Introduction

OCN 623 – Chemical Oceanography

TR 10:30 – 11:45am in MSB 315

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Gases & tracers

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Ocean Data View
OCN623 Web Presence

OCN Dept Courses Page

Glazer ‘Teaching’ Page

Google@UH Classroom

Twitter: @glazer, #OCN623
Course Philosophy

Every oceanographer needs to have a fundamental understanding of all of the disciplines of oceanography. This is not just because we desire to turn out well rounded oceanographers -- it is extremely important to your career & moving fields forward.

Like any science, the most interesting discoveries are often waiting to be made at the interface between disciplines; it is the application of knowledge in one area to problems in another that leads to fundamental improvements in our understanding.

Further, “skills” from one branch of oceanography can frequently be useful to research efforts in the other branches.

Finally, all of us need to know enough about the other fields of oceanography so that we are literate in them and are thus capable of understanding the literature in those areas and able to talk other researchers.
Each of the other oceanographic sub-disciplines interact with chemical oceanography on some spatial/temporal scale:

- **Physical oceanography** uses the chemical parameters provided by chemical oceanography to provide constraints on the origin and circulation of the water masses.

- **Geological oceanography** and chemical oceanography are related through both the chemical cycles and the interaction between rocks and water in the weathering cycle at both high and low temperature.

- **Biological oceanography** is highly affected by the chemical dependency of organisms and the inverse, their effect on the distribution of chemicals.
Therefore, upon successful completion of this course, students are expected to be able to:

- Explain the underlying principles of chemical and biogeochemical cycling in marine systems;
- Identify marine chemical and biogeochemical processes that impact the students’ areas of oceanographic interest, and know how to access and understand information on these processes;
- Use written and oral communication to clearly explain marine chemical and biogeochemical processes and related contemporary research.
Course Structure

• **Fundamental Concepts** – Equations, redox, thermodynamics, ion speciation (*break out the freshman chem books!*)

• **Chemical properties** – Trace elements, dissolved gases, pH, alkalinity, the CO$_2$/carbonate system, organic matter, isotopes

• **Geochemical reservoirs and fluxes** –
  • Origin of the earth, comparing it to other nearby planets
  • Origin of the oceans on Earth, and the concept of separate identifiable geological reservoirs
  • The cycling of materials within and between these reservoirs
  • Fluxes of materials into the oceans from land, marine sediments, and the interaction between sea water and the crust
  • Fluxes of materials both into and out of the oceans at the sea surface
**Biogeochemical transformations** – These lectures will demonstrate the fundamental processes (input, removal and recycling) that govern the behavior of chemicals in sea water. We will look at:

- The nature and reactivity of gases, organic compounds, nutrients, trace metals and stable and radio-isotopes
- The distributions of these chemicals, which will help us understand the processes that produce them
- The sinks of chemical materials in the oceans
- The biogeochemical processes that occur in estuaries, and the role that these processes have in modifying the fluxes of materials from the continents to the oceans
- The ocean-atmosphere interactions and the importance of the sea-surface microlayer
- The feedback mechanisms that exist between the oceans and atmosphere
- The importance of these feedbacks to global climate and the evolution of the chemical cycles
- The role that these cycles have played in maintaining the temperature and conditions at the surface of the Earth over geologic time
- Lessons that can be learned from the fossil record of these cycles in terms of predicting the future climatic consequences of anthropogenic activity
# Course Outline

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<td>12-Jan</td>
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<td>Syllabus</td>
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<tr>
<td>14-Jan</td>
<td>Balancing reaction equations, oxidation state, redox reactions</td>
<td>Handout</td>
<td>CM</td>
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<td>19-Jan</td>
<td>Chemical equilibrium, redox and pE-pH diagrams</td>
<td>S (1st half), L ch. 7</td>
<td>CM</td>
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<td>21-Jan</td>
<td>Ion speciation</td>
<td>S (2nd half), L ch. 5</td>
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<td>26-Jan</td>
<td>Chemical composition of sea water: major constituents</td>
<td>L ch. 2, 3, 4</td>
<td>CM</td>
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<td>28-Jan</td>
<td>Trace elements in sea water</td>
<td>L ch. 11</td>
<td>CM</td>
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<tr>
<td>2-Feb</td>
<td>GEOTRACES</td>
<td>Handout</td>
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<td>4-Feb</td>
<td>Ocean Data View</td>
<td>Websites &amp; handouts</td>
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<td>9-Feb</td>
<td>Dissolved gases other than carbon dioxide in sea water</td>
<td>L ch. 6 (1st half)</td>
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<td>11-Feb</td>
<td>Carbon dioxide, alkalinity and pH, 1988-2011 sea surface CO2</td>
<td>L ch. 15</td>
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<td>16-Feb</td>
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<td>18-Feb</td>
<td>Oceanic water mass tracers</td>
<td>L ch. 10 &amp; 24</td>
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<td>23-Feb</td>
<td>Stable isotopic tracers</td>
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<td>25-Feb</td>
<td>Stable isotopic tracers</td>
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<td>1-Mar</td>
<td>Nutrients: Aerobic carbon production and consumption</td>
<td>L ch. 8 &amp; 9</td>
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<td>3-Mar</td>
<td>Biogenic production, carbonate saturation and sediment distributions</td>
<td>L ch. 15 &amp; 16</td>
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<td>10-Mar</td>
<td>Diagenesis in sediments and resulting sediment-seawater fluxes</td>
<td>L ch. 12</td>
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<td>15-Mar</td>
<td>Organic matter in seawater and sediments</td>
<td>L ch. 22, 23</td>
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<td>17-Mar</td>
<td>Student reports - ODV visualization challenge</td>
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<td>22-Mar</td>
<td>Spring Break - No Class</td>
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<td>24-Mar</td>
<td>Spring Break - No Class</td>
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<td>29-Mar</td>
<td>Estuarine structure and function</td>
<td>L ch. 28</td>
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<td>31-Mar</td>
<td>Estuarine coastal biogeochemistry</td>
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<td>5-Apr</td>
<td>Hydrothermal Systems I: History, structure, chemistry</td>
<td>L ch. 19</td>
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<tr>
<td>7-Apr</td>
<td>Hydrothermal Systems II: Chemosynthesis, fluxes, ridge-flanks</td>
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<td>12-Apr</td>
<td>Discussion of peer reviews</td>
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<td>14-Apr</td>
<td>Geochemical reservoirs and transfer processes</td>
<td>L ch. 21</td>
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<td>19-Apr</td>
<td>Atmosphere, the water cycle, climate change</td>
<td>Handout</td>
<td>BG</td>
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<tr>
<td>21-Apr</td>
<td>People, oceans, climate change</td>
<td>L ch. 25</td>
<td>BG</td>
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<td>26-Apr</td>
<td>Electrons, life, and the evolution of Earth's chemical cycles</td>
<td>Handout</td>
<td>BG</td>
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<td>28-Apr</td>
<td>Student Presentations I</td>
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<tr>
<td>3-May</td>
<td>Student Presentations II</td>
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<td>all</td>
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<tr>
<td>9-May</td>
<td>Final Exam Week</td>
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Readings from Libes, Marine Biogeochem 2nd edition and/or handouts & web links
**Homework:** The homework will give you a chance to develop chemical skills used in oceanography. Problems sets are due one week after they are assigned (e.g., homework assigned on Tuesday is due at the start of class on the following Tuesday). If homework is not handed in by the deadline, you will get a zero.

**Readings** are important! They are listed on the Course Outline. **DO** expect reading material to be covered on the exams, even if it isn’t specifically addressed in the lectures!!

**Lectures:** Nominally they are from 10:30 - 11:45, but realize that classroom discussion can cause the end of class to extend to 11:50 or, occasionally, 11:55. Please plan accordingly.

**Exams:** The mid-term and final exams will focus on the lectures from the first and second halves of the course, respectively, but not exclusively so: the use of knowledge gained in the first half of the course may be required to answer questions on the final exam. Both exams will be “open book” -- you can bring any written material you wish.

**Final Grade:** 25% Final Exam; 25% Mid-term Exam; 30% Term Papers (peer review, final draft, oral presentation); 10% homework assignments, 10% ODV project
The great ODV visualization extravaganza of 2016 begins 2/5/16!!
TERM PAPER INSTRUCTIONS

Term Papers and Presentations—Each student will be required to write a term paper on a topic of their choice, and to give an oral presentation based on the paper.

Why a term paper??

• Makes concepts covered in the course more “concrete”
• Opportunity to refine technical writing skills
• Provides experience in finding biogeochemical oceanographic info and references

Topics:

• You are free to choose a topic that interests you. They must be chosen by **February 11**.
• Must be a topic of *current* interest in Chemical Oceanography
• Unfortunately, research from Station ALOHA and HOT is primarily "off-limits" -- due to the fact that all of the relevant papers are listed on the ALOHA/HOT web sites. (These convenient lists short circuit your opportunity to dig into the scientific literature and find relevant papers on your own.)
• It can NOT be the *primary* topic of your thesis/dissertation research. (At least “an arm’s length away--we hope that the term paper will be used to expand your scientific horizons.)
• Topics used in the past three years cannot be used
Objective
Provide a good review (at minimum) of a current topic of interest in the field of chemical oceanography

Guidelines
A good paper has two key points: good ideas and good writing

- Find references
- Take notes
- Organize topic/subtopics
- Incorporate class material
- Generate outline
- Write draft
- Revise
- Proof

Communicate efficiently and effectively
Requirements for the term paper:

• Proposals should be printed double-spaced, 8 pages in length (not including figures or tables).

• References must only be from the original (primary) scientific literature. Please, no textbooks or web pages!

• You should strive to present a coherent story, hopefully interjected with novel observations and conclusions. We are looking for a synthesis/integration of information.

• Please use a spell-checker & self-edit before submitting each version.

• Each line and page of the draft should be numbered for easy peer reviewing/editing. 3 hard copies of the draft are due March 29.

• Each student will peer “review” 2 drafts; reviews are due April 12. That class period will be used to discuss drafts & reviewer comments/suggestions.

FINAL DRAFT (& previous versions/comments) are due April 28.

(Do independent work on drafts & revisions prior to the final version.)
Please provide answers to the following questions for the paper you are reviewing. Also, feel free to attach any other comments you may have, and to write comments/suggestions onto the text.

Who wrote the paper you are reviewing? ______________________________

1. Is the subject of the paper clear from the beginning? Does the reader have a sense as to where the paper is going?

2. Has the author made an attempt to interest the reader in the topic?

3. Are the paper’s arguments presented in a clear and logical fashion?

4. Are the conclusions clearly and concisely presented?

5. Are there sufficient and appropriate references to support the concepts discussed? Are the references from the primary literature (i.e., scientific journals instead of encyclopedias, etc.)?

6. Is the paper easy to read? If not, why?

7. What specific suggestions can you make to improve the paper?

8. What is your overall evaluation of the paper?
Grading of the term papers will be based on the following criteria:

• Comprehensive coverage of the topic, synthesis of the information presented and indication of critical thinking by the author
• Use of references, judged by quality and type (primary vs. secondary)
• Use of figures to illustrate ideas, judged by quality and appropriateness
• Written presentation, judged by writing skills, spelling, grammar, adherence to the rules

Grading of the presentations will be based on the following criteria:

• Quality and comprehensiveness of the material covered
• Organization of talk, including the quality of the conclusions given
• Quality and use of figures
• Keeping within the allotted time
• Quality of speaking style
• Participation in discussions