

GEOL - GEOLOGY

GEOL 609 Field Geology

Credits 1 to 6. 1 to 6 Other Hours. Individual instruction in advanced and specialized field methods, geologic interpretation and field evaluation procedures. Choice of topics and locations of field studies will vary depending upon individual and specific needs. **Prerequisite:** GEOL 300 or approval of instructor.

GEOL 610 Field Methods in Hydrogeology

Credits 3. 1 Lecture Hour. 6 Lab Hours. Field methods in hydrogeology; including ground water drilling technology and law; investigation and planning of well sites; installation of ground water wells; field testing of aquifer properties and analysis of field data. Field trips may be required for which departmental fees may be assessed to cover costs. **Prerequisite:** GEOL 410 or approval of instructor.

GEOL 611 Tracers in Hydrogeology

Credits 3. 3 Lecture Hours. Discussion and practice on the use of natural and artificial tracers to quantify physical, chemical and biological processes that occur in aquifers; examination of the processes that alter water quantity and quality. **Prerequisites:** GEOL 410 or equivalent.

GEOL 612 Structural Geology

Credits 3. 3 Lecture Hours. Mechanical principles important to structural geology and experimental results relating to rock deformation followed by applications to natural deformation; mechanisms, rather than geometries. Primarily for students not concentrating in structural geology but who desire an advanced general course. **Prerequisite:** Approval of instructor.

GEOL 613 Global Tectonics

Credits 3. 3 Lecture Hours. Investigation of global plate tectonic system as expressed along key plate margins in modern and ancient settings; includes literature review, individual and group exercises, student presentations, and an optional field trip to southern Peru. **Prerequisites:** GEOP 628 or approval of instructor.

GEOL 614 Advanced Hydrogeology

Credits 3. 2 Lecture Hours. 2 Lab Hours. Geologic conditions determining the distribution and movement of ground water and their effect on the hydrologic properties of aquifers. **Prerequisites:** MATH 151 and MATH 152, or equivalent.

GEOL 616 Petroleum Systems Analysis and Basin Modeling

Credits 3. 3 Lecture Hours. Geological processes in sedimentary basins; petroleum system elements and modeling; hydrocarbon generation, expulsion, migration, accumulation; fluid analysis; multi-disciplinary data integration; basin modeling software and simulation.

GEOL 617 Introduction to the Petroleum Industry

Credits 3. 3 Lecture Hours. Introduction to the petroleum industry and geoscience issues associated with the full petroleum cycle from resource discovery to marketing of refined petroleum products; focuses on the role of geoscientists in all facets of the business. **Prerequisite:** Graduate classification or approval of instructor.

GEOL 619 Petroleum Geology

Credits 3. 3 Lecture Hours. Properties of reservoir rocks; origin, migration and accumulation of petroleum; geologic interpretation of borehole logs and fluid-pressure measurements and the role of hydrostatic and hydrodynamic pressures in oil accumulation. **Prerequisite:** Graduate classification.

GEOL 621 Contaminant Hydrogeology

Credits 3. 3 Lecture Hours. Physical concepts of mass transport; dispersion; diffusion; advection; geochemical processes including surface reaction; hydrolysis; biodegradation; aspects of modeling; process and parameter; and remediation. **Prerequisite:** GEOL 410 or equivalent or approval of instructor.

GEOL 622 Stratigraphy

Credits 3. 3 Lecture Hours. Principles for correlating and naming stratigraphic units; controls on stratigraphic development (sediment supply, base-level change, subsidence, climate, and compaction); principles and application of sequence stratigraphy; subsurface stratigraphy; facies analysis and stratigraphic architecture. **Prerequisite:** Graduate classification or approval of instructor.

GEOL 623 Carbonate Rocks

Credits 3. 3 Lecture Hours. Principles of carbonate sedimentology; carbonate depositional sequences defined in modern environments and utilized to interpret the rock record; introduction to depositional and diagenetic microfacies; shelves, ramps and isolated platforms and their tectonosedimentary significance; suggested for geoscience majors. **Prerequisites:** A basic understanding of sedimentology and the associated terminology; graduate classification.

GEOL 624 Carbonate Reservoirs

Credits 3. 3 Lecture Hours. Recognition and description of hydrocarbon reservoirs in carbonate rocks; classification of carbonate porosity; capillary pressure curves and pore types; pore characteristics as proxies for permeability in reservoir modeling; techniques for mapping flow units. **Prerequisites:** Graduate classification and approval of instructor.

GEOL 625 Applied Ground Water Modeling

Credits 3. 3 Lecture Hours. Concept of groundwater flow and contaminant transport; numerical simulations of solving flow and transport equations; finite difference and finite element methods; software structures of groundwater flow, contaminant transport, density-dependent fluid flow and hydrocarbon remediations; real case applications of software including geological, physical, chemical, biological and hydrological information. **Prerequisite:** GEOL 410 or approval of instructor.

GEOL 628 Siliciclastic Depositional Systems & Reservoir Architectures

Credits 3. 3 Lecture Hours. Siliciclastic Depositional Systems & Reservoir Architectures. The stratigraphic record of siliciclastic depositional systems; tools and techniques for predicting distribution, quality and thickness variations of conventional and unconventional, tight rock, siliciclastic reservoirs; integration of data including outcrop, core, well-log and seismic for interpretation of facies successions and depositional environments.

GEOL 629 Regional Geology of North America

Credits 3. 3 Lecture Hours. Regional geology of North America, examining the accumulation and deformation of the rock units involved; structural form and style emphasized; entire geologic history investigated.

Prerequisite: Graduate classification or approval of instructor.

GEOL 631 Engineering Geomorphology

Credits 3. 3 Lecture Hours. Active surface processes as they influence engineering construction; erosion, rivers and floods, slope processes, subsidence, coastal processes, ice, weathering and ground water.

Prerequisites: Graduate classification in engineering or geosciences; GEOG 331 or approval of instructor.

GEOL 632 Geofluids

Credits 3. 2 Lecture Hours. 2 Lab Hours. Fundamentals of how fluids drive geologic processes in sedimentary basins; stresses and pressures, compression models, origin of overpressure, trapping of hydrocarbons, formation of mud volcanoes, generation of submarine landslides; exercises and laboratory experiments that build theoretical understanding and illustrate the use of data. **Prerequisite:** Approval of instructor.

GEOL 633 River Restoration

Credits 3. 3 Lecture Hours. Geologic, geomorphic and geomechanical principles applied to the investigation, design, construction, and maintenance of river restoration projects. **Prerequisite:** GEOL 631 or GEOG 626 or approval of instructor.

GEOL 635 Engineering Geology

Credits 3. 3 Lecture Hours. Geological principles applied to the investigation design, construction and maintenance of engineering projects; history, development and role of engineering geologic practice as applied to dams, waste disposal, surface and ground water, tunneling, quarrying and construction materials.

GEOL 640/WMHS 640 Geochemistry of Natural Fresh Waters

Credits 3. 3 Lecture Hours. Chemistry of aqueous solutions; weathering/redox reactions and controls on fresh waters; natural and anthropogenic factors affecting major, minor, and trace elements in fresh waters; evaluation of fresh water composition; application of water-quality measurements to quantitative hydrology. **Cross Listing:** WMHS 640/GEOL 640.

GEOL 641 Environmental Geochemistry

Credits 3. 3 Lecture Hours. Geochemical processes affecting the fate and transport of inorganic and organic pollutants in terrestrial systems; equilibrium and kinetic modeling. **Prerequisite:** GEOL 451 or approval of instructor.

GEOL 642/GEOG 642 Past Climates

Credits 3. 3 Lecture Hours. Terrestrial and marine proxy records of past climate variability, including tree rings, coral, and sediments; past climate change events such as the Little Ice Age and Medieval Warm Period; greenhouse gases and global temperature; insight into the nature of climate change and challenges humankind faces in the next few centuries. **Prerequisites:** Graduate classification. **Cross Listing:** GEOG 642/GEOL 642.

GEOL 643 Introduction to Electron Microprobe Analysis

Credits 2. 1 Lecture Hour. 3 Lab Hours. Digital imaging and qualitative and quantitative chemical analysis of geological and material science samples using the electron microprobe; emphasis on quantitative chemical analysis using WDS (wavelength-dispersive spectrometry) methods; use the electron microprobe and correctly interpret analytical results. **Prerequisite:** Approval of instructor.

GEOL 645 Geochronology

Credits 3. 3 Lecture Hours. Earth's 4.5 billion-year history is divided into units of geologic time based on the observed changes in the rock record: the timing of those changes is quantified by numerical dating methods: this course examines both dating methods and physical and biological changes observed in the rock record. **Prerequisite:** Graduate classification or approval of instructor.

GEOL 647 Radiogenic Isotope Geology

Credits 3. 3 Lecture Hours. Use of radiogenic isotopes in addressing problems in high- and low-temperature geochemistry; their use as tracers for past and present-day processes at the surface and interior of the Earth. **Prerequisite:** Approval of instructor.

GEOL 648 Stable Isotope Geology

Credits 3. 2 Lecture Hours. 3 Lab Hours. Stable isotopes of oxygen, carbon, sulfur and hydrogen applied to problems in paleontology and paleoecology, carbonate diagenesis, petroleum exploration, and igneous and metamorphic petrology; isotopic paleotemperatures; analytical methods; theory of isotopic fractionation. **Prerequisite:** GEOL 451 or approval of instructor.

GEOL 650 Paleoecology

Credits 3. 2 Lecture Hours. 3 Lab Hours. Interrelationships of organisms and environment in the fossil record; methods and criteria available for interpreting ancient environments; critical review of classical studies and current research in paleoecology. **Prerequisite:** Approval of instructor.

GEOL 651 Paleoecological Community Analysis

Credits 3. 3 Lecture Hours. Quantitative analysis of multivariate paleoecological community data; measurement of diversity; cluster analysis; gradient analysis by standard and canonical ordination techniques. **Prerequisite:** A basic course in statistics or approval of instructor.

GEOL 654 Evolutionary Patterns and Theory

Credits 3. 3 Lecture Hours. Evolutionary patterns in the fossil record and application of evolutionary theory to understanding these patterns; comparisons of neo-Darwinian and punctuational hypotheses; events and processes pertaining to microevolutionary and macroevolutionary change; and methods of determine phylogenies of organisms. **Prerequisite:** Graduate classification in geological or biological sciences.

GEOL 658 Earth Systems Through Deep Time: Global Change, Paleoclimate and Life

Credits 3. 3 Lecture Hours. History and cause of global change in the earth system, Archean to Holocene; Impact of biotic change on the earth system; influence of tectonics on paleochemistry and climate change; influence of climate on tectonics; methods and models for evaluating global change. **Prerequisite:** Graduate classification.

GEOL 661 Metamorphic Petrology and Phase Equilibria

Credits 3. 3 Lecture Hours. Origin and evolution of metamorphic rocks via the application of thermodynamics and phase equilibria; geothermobarometry, fluid-rock interaction, and relations between metamorphic and tectonic processes; application of phase equilibria to real data sets to constrain important variables such as pressure, temperature, and fluid fugacities. **Prerequisite:** Approval of instructor.

GEOL 665 Structural Petrology

Credits 4. 3 Lecture Hours. 3 Lab Hours. Mechanisms of rock deformation from single crystal to mountain range; techniques for mapping stresses and strains and for inferring physical conditions and mechanical behavior at time of deformation; laboratory assignments on descriptive techniques include petrographic microscope-universal stage methods, field procedures and data analysis. **Prerequisite:** Approval of instructor.

GEOL 668 Clastic Sedimentology and Sedimentary Petrology

Credits 4. 3 Lecture Hours. 3 Lab Hours. Detailed analyses of clastic sedimentary rocks: relationships of facies and depositional environments with emphasis on continental, coastal and shallow shelf clastic sediments; petrography and diagenesis of modern and ancient clastic sediments. **Prerequisites:** Optical mineralogy course and sedimentology (undergraduate); graduate classification.

GEOL 670 Geological Data Analysis

Credits 3. 3 Lecture Hours. Scientific programming and statistical methods commonly used in geology and paleontology; applying univariate and multivariate statistical analyses to geological data and writing short programming scripts for R; practical expertise in evaluating statistical approaches and solving methodological obstacles.

GEOL 678 Earth Science Modeling

Credits 4. 3 Lecture Hours. 3 Lab Hours. Techniques for building, solving and analyzing numerical models applied to a wide variety of problems in geology, geochemistry, geobiology and geophysics; derivation and scaling of conservation laws; finite difference and finite element techniques and error analysis; programming in MATLAB or a high-level language.

GEOL 681 Seminar

Credit 1. 1 Lecture Hour. Reports and discussions of current research and selected topics from geologic literature. **Prerequisite:** Graduate classification.

GEOL 685 Directed Studies

Credits 1 to 12. 1 to 12 Other Hours. Enables graduate students to undertake limited investigations not within their thesis or dissertation research and not covered in established curricula. **Prerequisites:** Graduate classification and approval of instructor.

GEOL 689 Special Topics in...

Credits 1 to 4. 1 to 4 Lecture Hours. 1 to 7 Lab Hours. Selected topics in an identified area of geology. May be repeated for credit. **Prerequisite:** Approval of instructor.

GEOL 691 Research

Credits 1 to 23. 1 to 23 Other Hours. Original research on problems in various phases of geology. Research for thesis or dissertation.