

# Earth Sciences (ERTH)

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## Department of Earth Sciences

### Faculty of Science

#### **ERTH 1006 [0.5 credit]**

##### **Exploring Planet Earth**

Origin of the Earth, concepts of geological time, and exploration of the interaction and duration of geological processes that shape the surface to deep interior of our planet, the climate, and formation of rocks and earth resources.

Precludes additional credit for ERTH 1001 (no longer offered), ERTH 1010, ERTH 2404.

Prerequisite(s): a 4U/M level in Advanced Functions and at least one of Biology, Chemistry, Earth and Space Sciences or Physics are recommended. This course is for students who are enrolled in the Faculty of Science. Lectures three hours a week, a laboratory three hours a week, and a field excursion.

#### **ERTH 1009 [0.5 credit]**

##### **The Earth System Through Time**

Earth's changing patterns of continent and ocean basin distribution related to plate tectonics; resulting change in global sea level, sedimentation, paleoclimates and life on Earth.

Precludes additional credit for GEOL 1008 (no longer offered) and ERTH 1011.

Prerequisite(s): ERTH 1006. This course is for students who are enrolled in the Faculty of Science.

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

#### **ERTH 1010 [0.5 credit]**

##### **Our Dynamic Planet Earth**

Origin of the Earth, concepts of geological time, and exploration of the interaction and duration of geological processes that shape the surface to deep interior of our planet, the climate, and formation of rocks and earth resources.

Precludes additional credit for ERTH 1001 (no longer offered) and ERTH 1006.

Prerequisite(s): a 4U/M level in Advanced Functions and at least one of Biology, Chemistry, Earth and Space Sciences or Physics are recommended. This course is for students who are not enrolled in the Faculty of Science. Lectures three hours a week.

#### **ERTH 1011 [0.5 credit]**

##### **Evolution of the Earth**

Earth's changing patterns of continent and ocean basin distribution related to plate tectonics; resulting change in global sea level, sedimentation, paleoclimates and life on Earth.

Precludes additional credit for GEOL 1008 (no longer offered) and ERTH 1009.

Prerequisite(s): a 4U/M level in Advanced Functions and at least one of Biology, Chemistry, Earth and Space Sciences or Physics are recommended; ERTH 1010 is normally taken prior to this course. This course is for students who are not enrolled in the Faculty of Science. Lectures three hours a week.

#### **ERTH 2102 [0.5 credit]**

##### **Mineralogy to Petrology**

Chemical, optical and crystallographic properties of common rock-forming minerals, with introduction to common mineral assemblages of igneous, sedimentary, and metamorphic rocks.

Precludes additional credit for ERTH 3202 (no longer offered).

Prerequisite(s): ERTH 1006 and (ERTH 1009 or GEOG 2013) and (CHEM 1001 or CHEM 1005) and (CHEM 1002 or CHEM 1006) and (MATH 1004 or MATH 1007) and (MATH 1104 or MATH 1107).

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

#### **ERTH 2104 [0.5 credit]**

##### **Igneous Systems, Geochemistry and Processes**

The sources and magmatic evolution of volcanic and plutonic rocks systems, with emphasis on geochemical, mineralogical, and textural characteristics, and relations to igneous processes.

Precludes additional credit for ERTH 3202 (no longer offered).

Prerequisite(s): (CHEM 1001 or CHEM 1005) and (CHEM 1002 or CHEM 1006), (MATH 1004 or MATH 1007), (MATH 1104 or MATH 1107) and ERTH 2102.

Lectures two hours a week, laboratory three hours a week, tutorial one hour per week, and a field excursion.

#### **ERTH 2105 [0.5 credit]**

##### **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 ERTH 3805 (no longer offered).

Prerequisite(s): ERTH 1001 (no longer offered) or ERTH 1006 and (ERTH 1009 or GEOG 2013).

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

**ERTH 2312 [0.5 credit]****Paleontology**

Introduction to macrofossil and microfossil groups, their paleoenvironmental significance, and principles of evolutionary paleoecology.

Precludes additional credit for ERTH 2316, GEOL 2301 (no longer offered) and GEOL 2306 (no longer offered). Prerequisite(s): ERTH 1006 and (ERTH 1009 or GEOG 2013).

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

**ERTH 2314 [0.5 credit]****Sedimentation and Stratigraphy**

Origin of sediments and their transport, distribution, and primary structures; processes of sediment-to-rock transformation; spatial patterns; controls of stratigraphy; methods of correlation.

Precludes additional credit for ERTH 2318.

Prerequisite(s): ERTH 1006 and (ERTH 1009 or GEOG 2013).

Lectures three hours a week and a laboratory three hours a week.

**ERTH 2316 [0.5 credit]****Paleoecology**

Introduction to macrofossil and microfossil groups, their paleoenvironmental significance, and principles of evolutionary paleoecology.

Precludes additional credit for ERTH 2312. Not available for credit in B.Sc. Earth Sciences programs.

Prerequisite(s): ERTH 1006 and ERTH 1009. Priority given to students in the Minor in Earth Sciences.

Lectures two hours a week.

**ERTH 2318 [0.5 credit]****Sedimentology**

Origin of sediments and their transport, distribution, and primary structures; processes of sediment-to-rock transformation; spatial patterns; controls of stratigraphy and methods of correlation.

Precludes additional credit for ERTH 2314. Not available for credit in B.Sc. Earth Sciences programs.

Prerequisite(s): ERTH 1006 and ERTH 1009. Priority given to students in the Minor in Earth Sciences.

Lectures three hours a week.

**ERTH 2401 [0.5 credit]****Dinosaurs**

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

Lectures three hours a week.

**ERTH 2402 [0.5 credit]****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.

Lectures three hours a week.

**ERTH 2403 [0.5 credit]****Introduction to Oceanography**

An environmental approach to understanding the oceans; introducing the physical and biological aspects of oceanography, marine resources and marine pollution.

Lectures three hours per week.

**ERTH 2404 [0.5 credit]****Engineering Geoscience**

Applications of the basic concepts of geology, earth materials and earth processes to practical engineering and environmental science. Topics include rock and soil mechanics, slope stability, hydrogeology, geological hazards, and site investigations. Overview of related geophysical methods.

Precludes additional credit for ERTH 2414 (no longer offered) and ERTH 1006.

Prerequisite(s): completion of first year of any B.Eng. program.

Lectures three hours a week and a laboratory three hours a week.

**ERTH 2406 [0.5 credit]****Geology and Map Interpretation**

Analysis and interpretation of geological features and processes using rocks, maps and cross sections.

Introduction to computational methods.

Prerequisite(s): ERTH 2102 and GEOM 2007.

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

**ERTH 2415 [0.5 credit]****Natural Disasters**

Physical characteristics and causes of natural disasters of geological origin such as volcanic eruptions, earthquakes, tsunamis, landslides, hurricanes and meteor impacts.

Discussion on historical perspective, societal impact and mitigation strategies. Emphasis on Canadian case histories.

Precludes additional credit for ERTH 1003 (no longer offered).

Prerequisite(s): second-year standing in any degree program. With the exception of the Minor in Earth Sciences, available as a free elective only in any B.Sc. program, including Earth Sciences.

Lectures three hours a week.

**ERTH 2802 [0.5 credit]****Field Geology I**

Field analysis using geological, geophysical and computational methods leading to the interpretation of the origins of geological features and processes.

Prerequisite(s): ERTH 2406 and permission of the department.

Field work for two weeks off campus.

**ERTH 3002 [0.5 credit]****Gemology**

Gemstones including their physical and chemical properties, geological formation and geographic occurrence. Introduction to gemological laboratory methods.

Prerequisite(s): EARTH 2102.

Lectures two hours a week and laboratory two hours a week.

**ERTH 3003 [0.5 credit]****Geochemistry and Geochronology**

Geochemical processes within crustal to surface environments, and use of isotopic variations of certain elements to define geochronological frameworks and geochemical pathways to better understand the earth's history.

Precludes additional credit for EARTH 2101 (no longer offered).

Prerequisite(s): EARTH 2102, EARTH 2104 and EARTH 2105.

Lecture two hours a week, and a laboratory three hours a week.

**ERTH 3111 [0.5 credit]****Vertebrate Evolution II**

Evolution of mammals, reptiles and birds. Emphasis on surveying amniote diversity, and the origin of key amniote transformations, as evidenced by the fossil record.

Prerequisite(s): EARTH 1006 and EARTH 1009, BIOL 2001 (may be taken concurrently) or permission of the department.

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

**ERTH 3112 [0.5 credit]****Vertebrate Evolution I**

Evolution of fish and amphibians. Emphasis on surveying fish and amphibian diversity, and the origin of key transformations of these groups, as evidenced by the fossil record.

Prerequisite(s): EARTH 1006 and EARTH 1009, BIOL 2001 (may be taken concurrently) or permission of the department.

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

**ERTH 3113 [0.5 credit]****Geology of Human Origins**

The origin and evolution of our species from geological, biological and cultural perspectives. The course traces human ancestry from our primate roots through time and changing environments, and explores controversies, frauds, and misperceptions.

Prerequisite(s): any 1000- or 2000-level Earth Sciences course.

Lectures three hours per week.

**ERTH 3203 [0.5 credit]****Applied Sedimentology**

Field-based analysis of sedimentary processes as developed in modern and preserved in ancient geological environments. This course occurs off campus over a 10-day period. A supplementary fee may apply.

Precludes additional credit for EARTH 3201 (no longer offered).

Prerequisite(s): EARTH 2102, EARTH 2104, EARTH 2105, EARTH 2312, EARTH 2314, EARTH 2406, EARTH 2802 and a second-year Earth Sciences average of 8.00 and permission of the department.

**ERTH 3204 [0.5 credit]****Mineral Deposits**

Analysis and interpretation of the geological and geochemical processes responsible for mineral deposit genesis in a global context.

Prerequisite(s): EARTH 2104.

Lectures and laboratory five hours a week.

**ERTH 3205 [0.5 credit]****Physical Hydrogeology**

Principles of deep- to shallow fluid flow within the Earth's crust, and introduction to the exploration, development and management of groundwater as a global resource.

Prerequisite(s): EARTH 1006 and (EARTH 1009 or GEOG 2013).

Lecture three hours a week and a laboratory three hours a week.

**ERTH 3206 [0.5 credit]****Oceanography: Its Modern and Geologic Records**

Composition and movement of the oceans, processes of sediment production and its distribution, ocean/climate interactions, geological proxies for ancient oceanographic conditions, and cyclic sedimentary and geochemical patterns.

Precludes additional credit for EARTH 3208.

Prerequisite(s): EARTH 2314.

Lectures three hours a week and a laboratory three hours a week.

**ERTH 3207 [0.5 credit]****Metamorphic Petrology and Processes**

Genesis of metamorphic rocks as determined from field, petrographic and geochemical data.

Precludes additional credit for EARTH 3202 (no longer offered).

Prerequisite(s): EARTH 2104.

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

**ERTH 3208 [0.5 credit]****Oceanography: An Earth Sciences Perspective**

The principal geological, physical, chemical and biological oceanographic processes and their interaction in today's oceans in comparison to a succession of critical stages of oceanographic development through geologic time.

Precludes additional credit for ERTH 3206.

Prerequisite(s): (ERTH 1006 or ERTH 1010) and (ERTH 1009 or ERTH 1011).

Lectures three hours a week.

**ERTH 3405 [0.5 credit]****Geophysical Methods**

An introduction to the tools of applied geophysics including seismology, electrical, magnetic, and gravitational surveying methods.

Precludes additional credit for ERTH 2405 (no longer offered).

Prerequisite(s): ERTH 2105.

Lecture two hours a week and a laboratory three hours a week.

**ERTH 3806 [0.5 credit]****Structural Geology**

Structures and deformational processes in a variety of crustal settings. Applications to geological engineering and mineral and petroleum exploration.

Prerequisite(s): ERTH 2105 and ERTH 2406.

Lecture two hours a week and a laboratory three hours a week.

**ERTH 3999 [0.0 credit]****Co-operative Work Term****ERTH 4003 [0.5 credit]****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.

Prerequisite(s): fourth-year standing in any B.Sc. Hons. or Combined Hons. program in Earth Sciences.

Schedule to be arranged.

**ERTH 4004 [0.5 credit]****Special Topics in Earth Sciences**

Field, laboratory or literature research, not related to thesis research. Assessment based on written reports and an oral presentation. Expenses for travel are borne by the student.

Prerequisite(s): fourth-year standing in any B.Sc. Hons. or Combined Hons. program in Earth Sciences. Major CGPA 8.5 or higher at time of registration for the course.

Schedule to be arranged.

**ERTH 4005 [0.5 credit]****Micropaleontology**

Paleoecological and biostratigraphic significance, and evolutionary history of marine and freshwater microorganisms.

Prerequisite(s): ERTH 2312.

Lectures, seminars and/or laboratory five hours a week.

**ERTH 4006 [0.5 credit]****Geobiology**

Exploration of the relationship between micro- and macro-evolutionary processes and the Earth's physical and chemical environment. Paleobiology and evolutionary ecology in the context of paleoceanography, paleolimnology and paleoclimatology. May include one or two weeks of field based instruction with costs borne by the student.

Prerequisite(s): ERTH 2312.

Lectures and seminars three hours a week.

**ERTH 4007 [0.5 credit]****Evolutionary Developmental Paleobiology**

This course explores the mechanistic basis of organismic evolution from genetic, morphogenetic and epigenetic perspectives, within a phylogenetic context of living and extinct vertebrates.

Prerequisite(s): ERTH 2312 and BIOL 2001.

Lectures two hours a week and a laboratory three hours per week.

**ERTH 4107 [0.5 credit]****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.

Prerequisite(s): ERTH 2406 and completion of the third-year Earth Sciences course requirements, or permission of the Department.

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

**ERTH 4206 [0.5 credit]****Contaminant and Remediation Hydrogeology**

Geochemical and physical processes controlling contaminant release, migration, and fate in groundwater along with the processes and techniques used for contaminant mitigation and remediation. Examples will include organic and inorganic contaminants in a variety of settings.

Prerequisite(s): ERTH 3003 and ERTH 3205.

Lectures and seminars three hours per week.

**ERTH 4303 [0.5 credit]****Resources of the Earth**

Earth's resources: where they occur, how they are concentrated, how they are extracted and used, and how human exploitation of natural resources impacts on the environment.

Prerequisite(s): third-year standing in any degree program.  
Lectures three hours a week.

**ERTH 4305 [0.5 credit]****Carbonate Sedimentology**

The origin, composition and diagenesis of carbonate rocks. Study of modern and ancient platform systems; development of facies models; petrographic and geochemical analysis of limestones and dolostones.

Prerequisite(s): ERTH 3203 or ERTH 3206.

Lecture two hours a week and a laboratory three hours a week.

**ERTH 4306 [0.5 credit]****Resource Basin Analysis**

Surface and subsurface geological and geophysical techniques used to define the distribution and origin of geological basins, the architecture of basin fill, and characterize the distribution of water, petroleum and mineral resources.

Prerequisite(s): ERTH 3203 or ERTH 3206, ERTH 3205, and ERTH 3806.

Lectures, seminars and laboratory five hours a week.

**ERTH 4402 [0.5 credit]****Structural Geology**

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

Prerequisite(s): ERTH 3806.

Lectures, seminars and laboratory five hours a week.

**ERTH 4403 [0.5 credit]****Tectonic Evolution of Canada**

Geologic evolution of Canada focusing on geological styles and tectonic processes of Archean cratons, Proterozoic and Phanerozoic orogenic belts.

Prerequisite(s): ERTH 3806.

Lectures and seminars three hours a week.

**ERTH 4504 [0.5 credit]****Advanced Igneous Petrology**

Volcanology, petrology, mineralogy and geochemistry of igneous rocks and their tectonic setting; may include one to two weeks of field-based instruction with costs borne by the student.

Prerequisite(s): ERTH 2104 and ERTH 3003.

Field excursions, seminars three hours per week.

**ERTH 4507 [0.5 credit]****Advanced Metamorphic Petrology**

Introduction to the quantitative analysis of pressure-temperature-time trajectories and rock-forming processes during metamorphic petrogenesis; may include one or two weeks of field-based instruction, with costs borne by the student.

Prerequisite(s): ERTH 2802 and ERTH 3207.

Field excursions, lectures, or seminars three hours per week.

**ERTH 4707 [0.5 credit]****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.

Prerequisite(s): one of MATH 1007 or MATH 1004, and one of MATH 1107 or MATH 1104, STAT 2507, and one of ERTH 2404, ERTH 2406.

Also offered at the graduate level, with different requirements, as ERTH 5707, for which additional credit is precluded.

Lectures three hours a week.

**ERTH 4801 [0.5 credit]****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.

Prerequisite(s): ERTH 2105.

Also offered at the graduate level, with different requirements, as ERTH 5701, for which additional credit is precluded.

Lectures three hours a week.

**ERTH 4803 [0.5 credit]****Advanced Isotope Geology**

Chemical evolution of the Earth, meteorites; mantle and crustal evolution; radiogenic and stable isotopes; noble gas isotopes; applications to mineral deposits; environmental applications.

Prerequisite(s): ERTH 3003.

Also offered at the graduate level, with different requirements, as ERTH 5609, for which additional credit is precluded.

Lectures, seminars or laboratories three hours per week.

**ERTH 4804 [0.5 credit]****Exploration Geophysics**

Application of geophysical methods to explore for petroleum and mineral resources, with emphasis on seismic and electromagnetic methods. Case histories illustrate the concepts.

Prerequisite(s): ERTH 3405.

Lectures and laboratories five hours per week.

**ERTH 4807 [0.5 credit]****Field Geology II**

Two-week field camp integrates advanced field, theory and experimental data. Assessment is based on reports, seminars, and oral examinations. Part of the cost is borne by the student. Departmental funding assistance is available for only one of ERTH 4807 and ERTH 4808. Prerequisite(s): completion of the third-year Earth Sciences course requirements and permission of the Department. A supplementary fee may apply.  
Field Studies

**ERTH 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 ERTH 4807 and ERTH 4808. Prerequisite(s): completion of third-year course requirements within the Vertebrate Paleontology concentration, and permission of the Department.

**ERTH 4815 [0.5 credit]****Natural Hazards in Canada**

Overview of the main natural hazards (such as floods, landslides, forest fires, earthquakes) and severe weather phenomena (such as ice storms, hail, tornadoes) in the Canadian environment. Risk of catastrophic events and their impact on society and infrastructure. Prerequisite(s): third-year standing in earth science programs or permission of the department. Also offered at the graduate level, with different requirements, as ERTH 5215, for which additional credit is precluded.  
Lectures three hours a week.

**ERTH 4820 [0.5 credit]****Research Methods in Earth Sciences**

Research approaches, methodologies and resources in Earth Sciences; analytical methods in Earth Sciences; data acquisition, evaluation and interpretation; principles and strategies of scientific and professional writing; and communication of results. Prerequisite(s): third-year standing in Earth Sciences programs.  
Lectures, seminars, or laboratories three hours a week. May also include visits to other research institutes or workshops with visiting instructors.

**ERTH 4908 [1.0 credit]****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. Precludes additional credit for ERTH 4909, ERTH 4910. Prerequisite(s): restricted to B.Sc. Honours and Combined Honours ERTH programs. Major CGPA 8.5 or higher at time of registration for the course.

**ERTH 4909 [0.5 credit]****Research in Earth Sciences**

Understanding research methods, data interpretation and presentation, through readings, seminars and/or laboratory projects related to a topic selected by the student with approval of a faculty advisor. Precludes additional credit for ERTH 4908, ERTH 4910. Prerequisite(s): restricted to B.Sc. Honours and Combined Honours Earth Sciences programs.

**ERTH 4910 [1.0 credit]****Honours Thesis in Resource Evaluation**

Independent studies: Analysis and interpretation of geological, environmental and/or financial data to determine economic value of a natural resource, and its viability for sustainable development. Requires approval of the supervisor and course coordinator. Oral and written proposal, progress and defense reports are required. Precludes additional credit for ERTH 4908 and ERTH 4909. Prerequisite(s): Restricted to B.Sc. Honours in Earth Sciences with Concentration in Finance: Resource Valuation.  
Honours Thesis .