Intro to Geochemistry EPSc 441  Monday and Wednesday 8:30–9:50 AM, Meet virtually through Zoom

Instructor: Mike Krawczynski, Rudolph Hall 185, email: mikekraw@wustl.edu

Office Hours: I have a ‘virtual’ open door policy, please contact me by email anytime to set up a meeting in my Zoom office.

  **Note** This textbook is available for free online from the library http://catalog.wustl.edu:80/record=b4987897~S2, and is also on reserve in the Library.

Prerequisites: EPSc 201 and Chem 112A or by permission from instructor.

Overview and objectives: This course provides a broad introduction to geochemistry, a discipline that pervades all of Earth sciences. The main focus of this course is on fundamental principles and processes the have occurred or are occurring on Earth and our local solar system. The goal is to develop a deep understanding of the geochemical habits of elements and isotopes, and to create a problem solving intuition that can be applied to a variety of aspects of geochemistry. There will be an emphasis on developing quantitative skills for addressing a broad range of geochemical problems. We will primarily deal with inorganic geochemistry of condensed and differentiated rocky planets. But we will also touch on aspects of low temperature and aqueous geochemistry, primarily through isotope geochemistry.

Grading Policy: Final grades will be based on the following: Homework 30%, mid terms 15% each, class participation 10%, final exam 30%. For students who elect to take the class pass/fail a passing grade will be a C- or better.

Homework: Homework assignments will be distributed on an approximately bi-weekly basis. Group work on homework assignments is encouraged, but all participating parties should submit their own assignment with the names of all co-workers acknowledged. Late homework assignments will be accepted but lose 25% credit for each unexcused day it is late. After 4 days it will no longer be accepted and the student will receive no credit.

Class notes: On a rotating basis one student for each class session is responsible for producing a set of typed notes with figures, ultimately to be distributed to the class. This is what constitutes the class participation portion of your grade, your grade will be based on the amount of genuine effort put into the class notes. A draft of the class notes will be submitted to the instructor by email within 1 week of the class. The grade will be based on this first draft of the notes. Revised notes will be distributed to the class in a timely manner. I do not recommend using these as your only class notes, note taking is an important skill and learning style and everyone should take notes for every class!

Recitation Sessions: There will be an informal evening recitation session by Zoom each week
that a homework is due. Attendance is not mandatory at the recitation, it is meant to accommodate students that want to work together on problems, and get clarification of concepts discussed during class. Recitation is a complement to lecture. Whereas lectures are often filled with material you might be seeing for the first time, recitation is aimed at review and further application of the concepts discussed in class. At recitation we will address anything covered during lecture or assigned reading or from homework problems. Recitation is a safe space in which students can feel free to guide the pace and topics covered, asking questions for clarification on big ideas is encouraged.

**Extra Help:** In addition to the recitation session, do not hesitate to schedule a meeting with me to discuss a homework problem or any aspect of the course. I have an ‘open door’ policy. Should a student wish to improve a grade on a homework or test they should contact me, and it is possible that an extra credit assignment can be worked out.

**Attendance Policy:** Students are expected to attend classes regularly and be on time. However, we are living in extraordinary times and I realize there may be times during the semester when issues beyond your control might force an absence. I encourage students to stay in contact with me to get an excused absence if necessary. See below for some specific information regarding COVID-19.

**COVID-19 Health and Safety Protocols:** Exceptions to course policies, expectations, and requirements (including attendance and assignment deadlines) because of a COVID-19 diagnosis, symptoms consistent with COVID-19, or exposure to a person with a confirmed or suspected COVID-19 diagnosis that requires quarantine or isolation will be made in collaboration between the student and instructor. In these cases, please notify your instructor as soon as possible to discuss appropriate accommodations.

All students on the Danforth Campus are required to complete the self-screening app before they come to campus or leave their residence hall room. To complete the screening app, visit http://screening.wustl.edu/ for campus access and log in with your WUSTL Key. If you do not receive a green check and pass the screening app, you are not permitted to come to campus or leave your residence hall room. You must contact Habif Health and Wellness Center immediately.

While on campus, it is imperative that students follow all public health guidelines established to reduce the risk of COVID-19 transmission within our community. The full set of University protocols can be found at https://covid19.wustl.edu/health-safety/. This includes:

- Complying with physical distancing requirements at all times and adhering to signage and environmental cues. This includes not congregating before or after class as well as during breaks or class activities.

- Complying with universal masking. All individuals on campus must wear disposable masks or cloth face coverings while occupying indoor public settings, including: multi-person offices; hallways; stairwells; elevators; meeting rooms; classrooms; restrooms; and when in campus outdoor spaces unless they can maintain six feet of physical distance from others. In the event that a student cannot wear a mask due to a medical condition, they should contact Habif or Disability Resources to seek an accommodation and, if an accommodation is granted, communicate with their instructor.

- Practicing healthy personal hygiene, including frequent handwashing with soap and warm water for at least 20 seconds and/or using hand sanitizer with at least 60% alcohol.
• Complying with cleaning and sanitation protocols. Students may be responsible for wiping down common surfaces after use, particularly those that might be shared with others (e.g. classroom desks). Instructions for sanitizing technology equipment can be found here https://sites.wustl.edu/itss/sanitizing-technology-equipment/.

We take your health and the health of our community very seriously. Any Danforth Campus student who is currently diagnosed with COVID-19, is experiencing symptoms consistent with COVID-19, or has had direct contact with a person with a confirmed or suspected COVID-19 diagnosis must remain home and isolate yourself from others. Students who have symptoms and/or do not pass the screening protocol must call the Habif Health and Wellness Center at 314-935-6666 for additional instructions.

Reporting Sexual Harassment: If a student discusses or discloses an instance of sexual assault, sex discrimination, sexual harassment, dating violence, domestic violence or stalking, or if a faculty member otherwise observes or becomes aware of such an allegation, the faculty member will keep the information as private as possible, but as a faculty member of Washington University, they are required to immediately report it to the Department Chair or Dean or directly to Ms. Jessica Kennedy, the University’s Title IX Director, at (314) 935-3118, jwkennedy@wustl.edu. Additionally, you can report incidents or complaints to the Office of Student Conduct and Community Standards or by contacting WUPD at (314) 935-5555 or your local law enforcement agency. See: https://titleix.wustl.edu/

Confidential Resources for Instances of Sexual Assault, Sex Discrimination, Sexual Harassment, Dating Violence, Domestic Violence, or Stalking: If a student needs to explore options for medical care, protections, or reporting, there are free, confidential support resources and professional counseling services are available through the Relationship and Sexual Violence Prevention (RSVP) Center in Seigle Hall, Suite 435, rsvpcenter@wustl.edu, 314-935-3445. For after-hours emergency response services, call 314-935-6666 or 314-935-5555 and ask to speak with an RSVP Counselor on call.

Academic Accommodations: Reasonable Accommodations for Disabled Students - Washington University in St. Louis supports the rights of enrolled students to a full and equal educational opportunity and, in compliance with federal, state, and local requirements, is committed to reasonable accommodations for individuals with documented disabilities. Disabled students for whom accommodations may be necessary must be registered with, and provide their instructors official notification through, WUSTL’s Disability Resources (https://students.wustl.edu/disability-resources/). Once established, responsibility for disability-related accommodations and access is shared by DR, faculty, and the student. Please contact Disability Resources at 314.935.5970 or disabilityresources@wustl.edu.

Sexual Assault Resources: The University is committed to offering reasonable academic accommodations (e.g., a no-contact order, course changes) to students who are victims of relationship or sexual violence, regardless of whether they seek criminal or disciplinary action. If you need to request such accommodations, please contact RSVP (information above) to schedule an appointment with an RSVP confidential and licensed counselor. Although information shared with counselors is confidential, requests for accommodations will be coordinated with the appropriate University administrators and faculty. See: https://rsvpcenter.wustl.edu/
Bias Reporting: The University has a process through which students, faculty, staff, and community members who have experienced or witnessed incidents of bias, prejudice, or discrimination against a student can report their experiences to the University’s Bias Report and Support System (BRSS) team. See: brss.wustl.edu.

Mental Health: Mental Health Services’ professional staff members work with students to resolve personal and interpersonal difficulties, many of which can affect a student’s academic experience. These include conflicts with or worry about friends or family, concerns about eating or drinking patterns, and feelings of anxiety, depression, and thoughts of suicide. See: https://students.wustl.edu/mentalhealth-services/ Additionally, see the mental health services offered through the RSVP Center listed above.

WashU Cares: WashU Cares, within the Health and Wellness Unit, provides resources to all students on the Danforth Campus who may be having a hard time. WashU Cares is committed to helping create a culture of caring. Through proactive, collaborative, and systemic approaches, WashU Cares works with students to identify interventions, resources, and supports that allow them to be successful. If there is a concern about the physical or mental well-being of a student, please file a report on the WashU Cares website. See: https://washucares.wustl.edu/.

Center for Diversity and Inclusion (CDI): The Center for Diversity and Inclusion (CDI) supports and advocates for undergraduate, graduate, and professional school students from under-represented and/or marginalized populations, collaborates with campus and community partners, and promotes dialogue and social change to cultivate and foster a supportive campus climate for students of all backgrounds, cultures, and identities. See: https://diversityinclusion.wustl.edu/.

Preferred Name and Gender Inclusive Pronouns: In order to affirm each person’s gender identity and lived experiences, it is important that we ask and check in with others about pronouns. This simple effort can make a profound difference in a person’s experience of safety, respect, and support. See: https://students.wustl.edu/gender-pronounsinformation/, https://registrar.wustl.edu/student-records/ssn-name-changes/preferred-name/.

Military Service Leave: Washington University recognizes that students serving in the U.S. Armed Forces and their family members may encounter situations where military service forces them to withdraw from a course of study, sometimes with little notice. Students may contact the Office of Military and Veteran Services at (314) 935-2609 or veterans@wustl.edu and their academic dean for guidance and assistance. See: https://veterans.wustl.edu/policies/policy-for-military-students/.

Gephardt Institute: There is a federal election happening on November 3, 2020. If you would like to register to vote prior to the election or request an absentee ballot, you can do so at wustl.turbovote.org. If you are ineligible to vote, you can still participate by referring your friends who are eligible to the TurboVote link to register. Additionally, everyone can contribute to the campus energy surrounding voting by starting dialogue with your peers about the importance of voting, educating yourself on American democracy and the ways public policy affect you and others, and participating in year-round forms of civic engagement beyond voting. If you have any questions about the voting process, please visit http://washuvotes.wustl.edu.
Course Outline:

The Earth in relation to the Solar System ................. Sept 14
Nucleosynthesis/cosmochemistry ........................ Sept 16-21
Solar system materials/intro to meteoritic material .... Sept 23
The structure and composition of the Earth ............ Sept 28
Intro to equilibrium thermodynamics .................. Sept 30
1-component and binary Phase diagrams ................ Oct 5
Solid solutions ............................................. Oct 7
Melting/crystallization .................................... Oct 12-14
Intro to trace element geochemistry ..................... Oct 19
Mid Term I ................................................. Oct 21
Element fractionation/simple models ..................... Oct 26
Geothermometers/barometers ............................ Oct 28
Equilibrium stable isotope fractionation ................. Nov 2
Oxygen isotopes in the solar system ...................... Nov 4
Isotopic tracers and mixing ................................ Nov 9
Radioactivity and radionuclides ........................... Nov 11
Mid Term II .................................................. Nov 16
The decay equation and Isochrons ....................... Nov 18
Pb-Pb, Ar-Ar, and Sm-Nd dating ........................... Nov 23-25
Extinct radionuclides ..................................... Nov 30
Intro to kinetics and non-equilibrium geochemistry .... Dec 2
Chemical diffusion ......................................... Dec 7
Timescales of geologic processes ........................ Dec 9
U-series disequilibrium .................................... Dec 14
Final Class .................................................... Dec 16