GEOS 618 (3 credits) INTRODUCTION TO GEOCHEMISTRY Fall 2005

Class: TR 11:30 am-1pm NSCI 235 Prerequisites: Chem 106+ Geos 322 or Chem 202
(mandatory) Recitation: TBA (hopefully Weds. afternoon?) NSCI 237

Instructor: Rainer Newberry NSCI 328 X6895 ffrn@uaf.edu home: 479-0140
Office Hours: Monday 10-1,3-5 & by arrangement—I can be around evenings & weekends

Textbooks: **Faure, Geochemistry, 2nd ed.** and Rollinson, Using Geochemical Data. Xeroxes of Butler and a few supplementary readings will be in the Geology student workroom (NatSci 314).

Course Description: This course is an introduction to how one applies chemical principles and ideas to geologic problems. It will cover:

1. Low Temperature ('classical') Geochemistry of elements and isotopes
2. Kinetics applied to geological problems
3. Cosmogeochemistry and geochemistry of igneous and metamorphic rocks & processes

This course is a little different from many you have taken, as it transcends two different disciplines--chemistry and geology. Many students have some difficulty with this course. Please don't let that scare you off: most people have also had at least some difficulty in learning to ride a bike or drive a car, too. It is my job to make this somewhat difficult experience also enjoyable and rewarding. I strongly encourage your feedback in this regard. With your cooperation we can all have a good time and learn a great deal. This is a graduate course and I have higher expectations for the students in this class than I have for students in Geos 417.

Course Goals:

1. To establish a framework of basic chemical concepts,
2. To present a general overview of how the elements and isotopes behave in nature,
3. To specifically demonstrate scientific methods (hypothesis testing) and uncertainties.

Student Learning Outcomes: By actively participating in this course you will become proficient at

1. Expressing chemical concentrations in a variety of units; converting between units
2. Converting between concentrations, activities, and fugacities
3. Expressing geochemical problems in terms of chemical equilibrium expressions
4. Solving chemical equilibrium expressions as functions of T, P, and chemical composition
5. Construction of a variety of phase diagrams involving fluid composition and Temperature
6. Expressing mineral stability as a function of oxidation state and pH
7. Stable Isotope nomenclature & stable isotope fractionation expressions
8. Interpretation of radiometric isotopic data for determining ages of rocks and minerals
9. Use of trace elemental data for understanding the origins of igneous rocks
10. Use of Microsoft Excel for computation and graphing

Instructional Methods: Daily reading and problem assignments will be made to accompany the lectures. Problems from a given Tuesday → Thursday will be due on the following Tuesday by 5 pm. These problems will be graded by Wednesday afternoon and will be discussed in the recitation. I will give out 'order-of-magnitude' answers for most problems, to give you a sense of 'am I on the right track?' Note that *all answers must be accompanied by appropriate calculations and discussion*. **Students in this class are required to attend the recitation. You will be called on to explain problems to other students in the class. We will also discuss geologic implications of the assigned and similar problems.**

It is vital to complete the weekly homework exercises, as it is essentially impossible to learn the course material without doing so.!! Honest-to-God, it's like learning to drive: you can talk and talk about putting in the clutch and shifting gears, but you never really learn it until you do it.

I encourage you to call me at home (but please, not after 10 pm) if you have questions about the problems, but I have found that it is difficult (and often frustrating) to explain computational stuff over the phone. Consequently, I encourage you to work on the problems ***before*** the night before they're due--that way we can discuss problem difficulties in person at school. I live close to school and can easily come in most evenings and Sundays to help you. If you do your work on a spreadsheet you can email it to me with questions. We can work out something for everyone's needs; the critical objective is to set aside time well before Tuesday for homework and to call for help when you need it.

Course Policies: Naturally, I would like you to attend class and to show up on time**.** If you know you will miss a class or exam, let me know and I will give or email you the lecture notes and assignments and (or) exam in advance**.** *As routine completion of problem sets is essential to understanding the material in this course, I will submit an instructor-designated drop if you are missing more than 2 assignments by the 5th week of classes.* **I also reserve the right to dock points for severely late problem sets**. *Formation of regular study groups has helped many students in past years—but be sure to do your own work.*

Evaluation: There will be two take-home mid-term exams and a final exam. Students with a B average or better on the mid-term who have completed all the problem sets can elect to skip the final examination. The final exam is a take-home exam, due Dec 17, and will cover the entire course, although it will concentrate on the last half of the course. You will also prepare a written and oral presentation concerning some aspect of geochemistry. Ideally, this will involve your thesis research, thesis proposal, or work undertaken for a different current or former class. I will discuss your presentation topic with you individually by the 5th week of class and work with you on it during the semester. You will make your oral presentation during the final exam period, Dec 17, 10am-noon.
Overall class grade based on**:**
problem sets= 45%; mid term exams=25% (40% IF final skipped); final exam=15%; presentation=15%
Final grades will be normalized to the highest point total among students in the class. A point total within 90% of this will be an 'A:, within 80% = B; within 70% of the top score = C, within 60% = D, < 60% = F.

Support Services: Ability to rapidly and reliably perform algebraic operations (equation manipulation, logs, antilogs, exponentials) is critical to geochemical calculations. I highly recommend you consider the Math Lab (305 Chapman), which provides excellent advice, tutoring and assistance, if you have problems with the algebra in this class. Also consider the Office of Student Support Services (508 Gruening, 474-6844) if you find the Math Lab unsatisfactory.

Disabilities 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. UAF is committed to equal opportunity for all students. If you have a documented disability, please let me know within the first two weeks of class, and I will work with the Office of Disabilities Services to make the appropriate accommodation. If you have a specific undocumented physical, psychiatric or learning disability, you will benefit greatly by providing documentation of your disability to Disability Services in the Center for Health and Counseling, 474-7043, TTY 474-7045.

If you are the first in your family to attempt a four-year college degree, and/or eligible for Pell grants, you have opportunities for tutorial and other forms of support from the office of Student Support Services. I will collaborate with the Office of Disabilities and/or the Office of Student Support Services to make your educational experience in my class as positive as possible. Check the following website for further information. http://www.uaf.edu/advising/learningresources/

Calendar* for GEOS 618 Graduate INTRODUCTION TO GEOCHEMISTRY Fall 2005

*** modifications may be made over the course of the semester**

Date	Day	Topic	[1]Reading	[2]Problems
9- 1	R	1. Overview; ions, units, ion names, solubility, K's	F110-13, 130-36; B7-8,11-15	F10#1,2;B2#6
9- 6	T	2. activity vs. conc., pH, simple acids & bases, $K_{a's}$	F113-16; B20-24,31-40	B2#31, 33; 3#1
9- 8	R	3. intro to weak acids & polyprotic acids	F 115-121; B 42-47, 69-71	F9#6, B 4#3,+
9- 13	T	4. predominance diagrams, weak bases	F 121-28; B1-6, 48-53, 74-78	F 9#7,B4#28,+
9- 15	R	5. complexation, buffers, activity calculations	F 137-42; B26-27, 62-64	B4#34,F10#5,6
9- 20	T	6. Elemental patterns: Lewis H & S acids & bases	Gill 160, 201,207; F84-7,91-6	+
9- 22	R	7. Carbonate and phosphate equilibria	F 142-148	F10#8 **note**,14#3
9-27	T	8. Chemistry of weathering	F 148-151; 342-51	F 11#9, 20#2 **note**
9-29	R	9. activity diagrams—mineral/solution interactions	F 151-2, 172-182, 190-93	F11#7',12#1,+
10- 4	T	10. overview of thermodynamic functions	F 155-163	F11#1,2,3,+
10- 6	R	11. ΔG, ΔG(T, P, comp.), and K_{eq}	F 163-170	F11#4,5,6
10-11	T	12. ΔG from electrochemisry, Eh-pH diagrams	F 226-238	F14#4ab,7,10
10- 13	R	13. Eh-pH II; Fe + some S equilibria	F 238-250	F14#8, 5
10- 18	T	14. Eh-pH III: weathering & groundwater	F400-413	F 14#9,11
11-20	R	15. Kinetics, part I—reaction order, T-dependence	F 253-258	F15# 2,3,4
10- 25	T	16. Kinetics, part II—diffusion and related processes	F 259-270	TAKE HOME
10-27	R	17. Applications of kinetics to Radiometric Dating		**MID-TERM**
11- 1	T	18. Light stable isotopes I: principles	F301-12 ; R266-71,304-8	F17#6,8,11
11- 3	R	19. Light stable isotopes II: applications to low T	F313-323; R285-89, 295-301	+
11- 8	T	20. Applications of stable isotopes to high T	R271-84; 308-314	+
11- 10	R	21. Formation & cosmic abundance of the elements	F 13-20	F 2#3,+
11- 15	T	22. Thermo of melting; intro to trace elem behavior	Gill 36-43, 45	+
11-17	R	23. Elemental distributions in minerals & the earth	F46-50, 99-107	F 4#2 (KBK Si), 3,4; 8#2,5,6
11-22	T	24. Igneous Rocks: names & generalized genesis	R, p. 48-63, 76-77	+
11-24	**R**	**THANKSGIVING HOLIDAY**		
11-29	T	25. Trace elements in igneous rocks I: Theory	R102-133	+
12- 1	R	26. Trace elements--rock & tectonic environment I.D.	R166-170	+
12- 6	T	27. Mafic rocks & their trace element behavior.	R172-193	+Class of Ak rx
12- 8	R	28. Felsic Rock Tectonic environments & Interior Ak		None
12-17	S	10:15 am**: presentation of final projects	*Will change as class wishes	

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[1]Reading assignments F= Faure, Geochem 2nd ed; R=Rollinson (supplemental text); B= Butler (many zerox copies will be available); + =additional reading to be assigned-- available in the Geology Dept student work room.

[2]key: 1st # = chapter number; 2nd = problem number (F= Faure, B= Butler); + = additional problems to be assigned