IGNEOUS & METAMORPHIC PETROLOGY

GEOS 4333/5333 - Spring 2024 Syllabus

LECTURE: Monday and Wednesday 9:40-10:30 AM, GEAR 008

LAB: Thursday 2:00-3:50 PM, GEAR 008

Igneous Professor: Adriana Potra Office: GEAR 022 Email: potra@uark.edu
Office Hours: Monday and Wednesday 1-3 PM

Metamorphic Professor: Gregory Dumond Office: GEAR 021 Email: gdumond@uark.edu
Office Hours: Tuesday 1-4 PM in GEAR 021, Friday 1-3 PM in the CRZ

Required Textbook: *Winter, J. D. (2013). Principles of Igneous and Metamorphic Petrology. 2nd ed., 744 p., Pearson.*
https://www.geoshare.in/principles-of-igneous-and-metamorphic-petrology-by-jd-winter/

PURPOSE. This senior/graduate-level geology major course focuses on the origin and evolution of igneous and metamorphic rocks in a variety of plate tectonic settings. The igneous half of the class explores the differentiation and emplacement of both mantle- and crustal-derived magmas. The metamorphic half of the class explores the causes of metamorphism, their impacts on Earth's crust, and how we derive this data from the rock record. The class emphasizes theoretical and practical approaches to understanding prograde and retrograde metamorphism, the role of fluids, the role of melting, common geochemical projections + petrogenetic grids + phase diagrams, elementary thermodynamics, and phase equilibria modelling.

LEARNING GOALS. By the end of the course:

(1) Confidently describe and characterize igneous and metamorphic rocks using hand samples and optical microscopy to infer the processes responsible for their occurrence.

(2) Classify igneous and metamorphic rocks using the most common approaches and understand why these approaches are used.

(3) Qualitatively and quantitatively analyze common geochemical systems using graphical plotting, projections, grids, and phase diagrams to infer how crystalline rocks form and evolve.

(4) Demonstrate a basic understanding of the plate tectonic settings and mechanisms for producing the most common types of igneous and metamorphic rocks.

EVALUATION.

	Undergraduate (700 points)	**Graduate (900 points)**
Igneous Exam 1	100 points	100 points
Igneous Exam 2	100 points	100 points
Metamorphic Exam 1	100 points	100 points
Metamorphic Exam 2	100 points	100 points
10 – Lab Exercises with Problem Sets	300 points (30 points each)	300 points (30 points each)
* Final Project		200 points

Undergrade Grade:	**A = 630 – 700**	**B = 560 – 629**	**C = 490 – 559**	**D = 420 – 489**	**F < 420**
Graduate Grade:	**A = 810 – 900**	**B = 720 – 809**	**C = 630 – 719**	**D = 540 – 629**	**F < 540**

* **Final Project:** Graduate students will choose a suite of rocks and report their findings and interpretations related to petrogenesis and tectonic history (if they choose a suite of tectonites). The project will consist of a short (8-10 page) paper and brief PowerPoint presentation given to the class.

Late Work Policy: Labs and problem sets turned in after the due date will be docked one letter grade.

LECTURE OUTLINE. *(Below subject to change at the teachers' discretion.)*

Class	Date	Topic	Readings
01	W 1/17	Fundamental Concepts	Chapter 1
02	M 1/22	Classification of Igneous Rocks	Chapter 2
03	W 1/24	Textures of Igneous Rocks	Chapter 3
04	M 1/29	Igneous Structures and Field Relationships	Chapter 4
05	W 1/31	An Introduction to Thermodynamics	Chapter 5
06	M 2/5	Phase Diagrams	Chapter 6
07	W 2/7	Chemical Petrology I	Chapter 8
Exam	M 2/12	**IGNEOUS EXAM 1**	
08	W 2/14	Chemical Petrology II	Chapter 9
09	M 2/19	Mantle Melting Magma Diversity	Chapter 10 Chapter 11
10	W 2/21	Mid-Ocean Ridge Volcanism	Chapter 14
11	M 2/26	Oceanic Intraplate Volcanism Continental Flood Basalts	Chapter 13 Chapter 15
12	W 2/28	Subduction-Related Igneous Activity	Chapter 16
13	M 3/4	Subduction-Related Igneous Activity	Chapter 17
14	W 3/6	Granitoid Rocks	Chapter 18
Exam	Th 3/7	**IGNEOUS EXAM 2** (2:00 pm – 3:50 pm during lab time)	
15	M 3/11	Metamorphism and Classification	Chapter 21-22
16	W 3/13	Metamorphic Textures and Tectonites	Chapter 23
March 18-22: *Spring Break*			
17	M 3/25	Porphyroblasts, Fabrics, and Geochronology	Chapter 23
18	W 3/27	Equilibrium Assemblages and Gibbs Phase Rule	Chapter 24
19	M 4/1	Chemographic Projections, Metamorphic Facies	Chapter 24-25
20	W 4/3	Metamorphism of Mafic Rocks	Chapter 25
Exam	M 4/8	**METAMORPHIC EXAM 1**	
21	W 4/10	Metamorphic Reactions I	Chapter 26
22	M 4/15	Metamorphic Reactions II	Chapter 26
23	W 4/17	Thermobarometry	Chapter 27
April 21-23: *Geological Society of America North-Central/South-Central Section Meeting*			
24	W 4/24	Thermodynamics and Phase Equilibria Modeling. http://www.perplex.ethz.ch/	Chapter 27, Handouts
25	M 4/29	Metamorphism of Pelitic Sediments vs. Mafic Rocks	Chapter 28
26	W 5/1	Partial Melting, Migmatites, and Granulites	Chapter 28
Friday, May 5: *Reading Day – No Class*			
Exam	**METAMORPHIC EXAM 2, GEAR 008 = ??:??-??:?? AM, ?day, May ?, 2024**		

LAB OUTLINE. *(Below is subject to change at the teacher's discretion.)*

Lab	Date	Topic
1	Th 2/1	**Introductory Lab #1:** Optical Microscopy Refresher, Mineral Identification, and Igneous Rock Classification
2	Th 2/8	**Igneous Lab #2:** Melting the Mantle to Make the Most Abundant Rock on the Earth's Surface – Mid-Ocean Ridge Basalt
3	Th 2/15	**Igneous Lab #3:** Fractional Crystallization and Cumulates – The View from Layered Igneous Intrusions
4	Th 2/22	**Igneous Lab #4:** Continental Arc Rocks
5	Th 2/29	**Igneous Lab #5:** The Granite Perspective on the Differentiation of Continental Crust
6	Th 3/14	**Metamorphic Lab #6:** Metamorphic Minerals, Rock Identification + Classification
March 18-22: *Spring Break*		
7	Th 3/28	**Metamorphic Lab #7:** Metamorphic Textures, Porphyroblasts, and Tectonites
8	Th 4/4	**Metamorphic Lab #8:** Relative and Absolute Timing of Mineral Growth/Alteration, Prograde vs. Retrograde Reactions, Open vs. Closed System Processes (Presence or Absence of Fluid, Melt, etc.)
9	Th 4/11	**Metamorphic Lab #9:** Phase Equilibria Modelling with **Perple_X**
10	Th 4/18	**Lab #10:** Introduction to Petrochronology; Final Project Presentations

COOL STUFF!

- https://www.virtualmicroscope.org/
- https://www.zeiss.com/microscopy/int/cmp/rwm/21/adapts-registration.html
- https://sketchfab.com/sgfrance/collections

SYLLABUS INFORMATION REQUIRED BY THE UNIVERSITY

EXCUSED ABSENCES are: (1) illness of the student, (2) serious illness or death of a member of the student's immediate family or other family crisis, (3) University-sponsored activities for which the student's attendance is required by virtue of scholarship or leadership/participation responsibilities, (4) religious observances, (5) jury duty or subpoena for court appearance, and (6) military duty. The instructor has the right to require that the student provide appropriate documentation for any absence for which the student wishes to be excused. Only students with excused absences will have access to lecture and lab recordings.

STUDENT SUCCESS AND SUPPORT: U of A Cares is a supportive partnership with students linking them with resources that help them overcome barriers on their path to success, both personal and educational. See https://uofacares.uark.edu/ *and* https://success.uark.edu/.

ACCOMMODATION OF DISABILITIES: University of Arkansas Academic Policy Series 1520.10 requires that students with disabilities are provided reasonable accommodations to ensure their equal access to course content. If you require accommodations, contact me privately and/or the Center for Educational Access (CEA) at the beginning of the semester to arrange for necessary accommodations. You must first verify your eligibility for accommodations through the Center for Educational Access (contact 479–575–3104 or visit https://cea.uark.edu/ for more information on registration procedures).

TECHNOLOGY POLICY: The use of phones, tablets, laptops, etc., for purposes other than note taking or learning geology is not allowed during class. **Violation of this policy more than once will result in you being dismissed from class for the day!**

INCLEMENT WEATHER: If the University is open, class will meet. Call the Weather Hotline when in doubt at (479) 575-7000. I will follow-up with a class-wide email notifying you of the situation. See UA policy @ http://emergency.uark.edu/14701.php

ACADEMIC HONESTY STATEMENT: "As a core part of its mission, the University of Arkansas provides students with the opportunity to further their educational goals through programs of study and research in an environment that promotes freedom of inquiry and academic responsibility. Accomplishing this mission is only possible when intellectual honesty and individual integrity prevail. Each University of Arkansas student is required to be familiar with and abide by the University's 'Academic Integrity Policy' which is found at https://honesty.uark.edu/policy/index.php Students with questions about how these policies apply to a particular course or assignment should immediately contact their instructor."

SEXUAL ASSAULT AND DOMESTIC OR DATING VIOLENCE: If you are in danger, dial 9-1-1. For confidential help, call the University Victim Advocate at (479) 575-7252. The University of Arkansas prohibits sexual harassment or acts of sexual assault, domestic violence, dating violence, and stalking committed against students, employees, campus visitors, and other persons who use University facilities. Sexual assault is any form of sexual activity where consent is not consciously and voluntarily given. Anyone can be a victim of sexual assault. Sexual harassment is prohibited by University policy, Title VII of the Civil Rights Act of 1964, and Title IX of the Education Amendments of 1972. Sexual assault is a crime. Important sexual assault information and guidance is available at: https://report.uark.edu/sexual-assault-or-domestic-dating-violence/index.php *and* respect.uark.edu.

EMERGENCY PROCEDURES: See the web at https://safety.uark.edu/emergency-preparedness/

SEVERE WEATHER (e.g., Tornado Warning):

- Follow the directions of the instructor or emergency personnel.
- Seek shelter in the basement or an interior room or hallway on the lowest floor, putting as many walls as possible between you and the outside.
- Get to lowest floor in multi-story buildings. If not possible, go to hallway near center of building.
- Stay in the center of the room, away from exterior walls, windows, and doors.

VIOLENCE or ACTIVE SHOOTER (C.A.D.D.):

- **C**ALL. 9-1-1
- **A**VOID. Evacuate to safe area outside building, if possible. Follow directions of police officers.
- **D**ENY. Barricade door with desks, chairs, bookcases, etc. Move to a place inside the room where you are not visible. Turn off lights and remain quiet. Remain there until told by police it is safe.
- **D**EFEND. Use desks, chairs, cell phones, or whatever is immediately available to distract and/or defend yourself and others from attack.

CONCEALED CARRY ON CAMPUS: Handguns are only allowed on campus (including all classrooms) to the extent specifically authorized by state law. Everyone who lawfully possesses a handgun and an enhanced carry permit must keep the handgun concealed from public view and is responsible for carrying the handgun in a safe manner. If the concealed handgun is in a personal carrier such as a backpack, purse, or handbag, the carrier must remain within arm's reach. During this class, you may be required to engage in activities that require you to be physically separate from your belongings and you should plan accordingly. Any student who violates the concealed carry laws while on campus may be subject to criminal prosecution and/or discipline by the University, up to and including dismissal. If you observe someone displaying a handgun or other weapon on campus, it should be reported to the University of Arkansas Police Department. For more information, please go to https://safety.uark.edu/.