

**Department of Earth Sciences**  
**ERTH640 Coastal geochemistry**  
**Spring 2024**

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

**Office hours:** Available after class or by appointment.

**Lecture:** Tue & Thu 10:30-11:45 pm, POST708.

**I. Course Description:**

**Course catalog:** Aqueous geochemistry at the land-ocean interface is driven by coastal hydrology, as well as estuarine and marine processes. These drive the distribution of major and minor ions, trace metals, organic chemicals, and nutrients. Pre: CHEM 162, and MATH 241 or MATH 251A; or consent. (Alt. years)

**Additional details:** Geochemistry and water quality at the land-ocean interface spans the continuum across coastal aquifers, estuaries, and the coastal ocean. Water composition in this setting is driven by land use, coastal hydrology, surface and subterranean estuaries, coastal mixing, and ecosystem processes.

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 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.

**II. Course Information, Policies and Resources:**

**Attendance policy:** Students who are enrolled in this course, but never attend will be flagged by the course instructor for non-participation before the last day to add/drop (for 100% tuition refund) deadline. Flagged students will be administratively dropped by the Office of the Registrar. Any changes to a student's enrollment status may affect financial aid eligibility and can result in the return of some of all of federal student financial aid.

Use of Internet, mobile devices, and social media is only allowed for immediate class needs and only when instructed by the instructor.

**Statement on Disability: KOKUA Program** If you have a disability and related access needs, please contact the KOKUA Program (Office for Students with Disabilities) at 956-7511, [KOKUA@hawaii.edu](mailto:KOKUA@hawaii.edu), or go to Room 013 in the Queen Lili'uokalani Center for Student Services. Please know that I will work with you and KOKUA to meet your access needs based on disability documentation. Kokua's services are confidential and offered free of charge.

**Academic Integrity and Ethical Behavior: Office of Student Conduct** Cheating, plagiarism, or other forms of academic dishonesty are not permitted within this course and are prohibited within the System-wide Student Conduct Code (EP 7.208). Examples include: fabrication, facilitation, cheating, plagiarism, and use of improper materials. Any incident of suspected academic dishonesty will be reported to the Office of Student Conduct for review and possible adjudication. Additionally, the instructor may take action in regards to the grade for the deliverable or course as they see fit.

Office of Title IX: (808) 956-2299 / [t9uhm@hawaii.edu](mailto:t9uhm@hawaii.edu) / <https://manoa.hawaii.edu/titleix/>

Department of Public Safety: (808)956-6911 (Emergency) / (808)956-8211 (Non-Emergency) <http://manoa.hawaii.edu/dps/>

UH System Basic Needs include food and housing, childcare, mental health, financial resources and transportation, among others. Student basic needs security is critical for ensuring strong academic performance, persistence and graduation and overall student well being. If you or someone you know are experiencing basic needs insecurity, please see the following resources: [UH System Basic Needs](#)

### III. Course Content and Learning Objectives:

#### 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.

#### Tentative schedule and content

#### Spring Semester 2024

Class # and topic covered	Reading
1 Overview of water cycle, overview of acid/base and redox chemistry, chemical equilibria	Stumm&Morgan:Aquatic Chemistry, Libes:Intro into Marine BGC
2 Trace metal chemistry, precipitation and dissolution, the solid solution interface	Stumm&Morgan:Aquatic Chemistry, Libes:Intro into Marine BGC
3 Chemical composition of natural waters	Stumm&Morgan:Aquatic Chemistry, Libes:Intro into Marine BGC
4 C, N, P, S cycles	Stumm&Morgan:Aquatic Chemistry, Libes:Intro into Marine BGC; Seitzinger et al., 2010
5 Diagenesis	Stumm&Morgan:Aquatic Chemistry, Libes:Intro into Marine BGC Chopin: Radiochemistry
6 Paper discussion	
7 Overview of radioactivity and radiotracers	
8 Intro into radiotracer applications in coastal environments (radon, radium, uranium, thorium, lead)	U and Th series Nuclides in Aquatic Systems by Cochran and Krishnaswami
9 Sediment accumulation rates –Pb-210 dating	Appleby and Oldfield, 1976
10 Overview of hydrology - hydrologic cycle: watershed, precipitation, evapotranspiration, infiltration, groundwater	
11 Coastal Aquifers	USGS reports
12 Estuaries	Froelich et al., 1986

13	The subterranean estuary –structure, redox, geochemical zonation, trace metal chemistry	Moore, 1999, Charette, 2002, 2006; Dulaiova 2008,
14	The subterranean estuary – biogeochemistry, nutrients	Kroeger and Charette, 2008; Wilson 2023
15	Submarine groundwater discharge (SGD)	Moore 1996; Burnett et al., 2006
16	Assessment of SGD – overview of methods	Burnett et al., 2006; Taniguchi 2020
17	Assessment of SGD - geochemical tracers	U and Th series Nuclides in Aquatic Systems by Cochran and Krishnaswami
18	Radon, radium, thorium, lead isotope measurement techniques	Moore and Arnold, 1995; Radon in groundwater
19	SGD typology	Bokuniewicz, 1999
20	SGD as a source of nutrients into the coastal zone	Valiela, 1996;
21	SGD’s influence on the chemical budgets in the ocean	Charette, 2006
22	SGD implication on biological processes in the coastal zone	Dailer et al., 2009; Umezawa, 2008
23	Paper discussion	
24	The fate of groundwater derived components in the ocean	U and Th series Nuclides in Aquatic Systems by Cochran and Krishnaswami; Moore, 2000
25	Seawater intrusion	Edmunds 2009; Gimenez-Forcada 2019
26	Seawater desalination projects	Heck et al., 2016; Stein et al., 2016
27	Tracer budget data analysis	
28	Tracer budget data analysis	
29	Paper discussion	
30	Discussion of project results	
31	Discussion of project results	
32	Class presentation	
33	Class presentation	
34	Discussion – relevant research directions	
35	Discussion - relevant research directions	

### **Program Learning Objectives for the M.S.**

1. Technical knowledge: M.S. graduates are proficient in applying technical knowledge of theory, laboratory methods, field methods, computer applications, and the supporting disciplines (math, physics, chemistry, biology) to help advance the fields of geology, geophysics, and planetology.
2. Scientific method (effective and ethical practice): M.S. graduates are able to (a) construct scientific hypotheses, (b) define and carry out research to evaluate them in a timely manner, (c) analyze and synthesize the results of their research, and (d) derive conclusions that help advance

the fields of geology, geophysics, and planetology. The highest standards of ethical practice and consideration of and respect for other cultural perspectives are emphasized.

3. Communicate geological knowledge: M.S. graduates are able to effectively and professionally communicate about the findings of their research in writing at a level comparable to that of a scientific journal publication, and defend it orally to the satisfaction of a scientific audience. They are also able to communicate orally about geology, geophysics, and planetology through seminar or conference presentations.

4. Employability/Contributions: Post-Graduation M.S. graduates have acquired the knowledge and skills in the profession needed to pursue employment or other activities that contribute to the advancement of the Earth and planetary sciences and/or the solution of societal problems.

#### **Program Learning Objectives for the Ph.D.**

1. Technical knowledge: Ph.D. graduates are proficient in applying technical knowledge of relevant theory, laboratory methods, field methods, computer applications, and the supporting disciplines (math, physics, chemistry, biology) to advance the fields of geology, geophysics, and planetology.

2. Expertise in a sub-discipline: Ph.D. graduates are able to comprehensively synthesize, evaluate, and interpret relevant fundamental knowledge in their sub-discipline.

3. Scientific method (effective and ethical practice): Ph.D. graduates are able to independently (a) construct scientific hypotheses, (b) design and carry out research to evaluate them in a timely manner, (c) analyze and synthesize the results of their research, and (d) derive conclusions that advance the fields of geology, geophysics, and planetology. The highest standards of ethical practice and consideration of and respect for other cultural perspectives are emphasized.

4. Communicate geological knowledge: Ph.D. graduates are able to effectively and professionally communicate the findings of their research in writing at a level comparable to that of scientific journal publications, and defend it orally to the satisfaction of a scientific audience. They are also able to communicate orally about geology, geophysics, and planetology through seminar or conference presentations.

5. Employability/Contributions: Post-Graduation Ph.D. graduates have acquired the knowledge and skills in the profession needed to pursue employment or other activities that contribute to the advancement of the Earth and planetary sciences and/or the solution of societal problems.

#### **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.

#### **IV. Required Texts and reading:**

**Texts are recommended but not required to purchase -some may be available on-line:**

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 will be provided through Laulima or through UHM Library.

**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: EARTH640-001 MAN.xxxxxxx.SP24.

**E-mail:** Please, note that Laulima has an E-mail tool and your fellow students in the course may use it to contact you. The use of the Laulima E-mail tool is strictly for class collaboration and it’s inappropriate use will result in corresponding actions - see codes of ethical conduct [http://www.studentaffairs.manoa.hawaii.edu/policies/conduct\\_code/](http://www.studentaffairs.manoa.hawaii.edu/policies/conduct_code/) and [http://www.soest.hawaii.edu/GG/resources/docs/EARTH\\_Guidelines\\_Ethical\\_Professional\\_Conduct\\_11\\_04\\_19.pdf](http://www.soest.hawaii.edu/GG/resources/docs/EARTH_Guidelines_Ethical_Professional_Conduct_11_04_19.pdf)

## V. Course Assignments, Evaluation and Grading

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

**Paper discussions (10%):** there will be 4 paper discussions where students are expected to synthesize, evaluate and apply knowledge from assigned peer-reviewed literature.

**Homework (30%):** There will be 4 homework assignments on biogeochemistry of major nutrients and diagenesis, interpretation of estuarine profiles of non-conservative elements, anthropogenic pollutants.

**Class Project (30%):** In-class exercise of chemical equilibria and geochemical tracer model calculations leading to a project on geochemical tracer budgets. Presentation of project results.

**Exams (30%):** quizzes (10%), midterm (10%) and final exam(10%) will be given.

%	Grade	%	Grade
>96.6	A+	73.3 – 76.5	C
93.3 – 96.5	A	70 – 73.2	C-
90 – 93.2	A-	66.6 – 69.9	D+
86.6 – 89.9	B+	63.3 – 66.5	D
83.3 – 86.5	B	60 – 63.2	D-
80 – 83.2	B-	<59	F
76.6 – 79.9	C+		

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### University of Hawai‘i at Mānoa (UHM) TITLE IX SYLLABUS INFORMATION

UHM 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 experiences any of these, UHM has staff and resources on campus to support and assist you. Staff also can direct you to resources in the community. Here are some:

If you wish to remain **ANONYMOUS**, speak with someone **CONFIDENTIALLY**, or would like to receive information and support in a **CONFIDENTIAL** setting, contact: (\*  
**Confidential Resource**)

**Counseling & Student Development Center\*** (808) 956-7927

• [manoa.hawaii.edu/counseling/](http://manoa.hawaii.edu/counseling/)

**Office of Gender Equity\*** (808) 956-9499 • [manoaadv@hawaii.edu](mailto:manoaadv@hawaii.edu)

**Lesbian, Gay, Bisexual, Transgender, Queer (LGBTQ+) Center** (808) 956-9250

• [manoa.hawaii.edu/lgbt](http://manoa.hawaii.edu/lgbt)

**Respondent Support (808) 956-4392** • [PAUrs@hawaii.edu](mailto:PAUrs@hawaii.edu)

**Student Parents at Mānoa (SP@M)\*** (808) 956-8059 • [manoa.hawaii.edu/studentparents/](http://manoa.hawaii.edu/studentparents/)

**UH Confidential Advocacy\*** • [advocate@hawaii.edu](mailto:advocate@hawaii.edu)

**University Health Services Mānoa\*** (808) 956-8965 • [hawaii.edu/shs/](http://hawaii.edu/shs/)

<http://www.manoa.hawaii.edu/titleix/resources.html#confidential>

If you wish to **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**

Director and Title IX Coordinator

Hawai'i Hall 124

2500 Campus Road

Honolulu, HI 96822

(808) 956-2299

[t9uhm@hawaii.edu](mailto:t9uhm@hawaii.edu)

As a member of the University faculty, I am **required to immediately report** any incident of sex discrimination or gender-based violence to the campus Title IX Coordinator. Although the Title IX Coordinator and I cannot guarantee confidentiality, you will still have options about how your case will be handled. My 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. For more information regarding sex discrimination and gender-based violence, the University's Title IX resources and the University's Policy, EP 1.204, go to: <http://www.manoa.hawaii.edu/titleix/>