EARTH SCIENCE

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 CU Boulder is ranked as one of the top three universities in the world for geosciences by *U.S. News and World Report*.

Graduate students have an opportunity to work with over 30 tenured and tenure-track faculty who support a wide range of interdisciplinary research programs in such areas as: cosmochemistry and planetary geology; Earth science education; economic and energy resources; geobiology and astrobiology; geochemistry; geochronology and thermochronology; geodynamics, geophysics, and remote sensing; geomorphology and cryosphere; global change; hydrology; natural hazards; paleoclimate and paleoceanography; paleontology and paleobiology; petrology and mineralogy; sedimentology and stratigraphy; and structure and tectonics.

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 Earth Science (http://www.cugeology.org/) website.

Professional Licensure

The State of Colorado does not require individuals working in earth science, geology or the geological sciences to obtain Professional Geology Licensure, however many states require professional geologists to pass the ASBOG Fundamentals of Geology (FG) and/or Practice of Geology (PG) examinations. Information regarding ASBOG examination specifications can be found on the ASBOG (https://www.asbog.org/) website.

Students planning to seek professional licensure or certification for employment in a state other than Colorado, are strongly recommended to contact the appropriate licensing entity in the state in which they are, or plan to be, located in order to seek information and guidance regarding licensure or certification requirements and how the education received at CU Boulder may assist the student in their efforts to gain licensure in that state.

Course code for this program is ERTH.

Master's Degree

- Earth Science - Master of Science (MS) (https://catalog.colorado.edu/graduate/colleges-schools/arts-sciences/programs-study/earth-science/earth-science-master-science-ms/)

Doctoral Degrees

- Earth Science - Doctor of Philosophy (PhD) (https://catalog.colorado.edu/graduate/colleges-schools/arts-sciences/programs-study/earth-science/earth-science-doctor-philosophy-phd/)
- Geophysics - Doctor of Philosophy (PhD) (https://catalog.colorado.edu/graduate/colleges-schools/arts-sciences/programs-study/earth-science/geophysics-doctor-philosophy-phd/)

Certificates

- Geophysics - Graduate Certificate (https://catalog.colorado.edu/graduate/colleges-schools/arts-sciences/programs-study/earth-science/geophysics-graduate-certificate/)
- Hydrologic Sciences - Graduate Certificate (https://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. (https://experts.colorado.edu/display/fisid_145044/)
Teaching Professor of Distinction; PhD, University of California, Santa Cruz

Anderson, Robert S. (https://experts.colorado.edu/display/fisid_130117/)
Distinguished Professor; PhD, University of Washington

Anderson, Suzanne Prestrud (https://experts.colorado.edu/display/fisid_131099/)
Professor; PhD, University of California, Berkeley

Arthurs, Leilani A. (https://experts.colorado.edu/display/fisid_145087/)
Associate Professor; PhD, University of Notre Dame

Chin, Karen (https://experts.colorado.edu/display/fisid_122666/)
Professor; PhD, University of California, Santa Barbara

Clark, Alisha (https://experts.colorado.edu/display/fisid_164457/)
Assistant Professor; PhD, University of California-Davis

Crow, Carolyn Alicia (https://experts.colorado.edu/display/fisid_163334/)
Assistant Professor; PhD, University of California-Los Angeles

Eberle, Jaelyn J. (https://experts.colorado.edu/display/fisid_126544/)
Professor; PhD, University of Wyoming

Farmer, G. Lang (https://experts.colorado.edu/display/fisid_100498/)
Professor; PhD, University of California, Los Angeles

Flowers, Rebecca M. (https://experts.colorado.edu/display/fisid_144054/)
Professor; PhD, Massachusetts Institute of Technology

Ge, Shemin (https://experts.colorado.edu/display/fisid_101387/)
Distinguished Professor, Chair; PhD, Johns Hopkins University

Hynek, Brian Michael (https://experts.colorado.edu/display/fisid_130622/)
Professor; PhD, Washington University

Jones, Craig H. (https://experts.colorado.edu/display/fisid_105590/)
Professor; PhD, Massachusetts Institute of Technology

Kopf, Sebastian H. (https://experts.colorado.edu/display/fisid_155295/)
Assistant Professor; PhD, California Institute of Technology

Mahan, Kevin H. (https://experts.colorado.edu/display/fisid_143975/)
Professor; PhD, University of Massachusetts at Amherst

Marchitto, Thomas (https://experts.colorado.edu/display/fisid_128241/)
Professor, Associate Chair; PhD, Massachusetts Institute of Technology

Markle, Bradley R. (https://experts.colorado.edu/individual/fisid_167413/)
Assistant Professor; PhD, University of Washington

Mueller, Karl Jules (https://experts.colorado.edu/display/fisid_107629/)
Professor; PhD, University of Wyoming

Overeem, Irina (https://experts.colorado.edu/display/fisid_125258/)
Associate Professor; PhD, Delft University of Technology (Netherlands)

Rahman, Shaily (https://experts.colorado.edu/display/fisid_168587/)
Assistant Professor; PhD, SUNY at Stony Brook

Schulte-Pelkum, Vera (https://experts.colorado.edu/display/fisid_126623/)
Associate Research Professor, Lecturer; PhD, University of California-San Diego

Sepulveda Arellano, Julio Cesar (https://experts.colorado.edu/display/fisid_154923/)
Associate Professor; PhD, University of Bremen (Germany)

Sheehan, Anne (https://experts.colorado.edu/display/fisid_103645/)
Chair, Professor; PhD, Massachusetts Institute of Technology

Simpson, Carl (https://experts.colorado.edu/display/fisid_159652/)
Assistant Professor; PhD, University of Chicago

Tilton, Eric (https://experts.colorado.edu/display/fisid_126548/)
Professor, Associate Chair; PhD, University of California, Santa Cruz

Snell, Kathryn Elaine (https://experts.colorado.edu/display/fisid_155298/)
Associate Professor; PhD, University of California, Santa Cruz

Stempien, Jennifer (https://experts.colorado.edu/individual/fisid_143751/)
Associate Teaching Professor; PhD, Virginia Polytechnic Institute and State University

Templeton, Alexis S. (https://experts.colorado.edu/display/fisid_141202/)
Professor; PhD, Stanford University

Tiampo, Kristy F. (https://experts.colorado.edu/display/fisid_155908/)
Professor; PhD, University of Colorado Boulder

Trower, Lizzy (https://experts.colorado.edu/display/fisid_159463/)
Assistant Professor; PhD, Stanford University

Tucker, Gregory E. (https://experts.colorado.edu/display/fisid_130605/)
Professor; PhD, Pennsylvania State University

Wing, Boswell A. (https://experts.colorado.edu/display/fisid_158302/)
Associate Professor; PhD, Johns Hopkins University

Courses

ERTH 5003 (2) Graduate Writing Seminar
Aims at improving graduate student writing, editing, and reviewing skills, while meeting student writing goals. Includes discussion of materials about effective writing, and peer-editing of text that students are producing for their graduate research endeavors. Formerly GEOL 5003.

ERTH 5020 (3) Marine Geology
Students will learn about marine geology. Formerly GEOL 5020.

ERTH 5021 (4) Petrology: Evolution of Crustal and Mantle Rocks
Origin, physical, and chemical properties of igneous and metamorphic rocks. This course develops a thermodynamic framework for the interpretation of geologic processes from observed mineral assemblages and rock textures. Laboratory component emphasizes the study of rocks in thin section and hand samples to understand earth processes in the mantle and crust.
Equivalent - Duplicate Degree Credit Not Granted: ERTH 4021
Requisites: Restricted to graduate students only.

ERTH 5030 (3) Coastal Processes
Students will learn about coastal processes. Formerly GEOL 5030.

ERTH 5042 (3) Computational Tools in Geosciences
Scientific research and teaching in geological sciences and related disciplines relies increasingly on computational tools. This class aims to introduce graduate students in the geological, geophysical and biogeochemical sciences to a wide range of commonly used concepts and open source data tools to empower them to find the right tool for their computational needs in research and teaching. Previously offered as a special topics course. Formerly GEOL 5042.
Repeatable: Repeatable for up to 6.00 total credit hours.
Recommended: Prerequisite Prior experience with at least one programming language is recommended.

ERTH 5050 (3) Earthquakes
Covers causes and effects of earthquakes, earthquake prediction, seismic waves, record interpretation, parameters of seismic foci, and seismo-tectonics ofthe world.
Equivalent - Duplicate Degree Credit Not Granted: ERTH 4050

ERTH 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: ERTH 4093 and GEOG 4093 and GEOG 5093
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

ERTH 5101 (1) Introduction to Earth Science Faculty I
Welcomes and introduces all new graduate students to the Department of Earth Science. Faculty discuss their research and their academic trajectories. The week¿s geology colloquium is discussed. Tutorials from staff introduce how the university works, what funding opportunities exist, and how and when to apply for such funding. Formerly GEOL 5101.
Grading Basis: Letter Grade

ERTH 5102 (1) Introduction to Earth Science Faculty II
Continues to introduce all new graduate students to the Department of Earth Science. Faculty discuss their research and their academic trajectories. The week¿s geology colloquium is discussed. In addition, students craft reports on their intended research. Formerly GEOL 5102.
Grading Basis: Letter Grade

ERTH 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. Formerly GEOL 5110.
Requisites: Restricted to graduate students only.
Recommended: Prerequisite course in calculus.
Additional Information: Departmental Category: Graduate Course

ERTH 5111 (3) Rheology: Fracture and Flow of Rocks
Focuses on the elastic and plastic deformation of planetary materials (e.g. rocks and minerals, melts, tectonic plates, etc.). Topic include stress and strain, failure criterion, fracture propagation, creep (dislocation and diffusion), and deformation of multiphase materials. Formerly GEOL 5111.
Requisites: Restricted to graduate students only.
Recommended: Prerequisite prior coursework in basic chemistry, physics, mineralogy/petrology, and structure/geology.
Grading Basis: Letter Grade

ERTH 5120 (3) Advanced Structural Geology and Tectonics
Provides valuable exposure to theory and applications related to deformation (rheology) of solid Earth materials as well as the structural and geophysical characteristics of the world's major orogenic belts. The processes that will be covered span a wide range of Earth's depths, from compaction in sedimentary rocks and flow of ice/salt near Earth's surface to cataclastic mechanisms in fault rocks to plastic flow of deep crust and mantle rock. The course will involve lectures, some in-class and take home problem sets, some local field exercises and field data analysis, classic and modern paper discussions, and a research term project (written and oral presentation).
Equivalent - Duplicate Degree Credit Not Granted: ERTH 4120
Recommended: Prerequisite ERTH 3120.
Grading Basis: Letter Grade

ERTH 5123 (3) Teaching and Learning in Post-Secondary Science Education
Introduces the science of learning and research-based instructional strategies. Open to students in any STEM discipline considering a career that involves college-level teaching. Students apply research on learning and teaching to the development of instructional materials for a target course they envision teaching at the college level in the future. Formerly GEOL 5123.
Recommended: Prerequisite at least one semester teaching/TAing undergraduate courses (waived with instructor approval).

ERTH 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. Formerly GEOL 5150.
Repeatable: Repeatable for up to 12.00 total credit hours.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

ERTH 5185 (3) Geomicrobiology
Examines how microbial and chemical processes interact on the Earth¿s surface today and have shaped the planet throughout its history. Emphasis will be placed on how the life styles and chemical ingenuity of microorganisms drive key biogeochemical processes including weathering and transformations of carbon, oxygen, sulfur, iron and nitrogen. Towards this goal, major geologic and evolutionary events will be examined through the lens of microbial diversity, metabolic energetics, microbe-mineral interactions, and molecular biomarkers.
Equivalent - Duplicate Degree Credit Not Granted: ERTH 4185, ENVS 4185, and MCDB 4185
Grading Basis: Letter Grade

ERTH 5210 (3) Advanced Igneous Petrology
Systematic Analysis of Petrology of Igneous Rocks. Emphasizes Integrating Knowledge Obtained from Theory, Experiment, and Field Studies. Formerly GEOL 5210.

ERTH 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: ERTH 4215
Additional Information: Departmental Category: Graduate Course

ERTH 5216 (1) Geochronology Reading and Discussion Seminar
The goals of this reading and discussion seminar are to: 1) learn key aspects of a selected geochronology topic, 2) read, critically evaluate, and discuss peer-reviewed scientific papers that include geochronology data, methods, and interpretations, and 3) set up a framework and appropriate environment in which participants will discuss the ¿next steps¿ to address the big problems associated with each theme. This course will focus on a different geochronology theme each time that it is offered. A theme will be selected based on conversations among interested participants. At the beginning of the semester, weekly discussion topics and associated papers will be chosen to systematically work through concepts associated with that theme. Previously offered as a special topics course. Formerly GEOL 5216.
Repeatable: Repeatable for up to 5.00 total credit hours.

ERTH 5230 (4) Mineral Exploration
Students will learn about mineral exploration. Formerly GEOL 5230.

ERTH 5240 (4) Remote Sensing Image Analysis
Digital image processing emphasizing hands-on computer analysis of space-acquired images. Theory and practice of image enhancement and thematic information extraction. Formerly GEOL 5240.
Requisites: Requires prerequisites of GEOG 4093 or GEOG 5093 or ERTH 4093 or ERTH 5093 (min grade C-).
Recommended: Prerequisite knowledge of multivariate statistics.
Additional Information: Departmental Category: Graduate Course

ERTH 5253 (3) Stable Isotope Fractionation in Biogeochemical Processes
Investigates the origins of stable isotope fractionation in geochemical systems with special emphasis on the role of biological catalysts as key drivers of isotopic effects during biogeochemical transformations. The class will cover a wide range of topics relevant to isotope fractionation including partition functions, diffusional, enzymatic and equilibrium isotope effects, open and closed system behavior, Rayleigh distillation, reservoir effects, enzymatic catalysis, physiological drivers and signal preservation. Formerly GEOL 5253.
Recommended: Prerequisites MATH 1300 or APPM 1350.

ERTH 5260 (3) Field Study of Mineral Deposits
Field Mapping Studies of Ore Deposits, Emphasizing Petrology, Wall Rock Alteration, and Ore Mineralogy. Formerly GEOL 5260.

ERTH 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: ERTH 4270
Recommended: Prerequisites introductory chemistry, introductory geology, introductory oceanography.
Additional Information: Departmental Category: Graduate Course

ERTH 5280 (3) Aqueous 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. Formerly GEOL 5280.
Recommended: Prerequisite ERTH 3320 or 2 years of college chemistry.
Additional Information: Departmental Category: Graduate Course

ERTH 5300 (3) Low Temperature Geochemistry
Discussion of Geochemistry of Sedimentary and Near- Surface Environments. Stability Diagrams, Ion Exchange, Weathering, Geochemical Prospecting, and Topics in Thermodynamics. Formerly GEOL 5300.

ERTH 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.
Equivalent - Duplicate Degree Credit Not Granted: ENVS 5840
Requisites: Restricted to graduate students only.
Recommended: Prerequisite general chemistry and some organic chemistry.
Additional Information: Departmental Category: Graduate Course

ERTH 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.
Equivalent - Duplicate Degree Credit Not Granted: ERTH 4330 and ASTR 4330 and ASTR 5330
Recommended: Prerequisite graduate standing in physical science and graduate chemistry or physics or math courses.
Additional Information: Departmental Category: Graduate Course

ERTH 5341 (3) The Cryosphere: Earth's Icy Environments
Serves as an advanced introductory course in to the cryosphere. The course covers the nature of ice and the icy component of the Earth System, and how changing ice affects society. The course will not cover sea ice. Formerly offered as a special topics course.
Equivalent - Duplicate Degree Credit Not Granted: ERTH 4341
Requisites: Restricted to graduate students only.

ERTH 5380 (3) Fundamentals of Stable Isotope Geochemistry
This course teaches students the fundamental principles of stable isotope fractionation during physical and biological processes, and the application of these behaviors to a wide range of important geologic questions. The course will use classic case studies from the geologic record to illustrate these principles.
Equivalent - Duplicate Degree Credit Not Granted: ERTH 4380
Requisites: Restricted to graduate students only.

ERTH 5410 (3) Ancient Sedimentary Environments
Analysis of sedimentary rock sequences, sedimentary environments, and stratigraphic synthesis. Formerly GEOL 5410.
Requisites: Requires prerequisite ERTH 3430 (minimum grade C-).
Additional Information: Departmental Category: Graduate Course

ERTH 5430 (3) Paleoceanography and Paleoclimatology
Examines scientific tools, data, and theories related to the dramatically varied past climate of the Earth. Focus will be on marine records of climate change and ocean circulation, but ice cores and other continental archives will also be discussed. Course covers the Cenozoic Era (66 Ma to present), but with particular emphasis on the Quaternary ice age cycles. Formerly GEOL 5430.
Recommended: Prerequisites Introductory geology and introductory oceanography or atmospheric science.
Additional Information: Departmental Category: Graduate Course

ERTH 5432 (3) Active Tectonics
Considers the physical processes that drive coseismic and interseismic strain in the upper crust on Earth. It is focused on recognition and interpretation of surface strain produced by active faulting, folding and flexure at a range of timescales. This includes defining how coseismic strain cycles act to build geologic structures while considering methods of analysis with rapidly emerging remotely sensed and geochronologic datasets to quantify strain rates for seismic hazard assessment. Formerly GEOL 5432.
Repeatable: Repeatable for up to 6.00 total credit hours.
Recommended: Prerequisite previous coursework in structural geology, geomorphology and remote sensing.
Grading Basis: Letter Grade

ERTH 5444 (3) Data Visualization for Earth and Environmental Scientists
Data fluency and visualization are highly desirable skills both inside and outside of academia. This class focuses on the power, theory, best practices, and common pitfalls of programmatic data visualization with hands-on in-class programming sessions and fun weekly data wrangling and visualization exercises using data from across the earth, environmental, and biological sciences. We¿ll be using Quarto/RMarkdown notebooks and tidyverse-style R programming for data wrangling; ggplot2 and its powerful grammar-of-graphics approach for data visualization; and Git & GitHub for code management, collaborative coding, and instructor/peer feedback.
Equivalent - Duplicate Degree Credit Not Granted: EBIO 5444 and ERTH 4444 and EBIO 4444
Requisites: Restricted to graduate students only.
Recommended: While some experience with a programming language (R, python, matlab, C++, fortran, or any other) is beneficial, students with no prior programing experience are welcome to take this course.
Grading Basis: Letter Grade

ERTH 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: ERTH 4474 and MUSM 5474
Additional Information: Departmental Category: Graduate Course

ERTH 5540 (4) Petroleum Geology
Examines the generation, migration, and accumulation of petroleum, types of petroleum hydrocarbons, sedimentary basins and petroleum systems, source rocks, trapping mechanisms, types of seals, reservoir rocks and their properties, methods of exploration and subsurface mapping, estimating resources and reserves.
Equivalent - Duplicate Degree Credit Not Granted: ERTH 4540
Recommended: Prerequisite ERTH 3120 and ERTH 3430 or instructor consent required.

ERTH 5555 (3) Topics in Macroevolution
Macroevolution extends beyond the limits of microevolution by including processes that encompass many species, in both recent and fossils organisms. Some of the topics include evolutionary novelty and innovation, developmental evolution, disparity and diversity dynamics, and extinction. We will survey case studies, methods, and the current literature. Formerly GEOL 5555.
Repeatable: Repeatable for up to 9.00 total credit hours.

ERTH 5570 (1-3) Topical Seminar - Paleobiology and Paleoenvironment
Seminar on Current Topics of Exceptional Interest Built Around a Series of Prominent Invited Speakers. Formerly GEOL 5570.
Repeatable: Repeatable for up to 3.00 total credit hours.

ERTH 5610 (2) Mammalian Micropaleontology
Studies mammalian microfossils. Methods of analysis, collection, and use in stratigraphic problems such as correlation, paleoecology, and earth history. Formerly GEOL 5610.

ERTH 5611 (3) Organic Geochemistry
Explores the ¿biomarker concept¿ as a tool to elucidate microbial, biogeochemical, and climatic processes in natural systems through three fundamental goals: a) characterization and classification of organic molecules in complex, natural mixtures; b) biosynthesis, transport, transformation, preservation and destruction of organic matter in nature; c) application of lipid biomarkers and their stable isotope composition to study biological, biogeochemical, and climatic processes in modern and ancient systems.
Equivalent - Duplicate Degree Credit Not Granted: ERTH 4611
Recommended: Prerequisites CHEM 1113 or equivalent from undergraduate degree and ERTH 5270 or ERTH 5280 or ERTH 5305 or ERTH 5675.

ERTH 5612 (3) Techniques in Organic Geochemistry
Explores the techniques in analytical chemistry and organic geochemistry for the study of lipid biomarkers in the environment, which include the following topics: a) Extraction of environmental samples and separation of lipid classes; b) Analysis of apolar lipids using gas chromatography-mass spectrometry (GC-MS); c) Determine the stable isotope composition of lipids using GC-isotope ratio-MS (GC-IR-MS); d) Analysis of polar lipids using high performance liquid chromatography-MS (HPLC-MS). Requires previous coursework in general chemistry and Organic Geochemistry. Formerly GEOL 5612.
Recommended: Prerequisites Introductory or advanced courses in organic chemistry, biochemistry, biogeochemistry, geochemistry, geomicrobiology, paleoclimate, or geology.

ERTH 5620 (5) Field Problems in Vertebrate Paleontology
Field Techniques in Study of Fossil Vertebrates and Their Host Rocks. Four Weeks Field Work, One Week Faunal Analysis. Formerly GEOL 5620.

ERTH 5630 (2) Physics of Remote Sensing
Advanced study of optical and microwave techniques used in remote sensing of the atmosphere, oceans and land with emphasis on the latter. Studies are based on recent literature and text. The course is intended for those who have completed introductory courses in remote sensing fundamentals and Digital Image Analysis. Formerly GEOL 5630.

ERTH 5640 (3) Glaciology
Explores ice physics, snow, glaciers, floating ice, ice in the ground and in the solar system. Emphasizes glaciers and ice sheets, including reconstruction of past glaciations and impacts of ice and snow on society.
Equivalent - Duplicate Degree Credit Not Granted: ERTH 4640

ERTH 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, geobiochemistry, and petroleum genesis.
Equivalent - Duplicate Degree Credit Not Granted: ERTH 4670
Additional Information: Departmental Category: Graduate Course

ERTH 5680 (3) Global Tectonics
Studies geological and geophysical aspects of plate motions along accretionary transforming, subducting, and collisional margins. Relationships of sedimentation, volcanism, metamorphism, and deformation to mountain building are studied in conjunction with examination of type areas. Formerly GEOL 5680.
Requisites: Restricted to graduate students only.

ERTH 5690 (3) Tectonic History of the Western United States
Provides students with the practical tools needed to make tectonic interpretations through study of the geologic history of the western United States and the geodynamic models used in interpreting that history. Paleomagnetism, geobarametry, geothermometry, geodynamic modeling, and elements of structural geology and stratigraphy are topics considered in this class. Formerly GEOL 5690.
Recommended: Prerequisite structural geology and at least one semester of college physics and calculus are strongly recommended.
Additional Information: Departmental Category: Graduate Course

ERTH 5700 (1-4) Earth Science Topics Seminar
Offers seminar studies in geological subjects of special current interest. Primarily for graduate students, as departmental staff and facilities permit. Formerly GEOL 5700.
Repeatable: Repeatable for up to 15.00 total credit hours. Allows multiple enrollment in term.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

ERTH 5701 (2) Super-Problems in Quaternary Climate
Investigates major problems in the study and understanding of Quaternary climate variation, in seminar format. Each year one major topic will be addressed, such as: the physics and chemistry of the Ice Age ocean circulation; the theory and mechanics of glacial/interglacial atmospheric C02 change; the origins of the 20, 40, and 100 kyr orbital (Milankovitch) climate cycles. Formerly GEOL 5701.
Recommended: Prerequisites Introductory geology and climatology, oceanography, paleoclimatology, or paleoceanography.
Additional Information: Departmental Category: Graduate Course

ERTH 5702 (1-3) Geomorphology Seminar
Explores the dynamics and forms of the earth's surface through critical reading and discussion of both classical and modern literature. Formerly GEOL 5702.
Repeatable: Repeatable for up to 10.00 total credit hours.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

ERTH 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. Formerly GEOL 5703.
Repeatable: Repeatable for up to 6.00 total credit hours.
Requisites: Restricted to graduate students only.
Grading Basis: Letter Grade
Additional Information: Departmental Category: Graduate Course

ERTH 5704 (1) Carbonates Seminar
Focuses broadly on the topic of carbonates, including sedimentology, geochemistry, and geobiology of carbonates. Each semester will have a distinct theme under these sub-topics. Students will be responsible for leading discussion on individual readings and will be able to provide input on both the theme and the individual reading selections. Upper-level ERTH majors can register with instructor approval. Formerly GEOL 5704.
Repeatable: Repeatable for up to 10.00 total credit hours.

ERTH 5705 (1-3) Seminar in Paleoclimate
Investigates major problems in the study and understanding of past climate variations as preserved in the geologic record. Course format is a seminar-style critical reading and discussion of journal articles in paleoclimatology and paleoceanography. Topical focus varies from year to year. Formerly GEOL 5705.
Repeatable: Repeatable for up to 9.00 total credit hours.
Recommended: Prerequisite prior coursework in geology, climate science, and/or paleoclimate.

ERTH 5714 (2) Field Geophysics
Applies geophysical field techniques and data interpretation to studying geological and engineering problems. Fieldwork includes seismic, gravity, magnetic and electrical measurements. Formerly GEOL 5714.
Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.
Requisites: Requires prerequisites of (ERTH 2001 or ERTH 2700) and MATH 1300 and PHYS 1110 (min grade C-). Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

ERTH 5716 (1-3) Environmental Field Geochemistry
Develops basic field skills in the most commonly performed tasks required for the environmental characterization of solid and aqueous wastes. Media of study include soils, stream sediments, surface waters, ground waters and atmospheric particulates. Formerly GEOL 5716.
Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.
Requisites: Requires prerequisites of (ERTH 2001 or ERTH 2700) and CHEM 1011 and (CHEM 1031 or CHEM 1113 or CHEM 1133) and ERTH 3320 (minimum grade C-).
Additional Information: Departmental Category: Graduate Course

ERTH 5717 (2) 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. Formerly GEOL 5717.
Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.
Requisites: Restricted to graduate students only. Requires prerequisites of (ERTH 2001 or ERTH 2700) and at least one of the following: ERTH 3120 or ERTH 3320 or ERTH 3430 (minimum grade C-).
Additional Information: Departmental Category: Graduate Course

ERTH 5718 (1-3) Paleoenvironmental Field Techniques
Includes field geophysics, environmental, structural, and stratigraphic field geology, and/or field topics in petrology, hydrology, and geomorphology. Formerly GEOL 5718.
Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

ERTH 5719 (2) Field Analysis and Tectonics of Crystalline Rocks
Introduces basic and advanced mapping tools and concepts for structural and tectonic analysis of solid-state and magmatic deformation, metamorphism, and fluid flow in igneous and metamorphic rocks. Includes some digital mapping concepts using smartpad and smartphone applications, and computer-based analysis of structure data. Includes multi-day mapping projects in the Front Range, and in western Colorado, southern Wyoming, or northern New Mexico. Also includes introductions to Precambrian tectonic history of western North America and mineral resources of Colorado.
Equivalent - Duplicate Degree Credit Not Granted: ERTH 4719
Repeatable: Repeatable for up to 4.00 total credit hours.
Requisites: Restricted to graduate students only.
Grading Basis: Letter Grade

ERTH 5721 (2) Classics and Frontiers in Hydrology
The first part of this course studies classic papers in hydrology that include development of fundamental concepts and governing principles governing water flow in subsurface. It will also include benchmark papers that define critical advances in hydrology. The second part of this course focuses on latest research front that spans from theoretical and modeling studies to measuring and monitoring technologies. Formerly GEOL 5721.
Requisites: Restricted to graduate students only.
Grading Basis: Letter Grade

ERTH 5725 (1-4) Field Based Special Topics in Earth Science
Explores selected geological subjects of special interest in a field setting.
Equivalent - Duplicate Degree Credit Not Granted: ERTH 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

ERTH 5755 (2) Field Geobiology
Provides students technical fieldwork skills in the interdisciplinary field of geobiology, spanning modern environments and to ancient environments in preserved in rock record, and spanning techniques from geochemistry, environmental microbiology, and sedimentology. Formerly offered as a special topics course.
Equivalent - Duplicate Degree Credit Not Granted: ERTH 4755
Repeatable: Repeatable for up to 8.00 total credit hours.

ERTH 5775 (3) Introduction to Numerical Modeling in Geoscience
Numerical models play an essential role across the geosciences, with applications that include hypothesis exploration, data interpretation, and prediction. This course provides a hands-on introduction to numerical modeling. Students learn scientific programming and modeling concepts by iterating through a series of model-development assignments in Python and Matlab. Applications span a range of topics in the geosciences, with emphasis on physical processes that involve mass, energy, and/or momentum transport. Formerly GEOL 5775.

ERTH 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

ERTH 5820 (3) Origin and Evolution of Planetary Systems
Considers the origin and evolution of planetary systems, including proto-planetary 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
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

ERTH 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: ATOC 5830 and ASTR 5830
Repeatable: Repeatable for up to 9.00 total credit hours.
Additional Information: Departmental Category: Graduate Course

ERTH 5833 (3) Teaching and Learning Earth Systems
Learn and develop pedagogically effective strategies for teaching and understanding Earth Science concepts. Particular emphasis is placed on understanding the importance of geoscience habits of mind (i.e. spatial/temporal reasoning, multiple working hypotheses, geographic context). The course focuses upon inquiry and evaluation of evidence, the importance of background knowledge and misconceptions and developing effective discourse within and outside the classroom.
Equivalent - Duplicate Degree Credit Not Granted: EDUC 4833 and ERTH 4833 and EDUC 5833
Requisites: Restricted to graduate students only.
Grading Basis: Letter Grade

ERTH 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. Department enforced prerequisite: senior level undergraduate physics.
Equivalent - Duplicate Degree Credit Not Granted: ATOC 5835 and ASTR 5835
Repeatable: Repeatable for up to 4.00 total credit hours.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

ERTH 5862 (1-4) Earth Science Independent Study
Students may not enroll in this course without completing the Independent Study Application.
Equivalent - Duplicate Degree Credit Not Granted: ERTH 4862
Repeatable: Repeatable for up to 7.00 total credit hours. Allows multiple enrollment in term.

ERTH 5910 (3) Geothermodynamics
Provides a solid foundation in chemical thermodynamic concepts and calculations as applied to geochemistry and geobiology. Formerly GEOL 5910.

ERTH 5951 (3) Climatic Change Seminar
Cross-Disciplinary Survey of the Evidence for and Theories of Climatic Change. Formerly GEOL 5951.

ERTH 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

ERTH 6241 (1-3) Seminar in Hydrology and Geomorphology
Emphasizes process-oriented research in hydrology andgeomorphology. Sample topics include river mechanics, snow hydrology, and periglacial processes.
Equivalent - Duplicate Degree Credit Not Granted: GEOG 6241
Repeatable: Repeatable for up to 6.00 total credit hours.
Additional Information: Departmental Category: Graduate Course

ERTH 6270 (3) Thermodynamics for Petrologists 2
Advanced Topics in Thermodynamics, Emphasizing Properties of Electrolyte Solutions at Low and High Temperature; Thermodynamics of Silicate Melts; Experimental Methods for Determining Activity Coefficients in Gaseous, Liquid, and Crystalline Solutions; and Linear Algebra Techniques for Manipulation of Multicomponent Rock Compositions. Formerly GEOL 6270.

ERTH 6310 (3) Sedimentary Petrology
Covers interpretation of depositional and diagenetic history of sedimentary rocks as determined from thin-section studies. Formerly GEOL 6310.
Requisites: Requires prerequisites of ERTH 3010 and ERTH 3020 and ERTH 3430 (minimum grade C-).
Additional Information: Departmental Category: Graduate Course

ERTH 6320 (3) Sedimentary Petrology 2
Interpretation of Depositional and Diagenetic History of Seidmentary Rocks as Determined from Thin-Section Studies. Formerly GEOL 6320.

ERTH 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. Formerly GEOL 6330.
Requisites: Restricted to graduate students only.
Recommended: Prerequisite introductory undergraduate physics and ERTH 3430.
Additional Information: Departmental Category: Graduate Course

ERTH 6610 (3) Earth and Planetary Physics 1
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

ERTH 6620 (3) Earth and Planetary Physics 2
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

ERTH 6630 (3) Earth and Planetary Physics 3
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

ERTH 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

ERTH 6655 (3) InSAR Processing and Interpretation
Understand the concepts and applications of interferometric synthetic aperture radar (InSAR) and differential InSAR, to include an introduction to physical geodesy and satellite techniques.
Equivalent - Duplicate Degree Credit Not Granted: PHYS 6655
Grading Basis: Letter Grade

ERTH 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.
Equivalent - Duplicate Degree Credit Not Granted: PHYS 6670
Recommended: Prerequisites a course in calculus and a course in computer programming (any language).
Additional Information: Departmental Category: Graduate Course

ERTH 6690 (3) Advanced Seismology
Students will learn about advanced seismology. Formerly GEOL 6690.

ERTH 6940 (1) Master's Candidate for Degree
Registration intended for students preparing for a thesis defense, final examination, culminating activity, or completion of degree. Formerly GEOL 6940.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

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

ERTH 6960 (1-3) Plan II Master's Research
The Plan II program requires at least 3 credit hours of ERTH 6960 (Plan II Master¿s Research) under the supervision of the advisory committee. Formerly GEOL 6960.
Additional Information: Departmental Category: Graduate Course

ERTH 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. Formerly GEOL 8990.
Repeatable: Repeatable for up to 30.00 total credit hours.
Additional Information: Departmental Category: Graduate Course

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: Requisite a course in basic chemistry and a course in 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 paleooceanographic 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.
Requisites: 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 (1-3) 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 prerequisite: MATH 2300 or Fortran.
Additional Information: Departmental Category: Graduate Course

GEOL 5125 (3) Communicating Earth Science with the Public
Introduces research on science communication and discusses examples drawn from geoscience. Students apply research on science communication to conceptualizing how to communicate about their specific geoscience research to the public in different contexts. Students should be familiar enough with their area of graduate research in geoscience to apply different models of science communication to it.
Requisites: Restricted to graduate students only.

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.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

GEOL 5660 (3) Sedimentology & Geobiology of Carbonates
Carbonate sedimentary rocks are a significant component of the geobiological rock record, capturing a history of organisms and the environments they inhabit. This course will focus on how carbonate sediments are formed, deposited, and lithified and what influences the preservation and alteration of textural and geochemical signals. We will cover facies identification, interpreting depositional environment, and carbonate geochemistry, with a particular emphasis on recent advances and unanswered questions at the intersection of carbonates and geobiology, including the role of microbial carbonate precipitation and/or dissolution in the formation and degradation of stromatolites, carbonate mud, ooids, etc.
Equivalent - Duplicate Degree Credit Not Granted: GEOL 4660
Recommended: Prerequisite prior coursework in Sedimentology.

GEOL 5675 (3) Stable Isotopes in Paleoclimate and Paleoecology
Explores the use of stable isotope geochemistry for research questions in paleoclimatology and paleoecology. Covers physical and biological drivers of isotopic fractionation, systematics and applications of light elements such as carbon, nitrogen, oxygen, hydrogen, sulfur and boron and some less traditional isotopic systems. Applications include marine and terrestrial paleoclimate proxies and some uses for ecology and paleoecology.
Equivalent - Duplicate Degree Credit Not Granted: GEOL 4675
Grading Basis: Letter Grade
Additional Information: Departmental Category: Graduate Course

GEOL 5711 (1-3) Igneous and Metamorphic Field Geology
Applies field techniques to interpretation of igneous and metamorphic rocks. Field exercises and lectures focus on collecting data required to map igneous and metamorphic rock units. Department enforced prerequisites: restricted to graduate students only and GEOL 2001 or GEOL 2700 and GEOL 3020.
Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.
Additional Information: Departmental Category: Graduate Course

GEOL 5712 (1-3) Structural Field Geology
Methods of field study of structure of rocks, including observations, data collection and interpretation to understand geometry of deformation and causative processes and kinematics. Field projects are mapped using different scales, air photos, topographic maps and compass and tape. Department enforced prerequisites: GEOL 2001 or GEOL 2700 and GEOL 3020.
Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.
Additional Information: Departmental Category: Graduate Course

GEOL 5715 (1-3) Field Techniques in Surficial Geology and Geohydrology
Introduces various field techniques and data analysis methods in hydrogeologic studies for students in geology, environmental studies, geography and civil engineering. Exercises include mapping ground water levels, conducting slug and pumping tests, measuring steam flows, interpreting aquifer parameters from geophysical measurements and using field data for water budget analysis. Department prerequisite: GEOL 2001 or GEOL 2700.
Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.
Additional Information: Departmental Category: Graduate Course

GEOL 5747 (3) Unconventional Resources
To introduce the concepts, principles, methods, and techniques of unconventional reservoirs. Unconventional reservoirs can be defined informally as those reservoirs that need artificial stimulation to produce. Accumulations in conventional traps are due to buoyancy. Seven common kinds of unconventional reservoirs: tight-gas sandstones, shale gas, shale oil, coal-bed methane, heavy-oil sands, oil shale, gas hydrates. Formerly offered as a special topics course.
Equivalent - Duplicate Degree Credit Not Granted: GEOL 4747

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-Geochemistry
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
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Repeatable: Repeatable for up to 7.00 total credit hours.
Requisites: Restricted to graduate students only.
Additional Information: Departmental Category: Graduate Course

GEOL 5849 (1-3) Independent Study-Paleontology
Repeatable: Repeatable for up to 7.00 total credit hours.
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 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