

# GEOL - GEOLOGY

---

## GEOL100 Physical Geology (3 Credits)

A general survey of the rocks and minerals composing the earth, its surface features and the agents that form them, and the dynamic forces of plate tectonics.

**Credit Only Granted for:** GEOL100 or GEOL120.

**Additional Information:** CORE Distributive Studies Physical Science Laboratory Course only when taken concurrently with GEOL 110.

## GEOL102 Historical Geology (4 Credits)

Earth's history as revealed through the principles of stratigraphy and the processes of physical geology. Emphasis on formations and geologic development of the North American continent.

**Prerequisite:** GEOL120 or GEOL100; and GEOL110. Or permission of CMNS-Geology department.

## GEOL104 Dinosaurs: A Natural History (3 Credits)

Dinosaurs, their evolution, and our understanding of their fossil record. Students will examine the geologic record and the tools used by paleontologists to determine: geologic ages and ancient environments; evolutionary history and extinctions; dinosaurian biology and behavior; and their survival as birds. Mechanisms of global change ranging from plate tectonics to asteroid impact will be discussed.

## GEOL110 Physical Geology Laboratory (1 Credit)

The basic materials and tools of physical geology stressing familiarization with rocks and minerals and the use of maps in geologic interpretations.

**Prerequisite:** Must have completed or be concurrently enrolled in GEOL120 or GEOL100.

## GEOL120 Environmental Geology (3 Credits)

A review of geologic factors underlying many environmental problems and the interactions between population and physical environment: geologic hazards, land-use planning, conservation, mineral resources, waste disposal, land reclamation, and the geologic aspects of health and disease. The course is aimed at lower division students in education and liberal arts, and should be useful to any student concerned with geologic perspectives of environmental problems.

**Credit Only Granted for:** GEOL100 or GEOL120.

## GEOL123 Causes and Consequences of Global Change (3 Credits)

Study of the major components of Earth's climate system and climate change history. Discussion of 21st century climate change prediction, mitigation and adaptation efforts.

**Cross-listed with:** AOSC123.

**Credit Only Granted for:** AOSC123, GEOG123, or GEOL123.

## GEOL124 Evolution of Life and Environment on Planet Earth (3 Credits)

An exploration of how life has shaped Earth's physical environments, both in the contemporary Earth and over the long course of Earth history. Topics range from evidence for the origin and diversification of life and its impact on Earth environments to the mind-set and methods of the scientists who interpret it, and what those methods tell us about future interactions between life and the environment, both on Earth and in the Solar System.

## GEOL125 Wicked Problems and Solutions in Climate Change (3 Credits)

If you were born after 1970, climate change is a part of the world you know. Why has it been so difficult for individuals, communities, nations and the global community to mitigate, adapt and reduce societal vulnerability to its present and future dangers? Climate change is a wicked problem: difficult to unravel because it has so many tangled dimensions. Using Kim Stanley Robinson's climate fiction novel "Ministry for the Future" to introduce the complexity of climate problems and solutions, we will develop the scientific, economic, psychological and social aspects of not only the wicked problem but wicked solutions - pathways to sustainability in the 21st century - your century. Along the way we will role play the conditions, choices, actions and events by which these same problems, illustrated on the UMD campus, could untangle the wickedness of the problem and illuminate the wickedness of plausible solutions.

**Cross-listed with:** AOSC125.

**Credit Only Granted for:** GEOL125 or AOSC125.

## GEOL200 Earth's Fury: Earthquakes, Volcanoes, and Tsunami (3 Credits)

Earthquakes, volcanic eruptions, and tsunami frequently remind us of the dangers associated with living on a constantly changing planet. How do people prepare for these rare but dramatic events? Student will study the science behind earthquakes and volcanoes, how it guides monitoring, forecasting, prevention, and response, and the cultural and ethical aspects of these events.

## GEOL204 Dinosaurs, Early Humans, Ancestors, and Evolution; The Fossil Record of Vanished Worlds of the Prehistoric Past (3 Credits)

What good is the fossil record? What relevance or insights might the remains of ancient living things have for our modern world? This course examines how the record of ancient life was made, and how we use diverse scientific techniques to reveal the information it contains. We will look at how the various inhabitants of our planet changed through time, and how different ecosystems such as reefs, forests, and grasslands were assembled. We will see how our own species came to be, and of our spread across the world from our ancestral home in Africa. We'll examine how the fossil record contains evidence of climate changes and extinction events far exceeding what we are currently experiencing, and how we can use these as warnings for our future. We'll address who are the owners and stakeholders in the evidence of the fossil world. Students will learn how to read and interpret the primary scientific literature, and how to present scientific information to others through various media.

## GEOL212 Planetary Geology (3 Credits)

An examination of the geologic and geochemical processes at work in the solar system from the perspectives supplied by space age exploration of the planets and other solar system bodies.

**Credit Only Granted for:** ASTR330 or GEOL212.

## GEOL224 Observations and Measurements of the Natural World (3 Credits)

A scientific research team experience focused on evaluating environmental controls on water quality in urbanized streams of College Park. Training in field, laboratory, and digital visualization techniques to gain hands on knowledge of the scientific method through detailed observations, measurements, manipulations, and interpretations of data gathered during the course.

## GEOL288 Field Studies I (1 Credit)

Examination and investigation of Earth Science phenomena in the field, particularly geology. Involves fieldwork of one week or longer duration, which work normally includes both observation and data collection. Particular programs may require certain prerequisites. Permission of Instructor is required. Special fees may be necessary.

**Repeatable to:** 3 credits if content differs.

**GEOL322 Mineralogy (4 Credits)**

Basic mineralogy for geology majors. The principles of morphologic crystallography, crystal chemistry, and determinative mineralogy.

**Prerequisite:** GEOL120 or GEOL100; and GEOL110. And CHEM131 and CHEM132; or (CHEM135 and CHEM136); or CHEM103.

**Restriction:** Permission of instructor is required for non-degree seeking students.

**GEOL329 Instructional Assistance Practicum (1-2 Credits)**

Undergraduate teaching assistantship in Geosciences. Individual instruction course. Contact department or instructor to obtain section number.

**GEOL331 Principles of Paleontology (4 Credits)**

A review of the theory, principles, and applications of Paleontology. A systematic overview of the morphology, evolution, and relationships of the major fossil-producing taxa.

**Prerequisite:** GEOL102; or (BSCI207 or BSCI392); or permission of CMNS-Geology department.

**Cross-listed with:** BSCI333.

**Restriction:** Permission of instructor is required of non-degree seeking students.

**Credit Only Granted for:** GEOL331 or BSCI333.

**GEOL340 Geomorphology (4 Credits)**

Analysis of landforms, organized on the basis of the geologic processes that have operated during the late Cenozoic. Constructional and erosional landforms related to physical systems operating on geologic structures through time.

**Prerequisite:** GEOL120 or GEOL100.

**Restriction:** Permission of instructor is required of non-degree seeking students.

**GEOL341 Structural Geology (4 Credits)**

Study of the deformation of Earth's lithosphere, especially stress, rheology, strain, and the origin and significance of structural features. Development of 3-dimensional thinking through drafting and drawing of structures, construction of geologic maps and cross-sections, and stereographic and orthographic representation of structures. Improvement of scientific writing. Two weekend field trips.

**Prerequisite:** GEOL120 or GEOL100; and GEOL102; and GEOL110. Or permission of CMNS-Geology department.

**Restriction:** Permission of instructor is required of non-degree seeking students.

**GEOL342 Sedimentation and Stratigraphy (4 Credits)**

Description, origin, and distribution of sediments and sedimentary rocks.

**Prerequisite:** GEOL120 or GEOL100; and GEOL110; and GEOL322. And CHEM103; or (CHEM131 and CHEM132); or (CHEM135 and CHEM136).

**Restriction:** Permission of instructor is required of non-degree-seeking students.

**GEOL346 Cycles in the Earth System (3 Credits)**

The Earth System operates through some fundamental cycles such as water, energy, and the Carbon Cycle. This course will build on GEOL/ GEOG/AOSC123 starting with concept of feedbacks within the Earth System, global energy balance and the Greenhouse Effect. A brief introduction to the atmospheric and oceanic circulation will lead to the water cycle connecting the land, ocean, and atmosphere to the Earth System. Introduction to the Global carbon, nitrogen, and sulfur cycles will be followed by the concept of long-term climate regulation and short-term climate variability. The concepts of cycles, feedbacks, forcings, and responses in the Earth System will be applied to Global Warming and Ozone Depletion.

**Prerequisite:** MATH140; and (GEOG123, AOSC123, or GEOL123). Or permission of CMNS-Geology department.

**Recommended:** PHYS171, PHYS141, PHYS161, or MATH141.

**Restriction:** Non-degree-seeking students require the permission of the instructor. Cross-listed with GEOG346.

**Credit Only Granted for:** AOSC346, GEOG346, or GEOL346.

**GEOL351 Statistics for Geoscientists (3 Credits)**

Practical approach to basic statistics applied in the geosciences. Experimental design, elementary statistics and probability, sequence analysis, spatial analysis, linear regression, nonparametric statistics, bivariate, multivariate and principal components analysis of variance, hypothesis testing. Problem sets and participatory discussion of statistical applications in the current literature.

**Prerequisite:** MATH115.

**Restriction:** Non-degree-seeking students require the permission of the instructor.

**GEOL375 Introduction to the Blue Ocean (3 Credits)**

The global ocean is a major component of the Earth System that shapes life on earth, including our weather and climate. We explore the observation-based interdisciplinary science of oceanography, identifying its strong connections to related sciences like meteorology, and geography. We apply this developing understanding to environmental issues such as marine pollution, fish and fisheries, as well as to climate variability and to the changes to the marine environment that are resulting from steadily rising levels of atmospheric greenhouse gasses. Focusses include the biogeochemical and physical changes we can observe in the nearby Chesapeake Bay and the coastal waters of Eastern Shore, Maryland.

**Prerequisite:** MATH120 or higher.

**Recommended:** MATH121, MATH141, PHYS161, or PHYS171.

**Cross-listed with:** AOSC375.

**Credit Only Granted for:** AOSC375 or GEOL375.

**GEOL386 Experiential Learning (3-6 Credits)**

**Prerequisite:** Permission of CMNS-Geology department.

**Restriction:** Junior standing or higher.

**GEOL388 Field Studies II (3 Credits)**

Examination and investigation of Earth Science phenomena in the field, particularly geology. Involves field work of one week or a longer duration, which would normally involve both observations and data collection, with associated classroom lectures and/or laboratory study, normally including additional analysis of collected observations and data. Particular programs may require certain prerequisites. Permission of instructor required. Special fees may be necessary.

**Restriction:** Non-degree-seeking students require the permission of the instructor.

**Repeatable to:** 6 credits if content differs.

**GEOL391 Biology of Extinct Animals (3 Credits)**

A survey of extinct animals that have few, if any, direct living descendants. The principles governing the functional design of animals will be used to infer life styles for extinct, and frequently bizarre, organisms.

**Prerequisite:** Minimum grade of C- in BSCI160 and (BSCI180 or BSCI161).

**Cross-listed with:** BSCI392.

**Credit Only Granted for:** GEOL391 or BSCI392.

**GEOL392 Biology of Extinct Animals Laboratory (1 Credit)**

An overview of the techniques used in paleobiological reconstructions of extinct animals.

**Prerequisite:** Must have completed or be concurrently enrolled in BSCI392.

**Cross-listed with:** BSCI393.

**Credit Only Granted for:** GEOL392 or BSCI393.

**GEOL393 Geology Senior Thesis I: Proposal (3 Credits)**

The first semester of the two-semester Geology Senior Thesis. Emphasis is on developing a plan for original research in the geosciences and presenting that plan both in writing and in public presentations that adhere to geosciences professional standards.

**Prerequisite:** PHYS141 or (PHYS161 and PHYS174); and MATH141; and (CHEM131 and CHEM132) or (CHEM135 and CHEM136); and must have completed at least two upper-level geology courses and be concurrently enrolled in a third.

**Restriction:** Junior standing or higher; and must be in Geology program.

**GEOL394 Geology Senior Thesis II: Research (3 Credits)**

The second semester of the two-semester Geology Senior Thesis. Investigation of specific original research question in geosciences. Emphasis is on completion of original research proposed in GEOL393 and presentation of results both in writing and in public presentations that adhere to geosciences professional standards.

**Prerequisite:** GEOL393; and must have completed at least three upper level GEOL courses.

**Restriction:** Must be in Geology program; and junior standing or higher.

**GEOL412 Geology of the Terrestrial Planets (3 Credits)**

Geological features of Mercury, Venus, Mars and the Moon with an emphasis on results from recent NASA planetary mission. Topics include interior structure, impact cratering, tectonic and volcanic history, surface conditions, climate change, and habitability.

**Prerequisite:** GEOL341 or GEOL340.

**Credit Only Granted for:** GEOL489A or GEOL412.

**Formerly:** GEOL489A.

**GEOL413 Geoscientific Modeling (3 Credits)**

A model is a simplified representation of reality. Modeling is implicit or explicit in almost everything we do as geoscientists. Model construction, coding, and the concepts of parsimony vs complexity, robustness, validation, uncertainty, and the scientific interpretation of simulation results. Problem sets, independent study and participatory discussion of modeling applications in the current literature.

**Prerequisite:** MATH115; and two 400-level GEOL courses.

**Recommended:** Some experience in computer programming.

**Jointly offered with:** GEOL613.

**Restriction:** Non-degree-seeking students require the permission of the instructor.

**Credit Only Granted for:** GEOL413, GEOL489G, GEOL613 or GEOL789G.

**Formerly:** GEOL489G.

**GEOL423 Optical Mineralogy (4 Credits)**

The optical behavior of crystals with emphasis on the theory and application of the petrographic microscope.

**Prerequisite:** GEOL100 or GEOL120; and GEOL110; and GEOL322. And CHEM131 and CHEM132; or (CHEM135 and CHEM136); or CHEM103.

**Restriction:** Non-degree-seeking students require the permission of the instructor.

**GEOL431 Vertebrate Paleobiology (4 Credits)**

A survey of the evolution of the vertebrates, encompassing information from the diversity of living members, but concentrating on the contribution of the fossil record. Emphasis is on the phylogenetic systematics, comparative and functional anatomy, developmental biology, and stratigraphic distribution of major extinct and extant groups.

**Prerequisite:** BSCI207, BSCI392, GEOL104, GEOL204, or GEOL331; or permission of CMNS-Geology department.

**GEOL435 Environmental Geochemistry (3 Credits)**

An understanding of geochemical cycles of Earth's surface systems including soils, rivers, lakes, and estuaries and causes and implications of alteration of geochemical cycles. Topics include chemical weathering, soils, chemical composition of inland waters, hydrologic tracers, salinization, eutrophication, nutrient and metal pollution, and global geochemical cycles.

**Prerequisite:** MATH115; and (GEOL100 or GEOL120); and (GEOL436 or GEOL444). And CHEM131 and CHEM132; or (CHEM135 and CHEM136).

**Restriction:** Nondegree-seeking students require the permission of the instructor.

**Credit Only Granted for:** GEOL489W or GEOL435.

**Formerly:** GEOL489W.

**GEOL436 Principles of Biogeochemistry (3 Credits)**

An introduction to the basic principles of biogeochemistry including aspects of organic geochemistry, biochemistry, microbiology, global geochemical cycles, the origin of life and paleoenvironmental evolution.

**Prerequisite:** MATH120 or MATH140; or must have completed MATH220. And (GEOL100 or GEOL120); and GEOL322. And CHEM131 and CHEM132; or (CHEM135 and CHEM136).

**Cross-listed with:** AOSC436.

**Restriction:** Non-degree-seeking students require the permission of the instructor.

**Credit Only Granted for:** GEOL436 or AOSC436.

**GEOL437 Global Climate Change: Past and Present (3 Credits)**

Introduction to the processes by which climate varies, the paleoclimate record, and projections of climate change into the 21st century, including discussion of climate sensitivity to external radiative forcing.

**Prerequisite:** MATH115 or MATH140; and (GEOL100 or GEOL120); and (CHEM131 or CHEM135); and (CHEM132 or CHEM136).

**Cross-listed with:** AOSC437.

**Jointly offered with:** GEOL637, AOSC685.

**Credit Only Granted for:** GEOL437, GEOL637, AOSC437 or AOSC685.

**GEOL443 Petrology (4 Credits)**

Study of igneous and metamorphic rocks: petrogenesis, distributions, chemical and mineralogical relations, macroscopic and microscopic descriptions, geologic significance.

**Prerequisite:** GEOL322. And CHEM131 and CHEM132; or (CHEM135 and CHEM136); or CHEM103. And must have completed or be concurrently enrolled in GEOL423; and (GEOL100 or GEOL120); and GEOL110.

**Corequisite:** Permission of CMNS-Geology department.

**Restriction:** Non-degree-seeking students require the permission of the instructor.

**GEOL444 Low Temperature Geochemistry (4 Credits)**

Basic chemical principles, thermodynamics, and kinetics of low-temperature inorganic and organic geochemical reactions in a wide range of surface environments. These geochemical tools will be used to provide a context for understanding elemental cycling and climate change. Laboratories will include problem sets as well as wet chemical and mass spectrometric techniques used in low temperature geochemistry.

**Prerequisite:** GEOL322, GEOL100, and MATH115. And CHEM103; or (CHEM131 and CHEM132); or (CHEM135 and CHEM136).

**Restriction:** Non-degree-seeking students require the permission of the instructor.

**GEOL445 High Temperature Geochemistry (4 Credits)**

Review of chemical principles and their use in understanding processes of Earth, and solar system formation and differentiation. Topics include nucleosynthesis and cosmochemical abundances of elements, bonding and element partitioning, equilibrium thermodynamics and phase stabilities, radiogenic isotopes and geochronology, kinetics, and diffusion.

**Prerequisite:** GEOL322, GEOL100, and MATH115. And CHEM131 and CHEM132; or (CHEM135 and CHEM136); or CHEM103.

**Restriction:** Non-degree-seeking students require the permission of the instructor.

**GEOL446 Geophysics (3 Credits)**

An introduction to modern geophysics. Topics include: global plate tectonics, plate motion, triple junctions, geomagnetism, earthquakes and faulting, reflection and refraction seismology, gravity and isostasy, heat flow and mantle dynamics, deep interior of the Earth, geophysical observations and measurements.

**Prerequisite:** PHYS141, MATH141, and MATH140; and (GEOL100 or GEOL120).

**Restriction:** Non-degree-seeking students require the permission of the instructor.

**GEOL447 Observational Geophysics (3 Credits)**

An introduction to practical signal processing, data analysis, and inverse theory in geophysics.

**Prerequisite:** MATH140 and MATH141; and (PHYS141, PHYS161, or PHYS171).

**GEOL451 Groundwater (3 Credits)**

An introduction to the basic geologic parameters associated with the hydrologic cycle. Problems in the accumulation, distribution, and movement of groundwater will be analyzed.

**Prerequisite:** GEOL110 and MATH140; and (GEOL120 or GEOL100); and (CHEM131 and CHEM132; or (CHEM135 and CHEM136); or CHEM103). Or permission of CMNS-Geology department.

**Restriction:** Non-degree-seeking students require the permission of the instructor; and junior standing or higher.

**GEOL452 Watershed and Wetland Hydrology (3 Credits)**

Physical processes by which water moves in watershed and wetland systems. Topics include: precipitation, infiltration, flow in the unsaturated zone, streamflow generation processes, and groundwater flow.

**Restriction:** Junior standing or higher; and all other students require the permission of the instructor.

**GEOL453 Ecosystem Restoration (3 Credits)**

Overview of ecosystem functions across biomes/geologic settings, and considerations and tradeoffs in ecosystem restoration strategies. Specific case studies and discussions will be aimed at understanding how structure can influence biophysical and biogeochemical processes supporting ecosystems, and then describes how rates, timing, and location of physical, chemical, and ecosystem processes can be altered by different restoration strategies to enhance ecosystem services.

**Prerequisite:** MATH120 or MATH140; or must have completed MATH220. And (CHEM131 or CHEM135); and (CHEM132 or CHEM136); and (GEOL100, GEOL120, or ENST200).

**Restriction:** Junior standing or higher; and permission of instructor is required of non-degree-seeking students.

**Credit Only Granted for:** GEOL453 or GEOL489L.

**Formerly:** GEOL489L.

**GEOL455 Marine Geophysics (3 Credits)**

Plate tectonics, earthquakes and faulting, isostasy and gravity, heat and mantle dynamics, ocean ridges and transform faults, hydrothermal vents, trenches and oceanic islands, subduction zones, accretionary and erosion wedges, sedimentary basins and continental rifts. Exploration of the oceans using geophysical methods.

**Prerequisite:** MATH141 and MATH140; and (GEOL120 or GEOL100). Or permission of CMNS-Geology department.

**Restriction:** Non-degree-seeking students require the permission of the instructor.

**Credit Only Granted for:** GEOL455 or GEOL489E.

**Formerly:** GEOL489E.

**GEOL456 Engineering Geology (3 Credits)**

An overview of engineering geology with an emphasis on physical understanding of natural hazards and natural resources. General theories of stress and strain, failure criteria, frictional stability, fluid flow in porous media and poroelasticity are introduced. Quantitative approaches on earthquakes, landslides, land subsidence, and geotechnical aspects of oil/gas exploration are discussed.

**Prerequisite:** PHYS141 and MATH141; and (GEOL120 or GEOL100). Or permission of CMNS-Geology department.

**Restriction:** Non-degree-seeking students require the permission of the instructor.

**Credit Only Granted for:** GEOL456 or GEOL489Z.

**Formerly:** GEOL489Z.

**GEOL457 Seismology (3 Credits)**

General overview of the basics of seismology, starting with wave propagation, seismic reflection and refraction. Applications to the determination of the seismic velocity and anisotropy structure of the Earth. Earthquake generation, postseismic deformation and creep events, relation to faulting and plate tectonics.

**Prerequisite:** GEOL120 or GEOL100; and (MATH141, GEOL110, and MATH140). Or permission of CMNS-Geology department.

**Recommended:** PHYS171, PHYS141, or PHYS161.

**Restriction:** Non-degree-seeking students require the permission of the instructor.

**Credit Only Granted for:** GEOL457 or GEOL489A.

**Formerly:** GEOL489A.

**GEOL460 Field Geophysics (4 Credits)**

Students will become familiar with geophysical instrumentation used for both scientific and industrial applications. Students will be given an introduction to the use of geophysical instrumentation for data collection, processing, and analysis, design of field experiments for investigating field geophysical problems, and an introduction to the theory of instrument design and use. Instruments that will be covered include (but are not limited to): broadband seismometers, geophones, ground-penetrating radar, magnetotellurics, and Global Positioning Satellites.

**Prerequisite:** GEOL100 or GEOL120, MATH140, MATH141, and (PHYS141, PHYS161, or PHYS171).

**Restriction:** Non-degree-seeking students require the permission of the instructor.

**GEOL463 Economic Geology (3 Credits)**

The geological setting, and mineralogy of ore bodies, as well as the chemical and physical factors affecting the source, transport and deposition of metallic ores, petroleum and natural gas will be covered. The economics of mineral resources will be discussed.

**Prerequisite:** GEOL322; and (CHEM131 or CHEM135); and (CHEM132 or CHEM136).

**Restriction:** Non-degree-seeking students require the permission of the instructor.

**GEOL471 Geochemical Methods of Analysis (3 Credits)**

Principles and application of geochemical analysis as applied to a variety of geological problems. X-ray and optical spectroscopy, X-ray diffraction, atomic absorption, electron microprobe, and electron microscopy.

**Prerequisite:** CHEM131 and CHEM132; or (CHEM135 and CHEM136); or CHEM103.

**Restriction:** Non-degree-seeking students require the permission of the instructor.

**GEOL472 Active Tectonics (3 Credits)**

Provides overview of the theories, findings, and tools of Active Tectonics. The course is designed for graduate and senior undergraduate students who have basic mathematics background and have taken Structural Geology or relevant courses. Topics covered in this class include: stress and strain, crustal structure and lithosphere rheology, rock friction, geodesy, earthquake cycles, slow earthquakes, earthquake modeling, and earthquake hazards.

**Prerequisite:** GEOL341.

**Recommended:** GEOL340, GEOL447, GEOL457.

**Restriction:** Non-degree-seeking students require the permission of the instructor.

**GEOL473 Origin and Evolution of the Continents (3 Credits)**

Introduction to current theories regarding the origin and evolution of the continents. Emphasis on development of critical reading and reasoning skills, and improvement of verbal and written communication.

**Prerequisite:** GEOL445 and GEOL443; or permission of instructor.

**Restriction:** Non-degree-seeking students require the permission of the instructor.

**Formerly:** GEOL489I.

**GEOL488 Geology Colloquium (1 Credit)**

Contemporary research topics and issues in geosciences are explored through the weekly Geology departmental colloquium and discussion of its contents.

**Prerequisite:** At least one 300 or 400-level Geology course of at least 3 credits.

**Restriction:** May not be taken concurrently with GEOL497 or GEOL497H.

**Repeatable to:** 4 credits.

**GEOL489 Special Topics (3 Credits)**

Recent advances in geology.

**Prerequisite:** Must have completed at least 2 upper-level GEOL courses plus one additional GEOL course.

**Corequisite:** GEOL393.

**Restriction:** Must be in Geology program; and junior standing or higher.

**GEOL490 Geology Field Camp (6 Credits)**

Intense field geology course taught off campus during the summer. Students describe and compile maps of formations and structures from outcrops, subsurface, and remotely sensed data. Special fees required.

**Prerequisite:** GEOL341 and GEOL443.

**Restriction:** Non-degree-seeking students require the permission of the instructor.

**GEOL491 Environmental Geology Field Camp (3-6 Credits)**

Intensive field course designed for students of environmental geology. Students will learn to make maps, to describe soil profiles and site characteristics, to monitor hydrologic and groundwater conditions, and to measure geologic structures and stratigraphic sections.

**Prerequisite:** GEOL341, GEOL342, and GEOL451; or permission of CMNS-Geology department.

**Restriction:** Non-degree-seeking students require the permission of the instructor.

**Credit Only Granted for:** GEOL490 or GEOL491.

**GEOL497 Recent Advances: Geology (3 Credits)**

A survey of important recent advances in geological sciences in the context of the methods and practices of scientific research.

**Prerequisite:** Must have completed at least 2 upper-level GEOL courses.

**Corequisite:** GEOL393; and a third upper-level geology course.

**Restriction:** Must be in Geology program; and GPA of 3.0 or better in both overall and in all courses required for the major; and senior standing; and to be taken as late as possible in the program.

**Credit Only Granted for:** GEOL497 or GEOL489H.

**Formerly:** GEOL489H.

**GEOL499 Special Problems in Geology (1-3 Credits)**

Intensive study of a special geologic subject or technique selected after consultation with instructor. Intended to provide training or instruction not available in other courses which will aid the student's development in his or her field of major interest.

**Prerequisite:** (GEOL120 or GEOL100; and (GEOL102 and GEOL110)); or students who have taken courses with comparable content may contact the department. And permission of CMNS-Geology department.

**Restriction:** Non-degree-seeking students require the permission of the instructor.

**Repeatable to:** 15 credits if content differs.