SYLLABUS

Course number	EES 261/461 (4 credits)
Course title	Stable Isotope Geochemistry: Fractionation Equations and Models
Term	Spring 2019
Meeting times and location	Goergen Hall 102, Tuesday & Thursday 9:40-10:55am

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

Most courses in stable isotope geochemistry highlight the analytical techniques and classic applications of stable isotopes. While several of these topics will be introduced here, the primary focus of this course will be on the fundamental equations and models used to interpret stable isotope data obtained from natural environmental samples. 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. The goal of this course is to equip students with the fundamental knowledge needed to both dissect as well as manipulate traditional stable isotope models so that they can analyze their own data in the most appropriate and intelligent fashion.

The first portion of this course will be theory based, investigating and manipulating stable isotope equations and models. The second portion of this course will be research based, investigating and 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. The goal of this course is to 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 geological systems,
2) formulate and solve equations that adequately characterize the parameters influencing stable isotope values and distributions,
3) establish measurement and experimentation plans to adequately 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
Office location	Hutchinson Hall, Room 210
Email address	john.kessler@rochester.edu
Telephone number	(585) 273-4572
Office hours	When I am not teaching or in the lab, my office door is almost always open. Please feel free to just stop by or you can make an appointment

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, reading assignments, homework assignments, and additional course material will be posted on *BlackBoard* as needed.

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) "CO_2 in Seawater: Equilibrium, Kinetics, and Isotopes," Richard E. Zeebe and Dieter Wolf-Gladrow, 2001.
5) "Chemical Equilibria in the Earth," Broecker and Oversby, 1971.
6) Various publications like Rayleigh, 1896; Bigeleisen and Wolfsberg, 1958; Dansgaard, 1964; Keeling 1958 & 1961, Reese, 1974; Monson and Hayes, 1980; etc.

Grading Policies

Grading will be based on the following: homework and class participation (20%), 3 exams (15% each), class project/presentation (20%), and a final exam (15%). 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. Note: in addition to the written report being longer for graduate students, assignments and exams will be more challenging/graded more strictly for the students enrolled in EES 461.

Course Topics, Calendar of Activities, Major Assignment Dates

In Class	At Home
Week 1 (Thursday, January 17) Introduction to stable isotopes: notation, standards, etc.	Reading Assignment: Criss (1999) & Hoefs (1997)
Week 2 (Tuesday, January 22 – Thursday, January 24) Introduction to stable isotopes: notation, standards, etc. Analytical techniques, Isotope Mixing Models	Reading Assignment: Criss (1999) & Hoefs (1997) Kessler Notes
Week 3 (Tuesday, January 29 – Thursday, January 31) Isotope Mixing Models and Keeling Plots Introduction to isotope fractionation	**Due Tuesday, January 29: HW #1** Reading Assignment: Kessler Notes, Keeling, Pataki

Week 4 (Tuesday, February 5 – Thursday, February 7) Introduction to isotope fractionation: Fractionation from diffusion	**Due Tuesday, February 5: HW #2** Reading Assignment: Kessler Notes, Criss, & Hoefs
Week 5 (Tuesday, February 12 – Thursday, February 14) Potential Energy Curve, Isotope Exchange Reactions Kinetic Isotope Fractionation: Fractionation Factors & Rayleigh Fractionation	**Due Tuesday, February 12: HW #3** Reading Assignment: Rayleigh, 1896; Bigeleisen and Wolfsberg, 1958; Broecker and Oversby, 1971
Week 6 (Tuesday, February 19 – Thursday, February 21) **Tuesday, February 19: In-Class Exam 1** Kinetic Isotope Fractionation	Reading Assignment: Criss (1999) & Hoefs (1997) Kessler Notes
Week 7 (Tuesday, February 26 – Thursday, February 28) Kinetic Isotope Fractionation: Fractionation Factors & Rayleigh Fractionation The water cycle: Evaporation/Condensation Isotope Fractionation	**Due Tuesday, February 26: HW #4** Reading Assignment: Kessler Notes, Monson and Hayes, (1980), Sigman and Casciotti, (2001)
Week 8 (Tuesday, March 5 – Thursday, March 7) Kinetic Isotope Fractionation: Open Systems (Steady-State)	**Due Tuesday, March 5: HW #5** Read Kessler notes
Week 9 (Tuesday, March 12 – Thursday, March 14) **SPRING BREAK – No Classes**	Relax
Week 10 (Tuesday, March 19 – Thursday, March 21) Kinetic Isotope Fractionation: Open Systems (Non-Steady-State)	**Due Thursday, March 21: HW #6** Read Kessler notes Reese, 1974; Monson and Hayes, 1980
Week 11 (Tuesday, March 26 – Thursday, March 28) **Tuesday, March 26: In-Class Exam 2** Kinetic Isotope Fractionation: Open Systems (Non-Steady-State)	Read Kessler notes Reese, 1974; Monson and Hayes, 1980
Week 12 (Tuesday, April 2 – Thursday, April 4) Kinetic Isotope Fractionation: Different Reaction Orders Fractionation with biogeochemical processes	**Due Tuesday, April 2: HW #7** Read Kessler notes
Week 13 (Tuesday, April 9 – Thursday, April 11) Kinetic Isotope Fractionation: Different Reaction Orders	**Due Tuesday, April 9: HW #8** Read Kessler notes
Week 14 (Tuesday, April 16 – Thursday, April 18) Fractionation with biochemical processes Presentation of Project Results	**Due Tuesday, April 16: HW #9** Read Kessler notes
Week 15 (Tuesday, April 23 – Thursday, April 25) **Tuesday, April 23: In-Class Exam 3** Presentation of Project Results	
Week 16 (Tuesday, April 30) Presentation of Project Results Review for Final Exam	

Week 17 (Thursday, May 9, 4:00 – 6:00PM) **Final Exam**	Comprehensive

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/ada/

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. In addition, collaborating with students who have previously taken EES 261/461 is prohibited, including the sharing of 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: www.rochester.edu/College/Honesty