ERTH640 Coastal geochemistry

**Instructor:** Henrietta Dulai, POST 707, 956-0720, [hdulaiov@hawaii.edu](mailto:hdulaiov@hawaii.edu)

**Office hours:** Available by appointment.

**Lecture:** Mon – Wed 1:30-2:45 pm, POST 702.

**Texts are recommended but not required to purchase:**
Libes: Introduction to marine geochemistry (recommended)
Stumm&Morgan: Aquatic chemistry (recommended)
Schlesinger: Biogeochemistry: An analysis of global change  (recommended)
Cochran&Krishnaswami: U- and Th series nuclides in aquatic systems (recommended)

Peer reviewed literature provided through Laulima

**Course Description:**

Geochemistry at the land-ocean interface: coastal hydrology, subterranean estuaries and coastal mixing and their importance in governing the distribution of selected radiotracers, trace metals, nutrients and organic pollutants. Combined lecture-lab course with field trips and group projects.

This interdisciplinary course offers insight into geochemistry at the land-ocean interface and the processes that govern the distribution of chemical compounds. The course provides the students with the opportunity to combine theory and experiments from three disciplines: hydrology, geology and oceanography. Students can learn about the relevance of these fields to society (groundwater sustainability, coastal water quality and biological implications), including those appropriate to Hawaii.

**Pre-requisites:**

Students are expected to have solid background in mathematics (MATH 241 or MATH 251A) and in chemistry (CHEM 162) or consent of the instructor.

**At the end of the course the students will be able to:**

identify coastal processes that have significant influence on coastal chemical budgets;
specify the major chemical processes in estuaries and subterranean estuaries;
name and apply geochemical tracers useful for the assessment of coastal hydrological processes;
describe the connection between coastal hydrology, marine pollution, oceanic chemical element budgets and biological processes.

**Activities and assignments by which students are expected to learn the course materials:**

Paper discussions
In-class exercise of chemical equilibria and geochemical tracer model calculations
Homework assignments
Field excursion and sample collection
Laboratory exercise of sample analysis
Testing & Grading: The final grade for the course will reflect the students’ performance in
lecture and lab assignments. The test/quiz and lab weighting is as follows: homeworks (50%),
class projects (30%), quizzes (20%).

Homework: There will be 3-4 homework assignments on biogeochemistry of major nutrients
and diagenesis, interpretation of estuarine profiles of non-conservative elements, anthropogenic
pollutants.

Class Project (worth 30% of grade): There will be one field trip during which we will collect
samples from a groundwater plume and subterranean estuary. We will follow up with sample
analysis in the lab and data interpretation in class.

Laulima: Course resources (power point slides from lectures and handouts) will be posted on
Laulima under the “Resources” link on the course site. In addition all homework assignments
must be turned in electronically. To do this follow the “drop box” link to access your personal
folder. To access the Laulima course web site use a web browser to visit the following address:
https://laulima.hawaii.edu/portal. Click on the tab with the heading: ERTH640-001
MAN.xxxxxxx.SP20.

Tentative schedule

<table>
<thead>
<tr>
<th>Class #</th>
<th>Topic covered</th>
<th>Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Overview of water cycle, acid/base and redox chemistry, chemical equilibria</td>
<td>Stumm&amp;Morgan: Aquatic Chemistry, Libes: Intro into Marine BGC</td>
</tr>
<tr>
<td>2</td>
<td>Trace metal chemistry, precipitation and dissolution, the solid solution interface</td>
<td>Stumm&amp;Morgan: Aquatic Chemistry, Libes: Intro into Marine BGC</td>
</tr>
<tr>
<td>3</td>
<td>Chemical composition of natural waters</td>
<td>Stumm&amp;Morgan: Aquatic Chemistry, Libes: Intro into Marine BGC</td>
</tr>
<tr>
<td>4</td>
<td>C, N, P, S cycles</td>
<td>Stumm&amp;Morgan: Aquatic Chemistry, Libes: Intro into Marine BGC</td>
</tr>
<tr>
<td>5</td>
<td>Diagenesis</td>
<td>Stumm&amp;Morgan: Aquatic Chemistry, Libes: Intro into Marine BGC; Seitzinger et al., 2010</td>
</tr>
<tr>
<td>6</td>
<td>Overview of radioactivity</td>
<td>Chopin: Radiochemistry</td>
</tr>
<tr>
<td>7</td>
<td>Intro into radiotracers (radon, radium, uranium, thorium, lead)</td>
<td>U and Th series Nuclides in Aquatic Systems by Cochran and Krishnaswami</td>
</tr>
<tr>
<td>8</td>
<td>Sediment accumulation rates – Pb-210 dating</td>
<td>Appleby and Oldfield</td>
</tr>
<tr>
<td>9</td>
<td>Overview of hydrology - hydrologic cycle: watershed, precipitation, evapotranspiration, infiltration, groundwater</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Aquifers</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Estuaries</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>The subterranean estuary – structure, redox, geochemical zonation, trace metal chemistry</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>The subterranean estuary – biogeochemistry, nutrients</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Submarine groundwater discharge (SGD)</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Assessment of SGD – overview of methods</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Assessment of SGD - geochemical tracers</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Lab: radon and radium measurements</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>SGD typology</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>SGD as a source of nutrients into the coastal zone</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>SGD’s influence on the chemical budgets in the ocean</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>SGD implication on biological processes in the coastal zone</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>The fate of groundwater derived components in the ocean</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Field exercise</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Lab: sample processing and data analysis</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Lab: sample processing and data analysis</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Lab: sample processing and data analysis</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Lab: sample processing and data analysis</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Discussion of field results</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Discussion of field results</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Class presentation</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Class presentation</td>
<td></td>
</tr>
</tbody>
</table>

- Froelich et al., 1986
- Kroeger and Charette, 2008
- Moore 1996; Burnett et al., 2006
- Burnett et al., 2006
- U and Th series Nuclides in Aquatic Systems by Cochran and Krishnaswami
- Moore and Arnold, 1995; Radon in groundwater
- Bokuniewicz, 1999
- Valiela, 1996;
- Charette, 2006
- Dailer et al., 2009; Umezawa, 2008
- U and Th series Nuclides in Aquatic Systems by Cochran and Krishnaswami; Moore, 2000
Graduate Student Learning Outcomes as defined by the ES department:

For the M.S.
1. Acquire knowledge and skills that will enable her or him to advance the state of the Earth sciences and their application to societal problems.
2. Evaluate the hypotheses, methods, results and conclusions of published literature relevant to a chosen scientific problem.
3. Define an appropriate and tractable thesis objective, in consultation with his or her advisor.
4. Present and defend her or his scientific findings in front of a public audience.
5. Write a thesis which documents his or her contribution to the field.

For the PhD
1. Satisfy the SLOs for the M.S.
2. Comprehensively synthesize, evaluate, and interpret the fundamental knowledge in her or his sub-discipline.
3. Independently construct scientific hypotheses and design and carry out research to evaluate them.
4. Critically analyze and synthesize the results of their research, derive conclusions which advance the field, and be capable of writing a manuscript describing these in the peer-reviewed literature.

Disability Access:
If you have a disability and related access needs the Department will make every effort to assist and support you. For confidential services students are encouraged to contact the Office for Students with Disabilities (known as “Kokua”) located on the ground floor (Room 013) of the Queen Lili‘uokalani Center for Student Services:

KOKUA Program
2600 Campus Road
Honolulu, Hawaii 96822
Office hours 7:45 AM – 4:30 PM
Voice: 956-7511
Email: kokua@hawaii.edu
URL: www.hawaii.edu/kokua

Title IX
The University of Hawai‘i is committed to providing a learning, working and living environment that promotes personal integrity, civility, and mutual respect and is free of all forms of sex discrimination and gender-based violence, including sexual assault, sexual harassment, gender-based harassment, domestic violence, dating violence, and stalking. If you or someone you know is experiencing any of these, the University has staff and resources on your campus to support
and assist you. Staff can also direct you to resources that are in the community. Here are some of your options:

As members of the University faculty, your instructors are required to immediately report any incident of potential sex discrimination or gender-based violence to the campus Title IX Coordinator. Although the Title IX Coordinator and your instructors cannot guarantee confidentiality, you will still have options about how your case will be handled. Our goal is to make sure you are aware of the range of options available to you and have access to the resources and support you need.

If you wish to remain ANONYMOUS, speak with someone CONFIDENTIALLY, or would like to receive information and support in a CONFIDENTIAL setting, use the confidential resources available here:
http://www.manoa.hawaii.edu/titleix/resources.html#confidential

If you wish to directly REPORT an incident of sex discrimination or gender-based violence including sexual assault, sexual harassment, gender-based harassment, domestic violence, dating violence or stalking as well as receive information and support, contact: Dee Uwono Title IX Coordinator (808) 956-2299 t9uhm@hawaii.edu.