EARTH 471: Mineral deposits

Contact Information:

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Schedule:

Tuesday	11:30 am –12:50 pm	Lecture	PAS 1229
Thursday	11:30 am –12:50 pm	Lecture	PAS 1229
Monday	9:30–12:20 am	Lab, Group 471-101	EIT 1009 / B1 370*
Wednesday	8:30–11:20 am	Lab, Group 471-102	EIT 1009 / B1 370*

*Starting the week of March 12, we will move to room B1 370 for the laboratory component.

Course description:

This course covers the genesis and localization of mineral deposits as well as the theoretical, economic, legal and technical aspects of mineral exploration. This course is designed for undergraduate students in their final year and for both geologists and geological engineers with a variety of backgrounds. The course is divided into lecture and laboratory components. The lecture component will involve PowerPoint presentations and chalkboard/whiteboard segments. The laboratory component is divided into two parts: (1) ore petrology using hand sample analysis and reflected light microscopy (groups of 3–4 students), and (2) an exploration project that involves core logging, geological map analysis, interpretation of geochemical data, and a final report of findings and recommendations (groups of 4 students). Students will also prepare a commodity report as an individual written assignment. The main goal of course is to provide an introduction to economic geology and to understanding the mineral exploration industry from exploration through mine development and closure.

Time commitment:

In addition to attending lectures and labs, students should be prepared to spend an additional 2–3 hours per week working on individual and team reports.

Course content*

1) Mineral commodities and economics
2) Ore minerals and textures as well as an introduction to hydrothermal alteration
3) Introduction to metallogeny and ore deposit classification
4) Magmatic ore deposits (e.g. Ni–Cu–PGE, carbonitites)
5) Hydrothermal ore deposits (e.g. VMS, SEDEX, MVT, porphyry)
6) Sedimentary ore deposits (e.g. laterites, placer, introduction to oil and gas)
7) Other ore deposits (e.g. diamonds, graphite, IOCG)
8) Exploration strategies and reserve estimates
9) Tectonics, metallogenic epochs and provinces
10) Responsible mining and ethics in mineral exploration

*This content is tentative and may be modified as we progress in the semester and according to the interests of the class. Students will be notified if there are any changes.

Course Objectives

At the end of the course, the students should be able to:

- Describe the formation of major ore deposit types and identify their geological settings
- Recognize and describe metallic minerals of economic interest
- Interpret mineral textures using ore petrology
- Estimate the reserves of a mineral deposit using geochemical data and core logging
- Explain the life cycle of mining operations in Canada
- Discuss the economics of mineral deposits
- Explain the laws and rules regulating the exploration industry in Canada
- Explain the life cycle of a mineral deposit
- Describe the different exploration tools and techniques
- Explain the methods to estimate/calculate the reserves of a mineral deposit

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Turnitin.com

Turnitin.com: Text-matching software (Turnitin®) will be used to screen assignments in this course. This is being done to verify that use of all materials and sources in assignments is documented. Students will be given an option if they do not want to have their assignment screened by Turnitin®. In the first week of the term, details will be provided about arrangements and alternatives for the use of Turnitin® in this course.

Course schedule:

The course lecture plan and the schedule of due dates given below will be followed as closely as possible, but some changes may occur. Any changes in assignment due dates or test dates will be discussed and announced in class and posted on LEARN. However, the grading scheme will remain the same.

Week	Lecture	Laboratory
1: Jan 4	Economics	–NO LAB–
2: Jan 9, 11	Ore minerals, Metallogeny	L1: Ore minerals
3: Jan 16, 18	Magmatic deposits, Hydrothermal I	L2: Ore petrography
4: Jan 23, 25	Hydrothermal deposits II	L3: Ni–Cu–PGE
5: Jan 30, F1	Hydrothermal deposits III	L4: VMS
6: Feb 6, 8	Hydrothermal deposits IV, Uranium	L5: Gold **Commodity Report due Fri 5pm**
7: Feb 13, 15	Sedimentary deposits, Mid term review	***LAB EXAM***
8: Feb 20, 222	READING WEEK	– No Lab –
9: Feb 27, M1	***MIDTERM FEB 27***, Mining cycle	E1: Core logging
10: Mar 6, 8	NO CLASS on Tues Mar 6 (PDAC)	Extra time for core logging on Wed only
11: Mar 13, 15	Geophysics, Rare Earth Elements	E2: Reserve estimate
12: Mar 20, 22	Oil and Gas, Gems deposits	E3: Write report
13: Mar 27, 29	Responsible Mining, Other deposits	E4: Write report
14: Apr 3	Review	E4: Write report

14: ***Exploration Reports due Wednesday April 4 at 5pm***

Grading:

Laboratories (L1–L5)	5% [1]
Lab Exam	15%
Exploration project report (E1–E4)	30% [2]
Commodity Report	10% [3]
Midterm Exam	15%
Final Exam	25% [4]

[1]Students have one week to complete each lab (L1–L5). Electronic or hard copies of the report must be submitted by the beginning of the next lab session.

[2] The project will be conducted in teams of four students. The final product is a report in the style of a NI 43-101 with three components: (1) core log, (2) assay data and reserve estimate, and (3) a summary of findings and recommendations. Each component will represent 1/3 of the final grade. The final mark on the exploration project report will go down 5% for each 24 hours following the due date.

[3]The mark on the report will go down 10% for each 24 hours (or portion thereof) following the due date.

[4]The final exam must be passed in order for the above grading scheme to apply. If the final exam is not passed the grade on the final exam, out of 100, will be the final grade for the course.

Textbooks and resources

Recommended

Mineral Exploration and Mining Essentials. 2010. Robert Stevens, 322pp, Pakawau Geomanagement Inc. ISBN 978-0-9867221-0-3. Available in the book store ($103.45) or from the Geological Association of Canada Bookstore ($68.75) if you are a GAC member.

Resources in the Library

Ore Textures: Recognition and Interpretation. 2009. Roger Taylor. Available free online from UW.

Ore Deposit Geology. 2013. John Ridley. Cambridge University Press. ISBN: 9781107022225. 3 Hour loan.

Mineral Deposits of Canada: Synthesis of Major Deposit Types, District Metallogeny, the Evolution of Geological Provinces & Exploration Methods. 2007. Wayne D. Goodfellow (ed). 1068 pp. Geological Association of Canada. ISBN-13: 978-1-897095-24-9. 3 Hour Loan.

Online Resources

British Columbia Mineral Deposit Profiles:
http://www.empr.gov.bc.ca/MINING/GEOSCIENCE/MINERALDEPOSITPROFILES/

USGS Mineral Deposit Models:
http://minerals.usgs.gov/products/depmod.html

Association of Professional Geoscientists of Ontario: APGO
https://www.apgo.net

Society of Economic Geologists
http://www.segweb.org

Virtual atlas of opaque and ore minerals in their associations
http://www.smenet.org/opaque-ore/

ACADEMIC INTEGRITY (from the Science Undergraduate Office):

Office of Academic Integrity provides relevant information for students, faculty and staff.

***Academic Integrity**:* In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. The Office of Academic Integrity provides relevant information for students, faculty and staff. Students are expected to know what constitutes academic integrity, to avoid committing academic offences, and to take responsibility for their actions. Completion of the Orientation to Academic Integrity Tutorial is encouraged and familiarity with Policy #71, (Student Discipline) is expected. Students who are unsure whether an action constitutes an offence, or need help in learning how to avoid offences (e.g., plagiarism, cheating) or understand 'rules' for group work/collaboration should seek guidance from their

course instructor, academic advisor, or the Associate Dean of Science for Undergraduate Studies. For information on typical Policy 71 penalties, students should check Guidelines for the Assessment of Penalties.

External organizations offering access to course materials (e.g., OneClass; CourseHero): The educational materials developed for this course, including, but not limited to, lecture notes and slides, handout materials, examinations and assignments, and any materials posted to Learn, are the intellectual property of the course instructor. These materials have been developed for student use only and they are not intended for wider dissemination and/or communication outside of a given course. Posting or providing unauthorized audio, video, or textual material of lecture content to third-party websites violates an instructor's intellectual property rights, and the Canadian Copyright Act. Recording lectures in any way is prohibited in this course unless specific permission has been granted by the instructor. Failure to follow these instructions may be in contravention of Policy 71 (Student Discipline). Participation in this course constitutes an agreement by all parties to abide by relevant University policies and guidelines – see Faculty, Staff and Students Entering Relationships with External Organizations Offering Access to Course Materials.

Plagiarism: Plagiarism is the act of directly copying material from another source word-for-word without acknowledging (citing) the source. Copying material from another student word-for-word (collusion) also constitutes plagiarism. It is unacceptable to claim another person's words as your own. Acts of plagiarism are not tolerated at the University of Waterloo and are subject to disciplinary action according to Policy 71, Student Discipline (see below). If you have not already done so, it is strongly recommended that you take the Academic Integrity Tutorial at http://www.lib.uwaterloo.ca/ait/.

Discipline*:* Students are expected to know what constitutes academic integrity, to avoid committing academic offenses, and to take responsibility for their actions. Students who are unsure whether an action constitutes an offense, or who need help in learning how to avoid offenses (e.g., plagiarism, cheating) or about 'rules' for group work/collaboration should seek guidance from the course instructor, academic advisor, or the Associate Dean of Science for Undergraduate Studies. For information on categories of offenses and types of penalties, students should refer to Policy #71, Student Discipline. For information on typical penalties, students should check Guidelines for the Assessment of Penalties.

Grievance*:* Students, who believe that a decision affecting some aspect of their university life has been unfair or unreasonable, may have grounds for initiating a grievance. Students should read Policy #70, Student Petitions and Grievances, Section 4. When in doubt, students must contact the department's/school's administrative assistant who will provide further assistance.

Appeals*:* A decision or penalty imposed under Policy 33 (Ethical Behavior), Policy #70 (Student Petitions and Grievances) or Policy #71 (Student Discipline) may be appealed, if there is a ground. Students, who believe they have a ground for an appeal, should refer to Policy #72 (Student Appeals).

***Team Assignments*:** In the case of team assignments, all members of the team are expected to have contributed equally to the final assignment. At the end of each team assignment, team members will be asked to evaluate the participation of their peers. Team members that receive low participation marks will see their case evaluated by the instructor, which may lead to a penalty on the final mark for this student. In addition, by including their name on a team submission, each student is verifying that they are aware of the content and understand the submission. Thus, if there should be an act of misconduct associated with a group assignment, all students are considered culpable unless there are extenuating circumstances.

***Changes to Course Outlines*:** Revised course outlines will be posted/provided, if course details change (e.g., topics covered, emphasis on certain topics, etc.). Course elements that will **not** change are the: (1) Grading scheme and (2) Course elements related to evaluation.

COURSE RULES/CONSIDERATIONS:

Verification of Illness Forms (VIF's): Science students should be aware that the only Verification of Illness forms (VIFs) accepted for accommodation for missed assessments will be those issued by the University of Waterloo´s Health Services, when this service is open (https://uwaterloo.ca/health-services/). VIFs issued by walk-in clinics will not be accepted, except when obtaining a VIF from Health Services is not possible. If a student is sick on a weekend, during off-hours, while out of town or receiving ongoing care from a family physician or specialist, it is acceptable to provide documentation from other health service providers. Information should include (1) date of the physician assessment, (2) dates of illness, (3) level of incapacitation and (4) whether the diagnosis was made by the physician or based on description by the student.

Keeping the playing field level for all of our students is a priority. Students are reminded that obtaining a VIF under false pretences is an academic offense. For tests and exams, a student found guilty of misrepresentation will receive a failing grade in the course and be suspended. Any questions concerning this policy can be directed to an undergraduate advisor in the Science Undergraduate Office. Student travel plans not considered acceptable grounds for granting an alternative examination time. Only illness and extenuating circumstances (such as a death in the family) will be considered.

Students with Disabilities:

AccessAbility Services, located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If students require academic accommodations to lessen the impact of their disability, they should register with AccessAbility Services at the beginning of each academic term