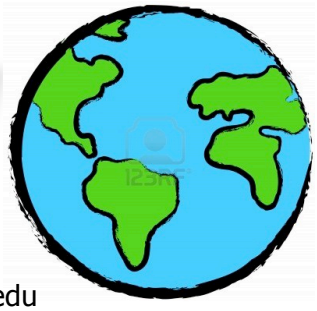
Geochemistry



GEOL 330 • Spring 2013

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Course Goals

In this course, you will:

- apply chemical concepts to predict the outcome of geologic processes;
- use geochemical data to solve applied, real-world problems;
- gather and interpret your own data using the appropriate geochemical methods and instruments; &
- improve your quantitative and scientific writing abilities.

Course Texts: Principles of Environmental Geochemistry by G. Nelson Eby
additional readings that are placed on Moodle

Course Description:

The goal of this course is to introduce you to the concepts, methods, and language of geochemistry. Geochemistry is a broad subject that can be used to study an array of Geologic environments, from the ocean floor to outer space. It is far beyond the scope of this class to cover all the interesting problems that can be investigated with the tools you will learn. Instead, we will focus on aqueous and environmental geochemistry, which are likely to be the subjects that will be most beneficial and helpful to your future. However, be assured that the basic techniques (thermodynamics, kinetics, water quality analysis, etc.) developed in this class can be used broadly.

The semester will be divided between five fundamental concepts of geochemistry. In order to use *geo*chemistry, you must first understand some basic principles in chemistry. Therefore, our first unit will be a review of inorganic chemistry and some associated mathematics. The next concept, solubility, is by far the most important. In this section, we will cover topics such as thermodynamics, solution chemistry, and acid-base reactions. Next we will cover redox chemistry, which is concerned with the transfer of electrons between different phases and with understanding the role of oxygen in the natural environment. The fourth fundamental concept is kinetics, or the rate of chemical reactions. We will not go into this topic in great detail, but rather discuss the limit of equilibrium thermodynamics and practice basic problems. We will wrap up the semester with geochemical weathering, in which you will see the direct application of the previous three fundamental concepts. The subjects covered in this class will be a sufficient introduction to geochemistry to allow you to seek a job in an environmental field or pursue advanced classes in graduate school.

Much of the material in this course may be unfamiliar and may be difficult. In order to be successful, you will need to do significant work out of class. This includes staying up on the reading, working problems well in advance of their due date, reviewing your notes regularly, and most importantly, asking questions about *anything* you don't understand. I am available to help you, but I am not a mind reader. Please let me know about any potential problems or concerns early so that we can work together to solve them.

Course Policies and General Information

- There is no formal attendance policy for this course. However, grades and attendance correlate strongly. I hope that your interest in the subject and your future will keep you coming to class. If you are sick, stay home and get better. If not, come to class.

- Instead of office hours, I have an open door policy; if the door is open, come on in! Additionally, I will be happy to work with you to schedule an appointment.

- For each unit in class, I will provide handouts with important concepts, definitions, and images. There will be a $15 fee to cover the costs of printing this material. The purpose of providing class notes is to keep you organized and to minimize errors associated with copying from the board. However, these notes are deliberately skeletal, and you will need to flesh them out with your own annotations, sketches, explanations, etc.

- 25% of your grade will come from problem sets that will be assigned regularly (approximately every week) throughout the semester. Problem sets will be assigned on Friday and will be due by 5PM the following Friday unless otherwise noted. I encourage you to work and learn together, but you must turn in your own, individual papers. **LATE PROBLEM SETS WILL NOT BE ACCEPTED.**

- Labs will meet on Tuesdays from 1-4 in Julian 228. Lab write-ups will be due at the beginning of class the following week, unless otherwise indicated.

- During the month of April, we will have several field trips to see geochemistry in action! We will plan on going rain or shine, so please dress accordingly.

- For most labs, a brief description of the purpose, methods, and results of the experiment of field trip, with a discussion of the significant findings, will serve as a sufficient write-up. For one lab, though, I would like you to practice writing more formal descriptions of your work. This is to simulate what you may encounter as a professional Environmental Scientist.

- There will be two exams during the semester. I have found that an hour is not a sufficient amount of time for most students to work problems and otherwise demonstrate their full and complete geochemical knowledge. Therefore, exams will take place during the lab period.

- If you have a condition or disability that will affect your ability to participate in any class activity, please make an appointment with Academic Support Services so that we can make appropriate accommodations.

- ****Academic Integrity**** Any activity which gives one student an unfair advantage over other students will be handled in accordance with established University procedures as described in the Student Handbook.

Grading:

Grades will be based on your performance according to the following:

Problem Sets	25% total
Lab Reports – informal	15% total
Lab Report – formal	10% total
In class exam (2)	30% total
Final Exam	20%

Grades will be based on the standard grading scale. I may *increase* your grade based on active participation. The same standard will be applied to everyone.

Technical Lab Write-ups

The career interests of students in this class are likely as varied as the number of individuals present. However, regardless of your future profession, chances are better than likely that you will be called upon to share the results of your work in written communication. Therefore, you will have the chance to practice this skill with a formal lab report. You may choose the specific lab for which you will write the more detailed paper to best accommodate your individual schedule for the semester. This paper is due **Wednesday, May 8**.

The report should contain the following elements:

- Introduction – Provides background on the problem, including any relevant previous work or references, and outlines the objectives of the lab.
- Methods – Includes detailed description of what was done in the lab. Pictures or diagrams are often helpful in this section.
- Results – Data collected during the lab.
- Discussion – An interpretation of what the data mean, including how they relate to the objectives of the lab. If I provide thought questions for a particular lab, it is appropriate to incorporate the answers into the discussion. Note, this should fit with the prose of the paper and *not* be a list of questions with answers.
- Conclusion – *Brief* wrap-up of the report. This section is often a summary of the most significant findings of the lab.

It is important to keep your audience in mind when writing any report. For this assignment, I want you to consider your audience to be a supervisor in a consulting firm. Imagine that your reader is someone who is familiar with geochemical investigations in general, but may not know the details of your specific project.

Feedback is an important part of developing any skill. Therefore, I encourage you to talk to each other and with consultants at the W center while working on these papers. I will also be happy to review sections of your paper well advance of the deadline to give suggestions about your paper.

Approximate Schedule and Important Dates

As you know from your other classes, the pace of any particular course may vary from the ideal schedule for a variety of reasons. Trust me, this is a *good* thing….we wouldn't want to push forward just because the syllabus says so! However, I know of your need to plan for the semester, so here is a guide to the whole semester. Specific topics and reading assignments will be provided with each major section.

Week 1:	Fundamental Concept 1 – Introduction to Geochemistry (chemistry and math review)
Week 2 – 6:	Fundamental Concept 2 – Solubility (thermodynamics, gas solubility, solution chemistry, acid – base chemistry, alkalinity, buffering, complexation)

****Exam 1 – Tuesday, March 19**

Week 7 - 8:	Fundamental Concept 3 – Redox (balancing redox reactions, the Nerst Equation), Eh-pH diagrams)
Week 9:	Spring Break! (have fun, be safe!)
Week 10:	Finish redox (Eh – pH diagrams, acid mine drainage case studies)
Week 11 & 12:	Fundamental Concept 4 – Kinetics (limits of equilibrium thermodynamics, box models, review of derivatives and integrals, rates of reactions)

****Exam 2 – Tuesday, April 30**

Week 13 – 15:	Fundamental Concept 5 – Geochemical Weathering (chemistry of natural waters, redox of natural waters, congruent & incongruent dissolution,)

****Formal Lab Report due – Wednesday, May 8**

****Final Exam – Take home final due by 11AM on Friday, May 16**

Lab and Field Trip Schedule

Labs will meet in Julian 228 on Tuesdays from 1 – 4 p.m., unless otherwise indicated. Lab write-ups will be due **at the beginning** of the next lab period. Late labs will be docked 10% for each 24 hours period past the due date. Late labs will not be accepted after 9 days.

Date	Lab Topic
Jan 29	*no lab*
Feb 5	Lab 1: Data Analysis and Statistical Treatment
Feb 12	Lab 2: Statistical Treatment of Data and Natural Water Chemistry
Feb 19	Lab 3: Determining Thermodynamic Data of Salts
Feb 26	Lab 4: The Effect of Ionic Strength on Solubility (pt 1)
March 5	The Effect of Ionic Strength on Solubility (pt 2)
March 12	Lab 5: Determining Alkalinity by Titration
March 19	*no lab – Exam I*
March 26	*spring break – no lab*
April 2	Field Trip I: Water Sampling at Nature Park
April 9	Field Trip II: Acid Mine Drainage
April 16	Field Trip III: Agricultural Runoff
April 23	Lab 6: Ion Chromatography
April 30	*no lab – Exam II*
May 9	Field Trip IV: RiverWatch