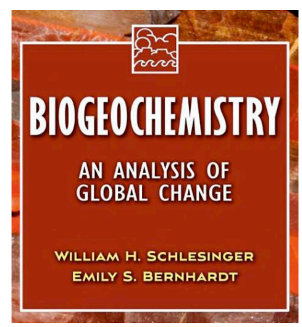
Geography 143: Global Change and Biogeochemistry
Fall 2014 (CCN: 36299)
Mon & Wed 12:30-2:00
575 McCone Hall

Course description:
We often wonder what makes Earth habitable (e.g., suitable climate, chemical composition, presence of water), but how does our global environment *maintain* habitability? What makes our planet sustainable? In particular, how does LIFE on this planet affect and regulate the chemical environment that in turn allows life to continue and not perish? Understanding the biological and chemical processes that regulate the environment is essential to answering this question. And answering this question will help us understand how HUMANS have been altering the chemistry of the world, with ramifications for other life, present and future. This is the essence of biogeochemistry. In this class, we will **explore the imprint that biota (including humans) have on the chemistry of the atmosphere, oceans, and lithosphere**. And we will learn HOW we can measure key biogeochemical processes, which may be largely invisible to the human eye, but are critically important in controlling exchange of chemicals between different reservoirs. To assist us in this endeavor, we will use one primary textbook, a couple supplementary texts, and both classic and very recent scientific journal articles. We will do problem sets, lab and field exercises, and an individual research project. The teaching method will involve active learning, bcourses website, and a lot of interaction.

Professor	Office	email address	Office hours*
Robert Rhew	539 McCone	rrhew@berkeley.edu	Mon 2:30-4:30 (office)

Readings (versions of these books will be put on reserve at Earth Sciences Library):



(Required) Biogeochemistry: An analysis of global change, 3rd edition, William Schlesinger and Emily Bernhardt. Academic Press, 2013.
(Optional) Principles of Terrestrial Ecosystem Ecology, 2nd edition, F. Stuart Chapin III, Pamela Matson, Peter Vitousek. Springer, 2012.
*Additional readings posted to bcourses.berkeley.edu

Grading

Lab/ homework assignments	45%
Take-home midterm	25%
Independent Research Project	30%

Oral reports on Friday, Dec 19, 2014, 11:30-2:30 (exam Group 18). Written reports due at 11:30 a.m.

Grading policy:

Lab homeworks will be graded on correctness, completeness and legibility. Because some assignments and all labs will be done in-class, class participation is necessary. This class will involve a lot of discussion and problem solving, so bring your calculator. Late homeworks will be docked 10% per day (or any part thereof).

You will also be conducting some work outdoors as well as in the Trace Gas

Biogeochemistry laboratory and will need to be knowledgeable of potential hazards and safety protocols. Labs cannot be made up, so you must let me know in advance if there are any scheduling conflicts.

Teaching goals:
Biogeochemistry is the study of chemical interactions between the biosphere and the non-living spheres of the earth system (atmosphere, lithosphere, cryosphere, and hydrosphere). The emphasis of this class will be on the "big picture": chemical and energy exchange associated with regional and global environmental problems (as opposed to local pollution, which falls under the purview of environmental chemistry classes). That being said, small-scale processes that are globally significant (i.e., photosynthesis, biomineralization, decomposition) will be explored in detail. We will also emphasize the role that humans have played in modifying the global biogeochemical cycles of many essential elements and compounds. The recommended prerequisite for this course is Chemistry 1A or equivalent.

Practical goals:
This class is also about developing fundamental scientific skills and tools. By the end of the class, you should be able:

1. To peruse modern scientific journals and understand the context of the important articles relevant to biogeochemistry.
2. To measure fundamental ecosystem processes, such as litter decomposition, net photosynthesis, soil pH and moisture.
3. To be able to calculate fundamental environmental parameters and rates associated with the above measurements.
4. To understand measurement uncertainty, basic statistics, and potential sources of error
5. To make careful observations that can explain experimental results.

Lecture notes and participation:
Lecture notes will be posted to bcourses, but it is not a substitute for coming to class! This class will introduce a lot of new information, especially since much of the material will come from recent journal articles. It is incumbent upon you to attend and participate in classes and ask lots of questions. This is a journey through an exciting and ever-changing field of science, and will provide an overview of many topics in earth system science.

Geog 143: Global Change and Biogeochemistry (cont.)

Oxidized → Reduced (columns); Reduced → Oxidized (rows, bottom to top)

	H_2O/O_2	C	N	S
H_2O/O_2	X	Photosynthesis $CO_2 \rightarrow C$ $H_2O \rightarrow O_2$		
C	Respiration $C \rightarrow CO_2$ $O_2 \rightarrow H_2O$	X	Denitrification $C \rightarrow CO_2$ $NO_3 \rightarrow N_2$	Sulfate-Reduction $C \rightarrow CO_2$ $SO_4 \rightarrow H_2S$
N	Heterotrophic Nitrification $NH_4 \rightarrow NO_3$ $O_2 \rightarrow H_2O$	Chemoautotrophy (Nitrification) $NH_4 \rightarrow NO_3$ $CO_2 \rightarrow C$	Anammox $NH_4 + NO_2 \rightarrow N_2 + 2H_2O$	?
S	Sulfur Oxidation $S \rightarrow SO_4$ $O_2 \rightarrow H_2O$	Chemoautotrophy (Sulfur-based Photosynthesis) $S \rightarrow SO_4$ $CO_2 \rightarrow C$	Autotrophic Denitrification $S \rightarrow SO_4$ $NO_3 \rightarrow N_2/NH_4$	X

FIGURE 1.4 A matrix showing how cellular metabolisms couple oxidation and reduction reactions. The cells in the matrix are occupied by organisms or a consortium of organisms that reduce the element at the top of the column, while oxidizing an element at the beginning of the row. Source: From Schlesinger et al. (2011).