With one of the most successful graduate programs in the nation, the Department of Geological Sciences has enjoyed a reputation of excellence for more than 100 years. Our doctoral program is ranked among the top 10 percent of U.S. geology programs by the National Research Council and is ranked 9th by U.S. News and World Report.

Graduate students have an opportunity to work with approximately 30 tenure and tenure-track faculty who support a wide range of interdisciplinary research programs in biochemistry, economic resources, geodynamics, geophysics, glaciology, global climate change, hydrogeology, paleontology and surficial processes.

The graduate degrees offered include Master of Science (MS) and Doctor of Philosophy (PhD).

Students interested in graduate work in the geological sciences should carefully read the detailed information regarding admission, registration and degree requirements on the Geological Sciences (http://www.cugeology.org) website.

Course code for this program is GEOL.

**Master’s Degree**
- Geology - Master of Science (MS) (catalog.colorado.edu/graduate/colleges-schools/arts-sciences/programs-study/geological-sciences/geology-master-science-ms)

**Doctoral Degrees**
- Geology - Doctor of Philosophy (PhD) (catalog.colorado.edu/graduate/colleges-schools/arts-sciences/programs-study/geological-sciences/geology-doctor-philosophy-phd)
- Geophysics - Doctor of Philosophy (PhD) (catalog.colorado.edu/graduate/colleges-schools/arts-sciences/programs-study/geological-sciences/geophysics-doctor-philosophy-phd)

**Certificates**
- Geophysics - Graduate Certificate (catalog.colorado.edu/graduate/colleges-schools/arts-sciences/programs-study/geological-sciences/geophysics-graduate-certificate)
- Hydrologic Sciences - Graduate Certificate (catalog.colorado.edu/graduate/colleges-schools/arts-sciences/programs-study/geological-sciences/hydrologic-sciences-graduate-certificate)

**Faculty**
While many faculty teach both undergraduate and graduate students, some instruct students at the undergraduate level only. For more information, contact the faculty member’s home department.

Abbott, Lon D  
Senior Instructor

Anderson, Robert S  
Distinguished Professor; PhD, University of Washington

Andrews, John T.  
Professor Emeritus

Atkinson, William W. Jr  
Professor Emeritus

Bilham, Roger G.  
Professor Emeritus

Birkeland, Peter W.  
Professor Emeritus

Bradley, William C.  
Professor Emeritus

Budd, David A  
Professor; PhD, University of Texas at Austin

Chin, Karen  
Associate Professor; PhD, University of California-Santa Barbara

Eberle, Jaelyn J  
Associate Professor; PhD, University of Wyoming

Eicher, Don L.  
Professor Emeritus

Farmer, G Lang  
Professor; PhD, University of California-Los Angeles

Flowers, Rebecca M  
Associate Professor; PhD, Massachusetts Institute of Technology

Ge, Shemin  
Professor; PhD, Johns Hopkins University

Goetz, F. H. Alexander  
Professor Emeritus

Hynek, Brian Michael  
Associate Professor; PhD, Washington University

Jakosky, Bruce M  
Professor; PhD, California Institute of Technology

Jones, Craig H  
Professor; PhD, Massachusetts Institute of Technology

Kraus, Mary J  
Professor; PhD, University of Colorado Boulder

Larson, Edwin E.  
Professor Emeritus

Lester, Alan P.  
Lecturer; PhD, University of Colorado Boulder

Mahan, Kevin H  
Associate Professor; PhD, University of Massachusetts at Amherst

Marchitto, Thomas  
Associate Professor; PhD, Massachusetts Institute of Technology

Miller, Gifford Hubbs  
Professor; PhD, University of Colorado Boulder

Mojzsis, Stephen J  
Professor; PhD, University of California-San Diego
Courses

**GEOL 5001 (3) Physics and Chemistry of the Solid Earth**
Reviews the physical and chemical characteristics of the solid earth, from the core to the crust, and the processes that govern behavior through the earth. Lectures are supplemented with readings from the recent literature. Topics include convection, phase transitions, melt generation, forces of plate tectonics, origin of continents and lithosphere, continental tectonics, and earthquakes.

**Requisites:** Restricted to graduate students only.
**Recommended:** Require courses in basic chemistry and physics.
**Additional Information:** Departmental Category: Graduate Course

**GEOL 5002 (3) Physics, Chemistry, and Biology of Sedimentary Systems**
Reading and discussion of current issues and themes in the stratigraphic sciences, including stratigraphic and facies analysis, spatial heterogeneity and self-organization, numerical modeling: origin, evolution, mass extinctions, and megatrajectories of life; and paleoceanographic and paleoclimatic signals in sedimentary rocks. Goal is to diversify students' understanding of the role of physics, chemistry, and biology in attacking research problems in sedimentary systems. Department enforced requisite, restricted to graduate students only.
**Additional Information:** Departmental Category: Graduate Course

**GEOL 5060 (4) Oceanography**
Examines the ocean as a system influencing the Earth's surficial processes and climate. Composition and properties of seawater, ocean circulation, waves, tides, coastal, shallow, and deep-water processes, biogeochemical cycles, deep sea sediments. Laboratory emphasizes the use of oceanographic data.
**Equivalent - Duplicate Degree Credit Not Granted:** GEOL 4060
**Requisites:** Restricted to graduate students only.
**Additional Information:** Departmental Category: Graduate Course

**GEOL 5080 (3) Advanced Hydrogeology and Modeling Concepts**
Introduces advanced groundwater flow and modeling concepts, equations for steady state and transient flow, saturated and unsaturated flow, finite difference method, application of modeling in geologic processes, radial flow and aquifer parameters, infiltration and groundwater recharge, model calibration, verification and prediction. Department enforced requisite: MATH 2300 or Fortran.
**Additional Information:** Departmental Category: Graduate Course

**GEOL 5093 (4) Remote Sensing of the Environment**
Covers acquisition and interpretation of environmental data by remote sensing. Discusses theory and sensors as well as manual and computerized interpretation methods. Stresses infrared and microwave portions of the spectrum.
**Equivalent - Duplicate Degree Credit Not Granted:** GEOL 4093 and GEOG 4093 and GEOG 5093
**Requisites:** Restricted to graduate students only.
**Additional Information:** Departmental Category: Graduate Course

**GEOL 5110 (3) Geomechanics**
Introduces fundamental physical processes important to the transport of heat and mass in the Earth and on Earth's surface. Provides practice with quantitative treatment of geological problems. Solutions for each problem are derived from first principles, including conservation and flux laws. Emphasizes heat conduction and viscous fluid flow. Department enforced prerequisite: restricted to graduate students only and a course in calculus.
**Additional Information:** Departmental Category: Graduate Course
GEOL 5150 (2) Planetary Field Geology
Provides an overview of the geology, age and origins of the solid (rocky) planets, dwarf planets and moons of our solar system and the processes that form them from comparative studies from comparative geology. Includes modules on volcanism, rifting, aeolian processes, fluvial erosion, impacts, climate change and paleontology.
Equivalent - Duplicate Degree Credit Not Granted: GEOL 4150
Additional Information: Departmental Category: Graduate Course

GEOL 5215 (3) Geochronology and Thermochronology
Constraining the timing of events and rates of processes is fundamental to earth science research. The field of geochronology and thermochronology is rapidly evolving. Cutting-edge aspects of geochronologic methods and emerging techniques will be especially emphasized. Lectures will emphasize the principles and assumptions of each technique. Seminar discussions will focus on recent papers that demonstrate state-of-the-art applications to diverse problems.
Equivalent - Duplicate Degree Credit Not Granted: GEOL 4215
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

GEOL 5270 (3) Marine Chemistry and Geochemistry
Examines the chemical, biological, geological and physical processes affecting (and affected by) the chemistry of the oceans. Topics include: chemical separation in seawater; the marine carbon cycle and its long-term control on atmospheric CO2; the large-scale interdependence of nutrient distributions and biological productivity, chemical tracers of ocean circulation; the chemistry of marine sediments, including early diagenesis.
Equivalent - Duplicate Degree Credit Not Granted: GEOL 4270
Recommended: Prerequisites introductory chemistry, introductory geology, introductory oceanography.
Additional Information: Departmental Category: Graduate Course

GEOL 5280 (3) Aquaeous and Environmental Geochemistry
Explores the fundamentals of low-temperature geochemistry to investigate element speciation and chemical behavior in waters, soils and sediments. Topics include water-rock interaction and weathering, mineral dissolution and precipitation reactions, aqueous complexation, mineral surface chemistry, kinetics, element cycles, and redox biogeochemistry. Includes exposure to spectroscopic tools, computer simulations and microbial geochemistry. Department enforced prerequisite: GEOL 3320 or 1 year of college chemistry.
Additional Information: Departmental Category: Graduate Course

GEOL 5305 (3) Global Biogeochemical Cycles
Focuses on the cycling of elements at the global scale with a particular emphasis on human modification of biogeochemical cycles. Major biogeochemical cycles, their past dynamics, present changes and potential future scenarios will be addressed. Ecosystem to global-scale model of the earth system will be discussed along with global scale measurements of element fluxes from satellites, aircraft and measurement networks. Department enforced prerequisite: restricted to graduate students only, general chemistry and some organic chemistry.
Equivalent - Duplicate Degree Credit Not Granted: ENVS 5840
Additional Information: Departmental Category: Graduate Course

GEOL 5330 (3) Cosmochemistry
Investigates chemical and isotopic data to understand the composition of the solar system: emphasis on the physical conditions in various objects, time scales for change, chemical and nuclear processes leading to change, observational constraints, and various models that attempt to describe the chemical state and history of cosmological objects in general and the early solar system in particular. Department enforced prerequisite: graduate standing in physical science and graduate chemistry or physics or math courses.
Equivalent - Duplicate Degree Credit Not Granted: GEOL 4330 and ASTR 4330 and ASTR 5330
Additional Information: Departmental Category: Graduate Course

GEOL 5420 (3) Quaternary Dating Methods
Features in-depth survey of standard and experimental dating methods that provide absolute ages for events of the last two million years of Earth history. Includes theory and application of radiocarbon, uranium series, amino acid, thermo-luminescence, fission track, potassium/argon, hydration, light stable isotopes, and other radioactive techniques. Recommended: GEOL 4270 and GEOL 4280.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

GEOL 5430 (3) Paleoceanography and Paleoclimatology
Examines scientific tools, data and theories related to the dramatically varied past climate of Earth. Focus will be on marine records of climate change and ocean circulation, but ice core and continental archives will also be discussed. Covers the Cretaceous Period to the present, with particular emphasis on the past 150,000 years (the last ice age cycle). Department enforced prerequisite: restricted to graduate students only and introductory geology and introductory oceanography or atmospheric science.
Additional Information: Departmental Category: Graduate Course

GEOL 5474 (4) Vertebrate Paleontology
Discusses the history and evolution of the vertebrates, including the phylogenetic relationships and evolutionary patterns of the major groups. Lab focuses on comparative vertebrate osteology and fossil representation of major groups.
Equivalent - Duplicate Degree Credit Not Granted: GEOL 4474 and MUSM 5474
Additional Information: Departmental Category: Graduate Course

GEOL 5550 (3) Petroleum Reservoir Characterization and Modeling
Introduces concepts and methods of petroleum reservoir analysis and 3-D reservoir modeling using subsurface data (cores, well logs, 3-D seismic) and outcrop analogs. Examines petroleum system, petrophysics (lithology, porosity, permeability, capillary pressure, flow units), and sequence-stratigraphic, facies, and structural controls on reservoir properties, heterogeneity and recovery efficiency. Deterministic and stochastic reservoir modeling methods are addressed.
Equivalent - Duplicate Degree Credit Not Granted: GEOL 4550
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

GEOL 5670 (3) Isotope Geology
Introduces principles of stable and radiogenic isotope systematics in inorganic and organic geochemistry. Emphasizes application of isotope data to problems in igneous, metamorphic and sedimentary petrology, geobiogeochemistry, and petroleum genesis.
Equivalent - Duplicate Degree Credit Not Granted: GEOL 4670
Additional Information: Departmental Category: Graduate Course
GEOL 5717 (1-3) Field Seminar in Geology and Tectonics
Studies geologic features in and around Colorado to gain an overview of the geologic and tectonic evolution of the western U.S. Department enforced prerequisites: restricted to graduate students only and GEOL 2001 or GEOL 2700 and at least one of the following: GEOL 3120 or GEOL 3320 or CHEM 1113 or CHEM 1133 and GEOL 3320.
Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.
Additional Information: Departmental Category: Graduate Course

GEOL 5703 (1) Seminar in Tectonics
Focuses on a wide variety of topics related to crust, mantle and whole earth tectonics. Published papers from recent peer-reviewed literature are read and discussed. The format and specific topics will vary each semester (e.g., a relatively focused theme or open format) and will in part be determined by the makeup of enrolled students. Department enforced prerequisite: restricted to graduate students only.
Repeatable: Repeatable for up to 6.00 total credit hours.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Graduate Course
GEOL 5725 (1-4) Field Based Special Topics in Geoscience
Explores selected geological subjects of special interest in a field setting.
Equivalent - Duplicate Degree Credit Not Granted: GEOL 4725
Repeatable: Repeatable for up to 8.00 total credit hours. Allows multiple enrollment in term.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Graduate Course

GEOL 5800 (3) Planetary Surfaces and Interiors
Examines processes operating on the surfaces of solid planets and in their interiors. Emphasizes spacecraft observations, their interpretation, the relationship to similar processes on Earth, the relationship between planetary surfaces and interiors and the integrated geologic histories of the terrestrial planets and satellites.
Equivalent - Duplicate Degree Credit Not Granted: ASTR 5800
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

GEOL 5810 (3) Planetary Atmospheres
Covers the structure, composition, and dynamics of planetary atmospheres. Includes the origin of planetary atmospheres, chemistry and cloud physics, greenhouse effects, climate, and the evolution of planetary atmospheres - past and future.
Equivalent - Duplicate Degree Credit Not Granted: ASTR 5810 and ASTR 5810
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

GEOL 5820 (3) Origin and Evolution of Planetary Systems
Considers the origin and evolution of planetary systems, including protoplanetary disks, condensation in the solar nebula, composition of meteorites, planetary accretion, comets, asteroids, planetary rings and extrasolar planets. Applies celestial mechanics to the dynamical evolution of solar system bodies.
Equivalent - Duplicate Degree Credit Not Granted: ASTR 5820 and ASTR 5820
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

GEOL 5830 (3) Topics in Planetary Science
Examines current topics in planetary science, based on recent discoveries, spacecraft observations and other developments. Focuses on a specific topic each time the course is offered, such as Mars, Venus, Galilean satellites, exobiology, comets or extrasolar planets. Department enforced prerequisite: restricted to graduate students in the physical sciences.
Equivalent - Duplicate Degree Credit Not Granted: ASTR 5830 and ASTR 5830
Repeatable: Repeatable for up to 6.00 total credit hours.
Additional Information: Departmental Category: Graduate Course

GEOL 5835 (1) Seminar in Planetary Science
Studies current research on a topic in planetary science. Students and faculty give presentations. Subjects may vary each semester.
Equivalent - Duplicate Degree Credit Not Granted: ASTR 5835 and ATOC 5835
Repeatable: Repeatable for up to 4.00 total credit hours.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

GEOL 5840 (1-3) Independent Study-Quaternary Geology
Repeatable: Repeatable for up to 7.00 total credit hours.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

GEOL 5841 (1-3) Independent Study-Economic Geology
Repeatable: Repeatable for up to 7.00 total credit hours.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

GEOL 5842 (1-3) Independent Study-Petrology
Repeatable: Repeatable for up to 7.00 total credit hours.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

GEOL 5843 (1-3) Independent Study-Sedimentology
Repeatable: Repeatable for up to 7.00 total credit hours.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

GEOL 5844 (1-3) Independent Study-Structure/Tectonics
Repeatable: Repeatable for up to 7.00 total credit hours.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

GEOL 5845 (1-3) Independent Study-Geochronology
Repeatable: Repeatable for up to 7.00 total credit hours.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

GEOL 5846 (1-3) Independent Study-Geophysics
Repeatable: Repeatable for up to 7.00 total credit hours.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

GEOL 5847 (1-3) Independent Study-Hydrology
Repeatable: Repeatable for up to 7.00 total credit hours.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

GEOL 5848 (1-3) Independent Study-Paleontology
Repeatable: Repeatable for up to 7.00 total credit hours.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

GEOL 5850 (1-3) Independent Study-Environmental Geology
Repeatable: Repeatable for up to 7.00 total credit hours.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

GEOL 5851 (1-3) Independent Study-Sediment Petrology
Repeatable: Repeatable for up to 7.00 total credit hours.
Additional Information: Departmental Category: Graduate Course

GEOL 5852 (1-3) Independent Study--GIS Applications in Quaternary Geosciences
Leads students through quantitative spatial analysis of environmental and paleoclimatic problems. Each student will develop a project from start to finish, with emphasis on raster GIS for building large empirical databases that bear on process and variability.
Additional Information: Departmental Category: Graduate Course

GEOL 6050 (3) Space Instrumentation
Provides an overview of the relevant space environment and process, the types of instruments flown on recent mission and the science background of the measurement principles.
Equivalent - Duplicate Degree Credit Not Granted: ASTR 6050 and ASEN 6050
Grading Basis: Letter Grade
Additional Information: Departmental Category: Graduate Course

GEOL 6060 (4) Petroleum Geology of Turbidite Systems
Covers the exploration and production aspects of petroleum submarine fans and turbidite systems.
Requisites: Requires prerequisite course of GEOL 6330 (minimum grade B).
Additional Information: Departmental Category: Graduate Course
GEOL 6310 (3) Sedimentary Petrology
Covers interpretation of depositional and diagenetic history of sedimentary rocks as determined from thin-section studies. Department enforced requisite, restricted to graduate students only. Department enforced prerequisites: GEOL 3010 and GEOL 3020 and GEOL 3430.
Additional Information: Departmental Category: Graduate Course

GEOL 6330 (4) Applied Sequence Stratigraphy and Basin Analysis
Develops skills in the stratigraphic interpretation of seismic reflection data, recognition of sequence stratigraphy in well logs and outcrop and their applications to basin analysis in petroleum exploration. Department enforced prerequisite: restricted to graduate students only and introductory undergraduate physics and sedimentology/stratigraphy.
Additional Information: Departmental Category: Graduate Course

GEOL 6610 (3) Earth and Planetary Physics 1
Offered alternate years. Examines mechanics of deformable materials, with applications to earthquake processes. Introduces seismic wave theory. Other topics include inversion of seismic data for the structure, composition and state of the interior of the Earth.
Equivalent - Duplicate Degree Credit Not Granted: ASTR 6610 and PHYS 6610
Additional Information: Departmental Category: Graduate Course

GEOL 6620 (3) Earth and Planetary Physics 2
Offered alternate years. Covers space and surface geodetic techniques as well as potential theory. Other topics are the definition and geophysical interpretation of the geoid and of surface gravity anomalies; isostasy; post-glacial rebound; and tides and the rotation of the Earth.
Equivalent - Duplicate Degree Credit Not Granted: ASTR 6620 and PHYS 6620
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

GEOL 6630 (3) Earth and Planetary Physics 3
Offered alternate years. Examines the solar system, emphasizing theories of its origin and meteorites. Highlights distribution of radioactive materials, age dating, heat flow through continents and the ocean floor, internal temperature distribution in the Earth, and mantle convection. Also covers the origin of the oceans and atmosphere.
Equivalent - Duplicate Degree Credit Not Granted: ASTR 6630 and PHYS 6630
Additional Information: Departmental Category: Graduate Course

GEOL 6650 (1-3) Seminar in Geophysics
Advanced seminar studies in geophysical subjects for graduate students.
Equivalent - Duplicate Degree Credit Not Granted: ASTR 6650 and PHYS 6650
Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.
Additional Information: Departmental Category: Graduate Course

GEOL 6670 (2) Geophysical Inverse Theory
Principles of geophysical inverse theory as applied to problems in the Earth sciences, including topography, Earth structure and earthquake locations. Department enforced prerequisites: a course in calculus and a course in computer programming (any language).
Equivalent - Duplicate Degree Credit Not Granted: PHYS 6670
Additional Information: Departmental Category: Graduate Course

GEOL 6940 (1) Master's Degree Candidate
Requisites: Restricted to graduate students only.
Grading Basis: Pass/Fail
Additional Information: Departmental Category: Graduate Course

GEOL 6950 (1-6) Master's Thesis
Repeatable: Repeatable for up to 6.00 total credit hours.
Additional Information: Departmental Category: Graduate Course

GEOL 6960 (3) Plan II Master's Research
Additional Information: Departmental Category: Graduate Course

GEOL 8990 (1-10) Doctoral Dissertation
All doctoral students must register for not fewer than 30 hours of dissertation credit as part of the requirements for the degree. For a detailed discussion of doctoral dissertation credit, refer to the Graduate School section.
Repeatable: Repeatable for up to 30.00 total credit hours.
Additional Information: Departmental Category: Graduate Course