EARTH AND PLANETARY SCIENCES

About Earth and Planetary Sciences

The Department of Earth and Planetary Sciences offers both **M.Sc.** and **Ph.D.** degree programs. Graduate programs are based on research, although some courses are required to build the backgrounds of students. Research in the Department is wide-ranging, and much of the research is highly interdisciplinary.

Facilities in the Department include experimental laboratories (both at low and high temperatures and pressures), stable-isotope mass spectrometers, cavity ringdown isotope analyzers, a laser-ablation ICP-MS, an electron microprobe, and atomic absorption spectrometers. Our students also make substantial use of other facilities at McGill and at the Geotop Research Centre facilities located nearby at *Université du Québec à Montréal*.

Financial assistance is available to all graduate students in the form of teaching assistantships, graduate student stipends, and scholarships.

Areas of Research

Carbon Cycle Biogeochemistry

Reconstructions of past climate and carbon cycle change using sediments from lacustrine, coastal, and marine sediments. Examining processes controlling carbon cycling in freshwater environments, including the burial of organic matter in sediments and the production of greenhouse gases through microbial respiration. Quantification and source apportionment of greenhouse gas emissions in human-dominated and natural environments.

Economic Geology

Studies of the genesis of hydrothermal mineral deposits through a combination of field-based, experimental, and theoretical methods. Research focuses on the understanding of physico-chemical controls of mineralization, through geological mapping of deposits; experimental studies of metal solubility and speciation in hydrothermal systems; simulations of hydrothermal alteration; and theoretical studies designed to estimate conditions of alteration and ore formation. Trace-element chemistry of minerals as quantitative probes of the compositions of ore-forming fluids.

Exoplanet Climate

Using telescopes on the ground and in space to explore the surfaces and atmospheres of the diverse planets outside the Solar System: How much incident stellar flux do planets absorb? How do they move this energy through atmospheric and oceanic circulation? Which planets enjoy habitable surface conditions? Do any of them exhibit atmospheric biosignatures?

Geobiology

Understanding the role of microorganisms in biogeochemical cycles; cultivation of environmental microorganisms; applying molecular and isotopic tools to characterize microbial activity in present and past environments.

Geophysics and Climate

Applying physics to study the interactions between the solid Earth, ice, ocean, and climate systems; numerical modelling, analysis, and interpretation of paleo and modern sea-level changes; solid earth deformation and glacial isostatic adjustment; and ice in the Earth and climate systems.

Hydrogeology

Studies of pore-water flow in permafrost environments; heat transport; heat as a tracer of natural systems; groundwater modelling; coupled numerical models of pore water flow and heat transport with freeze/thaw processes; and the impact of melting tropical glaciers on water resources.

Hydrology and Ecohydrology

Studies of the storage, release, and transport of water, nutrients, and other contaminants in watersheds; combination of field, laboratory, big data science and modelling approaches; use of a complex-systems lens to identify the resistance and resilience of watersheds to climate and environmental change; implications for water management and policy in forested, agricultural, and mixed-used watersheds.

Igneous Petrology

Experimental studies of the structure, thermodynamics, and transport properties (diffusion and viscosity) of silicate melts and applications to igneous petrogenesis. The nature of the Earth's upper mantle and the processes within it which give rise to basaltic volcanism on both the Earth and the other terrestrial planets. Applications of laser ablation ICPMS; petrology, geochemistry, and tectonics of the Appalachian lithosphere.

Integrated Earth System Dynamics

Research at the intersection of Earth system science and the global human system. Quantifying how human activities, constructions and machines function at the global scale, and how they interact with climate, ecosystems and biogeochemical cycles. Global data analysis and modelling; approaches that cut across traditional disciplinary boundaries; integration of human and natural systems; interactions between macroecology, biogeochemistry, and climate change; Earth System Economics.

Isotopic Geochemistry and Sedimentary Geology

Sedimentology, stratigraphy, and isotope geochemistry as guides to reconstructing ancient environments. Reconstruction of Proterozoic paleogeographies and the origin and evolution of Proterozoic sedimentary basins. Documenting and interpreting paleoenvironmental change during the Proterozoic. Relationships between tectonics (i.e., supercontinental break-up and assembly), seawater chemistry and ocean redox, and climate change. Calibrating the diversification of early eukaryotes and their impact on global biogeochemical cycles.

Mineralogy

Chemistry and crystallography of carbonate and a variety of rock-forming and biogenic minerals; experimental investigations of the effect of environmental factors (e.g., solution composition and temperature) on the morphology and composition of carbonate and phosphate minerals.

Seismology

Subduction earthquake nucleation and rupture propagation processes; physical mechanism of aseismic deformation transients, deep non-volcanic tremors, dynamic and static stress triggering of low-frequency earthquakes, and transients; pore-fluid pressure coupling with frictional strength and slip.

Tectonics and Structural Geology
Digital field mapping, microstructural characterization, and mineralogical analyses of deformation structure kinematics, geometry, and deformation processes; archean orogenic processes; structural controls on ore deposit genesis; fluid flow in faults, granular flow in faults, and catastrophic structural/geochemical events in faults; earthquake mechanics and processes recorded in rocks; brittle-ductile transition structures and rheology.

Volcanology
Petrology and geochemistry of intermediate and felsic magmas; understanding physical processes and forecasting eruptions at active subduction-zone volcanoes; geochemistry of volcanic gases, their use for eruption prediction, and their impact on the atmosphere.

Program Overview
The nature of graduate research in the Department of Earth and Planetary Sciences is highly variable. As a result, students may enter the graduate program with backgrounds in earth sciences, chemistry, or physics, depending on their research interests and the supervisor with whom they wish to work.

Students pursuing an M.Sc. are required to take four courses, but their major project is an M.Sc. thesis that typically results in a journal publication. Research for the thesis typically begins in the first year of residence and is completed, together with the written results, in the second year of residence.

Students graduating from the program typically proceed to a Ph.D. or work in the mineral exploration or petroleum industries. Excellent students admitted into the M.Sc. program can be fast-tracked from the M.Sc. into the Ph.D. program at the end of the first year if suitable progress has been demonstrated. Such students are required to take a minimum of 18 credits of coursework in total, and a comprehensive oral examination before the end of 18 months in the Ph.D. program.

Ph.D. students typically enter with an M.Sc., in which case they are required by our regulations to take only two courses, although a supervisor may require more, depending on the suitability of the student's background. In addition to courses, Ph.D. students commence work on the thesis research project, including preparation for an oral examination on their research proposal before the end of 18 months from starting the program. Conduct of the research and preparation of the results for thesis and publication typically takes three additional years. Students entering the Ph.D. program without an M.Sc. are required to take a full year of courses before embarking on the processes described above.

Students graduating from our Ph.D. program pursue careers in universities and government-funded research institutes, and in the mineral-exploration and petroleum industries.

Earth and Planetary Sciences Admission Requirements and Application Procedures
Admission Requirements
Applicants should have an academic background equivalent to that of a McGill graduate in the Honours or Major programs in geology, geophysics, chemistry, biology, physics, engineering or a related degree (minimum CGPA of 3.0 out of 4.0). The Admissions Committee may modify the requirements in keeping with the field of graduate study proposed. In some cases, a Qualifying year may be required.

English Language Proficiency
For graduate applicants whose mother tongue is not English, and who have not completed an undergraduate or graduate degree from a recognized Canadian or American (English or French) institution or from a recognized foreign institution where English is the language of instruction, documented proof of English proficiency is required prior to admission. For a list of acceptable test scores and minimum requirements, visit mcgill.ca/gradapplicants/international/proficiency.

Application Procedures
Students should first contact potential supervisors within the Department of Earth and Planetary Sciences and assess their interest in accepting new students before starting the formal application procedure. General inquiries concerning the Department should be addressed to Graduate Admissions, Department of Earth and Planetary Sciences at grad.eps@mcgill.ca. Candidates should indicate their field(s) of interest when making formal applications for admission.

McGill's online application form for graduate program candidates is available at mcgill.ca/gradapplicants/apply.

See Application Procedures for more information.

Application Dates and Deadlines
Application opening dates are set by Enrolment Services in consultation with Graduate and Postdoctoral Studies (GPS), while application deadlines are set by the Department of Earth and Planetary Sciences and may be revised at any time. Applicants must verify all deadlines and documentation requirements well in advance on the appropriate McGill departmental website; please consult the list at mcgill.ca/gps/contact/graduate-program.

Information on application deadlines is available at mcgill.ca/gradapplicants/how-apply/application-steps/application-deadlines.

Admission to graduate studies is competitive; accordingly, late and/or incomplete applications are considered only as time and space permit.

Available Programs
- Earth and Planetary Sciences (Ph.D.)
- Earth and Planetary Sciences (Thesis) (M.Sc.) (45 credits)

Location
Department of Earth and Planetary Sciences
Frank Dawson Adams Building
3450 University Street
Montreal QC H3A 0E8
Telephone: 514-398-6767
Email: grad.eps@mcgill.ca
Website: mcgill.ca/eps