Welcome to the Aqueous Geochemistry of Natural Waters Course!

We life on the blue planet which is to $\frac{3}{4}$ covered by water and 100% of all living organisms require some form of water to survive. It’s simple, no water- No life. Yet freshwater demand already exceeds supply in certain areas of this planet and water is becoming the "new oil". Where does water come from, what controls its composition and what are the environmental challenges we face today concerning our water resources? During this course we’ll be on the quest for processes that control the geochemistry and quality of natural waters by working with real datasets and by exploring case studies of environmental challenges that impact our freshwater resources.

**Course Goal #1:** Apply the knowledge of solute sources and geochemical reactions (acid-base, redox) to interpret processes controlling the composition of natural waters.

**Course Goal #2:** Demonstrate the ability to synthesize processes that impact water geochemistry with concept sketches

**Course Goal #3:** Apply excel spreadsheet analysis of geochemical data to generate interpretable time-series and correlation plots

We will practice with real datasets and formulate and test hypotheses about the source of water constituents and processes that control water chemistry. During class practice times I encourage group work. Take advantage of your peers knowledge and ideas during these times but make sure you have your own learning in mind.

I will assess you learning in 3 principal ways:
- You will be asked to do quizzes with concept sketches that will help to assess your process based understanding. The first one will be a "free" practice run.
- You will be assigned problem sets as homework where you'll use real data and tools that we practiced in class. This will help me to assess your ability to apply what you learned in class and test you critical thinking skills. I encourage peer-to-peer mentoring and it is fine to work in groups on homework but you need to hand in the homework separately. Take responsibility of your own learning and make sure that this group work enables you to do it by yourself - you will need it for the exams.
- Exams: you will have two exams where I will test your knowledge, comprehension and critical thinking skills.

**Grading:**
The different learning assessments will contribute to the overall grade as follows:

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Problem sets</td>
<td>30%</td>
</tr>
<tr>
<td>Two exams</td>
<td>30%</td>
</tr>
<tr>
<td>Quizzes/Concept sketches</td>
<td>20%</td>
</tr>
<tr>
<td>In class contribution/groupwork</td>
<td>10%</td>
</tr>
<tr>
<td>Paper presentation</td>
<td>10%</td>
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</tbody>
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These are the assessment rubrics for quizzes, exams and problem sets:

<table>
<thead>
<tr>
<th>Level of Achievement</th>
<th>Quizzes and Problem sets</th>
<th>Concept Sketches</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>General Approach</td>
<td>Comprehension</td>
</tr>
<tr>
<td>Exemplary 100% of points</td>
<td>• Addresses the question.</td>
<td>• Demonstrates an accurate and complete understanding of the question.</td>
</tr>
<tr>
<td></td>
<td>• States a relevant, justifiable answer.</td>
<td>• Backs conclusions with data and warrants.</td>
</tr>
<tr>
<td></td>
<td>• Presents arguments in a logical order.</td>
<td>• Uses ideas, examples and/or arguments that support the answer.</td>
</tr>
<tr>
<td>Adequate 75% of points</td>
<td>• Does not address the question explicitly, although does so tangentially.</td>
<td>• Demonstrates accurate but only adequate understanding of question because does not back conclusions with warrants and data.</td>
</tr>
<tr>
<td></td>
<td>• States a relevant and justifiable answer.</td>
<td>• Uses idea to support the answer.</td>
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</tbody>
</table>
| Needs Improvement 25-50% of points | • Does not address the question.  
• States no relevant answers.  
• Indicates misconceptions.  
• Is not clearly or logically organized. |
|-------------------------------------|----------------------------------------------------------------------------------|
|                                    | • Does not demonstrate accurate understanding of the question.  
• Does not provide evidence to support their answer to the question. |
|                                    | • Essential concepts left out; relationships not correctly portrayed;  
• major conceptual errors or misunderstandings  
• Sketch lacks detail or is illegible; difficult to interpret |
| No Answer (0 pts)                  |                                                                                  |

**Teaching and Learning Style:**

Students learning style and instructors teaching style do not always match but there are ways to help each other. A good start is to assess your own learning style and to find out 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](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 Friday.
- If you are sick and have to miss exams contact me ASAP.
- 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/~uvmppq/ppq/student/acadintegrity.pdf](http://www.uvm.edu/~uvmppq/ppq/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.
Further Reading: there is no required book for this course, all reading will be on blackboard. However the following books may be helpful:

"Environmental and Low temperature Geochemistry" by Pete Ryan;
"Geochemistry of Natural Waters" by James I. Drever;
"Global Environment: Water, Air and Geochemical Cycles" by Berner and Berner;
"Soil and Water Chemistry, an Integrative Approach" by Essington.

Schedule (subject to changes):

Week 1:
Introduction:
The global water cycle and its significance for geochemistry.
Water at the molecular scale, why does it matter?

Week 2:
Rainwater composition: source of rain constituents, pH of rain

Week 3:
Acid rain: Case study Hubbard Brook

Week 4:
From rain to catchments: headwater catchments and the Critical Zone

Week 5:
Soils as aquatic systems: geochemistry of organic soil horizons

Week 6:
Soils as aquatic systems: geochemistry of the mineral soil

EXAM

Week 7:
Water-rock interaction: weathering, weathering and the global carbon cycle

Week 8:
Water-rock interaction: environmental challenge acid mine drainage, Case Study

Week 9:
Streams and Rivers: in-stream vs. riparian vs. catchment processes

Week 10:
From streams to lakes: intro and data work

Week 11:
Environmental challenge: Lake Eutrophication, Lake Champlain

Week 12:
Ground water: redox reactor

Week 13:
Ground water pollution, arsenic in ground water

Week 14:
Ground water environmental challenge: Fracking