# Graduate Studies in Earth Sciences

## Graduate Studies

The Department of Earth Sciences offers programs of graduate study leading to master of science (MS), master of arts (MA), and doctor of philosophy (PhD) degrees with opportunity for research in a wide variety of specialty fields. Course work is designed to meet individual needs, and students may pursue independent research in geobiology, geochemistry, geodesy, geomechanics, geomorphology, geophysics, mineralogy, petrology, volcanology, paleontology, stratigraphy, sedimentary petrology, structural geology, and ore deposit geology. The master's degree program requires two years or more for completion.

Admission to the graduate program is competitive and based on academic records, scores on the Graduate Record Examinations (GRE), and letters of recommendation. Nonnative speakers of English must also submit scores for the Test of English as a Foreign Language (TOEFL) and the Test of Spoken English (TSE). Applications are welcome from students who are interested in using their background in related fields, such as physics, chemistry, and biology, to solve geologic or geophysical problems.

Graduate students are advised by a guidance committee consisting of three faculty members. This committee meets with each student shortly after he or she arrives on campus and as often thereafter as necessary for planning purposes.

### Requirements

Basic university requirements for graduate degrees are described in the Graduate School (http://catalog.uoregon.edu/archive/2022-2023/graduate/) section of this catalog. The department sets additional examination, course work, seminar, and thesis requirements. Applicants should read the *Guide to Graduate Study* on the department website (http://earthsciences.uoregon.edu/graduate-program/) or write to the Department of Earth Sciences for details.

## Programs

Graduate study in earth sciences is offered in five broad areas:

1. volcanology-petrology-geochemistry
2. stratigraphy–surface processes
3. paleontology-paleopedology-geobiology
4. structural geology–geophysics
5. economic geology (mineral deposits)

### Volcanology-Petrology-Geochemistry

The department has excellent analytical and other research facilities for studies in these subdisciplines, and the volcanic and metamorphic terrane of the Northwest offers unsurpassed opportunities for field studies. Active research programs are diverse and include studies of eruption dynamics, magma volatile inventories, and magma rheology; experimental studies of igneous phase equilibria and trace element partitioning; calculations of multicomponent equilibria in aqueous systems and volcanic gases; and studies of igneous protogenesis.

### Stratigraphy–Surface Processes

The stratigraphic record of tectonically active sedimentary basins indicates the dynamic interactions among basin subsidence, sediment input from eroding sources, evolution of depositional systems, and active faulting and folding that govern these processes. Research in this area combines field-based stratigraphic, sedimentologic, and geomorphic analysis with provenance studies and concepts derived from theoretical models to decipher the complex structural and climatic controls on the filling histories of active basins.

Surface processes regulate how tectonics and climate affect landscape evolution. Field observations, numerical simulations, topographic analyses, and experimental facilities are used to study sediment transport processes over a range of spatial and temporal scales. Projects incorporate links between active tectonics and structural geology, biology, geomechanics, and surface processes to address problems such as landsliding and hill-slope evolution, biological contributions to soil creep and landscape lowering, and the geomorphic implications of seismic-induced landsliding.

### Paleontology-Paleopedology-Geobiology

Studies of fossil soils, plants, and vertebrates aim to reconstruct life on land and its role in global change. Global changes of interest include Neogene paleoclimate and paleoenvironment of ape and human evolution in East Africa, environmental effects of terminal Cretaceous impact and dinosaur extinction in Montana, consequences of mass extinction and methane clathrate degassing at the Permian-Triassic boundary, and the effect of early land plants and forests on weathering and atmospheric composition during the early Paleozoic.

Geobiology focuses on the interaction of microorganisms with the geologic environment and the ways life forms affect geological processes, such as weathering and mineralization.

### Structural Geology–Geophysics

Graduate work in the structural geology–geophysics area involves the study of the earth's dynamic processes.

Seismic imaging techniques using regional arrays provide tools for understanding regional tectonics. Studies of upper-mantle and lithospheric structure beneath the Rocky Mountains and in the Pacific Northwest subduction zone are providing essential constraints, unavailable from surface geology, for detailed dynamical models of plate-lithospheric deformation.

Structural geology focuses on applying modern field and analytical techniques to solving problems in Cenozoic tectonics and active faulting. Detailed field mapping, trench logging, and geomorphic analysis are combined with seismic array data, land- and space-based geodetic data, and theoretical modeling to address problems including Oregon's Basin and Range province and coastal deformation, active tectonics of the San Andreas Fault system, and seismic risk along the Pacific margin of the United States and southeast and central Asia.

Geophysical experiments conducted at sea investigate the nature of sea-floor spreading including the segregation, transport, and storage of melt; the rifting of oceanic lithosphere; and the spatial and temporal connectivity between magmatic, tectonic, and hydrothermal processes.

### Mineral Deposits

Current research on ore deposits includes studies of porphyry copper deposits, epithermal veins, and active geothermal systems. These

projects combine field mapping, petrography, and chemical analyses with theoretical chemical modeling of processes of ore fluid generation, alteration, and mineralization.

## Related Research Activities

The Condon Collection of Fossils at the Museum of Natural and Cultural History maintains strong ties to the Department of Earth Sciences. Two geology professors are curators of the collection, and paleontology undergraduate and graduate students are often employed as assistants. The Condon Collection contains 60,000 specimens, including invertebrate and vertebrate fossils, paleobotanical remains, and an extensive collection of modern animals that are available to interested researchers for study.

## Research Facilities

Students may use a variety of analytical facilities and equipment including a three-component broadband (0.03–50Hz) seismic array, an electron microprobe, a scanning electron microscope with image analysis, x-ray diffraction, FTIR spectroscopy, stable isotope mass spectroscopy, and a geobiology laboratory.

An experimental petrology laboratory covers a range of crustal temperatures and pressures and includes equipment for doing experiments in controlled atmospheres. Two piston-cylinder apparatus with pressure-temperature capability to 35 kilobars and 1,500° C may be used to study crystalline, partially molten, and molten silicates under mantlelike conditions.

Computers are used for much of the research in the department including acquisition and processing of seismic and gravity data and numerical modeling of geophysical processes and geochemical reactions. A geochemistry laboratory is equipped with sophisticated computer programs for thermodynamic calculations of gas-liquid-solid equilibria and reaction processes important in metamorphic, volcanic gas, hydrothermal, and diagenetic systems. The Internet can be accessed through the UONet fiber-optic link. A student computer facility, equipped with PC and Macintosh computers and laser printers, is also connected to the networks.

The sedimentological and paleontological laboratories have, in addition to standard laboratory equipment, an electronic particle-size analyzer, an x-radiography unit, photomicroscopes, a Leitz Aristophot unit, a fully maintained catalog of foraminifera, an acid room, and a conodont-processing laboratory.

## Financial Aid for Graduate Students

Most of the department's graduate students are fully supported through teaching and research assistantships. More information about financial assistance and department policies for awarding and renewing teaching and research fellowships may be obtained by reading the *Guide to Graduate Study* on the department website (http://earthsciences.uoregon.edu/graduate-program/) or by writing to the department.

## Master of Science and Master of Arts in Earth Sciences

| Code | Title | Credits |
|---|---|---|
| 500 or 600 level [1] | | 24 |
| 600-699 level [2] | | 9 |
| Thesis [3] | | 9 |
| Remaining Credits [4] | | 3 |
| **Total Credits** | | **45** |

*At least 30 credit hours in residence, in the major*

1. *Only graded courses apply.* Up to 15 credits may be taken in courses offered outside the department (with advisor approval)
2. May be taken graded or pass/no pass, but only graded courses can apply toward the 24 credits above.
3. GEOL 503. At least 3 thesis credits must be taken in the final term.
4. Can include research, readings, and seminars. Students are expected to register for and attend the department seminar and graduate student seminar (607) each term.

## Ph.D. in Earth Sciences

| Code | Title | Credits |
|---|---|---|
| 500 or 600 Level Courses [1] | | 15 |
| Dissertation [2] | | 18 |
| Additional Credits [3] | | 48 |
| **Total Credits** | | **81** |

1. Must be taken for grade.
2. GEOL 603, with a minimum of 3 credits must be taken in the last term.
3. 3+ years of full-time study (at least 9 credits/term may include research or reading credits). Students are expected to register for and attend the department seminar and graduate student seminar (607) each term.

*Ph.D. students are required to take 15 graded classroom credits at the graduate-level (500-600 level). These courses must be approved by the guidance/dissertation committee chair to ensure that they are geared toward achieving balance between the increasing the breadth of their academic experience and maintaining focus on areas of relevance to their research. They must also take 18 hours of dissertation credits (GEOL 603).*