E-PSCI 54: Minerals and Rocks of the Earth and Planets, Spring 2024
Syllabus version: 22 January 2024

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Description: Minerals and rocks are the building blocks of the Earth and other planets, and understanding their properties and occurrences has applications to many diverse areas of Earth and planetary sciences. This course provides a comprehensive foundation of mineralogy and introductory petrology for students of Earth and planetary sciences, materials science, chemistry, or related fields. Topics include: bonding; symmetry; crystallography; deep Earth mineralogy; planetary mineralogy; petrology; and the bonding, structures, geology, and significance of a wide range of mineral and rock types. Weekly lab sections will cover crystal structures, symmetry, and the identification of a variety of common minerals and rocks.

Learning objectives: By the end of the semester, students will:

1) Have an in-depth understanding of the relationship between microscopic properties and macroscopic properties of minerals; be able to predict the macroscopic properties of a mineral given information about its microscopic properties, and vice versa. Examples of microscopic properties to be covered include the nature of bonding, symmetry, and crystal structures. Examples of macroscopic properties include physical properties (fracture/cleavage, hardness, luster, habit, etc.), chemical properties (bulk composition, reactivity, etc.), and geological formation environments. This will be the focus of the earlier portion of the course.
2) Apply knowledge of minerals to understanding deep Earth materials, the mineralogy of other planetary bodies, and complex rocks. This will be the focus of the later portion of the course.
3) Learn to identify minerals and rocks in laboratory samples. This requires a combination of logical deduction and familiarity with specimens that we will learn in lab. The focus will be on macroscopic hand samples, but identification of minerals and rocks in microscopic thin sections will also be introduced.

Grading:
Assignments: 20%
Lab work: 25%
Lab final exam: 15%
Midterm exam: 20%
Final exam: 20%

Prerequisites: None (introductory courses in EPS and inorganic chemistry may be beneficial, but are not required).

Meeting days/times/locations:
Lectures on Tuesdays and Thursdays, 12–1:15pm, in GeoMuseum 204
Labs on Thursdays, 3–5:45pm, in the Science Center

Enrichment activities: There will be two optional enrichment activities associated with this course, which will take place outside of normal lecture and lab times. Note that attendance is not mandatory, and students will not be held accountable for information presented on these trips.

1. A behind-the-scenes tour of the mineral collection at the Harvard Museum of Natural History (https://hmnh.harvard.edu/). Day/time TBD.
2. A field trip to Havey Quarry, a tourmaline mine in Maine (http://www.nemineral.org/geoscienceportal/ME/haveymine.html). This will be a daytrip, most likely on a weekend. Transportation and lunch will be provided. Day/time TBD.

Class website: The syllabus, lecture slides, and other class materials will be posted on Canvas.

Exams: There will be a midterm and a final exam associated with the lecture. Study guides will be provided. Both will be written exams given in class, closed book. There will also be a hands-on written lab final exam, closed book, given in a lab section.

Labs: You should be able to finish your lab assignments in the lab sessions (probably with plenty of time to spare), you and may turn it in immediately. If you would like extra time to work on it, you may turn it in during lecture or lab, with a due date of one week (i.e., it is due at the beginning of the following lab).

Assignments: There will be approximately five homework assignments throughout the semester. Each assignment is due at the beginning of class one week after it is assigned.

Textbook: Manual of Mineral Science by Cornelis Klein and Barbara Dutrow, 23rd edition (the 22nd edition is also fine), is recommended but not required. Suggested readings corresponding to lectures/labs are listed on the course schedule below. If you do obtain this textbook, please bring your copy to lab sessions, as it will be needed to complete some assignments (a couple extra copies will be available in the lab sessions). A scanned copy will also be available by ~early–mid February, and can be accessed via Canvas or HOLLIS.

Software: Some lectures, labs, and problem sets will make use of a free crystal structure viewing program called Vesta. It can be downloaded here:
https://jp-minerals.org/vesta/en/download.html
It is available for Windows, Mac, and Linux. It will also be installed on the computers in the computer lab.

Policy on attendance and due dates: In case of an occasional absence, please notify the professor in advance whenever it is feasible. If an absence will occur on an assignment due date, arrangements should be made to turn in the assignment in advance or remotely. In case of

unexpected absence, students are expected to contact the TF or professor as soon as possible to obtain missed assignments, and to get the class notes from a fellow student.

Policy on late work: Work should be turned in at the beginning of the lab/lecture in which it is due. Grades on late assignments will be lowered by 10% for each day they are late.

Academic integrity: Please read Harvard's policy on academic integrity in the Undergraduate Handbook (https://handbook.college.harvard.edu), and Harvard's guide to using sources (https://usingsources.fas.harvard.edu/home), which includes a section on avoiding plagiarism. It is your responsibility to read and understand the Harvard College Honor Code. Course materials are the property of the instructional staff, Harvard University, or other copyright holders, and are provided for your personal use. You may not distribute them or post them on websites.

Collaboration and academic honesty: Collaboration on lab and homework assignments is encouraged. However, it is expected that all assignments and lab reports submitted for academic credit will be the student's own work. If you use the work of others in preparing your responses, this must be properly acknowledged as outlined in the Undergraduate Handbook.

Accommodations for students with disabilities: Students who need academic adjustments or accommodations because of a disability should notify teaching staff as soon as possible (ideally before the end of the second week of the term) to discuss how we can best meet your needs. All discussions are confidential, but AEO may be consulted to discuss appropriate implementation (without disclosing personal information).

Diversity, inclusion, and belonging: We hope this classroom will be a place where you are treated with respect, and we welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, immigration status, religious affiliations, sexual orientation, ability, and other visible and nonvisible identities. All members of this class are expected to contribute to a respectful, welcoming, and inclusive environment for every other member of the class.

Additionally, we note that each member of the teaching staff is a "responsible employee" – that is, we "have a responsibility to share information that [we] learn about incidents of sexual and gender-based harassment with the Title IX Coordinator." If you are experiencing any kind of harassment, discrimination, or other barriers to your learning and/or social experience at Harvard, please notify one of the teaching staff who can connect you with the right resources (some of which are confidential) to ensure your emotional, physical, and mental safety.

Policy on the use of AI technology: As you are likely well aware, generative AI tools (GAI, such as ChatGPT) are widely available, and their capacity to complete tasks is quickly expanding. For any written work (e.g., lab or homework assignments), we permit the use of AI tools solely for grammar or sentence-level enhancement. Any such use must be appropriately acknowledged and cited. It is each student's responsibility to assess the validity and applicability of any GAI output that is submitted; you bear the final responsibility. Violations of this policy will be considered academic misconduct. If you have any questions about this policy, including possible applications of AI tools not explicitly mentioned here, please reach out to the teaching staff.

Approximate course schedule: This schedule is subject to change. Changes will be announced in class and posted on the class website.

		Reading in MMS (23rd/22nd editions)
Week 1		
1/23	Introduction, mineral chemistry	1–17, 90–96, 217–222 / 1–16, 38–41, 104–107
1/25	Bonding and Pauling's rules	37–89 / 42–89
Lab	*No lab*	
Week 2		
1/30	Symmetry	109–121 / 170–181
2/1	Point groups	121–129 / 181–189
Lab	*No lab*	
Problem set assigned: symmetry		
Week 3		
2/6	Crystallography	129–142 / 194–208
2/8	Native elements	331–336, 342–350 / 333–339, 342–351
Lab	Close packing, crystal structures, symmetry	66–68, 80–89, 182–208 / 70–74, 80–89, 251–276
Week 4		
2/13	Oxides, hydroxides, and halides	368–397 / 371–402
2/15	Oxides, hydroxides, and halides	368–397 / 371–402
Lab	Introduction to mineral identification in hand samples	19–36 / 17–37
Problem set assigned: practice midterm		
Week 5		
2/20	Orthosilicates	434–442 / 441–449
2/22	Orthosilicates and cyclosilicates	483–504 / 491–513
Lab	Oxides, hydroxides, and orthosilicates	368–393, 483–501 / 378–397, 491–510
Week 6		
2/27	Chain silicates	446–452, 505–513 / 452–457, 514–523
2/29	Chain silicates	452–456, 514–519 / 457–462, 523–527
Lab	Chain silicates	505–519 / 514–527
Week 7		
3/5	**Midterm exam**	n/a
3/7	Framework silicates	266–274, 467–476, 534–544 / 134–143, 475–484, 543–554
Lab	Framework silicates	226–234, 534–552 / 155–157, 208–213, 534–552

Week 8
Spring break – no classes

Week 9

3/19	Framework silicates	276–281, 477–482, 544–552 143–148, 484–489, 554–562
3/21	Sheet silicates	442–446, 502–505, 456–467, 519–534 / 449–452, 510–514, 462–475, 527–543
Lab	Sheet silicates	502–505, 519–534 / 510–514, 527–543

Problem set assigned: crystal structures – bonding, density, and identifying unknowns

Week 10

3/26	Carbonates, phosphates, and sulfates	399–433 / 404–440
3/28	Sulfides	337–341 / 339–342
Lab	-ates and sulfides	407–433, 350–367 / 411–440, 351–370

Problem set assigned: chemical compositions of minerals

Week 11

4/2	Igneous petrology	n/a
4/4	Sedimentary and metamorphic petrology	n/a
Lab	Petrology	n/a

Problem set assigned: petrology

Week 12

4/9	Deep Earth mineralogy	93–95 / 111–115
4/11	Deep Earth mineralogy	93–95 / 111–115
Lab	Introduction to mineral identification in thin sections	

Week 13

4/16	Deep Earth mineralogy	93–95 / 111–115
4/18	Planetary mineralogy	n/a
Lab	**Lab final exam**	n/a

Week 14

4/23	Planetary mineralogy	n/a

Final exam: Tuesday May 7, 9am–12pm (tentative; see registrar's exam schedule)