Geology 425
Geochemistry
Department of Geology
Spring, 2007

Credit hours: 4 units
Pre-requisites: GLY 110 or 200, CHM 211 & 212 or consent of instructor. GLY 314 preferred.
Instructor: Aley El-Shazly;
Tel: 696-6756; e-mail: elshazly@marshall.edu
Lectures: TR: 9:30 – 10:45 a.m.
Labs: W 3:00 – 4:50 p.m.
Office Hours: M, W, F: 9:00 - 11 a.m., M: 11:00 – 12, F: 11 – 1; 3 - 5, T,R: 1 - 3 or by appointment.

Course objectives: This introductory course deals with the application of chemical principles to understand geologic processes. Students will learn and understand (1) the distribution of elements in minerals and rocks, and their relative abundances and associations; (2) the quantification of key geological processes relating to the formation of various rock types, (3) the chemistry of aqueous solutions; (4) the principles of age determination for geological events and processes; (5) the principles of stable isotope fractionation and its applications. The lab will be run as an independent class dealing specifically with the practical methods of instrumental analysis, and the preparation of samples for such analyses.

Textbooks: Due to the diverse nature of this subject, there is no "perfect" textbook! I will therefore provide you with copies from some texts and handouts specific to the topic covered each week. However, most reading assignments will be from: "*Introduction to Geochemistry*" by *Krauskopf and Bird* (3nd edition; 1995), a tetxtbook that is **required** for this course. Because this textbook is 12 years old, you may wish to purchase John Walther's new and comprehensive (but not reader friendly!!!) textbook instead. I am therefore attaching 2 different reading assignments to the syllabus, depending on which textbook you buy! Several readings will be assigned from "*The geochemistry of Natural waters" by Drever* (3rd ed.; 1997), a text that is **recommended**, or from other texts. You are strongly encouraged to check out some of the textbooks listed at the end of this handout, as many will come in handy during the semester.

Grade assignment: 3 tests (2 mid-terms and a final)**: 50%, Homeworks: 20%, Lab project + term paper: 15%, Labs: 15%.**
The final exam will be comprehensive, and will consist of short answer questions, problem sets as well as essay type questions. The problems and short answer questions are designed to evaluate your level of understanding and overall knowledge of the subject matter. The essay questions are designed to show your level of understanding and knowledge, as well as how well you can organize your thoughts and express yourself in writing.

Homework assignements will be handed out almost every week, and are due a week later. Homeworks that are turned in late will be penalized 5% for every late day, **and will not be graded if turned in after graded assignments have been handed out**.

The Labs will include some short lecture at the beginning before you are "set loose" on the equipment. Lab grades will be assigned based on attendance and performance in the lab, and turning in the lab assignments for a grade in a timely fashion (to be arranged). Some of the lab times will be used as tutorials for solving some of the homework problem sets. Lab project: Each student is to select a particular project that can be performed at Marshall using one of the pieces of equipment at hand. The topic is to be cleared with me by **Feb 6, 2007**, the date when a short, 2-page proposal is due. You should discuss your ideas with me before that date.

Grading scale: > 85% A, 75 - 84.9% B, 65 - 74.9% C, 55 - 64.9% D, < 55% F.

Attendance Policy: Attendance of lectures is expected. Please contact your instructor if you must miss a class. Missing a lab will have a strong impact on the learning process, and is to be avoided at all costs. Not only will you not have the opportunity to make up the lab, but it will also have an impact on your grade. Once in class or lab, mature behavior is expected. Disruption of class/ lab activities will not be tolerated.

Honor Code: University regulations on academic dishonesty as defined on page 101 of the catalogue will be strictly enforced. Any violations of the Honor Code (e.g. cheating, copying, ... etc) may result in an F grade and the matter will be brought to the attention of the Dean of student affairs for further action.

Study tips: You should take your own notes during class, and should learn how to reproduce many of the figures in your textbook/ handouts for the tests. Please feel free to ask questions at any time. Do the **readings** promptly **after** each lecture (the reading list is given in the table below), and familiarize yourself with new terms. Use the handouts to organize your own lecture notes after you've done the reading. However, *these handouts are in no way a substitute for the reading assignments*! We will be covering many different topics in this class, so I don't expect you to "like" all of these topics! In the **Lab**, plan on spending at least *three extra hours per week* working on your own on the samples provided.

Final Thoughts: Please keep in mind that I am **committed** to making this course a positive experience for everyone, so don't hesitate to ask me questions, or approach me with problems that you are facing in this class. Feel free to stop by my office to discuss your progress in class or go over one of your tests/ homeworks with me (including your final!). I could also arrange for review sessions in the evenings whenever they are needed.

Students with disabilities:

Students with a particular learning disability should contact the H.E.L.P. office on campus. Every effort will be made by this instructor to accommodate their needs.

Geology 425
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Syllabus

Lecture	Topic	Reading Assignment
1	**Introduction**: What is geochemistry - Different fields and applications. Basic chemical principles. Basics of calculus.	W: Ch. 1
2, 3	**Mineral and Crystal Chemistry**: (A review) Types of bonding, coordination numbers, crystal structures, polymorphism	W.: Ch 5 K & B: 107 - 120
4	Isomorphism, Goldschmidt's rules for substitution; Camouflage, capture & admission	K & B: 120 - 130
5 - 6	**Distribution and Association of elements**: Cosmic abundance of elements; The Periodic Table of elements; **Goldschmidt's classification**; Distribution of elements in igneous, sedimentary, and metamorphic rocks; Partition coefficients, Trace elements in igneous petrology	W.: 22 – 24; K & B: Ch 20 W.: 286 - 299
7 - 11	Introduction to **thermodynamics**: 1^{st}, 2^{nd}, and 3^{rd} laws; Gibbs Free Energy, Enthalpy, Entropy, Heat capacity, thermal expansion, compressibility. Some key relations. Applications.	W. Ch 3 K&B: Ch 7
12 - 14	**Chemical equilibrium,** Reversible and irreversible chemical reactions, Balancing reactions, Law of Mass Action, Le Chatelier's principle, Solubility products, Common ion effect, Activity, Fugacity	W: 115 – 125 K&B: Ch 1; 191-210.
15 - 17	**Water chemistry**: Properties of water; Acids & bases; pH, Dissociation constants, Ionic concentrations, Buffers, pH-pC diagrams;	W: Ch 6 K&B: Ch 2 D: Ch 11
18 - 20	**Solution – Mineral equilibria**: carbonates; silicates; Chemistry of groundwater; chemistry of seawater, Analysis of water samples, Mixing, Dilution, Evaporation. Activity - activity diagrams: weathering and mineral stability	K&B: Ch 3 & 4; D: 41 - 68 W: Ch 7
21	**Kinetics**: Diffusion; Nucleation; Growth	W: Ch 13 K&B: Ch 2 D: p. 26 - 35

21, 22	**Oxidation and Reduction**; Eh – pH diagrams	W: Ch 14 K&B: Ch 9 D: Ch 7
23 - 27	**Radioactive isotopes**	W: Ch 10 K&B: 241 - 260
27 - 30	**Stable Isotopes**	W: Ch 11 K&B: 260 - 270; D:311-321
31 - 32	**Organic Geochemistry**	W.: Ch 15

Final Exam: 8:00 a.m. May 1, 2007.

W: Walther, John, 2005. Essentials of Geochemistry.Jones & Bartlett publishers.
K&B: Krauskopf and Bird, D.K., 1995. Introduction to Geochemistry. McGraw Hill.
D: Drever, J. I., 1997. The geochemistry of natural waters. Prentice Hall.

Some other useful textbooks

Brownlow, A. H., 1996. Geochemistry. Prentice Hall.
Cox, K. G., Bell, J. D., and Pankhurst, R. J., 1979. The interpretation of igneous rocks. George Allen and Unwin. 450 pp.
Deutsch, W., 1997. Groundwater Geochemsitry: fundamentals and applications to contamination. Lewis publishers, 221 pp.
Ehlers, E. G., 1972. The interpretation of geological phase diagrams. W. H. Freeman. 280 pp.
Faure, G., 1986. Principles of Isotope Geology. John Wiley and Sons.
Fyfe, W. S., 1976. Geochemistry of solids.
Garrels, R. M. and Christ, C. L., 1965. Solutions, Minerals, and Equilibria. Harper & Row.
Henderson, P., 1982. Inorganic Geochemistry. Pergamon Press.
Nordstrom, D. K. and Munoz, J. L., 1986. Geochemical Thermodynamics. Blackwell Scientific Publications.
Schultz, H. and Zabel, M. (eds.), 2000. Marine Geochemistry.Springer Verlag, 455 pp.
Snoeyink, V. L. and Jenkins, D., 1980. Water Chemistry. John Wiley & Sons.
Wood, B. J. and Fraser, D. G., 1977. Elementary Thermodynamics for Geologists. Oxford Science Publications, 303 pp.

Please note that you have access to an extensive collection of geochemistry textbooks in Drinko and Morrow (over 100 titles).