Solid Earth Discussions

Solid Earth Discuss., author comment AC2
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Reply on RC2

Xiaodong Ma et al.

Author comment on "Multi-disciplinary characterizations of the BedrettoLab – a new underground geoscience research facility" by Xiaodong Ma et al., Solid Earth Discuss., https://doi.org/10.5194/se-2021-109-AC2, 2021

- In general,

the paper: Well written, interesting and well referenced description of the performed rock characterizations. In addition, a good summary of the Bedretto Lab establishment

Response:

We thank the reviewer for the positive comments. We reply to your specific comments item by item below.

- Orientation system:

It becomes evident that the text is written by many authors when it comes to which orientation system that is used. Sometimes N ##°W are used, other tImes NW-SE striking, and sometimes strı́ke/dip, and even trend for fracture/zones. Different disciplines do use different systems as standard, but try to minimize the use of systems in the same paper.

Response:

We thank the reviewer for raising this issue. We revised the text to adhere to the N###°E convention for the fracture/fault strike, tunnel orientation and horizontal stress component azimuth. It might be confusing when the four fracture/fault sets are mentioned, which we arbitrarily divide into four categories (E-W, N-S, SE-NW and NE-SW).

- Uncertainty:

For the stress measurements there is some uncertainty span provided, but what about all other parameters; have you done any uncertainty evaluation of magnitudes and orientations? Multiple measurements are needed to get a good picture of the values

interpreted. The only text where it is stated that multiple test have been performed is at row 312-313

Response:

For the uncertainty of stress magnitudes and orientations, we refer to a dedicated stress study by (Bröker & Ma, n.d.). While additional tests are still warranted to further consolidate the stress uncertainty in the vicinity of the Bedretto Lab, Line 175-190 provides our best estimation to date.

- Title: A unique underground geoscience research facility

Not obvious that a reader absorbs what is the uniqueness of the facility. Few external comparisons are made with international URLs and just a brief benchmark with Grimsel regarding permeability of the granite, see also comment section 500-502. Instead of using "unique" in the title I suggest Bedretto should be presented as "a new underground geoscience research facility"

Response:

We appreciate that the reviewer points to this issue. We have toned down this and used 'new' instead.

- Line 68: A¨spo¨

A¨spo¨ HRL

Response:

Addressed.

- Line 137: 'of more than 100 earthquakes within the region' Time interval?

Response:

Addressed.

- Line 144: 'Medium to large-scale fracture'

Consider introducing the definition Full Perimeter Intersection "FPI" as used by SKB and other repository engineering companies, e.g. SKB R-06-05 "Using observations in deposition tunnels to avoid intersections with critical fractures in deposition holes"

Response:

We thank the reviewer for sharing this reference. However, we were unable to retrieve this one online. Instead, we identified a relevant reference, which we will try to implement in our future work.

Raymond Munier, 2010. Full perimeter intersection criteria – Definitions and implementations inf SR-Site. SKB TR-10-21, Svensk Kärnbränslehantering AB.

https://inis.iaea.org/collection/NCLCollectionStore/_Public/41/095/41095194.pdf

- Line 228: 'Three distinct lithological units are present in the characterized rock volume (Figure 5) '

Figure 5 is a not an interpretation of the rock volume but core descriptions from three boreholes?

Response:

Clarified.

- Line 322-324: 'Therefore, it is expected that the transmissivity values of CB1 and CB3 are at least as high as the largest transmissivity observed within the intervals of CB2, which is indeed the case'

"it is expected" and "indeed the case" in the same sentence?

Response:

Revised.

- Line 410-415: 'Risk of undersampling'

The configuration of the lab (orientations of tunnel + boreholes) may underestimate intensity of fractures and structure that have pole trend/plunge around 45/45 (strike/dip 135/45) It would therefore be of great interest to drill a hole with azimuth 45 and inclination -45 (from horizontal plane)

Response:

We thank the reviewer for this valuable suggestion, which is stressed by Dr. Earon (RC3, see below). We are aware of the risk of under sampling of fracture sets in the Bedretto Lab volume. Additional boreholes have been planned and will provide relevant information.

- Line 440: 'wavelengths'

Maybe use higher frequency?

Response:

Revised.

- Line 441-442: "As already shown, strong stress variations are evident along the CB boreholes, particularly around the fault zones."

Where is this already shown?

Response:

The stress variations we referred to concern the prominent rotations of borehole breakouts observed in all three boreholes. This is first described in Line 268-279, and also noted in Line 390-400.

- Line 500-502: 'The Bedretto Lab represents the state-of-the art for conducting meso-scale

experiments on the crystalline rock masses and offers opportunities for international collaborations'

"State-of-the-art" methods have indeed been used for the characterization of the local rock volume. However, as a novel laboratory this is too much of an exaggeration at this stage. There are several underground research laboratories in the crystalline rock with many decades of experience and solid scientific results, e.g A¨spo¨ HRL in Sweden where site investigations began 1986.

Other aspects that appear to be missing for the Bedretto Lab to be a "state-of-the-art" test bed are an open database with access to e.g. various data from continuous hydro monitoring and water chemistry development over time, a 3D-modelled interdisciplinary site description to e.g. assist in deciding on new survey sites as well as a customized service organisation at the site.

- Line 518-519: 'The rock volume will be further characterized and densely instrumented with tailored sensors. It will allow for in-depth studies of the hydro-seismo-mechanical response of fractured rock masses.' Possibly, it can be presented with even greater clarity what the Bedretto Lab can offer the future research customers, see comment 500-502.

Response:

We appreciate your comments on the 'state-of-the-art' description, which we have toned down and made relevant revisions. We are aware of many existing underground labs and the invaluable research findings generated there. These serve as great encouragement for

our future work!

- Table 4: ‘units’

I guess that the unit for the p and s waves should be m/s and not km/s, or the numbers should be divided by 1000?

Response:

Addressed.

- Figure 2: ‘reference’

The caption reference to the “lower row of figure 6”. I guess it should reference to figure 7.

Response:

Corrected. We thank the reviewer for spotting this!

- Figure 8: ‘Labelling’

The text reference e.g. Figure 8a, 8b etc, but there is no such labels in Figure 8.

Response:

Addressed.