GEOL 537 Rock Mechanics

Units: 3.0
Spring 2025 — T 1:00 pm - 3:25 pm (ZHS 130)

Instructor: Caroline Seyler
Office: ZHS 317
Office Hours: By appointment
Contact Info: seyler@usc.edu (typically will respond within 24 hours during the week)

IT Help: Help Desk ts@dornsife.usc.edu
Hours of Service: Weekdays, 8:00 am - 4:00 pm
Brightspace help: https://www.brightspacehelp.usc.edu/students/

Recommended Preparation: Background knowledge of structural geology and plate tectonics.

Course Description

Rock mechanics studies the response of rocks to applied forces, also termed rheology (rheo = Greek for flow). Rheology links the physical processing operating at the grain-scale to the mesoscale observations of shear zone architecture and up to global-scale plate tectonic dynamics. This course will cover the fundamentals of grain-scale deformation mechanisms, discuss experimental rock deformation techniques, and examine how we construct estimates for the strength of a mineral, a rock, and the lithosphere. The course will focus on dislocation- and diffusion-accommodated deformation mechanisms operating in the ductile regime.

Learning Objectives

1. Explain the physics behind defect motion in crystals
2. Define and recognize major deformation mechanisms in rock-forming minerals
3. Measure paleostress in rock samples
4. Evaluate experimental rock deformation techniques and interpret mechanical data
5. Construct lithospheric strength profiles
6. Develop scientific writing skills

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 rock rheology and how it intersects geologic processes

Course Notes

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

Textbooks

There is no required textbook for this course, but I will refer to material from these optional textbooks:

- *Deformation of Earth Materials* by Shun Karato (Cambridge University Press)
- *Creep of Crystals* by Jean-Paul Poirier (Cambridge University Press)

- *Elementary Dislocation Theory* by Johannes Weertman & Julia Weertman (Oxford University Press)
- *Materials Science for Structural Geology* by Mervyn Paterson (Springer)
- *Theory of Dislocations* by Peter Anderson, John Hirth, & Jens Lothe (Cambridge University Press)
- *Imperfections in Crystalline Solids* by Wei Cai & William Nix (Cambridge University Press)

Some of these textbooks are available through the Cambridge University Press USC Library collection in a hard copy or digital format.

Software

Graphing programs:

- Python (free)
- Google Sheets (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

Description and Assessment of Assignments

Bi-weekly assignments

Assignments will be initiated during class time and will be due according to the course schedule below. Collaborative work is encouraged but each student must turn in an assignment completed by themselves in full.

Final project

For the final project, each student will select a mineral or rock type to review what is currently known about its deformation behavior and construct a deformation mechanism map. This project will consist of two components:

1) In-class presentation, ~20 minutes
2) Report and code/spreadsheet for the deformation mechanism map

Participation

The participation grade will be based on in-class learning activities, discussion, and in-class work on bi-weekly assignments.

Grading Breakdown

Assignments.....50%
Participation.....10%
Final project 40%
Total..... *100%*

Grading Scale

Course final grades will be determined using the following scale:

Letter grade	Corresponding numerical point range
A	93-100
A-	90-92
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

Bi-weekly assignments will be submitted in-person during class according to the schedule below. Final presentations will take place during class, and final reports should be submitted via email to me. Late submissions will be penalized by 5% for every 2 days late.

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 fundamental to learning in this course. Attendance is mandatory to receive participation credit for in-class activities and discussions. Reading the recommended textbooks or online resources will augment, but not replace, class meetings. Please prearrange excused absences with as much notice as possible or let me know before class (via email).

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 dishonestly 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 the overall trajectory of the course and what may need to be adjusted.

Course Schedule*

	Date	Topics	Readings	Due Dates
Week 1	1/14	Introduction, basic rheology, and terminology	Rutter et al. (1986)	
Week 2	1/21	Introduction to crystal defects		Assignment #1
Week 3	1/28	Point Defects		Assignment #2
Week 4	2/4	Dislocations I		
Week 5	2/11	Dislocations II		Assignment #3
Week 6	2/18	Diffusion & diffusion creep		
Week 7	2/25	Dislocation creep	Hirth & Tullis (1992); Hirth et al. (2001)	Assignment #4
Week 8	3/4	Effects of fluids (water & melt)		
Week 9	3/11	Deformation of multi-phase materials (aka rocks)		Assignment # 5
Week 10	3/18	**SPRING RECESS**		
Week 11	3/25	Grain size & paleopiezometry		Assignment # 6
Week 12	4/1	Experimental techniques I		
Week 13	4/8	Experimental techniques II		Assignment #7
Week 14	4/15	Strength of the lithosphere	Rutter & Brodie (1991)	
Week 15	4/22	In-class presentations		Assignment #8
Week 16	4/29	**NO CLASS**		
FINAL		**Final Report**		Refer to the final exam schedule in the USC *Schedule of Classes* 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.