



GEOL 315 Minerals and Earth Systems

Units: 4.0

Fall 2024 — Lecture: T Th 11:00 am - 12:20 pm (ZHS 200)
Lab: M 2:00 - 4:50 pm (ZHS B65)

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Office Hours: By appointment

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Office: ZHS 309

Office Hours: W 9:00 am - 12:00 pm or by appointment

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IT Help: Steven Lin

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Co-Requisite(s): CHEM105a or CHEM115a

Concurrent Enrollment: GEOL315L

Recommended Preparation: any introductory GEOL course

Course Description

Minerals and their formation in the Earth; includes discussions of mineral properties, atomic bonding and crystal structures, the most common rock-forming minerals, mineral identification and analytical techniques, and the intersection of minerals and society.

Minerals are the fundamental building blocks of the Earth. Knowing when, where, and why they form is critical for understanding all aspects of geology. Minerals also influence many aspects of our lives: they make up the soil in which our food grows; they provide raw materials that we use for manufacturing (automobiles, paper, paint, pharmaceuticals, etc.); they help us remediate hazardous waste problems; biological systems produce minerals: they make up not just the carbonate shells we find as fossils, but many other structures including teeth, kidney stones, magnetite grains for orientation, etc. Minerals record clues that reveal information about formation and evolution of the Earth.

The course will begin with the fundamentals of mineralogy, including subjects such as: mineral properties, chemical bonding, crystal structure, the most common rock-forming mineral groups, and techniques for mineral analysis. Subsequently, we will place these minerals in a geologic context by exploring where they form and re-form from the core and deep mantle up to the Earth's surface. Lastly, we will discuss how mineralogy intersects with society, with topics such as mining, sustainability, and technology. The course will also include a field trip, a mid-term exam, and a final project. For the final project, each student will select a mineral and research its scientific and societal importance, producing an in-class presentation and a written report. The field trip will be an optional 1-day excursion to the San Gabriel Mountains.

The lab section of this course is required and will involve hands-on experience with mineral identification and training in optical microscopy.

Learning Objectives

1. Identify major rock-forming minerals in hand sample and thin section.
2. Relate the architecture of mineral structure to the mineral chemistry
3. Connect the geological environments to the formation of important minerals
4. Discuss economically important minerals and their role in society and technology
5. Develop research skills including literature review, laboratory techniques, scientific writing, referencing, and presenting.

Teaching Objectives

1. Provide an experiential learning environment in and out of the classroom.
2. Teach with a JEDI lens and provide a welcoming classroom to all.
3. Educate on the fundamentals of mineralogy and how it intersects geologic processes and society.

Course Notes

Letter grades will be assigned according to the grading scale below. Lecture slides and other resources will be available on Brightspace.

Software

Mineralogy/crystal drawing program:

[CrystalViewer](#) software (available for PC or Mac) will be required to complete some of the labs. A software license will be provided by the instructors to install the program on your own devices.

Image analysis program:

[ImageJ](#) will be required to complete one of the labs. This is free software that can be downloaded at the link.

Graphing programs:

- Python (free)
- Excel (available through USC)
- [MATLAB](#) (available through USC)

Citation managers:

Technical/scientific writing requires citations, which can be time-consuming and prone to errors. Citation managers can assist in formatting and organizing your reference list and the options listed below have plug-ins that work with Word and Overleaf.

- [Zotero](#) (free) (recommended)
- [Mendeley](#) (free)
- [EndNote Online](#) (available through USC)

Resources for software support and availability through USC include:

- [USC Software Available to Campus](#)
- [USC Computing Center Laptop Loaner Program](#)
- [Brightspace Help for Students](#)

Textbooks

There is no required textbook for this course. However, if you would like a textbook, the following are recommended:

Mineral Science, by Cornelis Klein and Barbara Dutrow, 23rd ed. (but earlier editions are also good), Wiley, 2002. It is the descendent of the classic *Dana's Manual of Mineralogy* and is rich in descriptive discussions of minerals, including extensive lists of minerals and their properties. This covers many details we will not have time to discuss.

Earth Materials, by Cornelis Klein and Anthony Philpotts, Cambridge Press, 2013. It has a good overview of geology, mineralogy and petrology, and lots of color figures. This covers most (but not all) of the topics we will discuss.

Minerals: Their constitution and origin, by H.R. Wenk and A. Bulakh, Cambridge Press, 2004. This textbook is a bit more in-depth than the titles above. Illustrations are half-tone, but include lots of good graphs and schematics. Less geology overview, but much more chemistry. We will not cover material quite as fully as this book presents it, but this will be an excellent future reference.

For a free, online mineralogy textbook you can visit: <http://opengeology.org/Mineralogy/>

For a free, online optical mineralogy reference for identifying minerals in thin section (includes 75 common minerals) you can visit: <https://optical.minpet.org/>

Description and Assessment of Assignments

Thursday Quizzes

At the beginning of each Thursday lecture period, there will be a 5–10 minute quiz. These quizzes will emphasize material from the previous 1–2 lectures, but they may also include earlier material if not yet mastered. The lowest two quizzes will be dropped, so a brief illness or absence should not affect your final grade.

Midterm Exam

An in-class midterm exam will cover all lecture material prior to the midterm (see weekly schedule). The exam will be closed book with no access to laptops/phones, but students will be allowed to bring one A4 page of notes prepared individually by each student themselves to use as a reference sheet.

Final Project

Topic: Each student will select a naturally occurring mineral for a literature-based research project that addresses the scientific and societal importance of their mineral. Minerals can either be selected from the suggestions below or your own suggestion (pending approval by the instructor).

Quartz	Amphibole	Perovskite	Zircon	Pyrite
Garnet	Pyroxene	Olivine	Apatite	Lepidolite
K-Feldspar	Plagioclase	Serpentine	Titanite	Bauxite
Mica	Calcite	Talc	Hematite	Gypsum

Learning objectives: This assignment achieves the learning objectives by developing research skills, including searching for relevant and valid source material, reading and distilling published literature, compiling relevant statistics, data, and figures, producing scientific writing, and combining these into a written report and presentation.

Products: The project will have three parts:

- 1) an annotated bibliography including 5 references (e.g., peer-reviewed journal articles)
- 2) a 10-minute in-class presentation (e.g., slides in PowerPoint)
- 3) a 5-page (double spaced) written report (not including the reference list)

Due Dates:

- 1) The annotated bibliography is due to the instructor via email by 11:59pm on 11/5.
- 2) The presentation will be given in-class during the last lecture period on 12/5.

3) The written report is due to the instructor via email by the end of the final exam window.

Late reports will be penalized by 5% for every 2 days late.

References: The source of text, figures, and pictures that you use must be acknowledged. This includes the full address of any website. These citations should be noted throughout the written report and on presentation slides and collated into a list at the end of the written report. Citations should follow the [AGU Style Guide](#). Citations on presentation slides should follow the in-text citation style, e.g., “Smith et al. (2014)”.

Grading: The project and/or presentation will be graded on quality and quantity of research, quality of presentation, adherence to time limit, and ability to answer questions after the presentation.

Grading Breakdown

Lab	40%
Lab Assignments	30%
Lab Practicals.....	10%
Lecture	60%
Thursday Quizzes	10%
Midterm Exam	20%
Final Project	30%
Total	100%

Grading Scale

Course final grades will be determined using the following scale:

Letter grade	Corresponding numerical point range
A	95-100
A-	90-94
B+	87-89
B	83-86
B-	80-82
C+	77-79
C	73-76
C-	70-72
D+	67-69
D	63-66
D-	60-62
F	59 and below

Assignment Submission Policy

Due dates and submission method for all assignments are noted in this syllabus. For the most part, weekly quizzes and the mid-term exam will be turned in during lecture periods. Final project materials should be emailed to the instructor.

Grading Timeline

All assignments other than the final project will be returned during the following lecture. The final project will be returned before the university deadline for final grades.

Attendance

Attendance in lecture and lab periods is ESSENTIAL. Reading the recommended textbooks or online resources will augment, but not replace, class meetings and exercises. Please prearrange excused absences with as much notice as possible or let me know before class (via email) for any reason.

Academic Integrity

The University of Southern California is foremost a learning community committed to fostering successful scholars and researchers dedicated to the pursuit of knowledge and the transmission of ideas. Academic misconduct is in contrast to the university's mission to educate students through a broad array of first-rank academic, professional, and extracurricular programs and includes any act of dishonesty in the submission of academic work (either in draft or final form).

This course will follow the expectations for academic integrity as stated in the [USC Student Handbook](#). All students are expected to submit assignments that are original work and prepared specifically for the course/section in this academic term. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s). Students suspected of engaging in academic misconduct will be reported to the Office of Academic Integrity.

Other violations of academic misconduct include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

Academic dishonesty has a far-reaching impact and is considered a serious offense against the university. Violations will result in a grade penalty, such as a failing grade on the assignment or in the course, and disciplinary action from the university itself, such as suspension or even expulsion.

For more information about academic integrity see the [student handbook](#) or the [Office of Academic Integrity's website](#), and university policies on [Research and Scholarship Misconduct](#).

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment or what information requires citation and/or attribution.

AI Generators Policy

Creating, analytical, and critical thinking skills are part of the learning outcomes of this course; as such, all assignments should be prepared by the student working individually or in groups. Students may not have another person or entity complete any substantive portion of the assignment. Therefore, using AI-generated tools is prohibited in this course, will be identified as plagiarism, and will be reported to the Office of Academic Integrity.

Course Content Distribution and Synchronous Session Recordings Policies

USC has policies that prohibit recording and distribution of any synchronous and asynchronous course content outside of the learning environment.

Recording a university class without the express permission of the instructor and announcement to the class, or unless conducted pursuant to an Office of Student Accessibility Services (OSAS) accommodation. Recording can inhibit free discussion in the future, and thus infringe on the academic freedom of other students as well as the instructor. ([Living our Unifying Values: The USC Student Handbook](#), page 13).

Distribution or use of notes, recordings, exams, or other intellectual property, based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes but is not limited to providing materials for distribution by services

publishing course materials. This restriction on unauthorized use also applies to all information, which had been distributed to students or in any way had been displayed for use in relation to the class, whether obtained in class, via email, on the internet, or via any other media. Distributing course material without the instructor's permission will be presumed to be an intentional act to facilitate or enable academic dishonesty and is strictly prohibited. ([Living our Unifying Values: The USC Student Handbook](#), page 13).

Course Evaluations

Course evaluation occurs at the end of the semester university-wide. It is an important review of your experience in the class and will help me to understand how to better teach this course in the future. In addition, we will complete a mid-semester course evaluation to gauge how the overall trajectory of the course and what may need to be adjusted.

Course Schedule*

	Date	Topics	Deliverables
Week 1	8/27	T: Introduction: What is a mineral?	
	8/29	Th: Formation of the Earth	
Week 2	9/3	T: Mineral properties	
	9/5	Th: Mineral chemistry and bonds	Quiz
Week 3	9/10	T: Physical properties of minerals I	
	9/12	Th: Physical properties of minerals II	Quiz
Week 4	9/17	T: Crystal systems & symmetry I	
	9/19	Th: Crystal systems & symmetry II	Quiz
Week 5	9/24	T: Mechanisms of crystallization I	
	9/26	Th: Mechanisms of crystallization II	Quiz
Week 6	10/1	T: Rock-forming minerals I	
	10/3	Th: Rock-forming minerals II	Quiz
Week 7	10/8	T: Rock-forming minerals III	
	10/10	Th: NO LECTURE – Fall break	
Week 8	10/15	T: Rock-forming minerals IV	
	10/17	Th: Mid-term exam	Mid-term exam (1 sheet)
Week 9	10/22	T: Igneous systems	
	10/24	Th: Sedimentary systems	Quiz
	10/26	Sat: Field trip to the San Gabriel Mtns	
Week 10	10/29	T: Metamorphic systems	
	10/31	Th: How do we study minerals? Analytical tools	Quiz
Week 11	11/5	T: Planetary systems	Annotated bibliography
	11/7	Th: Layers of the Earth	Quiz
Week 12	11/12	T: Optical mineralogy I	
	11/14	Th: Optical mineralogy II	Quiz
Week 13	11/19	T: Minerals & society: Mining, technology, and sustainability	
	11/21	Th: Minerals & society: Environmental effects	Quiz
Week 14	11/26	T: Minerals & society: Industrialization and colonialism	
	11/28	Th: NO LECTURE – Thanksgiving	
Week 15	12/3	T: Make-up day	
	12/5	Th: In-class presentations	Final presentations
Finals week		No final exam Final report due by the end of assigned exam time window	Refer to the final exam schedule at classes.usc.edu .

*Schedule is subject to change. I will communicate any changes in advance.

Statement on University Academic and Support Systems

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University's educational programs. [The Office of Student Accessibility Services \(OSAS\)](#) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Student Financial Aid and Satisfactory Academic Progress:

To be eligible for certain kinds of financial aid, students are required to maintain Satisfactory Academic Progress (SAP) toward their degree objectives. Visit the [Financial Aid Office webpage](#) for [undergraduate](#)- and [graduate-level](#) SAP eligibility requirements and the appeals process.

Support Systems:

[Counseling and Mental Health](#) - (213) 740-9355 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

[988 Suicide and Crisis Lifeline](#) - 988 for both calls and text messages – 24/7 on call

The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline consists of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

[Relationship and Sexual Violence Prevention Services \(RSVP\)](#) - (213) 740-9355(WELL) – 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

[Office for Equity, Equal Opportunity, and Title IX \(EEO-TIX\)](#) - (213) 740-5086

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

[Reporting Incidents of Bias or Harassment](#) - (213) 740-2500

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

[The Office of Student Accessibility Services \(OSAS\)](#) - (213) 740-0776

OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

[USC Campus Support and Intervention](#) - (213) 740-0411

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

[Diversity, Equity and Inclusion](#) - (213) 740-2101

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

[USC Emergency](#) - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

[USC Department of Public Safety](#) - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call

Non-emergency assistance or information.

[Office of the Ombuds](#) - (213) 821-9556 (UPC) / (323-442-0382 (HSC)

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

[Occupational Therapy Faculty Practice](#) - (323) 442-2850 or otfp@med.usc.edu

Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.

Land Acknowledgment: Borrowed from the History Department

See <https://dornsife.usc.edu/hist/home/department-of-history-land-acknowledgement/> for the full description

The Van Hunnicks History Department of USC acknowledges our presence on the ancestral and unceded territory of the Tongva people and their neighbors: (from North to South) the Chumash, Tataviam, Kitanemuk, Serrano, Cahuilla, Payomkawichum, Acjachemen, Ipai-Tipai, Kumeyaay, and Quechan peoples, whose ancestors ruled the region we now call Southern California for at least 9,000 years. Indigenous stewardship and rightful claims to these lands have never been voluntarily relinquished nor legally extinguished. We pay respects to the members and elders of these communities, past and present, who remain stewards, caretakers, and advocates of these lands, river systems, and the waters and islands of the Santa Barbara Channel.