

GEOSCIENCE (GEOSCI)

GEOSCI 100 – INTRODUCTORY GEOLOGY: HOW THE EARTH WORKS

3 credits.

Geologic processes; structure and history of the earth; earthquakes, volcanos, glaciers, groundwater, minerals, rocks, deserts, fossils; topographic and geologic maps; climate change on geologic and human time scales.

Requisites: Not open to students with credit for GEOSCI/ENVIR ST 106

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Describe the plate tectonic paradigm and how it relates to phenomena like earthquakes and volcanoes.

Audience: Undergraduate

2. Recognize landscape features and how they form.

Audience: Undergraduate

3. Describe the concept of geologic time.

Audience: Undergraduate

4. Recognize how water shapes Earth.

Audience: Undergraduate

5. Describe how life interacts with and shapes Earth.

Audience: Undergraduate

6. Recognize Earth energy and materials resources.

Audience: Undergraduate

7. Recognize key minerals and rocks.

Audience: Undergraduate

8. Read topographic and geologic maps.

Audience: Undergraduate

GEOSCI/ATM OCN/ENVIR ST 102 – CLIMATE AND CLIMATE CHANGE

3 credits.

Describes the basic climate principles governing the climate system. It describes the climate and climate variability at present, climate evolution in the past, and the projected climate change into the future. The scientific principles underlying the natural and anthropogenic greenhouse effect and climate model forecasts are elucidated.

Requisites: None

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Explain how climate has changed in the past and is projected to change in the future.

Audience: Undergraduate

2. Describe how the different components of Earth System affect the climate and how global warming will impact them.

Audience: Undergraduate

3. Connect physical climate changes to impacts on the environment, ecosystems, and people.

Audience: Undergraduate

4. Describe different adaptation and mitigation strategies.

Audience: Undergraduate

5. Explain how scientists study the climate.

Audience: Undergraduate

6. Describe the debate around climate change.

Audience: Undergraduate

GEOSCI/ATM OCN 105 – SURVEY OF OCEANOGRAPHY

3-4 credits.

Nature and behavior of ocean water, interaction of oceans and atmosphere, structure of the ocean floor, life in the oceans, our relationship to the marine environment.

Requisites: None

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Explain the processes that created the ocean basins.

Audience: Undergraduate

2. Explain the formation of seafloor features and landforms.

Audience: Undergraduate

3. Describe the major physical processes within the ocean.

Audience: Undergraduate

4. Describe ocean chemistry and processes of nutrient cycling.

Audience: Undergraduate

5. Describe the major surface and deep currents in the oceans and explain their causes and locations.

Audience: Undergraduate

6. Describe the major distribution, abundance, and production of marine species within the ocean.

Audience: Undergraduate

7. Explain how physical and chemical factors in the ocean affect the climate in the past, present, and future.

Audience: Undergraduate

GEOSCI/ENVIR ST 106 – ENVIRONMENTAL GEOLOGY

3 credits.

Application of geology to problems resulting from the ever more intense use of the earth and its resources.

Requisites: Not open to students with credit for GEOSCI 100

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Describe the materials that make up the earth and the natural processes that shape the earth over a variety of time scales.

Audience: Undergraduate

2. Use multiple lines of evidence (integrate multiple lines of data) to support or reject theories about Earth history, Earth processes, Earth hazards, and human impacts.

Audience: Undergraduate

3. Identify why various geologic resources, benefits, hazards, and constraints may be important in a given geologic environment, and support the explanation with evidence.

Audience: Undergraduate

4. Recognize the impacts of human actions and resource usage at regional, national, and global scales using available evidence.

Audience: Undergraduate

**GEOSCI 109 – THREE BILLION YEARS BENEATH YOUR FEET:
GEOLOGY OF THE NATIONAL PARKS**

3 credits.

Famously called "America's best idea", the National Parks of the US record two-thirds of Earth's history, from the most ancient mountains to active volcanic eruptions. The geologic story of the National Parks is explored in the framework of physiography, tectonics, time, and fundamental geologic processes, highlighting the major parks from Hawaii, to Alaska, to the conterminous US. Provides a view of the geological evolution of the Earth using specific examples.

Requisites: None

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Identify basic geologic concepts, including mineral and rock groups, geologic time, the geologic record of life, geologic structures, and plate tectonics.

Audience: Undergraduate

2. Identify the physiographic provinces of the US and how these are related to broad geologic and climatic factors.

Audience: Undergraduate

3. Compare the variety of tectonic processes that produce different mountain belts of the US, such as the Cascades, Sierra Nevada, Rockies, and Appalachians and how this affects the landscapes of the National Parks in these regions.

Audience: Undergraduate

4. Contrast the effects of recent and long-term climate change on the landscapes of the US, using specific National Parks as examples.

Audience: Undergraduate

5. Describe the interactions between humans and the environment in several physiographic provinces that host national parks and evaluate the current and future environmental challenges faced by organisms living in these regions.

Audience: Undergraduate

GEOSCI 110 – EVOLUTION AND EXTINCTION

4 credits.

Contemporary views of the origin and diversification of life and evolutionary processes; crises in the history of life, with emphasis on controversies regarding evolution, mass extinctions, and the co-evolution of Earth and life.

Requisites: None

Course Designation: Breadth - Biological Sci. Counts toward the Natural Sci req

Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Describe and appraise the arguments and evidence for evolution via natural selection.

Audience: Undergraduate

2. Describe the Central Dogma of molecular biology and define key molecular components therein.

Audience: Undergraduate

3. List key mechanisms involved in the regulation of gene expression during the development of organisms.

Audience: Undergraduate

4. Identify mechanisms that can result in speciation and extinction.

Audience: Undergraduate

5. Describe the nature of the fossil record as an archive for the history of life.

Audience: Undergraduate

6. Describe the methods used to partition and measure geological time and determine the age of the Earth and key evolutionary events.

Audience: Undergraduate

7. Describe macroevolution and characterize general macroevolutionary patterns in the fossil record.

Audience: Undergraduate

8. Define the basis for recognizing mass extinctions, their effects, and outline causal hypotheses.

Audience: Undergraduate

GEOSCI 117 – EX-FILES: LIFE IN THE EARTH'S EXTREME ENVIRONMENT

2 credits.

Explores the diversity of microbial life forms in modern and ancient geological environments, with a focus on extreme environments of geological origin or relevance. Includes exploration of unusual aspects of microbial life in everyday settings.

Requisites: None

Course Designation: Breadth - Biological Sci. Counts toward the Natural Sci req

Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Describe the potential for microbial life in extreme environments on Earth and other worlds.

Audience: Undergraduate

2. Apply fundamental concepts of biology and the chemistry of life to interpret the history of life of Earth in a geological context, and to evaluate possible modes of life in extraterrestrial environments.

Audience: Undergraduate

3. Utilize ribosomal RNA gene sequence information to determine the identity of unknown microorganisms and place them on the overall "Tree of Life".

Audience: Undergraduate

4. Read science news and other programs dealing with the history of life on Earth, as well as the potential metabolic basis for life on other worlds.

Audience: Undergraduate

5. Use on-line databases to obtain scientific information, summarize and document sources.

Audience: Undergraduate

6. Use hypothesis-driven inquiry to collect, analyze, and interpret simple experimental data obtained hands-on in the classroom.

Audience: Undergraduate

7. Use standard methods of scientific writing to produce laboratory reports and white papers.

Audience: Undergraduate

GEOSCI 118 – EYE IN THE SKY: MONITORING THE EARTH BY SATELLITE

1 credit.

Fundamentals of satellite imagery applied to the earth sciences. Basics of image interpretation. Multitemporal data. Resolution and uncertainty. Existing and emerging technologies. Orbits, wavelengths, and satellites. Socio-economic impact of remotely-sensed data.

Requisites: None

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Visualize examples of satellite imagery enabling earth science.

Audience: Undergraduate

2. Interpret a satellite image by identifying features, quantifying resolution, and determining scale.

Audience: Undergraduate

3. Discuss the current abilities, future potential, and limiting factors of satellite imagery.

Audience: Undergraduate

4. Recognize the importance of "ground truth" before drawing conclusions from remotely-sensed data.

Audience: Undergraduate

5. Apply critical thinking skills, particularly in spatial reasoning about satellite data.

Audience: Undergraduate

GEOSCI/ATM OCN 140 – NATURAL HAZARDS AND DISASTERS

3 credits.

An exploration of the science behind natural disasters including earthquakes, tsunamis, volcanic eruptions, landslides, tornadoes, hurricanes, and floods. Why, where, and when do these events occur, and why are some predictable but others are not? Addresses hazard assessment, forecasting, and mitigation to lessen their impact on society.

Requisites: None**Course Designation:** Breadth – Physical Sci. Counts toward the Natural Sci req

Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No**Last Taught:** Spring 2026**Learning Outcomes:** 1. Identify the underlying physical earth processes causing hazards including extreme weather, earthquakes, volcanic eruptions, tsunamis, landslides among others.

Audience: Undergraduate

2. Define hazard and risk and explain the difference between the two concepts.

Audience: Undergraduate

3. Apply methods of hazard mitigation and quantitative risk assessment.

Audience: Undergraduate

4. Utilize probabilistic forecasting of extreme events and their relative risks.

Audience: Undergraduate

5. Recognize the effects of anthropogenic climate change on hazard and risk due to changes in severity or frequency of hazardous events.

Audience: Undergraduate

6. Evaluate the advantages, disadvantages, and trade-offs among different policy responses to perceived hazards.

Audience: Undergraduate

7. Recognize how extreme events are related to the physical and chemical processes that form and shape our planet.

Audience: Undergraduate

GEOSCI/ASTRON 160 – LIFE IN THE UNIVERSE

2 credits.

An examination of the origin and evolution of life in the universe based on our knowledge of astronomy, biology, and geology. Includes discussions on the search for extraterrestrial life and the history of life in our solar system.

Requisites: None**Course Designation:** Breadth – Physical Sci. Counts toward the Natural Sci req

Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No**Last Taught:** Spring 2026**Learning Outcomes:** 1. Show how scientific reasoning and the scientific method are used to determine Earth's place within the solar system and the cosmos.

Audience: Undergraduate

2. Connect our current observations of exoplanets with their potential roles in the origin of life elsewhere in the Universe.

Audience: Undergraduate

3. Describe the physical and chemical limits of life on Earth to chart the potential for life on Mars and other worlds.

Audience: Undergraduate

4. Apply the genetic code to interpret the origin and evolution of life on Earth.

Audience: Undergraduate

5. Summarize key geologic events on Earth and Mars; interpret relationships between planetary tectonics and habitability.

Audience: Undergraduate

6. Explain the range of evidence in the rock record for early life on Earth and critique the fidelity of this record.

Audience: Undergraduate

7. Illustrate how quantitative approaches are used to analyze problems in astronomy, biology, and geology.

Audience: Undergraduate

GEOSCI 198 – DIRECTED STUDY

1-3 credits.

Independent study as arranged with a faculty member.

Requisites: Consent of instructor**Course Designation:** Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions**Last Taught:** Spring 2012

GEOSCI 199 – DIRECTED STUDY

1-3 credits.

Independent study as arranged with a faculty member.

Requisites: Consent of instructor

Course Designation: Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2023

GEOSCI 202 – INTRODUCTION TO GEOLOGIC STRUCTURES

4 credits.

Introduction to recognition and mapping of geologic structures in the field. Landforms, folds, faults, tectonics, geologic maps, and field instrumentation.

Requisites: GEOSCI 100 or ENVIR ST/GEOSCI 106

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Employ spatial reasoning skills to geological problems.

Audience: Undergraduate

2. Describe geological structures at the surface and below the surface of the Earth.

Audience: Undergraduate

3. Read and construct topographic and geologic maps.

Audience: Undergraduate

4. Read and construct geologic cross-sections.

Audience: Undergraduate

5. Determine temporal order of events from spatial patterns.

Audience: Undergraduate

6. Interpret geologic processes from observed landscape and bedrock patterns.

Audience: Undergraduate

GEOSCI 204 – GEOLOGIC EVOLUTION OF THE EARTH

4 credits.

Physical evolution of the earth and its relationship to the development of life through geologic time. Includes field trip.

Requisites: GEOSCI 100 or ENVIR ST/GEOSCI 106

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Explain the fundamental terminology and principles that form the foundation of the Earth Sciences.

Audience: Undergraduate

2. Recognize the geologic significance of common minerals, rocks, and fossils.

Audience: Undergraduate

3. Explain the rock records of tectonic processes, surficial processes, and climate change.

Audience: Undergraduate

4. Recognize and be able to articulate how plate tectonics has affected biological evolution, and how the history of evolution is recorded/expressed in the fossil record.

Audience: Undergraduate

5. Recognize the processes of mountain belt formation and post-orogenic erosion and/or extension and know the history of specific mountain belts that exemplify these processes.

Audience: Undergraduate

GEOSCI 304 – GEOBIOLOGY

3 credits.

An integrative approach to studying the interaction between the atmosphere, hydrosphere, biosphere, and geosphere as they have evolved during earth history. Overarching theme includes ocean-climate system changes, biogeochemical cycles, evolution from microbes to mammals, and critical events in life history.

Requisites: GEOSCI 204 or graduate/professional standing

Course Designation: Breadth - Biological Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Analyze fundamental processes that regulate environmental conditions on the surface of Earth.

Audience: Both Grad & Undergrad

2. Apply basic biological concepts to reveal the role of microbial metabolisms in nutrient and carbon cycling.

Audience: Both Grad & Undergrad

3. Examine how various geochemical proxies (i.e. isotopic systems) are used to study biogeochemical cycles.

Audience: Both Grad & Undergrad

4. Investigate the evolutionary tree of life on Earth and how it is reconstructed.

Audience: Both Grad & Undergrad

5. Analyze processes that drive speciation and extinction.

Audience: Both Grad & Undergrad

6. Characterize watershed events that have contributed to the evolutionary history of Life on Earth.

Audience: Both Grad & Undergrad

7. Read the published literature in geobiology.

Audience: Both Grad & Undergrad

8. Compare findings from multiple published papers with competing interpretations of the geobiological record.

Audience: Graduate

GEOSCI/GEOG 320 – GEOMORPHOLOGY

3 credits.

Principles and analysis of geomorphic processes and resulting land forms.

Requisites: GEOSCI/ENVIR ST 106, GEOSCI 100, 109, 204, ENVIR ST/ GEOG 120, 127 or graduate/professional standing

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2025

Learning Outcomes: 1. Recognize the processes that cause rivers to transport sediment.

Audience: Both Grad & Undergrad

2. Recognize the processes by which glaciers slip over or deform their beds and produce landforms.

Audience: Both Grad & Undergrad

3. Recognize the processes that govern hill slope stability.

Audience: Both Grad & Undergrad

4. Identify and explain the processes that govern the geomorphology of coastal regions.

Audience: Both Grad & Undergrad

5. Describe why parts of Wisconsin look the way they do.

Audience: Both Grad & Undergrad

6. Calculate glacier sliding speeds from glacier profiles.

Audience: Graduate

7. Calculate sediment transport by rivers.

Audience: Graduate

GEOSCI 331 – GEMS: THE SCIENCE BEHIND THE SPARKLE

1-2 credits.

Explores the formation, collection, properties, and treatment of many popular gemstones.

Requisites: Junior standing

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Recognize common / popular gems and their corresponding minerals in geological environments.

Audience: Undergraduate

2. Recognize factors that affect the quality and value of gems.

Audience: Undergraduate

3. Summarize differences among natural gems, enhanced gems, synthetic gems, and simulants.

Audience: Undergraduate

GEOSCI/ATM OCN/ENVIR ST/ GEOG 335 – CLIMATIC ENVIRONMENTS OF THE PAST

3 credits.

Climate change at timescales from the last several million years to the last 100 years, with emphasis on more recent timescales. Examines how climate variability arises from interplay between external forcings, feedbacks within the earth system, and (more recently) human activity.

Requisites: Sophomore standing

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Describe the major climatic events and trends during the Quaternary, spanning timescales from the last 50,000,000 years to the last 100 years.

Audience: Undergraduate

2. Identify the physical processes controlling the behavior of the earth system and its components (atmosphere, oceans, cryosphere, biosphere, etc.).

Audience: Undergraduate

3. Discuss how climatic variability results from a combination of external forcings and internal dynamics within the earth system.

Audience: Undergraduate

4. Recognize how paleoclimatologists collect, date, and analyze a staggering variety of paleoclimatic records, including ocean and lake sediment cores, ice cores, tree rings, corals, and speleothems.

Audience: Undergraduate

5. Analyze and critically evaluate climate experiments that are simulated by earth system models.

Audience: Undergraduate

6. Think and write critically, with particular attention to critically reading the scientific literature and critically employing the climate proxies and models used by paleoclimatologists.

Audience: Undergraduate

GEOSCI/G L E 350 – INTRODUCTION TO GEOPHYSICS: THE DYNAMIC EARTH

3 credits.

Methods of geophysics applied to earth structure and plate tectonics.

Principles of seismology, gravity, geodesy, magnetism and heat flow.

Requisites: MATH 217, 221, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Recognize at least three factors to consider during the design of a geophysical survey.

Audience: Both Grad & Undergrad

2. Show how the travel times, amplitudes, and polarities of different kinds of seismic waves can be used to locate earthquakes, determine their focal mechanisms, and estimate their size.

Audience: Both Grad & Undergrad

3. Describe how the thicknesses and seismic velocities of geologic units can be estimated from seismic refractions and reflections.

Audience: Both Grad & Undergrad

4. Describe the factors that cause variations in gravitational acceleration across Earth's surface, and explain how gravity anomalies can be used to estimate variations in mass at depth.

Audience: Both Grad & Undergrad

5. Draw Earth's magnetic field lines, describe how rocks record information about Earth's paleomagnetic field, and describe how paleomagnetic measurements can be used to infer movement of Earth's tectonic plates through time.

Audience: Both Grad & Undergrad

6. Define the concept of "magnetic anomaly", describe how magnetic surveys can be used for local studies of the subsurface, and describe circumstances in which magnetic surveys may be useful.

Audience: Both Grad & Undergrad

7. Define geotherm and describe why temperatures increase with depth below Earth's surface.

Audience: Both Grad & Undergrad

8. State the theory of plate tectonics and describe at least three kinds of supporting evidence, enumerate the major types of tectonic plate boundaries and the type of movement that occurs at each, and describe what drives the movements of the plates.

Audience: Both Grad & Undergrad

9. Explain the relationship between gravitational force and mass.

Audience: Graduate

10. Describe the factors that cause variations in gravitational acceleration across Earth's surface.

Audience: Graduate

11. Explain how gravity anomalies are used to estimate variations in mass at depth.

Audience: Graduate

GEOSCI/G L E 360 – PRINCIPLES OF MINERALOGY

3 credits.

Minerals, their physical and chemical properties, crystallography, and geologic significance.

Requisites: (GEOSCI 100 or ENVIR ST/GEOSCI 106) and (CHEM 103, 109, 115, or concurrent enrollment), graduate/professional standing, or member of Engineering Guest Students

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Use a petrographic microscope for mineral identification.

Audience: Both Grad & Undergrad

2. Identify around 40 common minerals (around 30 silicate minerals, and around 10 oxide, carbonate, and sulfide minerals).

Audience: Both Grad & Undergrad

3. Describe and apply concepts of phase transformations and solid solutions in minerals and factors that control the changes.

Audience: Both Grad & Undergrad

4. Determine the history (formation condition and possible changes / reactions) of a rock based on associated minerals and textures.

Audience: Both Grad & Undergrad

5. Write reports based on thin section observations.

Audience: Both Grad & Undergrad

6. Determine and correlate mineralogical changes with seismic discontinuities in the Earth's mantle based on crystal chemistry principles.

Audience: Both Grad & Undergrad

7. Explain the basics of nano-phase minerals in earth surface environments and their potential impacts on/in water and air.

Audience: Both Grad & Undergrad

8. Evaluate relevant scientific literature related to mineralogy and crystallography.

Audience: Graduate

GEOSCI/G L E 370 – ELEMENTARY PETROLOGY

3 credits.

Igneous and metamorphic rocks, studied in hand sample and thin section.

Requisites: G L E/GEOSCI 360, graduate/professional standing, or member of Engineering Guest Students**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No**Last Taught:** Spring 2026**Learning Outcomes:** 1. Identify, describe, and classify crystalline rocks.

Audience: Both Grad & Undergrad

2. Use phase equilibria and phase diagrams for interpreting rock petrogenesis.

Audience: Both Grad & Undergrad

3. Describe the main processes and tectonic settings of magma generation and diversification.

Audience: Both Grad & Undergrad

4. Interpret trace elements and isotope diagrams to determine igneous petrogenesis.

Audience: Both Grad & Undergrad

5. Describe conditions and main tectonic settings of metamorphism.

Audience: Both Grad & Undergrad

6. Identify and describe metamorphic textures and fabrics.

Audience: Both Grad & Undergrad

7. Evaluate relevant scientific literature related to igneous and metamorphic petrology.

Audience: Graduate

GEOSCI/ENVIR ST/G L E/GEOG/LAND ARC 371 – INTRODUCTION TO ENVIRONMENTAL REMOTE SENSING

3 credits.

Introduction to the Earth as viewed from above, focusing on use of aerial photography and satellite imagery to study the environment. Includes physical processes of electromagnetic radiation, data types and sensing capabilities, methods for interpretation, analysis and mapping, and applications.

Requisites: (Sophomore standing and MATH 113, 114, or 171), graduate/professional standing, or member of Engineering Guest Students**Course Designation:** Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No**Last Taught:** Spring 2026**Learning Outcomes:** 1. Demonstrate understanding of major theories, approaches, concepts, and methods in remote sensing science.

Audience: Undergraduate

2. Apply knowledge of the nature and properties of electromagnetic radiation and how it is affected by interactions with the atmosphere and the Earth's surface.

Audience: Undergraduate

3. Utilize the techniques, skills, and modern tools necessary for monitoring environmental phenomena with earth observation data.

Audience: Undergraduate

4. Know and effectively apply image analysis, data extraction, and map-making using earth observation data.

Audience: Undergraduate

5. Demonstrate how to analyze remote sensing data using photo-interpretation, digital image processing, and photogrammetric techniques using specialized software, within geographic information systems (GIS), and in conjunction with other data sources.

Audience: Undergraduate

6. Demonstrate how to perform classification, change detection, data fusion, and radiometric and geometric correction techniques.

Audience: Undergraduate

7. Identify and appropriately utilize data types from the optical, thermal, and microwave portions of the electromagnetic spectrum, and from a wide range of airborne and satellite platforms, including high (>5 m), medium (10-30 m), and coarse (250-1000 m) spatial resolution imagery.

Audience: Undergraduate

8. Demonstrate knowledge about environmental applications of remote sensing data, such as forest inventory, water resource management, agricultural assessment, land use planning, and global change science.

Audience: Undergraduate

9. Write clear and concise laboratory reports (in scientific format) describing analytical results from image classification and change detection experiments.

Audience: Undergraduate

10. Communicate effectively through discussion, small group work, hands-on lab activities, and written reports.

Audience: Undergraduate

GEOSCI 375 – PRINCIPLES OF GEOCHEMISTRY

3 credits.

Provides a chemical basis for understanding the origin, evolution, distribution and interactions of chemical elements and isotopes between the lithosphere, hydrosphere, biosphere, and atmosphere in geological and environmental processes.

Requisites: G L E/GEOSCI 360, (CHEM 109, 104, or 115) and G L E/GEOSCI 370 or concurrent enrollment in G L E/GEOSCI 370, or graduate/professional standing

Course Designation: Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Explain the principles of inorganic chemical bonds.

Audience: Both Grad & Undergrad

2. Explain elementary thermodynamics and its basis underlying petrologic phase diagrams.

Audience: Both Grad & Undergrad

3. Explore how major- and trace-element geochemistry can constrain the evolution of the Earth's mantle and crust in relation to plate tectonics.

Audience: Both Grad & Undergrad

4. Apply the principles of radioactive decay to geochronology using common radioactive isotope systems employed in the geosciences.

Audience: Both Grad & Undergrad

5. Explain the principles of stable isotope geochemistry and how it applies to the hydrologic system, fluid-rock interaction, and evolution of the oceans and biosphere.

Audience: Both Grad & Undergrad

6. Utilize equilibrium speciation calculations in aqueous electrolyte solutions, including use of public-domain geochemical simulation software.

Audience: Both Grad & Undergrad

7. Use information on geochemical reaction pathways and earth-surface physical processes to determine key low-temperature processes such as sediment diagenesis, chemical weathering, and organic matter decomposition.

Audience: Both Grad & Undergrad

8. Synthesize multiple types of geochemical information, obtained from the rock record, to explain specific worldwide changes in Earth's past.

Audience: Graduate

GEOSCI 376 – TOPICS IN GEOLOGY

1-3 credits.

Special topics or discussions of recent research in Geoscience.

Requisites: Consent of instructor

Course Designation: Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2025

Learning Outcomes: 1. Evaluate research in a specific field.

Audience: Undergraduate

2. Assess scientific information and ask thoughtful questions.

Audience: Undergraduate

3. Communicate scientific material to peers.

Audience: Undergraduate

GEOSCI 402 – RESEARCH AND COMMUNICATION IN THE GEOLOGICAL SCIENCES

3 credits.

Skills and strategies to conduct research in the geological sciences, including collection of data, analysis of the data, generation of models to explain the data, and clear communication of both the research process and results. As part of the research process, find, evaluate, and utilize information in the existing scientific literature. Practice effective scientific communication skills, including writing, oral presentations, and producing effective visualizations.

Requisites: Senior standing and declared in Geology and Geophysics

Course Designation: Gen Ed - Communication Part B

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Learn about how information is produced and disseminated in the geological sciences.

Audience: Undergraduate

2. Effectively and efficiently read the scientific literature for content - a foundation for life-long learning that is key to a successful career.

Audience: Undergraduate

3. Critically evaluate the primary literature including the nature of evidence, the logic of the approach, and appropriateness of the analyses to the addressed problem. This explicitly includes critical reading, logical thinking, quantitative analyses, and the use of evidence.

Audience: Undergraduate

4. Develop skills and strategies needed to find, evaluate, and utilize information in the geological sciences.

Audience: Undergraduate

5. Clearly communicate – both in writing and orally – the results of scientific investigation.

Audience: Undergraduate

6. Effectively use diagrams and graphs to explain scientific data.

Audience: Undergraduate

GEOSCI/ENVIR ST 411 – ENERGY RESOURCES

3 credits.

A critical examination of the full spectrum of renewable and nonrenewable energy options, from the unifying perspective of the Earth systems that govern their use. Energy conversion and efficiency, consumption patterns and trends, and environmental consequences of energy production and use.

Requisites: Sophomore standing

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Summer 2025

Learning Outcomes: 1. Explain the origins of both renewable and non-renewable energy resources.

Audience: Both Grad & Undergrad

2. Explain the dependency of energy resources on natural and geologic processes.

Audience: Both Grad & Undergrad

3. Describe how changing technology impacts energy resource utilization.

Audience: Both Grad & Undergrad

4. Analyze and interpret the constraints and negative consequences of renewable and non-renewable energy resources.

Audience: Both Grad & Undergrad

5. Discuss how energy use has changed since the industrial revolution and how evolving energy use impacts the climate and environment.

Audience: Both Grad & Undergrad

6. Evaluate relevant scientific literature related to energy resources.

Audience: Graduate

GEOSCI/GEOG 420 – GLACIAL AND PLEISTOCENE GEOLOGY

3 credits.

Principles, characteristics and work of glaciers; events of the Pleistocene. Field trip.

Requisites: GEOSCI/ENVIR ST 106, GEOSCI 100, 109, ENVIR ST/GEOG 120, 127, or graduate/professional standing

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2025

Learning Outcomes: 1. Explain the processes that cause ice deformation in a glacier.

Audience: Both Grad & Undergrad

2. Explain the processes by which glaciers slip over or deform their beds.

Audience: Both Grad & Undergrad

3. Identify subglacially and proglacially derived landforms and explain the processes that produce them.

Audience: Both Grad & Undergrad

4. Explain in general terms the history of ice advance during the later stages of the Pleistocene and the effects it had on glacial geomorphic record.

Audience: Both Grad & Undergrad

5. Assess how climate affected glacial processes.

Audience: Both Grad & Undergrad

6. Describe why glaciated parts of Wisconsin look the way they do.

Audience: Both Grad & Undergrad

7. Interpret glacial features and deposits while in the field.

Audience: Graduate

GEOSCI 430 – SEDIMENTOLOGY AND STRATIGRAPHY

3 credits.

Comprehensive survey of the processes and products of sedimentation, including depositional environments, sedimentary tectonics, sequence stratigraphic principles, and analytical methods.

Requisites: GEOSCI 204 and G L E/GEOSCI 370, or graduate/professional standing

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Describe qualitatively and quantitatively the chemical and physical processes that are involved in the production, transportation, and deposition of sediments.

Audience: Both Grad & Undergrad

2. Describe how sediment composition and sedimentary structures reflect sediment production and transport processes.

Audience: Both Grad & Undergrad

3. Characterize sedimentary depositional environments and deposits formed in them.

Audience: Both Grad & Undergrad

4. Enumerate sedimentary basin types and qualitatively compare and contrast their stratigraphic successions.

Audience: Both Grad & Undergrad

5. Critique primary scientific literature.

Audience: Both Grad & Undergrad

6. Extract and evaluate data from scientific papers and online databases.

Audience: Both Grad & Undergrad

7. Produce new synthetic results in written form.

Audience: Both Grad & Undergrad

8. Produce a regional macrostratigraphic summary for a focal region and present quantitative results in poster form.

Audience: Graduate

GEOSCI/G L E 431 – SEDIMENTARY & STRATIGRAPHY LAB

1 credit.

Covers Sedimentology and Stratigraphy; emphasizes qualitative and quantitative description and interpretation of sediments and sedimentary deposits.

Requisites: GEOSCI 204 or G L E/GEOSCI 360, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

GEOSCI/CIV ENGR/ENVIR ST/G L E 444 – PRACTICAL APPLICATIONS OF GPS SURVEYING

2 credits.

Global positioning system surveying for field applications. Signals. Coordinate systems. Datums. Cartographic projections. Satellite orbits. Choosing hardware. Strategies for data collection and analysis. Assessing uncertainty. Geocoding satellite images. Integrating data with Geographic Information Systems. Emerging technologies.

Requisites: MATH 211, 217, 221, or graduate/professional standing, or member of Engineering Guest Students

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Describe the current abilities, future potential, and limiting factors of GPS surveys.

Audience: Both Grad & Undergrad

2. Assess the tradeoff between accuracy and cost.

Audience: Both Grad & Undergrad

3. Summarize examples of applications of GPS surveying.

Audience: Both Grad & Undergrad

4. Design and implement a small field project using GPS surveying.

Audience: Both Grad & Undergrad

5. Assess quantitatively statistical precision and calibrated accuracy.

Audience: Graduate

GEOSCI/G L E 455 – STRUCTURAL GEOLOGY

4 credits.

Principles of rock deformation, structures in layered rocks, structural analysis, intrusive structures. Lab: three-dimensional problems involving structural concepts; field trip.

Requisites: GEOSCI 202, 204, and (G L E/GEOSCI 370 or concurrent enrollment), graduate/professional standing, or member of Engineering Guest Students

Course Designation: Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Use conceptual models as a foundation for quantitative analysis of physical processes of interest to geologists and engineers.

Audience: Both Grad & Undergrad

2. Summarize and articulate parameters influencing the geometries and types of geologic structures resulting from deformation in different tectonic environments.

Audience: Both Grad & Undergrad

3. Recognize common geological structures and determine their kinematic, dynamic, and rheologic significance.

Audience: Both Grad & Undergrad

4. Characterize rock deformation quantitatively.

Audience: Both Grad & Undergrad

5. Utilize a range of common approaches to documenting, representing, and manipulating structural data.

Audience: Both Grad & Undergrad

6. Recognize patterns formed from isolated data points to construct an appropriate conceptual model of a 3D geologic structure.

Audience: Both Grad & Undergrad

7. Extract and convey three-dimensional information using two-dimensional diagrams.

Audience: Both Grad & Undergrad

8. Analyze kinematic, dynamic, and rheological approaches to specific field settings.

Audience: Graduate

GEOSCI 456 – GEOLOGIC FIELD METHODS

2 credits.

Theory and techniques of geologic mapping; field trips.

Requisites: G L E/GEOSCI 455 or concurrent enrollment

Course Designation: Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2026

GEOSCI 457 – CONDUCTED FIELD TRIP

2 credits.

Study of the principles and methods of geologic mapping.

Requisites: G L E/GEOSCI 370 or concurrent enrollment**Course Designation:** Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No**Last Taught:** Spring 2026**GEOSCI/CIV ENGR/G L E/M S & E 474 – ROCK MECHANICS**

3 credits.

Classification of rock masses, stress and strain in rock, linear and non-linear behavior of rock, failure mechanisms, state of stress in rock masses, lab testing, geological and engineering applications.

Requisites: E M A 201, PHYSICS 201, 207, or 247, or graduate/professional standing, or member of Engineering Guest Students**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No**Last Taught:** Spring 2026**Learning Outcomes:** 1. Measure basic index properties for rock mass classification

Audience: Both Grad & Undergrad

2. Describe stress and strain in continuums

Audience: Both Grad & Undergrad

3. Describe the factors which control the mechanical behavior of rocks

Audience: Both Grad & Undergrad

4. Apply basic concepts of rock mechanics and rock physics to analyze basic geomechanical engineering problems

Audience: Both Grad & Undergrad

5. Prepare rock samples for mechanical testing, conduct experiment, and analyze experimental data to obtain rock strength properties

Audience: Both Grad & Undergrad

6. Describe analytically time-dependent rock behaviors

Audience: Graduate

GEOSCI/HIST SCI 514 – HISTORY OF GEOLOGIC THOUGHT

3 credits.

Major concepts from earliest to modern times.

Requisites: GEOSCI 204 or graduate/professional standing**Course Designation:** Breadth - Humanities

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No**Last Taught:** Spring 2024**Learning Outcomes:** 1. Describe the progression of ideas in the history of the geological sciences.

Audience: Both Grad & Undergrad

2. Discuss controversies that have existed in geology and how they have been resolved.

Audience: Both Grad & Undergrad

3. Provide a detailed understanding of the theory of continental drift and its relationship to the theory of plate tectonics.

Audience: Both Grad & Undergrad

4. Analyze and evaluate both the nature of science and the process of science, as applied to specific historical developments in geology.

Audience: Both Grad & Undergrad

5. Generate a history in one's subfield in geology or about a specific geologic controversy.

Audience: Graduate

GEOSCI 515 – PRINCIPLES OF ECONOMIC GEOLOGY

4 credits.

Composition, structure, occurrence, origin, and economic investigation of important groups of mineral deposits; problems of mineral deposition.

Requisites: GEOSCI 204 and G L E/GEOSCI 370, or graduate/professional standing

Course Designation: Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Students will be able to identify common ore minerals in a variety of deposit types.

Audience: Undergraduate

2. Students will be able to identify and interpret common alteration types that accompany hydrothermal alteration in mineralized rocks.

Audience: Undergraduate

3. Students will be able to understand and explain the basics of stable and radiogenic isotopic systems and their application to ore deposit research.

Audience: Undergraduate

4. Students will be able to tell the history (formation condition and possible changes / reactions) of a deposit based on associated minerals and textures.

Audience: Undergraduate

5. Students will be able to synthesize research and develop hypotheses with respect to mineral abundances in different geologic environments.

Audience: Graduate

6. Students will be able to conceptualize the 3D distribution of mineral deposits in the crust of the earth.

Audience: Undergraduate

7. Students will be able to recognize the overall role of plate tectonics in the distribution of ore deposits.

Audience: Undergraduate

8. Students will come to recognize the role of the evolution of the Earth's systems over 4.5 Ga in the formation of ore deposits.

Audience: Undergraduate

GEOSCI/G L E 537 – QUANTITATIVE METHODS FOR GEOSCIENCE

3 credits.

MATLAB is a powerful, high-level programming language and integrated development environment (IDE) that is used across a broad variety of scientific disciplines for tasks including data visualization, modeling, and application development. Focus on the active use of MATLAB for developing practical programming and data analysis skills that can be applied across a range of geoscience- relevant problems. Applications will include: data visualization and publishable figure development; automation of data processing; statistical and time-series analysis; image processing and mapping; and optimization. Additional topics may be guided by student interest.

Requisites: MATH 222, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Utilize an integrated development environment and documentation to solve geoscientific problems.

Audience: Both Grad & Undergrad

2. Interpret code in a high-level programming language to explain what an existing program does.

Audience: Both Grad & Undergrad

3. Organize geologic data and store them using appropriate data structures.

Audience: Both Grad & Undergrad

4. Develop basic algorithms by using key programming structures including: for-next loops, if-then-else statements, built-in functions, and other custom-built functions.

Audience: Both Grad & Undergrad

5. Plan, design and create a useful, well-documented computer program/utility that has general applicability.

Audience: Graduate

6. Develop codes that apply appropriate spatio-temporal data analysis routines to geologic datasets.

Audience: Graduate

7. Integrate data from several data sources to produce publication-ready maps or other geologically relevant figures.

Audience: Graduate

8. Implement quantitative models for geologic processes using appropriate analytical or numerical toolboxes.

Audience: Graduate

GEOSCI/ZOOLOGY 542 – INVERTEBRATE PALEONTOLOGY

3 credits.

The evolutionary history, morphology, and ecology of fossil invertebrates. Labs emphasize fossil identification and recognition of basic morphological features.

Requisites: (GEOSCI 110 or 204), (ZOOLOGY/BIOLOGY 101 and 102), ZOOLOGY/BIOLOGY/BOTANY 152, (BIOCORE 381 and 382), or graduate/professional standing.

Course Designation: Breadth – Biological Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2024

Learning Outcomes: 1. Identify fossils of marine invertebrate animals in the rock record.

Audience: Both Grad & Undergrad

2. Describe the processes involved in fossilization of marine invertebrate animals.

Audience: Both Grad & Undergrad

3. Recognize the hierarchical taxonomic classification of marine invertebrate animals and how it reflects their evolutionary histories.

Audience: Both Grad & Undergrad

4. Use fossils to infer past environmental and ecological conditions.

Audience: Both Grad & Undergrad

5. Use fossils to constrain the age of sedimentary rocks (i.e. biostratigraphy).

Audience: Both Grad & Undergrad

6. Summarize how the fossil record is used to reconstruct Earth history.

Audience: Both Grad & Undergrad

7. Evaluate relevant scientific literature related to invertebrate paleontology.

Audience: Graduate

GEOSCI 551 – PALEOCEANOGRAPHY

3 credits.

Investigates the history of the Earth's oceans, focusing on the last 65 million years, with discussion of the chemical and physical methods through which oceans are studied and the role of oceans in the climate system.

Requisites: GEOSCI 100, 110, ATM OCN/GEOSCI 105, ENVIR ST/GEOSCI 106, or graduate/professional standing

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Explain the major climatic and oceanographic events and trends during the Cretaceous through the Cenozoic, spanning timescales from the last 150,000,000 years to the last 1,000 years. For this class emphasis is placed on the global climate and oceanographic systems, with some attention to regional changes.

Audience: Both Grad & Undergrad

2. Explain the physical processes controlling the behavior of the earth system and its related components (atmosphere, oceans, cryosphere, biosphere, etc.), and to articulate how oceanic/climatic variability results from a combination of external forcings and internal dynamics within the earth system.

Audience: Both Grad & Undergrad

3. Understand how paleoceanographers collect, date, and analyze a staggering variety of deep-sea records, as well as other paleoclimate archives as they pertain to oceanic and climate processes including ocean and lake sediment cores, ice cores, and speleothems.

Audience: Both Grad & Undergrad

4. Develop skills in critical thinking and technical writing, with particular attention to critically reading the scientific literature and critically evaluating the climate proxies and model simulations used by paleoceanographers.

Audience: Both Grad & Undergrad

5. Both explain and critically evaluate the data on which the majority of our ocean/climate knowledge of the last 150,000,000 years is based.

Audience: Graduate

6. Both explain and assess the external forcings and internal dynamics within the earth system and across the different earth spheres.

Audience: Graduate

7. Critically evaluate the scientific literature and provide your own perspective on the literature discussion and conclusions.

Audience: Graduate

GEOSCI 556 – MOUNTAIN BELTS

3 credits.

Examination of interaction of tectonic plates and the resulting structures.

Requisites: G L E/GEOSCI 455 or graduate/professional standing

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Explain the overall tectonic development of a specific mountain belt (e.g., the western Cordillera).

Audience: Both Grad & Undergrad

2. Explain how movement of tectonic plates relates to deformation within the mountain belt (e.g., summarize current theories).

Audience: Both Grad & Undergrad

3. Demonstrate how using the earth's magnetic field (paleomagnetism) can be used in tectonic reconstructions.

Audience: Both Grad & Undergrad

4. Identify different aspects of an orogenic belt in both cross section and map view.

Audience: Both Grad & Undergrad

5. Synthesize the tectonic history of a specific area or process in a mountain belt.

Audience: Graduate

GEOSCI 557 – STRUCTURAL PETROLOGY

3 credits.

Petrographic investigation of rock fabrics and deformation using thin sections. Use of petrographic microscopes and Scanning Electron Microscopes (SEMs).

Requisites: G L E/GEOSCI 370 and 455, or graduate/professional standing

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2023

Learning Outcomes: 1. Recognize a wide range of deformation-related features in hand sample and thin section.

Audience: Both Grad & Undergrad

2. Recognize the interplay of physical and chemical processes in forming microstructure.

Audience: Both Grad & Undergrad

3. Explain the role of fluid-rock interaction during deformation.

Audience: Both Grad & Undergrad

4. Read scientific literature on various topics in structural petrology.

Audience: Both Grad & Undergrad

5. Evaluate new microstructural data or data in journal articles using analytical and/or statistical tools.

Audience: Graduate

GEOSCI/G L E 594 – INTRODUCTION TO APPLIED GEOPHYSICS

3 credits.

Survey of applied geophysics, including seismic refraction, seismic reflection, electrical resistivity, gravity, and magnetics methods. Basic physics of each method and modeling techniques and field procedures.

Requisites: MATH 222 and (PHYSICS 202, 208, 248, or E M A 202), graduate/professional standing, or member of Engineering Guest Students

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Describe the fundamental physics underlying applied geophysical methods and how these measurements and techniques are used to explore and characterize the near surface.

Audience: Both Grad & Undergrad

2. Describe the limitations of geophysical techniques and tools.

Audience: Both Grad & Undergrad

3. Describe the field procedures employed to collect geophysical data.

Audience: Both Grad & Undergrad

4. Use geophysical techniques to interpret and analyze geophysical data collected for applied and engineering purposes.

Audience: Both Grad & Undergrad

5. Evaluate the application of geophysical technique through critical analysis of published literature.

Audience: Graduate

GEOSCI/G L E 595 – FIELD METHODS IN APPLIED AND ENGINEERING GEOPHYSICS

1 credit.

The application of geophysical field methods for delineating near-surface features and/or structures as applied to engineering, environmental and exploration problems.

Requisites: GEOSCI/G L E 594 or concurrent enrollment, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Utilize different geophysical tools.

Audience: Both Grad & Undergrad

2. Analyze geophysical data with the help of computer modeling tools.

Audience: Both Grad & Undergrad

3. Report geophysical measurements and interpretations.

Audience: Both Grad & Undergrad

4. Design field-based surveys that use different geophysical techniques.

Audience: Both Grad & Undergrad

5. Report the geology of a site and the requirements for engineering and environmental applications to geophysical techniques.

Audience: Graduate

GEOSCI/G L E 596 – GEOMECHANICS

3 credits.

Observation, description, and prediction of deformation of geomechanical systems at depth, and the forces (stress) causing those deformations, relevant for petroleum/geothermal reservoirs and studies of earthquake mechanics. Emphasis on computational exercises using datasets from the petroleum industry and earthquake catalogues, as well as prediction of ground deformation.

Requisites: GEOSCI/CIV ENGR/G L E/M S & E 474, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2022

Learning Outcomes: 1. Conduct a borehole geomechanical analysis

Audience: Both Grad & Undergrad

2. Design casing plans for drilling

Audience: Both Grad & Undergrad

3. Use borehole data and earthquake focal mechanisms to gain information about in-situ stress and strain

Audience: Both Grad & Undergrad

4. Describe modern challenges in developing subsurface energy resources

Audience: Both Grad & Undergrad

5. Use modern software to find crustal deformation models that match observed ground deformation

Audience: Graduate

GEOSCI 610 – GEOCHRONOLOGY, TIMESCALES, AND RATES OF GEOLOGIC PROCESSES

3 credits.

Application of radioisotopic (Ar-Ar, U-Pb, U-Th, U-He) and cosmogenic (He, Ne, Cl, Be, C) dating methods. Status of geologic, astronomic and paleomagnetic timescales, Chronology of flood basalts, impacts, extinctions, glaciations. Constraints on rates of magmatism, mountain uplift, deformation, erosion, sedimentation.

Requisites: G L E/GEOSCI 370 or graduate/professional standing

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2023

Learning Outcomes: 1. Explain the relative strengths and weaknesses of radioisotopic (Ar- Ar, U-Pb, U-Th, U-He), cosmogenic (He, Ne, Cl, Be, Al, C), and radiogenic (OSL, Fission Track) dating methods.

Audience: Both Grad & Undergrad

2. Integrate radioisotopic dating with geomagnetic field behavior, astronomical clocks, and paleoclimatic records, applicable for current and future calibration of the geologic time scale.

Audience: Both Grad & Undergrad

3. Use dates to estimate rates of geological processes, including flood basalts, impacts, mass extinctions, deformation, and orogeny.

Audience: Both Grad & Undergrad

4. Evaluate the use of geochronology in the wider geoscience literature.

Audience: Both Grad & Undergrad

5. Evaluate a geochronological approach to a specific geological problem.

Audience: Graduate

GEOSCI/G L E 627 – HYDROGEOLOGY

3-4 credits.

Mathematical treatment of the physical principles governing the flow of groundwater; emphasis on well hydraulics and flow system analysis.

Requisites: (GEOSCI 100, 109, 110, ATM OCN/GEOSCI 105, 140, ENVIR ST/GEOSCI 106, or ASTRON/GEOSCI 160) and (MATH 217 or 221), graduate/professional standing, or member of Engineering Guest Students

Course Designation: Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Describe how groundwater flow and storage are impacted by geology.

Audience: Both Grad & Undergrad

2. Collect high-quality data in the field and laboratory to quantify hydrogeologic processes and properties.

Audience: Both Grad & Undergrad

3. Integrate data from wells, field reports and surficial data to create reasonable conceptual models of aquifers and surface water / groundwater interactions.

Audience: Both Grad & Undergrad

4. Implement appropriate quantitative analyses to characterize aquifer properties based on aquifer tests.

Audience: Both Grad & Undergrad

5. Apply numerical simulations and assess the output of these simulations in terms of their hydrologic meaning and predictions.

Audience: Both Grad & Undergrad

6. Critique news and technical reports related to groundwater science using hydrogeologic principles.

Audience: Graduate

GEOSCI/G L E 629 – CONTAMINANT HYDROGEOLOGY

3 credits.

Physical and chemical processes governing the transport of solutes in groundwater; application of hydrogeologic and geochemical theory and practice to the protection of aquifers from contamination.

Requisites: G L E/GEOSCI 627 and MATH 222, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Explain the physical, chemical, and biological processes controlling the transport of subsurface contaminants.

Audience: Both Grad & Undergrad

2. Apply mathematical expressions for analytically describing solute, colloid, and multiphase flow in porous and fractured media.

Audience: Both Grad & Undergrad

3. Interpret and synthesize scientific literature and technical reports to create subsurface flow and transport models of specific case studies.

Audience: Both Grad & Undergrad

4. Analyze the causes of, and solutions for, the sustainability challenge of natural and anthropogenic contaminants in the subsurface.

Audience: Both Grad & Undergrad

5. Explain the social, economic, and/or environmental dimensions of the sustainability challenges relevant to the protection of groundwater resources from contamination.

Audience: Both Grad & Undergrad

6. Create and evaluate a subsurface flow and transport model related to their graduate research or another specific environmental problem.

Audience: Graduate

GEOSCI 681 – SENIOR HONORS THESIS

3 credits.

Individual mentored study for seniors completing theses for Honors in the Major as arranged with a faculty member.

Requisites: Consent of instructor

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Honors - Honors Only Courses (H)

Repeatable for Credit: No

Last Taught: Fall 2025

GEOSCI 682 – SENIOR HONORS THESIS

3 credits.

Individual mentored study for seniors completing theses for Honors in the Major as arranged with a faculty member.

Requisites: Consent of instructor

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Honors - Honors Only Courses (H)

Repeatable for Credit: No

Last Taught: Spring 2026

GEOSCI 691 – SENIOR THESIS

3-4 credits.

Mentored individual research and study for students completing a senior thesis.

Requisites: Consent of instructor

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2025

GEOSCI 692 – SENIOR THESIS

3-4 credits.

Mentored individual research and study for students completing a senior thesis.

Requisites: Consent of instructor

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2026

GEOSCI 698 – DIRECTED STUDY

1-6 credits.

Independent study as arranged with a faculty member.

Requisites: Consent of instructor

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2025

GEOSCI 699 – DIRECTED STUDY

1-6 credits.

Independent study as arranged with a faculty member.

Requisites: Consent of instructor

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2026

GEOSCI 701 – QUANTITATIVE GEOMORPHOLOGY

4 credits.

Quantitative study of processes that shape Earth's surface. Use theory and field observations to investigate major components of continental geomorphic systems, including hillslopes, rivers, and glaciers. Understand how the major factors that shape Earth's surface-tectonics, climate, and life-create the landscapes we observe.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate

coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2024

Learning Outcomes: 1. Demonstrate knowledge of the processes that shape Earth's topography over a range of time scales and spatial scales
Audience: Graduate

2. Construct conservation of mass and momentum frameworks for topographic evolution
Audience: Graduate

3. Apply mathematical laws for mass transport that govern topographic evolution
Audience: Graduate

4. Make field observations that can be used to constrain multiple geomorphic processes
Audience: Graduate

5. Write scientific reports in the form of a short journal article
Audience: Graduate

GEOSCI 720 – GLACIOLOGY

3 credits.

Addresses the fundamentals of glaciology and glacier landform mechanics: mass balance, ice deformation, basal slip, temperature structure, glacial hydrology, sediment deformation and deposition, and landform building processes. Emphasizes an understanding of the mathematical principles that dictate how glaciers function. Begins with a classical treatment of the mechanics of glaciers and moves onto fundamental advances in the field of glaciology.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2024

Learning Outcomes: 1. Explain the different dislocation mechanism of ice.

Audience: Graduate

2. Compute a vertical velocity field in a glacier.

Audience: Graduate

3. Calculate steady-state and non-steady-state temperature profiles in a glacier.

Audience: Graduate

4. Describe mathematically the processes by which glaciers slip over and deform their beds.

Audience: Graduate

5. Compute the hydrological potential of water in and under a glacier and calculate steady-state channel sizes.

Audience: Graduate

6. Explain the causes of stable and unstable glacier slip.

Audience: Graduate

7. Calculate the rates of glacial erosion from abrasion and quarrying.

Audience: Graduate

8. Explain the mechanisms that produce subglacially derived landforms.

Audience: Graduate

GEOSCI/G L E 724 – GROUNDWATER FLOW MODELING

3 credits.

An introduction to the principles of modeling groundwater flow systems, with emphasis on regional flow system analysis. Conceptual understanding of governing equations, and the use of finite difference techniques to solve such equations are stressed. Develop codes and become introduced to packaged models, including those developed by the U. S. Geological Survey. Knowledge of hydrogeology [such as G L E/GEOSCI 627 or 629] required.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2025

Learning Outcomes: 1. Formulate a groundwater flow problem as a PDE-based mathematical statement from first principles (conservation of mass, conservation), and summarize how different governing equations are derived.

Audience: Graduate

2. Develop an algebraic approximation of a PDE and solve the algebraic equation using direct or iterative methods.

Audience: Graduate

3. Apply the USGS software MODFLOW intelligently and recognize the inherent assumptions in different options and packages.

Audience: Graduate

4. Evaluate model predictions and uncertainty using model refinement, testing, and calibration.

Audience: Graduate

GEOSCI 727 – ADVANCED HYDROGEOLOGY

1-3 credits.

Advanced topics in Hydrogeology.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2025

Learning Outcomes: 1. Evaluate peer-reviewed literature that focuses on advanced topics such as coupled models, multiphase flow, fracture-based flow, heterogeneity analysis, and optimization and uncertainty analysis in modeling.

Audience: Graduate

2. Evaluate advanced numerical models and research in terms of their underlying physics, assumptions, and simplifications.

Audience: Graduate

3. Utilize advanced software tools that implement coupling, multi-domain / multi-phase simulation, or statistical representations to perform relevant hydrologic simulations and answer research questions.

Audience: Graduate

GEOSCI 731 – CARBONATE GEOLOGY

2 credits.

Comprehensive survey of the processes and products of carbonate sedimentation.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2024

GEOSCI 732 – GEOCHEMISTRY OF SEDIMENTS

3 credits.

Processes involved in the origin of chemical sediments; shales, carbonates, and evaporites.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Construct a conceptual model for the climate system, which will provide a basis for testing key hypotheses about the mechanisms of climate change.

Audience: Graduate

2. Construct a conceptual (semi-quantitative) model that accounts for spatial and temporal variability in ocean water chemistry and sediments.

Audience: Graduate

3. Explain the vertical profile of elements within the ocean water column at any given location in the ocean.

Audience: Graduate

4. Explain geographic variability of elements within ocean water.

Audience: Graduate

5. Explain the geographic distribution of different sediment types in the world's oceans.

Audience: Graduate

6. Explain the basis of common isotopic, elemental (trace, minor, major), and organic geochemical proxies for paleoenvironmental change.

Audience: Graduate

7. Utilize sedimentary records of proxies to interpret paleoenvironmental change in Earth's past.

Audience: Graduate

GEOSCI/GLE 747 – TECTONOPHYSICS

3 credits.

Elasticity and flexure of the earth's lithosphere, heat conduction, mantle convection, earthquake mechanisms, rock rheology, and fluid migration in the earth's crust; integration of geophysical observations, laboratory experiments, and theoretical models.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2022

Learning Outcomes: 1. Demonstrate an understanding of the Scientific Theory of Plate Tectonics by writing, solving, illustrating, and exemplifying Euler's formula for rigid tectonic plates moving on a sphere.

Audience: Graduate

2. Demonstrate an understanding of the earthquake deformation cycle in time and space by sketching a map over ~100 km and a time series over ~1000 years.

Audience: Graduate

3. Demonstrate an understanding of the physical principles of crustal deformation by writing, applying, and solving the differential equations governing motion under the constitutive relations for rigid, elastic, and Maxwell visco-elastic rheologies.

Audience: Graduate

4. Demonstrate an understanding of quantitative reasoning for testing geophysical hypotheses by comparing two competing models with appropriate statistical tests.

Audience: Graduate

5. Visualize plate motions on a 3-dimensional sphere by writing, debugging, and writing computer applications.

Audience: Graduate

6. Analyze geophysical data and interpret them by implementing simple models in the Matlab computer language.

Audience: Graduate

GEOSCI/ATM OCN/ENVIR ST/ZOOLOGY 750 – PROBLEMS IN OCEANOGRAPHY

3 credits.

Introduction to techniques used in the study of the biology, chemistry, geology, and physics of the marine environment.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2024

Learning Outcomes: 1. use satellite imagery and measurements in meteorological research and operations.

Audience: Both Grad & Undergrad

2. describe orbital characteristics, navigation, instrumentation and remote sensing techniques.

Audience: Both Grad & Undergrad

3. perform quantitative retrievals of atmospheric properties from active and passive measurement systems and rigorously assess accuracy.

Audience: Both Grad & Undergrad

4. share skills and techniques in analysis and interpretation with classmates.

Audience: Graduate

GEOSCI 755 – ADVANCED STRUCTURAL GEOLOGY

3 credits.

Structures in layered, intrusive, and metamorphic rocks; structural analysis.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Explain how geological structures record some combination of displacement, strain, stress, and rheology.

Audience: Graduate

2. Apply simple mathematics to understanding geological structures (that is, what problems can you address with what mathematics).

Audience: Graduate

3. Apply tensor analysis to deformed rocks.

Audience: Graduate

4. Analyze microstructures using concepts of displacement, strain, stress, deformation mechanisms, reactions, and rheology.

Audience: Graduate

5. Describe, at a fundamental level, simple shear and transpressional/transensional deformation.

Audience: Graduate

GEOSCI/G L E 757 – ADVANCED ROCK MECHANICS

3 credits.

Experimental rock mechanics, rock mechanics apparatus design, static and dynamic rock friction, rate and state friction, crack phenomena and rock fracture mechanics, earthquake energy budget, elastic/viscoelastic/plastic behavior of rocks, engineering and geological applications. Knowledge of introductory rock mechanics [such as M S E/GEOSCI/CIV ENGR/G L E/ M S & E 474] required.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2021

Learning Outcomes: 1. Analyze technical construction of rock mechanics apparatuses

Audience: Graduate

2. Design and fabricate load cells and displacement sensors

Audience: Graduate

3. Measure dynamic rock frictional properties for fault instability analysis

Audience: Graduate

GEOSCI 758 – MECHANICS OF EARTHQUAKES AND FAULTING

3 credits.

Addresses current topics and controversies on fault mechanics, earthquake physics, and the rock record of seismicity. Emphasizes critical reading and in-depth discussion of recent publications drawn from a variety of disciplines, including geophysical, geological, and geochemical studies and approaches.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2024

Learning Outcomes: 1. Explain the fundamental theory underlying our current knowledge of fault mechanics, rock friction, and seismicity.

Audience: Graduate

2. Summarize recent advances in topics including earthquake nucleation and propagation, dynamic friction and the rock record of seismicity.

Audience: Graduate

3. Establish skills in the critical reading and analysis of current scientific literature via classroom discussion.

Audience: Graduate

4. Show independent skills in scientific reasoning and advanced analysis of cutting-edge research in the field via construction of a term paper on a topic that involves or is relevant to their own research.

Audience: Graduate

5. Illustrate the development of skills in scientific writing via both one-page summaries of assigned reading and synthesis and presentation of data from multiple sources in a term paper.

Audience: Graduate

GEOSCI/ATM OCN 762 – ICE AND CLIMATE DYNAMICS

3 credits.

Introduction to the role of ice in the climate system. Review main components of the cryosphere (Arctic and Antarctic sea ice, Greenland and Antarctic ice sheets, mountain glaciers, snow cover, and permafrost), with particular focus on recent and future changes as documented in recent publications. Consider different methods to study the cryosphere and its role in the climate system, such as remote sensing and in situ observations, state estimates and reanalyses, with a particular focus on idealized and comprehensive global climate models. Covers fundamental physical concepts as well as unresolved research questions such as the debates surrounding potential instabilities in the climate system and uncertainties in future projections of ice loss, teleconnections, and sea level rise.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Differentiate between the main components of Earth's cryosphere and their respective roles in the climate system.

Audience: Graduate

2. Compare the range of methodologies used to study Earth's cryosphere, including in situ and remote sensing observations, theoretical considerations, and numerical models.

Audience: Graduate

3. Develop idealized models of sea ice, land ice, and snow and their interactions with the climate system.

Audience: Graduate

4. Carry out analysis of output from idealized and comprehensive ice and climate models.

Audience: Graduate

GEOSCI 765 – CRYSTAL CHEMISTRY

3 credits.

Principles of crystal chemistry, emphasizing the structure and behavior of rock forming minerals.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2022

Learning Outcomes: 1. Use symmetrical theories (both point groups and space groups) to interpret crystal structures.

Audience: Graduate

2. Summarize X-ray diffraction theory, operate powder X-ray diffraction experiments, and carry out quantitative analyses (rietveld analysis and structure refinements).

Audience: Graduate

3. Demonstrate mineral phase transformations, solid solutions / exsolution processes and thermodynamics.

Audience: Graduate

4. Identify defects and their formation processes in minerals and related host rocks.

Audience: Graduate

5. Explain the principles governing size-dependent properties of nano-phase minerals in the earth system.

Audience: Graduate

6. Identify structures, symmetries and superspace groups for quasi-crystals, and aperiodic minerals with incommensurately modulated structures.

Audience: Graduate

GEOSCI 771 – IGNEOUS PETROLOGY

3 credits.

Classification, characteristics, and petrogenesis of igneous rocks. Representative rock suites studied in lab.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Explain how magmas are formed by partial melting of rocks within the Earth, and how magmas are modified by differentiation processes during storage and transit within the earth.

Audience: Graduate

2. Explain how the products of volcanism on earth, including lava flows and pyroclastic deposits, provide windows into the processes of partial melting and magma differentiation.

Audience: Graduate

3. Utilize the many tools used to quantify the processes of partial melting and magma differentiation, including thermodynamic modeling of phase equilibria, trace element geochemistry of minerals, melts, and rocks, isotope geochemistry of minerals, melts, and rocks, and diffusion chronology of igneous minerals.

Audience: Graduate

4. Explain how magmas are formed and modified in different ways depending on the plate tectonic setting, including at mid-ocean ridges, subduction zones, and continental rifts.

Audience: Graduate

5. Interpret what the solidified products of igneous activity on earth are, and how to distinguish processes of formation from the textures and minerals comprising them.

Audience: Graduate

GEOSCI 777 – ELECTRON MICROPROBE ANALYSIS

3 credits.

Proper use and functioning of electron probe and SEM, their use in microanalysis (WDS, EDS), range of applications, and limitations.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Operate electron beam instruments (SEM and EPMA) to acquire images and data.

Audience: Graduate

2. Analyze images from different emission types.

Audience: Graduate

3. Analyze chemical data from different types of X-ray detectors.

Audience: Graduate

4. Analyze quantitative chemical measurements using electron microprobe.

Audience: Graduate

5. Describe sample and detector artifacts.

Audience: Graduate

6. Explain basic interactions of electrons and atomic structure.

Audience: Graduate

GEOSCI 793 – GEOPHYSICAL INVERSE THEORY

3 credits.

Application of inverse methods to geophysical measurements of the structure of the earth.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2024

Learning Outcomes: 1. Discuss fundamental similarities and differences between inverse methods, as well as their benefits and drawbacks.

Audience: Graduate

2. Determine estimation or inversion approaches that are appropriate for a particular geoscience-relevant problem.

Audience: Graduate

3. Apply appropriate inverse methods to geoscience problems such as seismic tomography, electrical resistivity imaging, source location estimation, and image processing.

Audience: Graduate

4. Evaluate solutions to parameter estimation and inverse problems using concepts such as bias, null spaces, uncertainty, stability, resolution, nonlinearity, and over/under-fitting.

Audience: Graduate

GEOSCI 796 – PHYSICS OF THE EARTH II

3 credits.

Theory and observations of earthquakes, seismic waves and plate tectonics.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Explain, quantitatively, the physical principles that govern seismic wave propagation.

Audience: Graduate

2. Identify and describe the major features of a seismogram.

Audience: Graduate

3. Incorporate seismic data in an inverse framework to generate geophysical models.

Audience: Graduate

4. Interpret the results of common seismic analysis techniques in terms of information gained about the Earth's structure, geological processes, and/or seismic source mechanisms.

Audience: Graduate

5. Communicate information and uncertainties about seismic hazards to scientific and general audiences.

Audience: Graduate

GEOSCI 875 – ADVANCED TOPICS IN GEOLOGY

1-3 credits.

Special topics in Geoscience.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2026**Learning Outcomes:** 1. Evaluate research in a specific field.

Audience: Graduate

2. Assess scientific information and ask thoughtful questions.

Audience: Graduate

3. Communicate scientific material to peers.

Audience: Graduate

GEOSCI/ATM OCN/BOTANY/CIV ENGR/ENVIR ST/ZOOLOGY 911 – LIMNOLOGY AND MARINE SCIENCE SEMINAR

1 credit.

Sections in various fields of zoological research.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2026**Learning Outcomes:** 1. Explain important research in current limnology.

Audience: Graduate

2. Utilize different research presentation methods.

Audience: Graduate

3. Assess scientific information and ask thoughtful questions.

Audience: Graduate

GEOSCI 920 – SEMINAR IN GLACIAL AND PLEISTOCENE GEOLOGY

1-3 credits.

An exploration of modern glacial, glaciology, and Pleistocene geology literature. Includes a field trip to explore local glacial geology.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Fall 2025**Learning Outcomes:** 1. Distinguish the physical processes driving change in the cryosphere in response to a changing climate.

Audience: Graduate

2. Evaluate the various ways in which these changes impact human societies, such as water availability, increased risk of flooding, and coastal erosion.

Audience: Graduate

3. Effectively convey complex scientific information.

Audience: Graduate

GEOSCI 929 – SEMINAR-HYDROGEOLOGY

1-2 credits.

Special topics in Hydrogeology.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Fall 2022**Learning Outcomes:** 1. Explain the technical, economic, and environmental dimensions of groundwater challenges in Wisconsin.

Audience: Graduate

2. Synthesize scientific and technical literature describing challenges to groundwater quality and quantity.

Audience: Graduate

3. Articulate the scope, educational path, and responsibilities of different careers in a range of organizations working on groundwater issues in Wisconsin.

Audience: Graduate

GEOSCI 970 – SEMINAR-GEOCHEMISTRY

2 credits.

Exploration of topics in the field of Geochemistry with an emphasis on engagement with recent literature.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2026

Learning Outcomes: 1. Identify the physical principles of isotope fractionation and the natural processes that can cause isotope fractionation.

Audience: Graduate

2. Recognize the fundamentals of modern isotope analysis.

Audience: Graduate

3. Evaluate recent peer-reviewed literature in the topical area of isotope geochemistry.

Audience: Graduate

4. Recognize how isotope data could be used to address your research questions.

Audience: Graduate

GEOSCI/ATM OCN/BOTANY/ENVIR ST/ GEOG/ZOOLOGY 980 – EARTH SYSTEM SCIENCE SEMINAR

1 credit.

Topics in earth system science. Emphasis on the coupling between atmospheric, oceanic and land surface systems, involving physical geochemical and biological processes, and including interactions with human systems.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2024

GEOSCI 990 – RESEARCH

1-12 credits.

Research supervised by individual faculty members.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2026

GEOSCI 999 – ADVANCED INDEPENDENT READING

1-3 credits.

Advanced level mentored reading and research for students with dissertator status.

Requisites: Consent of instructor

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2017