School of Science

GEOL 200
Mineralogy

Term: Fall 2023

Number of Credits: 3

Course Outline

INSTRUCTOR: Dr. Joel Cubley (Lecture); Dr. Chad Morgan (Laboratory)
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OFFICE HOURS: Drop-in and by appointment
CLASSROOMS: A2601 (lecture); T1090 (laboratory)
DATES: September 6, 2023, to December 14, 2023

COURSE DESCRIPTION

Mineralogy provides a practical and systematic treatment of the crystallography, physical, chemical, and optical properties of the main rock-forming and economic minerals. Students will learn how to apply knowledge of minerals' atomic structure and crystallography to identify and explain the physical properties of individual minerals and mineral groups. A course focus will be on the correlations between chemical concepts such as substitution and solid solution and the components of chemical formulas that control the properties and classification of the major mineral classes. Emphasis will be placed on understanding the occurrence and behavior of minerals with respect to changing physical and chemical conditions in geologic environments. Lab exercises focus on the identification of common minerals and associated rocks in both hand sample and thin section. Local examples of mineral species and rocks containing those minerals will be used whenever possible.

COURSE REQUIREMENTS

Successful completion of Physical Geology (GEOL 105), or permission from the instructor.

EQUIVALENCY OR TRANSFERABILITY

Receiving institutions determine course transferability. Find further information at:
https://www.yukonu.ca/admissions/transfer-credit

Simon Fraser University – EASC 202 (3)
Thompson Rivers University – GEOL 2100 (3)
University of British Columbia Vancouver – EOSC 220 (3)
University of British Columbia Okanagan – EESC 200 (3)
University of Victoria – EOS 205 (1.5)
Vancouver Island University – GEOL 200 (3)

LEARNING OUTCOMES

Upon successful completion of the course, students will be able to:

- Describe common rock-forming minerals on the basis of chemical bonding, physical properties, crystal structure, structural formula, and occurrence.

- Explain correlations between relevant chemical concepts (e.g., substitution, solid solution) and the parts of chemical formulas that control the properties and classification of the major mineral classes on Earth.

- Describe and measure properties of hand specimens to confidently identify minerals and to place them in groups.

- Utilize common optical microscopy techniques to characterize mineral assemblages in thin section and name rocks using accepted naming conventions.

- Recognize symmetry elements in crystal's external form and describe how those elements are controlled by a mineral's unit cell geometry and crystal structure.

- Describe the theory behind common mineral analysis techniques, as well as manipulate mineral chemistry data to produce common data products and mineral formulas.

COURSE FORMAT

Weekly breakdown of instructional hours

This course consists of two 90-minute lectures and one three-hour lab period per week. The topic outline included in this course outline details the major topics covered and the order in which topics will be presented throughout the course. It is expected that this course will require 3-4 hours/week of homework and additional reading. It is important to note that the time required will vary by individual.

Delivery format

Lectures and laboratory sections for the Fall 2023 offering of this course will be delivered in a face-to-face format. Whereas students will be given after-hours access to the Earth Sciences laboratory (T1090) to complete lab assignments, the course instructor will not necessarily be present to guide learning. It is thus important that students fully engage and participate during the designated lab period.

EVALUATION

Weekly lab assignments (10)	30% (3% each)
Midterm lecture exam	15%
Final lecture exam	25%
Whitehorse Batholith project	15%
Lecture assignments	10% (5% each)
Review Quizzes (5)	5% (1% each)
Total	100%

Assignments

This course includes weekly laboratory exercises that are due one week from the initial laboratory activity unless otherwise indicated by the instructor. Successful completion of these activities is critical for understanding and reinforcing lecture material. Two lecture-based assignments assigned over the course of the semester; these provide opportunities for students to apply their new mineralogy knowledge to real datasets and characterize mineral assemblages and chemistry. Due dates for these assignments will be clearly communicated in lecture and on the Moodle LMS platform.

In addition to their regular labs and lecture assignments, students will be assigned a project to mineralogically characterize different intrusive phases of the Cretaceous Whitehorse batholith based on hand sample and thin section analysis. This project will be due on the last day of classes, and additional project details and deliverables will be presented on the first day of class. This project requires application of newly developed optical mineralogy skills to identify common mineral phases in thin section.

Late assignments will be graded based on the following scheme: a deduction of 10% per day up until a total deduction of 50% is reached, following that, assignments must be submitted prior to the date that the instructor hands back the graded assignment (set by the instructor).

Examinations

This course has two lecture examinations, a midterm and a final. The midterm exam is conducted during scheduled lecture time; the final exam is conducted during the final exam period scheduled by the Office of the Registrar. The midterm lecture exam is a 1.5-hour exam; the lecture final exam is designed to take 3 hours.

Missed exams will be assigned a grade of 0% unless re-scheduling for a valid reason is approved and determined in advance of scheduled exam date. If there are known conflicts with exam scheduling, please see the instructor as soon as possible to discuss an alternative examination date.

Quizzes

Short, biweekly review quizzes will be administered using the Moodle LMS platform. Material on these quizzes may be derived from the lecture material and/or assigned textbook readings.

COURSE WITHDRAWAL INFORMATION

Refer to the YukonU website for important dates.

TEXTBOOKS & LEARNING MATERIALS

This course utilizes an open-source textbook offered through the Open Geology project.

Perkins, D. 2022. *Mineralogy* (2nd ed.) https://opengeology.org/Mineralogy/

An additional recommended, but not required, text is:

Deer, W.A., Howie, R.A., and Zussman, J. 2013. *Rock-Forming Minerals* (3rd edition). https://doi.org/10.1180/DHZ

ACADEMIC INTEGRITY

Students are expected to contribute toward a positive and supportive environment and are required to conduct themselves in a responsible manner. Academic misconduct includes all forms of academic dishonesty such as cheating, plagiarism, fabrication, fraud, deceit, using the work of others without their permission, aiding other students in committing academic offences, misrepresenting academic assignments prepared by others as one's own, or any other forms of academic dishonesty including falsification of any information on any Yukon University document.

Please refer to Academic Regulations & Procedures for further details about academic standing and student rights and responsibilities.

ACADEMIC ACCOMMODATION

Reasonable accommodations are available for students requiring an academic accommodation to fully participate in this class. These accommodations are available for students with a documented disability, chronic condition or any other grounds specified in section 8.0 of the Yukon University Academic Regulations (available on the Yukon University website). It is the student's responsibility to seek these accommodations by contacting the Learning Assistance Centre (LAC): LearningAssistanceCentre@yukonu.ca.

LECTURE TOPIC OUTLINE

Module	Topics	Recommended reading**
1	Course introduction; definition of minerals; systematic classification of minerals; importance of minerals as commodities and in environmental systems	Chapter 1
2	Mineral chemistry I: Electronic configuration of atoms and ions, bonding and the periodic table; radioactive decay	Chapter 2
3	Mineral chemistry II: Fundamentals of crystal structures: atomic vs. ionic radii, coordination number, Pauling's rules, controls on atomic substitutions	Chapter 2; Chapter 13
3	Physical properties of minerals in hand specimen	Chapter 3
4	Formation of crystals; factors controlling crystal size and perfection; mineral stability and polymorphs; crystalline vs. non-crystalline solids	Chapter 4
5	Crystallography I: Symmetry elements and operations; crystal systems and crystallography notation (crystal classes); unit cells	Chapters10, 11
6	Crystallography II: Miller indices; crystal forms stereographic projection of crystals; point groups;	Chapters 10, 11
7	Crystallography III: Twinning; space groups; Bravais lattices; polymorphism	Chapters 10, 11
8	Optical Mineralogy I – interaction of light with minerals, polarization, refraction; birefringence and retardation, color and pleochroism, extinction angles	Chapter 5
9	Optical Mineralogy II – optical indicatrices (uniaxial and biaxial)	Chapter 5
10	Crystallization of minerals in igneous systems: magma types and magmatic settings, crystal-melt equilibrium (and disequilibrium), Bowen's reaction series	Chapter 6
11	Silicate minerals: SiO2 polymorphs; framework silicates (e.g., feldspars); sheet silicates (micas and clays); single and double chain silicates (pyroxenes and amphiboles); ring silicates and paired tetrahedral silicates; isolated tetrahedral silicates	Chapter 6
12	Sedimentary minerals and sedimentary systems: clastic and chemical sedimentation; clay minerals, carbonate minerals, sulfates, halides, zeolites, phosphates, chert; chemical weathering and secondary minerals	Chapter 7
13	Metamorphism and mineral changes: underlying thermodynamics; equilibrium vs. non-equilibrium minerals and textures; kinetic considerations; introduction to phase diagrams and petrogenetic grids	Chapter 8
14	Ore Deposits and Economic Minerals: Introduction to common ore deposit types (magmatic, hydrothermal, etc.); native metals; sulfides and sulfosalts; oxide and hydroxide minerals	Chapter 9
15	X-ray diffraction (XRD), electron microprobe, scanning electron microscope (SEM) and electron backscatter diffraction (EBSD) analysis and imaging of minerals: theory, data interpretation and presentation	Chapter 12
16	Mineral evolution: the history of mineral species from the early universe to present	TBD

LABORATORY TOPIC OUTLINE

Week	*Topic*
1	Mineral analyses and stoichiometry
2	Crystal symmetry, point groups and Miller indices
3	Exploration of crystal structures using Xtal Draw and the AmMin database
4	Introduction to Optical Microscopy I: microscope usage, color/pleochroism; cross-polarized light; relief and Becke lines; birefringence; extinction angles
5	Introduction to Optical Microscopy II: uniaxial and biaxial optic figures; length slow/fast, etc.
6	Silicate minerals in felsic igneous rocks (hand sample/thin section)
7	Silicate minerals in mafic igneous rocks (hand sample/thin section)
8	Sedimentary rock identification and common mineral phases (hand sample/thin section)
9	Metamorphic rock identification and classification of common mineral phases in metapelites and metabasites (hand sample/thin section)
10	X-ray diffraction – identifying mineral assemblages based on XRD results