GEOLOGICAL SCIENCES

The options available in the undergraduate program in geological sciences are geology and geophysics and lead to the BA degree. Both options provide a strong basis for understanding the functioning of the Earth system. Students who are uncertain as to which option best suits their needs should contact a departmental advisor or faculty member. In each option, the undergraduate program emphasizes course work in theoretical, laboratory and field-oriented aspects of the geological sciences. The nearby Rocky Mountains provide a natural laboratory for many of these courses.

Students interested in the geological sciences may also wish to consider the Baker Residential Academic Program (see the Undergraduate Residential Programs section). Students who do not wish to pursue a career in the geosciences, or who would like to combine a basic knowledge of geologic sciences with that of some other field, should consider using geological sciences as one subject in a distributed studies major or as a minor. Students who intend to pursue graduate study in the geological sciences are encouraged to consider developing an honors thesis as part of their undergraduate studies.

The two options available in the undergraduate major offer different focus areas of instruction. Both options offer excellent preparation for students interested in pursuing professional careers, or graduate study, in the geological sciences.

Each option emphasizes knowledge in:

- the ways in which Earth responds to internal and external forces; the physical, chemical and biological evolution of Earth; and the nature of the materials of which the Earth is made
- the role of physics, chemistry, mathematics and biology in understanding geological processes
- the history of discoveries and ideas that have contributed to our current knowledge of Earth and the planetary system

Course code for this program is GEOL.

Geology Honors Program

Opportunity is provided for qualified geology majors to participate in the geology honors program and graduate with honors (cum laude, magna cum laude or summa cum laude) in geology. Students interested in the honors program should contact the departmental honors advisor during their junior year.

Bachelor's Degree

- Geology - Bachelor of Arts (BA) (catalog.colorado.edu/undergraduate/colleges-schools/arts-sciences/programs-study/geological-sciences/geology-bachelor-arts-ba)

Minor

- Geology - Minor (catalog.colorado.edu/undergraduate/colleges-schools/arts-sciences/programs-study/geological-sciences/geology-minor)

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)
Senior Instructor

Anderson, Robert S (https://experts.colorado.edu/display/fisid_130117)
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 (https://experts.colorado.edu/display/fisid_101963)
Professor; PhD, University of Texas at Austin

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

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

Eicher, Don L.
Professor Emeritus

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)
Associate Professor; PhD, Massachusetts Institute of Technology

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

Goetz, F. H. Alexander
Professor Emeritus

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

Jakosky, Bruce M (https://experts.colorado.edu/display/fisid_105845)
Professor; PhD, California Institute of Technology

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

Kraus, Mary J (https://experts.colorado.edu/display/fisid_100903)
Professor; PhD, University of Colorado Boulder

Larson, Edwin E.
Professor Emeritus
Lester, Alan P.  (https://experts.colorado.edu/display/fisid_105385)
Lecturer; PhD, University of Colorado Boulder

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

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

Miller, Gifford Hubbs  (https://experts.colorado.edu/display/fisid_102374)
Professor; PhD, University of Colorado Boulder

Mojzsis, Stephen J  (https://experts.colorado.edu/display/fisid_118484)
Professor; PhD, University of California-San Diego

Molnar, Peter Hale  (https://experts.colorado.edu/display/fisid_114528)
Professor; PhD, Columbia University In the City of New York

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

Munoz, James L.
Professor Emeritus

Robinson, Peter
Professor Emeritus

Runnells, Don
Professor Emeritus

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

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

Smyth, Joseph R  (https://experts.colorado.edu/display/fisid_101056)
Professor; PhD, University of Chicago

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

Spetzler, Hartmut A. W.
Professor Emeritus

Stern, Charles R  (https://experts.colorado.edu/display/fisid_100941)
Professor; PhD, University of Chicago

Syvitski, James P  (https://experts.colorado.edu/display/fisid_107424)
Professor; PhD, Univ of British Columbia (Canada)

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

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

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

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

Walker, Theodore R.
Professor Emeritus

Weimer, Paul  (https://experts.colorado.edu/display/fisid_104630)
Professor; PhD, University of Texas at Austin

White, James  (https://experts.colorado.edu/display/fisid_102726)
Professor; PhD, Columbia University In the City of New York

**GEOL 1010 (3) Introduction to Geology**

Introductory geology for majors and non-majors. Studies Earth, its materials, its characteristics, its dynamic processes, and how it relates to people. Separate lab (GEOL 1030) is recommended.

**Additional Information:** GT Pathways: GT-SC2 - Natural Physical Sci Lec Crse w/o Req Lab
Arts Sci Core Curr: Natural Science Sequence
Arts Sci Core Curr: Natural Science Non-Sequence
MAPS Course: Natural Science

**GEOL 1020 (3) Introduction to Earth History**

Examines how Earth’s interior and surface, the atmosphere and climate, the oceans, and life interact and have changed over the immensity of geologic time. For majors and non-majors. Separate lab (GEOL 1030) is recommended.

**Equivalent - Duplicate Degree Credit Not Granted:** GEOL 1040

**Requisites:** Requires prerequisite course of GEOL 1010 (minimum grade D-).

**Additional Information:** GT Pathways: GT-SC2 - Natural Physical Sci Lec Crse w/o Req Lab
Arts Sci Core Curr: Natural Science Sequence
Arts Sci Core Curr: Natural Science Non-Sequence

**GEOL 1030 (1) Introduction to Geology Laboratory 1**

Features field trips to local points of geologic interest. Studies rocks and topographic and geologic maps. Meets the MAPS requirement for natural science lab, if taken with GEOL 1010.

**Recommended:** Requisite prior or current registration in 1000-level geology course.

**Additional Information:** GT Pathways: GT-SC2 - Natural Physical Sci Lec Crse w/ Req Lab
Arts Sci Core Curr: Natural Science Lab
Arts Sci Core Curr: Natural Science Non-Sequence

**GEOL 1040 (3) Geology of Colorado**

Reviews the geologic evolution and history of Colorado. It first develops the basic concepts needed to interpret the geology and then systematically shows how the state evolved through geologic time.

**Recommended:** Separate lab (GEOL 1030) is recommended.

**Equivalent - Duplicate Degree Credit Not Granted:** GEOL 1020

**Additional Information:** Arts Sci Core Curr: Natural Science Sequence

**GEOL 1060 (3) Global Change: An Earth Science Perspective**

Focuses on evidence for planetary warming, climate change, glacier and ice-sheet melting and sea level rise both now and in the recent past.

Attempts to develop understanding of the interactions within the coupled Earth system that regulate such changes. Utilizes examples from the geological and instrumental records, and evaluates the global warming forecast. Department enforced prerequisite: GEOL 1010 (minimum grade D-).

**Equivalent - Duplicate Degree Credit Not Granted:** ATOC 1060

**Additional Information:** Arts Sci Core Curr: Natural Science Sequence
Arts Sci Core Curr: Natural Science Non-Sequence
MAPS Course: Natural Science
**GEOL 2001 (4) Planet Earth**
Explores the dynamics of planet Earth with particular emphasis on the factors that make the planet habitable. Includes examination of heat balance, hydrology, geomorphology, biogeochemistry and climate history through both lecture and lab-based activities. Required for the Geology major; introduces students to the major concepts in contemporary Earth system science.  
**Requisites:** Requires prerequisite course of GEOL 1010 or GEOL 2100 or ENVS 1000 (minimum grade D-).  

**GEOL 2005 (4) Introduction to Earth Materials**
Provides introduction to the classification, composition and properties of the materials that compose the Earth, how these materials are studied, and how they are used to interpret Earth history and processes. Required for the Geology major.  
**Requisites:** Requires prerequisite courses of GEOL 1010 or GEOL 2100 and CHEM 1113 and CHEM 1114 (all minimum grade D-).  

**GEOL 2040 (3) The Search for Life in the Universe**
Introduces the scientific basis for the possible existence of life elsewhere in the universe. Includes origin and evolution of life on Earth and the search for evidence of life in our solar system, including Mars and Jupiter's moon Europa. Discusses the conditions necessary for life and whether they might arise on planets around other stars.  
**Equivalent - Duplicate Degree Credit Not Granted:** ASTR 2040  
**Additional Information:** Arts Sci Core Curr: Natural Science Non-Sequence  

**GEOL 2100 (3) Environmental Geology**
Introduces the influences of geologic processes on human lives and the changes human actions cause in geologic systems. Uses examples and case studies from Colorado and the West.  
**Additional Information:** Arts Sci Core Curr: Natural Science Non-Sequence  

**GEOL 2700 (2) Introduction to Field Geology**
Introduces basic field techniques necessary to collect geologic data and samples, and necessary to map geologic units.  
**Requisites:** Requires prerequisite courses of GEOL 1010 and GEOL 1030 and GEOL 2005 (all minimum grade D-).  

**GEOL 3010 (3) Introduction to Mineralogy**
Covers origin, occurrence, identification, classification, and uses of minerals with emphasis on applications of mineralogy to economic geology and petrology. Two lectures and one lab per week.  
**Requisites:** Requires prerequisite courses of CHEM 1113 and CHEM 1114 and GEOL 2005 and MATH 1300 or APPM 1350 (all minimum grade D-).  
**Recommended:** Prerequisite GEOL 2005.  

**GEOL 3020 (3) Petrology**
Studies field relations, petrography, petrology, chemistry, and origins of igneous and metamorphic rocks by means of lectures, reading, and lab and field experience. Labs include instruction in the fundamentals of optical petrography and the study of rocks in thin section.  
**Requisites:** Requires prerequisite course of GEOL 2005 or GEOL 3010 (minimum grade D-).  

**GEOL 3023 (4) Statistics for Geography**
Introduces parametric and distribution-free statistics, emphasizing applications to earth science problems.  
**Equivalent - Duplicate Degree Credit Not Granted:** GEOG 3023  

**GEOL 3030 (3) Introduction to Hydrogeology**
Introduces groundwater flow concepts, hydrologic cycle, physical and chemical properties, flow net, hydraulic potential, geologic controls on heterogeneity and anisotropy, aquifers and aquitards in a geologic system, saturated and unsaturated flow, flow to a well, pumping tests, and role of groundwater in geologic processes.  
**Requisites:** Requires prerequisite courses of GEOL 1010 and MATH 1300 or APPM 1350 (all minimum grade D-).  

**GEOL 3040 (3) Global Change: The Recent Geological Record**
Geological records in lakes, oceans, deserts, and around glaciers indicate the significant changes in the global systems that have taken place over the last few hundred or thousand years. Explores the timing and nature of these changes. Department enforced prerequisites: any two-course sequence of natural science core courses.  
**Equivalent - Duplicate Degree Credit Not Granted:** GEOG 4070  
**Additional Information:** Arts Sci Core Curr: Natural Science Non-Sequence  

**GEOL 3060 (3) Hydrology**
Explores the dynamics of planet Earth with particular emphasis on the factors that make the planet habitable. Includes examination of heat balance, hydrology, geomorphology, biogeochemistry and climate history through both lecture and lab-based activities. Required for the Geology major; introduces students to the major concepts in contemporary Earth system science.  
**Requisites:** Requires prerequisite course of GEOL 1010 or GEOL 2100 or ENVS 1000 (minimum grade D-).  

**GEOL 3070 (3) Introduction to Oceanography**
Explores Earth's dynamic oceans. Discusses the disciplines of oceanography including marine geology, chemistry, biology and physical oceanography with emphasis on global change. Specific topics may include: tectonics, currents, biogeochemical cycles, ecology and global warming.  
**Equivalent - Duplicate Degree Credit Not Granted:** ATOC 3070  
**Recommended:** Prerequisite any 1000-level ATOC or GEOL course or ATOC major.  
**Additional Information:** Arts Sci Core Curr: Natural Science Non-Sequence  

**GEOL 3080 (3) Intro to Hydrogeology**
Introduces groundwater flow concepts, hydrologic cycle, physical and chemical properties, flow net, hydraulic potential, geologic controls on heterogeneity and anisotropy, aquifers and aquitards in a geologic system, saturated and unsaturated flow, flow to a well, pumping tests, and role of groundwater in geologic processes.  
**Requisites:** Requires prerequisite courses of GEOL 1010 and MATH 1300 or APPM 1350 (all minimum grade D-).  

**GEOL 3090 (3) Developing Scientific Writing Skills**
Focuses on the development of scientific writing skills. Enhances student ability to write professionally, revise text and review the work of others. Writing assignments integrate the subject matter of different topics in earth science. Department enforced prerequisites: a lower division writing course and one of the following: GEOL 2001 or GEOL 2005 or GEOL 2700 or GEOL 3010 or GEOL 3030 or GEOL 3120 or GEOL 3320 or GEOL 3430 or GEOL 3820.  
**Additional Information:** Arts Sci Core Curr: Written Communication  

**GEOL 3100 (3) Structural Geology**
Introduces the basic principles and processes involved in deformation of natural rocks and minerals and the techniques used to analyze a variety of common geological structures (e.g., fractures, folds, fault zones).  
**Requisites:** Requires prerequisite course of GEOL 1010 and GEOL 2005 (minimum grade D-).  
**Recommended:** Prerequisite GEOL 2001.  

**GEOL 3130 (3) Global Warming: Understanding the Forecast**
Uses the example of man-made climate change to develop an analytical understanding of the Earth system (solid, fluid, and living) that can be used to interpret the complex and uncertain forecast. Emphasis is given to the concepts of forcing, feedback and response in order to examine natural vs. man-made environmental changes and climate change mitigation strategies.
GEOL 3300 (3) Extraterrestrial Life
Discusses the scientific basis for the possible existence of extraterrestrial life. Includes origin and evolution of life on Earth; the possibility of life elsewhere in the solar system, including Mars; and the possibility of life on planets around other stars. Department enforced prerequisite: one-year sequence in a natural science.
Equivalent - Duplicate Degree Credit Not Granted: ASTR 3300

GEOL 3230 (3) Introduction to Geochemistry
Introduces chemical principles as applied to geologic processes. Includes an introductory discussion of mineral and rock chemistry, aqueous geochemistry, and organic geochemistry.
Requisites: Requires prerequisite courses of CHEM 1113 and CHEM 1114 and MATH 1300 or APPM 1350 (all minimum grade D-).

GEOL 3410 (3) Paleobiology
Surveys morphology, ecology and evolution of ancient animal and plant life and their interactions on Earth. Fossils used to solve geological and biological problems. Department enforced prerequisites: GEOL 1010 and GEOL 1020 or GEOL 2005 or EBIO 1030 and EBIO 1210 and EBIO 1220.

GEOL 3430 (4) Sedimentology and Stratigraphy
Introduces the study of sedimentary rocks emphasizing their origin, characteristics, and interpretation; and the principles and techniques for establishing the temporal order and spatial distribution of sedimentary layers.
Requisites: Requires prerequisite course of GEOL 2005 or GEOL 3010 (minimum grade D-).
Additional Information: Departmental Category: Geology

GEOL 3520 (3) Energy & Climate Change: An Interdisciplinary Approach
Examines sources of energy and other resources in light of their availability, use, environmental impact, as well as their impact on policy, economics and values. As fossil fuels are the dominant energy source today, particular emphasis is placed on climate impacts and the carbon cycle. All material is assessed through the lenses of the physical sciences, policy, ethics and economics. Department enforced prerequisite: a two-course sequence in any natural science.
Equivalent - Duplicate Degree Credit Not Granted: ENVS 3520
Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.
Additional Information: Arts Sci Core Curr: Natural Science Non-Sequence

GEOL 3540 (3) Introduction to Petroleum Geology
Discusses the origin and distribution of conventional and unconventional petroleum resources, source rocks, types of traps and seals, reservoir rock properties, exploration methods (seismic data analysis and interpretation, formation evaluation, subsurface mapping), reservoir characterization and modeling, reserves calculations. Department enforced prerequisite: GEOL 1010.
Recommended: Corequisite GEOL 3430.
Additional Information: Departmental Category: Geology

GEOL 3720 (3) Evolution of Life: The Geological Record
Discusses the evolution of life on Earth, beginning with the earliest origins and surveying the major steps that led to the rise of higher plants and animals. Covers modern ideas on the causes of periodic mass extinctions in both the marine and terrestrial realms. Emphasizes geologic evidence for the pathways of evolution, using examples from the ordinary to the bizarre.
Additional Information: Arts Sci Core Curr: Natural Science Non-Sequence

GEOL 3820 (4) The Fluid Earth
Examines the myriad forms of fluid behavior found on Earth, from the atmosphere to the inner core. Explores how basic principles of fluid physics may be used to understand a broad range of earth processes, including mantle convection, atmosphere and ocean dynamics, stream flow, lava spreading, and glacier motion, among others. Covers fundamental fluid concepts such as viscosity, pressure, convection, friction, and free-surface flow. Department enforced prerequisites: MATH 1300 or APPM 1340 and APPM 1345 or APPM 1350.
Recommended: Prerequisites GEOL 1010 and PHYS 1110.

GEOL 3930 (1-6) Internship
Offers an academically supervised opportunity for geological sciences majors to work with public or private organizations. Projects are usually associated with students’ career goals; each project has an academic emphasis. Department enforced prerequisites: restricted to students with 57-180 credits (Juniors or Seniors) and completion of at least two courses (minimum grade B) for geology majors.

GEOL 3950 (3) Natural Catastrophes and Geologic Hazards
Surveys historic and prehistoric natural disasters, their cause and potential for recurrence. Meteorite impact, earthquakes, volcanic eruptions, tsunamis, landslides, floods, magnetic reversals and major extinction events. Department enforced prerequisite: one year of science.
Additional Information: Arts Sci Core Curr: Natural Science Non-Sequence

GEOL 4060 (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. Department enforced prerequisite: one semester chemistry or physics or geology.
Equivalent - Duplicate Degree Credit Not Granted: GEOL 5060

GEOL 4070 (3) Paleoclimatology
Covers the primary forcings and feedbacks that determine Earth's energy balance and the resultant climate system on decadal to millennial time scales. Covers ocean/atmosphere circulation, the role of ice sheets in the climate system, monsoons, Holocene climate change and 20th Century warming. Includes coverage of the proxies available to reconstruct climates of the past and the archives that contain these proxies. Department enforced prerequisite: environmental science or geology introduction sequence courses.
Equivalent - Duplicate Degree Credit Not Granted: GEOL 3040
Recommended: Prerequisite natural science majors only.

GEOL 4093 (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 5093 and GEOG 4093 and GEOG 5093

GEOL 4130 (3) Principles of Geophysics
Provides an introduction to fundamental geophysics including seismology, geomagnetism, gravity, radiometric dating, and heat flow with applications to plate tectonics and exploration of the subsurface.
Requisites: Requires prerequisite courses of MATH 1300 or APPM 1350 and PHYS 1110 and GEOL 1010 (all minimum grade D-).
GEOL 4150 (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 5150

GEOL 4160 (3) Introduction to Biogeochemistry
Covers fundamentals of biogeochemical cycling, emphasizing water, carbon and nutrient dynamics in terrestrial ecosystems; chemical interactions of atmosphere, biosphere, lithosphere and hydrosphere; natural and human-managed environments. Department enforced prerequisites: GEOL 3320 or EBIO 3270 and CHEM 1011.
Equivalent - Duplicate Degree Credit Not Granted: EBIO 4160 and ENVS 4160

GEOL 4215 (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 5215

GEOL 4241 (4) Principles of Geomorphology
Studies weathering, mass-wasting, fluvial, wind, and marine processes and the resulting landforms.
Equivalent - Duplicate Degree Credit Not Granted: GEOG 4241
Requisites: Requires prerequisite course of GEOG 1011 or GEOL 1010 and MATH 1300 or APPM 1350 or APPM 1340 and APPM 1345 (all minimum grade D-).
Additional Information: Arts Sci Core Curr: Natural Science Non-Sequence

GEOL 4270 (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 5270
Requisites: Restricted to students with 57-180 credits (Juniors or Seniors).
Recommended: Prerequisites introductory chemistry, introductory geology, introductory oceanography.

GEOL 4330 (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: upper-division undergraduate standing in physical science and upper-division undergraduate chemistry or physics or math courses.
Equivalent - Duplicate Degree Credit Not Granted: GEOL 5330 and ASTR 4330 and ASTR 5330

GEOL 4474 (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. Department enforced prerequisites: GEOL 1010 and GEOL 1020 and GEOL 3410.
Equivalent - Duplicate Degree Credit Not Granted: GEOL 5474
Requisites: Restricted to students with 57-180 credits (Juniors or Seniors).

GEOL 4500 (3) Critical Thinking in the Earth Sciences
Deals with controversies within the broad realm of geological sciences, including planetary geology, evolution, paleobiology, global change, environmental issues, plate tectonics, resources, other societal problems, or geologic thought in general. Students are provided the opportunity to analyze and debate scientific issues in the earth sciences. Department enforced prerequisites: GEOL 1010 and GEOL 1030 and GEOL 2001 or GEOL 2005 or GEOL 2700 (minimum grade D-).
Repeatable: Repeatable for up to 6.00 total credit hours.

GEOL 4550 (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. Department enforced prerequisites: GEOL 1010 and GEOL 3430.
Equivalent - Duplicate Degree Credit Not Granted: GEOL 5550
Requisites: Restricted to students with 57-180 credits (Juniors or Seniors).

GEOL 4670 (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, geobiocemistry, and petroleum genesis.
Equivalent - Duplicate Degree Credit Not Granted: GEOL 5670
Requisites: Requires prerequisite a course of MATH 1300 or APPM 1350 (minimum grade D-).

GEOL 4675 (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 5675
Grading Basis: Letter Grade

GEOL 4700 (1-4) Special Geological Topics
Studies in selected geological subjects of special current interest (for undergraduates).
Repeatable: Repeatable for up to 9.00 total credit hours. Allows multiple enrollment in term.
Requisites: Restricted to students with 57-180 credits (Juniors or Seniors).
GEOL 4711 (2) 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.
**Requisites:** Requires prerequisite courses of GEOL 3020 and GEOL 2001 or GEOL 2700 (all minimum grade D-).

GEOL 4712 (2) Structural Field Geology
Explores 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.
**Requisites:** Requires prerequisite courses of GEOL 2700 and GEOL 3120 (all minimum grade D-).

GEOL 4714 (2) Field Geophysics
Applies geophysical techniques and data interpretation to studying geological and engineering problems. Fieldwork includes seismic, gravity, magnetic, and electrical measurements.
**Requisites:** Requires prerequisite courses of GEOL 2001 or GEOL 2700 and MATH 1300 and PHYS 1110 (all minimum grade D-).

GEOL 4715 (2) Field Techniques in Hydrogeology
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 stream flows, interpreting aquifer parameters from geophysical measurements, and using field data for water budget analysis.
**Requisites:** Requires prerequisite courses of GEOL 3030 and GEOL 2001 or GEOL 2700 (all minimum grade D-).

GEOL 4716 (2) 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.
**Requisites:** Requires prerequisite courses of GEOL 2001 or GEOL 2700 and GEOL 3320 and CHEM 1011 and CHEM 1031 or CHEM 1113 and CHEM 1133 (all minimum grade D-).

GEOL 4717 (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.
**Requisites:** Requires prerequisite courses of GEOL 2001 or GEOL 2700 and GEOL 3120 or GEOL 3320 or GEOL 3430 or GEOL 4241 (all minimum grade D-).

GEOL 4721 (2) Field Methods in Active Tectonics
Analysis of active geologic structures, including strike slip fault systems, secondary structures in stepovers and related eruptive centers. Includes the use of digital imagery, elevation models, offset geomorphic features and Quaternary deposits to determine local deformation rates and their relation to plate motions.
**Requisites:** Requires prerequisite courses of GEOL 2700 and GEOL 3120 (all minimum grade D-).
**Recommended:** Prerequisite GEOL 4712.

GEOL 4725 (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 5725
**Repeattable:** Repeatable for up to 8.00 total credit hours. Allows multiple enrollment in term.
**Grading Basis:** Letter Grade