



GEOL 316 - Igneous and Metamorphic Petrology **Spring 2025 ; Units: 4**

Lectures: Tuesdays & Thursdays, 11am – 12:20pm, ZHS 200

Labs: Fridays, 10am – 1pm, ZHS B65

Instructor: Dr. Noah Phillips

Office: ZHS 305

Office Hours: TBD based on student / instructor schedules

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Teaching Assistant:

Office: TBD

Office Hours: TBD

Contact Info: TBD

Course Description:

This course teaches students the dynamic processes which produce igneous and metamorphic rocks (for example, active volcanism and associated plumbing systems, continental collisions, rifting, subduction) and how to describe/analyze igneous and metamorphic rock mineralogies, textures, and chemistries to quantify the processes which produced individual rock types. Students will also learn how to use the igneous and metamorphic rock record to interpret the geologic history of terranes.

Learning Objectives:

By the end of this course, students will be able to:

- Understand the geologic processes which produce individual igneous and metamorphic rock types
- Accurately and precisely describe igneous and metamorphic rocks in hand sample and thin section
- Relate rock textures (observed in the field, hand samples, and thin sections) to the volcanic and/or metamorphic processes which produced them
- Use a combination of whole rock chemistry, mineral chemistry, and/or rock mineralogy to determine the pressures and temperatures metamorphic rocks were subjected to and/or the source of melts which produced igneous rocks, as well as the timing of these processes
- Relate metamorphic reactions in subduction zones to the production of magma and earthquakes
- Connect individual rock types to where they formed in relation to plate tectonic processes
- Combine knowledge of igneous and metamorphic processes to unravel the geologic history of an unknown suite of rocks

Prerequisite: Ideally, students will have taken *GEOL 315: Minerals and Earth Systems* before this course. Please let Noah know if this is not the case for you.

Course Notes, Readings, and Supplemental Materials

Lecture notes: Lecture PowerPoints will be made available online in Blackboard. Note that a slightly redacted version of the lecture notes may be given out prior to lecture (to facilitate in-class discussions) and that an updated version with all slides will be uploaded after class.

Textbook: This class has no required textbook; however, I highly recommend having a copy of the following textbook to read along with at your own pace:

- *Principles of Igneous and Metamorphic Petrology* (2nd edition), Winter. Prentice Hall, 2009.

Additionally, the following textbook (available online through the library) may prove a useful extra resource for the metamorphic section:

- *An Introduction to Metamorphic Petrology* (2nd edition), Yardley & Warren Cambridge University Press, 2020.

Readings: There will be four sets of readings with associated quizzes to be completed in Blackboard. The readings are meant to highlight active avenues of research in the fields of igneous and metamorphic petrology, methods employed in the labs, and to build competency in scientific reading and comprehension. Additional readings will be assigned (but not assessed) to supplement the lecture materials.

Additional Resources: John Brady has an excellent website with visualization tools for igneous and metamorphic plots, well described methodologies for producing plots, and overviews of igneous and metamorphic principles:

<https://www.science.smith.edu/~jbrady/petrology/index.php>

Field Excursions

The course will have two field trips. The field trips are learning experiences meant to highlight topics discussed in class. There will be a minor assignment associated with each field trip to engage participants and to ensure comprehension of the observed rocks / in-field discussions. The goal of the trips is **to learn** (not to be assessed): please ask lots of questions during the trips to both the instructor and TA. We are here to guide you through making field observations and to help connect rocks observed in the field to topics discussed in class.

Tentative dates for the field trips:

TBD

Grading Breakdown

Midterm	15% on February 15 th during class time
Final	15%
Readings	10%
Lab Assignments	25%
Field Trip Reports	10%
Final Project	20%
In-Class Exercises	5%

Description and Assessment of Assignments

Midterm and Final: Closed book exams on igneous (midterm) and metamorphic (final) processes. Note that while the final is not cumulative (*i.e.*, material taught after the midterm will mainly be tested), there may be a few questions which integrate concepts from both halves of the course. Details on the style of questions and length of the exam will be discussed in the review sessions before each exam.

Lab Assignments: Labs are due at the start of the following lab and must be handed in **prior to the lab** through Blackboard (*i.e.*, by 10am on the following Friday). Due dates and times will be

clearly written at the top of each lab. Late lab assignments are docked 10% / day (labs handed in after the following lab begins count as 1 day late) and will not be accepted any later than the Thursday following the due date.

Field Trip Reports: Field trip reports will consist of short “assignments” associated with the field trips. They will be completed in your field notebooks and handouts, and most of the assignment will be completed during the field trip (i.e., not much homework following trips, yay!). They will be due on the Thursday following the field trip.

Readings: Online quizzes associated with the readings (each worth 2.5%). These will be open for a week prior to the due-date, will be ~10 questions in length, and will predominantly consist of multiple choice and short answer (<2 sentences) questions, with one longer format (1-2 paragraph) question. I highly recommend completing them well before the due date as there will be no extensions for reading assignments.

In-Class Exercises: The course will include many in-class exercises to solidify understanding of taught subject matter. Again, these are learning experiences and will not be graded for content. Instead, six in-class assignments during the year (selected in advance, at random, by the instructor) will be used to assess participation, with each exercise worth 1% of the final grade (the sixth will serve as a bonus mark and/or as a built-in makeup for folks who miss one of the previous exercises).

Final Project: Students will work in groups of two to produce independent research on a suite of rocks and thin sections. Projects will be tailored to students’ interests in the course material to date, and Dr. Phillips will provide each group with a few papers to begin their research on the background of the project. Students will write a short research paper (AGU format) on their research and will present their projects on the final day of class. This is a unique opportunity to collect your own data on some of USC’s cutting edge research equipment! Timeframe for the project and grading scheme are as follows:

March 11: In-class discussion on project and potential topics

March 14: Distribute thin sections for final projects to groups during lab and assign readings

March 27, April 3, 10, Brief class discussions on progress / tips for

April 17: Rough draft of report due

Grade Breakdown: Final presentation: 10% ; Report 10%

Grading Scale

Course final grades will be determined using the following scale:

Letter grade	Corresponding numerical point range
A	90-100
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

Course Schedule

Tentative Lecture Schedule:

January 14:	Introduction to Petrology
January 16, 21:	Types of Volcanoes, Eruptions, and Volcanic Edifices
January 23:	Volcanic Rock Types and Textures
January 28:	Magma Chambers and the Inner Workings of Volcanoes
January 30:	Plutonic Rock Types and Textures
February 4:	The Mantle: Ultramafic Rocks and Archean Ultramafic Flows
February 6:	Thermodynamics and its Application to Melts
February 11:	Ridges, Hotspots: Mantle Derived Basaltic Melts
February 13:	Evolving Magmas: Formation of Intermediate and Felsic Melts
February 18, 20:	Our Dynamic Planet: Discriminating Tectonic Setting from the Rock Record
February 25:	Midterm Review
February 27:	Midterm
March 4	Introduction to Metamorphism
March 6:	Chemical Equilibrium & Disequilibrium
March 11:	Introduction to Analytical Techniques: XRD & SEM/EDS + Intro to Final Project
March 13:	Group Visit to Center for Nano-Imaging (XRD/EDS Data Collection)
March 16-23:	Reading Week
March 25:	Pressure-Temperature Conditions of Metamorphism
March 27:	Metamorphic Processes: Metabasites and the Metamorphic Facies
April 1: :	Introduction to Analytical Techniques: FTIR & Raman
April 3:	Group Visit to “Field to Nano Lab” +/- “Natural History Museum” (FTIR/Raman Data Collection)
April 8:	Metamorphic Processes: Metapelites
April 10:	Metamorphic Processes: Metapelites
April 15:	Metamorphic Processes: Marbles and Skarns
April 17:	Metamorphic Processes: Serpentinization and CO ₂ Sequestration
April 22:	Metamorphism and Past Plate Tectonics: P-T-t paths
April 24:	Final Project Presentation Discussion Session: What makes a great presentation?
April 29:	<i>Great Debates: Why Are Subduction Zone Rocks Hotter than Models?</i>
May 1:	Final Project Presentations

Tentative Reading Schedule:

Reading Set 1: InSAR: Technique and Applicability to Understanding Active Volcanism (Due Wednesday Jan 22 nd by 9pm)
Reading Set 2: <i>Great Debates: How Voluminous are Active Magma Chambers?</i> (Due Wednesday Feb 19 th by 9pm)
Reading Set 3: Pseudosection Modelling: Techniques and Applications (Due Wednesday March 26 th by 9pm)
Reading Set 4: <i>Great Debates: Why Are Subduction Zone Rocks Hotter than Models?</i> (Due Wednesday April 23 rd by 9pm)

Tentative Lab Schedule:

January 17:	Lab 1: Review of Optical Microscopy & Mineralogy
January 24:	Lab 2: Explosive Volcanic Deposits & Monitoring Volcanoes
January 31:	Lab 3: Volcanic Plumbing Systems: Intro to Plutonic Rocks
February 7:	Lab 4: The Mantle and Ancient Flows: Ultramafic Rocks
February 14:	Lab 5: Melts in Theory and Nature

February 21: Lab 6: Ridges, Hotspots, and Arcs Oh My! Discriminating Melt Sources and Settings Using Geochemistry
February 28: Midterm week – no lab
March 7: Lab 7: Introduction to Metamorphic Minerals and Rocks
March 14: Data Collection for Final Project
March 28: Lab 8: Greenschist, Amphibolite & Granulite Facies Metamorphism
April 4: Data Collection for Final Project
April 11: Lab 9: Marbles, Skarns & Serpentinities
April 18: Lab 10: Subduction Zone Metamorphism
April 25: Lab 11: Catalina

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 Policy

In this course, I encourage you to use artificial intelligence (AI)-powered programs to help you with **assignments that indicate the permitted use of AI**. You should also be aware that AI text generation tools may present incorrect information, biased responses, and incomplete analyses; thus they are not prepared to produce text that meets the standards of this course. To adhere to our university values, you must cite any AI-generated material (e.g., text, images, etc.) included or referenced in your work and provide the prompts used to generate the content. Using an AI tool to generate content without proper attribution will be treated as plagiarism and reported to the Office of Academic Integrity. Please review the instructions in each assignment for more details on how and when to use AI Generators for your submissions.

If found responsible for an academic violation, students may be assigned university outcomes, such as suspension or expulsion from the university, and grade penalties, such as an “F” grade on the assignment, exam, or in the course.]

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 students’ experience in the class. The process and intent of the end-of-semester evaluation should be provided. In addition, a mid-semester evaluation is recommended practice for early course correction. [Contact CET](#) for support in creating a mid-semester evaluation.

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.