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Interactive comment on "Identification of rock and fracture kinematics in high Alpine rockwalls under the influence of altitude" *by* Daniel Draebing

Anonymous Referee #1

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Review of Draebing, "Identification of rock and fracture kinematics in high Alpine rockwalls under the influence of altitude" submitted to Earth Surface Dynamics.

General Comments

This manuscript presents a highly detailed study of the cooling and heating effects of alpine rocks in a laboratory and field setting. The author should be commended for capturing this type of data set as it is clear that it has the ability to inform on several key attributes of the geomorphological behavior of high altitude rock walls. The author makes several interesting points and clearly has collected a significant data set to stand behind some important interpretations. The confirmation of hysteretic thermally-generated fracture deformation is a very good contribution, as is the observation that the thermal expansion coefficients are different between cooling and warming. In ad-

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Discussion paper

dition, the observations that snow cover (and lack thereof from future climate change) will affect the cyclic thermal effect at different altitudes is an important result in itself, especially since it is clearly shown by the field data. However, overall, I found the structure and presentation of the manuscript requiring significant revision. At the outset, the Abstract should summarize the main findings of the research. I found these difficult to identify. The Abstract discusses rock fracture, altitudinal dependence, and climate change, but also presents results on shear plane controls, ice segregation effects, and snow cover. Whereas these latter three items are all part of the overall arching theme of rock fracture and altitudinal dependence, I believe that setting up the subject more clearly would assist with the delivery of the major findings. That is, I would suggest text along the lines of: "In this study, I investigate the various altitudinal effects (i.e., thermal cycling, snow cover, ice segregation) on rock fracture and place these in the context of climate change." On this last notion, climate change is discussed in the manuscript, but really only casually at the end and I feel that to tackle this subject, the Discussion should include a more in depth overview of what others have found on this subject. Referring back to the Abstract, I noted that the Conclusions section is almost exactly the same as the Abstract. Please note that the Abstract should provide an overview for readers who have not yet read the paper. The Conclusion summarizes the work for those readers who have finished reading the paper. They should therefore not contain the same identical content. Finally, regarding the overall structure of the manuscript, I found the Results and parts of the Discussion section quite tedious within the overall presentation. Whole sections of the text could be summarized in a table or chart, and it is not necessary to highlight the results of every fracture measurement or temperature reading. I therefore recommend a rewrite of large sections of the text (including the Abstract, Results, Discussion, and Conclusion) so that the results and main findings of the research are more clearly represented. Overall, I found the manuscript did not clearly deliver the apparent intended results of the study.

Specific Comments

Dummy Crackmeters. The use of the word “Dummy” should probably be changed to “Control”. Dummy implies that the device does not provide any useful information. Regarding the devices themselves, they are not quite control crackmeters either, however, since they are still measuring rock deformation, just not across a fracture. Thus, whereas they provide some guidance for understanding the fracture measurements, there use should be put into context that they are better for understanding the non-fractured behaviour of the rock mass. Also, since the crackmeters were temperature corrected (L113), it was unclear how the controls were used for verification of the measured signals.

Thermal Shock. The term thermal shock is used to describe rapid deformation and fracture observed in several previous studies (L265), however my understanding is that those studies did not depend on rapid temperature increases to cause the deformation. Rather, thermal shock has been more accurately described by others such as Hall, especially in the context of Antarctic environments which might be applicable to this study. This could be a case of needing to be more clear as to what temporal range thermal shock applies to.

Results. Many pages of the results are tedious to read and are presented as detailed descriptions of the exact deformation and temperature changes that the laboratory and field rocks went through. For example, most of Section 4.1 and nearly all of Sections 4.2.3 and 4.2.4 (which encompasses $\sim$ 2 pages of text) could be summarized in a few generalized sentences that describe the results in a chart form. The idea here is to ensure that the reader is guided through the results and their meaning instead of needing to interpret them on their own. As presented, it is not clear what the meaning is of the numerical values presented, other than a description of some parts of the figures.

Discussion. I found the Discussion section lacking in overall applicability to the geomorphological community at large. Typically, discussion sections try to place the context of the study in relationship to existing work. The author does that to some degree,

but mostly only to their own previous publications. I would have liked to see the results compared to those from other researchers working in this field and also to what they think is the likelihood that these results apply to other mountainous settings. In addition, placing the climate change interpretations in the context of others working on similar research in mountainous settings (e.g., Ravenel, Gruber, and others) would also provide the broader applicability that could make this research more impactful. Finally, much of the Discussion (large parts of Sections 5.1 and 5.2, which again span several pages) appear to be a continuation of the intricately detailed results. The Discussion is the section that allow the results to be placed into context, but I did not find this to be the case.

Figures. Whereas this study is clearly complex with bringing together observations from both a laboratory setting and several field sites, I am not sure that there is a need to present all the data for all of the sites in all of the figures. For example, Fig. 4 presents what appears to be similar data for both cracks at RW-1. If this is the case, only one plot could be presented and the other could be moved to the supplementary information. The idea is that if the data does not add to the story, than it does not necessarily need to be presented in the main text. For those scientists interested in using the data, the supplementary information could be consulted. This could also apply to Figs. 6, 7, 8, and 10. As currently presented, the take-home message of the presented results is not clear. On this note, I believe that more detailed captions could assist with describing the salient aspects and findings of the study. On a final note, I found Fig. 11 quite interesting and would recommend that this figure be used to structure the a large part of the Discussion section.

Technical Corrections

L10-12. Suggest rewrite without the numbers (i.e., (1), (2), etc.). This reads awkwardly and the main points of the study are therefore not presented clearly.

L11. Change to "...kinematics of intact rock samples..."

L13. Change to "...2935 m in elevation."

L31. Change to "and amplify fracturing by thermo-hydro-mechanical..." The sentence requires a verb, so this fixes the issue.

L63. Remove numbers of main points and try summarizing in more typical sentence form.

L63. Change to "Furthermore, I installed..."

L126. The use of the C1, C2 terminology should be clarified as these are not shown in Fig. 2.

L161. This section should likely be placed in the Methods.

Fig. 1. It would be helpful to point out that the red parallelogram in (d) is the area shown in (c).

Fig. 4. The forward slash symbol should not be used in the y-axis label, as this appears to represent that rock temperature is being divided by rock top temperature. Better to use a comma to avoid confusion. In addition, consider spelling out some of the abbreviations so that consultation with the caption is not necessary. At a minimum, the rock types could be spelled out, and perhaps the y-axis labels.

Fig. 5. The time frame over which the data is presented is not shown. This is needed to identify the hysteresis effect.

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