Marine Chemistry Syllabus Revision

Course Description:

The ocean is a dynamic, ever-changing environment, that has immense impact on our global climate and element cycles, especially carbon. This course is designed to examine the chemical, biological, geological and physical processes that affect (and are affected by) the chemistry of the oceans. A lot of the data used to support our current understanding of ocean chemistry is a result of scientific progress made in conjunction with World War II and the weapons created as a part of the Manhattan Project. In this course, we will prioritize engagement with and interpretation of real data, as well as the broader motivations behind the scientific studies from which we base most of our understanding.

Throughout the semester, we will focus on a range of topics, including chemical cycling in seawater, chemical tracers of ocean circulation, the marine carbon cycle, interactions between the ocean and the atmosphere, interactions between the ocean and sediments, large scale nutrient distributions, and biological productivity. Our investigation into ocean chemistry and its implications for the global climate will place an emphasis on understanding and interpreting data over memorization of patterns and previous findings. We will learn how and why this type of science is funded and consistently grapple with who is given the credit and why. It is our responsibility as the next generation of scientists to question the motivations of those who created the knowledge we come to accept as fact, to identify potential questions and directions they may have missed.

This is a course that will ask you to respectfully engage with the ideas of your fellow scientists, and the scientists that came before you, while challenging yourself to derive your own conclusions from the data, to better understand the importance of our ocean's chemistry and what is required to move science forward. We will achieve this mission through project and collaboration-based learning; we will gain knowledge and skills through discussions of data and scientific study design, with different guiding studies for each main topic of the course. Through our collaboration, we will become more critical of scientific findings and understanding, improve our scientific communication, and hopefully feel more empowered as scientists moving forward.

Course Learning Objectives:

<u>General Skills:</u>

1. Summarize the important components of chemical profiles, sections, maps, and time series.
2. Provide interpretations of data shown in chemical profiles, sections, maps, and time series of the global oceans.
3. Analyze multiple chemical profiles, sections, maps, or time series, and interpret how they come together to create a cohesive story of a process or trend in the global ocean.

4. Justify your interpretations of real-world data by comparing your conclusions with previously made findings. If your findings agree, why do they agree? If they disagree, what could have gone wrong or where do these differences come from?
5. Build box models to explain how concentrations of chemicals change with variation in physical and biological fluxes in different parts of the ocean and through geologic time.
6. Design a possible unique study, create figures (chemical profiles, sections, maps or time series) and justify your choices and interpretations.

Grading: 50% class participation (including attendance), 50% Final project.

Final Project: Details for the final project for this course will be provided after the first three weeks of class to allow for adequate time to work on a topic of your choosing. Briefly, the aims of this project are for students to write an NSF style research study proposal and do a brief, 10-minute presentation on their proposed study. The proposal should be on a topic related to any aspect of marine chemistry covered during this course and should include some component of real-world data that the students manipulate to provide preliminary figures supporting their expected results. The instructor will provide support in identifying a reasonable topic and sourcing data that the student can use.

Pre-Requisites: Introductory Geology and/or Introduction to Oceanography, General Chemistry, comfort with algebra and some calculus.

Class Schedule:

Chemical Cycling in Seawater:

Week 1: Marine Chemistry & Tracking elements

Week 2: Tracking Elements in the Whole Ocean

Week 3: Tracking Elements Source to Sink

Chemical Tracers & Ocean Circulation:

Week 4: Tracers in the Upper ocean vs Deep Ocean

Ocean and Atmosphere Interactions:

Week 5: Air-Sea exchange & Primary Production

Primary Production & Biological Cycling:

Week 6: Limiting Nutrients & Nutrient cycling

Week 7: Organic matter, oxygen, and deep ocean

Carbon Cycling in the Ocean:

Week 8: The carbonate system & CO_2 in seawater

Week 9: Calcium Carbonate Cycling & Anthropogenic Impacts

Isotopes as Tracers:

Week 10: Stable Isotope Tracers

Week 11: Radiogenic Isotope Tracers

Sediment & Ocean Interactions:

Week 12: Porewater chemistry & organic matter remineralization

Week 13: Redox conditions & element cycling

Final Project Work:

Week 14: Extra time to cover content missed during the previous weeks; Alternatively, time for in class work on final projects & instructor support.

Week 15: Final project presentations

Credit:

The structure of the class schedule and main topics of the course were inspired by CU Boulders Marine Chemistry & Geochemistry course (GEOL 4270 / 5270).

University Policies were left out of this syllabus, as well as community agreements.