



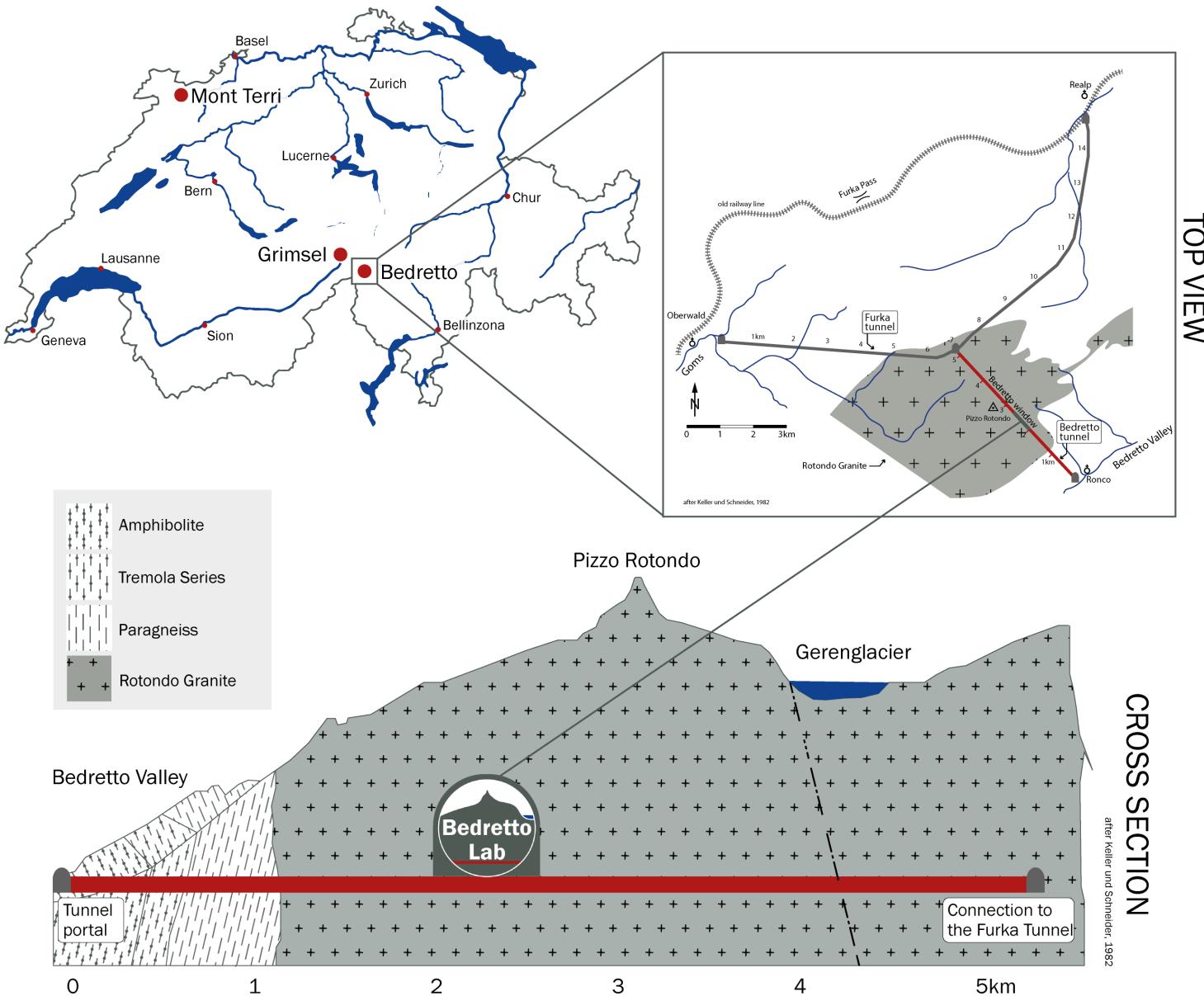
Reservoir creation in crystalline rock - the Bedretto experiment

Dr. Marian Hertrich
Lab Manager
02.11.2020, SCCER annual conference

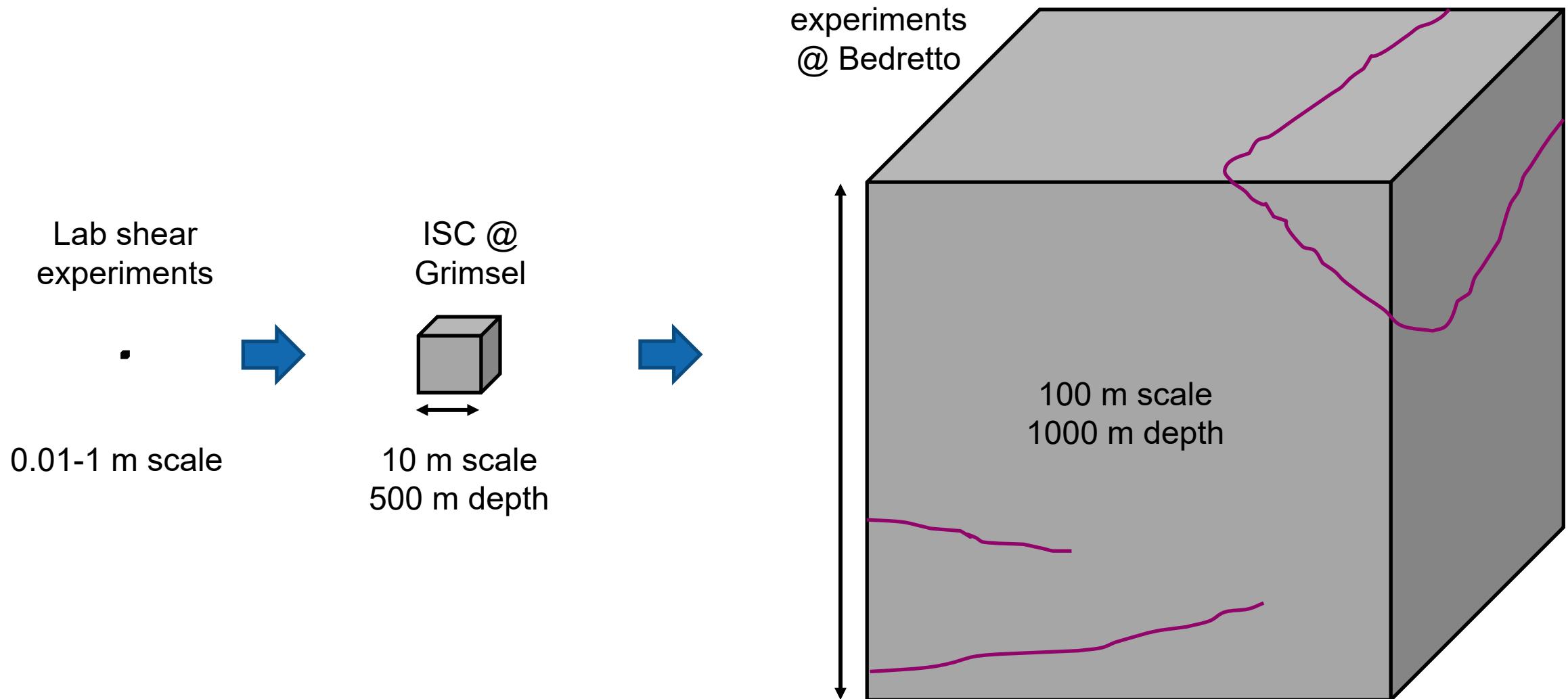


Werner Siemens Foundation, 2019 (Image: Felix Wey).

Situation



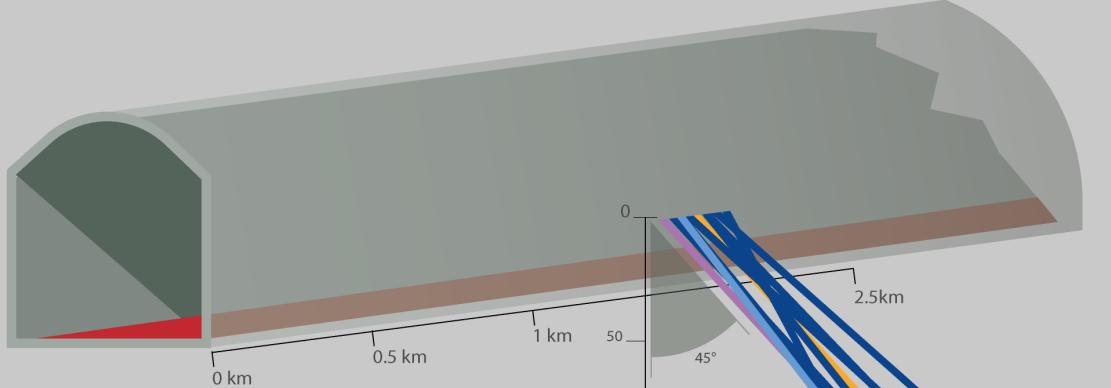
Climbing up the stairs: We are ready for the next step...



The Bedretto Reservoir Project – three joint experiments

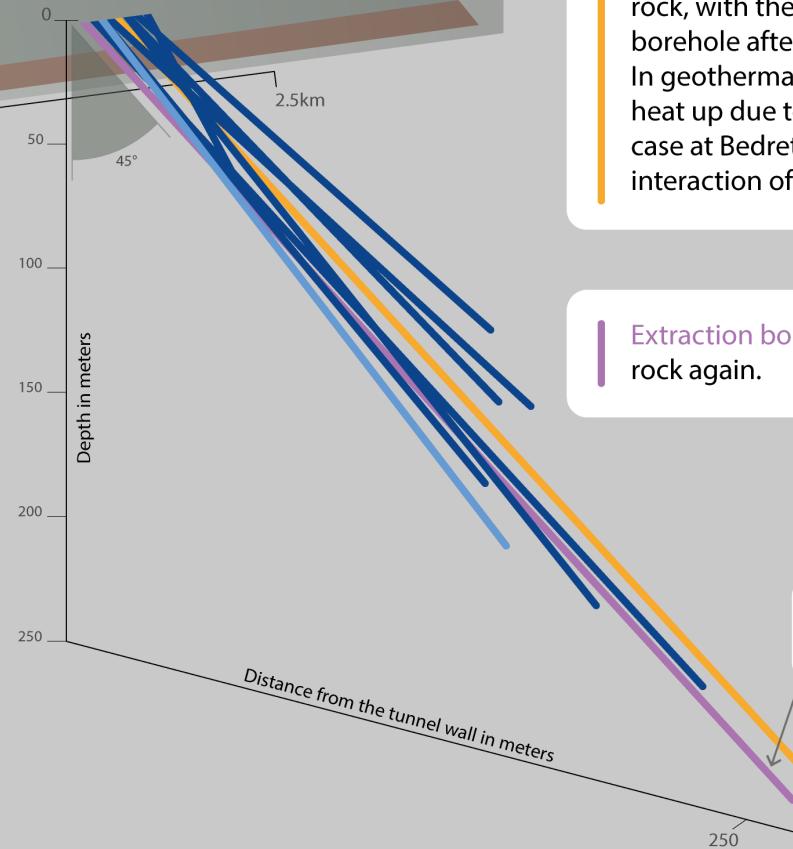


Types of boreholes at the Bedretto Lab



Monitoring borehole: Holds the various instruments we need to observe the processes in the rock. After instrumentation, we fill the boreholes completely with cement so that the measuring instruments sit still in the rock.

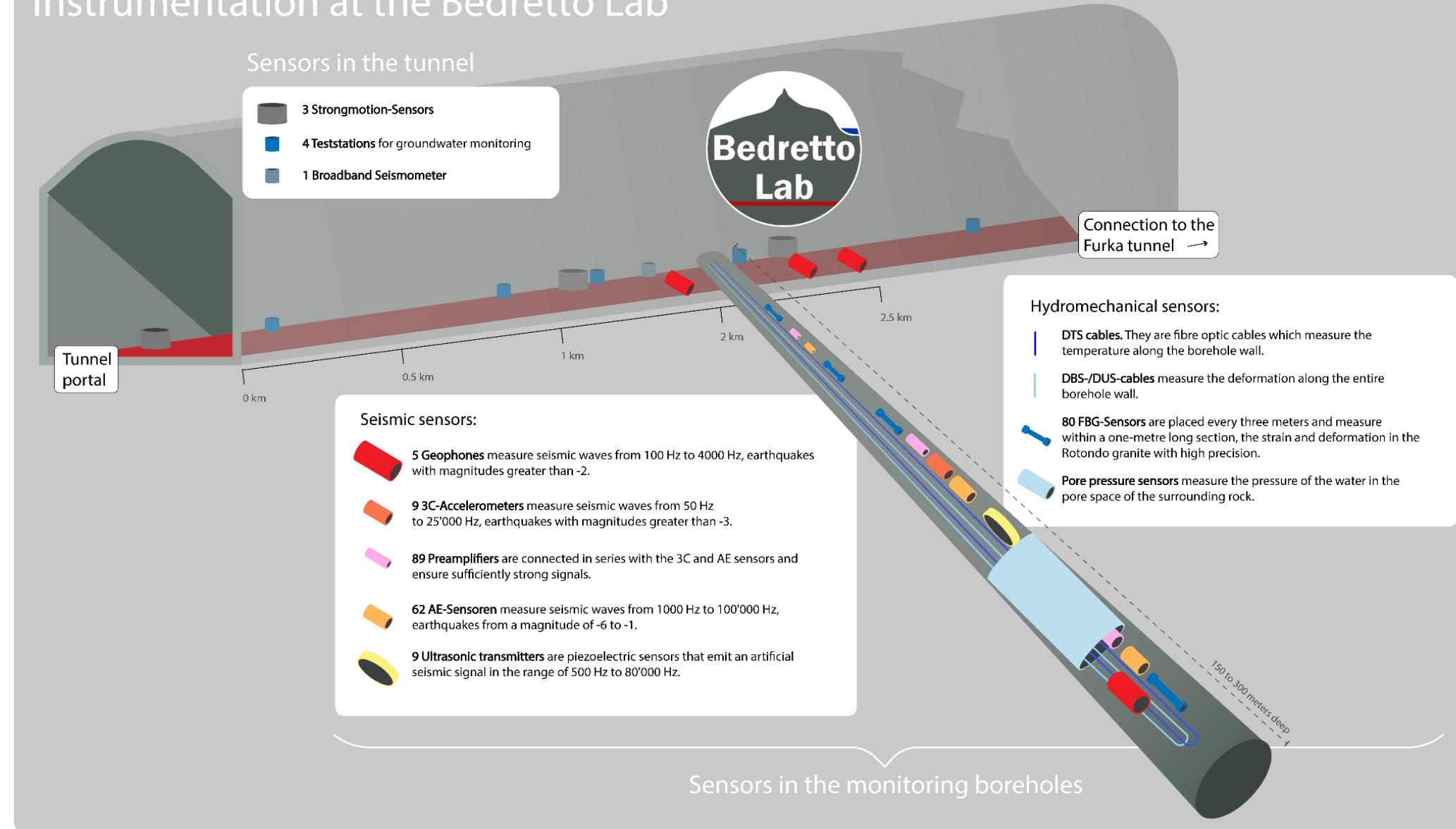
Uncemented borehole with water pressure sensors: In this borehole pore pressure sensors are installed at certain intervals to monitor the pore pressure of the surrounding rock.



Injection borehole: Here we press water into the rock, with the aim that it reaches the extraction borehole after passing through the rock volume. In geothermal power plants, the water would heat up due to the great depth. This is not the case at Bedretto Lab: here we research the interaction of water and rock.

Extraction borehole: Here the water leaves the rock again.

Instrumentation at the Bedretto Lab



Impressions



Impressions



- Special drill rigs for underground drilling are mobilized
- And put in place

Impressions

Wireline core-drilling



Impressions

Hammer drilling



Impressions



Instrumentation



ETH zürich

Bedretto Underground Laboratory for Geosciences & Geoenergy

Impressions



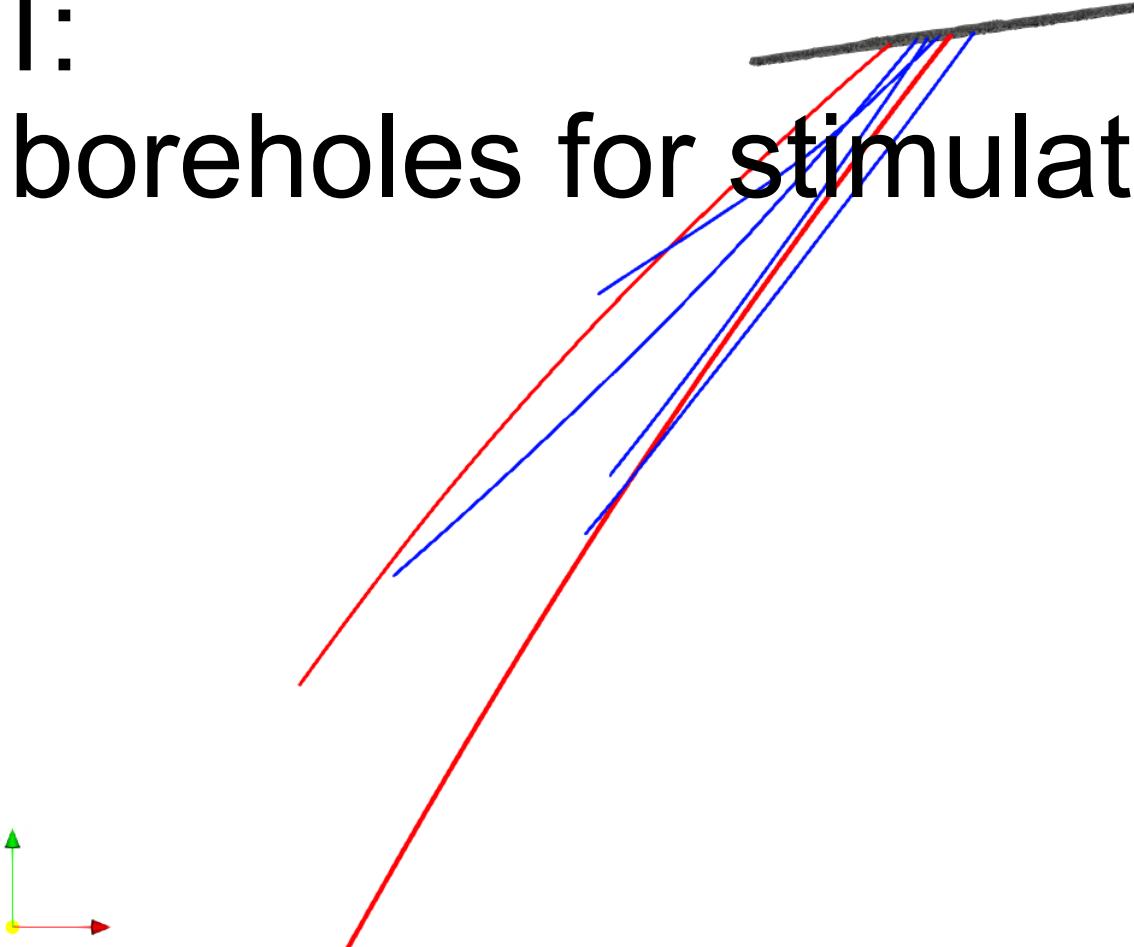
cementing

4 boreholes for monitoring

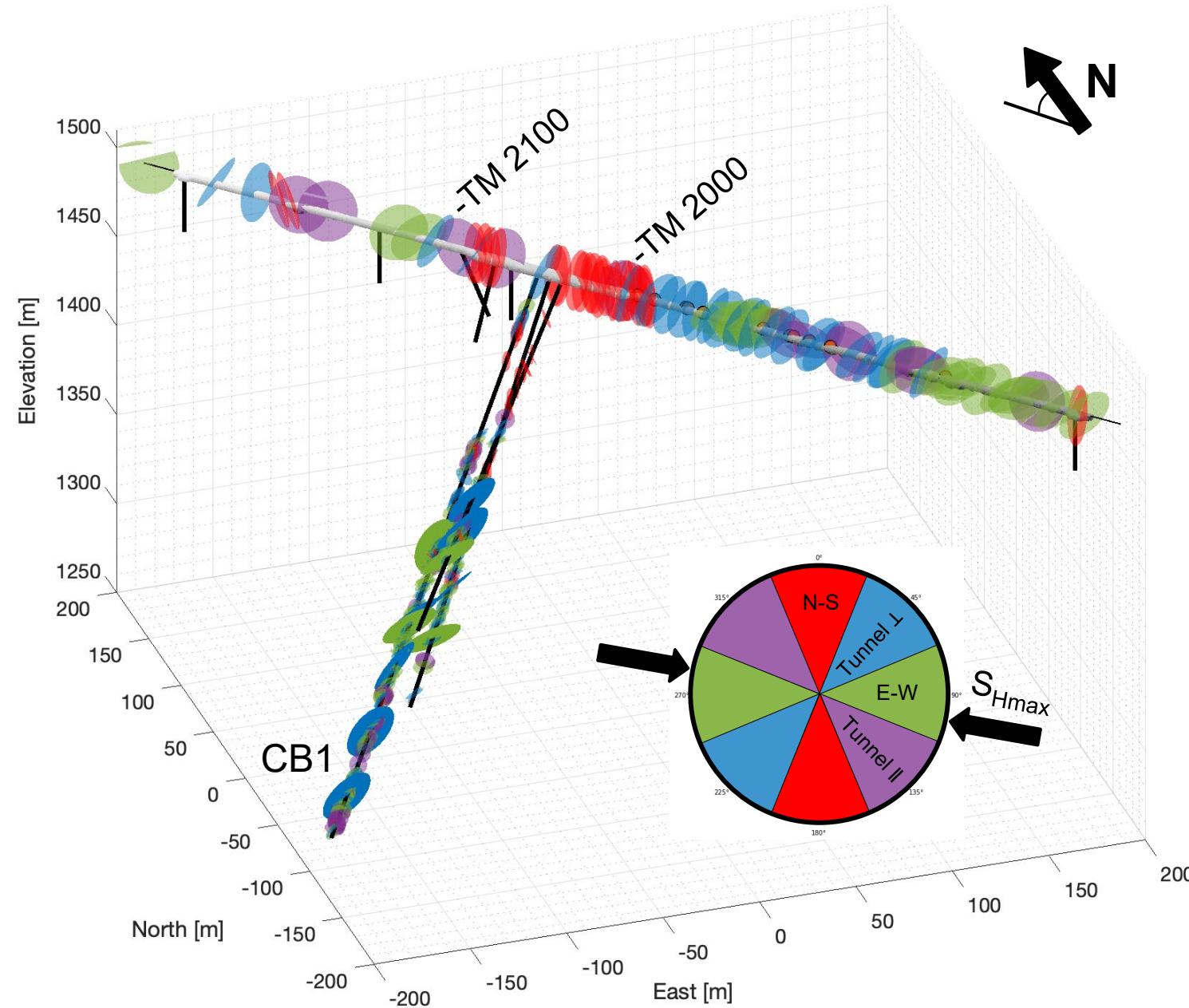
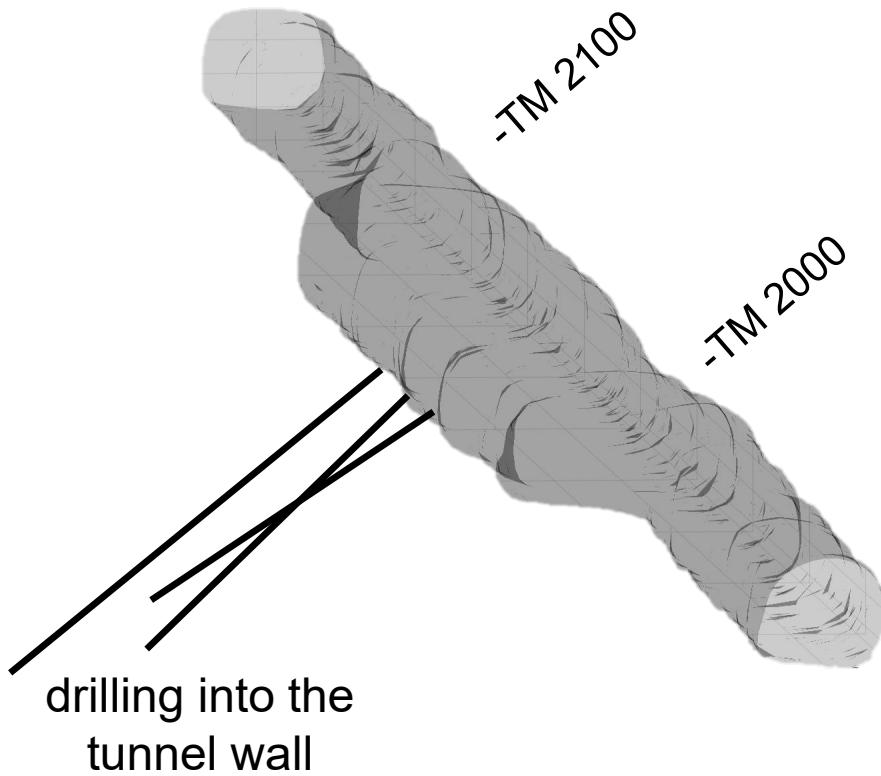
The Bedretto Reservoir Project – borehole geometry phase 2
more to come

ST:

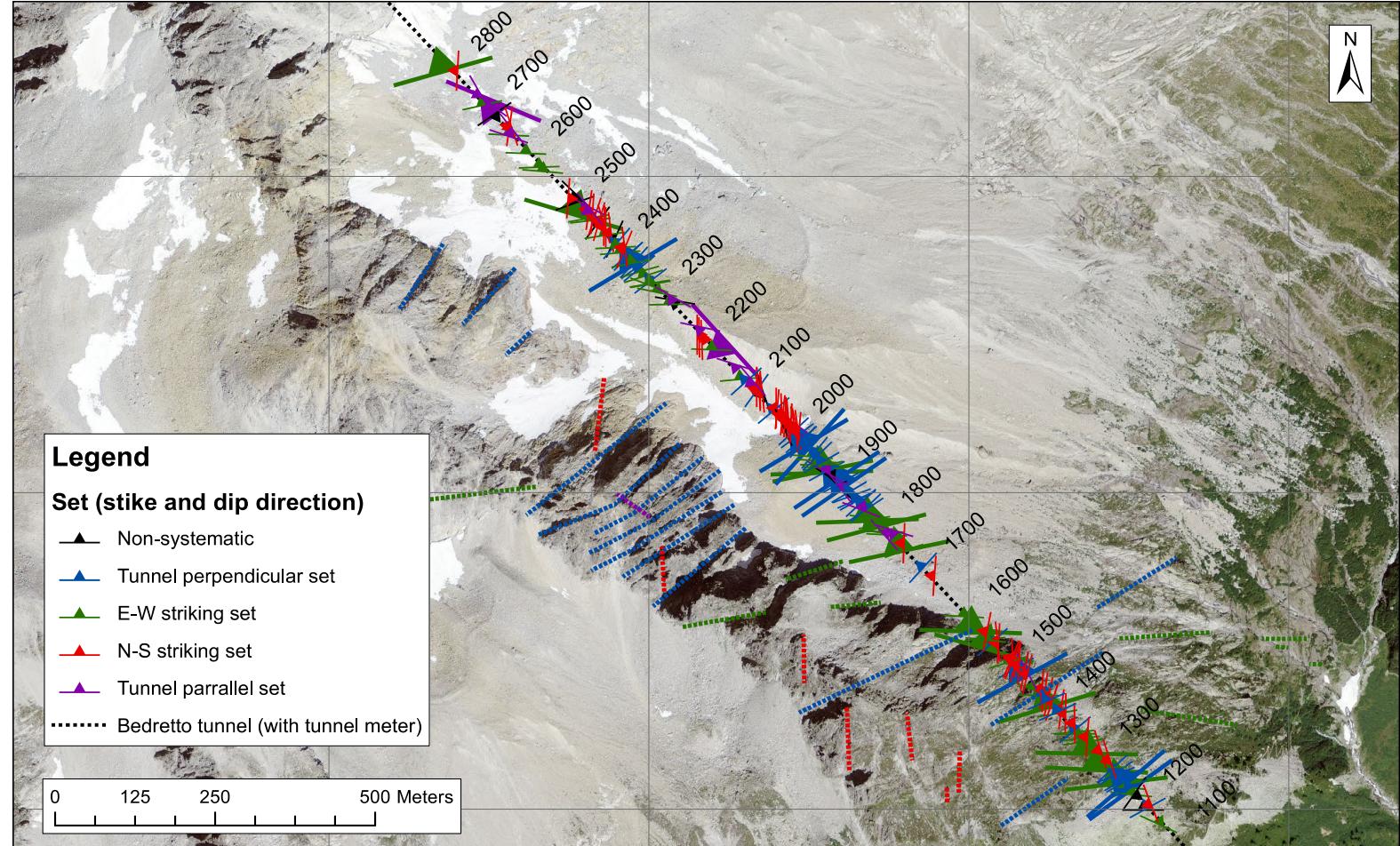
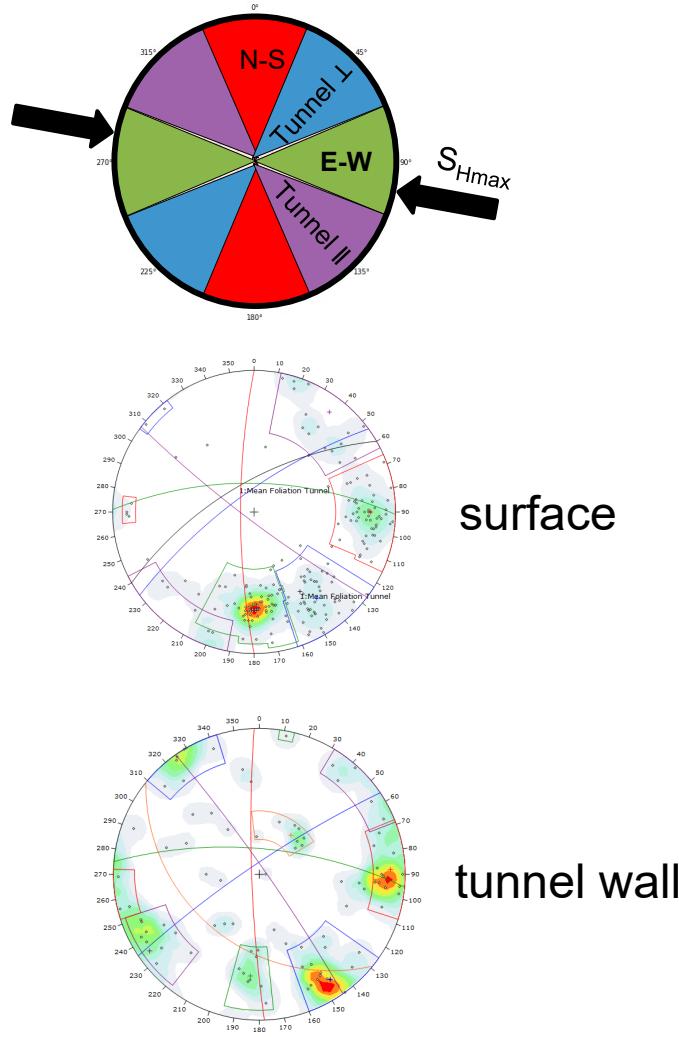
2 boreholes for stimulation and circulation



Characterisation boreholes



Fracture mapping inside and out



Compartmentalized hydro-structures?

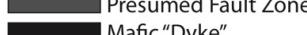
Legend



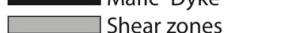
Intact Granite



Lampronite Dykes



Presumed Fault Zone



Mafic "Dyke"



Shear zones



Foliation



Porosity



Relative Flow-rate



47.47 m
47.72 m
48.40 m
48.70 m
50.50 m
54.28 m
72.20 m



142.1 m
144 m



145 m
180 m
182 m



180 m
182 m



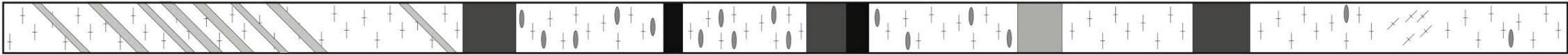
206 m
207 m



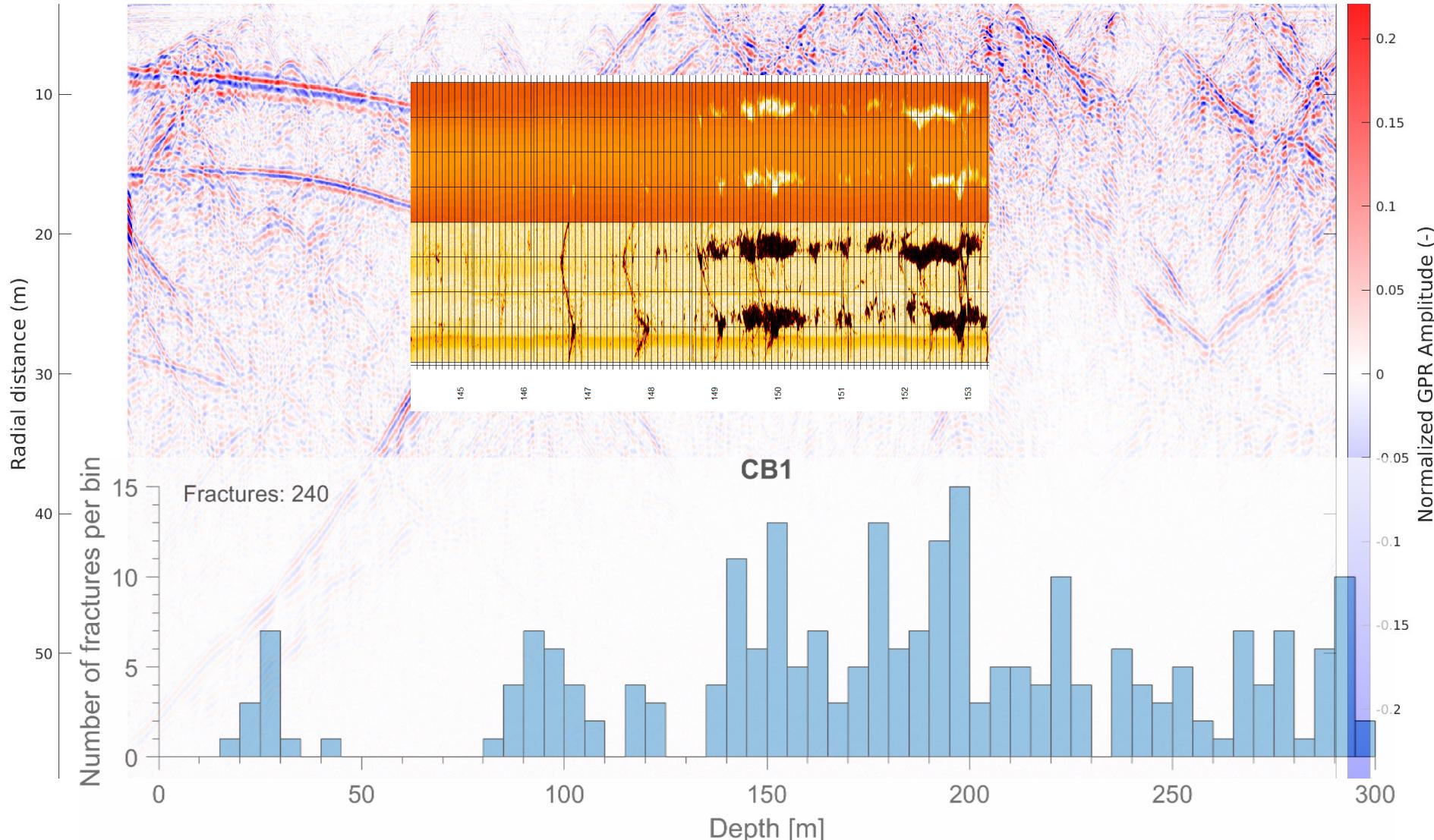
242 m
243 m



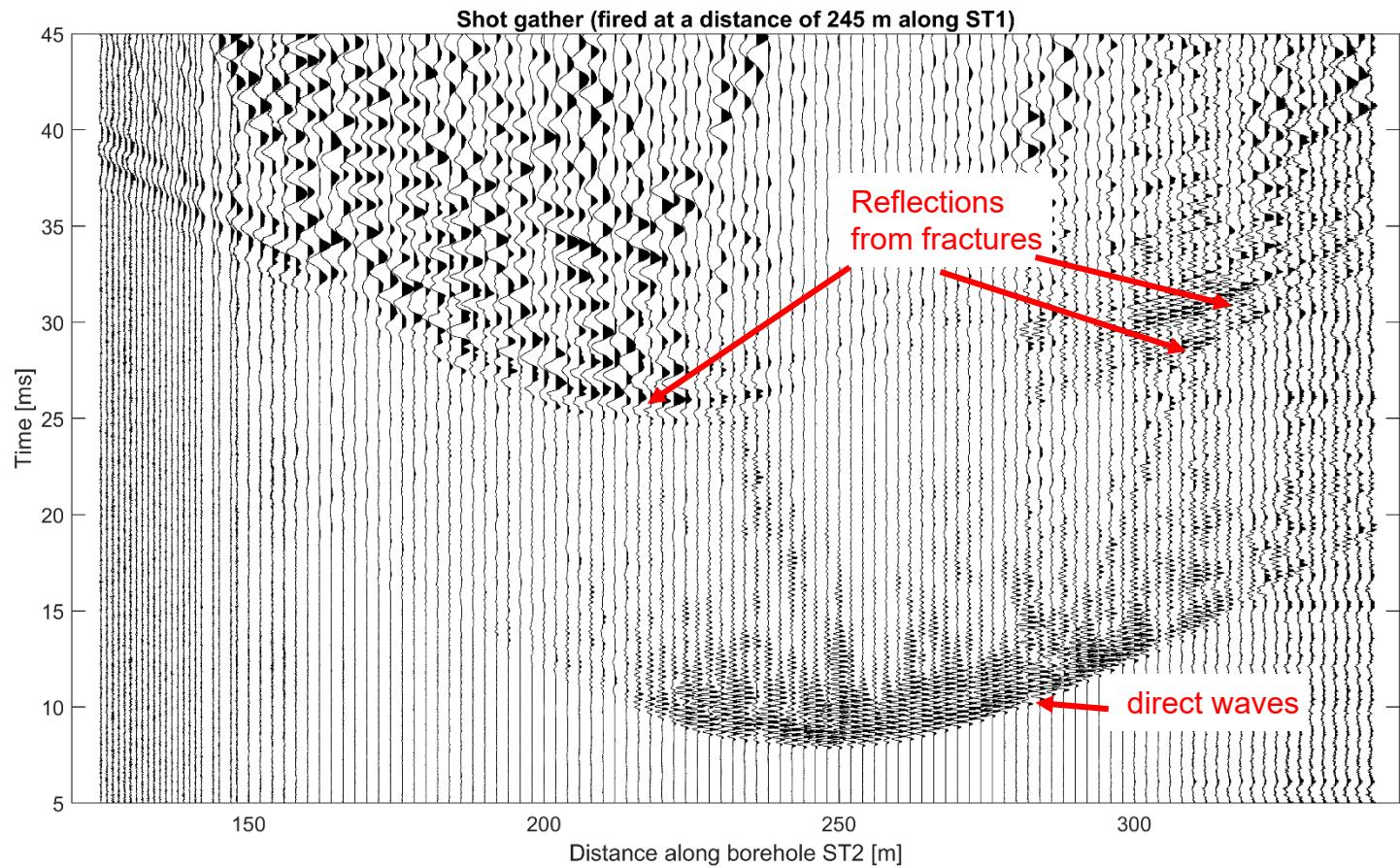
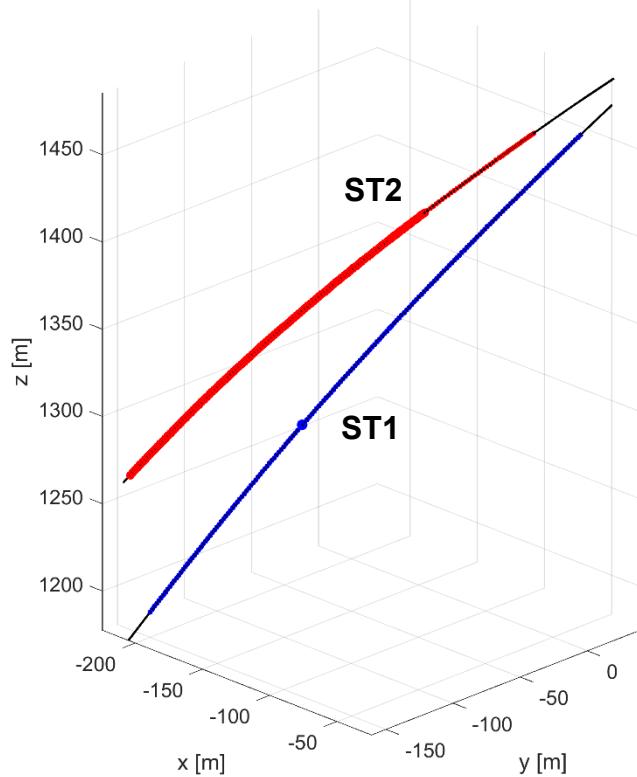
250 m



Fracture geometry in the reservoir

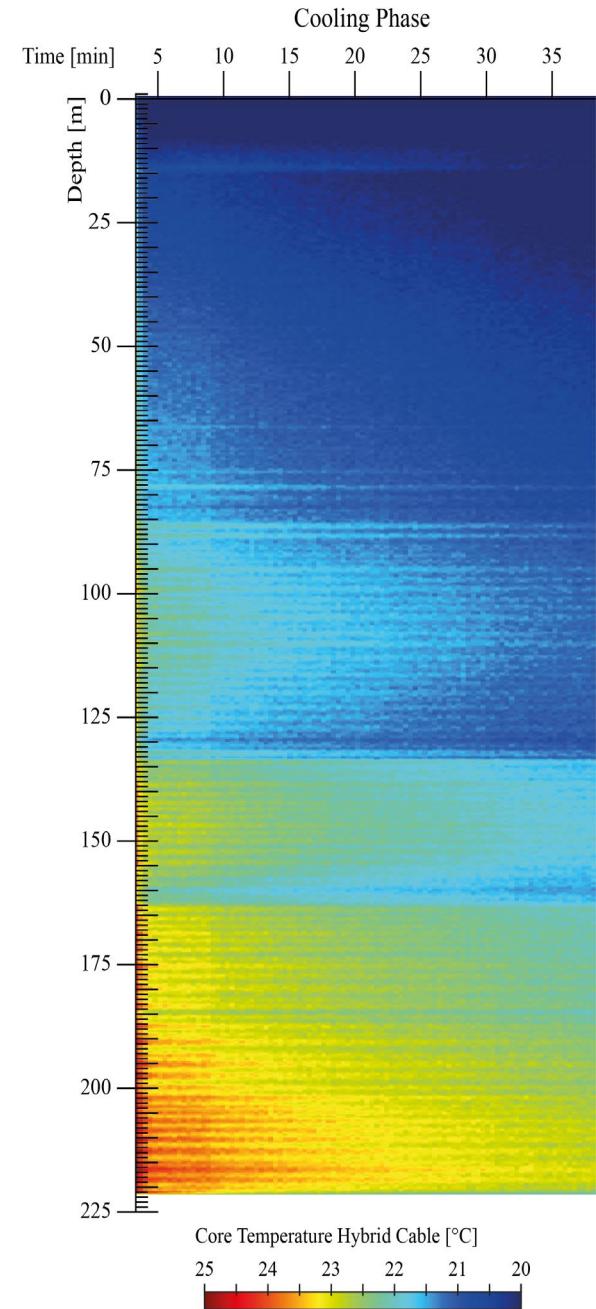
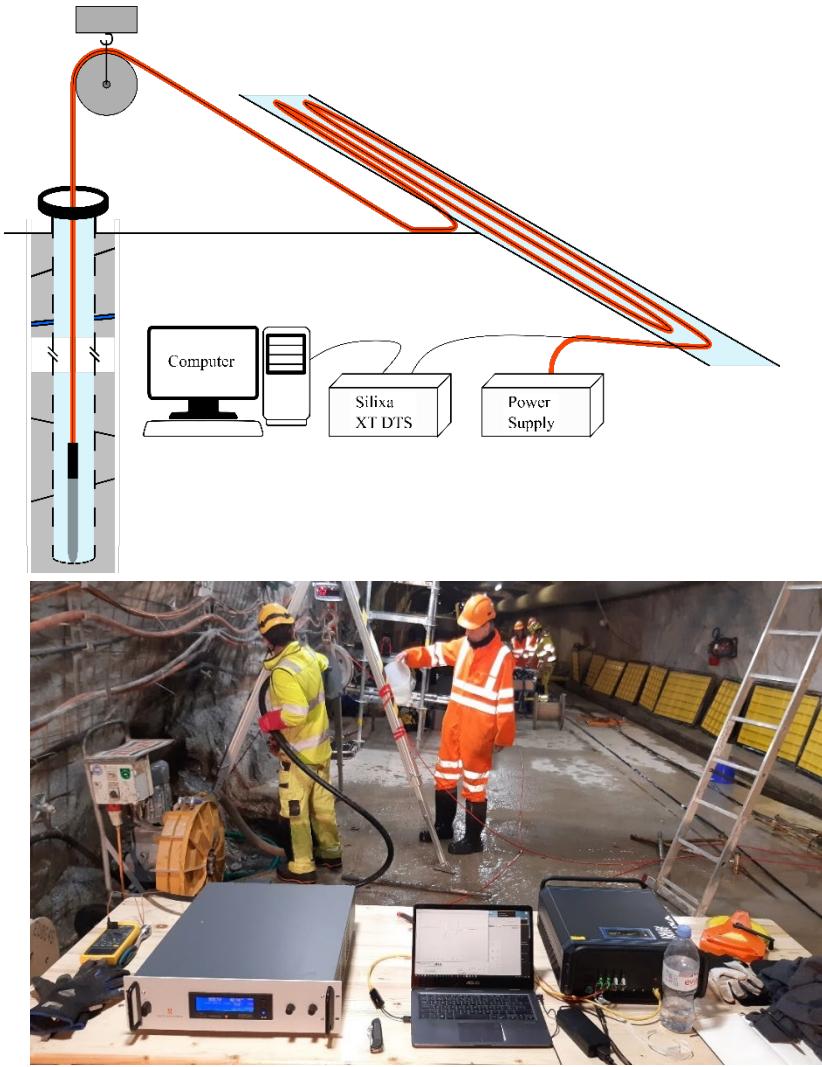


Seismic cross-hole measurements



Heat dilution test (CB2)

- Hybrid Cable
 - Hybrid of Fiber Optic cable for Distributed Temperature Sensing (FO-DTS) and heating element.
- Interrogator
 - Silixa Ultima XT-DTS to measure temperature along the cable with spatial sampling resolution of 0.25 m.
- Power Supply: up to 15 kW
- Method
 - Cable heated for 2 h (40 minutes of heating with 10 kW and 80 minutes of heating with 15 kW) and the change in temperature measured with FO-DTS both during heating as well as during cooling.



Packer placement in CB2 for hydraulic characterisation

CB1 CB2 CB3

Interval 7
(length: 15.48 m)

Interval 5&6
(length: 25.1 m)

Interval 4
(length: 9.48 m)

Interval 3
(length: 18.51 m)

Interval 2
(length: 2.01 m)

Interval 1
(length: 22.23 m)

Packer 7
(at 124.4 m)

Packer 6
(at 140.9 m)

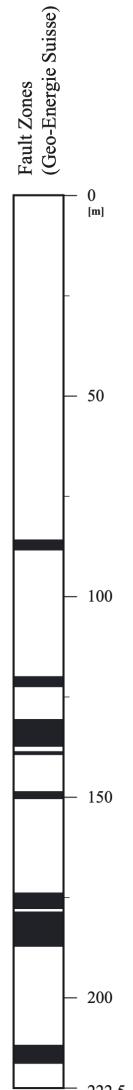
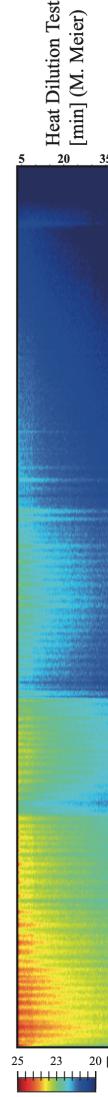
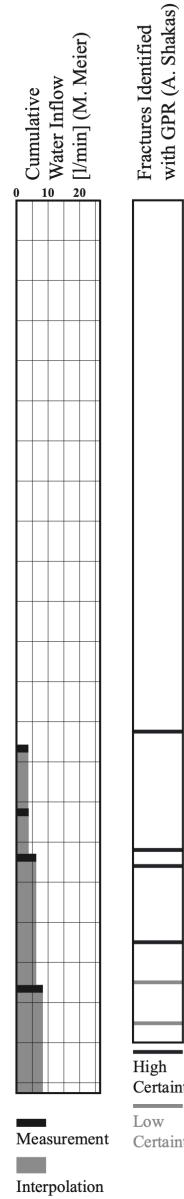
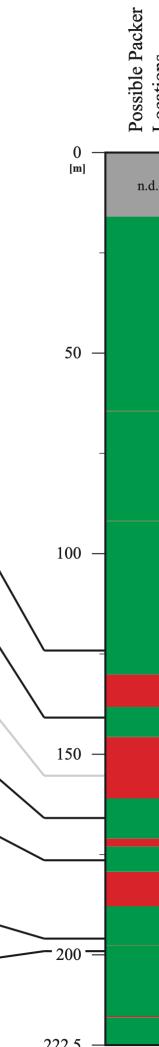
Packer 5
(at 155.5 m)

Packer 4
(at 166.0 m)

Packer 3
(at 176.5 m)

Packer 2
(at 196.0 m)

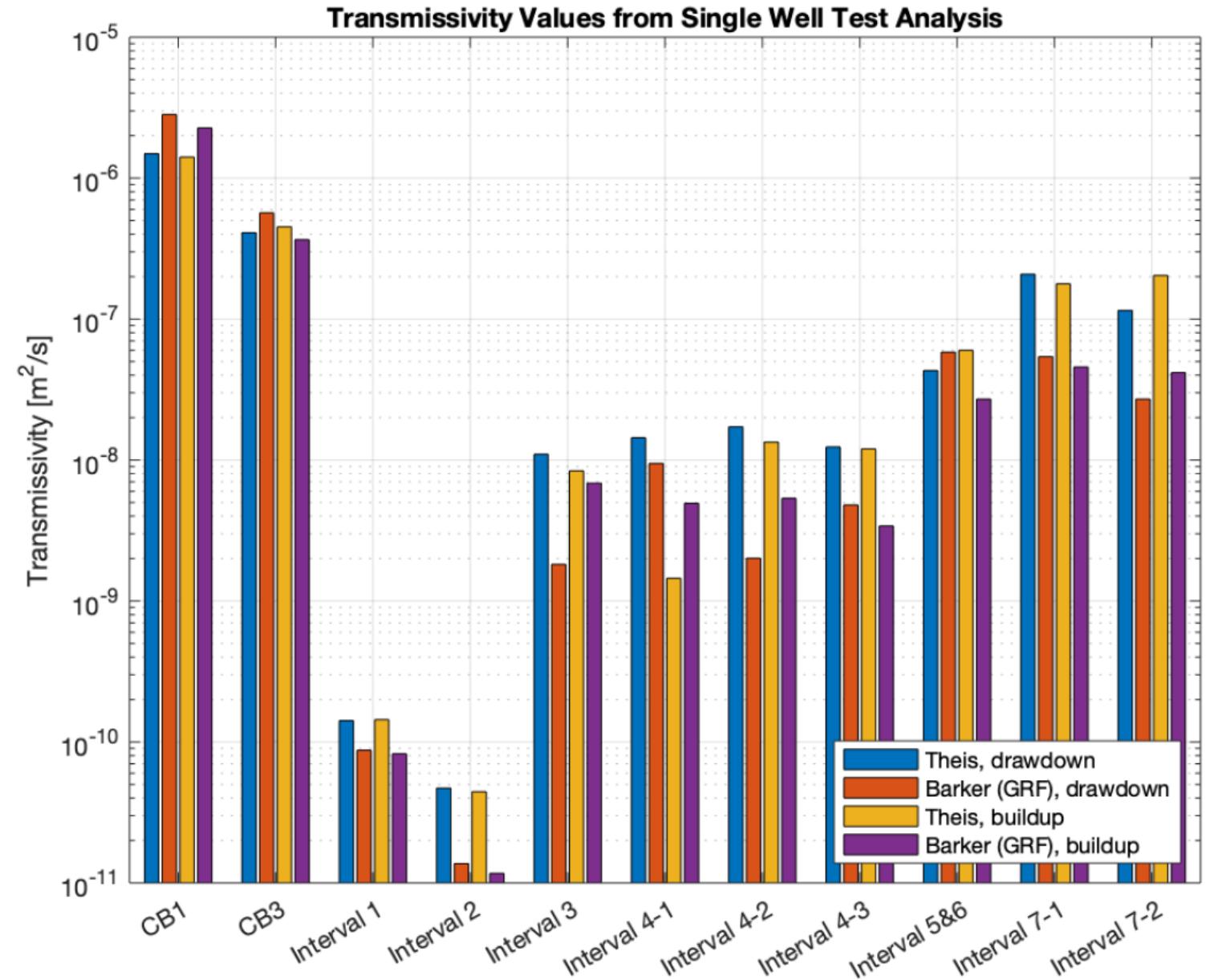
Packer 1
(at 199.0 m)



Hydraulic testing equipment



Hydraulic properties



Project Status

The BerettoLab has been completed, now fully in operation

Through three characterization boreholes, the reservoir has been studied in great detail

Two stimulation boreholes have been drilled up to 400m length

Four monitoring boreholes are completed with high resolution monitoring sensors

The first stimulation in deep intervals is about to start

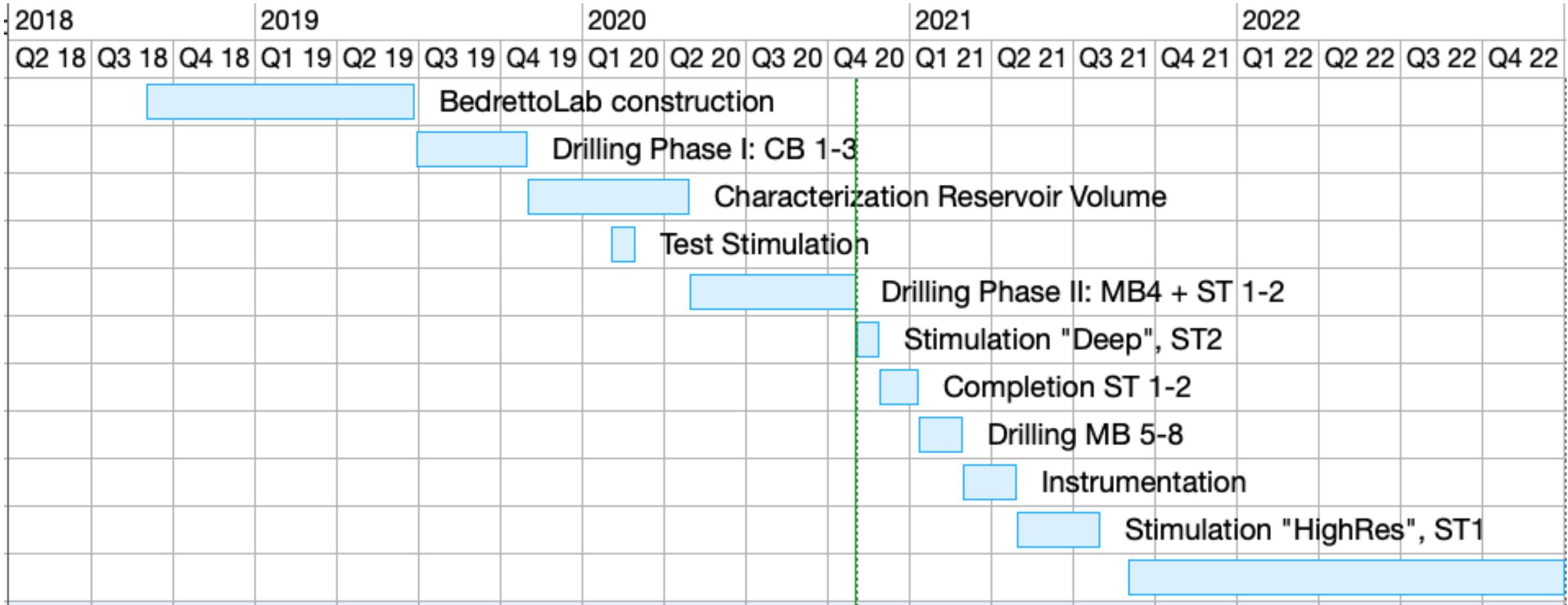
Coming soon:

Extension of monitoring by additional boreholes

Detailed stimulation in high resolution volume

Extensive circulation in the created reservoir

Project Schedule







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