

# Geological Sciences

In the College of Sciences

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## Faculty

Emeritus: Abbott, Berry, Bertine, Gastil, Jiracek, Kern, Krummenacher, Marshall, McEuen, Miller, Ptacek, Roberts, Threet, Walawender, Wallace

Chair: Girty

The Rollin and Caroline Eckis Chair in Seismology: Day

Professors: Day, Dorman, Girty, Huntley, Kimbrough, Peterson, Rockwell

Associate Professors: Frost, Olsen, Thorbjarnarson

Assistant Professors: Leighton, Pietruszka, Riggs, Schellenberg

Lecturers: Camp, Robinson, SacramentoGrilo

## Offered by the Department

Master of Science degree in geological sciences.

Major in geological sciences with the B.S. degree in applied arts and sciences.

Emphasis in general geology.

Emphasis in engineering geology.

Emphasis in geochemistry.

Emphasis in geophysics.

Emphasis in hydrogeology.

Emphasis in marine geology.

Emphasis in paleontology.

Teaching major in geological sciences for the single subject teaching credential in science.

Minor in geological sciences.

Minor in oceanography.

## The Rollin and Caroline Eckis Chair in Seismology

A gift from Rollin and Caroline Eckis, combined with matching funds from the Atlantic Richfield Company and contributions from SDSU faculty and staff, established The Rollin and Caroline Eckis Chair in Seismology at SDSU. The late Rollin Eckis was former president of Richfield Oil Company and vice chairman of the board of Atlantic Richfield Company.

The first appointee to the chair, Dr. Steven M. Day, conducts research on the mechanics of earthquakes and earthquake hazards.

## The Major

Geology is the study of the earth, its composition, its history, and its constantly changing character.

Geologists study the origin and evolution of our planet; the chemical and physical properties of minerals, rocks, and fuels; the structure of our mobile crust – its newly forming ocean floors and its ancient, drifting continents; the history of life; and human adaptation to earthquakes, volcanic eruptions, landslides, and floods. The subject matter of geology ranges from dinosaurs to the prediction of earthquakes.

Students who are curious about the planet on which we live, challenged by problems which involve the earth, and intrigued by the potential of a subject which combines both the arts and sciences, should consider geological sciences as a major.

The employment outlook is favorable, particularly with engineering, hydrogeology, toxic waste disposal firms, energy companies, and as school teachers.

A geology graduate may be employed as one of the following professionals: hydrologist, geophysicist, geochemist, environmental scientist, oceanographer, teacher, research technician, geological surveyor, paleontologist, energy and resource explorer, and resource planner.

Geologists are primarily employed by private corporations, including petroleum, mining, construction, quarry, hydrology, and engineering geology companies and by government agencies, such as the U.S. Geological Survey, the U.S. Bureau of Reclamation, the California Department of Conservation, and regional planning offices. Students with graduate degrees are sought for teaching positions in secondary schools, community colleges, and universities.

## Geological Sciences Major

With the B.S. Degree in Applied Arts and Sciences  
(Major Code: 19141)

All candidates for a degree in applied arts and sciences must complete the graduation requirements listed in the section of this catalog on "Graduation Requirements." All required upper division courses must be taken for letter grades only, not credit/no credit.

Courses to satisfy the requirement of 36 or more upper division units in the major may be selected from upper division geological sciences courses not explicitly excluded. Students may petition the department to include courses from other disciplines to complete the upper division major requirement.

A minor is not required with this major.

### Emphasis in General Geology

**Preparation for the Major.** Oceanography 100, or Geological Sciences 100 and 101, or Geological Sciences 104 and 101; Geological Sciences 105, 200, 221; Biology 100, 100L; Chemistry 200, 201; Mathematics 150, 151; Physics 195, 195L, 196, 196L. (45 units)

**Recommended:** Physics 197, 197L; Mathematics 252.

**Graduation Writing Assessment Requirement.** Completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better or passing the Writing Proficiency Assessment with a score of 10 or above. See page 73 in "Graduation Requirements" section for a complete listing of requirements.

**Major.** A minimum of 38-40 upper division units in approved courses to include Geological Sciences 300, 306, 307, 324, 498A, 498B, 508, 530, 536, 537; plus six additional upper division units from geological sciences (upper division courses from outside department by approval).

### Emphasis in Engineering Geology

**Preparation for the Major.** Oceanography 100, or Geological Sciences 100 and 101, or Geological Sciences 104 and 101; Geological Sciences 105, 200, 221; Biology 100; Chemistry 200, 201; Engineering Mechanics 200; Mathematics 150, 151, 252; Physics 195, 196, 197; Statistics 250. (55 units)

**Recommended:** Civil Engineering 218; Physics 195L, 196L, 197L.

**Graduation Writing Assessment Requirement.** Completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better or passing the Writing Proficiency Assessment with a score of 10 or above. See page 73 in "Graduation Requirements" section for a complete listing of requirements.

**Major.** A minimum of 41 upper division units in approved courses to include Geological Sciences 300, 306, 307, 324, 498B, 508, 536, 550, 551; Civil Engineering 301\*, 462, 463; one of the following: Geological Sciences 505, 514, 530, 560, or Civil Engineering 465.

Because of the preparation in mathematics, physics, and geology called for in this emphasis, the College of Engineering will not require majors in this emphasis to take the prerequisites specified for Civil Engineering 301, 462, and 463.

\* Prerequisites waived.

### Emphasis in Geochemistry

**Preparation for the Major.** Oceanography 100, or Geological Sciences 100 and 101, or Geological Sciences 104 and 101; Geological Sciences 200, 221; Biology 100 or 101; Chemistry 200, 201, 231, 251; Mathematics 150, 151; Physics 195, 196, 197; Statistics 250. (53 units)

**Recommended:** Geological Sciences 105, 307; Chemistry 431; Physics 195L, 196L, 197L; Mathematics 252.

**Graduation Writing Assessment Requirement.** Completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better or passing the Writing Proficiency Assessment with a score of 10 or above. See page 73 in "Graduation Requirements" section for a complete listing of requirements.

**Major.** A minimum of 40 upper division units in approved courses to include Geological Sciences 300, 306, 324, 498B, 501, 530, 536, 551, 552; Chemistry 410A\*-410B, 571.

\* Prerequisites waived.

### Emphasis in Geophysics

**Preparation for the Major.** Oceanography 100, or Geological Sciences 100 and 101, or Geological Sciences 104 and 101; Geological Sciences 200, 221; Biology 100 or 101; Chemistry 200, 201; Mathematics 150, 151, and 252; Physics 195, 195L, 196, 196L, 197. Engineering 280 must be taken if students select Engineering 510 in the major. (47-50 units)

**Recommended:** Geological Sciences 105, Physics 197L, Statistics 250.

**Graduation Writing Assessment Requirement.** Completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better or passing the Writing Proficiency Assessment with a score of 10 or above. See page 73 in "Graduation Requirements" section for a complete listing of requirements.

**Major.** A minimum of 40 upper division units in approved courses to include Geological Sciences 300, 306, 307, 324, 498B, 533, and 560; Mathematics 342A and 342B, or Engineering 510; Physics 311, 350; Physics 400A or Electrical Engineering 340; plus three upper division units of approved courses in geological sciences at the 500 level.

### Emphasis in Hydrogeology

**Preparation for the Major.** Oceanography 100, or Geological Sciences 100 and 101, or Geological Sciences 104 and 101; Geological Sciences 105, 200, 221; Biology 100; Chemistry 200, 201; Mathematics 150, 151; Physics 195, 196, 197; Mathematics 252 or Chemistry 231; Statistics 250. (52 units)

**Recommended:** Physics 195L, 196L, 197L.

**Graduation Writing Assessment Requirement.** Completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better or passing the Writing Proficiency Assessment with a score of 10 or above. See page 73 in "Graduation Requirements" section for a complete listing of requirements.

**Major.** A minimum of 39 upper division units in approved courses to include Geological Sciences 300, 306, 324, 498B, 514, 530, 536, 551, 552; Mathematics 342A-342B, or Chemistry 571; plus three to six upper division units of departmentally approved courses.

### Emphasis in Marine Geology

**Preparation for the Major.** Oceanography 100, or Geological Sciences 100 and 101, or Geological Sciences 104 and 101; Geological Sciences 105, 200, 221; Biology 100 or 101; Chemistry 200, 201; Mathematics 150, 151, 252; Physics 195, 195L, 196, 196L, 197, 197L. (52 units)

**Recommended:** Geological Sciences 537. A foreign language.

**Graduation Writing Assessment Requirement.** Completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better or passing the Writing Proficiency Assessment with a score of 10 or above. See page 73 in "Graduation Requirements" section for a complete listing of requirements.

**Major.** A minimum of 40 upper division units in approved courses to include Geological Sciences 300, 306, 307, 324, 498B, 530, 536, 540, 545, and two of the following courses: Geological Sciences 501, 508, 537, Biology 517; plus four upper division units of departmentally approved courses. Recommended: Chemistry 410A-410B for students anticipating postgraduate studies.

### Emphasis in Paleontology

**Preparation for the Major.** Oceanography 100, or Geological Sciences 100 and 101, or Geological Sciences 104 and 101; Geological Sciences 105, 200, 221; Biology 201A, 201B, 215; Chemistry 200, 201; Mathematics 150 or 121 and 122 (alternative of 121 and 122 should not be selected by students planning academic work beyond the B.S. degree); Physics 180A-180B and 182A-182B. (48-50 units)

**Recommended:** Geological Sciences 307.

**Graduation Writing Assessment Requirement.** Completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better or passing the Writing Proficiency Assessment with a score of 10 or above. See page 73 in "Graduation Requirements" section for a complete listing of requirements.

**Major.** A minimum of 38 upper division units in approved courses to include Geological Sciences 300, 306, 324, 498A, 498B, 501, 508, 536, 537\*; Biology 352, 354; plus four upper division units of departmentally approved courses.

\* Prerequisites waived.

## Geological Sciences Major

### In preparation for the Single Subject Teaching Credential in Science/Geological Sciences

#### With the B.S. Degree in Applied Arts and Sciences (Major Code: 19141)

One of the requirements for acceptance into the College of Education's post-baccalaureate credential program is to either pass the appropriate CSET examinations or complete an approved academic program. The single subject teaching credential in science subject matter preparation program described below satisfies the academic requirements for a student planning to teach integrated science and geosciences at the secondary level. Entrance into the post-baccalaureate credentialing program in part requires certification of subject matter competency by this department. This certification requires completion of the academic program with the required grades, submission of a satisfactory portfolio, and the recommendation of the department. Contact the subject matter preparation program adviser. In addition, all candidates for a Single Subject Teaching credential at San Diego State University must complete the requirements outlined in the catalog under Teacher Education or Policy Studies. Contact the School of Teacher Education or the Policy Studies in Language and Cross-Cultural Education Department for up-to-date information on prerequisites.

**General Education Requirements.** Students will complete a minimum of 49 units in General Education to include a minimum of nine upper division units. No more than 12 units may be used for General Education credit from any one department or academic unit. No more than 7 units from one department can be used in Sections II and IV combined (Foundations and Explorations), nor more than 10 units from one department in Sections II, III, and IV combined (Foundations, American Institutions, and Explorations).

#### I. Communication and Critical Thinking: 9 units

You may *not* use Credit/No Credit grades in this section.

1. **Oral Communication (3 units)** to be satisfied by Africana Studies 140, Chicana and Chicano Studies 111A, or Communication 103.
2. **Composition (3 units)** to be satisfied by Africana Studies 120, Chicana and Chicano Studies 111B, or Rhetoric and Writing Studies 100.

## Geological Sciences

- Intermediate Composition and Critical Thinking (3 units) to be satisfied by Africana Studies 200 or Rhetoric and Writing Studies 200.

### II. Foundations (28 units)

- Natural Sciences and Quantitative Reasoning (13 units):
  - Physical Sciences (6 units) to be satisfied by Chemistry 200 and Physics 180A or 195.
  - 2-3. Life Sciences and Laboratory (4 units) to be satisfied by Biology 100 and 100L.
  - Mathematics/Quantitative Reasoning (3 units) to be satisfied by Mathematics 150. You may **not** use Credit/No Credit grades.
- Social and Behavioral Sciences (6 units).
- Humanities (9 units):

Complete a course in each of three of the following four areas (1. Literature; 2. Art, Classics, Humanities, Music, and Theatre; 3. Philosophy and Religious Studies; 4. Foreign Language) in the Humanities section of the Foundations component of the regular General Education program. Refer to General Education course offerings in the Graduation Requirements section of the catalog. One semester of a foreign language is recommended.

### III. American Institutions

Three units of the six units of coursework which meet the American Institutions graduation requirement may be used in General Education, excluding courses numbered 500 and above.

### IV. Explorations (9 units)

Courses in this area must not be taken sooner than the semester in which you achieve upper division standing (60 units passed). Upper division courses in the major department may not be used to satisfy General Education.

- Upper division Social and Behavioral Sciences (3 units). Linguistics 420 is recommended.
- Upper division Humanities to be satisfied by History 441 (3 units).
- Upper division Humanities (3 units). A course in cultural diversity is required. Refer to Part C of Explorations under the General Education requirements section in the catalog.

## The Major

**Preparation for the Major.** Africana Studies 140, Chicana and Chicano Studies 111A, or Communication 103; Africana Studies 120, Chicana and Chicano Studies 111B, or Rhetoric and Writing Studies 100; Africana Studies 200 or Rhetoric and Writing Studies 200; Astronomy 101, 109; Biology 100, 100L; Chemistry 200, 201; Geography 103; Geological Sciences 105, 200, 221; Mathematics 150; Physics 180A, 180B, 182A, 182B **OR** Physics 195, 195L, 196, 196L, 197, 197L; Statistics 250. (56-60 units)

**Graduation Writing Assessment Requirement.** Completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better or passing the Writing Proficiency Assessment with a score of 10 or above. See page 73 in "Graduation Requirements" section for a complete listing of requirements.

**Major.** A minimum of 39 units to include Geological Sciences 300, 303 (allowed only in this version of the major in Geological Sciences), 306, 324, 498A, 498B, 501, 536, 537; Biology 319; Oceanography 541; and six units selected from Geological Sciences 305, 307, 505, 508, 514, 520, 530, 540, 545.

## Additional Requirements for Subject Matter Preparation Certification

**Satisfactory Grades.** At most one course with a C– or lower among the courses listed under Preparation for the Major, and at most one course with a C– or lower among the courses listed under the Major. If a course is repeated, the highest grade will count.

**Formative Assessment.** Completion of a satisfactory, preliminary portfolio two semesters prior to graduation. Contact the subject matter preparation adviser for information.

**Summative Assessment.** Completion of a satisfactory, final portfolio, and a positive recommendation from a committee consisting of the senior project supervisor, the Department of Geological Sciences chair, and the subject matter preparation program adviser.

## Geological Sciences Minor

The minor in geological sciences consists of a minimum of 20 units in geological sciences, twelve of which must be in upper division courses. Courses include Geological Sciences 100, 101, 105; and twelve units selected from Geological Sciences 301, 302, 303, 304, 305, 306, 307, 324, 502, 505, 514, 536, 537. In addition, Geological Sciences 200 and 221 are appropriate for geology minors.

Courses in the minor may not be counted toward the major, but may be used to satisfy preparation for the major and general education requirements, if applicable. A minimum of six upper division units must be completed in residence at San Diego State University.

## Oceanography Minor

For a listing of requirements refer to the section of this catalog on Oceanography.

## Courses (GEOL)

Refer to Courses and Curricula and University Policies sections of this catalog for explanation of the course numbering system, unit or credit hour, prerequisites, and related information.

### LOWER DIVISION COURSES

#### GEOL 100. Planet Earth (3) I, II

Earth's global systems. Plate tectonics, earthquakes, and volcanoes; evolution of our planet and life through geologic time; economic resources including fossil fuels and precious minerals; agents of erosion that shape the land.

#### GEOL 101. Dynamics of the Earth Laboratory (1) I, II

Three hours of laboratory.

Prerequisite: Credit or concurrent registration in Geological Sciences 100.

Hands-on experience with land forms, rocks, minerals, topographic maps, and aerial photographs. Includes demonstrations and field trips. Designed to accompany and augment Geological Sciences 100.

#### GEOL 104. Earth Science (3)

Overview of the earth and its history, the solid earth and its processes, the earth's oceans and atmosphere, and the earth's place in the solar system and the universe. Most appropriate for liberal studies majors.

#### GEOL 105. Historical Geology (4) I

Three lectures and three hours of laboratory. Arrangement for field study during the semester.

Prerequisites: Oceanography 100, or Geological Sciences 100 and 101, or Geological Sciences 104 and 101.

Theories of earth origin, and the evolutionary history of the earth as traced through rock and fossil records. Consideration of the paleontologic sequence.

#### GEOL 200. Geologic Inquiry and Problem Solving (3) I

Two lectures and three hours of laboratory

Scientific thought process using real problems addressed by student research in field and laboratory. Includes written report and oral presentation.

#### GEOL 221. Mineralogy (4) I

Two lectures and six hours of laboratory.

Prerequisites: Credit or concurrent registration in Geological Sciences 200; high school chemistry and trigonometry, or credit or concurrent registration in college chemistry and trigonometry.

Practice in determination of common minerals; their geologic environment, utilization, and economic significance. Introduction to optical techniques in mineral identification.

**GEOL 296. Experimental Topics (1-4)**

Selected topics. May be repeated with new content. See *Class Schedule* for specific content. Limit of nine units of any combination of 296, 496, 596 courses applicable to a bachelor's degree.

**UPPER DIVISION COURSES  
(Intended for Undergraduates)**

**GEOL 300. Computer Applications in Geology (3)**

Two lectures and three hours of laboratory. Programming and applications of software fundamentals to geological sciences. Applications software will include DOS, Windows, and Macintosh operating systems, word processing, spreadsheets, graphing, contouring, and drawing. Introduction to Internet and overview of geology-specific software.

**GEOL 301. Geology of National Parks and Monuments (3) I, II**

Prerequisites: Geological Sciences 100 or completion of the General Education requirement in Foundations II.A., Natural Sciences and Quantitative Reasoning.

Geology of a group of national parks and monuments, selected for their geological significance, scenic beauty, and visitor popularity. Not acceptable for a major in geological sciences.

**GEOL 302. Fossils: Life Through Time (3) I, II**

Prerequisite: Completion of the General Education requirement in Foundations II.A., Natural Sciences and Quantitative Reasoning.

Traditional and recently discovered aspects of history of life on earth. Topics from the origin of life to extinctions. Not acceptable for a major in geological sciences.

**GEOL 303. Natural Disasters (3) I, II**

Prerequisite: Geological Sciences 100 or completion of the General Education requirement in Foundations II.A., Natural Sciences and Quantitative Reasoning.

Geologic processes that have dramatically affected the human race: earthquakes, volcanoes, landslides, and floods. Not acceptable for a major in geological sciences.

**GEOL 304. Planetary Geology (3)**

Prerequisite: Completion of the General Education requirement in Foundations II.A., Natural Sciences and Quantitative Reasoning. Recommended: Geological Sciences 100.

Structure, evolution, and surface features of planets from a geological point of view. Insights gained into origin and evolution of planetary bodies provide greater understanding of how planet earth operates and why it is unique. Not acceptable for a major in geological sciences.

**GEOL 305. Water and the Environment (3)**

Prerequisites: Geological Sciences 100 or Geography 101 and completion of the General Education requirement in Foundations II.A., Natural Sciences and Quantitative Reasoning.

Movement of fresh water on earth. Hydrologic cycling of water from precipitation, runoff, infiltration, stream and groundwater flow to the ocean. Problems caused by over-use of water resources, urbanization, and water pollution examined with case studies. Not acceptable for a major in geological sciences, emphasis in hydrogeology. (Formerly numbered Geological Sciences 351.)

**GEOL 306. Structural Geology and Field Methods (5) I**

Two lectures and three hours of laboratory and six weekends in the field.

Prerequisites: Geological Sciences 300, 324; algebra, trigonometry and at least high school physics. Highly recommended: First semester college physics.

Integrates structural and introductory field geology. Principles, causes, and mechanisms of rock deformation combined with field study. Graphical, computer, and analytical techniques for working with folds and faults are applied in the field. Field observations are presented in geologic maps, cross sections, and reports.

**GEOL 307. Geophysics and Field Methods (4) II**

Two lectures and three hours of laboratory and a minimum of three weekends in field during semester.

Prerequisites: Geological Sciences 306; Mathematics 150; Physics 195 or 180A.

Principles and field studies of gravity, magnetic, and seismic techniques applied to structure, dynamics, and shallow environment of the earth. Computer-aided data reduction and interpretation.

**GEOL 308. How Volcanoes Work (3)**

Prerequisites: Geological Sciences 100 or completion of the General Education requirement in Foundations II.A., Natural Sciences and Quantitative Reasoning.

Science behind volcanoes and volcanic processes, effect of volcanic eruptions on global climate conditions, ecological habitat, and social change. Classic eruptions in geologic and historic past examined with paradigms for future events. Not acceptable for a major in geological sciences.

**GEOL 324. Petrology (4) II**

Two lectures and six hours of laboratory.

Prerequisite: Geological Sciences 221.

Composition, classification, occurrence, and origin of igneous, sedimentary, and metamorphic rocks. Identification of rocks in hand specimen; petrographic analysis of rocks in thin section; modeling and interpretation of petrologic data. (Formerly numbered Geological Sciences 224.)

**GEOL 412. Processes and Inquiry in the Earth Sciences (4)**

Three lectures and two hours of activity.

Prerequisite: Completion of the General Education requirement in Foundations II.A., Natural Sciences and Quantitative Reasoning.

Investigation of processes of inquiry and rational thinking skills characteristic of the earth sciences. (Formerly numbered Natural Science 412D.)

**GEOL 496. Selected Topics in Geology (1-4)**

Prerequisite: Consent of instructor.

Selected topics in geology and related earth sciences. May be repeated with new content. See *Class Schedule* for specific content. Limit of nine units of any combination of 296, 496, 596 courses applicable to a bachelor's degree. Maximum credit six units.

**GEOL 498A. Senior Seminar (1) Cr/NC I,II**

Prerequisite: Senior standing in geological sciences.

Preparation of written and oral scientific reports and attendance at departmental seminars.

**GEOL 498B. Senior Thesis (2) I, II**

Prerequisite: Consent of instructor.

Individual research project, written thesis, and oral presentation done under supervision of professor chosen by student.

**GEOL 499. Special Study (1-3) I, II**

Prerequisites: Acceptable grade average in at least 12 upper division units within the major and consent of staff.

Individual study in field, library, laboratory, or museum work. Maximum credit four units.

**UPPER DIVISION COURSES  
(Also Acceptable for Advanced Degrees)**

**GEOL 501. Geochronology (3)**

Two lectures and three hours of laboratory.

Prerequisite: Geological Sciences 324.

Survey of radiometric, chemical, stratigraphic, and paleomagnetic methods used to establish time in relationship to the history of the earth. Basis for correlation of geologic events and estimation of rates and periodicity of geologic processes.

**GEOL 502. Geology of North America (3) I**

Prerequisite: Geological Sciences 105.

A regional analysis of North American geology, its structural, stratigraphic, and tectonic patterns, and hypotheses concerning their origin and evolution.

### **GEOL 505. Photogeology and Remote Sensing (3) II**

Two lectures and three hours of laboratory.

Prerequisite: Geological Sciences 200.

Geologic interpretation of aerial and satellite photographs, elementary stereoscopy and stereometry applied to structural and stratigraphic problems, and compilation of geologic maps from annotated aerial and satellite photographs.

### **GEOL 508. Advanced Field Geology (4 or 6) S**

One lecture and three hours of laboratory plus 28 days in the field. For the option with six units: two additional weeks of field or laboratory work.

Prerequisite: Geological Sciences 306.

Investigation of individually assigned areas, preparation of geologic maps, geologic sections, and gathering other types of data, e.g., petrologic, geophysical, or paleontologic, as appropriate. Students are responsible for cost of food and transportation.

### **GEOL 514. Process Geomorphology (3)**

Two lectures and three hours of laboratory.

Prerequisite: Geological Sciences 306.

Processes shaping and affecting the earth's surface, and application of resultant land forms in interpretation of geologic structure, stratigraphy, and neotectonics.

### **GEOL 520. Ore Deposits (3) I**

Prerequisite: Geological Sciences 306.

Geologic relations, origin, distribution, and economics of metallic and nonmetallic mineral deposits.

### **GEOL 525. Petrography (3) I**

Two lectures and three hours of laboratory.

Prerequisite: Geological Sciences 324.

A study of rocks with the polarizing microscope; identification of mineral constituents; interpretation of textures; classification of rocks; problems of genesis.

### **GEOL 530. Geochemistry (3) I**

Two lectures and three hours of laboratory.

Prerequisites: Geological Sciences 324; Chemistry 201; Mathematics 150.

Fundamental principles of low- and high-temperature geochemistry. Origin of the elements; formation of the solar system; differentiation of the earth; weathering at the earth's surface; chemistry of natural waters. Laboratory methods applied to geological problems. Not open to students with credit in Geological Sciences 530L.

### **GEOL 533. Geophysical Analysis (3)**

Two lectures and three hours of laboratory.

Prerequisites: Geological Sciences 307, Mathematics 252, Physics 197. Recommended: Physics 195L, 196L, 197L.

Analog and digital data collection, processing, modeling and error estimation. Computer-aided examples and field tests from seismics, gravity, magnetics, and electromagnetics including magnetotellurics.

### **GEOL 536. Sedimentology and Lithostratigraphy (3) I**

Two lectures and three hours of laboratory.

Prerequisites: Geological Sciences 105 (not required but recommended for Emphases in Geochemistry and Geophysics) and 324.

Sedimentologic description and interpretation of the textures and structures of sediments and sedimentary rocks. Stratigraphic analysis of stratal succession, age relationships, and correlation on local and global scales.

### **GEOL 537. Geobiology (3) II**

Two lectures and three hours of laboratory.

Prerequisites: Geological Sciences 105 and either Biology 100-100L or 101-101L, and Geological Sciences 536.

Principles of paleontology, including ecology and evolution. Tools of paleontology, including biomechanics, shape analysis, phylogeny, population analysis, study of biogeographic, temporal, and environmental distribution. Focus on using biology to solve geologic problems and vice versa.

### **GEOL 540. Marine Geology (3)**

Prerequisites: Geological Sciences 105, and either Geological Sciences 324, 502, 514, or 537.

Plate tectonic origin and history of the ocean basins. Formation and distribution of sediments in response to biologic, chemical, and geologic processes.

### **GEOL 545. Descriptive Physical Oceanography (3)**

Prerequisites: Mathematics 121 and 122, or 150; Physics 180A or 195.

Physical environment of oceans including heat, water, and salt budgets, physical properties of sea water, sea ice, air-sea relationships, effects of light and sound, distribution of temperature, salinity, density, surface current, deep circulation, water mass formation, instruments and methods of study.

### **GEOL 550. Engineering Geology (3)**

Two lectures and three hours of laboratory.

Prerequisite: Geological Sciences 306.

Relationships between geologic processes and works of humans. Topics include rock and soil mechanics, ground water flow, slope stability, seismicity, land subsidence, and evaluation of geologic materials with respect to dam sites, tunnel alignments, and building foundations.

### **GEOL 551. Hydrogeology (3) I**

Two lectures and three hours of laboratory.

Prerequisites: Geological Sciences 306 and Mathematics 150.

Theory of ground water flow. Exploration for and development of the ground water resource. Aquifer tests, water quality, and water resource management. Occurrence of water in alluvial, sedimentary, volcanic, plutonic, and metamorphic terrains.

### **GEOL 552. Field and Laboratory Techniques in Hydrogeology (4) II**

One lecture and nine hours of laboratory.

Prerequisites: Geological Sciences 551 and credit or concurrent registration in Geological Sciences 530.

Use and application of common field and laboratory techniques in hydrogeology. Exercises include drilling, coring, and sediment sampling, aquifer testing, unsaturated zone monitoring, fluid level measurement, tracer testing, laboratory measurement of permeability, capillarity, and analysis of inorganic and organic constituents in groundwater.

### **GEOL 560. Earthquake Seismology (3)**

Two lectures and three hours of laboratory.

Prerequisites: Mathematics 252, Physics 197. Recommended: Mathematics 342A.

Theory of seismic wave excitation, propagation, and recording. Methods of seismogram interpretation and analysis. Applications to tectonics and earthquake hazard analysis.

### **GEOL 596. Advanced Topics in Geology (1-4)**

Prerequisite: Consent of instructor.

Advanced special topics in the geological sciences. See *Class Schedule* for specific content. Limit of nine units of any combination of 296, 496, 596 courses applicable to a bachelor's degree. Maximum credit of six units of 596 applicable to a bachelor's degree. Maximum combined credit of six units of 596 and 696 applicable to a 30-unit master's degree.

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## GRADUATE COURSES

Refer to *Bulletin of the Graduate Division*.

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