Course Change Request

Date Submitted: 01/26/25 11:53 pm

Viewing: GEOL 603 : Geochemistry

Last approved: 04/05/22 5:18 am

Last edit: 02/17/25 11:19 am

Changes proposed by: bklinger

Catalog Pages referencing this course

Department of Atmospheric, Oceanic and Earth Sciences

Geology (GEOL)

In Workflow

1. **AOES Curriculum Committee**
2. **AOES Chair**
3. **SC Curriculum Committee**
4. SC Assistant Dean
5. Assoc Provost-Graduate
6. Registrar-Courses
7. Banner

Select modification type:

Substantial

Approval Path

1. 01/27/25 10:09 am Barry Klinger (bklinger): Approved for AOES Curriculum Committee
2. 01/27/25 11:46 am Mark Uhen (muhen): Approved for AOES Chair

History

1. Apr 5, 2022 by Geoff Gilleaudeau (ggilleau)

Are you completing this form on someone else's behalf?

No

Effective Term: Fall 2025

Subject Code: GEOL - Geology **Course Number:** 603

Bundled Courses:

Is this course replacing another course? No

Equivalent Courses:

Catalog Title: Geochemistry

Banner Title: Geochemistry

Will section titles vary by semester? No

Credits: 4 ~~3~~

Schedule Type: Lecture w/Lab

Hours of Lecture or Seminar per week: 2.5 ~~3~~

Hours of Lab or Studio per week: 2.75

Repeatable: May only be taken once for credit (NR)
GRADUATE ONLY

Default Grade Mode: Graduate Regular

Recommended Prerequisite(s):
An undergraduate degree in physical or natural sciences, including at least one semester of chemistry, introductory physical geology, and preferably, mineralogy, or permission of instructor.

Recommended Corequisite(s):

Required Prerequisite(s) / Corequisite(s) (Updates only):

Registrar's Office Use Only - Required Prerequisite(s)/Corequisite(s):

And/Or	(	Course/Test Code	Min Grade/Score	Academic Level	)	Concurrency?

Registration Restrictions (Updates only):

Registrar's Office Use Only - Registration Restrictions:

Field(s) of Study:

Class(es):

Include

Limited to students with a class of Advanced to Candidacy. (SCRRCLS_ONLY_DC)

Limited to students with a class of Graduate. (SCRRCLS_ONLY_GR)

Limited to students with a class of Non Degree (SCRRCLS_ONLY_ND)

Limited to students with a class of Junior Plus (SCRRCLS_ONLY_JP)

Limited to students with a class of Senior Plus (SCRRCLS_ONLY_SP)

Level(s):

Degree(s):

Exclude

Non-Degree Undergraduate Degree students may not enroll. (SCRRDEG_NO_NDU)

School(s):

Catalog Description:

Lecture and laboratory course that covers stable and radiogenic isotopes, the geochemistry of rocks, and mineral, aqueous, atmospheric, and organic geochemistry. Laboratory is focused upon geochemical techniques and analytical approaches with a focus on production, visualization, and interpretation of a wide array of geochemical data types. ~~Includes stable isotope, crystal, water, and organic geochemistry; geochronology; and geochemistry of rocks.~~

Justification:

Summary of Changes: Add weekly laboratory to course, change course credit from 3 to 4, and change catalog description from:

Includes stable isotope, crystal, water, and organic geochemistry; geochronology; and geochemistry of rocks.

To:

Lecture and laboratory course that covers stable and radiogenic isotopes, the geochemistry of rocks, and mineral, aqueous, atmospheric, and organic geochemistry. Laboratory is focused upon geochemical techniques and analytical approaches with a focus on production, visualization, and interpretation of a wide array of geochemical data types.

Why: We would like to add a lab to the existing Geochemistry course so that our majors may advance their understanding of chemistry within the context of the earth system, while also developing skills relevant to

geochemical careers. Much of practical geochemistry involves generating, manipulating, and visualizing data from a range of earth materials. The addition of a lab allows the students to build a deeper understanding of the nuances of geochemical sampling, data production, and data interpretation through experiential learning. The lab component will familiarize students with operation of common geochemical instrumentation such as our portable x-ray fluorescence device and a stable isotope mass spectrometer, for which students will learn to prepare samples. To accommodate the addition of the lab, a student learning objective has been added: #11) Recall the different analytical approaches by which geochemical data is obtained.

Lab Project: The lab will include a 3-week project where students will pick from one of three potential projects where we as a class will conduct a full geochemical investigation, from the initial sampling to sample preparation, analysis, data visualization, and interpretation. This project, in conjunction with the other laboratory exercises, will give students experience working with real data and instrumentation, thus developing career marketable skills.

Resource Requirements: There will not be a textbook required for the lab, as the laboratory exercises and materials needed each week will be provided by the instructor. Prof. Brittany Hupp will teach the lab in addition to the lecture in Year 1, however a GTA will be teach the lab in future years. The lab will take place on Fairfax Campus (Room 1309 or an equivalent space for working with sediment/rock core material) and AOES research lab spaces will be used sparingly if needed (e.g., to access larger instrumentation).

GEOL 603 serves as an elective for the Earth Systems Science MSc degree.

Does this course cover material which crosses into another department? Yes

Impacted Departments:

Department
CHEM - Chemistry & Biochemistry
ESP - Environmental Science & Policy

Learning Outcomes:

Upon successful completion of this course, students will be able to:
1. Define and make calculations using geochemical variables.
2. Describe the origin, behavior, and distribution of elements on Earth.
3. Understand the principles of chemical bonds and the chemical structure of silicate minerals.
4. Recall geochemical thermodynamic laws, conduct calculations relevant to thermodynamics, and interpret T-P diagrams.
5. Interpret major and trace element data to constrain the evolution of Earth's mantle and crust in relation to plate tectonics.
6. Describe the mechanisms of radioactive decay and its application to geochronology and tracer geochemistry using common radioactive isotope systems employed in the geosciences.
7. Recall the principles of stable isotope geochemistry and interpret stable isotope records as they apply to the hydrologic system and evolution of the ocean-atmosphere-biosphere system.
8. Conduct equilibrium speciation calculations of aqueous solutions and predict changes in the carbonate system.
9. Use information on geochemical reaction pathways and earth-surface physical processes to understand low-temperature geochemical processes such as redox reactions, sediment diagenesis, chemical weathering, and organic matter decomposition.
10. Predict changes in fluxes associated with global biogeochemical cycles and interpret box models of geochemical systems.
11. Recall the different analytical approaches by which geochemical data is obtained.
12. Critically evaluate published literature of geochemical research.
13. Formulate a testable earth science question that can be investigated using geochemical methods. ~~To use basic and advanced principles of geochemistry to analyze natural processes on Earth.~~

Will this course be scheduled as a cross-level cross listed section? Yes

Please use the Additional Attachments button to attach two syllabi for review, one undergraduate and one graduate, preferably as separate documents. These should be provided in order to demonstrate the difference in expectations and assessments for undergraduates and graduates taking the course.

Attach Syllabus
~~GEOL 603 Geochemistry_revFeb25.pdf~~
GEOL603_syllabus_withlab_grad_v2.pdf

Additional Attachments
GEOL403_syllabus_withlab_undergrad_v2.pdf

Specialized Course Categories:

Additional Comments:

Reviewer Comments

Key: 17534

GEOL 603: GEOCHEMISTRY, SPRING 2025

Artwork by Alex Sessions

COURSE INFORMATION

Instructor: Dr. Brittany Hupp (she/her/hers)
Contact Information: bhupp@gmu.edu
Office Hours: W 2:00 to 3:00 pm or by appointment; Exploratory Hall 3454
Lectures: Mondays & Wednesdays, 9:00 to 10:15 am
Lab: TBD
Class Location: Exploratory Hall 1309

COURSE CATALOGUE DESCRIPTION

Lecture and laboratory course that covers stable and radiogenic isotopes, the geochemistry of rocks, and mineral, aqueous, atmospheric, and organic geochemistry. Laboratory is focused upon geochemical techniques and analytical approaches with a focus on production, visualization, and interpretation of a wide array of geochemical data types.

RECOMMENDED CLASS TEXTS*:

- *Chemical Fundamentals of Geology and Environmental Geoscience*, 3rd Edition, Robin Gill, ISBN: 978-0-470-65665-5 → A free e-copy can be downloaded from the GMU library website.
- *Principles of Environmental Geochemistry*, Nelson Eby, ISBN 10: 1-4786-3164-3 → A physical copy of this book can be found in the GMU Fenwick Library.

*Additional readings will be added to the course website as needed.

Recommended Prerequisites

An undergraduate degree in physical or natural sciences, including at least one semester of chemistry, introductory physical geology, and preferably, mineralogy, or permission of instructor.

Student Learning Objectives

Upon successful completion of this course, students will be able to:

1. Define and make calculations using geochemical variables.
2. Describe the origin, behavior, and distribution of elements on Earth.
3. Understand the principles of chemical bonds and the chemical structure of silicate minerals.
4. Recall geochemical thermodynamic laws, conduct calculations relevant to thermodynamics, and interpret T-P diagrams.
5. Interpret major and trace element data to constrain the evolution of Earth's mantle and crust in relation to plate tectonics.
6. Describe the mechanisms of radioactive decay and its application to geochronology and tracer geochemistry using common radioactive isotope systems employed in the geosciences.
7. Recall the principles of stable isotope geochemistry and interpret stable isotope records as they apply to the hydrologic system and evolution of the ocean-atmosphere-biosphere system.
8. Conduct equilibrium speciation calculations of aqueous solutions and predict changes in the carbonate system.
9. Use information on geochemical reaction pathways and earth-surface physical processes to understand low-temperature geochemical processes such as redox reactions, sediment diagenesis, chemical weathering, and organic matter decomposition.
10. Predict changes in fluxes associated with global biogeochemical cycles and interpret box models of geochemical systems.
11. Recall the different analytical approaches by which geochemical data is obtained.
12. Critically evaluate published literature of geochemical research.
13. Formulate a testable earth science question that can be investigated using geochemical methods.

Course Structure

This course is divided into four major units each spanning ~3 weeks:

- Introduction to Geochemistry & Geochemistry of the Solid Earth
- Isotope Geochemistry
- Geochemistry of the Hydrosphere & Atmosphere
- Geochemistry of the Surficial Earth

Your course grade is determined by successful completion of the follow assignment types, which are summarized in the table below:

1. **Laboratory Exercises:** Weekly laboratory exercises will compliment weekly lecture topics and provide students experience in using geochemical instrumentation, data production, and data manipulation, visualization, and interpretation. There will be a total of 13 laboratory exercises which collectively account for 32% of your grade. *The laboratory exercises are*

meant to provide students experience working with and interpreting real data to develop skills relevant to the careers in the geologic workforce, improve understanding of course topics, and provide practice doing common geochemical calculations.

2. **Unit Exams**: There will be an exam at the end of every unit, with each exam accounting for 12.5% of your final grade. Exams will be "closed book". However, a list of potential exam questions will be provided 1 week before the exam to encourage students to study and solidify their understanding of exam topics. *This approach provides students the opportunity to have more control over their potential for success in this course and encourages long-term retention of course topics.*

To differentiate the graduate level section of this course from the undergraduate section, graduate students must also complete paper reading reviews and a research proposal and presentation (described in further detail below).

3. **Paper Readings & Reviews**: For each unit, students will be required to find, read, and critically evaluate one peer-reviewed, published research paper relevant to at least one topic being covered within the unit. The template to be used for each review is provided on the course website. You are encouraged to read over the template before you start reading your paper of choice. Each unit paper review is due at the start of the following unit and is worth 2% of your final grade. *The paper readings and reviews are meant to be useful to students' thesis research and/or to provide insight and experience into how to critically review (and thoroughly write your own) geochemical research paper.*
4. **Research Proposal & Presentation:** For your final assessment of the semester, you will need to write and present an original, short (5 pages) research proposal which aims to answer a question using geochemistry. Your leading research question can be on any topic that can be addressed using geochemical methods. You are welcome to also have your research proposal be related to your thesis or dissertation research. This project accounts for 10% of your final grade, with the presentation portion occurring during our final exam period.
5. **Bonus!** There are two potential bonus opportunities with directions posted to Blackboard. Each bonus activity may be completed up to 3 times, with the potential of each bonus assignment raising your total final grade by 0.5% (for a maximum potential grade increase of 3.0% upon high-quality completion of up to 6 bonus activities). You can find more information on bonus grading and requirements in the activity directions. All bonus assignments must be turned in by midnight on the last day of classes for the semester, May 5th.

Assignment Type	Graduate % of Total Grade
Unit Exams (4)	50% (12.5% each)
Laboratory Exercises (13)	32%
Research Proposal & Presentation	10%
Paper Readings & Reviews (4)	8% (2% each)
Total	100%

Final Grade Scale

A+ = 97 – 100%	B+ = 87 – 89%	C+ = 77 – 79%	D = 60 – 69%
A = 93 – 96%	B = 83 – 86%	C = 73 – 76%	F = 0 – 59%
A- = 90 – 92%	B- = 80 – 82%	C- = 70 – 72%	

Course Policies

Attendance: Attendance at all scheduled lecture sections is required to achieve the requisite level of knowledge in this course.

Expectations for time spent outside of class: Please allot two hours per class meeting outside of class time work on problem sets and reading reviews, study for exams, and complete readings.

Technology requirements: Access to a working computer with a strong internet connection is required for course work done outside of class. If you have a laptop, please bring it to each class meeting. Microsoft Excel software is required to complete course problem sets and can be downloaded for free; read more about Excel installation here: https://its.gmu.edu/service/microsoft365apps/. You will also need access to a basic scientific calculator.

Use of technology: During class, please be respectful of our time together and do not engage in activities that are unrelated to class. Cell phones may be left on but muted and used for emergencies only.

Names and Pronouns: I will gladly honor your request to address you by your preferred name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes.

Late Policy: All assignments are due at their assigned due dates unless an alternative arrangement has been made. In general, each student is allowed one "freebie" extension of 3 days for one assignment per semester. Beyond the freebie extension, grades earned for work turned in late will be reduced by 25% each set of 3 days it is late (e.g., an assignment turned late will have the grade reduced by 25%, whereas an assignment 3 to 5 days late will have the grade earned reduced by 50%.) If there are circumstances that prevent you from turning in an assignment on time, please contact me before an assignment is late so that we may establish an alternative timeline.

Communication Plan: Email is the best way to get in touch with me. If you send me an email, I will respond within 2 business days. *Please note, I do my best not to read or respond to emails past 6 pm.* I am also reachable in-person before/after class and during office hours. If you would like to meet at an alternative time in person or via zoom, feel free to reach out and we can work together to find a different time to meet.

COURSE SCHEDULE

Unit	Class Date	Day	Lecture Topic	Helpful Reading	Lab Topic
1. Introduction & Geochemistry of the Solid Earth	Jan. 22	W	Intro to Class		No Lab
	Jan. 27	M	Behavior, Distribution, & Origin of the Elements	Gill Ch. 6 & 11	X-ray Safety Training & Data Basics
	Jan. 29	W	Crystal Chemistry & Mineral Reactions	Gill Ch. 7, 8	
	Feb. 3	M	Thermodynamics	Gill Ch. 1, 2	Crystal Chem., X-ray Diffraction & Mineral Identification
	Feb. 5	W	Thermodynamics (continued)	Gill Ch. 2	
	Feb.10	M	Chemical Equilibria & Phase Diagrams	Gill Ch. 2	Chemical Equilibria & Phase Diagrams
	Feb. 12	W	Geochemistry of the Solid Earth	Gill Ch. 11; White Ch. 11*	
	Feb. 17	M	**Unit 1 Exam**		Chemistry of Igneous Rocks
2. Isotope Geochemistry	Feb. 19	W	Introduction to Isotopes	White Ch. 9*; Gill Ch. 10	
	Feb. 24	M	Stable Isotopes I	White Ch. 9*; Gill Ch. 10	Stable Isotopes
	Feb. 26	W	Stable Isotopes II & Clumped Isotopes	White Ch. 9*; Gill Ch. 10	
	Mar. 3	M	Radiogenic Isotopes I	White Ch. 8*; Gill Ch. 10	Radiogenic Isotopes as Tracers & Timekeepers
	Mar. 5	W	Radiogenic Isotopes II & Cosmogenic Isotopes	White Ch. 8*; Gill Ch. 10	
	Mar 10th-14th: Spring Break				
	Mar. 17	M	**Unit 2 Exam**		Class Project: Field Trip/Sampling
3. Geochemistry of the Hydrosphere & Atmosphere	Mar. 19	W	Atmospheric Chemistry	Misra, Ch. 13*	
	Mar. 24	M	Evolution of the Atmosphere	Misra, Ch. 13*	Class Project: Sample Prep. & Analysis
	Mar. 26	W	Seawater Chemistry I	Eby Ch. 10	
	Mar. 31	M	Seawater Chemistry II	Eby Ch. 10	Class Project: Data Visualization & Interpretation
	Apr. 2	W	Aqueous Geochemistry I	Eby Ch. 2 & 3; Gill Ch. 4	
	Apr. 7	M	Aqueous Geochemistry II	Eby Ch. 2 & 3; Gill Ch. 4	Seawater Chemistry
	Apr. 9	W	Aqueous Geochemistry II	Eby Ch. 2 & 3; Gill Ch. 4	
	Apr. 14	M	**Unit 3 Exam**		Aqueous Geochemistry
4. Geochemistry of the Surficial Earth	Apr. 16	W	Redox	Eby Ch. 4	
	Apr. 21	M	Chemical Weathering	Eby Ch. 9	Redox, Chemical Weathering, & Organic Matter
	Apr. 23	W	Organic Matter	Eby Ch. 5	
	Apr. 28	M	Biogeochemical Cycles	---	Paleoenvironmental Reconstructions
	Apr. 30	W	Paleoenvironmental Proxies	---	
	May. 5	M	**Unit 4 Exam**		No Lab
	Research Proposal Presentations: Monday, May 12th, 7:30-10:30 am				

*Indicates chapter will be uploaded to Blackboard

MASON POLICY GUIDELINES

These university and class policies are important to understand:

Disability Accommodations

Disability Services at George Mason University is committed to upholding the letter and spirit of the laws that ensure equal treatment of people with disabilities. Under the administration of University Life, Disability Services implements and coordinates reasonable accommodations and disability-related services that afford equal access to university programs and activities. Students can begin the registration process with Disability Services at any time during their enrollment at George Mason University. If you are seeking accommodations, please visit http://ds.gmu.edu/ for detailed information about the Disability Services registration process. Disability Services is located in Student Union Building I (SUB I), Suite 2500.
Email: ods@gmu.edu | Phone: (703) 993-2474
Office of Disability Services: http://ods.gmu.edu

Academic Integrity

The integrity of the University community is affected by the individual choices made by each of us. Mason has an Honor Code with clear guidelines regarding academic integrity. Three fundamental and simple principles to follow at all times are that: (1) all work submitted be your own; (2) when using the work or ideas of others, including fellow students, give full credit through accurate citations; and (3) if you are uncertain about the ground rules on a particular assignment, ask for clarification. No grade is important enough to justify academic misconduct. Plagiarism means using the exact words, opinions, or factual information from another person without giving the person credit. Writers give credit through accepted documentation styles, such as parenthetical citation, footnotes, or endnotes. Paraphrased material must also be cited, using the appropriate format for this class. A simple listing of books or articles is not sufficient. Plagiarism is the equivalent of intellectual robbery and cannot be tolerated in the academic setting. If you have any doubts about what constitutes plagiarism, please see me.

If only your name appears on an assignment, your professor has the right to expect that you have done the work yourself, fully and independently. Mason is an Honor Code university; please see the Office for Academic Integrity for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously, and violations are treated gravely. What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else's work in an aspect of the performance of that task, you will give full credit in the proper, accepted form.

Diversity and Inclusion

George Mason University promotes a living and learning environment for outstanding growth and productivity among its students, faculty and staff. Through its curriculum, programs, policies, procedures, services and resources, Mason strives to maintain a quality environment for work, study and personal growth.

An emphasis upon diversity and inclusion throughout the campus community is essential to achieve these goals. Diversity is broadly defined to include such characteristics as, but not limited to, race, ethnicity, gender, religion, age, disability, and sexual orientation. Diversity also entails

different viewpoints, philosophies, and perspectives. Attention to these aspects of diversity will help promote a culture of inclusion and belonging, and an environment where diverse opinions, backgrounds and practices have the opportunity to be voiced, heard and respected.

The reflection of Mason's commitment to diversity and inclusion goes beyond policies and procedures to focus on behavior at the individual, group and organizational level. The implementation of this commitment to diversity and inclusion is found in all settings, including individual work units and groups, student organizations and groups, and classroom settings; it is also found with the delivery of services and activities, including, but not limited to, curriculum, teaching, events, advising, research, service, and community outreach.

Acknowledging that the attainment of diversity and inclusion are dynamic and continuous processes, and that the larger societal setting has an evolving socio-cultural understanding of diversity and inclusion, Mason seeks to continuously improve its environment. To this end, the University promotes continuous monitoring and self-assessment regarding diversity. The aim is to incorporate diversity and inclusion within the philosophies and actions of the individual, group and organization, and to make improvements as needed.

Sexual Harassment, Sexual Misconduct, and Interpersonal Violence

Notice of mandatory reporting of sexual or interpersonal misconduct: As a faculty member, I am designated as a "Non-Confidential Employee," and must report all disclosures of sexual assault, sexual harassment, interpersonal violence, stalking, sexual exploitation, complicity, and retaliation to Mason's Title IX Coordinator per University Policy 1202. If you wish to speak with someone confidentially, please contact one of Mason's confidential resources, such as Student Support and Advocacy Center (SSAC) at 703-380-1434 or Counseling and Psychological Services (CAPS) at 703-993-2380. You may also seek assistance or support measures from Mason's Title IX Coordinator by calling 703-993-8730 or emailing titleix@gmu.edu.

Privacy

Students must use their MasonLive email account to receive important University information, including messages related to this class. Please see http://masonlive.gmu.edu for more information.