

GEOLOGICAL SCIENCES

College of Natural Sciences and Mathematics

Department Chair: Stanley C. Finney

Department Office: Hall of Science (HSCI) 322
Telephone/FAX: (562) 985-4809 / (562) 985-8638
Website: www.csulb.edu/depts/geology/index.shtml

Faculty: Matthew Becker, Richard J. Behl, Stanley C. Finney, Robert D. Francis, Roswitha B. Grannell, K. Benjamin Hagedorn, Gregory J. Holk, Thomas Kelty, Nathan Onderdonk, Lora Stevens

Administrative Support Coordinator: Margaret Costello

Advisors:

Undergraduate: Thomas Kelty
Credential: James Kisiel, Tim Williamson
Graduate: Lora Stevens-Landon

Students desiring information should contact the Department Office for referral to one of the faculty advisors.

Career Possibilities

Geologist • Geophysicist • Hydrologist • Mineralogist • Paleontologist • Seismologist • Geophysical Prospector • Laboratory Assistant • Soils Engineer • Stratigrapher • Crystallographer • Geodesist • Environmental Analyst • Oceanographer • Teacher • Petrologist • Ecologist • Geochemist (Some of these, and other careers, require additional education or experience. For more information, see www.careers.csulb.edu.) Various entry-level trainee positions in business and industry are available for graduates regardless of academic discipline.

Introduction

The Geological Sciences includes the study of the solid earth, the hydrosphere, and the atmosphere. All Earth Science and Geology majors must contact the Undergraduate Advisor prior to the first semester in residence.

The Geological Sciences Department participates in the Southern California Marine Institute for marine geology, oceanography, and seismic studies. See the Ocean Studies Institute section of this *Catalog* for additional information.

Academic Advising and Facilitated Enrollment into Classes

All entering students who declare a major in a degree program offered by this department need to contact the College of Natural Sciences and Mathematics' (CNSM) Academic Advising Center (HSCI 164) and participate in the College's Science Safari to Success (for first time freshmen) or EONS (Enrollment and Orientation in the Natural Sciences and Mathematics for transfer students) Program. These programs are held in June/July for those starting in the Fall Semester and in January for those starting in the Spring Semester. Department advisors will be available to provide an overview of the students' chosen baccalaureate degree program, to assist with academic advisement, to provide information on the many career opportunities available, and to aid students in enrolling in classes. Contact the CNSM Academic Advising Center, Jensen Student Access to Sciences and Mathematics Center (HSCI 164), or department office for additional information.

Concurrent and/or Summer Enrollment at Another College

Students who wish to take course work at a community or another college to meet curricular requirements while enrolled as undergraduates in the College of Natural Sciences and Mathematics must petition the appropriate Department for prior approval to earn credit for specific courses. This policy applies to concurrent enrollment or summer enrollment. University policy must also be complied with; see 'Concurrent Enrollment' and 'Transfer of Undergraduate Credit' in this *Catalog*. Courses not receiving prior approval will not be accepted for credit by the Department.

Undergraduate Programs

Bachelor of Science in Geology (120 units)

The bachelor of science degree program provides training in the geological sciences for those planning to pursue professional careers in industry or enter a graduate degree program. Students explore fundamental geological processes, cultivate skills in integrative three-dimensional geological thinking, and engage in laboratory and field experience, and pursue interests in the many subdisciplines of the geological sciences. Students interested in pursuing a career in geophysics must consult the undergraduate advisor to construct an appropriate program.

Geology majors must receive a grade of "C" or better in all courses required for the major. A minimum of 120 units is required for the Bachelor of Science degree. Transfer students should attempt to fulfill, prior to transferring, the appropriate lower division curricular requirements as outlined below. In particular students should take prior to transferring the equivalent of GEOL102 and 104, and at least three of the following four: CHEM 111A, CHEM 111B, MATH 122, and MATH 123.

GEOL 420 (Geological Writing) and GEOL 450 (Summer Field), both required courses for the major, are also capstone General Education courses, and GEOL 420 fulfills the GWAR requirement for a writing intensive course. Geology majors should take these two courses, and one other course to fulfill their upper division GE and GWAR requirements.

Lower Division:

Take all of the following:

GEOL 102 General Geology (3)

Prerequisites/Corequisites: A course that fulfills the A.1 GE requirement and three years of high school mathematics including algebra, geometry, and intermediate algebra or the equivalent.

GEOL 104 Geology Laboratory (1)

Prerequisites/Corequisites: A course that fulfills the A.1 GE requirement and three years of high school mathematics including algebra, geometry, and intermediate algebra or the equivalent, and concurrent or prior enrollment in GEOL 102.

GEOL 240 Historical Geology (4)

Prerequisite: GEOL 106 or both GEOL 102, GEOL 104.

GEOL 250 Introduction to Field Petrology and Geological Field Techniques (3)

Prerequisites: GEOL 102 with GEOL 104 or GEOL 105; or GEOL 106; all with grades of "C" or better. Corequisite: GEOL 240.

CHEM 111A General Chemistry (5)

Prerequisites: A passing score on the Chemistry Placement Examination.

Corequisite: MATH 109 or higher.

CHEM 111B General Chemistry (5)

Prerequisites: CHEM 111A and MATH 113 or MATH 115 or MATH 117 or MATH 119A or MATH 122 all with a grade of "C" or better.

MATH 122 Calculus I (4)

Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and MATH 113.

MATH 123 Calculus II (4)

Prerequisite: A grade of "C" or better in MATH 122.

PHYS 151 Mechanics and Heat (4)

Prerequisite/Corequisite: MATH 122.

PHYS 152 Electricity and Magnetism (4)

Prerequisite: PHYS 151; Prerequisite/Corequisite: MATH 123.

Upper Division:

Take all of the following:

GEOL 322 Crystallography and Mineralogy (3)

Prerequisites: GEOL 250; CHEM 101 or CHEM 111A.

GEOL 326 Optical Mineralogy (2)

Prerequisite: GEOL 250; A passing score on the Chemistry Placement Examination or CHEM 111A;

Prerequisite/Corequisite: GEOL 322

GEOL 322 and GEOL 326 must be taken concurrently unless the undergraduate advisor approves otherwise.

GEOL 341 Paleontology and Biostratigraphy (4)

Prerequisites: GEOL 240 and GE Life Science requirement B.1.a.

GEOL 350 Spring Field Geology (2)

Prerequisites: GEOL 250 and GEOL 443 with grades of "C" or better. Prerequisite/Corequisite: GEOL 433.

GEOL 420 Geological Writing (3)

Prerequisites: GE Foundation completed, upper division standing, GEOL 102, GEOL 104, GEOL 240, GEOL 250; and at least 6 units of Geology courses at 300-level or above. Students must have scored 11 or higher on the GEAR Placement Examination or completed necessary portfolio course that is a prerequisite for a GEAR Writing Intensive Capstone.

GEOL 426 Igneous Metamorphic Petrography Laboratory (1)

Prerequisites: GEOL 322 and GEOL 326

Prerequisite/Corequisite: GEOL 428

GEOL 428 Igneous and Metamorphic Petrology and Petrography (3)

Prerequisites: GEOL 322; CHEM 111A, B.

GEOL 428 and GEOL 426 must be taken concurrently unless the undergraduate advisor approves otherwise.

GEOL 433 Structural Geology (4)

Prerequisites: GEOL 250, GEOL 322; PHYS 151.

GEOL 443 Stratigraphy/Sedimentology (4)

Prerequisites: GEOL 240, GEOL 322.

GEOL 450 Summer Field Geology (4)

Prerequisites: GEOL 350, GEOL 428, GEOL 433, and GEOL 443.

GEOL 460 Introduction to Geophysics (3)

Prerequisites: PHYS 151, PHYS 152; and MATH 123, all with a grade of "C" or better.

GEOL 461 Introduction to Geochemistry (3)

Prerequisites: CHEM 111A,B and MATH 123.

In addition, nine units of electives (normally at upper division) approved in advance by the undergraduate advisor.

Minor in Geology

The Minor in Geology is available to any non-Geology major.

Twenty units in geology courses that must include:

Lower Division:

Take all of the following:

GEOL 102 General Geology (3)

Prerequisites/Corequisites: A course that fulfills the A.1 GE requirement and three years of high school mathematics including algebra, geometry, and intermediate algebra or the equivalent.

GEOL 104 Geology Laboratory (1)

Prerequisites/Corequisites: A course that fulfills the A.1 GE requirement and three years of high school mathematics including algebra, geometry, and intermediate algebra or the equivalent, and concurrent or prior enrollment in GEOL 102.

GEOL 240 Historical Geology (4)

Prerequisite: GEOL 106 or both GEOL 102, GEOL 104.

Upper Division:

Take at least 9 additional units of geology approved in advance by the Undergraduate Advisor.

Bachelor of Science in Earth Science (120 units)

The bachelor of science degree in Earth Science is designed for those students considering a professional career in environmental, geotechnical, or engineering geology. The program also provides a fundamental education in geology that prepares students for graduate studies in the geological sciences. The required curriculum includes surficial geology courses (geomorphology, hydrology) not required as part of the B.S. in Geology. Students interested in pursuing a career in geophysics must consult the undergraduate advisor to construct an appropriate program.

Earth Science majors must receive a grade of "C" or better in all courses required for the major. A minimum of 120 units is required for the bachelor of science degree. Transfer students should attempt to fulfill, prior to transferring, the appropriate lower division curricular requirements as outlined below. In particular students should take prior to transferring the equivalent of GEOL 102 and 104, and at least three of the following four: CHEM 111A, CHEM 111B, MATH 122, and MATH 123.

GEOL 420 (Geological Writing) and GEOL 450 (Summer Field), both required courses for the major, are also capstone General Education courses, and GEOL 420 fulfills the GEAR requirement for a writing intensive course. Earth Science majors should take these two courses, and one other course to fulfill their upper division GE and GEAR requirements.

Lower Division:

Take all of the following:

GEOL 102 General Geology (3)

Prerequisites/Corequisites: A course that fulfills the A.1 GE requirement and three years of high school mathematics including algebra, geometry, and intermediate algebra or the equivalent.

GEOL 104 Geology Laboratory (1)

Prerequisites/Corequisites: A course that fulfills the A.1 GE requirement and three years of high school mathematics including algebra, geometry, and intermediate algebra or the equivalent, and concurrent or prior enrollment in GEOL 102.

GEOL 240 Historical Geology (4)

Prerequisite: GEOL 106 or both GEOL 102, GEOL 104.

GEOL 250 Introduction to Field Petrology and

Geological Field Techniques (3)

Prerequisites: GEOL 102 with GEOL 104 or GEOL 105; or GEOL 106; all with grades of "C" or better. Corequisite: GEOL 240.

CHEM 111A General Chemistry (5)

Prerequisites: A passing score on the Chemistry Placement Examination.

Corequisite: MATH 109 or higher.

CHEM 111B General Chemistry (5)

Prerequisite: CHEM 111A with a grade of "C" or better.

MATH 122 Calculus I (4)

Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and MATH 113.

MATH 123 Calculus II (4)

Prerequisite: A grade of "C" or better in MATH 122.

PHYS 151 Mechanics and Heat (4)

Prerequisite/Corequisite: MATH 122.

PHYS 152 Electricity and Magnetism (4)

Prerequisite: PHYS 151; Prerequisite/Corequisite: MATH 123.

Upper Division:

Take all of the following:

GEOL 322 Crystallography and Mineralogy (3)

Prerequisites: GEOL 250; CHEM 101 or CHEM 111A.

GEOL 339 Geomorphology (3)

Prerequisites: GEOL 102 with GEOL 104 or GEOL 105; or GEOL 106; or GEOG 140.

GEOL 350 Spring Field Geology (2)

Prerequisites: GEOL 250 and GEOL 443 with grades of "C" or better. Prerequisite/Corequisite: GEOL 433.

GEOL 420 Geological Writing (3)

Prerequisites: GE Foundation completed, upper division standing, GEOL 102, GEOL 104, GEOL 240, GEOL 250; and at least 6 units of Geology courses at 300-level or above. Students must have scored 11 or higher on the GWAR Placement Examination or completed necessary portfolio course that is a prerequisite for a GWAR Writing Intensive Capstone.

GEOL 428 Igneous and Metamorphic Petrology and Petrography (3)

Prerequisites: GEOL 322; CHEM 111A, B.

GEOL 433 Structural Geology (4)

Prerequisites: GEOL 250, GEOL 322; PHYS 151.

GEOL 443 Stratigraphy/Sedimentology (4)

Prerequisites: GEOL 240, GEOL 322.

GEOL 450 Summer Field Geology (4)

Prerequisites: GEOL 350, GEOL 428, GEOL 433, and GEOL 443.

GEOL 460 Introduction to Geophysics (3)

Prerequisites: PHYS 151, PHYS 152; and MATH 123, all with a grade of "C" or better.

GEOL 461 Introduction to Geochemistry (3)

Prerequisites: CHEM 111A, CHEM 111B and MATH 123.

GEOL 474 Physical Hydrology (3)

Prerequisites: GEOL 102, MATH 122; PHYS 151

In addition, nine units of electives (normally at upper division) approved in advance by the undergraduate

advisor. At least one elective must be chosen from the following list:

GEOL 477./577. Hydrogeology (4)

Prerequisites: GEOL 102, 104; CHEM 111B; PHYS 152; MATH 123. (Undergraduates enroll in GEOL 477; graduates enroll in GEOL 577).

MATH 370A. Applied Mathematics I (3)

Prerequisites: MATH 123. Not open to Freshmen.

Geoscience Concentration

The Geosciences Concentration meets the subject matter competence requirement for the Single Subject Teaching Credential in Geosciences. Prospective students should consult the Single Subject Science Education Advisor in the Department of Science Education early to plan their program.

Requirements

Lower Division:

Take all of the following

ASTR 100 Astronomy (3)

Corequisites: One course from General Education Category B.2 and ASTR 100L.

BIOL 211 Introduction to Evolution and Diversity (4)

Prerequisite/Corequisite: CHEM 111A with a grade of "C" or better.

BIOL 212 Intro to Cell and Molecular Biology (4)

Prerequisites: Completion of BIOL 211 and CHEM 111A with grades of "C" or better.

Prerequisite/Corequisite: CHEM 111B

BIOL 213 Introduction to Ecology and Physiology (4)

Prerequisites: BIOL 211, 212, CHEM 111B all with a grade of "C" or better.

CHEM 111A General Chemistry (5)

Prerequisites: A passing score on the Chemistry Placement Examination.

Corequisite: MATH 109 or higher.

CHEM 111B General Chemistry (5)

Prerequisites: CHEM 111A and MATH 113 or MATH 115 or MATH 117 or MATH 119A or MATH 122 all with a grade of "C" or better.

MATH 122 Calculus I (4)

Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and MATH 113.

MATH 123 Calculus II (4)

Prerequisite: A grade of "C" or better in MATH 122.

PHYS 151 Mechanics and Heat (4)

Prerequisite/Corequisite: MATH 122.

PHYS 152 Electricity and Magnetism (4)

Prerequisite: PHYS 151; Prerequisite/Corequisite: MATH 123.

GEOL 102 General Geology (3)

Prerequisites/Corequisites: A course that fulfills the A.1 GE requirement and three years of high school mathematics including algebra, geometry, and intermediate algebra or the equivalent.

GEOL 104 Geology Laboratory (1)

Prerequisites/Corequisites: A course that fulfills the A.1 GE requirement and three years of high school mathematics including algebra, geometry, and intermediate algebra or the equivalent, and concurrent or prior enrollment in GEOL 102.

GEOL 160 Introduction to Oceanography (3)

Prerequisites/Corequisites: A course that fulfills the A.1 GE requirement and three years of high school mathematics including algebra, geometry, and intermediate algebra or the equivalent.

NOTE: BIOL 111, BIOL 111L, BIOL 212, BIOL 212L, BIOL 213, BIOL 213L are required if courses were taken prior to catalog year 2010-11.

Upper Division:

Take all of the following

GEOL 341 Paleontology and Biostratigraphy (4)

Prerequisites: GEOL 240 and GE Life Science requirement B.1.a.

GEOL 428 Igneous and Metamorphic Petrology and Petrography (3)

Prerequisites: GEOL 322; CHEM 111A, B.

GEOL 433 Structural Geology (4)

Prerequisites: GEOL 250, GEOL 322; PHYS 151.

GEOL 443 Stratigraphy/Sedimentology (4)

Prerequisites: GEOL 240, GEOL 322.

GEOL 450 Summer Field Geology (4)

Prerequisites: GEOL 350, GEOL 428, GEOL 433, and GEOL 443.

SCED 403 Integrated Science (3)

Prerequisites: Completion of all credential breadth requirements for the Single Subject Teaching Credential Program in Science, three-fourths of the credential specializations courses, and consent of instructor.

Single Subject Teaching Credential in Geosciences

In addition to meeting the subject matter competence requirement for the Teaching Credential, prospective Geosciences teachers are also required to complete 45 units of professional preparation in the Single Subject Credential Program, including student teaching. Students may begin the professional preparation courses as early as the junior year. With careful planning, it is possible to complete many of the credential program courses, except for student teaching, as an undergraduate. Courses may also be started as a post-baccalaureate student. Refer to the Single Subject Teacher Education section of this catalog or the Single Subject Credential Program website (www.ced.csulb.edu/single-subject) for a description of the professional preparation requirements, courses, and application procedures.

The Geosciences Subject Matter Program is being revised to meet new state standards. When the revised program has been approved by the Commission on Teacher Credentialing, the new course requirements will be in effect and supersede current requirements.

GRADUATE PROGRAMS

Master of Science in Geology

The Department of Geological Sciences offers a comprehensive program of courses coupled with appropriate thesis projects leading to the Master of Science in Geology. Within geology, students specialize in any of a number of sub-disciplines including paleoclimatology, environmental geochemistry, geophysics, hydrogeology, mineralogy and petrology, tectonic geomorphology, paleontology, petroleum geology, sedimentology, stratigraphy, structural and field geology. In addition, a formal emphasis in geophysics is available. Students may include in their studies courses offered by other departments at CSULB with the approval of their principal thesis advisor (or their Thesis Committee).

Offshore Resources

The Department has access to an ocean-going research vessel, support staff, and dockside facilities of the Southern California Marine Institute (SCMI), a consortium of several California State University campuses, University of Southern California, and Occidental College.

Admission to the Program

The basic requirement for admission to the graduate program is possession of a bachelor's degree or equivalent in geological sciences, or a closely related field. The final curriculum requirements for the Master of Science Degree are set by the Thesis Committee at Advancement to Candidacy, but the following undergraduate courses are considered an essential foundation for the program: (1) two courses in calculus, (2) two courses in general chemistry, (3) two courses in calculus-based physics, (4) a course in physical geology, (5) a course in historical geology, (6) mineralogy, (7) sedimentology/stratigraphy, (8) structural geology, (9) a course in field methods or a field camp. Students who are missing some of this course work may be admitted conditionally to the program but will be expected to remove deficiencies or present acceptable alternatives prior to Advancement to Candidacy. Courses taken to remove deficiencies cannot be used towards satisfying the minimum requirements of the Graduate Program. Students who are missing the general science and math requirements are recommended to complete an undergraduate degree in Geological Sciences or a closely related field before applying to the Graduate Program.

In addition to the above course work requirements, students are required to take the General test of the Graduate Record Examination and to submit three letters of recommendation prior to entry.

Prospective graduate students in the geological sciences, including CSULB graduates, must formally apply for admission to CSULB (CSUMentor) as described previously in this Catalog and must also apply directly to the Department of Geological Sciences. All applicants must submit all required documents directly to the Department by February 1 to receive full consideration for admission and financial support. Applications completed as late as April 1 may be considered on a case by case basis for any remaining positions. Required documents include:

1. Department Application Form, available on the Department's website;
2. Personal Statement/Letter of Intent
3. Official transcripts of all college level academic work including that done at CSULB, in addition to those transcripts required for general graduate admission to CSULB;
4. Three letters of recommendation from persons familiar with the applicant's academic performance and research potential. Instructions, including forms to be used for these letters, are included in the Department application form, available from the Department's website;
5. Official reports of scores on the General test of the Graduate Record Examination.

A limited number of teaching and research assistantships are available to fund graduate studies in the Department of

Geological Sciences. Applicants wishing to secure research assistantships must discuss the possibility directly with their intended advisor.

Johnson-Conrey Graduate Fellowship

The Johnson-Conrey Graduate Fellowship is awarded to the most highly qualified incoming Geological Sciences graduate students each year. The Fellowship, which provides \$15,000 per year for two years, is competitive, and is awarded by the Department based on students' application materials and a separate essay. Up to two Fellowships are awarded each year. (Note that former CSULB students are ineligible to apply.)

Initiation of Graduate Study

Students are responsible for all University and Department regulations governing master's degrees as outlined in this *Catalog* and the Department Graduate Student Handbook. All applicants must be matched to a potential thesis advisor prior to acceptance. This advisor will provide academic advising. Administrative advising is carried out by the graduate advisor, who explains the requirements of the program.

All entering students must take GEOL 500 (Introductory Graduate Seminar) during their first Fall semester. This course consists of lectures and activities to help students focus their research projects and goals and work effectively toward the Advancement to Candidacy.

Students are required to maintain a GPA of 3.0 or higher at all times. If at any time a student's GPA drops below 3.0, that student will immediately be placed on academic probation for a maximum of two semesters. If the student does not bring the GPA back up to 3.0 during the probationary period, he/she will not be allowed to continue as a graduate student in this Department. In order for a student to regain status in the Department after failing to maintain this academic standard, he/she must formally reapply for Department admission.

Advancement to Candidacy

A student must have been advanced to candidacy before the beginning of their third semester. International students must have fulfilled the Graduation Writing Assessment Requirement (GWAR) or taken ENG 301B prior to Advancement to Candidacy. All students must Advance to Candidacy prior to enrollment in GEOL 698: Thesis Units. Requests to graduate must be received during the preceding May for Spring/Summer graduation or preceding December for Fall graduation. Filings after the deadlines are not accepted.

Prior to Advancement, a thesis topic, thesis committee, and graduate program consisting of at least 30 units (see below) must be established by the student and the prospective thesis committee chair. In addition, the following requirements must be met:

1. Completion of all deficiencies and incompletes. This includes courses required in the undergraduate major for the emphasis in which the student is pursuing graduate research, as well as additional courses specified by the thesis advisor.
2. Completion of six units of graduate level courses with

a 3.0 or higher grade point average and attainment of a 3.0 or higher grade point average in all upper division and graduate work attempted, as well as in courses to be listed in the student's graduate academic program (see below).

3. A passing grade in GEOL 500.

Advancement to Candidacy includes a successful completion of an oral presentation given by the student to their thesis committee, and acceptance of a written proposal for the thesis research. The student's thesis topic will be the subject of the examination.

Once the above requirements are met, Advancement to Candidacy proceeds with approval of the thesis committee followed by the Department Graduate Advisor, and Associate Dean of Graduate Studies in the College of Natural Sciences and Mathematics. After the student has been advanced, no course work in addition to that specified in the graduate program may be required of the student. In order for a student to change thesis chair/director, topic, committee members, or courses in the graduate program, approvals must be obtained. Under some circumstances this may mean that additional courses are required.

Requirements of Graduate Academic Program

The graduate academic program consists of at least 30 units of courses and is established when the student Advances to Candidacy. The program proposed by the thesis committee chair and the student must be approved by the thesis committee, Graduate Advisor and Associate Dean of Graduate Studies. Six units of GEOL 698 (Thesis) must be taken as part of the program, GEOL 695 (Directed Reading) may account for up to four units). Directed Research, GEOL 697, may account for up to three units, but normally cannot be taken before the student completes 12 units of the graduate program with a grade point average of 3.0 or higher.

A minimum of 21 units of 500 or 600 level courses, including Thesis, must be completed; the remaining units (9 or less) may be 300, 400, 500, or 600 level courses, although courses at 300 level in the Department may not be used in the program. Up to 9 units may be taken at other universities if suitable courses are not offered at CSULB. Appropriate courses from related areas in science, mathematics, or engineering may be substituted within limits with consent of the Department.

Thesis Defense

All M.S. students are required to submit a thesis that conforms to the University and Department guidelines. The thesis should document the systematic study of a significant geological problem; evidence originality and critical, independent thinking; and conform to appropriate and accepted organization, format, and writing style. Each student should discuss thesis format with his/her thesis committee chair.

All M.S. students are also required to present the results of their research orally to members of the department. The student must schedule his/her presentation at least two weeks in advance, and with the approval of the thesis committee. The date of the presentation must precede the semester's thesis submission deadline for which the student plans to graduate.

Single Subject Teaching Credential in Geosciences

For information, refer to the undergraduate section in this department.

Courses (GEOL)

LOWER DIVISION

102. General Geology (3)

Prerequisites/Corequisites: A course that fulfills the A.1 GE requirement and three years of high school mathematics including algebra, geometry, and intermediate algebra or the equivalent. Recommended: Concurrent enrollment in GEOL 104 or 105.

Broad based introductory study of geology. Broad based introductory study of geology. Structure, composition, distribution, and modification of earth materials and elementary geologic history of the Earth.

(Lecture, demonstration 3 hrs.)

104. Geology Laboratory (1)

Prerequisites/Corequisites: A course that fulfills the A.1 GE requirement and three years of high school mathematics including algebra, geometry, and intermediate algebra or the equivalent, and concurrent or prior enrollment in GEOL 102.

Laboratory study of earth materials.

(Laboratory 3 hrs.)

105. Geology Field Laboratory (1)

Prerequisites/Corequisites: A course that fulfills the A.1 GE requirement and three years of high school mathematics including algebra, geometry, and intermediate algebra or the equivalent, and concurrent or prior enrollment in GEOL 102.

Field trips to areas of geologic significance and field study of earth materials.

May be repeated to a maximum of 3 units with consent of instructor. (Field trips, 6 days per unit.) Course fee may be required for bus trips.

106. Earth Science for Teachers (4)

Prerequisites/Corequisites: A course that fulfills the A.1 GE requirement and three years of high school mathematics, including algebra, geometry, and intermediate algebra or the equivalent.

Introduction to earth science including geology, oceanography, meteorology, solar system and astronomy. Scientific method addressed. Methods of teaching science to K-8 pupils.

Letter grade only (A-F). (Lecture, demonstration 3 hours., laboratory 3 hrs., field trips.)

110. Natural Disasters (3)

Prerequisites/Corequisites: Courses that fulfill the GE A.1 and B.2 requirements.

Recommended: Concurrent enrollment in GEOL 110L.

Introductory study of Earth's natural processes that severely impact humans. Includes study of processes causing natural disasters such as earthquakes, volcanic eruptions, landslides, floods, tornadoes, hurricanes, tsunamis, and asteroid impacts.

(Lecture 3 hrs.)

110L. Natural Disasters Laboratory (1)

Prerequisites/Corequisites: Courses that fulfill the GE A.1 and B.2 requirements.

Corequisite: GEOL 110.

Laboratory analysis of geological data and field observations of geologic features associated with natural disasters.

Course fee may be required. (Laboratory 3 hrs, field trips).

160. Introduction to Oceanography (3)

Prerequisites/Corequisites: A course that fulfills the A.1 GE requirement and three years of high school mathematics including algebra, geometry, and intermediate algebra or the equivalent.

Origin and extent of oceans, nature of ocean floor, and cause and effect of currents, tides, and waves; and life in the ocean.

(Lecture, discussion 3 hrs.)

160L. Introduction to Oceanography Laboratory (1)

Prerequisites/Corequisites: A course that fulfills the A.1 GE requirement and three years of high school mathematics including algebra, geometry, and intermediate algebra (MAPB 7) or the equivalent; and previous credit or concurrent registration in GEOL 160.

Field and laboratory study of marine environment. Analysis of maps, plus shore and on-water trips for experience in use of oceanographic instruments. Analysis and interpretation of results.

(Laboratory-field 3 hrs.) Course fee may be required.

190. Environmental Geology (3)

Prerequisites/Corequisites: A course that fulfills the A.1 GE requirement and three years of high school mathematics including algebra, geometry, and intermediate algebra or the equivalent.

Interrelationships between humans and hazards: landslides, floods, erosion, subsidence, volcanism, earthquakes, and seismic sea waves. Origin of resources and impacts of resource development: water, soils, and energy. Waste and waste disposal.

(Lecture 3 hrs.)

191. Air and Water Pollution (3)

Prerequisites/Corequisites: A course that fulfills the A.1 GE requirement and three years of high school mathematics including algebra, geometry, and intermediate algebra or the equivalent.

Survey course dealing with the causes and nature of pollution in the air, groundwater, fresh water lakes and streams, and the ocean. Effects of air and water pollution on the environment.

(Lecture 3 hrs.)

240. Historical Geology (4)

Prerequisite: GEOL 106 or both GEOL 102, GEOL 104.

History of earth and evolution of animals and plants.

(Lecture 3 hrs., laboratory 3 hrs., field trips.)

250. Introduction to Field Petrology and Geological Field Techniques (3)

Prerequisites: GEOL 102 with GEOL 104 or GEOL 105; or GEOL 106; all with grades of "C" or better.

Corequisite: GEOL 240.

Identification and description of igneous, sedimentary, and metamorphic rocks in the field. Development of fundamental geological field techniques: recording, collection, and interpretation of geological field data. Creation and interpretation of geological maps, writing technical reports, and construction of geological illustrations.

Letter grade only (A-F). (Lecture 1 hour, weekend field trips.)

280. Water Resources and Society (3)

Prerequisites: GEOL 102, GEOL 104. Four years of high school mathematics.

Hydrologic, geologic, and other factors controlling groundwater and surface water occurrence, movement, quality, and contamination. Environmental effects of groundwater and surface water contamination.

(Lecture 3 hours; field trips)

UPPER DIVISION

300. Earth Systems and Global Change (3)

Prerequisites: GE Foundation requirement, upper division standing, and CHEM 100 or CHEM 111A or GEOL 102 or GEOL 106 with a grade of "C" or better.

Interaction of Earth's systems (biosphere, lithosphere, hydrosphere, cryosphere, and atmosphere) and links between life, oceans, climate, and the solid earth. This approach is used to understand important issues confronting society regarding climatic and environmental change.

Letter grade only (A-F). (Lecture 3 hrs.)

322. Crystallography and Mineralogy (3)

Prerequisites: GEOL 250; CHEM 111A.

Morphological and structural crystallography, crystal structure, chemistry, classification, origin, occurrence, and association of minerals reviewed. Analysis and identification of minerals by megascopic, qualitative, chemical, and instrumental means.

(Lecture 2 hrs., laboratory 3 hrs., field trip)

326. Optical Mineralogy (2)

Prerequisites: GEOL 250; a passing score on the Chemistry Placement Examination or CHEM 111A;

Corequisite/Prerequisite: GEOL 322.

Review of morphological and optical properties of minerals including basics of the nature of light. Use of petrographic microscope in rock and mineral examination.

Letter grade only (A-F).

339. Introduction to Geomorphology (3)

Prerequisites: GEOL 102 with GEOL 104 or GEOL 105; or GEOL 106; or GEOG 140.

Study of landforms and processes producing and modifying them. Emphasis on mechanics of geomorphic processes and relationships between properties of earth materials and forces applied to them by gravity, wind, ice, water, waves, and humans. Conceptual basis of geomorphology addressed.

Designed for Geology, Geography, Biology, Anthropology, and Civil Engineering majors. Letter grade only (A-F). (Lecture 2 hrs., laboratory 3 hrs., field trips)

341. Paleontology and Biostratigraphy (4)

Prerequisite: GEOL 240 and GE Life Science requirement B.1.a.

Morphologic, systematic, and ecologic aspects of invertebrate fossils; methods and techniques in collection, preparation, illustration, and description of fossils; uses of fossils in stratigraphic work; principles of biostratigraphy.

(Lecture 3 hrs., laboratory 3 hrs., fieldtrips) Course fee may be required.

350. Spring Field Geology (2)

Prerequisites: GEOL 250 and GEOL 443 with grades of "C" or better. Prerequisite/Corequisite: GEOL 433.

Development of proficiency in geological mapping skills. Construction of stratigraphic columns and structural cross sections.

Letter grade only (A-F). (Field trips, 5 days per unit)

370. Geology for Engineers (2)

Prerequisite: CE 200

Earth processes and materials which influence the design, construction and operation of engineering works, construction materials. Not open for credit to geology majors.

(Lecture 2 hrs., field trips.)

420. Geologic Writing (3)

Prerequisites: GE Foundation completed, upper division standing, GEOL 102, GEOL 104, GEOL 240, GEOL 250; and at least 6 units of Geology courses at 300-level or above. Students must have scored 11 or higher on the GVAR Placement Examination or completed necessary portfolio course that is a prerequisite for a GVAR Writing Intensive Capstone.

A writing-intensive capstone. Writing for a geological audience; writing scientific/geological content at an advanced level emphasized. Journal articles and abstracts reviewed. Includes handling scientific data, distinction between data and interpretation, logic and argument, clarity of style, and types of writing (abstracts, proposals, articles, etc.). Library search methods. Extensive writing, editing, and peer review. Enrollment limited.

Letter grade only (A-F). (Lecture 1 hr. and laboratory (6 hrs.))

426. Igneous Metamorphic Petrography Laboratory (1)

Prerequisites: GEOL 322 and GEOL 326;

Prerequisite/Corequisite: GEOL 428

Laboratory microscopic analysis of igneous and metamorphic rocks, including fabric and mineral content.

Letter grade only (A-F). (Laboratory 3 hrs.)

428. Igneous and Metamorphic Petrology and Petrography (3)

Prerequisites: GEOL 322; CHEM 111A, B.

Magmatic and metamorphic rock bodies and systems characteristics, including mineralogical and chemical aspects. Fabrics' origin, evolution of igneous and metamorphic rocks, modeling of magma genesis. Microscopic, hand specimen and x-ray analysis of rocks, including fabric and mineral content.

Letter grade only (A-F). (Lecture 2 hrs., laboratory 3 hrs., field trips)

433. Structural Geology (4)

Prerequisites: GEOL 250, GEOL 322; PHYS 151.

Theories/principles of structural geology, orogenesis, and tectonics. Planar/linear structures in naturally deformed rocks. Description, classification, interpretation, and kinematic and dynamic analysis of faults/folds. Field measurement, analysis and mapping of structures. Deformation, strength, fracture, and rheological properties of rocks.

Letter grade only (A-F). (Lecture 3 hrs., laboratory 3 hrs., required field trips)

443. Stratigraphy/Sedimentology (4)

Prerequisites: GEOL 240, GEOL 322.

Introduction to sedimentology and stratigraphy, flow mechanics and sedimentary structures, laboratory and field methods for the description and classification of sedimentary rocks, depositional systems, sequence stratigraphy, subsurface stratigraphic methods, sedimentation and tectonics, and preparation of sedimentologic field reports.

Not open for credit to students with credit in GEOL 343. Letter grade only (A-F). (Lecture 3 hrs., laboratory 3 hrs., required field trips)

444. Engineering Geology (4)

Prerequisites: GEOL 250, GEOL 433; MATH 122, MATH 123; PHYS 151, PHYS 152.

In depth study of the fundamentals of engineering geology and related hazards. Topics covered include rock and soil mechanics, active faulting, landslides, coastal and fluvial processes.

Letter grade only (A-F). (Lecture 3 hrs., laboratory 3 hrs.; field trips.)

445. Paleoclimatology (4)

Prerequisites: ESP 200 or GEOG 340 and GEOG 200 (or equivalent) or consent of instructor.

Methods and theories used in reconstructing and dating climates of the past 2 million years, using such proxies as sediment sequences, packrat middens, ice cores, tree rings, corals, and documentary data. Causes of environmental change and human interactions are analyzed.

Letter grade only (A-F). Same course as GEOG 445. Not open for credit to students with credit in GEOG 445. (Lecture 3 hours, lab activities 2 hours)

450. Summer Field Geology (4)

Prerequisites: GEOL 350, GEOL 428, GEOL 433, and GEOL 443.

An integrative learning capstone. Four weeks of geological field mapping at a selected area. Preparation of geological reports of the field problems.

(Lecture as needed, daily field work)

460. Introduction to Geophysics (3)

Prerequisites: PHYS 151, PHYS 152; and MATH 123, all with a grade of "C" or better.

Introduction to geophysics; principles and processes; methods of investigation.

Letter grade only (A-F). (Lecture 2 hrs., laboratory 3 hrs., field trips.)

461. Introduction to Geochemistry (3)

Prerequisites: CHEM 111A,B and MATH 123.

Abundance and migration of elements in the earth; chemical processes in evolution of earth and its crust including geochemistry of organic compounds.

Letter grade only (A-F). (Lecture 2 hrs., laboratory 3 hrs.)

462. Physics and Chemistry of the Earth's Interior (3)

Prerequisites: GEOL 240, GEOL 428; PHYS 152.

Structure and composition of the Earth's interior. Origin and evolution of the Earth. Review of geophysical data, petrologic analyses, and other types of evidence for Earth structure and compositional models.

Letter grade only (A-F). (Lecture 3 hrs.)

465. Physical and Chemical Oceanography (3)

Prerequisites: CHEM 111B; PHYS 100A or PHYS 151, and upper division standing in the College of Natural Sciences and Mathematics or Engineering.

Physics and chemistry of the oceans, carbon cycle; minor and trace elements in sea water, nutrients, water masses and currents; physical concepts and interpretative theories related to ocean circulation.

Letter grade only (A-F). (Lecture 3 hrs.)

466. Oceanography Laboratory and Ocean Studies (1)

Prerequisite/Corequisite: GEOL 465.

Analysis and interpretation of oceanographic data, acquisition of data at sea on field trip, and post-cruise analysis and presentation of results.

Not open for credit to students with credit in GEOL 462. (Laboratory 3 hrs., sea trips.)

474./574. Physical Hydrology (3)

Prerequisites: GEOL 102, MATH 122; PHYS 151. (Undergraduates enroll in GEOL 474; graduates enroll in GEOL 574.)

Quantitative study of the terrestrial water cycle; prediction and measurement of precipitation, surface water, soil water, and groundwater.

Letter grade only (A-F). (Lecture 2 hrs, lab/field trips 3 hrs)

477./577. Hydrogeology (4)

Prerequisites: GEOL 102, GEOL 104; CHEM 111B; PHYS 152; MATH 123. (Undergraduates enroll in GEOL 477; graduates enroll in GEOL 577.)

Groundwater flow, occurrence, development, chemistry, and contamination. Elementary groundwater flow theory. Well hydraulics.

Letter grade only (A-F). (Lecture 3 hrs., laboratory 3 hrs.)

489. Current Topics in Geological Sciences (3)

Prerequisite: Consent of instructor.

Topics of current interest in the geological sciences selected for intensive development.

May be repeated to a maximum of 6 units. Field trips may be required. (Lecture 2 hrs., laboratory 3 hrs.)

490. Current Topics in Geological Sciences (1-3)

Prerequisite: Consent of instructor.

Topics of current interest in the geological sciences selected for intensive development.

May be repeated to a maximum of 6 units. Field trips may be required.

496. Investigations in Geology and Other Earth Sciences (1-4)

Prerequisites: Senior standing in geology, earth science or related fields, completion of an upper division course in geology or earth science in the area of the topics chosen and approval of the topic chosen by the Geological Sciences faculty.

Supervised research in geology or the other earth sciences. Field trips may be required.

GRADUATE LEVEL

500. Introductory Graduate Seminar (1)

Prerequisite: Graduate standing.

Introduction to graduate policies and faculty research in Geological Sciences. Abstracts on faculty presentation required of all students.

Course cannot be counted for program requirements for the M.S degree in Geology. Credit/No Credit grading only. May be repeated to a maximum of 3 units. (Seminar 1 hr.)

510. Biogeochemical Cycles (3)

Study of carbon, nitrogen, phosphorus, iron, and sulfur cycles among the bio-, hydro-, and geospheres with an emphasis on transfer rates, mass balance, and residence times. Evaluation of processes and interactions among key ecosystems (wetlands, rivers, ocean, lakes, estuaries).

Letter grade only (A-F). (Lecture 3 hrs.)

524. Sedimentary Petrology (4)

Prerequisites: GEOL 322 and GEOL 443.

Microscopic and macroscopic study of the origin and diagenesis of sedimentary rocks. Identification of grain types, textures, structures, and cements emphasizing provenance, paleotectonics, paleoenvironmental reconstructions, and post-depositional alteration.

Letter grade only (A-F). (Lecture 3 hrs., laboratory 3 hrs.)

530. Seminar in Structural Geology and Tectonics (3)

Prerequisite: GEOL 433.

Review of analysis, interpretation and origin of geologic structures, mechanics of rock deformation and of large scale crustal deformation.

(Lecture 2 hrs., laboratory 3 hrs.; field trips.)

531. Tectonic Geomorphology (4)

Prerequisite: GEOL 433.

Observation and analysis of Earth surface processes, and development of landforms and landscape. Interaction between surficial processes and tectonic, biologic, hydrologic, climatic, and atmospheric processes. Tectonic generated landforms, earthquake hazards evaluated, and geomorphic assessment. Assessing problems including landforms and environmental hazards.

Letter grade only (A-F). (Lecture 2 hrs., laboratory 6 hrs., field trips).

537. California Geology (3)

Prerequisites: GEOL 433, GEOL 450.

Examination of recent theories concerning evolution of California's geological provinces; geological, geochemical, and geophysical evidence for these theories.

Letter grade only (A-F). (Lecture 3 hrs., field trips.)

541. Seminar on Mass Extinctions (3)

Prerequisites: GEOL 341, 443, 461.

Study of the nature, causes, and stratigraphic record of mass extinction events in Earth history.

Letter grade only (A-F). (seminar 3 hrs.)

543. Seminar on Integrated Stratigraphy (3)

Prerequisites: GEOL 341, 443, 461.

Study of all stratigraphic subdisciplines and their integrated use for effecting high-resolution stratigraphic correlations.

Letter grade only (A-F). (Seminar 3 hrs.)

554. Environmental Geochemistry (3)

Prerequisites: CHEM 111B and consent of instructor.

Geochemical cycles. Human interference with cycles. Trace elements, health and agriculture. Clay mineral reactions. Groundwater chemistry. Reading and discussion of research articles; projects in environmental geochemistry.

Letter grade only (A-F). (Lecture 3 hrs., field trips)

555. Stable Isotopes (3)

Prerequisites: GEOL102, CHEM 111B.

Fractionation of stable isotopes, mass spectrometry, application of stable isotopes to geologic, ecologic, and archaeological studies such as paleoclimatology, petrologic studies, paleodiet analysis.

Letter grade only (A-F). Lecture 3 hrs.

570. Special Topics in Geology (3)

Prerequisite: Consent of instructor.

Investigation of selected topics in geology. May be repeated to a maximum of 9 units toward any single degree with different topics. Seminars with field trips as appropriate.

Letter grade only (A-F). (Seminar, 3 hrs.) May be repeated to a maximum of 9 units with different topics in different semesters.

571. Contaminant Hydrogeology (3)

Prerequisites: GEOL 102, GEOL 104, GEOL 477/577; CHEM 111B; PHYS 152; MATH 123.

Study and prediction of groundwater pollution transport, reaction, and remediation.

Letter grade only (A-F). (Lecture 2 hrs., laboratory 3 hrs.)

574./474. Physical Hydrology (3)

Prerequisites: GEOL 102, MATH 122; PHYS 151. (Undergraduates enroll in GEOL 474; graduates enroll in GEOL 574.)

Quantitative study of the terrestrial water cycle; prediction and measurement of precipitation, surface water, soil water, and ground water.

Letter grade only (A-F). (Lecture 2 hrs, lab/field trips 3 hrs)

575. Advanced Topics in Sedimentology (3)

Prerequisite: Consent of instructor.

Investigation of topics in sedimentology such as depositional facies analysis, basin evolution, coastal processes, fluvial processes, advanced stratigraphic analysis, and tectonics and sedimentation.

Content varies form year to year. May be repeated to a maximum of 9 units toward any single degree with different topics in different semesters. Letter grade (A-F). Seminars with field trips as appropriate. (Seminar 3 hrs.)

577./477. Hydrogeology (4)

Prerequisites: GEOL 102, GEOL 104; CHEM 111B; PHYS 152; MATH 123. (Undergraduates enroll in GEOL 477; graduates enroll in GEOL 577.)

Groundwater flow, occurrence, development, chemistry, and contamination. Elementary groundwater flow theory. Well hydraulics.

Letter grade only (A-F). (Lecture 3 hrs., laboratory 3 hrs.)

579. Applied Groundwater Modeling (4)

Prerequisites: GEOL 102, GEOL 104, GEOL 477/577; PHYS 152; MATH 123. Recommended: MATH 370A.

Numerical modeling of groundwater flow and mass transport. Emphasis is on creation of numerical models from conceptual models of geology derived from geologic mapping and sampling.

Letter grade only (A-F). (Lecture 3 hrs., laboratory 3 hrs.)

582. Petroleum Geology and Well Log Analysis (4)

Prerequisites: GEOL 240, GEOL 443.

Geological application in exploration and production of petroleum, including uses of surface and subsurface techniques. Basic well logging techniques employed, including data collection, reduction, interpretation, and integration among various logging methods as well as with surface geology and geophysical data.

(Lecture 2 hrs., laboratory 6 hrs., field trips.)

586. Engineering Geophysics (3)

Prerequisite/Corequisite: GEOL 460.

Applying geophysical techniques to geology and hydrogeology problems. Geophysical techniques, and identification and utilization of specialized techniques. Case histories in site evaluations, subsiding areas, basement topography mapping, seawater problems, water table mapping, groundwater contamination, and subsurface cavities detection.

Letter grade only (A-F). (Lecture 2 hrs., laboratory 3 hrs.; field trips.) Course fee may be required.

695. Directed Reading (1-3)

Survey of information in published or unpublished geological literature or databases on a designated topic, under the direction of a faculty member. Written reports prepared from these readings.

May be repeated to a maximum of 4 units toward any single degree with different topics in different semesters. Limited to 3 units per semester. Letter grade only (A-F).

697. Directed Research (1-3)

Prerequisite: Consent of instructor.

Research on a specific subject in geology. Topic for study to be approved and directed by a faculty member in geological sciences.

Letter grade only (A-F).

698. Thesis (1-6)

Prerequisites: Advanced to candidacy for M.S. in Geology, consent of Graduate Committee and graduate advisor.

Either laboratory or field investigations, or both, for a total of six semester units to culminate in an approved thesis.

Letter grade only (A-F).