



Contact Us

Department of Earth Science
University of Waterloo

Graduate Course Descriptions

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Information](#)[Course Descriptions](#)[Graduate Student Directory](#)[Earth Sciences Home](#)[Science Home](#)**EARTH 601 Stratigraphic Paleontology (0.50) LEC Course ID: 000876**

Analysis of the factors controlling the distribution of organisms and fossils. Important zone fossils of invertebrates, vertebrates, and plants will be studied with reference to their vertical and lateral distribution. Problems of migration, dispersal, and provincialism will be considered in detail.

EARTH 602 Paleontology(0.50) RDG Course ID: 000877

Selected topics in paleontology will be studied in depth with emphasis on evolution and paleoecology.

EARTH 603 Micropaleontology(0.50) LEC Course ID: 010449

A systematic examination of major groups of microfossils, particularly palynomorphs, and insects, with emphasis on their classification, evolution, paleoecology and stratigraphic application.

EARTH 606 Principles of Palynology(0.50) LEC Course ID: 000879

The morphology, taxonomy, biostratigraphy and paleoecology of marine and non-marine palynomorphs from Paleozoic to Recent time are examined. Palynomorph morphology and taxonomic principles and methods of pollen analysis, pollen dispersal, deposition and preservation are explored and related to the geological record and their use in environmental reconstructions. The role of pollen analysis in Quaternary paleoecology is presented.
Prerequisite: EARTH 236

EARTH 610 Sedimentology - Recent Sediments (0.50) LEC Course ID: 000880

The origin of recent clastic and non-clastic sediments, the study of composition, structures, relationships, and environments towards an interpretation of ancient sedimentary rocks. The origin and significance of sedimentary structures, environmental associations, sedimentological models, hydrodynamics.

EARTH 611 Sedimentology - Ancient Sediments (0.50) LEC Course ID: 000881

Interpretation of ancient sedimentary rocks. Sedimentation and tectonics, basin evolution, continental margins. Ancient clastic and chemical suites, diagenetic

indicators, evolution of sedimentary suites through time.

EARTH 612 Carbonate Sedimentology(0.50) LEC Course ID: 000882

Weekly seminars will introduce current concepts in a variety of subject areas in the deposition and diagenesis of carbonate sediments. Laboratory exercises will involve study of Pleistocene and older carbonate rock suites from a selection of geologic settings. Several laboratories will be devoted to introduction of common analytical techniques such as cathodoluminescence and SEM.
Prerequisite: EARTH 333 or 433

EARTH 620 Metamorphic Tectonites (0.50) LEC Course ID: 000883

The study of textural and structural features of deformed metamorphic rocks. A synthesis of micro- and mega-scopic techniques directed at elucidating sequences of deformation and crystallization. Quantitative methods in the study of deformed rocks. Elements of style and symmetry in tectonites.

EARTH 621 Aqueous Geochemistry(0.50) LEC Course ID: 000884

a) Basic thermodynamics and activity-fugacity relationships. Chemical equilibria ion association and complexing, oxidation-reduction reactions. Models for aqueous equilibria in high concentration solutions.

b) Interaction of groundwater with porous media; mineral dissolution/precipitation reaction kinetics, ion exchange, surface ionization of oxides. c) Use of computer codes such as PHREEQE and GEOCHEM to simulate mass transfer in geochemical systems. Examining and modelling chemical evolution in groundwater flow systems.

Prerequisite: EARTH 421

EARTH 622 Isotope Hydrology and Geochemistry(0.50) LEC Course ID: 000885

a) The theory and use of stable and radioactive isotopes. Abundance and variation of the stable isotopes of carbon, sulphur, hydrogen and oxygen.

b) Isotopes and hydrogeology: the application of stable and radioactive isotopes in hydrogeological models. Origin, movement, geochemical history and age of groundwater systems and surface water investigations. c) Isotopes and ore formation. Stable isotope variations in sulphides and related gangue minerals to determine physiochemical environments of deposition and associated alteration processes.

EARTH 623 Geochemistry of Hydrothermal Ore Deposits(0.50) LEC Course ID: 000886

The application of stable isotopes, fluid inclusions, metal solubility and mass transfer in high temperature geochemistry. Emphasis is placed on silicate melt-aqueous fluid equilibria and the genesis of high to medium temperature hydrothermal ore deposits.

EARTH 624 Environmental Biogeochemistry(0.50) LEC Course ID: 000180

EARTH 650 Physical Processes in Groundwater Systems (0.50) LEC
Course ID: 000899

This course aims to deepen the student's understanding of physical processes occurring in natural groundwater systems. Flow and transport processes and their interrelationships with the characteristics of the porous medium are studied and the governing equations developed. Topics covered include the fundamental concepts of physical hydrogeology, flow in the saturated and unsaturated zones, flownet analysis, immiscible flow of non-aqueous phase liquids (NAPLs), contaminant transport in porous and fractured media, stochastic principles of transport in heterogeneous media, coupled nonlinear processes, and applications in groundwater contamination/remediation.

Recommended: EARTH 456 (can be taken concurrently with EARTH 650).
Prerequisites: MATH 213A and EARTH 359 or 458.

EARTH 651 Advanced Groundwater Modelling (0.50) LEC Course ID: 000900

This course covers advanced numerical modelling topics in groundwater flow and contaminant transport in the subsurface. Topics to be explored include two- and three-dimensional transport in groundwater systems, density/ heat-dependent flow/transport, flow in the vadose zone, immiscible flow of non-aqueous phase liquids, multiphase dissolution and mass transfer processes, transport of biodegrading or chemically interacting contaminants, transport in fractured systems, transport in the vapour phase. The focus is on the use of models to obtain insight into the complex coupled processes that control groundwater contamination and remediation problems. Students will work with their own as well as existing models.

Prerequisites: EARTH 456 or 650 and 656.

EARTH 653 Contaminant Hydrogeology (0.50) LEC Course ID: 000901

Physical and chemical processes influencing contaminant behaviour in groundwater with emphasis on field approaches. Interpretation of process effects in the context of various causes of groundwater contamination such as those related to landfills, chemical spills, mining and agriculture. Field experiments and case studies.

(EARTH 621 and EARTH 657 or equivalent are recommended).
Instructor Consent Required.

EARTH 654 Groundwater Research Management (0.50) LEC Course ID: 000902

Advanced topics in the design and analysis of aquifer tests, behaviour of aquifer-aquitard systems, aquifer exploration, groundwater resource evaluation in undeveloped areas, artificial recharge, induced recharge, conjunctive use of surface water and groundwater, effects of excessive groundwater withdrawals, role of analog and digital models in groundwater management.

Prerequisite: EARTH 458 and 650

EARTH 656 Groundwater Modelling (0.50) LEC Course ID: 000903

This course is an enriched version of EARTH 456 for graduate students. It introduces the student to numerical modelling techniques in groundwater science, with an emphasis on a sound understanding of the fundamental

principles as a basis for developing and using models in a research environment. Numerical techniques including finite difference, finite element, and particle tracking methods are studied and applied to the solution of problems in groundwater flow, aquifer mechanics, flownet generation, and advective-dispersive transport. Proper modelling approaches, error analysis, stability, discretization constraints, pitfalls, and model misuse are discussed. Students will be developing some of their own groundwater models, and will be obtaining hands-on experience with state-of-the-art interactive groundwater models in the PC laboratory. Prior experience with FORTRAN is essential. Recommended: MATH 111B or equivalent. Students without the required prerequisite may seek consent of the instructor.

Prerequisites: CS 102 and EARTH 359 and EARTH 650

EARTH 657 Organic Contaminants in the Subsurface(0.50) LEC Course ID: 000904

Fundamental processes governing the fate of organic contaminants in soil and aquifer systems. Emphasis on partitioning between phases (dissolution, sorption and volatilization) with applications. Students without the required prerequisite may seek consent of the instructor.

Prerequisites: EARTH 459 and 650

EARTH 658 Flow and Transport in Fractured Rock(0.50) LEC Course ID: 000905

An introduction to the physical hydrogeology of fractured rock. Topics will include a review of the structural geology of fractured rocks, development and validity of the cubic law, groundwater flow and contaminant transport in discrete fractures and fracture networks, hydraulic testing methods and the hydrogeology of low-permeability environments.

Recommended: Differential Calculus.

Prerequisites: EARTH 458 and 459.

EARTH 659 Chemical Hydrogeology(0.50) LEC Course ID: 000906

This course builds on the fundamental principles of aqueous chemistry and water-rock interactions with emphasis on groundwater environments. Topics include the evolution of natural groundwater chemistry, chemical aspects of contaminant hydrogeology such as hydrocarbons, radioactive wastes, acid mine drainage and industrial and municipal waste disposal. Geochemical models are introduced and applied by students in a course project. Students without the required prerequisite may seek consent of the instructor.

Prerequisites: EARTH 458 and 221 or, EARTH 231 and CIV E 375

EARTH 661 Analytical Methods in Mathematical Geology(0.50) LEC Course ID: 000907

A course intended to provide MSc and PhD students with a working knowledge of analytical techniques for solution of differential equations governing flow and mass transfer in hydrogeologic systems. Use of various transform methods such as Fourier and Laplace will be covered and applied to a variety of problems of hydrogeological interest. The course will consist of lectures, selected problem assignments and/or individual projects. Recommended: Second Year Calculus.

Prerequisite: EARTH 458.

EARTH 668 Advanced Applied Geophysics(0.50) LEC Course ID: 000908

A field-oriented course on current methodology in the general area of geotechnical or engineering geophysics as applied to environmental problems. Typical topics covered: well logging and time domain electromagnetic surveys for groundwater supply; magnetic and terrain conductivity surveys for waste materials; ground penetrating radar applications to stratigraphy and contamination; streaming potential surveys of dam leakage.

Usually taught with EARTH 461.

Instructor Consent Required

EARTH 671 Field Methods in Hydrogeology(0.50) LEC Course ID: 000909

A course dealing with the theory and applications of field techniques in hydrology. Physical, chemical, and isotopic methods are included with applications to groundwater and surface water hydrology. The course will consist of lectures, field activities, projects and assignments. All will be conducted over a 3-week time period at the end of the Winter term in April. Students without the required prerequisite may seek consent of the instructor.

Prerequisite: EARTH 458 or 650 Click here for more information.

EARTH 690 Current Problems in Geology(0.50) SEM Course ID: 000911

Seminars will be held to cover major topics excluded from other available courses. Graduate students will be required to present for discussion short colloquia based on their reading of assigned topics. Participation in the discussions, as well as the actual presentation of papers, will be an integral part of the course.

EARTH 691 Special Studies for MSc Students(0.50) RDG Course ID: 00091

Course credit may be given for special studies related to the research interest of a student and a member of the faculty by special arrangement.

Instructor Consent Required

EARTH 692 Special Studies for PhD Students(0.50) RDG Course ID: 00091

Course credit may be given for special studies related to the research interest of a student and a member of the faculty by special arrangement.

Instructor Consent Required

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