

Preliminary results from Interdisciplinary fault characterization in the Bedretto Underground Laboratory



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1 Introduction

The Bedretto Underground Laboratory for Geoenergies (BULG) is a newly created underground research facility that promotes experiments aimed at understanding processes related to geothermal energy extraction. The lab is located in the Swiss Alps and is constructed inside an abandoned 5218 m long tunnel. For more information about the lab, go to <http://www.bedrettolab.ethz.ch/>

Here, we present some preliminary results that can be useful for the general characterization of the lab and in specific the investigation volume where the stimulation experiments will take place. The existing data includes geophysical logs, geological observations and hydrologic tests.

2 Characterization volume

The Bedretto tunnel is located within the Gotthard massif and embedded entirely in the Rotondo granitic intrusion. The site was deemed suitable for the new underground laboratory because it offers conditions that resemble real Engineered Geothermal System (EGS) site candidates in Switzerland. It has high overburden and the investigation volume is under suitable stress conditions. The main laboratory, at 2km from the tunnel entrance, is surrounded by the crystalline rock mass. Moreover, the tunnel is located far from any sensitive infrastructure. The Rotondo granitic intrusion is mainly homogeneous and with several discontinuities (fault zones and fractures) that are often characterized by high water outflows. To date, three characterization boreholes have been drilled in the BULG (CB1: 300 m and 45 deg, CB2 222 m and 50 deg, CB3: 190 m and 40 deg dip) and these have been used for the initial characterization phase. A geological cross-section of the tunnel is shown below.

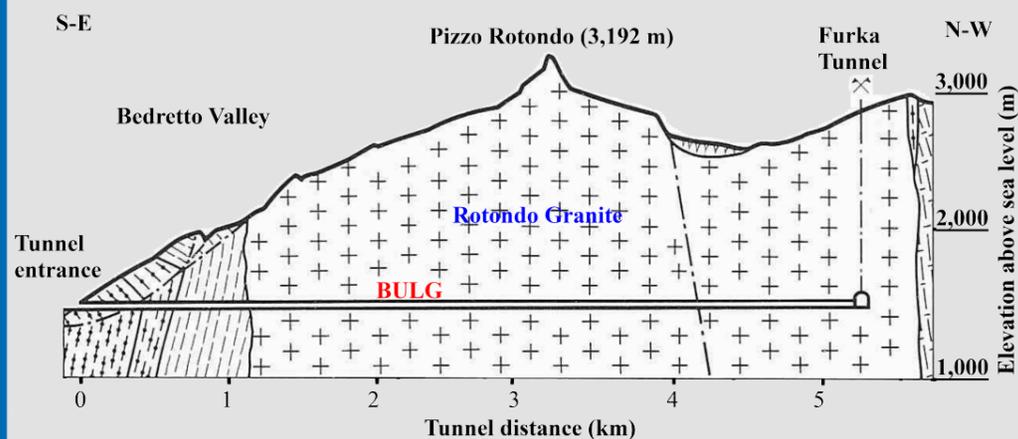


Figure 1. A geological cross-section of the Bedretto tunnel and the location of the BULG. The volume surrounding the lab is dominated by the Rotondo granite. Figure modified from Keller and Schneider (1982), *Geologie und geotechnik, Schweizer Ingenieur und Architekt*, 100 (24), 512-520.

3 Preliminary results on fault characterization

Figure 2. (Below) 3D rendering of part of the Bedretto tunnel which includes the main laboratory (from TM 2000 to TM 2100). The three characterization boreholes are shown (CB1, CB2 and CB3). The fractures identified from logging are plotted along the boreholes, as well as the fractures mapped along the tunnel. The coloring of the fractures corresponds to their strike. The classification of strike directions into four major groups and the maximum horizontal stress direction, which is oriented towards N100°E, are shown in the figure inset.

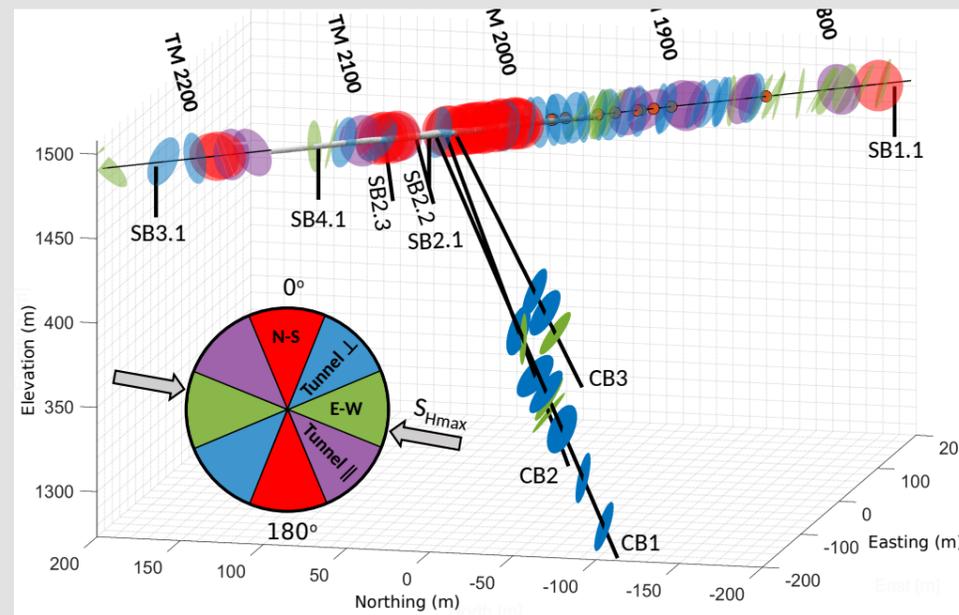
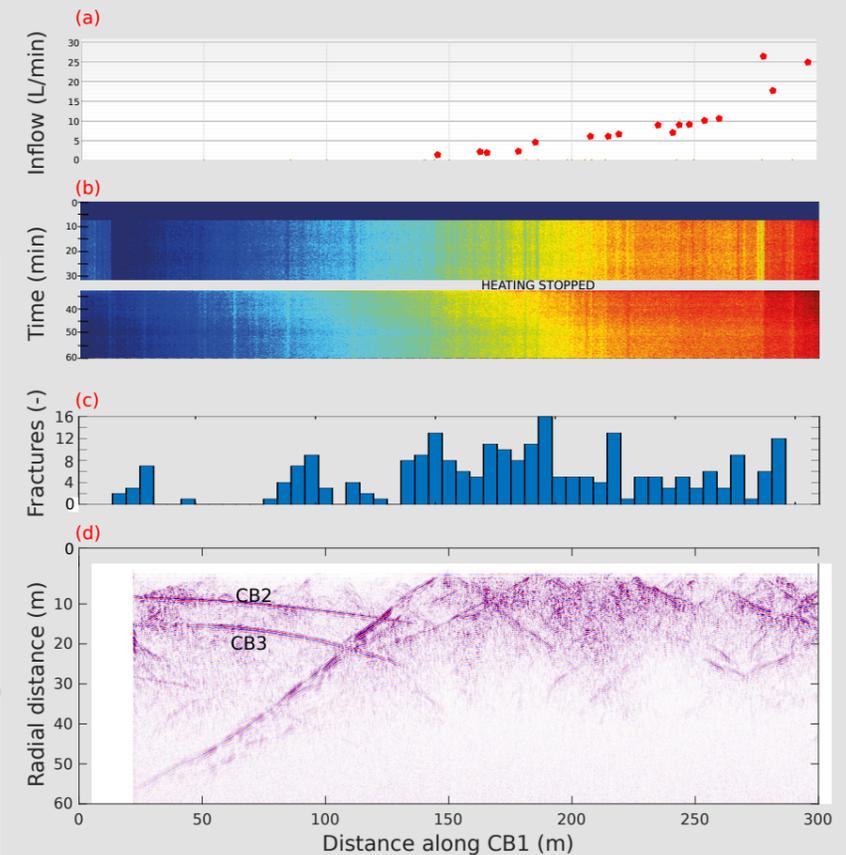


Figure 3. (top right) A variety of data that is available for CB1 plotted on the same horizontal axis. (a) The inflow observed in the borehole during its drilling shows the major inflow zones. (b) A heat dilution test performed agrees well with the inflow zones observed, as the heat is seen to dissipate strongly during the cooling period (heating from 0 to 30 min and cooling from 30 to 60 min). (c) The fracture density computed from fracture intersections with the borehole, using optical and acoustic televiwer logs. A highly fractured zone is observed after ~ 140 m. (d) A single-hole ground penetrating radar reflection survey reveals the water-filled fractures in the vicinity of the borehole. These are observed as dipping reflections and often exhibit a chevron-type pattern. A major fault zone is seen to traverse the characterization volume and intersect the borehole at ~145 m depth. This intersection has been verified with cross-hole hydraulic tests, core characterization and logging observations.



4 Discussion and Outlook

The investigation volume in the BULG is characterized by discrete fracture and fault zones that are often highly transmissive. In the initial phase, the data revealed a highly fractured zone in the lower half of the existing boreholes, further than 150 m length along CB1 and equivalent to 100 m in vertical depth. Upcoming hydraulic stimulation experiments are planned in the lower half of the volume, and more boreholes will be drilled in the next months that will serve for monitoring and hydraulic stimulations. The lab offers an exciting ground for collaboration aimed at understanding processes that will pave the future of geothermal energy.

6 Acknowledgements

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