Environmental Radioisotope Geochemistry

GEOL/MSCI 524

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Class Schedule: Tues/Thurs from 2:00 to 3:15 pm in EWSC 209
Office hours: Mon/Thurs 15:15 to 16:15 and by appointment
Text: Papers from the literature and handouts.
Suggested Texts:
Isotopes, Principles and Applications, 3rd ed. by Faure and Mensing
Nuclear and Radiochemistry: Fundamentals and Applications, 2nd ed. by K. H. Lieser
Tracers in the Sea, by W. S. Broecker and T.-H. Peng
Grading: *Undergraduates:* 3 tests: 30%, Homework/In Class Assignments: 55%, 10 minute talk, 15%
Graduate Students: 3 tests: 30%, Homework: 30%, Special topic paper: 25%, 10 min talk, 15%.

Note that there is a POSSIBLE Field Trip to the Savannah River Site

Course Description: Radioisotopes are powerful and often overlooked tools. The objectives of this course are to introduce you to radioisotopes in natural ecosystems. In this class you will learn the principles behind radioactivity, techniques of measurement, and how radionuclides are used in a broad spectrum of environmental related research. We will cover a wide range of applications such as atmospheric and oceanic mixing, biogeochemical cycling, groundwater, sea level change, sediment dating and more. There are no texts that fully cover this subject material. As such, in addition to *Isotopes, Principles and Applications, 3rd ed.* by Faure and Mensing, I have compiled a series of papers and handouts that will be distributed periodically throughout the class. All handouts, assignments, and other information will also be posted on the class website.

Course Organization: This course will consist of 3 exams (No Final). Short homework assignments will consist of 5-6 problem and reading sets as well as in class discussion topics. For graduate students, one term paper (~ 10 pages) will be due at the end of the semester that focuses on a topic of the student's choosing (after discussion with the instructor). All students will be required to give a 10 minute presentation on a specific topic to the rest of the class. For graduate students, it is preferred that talk and paper topics are the same. The course is organized to first give the basics of radioactivity and decay. The remaining lectures are predominantly structured around distinct radioisotope pairs, although there are several occasions when specific applications are discussed instead.

Research Paper: The goal of this term paper is for you to use radioisotopes to investigate a topic that you find interesting. Length should be no more than 10 type written, double spaced pages. ***Please talk to me first before beginning and I will point you in the right direction!*** Figures and Tables are highly recommended.

Final Paper Due Tuesday, April 3rd

Presentation: The goal of this presentation is for you to practice speaking in front of a friendly audience and to learn how to present material following a format that is commonly used among the major research societies (i.e. AGU, ASLO). You will have 12 minutes to complete your presentation, which should include a 10 minute talk (Rule of thumb is one minute per slide) and 2 minutes for questions from the audience. Your presentation should include: Title, Introduction (why is this important?), Background (What has been done), Hypothesis (What is the issue you are trying to answer or what are the major questions), Proposed Research (How would you answer the question?), and Conclusions (What do you think the answer will be and what does this mean?). You are welcome to use Powerpoint or overheads. If you use Powerpoint, please come to class ~ 5 minutes early to load the presentation.

Student Talks, **April 17th and 19th**

Syllabus

1. Basic Principles	
What is Radioactivity?	Chapters 1-4, Faure
Earth Formation	Handouts
Nuclear Stability	
Modes of Radioactive Decay	
Radioactive decay/growth equations	
Half-Life Derivations	
Secular Equilibrium	
Activity vs. atoms	
Simple Box models	Handouts
Measurement Techniques	
(Includes USC lab visit)	Handouts

Exam 1 Tuesday, February 7th

2. Sources of Radioisotopes	
Natural (U-Th)	Masque & Cochran Paper
Cosmogenic (14C, 7Be)	Lal Paper, Chapter 23, Faure
Anthropogenic (90Sr, 137Cs, 3H)	Broecker and Peng
3. U-Th series (8 classes)	Chapter 20, Faure
Overview of U-Th decay series	Handouts
Sea level Change	
Particle transformations and colloids	
Particulate Export (short and long term)	Handouts and paper discussion
and Sediment Traps (Th isotopes)	
Gas Exchange (Rn)	
Groundwater flow	Guest Lecture, Moore paper
Soil Erosion	
Sediment Accumulation	Handouts

Exam 2: Thursday March 1st

4. Cosmogenic Radionuclides (6 classes)	
14C	Chapter 27, Faure
How does it work?	
Org. C	
Dating of Seds.	
Atmospheric Mixing	Handouts
Oceanic Mixing	Jenkins paper
Biological Uptake/Primary production	
5. Anthropogenic Radionuclides (6 classes)	Chapter 25, Broecker and Peng
Health Effects	Chapter 22, Lieser, Guest Lecture
Nuclear energy, Nuclear waste disposal	
Savannah River (239/240Pu)	Possible Guest Lecture
Neutron activation analysis	
Ocean Ventilation (3H, 14C)	

Possible Field Trip to Savannah River Site (all day).

Exam 3: Tuesday April 10th