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# Use of ground work techniques for soil decontamination and HaloCrete technique for remediation using jet grouting

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Cecilia Bohn, Keller Holding GmbH, Offenbach am Main, Germany

Peter Freitag, Keller Grundbau Ges. mbH, Vienna, Austria

Thomas G. Reichenauer, Austrian Institute of Technology, Tulln, Austria

# Outline

- General solutions for soil remediation
- Appropriate ground work techniques
- HaloCrete: in situ decontamination treatment for chlorinated hydrocarbons using jet grouting technique
  - Context
  - Principle
  - Laboratory tests
  - Large scale field tests
- Conclusion/Outlook

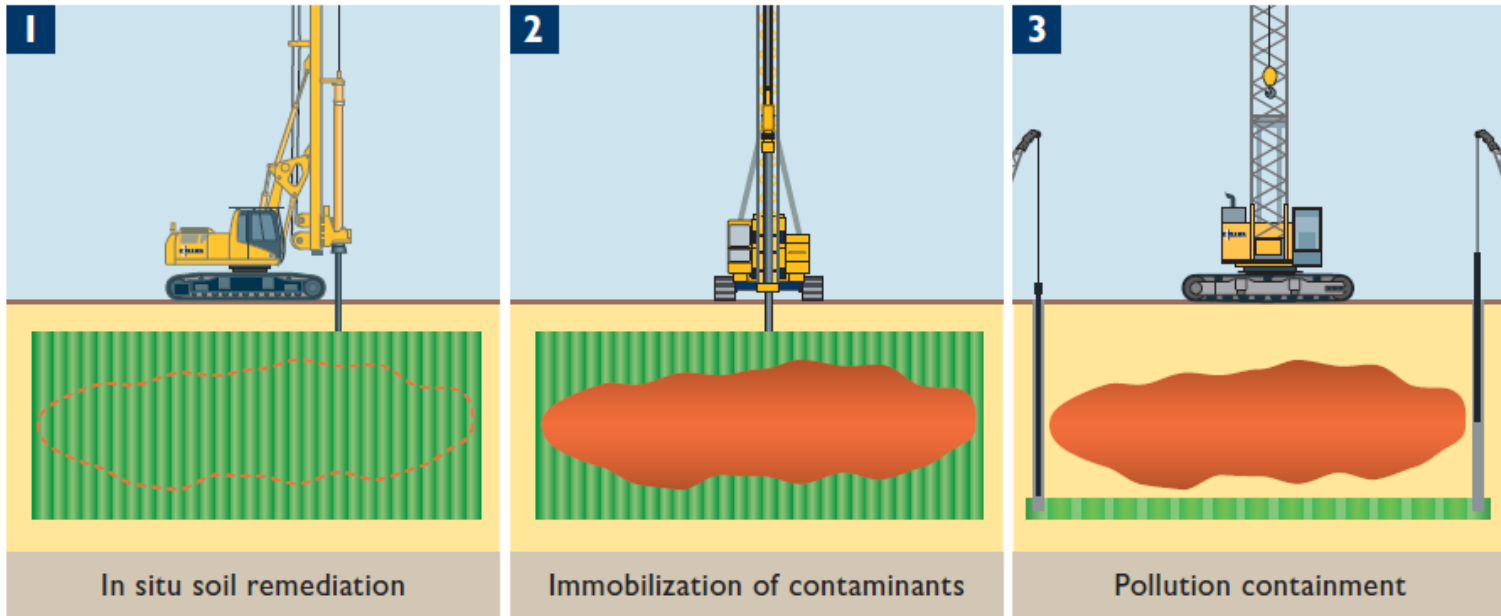
# General solutions for soil remediation

# Parameters for choice of solution

- Type and amount of contaminant
- Ground water conditions
- Various chemical parameters
- Presence of structures on/in the contaminated ground
- ...



# Possible solutions



In situ soil remediation

Immobilization of contaminants

Pollution containment

**Jet grouting / Grouting**  
**Deep soil mixing**  
**Compensation grouting**

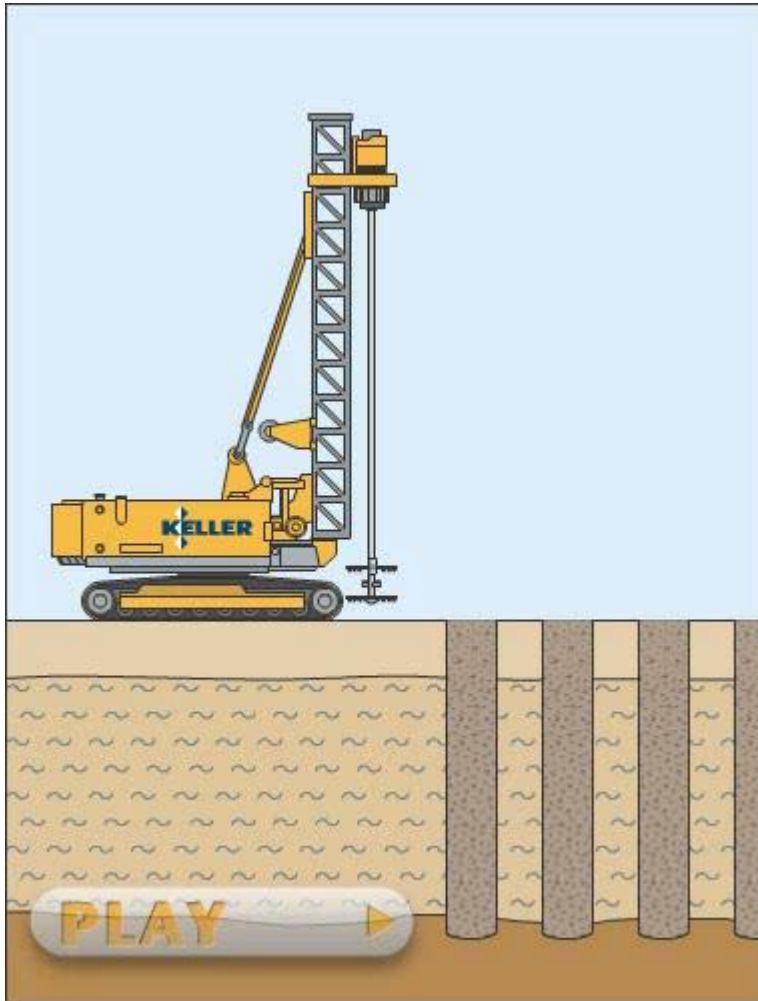
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**Vibrated or diaphragm wall**  
**Deep soil mixing**  
**Use of slurry and/or membrane**

...

# **Appropriate ground work techniques**

# Deep soil mixing

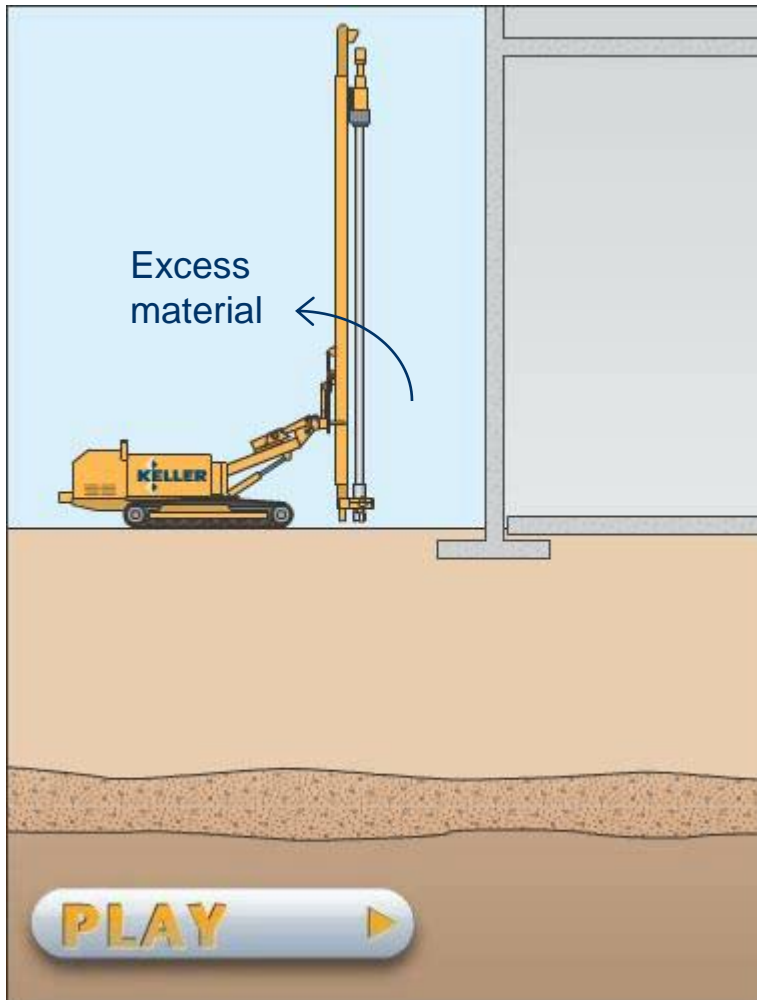


Cut-off wall with DSM, dike in Germany





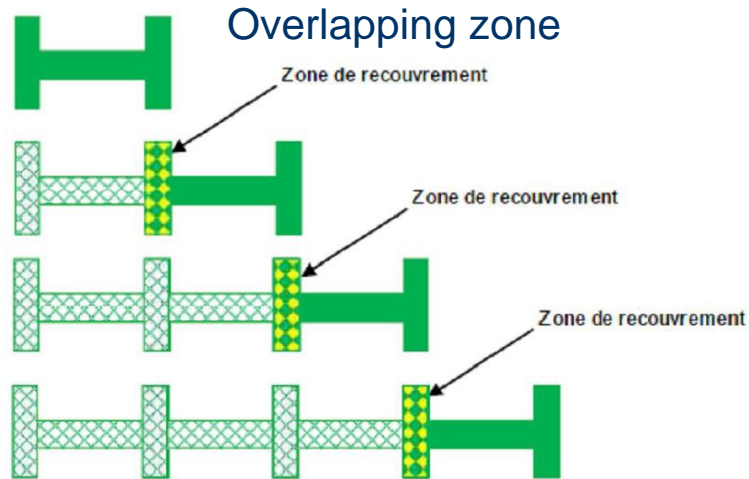
# Jet grouting Soilcrete®



Immobilization of oil pollution with jet grouting,  
gas station in Austria

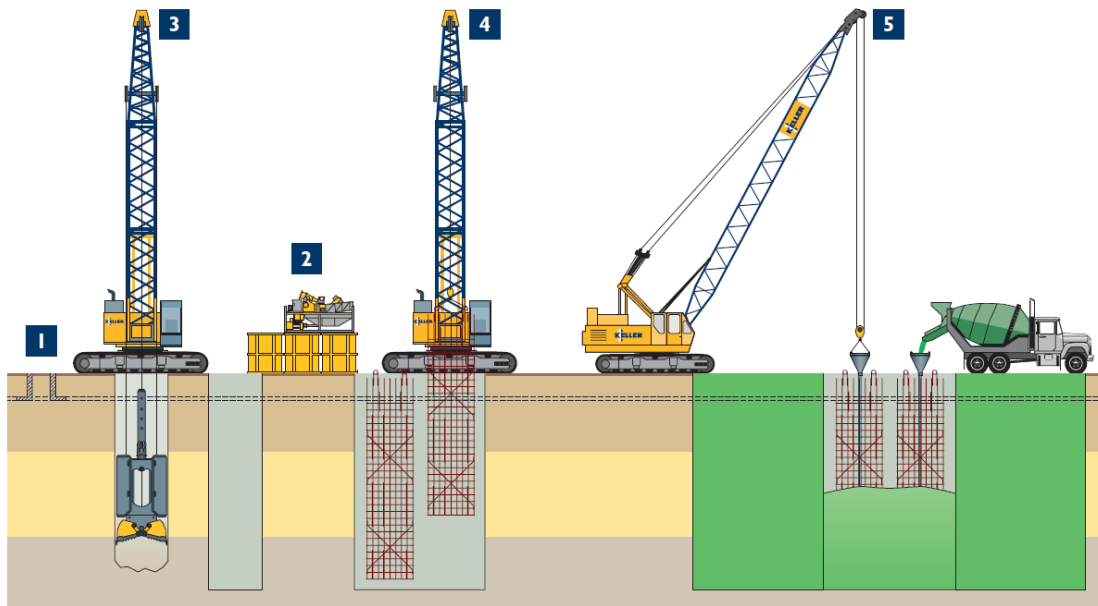


# Cut-off wall with vibrated profile



Cut-off wall with vibrated profile, dike in France

# Cut-off wall as diaphragm wall



Cut-off wall with membrane,  
landfill containment, United Kingdom

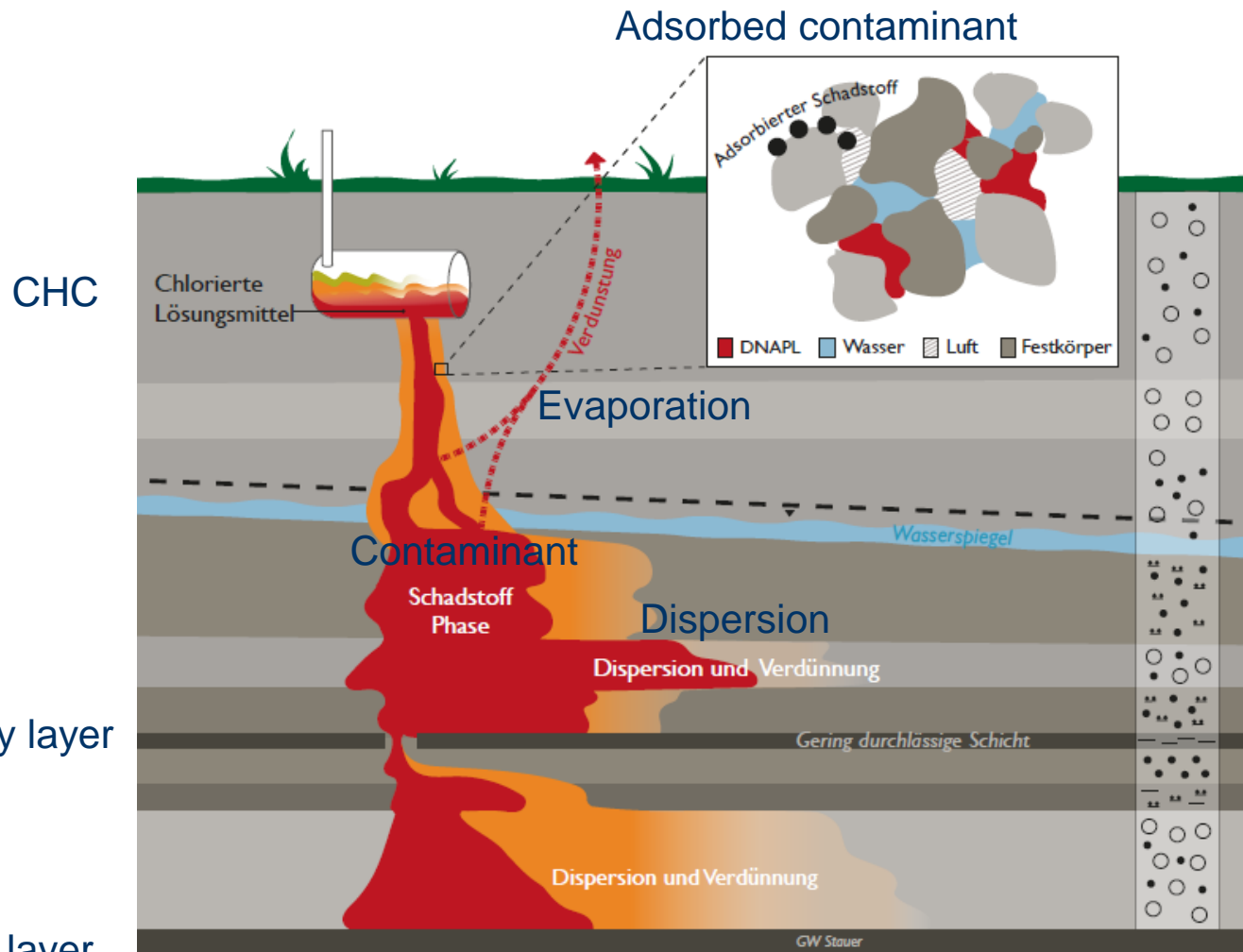
# **HaloCrete: in situ decontamination for chlorinated hydrocarbons treatment using jet grouting technique**

# Context

## Chlorinated hydrocarbons (CHC):

- Solvent and degreasing agent
- Carcinogen
- Highly volatile
- Diffuses through concrete
- Dense-Non-Aqueous-Phase Liquid (DNAPL)

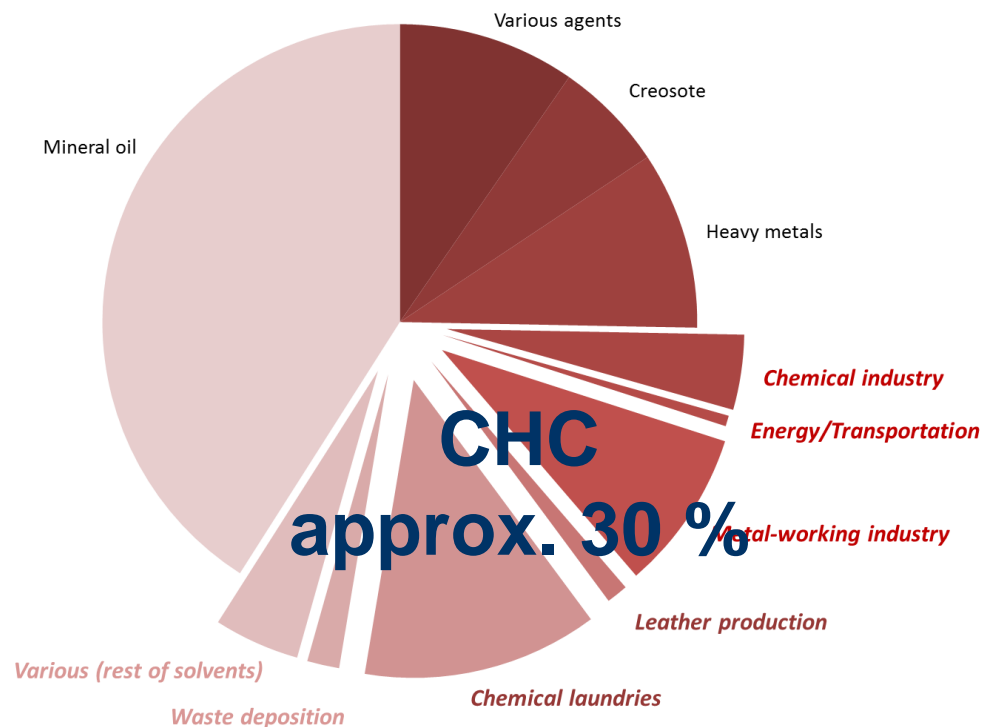
# Context



→ **Complex distribution pattern**

# Context

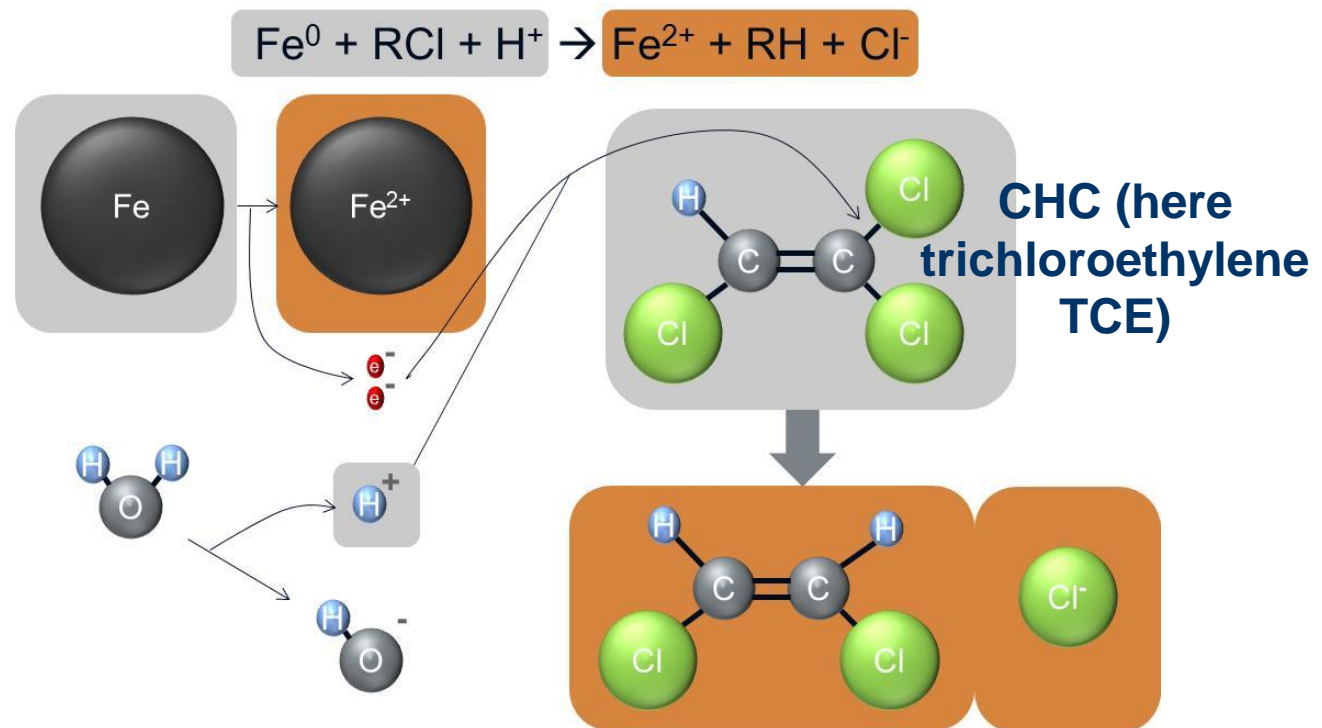
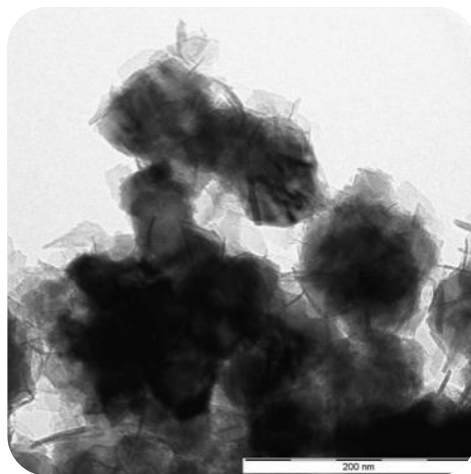
- Estimated 2000 polluted sites to be treated in Austria
- Origin of soil pollution in Austria (situation similar in other european countries):





# Principle

In situ chemical reduction with zero-valent iron (nano particles)



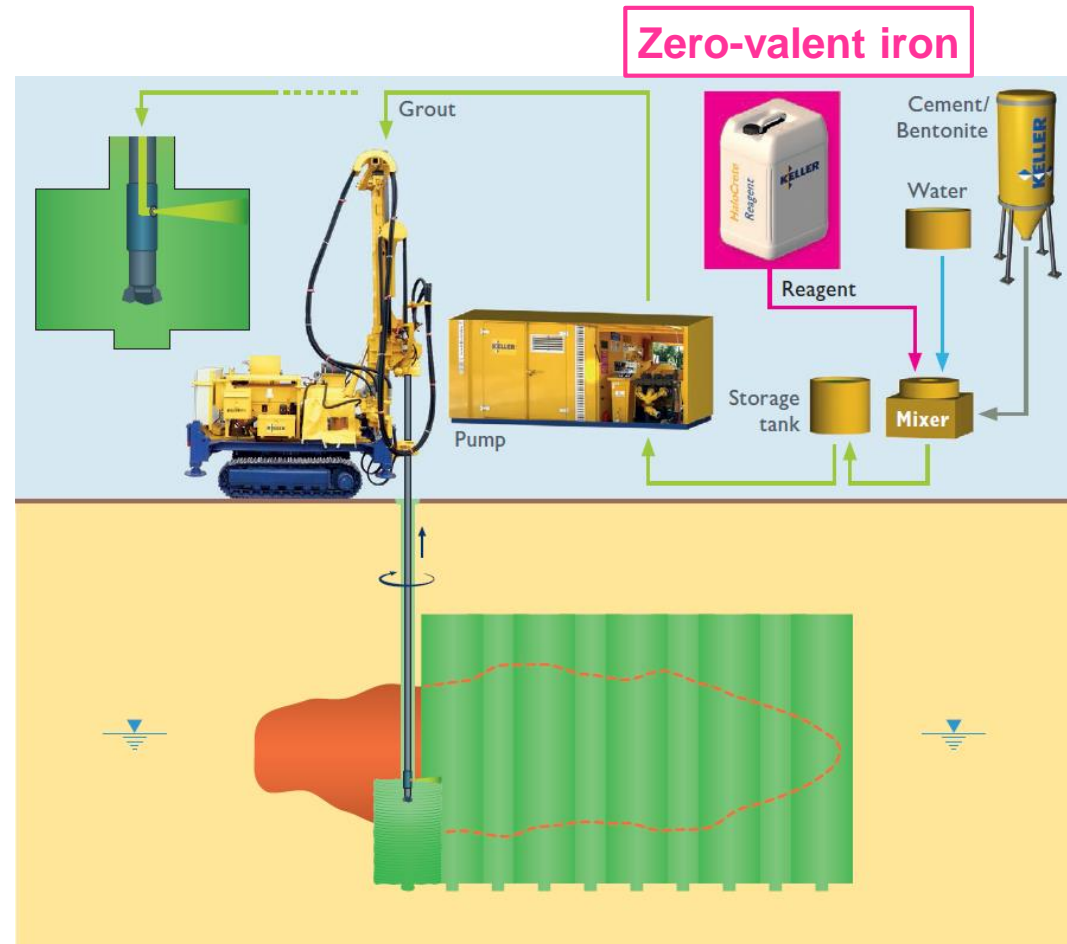
→ at the end only chloride ions and innocuous hydrocarbons



# Principle

Jet grouting technique fulfills requirements:

- Contact iron/contaminant
- Good iron distribution
- Possible application under buildings
- Sufficient soil stiffness and strength after treatment



# Testing program



## Phase 1: **Batch tests**

- Interaction TCE/Iron in presence of binders
- Prove absence of toxic by-products



## Phase 2: **Column tests**

- Presence of soil
- Washing-off effects



## Phase 3: **Field tests**

- Reaction in jet grouting column
- Distribution of iron inside column section

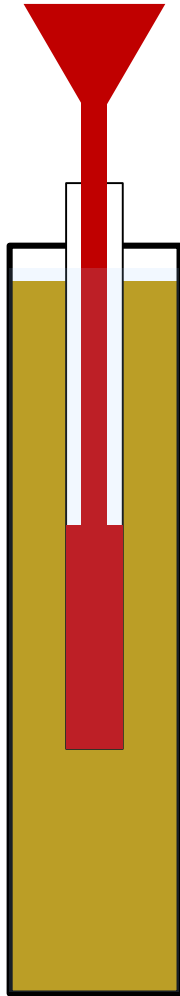
# Laboratory tests: batch tests



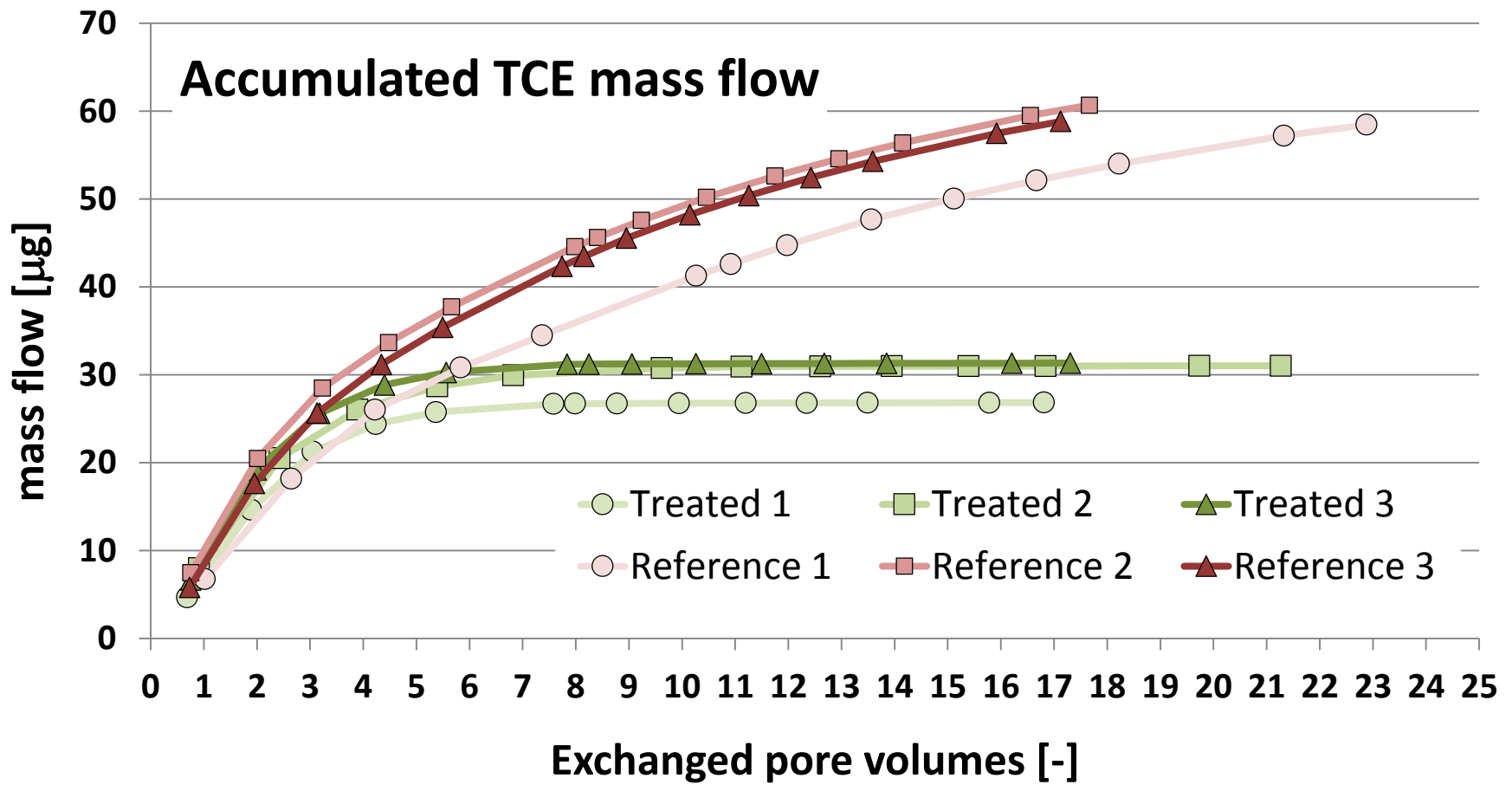
## Conclusions:

- Reduction reaction not negatively influenced by binders (7 tested)
- Clay-based additives have catalyzing effect (increase of degradation reaction products / no adsorption)

# Laboratory tests: column tests



# Laboratory tests: column tests



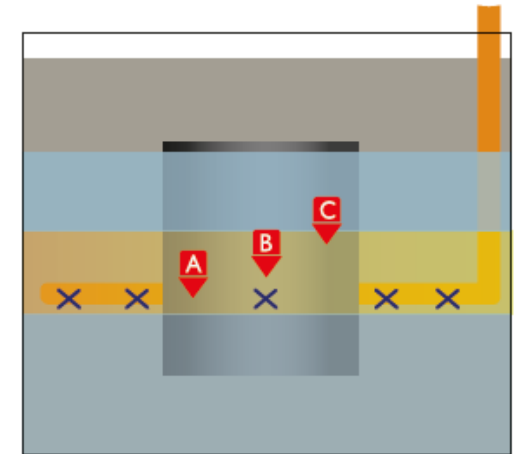
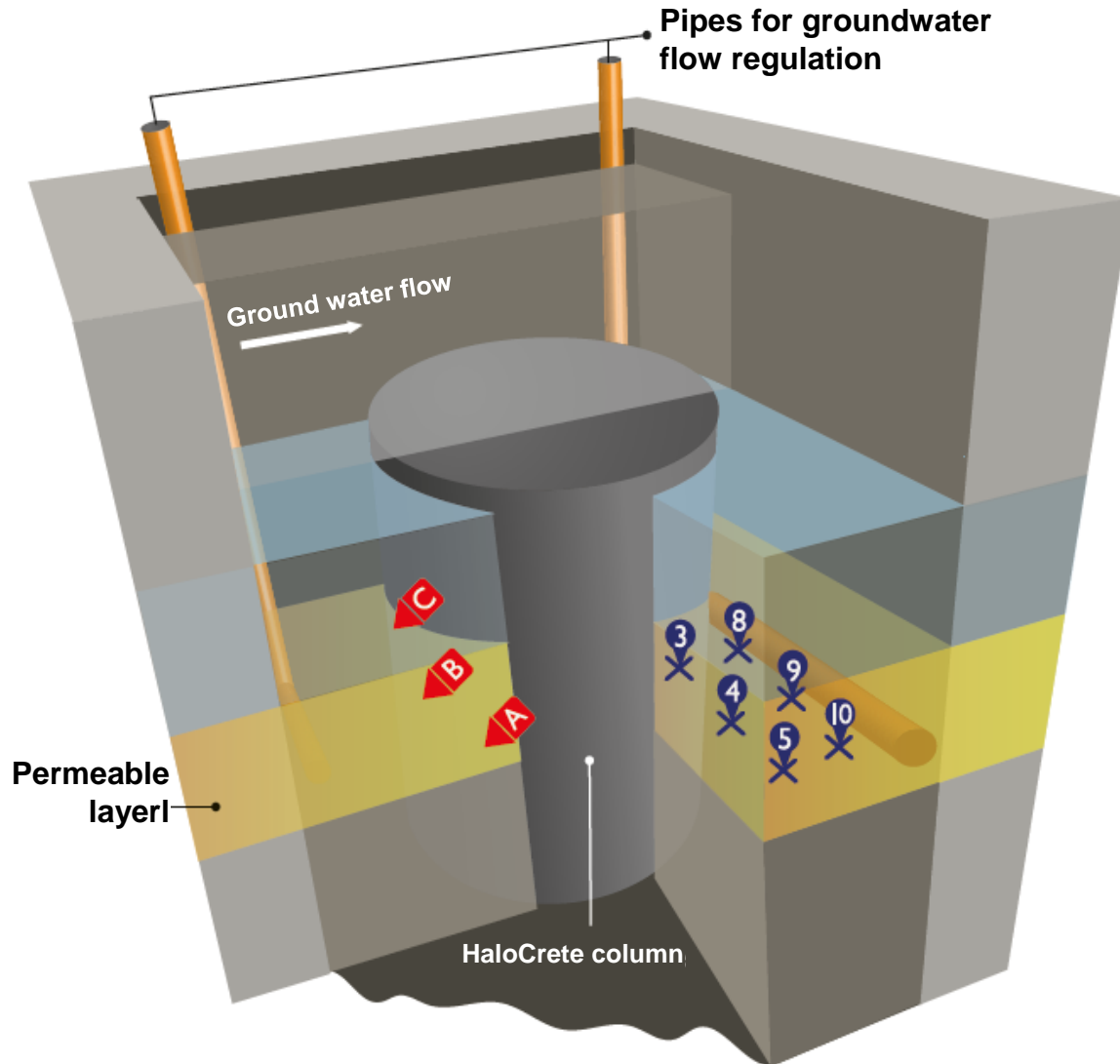


# Large-scale field tests

4 lysimeter chambers (Austrian Institute of Technology, Seibersdorf)

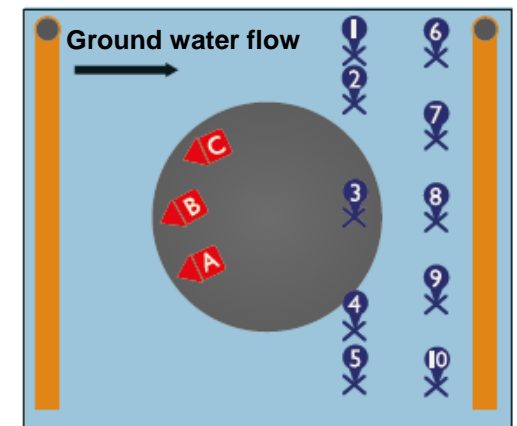


# Large-scale field tests



5 Sampling point

A Contaminant injection

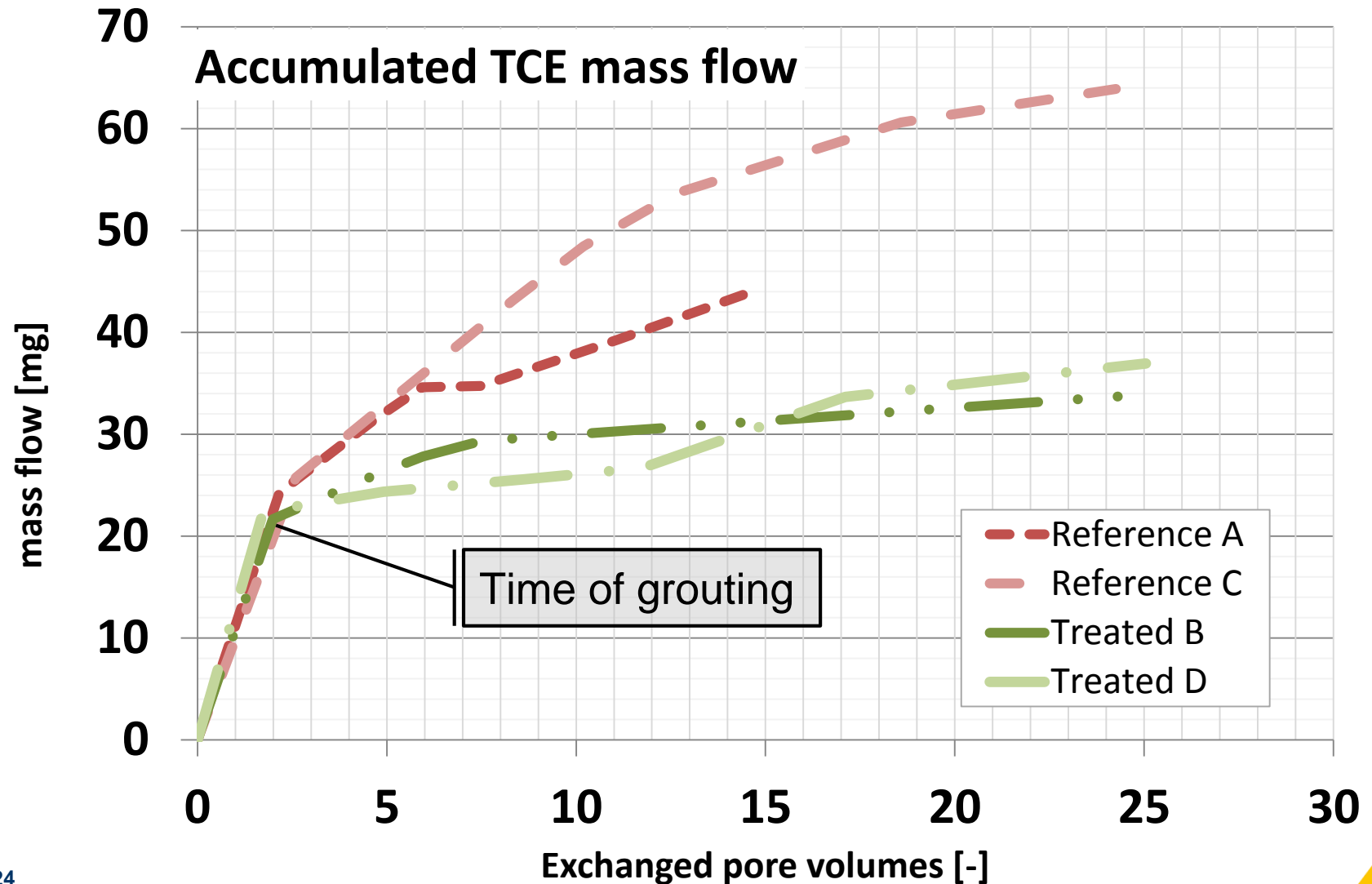




# Large-scale field tests



# Large-scale field tests



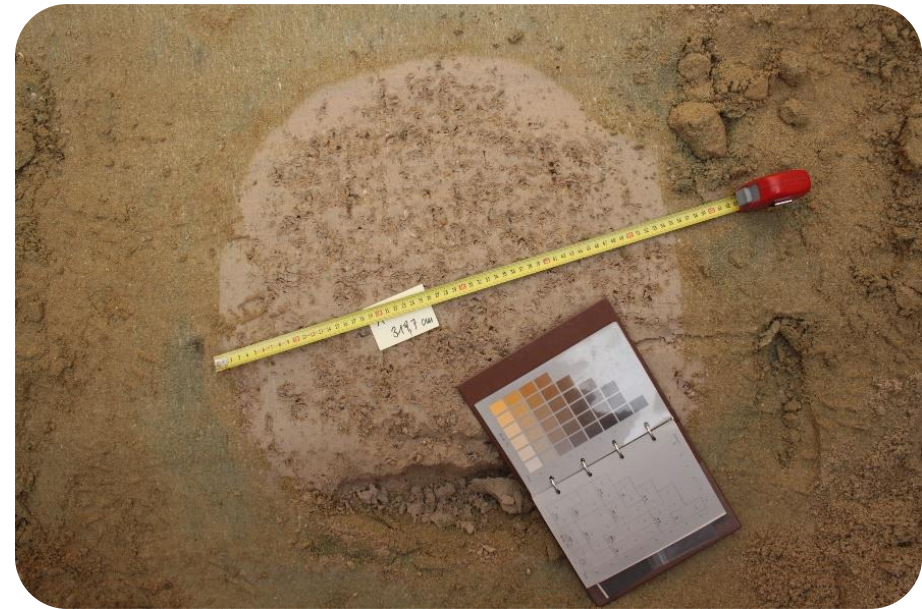


# Large-scale field tests

Treated

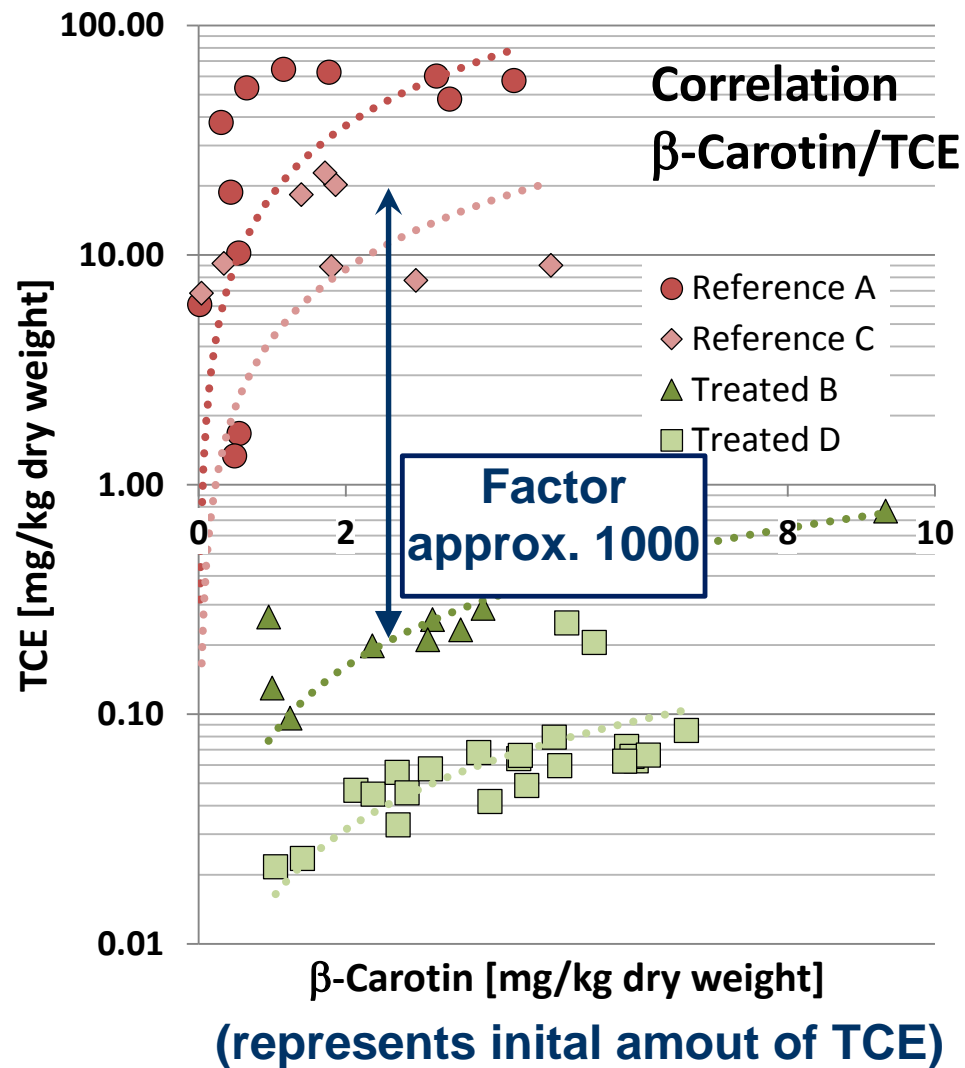


Untreated (reference)



Compressive strength: all around 1 MN/m<sup>2</sup>

# Large-scale field tests



## Conclusion/Outlook

- Various ground work techniques have been used successfully for soil remediation applications internationally
- HaloCrete jet grouting remediation of CHC
  - Jet grouting technique fulfils requirements
  - Efficiency proven based on lab and large-scale field tests
  - Pilot project running

# **Thank you for your interest!**

[c.bohn@kellerholding.com](mailto:c.bohn@kellerholding.com)