

Interactive comment on “Fracture dynamics in an unstable, deglaciating headwall, Kitzsteinhorn, Austria” by A. Ewald et al.

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We thank Anonymous Referee #2 for his/her insightful and constructive comments. The expressed criticism is substantial and points to a lack of novelty and originality in the submitted manuscript. We therefore consider a complete revision of our manuscript. The intended new manuscript will no longer focus on recent deglaciation, instead we will explore the relation between fracture kinematics and active layer dynamics in steep, frozen rockwalls. For this purpose we will now concentrate on regression analyses between data from the described crackmeter station and an adjacent permafrost borehole. We consider the immediate vicinity of a deep borehole and a crackmeter station a novel measurement setup that has the potential to advance the current knowledge on kinematics in steep bedrock permafrost. To increase the significance of the new

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analysis we will expand the time series to four years (2016-2019) as opposed to 2.5 years in the current manuscript. To model thermo-elastic deformation we will resort to the linear regression model published by Weber et al. (2017), and will no longer derive the thermo-elastic deformation component from cracktop temperatures below -10 °C, which has been criticized by all reviewers. To identify potential discrepancies between measured and modeled fracture kinematics we intend to implement state-of-the-art ice segregation models driven by borehole temperature data. Below, we respond to the major concerns/points of criticism of Anonymous Referee #2 only. Facing significant changes of the revised manuscript we assume that most minor comments will no longer apply, therefore we will not comment on here. More general comments of this section will be considered in the revision process.

REVIEWER COMMENT: MAJOR POINTS

1) How does steep rock slopes differ from deglaciated headwalls? Without a direct comparison, it is difficult/critical to assign processes to deglaciation.

REPLY: We agree. The intended new manuscript will account for this concern by focusing less on the impact of deglaciation, which cannot be quantified adequately with our measurement setup - and will instead focus on the correlation between fracture kinematics and active layer dynamics.

REVIEWER COMMENT: 2) I find the term deformation for discontinuities or fractures/cracks confusing or problematic. I associate 'deformation' in rock mechanical contexts with a continuum, so a deforming fracture would be one that changes for instance shape from being planar to being curved. You are referring to movement of one side of the fracture with respect to the other one, while the fracture itself remains undeformed. I suggest using to use the term 'dislocation' for fractures (i.e. infinite deformation along a nominally flat fracture with very small aperture), and leave the term deformation for intact rock.

REPLY: We will follow your suggestion and use the term fracture 'dislocation'.

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REVIEWER COMMENT: 3) You focus on steep rock slope but gravitation is totally missing in interpretation and discussion.

REPLY: We will put a stronger focus on the integration of gravitation in the new intended manuscript.

REVIEWER COMMENT: 4) You often mix results and discussion. I would suggest to clearly distinguish them.

REPLY: We will revise the document and separate results and discussion parts more thoroughly.

REVIEWER COMMENT: 5) Figure quality could overall be improved.

REPLY: We will cross-check figure quality and improve the quality if required.

REVIEWER COMMENT: 6) For me, the installation setup is not fully clear. I do not understand for certain what the two different crackmeters exactly measure. Therefore, it is difficult to fully review the results and discussion. Please also clarify the methods used.

REPLY: We will add another sketch depicting the installation setup to better illustrate the operation of the instruments used. We also look through the methods section to be more precise here.

REVIEWER COMMENT: 7) Think about to refine the research questions including some novel idea/thoughts. The first two questions are mainly answered by several studies for the third one you do not have any evidence!

REPLY: Since we decided to include the borehole temperature data into our analysis new research questions will arise. One new research questions will be: How do temperature changes in the subsurface affect crack behaviour. Further, we intend to include frost cracking models to identify identify and explain potential deviations between measured and modeled fracture dislocation.

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REVIEWER COMMENT: 8) You often relativize your findings by statements like "... not be detected with the current measurement setup.", "... not been observed in this study." or similar.

REPLY: We will revise our manuscript and change the language to avoid statement on findings, which we cannot prove.

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2019-42>, 2019.

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