

Igneous and Metamorphic Petrology



Above: Askja caldera, Iceland. Below, dikes and sills exposed at Pico do Arieiro, Madeira

Instructor:

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Course Objectives:

Petrology is the study of rocks: their origins and evolution.

In this course, you will thoroughly investigate the lifecycle of igneous and metamorphic rocks using many converging lines of evidence. You will ask, and learn to answer, questions like: What type of rock is this? What is its composition? What minerals are present and in what relative abundances?

What textures are visible in the rock? What are its macro- and microscopic characteristics? How did it form? Where did this rock originate and where was it ultimately found? How has the rock changed since its formation? Where else on earth do we find rocks with similar characteristics? Throughout it all, ask “why, Why, *WHY*!?” and “how do we know?” and “could there be another explanation?”

Meeting logistics:

Event	Location	Date and Time
Lecture	Van Wickle 15	Tuesday & Thursday, 9:30 am – 10:45 am
Lab	Van Wickle 15	Tuesday, 1:15 – 4:00 pm
Office hours	Van Wickle 1c or 101c	Thursday, 1:15 am – 4:00 pm Other days by drop-in or appointment

Learning outcomes:

- Describe, explain, and differentiate the compositional and physical layers of the Earth
- Identify basic minerals; understand relationships between their chemistry and occurrence
- Know basic igneous and metamorphic rock processes and types
- Relate rock processes to plate tectonics or other broad-scale earth processes
- Explain where, why and how specific igneous and metamorphic rock types are produced
- Skillfully acquire, interpret and access sound scientific data and information about the Earth

Talkin' rocks: I'm here for you! I'm very happy to discuss the course, assignments, your experience, and this dynamic planet of ours. My office hours are listed at the top of this syllabus, and I'm also happy to see you by appointment or drop-in (but let's talk about the "law of angles"). Please note that I will often hold my "office hours" in my research lab. I try to limit my time on email outside of standard business hours. Plan accordingly!

A typical day / the way I teach: I am a strong proponent of active learning and challenge-based learning. The majority of our shared class time will be dedicated to hands-on investigation, problem-solving exercises, demonstrations, discussions, and more. You will learn a great deal about geology; you will also improve your scientific literacy, critical thinking, and communication skills. This approach to teaching and learning has huge benefits, but it requires a great deal of participation, cooperation, engagement, and enthusiasm on your part.

Attendance: If you are healthy and it is safe for you to participate in face-to-face opportunities, I expect you to come to class and lab and participate fully. Be punctual. If you are unwell and your attendance will jeopardize the health and wellbeing of yourself and your community, I expect you to be responsible and stay at home. If you find that you need to miss excessive classes for health and wellness reasons, we will work together with your class Dean to develop a strategy for success.

Technology in the classroom: Please develop the habit of bringing a laptop and cellphone to lab (let me know ASAP if this poses a problem—we'll figure it out). However, please consider our classroom to be a *laptop and phone free space* during lecture (the use of tablets for note taking is acceptable). I will be very clear about times when laptops and phones may be used. Failure to cooperate will negatively impact my ability to teach and your ability to actively engage and participate. "The Daily" grade will be adjusted to reflect distracting use of screens.

Academic Accommodation: In compliance with Lafayette College policy and equal access laws, I am available to discuss appropriate academic accommodations that you may require as a student with a disability. Requests for academic accommodations need to be made during the first two weeks of the semester, except for unusual circumstances, so arrangements can be made. Students must register with the Office of the Dean of Advising and Co-Curricular Programs for disability verification and for determination of reasonable academic accommodations.

Moodle: We will use Moodle frequently—for communication, daily reading assignments, resource distribution, and assignment submissions. Please familiarize yourself with Moodle and develop a habit of checking it frequently. Please let me know if you have any questions or concerns.

Moodle Disclaimer: Moodle contains student information that is protected by the Family Educational Right to Privacy Act (FERPA). Disclosure to unauthorized parties violates federal privacy laws. Using Moodle will make student information visible to other students in this class. This information is protected by these federal privacy laws and must not be shared with anyone outside the class.

Federal Credit Hour Compliance: The work in this course is in full compliance with the federal definition of a four credit hour course. See the Registrar's Office web site for the full policy and practice statement.

Academic Honesty: Integrity is of paramount importance and I hold it in the highest regard. The official Lafayette policy is: *"To maintain the scholarly standards of the College and, equally important, the personal ethical standards of our students, it is essential that written assignments be a student's own work, just as is expected in examinations and class participation. A student who commits academic dishonesty is subject to a range of penalties, including suspension or expulsion. Finally, the underlying principle is one of intellectual honesty. If a person is to have self-respect and the respect of others, all work must be his/her own."* Any perceived breach of integrity will be reported to the head of the Department and to your class Dean.

AI Policy: Students are not allowed to use advanced automated tools (artificial intelligence or machine learning tools such as ChatGPT or Dall-E 2) on assignments in this course. Each student is expected to complete each assignment without substantive assistance from others, including automated tools. Any exceptions to this rule will be explicitly stated in class and in assignment instructions.

Textbook: Principles of Igneous and Metamorphic Petrology (2nd Edition) by John D. Winter (Prentice-Hall). Watch for Walla Walla references!

Photo: Columbia River Basalt at Palouse Falls, WA



Work Submission:

- The standard due date for all work, unless explicitly stated otherwise, is Monday by the end of business hours (5:00 pm via Moodle or to Dr. Carley's office).
- Standard labs and in-class activities with a take-home component submitted by the end of business hours on Friday (5:00 pm via Moodle or to Dr. Carley's office) will earn a 5 point early incentive bonus (exceptions explicitly stated).
- Late work will be accepted until graded work is returned to your classmates: 5% penalty if late on deadline day, plus an additional 25% penalty if submitted after that.
- Extra credit write-ups can be submitted via Moodle at any time before midnight on the last day of regularly-scheduled classes for Geology 307. Extra credit will be assessed at the end of the term.

Protected Privacy: You will be assigned a random 4 digit ID number to use on all paper submissions of work (exams, printed labs, etc.). Respect the anonymity of the number.

Work Return: You may pick up graded work (lab rubrics, exam and quiz scores, etc.) from the hanging files outside my office door, in a folder labeled with your anonymous ID number. You can view your graded exams in office hours (typically available one week after you take the exam).

Grade Communication: You are responsible for keeping track of your grades throughout the course of the semester. The value of each assignment is available in the "Assignment Overview and Grade Distribution" section of this syllabus. You may inquire about your grade in office hours at any point in the semester. Grades are not negotiable—take advantage of extra credit opportunities!

Grading policy and a breakdown of the numbers:

Excellent; Truly great work.		Good; High-quality work.			Sufficient; Baseline expectations met.			Insufficient; Room for improvement.		
A	A-	B+	B	B-	C+	C	C-	D+	D	D-
94%	90%	87%	84%	80%	77%	74%	70%	67%	64%	60%
These numbers indicate the minimum score that must be earned for each corresponding letter grade. Grades are firm (no rounding!) and non-negotiable. Take advantage of extra credit opportunities and the midterm exam meeting!										

Extra Credit: You may add a maximum of 5% extra credit towards your final grade (this is significant—take advantage!). All extra credit will be assessed and factored into your final grade at the end of the semester. The most common way to earn extra credit is to attend Geology seminars and other campus events (on a case-by-case basis). Attendance and appropriate participation will add 0.25% extra credit to your final grade. A short write up (2 pages, 1 inch margins, 1.5 spacing, size 11 font) can be submitted for a maximum of 0.75% extra credit towards your final grade. The write up must contain: (1) a summary of the lecture; (2) an overview of issues you found particularly interesting; and (3) questions you have related to the content of the lecture. Write-ups are due via Moodle by midnight on the last day of class of the semester.

Course schedule: This schedule is subject to change. Check Moodle frequently for up-to-date information.

Week	General topic	Significant dates and deadlines
01/26	Introduction to igneous petrology	
02/02	Magma: Origins and intrusions	
02/09	Magma: Eruptive styles and products	
02/16	Magma: Evolution and differentiation (Part 1)	
02/23	Magma: Evolution and differentiation (Part 2)	
03/02	Igneous world tour: Mid-ocean ridges	<i>Lego Lab due (Mon.)</i>
03/09	Igneous world tour: Ocean islands	<i>Extra credit lecture (Kirby 104, 7:30 pm); Midterm Exam (Thurs.)</i>
03/16	Spring Break	
03/23	Igneous world tour: Convergent margins	
03/30	Igneous world tour: Global trends, global comparisons	
04/06	Transition from igneous to metamorphic petrology	<i>Possible lab fieldtrip (weather dependent)</i>
04/13	Metamorphism: fundamentals	<i>Igneous World Tour due (Mon.)</i>
04/20	Metamorphism: mafic rocks	
04/27	Metamorphism of pelitic rocks	<i>Last opportunity for Midterm Exam meetings (Thurs.)</i>
05/04	Metamorphic wrap-up and final reflections	<i>Metamorphic exhibit proposal due (Thurs.) Last opportunity to submit extra credit or late work (Thurs.)</i>
Finals	Final exam date determined by the Registrar	

Grade breakdown and Assignment Overview

Category	Brief Description	%
The Daily	During lecture, you will brainstorm ideas, respond to questions, engage in discussion, and participate in hands-on activities. Questions may relate to <i>the assigned reading for the week</i> , content discussed in lecture, lab activities, rock or mineral specimens, etc. Notecards are typically worth 10 points; in-class activities are typically worth 20 points. You will receive partial credit for attendance and participation and full credit for punctuality and high quality responses. Your lowest scores, up to 20 possible points (e.g., two notecards or one activity) will be factored out of your final grade.	10
Standard Labs	“Standard Labs” will be weighted equally, unless otherwise indicated. Many of the activities conducted during lab periods will contribute to the Lego Lab, the Igneous World Tour, or the Metamorphic Exhibit Proposal. Project-associated lab activities will not be factored into this “Standard Lab” category.	10
Lego Lab Project	You will explore chemical differentiation using Legos to simulate a crystallizing magma body. This project will help you build necessary skills for the “Igneous World Tour.” You will: classify rocks and magma using bulk rock chemistry and mineral assemblages; use Excel to calculate and plot evolving chemistry; analyze and interpret geochemical plots; find and document hand samples that correspond to the rocks and minerals in your simulation. You will summarize your results in a concise, well-illustrated report.	10
Igneous World Tour Project	Together, we will explore mid-ocean ridges. You will then take personal responsibility for unique volcanic systems in (1) an ocean island setting, and (2) a subduction zone. This project will be the culmination of several labs and lectures in the igneous petrology unit of the class. You will present your results and interpretations in a well-illustrated WordPress website.	30
Metamorphic Exhibit Proposal	You will design an educational, content-rich, creative, and aesthetically-engaging exhibit for the Van Wickle museum related to metamorphic petrology. You will craft a compelling, persuasive, proposal that effectively lays out the vision for your exhibit, the value it will add to museum visitors, its petrological underpinnings, and the practicalities (materials, budget, upkeep, etc.) necessary to install and maintain your exhibit. You will share your proposal with classmates and engage in peer-review before presenting your proposal to members of the department.	10
Midterm Exam	This 75 minute exam may include short answer responses, labeling of figures and graphs, calculations, phase diagram and geochemical plot interpretation, and specimen work (ID, interpretation). Exam 1 will include content through compatibility and partitioning. You may complete the exam using pencil before switching to pen and making corrections for partial credit using a handwritten reference notecard. You can earn back partial credit (up to 30% of missed points) in a post-exam meeting.	15
Final Exam	The final exam will follow the same general format as Exam 1. It will be written for a two hour period. The final will be cumulative, and will consist of ~25% igneous and ~75% metamorphic concepts. There will be no post-exam meeting following the final exam.	15

