GEOL 417: ISOTOPE GEOCHEMISTRY

Fall 2015

INFORMATION

COURSE: GEOL 417 Section: 001
INSTRUCTOR: Dr. Liliana Lefticariu (Phone: 453-7373)
Office: P 301D Parkinson, SIUC
E-mail: lefticar@siu.edu; Website: http://www.geology.siu.edu/people/lefticariu.html
TIME: 8:00 am - 9:15 am T, Th, in Parkinson 110
OFFICE HOURS: M, W, F: 10:00 – 11:00; T, Th: 1:00 – 2:00, or by appointment

COURSE DESCRIPTION:
This course provides a general overview of the applications of both stable and radiogenic isotopes to a wide
range of research problems in geology, anthropology, ecology, and environmental sciences. This course
will begin with a review of isotopes and isotopic equilibria, and proceed through a review of stable isotopes
and their use in hydrology, water-rock interaction, environmental studies, paleoclimate research, petrology,
anthropology, and biogeochemistry. Additional information concerning isotopic techniques and mass
spectroscopy are provided. The second half of the class deals with the systematic of several isotope systems
that are useful in geochronology and isotope tracer studies.

CLASS PREREQUISITES:
Previous courses in general geology, chemistry, or other introductory science classes are beneficial. A basic
understanding of chemical principles and scientific concepts is especially helpful, although all concepts are
considered without presumption of any prior knowledge. If you are uncertain of any assumptions made in
the class please ask for clarification.

CLASS TIMES & COURSE FORMAT:
Class meetings are on Tuesday and Thursday from 8:00 am - 9:15 am in Park 110; they consist of lectures
and discussions sessions. A research project is required. Course grades are based on performance in two
exams, problem sets, final term paper, and on contributions to discussions during class sections.

COURSE COMPONENTS AND ASSESSMENT:
Class preparation and attendance: 10%

Problem sets: Four problem sets (5% each) are designed to familiarize you with isotopic conventions and
notation, and to introduce you to the algebraic techniques applied to isotopic data. Late problem sets will
receive at most half credit. Please do your own work. Problem sets that are identical “twins” will not
receive credit.

Exams: Two written exams (25% each), consisting of in-class exams, midterm exam on October 8th
(tentative date) and the final exam on December 10th. Examples of illustrative questions and problems will
be distributed and discussed in the review sessions prior to the exams.

Final Term Paper (20%) The paper (~4000 to 6000 words) can be a proposed project using stable isotopes
in your research area. It can also be a review paper on a topic that involves the use of stable and/or
radioactive isotopes (your topic can be directly related to your research project). It will be judged from the
layout of the history of the problem, hypothesis, major progresses, current debates, gaps of knowledge, and
possible frontiers for further study. The goal of the paper is to compose a cogent, structured discussion of
the chosen topic rooted in sound scientific arguments and principles. It should include an abstract, figure
and table captions, page numbers, and references. Please don’t write a wordy paper in an effort to fill
pages. Scientists strive to be economical in their writing.

The paper is developed and evaluated through four iterations as follows:
1. An initial extended outline/rough draft critiqued by instructors – due September 17.
2. A revised draft (electronic format) for anonymous peer review – due October 15. All students will be required to review two other papers – due November 12.
3. A complete final draft reviewed by instructors – due December 10.
4. Paper presentation and discussions: Fifteen-minute oral presentation will be given on **Tuesday December 8 and Thursday December 10, 2013.** Written report will be due **Monday December 14, 2013 at 5:00 PM.**

**GRADE BREAKS:** A = >= 87%; B = 75-86%; C = 65-74%; D = 55-65%; F = <55 %

**TEXT AND RESOURCES:**

*Recommended Text:*

- **Principles of Stable Isotope Geochemistry**, by Zachary Sharp, Princeton 2006, 344 p. This text provides a general introduction to many of the course themes in a narrative format. It offers a comprehensive treatment of several of the class topics and an adequate representation of most others. Most importantly it represents a companion to the class that supplements and augments the lecture materials. Its contents are not followed directly, and topics are considered in a different order from this text.

*Additional Resources:*


PRELIMINARY OUTLINE AND POTENTIAL TOPICS:

A. Characteristics of isotopes (what are isotopes and why are they important)

B. Stable isotope methods (why there is isotope geology)
   • Evolution of the mass spectrometer
   • Measurement of isotope ratios— isotope ratio mass spectrometer, ion microprobe
   • Sample preparation techniques
   • Conventions, notations, and standards

D. Theoretical basis for isotopic fractionation (tedious but necessary)
   • Kinetic fractionation
   • Equilibrium fractionation

E. Oxygen \(^{18}\text{O}/^{16}\text{O}\) and hydrogen \(^{2}\text{H}/^{1}\text{H}\) isotopes (it's the water)
   • Distribution in nature and fractionation relations
   • Oxygen and hydrogen isotopes in igneous and metamorphic rocks
   • Oxygen and hydrogen isotopes as tracers in natural waters
   • Sedimentary carbonates— paleotemperatures
   • Oxygen isotope stratigraphy of Quaternary, Tertiary, and Paleozoic marine sediments

F. Carbon isotopes \(^{13}\text{C}/^{12}\text{C}\) (you are what you eat)
   • Carbon geochemistry
   • \(^{13}\text{C}/^{12}\text{C}\) ratios in nature and fractionation relations
   • \(^{13}\text{C}\) in natural waters— carbon cycling in the ocean and terrestrial subsurface
   • \(^{13}\text{C}\) in organic matter— tracing the food web, origin of organic matter, changes in global \(\text{pCO}_2\), tracing molecular markers, etc.
   • \(^{13}\text{C}\) in marine carbonates— the global carbon budget, ancient ocean chemistry, paleoceanography
   • Carbon and oxygen isotopes and carbonate diagenesis— temperature and chemistry of diagenetic fluids
   • Carbon and hydrogen isotopes in natural gas and petroleum— origin of methane

G. Sulfur isotopes \(^{34}\text{S}/^{32}\text{S}\) (swamp gas and global change)
   • Sulfur geochemistry
   • \(^{34}\text{S}/^{32}\text{S}\) ratios in nature and fractionation relations
   • Microbial processes and sulfur isotopes
   • Sulfur isotopes in groundwater sulfate— origin of sulfate, microbial processes
   • The sulfur isotope curve— major changes in ocean chemistry through time

H. Geochronology and Isotope Tracer Studies
   • Use of radiogenic isotopes to understand how the Earth formed and how it has evolved through its history.
   • Use of radiogenic isotopes to constrain the past and present geological processes.
   • \(^{14}\text{C}\) dating system
   • U-Th-Pb geochronology system
   • Rb-Sr and Sm-Nd isotope tracer study
IMPORTANT DATES *

Semester Class Begins: ..................................................08/24/2015
Last day to add a class (without instructor permission): ...............08/30/2015
Last day to withdraw completely and receive a 100% refund: ........09/06/2015
Last day to drop a course using SalukiNet: ................................11/01/2015
Last day to file a course repetition (for name to appear in Commencement program): ..................................................09/18/2015
Final examinations: ..................................................................12/14–12/18/2015

Note: For outreach, internet, and short course drop/add dates, visit Registrar’s Academic webpage http://registrar.siu.edu/

FALL SEMESTER HOLIDAYS
Labor Day Holiday 09/07/2015
Fall Break 10/10—10/13/2015
Veterans Day Holiday 11/11/2015

WITHDRAWAL POLICY ~ Undergraduate only
Students who officially register for a session may not withdraw merely by the stopping of attendance. An official withdrawal form needs to be initiated by the student and processed by the University. For the proper procedures to follow when dropping courses and when withdrawing from the University, please visit http://registrar.siu.edu/pdf/ugradcatalog1314.pdf

INCOMPLETE POLICY~ Undergraduate only
An INC is assigned when, for reasons beyond their control, students engaged in passing work are unable to complete all class assignments. An INC must be changed to a completed grade within one semester following the term in which the course was taken, or graduation, whichever occurs first. Should the student fail to complete the course within the time period designated, that is, by no later than the end of the semester following the term in which the course was taken, or graduation, whichever occurs first, the incomplete will be converted to a grade of F and the grade will be computed in the student’s grade point average. For more information please visit: http://registrar.siu.edu/grades/incomplete.html

REPEAT POLICY
An undergraduate student may, for the purpose of raising a grade, enroll in a course for credit no more than two times (two total enrollments) unless otherwise noted in the course description. For students receiving a letter grade of A,B,C,D, or F, the course repetition must occur at Southern Illinois University Carbondale. Only the most recent (last) grade will be calculated in the overall GPA and count toward hours earned. See full policy at http://registrar.siu.edu/pdf/ugradcatalog1314.pdf

GRADUATE POLICIES
Graduate policies often vary from Undergraduate policies. To view the applicable policies for graduate students, please visit http://gradschool.siu.edu/about-us/grad-catalog/index.html

DISABILITY POLICY
Disability Support Services provides the required academic and programmatic support services to students with permanent and temporary disabilities. DSS provides centralized coordination and referral services. To utilize DSS services, students must come to the DSS to open cases. The process involves interviews, reviews of student-supplied documentation, and completion of Disability Accommodation Agreements. http://disabilityservices.siu.edu/

PLAGIARISM CODE

MORRIS LIBRARY HOURS
http://www.lib.siu.edu/about

SAFETY AWARENESS FACTS AND EDUCATION
Title IX makes it clear that violence and harassment based on sex and gender is a Civil Rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, etc. If you or someone you know has been harassed or assaulted, you can find the appropriate resources here: http://safe.siu.edu

SALUKI CARES
The purpose of Saluki Cares is to develop, facilitate and coordinate a university-wide program of care and support for students in any type of distress—physical, emotional, financial, or personal. By working closely with faculty, staff, students and their families, SIU will continue to display a culture of care and demonstrate to our students and their families that they are an important part of the community. For Information on Saluki Cares: (618) 453-5714, or siucares@siu.edu, http://salukicares.siu.edu/index.html

EMERGENCY PROCEDURES
Southern Illinois University Carbondale is committed to providing a safe and healthy environment for study and work. We ask that you become familiar with the SIU Emergency Response Plan and Building Emergency Response Team (BERT) programs. Please reference the Building Emergency Response Protocols for Syllabus attachments on the following pages. It is important that you follow these instructions and stay with your instructor during an evacuation or sheltering emergency.

INCLUSIVE EXCELLENCE
SIU contains people from all walks of life, from many different cultures and sub-cultures, and representing all strata of society, nationalities, ethnicities, lifestyles, and affiliations. Learning from and working with people who differ is an important part of education as well an essential preparation for any career. For more information please visit: http://www.inclusiveexcellence.siu.edu/

LEARNING AND SUPPORT SERVICES
Help is within reach. Learning support services offers free tutoring on campus and math labs. To find more information please visit the Center for Learning and Support Services website:
Tutoring: http://tutoring.siu.edu/
Math Labs http://tutoring.siu.edu/math_tutoring/index.html

WRITING CENTER
The Writing Center offers free tutoring services to all SIU students and faculty. To find a Center or Schedule an appointment please visit http://write.siu.edu/

AFFIRMATIVE ACTION & EQUAL OPPORTUNITY
Our office’s main focus is to ensure that the university complies with federal and state equity policies and handles reporting and investigating of discrimination cases. For more information visit: http://diversity.siu.edu/

Additional Resources Available:
SALUKINET: https://salukinet.siu.edu,cp/home/displaylogin
ADVISEMENT: http://advisement.siu.edu/
SIU ONLINE: http://online.siu.edu/