GEOLOGICAL, ENVIRONMENTAL, AND PLANETARY SCIENCES (GEOL)

Graduate Degree Program
College: Computer, Mathematical, and Natural Sciences

Abstract

Graduate students in the *Department of Geological, Environmental, and Planetary Sciences* engage in independent, original research through collaborative, mentored programs that promote creative thinking and generate new understanding of Earth and other planetary bodies. Departmental research spans the origin and evolution of Earth and the Solar System, the origin and history of life, the dynamics of planetary interiors and surfaces, and the processes by which the atmosphere, hydrosphere, biosphere, crust, mantle, and core interact and change through time. Although the program is organized broadly around **geological**, **environmental**, and **planetary sciences**, these areas are deeply interconnected, and students are encouraged to develop research programs that cross traditional disciplinary boundaries.

The department offers research-based programs leading to the M.S. and Ph.D. degrees. On a full-time basis, the M.S. normally requires two to three years of work, including coursework, completion of an M.S. research thesis, and oral defenses of the thesis proposal and final thesis. The Ph.D. commonly requires three to four years of work after completion of an M.S. program, or four to five years when pursued directly from the Bachelor's level. The Ph.D. program normally includes coursework, a qualifying examination and proposal defense, a dissertation, and an oral defense and examination of the dissertation. The graduate community includes students from diverse backgrounds pursuing a wide range of research interests and career goals. Most students are enrolled in the Ph.D. program, though the M.S. remains an important pathway for students seeking advanced research training, preparation for professional practice in government or industry, or eventual transition into doctoral study.

Our students engage in independent, original research through a collaborative mentored program that promotes creative thinking and generates new understanding of the Earth and other planets. Our collective research at the intersection of **geological, environmental,** and **planetary sciences** is concerned with the Earth, its origin and evolution as a planet, the origin and history of life, and the processes by which Earth and planetary atmospheres, surfaces and interiors have been and continue to be modified. Below, we detail research and expertise within the department subclassified into **geological**, **environmental**, and **planetary sciences**; however, these areas are not mutually exclusive, and students are encouraged to develop a program that suits their interests.

Our department has broad expertise in **geological sciences**, leveraging the tools of physics, chemistry, biology, and mathematics to understand our home planet. Specifically, our faculty and students study the chemistry, mineralogy, and physical evolution of rocks, magmas, and deep reservoirs using petrology, isotope geochemistry, microanalysis, field observations, and experiments. This work focuses on metamorphism, igneous systems, crustal and mantle fluid flow, volcanism, volatile cycling, tectonic change through time, and associated hazards such as earthquakes and landslides. We also study the structure, dynamics, and physical evolution of Earth's interior using seismology, geodesy, geodynamics, laboratory rock physics, and fluid dynamics. This work includes seismic imaging of the critical zone, crust, mantle, and core, geodetic measurements of earthquakes, volcanoes, landslides, and studies of rock deformation, percolation, turbulence, and geophysical magnetic fields. Together, this research seeks to understand deformation, flow, and material transport between the crust and mantle.

Environmental science research in the department focuses on processes at or near Earth's surface, including the critical zone, where geological processes, ecosystems, climate, and human activities interact. These processes, studied through both geophysical and geochemical techniques, include fluxes and reservoirs of water, dissolved constituents, soils and sediment and the interactions of these fluxes with the biosphere, atmosphere, and human activities, responding to and generating climate changes. Isotope geochemistry, high-precision mass spectrometry, and spectroscopy are used to investigate atmospheric gases such as methane, chemical reactions in soils tied to organic carbon, nutrient and metal cycling, and long-term changes in ocean chemistry recorded in carbonate rocks. We also study past environments and the rock record itself, asking how environmental, biological, and geochemical signals are preserved, altered, and correlated across sedimentary successions to reconstruct ancient Earth systems and the history of life.

Faculty and students also pursue research in **planetary science**, including astrobiology, cosmochemistry, geodynamics, planetary geology, seismicity, tectonics, volcanism, and the origin and preservation of life's signatures. We investigate planetary materials, interiors, and surfaces using a combination of cosmochemistry, petrology, geophysics, spectroscopy, analog environments, and remote sensing, with the goal of understanding how planets and small bodies formed, differentiated, evolved, and continue to change. Our work spans the chemical evolution of planetary mantles and cores, the accretion and crystallization histories of the Earth, Moon, Mars, and early Solar System planetesimals, the composition and origin of comets, asteroids, meteorites, and the Moon, and the physical structure and dynamics of planetary interiors inferred from seismology, deformation, and geodynamics. We have faculty engaged in NASA missions including efforts to train future astronauts, deploy seismometers on the Moon, evaluate the potential for lava tubes as shelters for future lunar missions, and design instrumentation for identifying biosignatures in planetary environments.

Students choose an advisor within the *Department of Geological, Environmental, and Planetary Sciences*, while also benefiting from research opportunities across campus and in the greater Washington, D.C., region. Campus collaborators include Astronomy, Atmospheric and Oceanic Science, Chemistry and Biochemistry, Geographical Sciences, Environmental Science and Technology, Mathematics and the Applied Mathematics and Scientific Computation Program, and Physics. Regional collaborators include the Smithsonian Institution, the United States Geological Survey (USGS), NASA Goddard Space Flight Center (GSFC), the Carnegie Institution for Science Earth and Planets Laboratory, and the National Institute of Standards and Technology (NIST). The Earth System Science Interdisciplinary Center (ESSIC) is a collaborative venture among the Departments of Geographical Sciences, Geological, Environmental, and Planetary Sciences, and Atmospheric and Oceanic Science on campus, and the Earth Sciences Directorate at NASA GSFC. These in-house and regional resources give graduate students access to a broad multidisciplinary program with international reach.

Financial Assistance

Graduate students are eligible for Departmental teaching assistantships, Graduate School fellowships and grant-supported fellowships and research assistantships. In addition, some curatorial, library and other part-time work is sometimes available.

Contact

See the Department of Geology Web page at URL https://www.geol.umd.edu (http://www.geol.umd.edu) for additional information. The Department's Graduate Studies in Geological Sciences also provides additional information on the requirements, examinations, faculty research interests and publications, research facilities and financial aid. Copies are available from:

Graduate Coordinator
1118 Geology Building
8000 Regents Drive
University of Maryland
College Park, MD 20742
Telephone: 301.405.4065
Email: grad-sec@umd.edu

Website: https://www.geol.umd.edu **(**http://www.geol.umd.edu**)**

Courses: GEOL **(**https://umd-curr.courseleaf.com/graduate/courses/geol/**)**

ADMISSIONS

General Requirements

- Statement of Purpose
- Transcript(s)
- TOEFL/IELTS/PTE (international graduate students (https://gradschool.umd.edu/admissions/english-language-proficiency-requirements/))

Program-Specific Requirements

- Letters of Recommendation (3)

Qualified students with a B.S. degree in geology, physics, mathematics, chemistry, biology, engineering or other related sciences are invited to apply for admission to the graduate programs. Our graduate degree program in geophysics welcomes students with undergraduate degrees in physics and or astronomy having little to no background in geology. Coursework expectations for students applying to the program is at least a year of calculus, a semester of physics for science majors, and for those in the in geology and geochemistry track a year of chemistry or its equivalent.

Application Deadlines

Type of Applicant	Fall Deadline
Domestic Applicants	
US Citizens and Permanent Residents	January 8, 2026
International Applicants	
F (student) or J (exchange visitor) visas; A, E, G, H, I and L visas and immigrants	January 8, 2026

RESOURCES AND LINKS:

Program Website: http://www.geol.umd.edu

Application Process: gradschool.umd.edu/admissions (https://gradschool.umd.edu/admissions/)

REQUIREMENTS

FACILITIES AND SPECIAL RESOURCES

The goal of geological, environmental and planetary sciences is to study the Earth and other planetary bodies from their cores to the upper reaches of their atmospheres. Our faculty, students, postdocs and researchers carry out geological, biological, chemical, and physical investigations. Below, you can find information on the facilities in our department, organized by various disciplines and approaches:

Biological and Environmental Geoscience: paleoclimate/paleoenvironments, paleobiology/paleontology, taphonomy, geomorphology, hydrology, soil science, low-temperature geochemistry

Faculty: Michael Evans (https://www.geol.umd.edu/michaelevans/), James Farquhar (https://www.geol.umd.edu/jamesfarquhar/), Thomas Holtz (https://www.geol.umd.edu/thomasholtz/), Alan Kaufman (https://www.geol.umd.edu/alankaufman/), Sujay Kaushal (https://www.geol.umd.edu/sujaykaushal/), Cédric Magen (https://www.geol.umd.edu/cedricmagen/), John Merck (https://www.geol.umd.edu/johnmerck/), Karen Prestegaard (https://www.geol.umd.edu/karenprestegaard/), Cecilia Sanders (https://www.geol.umd.edu/ceciliasanders/), Mengqiang Zhu (https://www.geol.umd.edu/mengqiangzhu/)

Facilities: AIM Lab (https://www.nanocenter.umd.edu/aimlab/), Biogeochemistry Laboratory (https://kaushallab.wixsite.com/kaushallab/), Laboratory for Hydrologic Studies (https://www.geol.umd.edu/facilities/hydrologic.php), Panorama Laboratory (https://www.geol.umd.edu/facilities/mdpanolab/), Sanders of Time Laboratory (https://www.sandersoftimelab.com/), Soil and Environmental Biogeochemistry Group (https://www.geol.umd.edu/facilities/sebg/), Stable Isotope Laboratory (https://www.geol.umd.edu/facilities/SIL/)

Geo- and Cosmo-chemistry: stable and radiogenic isotopes, meteorites, high-temperature geochemistry

Faculty: Ricardo Arévalo (https://www.geol.umd.edu/ricardoarevalo/), Richard Ash (https://www.geol.umd.edu/richardash/), Michael Evans (https://www.geol.umd.edu/michaelevans/), James Farquhar (https://www.geol.umd.edu/jamesfarquhar/), Valerie Finlayson (https://www.geol.umd.edu/valeriefinlayson/), Alan Kaufman (https://www.geol.umd.edu/alankaufman/), William McDonough (https://www.geol.umd.edu/williammcdonough/), Sarah Penniston-Dorland (https://www.geol.umd.edu/sarahpenniston-dorland/), Igor Puchtel (https://www.geol.umd.edu/igorpuchtel/), Richard Walker (https://www.geol.umd.edu/richardwalker/)

Facilities: AIM Lab (https://www.nanocenter.umd.edu/aimlab/), Isotope Geochemistry Laboratory (https://www.geol.umd.edu/facilities/igl.php), M-CLASS Laboratory (https://mclasslaboratory.wixsite.com/mclass/), Plasma Laboratory (https://www.geol.umd.edu/plasma-lab/), Stable Isotope Laboratory (https://www.geol.umd.edu/facilities/SIL/)

Geology, Petrology, Volcanology, Tectonics: metamorphic petrology, igneous petrology, volatiles, active tectonics, orogeny, subduction, economic geology, mineralogy

Faculty: Hannes Bernhardt (https://www.geol.umd.edu/hannesbernhardt/), Michael Brown (https://www.geol.umd.edu/michaelbrown/), Philip Candela (https://www.geol.umd.edu/philipcandela/), Jackie Clark (https://www.geol.umd.edu/jackieclark/), Mong-Han Huang (https://www.geol.umd.edu/mong-hanhuang/), Laurent Montési (https://www.geol.umd.edu/laurentmontesi/), Megan Newcombe (https://www.geol.umd.edu/megannewcombe/), Sarah Penniston-Dorland (https://www.geol.umd.edu/sarahpenniston-dorland/), Philip Piccoli (https://www.geol.umd.edu/philippiccoli/), Ann Wylie (https://www.geol.umd.edu/annwylie/)

Facilities: Active Tectonics Laboratory (https://sites.google.com/site/monghanhuang/home/), Isotope Geochemistry Laboratory (https://www.geol.umd.edu/facilities/igl.php), Laboratory for Crustal Petrology (https://www.geol.umd.edu/facilities/LCP/lcp.php), Laboratory for Mineral Deposits Research (https://www.geol.umd.edu/facilities/lmdr/), Rock Preparation and Mineral Separation Facilities (https://www.geol.umd.edu/facilities/rockprep.php)

Geophysics: seismology, mineral and rock physics, geodynamics, geodesy, structural geology

Faculty: Mong-Han Huang (https://www.geol.umd.edu/mong-hanhuang/), Daniel Lathrop (https://www.geol.umd.edu/daniellathrop/), Vedran Lekić (https://www.geol.umd.edu/vedranlekic/), Laurent Montési (https://www.geol.umd.edu/laurentmontesi/), Nicholas Schmerr (https://www.geol.umd.edu/nicholasschmerr/), Wenlu Zhu (https://www.geol.umd.edu/wenluzhu/)

Facilities: GEODES: Geophysical Exploration of the Dynamics and Evolution of the Solar System (https://www.geodes.umd.edu/), Geodynamics Laboratory (https://www.geol.umd.edu/geodynamics/), Laboratory for Rock Physics (https://www.geol.umd.edu/facilities/rockphysics/), Nonlinear Dynamics Laboratory (https://complex.umd.edu/), Seismology Laboratory (https://www.geol.umd.edu/facilities/seismology/)

Planetary Science: planetary geology, planetary interiors, astrobiology

Faculty: Ricardo Arévalo (https://www.geol.umd.edu/ricardoarevalo/), Hannes Bernhardt (https://www.geol.umd.edu/hannesbernhardt/), Jackie Clark (https://www.geol.umd.edu/jackieclark/), Vedran Lekić (https://www.geol.umd.edu/vedranlekic/), Laurent Montési (https://www.geol.umd.edu/laurentmontesi/), Megan Newcombe (https://www.geol.umd.edu/megannewcombe/), Nicholas Schmerr (https://www.geol.umd.edu/nicholasschmerr/), Jessica Sunshine (https://www.geol.umd.edu/jessicasunshine/)

Facilities: GEODES: Geophysical Exploration of the Dynamics and Evolution of the Solar System (https://www.geodes.umd.edu/), M-CLASS Laboratory (https://mclasslaboratory.wixsite.com/mclass/), Planetary Volcanism Laboratory (https://sites.google.com/view/umdplanetaryvolcanism/home/)

Further information is found at the following URL https://www.geol.umd.edu/graduate/index.php (https://www.geol.umd.edu/graduate/)