GEOPRACTICAL

SYLLABUS

GEOCHEMICAL CONSEQUECES OF LANDFILL IMPACTS

Course Instructors:

Carol L. Stein, PhD: Carol has over 30 years of experience in a range of environmental investigations. She was a research scientist for Sandia National Laboratories on the nation's radioactive waste isolation programs, and subsequently was on the faculty of the School of Oceanography at the University of Washington. In her work as an environmental consultant, she specializes in geochemical aspects of soil and groundwater contamination. She holds graduate degrees in geochemistry (MA, PhD: Harvard).

Brian Yellen, PhD, MEd: In addition to private sector groundwater remediation work, Brian has published several peer-reviewed papers about surface water-groundwater interactions, flood geomorphology, and sediment transport. He has taught glacial geology and hydrogeology at UMass Amherst and Smith College. He holds graduate degrees in hydrogeology and sedimentology (UMass Amherst) and science education (UH Manoa).

David F. McTigue, PhD: Dave has over 30 years of experience in environmental research and applications. He worked on US radioactive waste isolation programs at Sandia National Laboratories, and taught hydrogeology at the University of Washington. He then entered the environmental consulting field, where he focuses primarily on groundwater flow and contaminant transport. He holds graduate degrees in engineering (MS: Stanford) and geology (PhD: Stanford).

Morning: 8:00 – 12:00

Warm-up: Self-introduction of participants with inquiry regarding interest in this course, e.g., describe a site or a project where some knowledge of geochemistry would have been beneficial (and in what way); if none, then ask why they are attending this particular course and their expectations.

(15 min.)

I. Introduction: Why is there a need for an understanding of geochemical processes in evaluating contaminant behavior? Course material will provide basis for consideration of field- and lab-derived data in site characterization, development of a conceptual model, recommendation of remedial alternatives, and design of an appropriate monitoring program.

(10 min.)

II. Basics, Part I: Field Parameters (importance of low-flow protocol)

A. pH: acid-base reactions
B. ORP & DO: oxidation state of system and how landfills impact groundwater redox conditions
C. Specific Conductivity: what is this and why is it important?
D. Turbidity: dissolved constituents vs. particulates

(35 min.)

III. Basics, Part II: Solutes in groundwater

A. cations and anions: major, minor, trace; typical landfill-impacted groundwater composition and concentrations
B. cation/anion balance (class problem?)
C. Major-element chemistry, hydrogeochemical facies and mixing, changes along a flowpath

(45 min., including two classroom exercises: compute a cation/anion balance; construct a Piper diagram with major elements)

IV. Redox-sensitive Analytes

A. As, Cr (metals with EPA MCLs)
B. Fe, Mn
C. Oxidation-reduction reactions
D. Disequilibrium and redox pairs
E. Organics, e.g. VOCs – why measure chloride? MNA guidance (class exercise)
    1. microbial effects (e.g. BTEX degradation, PCE, TCE & daughter products, TNT-DNT, wood preservatives such as PCP, etc.)
    2. electron donors, acceptors
    3. redox facies

(45 min., including one classroom exercise: compute chloride concentration due to dechlorination of PCE or TCE)

V. Controls on solubility

A. Adsorption/Desorption/Reductive Dissolution – Precipitation/Dissolution
    1. Saturation index
    2. Eh-pH diagrams

(30 min. including one classroom exercise: compute a saturation index and decide if the phase is precipitating or dissolving)

VI. Transport: How do these processes affect contaminant fate and transport?

a. Description of site and site history
b. Description of site geology and geologic history.
c. Present conceptual diagram of how water flows through the system

d. Present recent monitoring data

(20 min.)

VII. Anthropogenic vs. Natural Occurrence vs. Some of Both? Arsenic as example.

(15 min.)

VIII. Conceptual Model Development
A. Definition of "conceptual model"
B. Key elements
C. Significance (with some examples)

(15 minutes)

IX. Analytical Methods, Instrumentation, Applications, Issues (field and lab) – example: Fe(II) test kits vs. lab results.

(20 min.)

LUNCH and transportation

Afternoon: 1:00 – 5 pm

X. Field Trip: Old Amherst town landfill (1 – 4 pm)

a. Geology tour. Observe streams entering Lawrence Swamp Basin, measure dh/dl in a few piezometers to evaluate where water comes from in system. Observe heads and conductivity in a few wells to distinguish between aquifer systems. Evaluate surficial geology and controls on the basin. (1 hour)

b. Sample Collection. Collect surface water samples at a variety of sites and collect field parameters; discuss their significance (i.e., what do we infer from what we measured?) Couple these observations with instantaneous results from Hach kit to screen for reduced iron in solution. (1 hour)

c. Run a simple tracer test to calculate stream discharge and estimate metals input to Gull Pond. (1 hour)

XI. Amherst College Geochemistry Lab tour. Introduction to measurement of analytes by various instruments. How is each calibrated? Potential for inaccuracy and clues that data are not reliable. (45 mins)

XII. Wrap-up and course evaluation (15 mins)

XIII. Optional panel discussion with Five College geology students about groundwater/soil remediation. (5 – 6 pm)