Environmental Systems 203: Geochemistry of Earth Systems
Fall 2017 (3 credits)

Instructor: Peggy O'Day (poday@ucmerced.edu), office SE1 216; 209-228-4338
Office hours: Tuesdays 4:00-5:00 pm and by appointment.

Lecture/Discussion: Thursdays, 1:30-3:20 pm, COB2 265
Additional computer workshops or other class activities will be arranged during the semester.

Course Description: This course will focus on processes that control the chemical composition of natural waters, and on reactions among aqueous solutions, gases, and rock-forming minerals in natural and human-impacted Earth systems. *It will emphasize basic principles and applications of thermodynamics and kinetics to environmental and geochemical systems*. We will consider equilibrium, kinetic, mass transfer, and surface reaction approaches to speciation, phase partitioning, adsorption, ion exchange, and bioavailability in natural systems. We will examine how aqueous speciation, mineral solubilities, mineral surface processes, and microbially catalyzed reactions control the partitioning of inorganic and organic species between aqueous and solid phases, and thus their influence on water, soil, and sediment composition. Problem solving skills will be developed through a combination of hand calculations and application of computer geochemical codes (such as PhreeqC). A second emphasis of the course is to develop writing and oral presentation skills for the effective communication of scientific information. This course is intended for graduate students with interests in environmental systems related to geochemistry, environmental sciences, environmental engineering, and life sciences.

Prerequisite: Graduate standing; working knowledge and understanding of basic chemical principles; environmental chemistry or related courses are helpful but not required.

Format: Class meetings will combine formal lectures, class discussions, student-led presentations, and computer-based exercises. Emphasis will be on the practical applications of thermodynamic/kinetic principles and geochemical modeling to real systems using case studies and computer-based student research projects. In-class time will be used for lecture, discussion, computational exercises, and student presentations.

Reading: Background reading and peer-reviewed articles will be available online. A useful text that you may find worth the investment is *Geochemistry, Groundwater and Pollution*, Second Edition (2005) C.A.J. Appelo and Dieke Postma, Taylor & Francis. This book is available through CRC Press in hardback, paperback, or electronic formats for sale or rent: http://www.crcpress.com/product/isbn/9780415364218

Course Objectives: The objective of this course is to provide you with fundamental chemical knowledge and a working ability to solve problems in environmental and geochemical systems. Assignments and the mid-term exam are aimed at developing basic understanding of the principles of thermodynamics, kinetics, and surface chemistry and how to apply them to natural systems, and to gain experience using applied geochemical modeling. The majority of work in this course will be associated with your individual term project. Students will explore a topic of their choice in depth by designing and executing a computer-based term project that explores a

specific environmental or geochemical problem. I will help you develop your project, but you are expected to identify a topic, develop a testable hypothesis, explore outcomes, and evaluate results using chemical principles and geochemical computations. *Students are encouraged to develop a project that benefits your dissertation or thesis research.*

Grading (Letter grade only[1]): Grading will be based on:

Research project and written final report: 40%
In-class presentations: 25%
Mid-term exam (take-home): 25%
Assignments and class participation: 10%

Class assignments will include problem solving by hand calculations and the application of computer-based thermodynamic, speciation, and mass transfer modeling of natural systems.

In-class presentations consist of:
-- a short oral presentation in class about the subject of your term project (5-10 min.)
-- a poster presentation on fundamental principles and your approach for your term project
-- a final oral presentation on your term project at the end of the semester in the style of a presentation at a professional meeting

Students are expected to come to all classes and be prepared to engage fully in class activities. This requires that reading, literature research, and take-home problems be done in advance. Students are expected to work independently between class meetings on assignments and their individual term research projects.

Course Learning Outcomes: By the end of this course, students should have attained the following:

- Ability to apply chemical principles to the study of different types of environmental systems and a working knowledge of problem solving in environmental and geochemical systems.
- Ability to recognize when thermodynamic or kinetics approaches may be useful in solving problems in complex geochemical systems.
- The ability to formulate a research question and hypothesis about a specific subject area, and to design a tractable approach to a testing the hypothesis using appropriate computer-based modeling programs or other computational tools.
- The ability to effectively communicate scientific information and research results to peers through oral, written, and visual means.

Program Learning Outcomes: This course supports the following ES program learning outcomes:

- **Core Knowledge** - Graduates will be knowledgeable, skillful and self-directed in the observation and analysis of environmental systems in terms of their capacity to

[1] Per university policy for graduate degree programs, a letter grade of B or higher must be achieved in this course in order to receive credit towards your degree.

independently identify important research questions, formulate experimental plans, analyze data, and formulate conclusions in the context of a doctoral dissertation or M.S. thesis

- **Communication Skills** - Graduates will be conversant in at least two areas of environmental systems, and be adept at oral, written and visual communication of research results to peers and non-technical decision makers

Course policies: Your attendance and participation in class activities are important parts of this course. Please be considerate of your classmates! *All cell phones, electronic devices, and other noisemakers should be off during the entire class.* Please do not disrupt class by arriving late or leaving early. You are expected to come to all classes prepared to engage in activities, to work on assignments and your term project outside of class, and to carry out literature research independently.

Academic Integrity: Working collaboratively with your classmates is encouraged and we will do group activities in class. Any assignments submitted for grading should be your own work. Any information or material taken from published sources (in print or electronic) should be properly attributed using an accepted scientific reference format. Discussions about ideas and approaches are not cheating; the exchange of finished, written answers is cheating. Direct copying from other sources, either published or from individuals, is plagiarism. Cheating and plagiarism will be subject to disciplinary action by University policies. Further information about campus policies on academic integrity can be found here:
http://studentlife.ucmerced.edu/content/uc-conduct-standards

Disability and Conflict Accommodations: If you need disability accommodations for this course, please contact me during the first week of class. Students are encouraged to register with Disability Services Center to verify their eligibility for appropriate accommodations. Information regarding disabilities is confidential. If you have a religious or personal conflict with any scheduled classes, please contact me during the first week of class.