

ERTH3204**MINERAL DEPOSITS****Winter 2022**

Instructor: Ingrid Kjarsgaard*, Ph.D., Adjunct Professor & Consulting Mineralogist
 *available during lab hours, or upon request via e-mail (ikjarsgaard@sympatico.ca)

TAs: Yingzhou Li (yingzhouli@cmail.carleton.ca),
 Claudia Augustin (CLAUDIAAUGUSTIN@cmail.carleton.ca)

Course Objective

This course introduces the students to a wide variety of ore deposit types and ore minerals hosting elements such as Al, Cr, V, Ti, Mn, Fe, Ni, Co, Cu, Zn, Pd, Ag, Sn, Mo, W, Nb, Ta, Pt, Au, Hg, Pb, REE, and U. The course does not cover fossil fuels or industrial mineral deposits, with the exception of diamonds in kimberlite. Students will learn about the ore minerals, mineral assemblages, alteration, textures and geological setting of different types of ore deposits, such as magmatic, hydrothermal, sedimentary and residual deposits, as well as the geological processes leading to the enrichment and concentration of metals in the rocks. In the practical portion of the course, we will examine and learn to identify the minerals, textures and typical alteration associated with the various deposit types both in hand samples and polished section with the reflected light microscope. In addition, students will be asked to present a short talk on one metal of their choice (for details see below).

Course Prerequisite: ERTH2104 (Igneous Petrology)

Schedule: Lecture: Mondays 2:35pm to 4:25pm Tory 210, Lab: Tuesdays 8:35am to 11:25am or 2:35pm to 5:25pm in HP 2120. **Note: The course will be taught on-line until Jan 28th (or further notice) after that in-person - attendance is mandatory!**

Week	Date	Elements	Lecture Topic	Lab Topic
1	Jan.10/11		<i>Introduction</i>	Ore Microscopy
2	Jan.17/18		Diamonds in Kimberlite	Indicator Minerals
3	Jan.24/25	RE, Nb&Ta, Li	Pegmatites, Carbonatites	RE-, Nb-Ta-, Li-minerals
4	Jan.31/1	Cr, V, Ti	Magmatic Cr, V and Ti	Cr- and Fe-Ti-oxides
5	Feb. 7/8	Ni, Co, Pt	Magmatic Ni-Cu-PGE	Fe-Ni-sulph., Sudbury
6	Feb.14/15	Mo, Sn, W	Porphyry, Skarn, Greisen	Porphyry Cu-Mo, Skarn
7	<i>Feb.21/22</i>		<i>Reading Week - no classes</i>	
8	Feb.28/Mar1		Midterm theory exam	Midterm lab exam
9	Mar. 7/8		PDAC – no lecture, lab time can be used to catch up	
10	Mar.14/15	Au, Hg, Sb	Epithermal Gold	epithermal gold, mercury
11	Mar.21/22	Cu, Ag	Mesothermal Veins, VMS	silver, VMS
12	Mar.28/29	Zn, Pb, Bi	SEDEX & MVT, SSC	SEDEX & MVT, SSC
13	Apr. 4/05	Fe, Mn, Al	BIF, Bauxite, Supergene,	BIF, bauxite, Mn nodules
14	Apr. 11/12	U	Placers, U-deposits, IOCG	Final Lab exam

On-line delivery of lectures and labs from Jan 10th to Jan 28th, 2022

During this period lectures and labs will be taught synchronously on-line only. Please make sure you have access to a computer with a big enough screen that you can look at enlarged images of thinsections and rocks in 3D that you will need to describe (a smart phone screen will not be sufficient). Make sure you have a strong and stable internet or WiFi connection

(use a WiFi booster if needed or plug an ethernet cable directly into the internet modem). Links to on-line lectures and lab sessions will be provided on our course website on Brightspace (CuLearn). Links to on-line resources will be posted there and in the lab manual.

Recommended Reading (but not required):

M. Jebrak & E. Marcoux: Geology of Mineral Resources, GAC, 2015 (order from GAC)

D. Marshall, C.D. Anglin and H. Mumin - Ore Mineral Atlas (order from GAC)

J.F. Craig & D.V. Vaughn - Ore Microscopy and Ore Petrography (Wiley), *available as free download from* http://www.minsocam.org/msa/openaccess_publications/#Ore

Exams & Grades

There will be four exams in total. The mid term exams will cover the first half of the term and the final lab exam the second half, while the final theory exam spans the entire course. The final grade is composed of:

10 weekly lab assignments* (25% total)

Element talk 5%

Mid term theory exam 10%

Mid term lab exam 10%

Final lab exam 15%

Final Theory exam 35%

*Lab assignments need to be handed in to the TA at the beginning of the following week's lab in order to avoid deductions to the marks.

Element Talks

In addition to the weekly lab assignments, each student is asked to research one or more element(s) of economic interest (see list below) and give a short power point presentation (5-10 minutes, max) on the day this element is listed in the course schedule. The element presentation has to be on schedule and cannot be deferred, because it is linked to the topic of the lecture and labs.

Choose one of the following elements (or element groups): Li, Al, Cr, V, Ti, Mn, Fe, Ni & Co, Cu, Zn & Cd, Sn, Pt & Pd, Nb & Ta, REE & Y, Mo, W, Ag, Au, Hg, Pb, U.

Information to compile for each element:

1. position in the periodic table, chemical and physical characteristics (most common oxidation states, melting point) including any special properties that might be of importance (no need to name all the isotopes except for those of U, Pb).
2. how it naturally occurs (main ore minerals with formula)
3. in which host rocks and deposit types it occurs (include crustal abundance)
4. where in the world it is mined (major deposits, geographically)
5. how it is extracted and processed (briefly, you can refer to previous talks if it is the same process)
6. how much is produced and in reserves (USGS)

7. what it is used for

8. world demand (is it increasing or decreasing?), sustainability

A good source for reserve and production statistics is the USGS website (mineral commodities summary). Use diagrams (pie charts, histograms, x-y graphs) rather than tables with numbers to illustrate points 6 to 8. Show maps and pictures, quote your sources, but keep it short! Don't forget to put your name on the title slide.

Please decide by January 10th, 2022, which element(s) you are going to cover.

If you have questions or need to contact me, please e-mail: ikjarsgaard@sympatico.ca

Learning Outcomes

After completion of this course the attentive student should be able to recognize the most common ore minerals in hand sample and in polished sections under the reflected light microscope, and from their association, textures, host rocks and accompanying alteration assemblage be able to identify the type of ore deposit they belong to. Using their acquired knowledge the student will be able to evaluate the general prospectivity of specific geological areas and the economic potential of individual metals and ore deposits. In addition, the student will learn how to describe ore-bearing assemblages, interpret mineral chemical data and write and interpret professional reports and present their findings in front of an audience.

Covid-19 Requirements

Carleton University requires **mandatory vaccination** against COVID-19 for all students, teaching assistants and instructors participating in any in-person university activities. Since both lectures and labs in this course are in-person, only fully vaccinated students may participate in EARTH 3204. For more information, visit: <https://carleton.ca/covid19/health-and-safety/covid-19-vaccines/> .

cuScreen: everyone entering Carleton University campus must upload their **vaccine documents** to **cuScreen** prior to the start of the course and self-declare their **health status** before they come to class **every day**. Wear a mask and wash hands upon entering the building, and scan QR Codes in your path as you progress towards your lab or lecture room. You must also log into HP 2120 at the beginning of every lab and log out of the room when you leave. All students must wash their hands **in the lab** prior to starting the lab.

General Safety Measures

All members of the Carleton community are required to follow general COVID-19 prevention measures and all mandatory Ontario Public Health requirements, since the course is in-person. This includes wearing a well-fitted mask that covers the nose, mouth and chin at all times; physical distancing; bring your own hand sanitizer; practise proper hand hygiene, respiratory and cough etiquette; mandatory self- screening prior to coming to campus daily; and using the QR codes when entering/exiting the class. When in class or in a lab, students **must** maintain a minimum of 2-metre distance apart. A hand must be raised to signify the need for help.

Students, TA's or instructors should not come to campus if they feel unwell.

In the case of classes or meetings being held on-campus in our lecture rooms or teaching labs, you must follow the COVID-19 screening protocols established by the University: use cuScreen to request access to campus and self-declare your health status, wash hands upon entering the Herzberg Building, and scan QR Codes in your path as you progress towards your lab room. For details, please review the Return To Campus COVID-19 Teaching Labs and General Policies forms, and watch the lab protocols video at:

<https://earthsci.carleton.ca/return-to-campus-2021/>

For the most recent information on COVID-19 protocols, visit:

<https://carleton.ca/covid19/policies-and-protocols/> .

Course Copyright

Classroom teaching and learning activities, including lectures, discussions, presentations, etc., by both instructors and students, are copyright protected and remain the intellectual property of their respective author(s). All course materials, including PowerPoint presentations, outlines, and other materials, are also protected by copyright and remain the intellectual property of their respective author(s).

Students registered in the course may take notes and make copies of course materials for their own educational use only. Students are **not permitted to reproduce or distribute** lecture notes and **course materials publicly for commercial or non-commercial purposes** without express written consent from the copyright holder(s).

Academic Integrity

The University Academic Integrity Policy defines plagiarism as “presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one’s own.” This includes reproducing or paraphrasing portions of someone else’s published or unpublished material, regardless of the source, and presenting these as one’s own without proper citation or reference to the original source. Examples of sources from which the ideas, expressions of ideas or works of others may be drawn from include but are not limited to: books, articles, papers, literary compositions and phrases, performance compositions, chemical compounds, art works, laboratory reports, research results, calculations and the results of calculations, diagrams, constructions, computer reports, computer code/software, material on the internet and/or conversations.

Examples of plagiarism include, but are not limited to:

- any submission prepared in whole or in part, by someone else;
- using ideas or direct, verbatim quotations, paraphrased material, algorithms, formulae, scientific or mathematical concepts, or ideas without appropriate acknowledgment in any academic assignment;
- using another’s data or research findings without appropriate acknowledgement;
- submitting a computer program developed in whole or in part by someone else, with or without modifications, as one’s own; and
- failing to acknowledge sources through the use of proper citations when using another’s work and/or failing to use quotations marks.

Plagiarism is a serious offence that cannot be resolved directly by the course’s instructor. The Associate Dean of the Faculty conducts a rigorous investigation, including an interview with the student, when an instructor suspects a piece of work has been plagiarized. Penalties are not trivial.

They can include a final grade of “F” for the course or even suspension or expulsion from the University.

Academic Accommodations

Carleton University is committed to providing access to the educational experience in order to promote academic accessibility for all individuals.

Academic accommodation refers to educational practices, systems and support mechanisms designed to accommodate diversity and difference. The purpose of accommodation is to enable students to perform the essential requirements of their academic programs. At no time does academic accommodation undermine or compromise the learning objectives that are established by the academic authorities of the University.

Addressing Human Rights Concerns

The University and all members of the University community share responsibility for ensuring that the University’s educational, work and living environments are free from discrimination and harassment. Should you have concerns about harassment or discrimination relating to your age, ancestry, citizenship, colour, creed (religion), disability, ethnic origin, family status, gender expression, gender identity, marital status, place of origin, race, sex (including pregnancy), or sexual orientation, please contact the [Department of Equity and Inclusive Communities](mailto:equity@carleton.ca) at equity@carleton.ca.

Requests for Academic Accommodation

You may need special arrangements to meet your academic obligations during the term. For an accommodation request, the processes are as follows:

Pregnancy Obligations

Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the [Student Guide to Academic Accommodation \(PDF, 2.1 MB\)](#)

Religious Obligation

Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the [Student Guide to Academic Accommodation \(PDF, 2.1 MB\)](#)

Academic accommodations for Students with Disabilities

If you have a documented disability requiring academic accommodations in this course, please contact the Paul Menton Centre for Students with Disabilities (PMC) at 613-520-6608 or pmc@carleton.ca for a formal evaluation or contact your PMC coordinator to send your instructor your Letter of Accommodation at the beginning of the term. You must also contact the PMC no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with your instructor as soon as possible to ensure accommodation arrangements are made. For more details, visit the [Paul Menton Centre website](#).

Survivors of Sexual Violence

As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton’s Sexual Violence Policy. For more information

about the services available at the university and to obtain information about sexual violence and/or support, visit the [Equity and Inclusive Communities website](#).

Accommodations for Student Activities

Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see the [Senate Policy on Accommodation for Student Activities \(PDF, 25KB\)](#).