HYDROGEOCHEMISTRY
GLY 5245, Section 07F3; GLY4930, Section21F7
Spring 2017

Instructor: Dr. Jon Martin
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Office Hours: 2-3 pm Mon/Weds or by appointment (call or email first)
Meeting Place: 218 Williamson Hall
Meeting Time: Wed/Fri 3rd, running into 4th period
Recommended Text: *Geochemistry of Natural Water, 3rd edition*, by James Drever - out of print
Useful texts: *Aqueous Environmental Geochemistry*, Donald Langmuir
Aquatic Chemistry, Werner Stumm and James Morgan
The Global Water Cycle Elizabeth Berner and Robert Berner
Geochemistry, groundwater and pollution, 2nd edition, by CAJ Appelo and D. Postma

Objectives and learning outcomes:

The objectives of this course are to introduce you to thermodynamic and kinetic controls on the chemical composition of "natural" water (i.e., we will not study waste water, water management, water treatment plants, or similar engineered systems). We will apply these fundamental chemical principles to a variety of reactions, mostly between fresh water and the atmosphere, carbonate, silicate, and iron-oxide minerals, as well as reactions in seawater and with other mineral phases. At the end of the class, you should:

1) have a thorough understanding of the theory behind the chemical controls on natural water in multiple systems (groundwater, surface water, seawater);
2) be able solve fundamental problems related to the control of water chemistry and reactions between water and rocks, minerals, and organic carbon;
3) have sufficient proficiency in several computer models to solve similar problems using the programs.

Class Logistics:

The course will include lectures on material from various textbook and other sources. The lecture material will be reinforced by occasional problem sets, approximately one every week or two. These problem sets will be worked on in teams and the answers will be turned in from the teams. The teams are:

Team 1	Scott Augustine; Daniel Fischer, Jennie Ford, Sunny Saini
Team 2	Kyle Chardi, Jacob Grigsby, Madison Flint, Meeka Mo, Kyle Bostik
Team 3	Shauna Flynn, Arturo Ayala, Cynthia Hotuject-Kanter, Mario Cortazar

We may have occasional recitation sessions in class to work over some of the problems and these problem sessions will be led by one of the three teams. The problem sets will be followed by short quizzes (multiple choice), that will be taken individually and immediately afterward as

teams. One cumulative final will take place the last day of classs. Some ground rules for the homework:

NEATNESS COUNTS. If I don't understand your answers, it will be a problem.
NO LATE WORK WILL BE ACCEPTED!

Some of the problems will require the use of geochemical modeling programs including Geochemist Workbench (a commercial product), TracerLMP, and PHREEQc (both from the USGS). Some of the exercises may be completed using Excel and it is often easier to manipulate data in excel and then copy them into the various programs. I assume everyone is familiar with Excel, but if not, please let me know and we will go over that program as well. We will start with Geochemist Workbench. You can download a student version for free after jumping through a few hoops. You should start to get the program immediately – it will be used in the initial problem set. Check on their website at http://student.gwb.com/student_overview.php for information. We will use the other two programs later in the semester. I will provide details then, but if you are curious, you may download them at http://wwwbrr.cr.usgs.gov/projects/GWC_coupled/phreeqc/ for PHREEQc and at http://ca.water.usgs.gov/user_projects/TracerLPM/ for TracerLMP.

Grading policy:

Grades will be assigned on the basis of the problem sets, quizzes and the final exam.

Work Required	**Tentative Dates**	**Total Value (%)**
Homework	Variable	60
Individual quiz	Variable	5
Team quizzes	Variable	15
Final exams	April 19	20
Total		**100**

Grading scale: ≥93 = A; 90-92 = A-; 87-89 = B+; 83-86 = B; 80-82 = B-, etc. Values will be rounded to nearest whole numbers

Here is some more information, some common sense, other required by the University:

1) Make up exams are highly discouraged, but will be granted if a written excuse is brought from a doctor (for illness) or mortician (for a death in the family).

2) I will be posting various bits of information on Canvas and you should all have access to this website. Please let me know if you don't have access.

3) Although the class is lecture format, I encourage questions and discussion. To encourage discussion, please speak loudly enough for all in the class to hear your questions and/or comments. Whispering to your friends will not be tolerated. If you whisper to your friends, I may ask you to speak up so we can all hear.

4) Attend all classes – most of the test material will come from the lectures. I will not require attendance in the class unless it drops off through the semester. If I am forced to take attendance, the grading policy will shift to reflect that change.

5) Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation.

6) I expect professional behavior in the class at all times. Please show up for class on time and turn off cell phones.

7) All students are expected to follow the University honor code: neither give nor receive unauthorized aid in doing any assignment. Not adhering to this policy will result in a failing grade.

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Topics	**Topics**
Introduction	Units and data presentation - GWB
	Hydrologic cycle and geochemistry
Chemical Background	Thermodynamics
	Math review & the total differential
	Gibbs Free energy and activities
	Activity coefficients
	Complexes
Inorganic carbon	P_{CO2} and alkalinity
	Carbonate mineral equilibrium
Thermo Modeling	PHREEQC
Kinetics	Introduction
	Rate laws
	Natural examples
Redox equilibrium	Valence states and SHE
	Oxidation- reduction half reactions
	Eh-pH diagrams
Redox examples	Organic carbon, photosynthesis and respiration
Clays	Clay mineralogy
	Cation exchange
	Water Isotopes – H & O*
Gas exchange:	Age of water*
	Second Exam

*If time

Important dates:

March 6 – 10: Spring break, no classes
March 29&31: no class, Bahamas
April 19: Exam

Note: *This schedule may, and probably will, change during the semester.*