

## Geology (GEOL)

Department of Earth Sciences  
Faculty of Science

GEOL 1004 [0.5 credit] (formerly 67.104)

### The Evolving Earth

The 4.6 billion year history of geological processes, catastrophic events, climatic change, and history of life, as the foundation from which to interpret the evolution of Earth's environments.

Precludes additional credit for GEOL 1008, GEOL 1000 or GEOL 1005, ISCI 2001 and ISCI 2000.

Prerequisite: For non-Science students.

Lectures three hours a week.

GEOL 1006 [0.5 credit] (formerly 67.106)

### Exploring Planet Earth

Origin of the Earth and concepts of geological time. Exploration of processes that shape our planet and form its rocks and mineral deposits: magmatism, volcanism, metamorphism within the Earth's interior; weathering, erosion and sedimentation at the Earth's surface.

Precludes additional credit for GEOL 1000 GEOL 1005, GEOG 1005, and GEOG 1100.

Prerequisites: OAC in Calculus and one of Physics, Biology or Chemistry; or permission of the Department.

Lectures three hours a week, laboratory three hours a week, field excursions.

GEOL 1007 [0.5 credit] (formerly 67.107)

### The Dynamic Earth: Plate Tectonics

Dynamic processes that drive our planet and create the interior structure of the Earth; plate tectonics and processes at plate boundaries; earthquakes and seismic hazards; use of geophysics to explore the subsurface.

Precludes additional credit for GEOL 1000 GEOL 1005, GEOG 1005, and GEOG 1100.

Prerequisites: OAC in Calculus and one of Physics, Biology or Chemistry; or permission of the Department.

Lectures three hours a week, laboratory three hours a week, field excursion.

GEOL 1008 [0.5 credit] (formerly 67.108)

### Earth Systems through Time

Historical development of ideas concerning gradualism, catastrophism, and complex systems as guiding forces of local to global geological changes that define the past 4.6 billion years, the history of life, and the evolution of Earth's environments.

Precludes additional credit for GEOL 1000, GEOL 1004 and GEOL 1005.

Prerequisite: OAC in Calculus and one of Physics, Biology or Chemistry; or permission of the Department.

Lectures three hours a week, laboratory three hours a week, field excursion.

GEOL 2001 [0.5 credit] (formerly 67.201)

### Co-operative Work Term Report 1

This course provides practical experience for students enrolled in the Co-operative Option. To receive course credit a student must receive satisfactory evaluations from their work term employer. Written and oral reports describing the work term project will be required.

Prerequisites: registration in the Earth Sciences Co-operative Option and permission of the Department.

Four-month work term.

GEOL 2203 [0.5 credit] (formerly 67.223)

### Optical Mineralogy

Methods of optical mineralogy and optics of the rock forming minerals.

Precludes additional credit for GEOL 2202.

Prerequisites: at least 1.0 credit from GEOL 1006, GEOL 1007, GEOL 1008 or GEOL 1000 or GEOL 1005 and Chemistry 65.100; or permission of the Department

Lectures two hours a week, tutorial one hour a week, laboratory three hours a week.

GEOL 2205 [0.5 credit] (formerly 67.225)

### Introductory Geochemistry

An introduction to thermodynamics, phase diagrams, and solution chemistry as applied to geological systems. Distribution of the elements.

Precludes additional credit for GEOL 2201.

Prerequisites: at least 1.0 credit from GEOL 1006, GEOL 1007, GEOL 1008 or GEOL 1000 or GEOL 1005 and Chemistry 65.100; or permission of the Department

Lectures two hours a week, laboratory three hours a week.

GEOL 2208 [0.5 credit] (formerly 67.228)

### Petrology and Geochemistry of Igneous Rocks

The classification of igneous rocks. The chemical characteristics of the crust and mantle. The generation and physical properties of magmas, magma emplacement of volcanic and plutonic rocks. Phase equilibrium and isotope geochemistry.

Prerequisites: GEOL 2203 and GEOL 2205.

Lectures two hours a week, tutorial one hour a week, laboratory three hours a week.

GEOL 2301 [0.5 credit] (formerly 67.231)

### Historical Geology and the Fossil Record

Evolution of the earth and its biosphere through geological time, the stratigraphic and fossil record in relationship to geological and paleontological processes, introduction to important fossil groups and their paleoenvironmental implications.

Prerequisites: at least 1.0 credit from GEOL 1006, GEOL 1007, GEOL 1008 or GEOL 1000 or GEOL 1005; or permission of the Department.

Lectures three hours a week and laboratory three hours a week. May involve one or more field trips.

GEOL 2306 [0.5 credit] (formerly 67.236)

### Evolutionary Paleocology

Principles of ecology and paleocology applied to the stratigraphic succession of fossil communities. Current concepts of micro- and macro-evolution and extinction and the synthesis of key paleontological events through the Phanerozoic are emphasized.

Precludes additional credit for GEOL 3302 and GEOL 3303.

Prerequisite: GEOL 2301 or permission of the Department.

Lectures two hours a week, laboratory three hours a week.

GEOL 2308 [0.5 credit] (formerly 67.238)

### Environmental and Resource Geology

Enhances appreciation of the resource basis of society and addresses issues related to the extraction and utilization of geological resources. Deals with the role of the Earth Sciences in the forecasting and mitigation of natural disasters such as earthquakes and volcanic eruptions.

Available only as a free elective in the Geology programs.

Prerequisite: any one of the 1000-level courses in Geology or ISCI 2001 or permission of the Department

Lectures three hours a week.

GEOL 2401 [0.5 credit] (formerly 67.241)

### Dinosaurs

A general introduction to dinosaurs, their place in evolution, their social behaviour, the Mesozoic landscape, extinction theories, and public perception of dinosaurs.

Not available as Science credit in Geology programs.

Lectures three hours a week.

GEOL 2402 [0.5 credit] (formerly 67.242)

### Climate Change: An Earth Sciences Perspective

An exploration of the often dramatic climate changes that have occurred through earth history from a geological perspective, emphasizing the history of earth climates, geological causes of climate change, and impact that rapid climate change has had on the biosphere.

Not available as Science credit in Geology programs.

Lectures three hours a week.

GEOL 2403 [0.5 credit] (formerly 67.243)

### **Introduction to Oceanography**

An environmental approach to understanding the oceans which cover over 70 percent of the Earth's surface; deals with origins, physical and organic components and processes, geological marine resources and marine pollution. Not available as Science credit in Geology programs. Lectures three hours per week.

GEOL 2404 [0.5 credit] (formerly 67.244)

### **Engineering Geology**

Overview of geological processes essential for understanding engineering problems. Topics include: geologic cycle; classification of rocks; stratigraphy; geological structures; physical and chemical weathering; erosion, transportation, and depositional environments; definition, classification and properties of soils; physical and geochemical aspects of groundwater; and geophysical techniques.

Precludes additional credit for any 1000-level Geology courses.

Prerequisites: registration in B.Eng.; CHEM 1101 or permission of the Department.

Lectures three hours a week, laboratory three hours alternate weeks, a field excursion.

GEOL 2801 [0.5 credit] (formerly 67.281)

### **Field Geology I**

An introduction to the study of rocks from the Precambrian and Phanerozoic Eras. Geologic mapping techniques are emphasized. A mandatory two-week field camp before classes in the fall with additional laboratories and field trips during the fall term.

Precludes additional credit for GEOL 2805 as a Science credit for students in Geology program but may be taken as a Free Elective.

Prerequisites: At least 1.0 credit from GEOL 1006, GEOL 1007, GEOL 1008, GEOL 1000 or GEOL 1005 and completion of the first-year Science program; or permission of the Department.

GEOL 2802 [0.5 credit] (formerly 67.282)

### **Field Geology II**

An introduction to methods of field analysis and interpretation in deformed and metamorphosed terranes. The course includes a two-week field camp to be taken in early May.

Prerequisites: GEOL 2801 and permission of the Department.

Lectures one hour a week, laboratory three hours a week, two-week field camp in early May.

GEOL 2805 [0.5 credit] (formerly 67.285)

### **Environmental Field Geology**

The geology of the environment studied in the field. The course includes exercises on topics such as hydrogeology, limnology and Pleistocene Geology. Mandatory two-week field camp before classes begin in the fall.

Precludes additional credit for GEOL 2801 as a Science credit for students in the Geology programs but may be taken as a Free Elective.

Prerequisites: At least 1.0 credit from GEOL 1006, GEOL 1007, GEOL 1008, GEOL 1000 or GEOL 1005 and completion of the first-year Science program; or permission of the Department.

GEOL 3001 [0.5 credit] (formerly 67.301)

### **Co-operative Work Term Report 2**

This course provides practical experience for students enrolled in the Co-operative Option. To receive course credit a student must receive satisfactory evaluations from their work term employer. Written and oral reports describing the work term project will be required.

Prerequisites: Registration in the Earth Sciences Co-operative Option and permission of the Department.

Four-month work term.

GEOL 3111 [0.5 credit]

### **Vertebrate Paleontology I**

Introduction to fossil vertebrates using both ancient and recent mammals to illustrate vertebrate paleontologists'

approach to anatomy, functional morphology, evolution and systematics.

Prerequisite: second-year standing, BIOL 2001 or concurrent enrolment; or permission of the Department.

Lectures two hours a week and laboratories three hours a week.

GEOL 3112 [0.5 credit]

### **Vertebrate Paleontology II**

A survey of the major groups of fossil vertebrates, concentrating on their anatomy, functional morphology, evolution and systematics. Emphasis will be placed on transitions into new adaptive zones and associated environmental factors.

Lectures two hours a week and laboratories three hours a week.

GEOL 3113 [0.5 credit]

### **Geology of Human Origins**

Evolution and dispersal of the hominid lineage and human species from the perspectives of geology of the African rift valleys and other important localities, environmental change, and paleoecology.

Prerequisite: any 1000- or 2000-level Earth Sciences course, or permission of the Department.

Lectures three hours per week.

GEOL 3201 [0.5 credit] (formerly 67.321)

### **Sedimentary Environments**

Principles of sediment transport, and classification of sedimentary rocks and structures, as applied to interpretation of sedimentary facies within the context of sequence stratigraphy.

Prerequisite: GEOL 2801 or GEOL 2805; or permission of the Department.

Lectures two hours a week and laboratories three hours a week. May involve one or more field trips.

GEOL 3203 [0.5 credit] (formerly 67.323)

### **Petrology and Geochemistry of Metamorphic Rocks**

The classification of metamorphic rocks. The origin of metamorphic rocks with emphasis on the chemical and mineralogical characteristics of these rocks and the processes involved in their evolution. Related phase equilibria and thermodynamics.

Prerequisite: GEOL 2203.

Lectures two hours a week, laboratory three hours a week, one day long field trip.

GEOL 3204 [0.5 credit] (formerly 67.324)

### **Mineral Deposits**

Metallic and non-metallic ore deposits, property valuation, mineral economics, exploration geochemistry, stable isotope and trace element geochemistry, partition coefficients.

Prerequisites: GEOL 3201 and GEOL 3203; or permission of the Department.

Lectures two hours a week and laboratory three hours a week, one day long field trip.

GEOL 3205 [0.5 credit] (formerly 67.325)

### **Physical Hydrogeology**

An introduction to the principles governing the movement of groundwater through various geological materials. The exploration, development and use of groundwater as a resource by man, and groundwater-related geohazards are examined.

Precludes additional credit for GEOL 4204.

Prerequisites: at least 1.0 credit from GEOL 1006, GEOL 1007, GEOL 1008 or GEOL 1000 or GEOL 1005; or permission of the Department.

Lectures two hours a week, laboratory two hours a week.

GEOL 3805 [0.5 credit] (formerly 67.385)

### **Geodynamics**

The structure, composition, and rheological properties of the Earth: lithosphere, mantle and core. Plate tectonics and its relation to geophysical fields, driving mechanisms, and processes at plate boundaries and in plate interiors.

Precludes additional credit for GEOL 3800 or GEOL 3802. Prerequisites: GEOL 2208; GEOL 2801 or GEOL 2805; and

GEOL 2802; or permission of the Department.  
Lectures two hours a week, laboratory three hours a week.

GEOL 3806 [0.5 credit] (formerly 67.386)

**Structural Geology**

Structure and tectonic evolution of mountain belts; analysis of strain and fabrics in a variety of crustal settings. Applications to geological engineering and mineral and petroleum exploration.

Precludes additional credit for GEOL 3800 or GEOL 3801.  
Prerequisites: GEOL 3805 or permission of the Department.

Lectures two hours a week, laboratory three hours a week.

GEOL 4001 [0.5 credit] (formerly 67.401)

**Co-operative Work Term Report 3**

This course provides practical experience for students enrolled in the Co-operative Option. To receive course credit a student must receive satisfactory evaluations from their work term employer. Written and oral reports describing the work term project will be required.

Prerequisites: Registration in the Earth Sciences Co-operative Option and permission of the Department.  
Four-month work term.

GEOL 4003 [0.5 credit] (formerly 67.403)

**Directed Studies in Geology**

One or more projects involving at least 15 days field and/or laboratory research, not related to thesis research. Assessment based on written reports and an oral presentation. Expenses for long-distance travel are borne by the student.

Prerequisites: Honours standing and permission of the Department.  
Hours to be arranged.

GEOL 4105 [0.5 credit] (formerly 67.415)

**Quaternary Geography**

Changes in the physical environment of the earth during the last 2 million years; methods of studying recent earth history; the last ice age in Canada. (Also listed as GEOG 4101.)

Note: GEOL 3201 and GEOG 3102 are recommended.  
Lectures three hours a week.

GEOL 4107 [0.5 credit] (formerly 67.417)

**Geotechnical Mechanics**

Soil composition and soil classification. Soil properties, compaction, seepage and permeability. Concepts of pore water pressure, capillary pressure and hydraulic head. Principle of effective stress, stress-deformation and strength characteristics of soils, consolidation, stress distribution with soils, and settlement. Laboratory testing. (Also listed as CIVE 3208, GEOG 4107.)

Precludes additional credit for GEOG 4204.  
Prerequisites: GEOL 2404 or equivalent and Third-year registration, or permission of the Department.  
Lectures three hours a week, laboratory three hours alternate weeks.

GEOL 4202 [0.5 credit] (formerly 67.422)

**Metallic Mineral Deposits**

Ore deposits studied from their relationships to the petrologic cycle. Ore genesis interpreted in light of field studies of local deposits, reflected light microscopy of ore suites, description of classic deposits, phase equilibria and isotopic evidence.

Prerequisites: GEOL 3203 and GEOL 3204.  
Lectures, seminars and laboratories five hours a week.

GEOL 4203 [0.5 credit] (formerly 67.423)

**Petroleum Geology**

Principles and methods of petroleum exploration geology with emphasis on the Western Canada Sedimentary Basin.

Prerequisites: GEOL 2301, GEOL 3201, GEOL 3806; or permission of the Department.  
Lectures, seminars and laboratories five hours a week.

GEOL 4205 [0.5 credit] (formerly 67.425)

**Geochemistry of Waters**

The principles and processes controlling the chemical quality of groundwater and the subsequent effects on water quality due to human activities. Isotope geochemistry of the hydrologic cycle and dissolved constituents in groundwater. Precludes additional credit for GEOL 4200.

Prerequisites: GEOL 3205 and CHEM 1000, or permission of the Department.

GEOL 4301 [0.5 credit] (formerly 67.431)

**Microfossils**

Oceanological and marine geological processes; microorganisms of the oceans; microfossils: their evolution, biostratigraphic and paleoecologic significance and economic use; microfaunal correlation in petroleum geology. Laboratory: Examination and identification of microfossils.

Prerequisite: GEOL 2301 or permission of the Department.  
Lectures and laboratories five hours a week.

GEOL 4302 [0.5 credit] (formerly 67.432)

**Marine Geology**

Development of ocean basins, physical and chemical oceanographic processes, paleoceanographic changes of watermass distribution and circulation patterns, interaction between atmosphere and ocean, marine sedimentation, offshore seismic stratigraphy, marine habitats, marine instrumentation.

Prerequisites: GEOL 2301, GEOL 3201; GEOL 3805; or permission of the Department.  
Lectures, seminars and laboratories five hours a week.

GEOL 4305 [0.5 credit] (formerly 67.435)

**Carbonate Sedimentology**

Aspects of modern depositional systems, dynamic facies models, sequence stratigraphy, mineralogy, and diagenesis of carbonate sediments. Practical part of the course will introduce various techniques in carbonate sedimentology (mapping, petrography, staining, cathodoluminescence, uorescence, SEM).

Precludes additional credit for GEOL 4603.  
Prerequisites: GEOL 3201 or permission of the Department.  
Lectures two hours a week and a three-hour laboratory.

GEOL 4402 [0.5 credit] (formerly 67.442)

**Advanced Structure**

A study of the structural evolution of mountain belts, with emphasis on field methods.

Prerequisites: GEOL 3805 and GEOL 3806; or permission of the Department.  
Lectures, seminars and laboratories five hours a week.

GEOL 4501 [0.5 credit] (formerly 67.451)

**Igneous Petrology**

Genesis of plutonic and volcanic rocks, their spatial and petrochemical relationships and crust-mantle differentiation; associated problems in phase equilibria and isotopic studies. One day-long field trip.

Prerequisite: GEOL 3203.  
Lectures and laboratories five hours a week.

GEOL 4502 [0.5 credit] (formerly 67.452)

**Metamorphic Petrology**

Field relations of metamorphic rocks; graphical treatment and interpretation of mineral assemblages. Laboratory: Petrographic techniques, study of rock suites.

Prerequisite: GEOL 3203.

GEOL 4604 [0.5 credit] (formerly 67.464)

**Precambrian Geology**

Introduction to problems of the Precambrian, emphasizing both classical and current North American studies. Laboratory: research methods, field trips, petrologic studies of representative rock suites.

Prerequisite: GEOL 3203.



GEOL 4707 [0.5 credit] (formerly 67.477)

**Engineering Seismology**

Seismological topics with engineering applications. Characterization of seismicity and seismic sources (areas and faults). Seismic hazard analysis. Empirical and theoretical modeling of strong ground motion in time and frequency domains.

Prerequisites: GEOL 3805 and GEOL 3806; or permission of the department.

Lectures two hours a week.

GEOL 4801 [0.5 credit] (formerly 67.481)

**Physics of the Earth**

The physical properties of the solid Earth. Gravitational, magnetic and palaeomagnetic fields; seismology and earthquake occurrence; heat flow and thermal history. Geodynamic processes.

Prerequisites: GEOL 3805 and GEOL 3806; or permission of the Department.

GEOL 4802 [0.5 credit] (formerly 67.482)

**Geochemistry and Isotope Geology**

Chemical evolution of the Earth, meteorites, development of the continental crust, origin of the atmosphere and hydrosphere, radiometric dating, stable isotopes, origin of life.

Prerequisites: GEOL 3203 and GEOL 3204; or permission of the Department.

Lectures and seminars five hours a week.

GEOL 4803 [0.5 credit] (formerly 67.483)

**Applied Geochemistry**

Chemical and physical factors responsible for the distribution and migration of the elements in the lithosphere, hydrosphere, atmosphere and biosphere; geochemistry applied to mineral exploration; methods of analysis. Laboratory: determination of trace amounts of the common metallic elements in soils and stream sediments; case histories, research problems, field trips.

Prerequisites: GEOL 2208, GEOL 3204, CHEM 1000; or permission of the Department.

GEOL 4804 [0.5 credit] (formerly 67.484)

**Exploration Geophysics**

An introduction to the fundamental theory and application of geophysics to economic and structural geology. Methods studied are electrical, gravitational, magnetic, radioactive and seismic. Case history studies integrate the application of the methods.

Prerequisites: GEOL 3805 and GEOL 3806, PHYS 1001 and PHYS 1002, or PHYS 1007 and PHYS 1008; or permission of the Department.

Lectures and problems three hours a week.

GEOL 4805 [0.5 credit] (formerly 67.485)

**Data Integration and Analysis in the Geosciences**

Integration and analysis of spatial data in a Geographical Information System environment. Topics include acquisition, representation, analysis, and modeling of geological, geophysical, geochemical, and remotely-sensed data.

Prerequisites: completion of the second-year Geology course requirements in Earth Sciences, or permission of the Department.

Lectures and laboratory five hours a week.

GEOL 4807 [0.5 credit] (formerly 67.487)

**Field Geology III**

Two-week field camp designed to extend the student's geological knowledge by integrating advanced field, theory and experimental data. Assessment based on written reports, seminars, and oral examinations. Part of the cost is borne by the student. Departmental funding assistance is available for only one of GEOL 4807 and 4808.

Prerequisites: completion of the third-year Geology course requirements and permission of the Department.

GEOL 4808 [0.5 credit]

**Vertebrate Paleontology Field Camp**

Two-week field camp at Dinosaur Provincial Park (Alberta) designed to extend the student's vertebrate paleontological

knowledge by integrating field, theory, and experimental data. Assessment based on written reports and seminars. Part of the cost is borne by the student. Departmental funding assistance is available for only one of GEOL 4807 and 4808.

Prerequisite: completion of third-year course requirements within the Vertebrate Paleontology concentration, and permission of the Department.

GEOL 4908 [1.0 credit] (formerly 67.498)

**Honours Thesis**

Independent studies. Requires prior written approval of a topic from a supervisor and the course co-ordinator. Oral and written proposal, progress and defence reports are required.

Prerequisite: Completion of the third-year Geology course requirements.