

Impermeable boreholes for High Temperature BTES

Tony Jernström, Geobatteri AB

José Acuña, Bengt Dahlgren AB

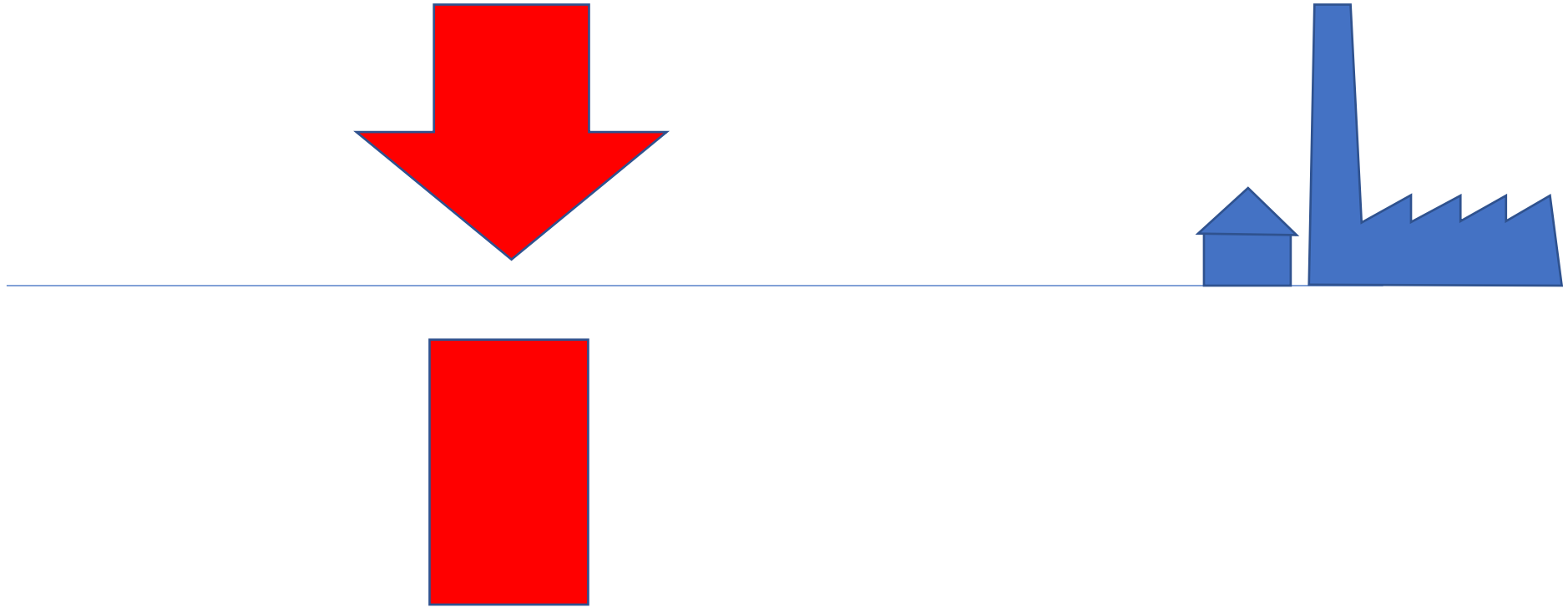
Project deliverables

1. Literature study about borehole wall permeability
2. Comparison of possible drilling and grouting screen methods
3. Fully documented measurement campaigns in two different boreholes

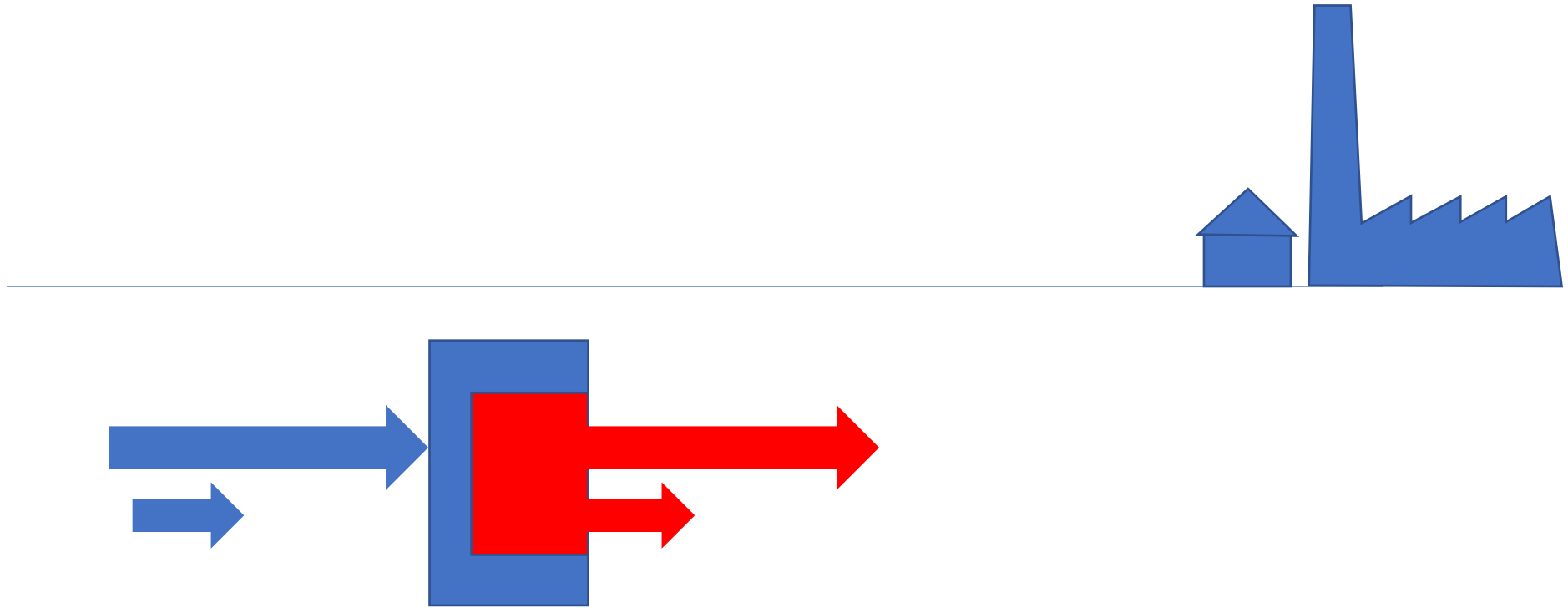
Project period: 2018-06-01 – 2020-06-30

Store temperature in Bedrock...

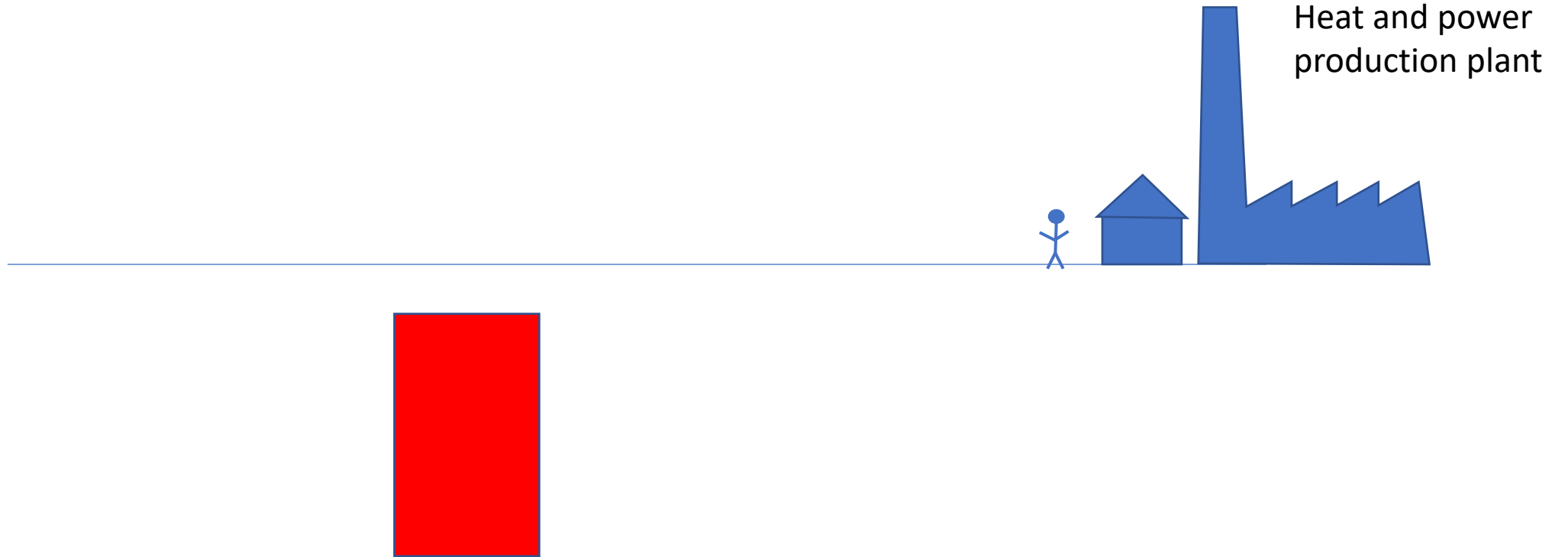




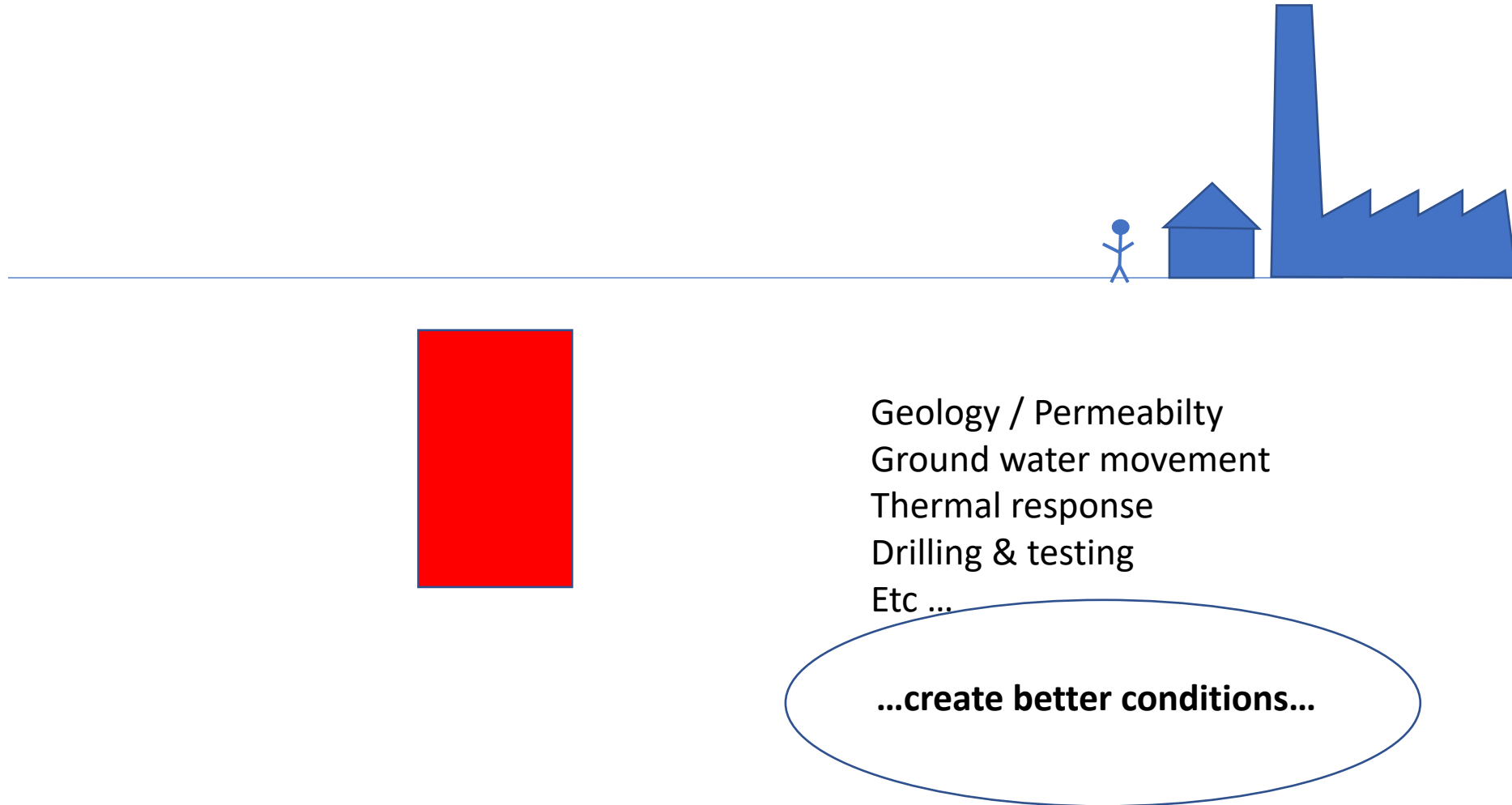
... Threats over time



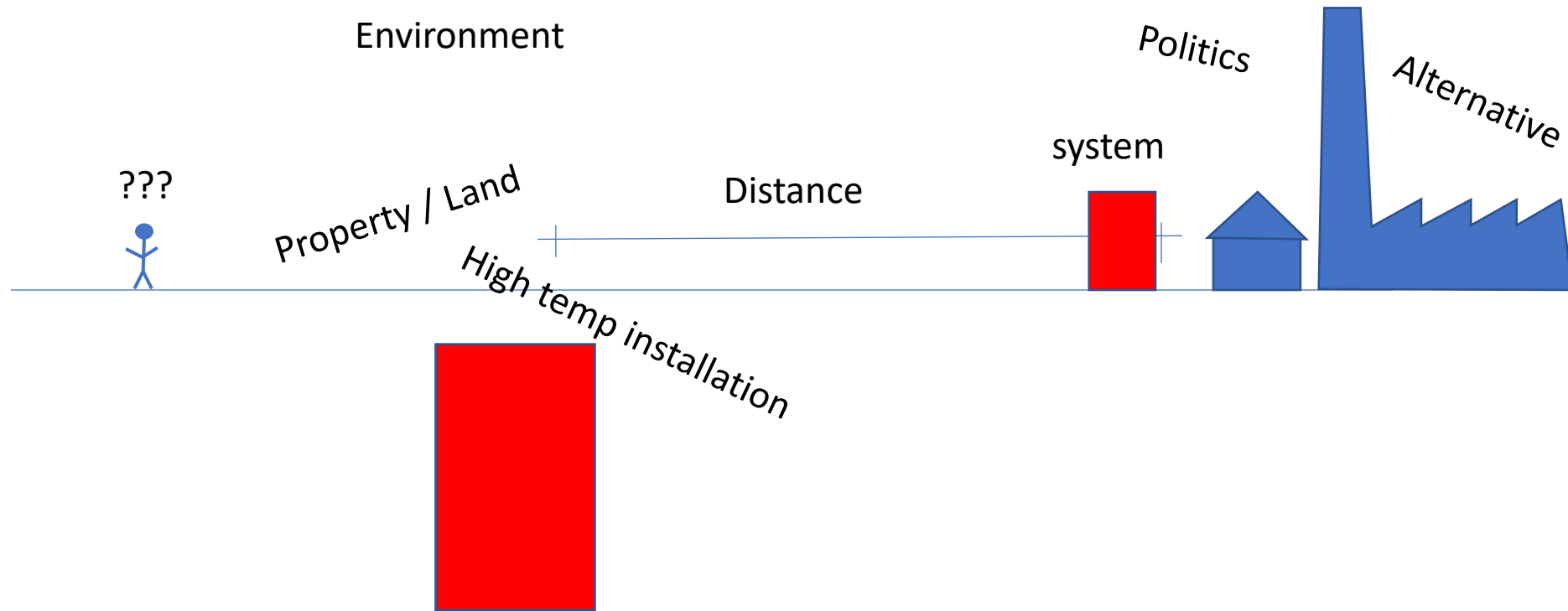
Good conditions for storage of temperature ?



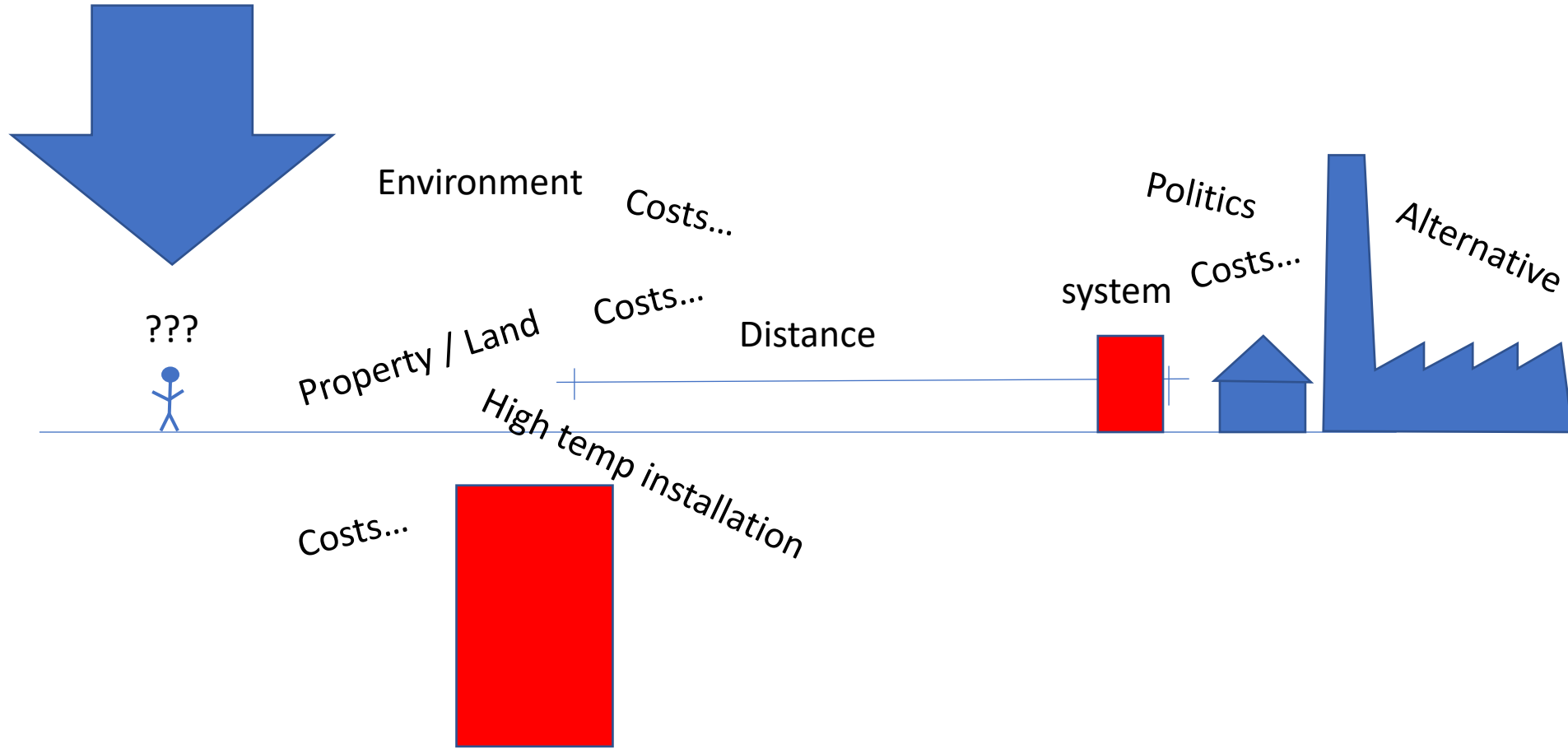
Good conditions for storage of temperature



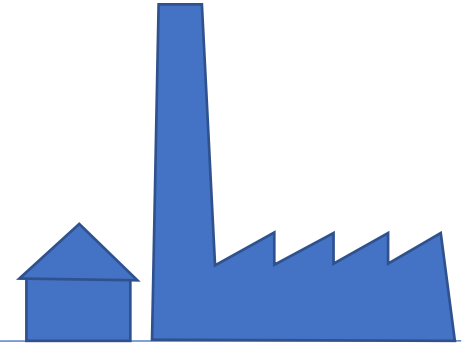
... and of course ...



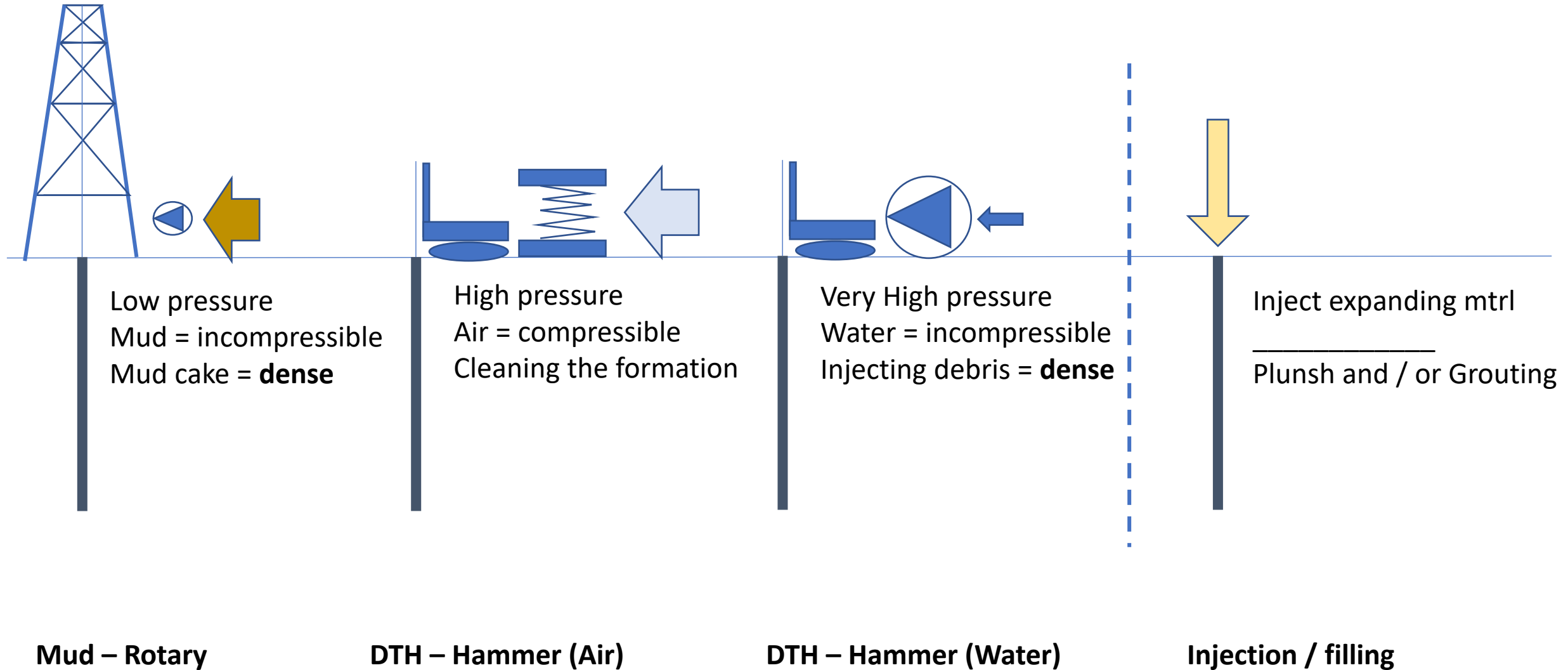
... Henrik's Problems ☺ ...



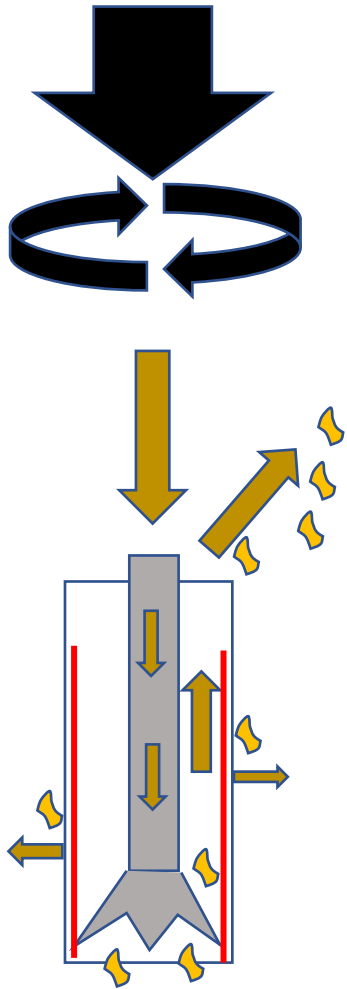
Phase 1
Test boreholes / Survey



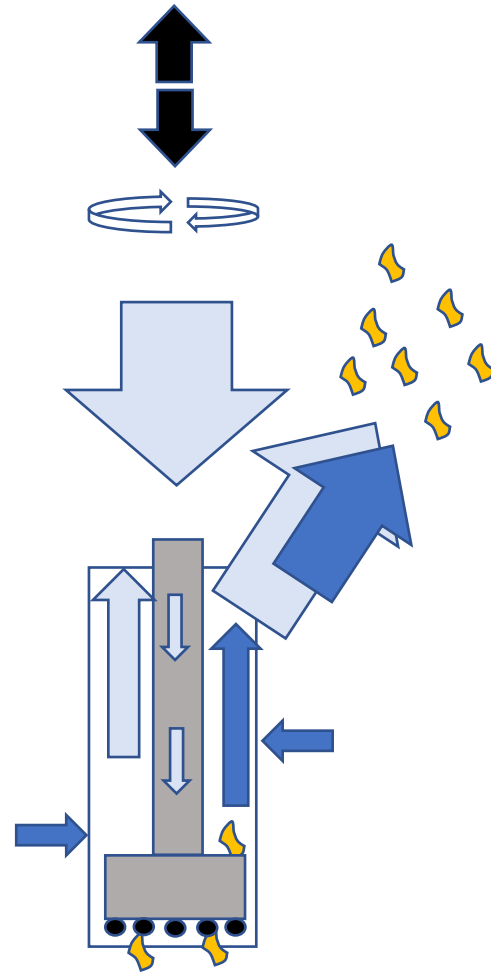
Drilling technique



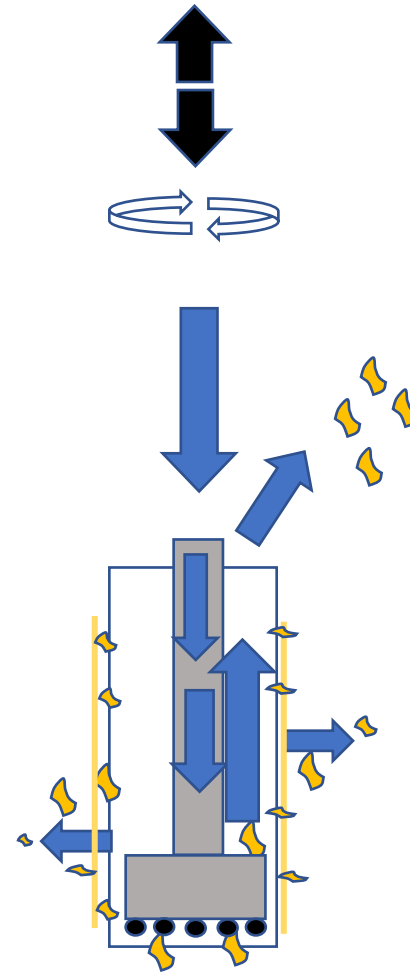
Drilling technique



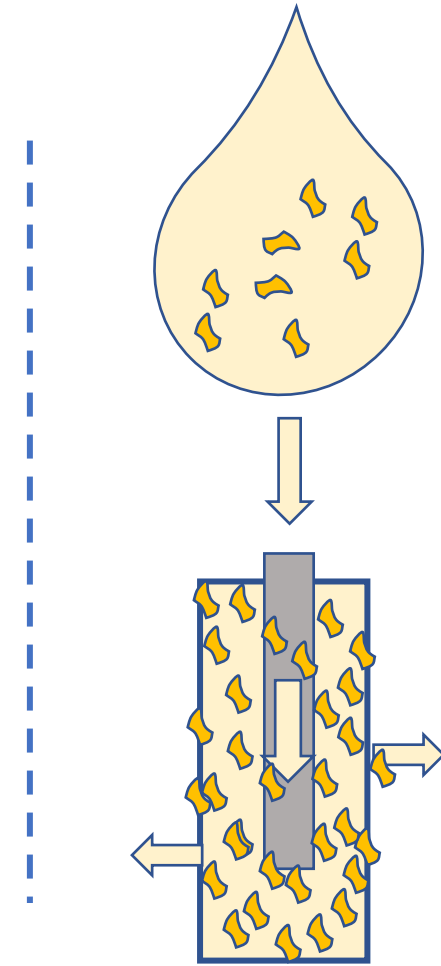
Mud – Rotary



DTH – Hammer (Air)

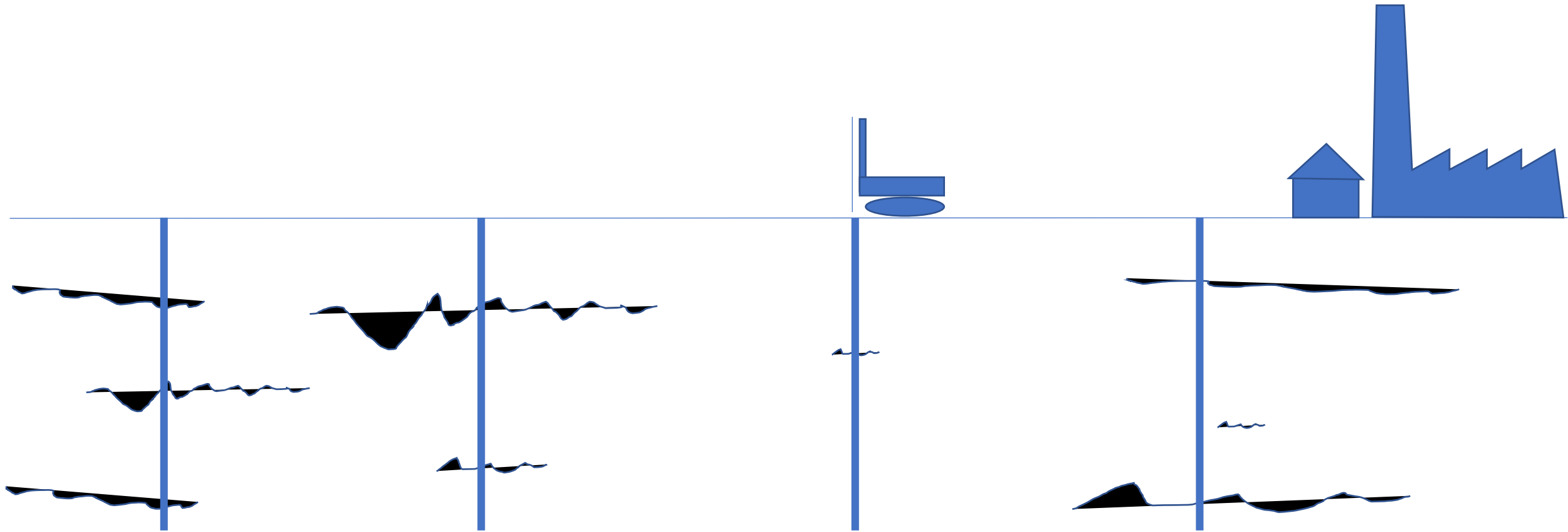


DTH – Hammer (Water)



Injection / filling

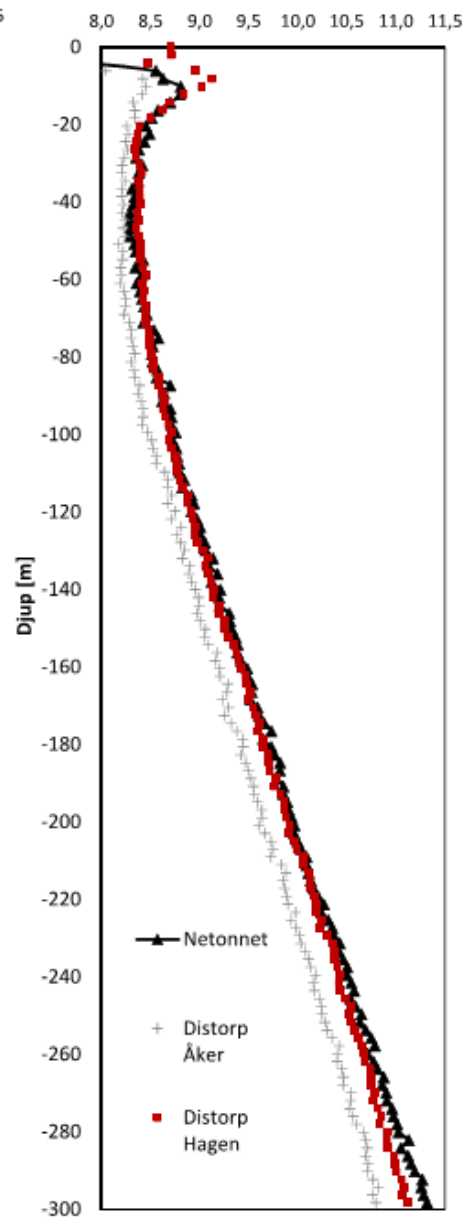
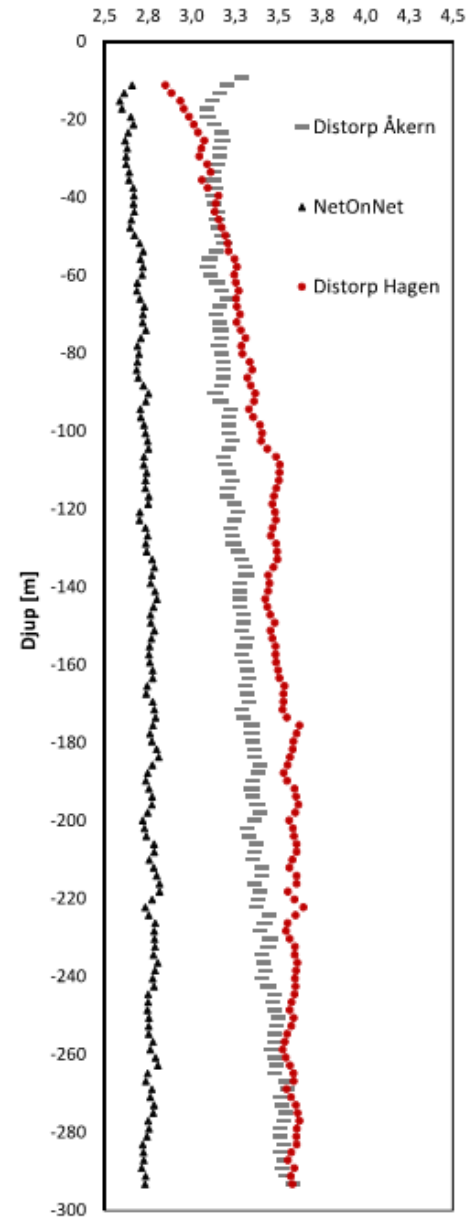
Test boreholes / Measurements





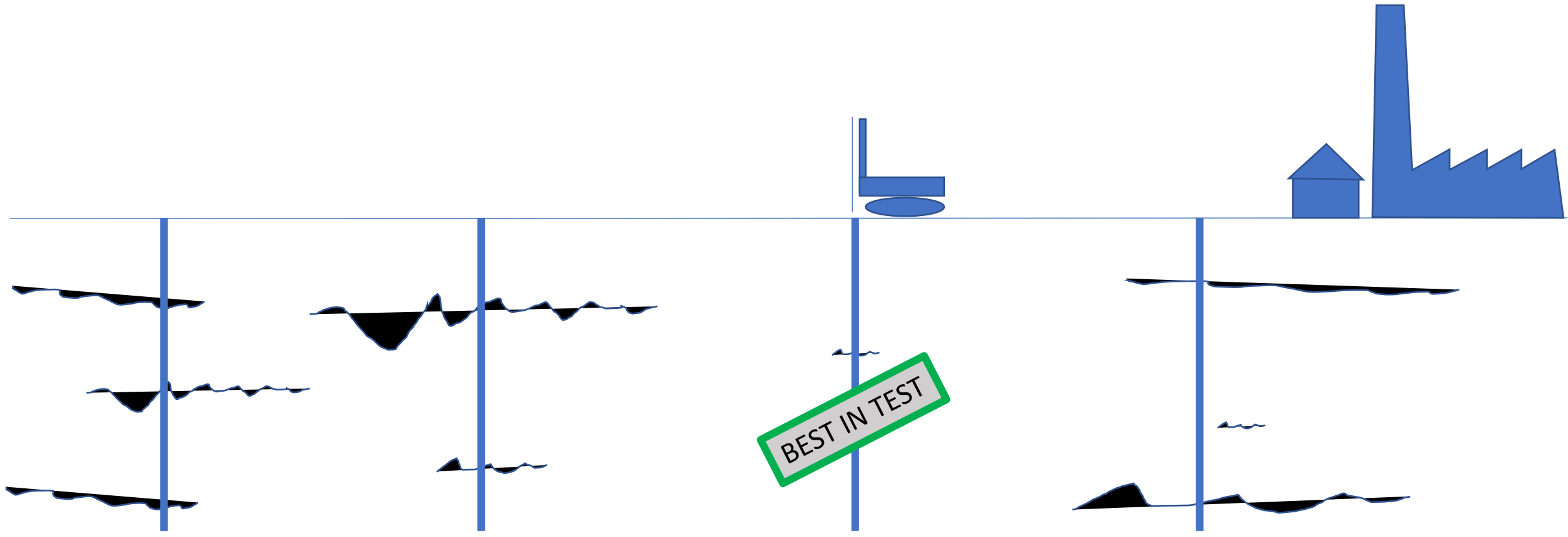
Thermal conductivity W/mK

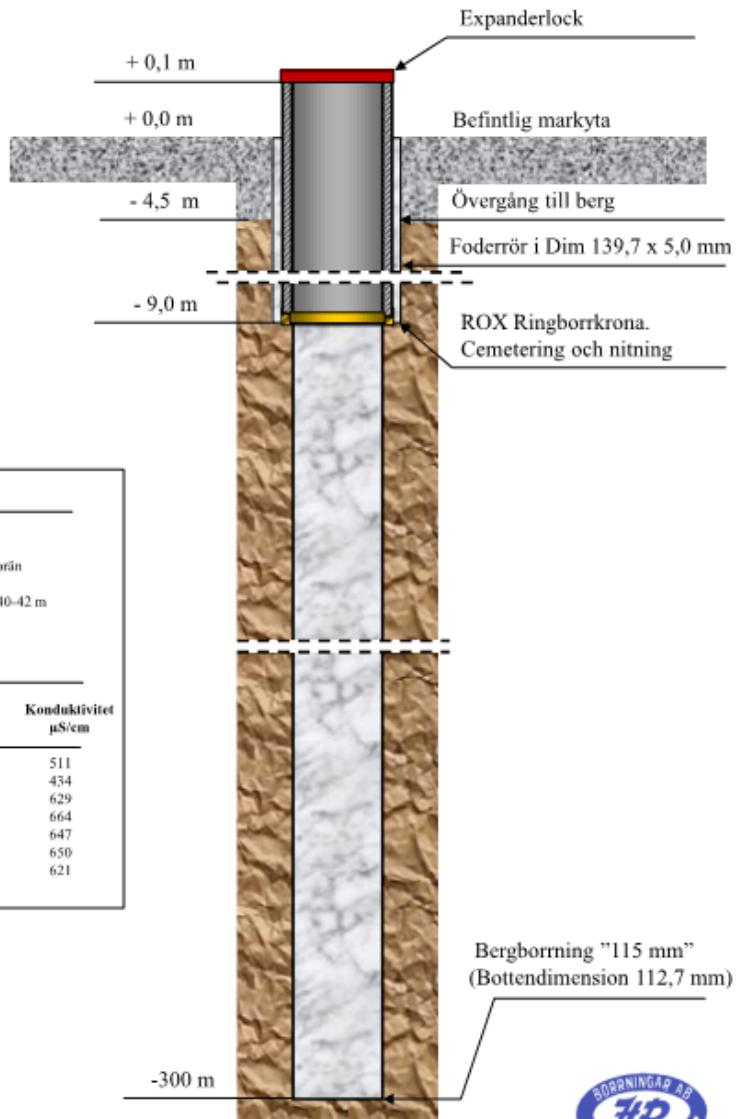
Temperature C



Drill cuttings



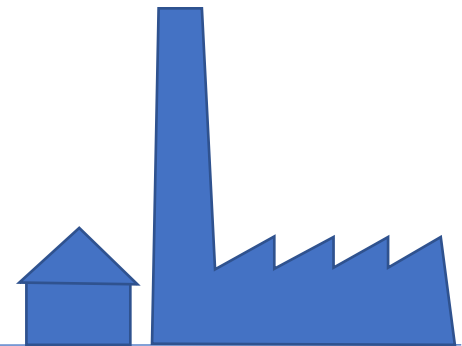
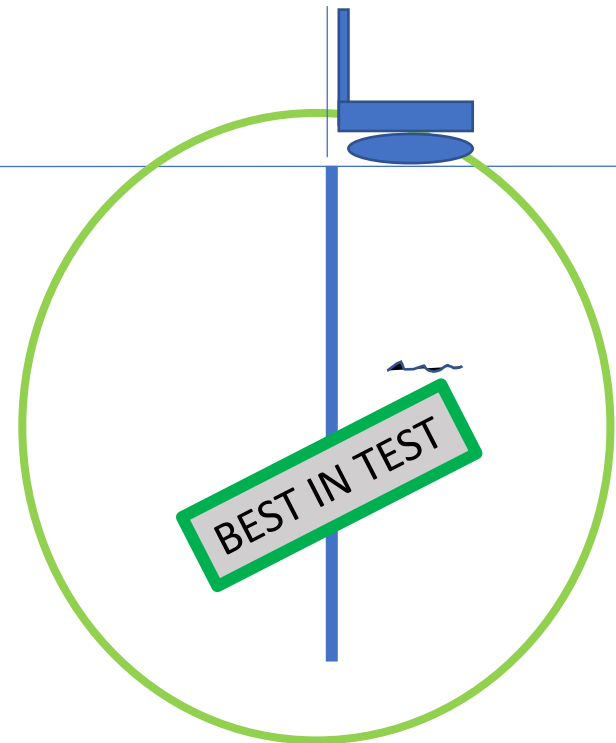




Geologisk Kartering:

0 – 0,5 m	Jord, sand
0,5 – 4,5 m	Sandig, grusig morän
4,5 – 42 m	Röd granit
	Något vittrat vid 40-42 m
42 – 76 m	Grå granit
76 – 136 m	Röd granit
136 – 300 m	Rödgrå granit

Djup m	Flöde l/min	Konduktivitet µS/cm
79	1	511
103	1-2	434
151	15	629
183	15	664
204	25	647
267	25	650
300	25	621

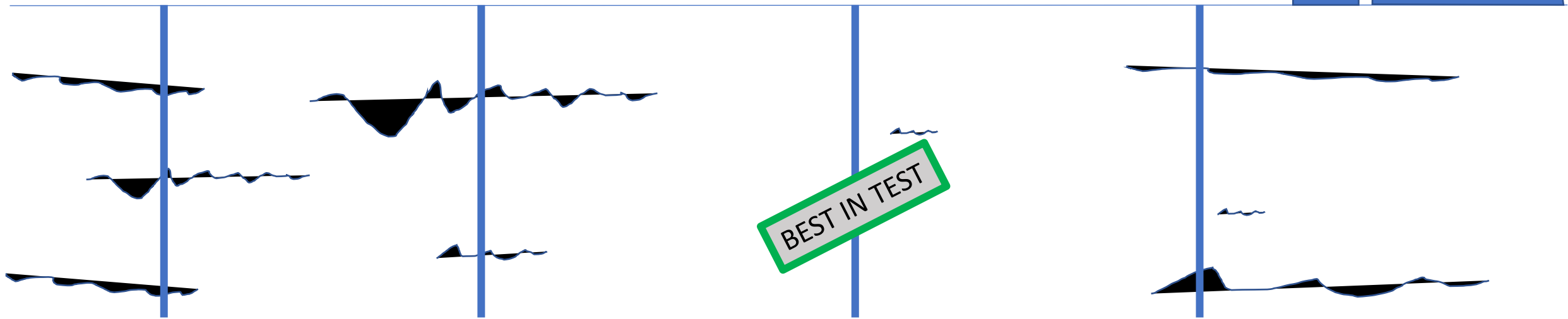


- Anmärkningar:**
- 1) Alla djup anges i förhållande till omgivande markyta
 - 2) Uppmätt vattenflöde vid uppblåsning med blåsning 25 l/min.
 - 3) GVY efter avslutad borrning var 3,0 m u.m.y. mätt 7 dygn.
 - 4) Geologisk samt övrig data är förenklad i denna presentation. All presenterad information är bedömd i fält utav borroperatören. För mer detaljerad data kontakta HP Borringar.
 - 5) Provtagning utförd var 3:e meter.
 - 6) Borrning utförd 2017-10-30 till 2017-10-31

BRUNNSRITNING FÖR: Brunn 5 – Hagen Distorp, Linköping
Tekniska Verken GPS:RT 90 x: 6480274 y: 1492054
Bengt Dahlgren

Datum: 2017-11-02	Beskrivning: Bergborrad brunn
Uppförd: Patrik Fernbrant HP Borringar AB	A) Foderörs-borrning dim 139,7 x 5,0 mm till övergång och ner i fast berg. Därefter cemetering och nitning av borsko. B) Bergborring i dimension "115 mm" till TD. C) Borrning avslutades med blåsning och rensning av borrhålet.
Fältansv: Jonas Jansson Stares Brunn- borringar	

Phase 2
Drilling technique / after-service
Hunt for “impermeability”



Drilling Technique

A) DTH – Hammer (Air)



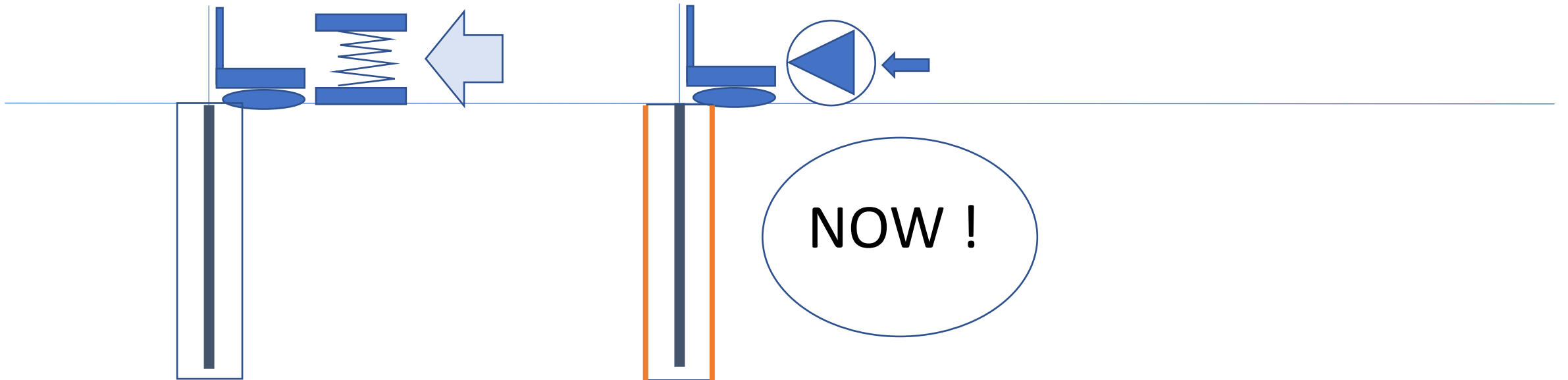
Lots of information

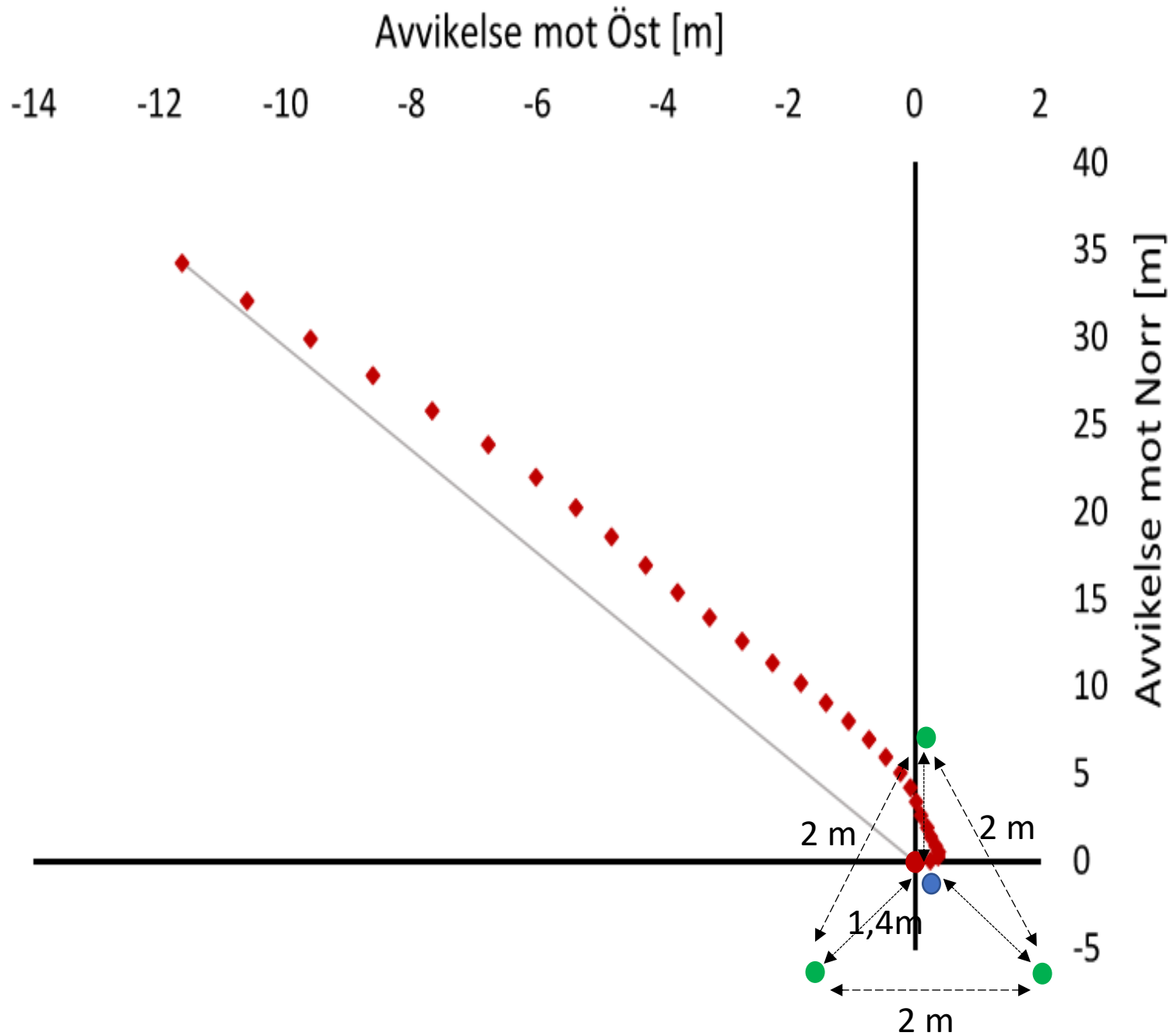


Comparing boreholes drilled with two different drilling techniques

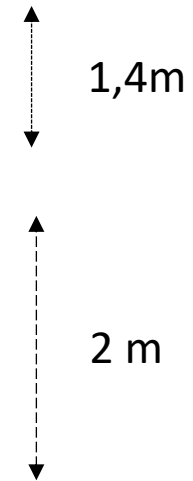
A) DTH – Hammer (Air)

B) DTH – Hammer (Water)





- New borehole
- Existing borehole (Air DTH)
- Observation well

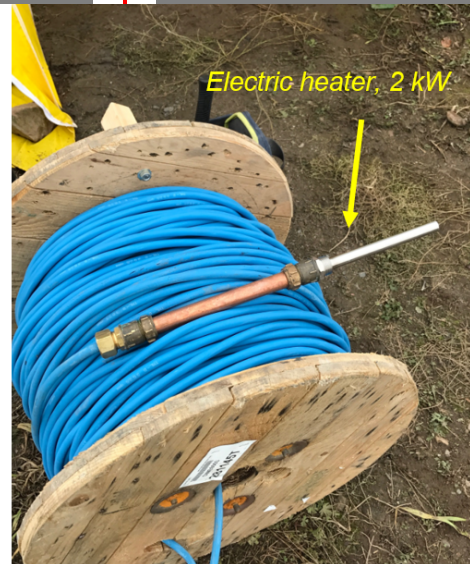
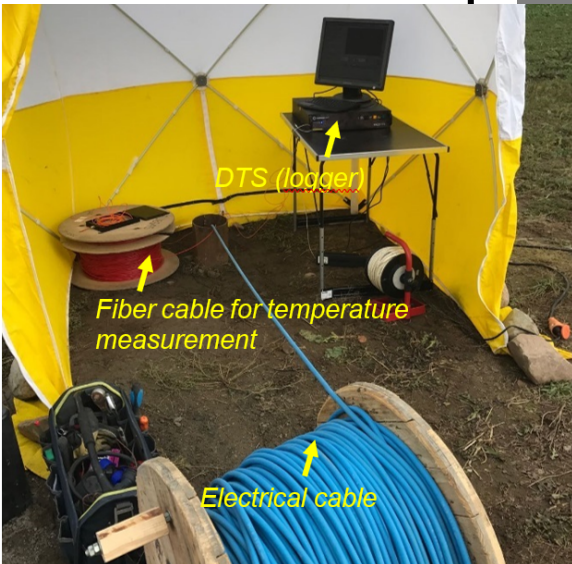
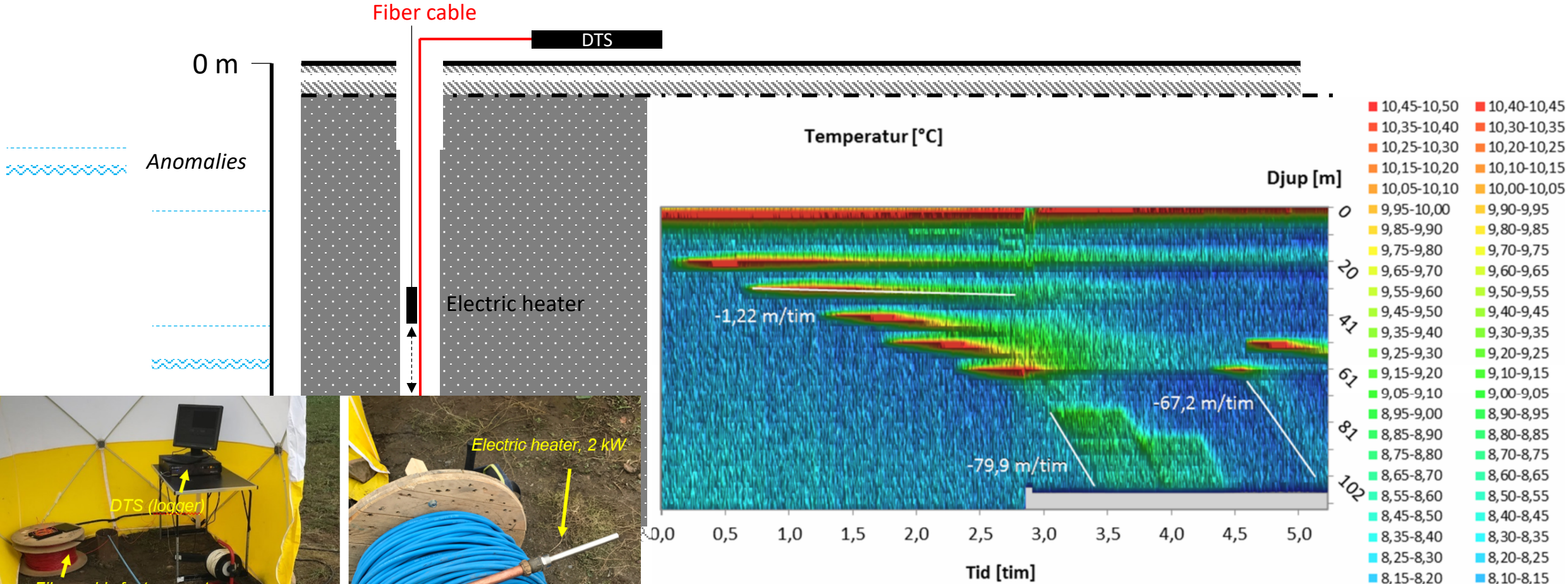




Video Logging for qualitative comparison of borehole wall structure

<https://www.youtube.com/watch?v=f3tnFHwNI8A>

Vertical water movement identification, heat tracing

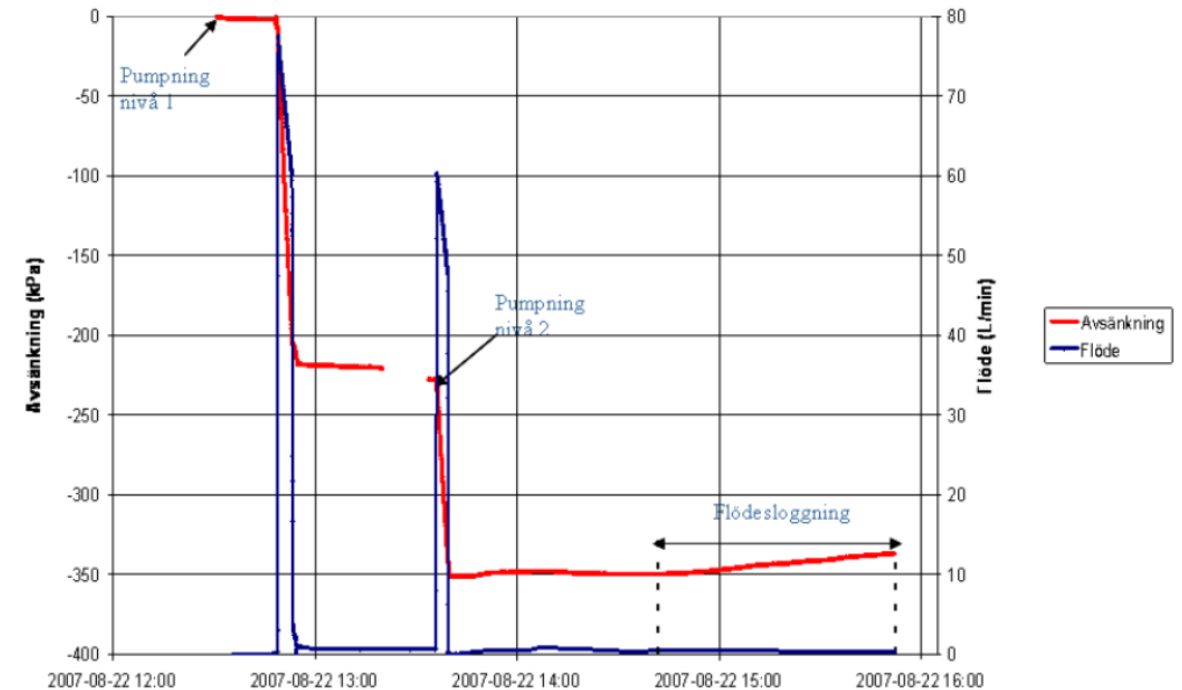
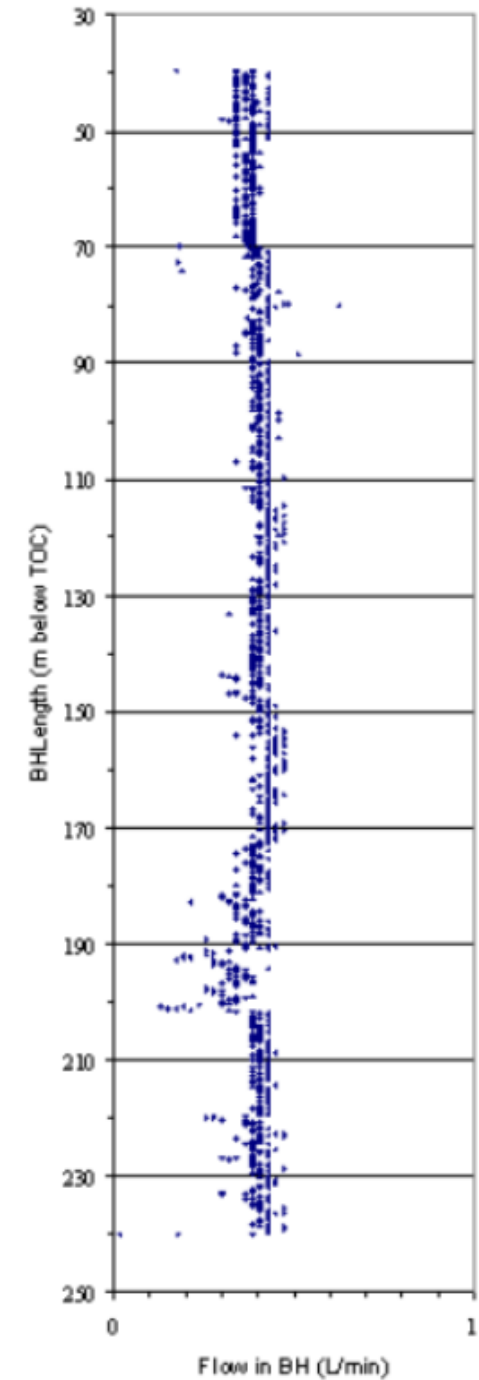
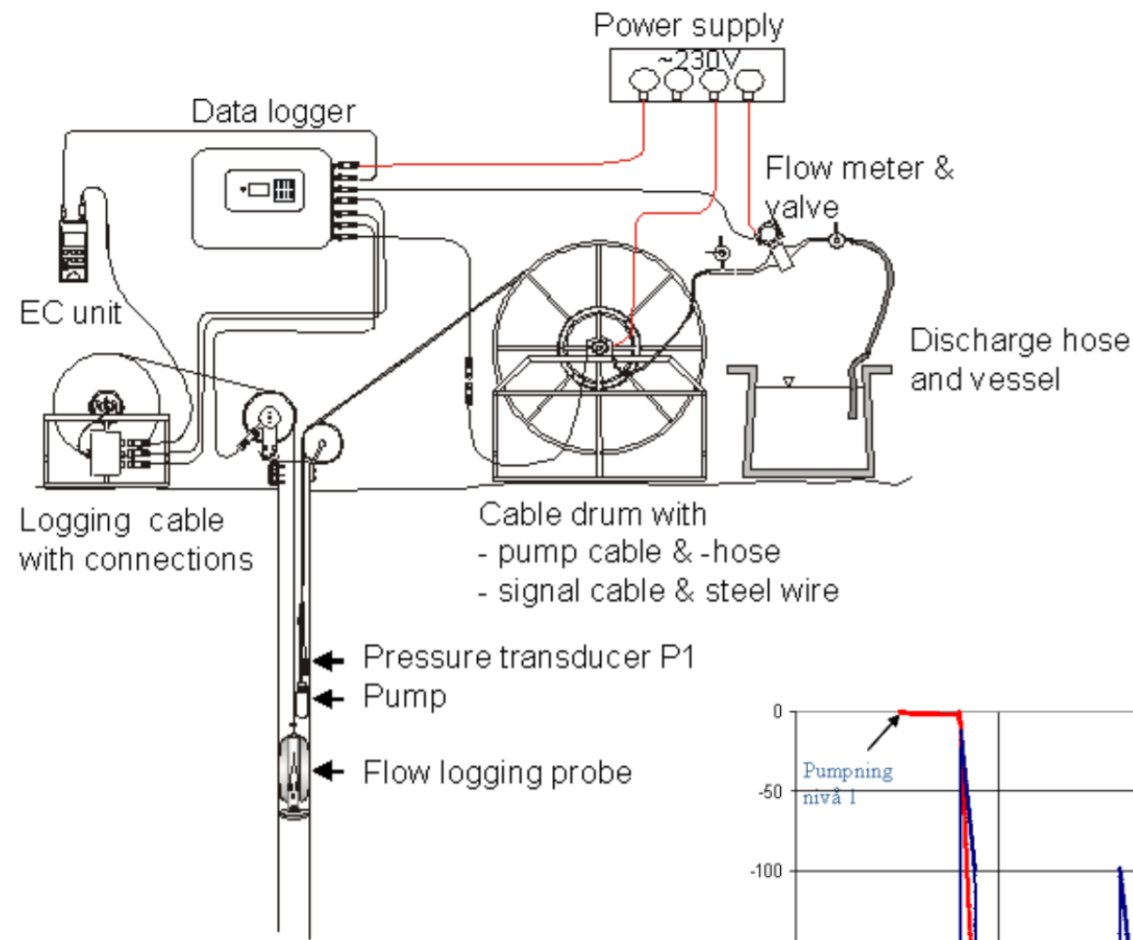


Pumping and pressure test

- Extracting and infiltrating water
- Infiltration at different pressure levels



Flow logging



Flow logg -> flow in fractures

Pressure test -> permeability vs. pressure

Heat tracing -> vertical water flow

Drilling technique -> costs vs permeability



VLT -> understanding

Pump test -> hydraulic conductivity and drawdown vs flow

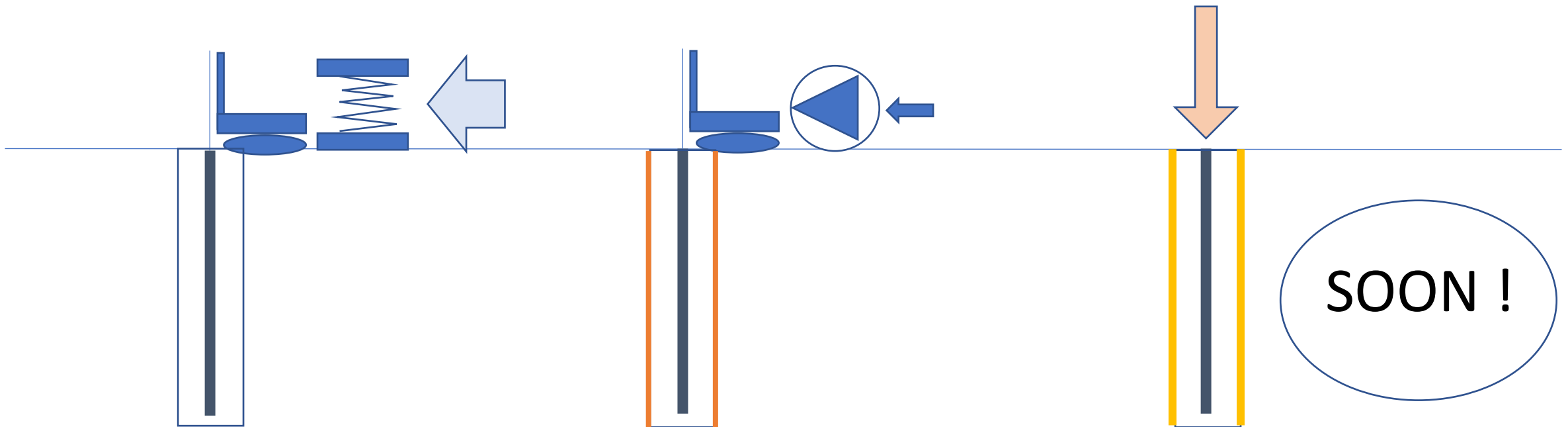
Deviation measurement -> geometrical constrains for grouting screening

Drilling Technique

A) DTH – Hammer (Air)

B) DTH – Hammer (Water)

C) Injection / filling

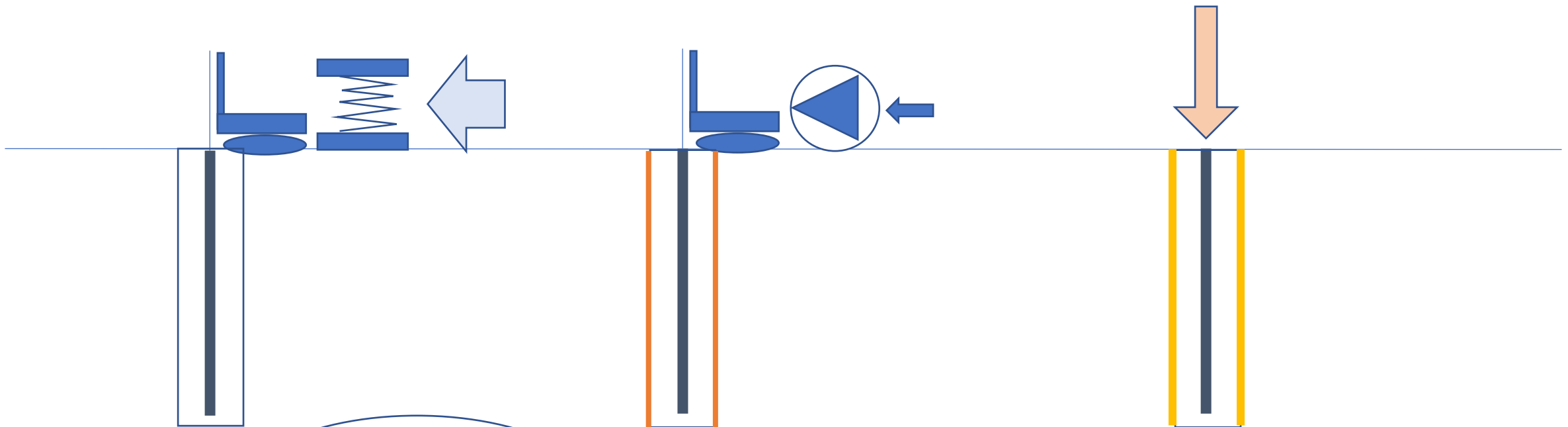


Drilling Technique

A) DTH – Hammer (Air)

B) DTH – Hammer (Water)

C) Injection / filling



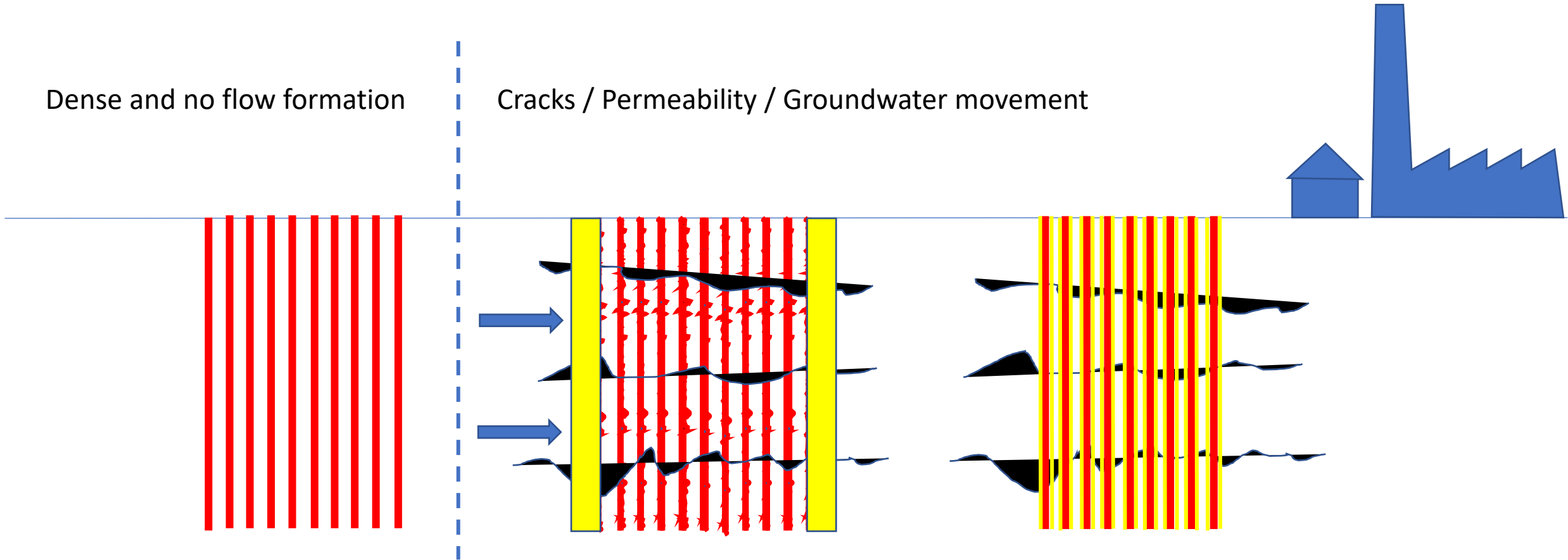
EVALUATE !

- Borehole wall permeability

NEED OF GROUTING SCREEN ?

Dense and no flow formation

Cracks / Permeability / Groundwater movement



Create boundaries / walls

or

Create impermeable boreholes

Thank you!

Tony Jernström, Geobatteri AB
José Acuña, Bengt Dahlgren AB