
Geological Sciences

In the College of Sciences

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Faculty

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

Chair: Girty

The Rollin and Caroline Eckis Chair in Seismology: Day

Professors: Day, Girty, Kimbrough, Olsen, Rockwell

Associate Professors: Frost, Schellenberg, Thorbjarnarson

Assistant Professors: Ma, Morrow, Pietruszka

Lecturers: Camp, DeYoung, 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.

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.

Major Academic Plans (MAPs)

Visit <http://www.sdsu.edu/mymap> for the recommended courses needed to fulfill your major requirements. The MAPs Web site was created to help students navigate the course requirements for their majors and to identify which General Education course will also fulfill a major preparation course requirement.

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 200, 205, 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. Passing the Writing Proficiency Assessment with a score of 10 or above or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "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, 336, 498A, 498B, 508, 530, 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 200, 205, 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. Passing the Writing Proficiency Assessment with a score of 10 or above or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "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, 307, 324, 336, 498B, 508, 551; Civil Engineering 301, 462, 463; one of the following: Geological Sciences 505, 514, 530, 550, 560, or Civil Engineering 465.

GEOL

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, 232, 232L, 251; Mathematics 150, 151, 252; Physics 195, 195L, 196, 196L, 197, 197L; Statistics 250. (60 units)

Recommended: Geological Sciences 205, 307; Chemistry 432, 432L.

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

Major. A minimum of 36 upper division units in approved courses to include Geological Sciences 300, 306, 324, 336, 498B, 530, 551; Chemistry 410A-410B, 571; plus three upper division units of departmentally approved courses.

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, 197L; Engineering 280 must be taken if students select Engineering 510 in the major. (47 units)

Recommended: Geological Sciences 205, Physics 197L, Statistics 250.

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

Major. A minimum of 40-43 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 200, 205, 221; Biology 100; Chemistry 200, 201; Mathematics 150, 151, 252; Physics 195, 196, 197; Statistics 250. (52 units)

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

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

Major. A minimum of 36 upper division units in approved courses to include Geological Sciences 300, 306, 324, 336, 498B, 514, 530, 551; Mathematics 342A-342B, or Chemistry 571; plus four to seven 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 200, 205, 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. Passing the Writing Proficiency Assessment with a score of 10 or above or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "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, 336, 498B, 530, 540, 545, and two of the following courses: Geological Sciences 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 200, 205, 221; Biology 203, 203L, 204, 204L, 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. Passing the Writing Proficiency Assessment with a score of 10 or above or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "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, 336, 498A, 498B, 508, 537; Biology 352, 354; plus seven upper division units of departmentally approved courses.

Geological Sciences Minor

The minor in geological sciences consists of a minimum of 20 units in geological sciences, 12 of which must be in upper division courses. Courses include Oceanography 100 or Geological Sciences 100 and 101, 205; and 12 units selected from Geological Sciences 301, 302, 303, 304, 305, 306, 307, 324, 336, 502, 505, 514, 537; Oceanography 320. 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 *Curricula and Courses 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) [GE]

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) [GE]

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) [GE]

Earth's four principal reservoirs and their interconnectedness: solid earth, ocean, atmosphere, and biosphere. How humanity affects and is affected by these reservoirs. Most appropriate for liberal studies majors.

GEOL 200. Geologic Inquiry and Problem Solving (3)

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 205. Historical Geology (4)

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 101 and 104.

Evolutionary history of earth as traced through rock and fossil records. Stratigraphic and depositional concepts. (Formerly numbered Geological Sciences 105.)

GEOL 221. Mineralogy (4)

Two lectures and six hours of laboratory.

Prerequisites: Credit or concurrent registration in Geological Sciences 200; Oceanography 100 or Geological Sciences 100 and 101 or Geological Sciences 101 and 104; 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.

Theory and practice of computer-based quantitative analysis in geological sciences to include spreadsheets and statistics, simple programming, vector graphics, visualization and image-processing, and an introduction to Geographic Information Systems.

GEOL 301. Geology of National Parks and Monuments (3) [GE]

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

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) [GE]

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

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) [GE]

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

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) [GE]

Prerequisite: Completion of the General Education requirement in Foundations of Learning 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) [GE]

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

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.

GEOL 306. Structural Geology and Field Methods (5)

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)

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

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

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 324. Petrology (4)

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.

GEOL 336. Sedimentology and Lithostratigraphy (3)

Two lectures and three hours of laboratory.

Prerequisites: Geological Sciences 205 (not required but recommended for Emphases in Geochemistry and Geophysics) and 221.

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. (Formerly numbered Geological Sciences 536.)

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 of Learning II.A., Natural Sciences and Quantitative Reasoning.

Investigation of processes of inquiry and rational thinking skills characteristic of the earth sciences.

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

Prerequisite: Senior standing in geological sciences.

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

GEOL 498B. Senior Thesis (2)

Prerequisite: Consent of instructor.

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

GEOL 499. Special Study (1-4)

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 502. Geology of North America (3)

Prerequisite: Geological Sciences 205.

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)

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)

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)

Prerequisite: Geological Sciences 306.

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

GEOL 521. Petroleum Geology (3)

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.

GEOL 530. Geochemistry (3)

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.

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 537. Geobiology (3)

Two lectures and three hours of laboratory.

Prerequisites: Geological Sciences 205 and either Biology 100-100L, 101-101L or 203-203L, and Geological Sciences 336.

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 205, 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)

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 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 580. Seismic Interpretation and 3D Visualization (3)

Two lectures and three hours of laboratory.

Prerequisite: Geological Sciences 306.

Computer-based seismic interpretation, mapping, and modeling in both 2D and 3D. Overview of basic seismic processing. Emphasis on industrial applications, both petroleum and shallow geotechnical. (Formerly numbered Geological Sciences 647.)

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

Prerequisite: Consent of instructor.

Advanced special topics in the geological 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 of six units of 596 applicable to a bachelor's degree. Credit for 596 and 696 applicable to a master's degree with approval of the graduate adviser.

GRADUATE COURSES
Refer to the *Graduate Bulletin*.
