SYLLABUS

Course number	EES 261/461 (4 credits)
Course title	Stable Isotope Geochemistry: Fractionation Equations and Models
Term	Spring 2021
Meeting times and location	Tuesday & Thursday 9:40-10:55am; Location – Online

Prerequisites

MTH 161-162 and CHM 131-132

College Credit Hour Policy

This course follows the College credit hour policy for four-credit courses. This course meets two times weekly for three academic hours per week. The course also includes independent and/or team-based out-of-class assignments for an average of one academic hour per week. In this course, students will complete an independent or group project activity using readings of scientific literature, data, and other class materials. These activities include the interpretation of isotope data to discover and quantify geoscience processes.

Course Description

The goal of this course is to empower students with the skills needed to discover geosciences processes encapsulated in stable isotope data. This goal will be achieved by taking a student-centered perspective in this course, imagining a student researcher who has a new handful of stable isotope data and wonders "what does my stable isotope data tell us about how this specific geosystem is functioning?" While topics such as measurement techniques and classic applications of stable isotopes will be introduced, the primary focus of this course will be on the fundamental equations and models used to interpret stable isotope data. Guided by several pioneering applications, not only will we learn the equations used, but we will also scrutinize their underlying assumptions as we set-up and derive these models. This course will ultimately equip students with the fundamental knowledge needed to both dissect as well as manipulate traditional stable isotope models so that they can appropriately analyze their own data.

The first portion of this course will be more theory based, investigating and manipulating stable isotope equations and models. The second portion of this course will be research/data based, interpreting stable isotope data with newly developed models and equations.

Learning Outcomes

The primary objective of this course is to familiarize students with mixing, equilibrium, and kinetic isotope equations and models used when investigating earth system processes with stable isotope data. This course will equip students with strategies on how they can appropriately interpret the stable isotope data they may collect so that they can answer the question "what does my stable isotope data tell us about how this specific geosystem is functioning?"

More specifically, at the end of this course, the student will be able to:
1) define parameters that may be influencing the isotope distributions in various geoscience systems,
2) formulate and solve equations that adequately characterize the parameters influencing stable isotope values and distributions,
3) establish measurement and experimentation plans to thoroughly test stable isotope models,
4) synthesize measurement and model results to establish a more thorough understanding of a geosystem.

Instructor Information

Name	Professor John Kessler
Zoom Office	https://rochester.zoom.us/j/6605869167
Email address	john.kessler@rochester.edu
Office hours	Thursday from 3:30-5pm over Zoom (or by appointment)

Teacher's Assistant Information

Name	Xin Tie (graduate student)
Zoom Office	https://rochester.zoom.us/j/3660465420?pwd=ajBlRmNaYndzL1FCWDJwbnloYmNTQT09
Email address	xtie@ur.rochester.edu
Office hours	Wednesday from 2:30-4pm over Zoom (or by appointment)

Synchronous Attendance and Participation

Our synchronous classroom sessions will be completely online using Zoom; the Zoom link for these sessions is best accessed from the "Course Home Page" on *Blackboard*. While all classroom sessions will be recorded, active synchronous participation is strongly encouraged as much as possible.

Textbook and/or Resource Material

No textbook is required for this course, however, reading material from the following sources will be distributed as the course progresses. Additionally, the lecture slides, data sets, homework assignments, quizzes, and exams will be posted on *Blackboard* as needed. We will use *Blackboard* heavily, so please refer to it regularly.

1) Kessler Notes: I have written class notes in a textbook-like fashion that I will distribute.
2) "Principles of Stable Isotope Distribution," Robert E. Criss, 1999.
3) "Stable Isotope Geochemistry," Jochen Hoefs, 1997.
4) "Chemical Equilibria in the Earth," Broecker and Oversby, 1971.
5) Various publications like Rayleigh, 1896; Bigeleisen and Wolfsberg, 1958; Dansgaard, 1964; Dickins, 1995; Emiliani 1978; Hayes 1983; Keeling 1958 & 1961; etc.

Course Structure

This course is structured so that in a typical week you will first watch several learning activities which are prerecorded and placed on *Blackboard*. This will provide a solid foundation for the material covered that week. After watching those videos, you will then be assigned textbook sections or journal articles to read. The hope is that by first watching the videos, you will better understand the reading material. After you watch the videos and complete the reading assignments, you are encouraged to post questions to the discussion board on *Blackboard* which we will address during the synchronous classroom sessions on Tuesday and Thursday. In addition to providing clarifying discussion during the classroom sessions, we will also work through several problems to better understand this material. Several of these problems will be components of your "Problem Set" for that week. On Thursday, we will hold another synchronous classroom session to cement our understanding of that week's material. On Friday, the weekly Problem Set is due and it should be uploaded to *Blackboard* using Gradescope. Between Thursday at noon and Saturday at 11:59pm, you will need to complete a short (15 minute) quiz on *Blackboard* to make sure you understand the material from that week. These quizzes will be mainly composed of multiple choice and true/false questions and are designed to be relatively easy to complete if you are keeping up on the weekly material and participating in the synchronous and asynchronous discussions.

Note: The course structure described here may deviate slightly from this general organization in order to accommodate examinations, holidays, and slight variations in the speed at which material is covered.

Grading Policies

Grading will be based on the following structure:
Participation in discussion and classroom activities (25%)
Problem Sets (15%)
Section Quizzes (15%)
Class Project and Presentation (10%)
3 exams at the end of each module (10% each)
Final exam (5%)
Note: The class project/presentation consists of a written report (5 single-spaced pages for undergraduates, 8-10 single-spaced pages for graduate students) and a 15-minute presentation to the class. Graduate students registered for EES 461 should also expect assignments and exams that will have additional (and more challenging) problems which will be graded more strictly.

Assignment of letter grades:

A	93-100
A-	90-92
B+	87-89
B	83-86
B-	80-82
C	same breakdown as B, between 70-79
D	same breakdown as B, between 60-69
E:	below 60

Instructor Response and Feedback:
Students should expect to receive feedback and grades on their assignment within approximately one week after the due date. Grades will be posted on *Blackboard*.

Participation

Both *synchronous and asynchronous participation counts 25% of your grade.*
1) Synchronous participation in the classroom sessions is strongly encouraged whenever possible via Zoom. I encourage active participation in our classroom discussions.

2) Asynchronous online participation will take place through Discussion Forums on *Blackboard*. You will find links to different discussions within each of the Learning Modules.

These discussion platforms are places to ask questions, respond to assist your classmates, and share ideas to better understand the topics and readings under investigation. Each class member is expected to participate in these discussions by both posting original comments and subsequently replying to the posts of classmates, **with a minimum of two posts per week**. You may comment on the course readings or material, ask a question about an assignment, respond to some of your classmate's posts, or even share a link to a news article or video that is related to what we are studying. At times, the professor or TA may post a prompt and request your response.

Since the discussion board is a place to not only ask questions, but also to help your classmates by providing clarification on points of confusion, you are asked to participate in these discussions even if you don't have a specific question. As such, you should contribute to these discussions over the course of the week, not simply within one brief session. Finally, always remember the rules of online etiquette when posting and replying to classmates' posts.

Course Topics, Calendar of Activities, Major Assignment Dates

1) *Learning Module 1 – Fundamentals of Isotope Geochemistry*
   a) Week 1: February 1 – 6
      i) Course Overview and Introduction to Stable Isotopes and Isotopic Fractionation
   b) Week 2: February 7 – 13
      i) Isotopic notations and standards and Overview of isotope measurement techniques
   c) Week 3: February 14 – 20
      i) Isotope mixing and Keeling plots
   d) Week 4: February 21 – 27
      i) Introduction to isotope kinetics and Isotope equilibrium
   e) Week 5: February 28 – March 6
      i) Review
      ii) **Module 1 Exam**

2) *Learning Module 2 – Isotopic Fractionation in Closed and Open Geosystems*
   a) Week 6: March 7 – 13
      i) Closed system reactant models and Evaporation-Condensation processes
   b) Week 7: March 14 – 20
      i) Closed system product models and common approximations
   c) Week 8: March 21 – 27
      i) Open system models
   d) Week 9: March 28 – April 3
      i) Tuesday: Study Break! (No class)
      ii) **Thursday: Module 2 Exam**

3) *Learning Module 3 – Establishing New Isotope Models for Different Kinetics*
   a) Week 10: April 4 – 10
      i) Non-Steady State Models
   b) Week 11: April 11 – 17
      i) Changing fractionation factors
   c) Week 12: April 18 – 24
      i) Processes that don't follow 1st order kinetics
   d) Week 13: April 25 – May 1
      i) Review
      ii) **Module 3 Exam**
   e) Week 14: May 2 – 7
      i) Term project presentations
      ii) Term project presentations and review for Final Exam

4) **Final Exam**
   a) Thursday, May 13th
   b) 4 – 6pm

Americans with Disabilities Act (ADA)

Center for Excellence in Teaching and Learning (CETL), 107 Lattimore Hall, 585-275-9049
http://www.rochester.edu/college/cetl/

The Center for Excellence in Teaching and Learning (CETL) offers a variety of disability services for undergraduates and graduate students in Arts, Sciences & Engineering. These services aim to provide an inclusive experience and equal access to academic content and program requirements. Their approach relies on collaboration among students, CETL staff, and instructors. Students are invited to make an appointment to meet with a disability support coordinator to get acquainted and talk about classroom accommodations. CETL also provides transition support and self-advocacy skill development.

In addition, students can find information on other University accommodations and services, including transportation and campus accessibility at: http://www.rochester.edu/eoc/

Academic Honesty

All assignments and activities associated with this course must be performed in accordance with the University of Rochester's Academic Honesty Policy. Unless otherwise noted, I encourage collaboration when studying and investigating assignments among students currently enrolled in this course. However, all individual assignments must be completed independently and must represent the work of only the specific student completing the assignment. In short, study together but write separately. Verbatim copying is a violation of the course Academic Honesty policy. In addition, collaborating with students who have previously taken EES 261/461 is prohibited, including the sharing of notes, assignments, exams, and project materials from past semesters, unless permission to do so is granted from the instructor prior to such collaboration. A comprehensive description of the University of Rochester's Academic Honesty Policy is available at: https://www.rochester.edu/college/honesty/