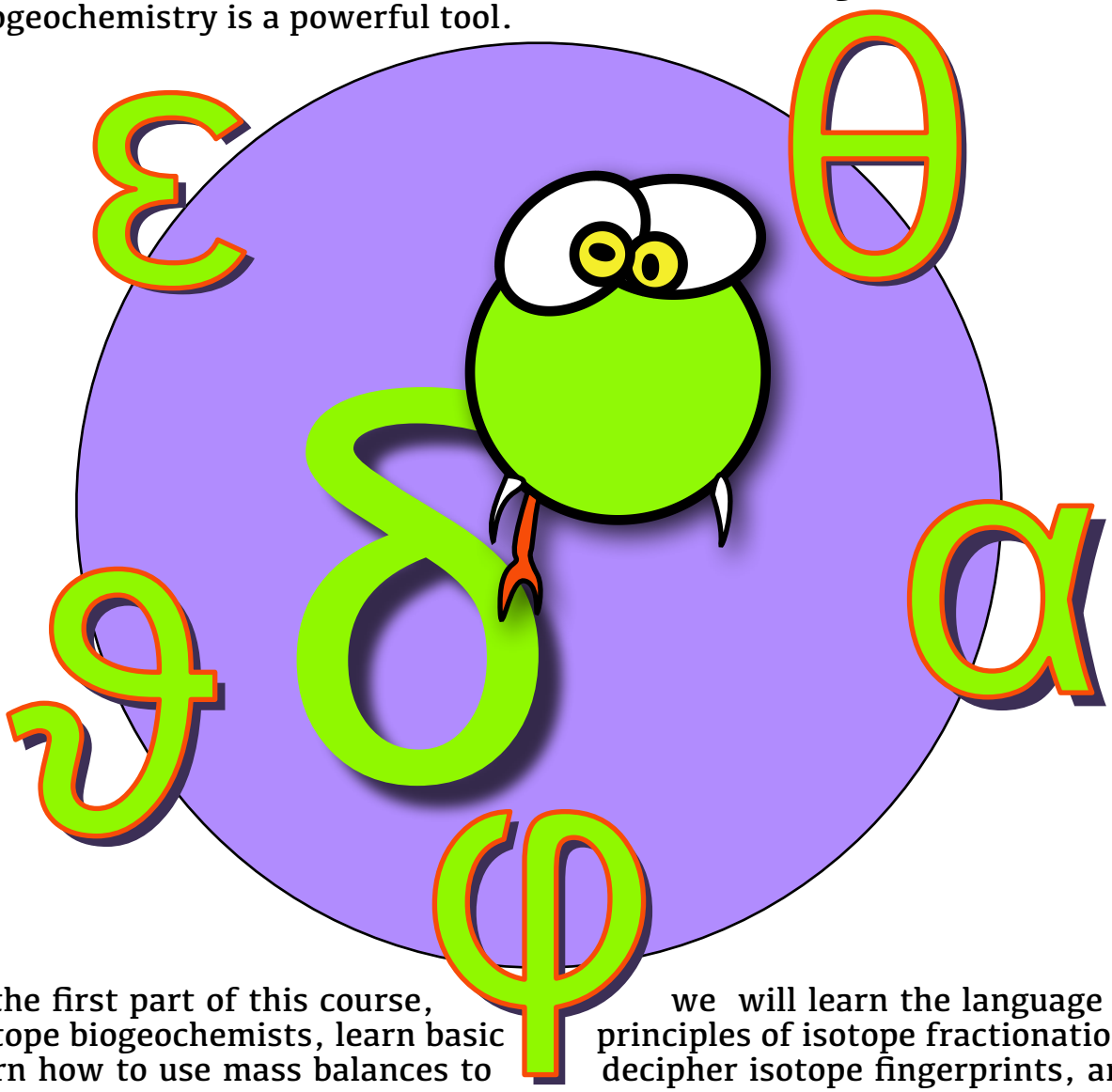
Fall 2017

Light Stable Isotope Biogeochemistry

Light elements such as hydrogen (H), carbon (C), nitrogen (N), phosphorous (P) and sulfur (S) are essential building blocks for every living organism. For the investigation of how organisms affect our environment, Earth's geologic past or the detection of extraterrestrial life, light stable isotope biogeochemistry is a powerful tool.



In the first part of this course, we will learn the language of isotope biogeochemists, learn basic principles of isotope fractionation, learn how to use mass balances to decipher isotope fingerprints, and gain a basic understanding on how isotope compositions are measured.

In the second part of this course, we will apply our gained knowledge to the study of student-selected examples of element cycling in the environment.

Dr. Ben Brunner
Geological Sciences 404
TR 3-4:20 PM (3 hours credit)
Master's students: 5315 CRN 14783 / Ph.D students 6315 CRN 16262

Light Stable Isotopes in Biogeochemistry

INSTRUCTOR
Dr. Benjamin Brunner
Assistant Professor, Geological Sciences

Office: 404 Geology Building
E-mail: bbrunner@utep.edu

MEETING PATTERN & LOCATION

TR 03:00pm-04:20pm Geology Building 494, 3 credits

MS students (GEOL 5315, CRN 14783)
PHD students (GEOL 6315 CRN 16262)

COURSE DESCRIPTION

Light elements such as hydrogen (H), carbon (C), nitrogen (N), phosphorous (P) and sulfur (S) are essential building blocks for every living organism. For the investigation of how organisms affect our environment, Earth's geologic past or the detection of extraterrestrial life, light stable isotope biogeochemistry is a powerful tool.

In the first part of this course, we will learn the language of isotope biogeochemists, learn basic principles of isotope fractionation, learn how to use mass balances to decipher isotope fingerprints, and gain a basic understanding on how isotope compositions are measured.

In the second part of this course, we will apply our gained knowledge to the study of selected examples of H, C, N, P and S cycling in the environment.

The third and last part of the course is dedicated to an introduction of two novel isotope tools – multiple isotope fractionation and clumped isotopes.

REQUIRED TEXTBOOK

Journal articles and review papers will be discussed throughout the course.

RECOMMENDED READING

Fry B. *Stable Isotope Ecology*. Springer 2006

COURSE OBJECTIVES

1) Learn the fundamentals of stable isotope biogeochemistry
2) Gain insight into key biogeochemical processes in H, C, N, S, P cycling.
3) Learn how to use isotope mass balances to understand processes
4) Apply learned concepts to examples of H, C, N, S, P cycling
5) Gain insight into multiple isotope fractionation and clumped isotopes

YOUR PARTICIPATION IS ESSENTIAL (SEE GRADES)

Please contact Dr. Brunner about any concerns, schedule conflicts, etc. in advance or otherwise as soon as possible! A significant portion of your grade is based on participation, so any missed classes and assignments must have proper documentation or your grade will drop. Valid excuses include illness, absence with the instructor's prior approval, official University business, etc.

Accommodations are possible for active duty military and others, but arrangements must be made in a timely manner. If you are in the military with the potential of being called to military service and /or training during the course of the semester, you are encouraged to contact the instructor as soon as possible.

If you think you may have a disability or if you are experiencing learning difficulties, please contact the Disabled Student Services Office (DSSO) at (915) 747-5148. They are located in Union East room 106 or you can reach them by email at dss@utep.edu. The student is responsible for presenting to the instructor any DSS accommodation letters and instructions.

Important notes:

1) During the classes and as homework assignments, there will be various exercises. In class, students who struggle with the exercises will have the opportunity to work with the instructor in a smaller group to overcome specific hurdles. This is by no means meant to single out students who do not reach the goals of the lecture/exercises – it is an attempt to give everybody a fair chance to immediately address the encountered challenges, and to stay on track with the class. Students who take advantage of this opportunity but still encounter difficulties can schedule additional tutoring with Dr. Brunner.
2) **Learning in teams** is much more effective than learning alone, and is highly encouraged.
3) This is partly a front-loaded class: reading assignments or exercises will precede the corresponding class. This will allow us to address the tricky issues of the topic in class. Doing these assignments before the lecture is the absolute key to the success of this form of teaching and learning.
4) **Drop date deadline: November 3, 2017.**
5) **Grades:** Quiz & Reports (60%), Participation in discussion (40%), **always** be prepared for 5 minute quizzes!

SCHEDULE OF TOPICS – ***subject to change!*** – ***second part of course is example from previous class!***

Date:	**Topic:**	**Reading / Assignments / Quiz**
Week 1	Part 1. Introduction to light stable isotopes I: from isotope to isotopologue. Evaluation of to-be-selected topics/examples with course participants	
Week 2	Part 1. Introduction to light stable isotopes II: from isotope pools to isotope fractionation. Selection of topics/examples with course participants	Handouts & Quiz
Week 3	Part 1. Introduction to light stable isotopes III: from mass balance to isotope mass balance, and from isotope fractionation to isotope mixing	Handouts
Week 4	Part 1. Introduction to light stable isotopes III: Expression of isotope effects and reversibility Repetition of part 1, exercises.	Handouts
Week 5	***Part 1. Exam, evaluation of part 1 exam***	
Week 6	*Updated Part 1.* More isotope mass balance exercises (group exercise mixing by diffusion)	tbd
Week 7	*Updated Part 1.* More isotope mass balance exercises (Anammox, microbial transformation of gypsum and hydrocarbons into calcium carbonate and sulfide)	tbd

Week 8	SPRING BREAK	
Week 9	*Tue) Recap Part 1.* A tour of what we have done so far *Thu)* ***Part 2.*** Case-study carbon cycle: methane cycling in marine sediments (C isotopes)	*Thu)* Ben: Ussler_Paull 2008 methane
Week 10	Case-studies nitrogen cycle: N-cycling (N, O isotopes) – nitrate reduction and nitrite oxidation	*Tue)* Ben: Tcherkez_Farquhar 2006 *Thu)* Alfredo Casciotti 2009
Week 11	Case-studies sulfur cycle I: O-isotopes of sulfate and sulfite related to sulfate reduction II: S-cycling at a Mars analogue	*Tue)* Joshua: Wankel et al. 2014 *Thu)* Diego: Szynkiewicz et al. 2012
Week 12	Case-studies sulfur cycle III: S isotopes of Sulfates and Sulfides in the Mineral Park Case-study phosphorus cycle I: Phosphorous cycling in Benguela upwelling system: P limitation and the role of enzymes (O isotopes)	*Tue)* Arturo: Lang et al. 2014 *Thu)* William: Goldhammer et al. 2011
Week 13	Case-study Cd cycle: I: Nonspecific uptake and homeostasis drive the oceanic cadmium cycle Case-study Mg cycle: I: Mechanisms of magnesium isotope fractionation in volcanic soil weathering sequences, Guadeloupe	*Tue)* Fotis: Horner et al. 2013 *Thu)* Jacqueline: Opfergelt et al. 2012
Week 14	Case-study Ca cycle: I: Calcium isotopes in the global biogeochemical Ca cycle: Implications for development of a Ca isotope proxy Case-study carbonates: I: Carbon- and oxygen-isotope records of palaeoenvironmental and carbonate production changes in shallow-marine carbonates (Kimmeridgian, Swiss Jura)	*Tue)* Jason: Fantle_Tipper 2014 *Thu)* Yvette: Colombie et al. 2011
Week 15	Case-study carbonates: I: Stable carbon and oxygen isotopes in Quaternary soil carbonates as indicators of ecogeomorphic changes in the northern Chihuahuan Desert, USA **Part 3.** Novel isotope tools: Multiple isotopes (O, S) & Clumped isotopes (i.e. C-O)	*Tue)* Anna: Monger et al. 1989 *Thu)* Ben: tbd
Week 16	Course review	

Grades: Exam Part 1 (30%), Participation in discussion (30%), Project presentation and handout (40%)

Assessment of 5315 vs 6315 students: There will be no discrimination for the Part I exam grading or for the participation in discussion (you are all expected to participate and do well on the exam) between 5315 and 6315 students. A higher level of performance is expected for the 6315 students for the project presentation and handout portion of the class.