

Simplify Science®

Trattamento di un sito contaminato da PCE con Permanganato associato a tensioattivi nell'area sorgente e nel plume

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Carus Remediation Technologies Director EMEA



Established in 1915

Privately owned

HQ located in Peru, IL

Certifications include:

- ISO 9001:2015
- Responsible Care®
- NSF®
- REACH®
- Kiwa



World Leader In:

- Permanganate oxidation
- Manganese catalysts
- Phosphates



Solutions for Environmental Applications:

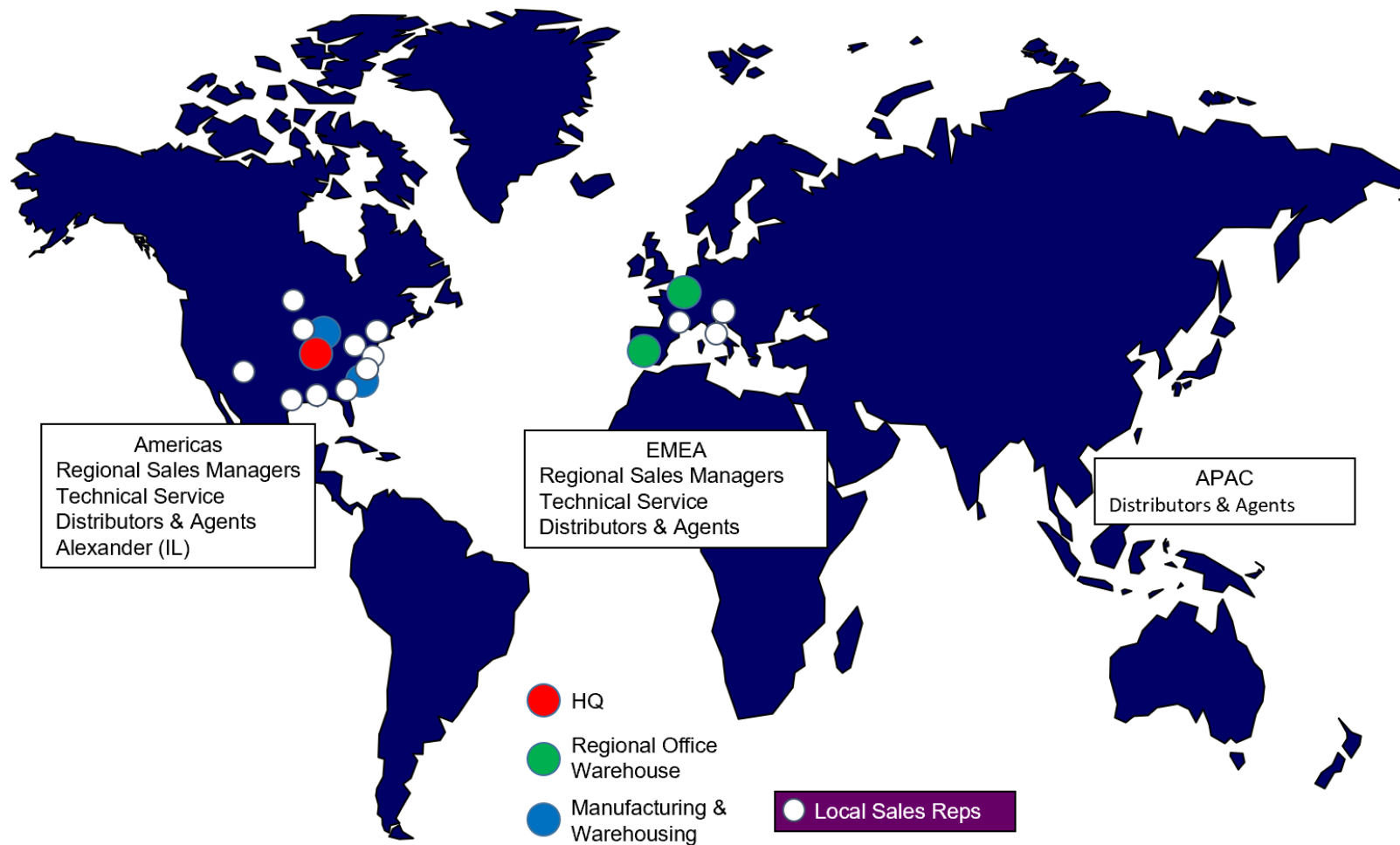
- Air purification
- Water purification
- Soil remediation



Innovative Solutions to Customers' Problems:

- R&D capabilities:
 - Fully equipped lab
 - Projects: bench & large scale

Locations



Remediation Grade Products

Simplify ISCO

PERMANGANATE BASED

RemOx[®] S ISCO Reagent
RemOx[®] S-D ISCO Reagent
RemOx[®] S-B ISCO Reagent
RemOx[®] L ISCO Reagent
RemOx[®] L-D ISCO Reagent

SUSTAINED-RELEASE BASED

RemOx[®] SR+ ISCO Reagent

Simplify Bio

AEROBIC

IXPER[®] 75C and 70C Calcium Peroxides

ANAEROBIC

CAP 18[®] Anaerobic Bioremediation Product

CAP 18 ME[®] Anaerobic Bioremediation Product

ABC-Olé

Simplify Chemical/Bio/Other

CHEMICAL OXIDATION/ AEROBIC BIO

Oxygen BioChem (OBC[™])

ANAEROBIC OXIDATION

Sulfate BioChem (SBC)

CHEMICAL REDUCTION/ ANAEROBIC BIO

ABC⁺ (Anaerobic BioChem⁺)

OTHER: PHOSPHATE BASED

CARUSQUEST[®] 101
CARUS[™] 1100
CARUS[™] 8100
SHMP

Simplify ISCO

RemOx[®] S
RemOx[®] S-D
RemOx[®] S-B
RemOx[®] L
RemOx[®] L-D
RemOx[®] SR+

Remediation Grade Products

RemOx[®] ISCO Reagents

Single Component Oxidant

- Complete mineralization of chlorinated ethenes and others
- Complex mixing and distribution of multiple compounds is not necessary
- No activation or catalyzing
- Total volume of fluids injected reduced
 - Potential reduction of injection costs and/or short circuiting

pH

- No need to adjust pH for application
- Reduced corrosion effects in injection equipment and utilities and structures

Chemical Persistence

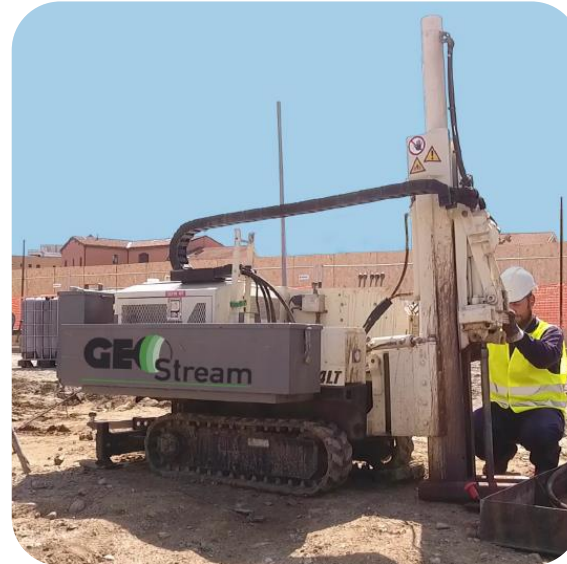
- Advection and diffusion main transport mechanism
 - Not pressure and reaction dependent
- Long-lasting oxidant
 - Treat compounds desorbing from matrix
 - Diffuse into tight matrices

Color

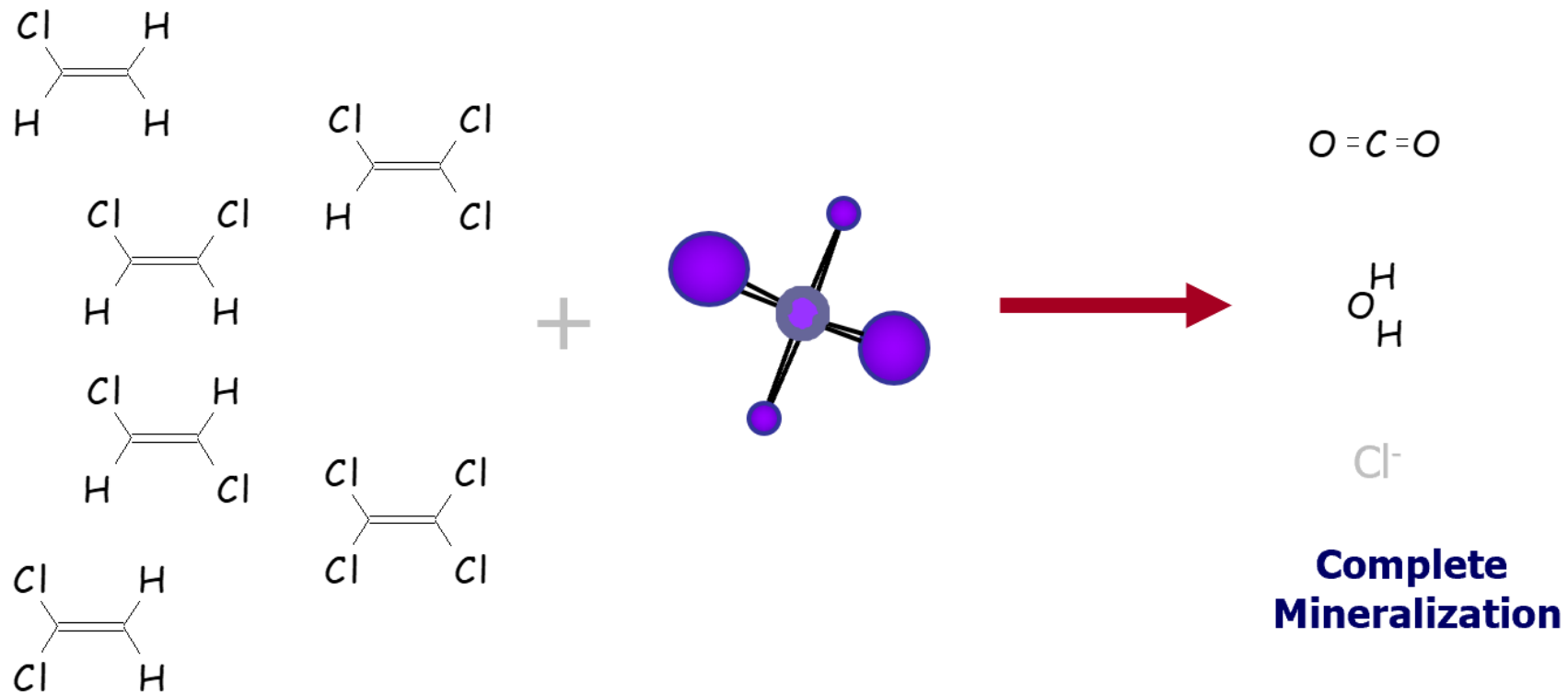
- No tracer required

Keys to Success with ISCO

- Choosing the **correct oxidant**
- Choosing the **correct delivery mechanism**
- Understanding the **site specific oxidant demand**
- Injecting **enough oxidant**
- **Creating contact**



Basic Permanganate Chemistry



Contaminants of Concern

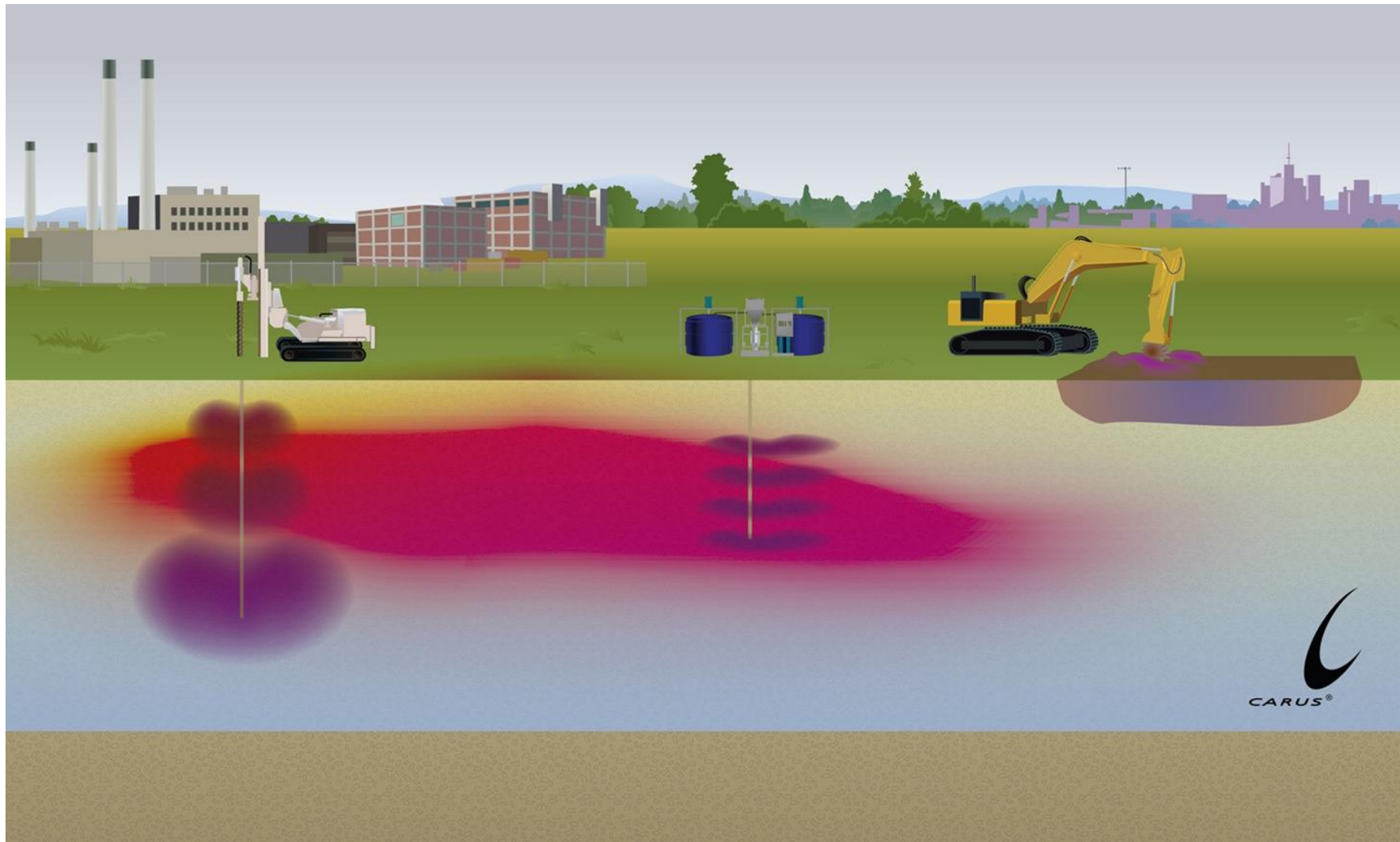
Permanganate works well on:

- Chlorinated solvents (TCE, PCE, vinyl chloride)
- 1,4-Dioxane
- Phenols
- Sulfides / organic sulfur compounds
- PAHs
- Double-bonded hydrocarbons (unsaturated)
- Energetics (RDX, HMX)

Permanganate not recommended for:

- Gasoline, diesel fuel
- BTEX (benzene, toluene, ethylbenzene, xylene)
- Single-bonded hydrocarbons (saturated)
- Methylene chloride, carbon tetrachloride

Implementations

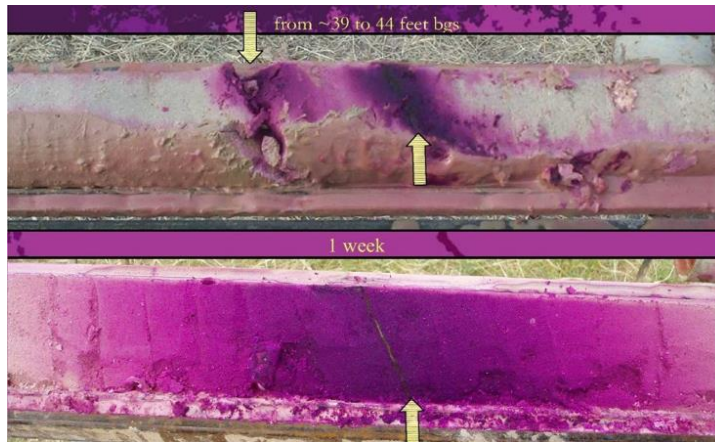


Permanganate Applications

Injection



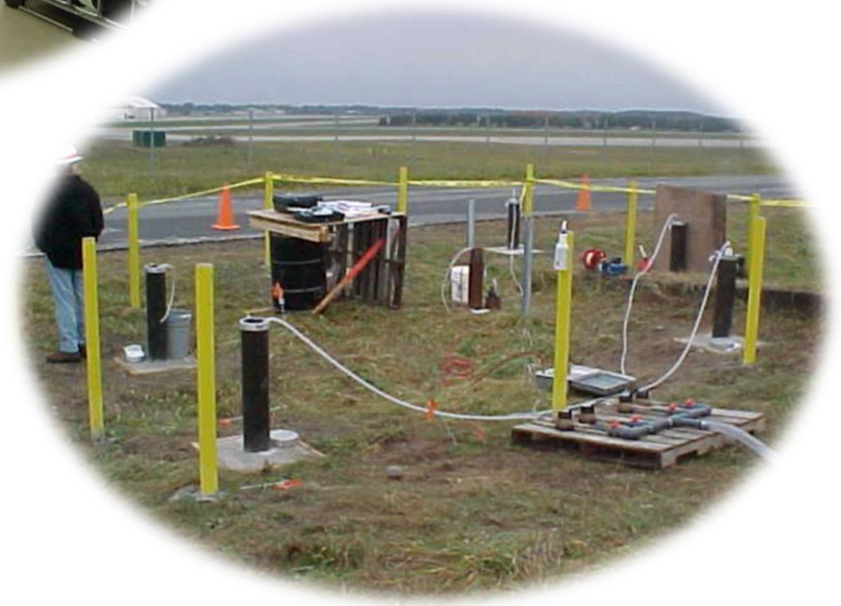
Hydraulic Slurry Emplacement



Soil Blending



Small Scale Injections



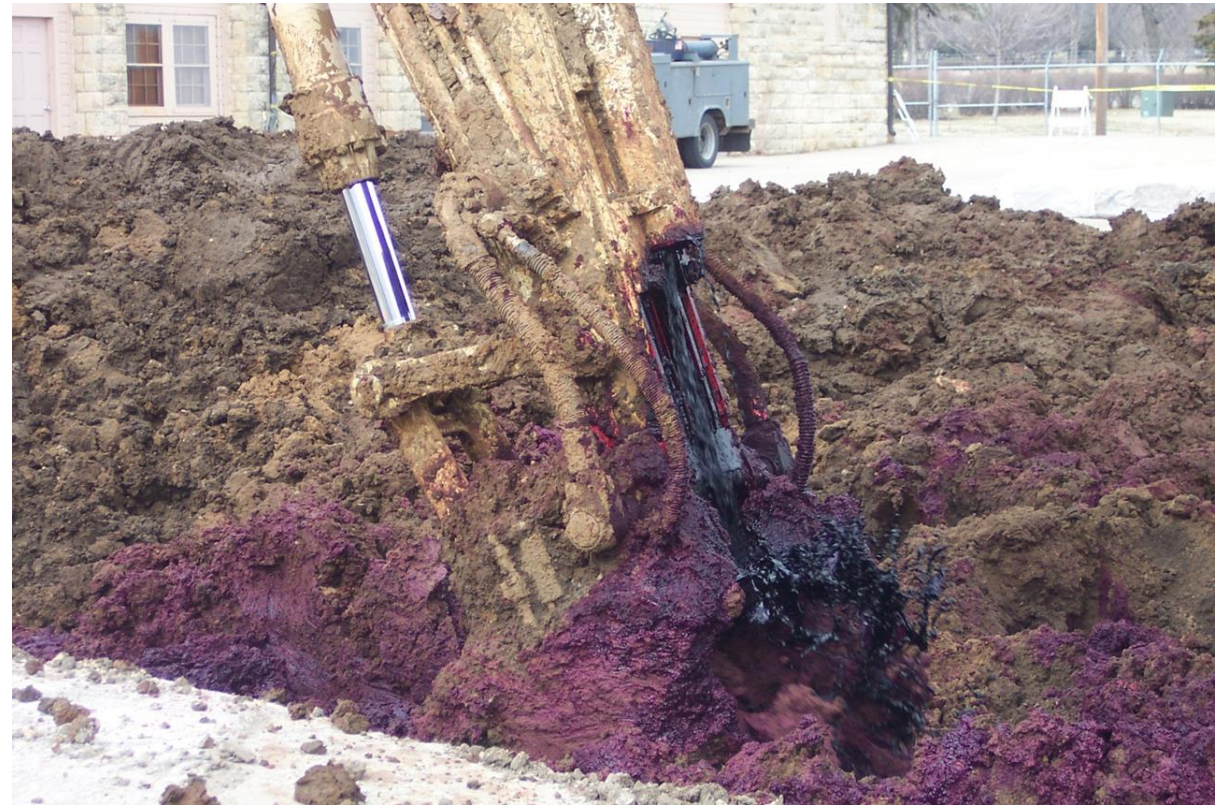
Large Scale Injections



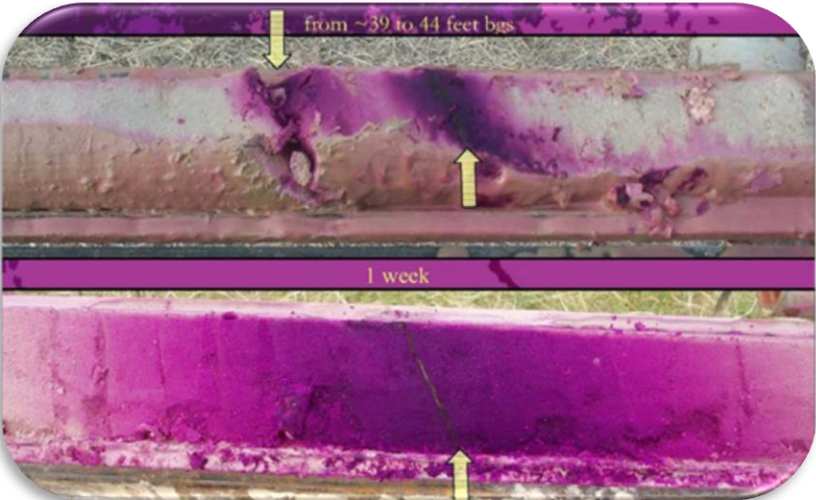
Soil Mixing



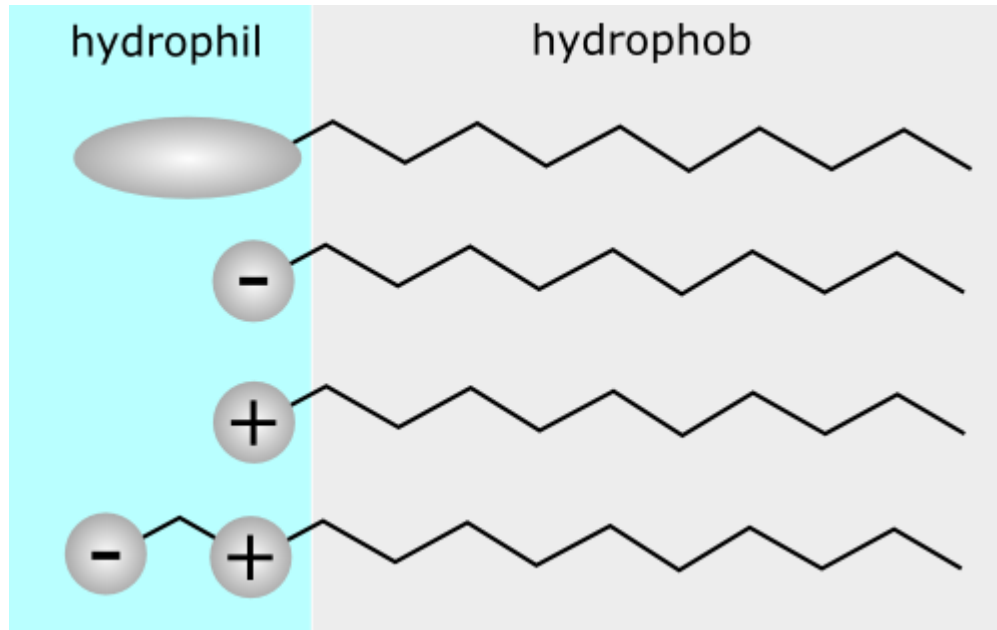
[Video](#)



Hydraulic Slurry Emplacement



Surfactants



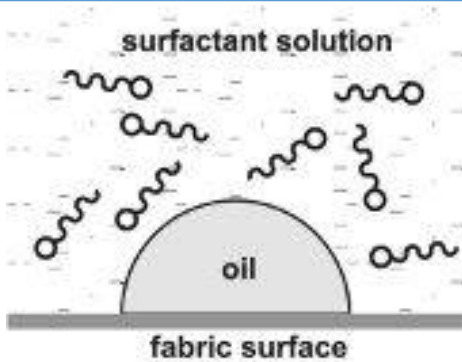
Non ionic – long chain alcohols

Anionic – sulphonated salts (soaps)

Cationic – long chain Carbon molecules with ammonial
IV tail

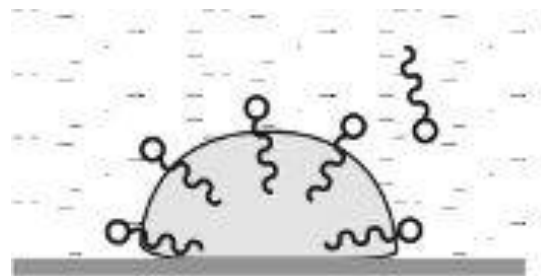
Anphoteours – sulphonated salts

Surfactants

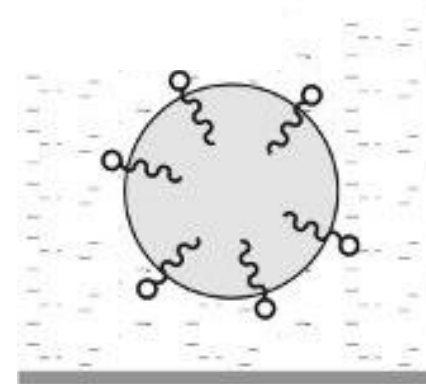


The surfactant contains molecules with hydrophilic and hydrophobic portions.

hydrophilic hydrophobic

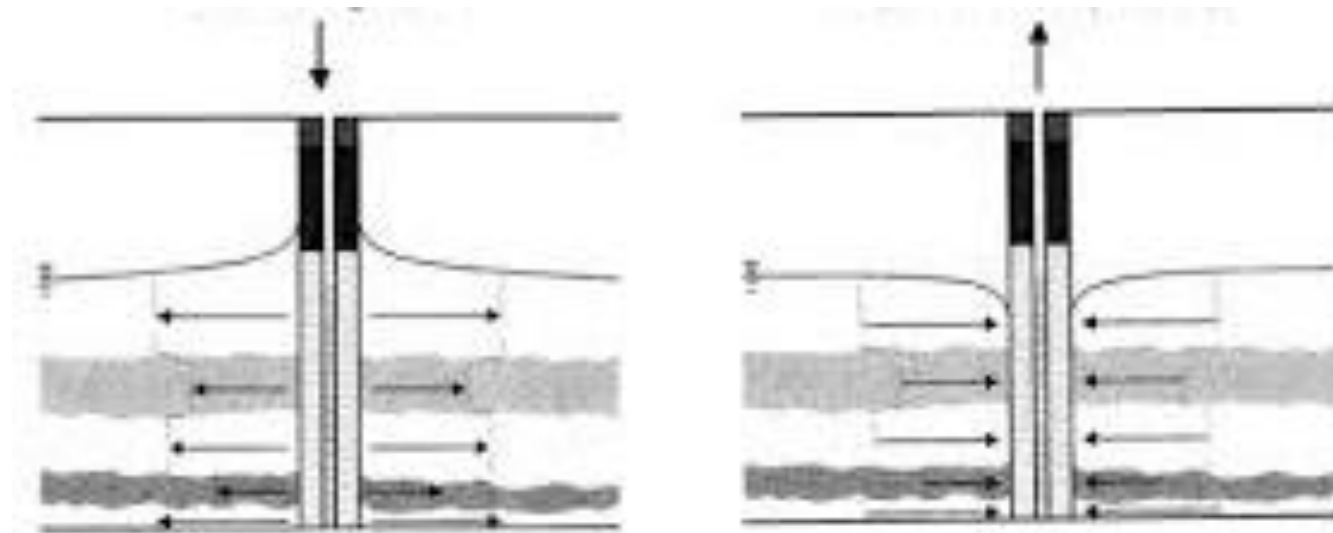


Surfactant molecules are absorbed into the surface of the oil and so remove it from the fabric surface.

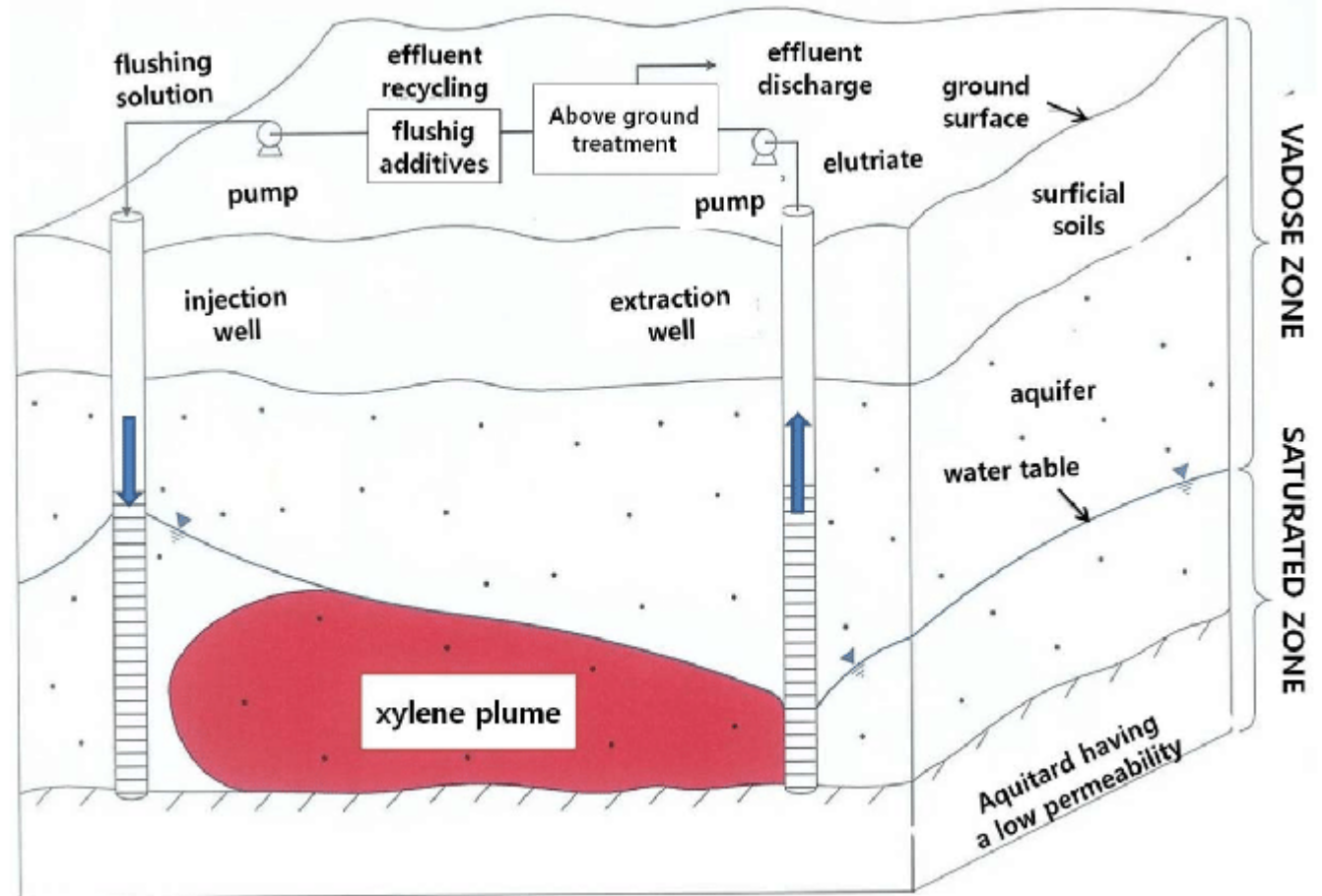


The surfactant molecules remain surrounding the oil once it has been removed, so helping to prevent its redeposition onto the cleaned surface.

Push pull extraction

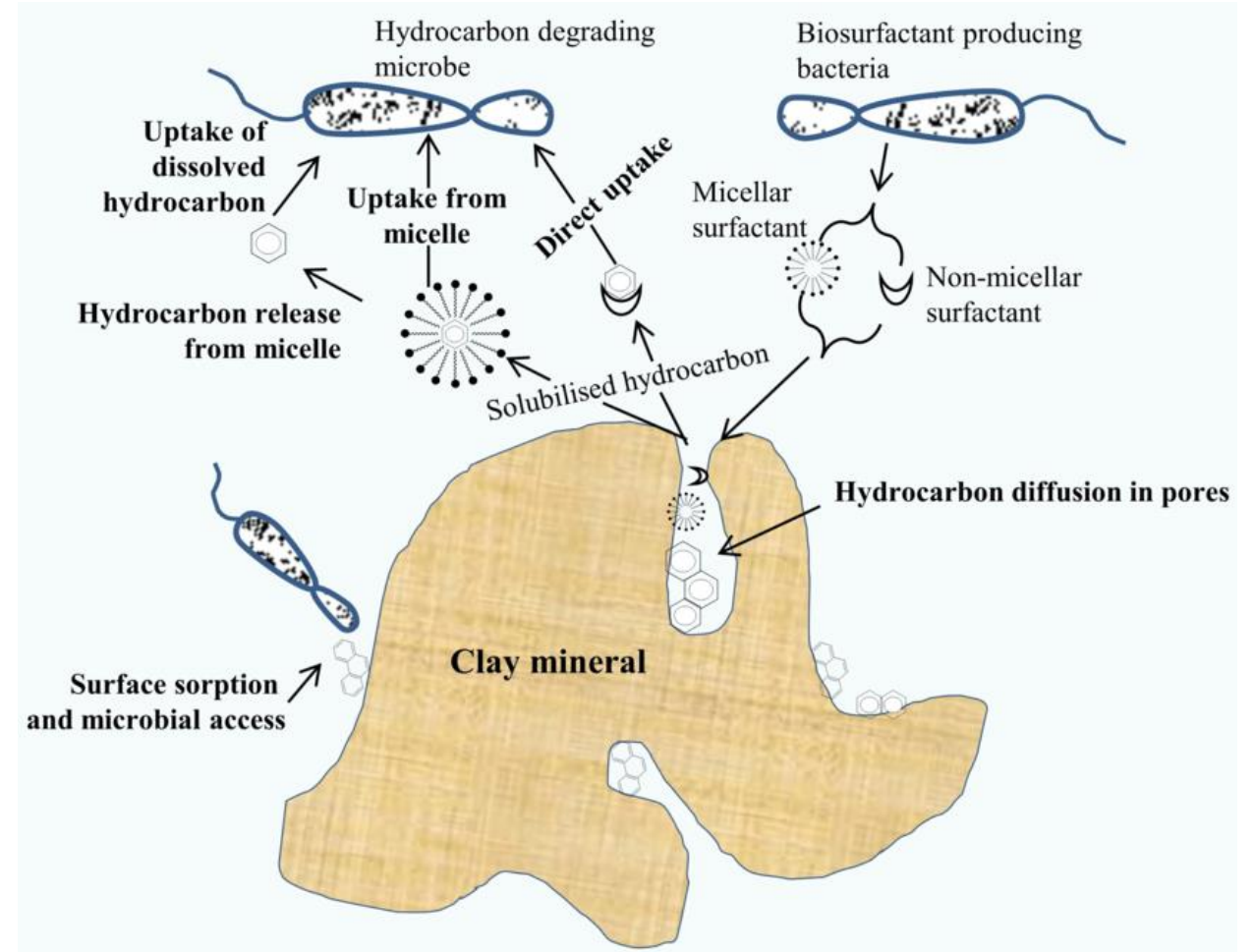


Soil flushing



ISCO and Biopiles treatment trains

- All reactions are in aqueous phase
- Solubility:
- bioavailability



Case study

Site

Former mechanical site- Automotive parts

Soil

Soil characteristics: Sandy Clay, very low permeability
TCE above 40 g/kg (4%!!!)

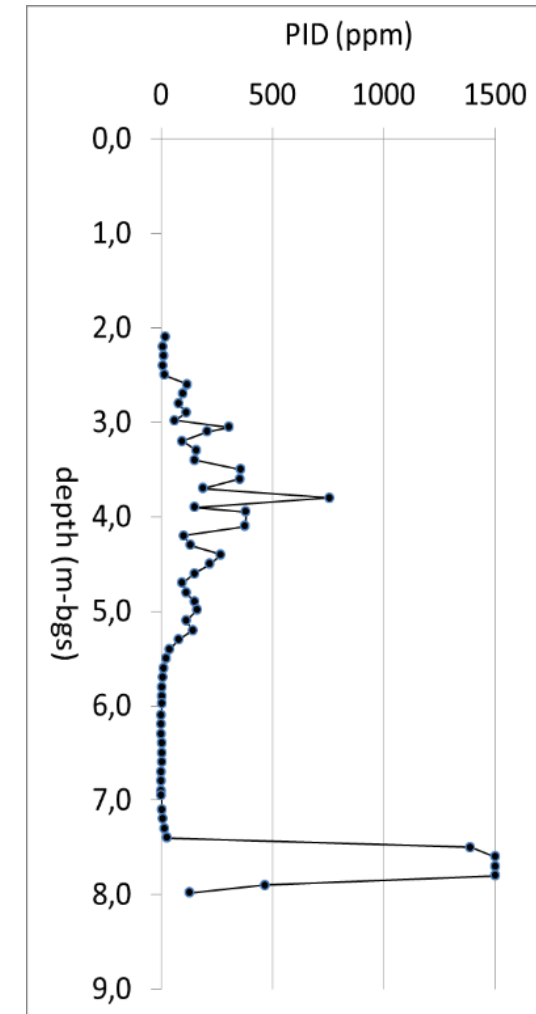
Groundwater

TCE above : 400.000 $\mu\text{g/l}$ (400 mg/l)
Traces of DCE and VC

DNAPL

Between 7 and 8 m bgl

Extent: Source zone of 450m²



P&T started in 2007 ongoing in 2018

Guess results

D&D

Below an active building below 7 m depth

Thermal

Cost above 2 million Euro with some production disruption

AS/SVE

Vapors treatment expensive, DNAPL

ISCO/ISCR

Fesible but limited by DNAPL

CYCLIC APPROACH

Carus Surfactants

Solubilise and recover 5% solution central immission uoutside extraction.

RemOx S Remediation grade sodium permanganate

Injections by direct push

	1 Surfactant	1 RemOx	2 surfactant	2 RemOx
Total CHCs	>100,000 ug/l	20,000 ug/l	>100,000 ug/l	1.200 ug/l

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Good Chemistry at Work



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