides direct access to many local, federal, and state agencies through internship and fieldwork opportunities.

Each student should plan a program according to his/her background, interests and objectives, in consultation with a faculty advisor. Students are required to consult with an advisor prior to admission to the program or initiation of graduate study. For information on how to select an advisor, students should contact the Geology Department Office. Graduate students who want to engage in teaching as professionals can apply for an appointment as a Graduate Teaching Associate. Graduate Teaching Associates have the opportunity to teach one to three lower division laboratory courses per semester and are paid at a rate commensurate with their teaching load.

All work toward the degree must be completed within a seven-year period. The general University requirements for graduate degrees are explained in the "Graduate Studies" section of this Catalog or visit the Web site <http://www.csus.edu/geology> (<http://www.csus.edu/geology>).

Admission Requirements

Admission as a classified graduate student in Geology requires:

- a degree in Geology, or 24 units of equivalent upper-division coursework in Geology which must have been passed with a grade of "C-" or better and includes:

GEOL 10	Physical Geology	3
GEOL 10L	Physical Geology Lab	1
GEOL 100	Mineralogy	4
GEOL 102	Igneous and Metamorphic Petrology	4
GEOL 103	Sedimentology/Stratigraphy	4
GEOL 110A	Structural Geology and Tectonics	4
GEOL 111A	Field Geology	2
GEOL 111B	Field Techniques	2
Total Units		24

These core undergraduate courses cannot be used as graduate electives by students who do not hold a degree in Geology or equivalent;

- a minimum 2.75 GPA in all Geology, Chemistry, Math and Physics courses, and a minimum 3.0 GPA in upper division Geology courses;
- three letters of recommendation from persons familiar with your academic record and professional capabilities, sent directly to the Department;
- a brief statement of interest, faculty sponsorship, area of specialty and long-term goals;
- two semesters of inorganic Chemistry with a lab (CHEM 1A and CHEM 1B);

- two semesters of Physics with a lab (PHYS 11A and PHYS 11B or PHYS 5A and PHYS 5B); and
- two semesters of Math (MATH 30 and MATH 31).

Students who have deficiencies in Admission Requirements that can be removed by specified additional preparation may be admitted with conditionally classified graduate status. Any deficiencies will be noted on a written response to the admission application. You must be admitted to the degree program before graduate level courses will count toward the degree.

Admission Procedures

All prospective classified graduate students, including Sacramento State graduates, must file the following with the Office of Graduate Studies:

- an online application for admission;
- an application for admission to the Geology Graduate Program; and
- two sets of official transcripts from all colleges and universities attended, *other than Sacramento State*.

For more admissions information and application deadlines please visit <http://www.csus.edu/gradstudies/>.

Applications are accepted as long as space for new students exists. A decision regarding admission will be mailed to the applicant upon receipt of all items listed above.

Advancement to Candidacy

Each student must file an application for Advancement to Candidacy, indicating a proposed program of graduate study. This procedure should begin as soon as the classified graduate student has:

- removed any deficiencies in admission requirements;
- completed at least 12 units in the graduate program with a minimum 3.0 GPA, including at least two courses at the 200-level;
- obtained the graduate committee's acceptance of the thesis proposal; and
- taken the Writing Placement for Graduate Students (WPG) or taken a Graduate Writing Intensive (GWI) course in their discipline within the first two semesters of coursework at California State University, Sacramento or secured approval for a WPG waiver.

Advancement to Candidacy forms are available in the Office of Graduate Studies, River Front Center 215, (916) 278-6470. The student must fill out the form after planning a degree program in consultation with his/her faculty advisor. After approval by the Geology Department Graduate Committee, the completed form is returned to the Office of Graduate Studies for approval.

MS Degree in Geology

Units required for MS: 30

Minimum required GPA: 3.0

Required Core Courses (9 Units)

GEOL 200	Graduate Research Methods Seminar	3
GEOL 275	Quantitative and Numerical Research Methods	3
GEOL 290	Regional Geology of the Western US	3

Graduate electives (15-21 Units)

Select 15-21 units of the following: ¹	15
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	21

GEOL 202	Aqueous Geochemistry
GEOL 204	Contaminant Hydrogeology
GEOL 208	Groundwater Modeling
GEOL 212	Geologic Remote Imaging
GEOL 213	Advanced Structural Geology and Tectonics
GEOL 218	Applied Geophysics
GEOL 220	Surficial Processes
GEOL 227	Advanced Hydrogeology
GEOL 230	Seminar In Geology
GEOL 240	Special Topics
GEOL 293	Engineering Geology
GEOL 299	Special Problems in Geology

Culminating Requirements (0-6 Units)

Select one of the following plans: 0 - 6

Plan A

GEOL 500	Master's Thesis
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Plan B

GEOL 596	Comprehensive Examination
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Total Units 30-36

¹ Courses taken to meet the graduate core requirement will not count as elective courses. Elective courses (including GEOL 299) will be selected with prior approval of the student's faculty advisor in the area of interest. In addition to 200-level courses, these may also include up to 6 units of approved technical electives (but not the required courses) from the undergraduate curriculum. Not more than 3 units of GEOL 299 may be taken without prior approval of the Graduate Coordinator.

GEOL 5. Geology Of Mexico. 4 Units

General Education Area/Graduation Requirement: Physical Science (B1), Laboratory (B3)

Introduction to Geology through examination of aspects of the geology of Mexico. Emphasizes problem-based approach to learning Geology and the process of scientific investigation. Topics include a wide range of geological concepts including plate tectonic setting of Mexico, living with volcanoes: the Mexican volcanic belt, the Mexico City earthquake, issues of water supply, flooding and atmospheric pollution in Mexico City, the Chicxulub crater and geologic time, ore deposits of Mexico. Lecture three hours; laboratory three hours.

GEOL 5A. Geology of Mexico Field Trip. 2 Units

Prerequisite(s): GEOL 5

Focuses on fundamental geologic concepts as seen from real world examples in Mexico that will be visited during several strategic field stops. Field stops will emphasize a problem-based approach to learning geology and the process of scientific investigation. Topics include a wide range of geological concepts including plate tectonic setting of Mexico, living with volcanoes, the Mexico City earthquake, issues of water supply, flooding, climate change and atmospheric pollution in Mexico City, the Chicxulub meteor impact crater, geologic time, ore deposits of Mexico, and natural hazards. Field trip ten days.

Field trip(s) may be required.

- GEOL 7. Natural Disasters. 3 Units**
General Education Area/Graduation Requirement: Physical Science (B1)
 Examination of earth materials and earth processes through the study of natural disasters. Topics include earthquakes, volcanoes, landslides, floods, tsunamis, hurricanes, tornadoes and meteorite impacts. Examination of causes, effects and mitigation of natural disasters.
- GEOL 8. Earth Science. 3 Units**
General Education Area/Graduation Requirement: Physical Science (B1)
 Earth and its neighbors in space. Scientific method and discovery in the study of stars, planets, weather, rivers, glaciers, oceans, rocks, volcanoes, earthquakes, landslides, mountains, drifting continents, the earth in time.
Note: Students contemplating a geology major or minor in geology should enroll in GEOL 10, not in GEOL 8. No credit for those who have taken GEOL 10 or equivalent.
- GEOL 8L. Earth Science Lab. 1 Unit**
Prerequisite(s): GEOL 8; may be taken concurrently.
General Education Area/Graduation Requirement: Physical Science (B1), Laboratory (B3)
 Emphasizes scientific methods and systematic laboratory procedures. Includes weather analysis, rock and mineral identification, study of geologic concepts by means of topographic maps, and exercises in astronomy and oceanography. Laboratory three hours.
- GEOL 8T. Earth Science Lab for Teachers. 1 Unit**
Prerequisite(s): GEOL 8; may be taken concurrently.
 Exploration of the solid Earth, its atmosphere and oceans, and the Earth's place in the solar system. Emphasizes learning Earth science through investigation, and uses Earth science to understand the processes of science. Laboratory three hours.
- GEOL 10. Physical Geology. 3 Units**
General Education Area/Graduation Requirement: Physical Science (B1)
 Rocks and their mineral constituents, geological processes such as weathering, erosion, glaciation, mountain building, etc., volcanoes, earthquakes, folds, faults, the earth's interior, plate tectonics and earth resources. Field trip. Fee course.
 Fee course.
 Field trip(s) may be required.
- GEOL 10L. Physical Geology Lab. 1 Unit**
Prerequisite(s): GEOL 10; may be taken concurrently.
General Education Area/Graduation Requirement: Physical Science (B1), Laboratory (B3)
 Laboratory supplement to GEOL 10. Emphasizes scientific method and systematic laboratory procedures. Identification of common minerals and rocks. Introduction to and analysis of topographic and geologic maps. Field trip. Laboratory three hours. Fee course.
 Fee course.
 Field trip(s) may be required.
- GEOL 12. Historical Geology. 3 Units**
Prerequisite(s): GEOL 5 or GEOL 10 and GEOL 10L.
General Education Area/Graduation Requirement: Further Studies in Area B (B5)
 Origin and geological history of the earth and the evolution of its animal and plant inhabitants. Fee course.
Note: Lecture 3 hours.
 Fee course.
- GEOL 12L. Historical Geology Lab. 1 Unit**
Prerequisite(s): GEOL 12; and GEOL 5 or GEOL 10 and GEOL 10L. GEOL 12 may be taken concurrently.
 Supplements GEOL 12. Use of sedimentary rocks, fossils, geologic maps, and structural sections in interpreting ancient environments, tectonic settings, and geologic history. Age relations and correlation of rock and time-rock units. Introduction to fossil identification and biostratigraphy. Laboratory three hours.
- GEOL 100. Mineralogy. 4 Units**
Prerequisite(s): CHEM 1A; and either GEOL 5 or GEOL 10 and GEOL 10L.
 Introduction to mineral identification by physical and optical properties. Techniques and theory of optical mineral analysis, crystallography and mineral formation. Lecture three hours; laboratory three hours.
- GEOL 102. Igneous and Metamorphic Petrology. 4 Units**
Prerequisite(s): GEOL 100 and GEOL 103
 Study of the origin, evolution, occurrence, geochemistry, dynamics and physical characteristics of igneous and metamorphic systems. The laboratory will focus on both hand-specimen and petrographic-microscope studies. Lecture three hours, laboratory three hours. Fee course.
 Fee course.
- GEOL 103. Sedimentology/Stratigraphy. 4 Units**
Prerequisite(s): GEOL 12, GEOL 12L, and GEOL 100
 Compositions, textures, classification, origins and structures of sediments and sedimentary rocks. Hand specimen observation and interpretation. Facies models, classification and correlation of stratigraphic units, subsurface techniques. Lab emphasizes hand specimen and microscope identification and subsurface techniques. Field trip. Lecture three hours; laboratory three hours. Fee course.
 Fee course.
 Field trip(s) may be required.
- GEOL 105. Paleontology. 4 Units**
Prerequisite(s): GEOL 5 or GEOL 10 and GEOL 10L, GEOL 12 and GEOL 12L.
 Biology, evolution, classification and paleoecology of important groups of fossil organisms. Uses of fossils in solving geologic problems.
Note: Lecture = 3 units; Lab = 1 unit. Fee Course. Field Trip.
 Fee course.
 Field trip(s) may be required.
- GEOL 110A. Structural Geology and Tectonics. 4 Units**
Prerequisite(s): GEOL 111A and GEOL 111B, PHYS 5A or PHYS 11A, MATH 26A or MATH 30.
 Description, analysis and interpretation of geologic structures and tectonic settings. Theory of stress and strain as it pertains to the origin of folds, faults, joints, cleavage, and other structural elements. Laboratory includes techniques of structural analysis such as orthographic projections, stereonet, structure contours, Mohr diagrams, interpretation of maps and cross sections. Lecture three hours, laboratory three hours.
 Fee Course.
 Fee course.

- GEOL 110B. Structural Geology Field.** **1 Unit**
Prerequisite(s): GEOL 103, GEOL 111A, GEOL 111B, and GEOL 110A. It is recommended that GEOL 110A be taken concurrently.
 Field description, mapping and interpretation of geologic structures. Includes techniques of taking detailed field notes, field photography measurement of structures using a pocket transit, geologic map and cross section construction, stereonet analysis, and report writing. Consists of off-campus fieldwork. Fee course.
 Fee course.
- GEOL 111A. Field Geology.** **2 Units**
Prerequisite(s): GEOL 12L and GEOL 100
Corequisite(s): GEOL 111B
 Science and art of recognizing, describing and interpreting geologic features in the field. Lecture and laboratory course on the preparation and use of topographic and geologic maps, stratigraphic and cross sections, compass and GPS instrument. Lecture one hour; laboratory three hours.
 Fee course.
 Fee course.
- GEOL 111B. Field Techniques.** **2 Units**
Prerequisite(s): GEOL 100 and GEOL 103. GEOL 103 may be taken concurrently.
Corequisite(s): GEOL 111A
 Introduction to geologic field methods including descriptions of rocks, geologic mapping, observation, interpretation and geologic report writing. Detailed mapping techniques will also be covered; these may include the use of plane table, total station theodolite and global position systems. Consists of off-campus fieldwork. Fee course.
 Fee course.
- GEOL 112. Geophysics For Geologists.** **3 Units**
Prerequisite(s): GEOL 5 or GEOL 10 and GEOL 10L, PHYS 5A, PHYS 5B which may be taken concurrently.
 Introduction to the principal geophysical concepts and techniques useful to geologists in the study of tectonics, the Earth's interior and resource exploration. Includes the study of seismology, heat flow, gravity, borehole geophysics, electromagnetism and geodynamics. Fee Course/Field Trip.
 Fee course.
 Field trip(s) may be required.
- GEOL 114. Volcanology.** **3 Units**
Prerequisite(s): GEOL 5 or GEOL 10.
 Seminar and lecture in physical volcanic processes, interpretation of volcanic deposits, historic eruptions and hazard assessment. Fee course.
 Fee course.
- GEOL 120. Surficial Processes.** **4 Units**
Prerequisite(s): GEOL 5 or GEOL 10 and GEOL 10L; GEOL 12, GEOL 12L.
 Focused study on the basic forces that drive surficial processes such as wind water and gravity and the role of weathering, sediment transport and deposition on landform and landscape development. A laboratory component will enhance student understanding by solving applied problems as well as develop proficiencies with various geologic tools.
Note: 150 minutes Lecture = 3 units, 150 minutes Lab = 1 unit. Fee Course.
 Fee course.
- GEOL 121. Geology of California.** **3 Units**
Prerequisite(s): GEOL 5 or GEOL 10.
 Regional study of California and certain surrounding areas with regard to geologic development, plate tectonics, economic resources and geologic hazards. Lecture and field trip(s). Fee course.
 Fee course.
 Field trip(s) may be required.
- GEOL 123. Geochemistry.** **3 Units**
Prerequisite(s): GEOL 5 or GEOL 10 and GEOL 10L, CHEM 1A.
 Fundamentals of the geochemistry of Earth materials. Thermodynamics and kinetics of geological environments, silicates and carbonates, major element geochemistry, trace and rare earth element geochemistry, stable and radiogenic isotopes. Applications to studies of aqueous, pedogenic, igneous, sedimentary, and metamorphic environments. Analysis of geochemical aspects of contemporary resource, environmental, and paleoenvironmental problems.
- GEOL 125. Metallic Ore Deposits.** **3 Units**
Prerequisite(s): GEOL 100, CHEM 1A.
 Origin, geology, and distribution of metallic ore deposits. Introduction to ore minerals. Exploration methods. Field trip. Fee course.
 Fee course.
 Field trip(s) may be required.
- GEOL 127. Hydrogeology.** **3 Units**
Prerequisite(s): CHEM 1A, GEOL 10, GEOL 10L, PHYS 5A, and MATH 26A or MATH 30, or instructor permission.
 Presents fundamentals of groundwater flow, as influenced by topography and geology; geological aspects of groundwater supply, contamination, remediation, and protection of hydrogeological regions of the U.S. and their critical groundwater issues. Lecture three hours.
- GEOL 130. Oceanography.** **3 Units**
General Education Area/Graduation Requirement: Further Studies in Area B (B5)
 Survey of geological, physical, chemical and biological oceanography including the sea floor; waves, tides, currents; the physical and chemical properties of seawater and their distribution in the sea; planktonic life and its relation to nutrients.
- GEOL 140. Geology and the Environment.** **3 Units**
Prerequisite(s): GEAR certification before Fall 09; or WPJ score of 80+; or 3-unit placement in ENGL 109M or ENGL 109W; or 4-unit placement in ENGL 109M or ENGL 109W and co-enrollment in ENGL 109X; or WPJ score 70 or 71 and co-enrollment in ENGL 109X.
General Education Area/Graduation Requirement: Writing Intensive Graduation Requirement (WI), GE AREA D
 Applies geologic data and principles to situations affecting our environment. The geologic study of earthquakes, volcanoes, floods, landslides, groundwater and similar topics supplies the background data for lectures on land use and other social choices. Topics such as geopolitics and mineral supply provide a basis for understanding international politics, social costs, and world economics. Fee course.
 Fee course.

- GEOL 150. Computer Mapping in Geology. 3 Units**
Prerequisite(s): GEOG 109 or instructor permission
 This course is designed to enhance the mapping skills of geology majors by providing them an opportunity to learn modern computer aided mapping techniques - methods and tools widely used across industry, government, and academe. The course is designed to teach students how to effectively use various tools and mapping software by applying their developing skills in solving a variety of geological problems. This course strategy will help develop both student technical map making and innovative problem solving skills.
- GEOL 171. Petroleum Geology. 3 Units**
Prerequisite(s): PHYS 5A & GEOL 103. GEOL 103 may be taken concurrently.
 Introduction to the origin, migration, and accumulation of hydrocarbons in the context of stratigraphic and structural systems. Exploration and production of both conventional and unconventional resources. Lecture three hours. Field trip. Fee Course.
 Fee course.
 Field trip(s) may be required.
- GEOL 177. Hawaii Volcanic Field Trip. 2 Units**
Prerequisite(s): Geology 10 or another physical geology course approved by instructor; Field Trip, 2 units.
 An investigation and visit to the many interesting volcanic features and eruption activities of Hawaiian volcanism. Topics include tectonics, physical volcanology, and volcanic monitoring techniques.
 Credit/No Credit
- GEOL 184. Geological Field Trip. 2 Units**
 10-day field trip to a region of outstanding geology. Attendance at preliminary meetings is required. Analyzes and interpretation of geologic features is emphasized. Fee course.
Note: Student should consult the Geology Department during the semester before planning to take the course. May be taken more than once for credit.
 Credit/No Credit
 Fee course.
 Field trip(s) may be required.
- GEOL 188. Advanced Geologic Mapping. 6 Units**
Prerequisite(s): GEOL 102, GEOL 103, GEOL 110A, GEOL 110B, GEOL 111A, GEOL 111B and instructor permission.
 Advanced principles/methods of geologic mapping, interpretation and geologic report writing for selected field areas in the western United States. Mapping techniques include the use of aerial photographs and global position systems. Consists of on-campus field preparation and off-campus fieldwork. Fee course.
 Fee course.
- GEOL 190A. Geology and Tectonic Development of California Seminar. 3 Units**
Prerequisite(s): GEOL 5 or GEOL 10, GEOL 12; GEOL 110A recommended.
 Seminar in the geologic and tectonic development of California.
- GEOL 193C. Engineering Geology. 3 Units**
Prerequisite(s): GEOL 5 or GEOL 10 and GEOL 10L, GEOL 12, PHYS 5A or PHYS 11A, MATH 29 or high school trigonometry.
 Investigates the engineering properties of earth materials, the engineering considerations required to build safe and durable structures on and within the Earth, and problems associated with structures designed and built neglecting physical environmental conditions. Designed to introduce engineering concepts to students who have a competent grasp of general geologic principles and processes. Lecture 3 hours.
- GEOL 195. Geology Internship. 1 - 3 Units**
 Supervised unpaid work experience in government or industry. Supervision is provided by the faculty instructor and responsible officials in the work situations.
Note: Open to all upper division Geology majors with instructor permission. Number of units earned depends on number of hours worked.
 Credit/No Credit
- GEOL 197. Advanced Laboratory Techniques for Geology. 1 - 3 Units**
Prerequisite(s): Appropriate upper division courses and instructor permission.
 Supervised individual instruction on techniques applied in geology laboratories for advanced research in mineralogy, petrology, geochemistry, geophysics, and paleontology.
 Credit/No Credit
- GEOL 198A. Senior Research Preparation. 1 Unit**
Prerequisite(s): Senior status and appropriate courses as determined by a Departmental faculty committee. The proposed project must be approved by a Department committee; instructor permission.
 Selection and design of an independent research project. A final written report is required and includes: research proposal, bibliography, and results of preliminary review of the literature. Student must choose a supervising instructor.
- GEOL 198B. Senior Research Project. 2 Units**
Prerequisite(s): Senior status and appropriate courses as determined by a Departmental faculty committee. The proposed project must be approved by the Department committee; instructor permission.
 Completion of an independent research project. A final written report is required. Progress reports may be required by the supervision instructor. Presentation of an oral report on the research project during the same semester is required.
- GEOL 199A. Beginning Special Problems. 1 - 3 Units**
 Individual projects or special studies at a beginning level, including fieldwork, lab work, library study, or other learning activities.
Note: Open only to students judged competent to carry on individual work. Credit/noncredit grading also available.
- GEOL 199B. Intermediate Special Problems. 1 - 3 Units**
 Individual projects or special studies at an intermediate level, including fieldwork, lab work, library study, or other learning activities.
Note: Open only to students judged competent to carry on individual work. Credit/noncredit grading also available.
- GEOL 199C. Advanced Special Problems. 1 - 3 Units**
 Individual projects or special studies at an advanced level, including fieldwork, lab work, library study, or other learning activities.
Note: Open only to students judged competent to carry on individual work. Credit/noncredit grading also available.

- GEOL 200. Graduate Research Methods Seminar. 3 Units**
Developing a research proposal, library and internet searches, seeking external funding, presentation graphics, and publication formats. Students will develop a research project in preparation for thesis requirement. Seminar three hours.
Note: Graduate Writing Intensive (GWI).
- GEOL 202. Aqueous Geochemistry. 3 Units**
Prerequisite(s): CHEM 1B; instructor permission.
Low temperature geochemical reactions in aqueous environments. Chemical kinetics, thermodynamics, mixing and dilution, mineral stability, chemical composition of surface water, stable isotopes. Three hours lecture.
- GEOL 204. Contaminant Hydrogeology. 3 Units**
Prerequisite(s): CHEM 1B and CHEM 6B or CHEM 20, GEOL 202.
Contaminants and contaminant transport in near-surface environments. Fluid-sediment interaction, fluid partitioning, common geochemical reactions, stability and mobility of groundwater contaminants, multi-phase systems, sampling considerations and overview of analytical techniques.
- GEOL 208. Groundwater Modeling. 3 Units**
Prerequisite(s): GEOL 127, MATH 45.
Computer modeling of groundwater systems using 2 and 3 dimensional numerical solutions and common software packages. Topics will include data acquisition, constructing a numerical model, model calibration, flow paths, particle tracking and model output.
- GEOL 212. Geologic Remote Imaging. 4 Units**
Prerequisite(s): PHYS 5B or PHYS 11B or equivalent; GEOL 102, GEOL 110A or equivalent; and proficiency using a personal computer.
Use of remote imaging in geologic applications. Types of imagery, acquisition, production, processing, and interpretation are covered. Lecture three hours; laboratory three hours.
- GEOL 213. Advanced Structural Geology and Tectonics. 3 Units**
Prerequisite(s): GEOL 110A and MATH 30
An advanced treatment of deformation of the lithosphere of the earth over short and long timescales. Construction of 2D and 3D models of the crust. Use of software packages to solve problems in tectonics and related disciplines.
- GEOL 214. Advanced Volcanology. 3 Units**
Analyzes volcanic eruption processes. Interpretation of volcanic deposits in the evaluation of volcanic hazards, risk, eruption processes, and geologic history. Field trip.
Field trip(s) may be required.
- GEOL 218. Applied Geophysics. 3 Units**
Prerequisite(s): PHYS 5B or PHYS 11C and GEOL 112.
Advanced field techniques used for geophysical exploration. Data collection and problem solving using resistivity, conductivity, seismic reflection, seismic refraction, gravity, magnetics and borehole geophysical techniques. Lecture two hours, laboratory three hours.
- GEOL 220. Surficial Processes. 3 Units**
Prerequisite(s): GEOL 120 or equivalent.
Dynamics of geological processes and the landscapes they carve. System thresholds, linked processes, data generation and evaluation that characterize landscape development.
- GEOL 223. Geochemistry. 4 Units**
Prerequisite(s): CHEM 1A, MATH 30, GEOL 100, or instructor permission.
Fundamentals of the geochemistry of Earth materials. Thermodynamics and kinetics of geological environments, silicates and carbonates, major element geochemistry, trace and rare earth element geochemistry, stable and radiogenic isotopes. Applications to studies of aqueous, pedogenic, igneous, sedimentary, and metamorphic environments. Analysis of geochemical aspects of contemporary resource, environmental, and paleoenvironmental problems.
Note: Lecture 3 hours = 3 units; laboratory 170 minutes = 1 unit.
- GEOL 227. Advanced Hydrogeology. 3 Units**
Prerequisite(s): GEOL 127, graduate level status in Geology.
Water budgets, theories of groundwater flow to wells, hydrogeologic regimes, fracture flow, dewatering, salt water intrusion, dating and chemical identification of water. Lecture 3 hours.
- GEOL 230. Seminar In Geology. 3 Units**
Reading, analysis and discussion of the geologic literature on selected topics in geology. Student presentations and reports are required.
Note: May be taken twice for credit.
- GEOL 240. Special Topics. 1 - 3 Units**
Prerequisite(s): Will vary with each special topic course.
Advanced special topics in Geology that may include structural geology, volcanology, hydrogeology, engineering geology or other specialized topics selected to meet student demand or respond to industry trends in geology.
- GEOL 275. Quantitative and Numerical Research Methods. 3 Units**
Prerequisite(s): MATH 31
Introduction to quantitative and numerical methods of solving geologic problems using high level programming.
- GEOL 290. Regional Geology of the Western US. 3 Units**
Prerequisite(s): GEOL 100, GEOL 102, GEOL 103 and GEOL 110A.
Application of advanced geological concepts in tectonics, stratigraphy, sedimentology, petrology, and volcanism to the geologic evolution of the Western United States from Precambrian to present. Field trip. Course Fee.
Field trip(s) may be required.
- GEOL 293. Engineering Geology. 3 Units**
Prerequisite(s): GEOL 193C.
Takes a geological approach to evaluating engineering issues associated with building with or on natural earthen materials. Rock and soil mechanics, slope stability, geophysical investigation of rock and soil properties.
Note: 150 minutes Lecture = 3 units.
- GEOL 299. Special Problems in Geology. 1 - 4 Units**
Prerequisite(s): Graduate-level status in geology, approval of project by a faculty sponsor and Department Chair; instructor permission.
Graduate research. Independent research in geology that may include library research, short-term original research, technique development, fieldwork, or laboratory research. May include research toward thesis proposal. Culminating experience will be in the form of a written report, oral presentation, or scientific paper.
- GEOL 500. Master's Thesis. 6 Units**
Prerequisite(s): Advanced to candidacy and chair permission of his/her thesis committee.
Completion of a thesis approved for the Master's degree. Should be taken in the final semester prior to the completion of all requirements for the degree.

GEOL 596. Comprehensive Examination. 0 Units

A written comprehensive examination administered by a committee of three faculty members. Assesses the student's ability to integrate knowledge from core and elective courses, show critical and independent thinking, and demonstrate mastery of the subject matter. Required for the non-thesis option. Graded: CR/NC. May be retaken one time after 4 calendar months. Units: 0.
Credit/No Credit