GEOL 445 SYLLABUS

High Temperature Geochemistry
Fall 2012
Tuesday & Thursday: 12:30 p.m. - 1:45 p.m.
PLS1172

Date	Subject	Reading*
Aug. 30	Geochemistry in a cosmic perspective, course structure and philosophy	
Sept. 4	Meteorites and cosmochemical abundances	White, Ch. 10, p. 433-446
Sept. 6	Stars: birthplace of the elements (nucleosynthesis)	L & B Ch. 3 White, Ch. 10 p. 421-433
Sept. 11	Nucelosynthesis, continued	
Sept. 13	Planetary accretion, differentiation, the solar system	White, Ch. 10, p. 457-473; Halliday
Sept. 18	topics of 9/13, continued	L & B Ch. 5
Sept. 20	Chemistry review – atomic structure, periodic table	White, Ch. 1 p. 6-11
Sept. 25	Bonding and crystal chemistry, mineralogy review	White Ch. 1 p. 11-14, 17-18; Walther Ch. 5 p. 149-158
Sept. 27	Element partitioning, classification of elements	White, Ch. 7 p. 260-273
Oct. 2	**Exam 1 (covering material through 9/27)**	
Oct. 4	Equilibrium thermodynamics	Gill, Ch.1; White, Ch. 2; Eby, Ch. 2 p. 27-36
Oct. 9	topics of 10/2, continued	
Oct. 11	Melting in the mantle, igneous differentiation	Walther Ch. 8, p. 255-266, 275-283
Oct. 16	topics of 10/13, continued	
Oct. 18	Trace element geochemistry	White, Ch. 7, p. 272-284; 290-291; 302-303; Shaw, Ch. 7, p. 142-158
Oct. 23	topics of 10/18, continued	
Oct. 25	Radiogenic isotopes: dating	White, Ch. 8, p. 313-314; 318-327; Walther Ch. 10, p.
Oct. 30	topics of 10/25, continued	

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Date	Subject	Reading*
		357-373
Nov. 1	Radiogenic isotopes: tracing	White, Ch. 8 p. 327-332; Walther
Nov. 6	topics of 11/1, continued	Ch. 10, p. 373-378
Nov. 8	**Exam 2 (covering material from 10/4 to 10/30)**	
Nov. 13	topics of 11/1, continued	
Nov. 15	Diffusion and kinetics	White, Ch. 5
Nov. 20	topics of 11/15, continued	
Nov. 22	**THANKSGIVING!**	
Nov. 27	Composition and differentiation of the Earth: The Core	White, Ch. 10, p. 473-478, Ch. 11 p. 501-507
Nov. 29	topics of 11/27, continued	
Dec. 4	Composition and differentiation of the Earth: Crust-mantle differentiation	White, Ch. 11 p. 507-517, 524-546
Dec. 6	topics of 12/4, continued	
Dec. 11	Project presentations	

Comprehensive Final Exam: Thursday, December 18, 1:30-3:30 pm

Laboratory/Section schedule

Week	Date	Place	Exercise
1	Sept. 5	Computer lab: Geol 3120	Cosmochemical abundances exercise
2	Sept. 12	Geol 2117	Nucleosynthesis exercise*
3	Sept. 19	Geol 2117	**Project:** thin section characterization, mapping and modes
4	Sept. 26	Geol 2117	Chemistry review problem set*
5	Oct. 3	Smithsonian	Fieldtrip to tour the rock and meteorite collections at the Natural History Museum
6	Oct. 10	Probe lab: Room 1237D Kim Bldg	**Project**: electron probe analyses
7	Oct. 17	Computer lab: Geol 3120	Mantle melting exercise: calculation of G, phase diagrams
8	Oct. 24	Computer lab: Geol 3120	**Project:** Work with your lab buddies to evaluate EMPA data, produce final data tables of major elements.
9	Oct. 31	ICP-MS lab: Room 0223 Chemistry	**Project**: LA-ICP-MS analyses
10	Nov. 7	Computer lab: Geol 3120	REE modeling exercise
11	Nov. 14	Computer lab: Geol 3120	Isotope geochemistry exercise: Rb-Sr
12	Nov. 21	Thanksgiving week	No lab
13	Nov. 28	Computer lab: Geol 3120	**Project:** Data evaluation, modeling and plotting
14	Dec. 5	Computer lab: Geol 3120	**Project:** Data evaluation, modeling and plotting

*For these labs a laptop would be handy – bring one if you can.

Professor

- Roberta Rudnick, contact: 5-1311, Rudnick@geol.umd.edu, Office 0223b Chemistry, office hours: by appointment (send email).

Teaching Assistant

- Dana Borg, contact: dborg@umd.edu, Office 1221A Chemistry, office hours: by appointment (send email)

Course Description

This course provides an introduction to high temperature geochemistry for upper level geology majors and beginning graduate students. The course focuses on understanding the fundamentals of geochemical processes and using this understanding to investigate nucleosynthesis, origin of the solar system, composition of the earth and planets, accretion and differentiation of the earth, composition and evolution of the core, mantle and crust.

Prerequisites: Math 115, Geol 100, General chemistry (CHEM 103), Mineralogy (GEOL 322)

Textbook

Although there are a plethora of geochemistry textbooks, and many of these are listed in the bibliography at the end of this syllabus, I have never found one that that is fully adequate. For this reason I am assigning readings from a variety of different books and literature. Note that a number of the chapters come from Bill White's geochemistry textbook, which is currently in press.

Please do the assigned readings before attending the lecture on the topic. The reading assignments are an important complement to the lecture materials. Exam questions will be based primarily on topics covered in lectures and supplemented with the readings.

Course Web Site and emails

The website for this course is available on the Blackboard web site: https//umd.blackboard.com. If you are registered for the course and you go to this site, you will be able to log in using your University Directory username and password. There you will find all relevant course materials (syllabus, problem sets, etc.), which you may download. ***It is highly recommended that you access this site immediately and check it on a regular basis***.

Emails will be sent via this web site. The site uses whatever email address you have registered with the University Directory. ***It is your responsibility to ensure that your email address is correct and current.***

Lecture Materials

PDFs of Powerpoint or overhead transparencies will be available for you to download on the Blackboard website. I recommend you either print them out or download the pdf and bring these to class in an accessible form so that you can take notes on them.

Laboratories

These will generally be held in room 2117 of the Geology building. Rather than a "lab", most of these sessions will be devoted to completing problem sets and are therefore better described as "sections". Many of these problem sets will require the use of computers in order to carry out calculations and make plots. In these cases, the lab will be held in the Geology computer lab (room 3120). We will also use this time period to go on a one-day fieldtrip to the meteorite and rock collection at the Smithsonian Institution (see below) and to visit analytical laboratories and carry out analyses as part of a semester-long project.

Fieldtrip

There will be a fieldtrip to the Smithsonian Institute's rock and meteorite collection. It will include behind-the-scenes tours of the meteorites by the curator, Tim McCoy, and rocks and minerals, by the curator, Sorena Sorensen. Tentative date is Wednesday, Oct. 3rd, leaving UMD at 1 pm via the Metro. Students can also arrange to meet the group at the Smithsonian at 1:45 pm. Further details will be provided at a later date.

Problem Sets

- Problem sets (to be undertaken in the lab sections) are very important for learning the course material. Accordingly, the grade for problem sets accounts for a quarter of your final grade. It is therefore very important to turn in all of your problem sets on time.
- Type your answers to problem sets out on a word processor (we need to be able to read what you've written!).
- Mathematics can be done by hand, but please, *make it neat*!
- You will need to use spreadsheets for some problems. In these cases, please email your Excel spreadsheet as an attachment.
- Be sure to make it clear how you got to the answer you've provided. No points will be given for simply providing the answer without explanation.
- While we encourage you to work together on problem sets, the material handed in should reflect your work and no-one else's. You will be individually responsible for knowing the material and you will be examined on it.
- **Please put your name** on any file you send.
- ***Problem sets are to be handed in on the due date. Ten percent will be deducted from the score for each day late (including weekend days).***

Semester Project

Six of the lab sessions will be devoted to carrying out analyses, evaluating the data and communicating the results as part of a semester-long project focusing on the most abundant magma type on Earth – mid-ocean ridge basalts (MORB). You will carry out this work in two-person teams, which will be determined based on the background of

each individual and schedules. The first session will involve detailed petrography of polished thin sections of the sample. The second session will be held in the electron microprobe laboratory where you will undertake major element analyses of the minerals in the section. In the third session you will organize and evaluate your EMPA results. The fourth session will be held in the ICP-MS laboratory, where you will undertake laser ablation analyses of the minerals. The next two sessions will be devoted to working with all of the data, making interpretations and presenting your results. Each group will then prepare a presentation to be given to the class on the final day of class.

Quizzes

Quizzes will be given on the assigned reading material at the beginning of most/many classes. To do well on these quizzes, you will need to have completed the reading assignment *before* the start of class.

Attendance

Attendance at lectures is strongly encouraged. If you know in advance that you cannot make a lecture, let me know and I will make arrangements for you to obtain the material covered. Unfortunately, there will be no make-up of the quizzes.

Structure and Grading

The course will consist of two 1 1/4 hour lectures per week, Tuesdays and Thursdays at 12:30 pm in room 1158 of Plant and Life Sciences Building and one lab/section held Wednesdays from 1 to 4 pm (see schedule for venue). Grading will be assessed on the basis of classroom participation and quizzes (5%), presentation of the semester project (5%), problem sets and labs (25%), 2 midterm exams (20% each) and a comprehensive final exam (20%). Although the final exam is comprehensive, it will be weighted toward material covered following the second midterm exam.

Course Evaluation

CourseEvalUM will be open for evaluations for Fall 2011 courses between Tuesday, November 27, and Wednesday, December 12. Please go directly to the website (www.courseevalum.umd.edu) to complete your evaluation. You will be alerted about these dates via their official University e-mail account.

As a bonus for being good, if you have completed evaluations for all of your courses in the previous semester (excluding summer), you may access the posted results via Testudo's CourseEvalUM reporting link for any course on campus that has at least a 70% response rate. Also, think about future generations of students – tell us what worked, what didn't work and how we can improve the course in the future!

Bibliography for Geol 445

The following texts may be used for supplemental reading, as well as reading assignments, which will be available via Blackboard. Some lecture material is drawn from these books, as noted in parentheses.

Albarède, F., 2003, Geochemistry, an Introduction, Cambridge Univ. Press (concise, quantitative geochemistry text)

Albarède, F., 1995, Introduction to Geochemical Modeling, Cambridge Univ. Press (Sourcebook for useful equations)

Brownlow, A.H., 1996, Geochemistry, 2nd edition, Prentice-Hall. (General geochemistry principles, isotope geochemistry, mantle melting)

Dicken, A.P., 1995, Radiogenic Isotope Geology, Cambridge University Press. (Isotope geochemistry)

Faure, G., 1998, Principles and Applications of Geochemistry, 2nd edition. Prentice-Hall. (atomic structure, periodic table, general chemical principles)

Faure, G. and Messing, T., 2005, Isotopes: Principles and Applications, 3rd edition. John Wiley & Sons. (Isotope geochemistry)

Gill, R. 1989, Chemical Fundamentals of Geology, Chapman and Hall (good review of chemical principles for the geologist, lots of nice diagrams)

Langmiur, C.H. and Broecker, W.S., 2012, How to Build a Habitable Planet. Princeton University Press. (Nucleosynthesis, cosmochemical abundances)

McSween, H., Richardson and Uhle, 2003, Geochemistry: Pathways and Processes, 2nd Ed., Columbia Univ. Press. (Diffusion)

Shaw, D.M., 2006, Trace Elements in Magmas. A theoretical treatment, Cambridge University Press (Trace element modeling)

Walther, J.V., 2005, Essentials of Geochemistry, Jones and Bartlett

Zhou, H., 2007, Quantitative Geochemistry, Imperial College Press (for the more quantitatively inclined student).

Academic Accommodations:

If you have a documented disability, you should contact Disability Support Services 0126 Shoemaker Hall. Each semester students with documented disabilities should apply to DSS for accommodation request forms, which you can provide to your professors as proof of your eligibility for accommodations. The rules for eligibility and the types of accommodations a student may request can be reviewed on the DSS web site at http://www.counseling.umd.edu/DSS/receiving_serv.html.

Religious Observances:

The University System of Maryland policy provides that students should not be penalized because of observances of their religious beliefs, students shall be given an opportunity, whenever feasible, to make up within a reasonable time any academic assignment that is missed due to individual participation in religious observances. It is the responsibility of the student to inform the instructor of any intended absences for religious observances in advance. Notice should be provided as soon as possible but no later than the end of the schedule adjustment period. Faculty should further remind students that prior notification is especially important in connection with final exams, since failure to reschedule a final exam before the conclusion of the final examination period may result in loss of credits during the semester. The problem is especially likely to arise when final exams are scheduled on Saturdays.

Academic integrity:

The University of Maryland has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit http://www.studenthonorcouncil.umd.edu/whatis.html

- The University of Maryland is one of a small number of universities with a student-administered Honors Code and an Honors Pledge, available on the web at http://www.jpo.umd.edu/aca/honorpledge.html. The code prohibits students from cheating on exams, plagiarizing papers, submitting the same paper for credit in two courses without authorization, buying papers, submitting fraudulent documents, and forging signatures. The University Senate encourages instructors to ask students to write the following signed statement on each examination or assignment: "I pledge on my honor that I have not given or received any unauthorized assistance on this examination (or assignment)."