Disciplines within the geological and environmental sciences are directed towards understanding the terrestrial system from the core of the earth to beyond our solar system. Students will conduct 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. 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.

Geology is the study of processes occurring in or on the earth. The B.S. in Geology prepares students for careers or graduate education in fields such as resource exploration, hydrogeology, 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 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 Association of Geological and Environmental Students (AGES) is open to all students. AGES hosts several off-campus field trips 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 other 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 basic research or a position at a community college or university are advised to plan on working towards 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 suitable minors with their advisor.
The Bachelor of Science in Geosciences

**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.

A suggested Major Academic Plan (MAP) has been prepared to help students meet all graduation requirements within four years. Please request a plan from your Student Advisor 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.

Geosciences majors in the Option in Science Education with a Concentration in Geosciences may meet the Breadth Area B2 requirement by completing BIOL 151.

**Cultural Diversity Course Requirements: 6 units**

See “Cultural Diversity” in the University Catalog. Most courses taken 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 130 and POLS 153. 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 in the major 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 130 (or its equivalent) with a C– or better before you may register for a WP course.

**Course Requirements for the Major: 64–65 units**

The following courses, or their approved transfer equivalents, are required to satisfy all graduation requirements within four years. Additional required courses, depending upon the selected option or advising pattern, are outlined following the degree core program requirements.

**Major Core Program: 15–16 units**

<table>
<thead>
<tr>
<th>2 courses required:</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 111 General Chemistry 4.0 FS *</td>
</tr>
<tr>
<td>Prerequisites: Second-year high school algebra; one year high school chemistry. (One year of high school physics and one year of high school mathematics past Algebra II are recommended.)</td>
</tr>
<tr>
<td>MATH 120 Analytic Geometry and Calculus 4.0 FS *</td>
</tr>
<tr>
<td>Prerequisites: Completion of ELM requirement; both MATH 118 and MATH 119 (or high school equivalent); a score that meets department guidelines on a department administered calculus readiness exam.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1 course selected from:</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 202A General Physics 4.0 FS *</td>
</tr>
<tr>
<td>Prerequisites: High school physics or faculty permission. High school trigonometry and second-year high school algebra or equivalent (MATH 051 and MATH 118 at CSU, Chico).</td>
</tr>
<tr>
<td>PHYS 204A Mechanics 4.0 FS *</td>
</tr>
<tr>
<td>Prerequisites: High school physics or faculty permission. Concurrent enrollment in or prior completion of MATH 121 (second semester of calculus) or equivalent.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1 course selected from:</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 105 Statistics 3.0 FS *</td>
</tr>
<tr>
<td>Prerequisites: Completion of ELM requirement.</td>
</tr>
<tr>
<td>MATH 121 Analytic Geometry and Calculus 4.0 FS</td>
</tr>
<tr>
<td>Prerequisites: MATH 120.</td>
</tr>
</tbody>
</table>

MATH 121 is strongly recommended for the Option in Physical Science Education and the Option in Science Education.

**Major Option Course Requirements: 49 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 Physical Science Education: 49 units**

This option provides students with a good foundation in each of the physical sciences so that they are prepared to pass the California Subject Examinations for Teachers (CSET) in Earth Science. Students who complete the program are also prepared to pass the General Science CSET, which will allow them to teach general science at the middle school level.

**Lower-Division Requirements: 24 units**

<table>
<thead>
<tr>
<th>7 courses required:</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 101 Concepts of Biology 3.0 FS *</td>
</tr>
<tr>
<td>CHEM 112 General Chemistry 4.0 FS</td>
</tr>
<tr>
<td>Prerequisites: CHEM 111.</td>
</tr>
<tr>
<td>CHEM 270 Organic Chemistry 4.0 FS</td>
</tr>
<tr>
<td>Prerequisites: CHEM 112.</td>
</tr>
<tr>
<td>GEOS 102 Physical Geology 3.0 FS *</td>
</tr>
<tr>
<td>Prerequisites: High school chemistry or physics is recommended; students with no previous science courses are advised to enroll in GEOS 101. No college credit for those who have passed GEOS 101.</td>
</tr>
<tr>
<td>GEOS 105 Introduction to Astronomy 3.0 FS *</td>
</tr>
<tr>
<td>GEOS 201 Principles of Historical Geol 3.0 FA</td>
</tr>
<tr>
<td>Prerequisites: GEOS 101 or GEOS 102.</td>
</tr>
<tr>
<td>PHYS 202B General Physics 4.0 FS</td>
</tr>
<tr>
<td>Prerequisites: PHYS 202A.</td>
</tr>
</tbody>
</table>

**Upper-Division Requirements: 25 units**

<table>
<thead>
<tr>
<th>8 courses required:</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 302 Evolution 3.0 SP</td>
</tr>
<tr>
<td>Prerequisites: BIOL 101 or BIOL 108 or equivalent.</td>
</tr>
<tr>
<td>CHEM 411 Chemistry Teaching Methods 3.0 SP</td>
</tr>
<tr>
<td>Prerequisites: CHEM 112, CHEM 270, CHEM 320 is recommended.</td>
</tr>
<tr>
<td>CHEM 440 Environmental Chemistry 3.0 SP</td>
</tr>
<tr>
<td>CHEM 441 Principles of General Chemistry 3.0 SP</td>
</tr>
<tr>
<td>GEOS 300 Earth System Science 3.0 FA WP</td>
</tr>
<tr>
<td>Prerequisites: ENGL 130 (or its equivalent) with a grade of C– or higher; CHEM 107 or equivalent; PHYS 202A, PHYS 202B.</td>
</tr>
<tr>
<td>GEOS 306 Mineralogy and Lithology 4.0 FA</td>
</tr>
<tr>
<td>Prerequisites: GEOS 101 or GEOS 102; CHEM 107 or CHEM 111 or equivalent; or faculty permission.</td>
</tr>
<tr>
<td>GEOS 321 Introduction to Meteorology 3.0 FA</td>
</tr>
<tr>
<td>GEOS 341 Teaching Practicum in GEOS 3.0 FA</td>
</tr>
<tr>
<td>Prerequisites: GEOS 102, GEOS 105, GEOS 203, GEOS 306, GEOS 327.</td>
</tr>
<tr>
<td>PHYS 360 Sound in the Environment 3.0 FS *</td>
</tr>
</tbody>
</table>

**The Option in Science Education with a Concentration in Geosciences: 49 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: 25 units**

<table>
<thead>
<tr>
<th>7 courses required:</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 151 Prin of Cell and Molec Biology 4.0 FS</td>
</tr>
<tr>
<td>Prerequisites: Recommend CHEM 111 or concurrent enrollment.</td>
</tr>
<tr>
<td>BIOL 152 Prin Ecol, Evol, Org Biology 4.0 FS</td>
</tr>
<tr>
<td>Prerequisites: BIOL 151; recommend CHEM 112 or concurrent enrollment.</td>
</tr>
<tr>
<td>CHEM 112 General Chemistry 4.0 FS</td>
</tr>
<tr>
<td>Prerequisites: CHEM 111.</td>
</tr>
<tr>
<td>GEOS 102 Physical Geology 3.0 FS *</td>
</tr>
<tr>
<td>Prerequisites: High school chemistry or physics is recommended; students with no previous science courses are advised to enroll in GEOS 101. No college credit for those who have passed GEOS 101.</td>
</tr>
<tr>
<td>GEOS 105 Introduction to Astronomy 3.0 FS *</td>
</tr>
<tr>
<td>GEOS 201 Principles of Historical Geol 3.0 FA</td>
</tr>
<tr>
<td>Prerequisites: GEOS 101 or GEOS 102.</td>
</tr>
<tr>
<td>PHYS 202B General Physics 4.0 FS</td>
</tr>
<tr>
<td>Prerequisites: PHYS 202A.</td>
</tr>
</tbody>
</table>

**Upper-Division Requirements: 24 units**

<table>
<thead>
<tr>
<th>7 courses required:</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOS 300 Earth System Science 3.0 FA WP</td>
</tr>
<tr>
<td>Prerequisites: ENGL 130 (or its equivalent) with a grade of C– or higher; CHEM 107 or equivalent; PHYS 202A, PHYS 202B.</td>
</tr>
<tr>
<td>GEOS 303 Invertebrate Paleontology 3.0 SP</td>
</tr>
<tr>
<td>Prerequisites: GEOS 203 or course in Biology.</td>
</tr>
<tr>
<td>GEOS 306 Mineralogy and Lithology 4.0 FA</td>
</tr>
<tr>
<td>Prerequisites: GEOS 101 or GEOS 102; CHEM 107 or CHEM 111 or equivalent; or faculty permission.</td>
</tr>
<tr>
<td>GEOS 307 Stratigraphy 3.0 FA</td>
</tr>
<tr>
<td>Prerequisites: GEOS 201 and GEOS 306 (both may be taken concurrently), or faculty permission.</td>
</tr>
<tr>
<td>GEOS 321 Introduction to Meteorology 3.0 FA</td>
</tr>
<tr>
<td>Prerequisites: MATH 120; either PHYS 202B or PHYS 204C.</td>
</tr>
<tr>
<td>GEOS 343 Oceanography 3.0 FA</td>
</tr>
<tr>
<td>Prerequisites: A lab course in the biological sciences and a lab course in the physical sciences.</td>
</tr>
</tbody>
</table>
GEOS 360 Field Methods 2.0 SP
Prerequisites: GEOS 306, GEOS 307.

1 course selected from:
GEOS 405 Solar System Astronomy 3.0 S1
Prerequisites: PHYS 202A or equivalent, or faculty permission.
GEOS 406 Origin/Evolution of Universe 3.0 S2
Prerequisites: PHYS 202A, PHYS 202B 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 advisor regarding the selection of courses which will provide breadth to your University experience and possibly 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 advisor for specific information.

Hons in the Major
Honors in the Major is a program of independent work in your major. It involves six units of honors course work completed over two semesters. 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. Your Honors work will be recognized at your graduation, on your permanent transcript, and on your diploma. It is often accompanied by letters of commendation from your mentor in the department or the department chair.

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 units are independent study (399, 499H) as specified by your department. You must complete each class with a minimum grade of B. You must complete 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 for your major carefully, as there may be specific courses that must be included in these units.
2. Your cumulative GPA should be at least 3.5 or within the top 5% of majors in your department.
3. Your GPA in your major should be at least 3.5 or within the top 5% of majors in your department.
4. 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.
5. 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 advisor to apply.

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.

A suggested Major Academic Plan (MAP) has been prepared to help students meet all graduation requirements within four years. Please request a plan from your major advisor 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: 62–63 units
The following courses, or their approved transfer equivalents, are required of all candidates for this degree:

Lower-Division Requirements: 21–22 units
4 courses required:
CHEM 111 General Chemistry 4.0 FS *
Prerequisites: Second-year high school algebra; one year high school chemistry. One year of high school physics and one year of high school mathematics past Algebra II are recommended.
The Bachelor of Science in Environmental Science

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.

A suggested Major Academic Plan (MAP) has been prepared to help students meet all graduation requirements within four years. Please request a plan from your major advisor 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: 67–75 units

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

**Major Core Program: 49 units**

Lower-Division Requirements: 36 units

8 courses required:

- **BIOL 151** Prin of Cell and Molec Biology 4.0 FS
- **BIOL 152** Prin Ecol, Evol, Org Biology 4.0 FS
- **CHEM 111** General Chemistry 4.0 FS
- **CHEM 112** Physical Geology 3.0 FS*
- **CHEM 203** Computer Apps in Geoscience 1.0 FS
- **MATH 120** Analytic Geometry and Calculus 4.0 FS
- **MATH 121** Analytic Geometry and Calculus 4.0 FS
- **PHYS 202A** General Physics 4.0 FS

2 courses selected from:

- **PHYS 202B** General Physics 4.0 FS
- **PHYS 204A** Mechanics 4.0 FS
- **PHYS 204B** Electricity and Magnetism 4.0 FS
- **PHYS 204C** Heat/Wave Motion/Sound/Light 4.0 FS

5 courses required:

- **CHEM 110** Organic Chemistry 4.0 FS
- **GEOS 101** Geology 3.0 SP
- **GEOS 102** Hydrology 3.0 SP
- **GEOS 203** Geophysics 3.0 SP
- **GEOS 306** Mineralogy and Lithology 4.0 FA

5 courses selected from:

- **CHEM 107** Principles of Chemistry 4.0 FS
- **CHEM 111** General Chemistry 4.0 FS
- **CHEM 112** General Chemistry 4.0 FS
- **CHEM 113** Organic Chemistry 4.0 FS
- **CHEM 114** Physical Chemistry 4.0 FS

Major Option Course Requirements: 18–26 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 Applied Ecology: 22 units**

**Lower-Division Requirements: 2 units**

1 course required:

- **GEOS 201** Introduction to Meteorology 3.0 FA

**Upper-Division Requirements: 20 units**

6 courses required:

- **BIOL 402** Microbial Ecology 4.0 SP
- **CHEM 440** Environmental Chemistry 3.0 SP
- **GEOS 427** Environmental Impact Analysis 3.0 SP
- **GEOS 535** Pollution Ecology 3.0 FA
- **GEOS 536** Applied Ecology 3.0 SP
- **CHEM 440** Environmental Chemistry 3.0 SP

**The Option in Atmospheric Science: 21 units**

7 courses required:

- **CHEM 440** Environmental Chemistry 3.0 SP
- **GEOS 321** Introduction to Meteorology 3.0 FA
- **GEOS 400** Physical Meteorology 3.0 F
- **GEOS 401** Dynamic Meteorology & Analysis 3.0 S
- **GEOS 502** Air Pollution Meteorology 3.0 S
- **GEOS 517** The Atmospheric Environment 3.0 F
- **GEOS 530** Environmental Sys Modeling I 3.0 F

**The Option in Earth Resource Science: 18 units**

1 course selected from:

- **GEOS 380** Hydrology 3.0 FA
- **GEOS 415** Hydrogeology 3.0 SP

**Upper-Division Requirements: 18 units**

5 courses required:

- **CHEM 107** Principles of Chemistry 4.0 FS
- **CHEM 110** Organic Chemistry 4.0 FS
- **CHEM 111** General Chemistry 4.0 FS
- **CHEM 112** General Chemistry 4.0 FS
- **CHEM 114** Physical Chemistry 4.0 FS

5 courses selected from:

- **CHEM 107** Principles of Chemistry 4.0 FS
- **CHEM 110** Organic Chemistry 4.0 FS
- **CHEM 111** General Chemistry 4.0 FS
- **CHEM 112** General Chemistry 4.0 FS
- **CHEM 113** Organic Chemistry 4.0 FS

**The Option in Environmental Chemistry: 21–22 units**

5 courses required:

- **CHEM 425** Basic Instrumental Analysis 3.0 SP
- **CHEM 440** Environmental Chemistry 3.0 SP
- **GEOS 516** Natural Water Systems 3.0 F
- **GEOS 517** The Atmospheric Environment 3.0 F
- **GEOS 565** Geochemistry 3.0 FA

6–7 units selected from:

- **CHEM 270** Organic Chemistry 4.0 FS
- **CHEM 112** General Chemistry 4.0 FS
CHEM 445 Environmental Toxicology 2.0 SP  
Prerequisites: CHEM 108 or CHEM 270.

GEOS 530 Environmental Sys Modeling I 3.0 F2  
Prerequisites: CHEM 112; GEOS 330 or faculty permission; MATH 120; either PHYS 202B or PHYS 204C.

GEOS 535 Pollution Ecology 3.0 FA  
Prerequisites: Chem 112.

The Option in Hydrologic Science: 25–26 units

Lower-Division Requirements: 2 units

1 course required:

GEOS 260 Environmental Soil Science 2.0 FA  
Prerequisites: CHEM 111, PHYS 202A or PHYS 204A (may be taken concurrently).

Upper-Division Requirements: 23–24 units

4 courses required:

GEOS 380 Hydrology 3.0 FA  
Prerequisites: GEOS 270, PHYS 202A or PHYS 204A (may be taken concurrently).

GEOS 381 Hydrologic Field Methods 2.0 FA  
Prerequisites: GEOS 270 (may be taken concurrently), GEOS 380, GEOS 415, prior hydrology course work or consent of instructor.

GEOS 415 Hydrogeology 3.0 SP  
Prerequisites: CHEM 111, GEOS 306, MATH 120; either PHYS 202A or PHYS 204A; either GEOS 270 or GEOS 380. Recommended: GEOS 307.

GEOS 460 Water Resources Management 3.0 SP  
Prerequisites: Upper-division standing; GEOS 330 or GEOS 380.

1 course selected from:

GEOS 516 Natural Water Systems 3.0 F2  
Prerequisites: CHEM 111. Suggested: CHEM 440.

GEOS 565 Geochemistry 3.0 FA  
Prerequisites: CHEM 111, GEOS 102. Recommended: GEOS 306.

1 course selected from:

GEOS 360 Mineralogy and Lithology 4.0 FA  
Prerequisites: GEOS 101 or GEOS 102; CHEM 107 or CHEM 111 or equivalent; or faculty permission.

GEOS 537 Ecohydrology 3.0 SP  
Prerequisites: GEOS 102, GEOS 203, GEOS 306. For majors in related sciences and technical fields, GEOS 102.

GEOS 565 Geochemistry 3.0 FA  
Prerequisites: CHEM 111, GEOS 102. Recommended: GEOS 306.

GEOS 570 Environmental/Engineering Geol 3.0 S2  
Prerequisites: GEOS 102, GEOS 203, GEOS 106. For majors in related sciences and technical fields, GEOS 102.

GEOS 572 Advanced Field Geology 2.0 SP  
Prerequisites: GEOS 403, GEOS 471.

The Minors in Geology

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 Geology may not pursue a minor in Geology.

5 courses required:

GEOS 102 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 101. No college credit for those who have passed GEOS 101.

GEOS 203 Principles of Historical Geol 3.0 FA  
Prerequisites: GEOS 101 or GEOS 102.

GEOS 306 Mineralogy and Lithology 4.0 FA  
Prerequisites: GEOS 101 or GEOS 102; CHEM 107 or CHEM 111 or equivalent; or faculty permission.

GEOS 307 Stratigraphy 3.0 FA  
Prerequisites: GEOS 201 and GEOS 306 (both may be taken concurrently), or faculty permission.

GEOS 360 Field Methods 2.0 SP  
Prerequisites: GEOS 306, GEOS 307.

7 units selected from:

GEOS 301 Invertebrate Paleontology 3.0 SP  
Prerequisites: GEOS 201 or course in biology.

GEOS 361 Preparing Geological Reports 1.0 SP WP  
Prerequisites: ENGL 130 (or its equivalent) with a grade of C– or higher, GEOS 360.

GEOS 402 Optical Mineralogy 1.0 SP  
Prerequisites: GEOS 306 with grade of C– or better. Must be taken concurrently with GEOS 403.

GEOS 403 Igneous/Metamorphic Petrology 4.0 SP  
Prerequisites: GEOS 306 with grade of C– or better. Must be taken concurrently with GEOS 402.

GEOS 408 Structural Geology 4.0 FA  
Prerequisites: High school or college trigonometry; GEOS 203; GEOS 307 with grade of C– or higher.

GEOS 415 Hydrogeology 3.0 SP  
Prerequisites: GEOS 111, GEOS 306, MATH 120; either PHYS 202A or PHYS 204A; either GEOS 270 or GEOS 380. Recommended: GEOS 307.

GEOS 436 Volcanology 3.0 F2  
Prerequisites: GEOS 101 or GEOS 102 and GEOS 306.

GEOS 440 Geology 306 3.0 SP  
Prerequisites: Upper-division standing; GEOS 330 or GEOS 380.

GEOS 471 Field Geology 2.0 SP  
Prerequisites: GEOS 360, GEOS 361, GEOS 408 (with grade of C– or higher in all courses).

GEOS 549 Economic Geology 3.0 SP  
Prerequisites: GEOS 306, GEOS 307.

GEOS 553 Sedimentary Basin Analysis 3.0 FA  
Prerequisites: GEOS 307, GEOS 403.

GEOS 565 Geochemistry 3.0 FA  
Prerequisites: CHEM 111, GEOS 102. Recommended: GEOS 306.

GEOS 570 Environmental/Engineering Geol 3.0 S2  
Prerequisites: GEOS 102, GEOS 203, GEOS 106. For majors in related sciences and technical fields, GEOS 102.

GEOS 572 Advanced Field Geology 2.0 SP  
Prerequisites: GEOS 403, GEOS 471.

GEOS 580 Geol Evolution of North Amer 3.0 SP  
Prerequisites: GEOS 555, senior standing in Geology major, or faculty permission.

The Certificate in Hydrogeology

This certificate provides Geology majors with the information and skills necessary to become certified hydrogeologists in the State of California. Before beginning the certificate, students must have completed the following courses with a minimum GPA of 2.5: CHEM 111, CHEM 112, GEOS 102, GEOS 306, PHYS 202A or PHYS 204A, PHYS 202B or PHYS 204C, MATH 120.

Course Requirements for the Certificate: 26 units

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

Lower-Division Requirements: 3 units

2 courses required:

GEOS 250 Computer Apps in Geoscience 1.0 FS  
Prerequisites: Prior or concurrent enrollment in MATH 120, or consent of instructor.

GEOS 270 California Water 2.0 SP  
Prerequisites: One course from Breadth Area B1 of General Education.

Upper-Division Requirements: 23 units

7 courses required:

GEOS 380 Hydrology 3.0 FA  
Prerequisites: GEOS 270, PHYS 202A or PHYS 204A (may be taken concurrently).

GEOS 381 Hydrologic Field Methods 2.0 FA  
Prerequisites: GEOS 270 (may be taken concurrently), GEOS 380, GEOS 415, prior hydrology course work or consent of instructor.

GEOS 390 Surficial Processes 3.0 FA  
Prerequisites: MATH 120; either PHYS 202A or PHYS 204A.

GEOS 415 Hydrogeology 3.0 SP  
Prerequisites: CHEM 111, GEOS 306, MATH 120; either PHYS 202A or PHYS 204A; either GEOS 270 or GEOS 380. Recommended: GEOS 307.

GEOS 460 Water Resources Management 3.0 SP  
Prerequisites: Upper-division standing; GEOS 330 or GEOS 380.

GEOS 490 Surficial Processes 3.0 FA  
Prerequisites: MATH 120; either PHYS 202A or PHYS 204A.

GEOS 493 Environmental Sys Modeling I 3.0 F2  
Prerequisites: CHEM 112; GEOS 330 or faculty permission; MATH 120; either PHYS 202B or PHYS 204C.

GEOS 543 Applied Geophysics 3.0 S2  
Prerequisites: Upper-division standing; GEOS 102, or faculty permission.

1 course selected from:

GEOS 516 Natural Water Systems 3.0 F2  
Prerequisites: GEOS 111, CHEM 112, Suggested: CHEM 440.

GEOS 566 Geochemistry 3.0 FA  
Prerequisites: CHEM 111, GEOS 102. Recommended: GEOS 306.
The Single Subject Matter Preparation Program in Science

Course requirements for the Single Subject Matter Preparation Program, 48 units, in conjunction with the Professional Education Program, leads to a Single Subject Teaching Credential.

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.

Your departmental credential advisor is responsible for verifying that the subject matter preparation program has been completed. If you are interested in obtaining a teaching credential, contact the appropriate credential advisor early in your University career. Department credential advisors can assist you in planning an educational program that meets both major and credential requirements.

Subject matter preparation requirements are governed by federal and state legislative action and approval of the California Commission on Teacher Credentialing. Requirements may change between catalogs. Please consult your departmental credential advisor for current information.

The Option in Science Education with a Concentration in Geosciences described above, along with a professional education program, fulfills the requirements for the Single Teaching Credential in Science with a Concentration in Geosciences.

The Master of Science in Geosciences

Course Requirements for the Master’s Degree: 30 units

Continuous enrollment is required. A maximum of 9 semester units of transfer and/or CSU Chico Open University course work 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 Studies.

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 Studies. 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, and physics.)

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. 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:

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 Studies, to include:

1. Completion of an approved program consisting of 30 units of 400/500/600-level courses as follows:

(a) At least 18 units in geosciences, which must include GEOS 600, GEOS 601, GEOS 640, and GEOS 699T. The Option in Hydrology/Hydrogeology also requires GEOS 621 and GEOS 660.

(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 and must be approved by the Graduate Coordinator.

(c) At least 18 of the units required for the degree in 600-level courses.

(d) Not more than 9 semester units of transfer and/or extension credit (correspondence courses and U.C. extension course work 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 (697) and Master’s Thesis (699T); not more than 6 units of Master’s Thesis (699T).

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

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<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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<tr>
<td>GEOS 600</td>
<td>Geosciences Seminar I</td>
<td>1.0 FA</td>
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<tr>
<td>GEOS 601</td>
<td>Geosciences Seminar II</td>
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<td>GEOS 617</td>
<td>Advanced Topics in Geology</td>
<td>3.0 FS</td>
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<td>GEOS 630</td>
<td>Geotectonic Development of CA</td>
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<td>GEOS 640</td>
<td>Hydrogeology</td>
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<td>GEOS 650</td>
<td>Environmental Monitoring</td>
<td>2.0 FA</td>
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<tr>
<td>GEOS 660</td>
<td>Numerical Analysis</td>
<td>3.0 SP</td>
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<tr>
<td>GEOS 699T</td>
<td>Master’s Thesis</td>
<td>1.0–6.0 FS</td>
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| CHEM 111    | General Chemistry                    | 11 units| Required; GEOS 600, GEOS 617, GEOS 621, GEOS 640, GEOS 660.
| CHEM 112    | General Chemistry                    | 11 units| Required; GEOS 600, GEOS 617, GEOS 621, GEOS 640, GEOS 660.

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<td>Master’s Thesis</td>
<td>1.0–6.0 FS</td>
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At least 1 unit of Master’s Thesis is required.

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.

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 Option in Hydrology/Hydrogeology

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 Studies.

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 Studies. 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, and physics.)

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. 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:

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 Studies, to include:

1. Completion of an approved program consisting of 30 units of 400/500/600-level courses as follows:

(a) At least 18 units in geosciences, which must include GEOS 600, GEOS 601, GEOS 640, and GEOS 699T. The Option in Hydrology/Hydrogeology also requires GEOS 621 and GEOS 660.

(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 and must be approved by the Graduate Coordinator.

(c) At least 18 of the units required for the degree in 600-level courses.

(d) Not more than 9 semester units of transfer and/or extension credit (correspondence courses and U.C. extension course work 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 (697) and Master’s Thesis (699T); not more than 6 units of Master’s Thesis (699T).

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.
including 597/697, 696, 699P, 699T 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 597/697, 696, 699P, 699T 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 minimum 3.0 grade point average in each of the following three categories: all course work taken at any accredited institution subsequent to admission to the master's program; all course work taken at CSU, Chico subsequent to admission to the program; and all courses on the approved master's degree program.

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 and/or CSU Chico Open University course work 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 are advised to 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 Studies.
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 Studies. The prospective student must have sufficient background to undertake a graduate program in Environmental Science: mathematics (one semester of statistics and one year of calculus), two semesters of college physics, two semesters of chemistry, and a semester of ecology.

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. 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:
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 Environmental Science:
Completion of all requirements as established by the graduate advisory committee, and the Office of Graduate Studies, to include:
1. Completion of an approved program consisting of 30 units of 400/500/600-level courses as follows:
   (a) A core of 12-15 units in required courses to include GEO 600, GEO 601, GEO 640, GEO 660, a 400/500/600-level course in biological science or chemistry and GEO 630 or GEO 650. 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 BIOL 699T or CHEM 699T or GEO 699T. At least one unit of Master's Thesis (699) is required.
   (d) At least 18 of the units required for the degree in 600-level courses.

Geological and Environmental Sciences

Course Requirements for the MS in Environmental Science:
8 units required:
GEOS 600 Geosciences Seminar I 1.0 FA
GEOS 610 Geosciences Seminar II 1.0 SP
GEOS 640 Hydrogeochmistry 3.0 SP
Prerequisites: CHEM 111, CHEM 112. Recommended: GEO 565.
GEOS 660 Numerical Analysis 3.0 SP
Prerequisites: MATH 120.

2-4 units selected from:
One 400/500/600-level course in Biological Sciences or Chemistry.

2-4 units selected from:
GEOS 630 Geotectonic Development of CA 3.0 FA
Prerequisites: Graduate standing or consent of instructor.
GEOS 650 Environmental Monitoring 2.0 FA
Prerequisites: CHEM 425 is recommended.
1-6 units selected from:
BIOL 699T Master's Thesis 1.0–6.0 FS
CHEM 699T Master's Thesis 1.0–6.0 FS
GEOS 699T Master's Thesis 1.0–6.0 FS
At least 1 unit of 699T is required.

Select 9–17 units from courses approved by the graduate committee.

Graduate Literacy Requirement:
Writing proficiency is a graduation requirement. Environmental Science students will normally demonstrate their writing competence through successful completion of GEO 600 and GEO 601, Geosciences Seminar, or an approved substitute.

Graduate Grading Requirements:
All courses in the major (with the exceptions of Independent Study—597/697, Comprehensive Examination—696, Master's Project—699P, and Master's Thesis—699T) must be taken for a letter grade, except those courses specified by the department as ABC/No Credit (400/500-level courses), AB/No Credit (600-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 597/697, 696, 699P, 699T 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 minimum 3.0 grade point average in each of the following three categories: all course work taken at any accredited institution subsequent to admission to the master's program; all course work taken at CSU, Chico subsequent to admission to the program; and all courses on the approved master's degree program.

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.

The Faculty
David L. Brown, 1995, Professor, PhD, UC Berkeley.
Amar Byker-Kaufman, 1995, Assoc Professor, PhD, U Arizona.
Karin A. Hoover, 2000, Assoc Professor, PhD, Johns Hopkins U.
Terence T. Kato, 1981, Professor, PhD, UCLA.
William M. Murphy, 2000, Assoc Professor, PhD, UC Berkeley.
Tal Nahir, 1998, Assoc Professor, PhD, U No Carolina.
Jeff T. Price, 2004, Assist Professor, PhD, Wayne State U.
Randall S. Senock, 2004, Assist Professor, PhD, Kansas State U.
Russell S. Shapiro, 2006, Assist Professor, PhD, UC Santa Barbara.
Gregory R. Taylor, 1988, Professor, PhD, U Washington.
Rachel A. Teasdale, 2004, Assist Professor, PhD, U Idaho.
Geological and Environmental Sciences

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.

GEOS 101 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 GEOS 102. 2.0 hours lecture, 2.0 hours activity. This is an approved General Education course. Special fee required; see the Class Schedule.

GEOS 102 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 GEOS 101. No college credit for those who have passed GEOS 101. 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. CAN GEO 2.

GEOS 105 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 both Planetarium and telescope observation of stars and galaxies at Observatory. 2.0 hours lecture, 2.0 hours activity. This is an approved General Education course.

GEOS 120 Weather 3.0 Fa/Spr
A descriptive study of weather processes; winds, circulations and storms; and weather impacts on life, property, crops, water availability, and air quality. Current weather briefings and California weather topics are emphasized.

GEOS 130 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 issue analysis are also covered. 2.0 hours lecture, 2.0 hours activity. This is an approved General Education course. Special fee required; see the Class Schedule.

GEOS 130H Introduction to Environmental Science (Honors) 3.0 Fa/Spr
Prerequisites: Acceptance into the Honors in General Education Program. 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 issue analysis are also covered. 2.0 hours lecture, 2.0 hours activity. This is an approved General Education course. Special fee required; see the Class Schedule.

GEOS 141 Concepts in the Physical Sciences 3.0 Fa/Spr
Prerequisites: Concurrent enrollment in or prior completion of MATH 100. Basic concepts of motion, force, energy, chemical change, and their interactions, intended for Liberal Studies majors. 2.0 hours lecture, 3.0 hours laboratory.

GEOS 203 Principles of Historical Geology 3.0 Fall
Prerequisites: GEOS 101 or GEOS 102. Principles of historical geology as they relate to rock sequences and geologic maps. 2.0 hours lecture, 3.0 hours laboratory. Special fee required; see the Class Schedule.

GEOS 250 Computer Applications in Geosciences 1.0 Fa/Spr
Prerequisites: Prior or concurrent enrollment in MATH 120, or consent of instructor. Develop skills in applying common computer software, including data analysis, presentation, graphics, and other. Use of this software as applied to selected problems in environmental sciences and geosciences. 2.0 hours activity.

GEOS 260 Environmental Soil Science 2.0 Fall
Prerequisites: CHEM 111, PHYS 202A or PHYS 202A (may be taken concurrently). Survey of the fundamental physical, chemical, and biological properties of soils in selected environmental processes.

GEOS 270 California Water 2.0 Spring
Prerequisites: One course from Breadth Area B1 of General Education. Introduction to physical hydrological processes, including precipitation, surface water, soils and groundwater, and evapotranspiration. California water issues are used to illustrate water movement and storage.

GEOS 300 Earth System Science 3.0 Fall
Prerequisites: ENGL 130 (or its equivalent) with a grade of C- or higher, CHEM 107 or equivalent, PHYS 202A, PHYS 202B. An intermediate treatment of astronomy, meteorology, and oceanography, with emphasis on climate change and its impacts. This is a writing proficiency, WP, course; a grade of C- or better certifies writing proficiency for majors.

GEOS 303 Invertebrate Paleontology 3.0 Spring
Prerequisites: GEOS 203 or course in Biology. Study of main groups of invertebrate fossils and their uses in biostatigraphy, paleobiogeography, and paleoecology. 2.0 hours lecture, 3.0 hours laboratory.

GEOS 304 History of Life 3.0 Spring
Prerequisites: BIOL 101 or BIOL 108, GEOS 101 or GEOS 102. 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.

GEOS 305 Observational Astronomy 3.0 OddFa
Prerequisites: GEOS 105 or GEOS 342. An intermediate treatment of astronomy from an observational viewpoint. Visual, photograhic, 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.

GEOS 306 Mineralogy and Lithology 4.0 Fall
Prerequisites: GEOS 101 or GEOS 102; CHEM 107 or CHEM 111 or equivalent; or faculty permission. Identification and origins of the more common minerals and rocks. 2.0 hours lecture, 6.0 hours laboratory. Special fee required; see the Class Schedule.

GEOS 307 Stratigraphy 3.0 Fall
Prerequisites: GEOS 201 and GEOS 306 (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.

GEOS 308 Planetary Operation 2.0 Jan
Prerequisites: GEOS 105; GEOS 405 or GEOS 406; faculty permission. Introduction to planetary 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 Roth Planetarium LCD projector. Each student will prepare an original planetarium program and present this program to an audience. 4.0 hours activity.

GEOS 309 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.

GEOS 310 Geological Field Reconnaissance 2.0 Spring
Prerequisites: GEOS 101 or GEOS 102. 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 intersession or spring vacation; and additional work or classroom meetings.) You may take this course more than once for a maximum of 4.0 units. Special fee required; see the Class Schedule. Credit/no credit grading only.

GEOS 315 Pollution Chemistry 3.0 Spring
Prerequisites: CHEM 107 or CHEM 111. A view of the environment from a chemical perspective. Principles and applications in the context of major natural and anthropogenic processes. Origins, transport, and sinks of organic and inorganic contaminants in the environment.

GEOS 320 Modern Topics in the Geosciences 3.0 Fa/Spr
Recent advances in the major areas of the physical sciences, including the important interdisciplinary fields.
GEOS 321 Introduction to Meteorology 3.0 Fall
Prerequisites: MATH 120, either PHYS 202B or PHYS 204C.
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.

GEOS 325 Geology of California 3.0 Fall
Prerequisites: GEOS 101 or GEOS 102 or consent of instructor.
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.

GEOS 330 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.

GEOS 331 Environmental Science Lab 2.0 Fall
Prerequisites: Either CHEM 107 or CHEM 111, one course from Breadth Area B2. A laboratory designed to complement GEOS 330. Physical, chemical, and ecological concepts related to the field and laboratory experience in environmental science. 1.0 hours lecture, 3.0 hours laboratory. Special fee required; see the Class Schedule.

GEOS 340 Environmental Geology 3.0 Fa/Spr
Prerequisites: One course from Breadth Area B1 and one course from Breadth Area B2 of the General Education requirements.
Provides the non-major with a geologic 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.

GEOS 341 Teaching Practices in Geological and Environmental Sciences 3.0 Fa/Spr
Prerequisites: GEOS 102, GEOS 105, GEOS 203, GEOS 306, GEOS 321.
This course provides students with classroom experience that utilizes a variety of interactive, engaging teaching styles that develop and reinforce skills and concepts through open-ended activities such as direct instruction, discourse, demonstrations, individual and cooperative learning explorations, peer instruction, and student-centered discussion. 1.0 hours lecture, 4.0 hours activity.

GEOS 342 Concepts in Earth and Space Science 3.0 Fa/Spr
Prerequisites: GEOS 141 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.

GEOS 343 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.

GEOS 350 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.

GEOS 351 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.

GEOS 354 Science and Ethics 3.0 Spring
Prerequisites: Completion of the General Education Breadth Area B requirement, PHIL 321.
The process of science and the scientific method. The Darwinian revolution and its social and ethical implications. Proteins and nucleic acids. Technological and ethical issues in biotechnology. Nuclear weapons. Conservation and environmental ethics. This course cannot be used for credit toward a geosciences major or minor. This is an approved General Education course.

GEOS 355 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.

GEOS 360 Field Methods in Geology 2.0 Spring
Prerequisites: GEOS 306, GEOL 307.
Elementary geologic field methods, descriptive geometry, photogeology, and geologic mapping. Ten days in the field during January intersession.

GEOS 361 Preparation of the Geological Report 1.0 Spring
Prerequisites: ENGL 130 (or its equivalent) with a grade of C– or higher, GEOS 360. This is a writing proficiency, WP, course; a grade of C– or better certificate writing proficiency for majors.

GEOS 370 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.

GEOS 380 Hydrology 3.0 Fa/Spr
Prerequisites: GEOS 270; PHYS 202A or PHYS 204A (may be taken concurrently). A survey of the mass transfer processes and storage elements within the hydrologic cycle: precipitation, interception, surface runoff, infiltration, evaporation-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. 2.0 hours lecture, 3.0 hours laboratory.

GEOS 381 Hydrologic Field Methods 2.0 Fall
Prerequisites: GEOS 270 (may be taken concurrently), GEOS 380, GEOS 415, prior hydrology course work, or 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 basis for field methods and hydrologic characterization approaches. 1.0 hours lecture, 3.0 hours laboratory.

GEOS 390 Surficial Processes 3.0 Fall
Prerequisites: MATH 120; either PHYS 202A or PHYS 204A.
A survey of the processes governing uplift and denudation of landscapes, including isostasy, chemical and physical weathering, mass movements, surface water erosion, formation of channels, and flow and sediment transport. 2.0 hours lecture, 3.0 hours laboratory.

GEOS 399 Special Problems 1.0–3.0 Fa/Spr
Prerequisites: Faculty permission.
This course is an independent study of special problems offered for 1.0–3.0 units. You may take this course more than once for a maximum of 6.0 units. Credit/no credit grading only.

GEOS 400 Physical Meteorology 3.0 OddFa
Prerequisites: GEOS 306 with grade of C– or better. Must be taken concurrently with GEOS 403.
Theory and practice of identification of minerals with the petrographic microscope. Emphasis on the common rock-forming silicates. 3.0 hours laboratory.

GEOS 402 Optical Mineralogy 1.0 Spring
Prerequisites: GEOS 306 with grade of C– or better. Must be taken concurrently with GEOS 403.
Study of minerals, meteorites, 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.

GEOS 403 Igneous and Metamorphic Petrology 4.0 Spring
Prerequisites: GEOS 306 with grade of C– or better. Must be taken concurrently with GEOS 402.
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.

GEOS 405 Solar System Astronomy 3.0 OddSp
Prerequisites: PHYS 202A or equivalent, or faculty permission.
Study of planets, asteroids, comets, and the dynamics of their orbits, the geology of their surfaces, and their origin. Study of the geology of the solar system, including its origin, evolution, dynamics and climate. 3.0 hours laboratory.

GEOS 391
GEOS 406 The Origin and Evolution of the Universe 3.0 EvnSp
Prerequisites: PHYS 202A, PHYS 202B or equivalents, 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. This course will meet in odd-numbered years.

GEOS 408 Structural Geology 4.0 Fall
Prerequisites: High school or college trigonometry; GEOS 201, GEOS 307 with grade of C– or higher.
Behavior of geologic materials. Folds, faults, small-scale structures in sedimentary, igneous, and metamorphic rocks. Copolymer 2.0 hours lecture, 4.0 hours activity. Special fee required; see the Class Schedule.

GEOS 410 Introduction to Watershed Hydrology 3.0 Spring
Prerequisites: GEOS 180 or prior hydrology course work and consent of instructor.
A survey of the hydrologic processes governing the movement and storage of water at the watershed scale. Emphasis is on computer-based methods for characterizing the physical framework and quantifying the resultant hydrology in terms of its temporal and spatial variability. 2.0 hours lecture, 3.0 hours laboratory.

GEOS 415 Hydrogeology 3.0 Spring
Prerequisites: CHEM 111, GEOS 306, MATH 120; either PHYS 202A or PHYS 204A; either GEOS 270 or GEOS 380. Recommended: GEOS 307.
Introduction to physical and chemical processes in groundwater flow, including fluid physics, aquifer properties, soil water, groundwater recharge, hydrologic environments, aquifer mechanics, and water quality degradation. 2.0 hours lecture, 3.0 hours laboratory.

GEOS 436 Volcanology 3.0 EvnFa
Corequisites: GEOS 101 or GEOS 102 and GEOS 306.
An introduction to physical processes associated with terrestrial and extraterrestrial volcanoes and their products. Specific topics include: volcano monitoring, rheologic properties of magma and volcanic flows, experimental volcanology, theoretical and analog flow modeling, as well as in-depth examination of local volcanoes and various eruptions (past, present, and future). This course includes an extended (4–5 days) field trip, required for all students. Students participate in the field by collecting data for future course projects, presenting prepared information at various field trip stops, or both. Students also complete research projects throughout the semester.

GEOS 450 Tectonics 3.0 Spring
Prerequisites: GEOS 306, GEOS 307.
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.

GEOS 460 Water Resources Management 3.0 Spring
Prerequisites: Upper-division standing; GEOS 130 or GEOS 380.
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.

GEOS 471 Field Geology 2.0 Spring
Prerequisites: GEOS 460, GEOS 361, GEOS 408 (with grade of C– or higher in all courses).
Mapping, recording, and interpreting data in the field; use of Brunton compass and topographic maps emphasized. Reports required. Field work during January Interession totaling at least 10 days. You may take this course more than once for a maximum of 6.0 units.

GEOS 490 Seminar in the Geosciences 1.0 Fall
Readings, reports, and discussion of topics in the current literature or of special studies in any area of the physical sciences.

GEOS 499H Honors Research in the Geosciences 3.0 Fa/Spr
Prerequisites: 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. Open only to 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 taken for 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.

GEOS 501 Dynamic Meteorology and Analysis 3.0 EvnSp
Prerequisites: GEOS 400.
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, meso-scale circulations, and the general global circulation. 2.0 hours lecture, 3.0 hours laboratory.

GEOS 502 Air Pollution Meteorology 3.0 OddSp
Prerequisites: CHEM 112, GEOS 321 or GEOS 400, MATH 121, or faculty permission.
Physical principles and meteorological processes relevant to air pollution with a primary focus on the atmospheric boundary layer. Topics include pollutant sources and sinks, visibility, stability, deposition and dispersion, atmospheric turbulence, plume modeling, and the design of air quality monitoring networks.

GEOS 516 Natural Water Systems 3.0 EvnFa
Prerequisites: CHEM 111. Suggested: CHEM 440.
An introduction to physical processes in environmental aquatic systems emphasizing acid-base and pE-pH relationships, solubility of carbon species in natural waters, and interactions at the solid-liquid interface.

GEOS 517 The Atmospheric Environment 3.0 OddFa
Prerequisites: CHEM 112. Suggested: CHEM 440.

GEOS 530 Environmental Systems Modeling I 3.0 EvnFa
Prerequisites: CHEM 112; GEOS 330 or faculty permission; MATH 120; either PHYS 202B or PHYS 204C.
Physical principles, theory and analysis techniques for computer modeling in the geosciences. Methods of estimation and error analysis, boundary values and initial conditions, steady-state and time-dependent models. Emphasis on problems relating to air and water pollution and hydrologic cycle.

GEOS 531 Environmental Systems Modeling II 3.0 OddSp
Prerequisites: GEOS 530.
The application of computer-based models in the geosciences. Introduction to widely used models and analysis packages. 2.0 hours lecture, 2.0 hours activity.

GEOS 535 Pollution Ecology 3.0 Fall
Prerequisites: Chem 112.
The application of biological, ecological, chemical, and physical sciences to understanding the fate and transport of pollutants through ecosystems.

GEOS 536 Applied Ecology 3.0 Spring
Prerequisites: BIOL 350.
Examination of the mechanisms, directions, and magnitude of an organism's or ecosystem's response to human perturbation.

GEOS 537 Ecohydrology 3.0 Spring
Prerequisites: BIOL 350, GEOS 270 or GEOS 380, or instructor consent.
The study of linkages between hydrologic processes and ecosystem functions; field methods for data gathering; hydrologic transport of nutrients and pollutants through ecosystems; case studies of problems in ecohydrology.

GEOS 545 Applied Geophysics 3.0 EvnSp
Prerequisites: One year of physics, GEOS 102, or faculty permission.
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.

GEOS 549 Economic Geology 3.0 Spring
Prerequisites: GEOS 306, GEOS 307.
The integrative course dealing with origins and occurrences of metallic and non-metallic mineral deposits, including factors in their use.

GEOS 555 Sedimentary Basin Analysis 3.0 Fall
Prerequisites: GEOS 307, GEOS 403.
Study of the paleographic evolution of sedimentary basins. Includes stratigraphic and paleontologic correlation, facies analysis, sedimentary petrology, depositional systems, and the tectonic framework of sedimentary basins. 2.0 hours lecture, 3.0 hours laboratory.

GEOS 565 Geochemistry 3.0 Fall
Prerequisites: CHEM 111, GEOS 102. Recommended: GEOS 306.
Investigation of the chemistry of minerals, rocks, and natural waters. Provides students with interests in geology, hydrology, environmental science, and other disciplines a 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.
GEOS 570  Environmental and Engineering Geology  3.0 EvnSp
Prerequisites: GEOS 102, GEOS 203, GEOS 306. For majors in related sciences and technical fields, GEOS 102.
Practical application of techniques to solve geological engineering and environmental problems. Techniques of 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 studies; surface 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.

GEOS 572  Advanced Field Geology  2.0 Spring
Prerequisites: GEOS 403, GEOS 471.
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.

GEOS 575  Senior Project  2.0 Spring
Prerequisites: Senior standing in Hydrology or Environmental Science Options.
Independent application of current standard field and laboratory methods to environmental analysis. Analysis and presentation of an individual environmental project. 1.0 hours discussion, 3.0 hours laboratory.

GEOS 580  Geological Evolution of North America  3.0 Spring
Prerequisites: GEOS 555, senior standing in Geology major, or faculty permission.
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.

GEOS 600  Geosciences Seminar I  1.0 Fall
Presentation and discussion of reports on current literature and special studies in geosciences.

GEOS 601  Geosciences Seminar II  1.0 Spring
Presentation and discussion of reports on current literature and special studies in geosciences.

GEOS 617  Advanced Topics in Geology  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 619  Advanced Topics in Meteorology  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 621  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 623  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 625  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 630  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 640  Hydrogeochemistry  3.0 Spring
Prerequisites: CHEM 111, CHEM 112. Recommended: GEOS 565.
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 650  Environmental Monitoring  2.0 Fall
Prerequisites: GEOS 403.
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 hours discussion, 3.0 hours laboratory. Special fee required; see the Class Schedule.

GEOS 660  Numerical Analysis  3.0 Spring
Prerequisites: MATH 120.
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 697  Independent Study  1.0–4.0 Fa/Spr
This course is a graduate-level independent study offered for 1.0–4.0 units. You must register directly with a supervising faculty member. You may take this course more than once for a maximum of 6.0 units.

GEOS 699T  Master’s Thesis  1.0–6.0 Fa/Spr
This course is a master’s thesis offered for 1.0–6.0 units. You must register directly with a supervising faculty member. You may take this course more than once for a maximum of 6.0 units.