

Earth as you have never seen it before!

Geochemistry

GEOL 4316 001 26804

and

Low Temperature Geochemistry

GEOL 5376 001 26805

INSTRUCTOR

Dr. Benjamin Brunner
Associate Professor, Geological Sciences

Office: 404A Geology Building
E-mail: bbrunner@utep.edu

MEETING PATTERN & LOCATION, important dates

In person, Monday and Wednesday 10:30 am - 11:50 am, Jan 17, 2023 - May 04, 2023

Geology Building 320, Limited ADA Access

First meeting: Wednesday, January 18, 2023

Note: Monday, January 16 is Dr. Martin Luther King, Jr. Holiday – University Closed

March 13-17: Spring break – No classes

Note: Thursday, Friday March 23/24: DEERS Colloquium

Thursday March 30: Spring Drop/Withdrawal deadline

Note: Friday March 31: Cesar Chavez day – No classes

Friday May 5: Dead Day – End of classes

May 8-12: Final exam week

NOTE: YOU WILL BE AUTOMATICALLY DROPPED FROM THIS COURSE IF:

- You accumulate (combined) more than three
 - Failures to submit an assignment
 - Unexcused absences or late arrivals to class
- You accumulate more than five absences or late arrivals to class (no matter if excused/unexcused). **I will grant hardship exemptions, but only in extremely well justified cases.**
- You demonstrate repeated absence of commitment to actively participate in the course. Examples of such behavior include any activities that have nothing to do with class (e.g., texting, emailing, use of social media during class time) and refusal to engage in group activities.

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.

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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 POST-PANDEMIC PHASE

Unfortunately, the pandemic is not entirely over at this point. There are still outbreaks of COVID-19, and it also appears that our immune systems do not do well with other diseases in the aftermath of social distancing. Please bring it to my attention if you have any health concerns and I will do my utmost to come up with a solution. It is up to the individual students to communicate with the instructor and the colleagues in class if they encounter challenges.

One positive side of the pandemic is that I taught the course asynchronously for one semester and have recordings of all the classes. I will make those recordings available to participants. The lecture material will not be fully identical to the recorded material but has plenty of overlap.

GRADES & COURSE MATERIAL ETC

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, we will start the course with a self-assessment so that we can determine learning goals of individual students that go beyond of the minimum requirement set by the instructor (myself). 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. **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.

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

RECOMMENDED READING:

1. Anderson: *Thermodynamics of Natural Systems (3rd Edition)* – please connect with me if you are interested in thermodynamics

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. These books can be borrowed from Dr. Brunner – all you have to do is ask.

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.

Office hours:

Preferred: by appointment made via email

MW: 8:30am – 10:00am

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.

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PARTICIPATION IS ESSENTIAL (SEE GRADES and DROP RULE)

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 – and excessive absences etc. can result in you being dropped from class (SEE BOX ON FIRST PAGE). 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.

How to get excused from missing/being late to class:

- Send email to bbrunner@utep.edu in advance where possible or as soon as safely possible (don't text & drive).
- Subject line **MUST** include GEOL 4316 (undergrads) or GEOL 5376 (grad) and your name
- Text **MUST** include
 - Reason for absence/being late
 - Request to be excused for this absence/being late
 - Acknowledgement that you are responsible to catch up with missed material in timely fashion and that you will acquire this material from colleagues in course

Example:

Subject line: GEOL 5376 – James Bond

Text:

Dear Dr. Brunner,

I missed class on Monday February 31st, 3131.

As a secret agent in Her Majesty's service, I had to defuse a nuclear bomb on that day in an undisclosed location. Could you please excuse me from missing class? I fully aware that it is my responsibility will catch up with the missed course material and will acquire it from my colleagues.

Sincerely yours,

J.B.



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. However, please note that there is a difference between learning in teams and copying assignments or parts of assignments from each other. One is highly encouraged, the other is not acceptable (see box about cheating/plagiarism. If you have any concerns or questions, please ask immediately!

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

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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? • 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. Chemical equilibrium continued</i>
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 	<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 	<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	<i>Final report</i>