Geochemistry– GEOL135

Spring Semester 2014

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Email: Julia.perdrial@uvm.edu

Office hours: MW 11:30-12:15 and by appointment;
Meeting Time: Lecture MWF 10:40-11:30; Lab T 8:30-11:15
Credits: 4, Pre/co-requisites: GEOL 110, CHEM 31, 32.
Book: Introduction to Geochemistry, Kula Misra, Wiley-Blackwell

Welcome to Geochemistry!

Geochemistry is a (happy) marriage of the fields of geology and chemistry. White (2013) defines this marriage as follows: "In geochemistry we use the tools of chemistry to solve geological problems; that is, we use chemistry to understand the Earth and how it works".

But how? Chemistry teaches us about elements, thermodynamics, kinetics and much more, all of which we need to understand the Earth. However, we face many interesting challenges: For example geological problems and chemical problems operate at very different time- and land-scales - can we ignore this? Or: chemistry is based on the assumption of equilibrium, whereas life brings geo-systems into non-equilibrium - how far can equilibrium thermodynamics bring us? These are important questions that we'll seek to answer during this course.

General goal of this course: At the end of this course you will be able to apply geochemical concepts to explain selected geological processes. You will also be able to critically evaluate applications and limitations of geochemistry for geological problems.
**Lab goal:** You will be able to perform low temperature geochemical analyses in the lab and collect analytical data independently and safely. You will also be able to perform data quality control, data analysis with Excel and use a geochemical model on your data independently.

**Lectures:**
We will use lecture class meeting times to review geochemical principles step by step (see preliminary schedule). Please get a copy of “Introduction to Geochemistry” by Kula Misra (available in the bookstore) to follow along.

We will also use lecture meetings for a paper presentation from each of you. For this you will be asked to choose a scientific paper dealing with geochemistry and its application to a geological problem and present this (as a power point) to the class. Your presentation will be evaluated by me (50%) and by your class mates (50%) but also your classmates understanding of the paper will be assessed. We’ll have a dry run so that you’ll know what to expect and can prepare accordingly.

**Labs:**
You will spend most of the lab meeting times in an actual biogeochemistry lab where you will receive training in lab methods and learn how to accurately and safely work with low T geochemical samples. You will work with protocols, learn to operate common aqueous geochemical probes and instruments. You will describe and note analytical procedures in a lab note book, so please bring one notebook dedicated to this class. You will also write protocols for lab procedures based on the training you’ll receive. The best protocols will be used in this lab in the future (of course under your name and with your consent).
You will also spend some time in the computer lab. Here you will use your own data as well as other datasets to practice data analysis and use a geochemical model.

**Learning assessment:**
I will assess your learning in the following principle ways, we will decide on weighing together at the beginning of the course:

- 4 Homework problem sets
- 1 Paper presentation
- Lab: Notes and protocols
- Lab: Data treatment results
- 1 Midterm and 1 final exam
These are the assessment rubrics for exams, problem sets and lab notes:

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<tr>
<th>Level of Achievement</th>
<th>Problem sets</th>
<th>Lab notes and protocols</th>
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<tbody>
<tr>
<td>Exemplary 100% of points</td>
<td>• Addresses the question.</td>
<td>• Organization is clear: All pages are numbered and dated. Experiments listed in table of contents (T.o.C).</td>
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<tr>
<td></td>
<td>• States a relevant, justifiable answer.</td>
<td>• Each experiment contains title, purpose, brief procedure or reference to lab manual.</td>
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<td></td>
<td>• Presents arguments in a logical order.</td>
<td>• Observations, recorded data and calculations present.</td>
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<td>• Demonstrates an accurate and complete understanding of the question.</td>
<td>No pencil</td>
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<td></td>
<td>• Backs conclusions with data and warrants.</td>
<td>Adequate 75% of points</td>
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<td>• Uses ideas, examples and/or arguments that support the answer.</td>
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<tr>
<td>Adequate 75% of points</td>
<td>• Does not address the question explicitly, although does so tangentially.</td>
<td>• Organization adequate: Most pages are numbered and dated. Some are missing in T.o.C.</td>
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<tr>
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<td>• States a relevant and justifiable answer.</td>
<td>• Some of the experiments are missing one or two of the following: title, purpose, brief procedure or reference to lab manual.</td>
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<td>• Presents arguments in a logical order.</td>
<td>• Recorded data and observations are incomplete</td>
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<tr>
<td></td>
<td>• Demonstrates accurate but only adequate understanding of question because does not back conclusions with warrants and data.</td>
<td>No Pencil</td>
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<td>• Uses idea to support the answer.</td>
<td>Needs Improvement 25-50% of points</td>
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<td>• Less thorough than above</td>
<td>• Organization needs improvement: Most pages are not numbered and dated and not in T.o.C.</td>
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<td>• Most of the experiments are missing several of the following: title, purpose, brief procedure or reference to lab manual.</td>
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<td>• Recorded data and observations are incomplete in most areas or not present.</td>
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<td>• All information is recorded in pencil.</td>
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<td>Needs Improvement 25-50%</td>
<td>• Does not address the question.</td>
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<td>of points</td>
<td>• States no relevant answers.</td>
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<td>• Indicates misconceptions.</td>
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<td>• Is not clearly or logically organized.</td>
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<tr>
<td>No Answer (0 pts)</td>
<td>• Does not demonstrate accurate understanding of the question.</td>
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<td>• Does not provide evidence to support their answer to the question.</td>
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Teaching and Learning Style:
It's always helpful to know about your own learning style and know what you can do to support your own learning. Please take the “Index of Learning Styles Questionnaire” following this link: http://www.engr.ncsu.edu/learningstyles/ilsweb.html
The results are for yourself only, but this very simple test will help you to better understand your learning (and probably my teaching).

Rules:
- Please turn in your homework problem sets in time; it will decrease your grade by 10% if you turn it in late. You can expect me to turn homework back the following Monday.
- If you are sick and have to miss exams contact me ASAP.
- Labs (except computer labs) cannot be repeated so make sure you don't miss them.
- Please mute cell phones during class and don't text.
- Adhere to the Code of Academic Integrity (no plagiarism, fabrication, collusion, and cheating). Deliberate offense against the code will be forwarded to the Center for Student Ethics and Standards (see http://www.uvm.edu/~uvmppg/ppg/student/acadintegrity.pdf for more information).

Student learning accommodations:
- Any student with a documented disability interested in utilizing accommodations should contact ACCESS, the office of Disability Services on campus. ACCESS works with you to create reasonable and appropriate accommodations via an accommodation letter to their professors as early as possible each semester. Contact ACCESS: A170 Living/Learning Center - 802-656-7753 - access@uvm.edu.

Reading:
Introduction to Geochemistry, Kula Misra, Wiley-Blackwell

Schedule (subject to changes):
Week 1:
Introduction: What is Geochemistry? What is the scientific method?
(No lab)

**Week 2:**
Crystal Chemistry: periodic table and what it has to do with the Earth and the Universe (Chapter 2)
(No lab)

**Week 3:**
Crystal Chemistry: bonding and what has to do with rocks and minerals (Chapter 3)

**Week 4:**
Crystal Chemistry: molecular orbital theory and what has to do with carbon (Chapter 3)

**Week 5:**
Chemical reactions: thermodynamics and what has to do with sustainability (Chapter 4)

**Week 6:**
Chemical reactions: thermodynamics of solutions (Chapter 5)

**EXAM**

**Week 7:**
Aqueous solutions: acid–bases, alkalinity and pH and what it has to do with acid rain (Chapter 7)

**Week 8: Spring break**

**Week 9:**
Aqueous solutions: solubility and weathering and what it has to do with climate change (Chapter 7)

**Week 10:**
Redox: Eh, pH, pe and what it has to do with acid mine drainage (Chapter 8)

**Week 11:**
Kinetics: Why reactions don’t happen although they should… (Chapter 9)

**Week 12:**
Isotopes: radiogenic isotopes and why the age matters (Chapter 10)

**Week 13:**
Isotopes: Stable isotopes and why the sources matter (Chapter 11)

**Week 14: EXAM**