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Interactive comment on "Nano-scale earthquake records preserved in plagioclase microfractures from the lower continental crust" *by* Arianne J. Petley-Ragan et al.

Arianne J. Petley-Ragan et al.

a.j.petley-ragan@geo.uio.no

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Responses to Reviewer #1

We find overall that the revisions done by Reviewer #1 are constructive and that we can address all of their concerns. We are happy that Reviewer #1 finds our TEM work 'superb' and worth publication in itself. In this respect, the revisions are quite positive and with the following edits, we believe our manuscript should be published in EGU Solid Earth. The main concerns from Reviewer #1 are the structure of the manuscript, the overlap with work by Petley-Ragan et al., the addition of a thermal diffusion model and further discussion of the importance of co-seismic fluid infiltration. The following

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Discussion paper

goes through these points plus other minor comments by the reviewer.

Reviewer #1 mentioned the similarity of our plagioclase microstructure with those observed by Bestmann et al. (2011, 2012, 2016) in quartz. They believe we should emphasize this similarity in the manuscript to enhance the significance of the study and highlight the general occurrence of this microstructure in paleoseismic faults. We agree with this point by the reviewer and will revise our Introduction and expand our Discussion to include this in the new version of the manuscript.

The structure of the manuscript, we agree, could be improved, and we appreciate the comments by both reviewers about this. We have expanded the Methods section to include EMPA and EBSD (as requested by Reviewer #2) and moved the section ahead of the microstructural description. We have also edited the Results section to include clear subheadings and moved any interpretations to the Discussion section.

The overlap with Petley-Ragan et al. (2018) was an issue for both reviewers. To fix this, we have edited Figure 2 of the EBSD so the reader does not need to go back and forth between the manuscripts (see Figure2_revised attachment). Figure 2 now includes the original uncropped phase maps of each microfracture with CPO diagrams of the plagioclase grains from Petley-Ragan et al. (2018). This emphasizes the strong crystallographic host-controlled orientation of the grains in the microfractures which is vital for the interpretation of the microstructure formation. The SPO rose diagrams are also included in a revised Figure 2.

We agree that a thermal model similar to that done in Bestmann et al. (2012) would enrich the manuscript greatly. We have now done this modelling and the results are presented in a new Figure 8 (see attachment). We thank the reviewer for noting the thickness of the pseudotachylyte was missing and have now included it as it is necessary for the thermal diffusion modelling. We used an ambient eclogite facies temperature of 700°C and appropriate thermal diffusivities for our rocks as defined in our revised Methods section. The new Figure 8 illustrates the contrasting thermal histories

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experienced by each microfracture.

Reviewer #1 brings forward many interesting points that will be included in our discussion: (1) the role of fluids in the formation of the microstructure, (2) the co-seismic timing of fluid infiltration, and (3) the source of the fluids. This are all very valid points and our research group have recently spent considerable effort addressing these issues. The main results will be published in separate papers, but we agree with the reviewer that these issues deserve a more comprehensive discussion in this paper. Hence, we have now expanded the discussion section significantly to address these points made by the reviewer and made proper references to other relevant studies mentioned by the reviewer.

Detailed comments by Reviewer #1 were all addressed and included in the revised manuscript. An additional pdf was added for the line-by-line comments and responses.

Please also note the supplement to this comment:
https://se.copernicus.org/preprints/se-2020-146/se-2020-146-AC1-supplement.pdf

Interactive comment on Solid Earth Discuss., https://doi.org/10.5194/se-2020-146, 2020.

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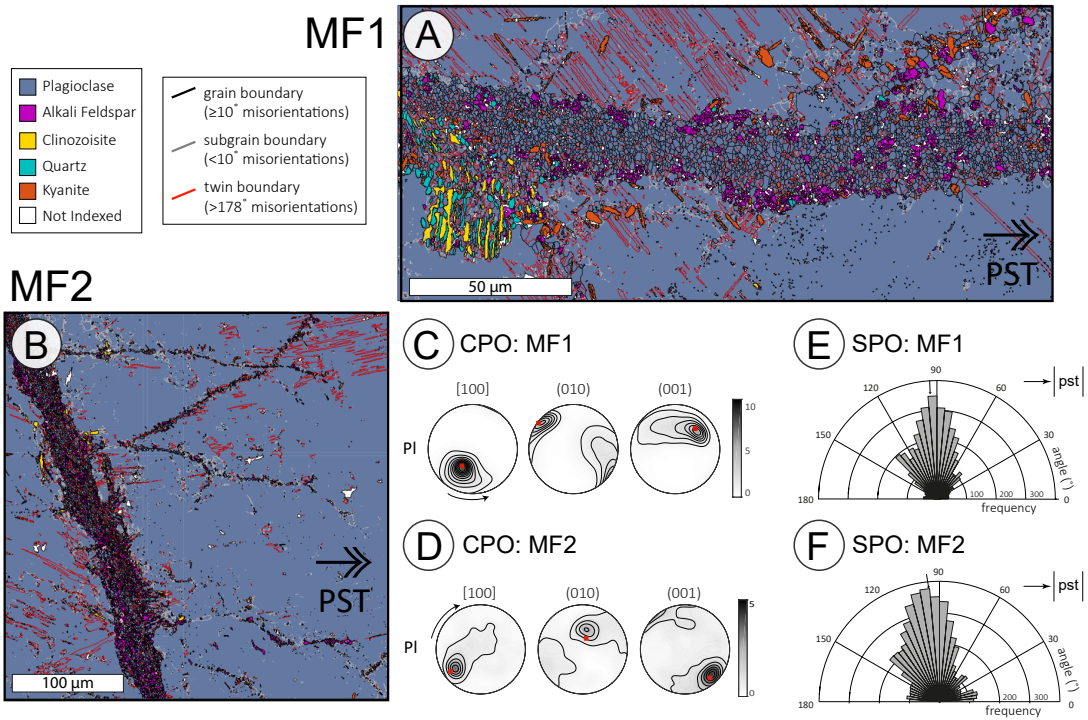

Fig. 1.

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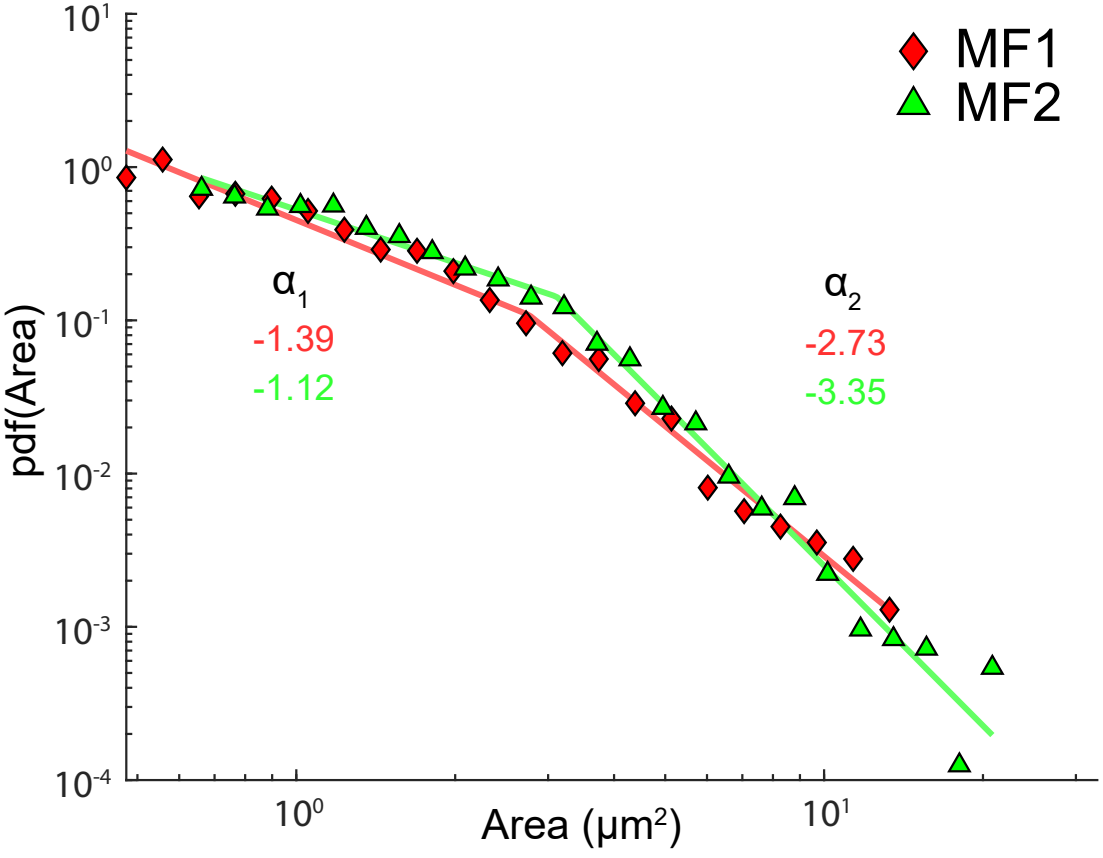
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Fig. 2.

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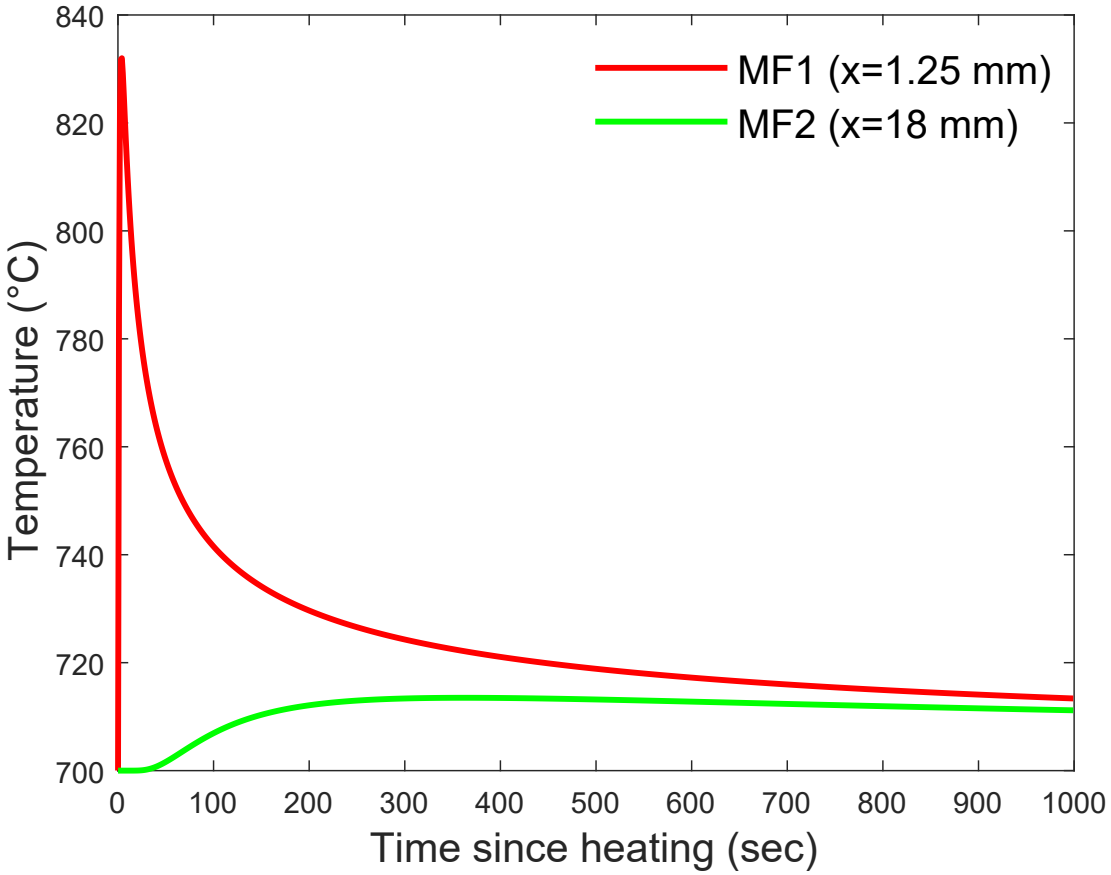
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Fig. 3.

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