

Geological Sciences

In the College of Sciences

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Faculty

Emeritus: Berry, Bertine, Gastil, Kern, Krummenacher, Marshall,

McEuen, Miller, Ptacek, Roberts, Threet, Walawender, Wallace

Chair: Girty

The Rollin and Caroline Eckis Chair in Seismology: Day

Professors: Abbott, Day, Dorman, Girty, Huntley, Jiracek,

Kimbrough, Peterson, Rockwell

Associate Professors: Frost, Thorbjarnarson

Assistant Professors: Leighton, Pietruszka, Riggs, Schellenberg

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 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.

General Geology Program

Preparation for the Major. Geological Sciences 105, 200, 221, and 224; Biology 100, 100L, or 101, 101L; Chemistry 200, 201; Mathematics 150; Physics 180A-180B and 182A-182B; Statistics 250. (45 units)

Recommended: Geological Sciences 100, 101; Mathematics 151 and 252 and the Physics 195 series are highly recommended for those students interested in the more quantitative aspects of geology.

Upper Division Writing Requirement. Passing the University Writing Examination or completing one of the approved writing courses with a grade of C (2.0) or better.

Major. A minimum of 37 upper division units in approved courses to include Geological Sciences 300, 306, 307, 498A, 498B, 508, 536, 537, and either 525 or 530 and 530L; at least two of the following: Geological Sciences 501, 502, 505, 514, 520, 521, 540, 550, 551; plus three upper division units of departmentally approved courses.

Emphasis in Engineering Geology

Preparation for the Major. Geological Sciences 105, 200, 221, 224; Biology 100; Chemistry 200, 201; Engineering Mechanics 200; Mathematics 150, 151, 252; Physics 195, 196, 197; Statistics 250. (56 units)

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

Upper Division Writing Requirement. Passing the University Writing Examination or completing one of the approved writing courses with a grade of C (2.0) or better.

Major. A minimum of 37 upper division units in approved courses to include Geological Sciences 300, 306, 307, 498B, 508, 536, 550, 551; Civil Engineering 301, 462, 463; one of the following: Geological Sciences 505, 514, 530 and 530L, 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.

Emphasis in Geochemistry

Preparation for the Major. Geological Sciences 200, 221, 224; Biology 100 or 101; Chemistry 200, 201, 231, 251; Mathematics 150, 151; Physics 195, 196, 197; Statistics 250. (54 units)

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

Upper Division Writing Requirement. Passing the University Writing Examination or completing one of the approved writing courses with a grade of C (2.0) or better.

Major. A minimum of 36 upper division units in approved courses to include Geological Sciences 300, 306, 498B, 501, 530, 530L, 536, 551, 552; Chemistry 410A-410B, 571.

Emphasis in Geophysics

Preparation for the Major. Geological Sciences 200, 221, 224; 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. (48-51 units)

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

Upper Division Writing Requirement. Passing the University Writing Examination or completing one of the approved writing courses with a grade of C (2.0) or better.

Major. A minimum of 39 upper division units in approved courses to include Geological Sciences 300, 306, 307, 498B, 532, 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. Geological Sciences 105, 200, 221, 224; Biology 100; Chemistry 200, 201; Mathematics 150, 151; Physics 195, 196, 197; Mathematics 252 or Chemistry 231; Statistics 250. (53 units)

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

Upper Division Writing Requirement. Passing the University Writing Examination or completing one of the approved writing courses with a grade of C (2.0) or better.

Major. A minimum of 36 upper division units in approved courses to include Geological Sciences 300, 306, 498B, 514, 530, 530L, 532, 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. Geological Sciences 105, 200, 221, 224; Biology 100 or 101; Chemistry 200, 201; Mathematics 150, 151, 252; Physics 195, 195L, 196, 196L, 197, 197L. (53 units)

Recommended: Geological Sciences 537. A foreign language.

Upper Division Writing Requirement. Passing the University Writing Examination or completing one of the approved writing courses with a grade of C (2.0) or better.

Major. A minimum of 36 upper division units in approved courses to include Geological Sciences 300, 306, 307, 498B, 530, 530L, 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. Geological Sciences 105, 200, 221, 224; 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. (49-50 units)

Recommended: Geological Sciences 307.

Upper Division Writing Requirement. Passing the University Writing Examination or completing one of the approved writing courses with a grade of C (2.0) or better.

Major. A minimum of 35 upper division units in approved courses to include Geological Sciences 300, 306, 498A, 498B, 501, 508, 536, 537; Biology 515, 517; plus three upper division units of departmentally approved courses.

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 PRAXIS and SSAT 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 with the Cross-Cultural, Language, and Academic Development (CLAD) emphasis 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, 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.
- 3. Intermediate Composition and Critical Thinking (3 units)** to be satisfied by Africana Studies 200 or Rhetoric and Writing Studies 200.

II. Foundations (28 units)

A. Natural Sciences and Quantitative Reasoning (13 units):

- 1. 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.
- 4. Mathematics/Quantitative Reasoning (3 units)** to be satisfied by Mathematics 150.

B. Social and Behavioral Sciences (6 units).

C. 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.

A. Upper division Social and Behavioral Sciences (3 units). Linguistics 420 is recommended.

B. Upper division Humanities to be satisfied by History 441 (3 units).

C. 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, 224; Mathematics 150; Physics 180A, 180B, 182A, 182B **OR** Physics 195, 195L, 196L, 197, 197L; Statistics 250. (61-66 units)

Upper Division Writing Requirement. Passing the University Writing Examination or completing one of the approved writing courses with a grade of C (2.0) or better.

Major. A minimum of 36 units to include Geological Sciences 300, 303 (allowed only in this version of the major in Geological Sciences), 306, 498A, 498B, 501, 536, 537; Biology 319; Oceanography 541; and six units selected from Geological Sciences 305, 307, 505, 508, 514, 520, 521, 530, 540, 545; plus one departmentally approved upper division unit.

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, 502, 505, 514, 536, 537. In addition, Geological Sciences 200, 221, and 224 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)

LOWER DIVISION COURSES

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.

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.

104. Earth Science (3) I, II

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.

105. Historical Geology (4) I, II

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

Prerequisites: Geological Sciences 100 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.

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.

221. Mineralogy (4) I

Three lectures and three 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.

224. Petrology (4) II

Two lectures and six hours of laboratory.

Prerequisite: Geological Sciences 221.

The origin, occurrence, identification, and classification of rocks in hand specimen. Use of optical techniques in mineral identification.

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)

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.

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.

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.

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.

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.

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.)

306. Structural Geology and Field Methods (5) I

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

Prerequisites: Geological Sciences 224, 300; 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.

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.

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.

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.

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.

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.

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)**

501. Geochronology (3)

Two lectures and three hours of laboratory.

Prerequisite: Geological Sciences 224.

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.

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.

505. Photogeology and Remote Sensing (3) II

Two lectures and three hours of laboratory.

Prerequisite: Geological Sciences 514.

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

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.

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.

520. Ore Deposits (3) I

Prerequisite: Geological Sciences 306.

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

521. Petroleum Geology (3) II

Prerequisite: Geological Sciences 306.

History of petroleum exploration; statistics of energy use; principles of well logging; theories of petroleum generation, migration, and accumulation; exploration and production techniques; case studies of important oil fields.

525. Petrography (3) I

Two lectures and three hours of laboratory.

Prerequisite: Geological Sciences 224.

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

530. Geochemistry (2) I

Prerequisites: Geological Sciences 224; Chemistry 201; Mathematics 121 and 122, or 150.

Relationship of basic chemical principles and isotopic methods to geologic phenomena and environments. Applications to geologic exploration problems, contaminant transport, chemical weathering, and evolution of atmosphere and ocean chemistry.

530L. Geochemistry Laboratory (1) I

Three hours of laboratory.

Prerequisite: Credit or concurrent registration in Geological Sciences 530.

Laboratory methods for determination of chemical concentrations in waters, sediments, and rocks, as well as x-ray diffraction methods for mineralogy.

532. Environmental Geophysics (3) I

Two lectures and three hours of laboratory.

Prerequisites: Mathematics 150 and Statistics 250; two semesters of physics. Recommended: Geological Sciences 307 and 551.

Applications of geophysical methods to hydrologic investigations, including d.c. resistivity, electromagnetics, radar, seismology, and magnetics.

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.

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 224.

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.

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.

540. Marine Geology (3)

Prerequisites: Geological Sciences 105, and either Geological Sciences 224, 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.

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.

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.

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.

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.

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.

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.

GRADUATE COURSES
Refer to Bulletin of the Graduate Division.
