

# GEOLOGY (GEOL)

## 100 Level Courses

**GEOL 101: *Physical Geology*.** 3 credits.

Covers Earth, processes that operate within Earth and on surface, and human interaction with Earth. Topics include minerals, earthquakes and seismology, isostasy, igneous processes and rocks, paleomagnetism and plate tectonics, weathering, mass movements, rivers and streams, groundwater, glaciers, and marine processes. Notes: May include field trips. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Mason Core:** Mason Core (All), Natural Science Overview, Encore: Sustainability (<http://catalog.gmu.edu/mason-core/>)

**Specialized Designation:** Green Leaf Related Course

**Schedule Type:** Lecture

### Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 102: *Historical Geology*.** 3 credits.

Earth processes in historical context. Topics include sedimentary rocks and principles, deformation and metamorphism, mountain building and plate tectonics, geologic time, fossils, and historical development of continents. Notes: May include field trips. For students desiring a four-credit sequence with a lab, GEOL 104 should be taken concurrently. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Mason Core:** Mason Core (All), Natural Science Overview, Encore: Sustainability (<http://catalog.gmu.edu/mason-core/>)

**Specialized Designation:** Green Leaf Related Course

**Recommended Prerequisite:** GEOL 101 + GEOL 103

**Schedule Type:** Lecture

### Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 103: *Physical Geology Lab*.** 1 credit.

Covers Earth, processes that operate within Earth and on surface, and human interaction with Earth. Topics include minerals, earthquakes and seismology, isostasy, igneous processes and rocks, paleomagnetism and plate tectonics, weathering, mass movements, rivers and streams, groundwater, glaciers, and marine processes. Notes: May include field trips. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Mason Core:** Mason Core (All), Natural Science with Lab (<http://catalog.gmu.edu/mason-core/>)

### Registration Restrictions:

**Required Prerequisite:** GEOL 101<sup>\*C</sup>.

<sup>\*</sup> May be taken concurrently.

<sup>C</sup> Requires minimum grade of C.

**Schedule Type:** Laboratory

### Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 104: *Historical Geology Laboratory*.** 1 credit.

Practical investigation of earth processes in historical context.

Topics include sedimentary rocks and principles, deformation and metamorphism, mountain building and plate tectonics, geologic time, fossils, and historical development of continents. Notes: May include field trips. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Mason Core:** Mason Core (All), Natural Science with Lab (<http://catalog.gmu.edu/mason-core/>)

### Registration Restrictions:

**Required Prerequisites:** (GEOL 102<sup>\*C</sup>, 134<sup>\*C</sup>, 102<sup>XS</sup> or 134<sup>XS</sup>).

<sup>\*</sup> May be taken concurrently.

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

**Schedule Type:** Laboratory

### Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 120: *The Changing Ocean*.** 3 credits.

Our oceans are rapidly changing in response to human-induced and natural catalysts such as carbon emissions, overfishing, and habitat destruction. This course closely examines a handful of such changes to our global ocean. To understand these changes, students explore physical, chemical, geological, and biological processes at work in the ocean, how these processes are disturbed by external factors such as societal activity, and how humanity can mitigate the disturbances. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Mason Core:** Mason Core (All), Natural Science Overview (<http://catalog.gmu.edu/mason-core/>)

**Recommended Corequisite:** GEOL 121

**Schedule Type:** Lecture

### Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 121: *The Changing Ocean Laboratory*.** 1 credit.

Our oceans are rapidly changing in response to human-induced and natural catalysts. Students will work with oceanographic data to build an understanding of the chemical, biological, geological, and physical processes that control ocean responses to such catalysts. This course should be taken in conjunction with GEOL 120: The Changing Ocean. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Mason Core:** Mason Core (All), Natural Science with Lab (<http://catalog.gmu.edu/mason-core/>)

### Registration Restrictions:

**Required Prerequisite:** GEOL 120<sup>\*C</sup>.

<sup>\*</sup> May be taken concurrently.

<sup>C</sup> Requires minimum grade of C.

**Schedule Type:** Laboratory

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 134: *Evolution and Extinction*.** 3 credits.

Evolution and Extinction is a science class for non-science majors that explores how diversity of animals and plants has changed through geologic time, when mass extinctions occurred, when major diversifications of life occurred, and how the position of continents on the surface of the earth influenced the evolution, extinction, and distribution of life, landforms and the atmosphere. Designated a Green Leaf Course. Note: For students desiring a four-credit sequence with a lab, GEOL 104 should be taken concurrently. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Mason Core:** Mason Core (All), Natural Science Overview, Encore: Sustainability (<http://catalog.gmu.edu/mason-core/>)

**Specialized Designation:** Green Leaf Related Course

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

## 300 Level Courses

**GEOL 302: *Mineralogy*.** 4 credits.

Crystallographic, optical, chemical, and physical properties of minerals. Notes: May include field trips. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Specialized Designation:** Mason Impact.

**Recommended Prerequisite:** GEOL 101, 103, and 102 with a grade of 2.0 or better, and CHEM 211.

**Schedule Type:** Laboratory, Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 303: *Field Mapping Techniques*.** 3 credits.

Basic techniques for collecting, recording, and plotting spatial field data including use of topographic maps, compasses, transit, alidade, and global positioning systems (GPS). Designated a Green Leaf Course. Notes: Includes field work. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Specialized Designation:** Green Leaf Related Course, Mason Impact.

**Recommended Prerequisite:** MATH 105, GGS 102 or GEOL 101 and GEOL 103, and 30 credits.

**Schedule Type:** Laboratory

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 304: *Sedimentary Geology*.** 4 credits.

Introduces sedimentation, sedimentary petrology, facies analysis, and stratigraphy. Notes: May include field trips. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Registration Restrictions:**

**Required Prerequisites:** ((GEOL 101<sup>C</sup> or 101<sup>XS</sup>) and (GEOL 102<sup>C</sup> or 102<sup>XS</sup>) and (GEOL 103<sup>C</sup> or 103<sup>XS</sup>) and (GEOL 302<sup>C</sup> or 302<sup>XS</sup>)).

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

**Schedule Type:** Laboratory, Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 305: *Environmental Geology*.** 3 credits.

Investigates geological principles directly relating to environmental hazards. Geological causes and effects of natural disasters such as earthquakes, tsunamis, volcanoes, floods and landslides; climate variability and change; prediction of, and planning for geological hazards and disasters and understanding their major societal impacts; and medical geology. Notes: May include field trips. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Mason Core:** Mason Core (All) (<http://catalog.gmu.edu/mason-core/>)

**Specialized Designation:** Green Leaf Related Course, Writing Intensive in Major

**Recommended Prerequisite:** GEOL 101 and GEOL 103, and one of the following: GEOL 102, GEOL/BIOL 309, GGS 309.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 306: *Soil Science*.** 3 credits.

Composition, classification, physical properties, and origin of soils. Notes: May include field trips. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Specialized Designation:** Green Leaf Related Course, Mason Impact.

**Recommended Prerequisite:** GEOL 101 and GEOL 103, and CHEM 103 or CHEM 211.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 308: *Igneous and Metamorphic Petrology*.** 4 credits.

Practical and theoretical background for identifying, classifying and interpreting igneous and metamorphic rocks with emphasis on their petrogenesis and relationship to the tectonic context. May include field trips. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>)

catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/). Limited to three attempts.

**Recommended Prerequisite:** MATH 105 or higher

**Registration Restrictions:**

**Required Prerequisites:** ((GEOL 101<sup>C</sup> or 101<sup>XS</sup>) and (GEOL 102<sup>C</sup> or 102<sup>XS</sup>) and (GEOL 103<sup>C</sup> or 103<sup>XS</sup>) and (GEOL 302<sup>\*C</sup> or 302<sup>\*XS</sup>)).

\* May be taken concurrently.

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

**Schedule Type:** Laboratory, Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 309: Oceanography.** 3 credits.

Explores the geological, chemical, physical, and biological aspects of the global oceans. For science majors and minors only. May include field trips. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts. Equivalent to BIOL 309, EVPP 309.

**Recommended Prerequisite:** Two of the following lab sciences courses are required for a total of 8 credits: [GEOL 101 + GEOL 103, or 102 + GEOL 104], [EVPP 108 and 109 or 112 and 113 or 210], CHEM 211 and 213, [BIOL 102 or 213], [PHYS 160 and 161 or 243 and 244].

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 312: Invertebrate Paleontology.** 4 credits.

Classification, evolutionary trends, and distribution of common invertebrate fossils. Notes: May include field trips. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts. Equivalent to BIOL 336.

**Recommended Prerequisite:** Either GEOL 101, GEOL 103, and GEOL 102; or BIOL 103 and BIOL 102; or BIOL 213 or U213 and BIOL 300.

**Schedule Type:** Laboratory, Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 313: Hydrogeology.** 3 credits.

Geological and hydrologic factors controlling occurrence, distribution, movement, quality, and development of groundwater. Designated a Green Leaf Course. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Specialized Designation:** Green Leaf Related Course

**Recommended Prerequisite:** GEOL 101 and GEOL 103, or GGS 102, MATH 113, and CHEM 211.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 315: Topics in Geology II.** 1-3 credits.

Discusses particular topic in geology. Notes: May include field trips.

Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May be repeated within the term for a maximum 12 credits.

**Specialized Designation:** Topic Varies

**Recommended Prerequisite:** GEOL 101 and GEOL 103, or GEOL 102, or permission of instructor.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 317: Geomorphology.** 4 credits.

Analyzes processes that occur at Earth's surface and resulting landforms. Labs stress recognition and evaluation of landforms using maps and aerial photographs, and methods of data collection used in study of surficial geology. Notes: May include field trips. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Mason Core:** Mason Core (All) (<http://catalog.gmu.edu/mason-core/>)

**Specialized Designation:** Writing Intensive in Major

**Recommended Prerequisite:** Grade of 2.0 or better in GEOL 101, GEOL 103, and 102, or 6 credits of GGS, including GGS 102; GGS 412 is strongly recommended.

**Schedule Type:** Laboratory, Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 320: Geology of Earth Resources.** 3 credits.

A survey of earth resources, including metallic and non-metallic ore deposits, mineral resources, precious gems, sand and gravel, water, and air. Designated a Green Leaf Course. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Specialized Designation:** Green Leaf Related Course

**Recommended Prerequisite:** GEOL 101, GEOL 103, GEOL 102, GEOL 302. GEOL 305 strongly suggested.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 321: Geology of Energy Resources.** 3 credits.

A survey of energy resources, including fossil fuels, renewable, nuclear and unconventional sources. Emphasis on origin, use and implications of development. Designated a Green Leaf Course. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Specialized Designation:** Green Leaf Focused Course

**Recommended Prerequisite:** GEOL 101 and GEOL 103, or GEOL 102. Additionally, the completion of all Mason Core science requirements.

**Schedule Type:** Lecture**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 325: Planetary Geology.** 3 credits.

Covers the geology and geologic processes of the terrestrial planets, moons, and other small bodies in the solar system including dwarf planets, asteroids and comets. The emphasis is on understanding past and present surface geologic processes. Observation session at campus observatory may be required outside of class hours. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Registration Restrictions:**

**Required Prerequisites:** (((GEOL 101<sup>C</sup> or 101<sup>XS</sup>) and (GEOL 103<sup>C</sup> or 103<sup>XS</sup>)) or (GEOL 102<sup>C</sup> or 102<sup>XS</sup>)).

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

**Schedule Type:** Lecture**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 332: Paleoclimatology.** 3 credits.

Explores the natural evolution of Earth's climate with the goal of providing a baseline for understanding present climate variability and future trends through increased knowledge of the physical, chemical, and biological processes that influence climate over the long-term. Designated a Green Leaf Course. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Specialized Designation:** Green Leaf Related Course

**Recommended Prerequisite:** GEOL 102 or BIOL 103 or EVPP 110.

**Schedule Type:** Lecture**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 334: Vertebrate Paleontology.** 4 credits.

Vertebrate Paleontology explores the evolution of vertebrates from the early Paleozoic to Recent. The course will cover the systematics, anatomy, paleogeography, and ecology of extinct vertebrates. Discussions will include fishes, early tetrapods & amniotes, dinosaurs, birds and mammals. Lab portion includes paleontology techniques, analysis, and study of fossil specimens and casts. A weekend field trip is included. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts. Equivalent to BIOL 334.

**Mason Core:** Mason Core (All) (<http://catalog.gmu.edu/mason-core/>)

**Specialized Designation:** Writing Intensive in Major

**Recommended Prerequisite:** Any two courses from the following list: GEOL 101 + GEOL 103, GEOL 102, BIOL 103, BIOL 102, BIOL 213, BIOL 300, or the permission of the instructor.

**Schedule Type:** Laboratory, Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 340: Modern Methods in Geology.** 3 credits.

An introduction to common types of datasets, including geologic map products, reflection seismic data, and outcrop photogrammetry, that geologists use in the workforce to complement field-based and observational methods of geology such as outcrop, core or sample descriptions. The class will focus on both learning about the applications of the various data types as well as developing skills in accessing, plotting, and making geologic interpretations of the data. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Recommended Prerequisite:** GEOL 101 and GEOL 103, or GEOL 102

**Recommended Corequisite:** GGS 311, GEOL 302, GEOL 304, GEOL 308, GEOL 317

**Schedule Type:** Lecture**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 363: Coastal Morphology and Processes.** 4 credits.

Studies global coastal geomorphology and processes with emphasis on U.S. Atlantic and Gulf coasts. Topics include plate tectonics, sea level changes, sediment supply, waves, tides, storm impacts, and human activities. Lecture and extended weekend field trips to mid-Atlantic coast. Designated a Green Leaf Course. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts. Equivalent to EVPP 363.

**Specialized Designation:** Green Leaf Related Course

**Recommended Prerequisite:** GEOL 309 or BIOL 309 or GEOL 317 or 9 credit hours in Geography including GGS 309.

**Schedule Type:** Laboratory, Lecture**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 364: Marine Geology.** 3 credits.

This course will present a global overview of the geologic origin and composition of the ocean seafloor, and an introduction to the basic principles of the geologic processes occurring in the marine environment. Primary topics include geologic, tectonic and sedimentary characteristics of the deep ocean basins and continental margins; transport and deposition of marine sediments; micropaleontology and paleoceanography; geochemistry and hydrothermal systems; and marine mineral resources. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Recommended Prerequisite:** GEOL 101 and GEOL 103, GEOL 102, GEOL 302, and CHEM 211.

**Schedule Type:** Lecture**Grading:**



This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 392: *Geology and Earth Science Seminar*.** 1 credit.

Undergraduate experience that includes discussion of scientific articles and attending seminars presented by outside experts, faculty, or students. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May be repeated within the degree for a maximum 4 credits.

**Recommended Prerequisite:** 30 credit hours.

**Schedule Type:** Seminar

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

## 400 Level Courses

**GEOL 401: *Structural Geology*.** 4 credits.

An introduction to both qualitative and quantitative methods of structural geology with emphasis on identifying and analyzing geologic structures in nature as well as learning the fundamentals of geological stress and strain, rock mechanics, and plate tectonics. Notes: field trips may be required. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Registration Restrictions:**

**Required Prerequisites:** (((GEOL 302<sup>C</sup> or 302<sup>XS</sup>) and (GEOL 304<sup>C</sup> or 304<sup>XS</sup>)) or GEOL 308<sup>\*C</sup> or 308<sup>\*XS</sup>) and (MATH 110<sup>C</sup>, 110<sup>XS</sup>, 111<sup>C</sup>, 111<sup>XS</sup>, 113<sup>C</sup> or 113<sup>XS</sup>) and (((PHYS 160<sup>C</sup> or 160<sup>XS</sup>) and (PHYS 161<sup>C</sup> or 161<sup>XS</sup>)) or ((PHYS 243<sup>C</sup> or 243<sup>XS</sup>) and (PHYS 244<sup>C</sup> or 244<sup>XS</sup>))).

\* May be taken concurrently.

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

**Schedule Type:** Laboratory, Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 403: *Geochemistry*.** 3 credits.

Includes stable isotope, crystal, water, and organic geochemistry; geochronology; and geochemistry of rocks. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Recommended Prerequisite:** GEOL 101, GEOL 103, GEOL 102, and CHEM 211.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 404: *Geological Field Techniques*.** 1-6 credits.

Mapping techniques involved in collecting geological field data. Notes: Includes field work. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May be repeated within the degree for a maximum 6 credits.

**Registration Restrictions:**

**Required Prerequisites:** (GEOL 101<sup>C</sup> or 101<sup>XS</sup>) and (GEOL 103<sup>C</sup> or 103<sup>XS</sup>) and (GEOL 102<sup>C</sup> or 102<sup>XS</sup>) and (GEOL 302<sup>C</sup> or 302<sup>XS</sup>) and (GEOL 304<sup>C</sup>

or 304<sup>XS</sup>) and (GEOL 308<sup>C</sup> or 308<sup>XS</sup>) and (GEOL 317<sup>C</sup> or 317<sup>XS</sup>) and (GEOL 401<sup>C</sup> or 401<sup>XS</sup>).

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

**Schedule Type:** Laboratory

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 409: *Practicum for Geology Laboratories*.** 1 credit.

Studies techniques to make geology lab effective component in geological education. Discusses developing testing materials, supplemented by experience operating geology course lab section. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Recommended Prerequisite:** Open only to GEOL/ESS majors with 80 credit hours and permission of Chair.

**Schedule Type:** Internship

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 410: *Research Proposal Preparation*.** 1 credit.

Prepares students for research in GEOL 411. Includes literature research, initial data collection, and preparing research proposal. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Recommended Prerequisite:** Geology or Earth Science major with 90 credits, cumulative GPA of 2.80 or higher, and permission of the Geology undergraduate coordinator.

**Schedule Type:** Research

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 411: *Geological Research*.** 3 credits.

Geological research: data collection and reduction, interpretation, preparation of written report, and oral presentation of results. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Recommended Prerequisite:** GEOL 410.

**Schedule Type:** Research

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 412: *Physical Oceanography*.** 3 credits.

Course describes the global patterns of temperature, salinity, currents and waves in the world's oceans, and how these patterns influence marine biota, climate, and human activity. Course introduces key concepts which explain physical features of the ocean ranging from microscopic turbulence to global circulation. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/>

atmospheric-oceanic-earth-sciences/). Limited to three attempts. Equivalent to CLIM 412.

**Recommended Prerequisite:** MATH 113 or MATH 115, and PHYS 160 or PHYS 243, or permission of instructor.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 417: *Geophysics*.** 3 credits.

Basic principles of geophysics including gravity, magnetism, and seismic reflection and refraction. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts. Equivalent to PHYS 417.

**Recommended Prerequisite:** GEOL 101 and GEOL 103, MATH 113, and one year of PHYS, or permission of instructor.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 420: *Earth Science and Policy*.** 3 credits.

Discusses Earth science issues that have policy implications. Course uses a broad definition of Earth science, from atmosphere to geosphere. Taught seminar-style, with emphasis on discussion, reading, writing, critical analysis, and student oral presentations. Notes: Course may include field trips. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Mason Core:** Mason Core (All), Mason Apex, Encore: Sustainability (<http://catalog.gmu.edu/mason-core/>)

**Specialized Designation:** Green Leaf Focused Course

**Recommended Prerequisite:** 18 credit hours in major or minor (geology, Earth science, ocean and estuarine science, or global and environmental change), and one of the following social science based courses: EVPP 361; ECON 103; ANTH 114; GGS 103; GLOA 101; GOVT 132 or 133; HIST 125 or 130; or SOCI 101, 102, or 120.

**Recommended Corequisite:** All other required Mason Core courses.

**Schedule Type:** Seminar

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 441: *Great Events in Earth History*.** 3 credits.

Through 4.5 billion years, Earth has undergone tumultuous changes, from the origin of life and atmospheric oxygenation, to mass extinction events and human evolution. In this seminar-style course, each week will involve an in-depth, student-led discussion on one 'Great Event' that helped shape the course of Earth history. The course is also focused on scientific literacy, with emphasis on reading the primary literature and writing/communicating effectively in a scientific setting. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Recommended Prerequisite:** GEOL 101 and GEOL 103

**Registration Restrictions:**

**Required Prerequisites:** GEOL 102<sup>C</sup> or 102<sup>XS</sup>.

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

**Schedule Type:** Seminar

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 458: *Chemical Oceanography*.** 3 credits.

The world's oceans, including a variety of closed basins and estuaries, comprise a complex and dynamic system of chemical processes that interact with biological, geological, physical, and atmospheric processes to play a significant role in defining the earth's fragile environment. This course will present an overview of the origin, occurrence, and distribution of the chemical components in sea water and an introduction to the basic principals of the chemical processes taking place in the marine environment. Designated a Green Leaf Course. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts. Equivalent to CHEM 458.

**Specialized Designation:** Green Leaf Related Course

**Recommended Prerequisite:** CHEM 211 and CHEM 212, and CHEM 321 or GEOL 302.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 480: *Internship*.** 1-3 credits.

Approved study programs with specific employers. Notes: Contact department one semester before enrollment. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Recommended Corequisite:** Open only to authorized majors with 90 credit.

**Schedule Type:** Internship

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

## 500 Level Courses

**GEOL 500: *Selected Topics in Modern Geology*.** 1-3 credits.

Topic designated in class schedule. Notes: Lecture, lab, field trip. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May be repeated within the degree.

**Specialized Designation:** Topic Varies

**Recommended Prerequisite:** Baccalaureate degree in geology, or permission of instructor.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 501:** *Selected Topics in Modern Geology*. 1-3 credits.

Topic designated in class schedule. Lecture, lab, field trip. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May be repeated within the degree.

**Specialized Designation:** Topic Varies

**Recommended Prerequisite:** Baccalaureate degree in geology or Permission of Instructor.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 503:** *Special Topics in Earth Science*. 1-6 credits.

In-service course to strengthen and update knowledge of Earth science. Notes: May include field trips. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May be repeated within the degree.

**Specialized Designation:** Topic Varies

**Recommended Prerequisite:** Employment or anticipated employment as an Earth Science teacher.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 504:** *Sedimentary Geology*. 4 credits.

Introduces sedimentation, sedimentary petrology, facies analysis, and stratigraphy. Notes: May include field trips. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit.

**Recommended Prerequisite:** Introductory physical geology and mineralogy course during undergraduate study; or permission of instructor.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Laboratory, Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 506:** *Soil Science*. 3 credits.

Explores the composition, classification, physical properties, and origin of soils. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit. Equivalent to EVPP 503.

**Recommended Prerequisite:** Previous lab-science courses in each of the following: geology and chemistry (8 credit hours); or permission of instructor.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 508:** *Igneous and Metamorphic Petrology*. 4 credits.

Practical and theoretical background for identifying, classifying and interpreting igneous and metamorphic rocks with emphasis on their petrogenesis and relationship to the tectonic context. Many include field trips. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). Limited to three attempts.

**Recommended Prerequisite:** Undergraduate courses in Physical Geology, Historical Geology, and Mineralogy at undergraduate institution

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Laboratory, Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 510:** *Advanced Structural Geology*. 3 credits.

Advanced concepts in structural geology including, stress in the lithosphere, strain analysis, constitutive laws, balanced cross-section construction and restoration, and quantitative analysis of crystal-plastic deformation. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit.

**Recommended Prerequisite:** GEOL 401 or equivalent and graduate standing. Undergraduates that have taken GEOL 401 may enroll with approval of instructor.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 512: *Invertebrate Paleontology*. 4 credits.**

Classification, evolutionary trends, and distribution of common invertebrate fossils. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Laboratory, Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 513: *Hydrogeology*. 3 credits.**

Geological and hydrologic factors controlling occurrence, distribution, movement, quality, and development of groundwater. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit.

**Recommended Prerequisite:** Previous lab-science courses in each of the following: geology, calculus, and chemistry (12 credit hours); or permission of instructor.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 521: *Geology of Energy Resources*. 3 credits.**

Survey of global non-renewable and renewable energy resources. Topics include petroleum, natural gas, coal, nuclear, geothermal, solar, wind, and hydro power, and biofuels. Course discusses global production, usage, impacts and future prospects of these resources, and data capture, analysis and modeling of finite resources. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 525: *Modeling Earth Signals and Systems*. 3 credits.**

Provides instruction on time series analysis customized for Earth signals and systems such as climate, Earth-space orientation, earthquakes, geomagnetism, river flow, tides and many other timedependent phenomena. Concepts including linear systems, filtering, spectrum estimation, harmonic analysis and hypothesis testing are applied to time series data sampled from natural processes to address a variety of scientific problems. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit.

**Recommended Prerequisite:** MATH 114 and STAT 250 or equivalent or permission of instructor.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 532: *Paleoclimatology*. 3 credits.**

Explores the natural evolution of Earth's climate with the goal of providing a baseline for understanding present climate variability and future trends through increase knowledge of the physical, chemical, and biological processes that influence climate over the long-term. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit.

**Recommended Prerequisite:** Previous lab-science courses in geology and/or atmospheric science and/or oceanography (12 credit hours); or permission of instructor.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**



This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 534: *Vertebrate Paleontology*. 4 credits.**

Explores the evolution of vertebrates from the early Paleozoic to Recent. Covers systematics, anatomy, paleogeography, and ecology of extinct vertebrates. Discussions include fishes, early tetrapods and amniotes, dinosaurs, birds, and mammals. Lab portion includes paleontology techniques, analysis, and study of fossil specimens and casts. Notes: A weekend field trip is included. Students who have taken GEOL 334 as an undergraduate may not take 534 as a graduate student. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit.

**Recommended Prerequisite:** Undergraduate degree in biology or geology or permission of instructor.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Laboratory, Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 535: *Quantitative Stratigraphy*. 3 credits.**

Quantitative stratigraphy is a branch of geology that applies statistics to reconstruct the time sequence of geological events recorded in sedimentary strata. Methods of interpolation and error analysis used for defining stratigraphic boundaries and events, time scale estimation using integrated chronostratigraphy, and intercalibration are examined. Students receive advanced training in graphic correlation, constrained optimization, ranking and scaling, and dynamic programming. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit.

**Recommended Prerequisite:** MATH 114 and STAT 250 or equivalent or permission of instructor.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 536: *Paleontology Seminar*. 1-2 credits.**

Paleontology Seminar presents topical research in paleontology and paleobiology in a structured discussion among graduate students and paleontology faculty. A theme for the seminar is chosen each semester the course is offered, tailored to the interests of the students. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May be repeated within the degree for a maximum 12 credits.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Seminar

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 540: *Modern Methods in Geology*. 3 credits.**

An introduction to common types of datasets (i.e. geologic map products, reflection seismic data, outcrop photogrammetry) that geologists use in the workforce (both public and private sector) to complement field-based and observational methods of geology (such as outcrop, core or sample descriptions). The class will focus on both learning about the applications of the various data types as well as developing skills in accessing, plotting, and making geologic interpretations of the data. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 541: *Great Events in Earth History*. 3 credits.**

Through 4.5 billion years, Earth has undergone tumultuous changes, from the origin of life and atmospheric oxygenation, to mass extinction events and human evolution. In this seminar-style course, each week will involve an in-depth, student-led discussion on one 'Great Event' that helped shape the course of Earth history. The course is also focused on scientific literacy, with emphasis on reading the primary literature and writing/communicating effectively in a scientific setting. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Seminar

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 545: *Planetary Geology*. 3 credits.**

Covers the geology and geologic processes of the terrestrial planets, moons, and other small bodies in the solar system including dwarf

planets, asteroids and comets. The emphasis is on understanding past and present surface geologic processes. Observation session at campus observatory may be required outside of class hours. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit.

**Recommended Prerequisite:** A course in Physical or Historical Geology at the undergraduate level.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 553: *Field Mapping Techniques*.** 3 credits.

Explores basic techniques for collecting, recording, and plotting spatial field data, including topographic maps, compass, transit, alidade, and global positioning systems. Field work and field based research project. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit. Equivalent to EVPP 503.

**Recommended Prerequisite:** Previous courses in geometry or trigonometry or equivalent; and environmental science, geography, or geology or equivalent.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Laboratory

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 563: *Coastal Morphology and Processes*.** 4 credits.

Investigates global coastal geomorphology and processes, with emphasis on U.S. Atlantic and Gulf coasts. Topics include plate tectonics; sea-level changes; sediment supply; impacts of waves, tides, storms; and human activities. Lecture and extended weekend field trips to U.S. mid-Atlantic coast. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit. Equivalent to EVPP 563.

**Recommended Prerequisite:** Previous courses in geology, oceanography marine science, earth science, or physical geography; or permission of instructor.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 565: *Paleoceanography*.** 3 credits.

Investigates ocean evolution through geologic time. Earth's sediment archive provides proxy data on paleo-ocean chemistry, biology, geology, and physical properties. Class examines proxy reconstructions of oceanic conditions such as circulation, salinity, stratification, anoxia, and biogeochemistry. Discusses the history of ocean basins, with case studies from Precambrian to Holocene. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit.

**Recommended Prerequisite:** Previous course in oceanography or marine science and 16 credits of geology or earth science courses, or permission of instructor.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

## 600 Level Courses

**GEOL 601: *The Lithosphere*.** 3 credits.

Global-scale overview of lithosphere, solid non-living Earth, materials, cycles, plate tectonic and geomorphic processes; and history, including interactions with and history of hydrosphere, atmosphere and biosphere, and methods of analysis. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit. Equivalent to GGS 657.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 603: *Geochemistry*.** 3 credits.

Includes stable isotope, crystal, water, and organic geochemistry; geochronology; and geochemistry of rocks. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit.

**Recommended Prerequisite:** An undergraduate degree in physical or natural sciences, including at least one semester of chemistry, introductory physical geology, and preferably, mineralogy, or permission of instructor.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 694: Supervised Internship.** 3-12 credits.

Training in application of geological skills under supervision of a qualified earth scientist at governmental agency, consulting firm, industry, or other acceptable organization Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May be repeated within the degree for a maximum 18 credits.

**Recommended Prerequisite:** Permission of student's MS thesis committee, graduate program director and department chair.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy or Graduate.

Enrollment is limited to Graduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Internship

**Grading:**

This course is graded on the Satisfactory/No Credit scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

## 700 Level Courses

**GEOL 700: Comprehensive Exam.** 1 credit.

Preparation for and completion of written comprehensive exam within AOES department. The comprehensive exam is given as part of the degree requirements in lieu of writing a master's thesis. Instructor should be the chair of the examination committee. The exam committee will specify exam content. Notes: No more than 1 credit of GEOL 700 may be applied toward the master's degree. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May be repeated within the degree for a maximum 2 credits.

**Recommended Prerequisite:** At least 15 graduate credits, approved project proposal, and permission of major advisor or chair of the examination committee.

**Registration Restrictions:**

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Independent Study

**Grading:**

This course is graded on the Satisfactory/No Credit scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 720: Bayesian Methods in Geology and Earth Sciences.** 3 credits.

The focus of this course is the development of a broad and general tool set that can be applied to the student's own research. Case studies from geology and Earth science literature are a guide to learn about common pitfalls, explore strategies for data analysis, understand how to select the best model for the task at hand, and learn the importance of properly quantifying and reporting the level of confidence in one's conclusions. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit.

**Registration Restrictions:**

**Required Prerequisites:** (GEOL 525<sup>B-</sup>, 525<sup>XS</sup>, 540<sup>B-</sup> or 540<sup>XS</sup>).

<sup>B-</sup> Requires minimum grade of B-.

<sup>XS</sup> Requires minimum grade of XS.

Enrollment limited to students with a class of Advanced to Candidacy, Graduate or Non-Degree.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 734: Paleobiology.** 3 credits.

Paleobiology involves the ways that paleontologists study fossil organisms as living entities in ecological context. It also deals with large scale patterns in the fossil record and the relationships of those patterns to geologic events. Paleobiology will use various statistical methods and other analytical methods to study these large scale patterns in the fossil record. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit.

**Recommended Prerequisite:** STAT 250 or equivalent or permission of instructor.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate or Non-Degree.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 741: Isotopes in Geology.** 3 credits.

Applications of isotope geochemistry to problems in geology, including both radioactive and stable isotopes, and low-temperature and high-temperature processes. Introduction to isotopes as a premier tool for tracing natural processes on Earth and in the solar system. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit.

**Recommended Prerequisite:** An undergraduate degree in physical or natural sciences that includes at least one semester of chemistry,

introductory physical geology, and preferably, a course in mineralogy, or permission of instructor.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate or Non-Degree.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 752: *Earth Sciences in Academia*.** 2 credits.

Earth Sciences in Academia prepares students for a career as a geoscientist in academia. It includes teaching and learning, pedagogy, research administration, and professional ethics. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May not be repeated for credit.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate or Non-Degree.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 792: *Seminar in Earth Systems Science, Geology, & Earth Science*.** 1 credit.

Capstone experience that includes discussion of scientific articles and attending seminars. Seminars presented by outside experts, faculty, and students. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May be repeated within the degree for a maximum 12 credits.

**Recommended Prerequisite:** 15 Graduate Credits including GEOL 601 or equivalent, or permission of instructor.

**Registration Restrictions:**

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Seminar

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 798: *Master's Research Project in Earth Systems Science*.** 1-6 credits. Experimental, observational, literature-based, or theoretical research project chosen and completed under guidance of faculty member. Proposal required before enrollment. Comprehensive technical report acceptable to student's committee required for completion. Notes: No more than 6 credits of GEOL 798 may be applied to master's degree. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May be repeated within the degree for a maximum 12 credits.

**Recommended Prerequisite:** 15 graduate credits, approved project or thesis proposal, and permission of instructor.

**Registration Restrictions:**

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Thesis

**Grading:**

This course is graded on the Satisfactory/No Credit scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 799: *Master's Thesis in Earth Systems Science*.** 1-6 credits.

Experimental, observational, or theoretical research under major advisor's supervision that culminates in production of thesis. Thesis work should be potentially publishable. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May be repeated within the degree for a maximum 18 credits.

**Recommended Prerequisite:** Approved thesis proposal by thesis committee, and permission of major advisor or instructor.

**Registration Restrictions:**

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Thesis

**Grading:**

This course is graded on the Satisfactory/No Credit scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

## 900 Level Courses

**GEOL 996: *Doctoral Reading and Research*.** 1-6 credits.

Reading and research on a specific topic in geology and earth sciences under the direction of a faculty member. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May be repeated within the term for a maximum 24 credits.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy or Graduate.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Research

**Grading:**

This course is graded on the Graduate Special scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 998: *Doctoral Dissertation Proposal*.** 1-12 credits.

Covers development of research proposal under guidance of dissertation director and doctoral committee. Proposal forms basis for geology and earth sciences doctoral dissertation. Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May be repeated within the degree for a maximum 12 credits.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy or Graduate.



**Schedule Type:** Dissertation

**Grading:**

This course is graded on the Satisfactory/No Credit scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**GEOL 999:** *Doctoral Dissertation*. 1-12 credits.

Doctoral dissertation research under direction of dissertation advisor.

Offered by Atmospheric/Oceanic/Earth Sci (<http://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/>). May be repeated within the degree for a maximum 24 credits.

**Recommended Prerequisite:** Admission to doctoral candidacy and permission of advisor.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy.

**Schedule Type:** Dissertation

**Grading:**

This course is graded on the Satisfactory/No Credit scale. (<http://catalog.gmu.edu/policies/academic/grading/>)