Earth as you have never seen it before!

Geochemistry

GEOL 4316 001 26859

and

Low Temperature Geochemistry

GEOL 5376 001 29200

INSTRUCTOR

Dr. Benjamin Brunner
Assistant Professor, Geological Sciences
Office: 404A Geology Building
E-mail: bbrunner@utep.edu

MEETING PATTERN & LOCATION

Online, asynchronous, Jan 19, 2021 - May 06, 2021
March 15-19: Spring break
March 26: Cesar Chavez day
April 1: Spring Drop/Withdrawal deadline
May 10-14: Final exam week
Zoom chat TBD – to be planned in coordination with all participants
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.

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, Michaelis-Menten kinetics
2) Refreshing/Review Chemical Toolbox:
   a. Chemical equilibrium / disequilibrium
   b. Balancing of chemical equations
   c. Redox reactions
   d. Concentration, partial pressure, activity, fugacity
   e. pH, eH
   f. Thermodynamics
   g. Kinetics
   h. Aqueous chemistry
   i. web-Phreeq aqueous speciation program
   j. surface chemistry

MODIFICATIONS THE COURSE IN RESPONSE TO COVID-19 PANDEMIC

The asynchronous online format of this class poses some challenges, but also offers opportunities. It is up to the individual students to make the most out of the opportunities and communicate with the instructor and the colleagues in class if they encounter challenges.

Typically, students in this course show a wide range of knowledge and skills – it is my goal that each of these students has a fair chance to succeed – no matter what the starting point is. A consequence of this is that to some degree, the definition of that success is individual. In other words – I, as instructor will set minimal goals for everybody, but I expect that students define their additional learning goals for the semester, and then strive to reach those aims.

To achieve this under the constraints of our online format, there will be substantial changes to how the content of this course will be delivered. In particular, the start of the course will involve a phase in which we will engage in several activities that will be somewhat disconnected: we will start reading two textbooks that follow completely different approaches, we will binge-watch online lectures that I gave in Spring and Fall 2020, and we will start geochemical modeling of aqueous species without having the full background of what is going on, and we will also engage the process of system's analysis. The goal of this phase is to determine the learning goals of individual students that go beyond of the minimum requirement set by the instructor. Once we know what those goals are, we will set a schedule for the remainder of the semester. Consequently, the schedule posted at the end of this syllabus is definitively a work in progress.

REQUIRED TEXTBOOKS AND OTHER MATERIALS

1. Anderson: *Thermodynamics of Natural Systems (3rd Edition)* – will be available from bookstore
Theory and Applications in Geochemistry and Environmental Science
Greg Anderson, University of Toronto
Cambridge University Press
Online ISBN: 9781316796856
Published online: 27 May 2018
Hardback ISBN: 9781107175211
Hardback publication date: 26 April 2017
DOI: https://doi.org/10.1017/9781316796856
Web link: https://www.cambridge.org/highereducation/books/thermodynamics-of-natural-systems/5E09A0A8D3BEC5ACBF67C871D18CDBF1

2. Krauskopf K.B. and Bird D.K.: *Introduction to Geochemistry, third edition*, McGraw-Hill 1976 – This book is out of print. If you can find it used for ~ $40 it is worth it! There will be handouts & material posted on Blackboard from this book for those who cannot access a copy.

3. Required software: PHREEQC (accessible as web interface and also downloadable as PC-application)

RECOMMENDED READING:

These books can be borrowed from Dr. Brunner – all you have to do is ask.
Faure G.: *Principles and Applications of Inorganic Geochemistry*, Macmillan1991.
Schulz H.D. and Zabel M. Eds: *Marine Geochemistry, second edition*, Springer 2005.
White W.M.: *Geochemistry*, Wiley-Blackwell 2014.

Class drop deadline date:
April 1st, 2021

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

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.

Never swim alone!

Yes – this is an asynchronous online course. But that does not mean you have to do it all alone.

Earth as you have never seen it before!

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) 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.
2) Learning in teams is highly encouraged because it is much more effective than learning alone.

Grades: Quiz & Reports (80%), Participation in discussion (20%)

SCHEDULE OF TOPICS – *subject to change!*

Date:	**Topic:**	**Reading & *Assignments***
Week 1	• 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	• From the bathtub to an exponential curve – how did that happen? • Geochemical cycles • Solving a simple differential equation	**Chemical equilibrium**
Week 3	• 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	***Hand in homework.*** **Chemical equilibrium continued**
Week 4	• **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	• 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	• Michaelis-Menten kinetics • Concentrations, Activities, Ion Strength	**MinetQ, PHREEQ**
Week 7	• Easing into thermodynamics	**Thermodynamics**
Week 8	SPRING BREAK	
Week 9	• Introduction to web-PHREEQ • COVID-19 prediction model based on Michaelis-Menten kinetics	***Hand in first PHREEQ output***
Week 10	• web-PHREEQ baby steps creating output • Activity, Couple & Sailors in a bar	***Hand in second PHREEQ assignment***
Week 11	• web-PHREEQ baby steps creating output • Activity, Couple & Sailors in a bar	***Hand in second PHREEQ assignment***
Week 12	• web-PHREEQ full project on anhydrite and gypsum stability • tying anhydrite and gypsum stability back to equilibrium	***Hand in second PHREEQ assignment***
Week 13	• Chapter 3 – Carbonate chemistry	***Hand in reading assignment chp 3***
Week 14	• Chapter 5 – Crystal chemistry	***Hand in reading assignment chp 5***
Week 15	• Chapter 6 – Surface chemistry	***Hand in reading assignment chp 6***
Week 16	Course review	***Final report***