

# Geology and Geological Engineering

M.A. in Geology (<https://catalog.und.edu/graduateacademicinformation/departments/courses/programs/geology/geol-ma/>)

M.S. in Geology (<https://catalog.und.edu/graduateacademicinformation/departments/courses/programs/geology/geol-ms/>)

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## Geological Engineering

### **GEOE 555. Advanced Rock Mechanics. 3 Credits.**

Fundamentals of rock mechanics, elasticity theory of rock, failure criterion of rocks, laboratory and field testing methods, field instrumentation, the applications of rock mechanics in mining, tunneling and rock slopes engineering, and the applications of numerical methods in rock mechanics. Prerequisite: GEOE 323 and ENGR 203. F.

### **GEOE 591. Advanced Subsurface Energy Recovery in Engineering. 3 Credits.**

This course describes technologies that can be applied to further recover from the subsurface energy resource in EOR/EGR and EGS, include renewable geothermal resource, hydrogen storage, CCUS, and hydrocarbons - oil/gas, that cannot be produced by primary or second extraction. Development of these processes requires significant technological advances in our understanding of subsurface mining from energy reservoirs and may be the stimulus for future technological development. Prerequisite: Background/knowledge of Multivariable Calculus, Introductory Chemistry, and Petrophysics. S.

### **GEOE 599. Doctoral Research. 1-15 Credits.**

Research contributing to the discovery and dissemination of knowledge and/or technology in Geological Engineering and contributing to the student's doctoral dissertation. Prerequisite: Admission to the PhD program in Geological Engineering. Repeatable to 15.00 credits. F,S,SS.

### **GEOE 996. Continuing Enrollment. 1-12 Credits.**

Repeatable. S/U grading.

### **GEOE 998. Thesis. 1-9 Credits.**

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### **GEOE 999. Dissertation. 1-18 Credits.**

PhD student doctoral dissertation. Prerequisite: Admission to the PhD program in Geological Engineering. Repeatable to 18.00 credits. S/U grading. F,S,SS.

## Undergraduate Courses for Graduate Credit

### **GEOE 323. Engineering Geology. 2 Credits.**

This course is to introduce the application of geological, hydrological and environmental principles to geotechnical/geological engineering design, construction and operation as well as various geohazards. Prerequisite: One introductory geology course and MATH 165. S.

### **GEOE 417. Hydrogeology. 3 Credits.**

Physical and chemical aspects of groundwater movement, supply, and contamination. Prerequisite: MATH 165. F.

### **GEOE 418. Hydrogeological Methods. 2 Credits.**

Field and laboratory methods used in hydrogeology; techniques of drilling, well and piezometer installation, determination of aquifer parameters, geophysical exploration, soil classification and analysis, ground water sampling and analysis. Includes field trip. Prerequisite: GEOE 417. F.

### **GEOE 419. Groundwater Monitoring and Remediation. 3 Credits.**

Statistical methods for groundwater sampling and monitoring network design. Groundwater remediation and design; including strategies that remove contaminants for external treatment and strategies for in-situ contaminant treatment. Prerequisite: MATH 165. S.

### **GEOE 420. Geological Modeling and Numerical Simulation of Reservoirs. 3 Credits.**

This technical elective course targets senior or graduate student who has desire to pursue fossil energy industry or a transition from fossil energy to renewable energy as a future career or related. The course introduces workflow designs and software application from geological modeling to numerical simulation for hydrocarbon or geothermal energy, so that engineering student can communicate knowledgeably about geologic processes to reservoir fluid flow process that formed and continued to shape the rock formation and reservoir. Prerequisite: GEOE 301 and GEOL 407. F.

### **GEOE 421. Cold Region Hydrologic Modeling. 3 Credits.**

This course aims to describe and explain the governing physical principles, processes and recent advances in cold region hydrology and physically based numerical simulation with special reference to northern prairie region. In addition, the students will learn the incorporation of physically based process into a numerical model using the cold region hydrologic model platform (CRHM). The CRHM allows the compilation of various modules (each module represent a process) to build a model to simulate watershed processes in a specific basin. Prerequisite: GEOL 101, GEOE 203, or MATH 165. F.

### **GEOE 425. Design Hydrology for Wetlands. 3 Credits.**

Principles of chemistry, geology, hydraulics, and hydrology applied to natural and constructed wetlands and other small catchments. Prerequisite: CHEM 121 and either CE 306/ME 306 or GEOE 417. S.

### **GEOE 427. Groundwater Modeling. 3 Credits.**

Fundamentals of numerical modeling applied to groundwater flow. Spreadsheet calculations will be used to demonstrate the finite difference method applied to groundwater movement and storage. Simulation of practical groundwater problems will be performed with the U.S. Geological Survey's MODFLOW code. Prerequisite: GEOE 417 and MATH 265; some programming experience is recommended. On demand.

### **GEOE 455. Geomechanics. 3 Credits.**

The objective of this course is to train the students to use fundamental principles and field and lab techniques of Rock Mechanics to analyze real-world problems, identify the optimal methods, and solve the practical geological engineering problems with the combination of field and laboratory, analytical and experimental means. Emphases will be on the fundamental principles and their application to practical engineering problems, both surface and underground. Prerequisite: GEOE 323 and GEOE 412/CE 412 or consent of instructor. F.

### **GEOE 493. Selected Topics in Geological Engineering. 1-3 Credits.**

Detailed study of selected topics in Geological Engineering. Includes laboratory if applicable. Repeatable. Repeatable. On demand.

## Geology

### **GEOL 500. Sedimentary Geology. 1-4 Credits.**

Selected topics in sedimentary geology, such as sedimentary processes, carbonate petrology, clastic petrology, and basin analysis. May be repeated up to 12 credits. Prerequisite: Consent of instructor. Repeatable to 12.00 credits. F.

### **GEOL 505. Isotope Geochemistry. 3 Credits.**

Geochemistry and cosmochemistry of radioactive and stable isotopes; isotope equilibria; applications in paleoclimatology, environmental isotope geochemistry, igneous, metamorphic, and sedimentary petrology. Prerequisite: GEOL 321 or permission of instructor.

### **GEOL 506. Glacial Geology. 4 Credits.**

Origin, growth, and movement of glaciers; landforms and deposits incident to glaciation. 3 hours lecture, 2 hours laboratory time per week. Prerequisite: GEOL 311.

**GEOL 509. Advanced Mineralogy. 1-4 Credits.**

Advanced study of specific mineral groups or selected topics in mineralogy. Prerequisite: GEOL 320; recommended prerequisite GEOL 321.

**GEOL 511. Advanced Structural Geology. 4 Credits.**

Reading and research in special topics in structural geology and geotectonics.

**GEOL 512. Advanced Petrology. 1-4 Credits.**

Selected topics in petrology taught using conventional lecture and laboratory/field approach. Prerequisite: GEOL 320.

**GEOL 515. Advanced Paleontology. 3 Credits.**

Selected topics include (but not limited to): Invertebrate paleontology; vertebrate paleontology; paleoecology; taxonomy; museum studies; western continental stratigraphy; critical boundaries. May be repeated. Prerequisite: GEOL 415, BIOL 150, or consent of instructor. Repeatable to 40.00 credits. On demand.

**GEOL 516. Earth Materials: Components of a Diverse Planet. 3 Credits.**

This course has three components. (1) We examine the context in which Earth materials are studied and some fundamental concepts about the Earth system. (2) We undertake a systematic look at the most important materials that make up our planet (elements, minerals, rocks of all sorts, soils, and water). We will examine their properties, their distribution and occurrences, the processes that form them, and how scientists use these materials to interpret Earth. The third, and perhaps most important focus of the class is on the importance of Earth materials in our society and lives. This includes consideration of mineral and energy resources, hazards, and engineering. Class time has both a lecture and a laboratory component. Students will be required to give class presentations and complete writing assignments. Students who have taken GEOL 316 cannot subsequently take GEOL 516 as an undergraduate or graduate student at UND. Prerequisite: CHEM 121 or equivalent. S.

**GEOL 518. Topics in Advanced Stratigraphy. 2-4 Credits.**

Selected topics in lithostratigraphy and biostratigraphy. Prerequisite: GEOL 411, GEOL 415. Repeatable to 4.00 credits.

**GEOL 520. Statistical Applications in Geology. 3 Credits.**

The application of statistical techniques to geologic data and problems, with emphasis on analysis of geologic sequences, map analysis, and multivariate analysis of geologic data. Prerequisite: An introductory statistics course, such as CTL 515 or PSYC 241, and consent of instructor.

**GEOL 522. History and Philosophy of Geology. 3 Credits.**

Historical and philosophical development of the science of geology. Prerequisite: Permission of instructor.

**GEOL 523. Topics in Advanced Geomorphology. 1-4 Credits.**

Selected topics in geomorphic processes and landforms. Prerequisite: GEOL 311. Repeatable to 4.00 credits.

**GEOL 525. Weathering and Soils. 3 Credits.**

Properties and classification of soils; the factors and processes of weathering and soil formation. Prerequisite: GEOL 311 and GEOL 411, or consent of instructor.

**GEOL 530. Topics in Physical Hydrogeology. 2 Credits.**

Selected topics in groundwater, vadose-zone hydrology, fracture flow, analytical/numerical modeling, GIS and hydrology, and wetland soils/hydrology. Repeatable when topics vary. Prerequisite: Consent of instructor. Repeatable to 8.00 credits. F,S.

**GEOL 531. Hydrogeochemistry. 3 Credits.**

The origin, characteristics and modeling of surface and ground water geochemistry. Prerequisite: GEOL 321 and MATH 166, or permission of instructor.

**GEOL 532. Contaminant Hydrogeology. 3 Credits.**

Chemical and physical processes affecting contaminant behavior in groundwater with analytical/numerical modeling and case studies. Prerequisite: GEOE 417 and GEOE 427 and MATH 265, or consent of instructor.

**GEOL 540. Water Sampling and Analysis. 3 Credits.**

Techniques of water and sediment sampling and analysis using equipment in the UND Water Quality Laboratory. Results are interpreted in the context of the natural systems from which the samples are taken. Enrollment is limited to eight students per section. A laboratory fee is required. Prerequisite: CHEM 121.

**GEOL 551. Heat Flow. 3 Credits.**

An exploration of Earth's thermal structure, thermal history and heat sources. The course begins with the theory of heat transfer within and through the surface of terrestrial planets. Methods of observation and modeling provide hands-on experience in field and laboratory activities. Applications of heat flow in tectonics, petrology, thermal maturity of kerogen, hydrogeology, geothermics and climate change are presented with current examples. Prerequisite: Graduate standing. Corequisite: Permission of instructor. On demand.

**GEOL 560. Geothermics I. 3 Credits.**

A survey of the methods of geothermal exploration, assessment and production. The course covers the various methods for discovery and characterization of geothermal resources. Methods for assessment of energy in place and determination of recoverable energy are covered in depth. Current technologies for energy extraction and power production are presented with current examples. Prerequisite: Graduate standing. Corequisite: Permission of instructor. On demand.

**GEOL 561. Geothermics II. 3 Credits.**

The course covers the historical development of geothermal policies, regulations and practices globally and in different states within the US. Matters of water usage, contamination and disposal are covered extensively. Current issues such as induced seismicity, hydrofracture, power plant size and location, electrical grid access and land use are critically examined. Prerequisite: Senior or Graduate Standing. Corequisite: Permission of Instructor. On demand.

**GEOL 590. Research. 1-4 Credits.**

Laboratory, field, or library research on problems of interest (may be repeated). Repeatable.

**GEOL 591. Directed Studies. 1-4 Credits.**

Directed advanced research in a specialized field of geologic study (may be repeated). Repeatable.

**GEOL 996. Continuing Enrollment. 1-12 Credits.**

Repeatable. S/U grading.

**GEOL 997. Independent Study. 2 Credits.**

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**GEOL 998. Thesis. 1-9 Credits.**

Repeatable to 9.00 credits.

**GEOL 999. Dissertation. 2-12 Credits.**

May be repeated up to 24 credits. Repeatable to 24.00 credits.

## Undergraduate Courses for Graduate Credit

**GEOL 311. Geomorphology. 4 Credits.**

In this course you will learn about the Earth's surface: what processes created the landforms we see today and how those landforms are evolving through time. The topics include: rivers, glaciers, wind, weathering, soils, groundwater, slope processes, dating of the surface deposits, and current and past climate change. The course objective is to provide students with a good understanding of the processes and materials that shape the Earth's surface. Includes field trip and hands on laboratory. Prerequisite: GEOL 101 or GEOE 203 or consent of instructor. F.

**GEOL 320. Petrology. 2 Credits.**

Description, classification and origin of igneous, metamorphic, and sedimentary rocks. Field and laboratory study of rocks. Engineering properties of earth materials. Advanced aspects of optical mineralogy. Prerequisite: GEOL 318. Corequisite: GEOL 320L for on-campus students; distance students will take GEOL 320L during the summer session. F.

**GEOL 321. Geochemistry. 3 Credits.**

Application of the principles of chemistry to geologic and hydrogeologic problems. Origin and distribution of the chemical elements. Introduction to radiochemistry, isotopic geochronology, and stable-isotope geochemistry. Prerequisite: GEOL 318 or GEOE 301; CHEM 122; MATH 165; or consent of instructor. S.

**GEOL 340. Digital Mapping Methods. 3 Credits.**

This course integrates "hands-on" data acquisitions and map generation with an overview of the technology (GPS, lasers, and data management). Field projects focus on mapping methodology and laboratory projects focus on analysis and presentation. It is assumed that students have an undergraduate geology background and a basic knowledge of computer applications. Prerequisite: Junior Standing in geology.

**GEOL 342. Conservation and Environmental Hydrology. 3 Credits.**

Topics relating hydrology to the environment and water conservation, including the global and local hydrological cycle, flood occurrence and prediction, water pollution, erosion and sedimentation, wetlands, and water management. Prerequisite: Introductory geology course or upper division standing; MATH 103. S, odd years.

**GEOL 407. Petroleum Geology. 3 Credits.**

This course is designed to provide students with an introduction to the application of geological principles in the exploration and production of oil and gas. Prerequisite: GEOL 101 or GEOE 203 or GEOE 210. S.

**GEOL 411. Sedimentology and Stratigraphy. 3 Credits.**

Describe and classify siliciclastic and carbonate sedimentary rocks; interpret sedimentary structures in ancient sedimentary rocks in terms of depositional, erosional or deformational processes, interpret ancient depositional environments of siliciclastic and carbonate sedimentary rocks; understand and appreciate the difference between rock and time units in sedimentary successions; recognize and appreciate the importance of unconformities in sedimentary successions and for the formation of hydrocarbons; discuss mechanisms responsible for sedimentary basin formation, and describe and classify sedimentary basins (if we get to that last point). This course is also designed to teach you how to reference adequately in the text and how to make a reference list (plus what should be in there). Prerequisite: GEOL 320. S.

**GEOL 414. Applied Geophysics. 3 Credits.**

Principles of various geophysical methods and their application to geologic problems. Prerequisite: GEOL 101 or GEOE 203; MATH 165; and PHYS 211 or 251. F.

**GEOL 415. Introduction to Paleontology. 3 Credits.**

This course provides an overview of the foundational principles of paleontology. Topics covered include the fundamentals of evolution, phylogenetics, fossilization, paleoecology, and fossil identification. Students also explore the critical importance of fossils to geology, industry, and other related geoscience careers. The separate laboratory portion of the course emphasizes practical application via identification and interpretation of fossils, especially invertebrates as they are common in the fossil record. Prerequisite: GEOL 102 and GEOL 102L. F.

**GEOL 422. Seminar II. 1 Credit.**

Continuation of GEOL 421 experience. Preparation and delivery of oral presentations in science and engineering, culminating in oral presentation of senior thesis (Geol 490) or Engineering Design (485). Includes critical review of student presentations and departmental guest lectures. Prerequisite: GEOL 421, senior or graduate status in departmental major. F,S.