Soil Treatability Studies: Soil Partitioning

Mark R. Matsumoto, PhD, BCEEM
University of California, Riverside

May 30, 2013

Department of Chemical and Environmental Engineering
UNIVERSITY OF CALIFORNIA, RIVERSIDE

Overview of Presentation

- Biosketches of Investigators
  - Dr. Mark Matsumoto
  - Mr. Jose Valle de Leon
- Soil Partitioning Study
  - What is soil partitioning analysis?
  - What will be learned from the soil partitioning study?

UC Riverside

- One of the 10 University of California campuses
- Citrus agricultural experiment station - 1907
- General campus – 1954
  - Current Enrollment:
    21,000 (19,000 undergraduates; 2,000 graduate students)
- Bourns College of Engineering – 1990
  - Current Enrollment:
    2,700 (2,200 undergraduate; 500 graduate students)
  - 10 undergraduate majors, 6 graduate degree programs

Biosketches

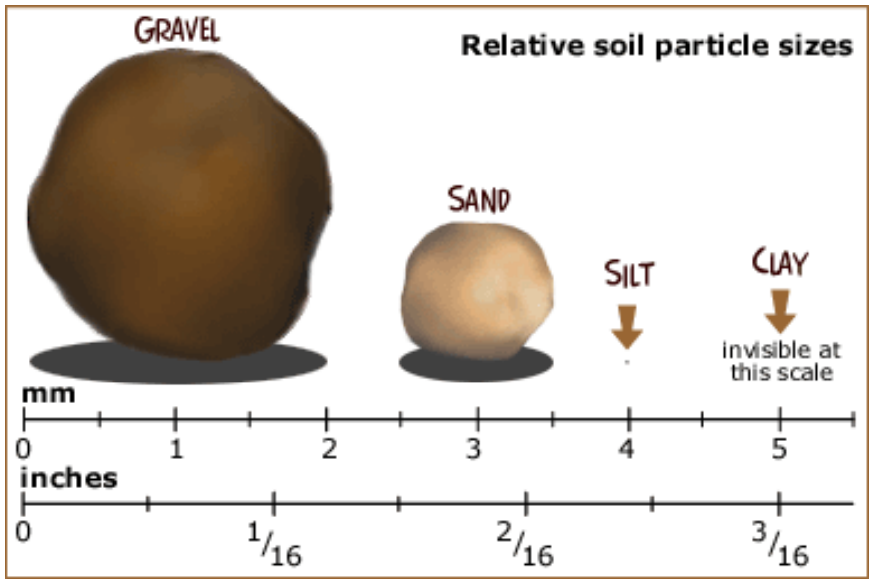
- Mark Matsumoto
  - Education
  - Positions held
  - Research experience
- Jose Valle de Leon
  - Education
  - Positions held
  - Research experience

What is Soil Partitioning Analysis?

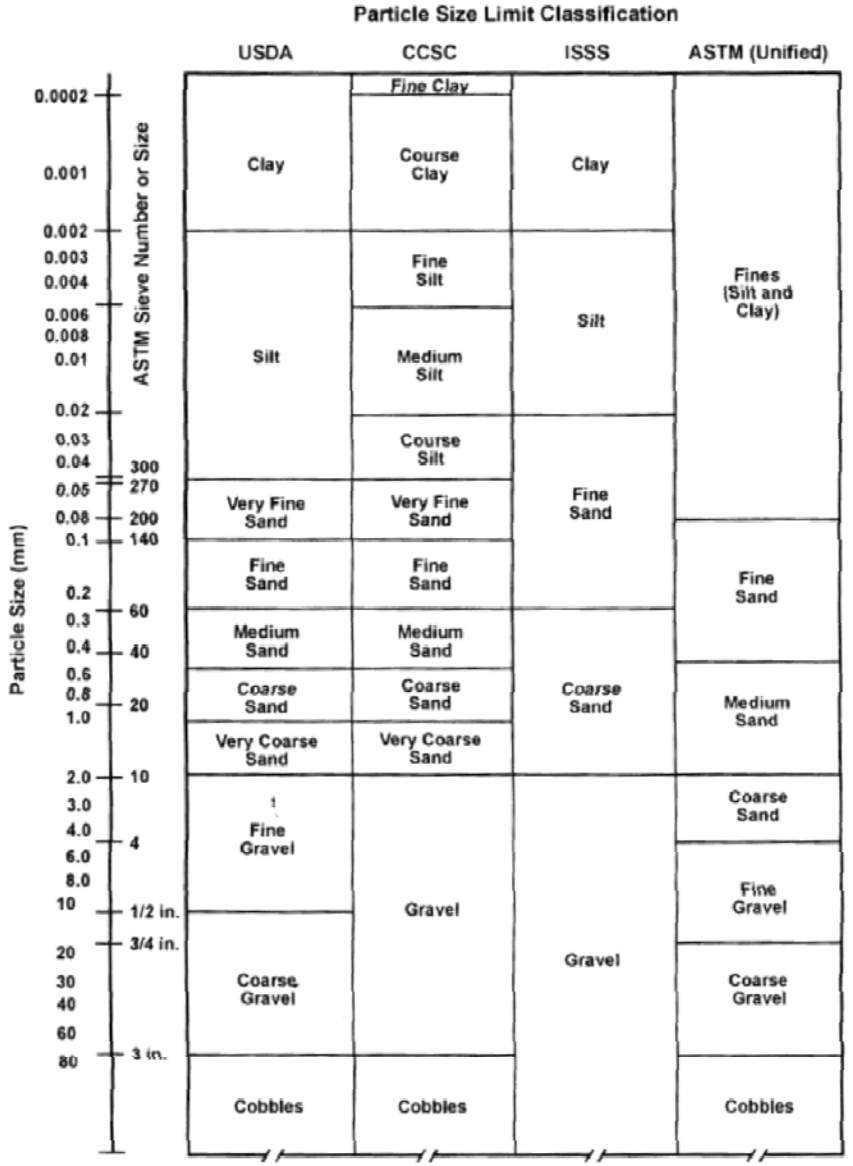
- Primary Purpose:
  - Determine where the contaminants are within a contaminated soil.
- Secondary Purpose:
  - Determine how tightly the contaminants are held within the contaminated portions of the soil.
- Soil Partitioning Categories:
  - Soil particle size
  - Contaminant association
    - Soil organic matter
    - Soil minerals (inorganic)

Soil Partitioning

- Soil Particle Sizes

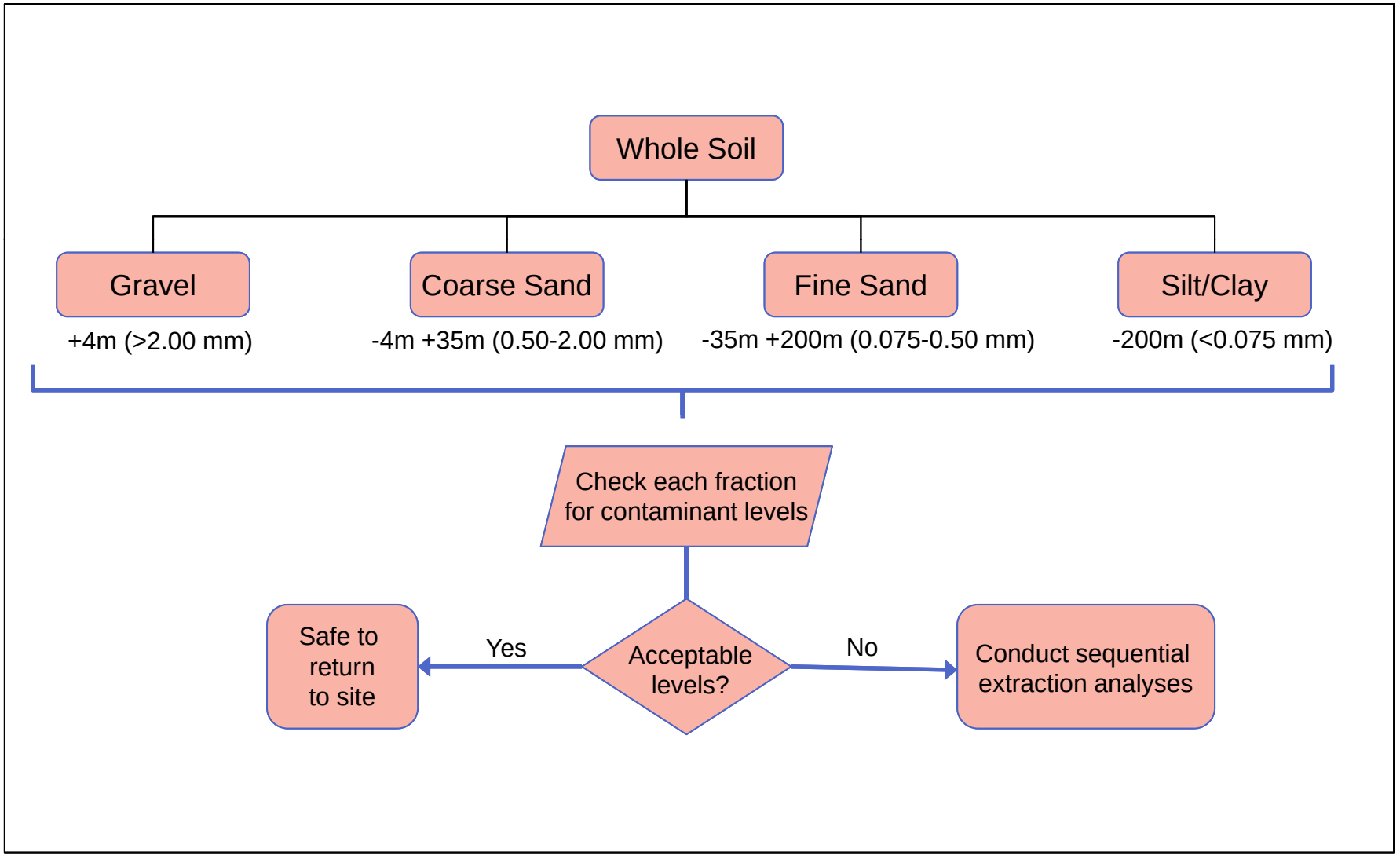


Source: school.discoveryeducation.com



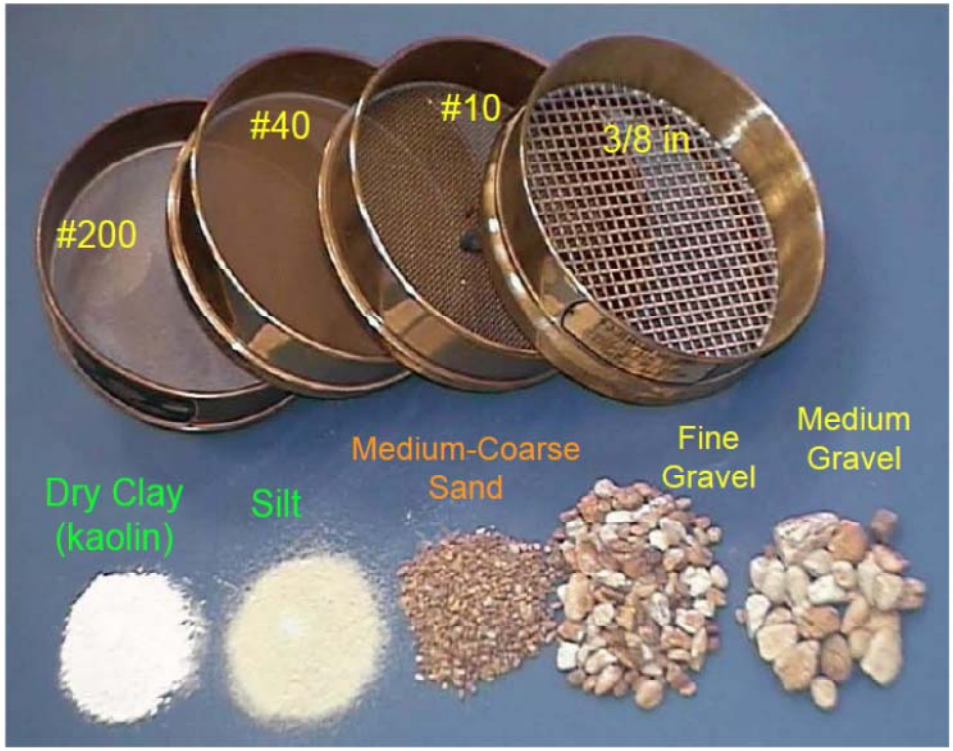
Source: usda.gov

Soil Partition Study



Soil Size Analysis

Size Fractions



Source: FHWA NH1-01-031

Description	Size (mm)
Gravel	>2.0
Coarse Sand	0.50 – 2.0
Medium/Fine Sand	0.075 – 0.50
Silt & Clays (Fines)	<0.075

Contaminant Analysis by Size Fraction

- Example Analysis from a Former Battery Facility in New York

Size Fraction (mm)	Soil Type	% by Weight	Lead (ppm)
0.85 - 2.00	Coarse sand	30.9	311
0.425 - 0.85	Coarse sand	18.8	1,220
0.25 - 0.425	Medium sand	10.8	3,000
0.106 - 0.25	Fine sand	16.4	1,720
0.075 - 0.106	Fine sand	6.3	1,750
< 0.075	Fines	16.9	1,710
Whole Soil			1,410

Source: Yarlagadda, P.S.; Matsumoto, M.R.; VanBenschoten, J.E.; and Kathuria A. (1995). *J. Environ. Engrg.*, 121, 276-286.

Contaminant Binding to Soil

- Principle
  - Chemical (extraction) binding analysis can provide engineers with insights into how tightly bound contaminants are attached to the soil particles and the approaches to treat them.
    - Can excavated contaminant soils be treated to remove contaminants and returned clean to the site?
    - Is there a likelihood that contaminants can be treated in place (in situ) by natural attenuation, bioremediation, or phytoremediation?

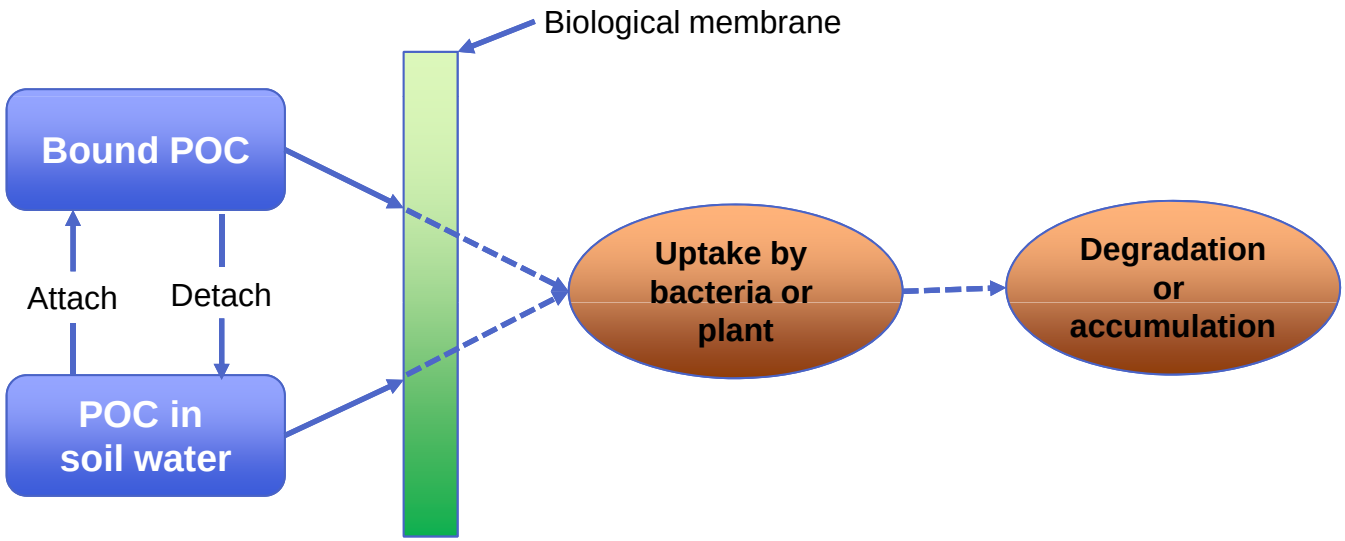
Metal Contaminants

Fraction	Description	Lead (ppm)
Exchangeable	Loosely bound contaminant metal; released via ion exchange mechanisms.	10
Carbonate	Contaminant associated with mineral carbonate; released by pH change.	290
Fe-Mn Oxide	Contaminant associated with mineral Fe-Mn oxide; released by oxidation-reduction potential (ORP) reduction.	900
Organic	Contaminant associated with organic fraction. Metals bound by specific adsorption.	50
Residual	Metals associated with the primary and secondary soil minerals.	160

Source: Yarlagadda, P.S.; Matsumoto, M.R.; VanBenschoten, J.E.; and Kathuria A. (1995). *J. Environ. Engrg.*, 121, 276-286.

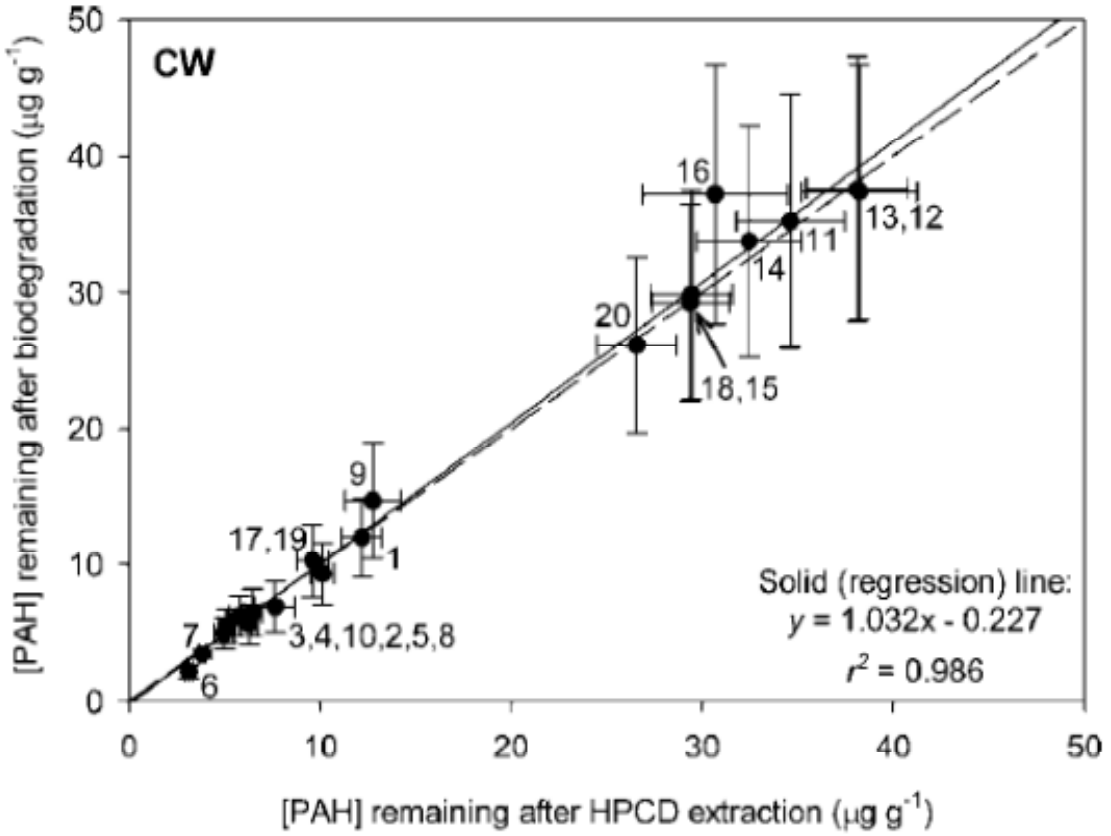
Persistent Organic Contaminants

- How easily can bacteria and/or plants extract persistent organics from the soil particles to degrade/remove them?



- Possible extractants: acetic acid, alcohol (methanol, butanol), surfactant (emulsifier: hydroxypropyl-beta-cyclodextrin (HPCD))

Persistent Organic Contaminants



Source: Stokes, J.D.; Wilkinson, A.; Reid, B.J.; Jones, K.C.; and Semple, K.T. (2005) *Environ Tox Chem,* 24(6), 1325-1330.

Summary

- What Is Soil Partitioning Analysis?
  - Characterizing how contaminants are physically and/or chemically associated with the soil.
- What Can Be Learned from the Soil Partitioning Study?
  - Volume of soil that may or may not need to be removed or treated.
  - Insights into how amenable soil is to biologically based treatment such as natural attenuation, bioremediation, or phytoremediation.

Estimated Schedule

Task	2013								2014					
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Literature/Data Review														
Sampling Plans														
Field Sampling														
Laboratory Testing														
Data Review														
DRAFT Report														
Internal Review														
Final Report														
Follow Sampling Plans (?)														
Follow Field Sampling (?)														
Follow Laboratory Testing (?)														
STIG Presentations														

Opportunities for STIG Involvement

- Sampling Plan Review
  - Early July
- Preliminary Data Review
  - Mid-September
- Draft Report Review (or Follow Sampling Plan Review)
  - End of November/Early December
- Preliminary Follow Data Review
  - Mid-February
- Draft Report Review
  - End of April/Early May

Thank you.

Questions