

Geochemistry

Earth as you have never seen it before!

INSTRUCTOR

Dr. Benjamin Brunner
Assistant Professor, Geological Sciences

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MEETING PATTERN & LOCATION

Tuesday and Thursday 9:00am-10:20am Geology Building 404, 3 credits
undergrad/MS/PhD students

COURSE DESCRIPTION

Students often find Geochemistry a field that is hard to access. One of the reasons for that challenge is the fact that Geochemistry combines the fields of Geology – bringing in a multitude of minerals with complex chemical compositions – with Chemistry, a topic that some students might feel out of touch with since their first Chemistry studies a few years back. Moreover, Geochemistry is quite often ‘spiced up’ with a hefty dose of Mathematics and Physics. At best, this combination of challenges creates a fairly steep learning curve; at the worst it renders the topic a daunting hurdle.

This class takes a new approach: we will oscillate between geochemical questions that we can understand on a qualitative basis and the review/refreshment of basic tools from Chemistry, Mathematics and Physics that allow for more quantitative approaches. Developing from qualitative to quantitative understanding, we will refresh our skillset in Chemistry, Mathematics and Physics, making our joyful first steps in the exciting field of Geochemistry.

REQUIRED TEXTBOOK

Krauskopf K.B. and Bird D.K.: *Introduction to Geochemistry, third edition*, McGraw-Hill 1976.
There will be handouts & material posted on Blackboard.

RECOMMENDED READING: All books are available at the office of Dr. Brunner.
Faure G.: *Principles and Applications of Inorganic Geochemistry*, Macmillan 1991.
Schulz H.D. and Zabel M. Eds: *Marine Geochemistry, second edition*, Springer 2005.
White W.M.: *Geochemistry*, Wiley-Blackwell 2014.

COURSE OBJECTIVES

- 1) Refreshing/Review Mathematical Toolbox:
 - a. System analysis: Fluxes and Pools
 - b. Algebra
 - c. Simple differential equations
 - d. First-order kinetics, exponential growth and decay
- 2) Refreshing/Review Chemical Toolbox:
 - a. Chemical equilibrium / disequilibrium
 - b. Balancing of chemical equations
 - c. (Redox reactions – limited due to changes in lecture plan because of COVID-19)
 - d. Concentration, partial pressure, activity, fugacity
 - e. pH, (eH – not discussed due to changes in lecture plan because of COVID-19)
 - f. (Thermodynamics– limited due to changes in lecture plan because of COVID-19)
 - g. Kinetics
 - h. Aqueous chemistry
 - i. web-Phreeq aqueous speciation program (expanded due to changes in lecture plan because of COVID-19)
 - j. surface chemistry (expanded due to changes in lecture plan because of COVID-19)

Class drop deadline date:

May 7, 2020 (last day of classes)

Office hours:

Preferred: by appointment
made via email
TR: 10:30am – 11:50am
404A Geology Building

Disabilities: I will make any reasonable accommodations for students with limitations due to disabilities, including learning disabilities. Please see me personally before or after class in the first two weeks or make an appointment, to discuss any special needs you might have. If you have a documented disability and require specific accommodations, you will need to contact the Center for Accommodations and Support Services (CASS) in the East Union Bldg., Room 106 within the first two weeks of classes.

CASS can also be reached in the following ways:

Web: sa.utep.edu/cass

Phone: (915) 747-5148 voice or TTY

Fax: (915) 747-8712

E-Mail: cass@utep.edu



Never swim alone!

Cheating/Plagiarism:

Cheating is unethical and not acceptable. Plagiarism is using information or original wording in a paper without giving credit to the source of that information or wording: it is also not acceptable. Do not submit work under your name that you did not do yourself. You may not submit work for this class that you did for another class. If you are found to be cheating or plagiarizing, you will be subject to disciplinary action, per UTEP catalog policy. Refer to <http://www.utep.edu/dos/acadintg.htm> for further information.

PARTICIPATION IS ESSENTIAL (SEE GRADES)

Please contact Dr. Brunner about any concerns, schedule conflicts, etc. in advance or otherwise as soon as possible! A significant portion of your grade is based on participation, so any missed classes and assignments must have proper documentation or your grade will drop. Valid excuses include illness, absence with the instructor's prior approval, official University business, etc.

Accommodations are possible for active duty military and others, but arrangements must be made in a timely manner. If you are in the military with the potential of being called to military service and /or training during the course of the semester, you are encouraged to contact the instructor as soon as possible.

If you think you may have a disability or if you are experiencing learning difficulties, please contact the Disabled Student Services Office (DSSO) at (915) 747-5148. They are located in Union East room 106 or you can reach them by email at dss@utep.edu. The student is responsible for presenting to the instructor any DSS accommodation letters and instructions.

Important notes:

- 1) During the classes and as homework assignments, there will be various exercises. In class, students who struggle with the exercises will have the opportunity to work with the instructor in a smaller group to overcome specific hurdles. This is by no means meant to single out students who do not reach the goals of the lecture/exercises – it is an attempt to give everybody a fair chance to immediately address the encountered challenges, and to stay on track with the class. Students who take advantage of this opportunity but still encounter difficulties can schedule additional tutoring with Dr. Brunner.
- 2) This is a front-loaded class: most reading assignments precede the corresponding class. This will allow us to address the tricky issues of the topic in class. Reading the assignments before the lecture is the absolute key to the success of this form of teaching and learning.
- 3) Learning in teams is much more effective than learning alone, and is highly encouraged.
- 4) In the course of this class, Dr. Brunner is going to introduce experiments he is conducting in his laboratory. Interested students can participate in the research projects.

SCHEDULE OF TOPICS – *subject to change!*

Date:	Topic:	Reading & Assignments
Week 1	<ul style="list-style-type: none">• Geochemistry and you? Introduction of participants, discussion of syllabus and course evaluation.• You after a field-trip, a bathtub, and system analysis.• Spreadsheets, and making plots (Excel® or similar)	
Week 2	<ul style="list-style-type: none">• From the bathtub to an exponential curve – how did that happen?• Introduction Dr. Brunner's research• Geochemical cycles• Solving a simple differential equation	Chemical equilibrium
Week 3	<ul style="list-style-type: none">• Discussion of exponential curves: relevance for geochemistry and other processes, lessons learned and refreshed skills• Evaluation and discussion of bathtub reports• Start gypsum dissolution experiment /How do design a chemical experiment / Data recording and analysis / Excel	<i>Hand in homework.</i> Chemical equilibrium continued

Week 4	<ul style="list-style-type: none"> • Quiz I: lessons learned from reading “Chemical equilibrium” • Discussion of outcome from Quiz I and of reading assignment • Solving an equation system – removing the rust from our algebraic skills • Solving a quadratic and cubic equations, common ion effect 	Aqueous Solutions
Week 5	<ul style="list-style-type: none"> • Evaluation and discussion of reports on quadratic equation. • Balancing chemical equations • pH – the log scale, and the natural logarithm • Reaction kinetics: reaction orders • Observations from gypsum dissolution experiment 	Aqueous Solutions
Week 6	<ul style="list-style-type: none"> • Michaelis-Menten kinetics • Concentrations, Activities, Ion Strength 	MinetQ, PHREEQ
Week 7	<ul style="list-style-type: none"> • Easing into thermodynamics 	Thermodynamics
Week 8	SPRING BREAK	
Week 9	<ul style="list-style-type: none"> • Introduction to web-PHREEQ • COVID-19 prediction model based on Michaelis-Menten kinetics 	Transition to online classes <i>Hand in first PHREEQ output</i>
Week 10	<ul style="list-style-type: none"> • web-PHREEQ baby steps creating output • Activity, Couple & Sailors in a bar 	<i>Hand in second PHREEQ assignment</i>
Week 11	<ul style="list-style-type: none"> • web-PHREEQ baby steps creating output • Activity, Couple & Sailors in a bar 	<i>Hand in second PHREEQ assignment</i>
Week 12	<ul style="list-style-type: none"> • web-PHREEQ full project on anhydrite and gypsum stability • tying anhydrite and gypsum stability back to equilibrium discussion 	<i>Hand in second PHREEQ assignment</i>
Week 13	<ul style="list-style-type: none"> • Chapter 3 – Carbonate chemistry 	<i>Hand in reading assignment chp 3</i>
Week 14	<ul style="list-style-type: none"> • Chapter 5 – Crystal chemistry 	<i>Hand in reading assignment chp 5</i>
Week 15	<ul style="list-style-type: none"> • Chapter 6 – Surface chemistry 	<i>Hand in reading assignment chp 6</i>
Week 16	Course review	Final report Options: <ul style="list-style-type: none"> • class review • COVID-19 prediction

Grades: Quiz & Reports (80%), Participation in discussion (20%) – Adjusted to lack of class interaction due to COVID-19 online class

Expected deviations from Syllabus:

A) I will integrate hands-on experiments, one introducing enthalpy and entropy, and the other introducing electrochemistry. Unfortunately, in Spring 2020, only one hands-on experiment was possible.

B) I will try to integrate existing knowledge/concepts from previous classes.