

# Applied Techniques in Geobiology

## GEOL 591

### Fall Semester 2005

**Format:** Laboratory sessions, Readings, Lecture, Discussion

**Time:** T TH 8:30-9:50 pm

**Room:** 118 Lindley

**Instructor:** Dr. Jennifer Roberts; 864-4997; Lindley 104

**Email:** jaroberts@ku.edu

**Office hours:** T TH 10:00 am – 11:30 am

**Line Number:** 29628/29629

**Course Description:** Geomicrobiology is an emerging interdisciplinary field that combines concepts and techniques from microbiology, geology, chemistry, physics, and mathematics. Microorganisms represent a living component of subsurface systems and impact both water and rock through their metabolic processes. This course is an upper-division undergraduate seminar that examines how microbial processes drive dissolution and precipitation of mineral phases. In addition, it provides students with the opportunity to conduct laboratory research on microbially-mediated silicate dissolution. Students will design, execute, and interpret microbial weathering experiments using a systems-based approach and gain experience with appropriate laboratory techniques.

The course will be run concurrently with a companion course at Allegheny College in Meadville, PA taught by Professor Rachel O'Brien. Students are expected to read relevant peer-reviewed literature and texts on biological and chemical weathering of minerals, and will receive supporting lectures on the theory and practice involved in conducting research on how microbes dissolve mineral phases.

### Goals

At the end of this course, students should be able to:

1. Critically evaluate proposed and/or published experimental work.
2. Collect, analyze, and interpret data from a research experiment in geomicrobiology.
3. Predict the physical, chemical, and biologic controls in a geomicrobiologic system.
4. Design experiments to investigate the geomicrobiology of an uninvestigated subsurface system.

**Prerequisites:** Junior or senior status in science major or graduate status in relevant field of science or engineering.

**Format and Expectations:** The course will consist of a mixture of lectures, readings, writing and laboratory work. The class will perform a group experiment, which will run for 5-6 weeks during the course. Techniques will be introduced during class meetings but the majority of data collection will be done outside of class. Students should expect to spend 8-10 hours per week outside of class working on writing assignments, readings, or collecting and analyzing experimental data. Additionally, there will be a fieldtrip for KU students scheduled for September 23-25, 2005.

Please come to all class meetings with your assigned readings, course notes, lab notebook, and a calculator. All students should have a three ring binder for course readings and handouts. For "data discussion" sessions, come to class with your data and any analysis that you've done as well as notes concerning calibration curves and instrument parameters.

**Readings:** Readings will be from the following books or will be from selected journal articles. The professor will provide Xerox copies of readings at least one week before they are due. The following texts will be on “reserve” in the instructor’s office. They can be checked out for a maximum of 24 hours. If you feel you need a basic reference for Microbiology I suggest that you purchase either the Atlas and Bartha text or the Madigan et al. text. These are available both new and used at [www.amazon.com](http://www.amazon.com) or alternatively you can check them out at the library.

Microbial Ecology: Fundamentals and Applications, (1998) Atlas and Bartha, Benjamin/Cummings, Menlo Park.

Geomicrobiology (2002) Ehrlich, Marcel Dekker, Inc., New York.

Subsurface Microbiology and Biogeochemistry (2001) Fredrickson and Fletcher, Eds., Wiley-Liss, New York.

Ground-Water Microbiology and Geochemistry (2001) Chapelle, John Wiley & Sons, Inc., New York.

Geomicrobiology: Interactions Between Microbes and Minerals (1997) Banfield and Nealson, Eds., Reviews in Mineralogy Vol. 35, Mineralogical Society of America, Washington D.C.

Brock Biology of Microorganisms (2005) Madigan and Martinko, Prentice Hall, Upper Saddle River, NJ.

### Grading Scheme:

Lab Reports	20%	Group Presentation of Weathering Experiment	15%
Writing Assignments	30%	Proposal for Future Work (due during final exam week)	25%
Proposal for Experimental Design	5%	Fieldtrip and Report (KU students) Participation in Peer Sessions (AC students)	5%

Each week, students will have either a lab report or writing assignment due. Unless noted by your professor, these are due one week after they are assigned at the beginning of the class period. Weekly assignments are subject to a **20% penalty per day** for each day they are late. Late materials that involve our research experiment (Proposal for Experimental Design, Group Presentation, and Proposal for Future Work) will not receive course credit.

**Lab Reports:** This will be a short write-up that presents the data collected during the lab with some brief analysis. Your reports should be ~2 pages in length and include professional figures and tables.

**Writing Assignments:** These are tiered assignments that prompt basic knowledge and synthesis of specific theoretical and practical topics covered in the seminar. These comprise a significant portion of your grade and should be given commensurate effort. Writing assignments have no set length but should be thoughtful and complete. Resources outside of those presented in class may be necessary and those references must be thoroughly cited.

**Proposal for Experimental Design:** Students should submit a 1-2 page written document that poses our research question, an experimental method to address the question, and the specific

parameters that will be monitored throughout the experiment. This assignment is due on September 22 (no extensions possible) and will be part of our discussion on experimental design for the class experiment.

**Group Presentation:** The group presentation will be based on data collected for the class experiment run over the course of the semester. Students will be responsible for a portion of the experiment and will collect a complete data set. Data discussion periods will be a venue to discuss that data in preparation for the final presentation. The final presentation must be a group effort that synthesizes all students' data sets and gives a well-supported interpretation of the data. KU students will give a power point presentation and 30-minute oral presentation to students at Allegheny College, while Allegheny students will make a similar presentation to KU students on the data collected over the course of their parallel experiment.

**Proposal for Future Work:** At the completion of the group experiment data from all students at both institutions will be distributed to everyone. These data will be used to create individual synthesis papers. Each student will use the data set as a platform to design a follow-up experiment. The premise of the experiment must be explained in detail along with the design, parameters measured, resources needed, and time frame necessary. This should take the form of a proposal and should be thoroughly referenced to support your research approach. A testable hypothesis should be presented as well as expected results. The paper should be 10-15 pages in length.

<b>Week</b>	<b>Month</b>	<b>Tuesday</b>	<b>Thursday</b>	<b>Assignment</b>
1	August/ September	30	1 Course Overview Origin/Evolution of Life	Reading: Gould and Gould Writing Exercise #1
2	September	6 Microbes in geologic processes/physiology	8 Scientific method Experimental design	Reading: ASM White paper; Madigan Writing Exercise #2
3	September	13 Microbially-driven silicate weathering	15 The role of pH in silicate weathering	Reading: Barker & Banfield ; Appelo and Postma Design Exercise
4	September	20 LAB 1: Microbial Enumeration	22 Bemidji Overview/ Our experimental approach KU Fieldtrip 9/23-25	Reading: Ruxton Exercise: Lab #1
5	September	27 Construction of microcosms	29 T <sub>0</sub> measurement of pH and biomass	Exercise: Writing Exercise #3 Start Experiment Appelo and Postma
6	October	4 DATA DISCUSSION: Microbial enumeration	6 LAB 2: Headspace analysis	Exercise: Lab # 2
7	October	11 LAB#3: Alkalinity	13 NO CLASS FALL BREAK	Reading: Appelo and Postma Exercise: Lab #3

8	October	18 NO CLASS GSA MEETING	20 DATA DISCUSSION: Gases	Writing Exercise #4
9	October	25 Microbial metabolism/C- cycle	27 Microbial metabolism/C-cycle	Reading: Madigan
10	November	1 LAB 4: Colorimetric analysis	3 DATA DISCUSSION: pH/Alkalinity	Reading: Writing Exercise #5 Exercise: Lab #4
11	November	8 Microbial mediation of redox reactions	10 Microbial mediation of redox reactions	Reading: Appelo and Postma
12	November	15 DATA DISCUSSION: Results & Interpretation	17 Open class for preparation of presentations	
13	November	22 Group Presentations (via teleconferencing)	24 THANKSGIVING	
14	November / December	29 Group presentation overview/proposal for future work assigned	1 Layered Communities	Nealson and Stahl; Writing Exercise #6
15	December	6 Course evaluations	8 AGU	Proposal for future work due Dec. 15, 5 pm

## Student Consent Form – Sharing Course Work

Once the course is over, Drs. O'Brien and Roberts will select student work to be copied and included in an archive for this course. As educators, this archive is important to us in several ways:

- Reviewing the work will help us reflect on how well students are learning in the course.
- We often use prior students' work as a point of comment for later students in the course.
- We maintain course portfolios in which we write about the quality of student performance generated in the course. Student work is an important piece of our work that we show to other professors to indicate how much and how deeply students are learning. Once course portfolios are completed, they will also be made available to a wider audience on public web sites on teaching and learning in higher education.
- Drs. O'Brien and Roberts will also use this course and your work as the topic of a research paper on teaching practice in earth science.

This form requests your consent to share your work with your instructors. Because of the small class size it is likely that your work may be selected; all students are being asked for their permission at the start of the course. If you choose to share your work, you have the choice to have it be anonymous or to have your name be part of the work.

*Please check the following designated purposes (if any) to which you give your consent:*

\_\_\_\_\_ I am willing to have copies of my coursework available so later students can use it for preparation.

\_\_\_\_\_ I am willing to have copies of my coursework included in my professor's course portfolio.

\_\_\_\_\_ I am willing to have copies of my coursework included in a public web site and/or a professional manuscript.

\_\_\_\_\_ I am not willing to share my work at all.

*Please check one of the following:*

\_\_\_\_\_ I wish to have my name remain on any work that is used.

\_\_\_\_\_ I wish to have my name removed on any work that is used.

By signing below you give your permission that work you produce for this course may be used with the restrictions and for the purposes you indicated above. You understand that your grade is *NOT* connected in any way to your participation in this project, and your instructor will not receive the list of students who have given permission to have their work shared until after final grades have been turned in for the course. Your anonymity will be maintained unless you

designate otherwise. Finally, you understand that you are *free to withdraw consent at any time*, now or in the future, *without being penalized*.

Signature \_\_\_\_\_ Date: \_\_\_\_\_

Please address questions to: name of faculty member, department, phone number, email.