SYLLABUS: CHEMISTRY OF CONTINENTAL WATERS W4885y Spring '08

The purpose of this course is to outline some aspects of the chemistry of natural waters on the continents, including rain, snow, springs, small streams, rivers, lakes, groundwaters and estuaries. It is directed to undergraduate & graduate students. The chemistry of many natural waters has been affected by human activities. Our focus will be on both anthropogenic effects and natural processes. Attention will be given to properties of water, aqueous chemical equilibria, acidity, alkalinity & pH, oxidation-reduction reactions and chemical weathering. Discussion will follow approximately the natural hydrologic cycle from formation of rain and snow to weathering of rocks in soils, transport of surface water in rivers, temporary retention in fresh water lakes, or groundwaters and finally saline lakes & estuaries. Emphasis will be placed on integrating information from water budgets, chemical equilibria concepts, major and trace element compositions, and distributions of natural and anthropogenic radionuclides. Case studies from a number of geographic regions, with practical management implications, will be discussed to illustrate processes that affect the chemistry of a range of types of continental waters.

Texts: (1) Global Environment, Water, Air, and Geochemical Cycles, E. K. Berner and R. A. Berner, Prentice-Hall, Upper Saddle River, NJ 07458, 1996, 376 pp (paperback). Unfortunately this book is no longer in print. We plan to purchase as many copies as feasible via the internet and to distribute them (on loan) among class members. Copies of this book should also be available on reserve in one or more libraries. About 75% of Berner & Berner will be assigned during the semester.
(2) Biogeochemistry of a Forested Ecosystem, 2nd Edition, G. E. Likens & F. H. Bormann, Springer-Verlag, New York, 1995, 159 pp (paperback). All of Likens & Bormann will be assigned reading and should be available from Labyrinth Bookstore (112th St).

Course grades will be based on:	Projects and Problem Sets	40%
	Midterm Exam	30%
	Final Exam	30%

Tuesday/Thursday 2:40 -3:55 PM, 603 Schermerhorn
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GENERAL OUTLINE OF TOPICS

The items below provide a general range of relevant topics, rather than a list of specific lecture titles. Most of these topics will be treated to some degree during the semester.

I. Atmospheric Water Cycle and Precipitation Chemistry
- -Chemical bonding of water molecules and related physical properties
- -Evolution of planetary atmospheres & structure of Earth's atmosphere
- -Atmospheric chemistry: aerosols
- -Radioactive fallout as tracers
- -Marine aerosol and precipitation chemistry (Hawaii)
- -Continental precipitation chemistry, including S & N cycles (NE USA)

II. Properties of Water, Weathering Reactions, Spring & Stream Chemistry
- -Chemical equilibria in aqueous solutions & acid-base aqueous chemistry
- -Solid phase & solution exchange reactions
- -Redox equilibria
- -Weathering of granitic and volcanic rocks (Sierra Nevada & Mt. Mazama, OR)
- -Major element and radionuclide budgets in lakes (Crater Lake, OR)
- -Forested ecosystems (Black Rock Forest, NY & Hubbard Brook, NH)
- -Chemistry of rivers: Amazon, Nile, Murray (Australia)

III. Biogeochemical Budgets in Freshwater Lakes
- -Physical and biogeochemical processes
- -Gas exchange between surface waters and the atmosphere
- -Photosynthesis, respiration and redox chemistry
- -Sediment pore water chemistry
- -Eutrophication (Experimental Lakes Area, Ontario)
- -Early effects of global warming on lakes
- -Trace metal cycles
- -Particle dynamics and sedimentation
- -Adsorption and "scavenging" - natural cleansing processes

IV. Groundwaters, Saline Lakes and Estuaries
- -Rockland County, NY & Murray Basin, Australia
- -Arsenic mobilization in reducing groundwaters
- -Closed basin lakes (Mono Lake, CA & the Dead Sea in Israel)
- -Meromictic lakes
- -Estuary physical transport processes
- -Nutrient & dissolved oxygen cycles as impacted by sewage influxes (Hudson)
- -Non conservative behavior of trace elements in estuarine dissolved transport
- -Persistent contaminants: radionuclides, trace metals & PCBs (Hudson River)

Course Web Address

http://eesc.columbia.edu/courses/w4885/

ASSIGNMENT W4885 January 22, 2008

Text (Berner & Berner): Global Environment: Water, Air & Geochemical Cycles

Chapters 1, 2, 3

1. Introduction: the water cycle, atmospheric and oceanic circulation
2. Air chemistry: the greenhouse effect and the ozone hole
3. Rainwater and atmospheric chemistry

Read the following pages as directly relevant preparation for this course:
1 - 9, 48 - 56, 62 - 130

The following pages should be skimmed if you are not already familiar with the material:
9 - 24, 27 - 48

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Alternative
ASSIGNMENT W4885 January 22, 2008

Text (Berner & Berner): The Global Water Cycle: Geochemistry & Environment

Chapters 1, 2, 3

1. Water: An important and unique substance
2. Water & energy cycles: oceanic & atmospheric circulation & green house effects
3. Rainwater and atmospheric chemistry

Read the following pages as directly relevant preparation for this course:
1 - 11, 12-30, 47-131

The following pages should be skimmed if you are not already familiar with the material:
30-48

Chemistry of Continental Waters (W4885) Spring '08

List of Lecture Titles: tentative (2/3/08)
Topics covered on first exam: Lectures #1-14

Lect #	(Date)	Title
1	(1/22)	Properties of water; Hydrogen Bond; abundance of H_2O
2	(1/24)	O_2 evolution; atmospheric H_2O cycle & T structure; atmospheric circulation
3	(1/29)	Formation of aerosols; sea salt nuclei & precipitation chemistry
4	(1/31)	Hawaii rain chemistry; cont. precipitation chem; S gases; acid emissions
5	(2/5)	S & N oxidation states; N gases; acid emissions & deposition
6	(2/7)	West Point, NY precipitation chemistry: acid rain
7	(2/12)	Weathering reactions: evaporites, sulfide oxidation, Sierra Nevada granites
8	(2/14)	Soils, weathering of silicates; organic acids; Sierra Nevada granites
9	(2/19)	Large river TDS: climate & topography; Amazon chemical weathering
10	(2/21)	NYC water supply system
11	(2/26)	Large river TSS, Tarbela Dam sedimentation & seepage water chemistry
12	(2/28)	Hudson R. dissolved O_2, nutrients, persistent chlorinated hydrocarbons
13	(3/4)	River and groundwater chemistry in Australia
14	(3/6)	Arsenic and other groundwater contaminants from landfills
15	(3/11)	**MIDTERM EXAM**
16	(3/13)	General chemical equilibrium relationships
		SPRING BREAK
17	(3/25)	Complexation & solubility equilibria
18	(3/27)	Exchange equilibria with solid surfaces #1
19	(4/1)	Exchange equilibria with solid surfaces #2
20	(4/3)	Acid-base equilibria #1
21	(4/8)	Acid-base equilibria #2
22	(4/10)	Oxidation-reduction equilibria
23	(4/15)	Classification of micro-organisms; biological processes, redox reactions
24	(4/17)	Hubbard Brook Experimental Forest #1
25	(4/22)	Hubbard Brook Experimental Forest #2
26	(4/24)	Lakes #1
27	(4/29)	Lakes #2
28	(5/1)	Lakes #3
	(5/9-5/16)	**FINAL EXAM**