INTRODUCTION

Geological Sciences is the study of Earth through time, including its physical nature, chemical composition and dynamics, as well as its origin and evolution. In addition to the quest for understanding the way Earth works and its relation to the solar system, Earth scientists are involved in the search for energy, mineral and water resources, the evaluation and remediation of environmental hazards, and the prevention and/or prediction of natural disasters such as earthquakes, volcanic eruptions, landslides, coastal erosion and floods.

Earth scientists are employed by private industry, (primarily by engineering, environmental, petroleum and mining companies), government agencies, educational institutions and research centers.

The B.S., B.A. and M.S. requirements are designed to help students develop an appreciation and understanding of Earth, as well as prepare them for: (1) employment in industry or government; (2) teaching at the elementary, high school and community college level; and (3) further graduate studies in the geological sciences. Over 30 300-, 400- and 500-level electives are offered on a regular schedule, enabling students to design individual study plans that satisfy their personal educational goals.

LEARNING GOALS AND STUDENT LEARNING OUTCOMES

The following goals and learning outcomes have been established for students pursuing a bachelor’s degree in geological sciences:

Skills, concepts and processes

■ Describe, classify and interpret geologic field data and interpret the geologic history of an area by integrating all types of field data
■ Read, interpret, and construct geologic maps, cross sections and block diagrams and use such diagrams to visualize geologic relations in the four dimensions of space and time
■ Understand geologic time, explain the geologic time scale and its scientific basis, recount the milestone events in Earth history, and understand the basics of common dating methods

Integrative approach to Earth Science problems

■ Apply physics, chemistry and biology to the understanding of Earth systems and cycles, including plate tectonics and the rock cycle, the water cycle, and the life cycle and evolution
■ Understand the role of geology in everyday life, appreciate the extent of human impact on Earth systems and environments, and understand the processes that create natural hazards, and the strategies that minimize their impact on society

Scientific method

■ Perform independent geological research by applying the scientific method, identify and locate existing geologic information, and communicate data and interpretations orally and in writing using appropriate technology
BACHELOR OF SCIENCE IN GEOLOGY (120 UNITS)

The Bachelor of Science in Geology requires 48 units in the major. Students must have a “C” (2.0) or better in all geological sciences courses applied towards the requirement; in addition, students must have a 2.0 average in required courses in related fields. Proficiency in English composition is required.

Undergraduate Thesis (3 units)

In this capstone experience, majors work one-on-one with a faculty adviser on a research project. Students are encouraged to begin research during their junior year. GEOL 498 satisfies the university’s upper-division writing requirement.

Minimum Course Requirements for the Major

GEOL 101 Physical Geology (3)
OR GEOL 110T Topics in Earth Science (4)
OR GEOL 140 Earth’s Atmosphere and Oceans (3)
GEOL 101L Physical Geology Lab (1)
GEOL 201 Earth History (3)
GEOL 303A Earth Materials (4)
GEOL 303B Igneous and Metamorphic Petrology (4)
GEOL 321 Sedimentation and Stratigraphy (4)
GEOL 335 Hydrology and Surface Processes (3)
GEOL 360 Structural Geology (4)
GEOL 380 Geologic Field Techniques (3)
GEOL 456 Geophysics (3)
OR GEOL 46 Geochemistry (3)
GEOL 481A Geology Field Camp I (4)
GEOL 498 Undergraduate Thesis (1-3) – must take a total of three units

Upper-Division Geological Sciences Electives (8-9 units)

Electives should be selected in consultation with an undergraduate adviser and/or the student’s thesis adviser. No more than 3 units from any combination of GEOL 493, 495, 496L and 499L can be counted toward meeting this eight- to nine-unit requirement.

Note: GEOL 310T is not accepted as credit toward meeting requirements for the B.S. in Geology major.

Related Fields (30 units minimum)

At least one of the related field’s tracks must include a second-semester lab course. If the selected related field’s courses total less than 30 units, additional units must be taken from other science-math-engineering departments (see list below). Courses not included on the list must be approved in writing by an undergraduate adviser.

BIOL 101 Elements of Biology (3)
OR BIOL 171 Evolution and Biodiversity (5)
OR a life science course from another institution that is acceptable to CSUF and demonstrates treatment of whole-organism biology and concepts of evolution and ecology.

CHEM 120A and 120B General Chemistry (5,5)
OR CHEM 120A General Chemistry (5)
AND CHEM 125 General Chemistry for Engineers (3)
MATH 150A and 150B Calculus (4,4)
OR MATH 130 A Short Course in Calculus (4)
AND MATH 337 Introduction to Experimental Design Statistics in Laboratory Sciences(3)
OR MATH 338 Statistics Applied to Natural Sciences (4)
PHYS 225, 225L Fundamental Physics - Mechanics (3,1)
AND PHYS 226 Fundamental Physics - Electricity and Magnetism (3)
OR PHYS 211, 211L, 212 Elementary Physics (3,1,3), with consent of adviser

One additional semester course selected with approval of adviser from courses such as the following:

BIOL 172, 210, 300, 319
CHEM 301A, 315, 325, 361A
CPSC 241
EGCE 301, 324, 436, 441
GEOG 481, 485
MATH 250A, 250B
PHYS 227, 227L, 300, 310, 320, 330

Science- or engineering-based transferable extension certificate courses from other universities

Undesignated Units (0-3 units)

These are to be taken in geological sciences, related fields and/or career-supporting fields, with adviser approval.

BACHELOR OF ARTS IN EARTH SCIENCE (120 UNITS)

The Bachelor of Arts in Earth Science requires a minimum of 32 units of Earth science courses in Geology and Geography, plus a minimum of 24 units in related fields. Students must have a “C” (2.0) or better in all Earth science courses applied toward the requirement; in addition, students must have a 2.0 average in required related fields courses.

Core Courses (20-21 units)

GEOL 101 Physical Geology (3)
OR GEOL 110T Topics in Earth Science (4)
OR GEOL 140 Earth’s Atmosphere and Oceans (3)
OR GEOL 102 Earth and Astronomical Science for Future Elementary Teachers (3)
GEOL 101L Physical Geology Lab (1)
GEOL 201 Earth History (3)
GEOL 333 General Oceanography (3)
GEOL 335 Hydrology and Surface Processes (3)
GEOL 380 Geologic Field Techniques (3)
GEOL 420 Earth Science for Science Teachers (4)
OR GEOL 470 Environmental Geology and Planning (4)
Earth Science Electives (12-15 units)

Additional courses may be approved by the Department of Geological Sciences Undergraduate Adviser. At least 6 units must be Geological Science.

Note: no more than 3 units from any combination of GEOL 493, 495, 496L, 498 and 499L can be counted toward the requirement. GEOL102 (if GEOL101 is taken in core) and/or GEOL140 may be taken if student is in teaching pathway

Related Fields Core (16-22 units)
Courses not included on the list must be approved in writing by an undergraduate adviser. Students must take at least one class from each of the related field subjects and at least one of these courses must have an associated lab.

BIOL 101/L Elements of Biology/Lab (3,1)
OR BIOL 171 Evolution and Biodiversity (5)
OR BIOL 102 Biology for Future Teachers (3)*
OR accepted life science course from another institution

CHEM 100L Survey of Chemistry/Lab (3,1)
OR PHYS/CHEM 102 Physical Science for Future Elementary Teachers (3)*
OR CHEM 120A General Chemistry (5)

PHYS 101/L Survey of Physics/Lab (3,1)
OR PHYS/CHEM 102 Physical Science for Future Elementary Teachers (3)*
OR 115 Introductory Physics - Mechanics (4)
OR PHYS 211/L Elementary Physics/Lab (3,1)
OR PHYS 225/L Fundamental Physics: Mechanics/Lab (3,1)

MATH 120 Introduction to Probability and Statistics (3)
OR MATH 125 Precalculus (5)
OR MATH 130 A Short Course in Calculus (4)
OR MATH 135 Business Calculus (3)
OR MATH 150A Calculus (4)

GEOG 110 Introduction to the Natural Environment (3)

* Courses recommended for elementary school teaching pathway

Undesignated electives (22 units)
Undesignated electives must be adviser-approved.

Upper-Division Writing Requirement (3 units)
ENGL 301 Advance College Writing (3)
ENGL 360 Scientific and Technical Writing (3)
GEOL 498 Undergraduate Thesis (3)

MINOR IN GEOLOGICAL SCIENCES (20 UNITS)
At least 12 units toward the Minor in Geological Sciences must be upper division; at least six of which must be taken in residence. Up to three units of GEOL 310T may be applied. Prospective minors should make an appointment with a department adviser in order to select courses that most closely match their educational goals. Prospective teachers should include courses in physical geology, Earth history, hydrology and surface processes, oceanography, mineralogy, petrology, plus GEOL 420.

GRADUATE EMPHASIS IN GEOCHEMISTRY
The Geochemistry Emphasis is offered jointly by the Department of Chemistry and Biochemistry and Department of Geological Sciences. Contact the graduate program adviser in the Department of Chemistry and Biochemistry for information regarding the Chemistry M.S. requirements, and the Department of Geological Sciences regarding the selection of appropriate graduate electives.

MASTER OF SCIENCE IN GEOLOGY (30 UNITS)
The Master of Science in Geology is based on the assumption that every geologist must have a thorough knowledge of fundamental geologic principles and that this knowledge must be rooted in field- and laboratory-based experiences.

Admission Requirements
Students must meet the CSU requirements for admission to a master’s degree program. Please consult the Graduate Admissions section in this catalog for complete information. In addition, acceptance into this program in a classified standing is contingent upon the following:

Elective Related Fields (8 units)
Taken with adviser approval, depending on the track; including, but not limited to, the following:

- GEOG 312, 323*, 325, 328, 329, 350, 422, 425, 426, 450, 452, 481, 485, 488
- BIOL 172, 274, 300, 305*, 318, 319, 352, 409*, 453*
- CHEM 120A*, 120B, 125, 303A,B,C, 313A,B,C*
- MATH 120, 125, 130, 135, 150A, 150B, 250B
- PHYS 120*, 212, 226, 301
- ANTH 344, 403, 404, 409
- EGCE 214/L, 305, 324

* Courses recommended for elementary school teaching pathway
• Bachelor’s degree in geology from an accredited institution, with an expected grade-point average of 3.0 in geology courses, which normally includes the equivalent to core courses of the Cal State Fullerton Geology B.S. program and a 2.5 grade-point-average in related science and mathematics courses; or, in the case of a bachelor’s degree in a related area, a selection of science courses deemed as adequate preparation for further study in geology by the Department Graduate Committee.

• Satisfactory performance on the Graduate Record Examination Aptitude Test with an expected score in the 50th percentile or better on the verbal and quantitative tests.

• Three letters of recommendation.

• Completion of the departmental application.

• Availability of faculty and resources in the student’s stated area of interest.

Students with limited subject or grade deficiencies may be considered for conditional acceptance into the program if they meet all other departmental and university requirements. Conditionally classified graduate standing may be removed upon completion of adviser- and graduate-committee-approved postgraduate courses in geology, mathematics, chemistry or physics, with grades of “B” (3.0) or better.

Students with a degree in a related field and/or substantial subject deficiencies are encouraged to apply. Such applicants may be considered for conditional acceptance if they meet all other departmental and university requirements. Such a student may later qualify for classified standing by completing all courses recommended by the Department Graduate Committee and by maintaining a 3.0 grade-point average in geology and in related science and mathematics courses.

Application Deadlines

Materials and deadlines for department and university applications are available on the Geological Sciences website: geology.fullerton.edu/.

Classified Standing

Students should achieve classified graduate standing as soon as they are eligible, since no more than nine units of graduate work taken before classification can be included on the study plan for the degree (see below). Students may apply for classified standing when they: (1) have met all university and departmental admission requirements; and (2) have filed a study plan approved by the adviser, the Department Graduate Committee and the Associate Vice President for Graduate Studies and Research.

Students must meet the Graduate Level Writing Requirement as described in this catalog under “Master’s Degree Requirements.” Students will meet this requirement by taking GEOL 501, Research Methods in Geology.

Advancement to Candidacy

Advancement to candidacy is attained by applying for graduation and receiving a recommendation by the Department Graduate Committee.

STUDY PLAN

A study plan must be approved by the Graduate Adviser. At least 21 units must be at the graduate level; a maximum of nine units may be 400 level. A minimum grade point average for courses satisfying the study plan is 3.0.

Required Courses (9-12 units)

GEOL 500 Advanced Concepts in Geology (3)
GEOL 501 Research Methods in Geology (1)
GEOL 590 Graduate Seminar (1,1) – must be taken twice for one unit each time
GEOL 598 Thesis (1-3) – must take a total of at least three, but no more than six units

Note: A public, oral defense of the thesis is required.

Focus and Breadth Courses (18-21 units)

Focus Geology Courses: Graduate adviser-approved 400- or 500-level geology courses. A maximum of three units of GEOL 599 and a maximum of three units of GEOL 593 may be taken. Course selection will be dependent on the student’s academic objectives and selected in consultation with the student’s thesis adviser.

Breadth Courses in Related Fields: A maximum of six units of graduate adviser-approved 400- or 500-level breadth courses offered by departments other than Geological Sciences. Courses may be taken from departments or programs such as, but not restricted to, Biological Sciences, Chemistry and Biochemistry, Physics, Mathematics, Geography, Civil and Environmental Engineering, or Environmental Studies. Course selection will be dependent on the student’s academic objectives and selected in consultation with the student’s thesis adviser.

COURSES IN GEOLOGY

Courses are designated as GEOL in the class schedule.

101 Physical Geology (3)

Prerequisite: high school chemistry or physics, or equivalent. Physical nature of the planet Earth, genesis of rocks and minerals, erosion processes and their effects.

101H Physical Geology (Honors) (3)

Prerequisite: high school chemistry or physics, or equivalent. Physical nature of the planet Earth, genesis of rocks and minerals, erosion processes and their effects. (weekend field trips)

101L Physical Geology Laboratory (1)

Pre- or corequisite: GEOL 101, 110T or 140. Rocks, earthquakes and map and aerial photographic interpretation. (3 hours laboratory or field trip)
102  Earth and Astronomical Science for Future Elementary Teachers (3)
   Designated especially for the prospective elementary school teacher, this activity-based course examines fundamental Earth/astronomical science concepts and the potential impacts of natural hazards on ecosystems on planet Earth.

105  Field Experiences in California Geology (1)
   Pre- or corequisite: GEOL 101, 110T or 140. Three field trips that examine the rich geology of California. Read and discuss topical papers and make presentations on selected topics. Weekend field trips are required. May be repeated once for credit.

110T Topics in Earth Science (4)
   Prerequisite: high school chemistry or physics, or equivalent. Public interest topics in Earth science. Alternating topics include: dinosaur world; earthquakes and volcanoes. Each course includes integrated labs, lectures and field trips that explore mainstream Earth science issues. (3 hours lecture, 3 hours lab and field trips.)

140  Earth's Atmosphere and Oceans (3)
   Prerequisite: high school chemistry or physics, or equivalent. Composition, structure and circulation of the Earth's atmosphere and oceans with a general focus on their interactions. Interdisciplinary topics that highlight atmosphere-ocean interactions will include global warming, ice ages, El Niño, Southern California storm activity and Santa Ana winds. (3 hours lecture, field trips)

201  Earth History (3)
   Prerequisite: GEOL 101L. Evolution of Earth as interpreted from rocks, fossils and geologic structures. Plate tectonics provides a unifying theme for consideration of mountain building, evolution of life and ancient environments. (2 hours lecture, 3 hours laboratory, field trips)

201L  Earth History Supplemental Lab (1)
   Prerequisite: GEOL 101L. Corequisite: GEOL 201. Supervised research on topics related to Earth history. Project will result in a term paper and/or web page. (3 hours laboratory, field trips)

303A  Earth Materials (4)
   Prerequisites: GEOL 101, 101L, ENGL 101. Pre- or corequisite: CHEM 120A, MATH 125 or equivalent. Identifying rock-forming minerals based on their chemical, physical and optical properties; relating mineral identification to rock lithology and classification; interpreting the significance of a rock's mineral assemblage in terms of its igneous, metamorphic, sedimentary or hydrothermal origin. (2 hours discussion, 6 hours laboratory, field trip)

303B  Igneous and Metamorphic Petrology (4)
   Prerequisites: GEOL 303A, 380; CHEM 120A. Corequisite: CHEM 120B or 125. Description, classification, occurrence and origin of igneous and metamorphic rocks. (1 hour discussion, 2 hours activity, 6 hours laboratory, field trips)

305  Earthquake Impact on Structures (3)
   (Same as EGCE 305)

310T Topics in California-Related Geology (1-3)
   Prerequisites: completion of one course each from General Education (G.E.) Categories B.4 and B.1. Directed investigations of one aspect of Earth science. Alternating topics are California geology, earthquakes, California geologic hazards, national parks geology, Earth's environmental crisis and California's water crisis. May be repeated for credit with a different topic. One or more sections offered online; some topics offered for three units only. (3 hours lecture for 5, 10, or 15 weeks; optional field trip)

321  Sedimentation and Stratigraphy (4)
   Prerequisites: GEOL 201, 303A. Sedimentary rocks, including classification, texture, mineralogy and provenance; sedimentary environments and interpretation of ancient environments in the rock record; stratigraphic methods and patterns. (2 hours lecture, 6 hours laboratory, field trips)

322  Paleontology (4)
   Prerequisites: GEOL 201; BIOL 101, 171 or equivalent. Identification, systematic, evolution, ichnology, biostratigraphy, taphonomy and paleoecologic analysis of fossil groups. (3 hours lecture, 3 hours laboratory, field trips)

333  General Oceanography (3)
   Prerequisites: GEOL 101L and junior or senior standing. Chemical, physical and geological nature of the oceans. (2 hours lecture, 3 hours laboratory, field trips)

335  Hydrology and Surface Processes (3)
   Prerequisites: GEOL 101 or equivalent, or completion of G.E. Category B.2. Impact of surface water on the formation of soils, weathering, surface features (rivers) and groundwater. Application of hydrology as a predictive and postdictive tool on geologic, biotic and engineering problems.

355  Earth's Interior (3)
   Prerequisites: GEOL 101; 303A; MATH 120 or 150A; PHYS 225, 225L or 211, 211L; CHEM 120A or equivalent. Geophysical, geochemical properties of mantle and core. Data collection techniques. Impact of internal processes on crustal/surface phenomena.

360  Structural Geology (4)
   Prerequisites: GEOL 380, MATH 125. Faults, folds, mechanics of rock deformation and elementary tectonics; solution of problems by geometric, trigonometric and stereographic analysis. (3 hours lecture, 3 hours laboratory, field trips)

376  Engineering Geology (3)
   Prerequisites: MATH 130 or 150A; GEOL 380 or EGCE 214 and 214L. Geology applied to engineering works. Earth materials, processes; site evaluation techniques; geologic hazard analysis; case histories. (2 hours lecture, 3 hours laboratory, field trips)
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>380</td>
<td>Geologic Field Techniques (3)</td>
<td>GEOL 101, 101L, ENGL 101; MATH 115, 125 or equivalent. Pre- or corequisite: GEOL 201. Basic geologic field equipment. In-class and weekend field projects include: basic geologic mapping on topographic maps and aerial photographs; field note-taking methods; field data interpretation; preparing geologic maps; preparing stratigraphic columns and geologic cross-sections; technical report writing. (2 hours lecture, 6 hours in-field activity, weekend field trips)</td>
</tr>
<tr>
<td>404</td>
<td>Optical Mineralogy and Petrography (3)</td>
<td>GEOL 303A. Principles of optical mineralogy and use of petrographic microscope to analyze minerals and textures of igneous, metamorphic and sedimentary rocks. (1 hour lecture, 6 hours laboratory, field trip)</td>
</tr>
<tr>
<td>406</td>
<td>Geochemistry (3)</td>
<td>GEOL 303B, CHEM 120B or 125, MATH 130 or 150A. Basic chemical and thermodynamic principles applied to the origin and alteration of igneous, metamorphic and sedimentary rocks. (2 hours lecture, 3 hours lab, field trips)</td>
</tr>
<tr>
<td>408</td>
<td>Volcanology (3)</td>
<td>GEOL 303B; MATH 130 or 150A or equivalent. Volcanic eruptions as well as their deposits, hazards and impact on society. Classroom activities and field trips (required) will explore modern and ancient volcanic environments. (3 hours lecture, field trips)</td>
</tr>
<tr>
<td>410</td>
<td>Physical Earth/Space Systems (3)</td>
<td>Completion of one course each from G.E. Categories B.4. and B.1. Physical and chemical interactions among major Earth systems (e.g., geosphere, atmosphere and hydrosphere) considered within the context of Earth's position in its solar system and in space. Appropriate for elementary teachers. Not available for degree credit in B.S. or M.S. in Geology; available for credit in M.A.T.S. in the Science Education program. (2 hours lecture, 2 hours activity)</td>
</tr>
<tr>
<td>420</td>
<td>Earth Science for Science Teachers (4)</td>
<td>GEOL 101, 101L and junior or senior standing, or science teaching credential. Major concepts of the earth sciences with primary emphasis on physical and planetary geology and secondary emphasis on meteorology and oceanography. (3 hours of lecture, 3 hours of laboratory, field trips)</td>
</tr>
<tr>
<td>436</td>
<td>Hydrogeology (3)</td>
<td>GEOL 101L and 335 or equivalent; MATH 130 or 150A. Occurrence, movement and utilization of groundwater resources; geological, geophysical and hydrological methods for groundwater exploration and development. Well hydraulics and ground-water contamination. (2 hours lecture, 3 hours laboratory, field trips)</td>
</tr>
<tr>
<td>440</td>
<td>Paleoclimatology (3)</td>
<td>GEOL 335. Methods and archives used to understand past climate; examining atmospheric circulation, oceanic circulation and the Earth’s energy budget in the context of past climate change. (3 hours lecture, field trips)</td>
</tr>
<tr>
<td>455</td>
<td>Earthquake Seismology (3)</td>
<td>GEOL 101; 360; PHYS 225, 225L or 211, 211L; MATH 130 or 150A. Seismic waves, their recording and measurement. Estimation of earthquake source strength, location and mechanism. Introduction to seismic risk and strong motion studies. (3 hours lecture, field trips)</td>
</tr>
<tr>
<td>456</td>
<td>Geophysics (3)</td>
<td>MATH 150A or 130; PHYS 225, 225L or 211, 211L; PHYS 226, 226L or 212, 212L. Recommended. Seismic refraction, gravity, magnetic and electrical techniques and fundamentals as applied to determine subsurface structure, groundwater and location of mineral resources. (2 hours lecture, 3 hours laboratory, field trips)</td>
</tr>
<tr>
<td>470</td>
<td>Environmental Geology and Planning (4)</td>
<td>GEOL 101L or 420. Geologic processes, hazards, mineral and energy resources and their interaction with planning and environmental regulations. (3 hours lecture, 3 hours lab, field trips)</td>
</tr>
<tr>
<td>475</td>
<td>Quaternary Tectonics (4)</td>
<td>GEOL 360, 380. Processes and products of relatively young Quaternary tectonics. Evaluation of surface tectonic features, their ages, deformation styles and structural regimes. Assessment of past and contemporary deformation rates. (2 hours lecture, 6 hours lab, field trips)</td>
</tr>
<tr>
<td>481A</td>
<td>Geology Field Camp I (4)</td>
<td>GEOL 303B, 321, 335, 360, 380. Advanced geologic mapping in a variety of geologic settings. Field report, map and cross-sections required. Instructional fee required. (45 hours per week for four weeks during summer)</td>
</tr>
<tr>
<td>481B</td>
<td>Geology Field Camp II (3)</td>
<td>GEOL 380 and consent of instructor. Advanced geologic field work in a variety of geologic settings. Field report, map and cross-sections required. Instructional fee required. (45 hours a week for three weeks during summer)</td>
</tr>
<tr>
<td>481C</td>
<td>Hydrology and Engineering Geology Field Camp (4)</td>
<td>GEOL 376, 380, 436. Geologic mapping and hydrologic mapping and techniques applied to integrated hydrogeologic model for selected areas. Field report(s), map(s), cross-sections required. Instructional fee required. (45 hours per week for three weeks during summer)</td>
</tr>
</tbody>
</table>
493 Directed Studies (1-4)
Prerequisites: junior and senior standing and consent of instructor. Directed studies in specialized areas of the geological sciences, such as petroleum geology, sedimentology, optical and instrumentation techniques. Library research and written reports required. May be repeated once with a different topic. Not available for M.S. Geology graduate credit.

495 Geological Sciences Internship (3)
Prerequisite: junior or senior standing in geological sciences. Geological sciences work experience, salaried or volunteer, with industry, government or private agencies. Student intern will be supervised by faculty adviser and employer. (1 hour of seminar per week plus a total of 120-150 hours of work experience)

496L Geological Sciences Tutorial (2)
Prerequisites: at least 20 completed units in geological sciences, in good academic standing. Provides a maximum of 6 hours per week of supervised tutoring or teaching experiences (including office hours) for undergraduate students assisting in laboratory or field geology classes. Not available for M.S. geology graduate credit.

498 Undergraduate Thesis (1-3)
Prerequisites: approval of thesis adviser for first unit; completion of thesis proposal that is approved by thesis adviser and the Department Undergraduate Adviser for second and subsequent units. Extension of an advanced course, conducted independently by the student under faculty supervision, culminating in a paper of professional quality. Must be repeated for three units total.

499L Independent Study (1-3)
Independent study of a topic selected in consultation with and completed under the supervision of the instructor. Not available for M.S. Geology degree credit.

500 Advanced Concepts in Geology (3)
Current advances in geological concepts with emphasis on Southern California geology. Concepts include: plate tectonics; igneous processes; sedimentary record; surficial processes; water resources. (2 hours lecture, 2 hours activity, field trips)

501 Research Methods in Geology (1)
Prerequisite: GEOL 500. Introduction to research planning; choosing a thesis topic; bibliographic search; research design (laboratory and field); research proposal preparation. (2 hours activity)

506T Advanced Topics in Geochemistry (3)
Prerequisite: GEOL 406 or consent of instructor. Special topics on modern techniques and recent advances in geochemistry, such as geochronology and environmental isotope geochemistry. May be repeated for credit with a different topic. (3 hours lecture; field trips)

510T Advanced Topics in Geology (3)
Prerequisite: consent of instructor. Modern techniques and recent advances in geology, such as basin analysis, carbonate sedimentology, paleontology, paleolimnology, igneous petrology, tectonics and studies of the Mesozoic Era. May be repeated for credit with a different topic. (3 hours lecture; field trips)

535T Advanced Topics in Hydrogeology (3)
Prerequisite: graduate standing or consent of instructor. Modern techniques and recent advances in hydrogeology, such as groundwater modeling, well hydraulics and aquifer analysis, contaminant hydrogeology, hydrogeochemistry and environmental sampling and protocols. May be repeated for credit with a different topic. (3 hours lecture; field trips)

555T Advanced Topics in Geophysics (3)
Prerequisite: consent of instructor. Selected topics in geophysics. Whole-Earth geodynamics; geophysical evidence of large-scale Earth properties; links between earthquakes and plate tectonics. May be repeated for credit once with different topic. (3 hours lecture/discussion, field trips)

575T Advanced Topics in Engineering Geology (3)
Prerequisite: consent of instructor. Modern techniques and recent advances in engineering geology, such as Quaternary geology, landslide analysis and paleoseismology. May be repeated for credit with a different topic. (3 hours lecture; field trips)

590 Geoscience Seminar (1)
Attendance at departmental and other seminars. Discussion and/or written assignments based on seminar topics required. Must be repeated at least once.

593 Directed Graduate Studies in the Geosciences (1-3)
Prerequisites: postbaccalaureate standing and consent of instructor. Directed studies of specialized geoscience topics not covered by existing courses and tailored to individual student interest. Literature research, recitations and written reports required. May be repeated for a total of 3 units.

598 Thesis (1-3)
Prerequisites: approval of thesis adviser for the first unit; completion of M.S. Thesis proposal that is approved by thesis committee and the Department Graduate Committee Chair for second and subsequent units. Design, analysis and presentation of a research problem culminating in a thesis for the master’s degree. May be repeated for up to six units total.

599 Independent Graduate Research (1-3)
Prerequisites: approval of adviser and Department Graduate Committee. Independent research on an approved topic. May be repeated for up to 3 units maximum.