GEOS 605 Geochronology - Fall 2008
Room: 235 NSCI MWF 1:00-2:00
Instructor: Paul Layer Office: 368 NSCI, x5514 Office hours: By appointment

Course Philosophy

This course is designed to briefly outline the major isotopic systems currently in use in geochronology and their specific applications. Some of the uses of radiogenic isotopes in geochemistry and some non-isotopic geochronologic techniques may be discussed. The principle goals of this course are to:

1. Introduce students to the principles of radioactivity and radioactive decay.
2. Demonstrate the applicability of radioactive isotopes to a variety of geologic problems.
3. Discuss the uses and limitations of the various isotopic dating systems.
4. Allow the student to critically evaluate isotopic data that they encounter in the literature.

Course Topic Summary

Week	Date	Topic
1	Sept 5	Introduction
2	Sept 8	Atoms and Decay, Mass spectrometers and measurement
3	Sept 15	Rb-Sr
4	Sept 22	K-Ar
5	Sept 29	40Ar/39Ar dating
6	Oct 6	40Ar/39Ar dating and Diffusion
7	Oct 13	Diffusion and Thermochronometry
8	Oct 20	U-Pb
9	Oct 27	Pb isotopes
10	Nov 3	Fission Track, U-Th/He
11	Nov 10	Sm-Nd
12	Nov 17	Re-Os and other dating methods (student lectures)
13	Nov 24	U-series and other dating methods
14	Dec 1	C-14 and other cosmogenic nuclides
15	Dec 8	Student Presentations

Text

The text for this class is Radiogenic Isotope Geology 2nd edition by Alan P. Dickin, Cambridge Press, 2005. It is a fairly up-to-date book and would make an excellent reference book. The 1st edition of the book is floating around. There isn't much difference, but the 1st edition is a bit out of date.

Another book that we will refer to is Geochronology and Thermochronology by the 40Ar/39Ar Method by Ian McDougall and T. Mark Harrison, Oxford, 1999. I will distribute parts of this book as handouts.

Additional published papers will be distributed to expand on the information in the text. There are many other geochronology books and we will look at sections from some of them as well.

Grading Procedure

Literature discussion	15%	
Classroom lecture	15%	
Paper	45%	*First Draft (15%), Final Paper (25%), Abstract (5%)*
Oral Presentation	15%	
Problem Sets	10%	

Literature Review and Discussions

Each student or team of students will choose (or be assigned) papers to evaluate and lead the class in discussion each Friday. We may do this as a pro- and con- discussion. Grading will reflect the degree of preparation and ability to defend (or repudiate) the premises of the paper. We will also discuss or go over parts of the text. Near the end of the semester I will assign a 'big picture question' (i.e. given a particular geologic problem, what isotopic methods would you use to address the problems and why) for discussion on December 1.

Lecture

Each student will choose or be given one topic not covered in other lectures and present a ~30 minute lecture (depending on the number of students) to the rest of the class on that topic. Examples are: Lu-Hf, Re-Os, La-Ce /La-Ba, Nd-Sr-Pb isotopes, K-Ca, Age of the Earth (Pb. Isotopes), Shrimp (SIMS), AMS. This will be the only presentation of the topic in the class. You can have hand-outs and should cover the material in the text and provide a bibliography of current papers on the topic beyond what is in the text. There will be peer evaluation of this lecture.

Paper

The paper is recommended to be about 10-15 pages of text and contain at least 8 references. The topic should be discussed with me by September 24. The first draft of the paper will be due on November 10. It will be evaluated and graded and handed back for revision (Hopefully by November 21). The final draft is due during the last week of class. A 15-20 minute oral presentation accompanies the paper, abstracts (AGU style) will be distributed to the class and are due on December 1. There are two options for this paper.

Option 1:

From your thesis or research area, imagine that you want some geochronologic or other isotopic information: e.g. the age of an ore deposit or stratigraphic section or deformational event; the uplift rate of a mountain; the isotopic signature of a magma source. Write a proposal-type paper that would allow you to collect that information. In some cases this might involve choosing 3 – 5 samples, prepare them for irradiation and 40Ar/39Ar analysis or for sending to another laboratory. It is doubtful that we will be able to analyze them this semester, but you never know. Write up the geologic background for the project, the geologic problem that you hope these will address, the rationale for selecting the samples that you did, the methodology that you used to prepare the samples and how you might interpret the data that you will obtain. This could ultimately lead to a chapter in your thesis.

Option 2:

Choose an isotopic systems, dating method or application, preferably one that is not well developed or somewhat controversial. Outline the principles of the methods and how they can be applied to a problem such as your thesis or research area or another area of interest to you. Discuss the

information that you hope to be able to get from the use of isotopes. Pay special attention to the limitations of the method (i.e. is the method precise enough to resolve your problem and what the fundamental assumptions in the methodology are).

Problem sets/assignments

During the first few weeks of the semester, I will assign problems to allow students to practice manipulating the equations used in geochronology. In addition, each student will participate in collection of data from one or two samples that the lab is working on for 40Ar/39Ar dating. You will work with me on data reduction, interpretation and presentation. The discussion will be done during one of the "Literature discussion" days. These data may be part of the paper.

Sitting in on the class or auditing

People "just sitting in" will be asked to give a brief presentation on the use of isotopes in their field and lead one of the discussion topics or lead a lecture when I am on travel.

Disability Services

The Office of Disability Services implements the Americans with Disabilities Act (ADA), and insures that UAF students have equal access to the campus and course materials. I will work with the Office of Disabilities Services (203 WHIT, 474-7043) in order to provide reasonable accommodation to students with disabilities.

I expect students to follow the Student Code of Conduct (page 83 of the 2008-2009 UAF Catalog).

Tentative Course Schedule

#	Week	Month	Day	Topic and Readings
1.	Week 1	**Sept**	5	Introduction. What is the age of a rock? The Atom; Isotopes and Isobars (ch. 1)
2.	Week 2		8	More about atoms and radioactive decay (ch. 1.3, 1.4)
3.			10	Decay and Mass Spectrometry (ch. 2)
4.			12	Isochrons and errors (ch 2.3)
5.	Week 3		15	**FT2008 *RESCHEDULE as lab tour/discussion***
6.			17	Rb-Sr dating as a 'generic' geochron method (ch 3)
7.			19	**Discussion about decay constants and geochronology**
8.	Week 4		22	Rb-Sr and K-Ar dating *******Paper topic due***
9.			24	K-Ar Methodology (ch. 10)
10.			26	**Literature Discussion**
11.	Week 5		29	$^{40}Ar/^{39}Ar$ Methodology (ch. 10)
12.		**Oct.**	1	$^{40}Ar/^{39}Ar$ Methodology (ch. 10) **Lecture topic assigned**
13.			3	**Literature Discussion**
14.	Week 6		6	Step Heating and comparison to K-Ar
15.			8	**Diffusion "Lab" ****Paper outline and bib due**
16.			10	Thermochronometry and Diffusion Data Analysis
17.	Week 7		13	Thermochronometry and Diffusion Discussion
18.			15	Applications and New Techniques
19.			17	**Literature Discussion**
20.	Week 8		20	The U, Th - Pb methods of dating (ch 5)
21.			22	U, Th - Pb dating
22.			24	**Literature Discussion**
23.	Week 9		27	New Methods: SHRIMP and single grain dating
24.			29	Pb isotopes
25.			31	**Literature Discussion**
26.	Week 10	**Nov.**	3	Fission Track dating (ch 16)
27.			5	U-Th/He
28.			7	**Literature Discussion**
29.	Week 11		10	Sm-Nd dating ch 4 ****** First Draft Due**
30.			12	**CCAS meeting *RESCHEDULE*** (Re-Os and other methods)
31.			14	**CCAS meeting *RESCHEDULE***
32.	Week 12		17	Isotopes of Nd and Sr (ch 6, 7)
33.			19	**Student Lecture**
34.			21	**Student Lecture **** First Draft Returned**
35.	Week 13		24	Thermoluminescence, ESR, Pleochroic Haloes, etc.
36.			26	U-Series (ch 13)
37.			28	***THANKSGIVING – No Class***
38.	Week 14	**Dec.**	1	U-Series (ch 12)
39.			3	C-14 dating (ch 14)
40.			5	**Literature Discussion **** Abstract Due**
41.	Week 15		8	Cosmogenic Nuclides
42.			10	**Student Presentations**
43.			12	**Student Presentations ************Final Paper Due**
	Week 16			Final exam time: **AGU -- *RESCHEDULE* Student Presentations**

Let me know if there are topics that you want to see covered in the class. This is a flexible schedule
I will be on travel for 3 lectures and the final (and may have other appointments that I cannot get out of). We need to reschedule these classes or I will try to get a guest lecturer.