Program

BS in Environmental Science
Options in:
- Applied Ecology
- Environmental Chemistry
- Earth Resource Science
- Watershed Science

BS in Geology

BS in Geosciences
Options in:
- Hydrology
- Science Education

Minor in Geosciences

Single Subject Teaching
- Credential in Science

MS in Environmental Science

MS in Geosciences
- MS Option in Hydrology/Hydrogeology

Disciplines within the geological and environmental sciences are directed toward understanding the terrestrial system from the core of the earth to beyond our solar system and conducting applied and basic research in an effort to understand physical processes on and within the earth and human influences that affect the environment.

Environmental science is the study of interactions within the earth’s biosphere, concentrating on natural and man-made perturbations such as pollution. Geology is the study of processes occurring in or on the earth.

The BS in Environmental Science prepares students for careers in areas such as pollution remediation, resource conservation, or environmental management, as well as providing a firm foundation for graduate studies. The B.S. in Geology prepares students for careers or graduate education in fields such as resource exploration, hydrology, or environmental geology.

Students who pursue a BS in Geosciences must choose an option. All options have fifteen core units in common. The science education option prepares students who are considering teaching science in secondary school. The option in hydrology provides a strong background in water processes, and is recommended for students interested in careers or graduate education in watershed management or restoration, or water contamination.

The MS in Geosciences or Environmental Science provides a framework for advanced study and research. A thesis is required, and students in the program may pursue any topic approved by a thesis committee. Some support for graduate students is available in the form of teaching or research assistantships.

Faculty and Facilities

In keeping with the interdisciplinary nature of the department, the faculty represent diverse academic areas, complemented by industrial experience. All have a strong commitment to excellence in teaching and engage in professional development.

Department equipment and facilities are extensive and include equipment for field and laboratory work in environmental science, geology, and hydrology/hydrogeology.

Academic Activities

Lecture courses are accompanied by laboratories and field trips. Internships and work experience are also available to supplement course work.

The Chico Geoscience Students (CGS) is an active organization open to all students. CGS typically hosts several field trips off campus each semester. Many majors are also members of national organizations such as the American Geophysical Union, American Meteorological Society, and the Geological Society of America.

Career Outlook

Employment opportunities are very good. Our graduates work for agencies such as the California Department of Water Resources, the United States Geological Survey, the Environmental Protection Agency, and many state agencies. Graduates are also employed by private companies specializing in such things as mineral and petroleum exploration, engineering or environmental consulting, and pollution remediation.

Graduates with a bachelor’s degree find entry-level positions which require a working knowledge of the geological and environmental sciences and involve gathering and interpreting scientific data. Management and field-oriented research positions generally require a master’s degree. Students interested in research or a position at a community college or university are advised to plan on working toward a graduate degree. The career outlook for science teachers is excellent. Geosciences majors may enter the single subject credential teaching program upon completion of their degree.

Department majors interested in maximizing their potential for graduate school or employment should discuss with their advisers suitable minors.
**THE BACHELOR OF SCIENCE IN GEO SCIENCES**

**Total Course Requirements for the Bachelor’s Degree: 120 units**

See “Requirements for the Bachelor’s Degree” in The University Catalog for complete details on general degree requirements. A minimum of 40 units, including those required for the major, must be upper division.

The department has prepared a suggested four year Advising Plan to help students meet all graduation requirements within four years. Please request a plan from your major adviser or view it and other current advising information on the CSU, Chico Web.

**General Education Requirements: 48 units**

See “General Education Requirements” in The University Catalog and The Class Schedule for the most current information on General Education Requirements and course offerings. The course requirements marked below with an asterisk (*) may also be applied toward General Education.

**Cultural Diversity Course Requirements: 6 units**

See “Cultural Diversity” in The University Catalog. Most courses used to satisfy these requirements may also apply to General Education.

**American Institutions Requirement: 6 units**

See the “American Institutions Requirement” under “Bachelor’s Degree Requirements.” This requirement is normally fulfilled by completing HIST 050 and POLS 053. Courses used to satisfy this requirement do not apply to General Education.

**Literacy Requirement:**

See “Mathematics and Writing Requirements” in The University Catalog. Writing proficiency is a graduation requirement and may be demonstrated through satisfactory completion of a course in your major which has been designated as the Writing Proficiency (WP) course for the semester in which you take the course. Students who earn below a C- are required to repeat the course and earn a C- or better to receive WP credit. See The Class Schedule for the designated WP courses for each semester. You must pass ENGL 001 (or its equivalent) with a C- or better before you may register for a WP course.

**Course Requirements for the Major: 63-72 units**

The following courses, or their approved transfer equivalents, are required of all candidates for this degree. Additional required courses, dependent upon a selected option or advising pattern, are outlined following the degree core program requirements.

**DEGREE CORE PROGRAM: 15-16 units**

2 courses required:

- CHEM 037 General Chemistry 4.0 FS *
  Prerequisites: Second-year high school algebra; one year high school chemistry or CHEM 016. (One year of high school physics and one year of high school mathematics after Algebra II are recommended.)

- MATH 007A Analytic Geometry and Calculus 4.0 FS *
  Prerequisites: Completion of ELM requirement; both MATH 004 and MATH 006 (or high school equivalent); a score that meets department guidelines on a department administered calculus readiness exam.

1 course selected from:

- PHYS 002A General Physics 4.0 FS *
  Prerequisites: High school physics or faculty permission. High school trigonometry and second-year high school algebra or equivalent (MATH 003 and MATH 004 at CSU, Chico).

- PHYS 004A Mechanics 4.0 FS *
  Prerequisites: High school physics or faculty permission. Concurrent enrollment in or prior completion of MATH 007 (second semester of calculus) or equivalent.

1 course selected from:

- MATH 007B Analytic Geometry and Calculus 4.0 FS
  Prerequisites: Completion of ELM requirement; MATH 007A with a grade of C- or higher.

- MATH 005 Statistics 3.0 FS *
  Prerequisites: Completion of ELM requirement.

Students choosing the Science Education Option must select either MATH 007B or MATH 005.

Students choosing the Earth Science, Geology, or Hydrology Option who contemplate attending graduate school should talk with an adviser about additional preparatory courses in chemistry, mathematics, and physics. We recommend CHEM 037 and CHEM 038; MATH 007A and MATH 007B; and either PHYS 002A and PHYS 002B or PHYS 004A, PHYS 004B, and PHYS 004C.

**Major Option Course Requirements: 48-56 units**

The following courses, or their approved transfer equivalents, are required dependent upon the option chosen. Students must select one of the following options for completion of the major course requirements.

**THE OPTION IN HYDROLOGY: 53-54 units**

Students anticipating becoming licensed as a Certified Hydrogeologist in the State of California must also be licensed as a Registered Geologist prior to certification. To qualify as a Registered Geologist in the State of California requires graduation with a major in geology or the completion of 30 semester units in geological science courses leading to a major in geology, of which at least 24 units must be upper-division or graduate courses. The department therefore recommends that students complete a major in geology in addition to the option in Hydrology.

**Lower-Division Requirements: 16 units**

5 courses required:

- CHEM 037 General Chemistry 4.0 FS
  Prerequisites: CHEM 037.

- GEOS 002 Physical Geology 3.0 FS *
  Prerequisites: High school chemistry or physics is recommended; students with no previous science courses are advised to enroll in GEOS 001. No college credit for those who have passed GEOS 001.

- GEOS 050 Computer Applications in Geosci 1.0 FS
  Prerequisites: Prior or concurrent enrollment in MATH 007A, or consent of instructor.

- GEOS 060 Environmental Soil Science 2.0 FA
  Prerequisites: CHEM 037, PHYS 002A or PHYS 004A (may be taken concurrently).

- GEOS 070 California Water 2.0 SP
  Prerequisites: One course from Breadth Area B1 of General Education.

1 course selected from:

- PHYS 002B General Physics 4.0 FS
  Prerequisites: PHYS 002A.

- PHYS 004B Electricity and Magnetism 4.0 FS
  Prerequisites: MATH 007B, PHYS 0004A.

- PHYS 004C Heat/Wave Motion/Sound/Light 4.0 FS
  Prerequisites: MATH 007B, PHYS 004A.

**Upper-Division Requirements: 37-38 units**

**Option Core: 26 units**

9 courses required:

- GEOS 100 Earth Science 3.0 FA
  Prerequisites: ENGL 001 (or its equivalent) with a grade of C- or higher, CHEM 027 or equivalent, PHYS 002A, PHYS 002B.

- GEOS 106 Mineralogy and Lithology 4.0 FA
  Prerequisites: GEOS 001 or GEOS 002; CHEM 037 or CHEM 027 or equivalent; or faculty permission.

- GEOS 130 Environmental Science 3.0 FS *
  Prerequisites: One course from Breadth Area B1 and one course from Breadth Area B2 of the General Education requirements.

- GEOS 180 Hydrology 3.0 FA
  Prerequisites: GEOS 070, PHYS 002A or PHYS 004A (may be taken concurrently).

- GEOS 181 Hydrologic Field Methods 2.0 FA
  Prerequisites: GEOS 070 (may be taken concurrently), GEOS 180, GEOS 215, prior hydrology course work, or consent of instructor.

- GEOS 215 Hydrogeology 3.0 SP
  Prerequisites: CHEM 037, GEOS 001, GEOS 070A, MATH 007A; either PHYS 002A or PHYS 004A; either GEOS 070 or GEOS 180. Recommended: GEOS 107.

- GEOS 260 Water Resources Management 3.0 SP
  Prerequisites: Upper-division standing, GEOS 130 or GEOS 180.

- GEOS 265 Geochemistry 3.0 FA
  Prerequisites: CHEM 037, GEOS 001. Recommended: GEOS 106.

- GEOS 275 Senior Project 2.0 SP
  Prerequisites: Senior standing in Hydrology or Environmental Science Options.

**ADVISING PATTERN CORE REQUIREMENTS: 11-12 units**

The following courses, or their approved transfer equivalents, are required depending upon the advising pattern chosen. Students must select one of the following advising patterns for the completion of the major course requirements.

**Watershed Advising Pattern: 11-12 units**

2 courses required:

- GEOS 190 Surface Processes 3.0 FA
  Prerequisites: MATH 007A, PHYS 002A or PHYS 004A.

- GEOS 210 Intro to Watershed Hydrology 3.0 SP
  Prerequisites: GEOS 180 or concurrent enrollment in GEOS 215 or prior hydrology course work and consent of instructor.

**5-6 units selected from:**

In consultation with an adviser, select 5-6 units of relevant upper-division courses in Biological Sciences, Civil Engineering, Chemistry, Geography, and Geosciences.
Hydrogeology Advising Pattern: 11-12 units
2 courses required:
- **GEOS 107** Stratigraphy 3.0 FA
  Prerequisites: GEOS 003 and GEOS 106 (both may be taken concurrently), or faculty permission.
- **GEOS 230** Geophysical Systems Modeling I 3.0 F2
  Prerequisites: CHEM 038; GEOS 130 or faculty permission; MATH 007A; either PHYS 002B or PHYS 004C.

5-6 units selected from:
In consultation with an adviser, select 5-6 units of relevant upper-division courses in Biological Sciences, Civil Engineering, Chemistry, Geography, and Geosciences.

**THE OPTION IN SCIENCE EDUCATION WITH A CONCENTRATION IN GEOSCIENCES: 48 units**
This option fulfills all requirements for the Single Subject Teaching Credential with a Concentration in Geosciences. See the Single Subject Credential section which follows for more information.

**Lower-Division Requirements: 24 units**
7 courses required:
- **BIOL 006A** Biological Principles 4.0 FS
  Prerequisites: Recommend CHEM 037 or concurrent enrollment.
- **BIOL 006B** Biological Principles 4.0 FS
  Prerequisites: BIOL 006A; recommend CHEM 038 or concurrent enrollment.
- **CHEM 038** General Chemistry 4.0 FS
  Prerequisites: CHEM 037.
- **GEOS 002** Physical Geology 3.0 FS *
  Prerequisites: High school chemistry or physics is recommended; students with no previous science courses are advised to enroll in GEO 001. No college credit for those who have passed GEO 001.
- **GEOS 003** Principles of Historical Geology 2.0 FA
  Prerequisites: GEO S 001 or GEO S 002.
- **GEOS 005** Introduction to Astronomy 3.0 FS *
- **PHYS 002B** General Physics 4.0 FS
  Prerequisites: PHYS 002A.

**Upper-Division Requirements: 21 units**
7 courses required:
- **GEOS 100** Earth Science 3.0 FA
  Prerequisites: ENGL 001 (or its equivalent) with a grade of C- or higher, CHEM 027 or equivalent, PHYS 002A, PHYS 002B.
- **GEOS 103** Invertebrate Paleontology 3.0 SP
  Prerequisites: GEO S 003 or course in Biology.
- **GEOS 106** Mineralogy and Lithology 4.0 FA
  Prerequisites: GEO S 001 or GEO S 002; CHEM 037 or CHEM 027 or equivalent; or faculty permission.
- **GEOS 107** stratigraphy 3.0 FA
  Prerequisites: GEO S 003 and GEO S 106 (both may be taken concurrently), or faculty permission.
- **GEOS 120** Introduction to Meteorology 3.0 SP
  Prerequisites: MATH 007A; either PHYS 002B or PHYS 004C.
- **GEOS 143** Oceanography 3.0 FA
  Prerequisites: A lab course in the biological sciences and a lab course in the physical sciences.
- **GEOS 160** Field Methods 2.0 SP
  Prerequisites: GEOS 106, GEO S 107.
1 course selected from:
- **GEOS 205** Solar System Astronomy 3.0 S1
- **GEOS 206** Origin/Evolution of Universe 3.0 S2
  Prerequisites: PHYS 002A; PHYS 002B; or equivalents; or faculty permission.

**Electives Requirement:**
To complete the total units required for the bachelor’s degree, select additional elective courses from the total university offerings. You should consult with an adviser regarding the selection of courses which will provide breadth to your university experience and apply to a supportive second major or minor.

**Grading Requirement:**
All courses taken to fulfill major course requirements must be taken for a letter grade, except those courses specified by the department as Credit/No Credit grading only.

**Advising Requirement:**
Advising is mandatory for all majors in this degree program. Consult your undergraduate adviser for specific information.

**Honors in the Major**
Honors in the Major is a program of independent work in your major. It involves 6 units of honors course work completed over two semesters. Your Honors work will be recognized at your graduation, on your permanent transcripts, and on your diploma. It is often accompanied by letters of commendation from your mentor in the department or the department chair. Most importantly, however, the Honors in the Major program allows you to work closely with a faculty mentor in your area of interest on an original performance or research project. This year-long collaboration allows you to work in your field at a professional level and culminates in a public presentation of your work. Students sometimes take their projects beyond the university for submission in professional journals, presentation at conferences, or competition in shows; such experience is valuable for graduate school and later professional life.

Some common features of Honors in the Major program are:
1. You must take 6 units of Honors in the Major course work. At least 3 of these 6 units are independent study (299H) as specified by your department. You must complete each class with a minimum grade of B.
2. You must have completed 9 units of upper-division course work or 21 overall units in your major before you can be admitted to Honors in the Major. Check the requirements carefully, as there may be specific courses that must be included in these units.
3. Your cumulative GPA should be at least 3.5 or within the top 5 percent of majors in your department.
4. Your GPA in your major should be at least 3.5 or within the top 5 percent of majors in your department.
5. Most students apply for or are invited to participate in Honors in the Major during the second semester of their junior year. Then they complete the 6 units of course work over the two semesters of their senior year.
6. Your honors work culminates with a public presentation of your Honors project.

While Honors in the Major is part of the Honors Program, each department administers its own program. Please contact your major department or major adviser for further information.

**THE BACHELOR OF SCIENCE IN GEOLOGY**

**Total Course Requirements for the Bachelor’s Degree: 120 units**
See “Requirements for the Bachelor’s Degree” in The University Catalog for complete details on general degree requirements. A minimum of 40 units, including those required for the major, must be upper division.

The department has prepared a suggested Four Year Advising Plan to help students meet all graduation requirements within four years. Please request a plan from your major adviser or view it and other current advising information on the CSU, Chico Web.

**Please see General Education, Cultural Diversity, American Institutions, and Literacy Requirements under the BS in Geosciences.**

**Course Requirements for the Major: 61-62 units**
The following courses, or their approved transfer equivalents, are required of all candidates for this degree.

**Lower-Division Requirements: 20-21 units**
4 courses required:
- **CHEM 037** General Chemistry 4.0 FS *
  Prerequisites: Second-year high school algebra; one year high school chemistry or CHEM 016. (One year of high school physics and one year of high school mathematics past Algebra II are recommended.)
- **GEOS 002** Physical Geology 3.0 FS *
  Prerequisites: High school chemistry or physics is recommended; students with no previous science courses are advised to enroll in GEO S 001. No college credit for those who have passed GEO S 001.
- **MATH 007A** Analytic Geometry and Calculus 4.0 FS *
  Prerequisites: Completion of the prerequisite; both MATH 004 and MATH 006 (or high school equivalent); a score that meets department guidelines on a department administered calculus readiness exam.
Course Requirements for the Major: 69-72 units
The following courses, or their approved transfer equivalents, are required of all candidates for this degree.

Total Course Requirements for the Bachelor's Degree: 120 units
See “Requirements for the Bachelor’s Degree” in The University Catalog for complete details on general degree requirements. A minimum of 40 units, including those required for the major, must be upper division.

The department has prepared a suggested Four Year Advising Plan to help students meet all graduation requirements within four years. Please request a plan from your major adviser or view it and other current advising information on the CSU, Chico Web.

DEGREE CORE PROGRAM: 50 units
Lower-Division Requirements: 36 units

Upper-Division Requirements: 41 units

12 courses required:
- GEOS 103 Invertebrate Paleontology 3.0 SP
- GEOS 106 Mineralogy and Lithology 4.0 FA
- GEOS 107 Stratigraphy 3.0 FA
- GEOS 160 Field Methods 2.0 SP
- GEOS 161 Preparing Geological Reports 1.0 SP
- GEOS 208 Structural Geology 4.0 FA
- GEOS 255 Sedimentary Basin Analysis 3.0 FA
- GEOS 263 Geochronology 3.0 FA
- GEOS 270 Environmental/Engineering Geol 3.0 S2
- GEOS 280 Geol Evolution of North Amer 3.0 SP
- GEOS 285 Computer Applications in Geosci 1.0 FS
- PHYS 002A General Physics 4.0 FS
- PHYS 002B General Physics 4.0 FS

2 courses selected from:
- BIOL 006A Biological Principles 4.0 FS
- BIOL 006B Biological Principles 4.0 FS
- CHEM 037 General Chemistry 4.0 FS
- GEOS 107 General Chemistry 3.0 FS
- PHYS 002C Heat/Wave Motion/Sound/Light 4.0 FS

2-3 courses selected from:
- BIOL 258 Fundamentals of Ecology 4.0 FS
- CHEM 100 Earth Science 3.0 FA
- GEOS 002 Sedimentary Basin Analysis 3.0 SP
- GEOS 130 Environmental Science 3.0 FS
- PHYS 004C Heat/Wave Motion/Sound/Light 4.0 FS

0-1 courses selected from:
- CHEM 101 Environmental Science Lab 2.0 FA

Students who are considering attending graduate school should consult with an adviser before selecting lower-division core courses. We recommend PHYS 004A, PHYS 004B, and PHYS 004C.

Upper-Division Requirements: 14 units

5 courses required:
- BIOL 258 Fundamentals of Ecology 4.0 FS
- GEOS 100 Earth Science 3.0 FA
- GEOS 131 Environmental Science Lab 2.0 FA

Students who are considering attending graduate school should consult with an adviser before selecting lower-division core courses. We recommend PHYS 004A, PHYS 004B, and PHYS 004C.

Upper-Division Requirements: 41 units

12 courses required:
- GEOS 103 Invertebrate Paleontology 3.0 SP
- GEOS 106 Mineralogy and Lithology 4.0 FA
- GEOS 107 Stratigraphy 3.0 FA
- GEOS 160 Field Methods 2.0 SP
- GEOS 161 Preparing Geological Reports 1.0 SP
- GEOS 208 Structural Geology 4.0 FA
- GEOS 255 Sedimentary Basin Analysis 3.0 FA
- GEOS 263 Geochronology 3.0 FA
- GEOS 270 Environmental/Engineering Geol 3.0 S2
- GEOS 280 Geol Evolution of North Amer 3.0 SP
- GEOS 285 Computer Applications in Geosci 1.0 FS
- PHYS 002A General Physics 4.0 FS
- PHYS 002B General Physics 4.0 FS

2 courses selected from:
- BIOL 006A Biological Principles 4.0 FS
- BIOL 006B Biological Principles 4.0 FS
- CHEM 037 General Chemistry 4.0 FS
- GEOS 107 General Chemistry 3.0 FS
- PHYS 002C Heat/Wave Motion/Sound/Light 4.0 FS

2-3 courses selected from:
- BIOL 258 Fundamentals of Ecology 4.0 FS
- CHEM 100 Earth Science 3.0 FA
- GEOS 002 Sedimentary Basin Analysis 3.0 SP
- GEOS 130 Environmental Science 3.0 FS
- PHYS 004C Heat/Wave Motion/Sound/Light 4.0 FS

0-1 courses selected from:
- CHEM 101 Environmental Science Lab 2.0 FA

Students who are considering attending graduate school should consult with an adviser before selecting lower-division core courses. We recommend PHYS 004A, PHYS 004B, and PHYS 004C.
CHEM 255 Basic Instrumental Analysis 3.0 SP
Prerequisites: CHEM 070.

CHEM 170L Organic Chem Laboratory 1.0 FS
Prerequisites: CHEM 170L may be taken as a prerequisite or concurrently with CHEM 170L.

CHEM 255 Basic Instrumental Analysis 3.0 SP
Prerequisites: CHEM 037, CHEM 038.

**THE OPTION IN APPLIED ECOLOGY: 22 units**

Lower-Division Requirements: 2 units

**1 course required:**

**GEOS 070** California Water 2.0 SP
Prerequisites: One course from Breadth Area B1 of General Education.

Upper-Division Requirements: 20 units

6 courses required:

- **Biol 259** Aquatic Ecology 4.0 FA
  Prerequisites: BIOL 006B, CHEM 038
- **BIOL 275** Microbial Ecology 4.0 SP
  Prerequisites: BIOL 006B. Recommended: BIOL 011.
- **CHEM 204** Environmental Chemistry 3.0 FA
  Prerequisites: CHEM 038.
- **GEOG 227** Environmental Impact Analysis 3.0 FS
  Prerequisites: GEOG 120 or equivalent.
- **GEOS 235** Pollution Ecology 3.0 FA
  Prerequisites: CHEM 038.
- **GEOS 236** Applied Ecology 3.0 SP
  Prerequisites: BIOL 258.

**THE OPTION IN EARTH RESOURCE SCIENCE: 19 units**

Upper-Division Requirements: 19 units

6 courses required:

- **GEOS 106** Mineralogy and Lithology 4.0 FA
  Prerequisites: GEO S 001 or GEO S 002; CHEM 037 or CHEM 027 or equivalent; or faculty permission.
- **GEOS 107** Stratigraphy 3.0 FA
  Prerequisites: GEO S 003 and GEO S 106 (both may be taken concurrently), or faculty permission.
- **GEOS 160** Field Methods 2.0 SP
  Prerequisites: GEO S 106, GEO S 107.
- **GEOS 161** Preparing Geological Reports 1.0 SP
  Prerequisites: ENGL 001 (or its equivalent) or a grade of C- or higher, GEO S 160.
- **GEOS 180** Hydrology 3.0 FA
  Prerequisites: GEO S 070; PHYS 002A or PHYS 004A (may be taken concurrently).
- **GEOS 270** Environmental/Engineering Geol 3.0 FA
  Prerequisites: GEO S 002, GEO S 003, GEO S 106.
  For majors in related sciences and technical fields, GEO S 002.

1 course selected from:

- **GEOS 190** Surficial Processes 3.0 FA
  Prerequisites: MATH 007A; either PHYS 002A or PHYS 004A.
- **GEOS 215** Hydrogeology 3.0 SP
  Prerequisites: CHEM 037, GEO S 106; MATH 007A; either PHYS 002A or PHYS 004A; or GEO S 180. Recommended: GEO S 107.
- **GEOS 245** Applied Geophysics 3.0 S2
  Prerequisites: One year of physics; GEO S 002; or faculty permission.

**THE OPTION IN ENVIRONMENTAL CHEMISTRY: 19-20 units**

Lower-Division Requirements: 4 units

1 course required:

**CHEM 070** Organic Chemistry 4.0 FS
Prerequisites: CHEM 038.

Upper-Division Requirements: 15-16 units

3 courses required:

- **CHEM 105** Quantitative Analysis 4.0 FS
  Prerequisites: CHEM 038.
- **CHEM 203B** Environmental Toxicology 2.0 SP
  Prerequisites: CHEM 028 or CHEM 070.
- **CHEM 204** Environmental Chemistry 3.0 FA
  Prerequisites: CHEM 038.

6-7 units selected from:

- **CHEM 170** Organic Chemistry 3.0 FS
  Prerequisites: CHEM 070.
- **CHEM 170L** Organic Chem Laboratory 1.0 FS
  Prerequisites: CHEM 170L may be taken as a prerequisite or concurrently with CHEM 170L.
- **CHEM 255** Basic Instrumental Analysis 3.0 SP
  Prerequisites: CHEM 037, CHEM 038.

GEOS 265 Geochemistry 3.0 FA
Prerequisites: CHEM 037, GEO S 002. Recommended: GEO S 106.

**NOTE:** If CHEM 170 is selected, CHEM 170L must also be taken.

**THE OPTION IN WATERSHED SCIENCE: 20 units**

Lower-Division Requirements: 2 units

1 course required:

**GEOS 060** Environmental Soil Science 2.0 FA
Prerequisites: CHEM 037, PHYS 002A or PHYS 004A (may be taken concurrently).

Upper-Division Requirements: 18 units

6 courses required:

- **GEOS 227** Environmental Impact Analysis 3.0 FS
  Prerequisites: GEOG 120 or equivalent.
- **GEOS 180** Hydrology 3.0 FA
  Prerequisites: GEO S 070; PHYS 002A or PHYS 004A (may be taken concurrently).
- **GEOS 190** Surficial Processes 3.0 FA
  Prerequisites: MATH 007A; either PHYS 002A or PHYS 004A.
- **GEOS 210** Intro to Watershed Hydrology 3.0 SP
  Prerequisites: GEO S 180 or concurrent enrollment in GEO S 215 or prior hydrology course work and consent of instructor.
- **GEOS 235** Pollution Ecology 3.0 FA
  Prerequisites: CHEM 038.
- **GEOS 260** Water Resources Management 3.0 SP
  Prerequisites: Upper-division standing; GEO S 130 or GEO S 180.

Students should consult with an adviser regarding selection of courses which will apply to a Biological Science or Chemistry minor.

Please see the Electives, Graduation, and Advising Requirements under the BS in Geosciences.

**THE MINOR IN GEO SCIENCES**

Course Requirements for the Minor: 22 units

The following courses, or their approved transfer equivalents, are required of all candidates for this minor.

Students majoring in Geosciences may not pursue a minor in Geosciences.

1 course selected from:

- **GEOS 001** General Geology 3.0 FS *
- **GEOS 002** Physical Geology 3.0 FS *

2 courses required:

- **GEOS 003** Principles of Historical Geology 2.0 FA
  Prerequisites: GEOS 001 or GEOS 002.
- **GEOS 005** Introduction to Astronomy 3.0 FS *

14 units selected from:

Any upper-division Geosciences (GEOS) courses.

**THE SINGLE SUBJECT TEACHING CREDENTIAL IN SCIENCE**

Course Requirements for the Single Subject Teaching Credential: 48 units

In most majors, candidates for this credential will normally fulfill the single subject matter preparation program by completing the appropriate education option in the major. Any exceptions to this procedure are noted at the end of this section. In addition to the single subject matter preparation program, completion of an additional professional education program is required to qualify for a California teaching credential. Professional education (credential) programs are available through the School of Education. For prerequisites and other admission requirements to professional education programs, see the “Education” chapter of this catalog. All credential candidates recommended by CSU, Chico (under the SB 2042 standards) are authorized to teach all students including English learners in the regular classroom. You may also want to consider qualifying for BCLAD (Bilingual, Cross-cultural, Language, and Academic Development) emphasis and supplementary authorizations in additional subject matter areas as you plan your program.

Your departmental credential adviser is responsible for verifying that the subject matter preparation program has been completed. If you are interested in obtaining a teaching credential, confer with the appropriate credential adviser early in your university career. Department credential advisers can assist you in planning an educational program that meets both major and credential requirements.
Course Requirements for the Master's Degree: 30 units

Continuous enrollment is required. A maximum of 9 semester units of transfer credit may be applied toward the degree.

Graduate Time Limit: All requirements for the degree are to be completed within five years of the end of the semester of enrollment in the oldest course applied toward the degree. See “Graduate Education” in The University Catalog for complete details on general degree requirements.

The MS degree in Geosciences is available for advanced study in any aspect of Geosciences including Astronomy, Environmental Science, Geology, Hydrology, and Meteorology. Prospective students should discuss their interests and goals with the department graduate coordinator.

Prerequisites for Admission to Conditionally Classified Status:

1. Satisfactory grade point average as specified in “Admission to Master’s Degree Programs” in The University Catalog.
2. Approval by the department and the Office of Graduate Programs.
3. An acceptable baccalaureate in one of the natural sciences, engineering, or mathematics from an accredited institution, or an equivalent approved by the Office of Graduate Programs. The prospective student must have sufficient background to undertake a graduate program in the Geosciences. (The Option in Hydrology/Hydrogeology requires a year of college chemistry, mathematics, physics, and a course in organic chemistry).

Prerequisites for Admission to Classified Status:

In addition to any requirements listed above:

1. Completion of the Graduate Record Examination Aptitude Test with a minimum combined score of 1000 on the verbal and quantitative portions.
2. Approval by the department and the Office of Graduate Programs.
3. Development of an approved program in consultation with the graduate advisory committee.

Advancement to Candidacy:

In addition to any requirements listed above:

Students must have classified graduate standing and must have completed at least 9 units of the proposed program at the university.

Requirements for the MS in Geosciences:

Completion of all requirements as established by the graduate advisory committee, and the Office of Graduate Programs, to include:

1. Completion of an approved program consisting of 30 units of 200/300-level courses as follows:
   (a) At least 18 units in geosciences, which must include GEOS 300, GEOS 301, GEOS 303, GEOS 304, GEOS 305, and GEOS 399. The Option in Hydrology/Hydrogeology also requires GEOS 321.
   (b) Graduate courses from geosciences or other areas (e.g., mathematics, engineering, chemistry, or biological sciences) may be selected to constitute the remaining 12 units, with the approval of the graduate advisory committee. Substitutions for required courses must be taken at Chico State and must be approved by the Graduate Coordinator.
   (c) At least 18 of the units required for the degree in the 300-level courses.
   (d) Not more than 9 semester units of transfer and/or extension credit (correspondence courses and U.C. extension course work are not acceptable).
   (e) Not more than 15 units taken before admission to classified status.
   (f) At least 9 units completed after advancement to candidacy.
   (g) Not more than 10 units of Independent Study (398) and Master's Thesis (399); not more than 6 units of Master's Thesis (399).
2. Completion and final approval of a thesis as specified by the student’s graduate advisory committee.
3. Satisfactory completion of a comprehensive final examination (written and/or oral) in the field of study.
4. Approval by the departmental graduate committee and the Graduate Coordinators Committee on behalf of the faculty of the university.

Course Requirements for the MS in Geosciences

13 units required:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
<th>Repeatable</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOS 300</td>
<td>Geosciences Seminar I</td>
<td>1.0</td>
<td>FS</td>
</tr>
<tr>
<td>GEOS 301</td>
<td>Geosciences Seminar II</td>
<td>1.0</td>
<td>SP</td>
</tr>
<tr>
<td>GEOS 330</td>
<td>Geotectonic Development of Calif</td>
<td>3.0</td>
<td>FA</td>
</tr>
<tr>
<td>GEOS 340</td>
<td>Hydrogeochemistry</td>
<td>3.0</td>
<td>SP</td>
</tr>
<tr>
<td>GEOS 350</td>
<td>Environmental Monitoring</td>
<td>2.0</td>
<td>FA</td>
</tr>
<tr>
<td>GEOS 360</td>
<td>Numerical Analysis</td>
<td>3.0</td>
<td>SP</td>
</tr>
<tr>
<td>Prerequisites:</td>
<td>CHEM 255 is recommended.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites:</td>
<td>MATH 207A.</td>
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</tbody>
</table>

1-6 units selected from:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
<th>Repeatable</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOS 399</td>
<td>Master's Study</td>
<td>1.0-6.0</td>
<td>FS</td>
</tr>
</tbody>
</table>

At least 1 unit of Master’s Study is required.

11-16 units selected from:

Select 11-16 units of courses approved by the graduate committee.

The Option in Hydrology/Hydrogeology

11 units required:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
<th>Repeatable</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOS 300</td>
<td>Geosciences Seminar I</td>
<td>1.0</td>
<td>FA</td>
</tr>
<tr>
<td>GEOS 301</td>
<td>Geosciences Seminar II</td>
<td>1.0</td>
<td>SP</td>
</tr>
<tr>
<td>GEOS 321</td>
<td>Advanced Topics in Hydrology</td>
<td>3.0</td>
<td>FS</td>
</tr>
<tr>
<td>GEOS 340</td>
<td>Hydrogeochemistry</td>
<td>3.0</td>
<td>SP</td>
</tr>
<tr>
<td>Prerequisites:</td>
<td>GEOS 200/300, GEOS 301, GEOS 321, GEOS 330, GEOS 340.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites:</td>
<td>CHEM 255 is recommended.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites:</td>
<td>MATH 207A.</td>
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</tr>
</tbody>
</table>

2-3 units selected from:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
<th>Repeatable</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOS 330</td>
<td>Geotectonic Development of Calif</td>
<td>3.0</td>
<td>FA</td>
</tr>
<tr>
<td>Prerequisites:</td>
<td>Graduate standing or consent of instructor.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites:</td>
<td>CHEM 255 is recommended.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GEOS 350</td>
<td>Environmental Monitoring</td>
<td>2.0</td>
<td>FA</td>
</tr>
<tr>
<td>Prerequisites:</td>
<td>MATH 207A.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1-6 units selected from:

<table>
<thead>
<tr>
<th>Course</th>
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<th>Repeatable</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOS 399</td>
<td>Master's Study</td>
<td>1.0-6.0</td>
<td>FS</td>
</tr>
</tbody>
</table>

At least 1 unit of Master’s Study is required.

10-16 units selected from:

Select from courses approved by the graduate committee.

Graduate Literacy Requirement:

Writing proficiency is a graduation requirement. Geosciences students will normally demonstrate their writing competence through successful completion of GEOS 300 and GEOS 301, Geosciences Seminar, or approved substitute.

Graduate Grading Requirements:

All courses in the major (with the exceptions of Independent Study-398 and Master's Study-399) must be taken for a letter grade, except those courses specified by the department as ABC/No Credit (200-level courses), AB/No Credit (300-level courses, or Credit/No Credit grading only. A maximum of 10 units combined of ABC/No Credit, AB/No Credit, and Credit/No Credit grades may be used on the approved program (including 398, 399, and courses outside the major). While grading standards are determined by individual programs and instructors, it is also the policy of the university that unsatisfactory grades may be given when work fails to reflect achievement of the high standards, including high writing standards, expected of students pursuing graduate study.

Students must maintain a 3.0 grade point average in all course work on the approved master's degree program as well as in all course work taken subsequent to admission to conditionally classified status.

Graduate Advising Requirement:

Advising is mandatory for new and readmitted students in the master’s program in Geosciences. Consult the Graduate Coordinator for specifics.
THE MASTER OF SCIENCE IN ENVIRONMENTAL SCIENCE

Course Requirements for the Master's Degree: 30 units

Continuous enrollment is required. A maximum of 9 semester units of transfer credit may be applied toward the degree.

Graduate Time Limit: All requirements for the degree are to be completed within five years of the end of the semester of enrollment in the oldest course applied toward the degree. See “Graduate Education” in The University Catalog for complete details on general degree requirements.

The MS degree in Environmental Science is available for advanced study in biological, chemical, or geoscience aspects of environmental science, as well as environmental policy and planning. Prospective students should discuss their interests and goals with the Department of Geological and Environmental Studies Graduate Coordinator.

Prerequisites for Admission to Conditionally Classified Status:

1. Satisfactory grade point average as specified in “Admission to Master's Degree Programs” in The University Catalog.
2. Approval by the department and the Office of Graduate Programs.
3. An acceptable baccalaureate in one of the natural sciences, engineering, or biological sciences. Selection must be approved by the graduate advisory committee.

Prerequisites for Admission to Classified Status:

1. Completion of the Graduate Record Examination Aptitude Test with a minimum combined score of 1000 on the verbal and quantitative portions.
2. Formation of a graduate advisory committee.
3. Development of an approved program in consultation with the graduate advisory committee.

Advancement to Candidacy:

In addition to any requirements listed above:

1. Completion of the Graduate Record Examination Test.
2. Approval by the department and the Office of Graduate Programs.
3. Approval by the graduate advisory committee.
4. Completion of at least 12 units of course work applied toward the degree. See “Graduate Education” in The University Catalog for details on guidelines for the acceptable course work.

Requirements for the MS in Environmental Science:

Completion of all requirements as established by the graduate advisory committee, and the Office of Graduate Programs, to include:

1. Completion of an approved program consisting of 30 units of 200/300-level courses as follows:
   (a) A core of 12-15 units in required courses to include GEO S 300, GEO S 301, GEO S 340, BIOL 360, a 200/300-level course in biological science or chemistry and GEO S 330 or GEO S 350. Substitutions for required courses must be taken at Chico and must be approved by the Graduate Coordinator.
   (b) 9-17 units of course work selected from areas such as mathematics, plant science, chemistry, geosciences, geography, political science, engineering, or biological sciences. Selection must be approved by the graduate advisory committee.
   (c) 1-6 units of BIO L 399 or CHEM 399 or GEO S 399. At least one unit of Master’s Thesis (399) is required.
   (d) At least 18 of the units required for the degree in 300-level courses.
   (e) Not more than 9 semester units of transfer and/or extension or Open University credit (correspondence courses and U.C. extension course work are not acceptable).
   (f) Not more than 15 units taken before admission to classified status.
   (g) At least 9 units completed after advancement to candidacy.
   (h) Not more than 10 units of Independent Study (390) and Master’s Thesis (399); at least 1, but not more than 6, units of Master’s Thesis (399).
2. Completion and final approval of a thesis as specified by the student’s graduate advisory committee.
3. Satisfactory completion of a comprehensive final examination (written and/or oral) in the field of study.
4. Approval by the Departmental Graduate Committee and the Graduate Coordinators Committee on behalf of the faculty of the university.

Graduate Literacy Requirement:

Writing proficiency is a graduation requirement.

Environmental Science students will normally demonstrate their writing competence through successful completion of GEO S 300 and GEO S 301, Geosciences Seminar, or an approved substitute.

Graduate Grading Requirements:

All courses in the major (with the exceptions of Independent Study-390 and Master’s Study-399) must be taken for a letter grade, except those courses specified by the department as ABC/No Credit (200-level courses), AB/No Credit (300-level courses), or Credit/No Credit grading only. A maximum of 10 units combined of ABC/No Credit, AB/No Credit, and Credit/No Credit grades may be used on the approved program (including 398, 399, and courses outside the major). While grading standards are determined by individual programs and instructors, it is also the policy of the university that unsatisfactory grades may be given when work fails to reflect achievement of the high standards, including high writing standards, expected of students pursuing graduate study.

Students must maintain a 3.0 grade point average in all course work on the approved master’s degree program as well as in all course work taken subsequent to admission to conditionally classified status.

Graduate Advising Requirement:

Advising is mandatory for new and readmitted students in the master’s program in Environmental Science. Consult the Graduate Coordinator for specifics.

Course Requirements for the MS in Environmental Science:

8 units required:

- GEO S 300 Geosciences Seminar I 1.0 FA
- GEO S 301 Geosciences Seminar II 1.0 SP
- GEO S 340 Hydrogeochemistry 3.0 SP
- GEO S 360 Numerical Analysis 3.0 SP
Prerequisites: CHEM 037, CHEM 038
- GEOS 399 Master's Study 1.0-6.0 FS

2-4 units selected from:

- One 200- or 300-level course in Biological Sciences or Chemistry.

2-3 units selected from:

- GEOS 330 Geotectonic Development of Calif 3.0 FA
Prerequisites: Graduate standing or consent of instructor.
- GEOS 350 Environmental Monitoring 2.0 FA
Prerequisites: CHEM 225 is recommended.

1-6 units selected from:

- BIO L 399 Master’s Study 1.0-6.0 FS
- CHEM 399 Master’s Study 1.0-6.0 FS
- GEO S 399 Master’s Study 1.0-6.0 FS

At least 1 unit of 399 is required.

Select 9-17 units from courses approved by the graduate committee

OR from the Environmental Policy and Planning Emphasis below.

Environmental Policy and Planning Emphasis: 12 units

3 courses required:

- GEO G 307 Environmental Planning 3.0 SP
Prerequisites: BIO L 134, GEO G 227, and faculty permission.
- GEO G 308 Environmental Project Management 3.0 Inq
Prerequisites: GEO G 227 and faculty permission.
- POLS 353 Environmental Policy & the Law 3.0 FS

1 course selected from:

- ECON 266 Environmental & Resource Econ 3.0 FS
Prerequisites: ECON 101.
- GEO G 226 Water Resource Development 3.0 FA
Prerequisites: GEO G 104 or equivalent.
The Faculty

Jerald J. Behnke, 1968, Professor Emeritus, PhD, U Nevada.
David L. Brown, 1995, Assoc Professor, PhD, U Berkeley.
Ann Byerker-Kaufman, 1990, Assoc Professor, PhD, U Arizona.
Richard A. Flory, 1973, Chair, Professor Emeritus, PhD, Oregon State Univ.
Rolland K. Hauser, 1967, Professor Emeritus, PhD, U Chicago.
Karina A. Hoover, 2000, Assist Professor, PhD, Johns Hopkins Univ.
Carolyn R. Johnston, 1971, Professor, PhD, U Florida.
Terence T. Kato, 1981, Professor, PhD, UCLA.
Robert Maurer, 1952, Professor Emeritus, PhD, Stanford U.
William M. Murphy, 2000, Assist Professor, PhD, U.C Berkeley.
James L. Regas, 1969, Professor Emeritus, PhD, Harvard U.
Howard L. Stensrud, 1970, Professor Emeritus, PhD, U of WA.
Gregory R. Taylor, 1988, Professor, PhD, U of WA.

Geological and Environmental Studies

Course Offerings

Please see the section on “Course Description Symbols and Terms” in The University Catalog for an explanation of course description terminology and symbols, the course numbering system, and course credit units. All courses are lecture and discussion and employ letter grading unless otherwise stated. Some prerequisites may be waived with faculty permission. Many syllabi are available on the Chico Web.

GEO 001 General Geology 3.0 Fa/Spr
Earth materials, processes, and history, and their significance to human kind. No college credit for students who have passed GEO 002. 2.0 hours lecture, 3.0 hours laboratory. This is an approved General Education course. Special fee required; see The Class Schedule.

GEO 002 Physical Geology 3.0 Fa/Spr
Prerequisites: High school chemistry or physics is recommended; students with no previous science courses are advised to enroll in GEO 001. No college credit for those who have passed GEO 002. Physical and chemical processes in the earth, including origin and identification of rocks and minerals, earth’s interior, movements and major features of the earth’s crust; erosion and sedimentation; geological structures; topographic maps; mineral resources. 2.0 hours lecture, 3.0 hours laboratory. This is an approved General Education course. Special fee required; see The Class Schedule.

GEO 003 Principles of Historical Geology 2.0 Fall
Prerequisites: GEO 001 or GEO 002. Principles of historical geology as they relate to rock sequences and geologic maps. 1.0 hour lecture, 3.0 hours laboratory. Special fee required; see The Class Schedule.

GEO 005 Introduction to Astronomy 3.0 Fa/Spr
Origin and evolution of the universe. Topics include black holes, pulsars, quasars, life in the universe, and interstellar communication. Constellation study in Roth Planetarium and telescope observation of stars and galaxies at Observatory. 2.0 hours lecture, 3.0 hours laboratory. This is an approved General Education course.

GEO 020 Weather 3.0 Fa/Spr
A descriptive study of weather processes; winds, circulation and storms; and weather impacts on life, property, crops, water availability, and air quality. Current weather briefings and California weather topics are emphasized.

GEO 030 Introduction to Environmental Science 3.0 Fa/Spr
An introduction to human impact upon planet Earth. Scientific principles applied to air pollution, water pollution, and solid and radioactive waste problems. Population dynamics, world hunger, and environmental impact analysis are also covered. 2.0 hours lecture, 3.0 hours laboratory. This is an approved General Education course. Special fee required; see The Class Schedule.

GEO 041 Concepts in the Physical Sciences 3.0 Fa/Spr
Prerequisites: Concurrent enrollment in or prior completion of MATH 004. Basic concepts of motion, force, energy, chemical change, and their interactions. Intended for Liberal Studies majors. 2.0 hours lecture, 3.0 hours laboratory.

GEO 050 Computer Applications in Geosciences 1.0 Fa/Spr
Prerequisites: Prior or concurrent enrollment in MATH 007A, or consent of instructor. Develop skills in applying common computer software, including data analysis, presentation, graphics, and others. Use of this software as applied to selected problems in environmental sciences and geosciences. 2.0 hours activity.

GEO 060 Environmental Soil Science 2.0 Fall
Prerequisites: CHEM 037, PHYS 002A or PHYS 004A (may be taken concurrently). Survey of the fundamental physical, chemical, and biological properties of soils in selected environmental processes.

GEO 070 California Water 2.0 Spring
Prerequisites: One course from Breadth Area B1 of General Education. Introduction to physical hydrological processes, including precipitation, surface waters, soil and groundwater, and evapotranspiration. California water issues are used to illustrate water movement and storage.

GEO 100 Earth Science 3.0 Fall
Prerequisites: ENGL 001 (or its equivalent) with a grade of C- or higher; CHEM 027 or equivalent; PHYS 002A; PHYS 002B. An intermediate treatment of astronomy, meteorology, and oceanography, with emphasis on the similarity of techniques and concepts used in these disciplines. This is a writing proficiency, W, P, course; a grade of C- or better certifies writing proficiency for majors.

GEO 102 Introductory Seismology 3.0 Spring
Prerequisites: A course in geology, physical science, or physics. Causes and effects of earthquakes, instrumental seismology; interior of the earth. Seismology applied to engineering studies; fault creep and earthquake prediction.

GEO 103 Invertebrate Paleontology 3.0 Spring
Prerequisites: GEO 003 or course in Biology. Study of main groups of invertebrate fossils and their uses in biostratigraphy, paleobiogeography, and paleoecology. 2.0 hours lecture, 3.0 hours laboratory.

GEO 104 History of Life 3.0 Spring
Prerequisites: BIOL 001 or BIOL 003, GEO 001, or GEO 002. Descriptive outline of the history of life as understood from the fossil record. Evolutionary concepts are examined, with emphasis placed upon paleontologic rather than genetic evidence.

GEO 105 Observational Astronomy 3.0 0 DdFall
Prerequisites: GEO 005 or GEO 142. An intermediate treatment of astronomy from an observational viewpoint. Visual, photographic, and photometric techniques for sun, moon, solar system, and deep-sky observations. Data analysis and methodology. Frequent use of campus observatory. 2.0 hours lecture, 3.0 hours laboratory.

GEO 106 Mineralogy and Lithology 4.0 Fall
Prerequisites: GEO 001 or GEO 002, CHEM 037 or CHEM 027 or equivalent or faculty permission. Identification and origins of the more common minerals and rocks. 2.0 hours lecture, 6.0 hours laboratory.

GEO 107 Stratigraphy 3.0 Fall
Prerequisites: GEO 003 and GEO 106 (both may be taken concurrently), or faculty permission. Basic concepts of stratigraphy. Methods of strata description, correlation, mapping, and interpretation. Sedimentary tectonics and lithic associations. Graphic representation of data. 2.0 hours discussion, 3.0 hours laboratory.

GEO 110 Geological Field Reconnaissance 2.0 Spring
Prerequisites: GEO 001 or GEO 002. Faculty permission required to take the course a second time for credit. Generalized field study of geologically noteworthy areas. (Minimum of eight consecutive days in the field during January intercession or spring vacation; and additional work or classroom meetings.) Credit/no credit grading only. You may take this course more than once for a maximum of 4.0 units.

GEO 120 Introduction to Meteorology 3.0 Spring
Prerequisites: MATH 007A; either PHYS 002B or PHYS 004C. Survey of physical and dynamic meteorology. Topics covered include thermodynamics, radiation, clouds and precipitation formation, tropical and extratropical weather systems, forecasting, and climate change. 2.0 hours discussion, 3.0 hours laboratory.

GEO 125 Geology of California 3.0 Fall
Prerequisites: GEO 001 or GEO 002. Geologic setting of California and historical development of its geologic provinces. The impact of earthquakes, volcanic activity, coastal erosion, and earth resources on California. Field trip required. Special fee required; see The Class Schedule.

GEO 130 Environmental Science 3.0 Fa/Spr
Prerequisites: One course from Breadth Area B1 and one course from Breadth Area B2 of the General Education requirements. Human impact on life-support systems; use of physical and ecological principles in environmental management and protection; discussion of land use and its environmental impact; and an evaluation of human influence on natural cycles. This is an approved General Education course.
GEO 131 Environmental Science Lab 2.0 Fall
Prerequisites: Either CHEM 027 or CHEM 037, one course from Breadth Area B1. A laboratory designed to complement GEO 130. Physical, chemical, and ecological concepts as related to the field and laboratory experience in environmental science. 1.0 hour lecture, 3.0 hours laboratory.

GEO 140 Environmental Geography 3.0 Fa/Spr
Prerequisites: One course from Breadth Area B1 and one course from Breadth Area B2 of General Education requirements.
Provides the non-major with a geographic approach to current environmental problems related to the origin and use of energy, mineral, and water resources, and the causes and mitigations of geologic hazards. This is an approved General Education course.

GEO 142 Concepts in Earth and Space Science 3.0 Fa/Spr
Prerequisites: GEO 041 or faculty permission.
Fundamental concepts in (1) the solar system and the universe, (2) the structure and composition of the solid Earth, and (3) Earth’s atmosphere and water. Intended for Liberal Studies majors and students pursuing a single subject teaching credential in science. 1.0 hour lecture, 4.0 hours activity. Special fee required; see The Class Schedule.

GEO 143 Oceanography 3.0 Fall
Prerequisites: A lab course in the biological sciences and a lab course in the physical sciences. Study of ocean currents and water masses; nutrient distribution and productivity; morphology and sediment distributions of ocean basins, continental shelves, and shorelines; sea floor spreading; and marine field techniques.

GEO 150 American Science and Technology 3.0 Fa/Spr
Prerequisites: Completion of the General Education Breadth Areas B1, The Physical Universe, and B2, Life Forms.
A consideration of the scientific principles underlying key scientific and technological occurrences in the United States, and the relationship of these occurrences to other aspects of American life. This is an approved General Education course.

GEO 151 Science and the American Idea 3.0 Spring
Prerequisites: Completion of the General Education Breadth Areas B1, The Physical Universe, and B2, Life Forms.
Major issues in the evolution of science within the development of the United States. This is an approved General Education course.

GEO 154 Science and Ethics 3.0 Spring
Prerequisites: Completion of the General Education Breadth Area B requirement; PHIL 106.
The process of science and the scientific method. Selected key scientific advances and revolutions, including the contributions of Copernicus, Galileo, Newton, Darwin, and others, from historical and cross-cultural perspectives. This course cannot be used for credit toward a geosciences major or minor. This is an approved General Education course. Formerly MATH 154.

GEO 155 Geologic Hazards 3.0 Fa/Spr
Prerequisites: One course from Breadth Area B1 and one course from Breadth Area B2 of General Education requirements.
A discussion of the geologic processes that cause geologic hazards; the methods of measuring their magnitude and frequency; the various ways in which hazards affect humans and their environment; the methods by which geologic hazards can be predicted and mitigated; and the various stages of recovery from catastrophic geologic hazards. This is an approved General Education course.

GEO 160 Field Methods 2.0 Spring
Prerequisites: GEO 010; GEO 017.
Elementary geologic field methods, descriptive geometry, photogeology, and geologic mapping. Ten days in the field during January intersession.

GEO 161 Preparation of the Geological Report 1.0 Spring
Prerequisites: ENGL 001 (or its equivalent) with a grade of C- or higher; GEO 160.
This is a writing proficiency, WP, course; a grade of C- or better certifies writing proficiency for majors.

GEO 170 Energy in the Human Environment 3.0 Spring
Prerequisites: One course from Breadth Area B1.
Analysis of present and long-term global energy crises; coverage of scientific concepts needed to understand energy and its environmental interactions; in-depth examination of alternative energy sources and their environmental impact. This is an approved General Education course.

GEO 180 Hydrology 3.0 Fall
Prerequisites: GEO 010, PHYS 002A or PHYS 004A. Special fee required; see The Class Schedule.
A survey of the mass transfer processes and storage elements within the hydrologic cycle: precipitation, interception, surface runoff, infiltration, evapo-transpiration, soil water and groundwater. Quantitative methods for estimating flow and storage, use of probability concepts to predict extreme hydrologic events in a time series. 1.0 hour lecture, 3.0 hours laboratory.

GEO 181 Hydrologic Field Methods 2.0 Fall
Prerequisites: GEO 010, PHYS 002A or PHYS 004A. Special fee required; consent of instructor.
Develops field and related laboratory skills in performing common measurements in all areas of the hydrologic cycle. Students learn to critically evaluate the theoretical bases for field methods and hydrologic characterization approaches. 1.0 hour lecture, 3.0 hours laboratory.

GEO 190 Surficial Processes 3.0 Fall
Prerequisites: MATH 007A; either PHYS 002A or PHYS 004A.
Description, analysis, and quantification of landscape-forming processes in hillslope, fluvial, desert, periglacial, and coastal environments. Emphasis on applications of process-based analyses for solving environmental and resource problems. 2.0 hours lecture, 3.0 hours laboratory.

GEO 198 Selected Topics in Geosciences 1.0-4.0 Fa/Spr
This course is a special topic offered as 198A-D for 1.0 to 4.0 units respectively. Typically the topic is offered on a one-time-only basis and may vary from term to term and be different for different sections. See The Class Schedule for the specific topic being offered.

GEO 199 Special Problems 1.0-3.0 Fa/Spr
Prerequisites: Faculty permission. This course is an independent study of special problems and is offered as 199A-C for 1.0 to 3.0 units respectively. Credit/no credit grading only.

GEO 200 Physical Meteorology 3.0 OddFall
Prerequisites: MATH 007B, either PHYS 002B or PHYS 004C.
Recommended: GEO 120.
The physical processes of the atmosphere: atmospheric hydrostatics and thermodynamics; aerosol physics; cloud microphysics and dynamics; radiative transfer. The role of these processes in cloud and storm development is also covered.

GEO 201 Dynamic Meteorology and Analysis 3.0 EvnSpr
Prerequisites: GEO 200.
Theory, analysis, and forecasting of intermediate- and large-scale motions in the atmosphere. Topics include the primitive flow equations, planetary boundary layer, synoptic-scale motions, atmospheric oscillations, mesoscale circulations, and the general global circulation. 2.0 hours lecture, 3.0 hours laboratory.

GEO 202 Optical Mineralogy 1.0 Spring
Prerequisites: GEO 108 with grade of C- or better. Must be taken concurrently with GEO 203.
Theory and practice of identification of minerals with the petrographic microscope. Emphasis on the common rock-forming silicates. 3.0 hours laboratory.

GEO 203 Igneous and Metamorphic Petrology 4.0 Spring
Prerequisites: GEO 108 with grade of C- or better. Must be taken concurrently with GEO 202.
Physical-chemical development and geotectonic settings of igneous and metamorphic rocks. Analysis of rock thin sections. Field trip required. 3.0 hours lecture, 3.0 hours laboratory.

GEO 204 Planetarium Operation 2.0 January
Prerequisites: GEO 105; GEO 203 or GEO 206; faculty permission.
Introduction to planetarium operation, including console operation, sky setting, and use of auxiliary projectors. Study of the use of the planetarium as a teaching tool. Development of planetarium programs, including the integration of Internet resources displayed with the Roper Planetarium LCD projector. Each student will prepare an original planetarium program and present this program to an audience. 0.0 hour activity.

GEO 205 Solar System Astronomy 3.0 O ddSpr
Prerequisites: PHYS 002A or equivalent, or faculty permission. Study of planets, asteroids, meteors, and comets, including the dynamics of their orbits, the geology of their surfaces, and their origin. Study of planetary atmospheres, including their origin, evolution, dynamics and climate. Space colonies and the possible colonization of other planets will also be discussed.

GEO 206 The Origin and Evolution of the Universe 3.0 EvnSpr
Prerequisites: PHYS 002A; PHYS 002B; or equivalent, or faculty permission.
Origin of the universe. Formation of galaxies and stars. Recent developments in astronomy: black holes, pulsars, quasars, radio galaxies, etc. Life in the universe. Possibility of interstellar communication with extraterrestrial civilizations.

GEO 208 Structural Geology 4.0 Fall
Prerequisites: High school or college trigonometry; GEO 063; GEO 107 with grade of C- or higher. Behavior of geologic materials. Folds, faults, small-scale structures in sedimentary, igneous, and metamorphic rocks. Graphical methods. 2.0 hours lecture, 4.0 hours activity. Special fee required; see The Class Schedule.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
<th>Terms</th>
<th>Prerequisites</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOS 210</td>
<td>Introduction to Watershed Hydrology</td>
<td>3.0</td>
<td>Spring</td>
<td>GEOS 145 or prior hydrology course work and consent of instructor.</td>
<td>Survey of the hydrologic processes that govern the movement and storage of water in a watershed context. Review of soils and sediment transport. Topics will include current water quality problems in agricultural, rangeland, forested, and urban watersheds. Quantitative computer-based methods for predicting runoff and erosion will be employed. 2.0 hours lecture, 1.0 hours laboratory.</td>
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<tr>
<td>GEOS 215</td>
<td>Hydrogeology</td>
<td>3.0</td>
<td>Spring</td>
<td>CHEM 037, GEOS 106; MATH 007A; either PHYS 002A or PHYS 004A; either GEOS 070 or GEOS 180. Recommended: GEOS 107.</td>
<td>Theory and analysis of groundwater flow, including fluid physics, aquifer properties, soil water, groundwater recharge, hydrogeologic environments, aquifer mechanics, and water quality degradation. 2.0 hours lecture, 3.0 hours laboratory.</td>
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<tr>
<td>GEOS 220</td>
<td>Modern Topics in the Geosciences</td>
<td>3.0</td>
<td>Fall</td>
<td></td>
<td>Recent advances in the major areas of the physical sciences, including the important interdisciplinary fields.</td>
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<tr>
<td>GEOS 230</td>
<td>Environmental Systems Modeling I</td>
<td>3.0</td>
<td>Spring/Fall</td>
<td>CHEM 038, GEOS 130 or faculty permission; MATH 007A; either PHYS 002B or PHYS 004C.</td>
<td>A continuation of GEOS 230. Application, verification, and modification techniques for time-dependent and multi-dimensional models used in the geosciences. Introduction to widely used models and analysis packages. 2.0 hours lecture, 2.0 hours activity.</td>
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<tr>
<td>GEOS 235</td>
<td>Pollution Ecology</td>
<td>3.0</td>
<td>Fall</td>
<td>Chem 038.</td>
<td>The application of biological, ecological, chemical, and physical sciences to understanding the fate and transport of pollutants through ecosystems.</td>
</tr>
<tr>
<td>GEOS 236</td>
<td>Applied Ecology</td>
<td>3.0</td>
<td>Spring</td>
<td>BIOL 121.</td>
<td>Examination of the mechanisms, directions, and magnitude of an organism’s or ecosystem’s response to human perturbation.</td>
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<tr>
<td>GEOS 245</td>
<td>Applied Geophysics</td>
<td>3.0</td>
<td>Spring</td>
<td>GEOS 002; or faculty permission.</td>
<td>Introduction to solid-earth geophysical exploration techniques and data analysis. Includes electrical, electromagnetic, gravimetric, and seismic surveying, and wireline well logging. Concentration on problems in environmental science, hydrology, mineral prospecting, and oil exploration.</td>
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<tr>
<td>GEOS 249</td>
<td>Economic Geology</td>
<td>3.0</td>
<td>Spring/Fall</td>
<td>GEOS 106, GEOS 107, GEOS 208.</td>
<td>The integrative course dealing with origins and occurrences of metallic and non-metallic mineral deposits, including factors in their use.</td>
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<tr>
<td>GEOS 250</td>
<td>Tectonics</td>
<td>3.0</td>
<td>Spring/Fall</td>
<td>GEOS 092. (May be taken concurrently).</td>
<td>Evolution of the larger features of the earth; continents, oceans, mountain ranges, and lithospheric plates. Methods of tectonic analysis, including interpretation. Geologic development of the western United States. Special fee required; see The Class Schedule.</td>
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<tr>
<td>GEOS 255</td>
<td>Sedimentary Basin Analysis</td>
<td>3.0</td>
<td>Fall</td>
<td>GEOS 107, GEOS 203.</td>
<td>Study of the paleographic evolution of sedimentary basins. Includes stratigraphic and paleoecologic correlation, facies analysis, sedimentary petrology, depositional systems, and the tectonic framework of sedimentary basins. 2.0 hours lecture, 3.0 hours laboratory.</td>
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<tr>
<td>GEOS 260</td>
<td>Water Resources Management</td>
<td>3.0</td>
<td>Spring</td>
<td>GEOS 130 or GEOS 180.</td>
<td>Water-resources, management plans of world; emphasis on California and Israeli plans. Water plans in primitive, agrarian, and industrial societies. Data gathering and interpretation, regulation of water resources, and control of water pollution.</td>
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<tr>
<td>GEOS 265</td>
<td>Geochemistry</td>
<td>3.0</td>
<td>Fall</td>
<td>CHEM 037, GEOS 092. Recommended: GEOS 106.</td>
<td>Investigation of the chemistry of minerals, rocks, and natural waters. Provides students with interests in geology, hydrology, and environmental science, and others with a physiological background on the chemical compositions of rocks, minerals, and natural waters; chemical processes in the formation of rocks and waters; principles of reaction chemistry, thermodynamics, and kinetics applied to geochemical systems; and migration of chemical contaminants in the environment.</td>
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<tr>
<td>GEOS 270</td>
<td>Environmental and Engineering Geology</td>
<td>3.0</td>
<td>Spring/Fall</td>
<td>GEOS 022.</td>
<td>For majors in related sciences and technical fields. GEOS 002. Practical application of techniques to solve geological engineering and environmental problems. Topics include surface investigations and remote sensing; borehole and surface geophysics; soil descriptions and properties; landslide mapping, mechanics and remediation, subsurface investigation of rock masses; mapping of discontinuities, establishing rock quality, tunneling techniques, seismic and trench mapping of faults, seismic risk analysis. Ground water monitoring, site assessment, techniques of hazardous waste cleanup, state and federal regulations on hazardous waste, siting of landfills.</td>
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<tr>
<td>GEOS 271</td>
<td>Field Geology</td>
<td>2.0</td>
<td>Spring</td>
<td>GEOS 160; GEOS 161; GEOS 208 (with grade of C- or higher in all courses).</td>
<td>Mapping, recording, and interpreting data in the field; use of Brunton compass and topographic maps emphasized. Reports required. Field work during January intersession totaling at least 10 days. You may take this course more than once for a maximum of 6.0 units.</td>
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<tr>
<td>GEOS 272</td>
<td>Advanced Field Geology</td>
<td>2.0</td>
<td>Spring</td>
<td>GEOS 203, GEOS 271.</td>
<td>Independent geologic mapping of a difficult area. Report required. Field work on weekends or during spring recess, totaling at least 10 days. You may take this course more than once for a maximum of 6.0 units.</td>
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<tr>
<td>GEOS 275</td>
<td>Senior Project</td>
<td>2.0</td>
<td>Spring</td>
<td></td>
<td>Independent study in geology. Must be completed in the senior year for a maximum of 6.0 units.</td>
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<tr>
<td>GEOS 280</td>
<td>Geologic Evolution of North America</td>
<td>3.0</td>
<td>Spring</td>
<td>GEOS 255; senior standing in Geology option, or faculty permission.</td>
<td>Group study of topics related to the geological evolution of North America. Student presentations and group discussion will focus on common themes or geologic regions.</td>
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<tr>
<td>GEOS 290</td>
<td>Seminar in the Geosciences</td>
<td>1.0</td>
<td>Fall</td>
<td></td>
<td>Readings, reports, and discussion of topics in the current literature or of special studies in any area of the physical sciences.</td>
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<tr>
<td>GEOS 299H</td>
<td>Honors Research in the Geosciences</td>
<td>3.0</td>
<td>Fall/Spring</td>
<td></td>
<td>Honors Research in the Geosciences. First semester: A total of 9 upper-division units in the major, with at least a B average, and faculty permission. Second semester: A grade of B or higher in the first semester of the course; an intensive two-semester course in research within a subdiscipline of the physical sciences. Students enroll for 3 units each semester. Only students with at least a 3.0 GPA in the major. The course consists of a research project done under the supervision of a faculty member, a formal written paper, and a public presentation. This course may be used to fulfill a maximum of 3 units of the upper-division requirement for the major. You may take this course more than once for a maximum of 6.0 units.</td>
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<tr>
<td>GEOS 300</td>
<td>Geosciences Seminar I</td>
<td>1.0</td>
<td>Fall</td>
<td></td>
<td>Presentation and discussion of reports on current literature and special studies in geosciences.</td>
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<tr>
<td>GEOS 301</td>
<td>Geosciences Seminar II</td>
<td>1.0</td>
<td>Spring</td>
<td></td>
<td>Presentation and discussion of reports on current literature and special studies in geosciences.</td>
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<tr>
<td>GEOS 310</td>
<td>Introduction to Watershed Hydrology</td>
<td>4.0</td>
<td>Spring</td>
<td>GEOS 130 or concurrent enrollment in GEOS 215 or prior hydrology course work.</td>
<td>Coupled hydrologic, soils and surficial geologic processes that govern watersheds will be emphasized. Students will critically review the theoretical basis for quantitative watershed analytical methods and the scientific basis for current regulations. Current water quality problems in agricultural, rangeland, forested, and urban watersheds will be examined. A variety of watersheds runoff and water quality models will be examined. 3.0 hours lecture, 3.0 hours laboratory.</td>
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<tr>
<td>GEOS 317</td>
<td>Advanced Topics in Geology</td>
<td>3.0</td>
<td>Fall/Spring</td>
<td></td>
<td>You must register directly with a supervising faculty member. Discussions and library research into selected topics; may include some lab or field work. Different topics presented each semester. May be repeated for credit, with permission of instructor.</td>
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<tr>
<td>GEOS 319</td>
<td>Advanced Topics in Meteorology</td>
<td>3.0</td>
<td>Fall/Spring</td>
<td></td>
<td>You must register directly with a supervising faculty member. Discussions and library research into selected topics; may include some lab work. Different topics presented each semester. May be repeated for credit, with permission of instructor.</td>
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</table>
GEOS 321  Advanced Topics in Hydrology  3.0 Fa/Spr
You must register directly with a supervising faculty member. Discussions and library research into selected topics; may include some lab work. Different topics presented each semester. May be repeated for credit, with permission of instructor.

GEOS 323  Advanced Topics in Astronomy  3.0 Fa/Spr
You must register directly with a supervising faculty member. Discussions and library research into selected topics; may include some lab work. Different topics presented each semester. May be repeated for credit, with permission of instructor.

GEOS 325  Advanced Topics in Environmental Science  3.0 Fa/Spr
You must register directly with a supervising faculty member. Discussions and library research into selected topics; may include some lab work. Different topics presented each semester. May be repeated for credit, with permission of instructor.

GEOS 330  Geotectonic Development of California  3.0 Fall
Prerequisites: Graduate standing or consent of instructor.
Geological and geophysical characteristics of the geomorphic provinces of California. Formation of surficial features, such as mountain ranges, drainage networks, and valleys as a response to active tectonic processes. Detailed geologic and physiographic framework of Northern California as a setting for field-based studies in the geosciences.

GEOS 340  Hydrogeochemistry  3.0 Spring
Prerequisites: CHEM 037; CHEM 038.
Origins and sources of chemical constituents of natural waters, including water-rock interactions, equilibrium aqueous speciation, reaction-path modeling, oxidation-reduction reactions, mineral solubility relations, geochemical transport, reaction kinetics, and aqueous isotopic systems.

GEOS 350  Environmental Monitoring  2.0 Fall
Prerequisites: CHEM 255 is recommended.
Survey of environmental monitoring for air quality, water quality, pollution, waste disposal, environmental resources, etc., including field and laboratory observations and exercises. An individual term project in environmental monitoring is required and may involve collection of field data, interpretation of field data, development of analytical capabilities, or other subjects pertinent to the student’s research interests. 1.0 hour discussion, 3.0 hours laboratory. Special fee required; see The Class Schedule.

GEOS 360  Numerical Analysis  3.0 Spring
Prerequisites: MATH 007A.
Survey and implementation of common numerical techniques in use in geoscientific data analysis, including multivariate data analysis, geostatistics, finite difference and finite element analyses, time-series analysis, and fractal geometry.

GEOS 398  Independent Study  1.0-4.0 Fa/Spr
This course is a graduate level independent study offered as 398A-D for 1.0 to 4.0 units respectively. You must register directly with a supervising faculty member.

GEOS 399  Master's Thesis  1.0-6.0 Fa/Spr
This course is a master’s thesis identified as 399A-F for 1.0 to 6.0 units respectively. You must register directly with a supervising faculty member.