Applied Metals Geochemistry
LSPA, September 2014

COURSE DESCRIPTION: This four-hour course will introduce the chemical principles needed to understand equilibrium chemical reactions and conditions controlling metals fate and transport in groundwater, along with case studies of metals transport. Topics covered include: (1) principles of aqueous geochemistry (thermodynamic principles, pH, and acid-base chemistry, mineral-solution chemistry, precipitation and dissolution); (2) surface chemistry and oxidation-reduction chemistry; (3) metals geochemistry; and (4) case studies of both natural water quality conditions and aquifers impacted by metals contamination. A working knowledge of college-level chemistry will be expected for those attending this course.

COURSE SCHEDULE:

Start Time	1:00 PM
Course Introduction	1:00 – 1:05 PM
Principles of Aquatic Chemistry, Equilibrium Chemical Reactions	1:05 – 1:30 PM
Adsorption and Surface Chemistry, Oxidation-Reduction Chemistry	1:30 – 2:10 PM
Metals Geochemistry	2:10 – 2:45 PM
Break	2:45 – 3:00 PM
Case Studies of Metals Transport and Contamination	3:05 – 3:50 PM
Summary	3:50 – 5:00 PM

COURSE INSTRUCTOR: Stephen P. Garabedian, PhD

Steve Garabedian is an independent hydrogeologist and lecturer working in the New England region. His education includes a B.S. in Geology from the University of Connecticut, an M.S. in Geology from Penn State, and Ph.D. in Civil Engineering from MIT. Steve worked for 30 years as a scientist with the US Geological Survey, having conducted hydrologic and water quality studies in New England and Idaho, supervised hydrologic studies in Massachusetts and Rhode Island, and managed the Conte Research Lab in Turners Falls, Massachusetts. He has taught a number of courses on hydrogeology and ground-water hydrology at Boston-area colleges and universities, in addition to short courses on the Hydrogeology of Massachusetts and Aqueous Geochemistry for the Massachusetts LSP Association.

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Course Outline

I. Introduction - Overview of Course Content

II. Principles of Aqueous Geochemistry
- A. Reactions - Chemical Activity - Thermodynamics
- B. pH, Acids/Bases
- C. Equilibrium Equation Calculations (ex: Carbonate Speciation)
- D. Ion Complexes
- E. Mineral Dissolution-Precipitation reactions

III. Adsorption
- A. Isotherms
- B. Ion Exchange
- C. Surface Complexation Reactions

IV. Oxidation-Reduction (Redox) Reactions
- A. pe-Eh
- B. Redox Reaction Chemistry
- C. Organic Compound Decomposition
- D. Electron Donors and Acceptors
- E. Metals (e.g. iron) Redox Chemistry

V. Metals Geochemistry
- A. Soil-Water-Gas Interactions (unsaturated zone)
- B. Mineral-water equilibrium reactions for metals in the saturated zone
- C. Ground-Water Quality Conditions in Northeastern U.S.
- D. Background Metals Concentrations: Pb, As, Cr, Cd, Mg

VI. Case Studies of Metals Transport and Contamination
- A. Introduction to Studies of Metals and Oxyanion Fate and Transport
- B. Lead Geochemistry
- C. Arsenic Geochemistry
- D. Chromium Geochemistry
- E. Cadmium Geochemistry
- F. Mercury Geochemistry
- G. Field Studies of Metals Contamination (e.g. Landfill Leachate Plumes)

VII. Summary