

Review of manuscript ‘Overdeepening or tunnel valley of the Aare glacier on the northern margin of the European Alps: Basins, riegels, and slot canyons’ by Schlunegger et al.

The manuscript ‘Overdeepening or tunnel valley of the Aare glacier on the northern margin of the European Alps: Basins, riegels, and slot canyons’ by Schlunegger et al. reviews and synthesizes a combination of existing data to investigate the Aare overdeepening in the Bern area. Gravimetry data is used to reconstruct the thickness of Quaternary sediment infill and is used to identify two basins separated by a bedrock riegel. Drilling data indicates deeper than expected bedrock which is interpreted to represent a series of slot canyons cut into this bedrock riegel by subglacial meltwater during deglaciation. A comparison to other alpine valleys is then made to highlight how the location of bedrock riegels formation tends to be related to the confluence zones of alpine glaciers and the relative difference in erodibility of the bedrock. Additionally, the same bedrock riegel/slot canyon landform assemblage is suggested to occur in these other alpine valleys. While the findings are relevant to readers of *Earth Surface Dynamics* and worthy of publication, I believe that there are a series of issues with the manuscript that should be addressed prior to publication. I list these comments below.

Major comments/questions:

Reviewer 1 has already raised the issue of whether the interpreted riegel could be the result of either an underestimation of the Quaternary infill by gravimetry and the misinterpretation of drillings and I note that you have already responded to these comments. So I don’t want to dwell on this topic too much. But I welcome the introduction of new data that would support your interpretation and while I don’t necessarily disagree with your interpretation, I would appreciate a brief discussion of the possible alternative interpretations to highlight some of the uncertainties and be more transparent to the reader. So I look forward to reading this addition.

On Figure 7, I would appreciate the location of deep drillings being labelled (in a similar style to Figure 6). This would allow the reader to easily see the ground-truthed evidence supporting the relatively low Quaternary infill (if any boreholes do show this) and location of slot canyons. While this information can be found in Figure 5, it can be quite difficult to interpret this data from a map figure and I would appreciate it plotted onto the cross-profiles as well. For example, on the Kehrsatz cross-profile you reconstruct a single slot canyon but on Figure 5 there don’t appear to be any drillings which would support this reconstruction? If there is a drilling that supports it then could you label it on Figure 7c, even if the drilling is one of those located a few hundred metres up or downstream of the drawn cross-profile.

Section 5.5 Chronological framework. A synthesis of dating evidence is mentioned in both the abstract and introduction of the paper, so I expected the discussion of the chronological constraints to be more important to the paper. But, this section feels a little bit like a brief review of the existing constraints and doesn’t really significantly add anything new or contribute to your aim of exploring the origin of these overdeepenings. While it is important to understand the timing of glaciations that formed these overdeepenings, I believe that this section could be simplified and cut to about half its current length. In its current length I felt like it distracted from the main message of the manuscript. In your conclusions section, you barely mention the chronology and I think this illustrates how this section isn’t a key element of your manuscript and its location in the discussion section is taking away from the message. Another alternative to shortening this section could be moving it earlier in the manuscript, perhaps after Section 2 on ‘Riegels and slot canyons in the Alpine valleys...’

The evolution of the slot canyon network across the bedrock riegel. Across Figure 7, there appears to be an evolution of the subglacial drainage network that incised these slot canyons as it passes over the riegel. At the Aare cross-section, upstream of the riegel there appears to be no evidence of a channelised subglacial drainage network incising into the bedrock (distributed subglacial drainage network or just no drilling data which identified a channel?). As you pass over the riegel there is the anastomosing network of slot canyons that you reconstruct. Then downstream of the riegel on the Bremgarten cross-profile, there is a single slot canyon (possibly?). I am aware that these reconstructed networks are very dependent on drilling data which struck one of these canyons and so this reconstruction has quite large uncertainties, but, I would be interested to see a description of this evolution of the channel network. If you believe that your data is reliable enough to reconstruct it, if not feel free to ignore this. What are the processes that could drive these changes in network and how it relates to the changing bed slope? Additionally, how could these variations in the subglacial drainage network affected ice flow and erosion? A lot of attention of the manuscript is focused on the overdeepenings themselves, but these slot canyons are also highlighted as a key feature so I would be interested to hear a bit more about the drainage system, if you feel confident enough to reconstruct it!

As a final note, while it is clear the authors have worked hard to integrate a lot of data for this paper, at times the manuscript does not fully reflect their work and can be a little sloppy. In the line-by-line comments, I highlight a few sentences where there are typos or the meaning of the sentence might be unclear. Additionally, I spent only a couple of minutes checking the citations and reference list and I noticed two or three mistakes already (that are listed in the minor comments section). I am sure there are other mistakes in the citations/reference list that I did not spot. Please can you thoroughly proof-read and double-check this for the next version of the manuscript.

Minor comments, line by line comments:

When I suggest any edits to a sentence, I use underline to indicate any suggested additions and ~~strikethrough~~ to indicate words that should be deleted.

Title: I'm not sure the purpose of 'tunnel valley' in the title. Is this to suggest that the whole Aare overdeepening is actually a tunnel valley incised by subglacial meltwater? I would probably remove '... or tunnel valley...' from the title.

Line 37: 'incision ~~of~~ by subglacial meltwater...'

I would probably also simply say deglaciation, rather than 'glacier's decay state'.

Line 67: 'a riegel is a rock wall' I would prefer a different term than rock wall, which gives the impression of a steep, exposed bedrock feature. Perhaps better to say 'bedrock bump oriented transverse to former glacier flow'.

Line 84: '... where we aimed ~~at~~ to exploring...'

Line 171: 'It bases on...' should be reworded to 'It is based on...'

Line 180: Which direction? Please can you specify the direction of the shallowing of the bedrock.

Line 318: citation reads 'Boultoon and Hindmarsch, 1987' but should read Boulton and Hindmarsh. The reference list has this correct.

Line 328: citation reads 'Hindmarsch', please change this to Hindmarsh.

Around line 350: You cite 'Stäger et al., 2020' multiple times but I cannot find this in the reference list.

Line 361: You do not need to define Lower Freshwater Molasse in this sentence as it has already been previously defined. Simply use the shortening of 'LFM'.

Line 421 – 423: This sentence is a little clunky. Reword to something like:

~~'Yet,~~ Preusser et al. (2011) summarized multiple lines of evidence ~~for proposing~~ that the piedmont glaciers ~~did~~ advanced into the Alpine foreland between 185 and 130 ka, i.e. the Beringen glaciation (MIS 6, Figure 8), and that this advance into the foreland was larger than during the LGM.'

Line 429 – 431: It is not immediately apparent how detailed mapping supports a chronological interpretation, please can you explain how the mapping evidence is inconsistent with an MIS 6 age? Even a brief explanation will make your assertion about the chronology more believable as opposed to vague statement about 'a-priori field-based information'. As someone without extensive regional knowledge I find statements like these unconvincing and just wishing I had more information!

I hope the authors find these comments useful and I apologize for the slight delay in preparing this review.