Geology 345 Mineralogy Autumn, 2001

SYLLABUS

Instructor: John Winter **Web page: http://people.whitman.edu/~winterj/**

This course will use **Blackboard** (http://blackboard.whitman.edu) for handing in electronic assignments and communication. *Please request a login right away*.

Office: 121 Science **Official office hours**: 1-3 M 9-11 W (but I'm there often)

Text: ***Manual of Mineral Science*** by Klein (the 22nd edition of what was originally the *Manual of Mineralogy* by J.D. Dana)

Materials needed:

Hand lens (see the Geotech *soon* if you want a good one)
Magnet (there will be a couple in the lab, but see the Geotech if you want your own- they're cheap)
3x5 cards?

The principal objective of this course is to enable you to identify and interpret the most common rock-forming and economic minerals in hand sample. The study of minerals is important to geologists, because minerals compose rocks. The proper identification of a rock, be it sedimentary, igneous, or metamorphic, requires the ability to identify the constituent minerals. Naturally this identification is only the first step toward an interpretation of the rock, and eventually the history of the area from which it came (the intent of petrology). However, mineralogy is a subject that goes beyond mere mineral identification. A knowledge of symmetry, twinning, phase equilibria, crystal chemistry, etc. helps us interpret the conditions of formation of a mineral, as well as other events that a mineral has experienced. Thus Mineralogy gives you access to the information that minerals can provide about Earth processes and Earth history.

In terms of basic foundational knowledge, you will learn the following this semester:

- Mineral identification (of about 70 common minerals).
- Know the class and major chemical constituents of each mineral.
- Know how to read and interpret the mineral descriptions cataloged in the text.
- Be able to determine the 3-dimensional Point Group and Crystal Class of a crystal on the basis of its shape, and then to assign appropriate crystal axes.
- Be able to determine the Miller Indices of crystal faces and use them to refer to the faces on a crystal.
- Be able to recognize and name the forms on a crystal, even when multiple forms are present.
- Be familiar with Stereographic Projections, and comfortable enough with their use to be able to visualize the orientation of a plane in space from the projection of its pole.
- Understand the nature of twinning and how twins may be used to interpret some of the history of a mineral.
- Have a comfortable background in crystal chemistry so that you are familiar with the concepts of the Bohr model of the atom, electron shells and sub-shells, electronegativity, ionic potential, bonding, atomic and ionic radii, Pauling's Rules for ionic crystals, coordination polyhedra, and closest-packing.
- Be familiar with the theory of x-ray crystallography, and know how to identify an unknown mineral on the basis of it's x-ray powder diffraction pattern.
- Be familiar with the general structural basis of the principal silicate minerals.
- Know the Phase Rule and be able to apply it to a number of binary and ternary Phase Diagrams in order to interpret the crystallization processes of various types of igneous systems.

Our Mineralogy class is presently in a state of flux. In the past I relied on class lectures and four "backward-directed" exams designed to "audit" how well you listened and learned. I am trying shift to more in-class exercises and take-home problem sets designed to engage you in applying the principles from your reading and developing the skills required for practical application of the science of Mineralogy. There will thus be weekly, and at times daily, smaller practical problems. These are not given as a check-up on your abilities and progress. They are meant to instill a deeper understanding and give you practice at applying what at times can be rather complex concepts. Like most scientific subjects, Mineralogy is best learned by doing it, rather than by listening to it. Therefore it is the *process* of doing the problems that is important. Toward that end, I shall try to do many in class. For those that you work on at home, I strongly recommend that you avail yourselves of help from me if you get stuck at any point. I try to be as available as I possibly can, with the exception of evenings, but you're welcome to call me at home (558-3724). I expect, of course, that you will have spent some time trying to figure out problems on your own before resorting to me. *I encourage you to work on problems and labs in groups of two or three*. The process of problem-solving and the discussions that groups of students have while working through assignments has proven to be quite beneficial. I will retain perhaps 3 exams, both in-class and take-home, in order to assess how well you are learning the material and if the present approach works better than the old one.

I have become convinced that a series of 50-minute lectures that simply cover the reading material is not the best way to impart a deep and flexible understanding of a body of knowledge. The lecture approach assumes that the material is somehow validated when the professor actually pays lip service to it in class. The material is presented very succinctly and clearly in the text, however, and classroom time that reiterates it is wasted and ineffective. I'd much rather we spent our precious classroom time doing things with the material so that we understand it better. Because class time will be spent working in groups on application of the principles that you encounter in your reading, ***it is absolutely imperative that you do the reading assignments prior to class and come prepared to work on the material or ask questions on any concepts on which you are unclear***. My lectures used in previous years are in Powerpoint format and are available on my web site (url at the top of the syllabus). Feel free to use them as study aids on course material. Only when the material is particularly complex, or when my choice of presentation differs from that in the text will I rely on in-class lectures. I'd also be happy to present "mini-lectures" on demand for any subject that is deemed conceptually difficult by class members.

Labs

The first lab will concentrate on the physical properties of minerals, without worrying about identifying any specific ones. In most subsequent "typical" labs you will receive a list of new minerals for the week, and proceed to observe the properties of various samples from the departmental collection, noting the most diagnostic ones on your 3x5 cards. For each mineral covered, you will be responsible for the name, class (oxide, sulfide, chain silicate, sheet silicate, etc.), most typical occurrence, and principal chemical constituents (as given on the handout). Some later labs will concentrate on specific topics, such as x-ray analysis, color in minerals, etc.

Because the identification and interpretation of minerals is one of the principal goals of this course, *there will be weekly quizzes on mineral identification on your own time at any time during a day of the week chosen by the class*. These quizzes are *cumulative*, in the sense that later quizzes will cover all of the previously encountered minerals. In a quiz you will be asked for the name, class, major chemical constituents, and most probable occurrence of the samples. Quizzes tend to concentrate on new minerals for each week, but it is typically impossible to find pure samples of only a single mineral, and there may be varying amounts of other minerals in the sample (even tiny bits). If there is more than one mineral in a quiz specimen, name every mineral which you have covered in a previous lab, but give only the most probable occurrence of the ***specimen*** (not of each mineral separately). You may ignore any minerals in a specimen that you have not yet encountered in labs. I correct the quizzes and leave the quiz tray out for a few days so that you can study samples again to analyze your errors. I often keep one or two samples for which errors were common on the following quiz, so it pays to take advantage of the opportunity to study the quiz in retrospect. Note, however, that a correct description for a sample one week may contain an uncovered mineral, and the same description may become incomplete later as you become responsible for more minerals. Quiz performance is usually proportional to the amount of time spent in lab observing the specimens and organizing your data. You may have access to the back room collection during lab periods if you like.

Computer literacy is an essential skill for any scientist in the 90's. There will be extensive use of the computer in Mineralogy/Petrology. If used effectively, computers can save you the drudge work of compiling and displaying data, and leave you more time for the creative act of interpreting it properly. In addition to the usual word processing, and special programs, I expect all geology majors to be adept at spreadsheets. Excel is the best spreadsheet currently available, but if you have experience with Quattro or Lotus, feel free to continue with that if you prefer. I have prepared a handout for learning Excel which is available in the computer lab. Like all new skills, doing your work on a spreadsheet will be somewhat more tedious at the beginning, but will soon become easier and easier. Soon you will wonder how you managed without one for so long. The more you use a spreadsheet for your homework (in any class), the more adept you will become. If Mineralogy is your first exposure to spreadsheets, your workload maybe a bit heavier at first, but you will soon be much more efficient at homework problems.

Grading:

Because I am restructuring this class, grading is also in a state of flux. Some exercises will count more than others. You can generally judge the weight of an exercise by the time that it takes to complete. I will try to tell you when a heavily-weighted exercise comes along. One of the benefits of not having big mid-terms and finals is that your grade will not suffer a major set-back from one poor performance. On the other hand, any single assignment may seem a minor event, any you may treat them lightly. Note, however, that the accumulated performance counts. At the moment I do not know what all of the class assignments will be. I'm figuring this out as I go along. I can only estimate that each of the following will constitute 1/3 of your final grade:

Mineral Identification Quizzes
Other assignments and problems done in class or on your own
Exams

Class Schedule

Week		Lecture	Laboratory	Reading (**bold** for lab, *italics* for web)
Aug.	30	Introduction	none	Ch. 5: p. 170-193, *1 Symm.ppt*
Sept.	3	Crystallography	Physical Properties	Ch. 5: p. 213-239, **Ch. 1** *2 Symm2.ppt*
	10	"	Tectosilicates I	Ch. 5: p. 194-208
	17	"	Tectosilicates II	Ch 6: p. 240-251, p. 251-276 (*read paragraph on each system only)* browse p. 276-289 *3 Xl Morph.ppt*
********************************			Exam 1	********************************
	24	Crystal Chemistry	Ino-, Phyllosilicates	Ch. 3: p. 38-69, p. 94-103
Oct.	1	& Structure	X-ray Lab	**Ch. 7**
	9	"	Cyclosilicates	Ch. 3: p. 69-90
	15	"	Neso-, Sorosilicates	
********************************			Exam 2	********************************
	22	"	Carbonates, Sulfates, Phosphates, Halides	Ch 4: p. 134-169 **Ch. 10, 12**
	30	"	Sulfides I	**Ch. 9, 10, p. 590-2** & handouts
Nov.	6	Phase Diagrams	Sulfides II, Hydroxides	Begin in Petrology text
	13	"	Native elements, Oxides	**Ch. 10, 11**
********************************			Exam 3	********************************
	27	"	Color	**Ch. 8**, Handout
Dec.	4	"	Misc	"

Like all class schedules, this is an **estimate** of the timing of lectures and reading assignments. Classes vary in pace from year to year. You have been given an outline of the subject matter to be covered. I suggest you refer to it often and bring it to class to help yourself organize the lecture content. Also use it to help you keep pace with your reading assignments. **Be sure to read the proper pages in your text *before* the subject is covered in lecture.**