The disciplines of Environmental Science and Environmental Analysis are devoted to a holistic study of our environment. They are cross-disciplinary and draw on insights from mathematics, the physical and biological sciences, politics, philosophy, sociology, and economics. An environmental scientist views our earth from three perspectives: earth as a geosphere, a biosphere, and an anthrosphere. The geosphere is defined as the physical earth with its structural and chemical components. The biosphere is constituted by the diversity of living organisms on the planet and their interactions with the geosphere. The subjective category anthrosphere addresses the interaction of our human institutions with the geosphere and biosphere and the consequences of these interactions for our civilization. In short, a comprehensive understanding of our planet requires the analysis of a complex web of interactions.

Chemistry 106, Environmental Chemistry, is an introduction to a study of the geosphere. The course will draw on material from geology and chemistry but will place primary emphasis on the chemical aspects of the environment. Since the dominant constituents of the geosphere are inorganic in nature, the course will have a strong geochemical flavor and a year of General Chemistry provides ample background for an understanding of the material. Our examination of the geosphere will raise ethical and political questions but a critical examination of these questions will be left to courses in ethics and politics.

For our purposes, we shall follow convention and divide the geosphere into the atmosphere, the hydrosphere, and the lithosphere, i.e. its gas-phase, liquid-phase, and solid-phase components. We shall examine the principal chemical species in each component, their properties, the consequences of these properties, and the cycling of these species. Some of these species are toxic and are generated by human activities. However, we shall attempt to provide a balanced view of all chemical substances in the environment, the good as well as the bad and the natural as well as the unnatural. This perspective is necessary if we wish to examine the environment objectively and as scientists provide optimal solutions to many vexing and complicated problems.

In our examination of the material, we shall apply all the techniques that you learned in General Chemistry. As a result, the course will have two results: a better understanding of the environment and an enhanced command of fundamental chemical principles. Setting General Chemistry as a prerequisite allows us to explore environmental chemistry in a non-trivial manner so completion of the course will satisfy one of the three elective requirements for the concentration in chemistry.
The course will be primarily lecture in format and attendance is expected. The size of the class will permit the instructors to develop some of the material using the Socratic method. Hence, you should come prepared to each class. Appropriate reading will be provided for each class session. However, the primary vehicles for learning the material will be the graded homework assignments, scheduled quizzes, the paper, and the cycling project. During the course, the instructors will discuss how carbon is cycled in the environment. Each member of the class will select an element from the list of nitrogen, phosphorus, and sulfur and give a presentation to the class on the cycling of this element. Further details on the paper and cycling project will be provided later. Because senior grades are due at 12 noon on Friday, 5 May, seniors' papers are due in class on Tuesday, 2 May. The deadline for other members of the class is 17:00 on Friday, 5 May. The course grade will be determined on the following weighting:

a) the homework assignments (10%)
b) the four 20-minute quizzes (40%)
c) the paper on a toxic component in the environment (25%)
d) presentation on cycling of an element (25%).

Resources
1) the course text
2) the course Web page, accessed at the following URL: http://pages.pomona.edu/~cjt04747/chem106.html
   (The index page accessed by this URL also has a link to MolData, a critical annotated bibliography to sources of reliable data on the WWW. The Environmental Chemistry page of MolData is a useful source of information.)
3) your instructors. The instructors will spell out their policy on office hours in class.
4) material on reserve in the Seeley G. Mudd (Pomona Science) Library.
   a) S. E. Manahan, Environmental Chemistry, 7th. ed, CRC Press, Boca Raton, FL, 2000. This monograph has been used as a text in previous versions of Chem. 6.
   b) T. G. Spiro and W. M. Stigliani, Chemistry of the Environment, 2nd. ed, Prentice-Hall, Upper Saddle River, NJ, 2003. This text was a candidate for the course text. Half of the text is devoted to the production of energy.
   d) R. M. Garrels, F. T. Mackenzie, and C. Hunt, Chemical Cycles and the Global Environment, Wm. Kaufmann, Inc., Los Altos, CA, 1975. The late Professor Garrels was the grand master of geochemistry and this masterpiece is a classic work.
   e) R. P. Schwarzenbach, P. M. Gschwend, and D. M. Imboden, Environmental Organic Chemistry, 2nd. ed., Hoboken, NJ, 2003. Two of the authors are on the faculty of the ETH-Zürich, the premier science university on continental Europe. The level of the monograph is advanced but the treatment is comprehensive.

g) D. J. Jacob, *Introduction to Atmospheric Chemistry*, Princeton University Press, Princeton, NJ, 1999. This is the book used in the atmospheric chemistry course at Harvard; the first chapters are relatively mathematical, the later ones more chemical.


5) the chemical literature. The literature is vast but we encourage you to develop the habit of browsing on a weekly basis the feature articles in *Science* and *Chemical and Engineering News*. Honnold Library has a subscription to electronic versions of these periodicals. Articles relevant to many of the paper topics can be found there.

**Schedule for Spring, 2007**

16 Jan. Introduction and an overview of the earth [Taylor and Oxtoby]

18 Jan. Hydrology: sources and cycling of water [Taylor]

23 Jan. Physical structure of the atmosphere [Oxtoby]

25 Jan. Chemistry of the "clean" atmosphere [Oxtoby]


1 Feb. Radiation chemistry: ozone formation via photolysis [Oxtoby]

6 Feb. Stratospheric ozone cycles and the ozone "hole" [Taylor]

8 Feb. Stratospheric ozone cycles and the ozone "hole" (continued) [Oxtoby]

13 Feb. Chemistry of the troposphere: NOx [Oxtoby] **Quiz 1**

15 Feb. Photochemical smog, free radicals, organics in the atmosphere [Oxtoby]

20 Feb. Smog remediation, engine operations, catalytic converters [Oxtoby]

22 Feb. Aerosols and particulate matter in the atmosphere [Oxtoby]

27 Feb. Greenhouse gases and global climate change [Oxtoby]

1 Mar. Greenhouse gases and global climate change, continued [Oxtoby]

6 Mar. Constituents of natural waters [Taylor] **Quiz 2**

8 Mar. Review of the properties of water [Taylor]

BREAK

20 Mar. Carbon dioxide and carbonic acid, definition of K_a's [Taylor]

22 Mar. Acid-base chemistry of carbonic acid [Taylor]

27 Mar. Acid-base chemistry of water in limestone [Taylor]

29 Mar. Electrochemistry and definition of pE [Taylor] **Quiz 3**
3 Apr.  pE/pH phase diagrams [Taylor]
5 Apr.  Iron in the hydrosphere and lithosphere [Taylor]
10 Apr. Organic compounds in the hydrosphere: trichloroethylene [Taylor]
12 Apr. Cycling of carbon in the environment [Taylor] Quiz 4
17 Apr. Overview of the lithosphere [Taylor]
19 Apr. Soil minerals and the consequences of acid rain [Taylor]
24 Apr. Class presentations on cycles: nitrogen
26 Apr. Class presentations on cycles: sulfur
  1 May  Class presentations on cycles: phosphorus

Chem106_syllabus.doc, 10 Jan. 2007