

# Geology (GEOL)

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## **GEOL 105L. Physical Geology Lab. 1 Credit.**

Study of the Earth as a physical body; its structure, composition, and the geologic processes acting on and within the Earth.

## **GEOL 105. Physical Geology. 3 Credits.**

Study of the Earth as a physical body; its structure, composition, and the geologic processes acting on and within the Earth.

## **GEOL 106. The Earth Through Time. 3 Credits.**

Introduction to the Earth through time; its origin, history, and evolution of animal and plant life.

## **GEOL 106L. The Earth Through Time Lab. 1 Credit.**

Introduction to the Earth through time; its origin, history, and evolution of animal and plant life.

## **GEOL 107L. Geology of the Red River Valley. 1 Credit.**

Field study of Mesozoic and Cenozoic sediments, landforms, and geological processes that have shaped the landscape of the Red River Valley. Two-day field excursion and a report. Fee required. Recommended: GEOL 105 or GEOL 106.

## **GEOL 150. Concepts, Skills, and Ethics in Geoscience. 2 Credits.**

This course introduces students to the geology major at NDSU. Students will learn basic skills for academic success along with specific skills and concepts in geosciences, including literature research, interdisciplinary scientific principles, field and lab safety, maps and geographic information systems, data analysis, computation and programming, and career paths in geoscience. The course will be team taught, with in-class active learning exercises, discussion, homework, and guest speakers.

## **GEOL 194. Individual Study. 1-5 Credits.**

## **GEOL 196. Field Experience. 1-15 Credits.**

## **GEOL 199. Special Topics. 1-5 Credits.**

## **GEOL 201. Climate Change and Energy. 3 Credits.**

Exploration and analysis of Earth system processes, geologic and instrumental records of global-scale climate change, and the interrelationship of climate change and energy consumption from fossil fuels.

## **GEOL 219. Oceanography. 3 Credits.**

Ocean formation and dynamics over geologic time; waves and energy transfer of oceans; oceanic effects on world climates; coastal hazards.

## **GEOL 291. Seminar. 1-3 Credits.**

## **GEOL 292. Global Practicum: Study Abroad. 1-15 Credits.**

Pre-Arranged study at accredited foreign institutions (study abroad), domestic institutions (National Student Exchange) or on approved study abroad programs. Pre-requisite: Sophomore standing and prior approval by International Student and Study Abroad Services and major department. Graded 'P' or 'F' (Undergraduate), or 'S' or 'U' (Graduate).

## **GEOL 294. Individual Study. 1-5 Credits.**

## **GEOL 299. Special Topics. 1-5 Credits.**

## **GEOL 300. Environmental Geology. 3 Credits.**

Human interaction with Earth's environment. Earthquakes, floods, volcanoes, landslides, water use, pollution, energy, mining, and land-use planning. Recommended: GEOL 105, GEOL 105L. (alternate years).

## **GEOL 301. Lake Superior Field Course. 2 Credits.**

Stratigraphy, mineralogy, and economic geology of northern Minnesota and northwestern Ontario. Weekly lecture, plus six-day field excursion. Offered periodically. Fee required. Recommended: GEOL 105, GEOL 105L, GEOL 106, GEOL 106L.

## **GEOL 302. Black Hills Field Course. 2 Credits.**

Stratigraphy, structure, and mineralogy of the Black Hills and Williston Basin. Weekly lectures, plus seven-day field excursion. Offered periodically. Fee required. Recommended: GEOL 105, GEOL 105L, GEOL 106, GEOL 106L.

## **GEOL 303. Paleontology Field Course. 1 Credit.**

Paleozoic stratigraphy and paleontology of southeastern Minnesota and northern Iowa. Lecture by arrangement, 1 three and one-half day field excursion. Fee required. Recommended: GEOL 106, GEOL 106L. (alternate years).

## **GEOL 310. Planetary Geology. 3 Credits.**

Survey of planetary geology reinforcing concepts of physical geology; formation and composition of the solar system, comparative planetary geology and geomorphology, extra-solar systems and habitable worlds, astrobiology. Recommended: GEOL 105.

## **GEOL 350. Invertebrate Paleontology. 3 Credits.**

Survey of invertebrate fossils emphasizing systematics, environments and as stratigraphic markers. Recommended: GEOL 106, GEOL 106L. (alternate years).

**GEOL 379. Global Seminar. 1-6 Credits.**

NDSU instructed experience or field study in a foreign country. Conducted in English for residence credit. Pre-requisite: Prior approval by International Student and Study Abroad Services and major department. May be repeated. Standard Grading.

**GEOL 391. Seminar. 1-3 Credits.****GEOL 392. Global Practicum: Study Abroad. 1-15 Credits.**

Pre-Arranged study at accredited foreign institutions (study abroad), domestic institutions (National Student Exchange) or on approved study abroad programs. Pre-requisite: Sophomore standing and prior approval by International Student and Study Abroad Services and major department. Graded 'P' or 'F' (Undergraduate), or 'S' or 'U' (Graduate).

**GEOL 394. Individual Study. 1-5 Credits.****GEOL 397. Coop Ed/Internship. 1-4 Credits.****GEOL 399. Special Topics. 1-5 Credits.****GEOL 410. Sedimentology/Stratigraphy. 4 Credits.**

Origin and classification of sedimentary rocks and their stratigraphic relationships. 3 lectures, 1 laboratory. Recommended: GEOL 105, GEOL 105L, GEOL 106, GEOL 106L. (alternate years).

**GEOL 412. Geomorphology. 3 Credits.**

Land forms and the processes by which they are formed and modified. 3 lectures, 1 two-hour laboratory. Recommended: GEOL 105, GEOL 105L. Cross-listed with GEOG. {Also offered for graduate credit - see GEOL 612.}.

**GEOL 413. Glacial Geology. 3 Credits.**

Glaciers as agents of geologic change; evolution of landforms and landscapes shaped by glaciers; glaciers and glacial landscapes as records of global climate and environmental change; glacial history of North America. Recommended: GEOL 105, GEOL 105L. {Also offered for graduate credit - see GEOL 613.}.

**GEOL 414. Hydrogeology. 3 Credits.**

Concepts of surface and groundwater hydrogeology in natural systems; the hydrologic cycle; physical properties of aquifers and subsurface flow; open channel flow; natural aqueous geochemistry. Prereq: GEOL 105, MATH 146 or MATH 165, CHEM 121 or CHEM 160. Coreq or prereq: GEOL 105L, MATH 147 or MATH 166. {Also offered for graduate credit - see GEOL 614.}.

**GEOL 420. Mineralogy. 3 Credits.**

Crystal forms, crystal chemistry, and formation of non-silicate and silicate minerals. Recommended: CHEM 121 or CHEM 150. (alternate years) {Also offered for graduate credit - see GEOL 620.}.

**GEOL 421. Mineralogy Laboratory. 1 Credit.**

Identification and classification of minerals using morphology, physical properties, XRF and XRD. Coreq: GEOL 420. (alternate years) {Also offered for graduate credit - see GEOL 621.}.

**GEOL 422. Petrology. 3 Credits.**

Principles of igneous and metamorphic petrology including geochemistry, phase relations, and rock forming processes. Prereq: GEOL 420. (alternate years) {Also offered for graduate credit - see GEOL 622.}.

**GEOL 423. Petrography. 1 Credit.**

Identification and classification of rocks in hand specimens and thin sections. Optical mineralogy. Field and laboratory projects required. Prereq: GEOL 422. (alternate years) {Also offered for graduate credit - see GEOL 623.}.

**GEOL 428. Geochemistry. 3 Credits.**

Introduction to geochemistry: chemistry of the Earth, groundwater, isotopes, global geochemical cycles, geochemical modeling, and environmental geochemistry. Recommended: CHEM 121 or CHEM 150. Cross-listed with CHEM 428. (alternate years) {Also offered for graduate credit - see GEOL 628.}.

**GEOL 450. Field Geology. 3 Credits.**

Interpretation of geology in the field; preparation of base maps and plotting geological data. Lectures and one-week fieldwork. Fee required. Prereq: GEOL 410, GEOL 421, GEOL 423, GEOL 457. (alternate years) {Also offered for graduate credit - see GEOL 650.}.

**GEOL 457. Structural Geology. 4 Credits.**

Dynamics of rock deformation and analyses of Earth structure. Recommended: GEOL 105, GEOL 105L, MATH 105. (alternate years) {Also offered for graduate credit - see GEOL 657.}.

**GEOL 460. Biogeochemistry. 3 Credits.**

An overview of how life affects Earth's chemistry, examining interactions between the atmosphere, the land surface, and the oceans. Biotic mechanisms will be followed via the global cycles of biologically relevant elements stressing human impacts. Recommended: GEOL 105, GEOL 105L, GEOL 106, GEOL 106L, CHEM 121, CHEM 122, BIOL 150, BIOL 151. {Also offered for graduate credit - see GEOL 660.}.

**GEOL 465. Remote Sensing of the Environment. 3 Credits.**

This course will focus on developing practical skills for using various types of accessible remote sensing technologies as applied to environmental sciences. We will learn to work with aerial photographs, aerial lidar data, Terrestrial Laser Scanning (TLS), structure from motion (sfm), and Unmanned Aerial Vehicles (UAVs). We will explore the drawbacks and benefits of each technology and how it can be used to gather information and measure change in the environment. Cross-listed with GEOG 465. Dual-listing: GEOL 665, GEOG 665.

**GEOL 470. Remote Sensing. 3 Credits.**

Application of principles of Remote Sensing technology to integrate multiple interrelated data, to identify and/or accentuate spectral indices, magnetic force, electromagnetic energy and other remotely collected data to analyze temporal and spatial variation. Cross-listed with GEOG. {Also offered for graduate credit - see GEOL 670.}

**GEOL 480. Geographic Information Systems Pattern Analysis and Modeling. 3 Credits.**

Application of GIS for determination of: factors or variables that influence geospatial patterns, data limitations in spatial and temporal continuum scales, identification of data anomalies, optimal data prediction, and evaluation of prediction uncertainty. Prereq: GEOG 455. Cross-listed with GEOG 480. {Also offered for graduate credit - see GEOL 680.}

**GEOL 491. Seminar. 1-5 Credits.****GEOL 492. Global Practicum: Study Abroad. 1-15 Credits.**

Pre-Arranged study at accredited foreign institutions (study abroad), domestic institutions (National Student Exchange) or on approved study abroad programs. Pre-requisite: Sophomore standing and prior approval by International Student and Study Abroad Services and major department. Graded 'P' or 'F' (Undergraduate), or 'S' or 'U' (Graduate).

**GEOL 493. Undergraduate Research. 1-5 Credits.****GEOL 494. Individual Study. 1-5 Credits.****GEOL 496. Field Experience. 1-15 Credits.****GEOL 499. Special Topics. 1-5 Credits.****GEOL 612. Geomorphology. 3 Credits.**

Land forms and the processes by which they are formed and modified. 3 lectures, 1 two-hour laboratory. Cross-listed with GEOG. {Also offered for undergraduate credit - see GEOL 412.}

**GEOL 613. Glacial Geology. 3 Credits.**

Glaciers as agents of geologic change; evolution of landforms and landscapes shaped by glaciers; glaciers and glacial landscapes as records of global climate and environmental change; glacial history of North America. {Also offered for undergraduate credit - see GEOL 413.}

**GEOL 614. Hydrogeology. 3 Credits.**

Concepts of surface and groundwater hydrogeology in natural systems; the hydrologic cycle; physical properties of aquifers and subsurface flow; open channel flow; aqueous geochemistry. {Also offered for undergraduate credit - see GEOL 414.}

**GEOL 620. Mineralogy. 3 Credits.**

Crystal forms, crystal chemistry, and formation of non-silicate and silicate minerals. (alternate years) {Also offered for undergraduate credit - see GEOL 420.}

**GEOL 621. Mineralogy Laboratory. 1 Credit.**

Identification and classification of minerals using morphology, physical properties, XRF and XRD. Coreq: GEOL 620. (alternate years) {Also offered for undergraduate credit - see GEOL 421.}

**GEOL 622. Petrology. 3 Credits.**

Principles of igneous and metamorphic petrology including geochemistry, phase relations, and rock forming processes. Prereq: GEOL 620. (alternate years) {Also offered for undergraduate credit - see GEOL 422.}

**GEOL 623. Petrography. 1 Credit.**

Identification and classification of rocks in hand specimens and thin sections. Optical mineralogy. Field and laboratory projects required. Prereq: GEOL 622. (alternate years) {Also offered for undergraduate credit - see GEOL 423.}

**GEOL 628. Geochemistry. 3 Credits.**

Introduction to geochemistry: chemistry of the Earth, groundwater, isotopes, global geochemical cycles, geochemical modeling, and environmental geochemistry. Cross-listed with CHEM 628. (alternate years) {Also offered for undergraduate credit - see GEOL 428.}

**GEOL 650. Field Geology. 3 Credits.**

Interpretation of geology in the field; preparation of base maps and plotting geological data. Lectures and one-week fieldwork. Fee required. Prereq: GEOL 610, GEOL 621, GEOL 623, GEOL 657. (alternate years) {Also offered for undergraduate credit - see GEOL 450.}

**GEOL 657. Structural Geology. 4 Credits.**

Dynamics of rock deformation and analyses of Earth structure. (alternate years) {Also offered for undergraduate credit - see GEOL 457.}

**GEOL 660. Biogeochemistry. 3 Credits.**

An overview of how life affects Earth's chemistry, examining interactions between the atmosphere, the land surface, and the oceans. Biotic mechanisms will be followed via the global cycles of biologically relevant elements stressing human impacts. {Also offered for undergraduate credit - see GEOL 460.}.

**GEOL 665. Remote Sensing of the Environment. 3 Credits.**

This course will focus on developing practical skills for using various types of accessible remote sensing technologies as applied to environmental sciences. We will learn to work with aerial photographs, aerial lidar data, Terrestrial Laser Scanning (TLS), structure from motion (sfm), and Unmanned Aerial Vehicles (UAVs). We will explore the drawbacks and benefits of each technology and how it can be used to gather information and measure change in the environment. Cross-listed with GEOG 665. Dual-listing: GEOL 465, GEOG 465.

**GEOL 680. Geographic Information Systems Pattern Analysis and Modeling. 3 Credits.**

Application of GIS for determination of: factors or variables that influence geospatial patterns, data limitations in spatial and temporal continuum scales, identification of data anomalies, optimal data prediction, and evaluation of prediction uncertainty. Prereq: GEOG 655. Cross-listed with GEOG 680. {Also offered for undergraduate credit - see GEOL 480.}.

**GEOL 695. Field Experience. 1-15 Credits.****GEOL 696. Special Topics. 1-5 Credits.****GEOL 712. Topics in Geomorphology. 3 Credits.**

This course focuses on developing an understanding of how Earth surface processes shape the landscape and how these processes relate to research in a broad range of disciplines.

**GEOL 760. Advanced Biogeochemistry. 3 Credits.**

Examines the nature of the interaction between Earth's biogeochemical cycles and climate and how this interaction has evolved over time and will change in the future. Recommended: GEOL 660.

**GEOL 793. Individual Study/Tutorial. 1-5 Credits.**