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Spring 2-1-2017

### GEO 327.01: Geochemistry

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# Geology 327 Geochemistry

Spring 2017

Nancy Hinman  
TTh 10:00 – 12:00, CHCB 304  
Office Hours: T 1:00-2:00, W 2:00-3:00, Th 8:00-9:00

Office: CHCB 316a  
Phone: 243-5277

**Description:** Geochemistry has many facets. The properties of elements determine their behavior in the environment. Thermodynamics and kinetics control the fate and transport of major, minor, and trace elements throughout the earth.

This course will be organized as geochemical puzzles. Each puzzle will take two or three weeks. I will introduce concepts, as they are needed to solve the puzzles. I do not intend to repeat concepts for new puzzles / problems – you will need to apply what you learned in the previous problem.

You are expected to write a report on each puzzle. The report will be prepared similarly to a laboratory report and must include a summary of all concepts needed to solve the problem. Each report will require tables and figures, along with examples of any calculations that were needed to reach your answer. You will be limited to two pages of text, not including references, tables, and figures.

For the final exam, you will prepare a presentation of a follow on question arising from the report of your choice. We will discuss this further throughout the semester.

## Outcomes:

- Students will understand how the properties of elements determine their distribution through the earth.
- Students will learn how to approach and use geochemistry to understand geology.
- Students will use laboratory experiments and natural examples to understand the techniques used to make geochemical observations.
- Students will learn to communicate their results verbally and in writing, in an ethical manner.

**Readings:** Required readings will be posted on the Moodle shell. These readings are selected from review articles and, as such, will require careful reading. I suggest you skim the material first, come to lecture, and then read it again.

**Laboratory:** We will conduct a laboratory experiment in which you will investigate the chemistry of carbonate rocks. The laboratory will be started early in the semester to allow full development and discussion of the results. Laboratory times will be scheduled outside of regular class times, for groups of three to four students, at a time that works for all members of the group. The laboratory will consist of one 3-hour session to prepare the samples, followed by analytical time schedule with the Environmental Biogeochemistry Laboratory and the Earth Materials Instrumentation Laboratory.

**Grades:** Each report will follow the same format and grading rubric. The reports will be worth 70 % of your grade. The final presentation will be worth 10 % of your grade. The laboratory report will be worth 20 % of your grade.

A field trip is tentatively scheduled for the weekend of 4/14/17.

**Weeks 1 through 3 (1/31 to 2/16)** – Low-temperature geochemistry - Why is the bone blue? **We will not meet in person for class on 1/31, 2/2, or 2/6.** Instead, I will lead an online discussion covering the second topic below.

1. mineral substitution
2. solubility and solution chemistry
3. carbonate chemistry

**Weeks 4 through 6 (2/21 to 3/9)** – Why is there no gold at Butte? - Ore Deposits

1. crystal substitution
2. isotope geochemistry
3. radionuclides and age dating

**Weeks 7 through 10 (3/14 to 4/6) (week 9 is Spring Break)** – What types of rocks would you predict for Mars? - Magmas

1. types of magmas – compositions, differentiation, properties
2. fluids and volatiles – origin, solar system chemistry, processes in the earth

**Weeks 11 through 12 (4/11 to 4/20)** – Why are Belt carbonate rocks striped? - Low-temperature and early diagenesis

1. Weathering
2. Sediment chemistry
3. Diagenesis

**Weeks 14 and 15 (4/25 to 5/4)** – Why should we be worried about nuclear waste disposal when a few meters change in sea level could blow the whole East Coast away? - Human Geochemistry - **We will not meet in person for class on 4/25 or 4/27.** Instead, I will lead an online discussion covering the first topic below.

1. Nuclear geochemistry
2. Environmental geochemistry

**Final's week** – Monday 5/8, 8:00 – 10:00 – Presentations

We will cover the following:

❖ **Topics:**

- A geochemists view of the periodic table
- Crystal chemistry and substitution
- Isotopes – stable isotopes and radiogenic isotopes
- Geochronology

- Oxidation/Reduction
- Acid/Base
- Solubility
- Sedimentary geochemistry and diagenesis
- Magmas, phase equilibrium

❖ **Systems**

- Carbonates
- Hydrothermal ore deposits
- Magmas
- Planets, moons, and smaller stuff (cosmic dust, meteorites)
- Continental shelf and seawater
- Human impacts

❖ **Toolbox**

- Isotopes for temperature
- Isotopes for age
- Isotopes for petrogenesis
- Elemental properties for abundance and differentiation
- Elemental properties for substitution and temperature determination
- Solubility
- Redox chemistry for ore formation
- Redox chemistry for sedimentary diagenesis
- Phase diagrams

## Policies

If you are a student with a disability and wish to request reasonable accommodations for this course, contact me privately to discuss the specific modifications. Please be advised, I may request that you provide a verification letter from Disability Services for Students. If you have not yet registered with Disability Services, located in Lommasson Center 154, please do so in order to coordinate your reasonable modifications. For more information, visit the Disability Services website at [www.umt.edu/disability](http://www.umt.edu/disability).

Attendance is required. I won't be taking attendance, but trust me, if you do not attend class then you will fall far behind and will be expected to catch up on your own. In this way, attendance will affect your grade.

All students must practice academic honesty. Academic misconduct is subject to an academic penalty by the course instructor and/or a disciplinary sanction by the University. All students need to be familiar with the [Student Conduct Code](http://www.umt.edu/vpsa/policies/student_conduct.php): ([http://www.umt.edu/vpsa/policies/student\\_conduct.php](http://www.umt.edu/vpsa/policies/student_conduct.php)).