

Geological Sciences

IN THE COLLEGE OF SCIENCES

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Faculty

Allen M. Gontz, Ph.D., Professor of Geological Sciences,
Chair of Department

Steven M. Day, Ph.D., Professor of Geological Sciences, Emeritus,
The Rollin and Caroline Eckis Chair in Seismology

Eric G. Frost, Ph.D., Professor of Geological Sciences

David L. Kimbrough, Ph.D., Professor of Geological Sciences

Kim Bak Olsen, Ph.D., Professor of Geological Sciences,
The Rollin and Caroline Eckis Chair in Seismology

Stephen A. Schellenberg, Ph.D., Professor of Geological
Sciences, Assistant Vice President for Educational Effectiveness,
Division of Academic Engagement and Student Achievement

Shuo Ma, Ph.D., Associate Professor of Geological Sciences
(Graduate Adviser)

Kathryn W. Thorbjarnarson, Ph.D., Associate Professor of
Geological Sciences, Emeritus

Jillian M. Maloney, Ph.D., Assistant Professor of Geological
Sciences

Barry B. Hanan, Ph.D., Resident Isotope Geochemist

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 current appointee, Dr. Kim Bak Olsen, conducts research on seismic wave propagation as well as earthquake source description and 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. The program is designed to (1) prepare students for careers in consulting, domestic and multinational firms, and government agencies, (2) provide students with university-level teaching experience and access to community college teaching positions, and (3) provide advanced training in the earth sciences for students planning on entering a Ph.D. program.

Section I. Master's Degree Programs

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, 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 for M.S. Degree

All students must satisfy the general requirements for admission to classified graduate standing as described in Admission and Registration. 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 deemed equivalent to the bachelor's degree in geological sciences at San Diego State University. Candidates whose preparation is deemed insufficient by the master's program committee will be required to complete specified courses in addition to the minimum 30 units required for the degree. Undergraduate grade point average should be at least 2.5, with a 2.85 in the last 60 units.
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 <http://www.calstate.edu/apply> along with the application fee.

All applicants must submit admissions materials separately to SDSU Graduate Admissions and to the Department of Geological Sciences.

Graduate Admissions

The following materials should be submitted as a complete package directly to:

Graduate Admissions
Enrollment Services
San Diego State University
San Diego, CA 92182-7416

1. Official transcripts (in sealed envelopes) from all postsecondary institutions attended;

NOTE:

- Students who attended SDSU need only submit transcripts for work completed since last attendance.
 - Students with international coursework must submit both the official transcript and proof of degree. If documents are in a language other than English, they must be accompanied by a certified English translation.
2. GRE scores (<http://www.ets.org> SDSU institution code 4682);
 3. English language score, if medium of instruction was in a language other than English (<http://www.ets.org> SDSU institution code 4682).

Department of Geological Sciences

The following materials should be mailed or delivered to:

Department of Geological Sciences

(Attention: Graduate Adviser)

San Diego State University

5500 Campanile Drive

San Diego, CA 92182-1020

1. Department application available at: <http://www.geology.sdsu.edu/gradprogram/applicants.htm>;
2. Two letters of reference.

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.

Geological Sciences

Advancement to Candidacy

All students must satisfy the general requirements for advancement to candidacy as stated in Requirements for Master's Degrees.

Specific Requirements for the Master of Science Degree (Major Code: 19141) (SIMS Code: 775301)

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 Requirements for Master's Degrees, and a graduate program consisting of 30 units of upper division and graduate courses selected from the geological sciences and closely related fields. This program must be approved by the graduate adviser.

A minimum of 18 units must be selected from 600- and 700-numbered courses in the Department of Geological Sciences. Graduate students are required to complete up to six units of Geological Sciences 797 Research, and three units of Geological Sciences 799A Thesis (Plan A) or three units of Geological Sciences 750, Research and Technical Writing (Plan B). Both Plan A and Plan B students are required to pass a final oral examination. With approval of the graduate adviser, students may include 12 units of approved upper division and graduate electives from acceptable courses offered in other related areas. No more than six units of the upper division electives may be Department of Geological Sciences courses; this requirement may be waived at the discretion of the graduate adviser in cases where the student's thesis committee chair determines more units are appropriate.

Students specializing in **Geophysics (SIMS Code: 775346)** or **Hydrogeology (SIMS Code: 775357)** are also required to include 15 units of specialization courses. The geophysics specialization must include at least two of the following courses: Geological Sciences 630, 690, or 691. The hydrogeology specialization must include Geological Sciences 675. In exceptional cases, this requirement may be waived at the discretion of the graduate adviser, provided a substitute course that enhances a coherent program in a specific professional area is included. The remaining nine units in the specialization must be selected from approved courses in the geological, mathematical, computational, physical, or engineering sciences, in consultation with the graduate adviser. The student is required to pass a final oral examination on the thesis.

Section II. Doctoral Program

WEBSITE: <http://sci.sdsu.edu/geology/jdp/opportunity/>

Geophysics

General Information

The cooperating faculties of the Department of Geological Sciences at San Diego State University and the Geophysics Curricular Program of the Scripps Institution of Oceanography Graduate Department at the University of California, San Diego offer a joint doctoral program in geophysics. The complementary specialties of the two groups result in two focus areas: earthquake science and applied geophysics. Each student's program is designed around one of these two areas.

Admission to Doctoral Study

Applicants for admission to the doctoral program in geophysics offered jointly by SDSU and UCSD must meet the requirements as outlined under General Requirements for Doctoral Degrees given in Requirements for Master's Degrees. Admission into the program requires acceptance by the graduate deans and by the participating departments at UCSD and SDSU. Candidates for admission should have a bachelor's or master's degree in physics, mathematics, earth science, or equivalent training; degrees in engineering science are also accepted. The student's preparation should include:

1. Mathematics through differential and integral calculus.
2. Physics, one year with laboratory (the course should stress the fundamentals of mechanics, electricity, magnetism, optics, and thermodynamics, and should use calculus in its exposition).
3. Chemistry, one year with laboratory.
4. An additional year of physics, chemistry, or mathematics.

Students seeking admission to the joint doctoral program in geophysics should electronically submit the university application available at <http://www.calstate.edu/apply>. Application deadlines and contact information for the joint doctoral program coordinator are available at <http://geology.sdsu.edu>.

In addition, all applicants must submit the following admissions materials separately to SDSU Graduate Admissions and to the Department of Geological Sciences, San Diego State University.

Graduate Admissions

The following materials should be submitted as a complete package directly to:

Graduate Admissions

Enrollment Services

San Diego State University

San Diego, CA 92182-7416

1. Official transcripts (in sealed envelopes or mailed directly from the issuing institution) from all postsecondary institutions attended (students with international coursework must submit both the official transcript and proof of degree. If documents are in a language other than English, they must be accompanied by a certified English translation).
2. GRE scores (<http://www.ets.org> SDSU institution code 4682);
3. English language score, if medium of instruction was in a language other than English (<http://www.ets.org> SDSU institution code 4682).

Department of Geological Sciences

The following materials should be mailed as a complete package to:

Department of Geological Sciences

(Attention: Joint Doctoral Program Coordinator)

San Diego State University

5500 Campanile Drive

San Diego, CA 92182-1020

1. Three letters of recommendation (in sealed and signed envelopes);
2. Curriculum vitae or resume;
3. Applicant's statement of purpose in seeking the Ph.D.

A scholastic average of B (3.0 /4.0) or better in upper-division courses, or prior graduate study, is required. Special consideration occasionally can be given to candidates with outstanding records who do not meet all preadmission criteria, but such students should expect to take additional courses to improve their backgrounds.

Satisfaction of the minimum requirements at San Diego State University or the Department of Geological Sciences does not guarantee admission to the doctoral program.

Specific Requirements for Doctoral Program

(Major Code: 19160) (SIMS Code: 775370)

Residency Requirements

After formal admission to the joint doctoral program, the student must spend at least one academic year in full-time residence on each of the two campuses. The definition of residence must be in accord with the regulations of UCSD and SDSU. Usually, the first year is spent at UCSD; the second and subsequent years at SDSU.

Advising Committee

Upon admission to the program, the joint doctoral graduate advisers of the two institutions will establish an advising committee for each student. The committee will consist of four faculty members, normally two from each campus. In consultation with the student, the committee will develop a course of study, including identifying academic deficiencies and recommending remedies for them. The advising committee will be the official advising group for the student until a joint doctoral committee has been chosen and recommended to the Graduate Divisions by the advising committee.

Language Requirement

There is no specific foreign language requirement for this program, but knowledge of a foreign language may be deemed necessary by the advising committee to successfully pursue the student's research goal. All students must be proficient in English.

Course Requirements

There is no single course of study appropriate to the geophysics doctoral program. Instead, the individual interests of the student will permit, in consultation with the advising committee, a choice of course work in earthquake science or applied geophysics, although certain core courses are usually taken during most of the first year. In the summer or early fall following the first year of study each student will take the departmental examination which is both written and oral. The foundation for this examination is laid by the core courses.

Departmental Examination

Doctoral candidates normally will be required to take a departmental examination not later than early in the second year of study. The examination will be oral and written. The examination tests the student's general preparation in geophysics and associated areas (e.g., geology, math, computer programming). The student will be required to demonstrate, in a quantitative and analytical manner, comprehension of required subject material and of the pertinent interactions. Part of the examination is based on the knowledge of a number of assigned journal articles. The oral examination includes a discussion of the student's research progress.

Qualifying Examinations

Joint Doctoral Committee

After the student has passed the departmental examination, a joint doctoral committee will be appointed. The joint doctoral committee must be formed before the student may proceed to the qualifying examination. The student will select a dissertation supervisor (major professor), who will chair the joint doctoral committee. The joint doctoral committee shall be composed of at least four members of the joint doctoral program faculty, two from the SDSU department and two from the UCSD department. The committee may be augmented as needed by an additional member from outside geophysics at UCSD or a member of the faculty at

SDSU from outside of geophysics or, when authorized, another university. The joint doctoral committee shall be responsible for evaluating the dissertation proposal, administering and evaluating the qualifying examination, judging the dissertation, and administering and evaluating the dissertation defense.

Qualifying Examination

The joint doctoral committee will determine the student's qualifications for independent research by means of a qualifying examination which will be administered no later than the end of the third year. The qualifying examination is an exploration of the research project, its feasibility, originality and appropriateness. The student must write a concise report describing his or her proposed original research project and give an oral presentation to the joint doctoral committee covering the planned work and any progress to date. The student's joint doctoral committee will conduct the oral qualifying examination to ensure that the student possesses the full knowledge and competence required to carry out her or his dissertation research proposal. Passing the oral presentation and defense of this proposal signifies that the doctoral dissertation proposal is approved.

Upon satisfactory completion of the oral qualifying examination and prescribed coursework, the student must apply to the graduate dean at UCSD for advancement to candidacy. Upon payment of the candidacy fee to UCSD, and after approval by the graduate deans of both campuses, students will be notified of their advancement to candidacy by the UCSD graduate dean.

Dissertation

Following the successful completion of all prescribed coursework and qualifying examination, the major remaining requirement for the Ph.D. degree will be the satisfactory completion of a dissertation consisting of original research of publishable quality carried out under the guidance of the major professor. Approval of the completed dissertation by the joint doctoral committee implies that an organized investigation yielding substantial conclusions of interest which expand the frontiers of knowledge and understanding in the discipline has been carried out. Results must be reported in a manner demonstrating the ability of the candidate to effectively prosecute and report independent investigation.

The requirement for completing and filing the dissertation, including the number of copies required, will be decided jointly by the graduate deans and in accordance with regulations of the Graduate Divisions.

Final Examination

The final examination, organized and administered by the joint doctoral committee, shall consist of a dissertation defense, before the joint doctoral committee with the public invited.

Award of the Degree

The Doctor of Philosophy degree in geophysics will be awarded jointly by the Regents of the University of California and the Trustees of The California State University in the names of both institutions.

Financial Support

The Department of Geological Sciences at SDSU has teaching assistantships and fellowships available on a competitive basis and research assistantships and internships are available from research grants and contracts or through industry contacts. All students applying for admission to the joint doctoral program will be considered for financial support.

Faculty

The following faculty members of the cooperating institutions participate in the joint doctoral program, being available for direction of research and as departmental members of joint doctoral committees.

San Diego State University:

Committee Members: Day, Ma, Olsen

University of California, San Diego:

Committee Members: Agnew, Bock, Constable, Dorman, Fialko, Harding, Minster, Sandwell, Shearer, Vernon

Courses Acceptable for Master's and Doctoral Degree Programs in Geological Sciences (GEOL)

Refer to *Courses and Curricula and Regulations of the Division of Graduate Affairs sections of this bulletin* for explanation of the course numbering system, unit or credit hour, prerequisites, and related information.

UPPER DIVISION COURSES

GEOL 505. Imaging and GIS in Disaster Response (3)

Two lectures and three hours of laboratory.
Prerequisite: Geological Sciences 200 or enrollment in homeland security program.
Imaging and Geographic Information Systems applications in disaster management.

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. Students must demonstrate the physical ability to adequately and safely perform fieldwork under varying weather conditions; in steep, uneven or rocky terrain; for long periods of time.

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 521. Petroleum Geology (3)

Prerequisite: Geological Sciences 336.
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; credit or concurrent registration in Chemistry 201; Mathematics 124 or 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 538. Notable Historic Earthquakes (3)

Two lectures and three hours of laboratory.
Prerequisite: Geological Sciences 300.
Earthquake magnitude, fault source physics and rupture mechanisms, earthquake location and ground motion estimation, geotechnical aspects, earthquake triggering and geodesy.

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 124 or 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.

GEOL 587. Volcanology (3)

Prerequisite: Geological Sciences 324.
Magma and magma chamber properties. Eruptive mechanisms, volcano types, and a variety of volcanic phenomena associated with Hawaiian, Strombolian, Plinian, Vulcanian, and hydrovolcanic eruptions. Volcanic phenomena applied to classic and historic eruptions. (Formerly numbered Geological Sciences 687.)

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

GEOL 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.

GEOL 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.

GEOL 633. Quaternary Geology (3)

Two lectures and three hours of laboratory.
Prerequisite: Geological Sciences 514.
Quaternary climate, geochronometric dating and soil stratigraphy.

GEOL 635. Petrology of Terrigenous Rocks (3)

Two lectures and three hours of laboratory.
Prerequisite: Geological Sciences 336.
Thin-section and hand-specimen description and classification of sandstones, conglomerates, and mudrocks. Emphasis on mineralogy, provenance, diagenesis, and paleogeographic reconstructions.

GEOL 638. Advanced Notable Historic Earthquakes (3)

Two lectures and three hours of laboratory.
Prerequisite: Geological Sciences 300.
Earthquake magnitude, fault source physics and rupture mechanisms, earthquake location and ground motion estimation, geotechnical aspects, earthquake triggering and geodesy. Term project on a selected earthquake including computer-based analysis of source, mechanism, and location. Not open to students with credit in Geological Sciences 538.

GEOL 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.

GEOL 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.

GEOL 675. Groundwater Geochemistry (3)

Prerequisites: Chemistry 201 and Mathematics 150.

Processes affecting inorganic solutes in groundwater. Applications to groundwater geochemical evolution, weathering processes, and inorganic contaminant transport.

GEOL 690. Earthquake Physics I (3)

Prerequisite: Geological Sciences 560. Recommended: Mathematics 342B.

Structure and tectonics of fault zones as inferred from geological and geophysical observations. Stress state and frictional behavior of faults, stress interaction models, thermal, and hydrological properties of fault zones. Mechanics and energy budget of earthquakes.

GEOL 691. Earthquake Physics II (3)

Prerequisites: Geological Sciences 560 and 690. Recommended: Mathematics 342B.

Theoretical and numerical models of earthquake rupture and wave propagation, with applications to ground motion prediction and seismic hazard estimation. Collective behavior of fault networks, seismicity models, earthquake predictability; application to earthquake forecast models.

GEOL 750. Research and Technical Writing (3) Cr/NC

Prerequisite: Advancement to candidacy.

Research and technical report writing in geological sciences for students in Plan B.

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

Prerequisite: Consent of the department.

Supervised research in an area of geological sciences. Maximum credit six units applicable to a master's or Ph.D. degree.

GEOL 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.

GEOL 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.

GEOL 799C. Comprehensive Examination Extension (0) Cr/NC

Prerequisite: Completion or concurrent enrollment in degree program courses.

Registration required of students whose only requirement is completion of the comprehensive examination for the master's degree. Registration in 799C limited to two semesters.

DOCTORAL COURSES**GEOL 897. Doctoral Research (1-15) Cr/NC/RP**

Prerequisite: Admission to doctoral program.

Independent investigation in general field of the dissertation.

GEOL 898. Doctoral Special Study (1-8) Cr/NC/RP

Prerequisite: Admission to doctoral program.

Individual study in field of specialization. Maximum credit eight units applicable to doctoral degree.

GEOL 899. Doctoral Dissertation (1-15) Cr/NC/RP

Prerequisite: An officially constituted dissertation committee and advancement to candidacy.

Preparation of the dissertation for the doctoral degree. Enrollment is required during the term in which the dissertation is approved.