Course Syllabus as of February 9, 2015
Geol 5450 - Geochemical Modeling, Spring 2015
Department of Geology and Geophysics, University of Wyoming

Instructor	
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Office Hours: Tues and Thurs 9:30 – 10:00a, Wed 3 – 4p, and by appointment	

Course Information: 11:00 am - 12:15 pm Tues/Thurs in Room 1006. In addition we will meet for approximately 6 hours on Saturday February 7, 2015. No class on January 27 or 29.

Prerequisites: GEOL 4777/5777 – Geochemistry of Natural Waters **OR** Geol 5610 – Geological Thermodynamics I **OR** GEOL 4490 – Geochemistry **OR** Consent of Instructor

Course Description: Modeling of geochemical processes in fluid-rock systems of the Earth's crust. Emphasizes development and application of conceptual models as well as quantitative numerical models. Reinforces and expands fundamental skills in aqueous and fluid-rock geochemistry to better understand geochemical processes and solve problems in fluid-rock systems. 3 credit hours. Limited to 10 students.

Disability Statement: If you have a physical, learning, sensory or psychological disability and require accommodations, please let me know as soon as possible. You will need to register with, and provide documentation of your disability to University Disability Support Services (UDSS) in SEO, room 330 Knight Hall, 766-6189, TTY: 766-3073.

Course Objectives/Outcomes/Standards: In this course students will reinforce and expand fundamental skills in aqueous and fluid-rock geochemistry to better understand geochemical processes and solve problems in fluid-rock systems. Geochemical modeling skills will be developed as a tool to perform these functions and, in the process, to improve understanding of geochemistry in natural systems. Both conceptual and numerical models will be developed and employed. At the conclusion of this course students will be able to apply geochemical skills to a wide range of fluid-rock problems that include geothermal energy, oil and gas, environmental geology, geologic carbon sequestration, diagenesis, hydrothermal systems, and contact metamorphic aureoles. In addition, students will develop geochemical problem solving skills as well as computer modeling skills prized by employers in a variety of geologic and engineering disciplines.

Primary Text: Craig M. Bethke, 2008, *Geochemical and Biogeochemical Reaction Modeling*, Cambridge University Press; 2 edition, ISBN-10: 0521875544, ISBN-13: 978-0521875547, 564 p.

Supplemental Books:

- Drever, J.I. (1997) *Geochemistry of Natural Waters: Surface and Groundwater Environments*, 3rd ed. Prentice Hall, 436 pp.
- Langmuir, D., 1997, *Aqueous Environmental Geochemistry*. Prentice Hall.
- Krauskopf, K.B. and Bird, D.K., 1995, *Introduction to Geochemistry*, 3rd Ed. McGraw-Hill, Inc.
- Nordstrom, D.K. and Munoz, J.L., 1985, *Geochemical Thermodynamics*. Benjamin Cummings Publishing Co.
- Stumm, W. and Morgan, J.J., 1996, *Aquatic Chemistry*, 3rd Ed. John Wiley & Sons.
- Grenthe, I., and Puigdomenech, I., 1997, *Modeling in Aquatic Chemistry*, Nuclear Energy Agency.
- Garrels, R.M., and Christ, C.L., 1982, *Solutions Minerals and Equilibria*, Freeman Cooper Co.
- Anderson, G.M., and Crerar, D.A., 1993, Thermodynamics in Geochemistry: The Equilibrium Model, Oxford University Press.

Computer Software: We will use the software code Geochemist's Workbench (abbreviated GWB) Standard 10.0 (http://www.gwb.com/), which I will provide for use in the course. This software is provided on an academic teaching license and is restricted to coursework. If you use GWB for your research then you'll have to obtain and use an official copy. User's manuals for this software are included in the software as PDF files.

Course Requirements/Assignments: In each 75 minute class meeting we will typically spend time in lecture and on the computer. Reading and problem sets are listed in the course outline. Reading assignments include material from your modeling textbook and the software manuals as well as relevant geochemistry textbooks and primary literature. Reading assignments should be completed prior to the class period as they serve as supplemental material. Bring your questions to class. The Saturday session will be a full day's immersion into the software and its application to geochemistry. Problem sets will be posted on the web by Tuesday noon of each week and due by the beginning of class on Tuesday of the following week. Problem sets will be submitted as PDF files via Course Studio. Information regarding Course Studio is provided on the last page of this syllabus.

Course Assignments/Grading: The course will be graded on the basis of problem sets (45% of grade) and a Term Project. The Term Project consists of a paper (45% of grade) and a class presentation (10% of grade).

Problem Sets. Problem sets will be assigned every week, depending on how things are going. No exams will be administered. I use standard percentages to assign grades (e.g., ≥ 90% = A, 80-89% = B, etc.). I do not grade on a curve. We will have approximately 9 problem sets, depending on how well students are able to master course objectives. Work turned in late (without prior consent of the instructor) will be penalized at a rate of 10% per day. You are encouraged to work together on the problem sets, and seek help from people and sources in addition to me. However, each assignment should be your own work. Learning how things work, developing your own understanding of the problem, submitting solutions that represent your own thinking, and conscientious completion of the problem sets are probably the most important keys to success on understanding this material.

Term Project. Everyone must complete a term project. The final products of this project will be a written paper and a class presentation. The project must consist of original work and can take the form of:

1) a research project conducted as part of a thesis, job, or other venue
2) an in-depth critical review of the literature of a topic related to the course content
3) a report on original field-based, theoretical or experimental research project undertaken solely for this course
4) a well-researched and documented proposal for a research, thesis, or dissertation project

Time Table for Term Project
February 20, 2015 – tentative title of project due
February 27, 2015 – project title due
March 6, 2015 - paper outline due
March 13, 2015 - annotated bibliography due (list of most of the references you intend to use with brief notes summarizing their contents)
April 10, 2015 - draft paper and presentation outline due. I will not read additional drafts or outlines outside of office hours after this date.
April 21-23, 2015 – Student Presentations (Status of Ongoing Project, not graded); two to three presentations per class period. Assess student problems & solutions as a class. Critique presentations.
May 5-7, 2015 – Final Student Presentations (graded); two to three presentations per class period. Critique presentations
May 8, 2015 - Final paper due

Detailed information on the paper and on the presentation are provided in separate handouts.

Lecture Final Exam: None.

Attendance/Participation Policy: University sponsored absences are cleared through the Office of Student Life. If you plan to be gone at any time during the semester and your absence will be officially authorized by UW, please contact me beforehand so that we can work out some way for you to make up any assignments. Any absences from class as a result of illness will require proper documentation from your physician.

Academic Honesty: UW Regulation 6-802. The University of Wyoming is built upon a strong foundation of integrity, respect and trust. All members of the university community have a responsibility to be honest and the right to expect honesty from others. Any form of academic dishonesty is unacceptable to our community and will not be tolerated [from the UW General Bulletin]. Teachers and students should report suspected violations of standards of academic honesty to the instructor, department head, or dean. Other University regulations can be found at:
http://uwadmnweb.uwyo.edu/legal/universityregulations.htm.

Course Outline and Reading Assignments for Geol 5450: Geochemical Modeling

	Lecture Topic	Reading Assignments (Bethke 2008)	Reading Assignments (Users Manual)	Recommended review in Langmuir 1997 OR Drever 1997	Other
Tues Jan 27	No Class				
Thurs Jan 29	No Class				
Tues Feb 3	Introductions and course mechanics	None	None	None	---
Thurs Feb 5	Geochemical models; equilibrium	Preface, A note about software, Ch 1 & 3	---	Langmuir Chapter 1 Drever Ch 2	---
Saturday Feb 7	**Saturday Class**	Chapters 2, 4, 5, 6, 11, 12, & 13	---	Langmuir Ch 7, 8, & 9 Drever Ch 10 & 12	GWB basics, phase diagrams, equilibrium
Tues Feb 10	Equilibrium models	Chapter 8	---	Langmuir Chapter 1 Drever Ch 2	Problem Set 1 – Equilibrium Geochemistry
Thurs Feb 12	Equilibrium models	Helgeson et al., 1969	---	---	---
Tues Feb 17	Databases	---	---	---	Problem Set 2 – Equilibrium Geochemistry, Complexes
Thurs Feb 19	Carbonate chemistry	Chapter 15	Reaction Modeling Guide Chapter 2	Langmuir Ch 3, 5, & 6 Drever Ch 3	---
Tues Feb 24	Carbonate chemistry	---	---	---	Problem Set 3 – Carbonate Geochemistry
Thurs Feb 26	Redox equilibria	Chapters 7 & 28	Essentials Guide Chapter 5	Langmuir Ch 11 & 12 Drever Ch 7 & 8	---
Tues Mar 3	Redox equilibria	---	---	---	Problem Set 4 – Carbonate Geochemistry and Redox Equilibria
Thurs	Redox equilibria	---	---	---	---

Mar 5					
Tues Mar 10	Redox equilibria	---	---	---	Problem Set 5 – More Redox Equilibria
Thurs Mar 12	Kinetics	Chapters 16 & 26	Reaction Modeling Guide Ch. 4 & 5	Langmuir Ch 2 Drever Ch 11	---
Tues Mar 17	**Spring Break**	None	---	None	None
Thurs Mar 19					
Tues Mar 24	Kinetics	---	---	---	Problem Set 6 – Kinetics
Thurs Mar 26	Kinetics	---	---	---	---
Tues Mar 31	Kinetics	---	---	---	---
Thurs Apr 2	Kinetics	---	---	---	---
Tues Apr 7	Large Datasets	---	Essentials Guide Chapter 3	---	Problem Set 7 – Large Datasets
Thurs Apr 9	Water-Rock Systems Exhibiting Extreme Geochemistry	Chapters 22, 24, 29, 30, 31, 32	---	Langmuir Ch 5 & 6 Drever Ch 3, 9, 13, & 15	---
Tues Apr 14	Water-Rock Systems Exhibiting Extreme Geochemistry	---	---	---	Problem Set 8 – Water-Rock Systems Exhibiting Extreme Geochemistry
Thurs Apr 16	Water-Rock Systems Exhibiting Extreme Geochemistry	---	---	---	---
Tues Apr 21	Student Presentations (Status of Ongoing Project)	---	---	---	Assess student problems & solutions as a class
Thurs Apr 23		---	---	---	
Tues Apr 28	Critical Analysis of Water-Rock	---	---	Langmuir Ch 7, 8, & 9	Problem Set 9 – Critical Analysis

	Systems			Drever Ch 10 & 12	of Water-Rock Systems
Thurs Apr 30	Critical Analysis of Water-Rock Systems	---	---	---	---
Tues May 5	Final Student Presentations	---	---	---	Graded
Thurs May 7		---	---	---	

Changes: The instructor may make changes to the syllabus as the course proceeds. If necessary, these changes will be announced in class. Substantive changes made to the syllabus shall be communicated in writing. The course schedule is an outline of the major topics we will discuss in class. Given the breadth of material that we will discuss as well as the diversity and level of student interest, we will undoubtedly deviate from this course outline. Thus, the schedule will be flexible and will evolve through time. "To be announced" scheduling later in the semester is designed to maximize this flexibility.

Online Resources: We will use *WyoCourses* for the online course platform to post announcements, reading material, course syllabus, etc. Consult this website regularly for announcements and other information. Students are automatically enrolled in this course website.

The developer of GWB operates an online forum (http://forum.gwb.com/. The forum shares comments and results and answer questions of general interest. The forum also serves as a bulletin board for posting announcements, bug notices, patches, and other current information about GWB.