Low Temperature Geochemistry 1: Introduction to biogeochemical cycles

EPS 186 **Fall 2014**
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This course will serve as an introduction to marine chemistry, low temperature geochemistry, and stable isotope biogeochemistry. We will focus on key biogeochemical elements (Carbon, Hydrogen, Oxygen, Nitrogen and Sulfur) and look to understand the linkages between the biosphere, atmosphere and hydrosphere. Through this, we will touch on basic chemical principles (thermodynamics, solubility, saturation, etc.) and measures of overall aqueous chemistry (pH, Eh, alkalinity). With an understanding of the basic chemistry of these geochemical cycles, we will begin to explore light stable isotope chemistry as a tool to track processes. Through simple exercises, we will learn how to use chemical and isotopic relationships to track the transfer of material in a system, where the systems of study will range in size from a single cell (micron-scale) to world's oceans (> km-scale). A course in college chemistry is recommended.

Schedule: Tuesdays and Thursdays, 10:00 – 11:30
Section: TBD
Midterm Exam: 2 x 1.5 hour closed book exams. More detail will follow.

PROBLEM SETS:
There will be problem sets to sharpen your understanding of geochemical principles, some of which will have been covered in class with other material coming from the readings. On average, there will be an assignment every ~2-3 classes.

BOOKS AND READINGS:
1) Emerson and Hedges, *Chemical Oceanography and the Marine Carbon Cycle* (2008)
2) Canfield et al., *Aquatic Geomicrobiology* (2005)
Reading from other sources will be provided.

GRADING:
Problem Sets: ~7 exercises at ~5% each (35% total)
Midterm Exams: 25% each (50% total)
Final problem set: 10%
Participation and Attendance (class and section) 5%

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Background:
Sept. 2 (1): Introduction and overview to the course
Sept. 4 (2): The world's oceans I

Sept. 9 (3): The world's oceans II

The chemical constituents of the ocean (C-cycle and alkalinity):
Sept. 11 (4): The Intro & review of basic chemical principles

Sept. 16 (5): The marine inorganic carbon cycle, alkalinity, and weathering I
Sept. 18 (6):The marine inorganic carbon cycle, alkalinity, and weathering II

Sept. 23 (7): The marine inorganic carbon cycle, alkalinity, and weathering III
Sept. 25 (8): The biological carbon cycle III: biological pump

Sept. 30 (9): Primary production, carbonate minerals and saturation state

Isotopes, microbes and mud:

Oct. 2 (10): Free energy and metabolism

Oct. 7 (11): Isotopic fractionation: equilibrium and kinetic effects
Oct. 9 (12): Early diagenetic microbial processes

Oct. 14 (13): Early diagenesis and marine sediments
Oct. 16 (14): Extensions to atmospheric O_2 and other gasses

Oct. 21: Midterm exam (concepts from lectures 1- 13),

Major biogeochemical elements and cycles:
Oct. 23 (15): The modern oxygen cycle

Oct. 28 (16): Guest Lecture
Oct. 30 (17): Guest Lecture

Nov. 4 (18): The sulfur cycle
Nov. 6 (19): The iron, phosphorus, cycle and trace elements

Nov. 11 (20): Trace metal biogeochemistry

Historical Records:
Nov. 13: (21): Holocene and Cenozoic

Nov. 18 (22): Guest Lecture

Nov. 20 (23): Guest Lecture

Nov. 25: Extra discussion and review
Nov. 27 (24): Thanksgiving

Dec. 2 (25): Mid term exam #2 (concepts from lectures 13 – 23)