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# Geological Sciences

In the College of Sciences

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## Faculty

Gary H. Girty, Ph.D., Professor of Geological Sciences,  
Chair of Department  
Patrick L. Abbott, Ph.D., Professor of Geological Sciences  
Steven M. Day, Ph.D., Professor of Geological Sciences,  
The Rollin and Caroline Eckis Chair in Seismology  
Clive E. Dorman, Ph.D., Professor of Geological Sciences  
David Huntley, Ph.D., Professor of Geological Sciences  
George R. Jiracek, Ph.D., Professor of Geological Sciences  
David L. Kimbrough, Ph.D., Professor of Geological Sciences  
Gary L. Peterson, Ph.D., Professor of Geological Sciences  
Thomas K. Rockwell, Ph.D., Professor of Geological Sciences  
Eric G. Frost, Ph.D., Associate Professor of Geological Sciences  
Kathryn W. Thorbjarnarson, Ph.D., Associate Professor of Geological  
Sciences (Graduate Adviser)  
Lindsey R. Leighton, Ph.D., Assistant Professor of Geological Sciences  
Aaron J. Pietruszka, Ph.D., Assistant Professor of Geological Sciences  
Eric M. Riggs, Ph.D., Assistant Professor of Geological Sciences  
Stephen A. Schellenberg, Ph.D., Assistant Professor of Geological  
Sciences  
Barry B. Hanan, Ph.D., Resident Isotope Geochemist  
Robert J. Mellors, Ph.D., Resident Computer Geoscientist

## Adjunct Faculty

Ronald Blom, Ph.D., Geological Sciences  
Robert Crippen, Ph.D., Geological Sciences  
Thomas A. Demere, Ph.D., Geological Sciences  
John M. Fletcher, Ph.D., Geological Sciences  
Jorg Geldmacher, Ph.D., Geological Sciences  
Marty Grove, Ph.D., Geological Sciences  
David R. Hargis, Ph.D., Geological Sciences  
Charles F. Kluth, Ph.D., Geological Sciences  
Harold W. Magistrale, Ph.D., Geological Sciences  
David Okaya, Ph.D., Geological Sciences  
Andres Polit, Ph.D., Geological Sciences  
Eleanora I. Robbins, Ph.D., Geological Sciences

## 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.

## Associateships

Graduate teaching associateships in geological sciences are available to a limited number of qualified students. Application forms and additional information may be secured from the graduate adviser of the department.

## General Information

The Department of Geological Sciences offers graduate study leading to the Master of Science degree in geological sciences. The program emphasizes research and an advanced set of courses. Faculty research activities comprise a broad spectrum of expertise, including both theoretical and applied interests. Opportunities exist for integrated field and laboratory research. The department is equipped to support research in geophysics, groundwater hydrology, geoscience education, oceanography, and geochemistry as well as the classic areas of mineralogy, petrology, structural geology, stratigraphy and paleontology. Laboratories devoted to geochronology, isotopes, clay mineral analysis, soils, paleomagnetism, and whole rock analysis, as well as the Allison Center (paleontology), support the graduate research program.

The San Diego area enjoys a mild climate which permits year round field activity. An interesting and diverse geological environment provides many opportunities for research in the local area. Many graduate students are supported in their work by grants and contracts from government and industry.

## Admission to Graduate Study

All students must satisfy the general requirements for admission to classified graduate standing as described in Part Two of this bulletin. In addition, all students should satisfy the following requirements in order to achieve classified standing and enroll in graduate courses.

1. Have preparation in geological sciences, mathematics, chemistry, and physics at least equivalent to the minimum required for the bachelor's degree in geological sciences at San Diego State University. Undergraduate grade point average should be at least 2.5, with a 2.75 in the last 60 units. Students with degrees in majors other than geological sciences may be admitted with conditional standing while deficiencies are being remedied.
2. Have successfully completed all courses listed as deficiencies.
3. Have a minimum GRE General Test combined verbal and quantitative score of 1000. Students with a verbal score of less than 450 may be required to take a writing course.
4. Have a minimum grade point average of 3.0 in any courses taken as a postbaccalaureate student at San Diego State University.

Students applying for admission should electronically submit the University application available at [www.csumentor.edu](http://www.csumentor.edu).

The following materials should be submitted as a complete package directly to the Department of Geological Sciences:

- (1) Two sets of official transcripts (in sealed envelopes);
- (2) GRE scores (official notification);
- (3) Two letters of reference;
- (4) Department application available at [www.geology.sdsu.edu/gradprogram/applicants.htm](http://www.geology.sdsu.edu/gradprogram/applicants.htm).

Mail or deliver your complete admissions package to:

Department of Geological Sciences  
(Attention: Graduate Adviser)  
San Diego State University  
5500 Campanile Drive  
San Diego, CA 92182-1020

All student applications are evaluated competitively and no fixed numerical standards automatically qualify or disqualify a student for graduate study in the Department of Geological Sciences. Students will be admitted on the basis of merit in relation to space and faculty availability.

## **Advancement to Candidacy**

All students must satisfy the general requirements for advancement to candidacy as stated in Part Two of this bulletin.

## **Specific Requirements for the Master of Science Degree**

**(Major Code: 19141)**

In addition to meeting the requirements for classified graduate standing, the student must satisfy the basic requirements for the master's degree as described in Part Two of this bulletin. The student's graduate program must include 24 units of approved 600- and 700-numbered courses in Geological Sciences to include 797 (3 units Cr/NC/RP), and 799A, Thesis (3 units Cr/NC/RP), and six units of upper division or graduate electives approved by the departmental adviser. With approval of the graduate adviser, students specializing in geophysics or hydrogeology may include 18 units of approved 600-700 numbered courses and 12 units of upper division or graduate electives, with no more than six units of upper division electives taken from courses in the Department of Geological Sciences. Geological Sciences 306 and 508 or their equivalent as approved by the graduate adviser, are required as prerequisite to the program if they were not a part of the student's undergraduate work. The student is required to pass a final oral examination on the thesis.

## **Courses Acceptable on Master's Degree Program in Geological Sciences (GEOL)**

### **UPPER DIVISION COURSES**

#### **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 stereometry 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

### 600. Seminar (1-3)

Refer to Class Schedule for lecture/laboratory format.

Prerequisite: Consent of instructor.

An intensive study in advanced geology. May be repeated with new content. Topic to be announced in the Class Schedule. Maximum credit six units applicable to a master's degree.

### 601. Investigations in Earth Science (3)

Prerequisites: Postbaccalaureate standing with B.S. or B.A. in geology or equivalent.

Review of major geologic concepts and processes. Relationships of research to advances in the understanding of modern earth processes and the geologic history of the earth.

### 611. Seminar: Geoscience Education Research and Practice (3)

Prerequisites: Senior or graduate standing. Strongly recommended: Background in earth science or education.

Research and practice in earth science education. Theory and practice in geoscience education at all levels, including research into constructivism in geoscience, influence of place and culture, and issues of spatial skills in the field and classroom.

### 615. Geology of Clays (3)

Two lectures and three hours of laboratory.

Prerequisite: Geological Sciences 530 or 536.

Systematic mineralogy of clays and routine methods of identification. Geologic interpretation of clay minerals with respect to environmental conditions of origin, deposition and diagenesis.

### 625. Paleocology (3)

Two lectures and three hours of laboratory.

Prerequisites: Geological Sciences 537 and Biology 354.

Problems and methods in the study of relationships between fossil organisms and their environment: interpretation of paleoenvironment, paleoclimate, and biologic relationships among fossil organisms.

### 629. Seminar: Advanced Studies in Stratigraphy (3)

Two lectures and three hours of laboratory.

Prerequisite: Geological Sciences 537.

Regional stratigraphic patterns in North America and their historical implications.

### 630. Selected Topics in Geophysics (3)

Prerequisite: Consent of instructor.

Research topics in seismic, gravity, magnetic, electrical, and electromagnetic methods. May be repeated with new content. See Class Schedule for specific content. Maximum credit six units applicable to a master's degree.

### 633. Quaternary Geology (3)

Two lectures and three hours of laboratory.

Prerequisite: Geological Sciences 514.

Quaternary climate, geochronometric dating and soil stratigraphy.

### 640. Geotectonics (3)

Prerequisites: Geological Sciences 306; Physics 180B or 196.

Combination of plate tectonics, structural geology, and geophysics. Topics in continental genesis and evolution, orogeny, plate tectonics theory, and a survey of classic plate boundaries.

### 642. Neotectonics (3)

Two lectures and three hours of laboratory.

Prerequisites: Geological Sciences 306 and 514.

Observation, interpretation and significance of late Quaternary crustal deformation.

### 643. Extensional Tectonics (3)

Two lectures and three hours of laboratory.

Prerequisites: Geological Sciences 306 and senior or graduate standing.

Geometries, kinematics, and dynamics of extensional deformation worldwide with emphasis on role in basin formation and resource localization. Focus on crustal scale view. Seismic reflection profiles interpreted and processed on workstations.

### 644. Compressional Tectonics (3)

Two lectures and three hours of laboratory.

Prerequisites: Geological Sciences 306 and senior or graduate standing.

Geometries, kinematics, and dynamics of compressional tectonics with emphasis on role in basin formation and resource localization. Focus on crustal scale view. Seismic reflection profiles interpreted and processed on workstations.

### 645. Advanced Structural Geology (3)

Prerequisite: Geological Sciences 306.

Topics in advanced structural geology in the light of petrographic, geophysical, and experimental data, combined with classic field observations.

**646. Sequence Stratigraphy (3)**

Two lectures and three hours of laboratory.

Prerequisites: Geological Sciences 306, 536, and senior or graduate standing.

Linkage between rock sequences and basin formation using seismic reflection profiles and outcrops. Profiles interpreted to determine sequences, boundaries, rock properties, and role in hydrocarbon localization.

**647. Seismic Interpretation and 3-D Visualization (3)**

Two lectures and three hours of laboratory.

Prerequisites: Geological Sciences 200, 306, 307, and 536.

Skills in modern workstation-aided seismic reflection interpretation with emphasis on modern petroleum geology.

**651. Numerical Modeling of Ground-Water Flow (3)**

Prerequisites: Geological Sciences 551 and experience in computer programming.

Finite difference approximations of ground water and mass transport equations. Direct and iterative solutions to simultaneous equations. Calibration, verification and application of numerical models to analyze ground water hydrologic problems.

**652. Multiphase Flow (3)**

Two lectures and three hours of laboratory.

Prerequisite: Geological Sciences 551.

Movement of water through the unsaturated zone and nonaqueous phase liquids (NAPL) through subsurface. Topics include vadose zone characterization, monitoring, and modeling; light and dense NAPL movement, monitoring, and remediation.

**653. Ground Water Aquifer Testing (3)**

Two lectures and three hours of laboratory.

Prerequisite: Geological Sciences 551.

Theory and practice of conducting and analyzing constant-rate aquifer tests, step-drawdown tests, and slug injection tests. Analysis of results for confined, unconfined, leaky-confined, and fractured aquifers.

**660. Isotope Geology (3)**

Two lectures and three hours of laboratory.

A survey of isotopic and geochronologic topics with individual projects in isotopic analysis.

**676. Solute Transport in Groundwater (3)**

Prerequisite: Geological Sciences 551.

Theory of dissolved solute transport in groundwater. Applications to contaminant delineation, modeling and characterization of aquifer heterogeneities. Case studies of tracer tests and contaminant plumes.

**677. Environmental Fate of Organic Contaminants (3)**

Two lectures and three hours of laboratory.

Prerequisites: Geological Sciences 551 and 530, 530L, or chemistry background.

Physical and chemical properties and processes affecting distribution of organic contaminants in the environment. Focus on subsurface environments with applications to surface waters.

**687. Volcanology (3)**

Prerequisite: Geological Sciences 224.

Chemical and physical properties of magma; generation, rise, and storage of magma. Eruptive mechanisms, volcano types, and a variety of volcanic phenomena associated with Hawaiian, Strombolian, Plinian, volcanian, and hydrovolcanic eruptions.

**797. Research (1-3) Cr/NC/RP**

Prerequisite: Consent of the department.

Supervised research in an area of geology. Maximum credit six units applicable to a master's degree.

**799A. Thesis (3) Cr/NC/RP**

Prerequisites: An officially appointed thesis committee and advancement to candidacy.

Preparation of a thesis for the master's degree.

**799B. Thesis Extension (0) Cr/NC**

Prerequisite: Prior registration in Thesis 799A with an assigned grade symbol of RP.

Registration required in any semester or term following assignment of RP in Course 799A in which the student expects to use the facilities and resources of the university; also student must be registered in the course when the completed thesis is granted final approval.

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