

Soil Mixing for Environmental Remediation: *An Effective Tool for Challenging Sites*

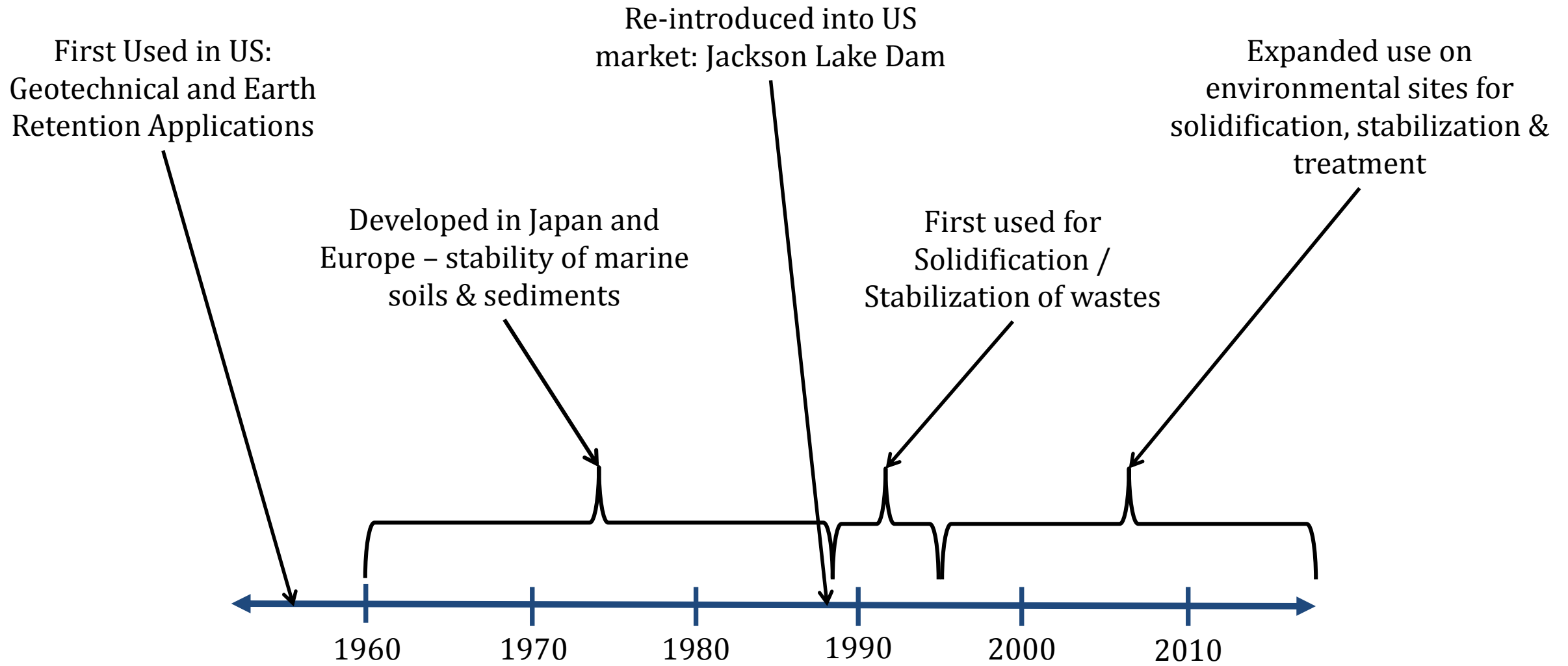


- Part I – Dan Ruffing

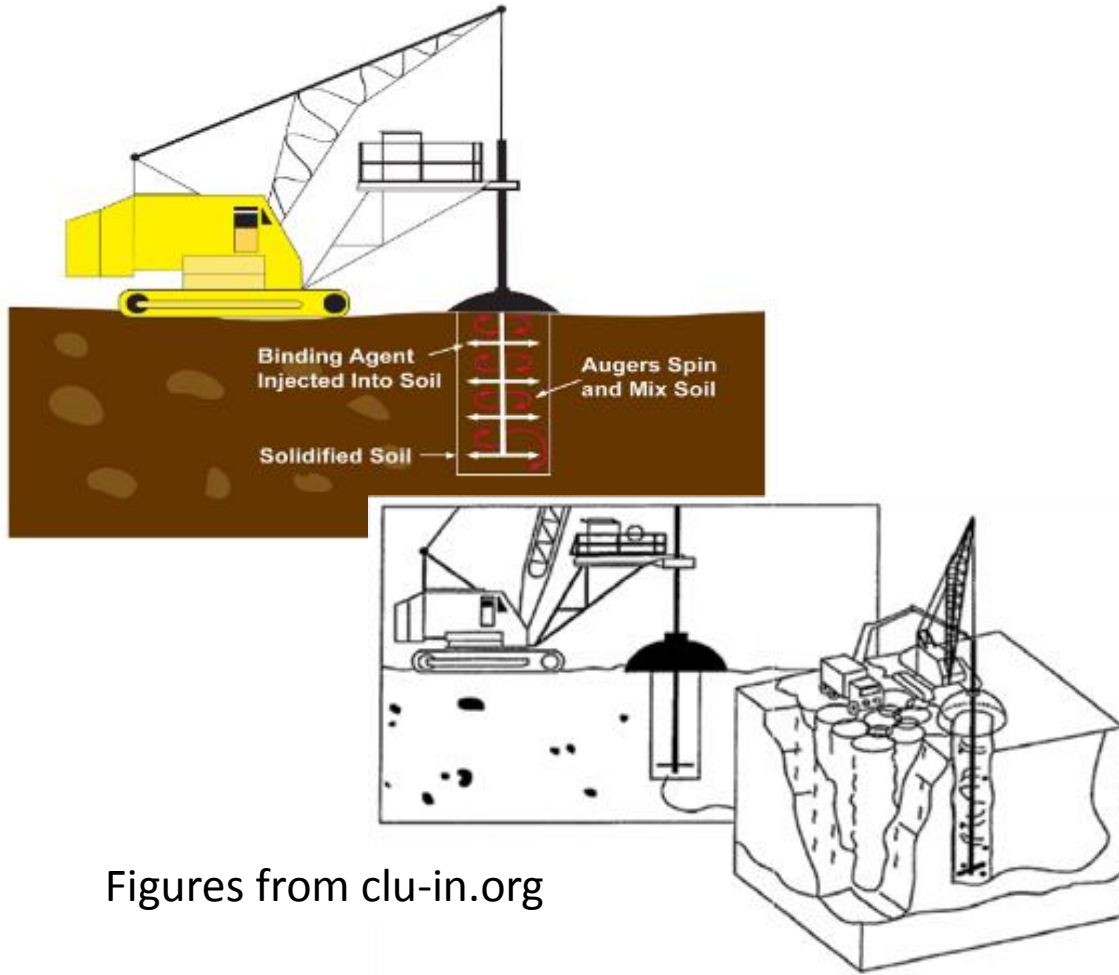
Main takeaways

- Soil mixing is a delivery method: pick the reagents and use soil mixing to get good contact
- Soil mixing has been around and used for a long time and is a technically viable and cost effective solution for a variety of contaminants

History



Process

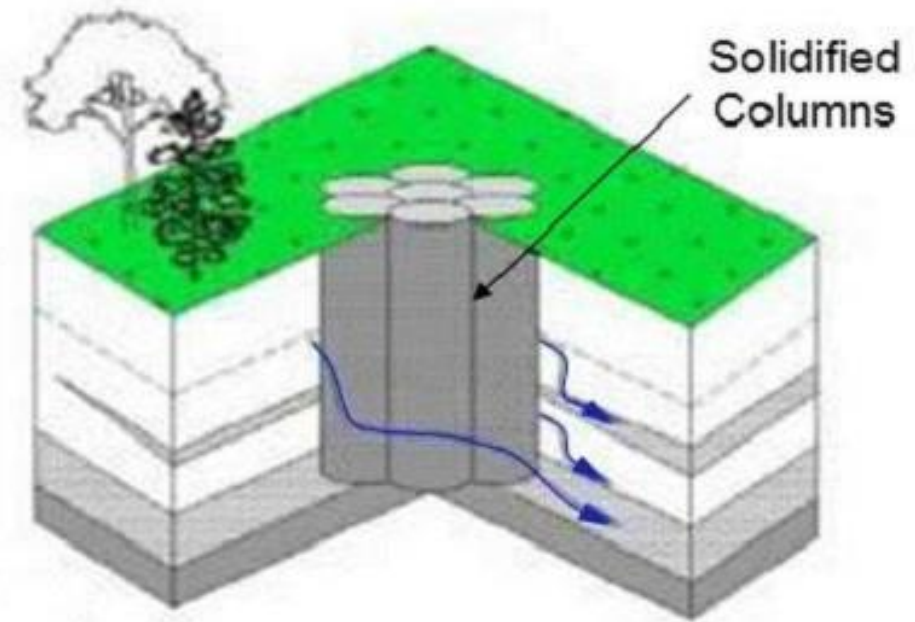
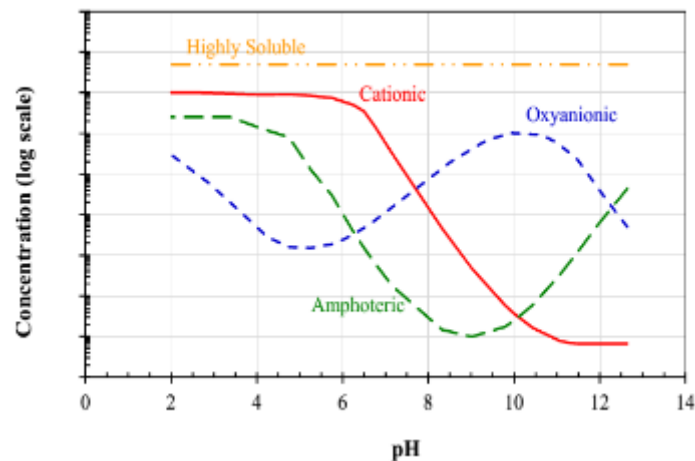
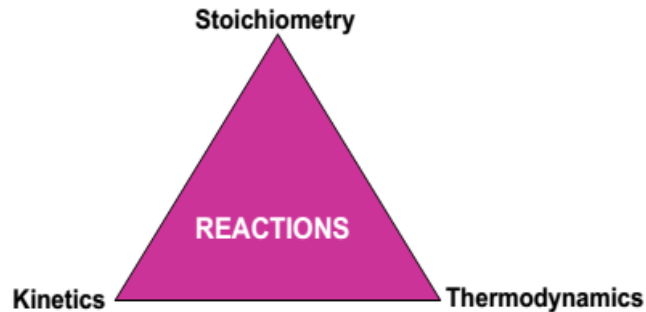


- Reagents added to and mixed with the soil.
 - In situ vs. ex situ
 - Wet vs. dry
 - Auger vs. bucket vs. rotary tool
 - Single auger vs. multi auger

*Most common for environmental work

Stabilization and Solidification

- Stabilization: fixation, oxidation, reduction
- Solidification: encapsulation, fixation



Acronyms - S/S and ISS

- When stabilization and solidification are or may both be happening
 - = S/S
- When S/S is performed in situ
 - = ISS

Common Reagents

- S/S:
 - Portland cement
 - Blast furnace slag
 - Bentonite
 - Kiln dust
 - Lime
- Ab- or Adsorption
 - Organoclay
 - Bentonite
 - Activated carbon
- Oxidation
 - Persulfates
 - Permanganates
 - Peroxides
- Reduction
 - Zero valent iron (ZVI)
 - Ferrous sulfate
- Biodegradation
 - EVO
 - guar

Steam Mixing / Air Stripping

- Steam or hot air can be pumped through the auger:
 - Volatilize contaminants
 - Collect the contaminants in a shroud
 - Trap the contaminant in a carbon (or other) filter



Air / Vapor Collection Shroud

Containment Walls



- Soil mixing can also be used to install containment walls
- Not the focus of this talk

Excavation Support

- Soil mixing can also be used to install excavation support
- Often used on sites where soil mixing is already specified – multiple objective w/ same technology = lower cost



Shallow Methods (< 15' or 20')



- Lowest cost
- Most primitive



- Better mixing than buckets
- Good for sludge, sediment

Deeper Methods (> 20' to 60'+)



- Better QC
- Most common method



- Highest cost
- Deeper / linear applications

Column Layout

- Columns can be installed in an overlapping pattern that ensures 100% coverage
- Test program can be used to observe installed product



Exposed soil mixed columns

Batch Plants

- Accurate reagent addition is critical



Capabilities

- Depths up to 60' are common
 - deeper depths possible / have been completed
 - Deeper than 60' = more expensive
- Lowest cost for shallower (<20') applications
 - Bucket or rotary tool mixing
- Can be performed in all soil types
- Can be performed below water table:
 - no dewatering or excavation support

Limitations

- Cannot be performed in or through rock
 - some limited penetration may be possible
- Cannot be performed around or through obstructions:
 - boulders, groups of cobbles, old foundations, utilities
 - Shallow methods can accommodate some obstructions
- Cannot be performed around or through utilities
 - above and below ground are a problem

Industries & Applications

- S/S
 - MGP
 - Wood treating
 - PCBs
 - Metals



Soil mixing with vapor shroud



MGP site during remediation



MGP site post remediation

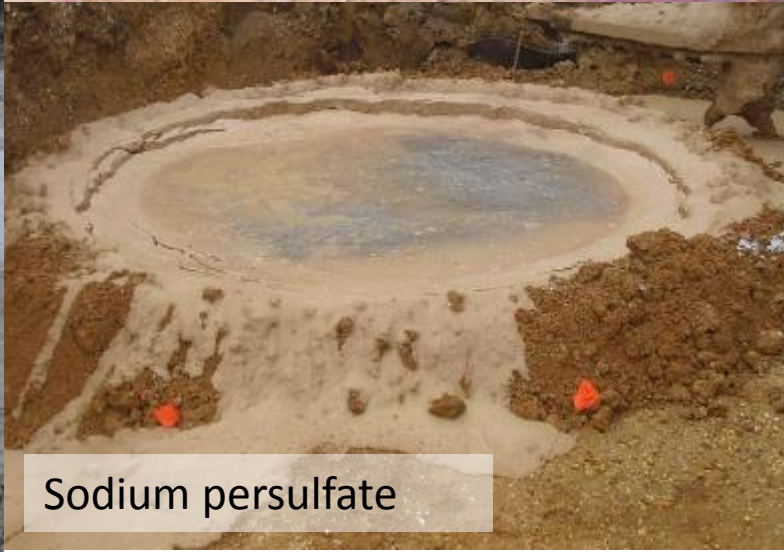
Industries and Applications



Activated carbon



Potassium permanganate



Sodium persulfate

- Treatment
 - Chlorinated solvents
 - VOCs
 - SVOCs

Questions?

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- Next up....
 - Chris Robb