COLLOIDS IN SOIL AND WATER

ECI-289I, Spring Quarter (4 units)

***Instructor*:**
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Meeting times and location:
TBD

Office hours:
TBD, 3136 Ghausi

***Course description*:**
The course covers select topics regarding colloid occurrence, behavior and transport in water and soils, paying particular attention to their role in water contamination. The following topics will be discussed: Problems of different types of environmental colloids. Nature and properties of colloids. Characterization techniques. Thermodynamic approaches to describe dispersivity and colloid-surface interactions. Biological processes that affect the fate of bio-colloids. The role of colloids as carriers of pollutants. Filtration theory and its deviations. Mechanisms of retention, detachment and enhanced mobility in porous media. Experimental approaches and their (dis)advantages. Mathematical models for filtration and framework appropriateness to capture known transport mechanisms. Examples of colloids to resolve environmental problems.

Pre-requisites (or equivalent courses):
Upper division standing. Chemistry 2B, Eng-103 or ECI-100 (recommended, not required).
Assumed knowledge: Basic physical chemistry thermodynamics and intermolecular interactions, some experience with advective-dispersive equations, some knowledge on environmental analytical methods.

***Content*:**
The course involves study of selected topics from the following:

1. Introduction to colloidal systems:
    a. Evidence for colloid driven contaminant transport
    b. Major classes of environmental colloids
    c. Properties of colloids and characterization techniques
2. Electrokinetic phenomena:
    a. Sources of surface charge
    b. Electrokinetic phenomena
    c. Short range interacting forces
3. DLVO theory:
    a. Force balance of repulsion and attraction
    b. Components and interpretation of potential curves
    c. Extension to DLVO theory
4. Particle stability:
    a. Critical coagulation concentration
    b. Aggregation attachment efficiency
5. Biologial colloids:
    a. Sources and detection methods
    b. Survival measurements and mathematical modelling
6. Filtration theory:

    a. Removal efficiency
    b. Contact efficiency
    c. Attachment efficiency
7. Transport and fate in porous media
    a. Pore-scale mechanisms
    b. Blocking, ripening and straining phenomena
    c. Fate and transport processes
8. Direct & inverse transport models in soils:
    a. Governing equation with reaction and/or sorption
    b. Unsaturated systems
    c. Two-site models

***Learning outcomes*:**
On successful completion of the course students will have:

1. established an appreciation for the unique properties and behavior of environmental colloids,
2. developed an understanding of concepts related to particle stability and interactions with charged surfaces encountered by colloids in the environment,
3. acquired the skills to model aggregation, transport and retention in water and soils,
4. a comprehension for the limitations of existing theoretical and modeling tools to predict realistic complex problems.

Evaluation:
Each student is responsible for completing all of the following compulsory requirements

- Homework assignments (60%)
- 2 quizzes (20%)
- Case report (10%)
- Participation in discussions (10%)

***Reading*:**

- Elimelech, Menachem, John Gregory, and Xiadong Jia. *Particle deposition and aggregation: measurement, modelling and simulation*. Butterworth-Heinemann, 2013.

Selection of key peer-reviewed articles

- McCarthy & Zachara. 1989. *Environmental science & technology*.
- Grasso, et al. 2002. *Reviews in Environmental Science and Biotechnology*.
- Chen & Elimelech. 2006. *Langmuir*.
- Yao, et al. 1971. *Environmental science & technology*.
- Bradford & Torkzaban. 2008. *Vadose Zone Journal*.
- Morales, et al. 2010. *Water research*.
- Goldberg, et al. 2014. *Environmental science & technology*.