USE OF COLLOIDAL SILICA GROUT FOR GROUND BARRIERS IN DECOMISSIONING:

A PROJECT OVERVIEW

Matteo Pedrotti
Christopher Wong, Dr Gráinne El Mountassir, Prof Rebecca Lunn
Civil and Environmental Engineering,
University of Strathclyde

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Bristol

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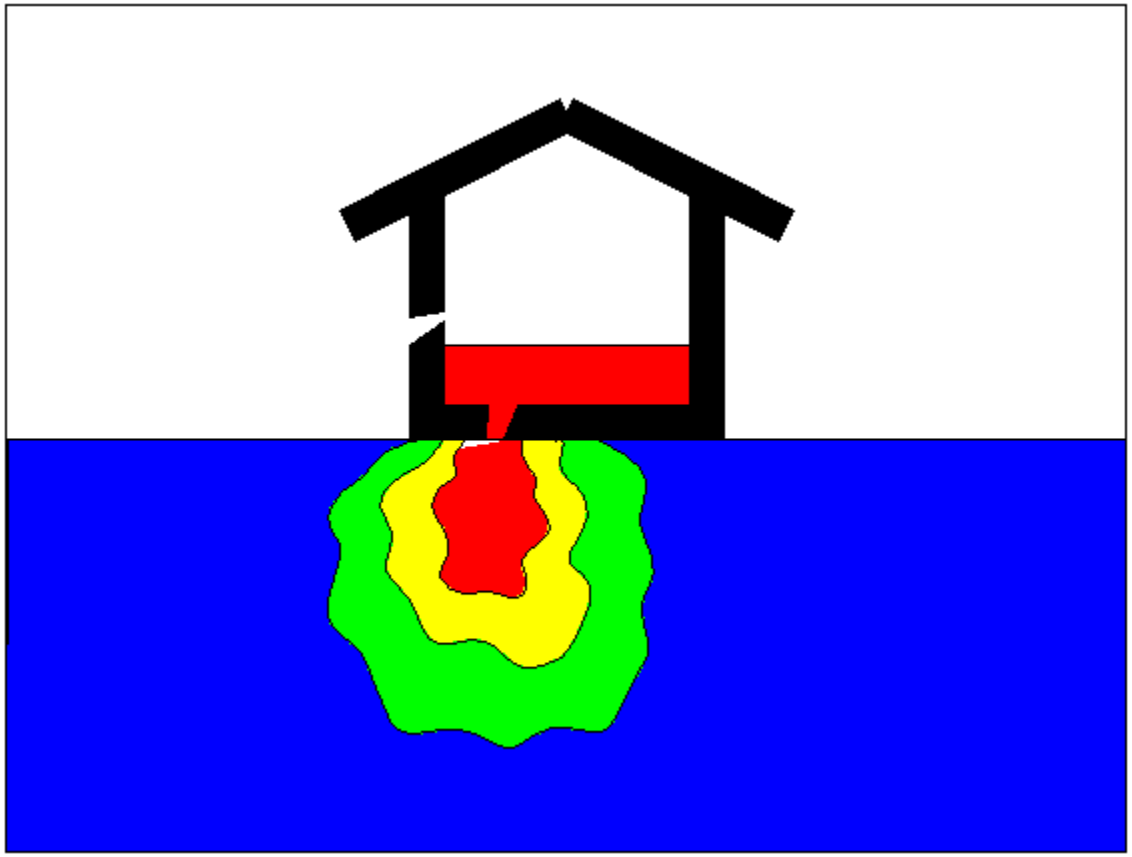
DISTINCTIVE

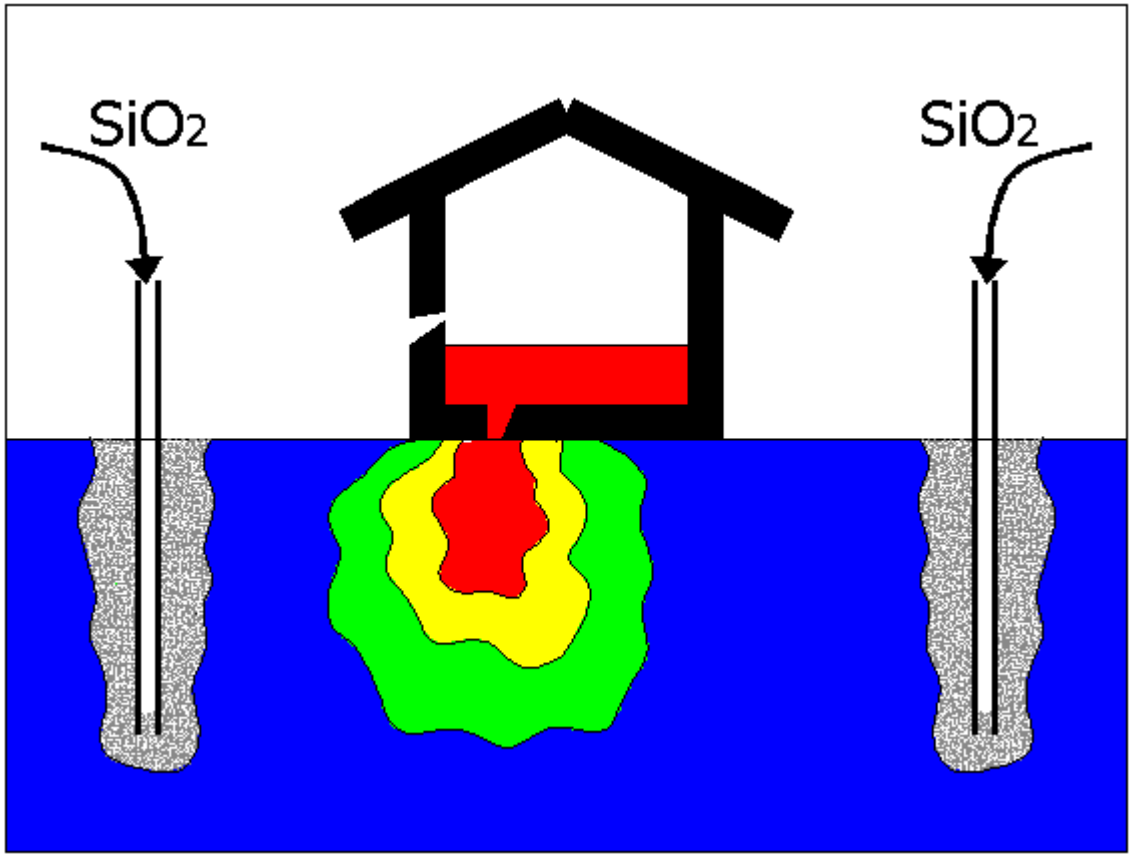
THE PROBLEM



Contaminated site

SITE APPLICATIONS

THE PROBLEM

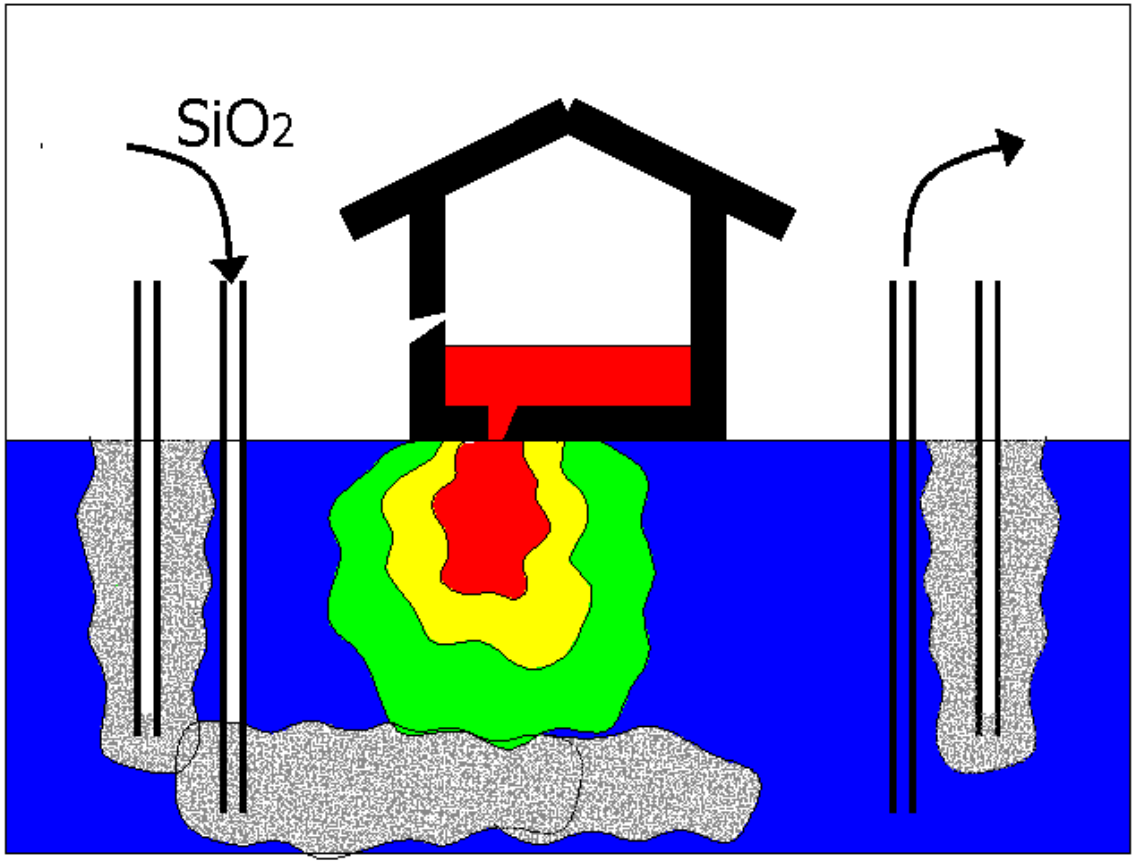


Contaminated site

SITE APPLICATIONS

- Vertical hydraulic barriers

THE PROBLEM

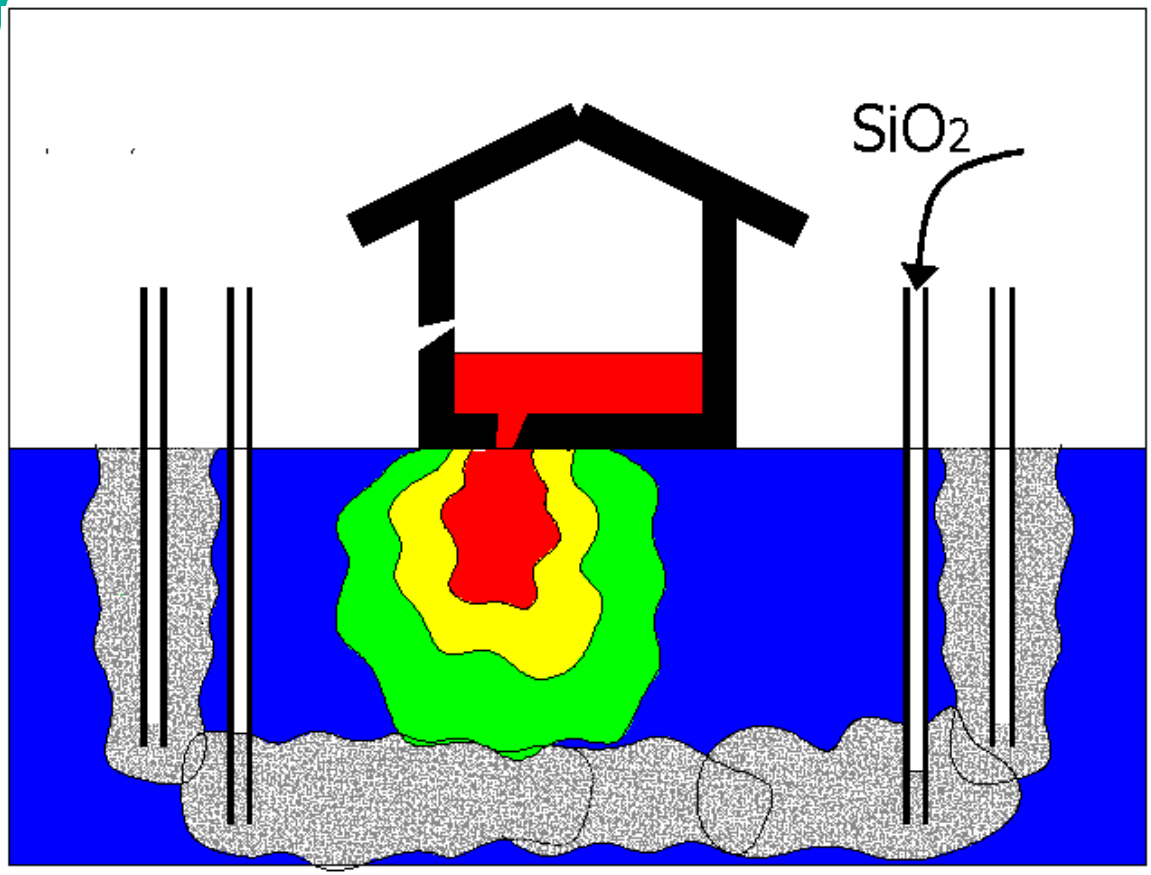


Contaminated site

SITE APPLICATIONS

- Vertical hydraulic barriers
- Horizontal hydraulic barriers

THE PROBLEM

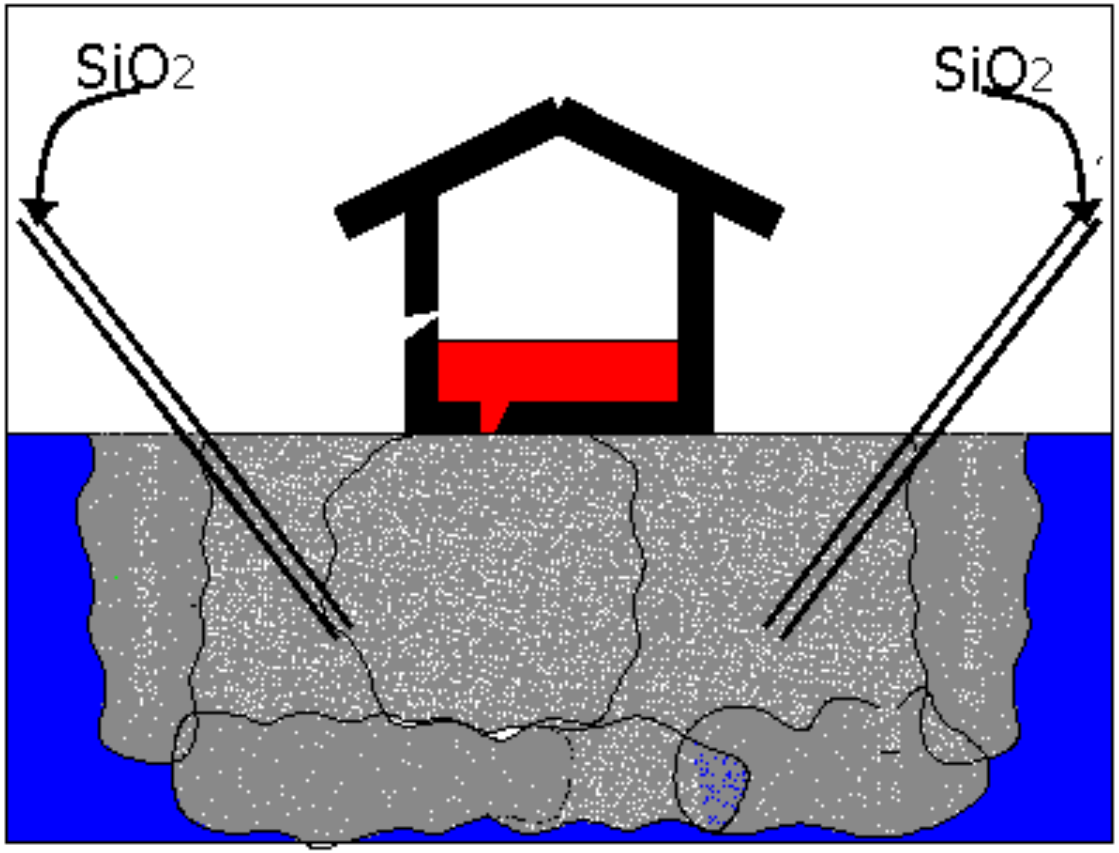


Contaminated site

SITE APPLICATIONS

- Vertical hydraulic barriers
- Horizontal hydraulic barriers

THE PROBLEM

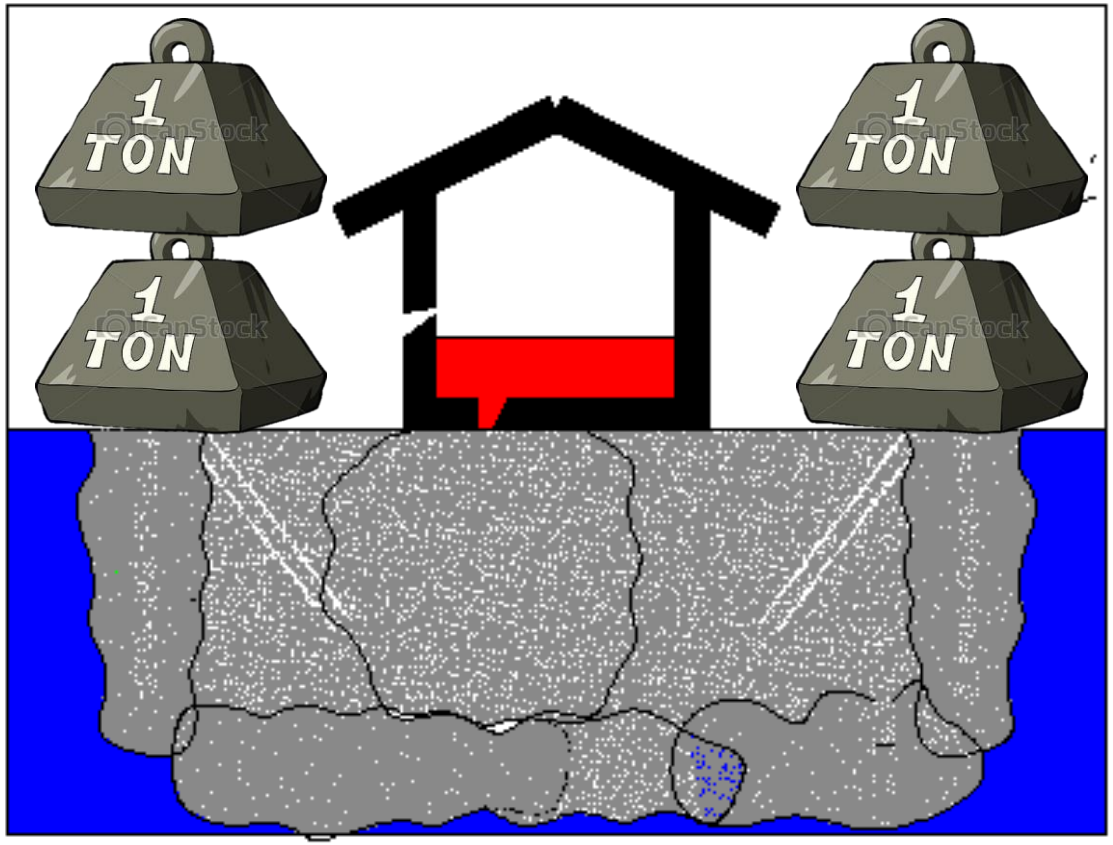


Contaminated site

SITE APPLICATIONS

- Vertical hydraulic barriers
- Horizontal hydraulic barriers
- Ground sealing

THE PROBLEM



Contaminated site

SITE APPLICATIONS

- Vertical hydraulic barriers
- Horizontal hydraulic barriers
- Ground sealing
- Combined hydraulic & mechanical improvement

THE GROUT

THE GROUT

COLLOIDAL SILICA GROUT

THE GROUT

COLLOIDAL SILICA GROUT

- Low initial viscosity

LOW INITIAL VISCOSITY

Initial viscosity ~ 5mPa·s

THE GROUT

COLLOIDAL SILICA GROUT

- Low initial viscosity
- Controllable gel time

LOW INITIAL VISCOSITY

CONTROLLABLE GEL TIME

Gel time can vary from minutes to days

THE GROUT

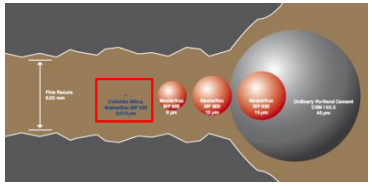
COLLOIDAL SILICA GROUT

- Low initial viscosity
- Controllable gel time
- Ability to permeate fine-grained soil

LOW INITIAL VISCOSITY

CONTROLLABLE GEL TIME

ABILITY TO PERMEATE FINE-GRAINED LAYER THANKS TO SMALL PARTICLE SIZE



Particle size from tens to hundreds of nanometres

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THE GROUT

COLLOIDAL SILICA GROUT

- Low initial viscosity
- Controllable gel time
- Ability to permeate fine-grained soil
- Non toxic

LOW INITIAL VISCOSITY

CONTROLLABLE GEL TIME

ABILITY TO PERMEATE FINE-GRAINED LAYER

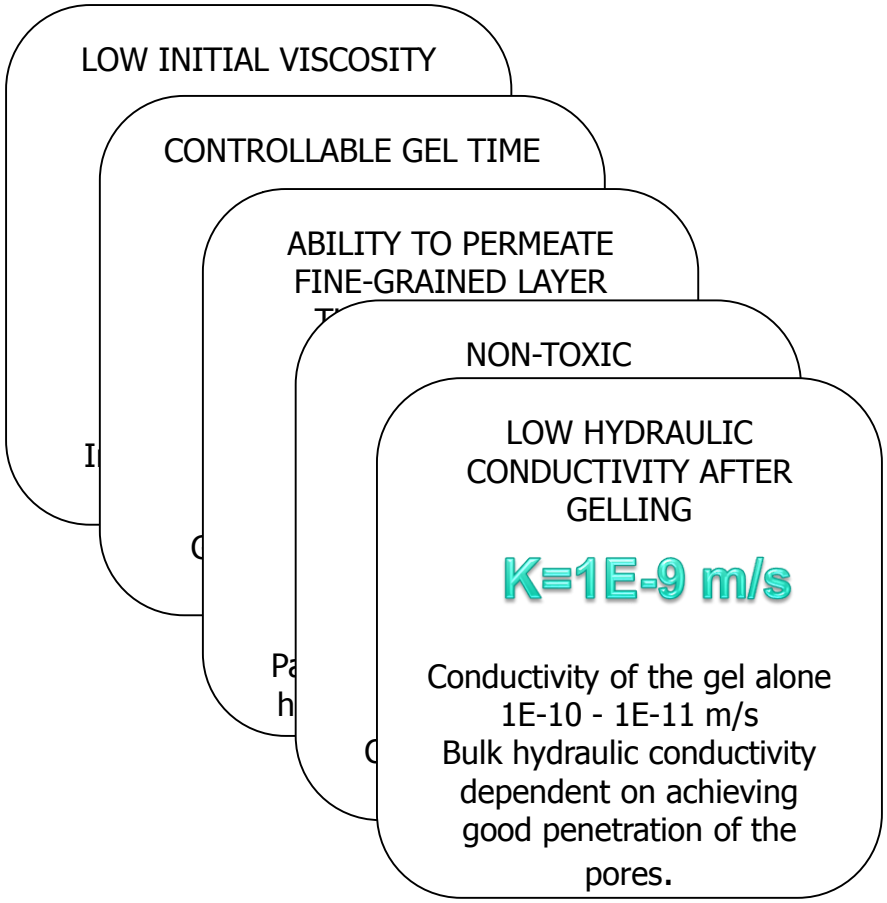
NON-TOXIC

Common addictive in food production

THE GROUT

COLLOIDAL SILICA GROUT

- Low initial viscosity
- Controllable gel time
- Ability to permeate fine-grained soil
- Non toxic
- Low final hydraulic conductivity



COLLOIDAL SILICA GROUT

RESEARCH PROJECT

SITE APPLICATIONS

PROJECT OVERVIEW

COLLOIDAL SILICA GROUT

1. Gelling behaviour

2. Grout-site interactions

3. The injection process

4. Injection monitoring

5. Hydro-mechanical characterisation

SITE APPLICATIONS

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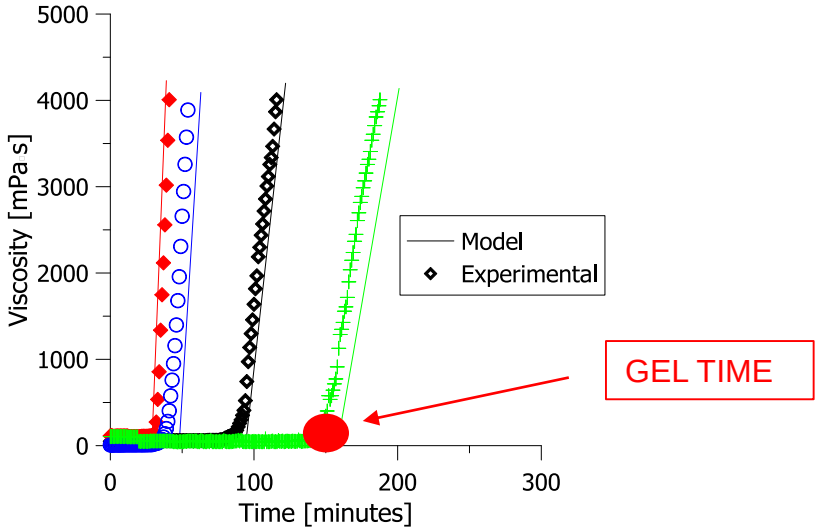
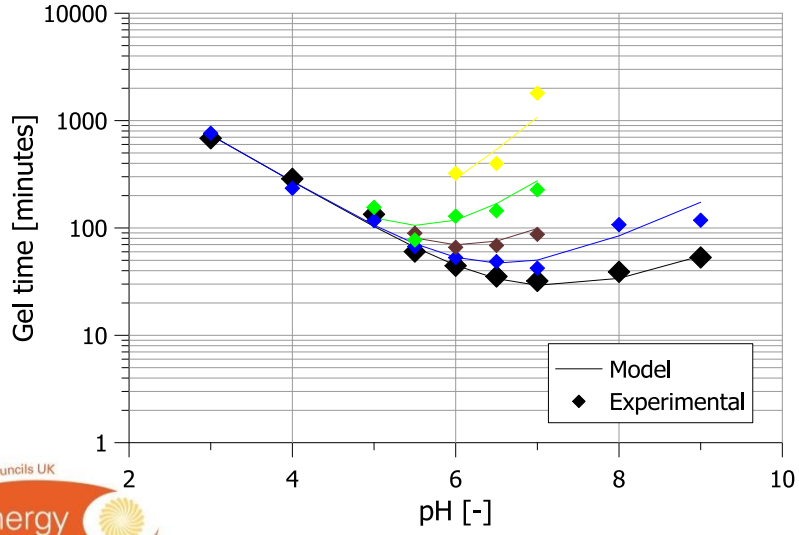
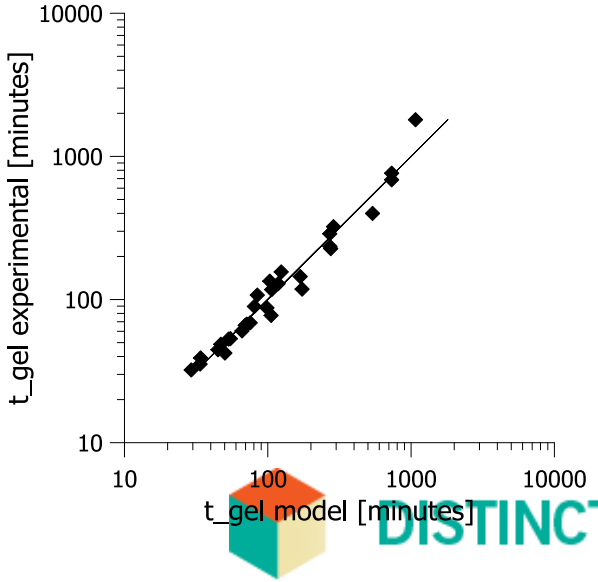
1. THE GELLING BEHAVIOUR

Pedrotti et al. (2016) – under review



Standard deviation of less than 20 minutes over a maximum experimental gel time of 1809 minutes





2. GROUT-SITE INTERACTIONS

Pedrotti et al. (2016) – under review

Salt present in the **ground** or dissolved in **groundwater** **shorten the grout gel time**

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DISTINCTIVE

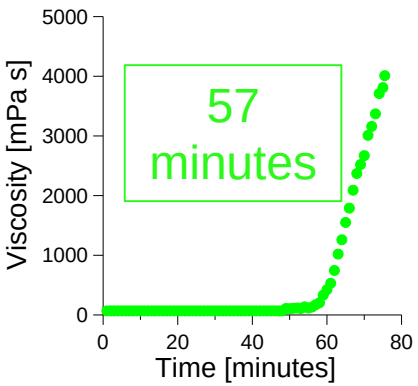
2. GROUT-SITE INTERACTIONS

Pedrotti et al. (2016) – under review

Salt present in the **ground** or dissolved in **groundwater** **<u>shorten the grout gel time</u>**

ACCELERATOR IN LABORATORY CONDITIONS

DISTILLED WATER
+
1.7 M NaCl



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DISTINCTIVE

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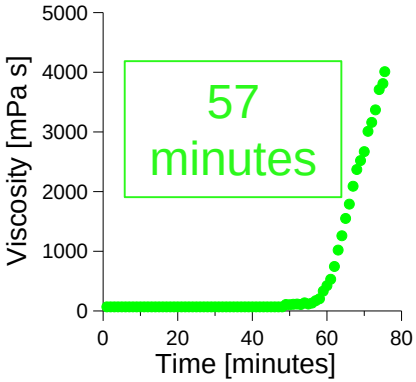
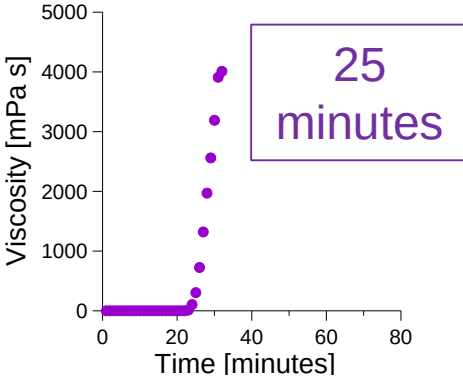
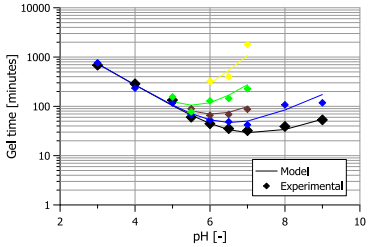


ACCELERATOR IN IN-SITU CONDITIONS

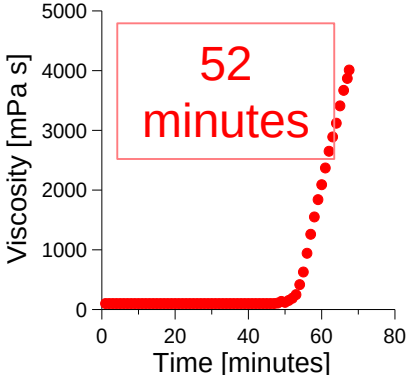
GROUND WATER
+
1.7 M NaCl



CORRECTED ACCELERATOR FOR IN-SITU CONDITIONS



GROUND WATER
+
1.1 M NaCl



2. GROUT-SITE INTERACTIONS

BATCH EXPERIMENTS

Grout injection might affect the **mobility** of **radionuclides** in the ground

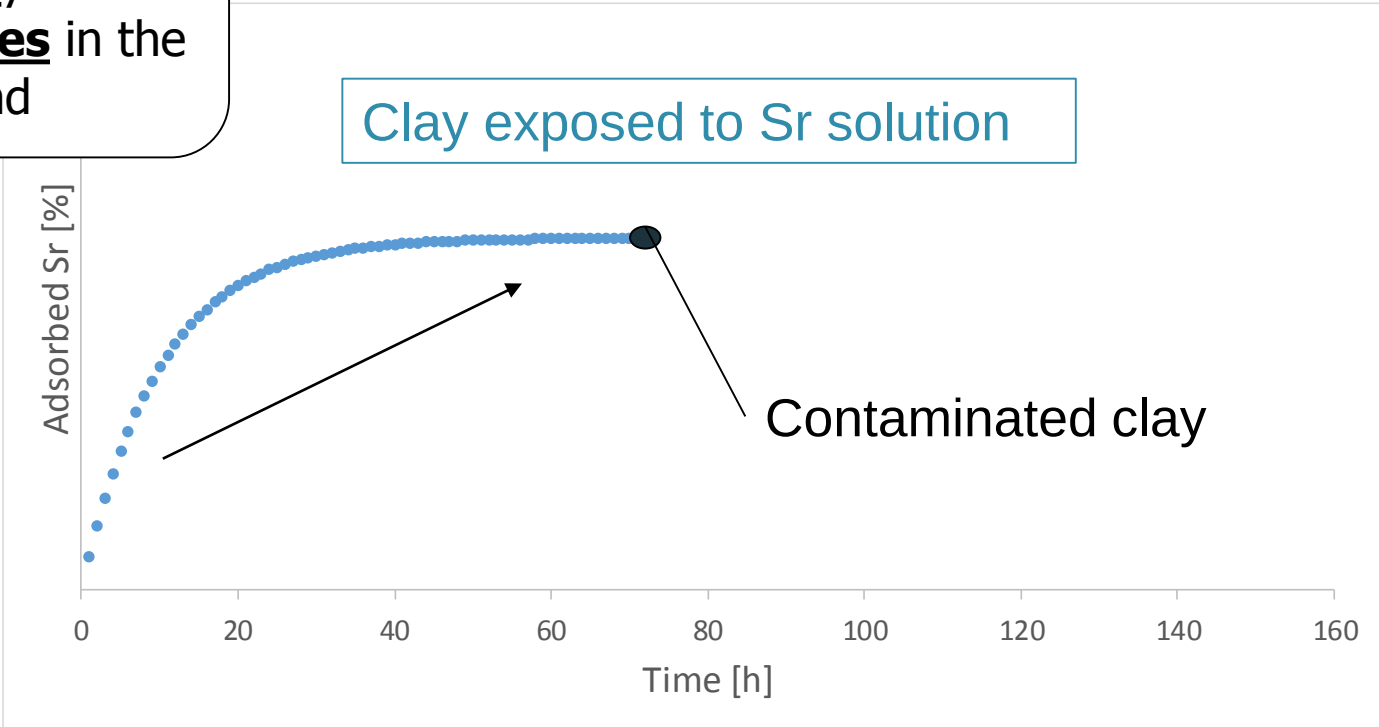
Grant awarded by DISTINCTIVE for experimental work at NNL

- Clay contamination with Sr (ad-sorption process)
- Study of Sr de-sorption, when contaminated clay is exposed to:
  - Clear water
  - Saline water
  - Colloidal silica

Tests on **cold isotopes** to be carried out at **University of Strathclyde** and tests on **hot isotopes** to be carried out at **NNL**.

2. GROUT-SITE INTERACTIONS

Grout injection might affect the **mobility** of **radionuclides** in the ground



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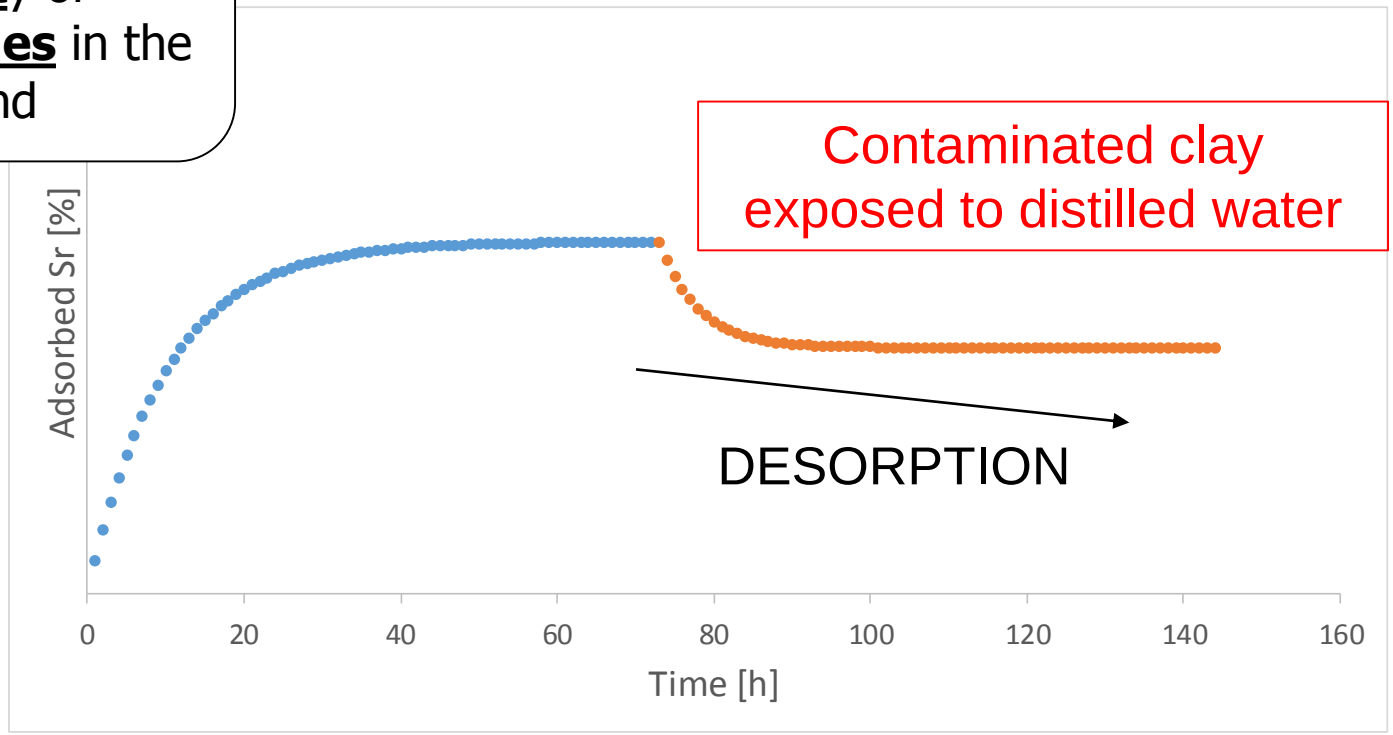

2. GROUT-SITE INTERACTIONS

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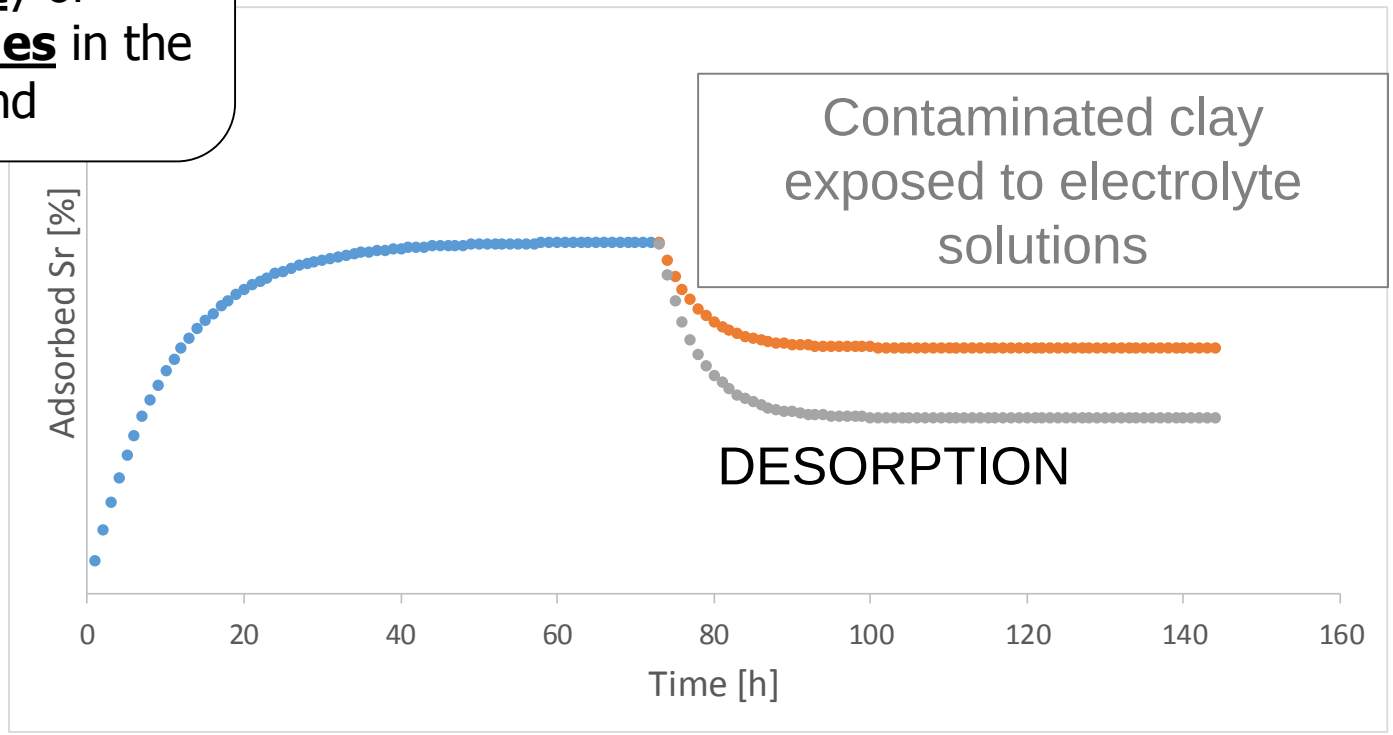
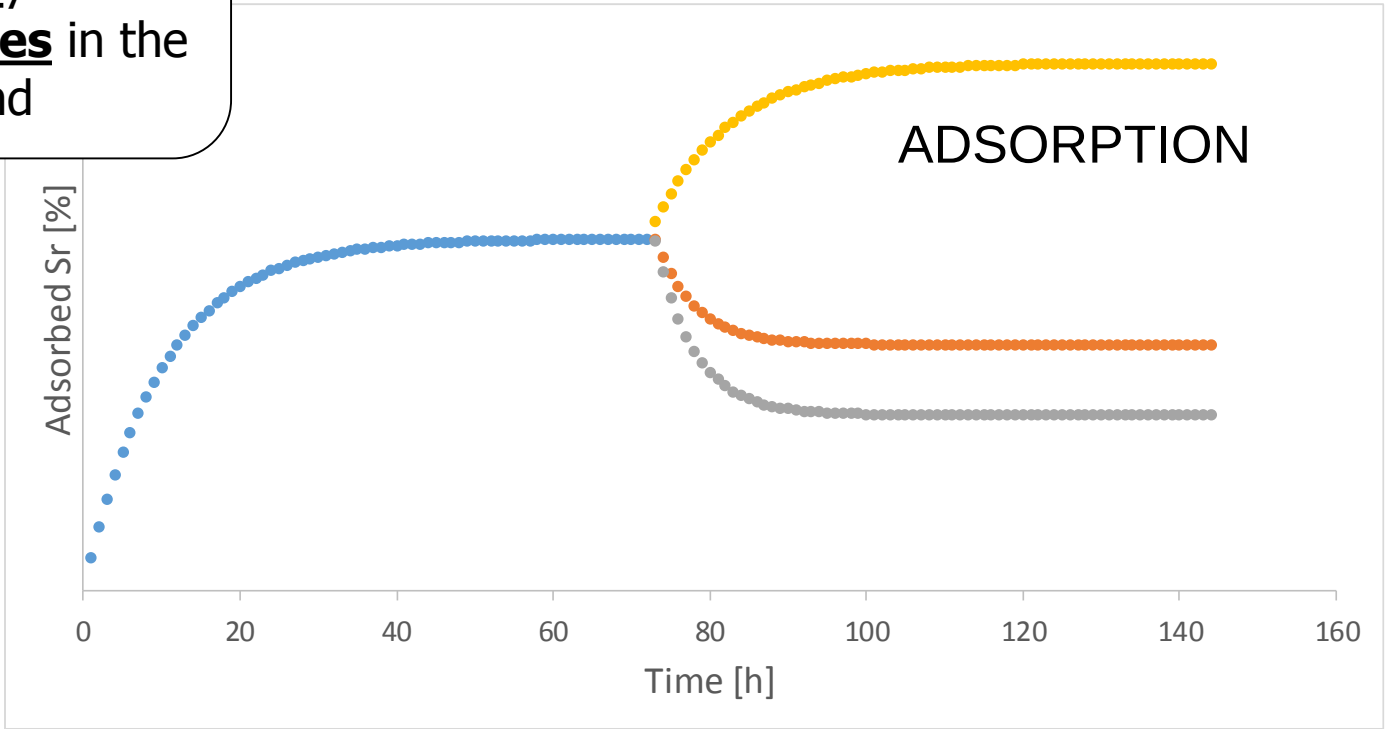


2. GROUT-SITE INTERACTIONS

Grout injection might affect the **mobility** of **radionuclides** in the ground

Contaminated clay exposed to colloidal silica



3. THE INJECTION PROCESS

DEPLOY A **FINITE ELEMENT MODEL** TO PREDICT THE **INJECTION PATHS** AND DESIGN THE **INJECTION STRATEGY**

-how to create an horizontal barrier
-fingering
-permeation distance
-required gelling time
-front effects
-.....

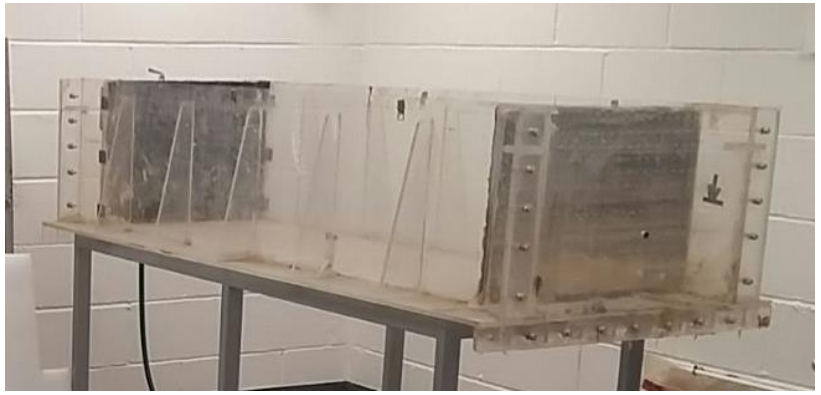
The model must consider the change in viscosity of the grout over time and «chemical changes»

The model will be calibrated by means of laboratory-scale injection tests and a final field test.

3. THE INJECTION PROCESS

Small scale experiment

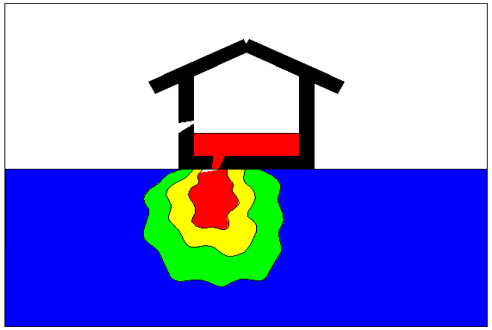
Medium scale experiment



Finite Element Model

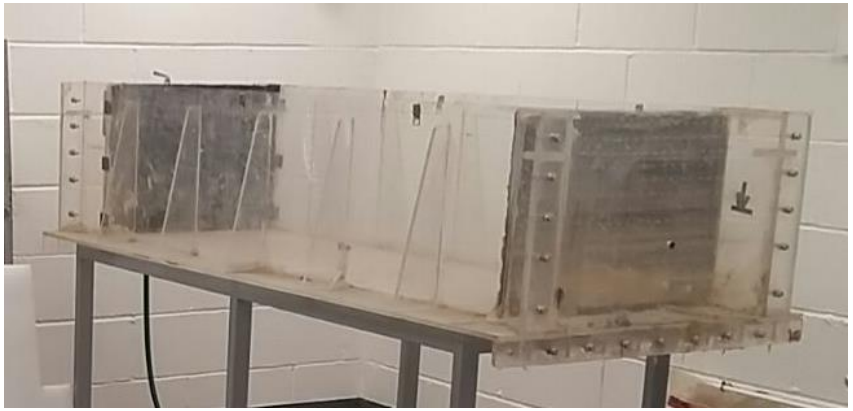
Field test

Real case



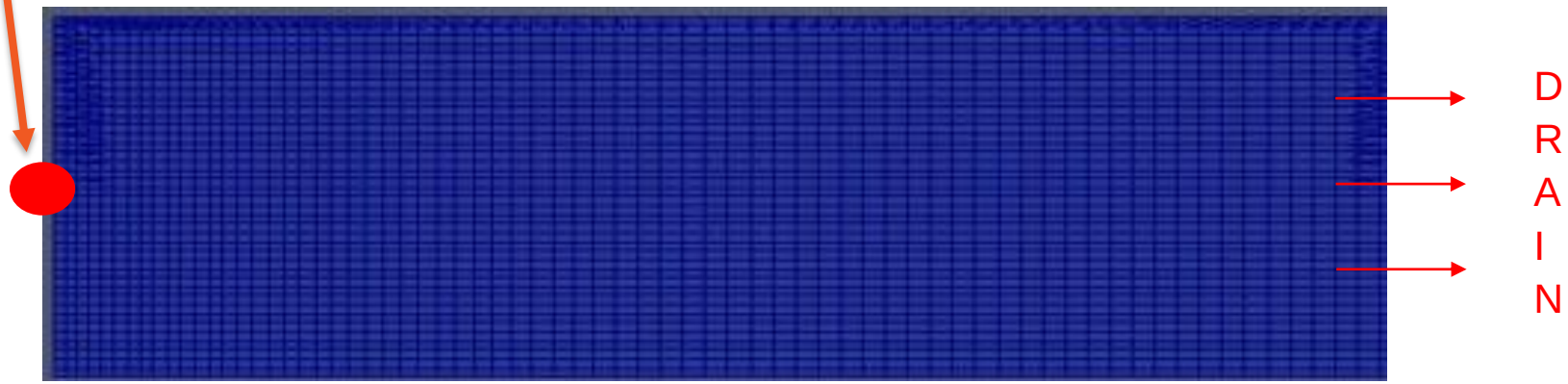
3. THE INJECTION PROCESS

INJECTION EXPERIMENT

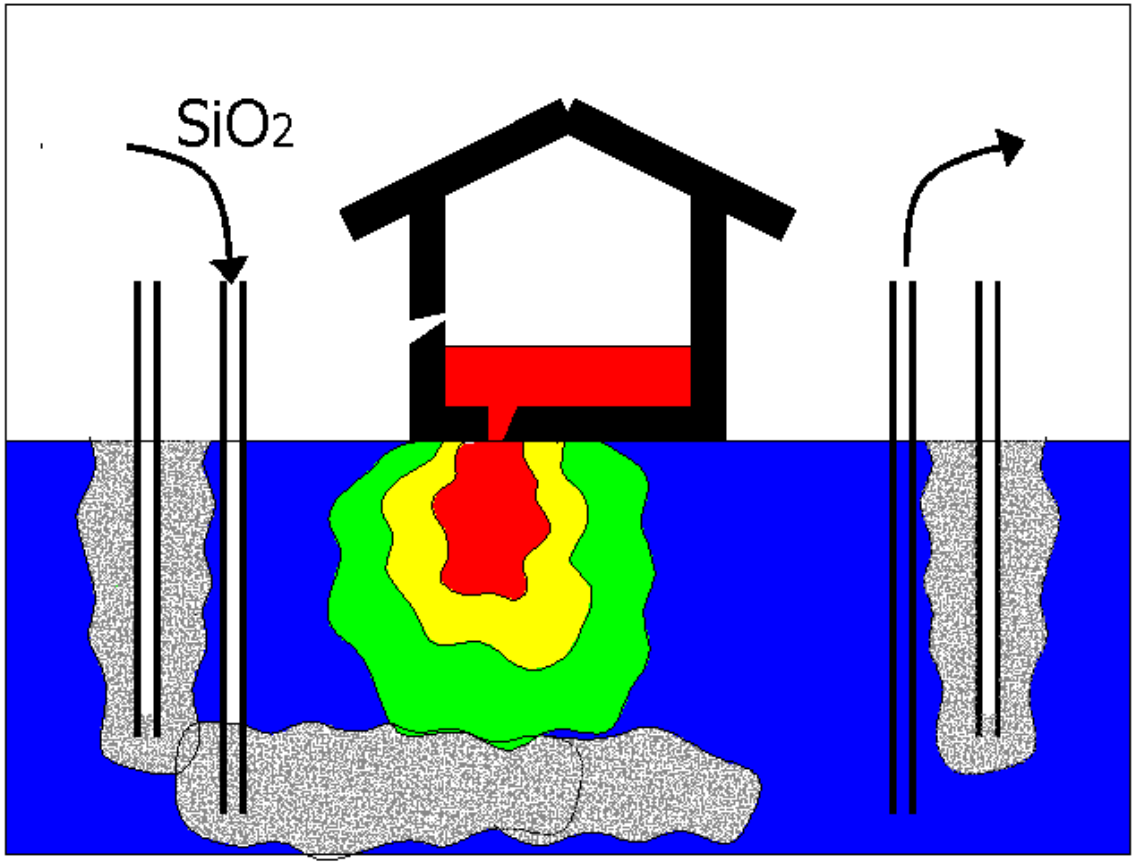


INJECTION POINT

INJECTION SIMULATION



4. THE INJECTION MONITORING



4. THE INJECTION MONITORING

Collaboration with **BGS** for injection monitoring by means of **Electrical Resistivity Tomography (ERT) technique**.

Preliminary test to check whether it is possible to **detect colloidal silica**

Collaborative trials with Dr Oliver Kuras, Geophysical Tomography, British Geological Survey (www.bgs.ac.uk/research/tomography)

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BGS 1835 British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL

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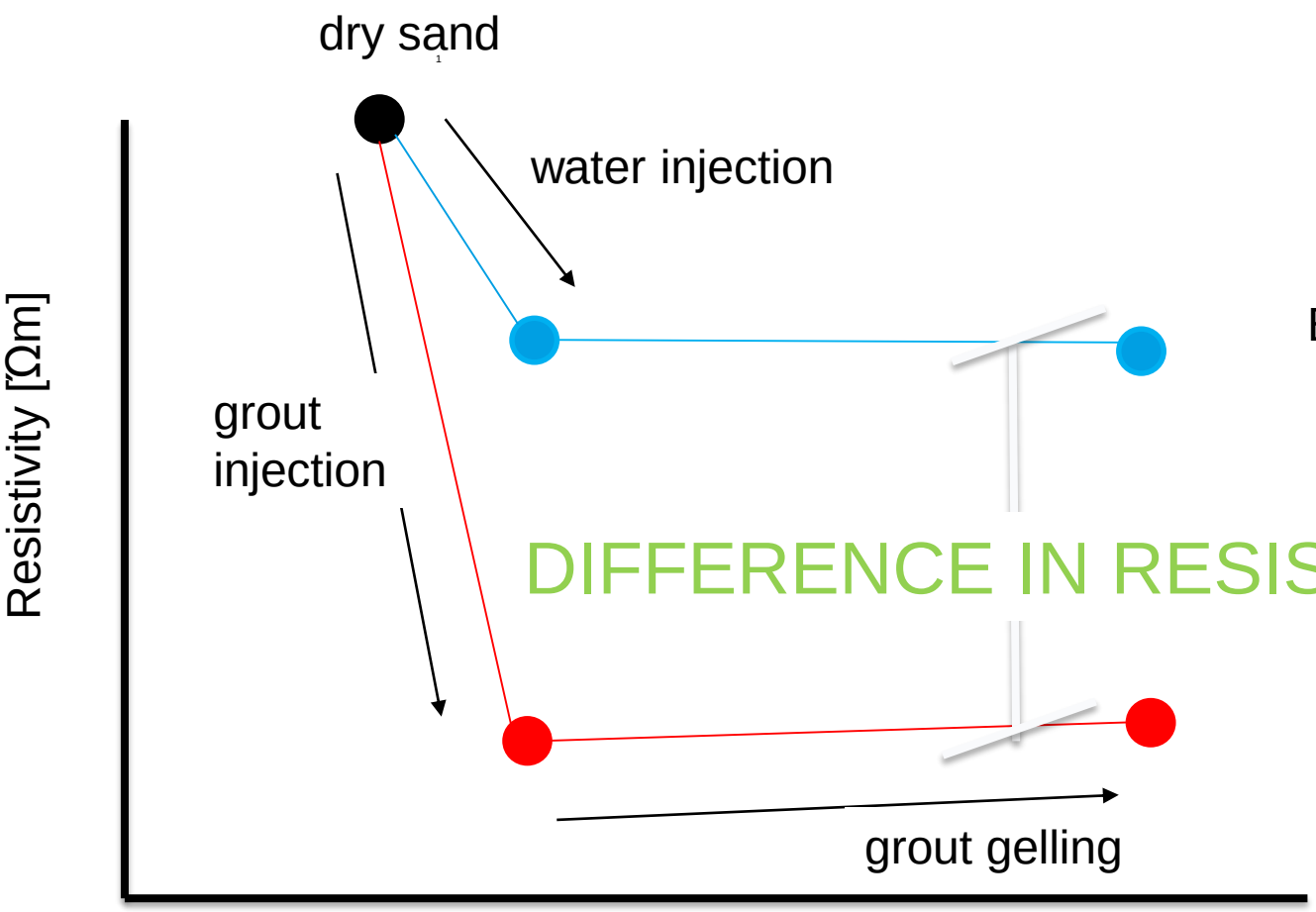
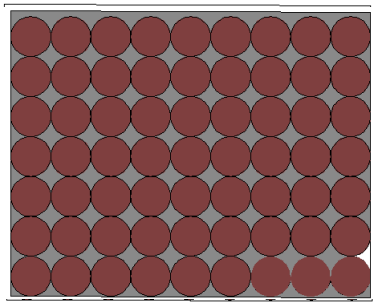
4. THE INJECTION MONITORING





Box with grouted sand

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British Geological Survey
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5. GEOTECHNICAL CHARACTERISATION

This topic will be presented by Christopher Wong in the next presentation

GROUTED SAND

CONCLUSIONS

COLLOIDAL SILICA GROUT

1. Gelling behaviour 
2. Grout-site interactions 
3. The injection process 
4. Injection monitoring 
5. Geotechnical characterisation 

SITE APPLICATIONS

THANKS