Syllabus for Geochemistry, Coronavirus version

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Text: Geochemistry, by William White, ISBN 978-0470656686 (paperback, PDF on Nexus)

Week	Book chapters	Topics (subject to change)
1	1, 10	Chemistry of the universe, stars, nucleosynthesis, origin of the solar system, meteorites. LAB 1: Oddo-Harkins rule, graphs, simple statistics.
2	2, 11	Ionic crystals, coordination, solid solutions, phase rule, partition coefficients. LAB 2: Crystal/liquid element partitioning and magmatic modeling A.
3	7, 12	Origin of igneous rocks: melting, crystallization, binary and ternary systems. LAB 3: Crystal/liquid element partitioning and magmatic modeling B.
4	3, 8	Radiometric ages, K-Ar, Rb-Sr, U-Th-Pb systems. LAB 4: *Discussion of short papers*.
5	4	Writing and balancing reactions, congruent and incongruent reactions. LAB 5: U-Th-Pb radiometric dating A.
6	13	Sedimentary rocks, soil development, solubility. LAB 6: U-Th-Pb radiometric dating B.
7	5	Dissolution, aqueous reactions, redox. LAB 7: *Discussion of short papers*.
8	6	Chemistry of river waters on basin-wide scales: element sources and solubility constraints. LAB 8: Chemistry of natural waters A.
9	15	The atmosphere and oceans: sources, sinks, and geochemical cycling. LAB 9: Chemistry of natural waters B.
10	9	Stable isotopes and isotope fractionation of H, C, O, S. LAB 10: *Discussion of short papers*.

Chapter 14 is not included in the readings, but it is interesting and you should read it anyway.

No exams. Grades will be based on

1. Grades on homework.
2. Demonstration of your ability to use various computer and analytical techniques.
3. Demonstration of your in-class understanding of the subject material.
4. Grades on lab reports.
5. Writing quality.
6. Presentations and participation in paper discussions.

Lab topics Subject	Work done (hands-on tasks are theoretical this year)
Oddo-Harkins rule, graphs, statistics	Introductory concepts of nucleosynthesis, simple mathematical procedures in spreadsheets, basic analytical statistics.
Crystal/liquid element partitioning and magmatic modeling	Hand pick phenocryst phases and matrix from a basalt, dissolve and analyze matrix, phenocrysts, and dacite glass. Calculate partition coefficients, model dacite as derived from the basalt by the processes of fractional crystallization or equilibrium melting. Identify the best model.
U-Th-Pb radiometric dating	Dissolve and analyze apatite and calcite from a pegmatite sample. Determine common and radiogenic Pb isotopes, U, and Th in a sample. Calculate Pb-U, Pb-Th, Pb-Pb, and concordia ages and evaluate in terms of the best age of the sample.
Chemistry of natural waters: speciation and water-rock interactions	Analyze major and trace elements in natural water; measure pH, O_2, alkalinity, temperature in the field. Calculate ion and neutral species and mineral saturation indexes in water using the USGS PHREEQ modeling software. Model water-rock interactions at different CO_2 and O_2 activities.
Discussion and summaries of short papers	Write a summary, prepare questions, prepare and present Powerpoint presentations, make comments, and discuss.

About this course

This course is designed to give you a basic introduction to inorganic geochemistry, mostly by examination of selected topics in some depth, with general overviews to provide context. There will be three lab exercises, associated homework exercises, written and oral summaries of geochemical papers, and discussion of those papers. This course should be sufficient background for more advanced work.

Course objectives

In this course you will learn about some important geochemical processes (e.g., melting, crystallization, dissolution, precipitation, erosion, evaporation) and the materials they affect (e.g., minerals, rocks, meteorite types, atmosphere, oceans, magmas). Though labs and other activities you will examine, evaluate, and apply problem-solving techniques, including mathematical models, to evidence to reach geologically plausible conclusions. You will practice technical writing, graphical and tabular ways to communicate the numerical results of your work, and making oral presentations.

Lab exercises

Approximately every three weeks there will be a lab project that will, more or less, be tied to the lecture material. The geochemical problems examined in lab will be discussed during sample preparation, sample analysis, graphing, interpretation, and writing and running computer models. You will do most models and other calculations using a spreadsheet. Each lab will involve a small amount of writing, which will be examined as part of the grade. All tables and figures must be cited sequentially in the text. Reports will be graded based on completeness, quality of writing as an indication of your understanding of the material, and quality of the tables

and figures (professional quality expected, within the limitations of the software). The lab reports should be concise and accurate. Care should be given to writing *and* presentation of data.

WARNING: the worst problems in scientific writing come from not understanding what you are writing about. If you don't understand your topic, you won't be able to convince anyone else that you do. Tips for better writing can be found here.

Lab safety course

All students in this course are required to have passed the lab safety course once this academic year. You will be automatically enrolled in this Nexus-based course.

Readings for discussion

There will be three presentations by each of you. Presentations will be on papers of your choosing, but should be from the last 5 years (2018-2023). They should be from journals like Geology, Elements, or another peer-reviewed primary or review *science* article of your choosing. Short articles preferred! Short means preferably 4-5 pages, maybe up to 10 if there are a lot of figures or tables. The discussions will be in this sequence of themes:

1) Cosmochemistry (element abundances inside and outside the solar system, meteorite chemistry and differentiation, planetary compositions, etc.), *or* igneous rocks and magmatic systems (origin, evolution, processes, sources, differences caused by where or how they form, ore deposits, etc.). Avoid stable or radiogenic isotopes, organic chemistry, hydrothermal topics.
2) Radiogenic isotopes (use of or problems in age dating, tracing materials, determining detrital or magmatic sources, timing of separation from source, etc.), *or* stable isotopes (fractionation, tracing materials, determining sources, finding and attributing patterns, etc.). Problems may include such things as early history of life, history of the atmosphere, ore deposits, climate records, etc. Avoid organic chemistry, hydrothermal topics.
3) Water-rock interaction (mineral dissolution, mineral formation, soil development, hydrothermal systems, formation of ore deposits, etc.), *or* water composition (relation to drainage basin, weather, climate, agriculture, anthropogenic effects, ocean composition, etc.). Organic chemical and hydrothermal topics OK.

After picking the article, send it to me as a PDF or a link. Once I approve the article, write a 1-page summary, including your name, the full paper citation, and at least one important illustration that helps with the summary. The illustration may be from the paper or it may be your own. THE ILLUSTRATION MUST BE LEGIBLE. The writing should be very well-done, succinct, with proper spelling and sentence structure, and should make logical sense. These must be handed in as PDFs. I will review them and give them back for revision. The revised versions will be posted to Nexus. The whole class must read each summary, and come prepared to the lab with at least two questions and/or comments on each. In lab, each person will present a 5-10 minute oral/PowerPoint version of their summary, and the questions and comments will form the basis of discussion.

Homework

There will be assorted homework assignments, in addition to labs and readings, covering basic theoretical material.

Turning in work

All work turned in must be in electronic format. *The file names must start with your name*, followed by the assignment name. All assignments, including labs, will be due one week after the assignment, unless otherwise specified. *Can't turn it in then? Get it in earlier!* If you have to miss a class or lab for some valid (e.g., medical) reason, let me *and* the Dean of Students office know beforehand to make alternative arrangements, *as per Union College policy*.

Technical requirements

The only real technical requirement is that you have a working version of Excel. If you don't have Excel on your own computer, all Union Students should have free access to Excel via their campus network account. Contact ITS for more information on getting that installed and running. I think that type of Excel is part of Office 365, which is the on-line version. All classroom computers also have Excel, so that is an alternative for anyone.

Once you have Excel running, install the Solver add-in, which we will be using a lot. Go to YouTube, and search for *excel installing solver add-in*, and you will be shown a nearly infinite number of videos to help you out.

To access some journals, the Schaffer Library database, or Office 365 from off campus, you will also need VPN software. Go here and follow the instructions for Option 2. Note that you should only use the VPN connection when you need to. The connection resources at Union are limited, and if they are strained ITS will send messages indicating their annoyance.

Extra help

For extra help there is always me, of course. I am generally available and I can always make appointments. I can even schedule weekly or more frequent regular appointments to give extra help to individuals or groups. I encourage you to see me about the summary papers.

Recommended on-line classes boilerplate

"*If you are quarantined or isolated for COVID-19-related reasons, I will be notified by the Dean of Students Office that you may require flexibility with regard to your participation in this course. Your responsibility will be to contact me as soon as you are able so that we can discuss your needs. If you are not able to keep up with the course in real time, I will make arrangements to provide you with full course material missed from classes.*" Note: All materials will be available on Nexus or the class web site.

Learning or other disabilities

From the Union College Student Handbook: "*Students seeking reasonable accommodations should be aware that it is their responsibility to...request accommodations from the Director [of Student Support Services] in person with at least two (2) weeks notice of the accommodation needed.*" Contact them directly: Accommodative Services Office, 388-8785, mailto:shinebas@union.edu. No accommodations can be provided without a letter or card from the Accommodative Services Office. You talk the them, they will notify me. You should also talk to me, too, to make sure I am aware of (or remember) the issue so we can arrange things appropriately.

Academic misconduct

You will sometimes work in small groups, but *all work that you hand in must be your own!* No copying or otherwise duplicating lab reports or computer-generated figures. No giving or accepting access to old course materials. This and all other forms of plagiarism, cheating, destruction of resource materials, and other forms of academic dishonesty will be referred immediately to the Dean of Studies, as per *Union College policy*.

We have an Honor Code at Union College. Here is the "model statement" that I have been asked to place right here in this very spot:

"Union College recognizes the need to create an environment of mutual trust as part of its educational mission. Responsible participation in an academic community requires respect for and acknowledgement of the thoughts and work of others, whether expressed in the present or in some distant time and place. Matriculation at the College is taken to signify implicit agreement with the Academic Honor Code, available at honorcode.union.edu. It is each student's responsibility to ensure that submitted work is his or her own and does not involve any form of academic misconduct. Students are expected to ask their course instructors for clarification regarding, but not limited to, collaboration, citations, and plagiarism. Ignorance is not an excuse for breaching academic integrity. Students are also required to affix the full Honor Code Affirmation, or the following shortened version, on each item of coursework submitted for grading: 'I affirm that I have carried out my academic endeavors with full academic honesty.'"

Signed
Whoever you are

Note that, if you forget to *"…affix the full Honor Code Affirmation,* or *this shortened version, on each item of coursework submitted for grading: "I affirm that I have carried out my academic endeavors with full academic honesty."*, I will assume that you meant to.