Solid Earth
Discussions

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Interactive
comment

Interactive comment on "The competition between fracture nucleation, propagation and coalescence in the crystalline continental upper crust" *by* Jessica A. McBeck et al.

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Dear anonymous reviewer,

Thank you for these constructive reviews. We have significantly modified the abstract, introduction and discussion to more clearly specify the motivation and new contribution of this work. We respond to the comments point-by-point below. We added numbers to each point for clarity. We respond to the annotations of the manuscript in the attached document.

Thanks, Jessica McBeck

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Discussion paper

Review #2

34. The main message of the manuscript is not clear. It is not clear if they want to highlight the methodological approach or the results they obtained by applying the method. The research question for this paper though is well hidden. The scope of the manuscript, the objectives and hypothesis are not clear.

We wish to highlight both the methods and the results. We have significantly modified the abstract, introduction, and discussion to highlight the research questions more clearly. We also now state that the main scientific question relates to the tracking of the mode of propagation of microfractures (see answer to comment #35 below). A secondary result is the effect of pore pressure.

35. It is not clear what the motivation for these experiments was. Data seems to be the same as in previous publications, which is fair to use as getting proposals funded and time allocated to do the experiments can be difficult, but it needs to made clear, where this data is new and where (re)used. 3. In the introduction, the overall concept of how fracture networks develop is not clearly outlined, thus that all assumptions and reasoning is vague. References are missing in many parts, which would allow substantiating some of the party awkward assumptions. The controlling variables which are used in the experiments and seem to be the main outcome are not introduced at all (effect of stress on fracturing, interstitial fluids).

Although the data has been described in other papers, the new contribution of this work is the method for tracking fractures such that we may classify them as nucleating, propagating or coalescing. We describe this point in the methods section 2.3 and in the introduction (lines 85-90, 144-146). We have expanded this point in the introduction section.

The central characteristics of fracture network growth that we focus on in this work include the three categories of development that are described in the first sentence of the introduction, and listed in the title. There are many aspects of fracture network growth

outside of the purview of this analysis that we did not describe. We have significantly modified the introduction to clarify our use of the term mode.

We discuss the influence of confining stress and fluids in the discussion section in depth.

36. The methods do not introduce the techniques applied both the mechanical loading (e.g. rate of loading) and the tomography (e.g. which voxel size), as well as how you analyse the data (e.g. volume calculation, attribution to which mode).

We have added these important points to the Method section 2.1. We also now describe more specifically the two other studies that described these experiments.

37. The material used is not introduced at all. No description of the microstructure, no material properties (e.g. porosity). This makes it impossible to relate the tomography images and fracture network development to anything. The nucleation and propagation, especially at lower stress steps will be at grain boundaries and pre-existing defects and flaws.

We have added these important points to the Method section 2.1.

38. The first part of the results seems to belong to the methods, yet it is not clear which point is made. The description and representation of the results are hard to follow and do not seem to grasp/show important information. For example, you could colour the "new" fractures and the ones that coalescence in the shown steps differently.

We assume that the reviewer is referring to section 3.1., which describes the macroscopic mechanical behaviour of the experiments. This behaviour is a result, and a method.

Assuming that the reviewer is referring to Figure 1, the 3 cores shown at the bottom of the figure are from the three difference experiments, and not from different steps of the same experiment. We now mention this point specifically in the caption.

39. The structure of each section is flawed. The wording is unclear. Logical jumps make it very hard to follow the text. Especially in the introduction, the methods and results.

We have worked to improve wording and logic.

40. Most parts of the discussion seem to be about something completely different than the experiment (upscaling- from 10mm to upper crustal) or research question (I am assuming crystalline rocks – yet the discussion is on sedimentary basins). The development of the fracture network is not discussed. References, if given, do not fit the topic.

Please see response to comments #7-8 to the reviewer Dr. Aben.

41. The conclusion is contradicting the introduction in several aspects (e.g. LEFM) and is tedious as it simply repeats some statements made before which are not substantiated in the manuscript.

We have now modified the conclusion for conciseness.

42. Detailed comments: I have commented on the manuscript in detail for the Abstract and the Introduction (see supplement .pdf). The extent of these comments highlight some of the main issues of the manuscript and are alike for the following sections. The Figures are not fitting the manuscript or provide a visualization to enhance the text, some detailed comments can be found there.

We have responded to all of the annotated comments in the attached document. We describe how we have modified the text in response to these comments as well.

Figure S1: - "vox" –> "voxel" - The variation in fond size and labelling position is a bit irritating. Could you work on it? - what does this # refer to? why #3, #5 and then #4. Maybe add to caption what the three panel show. - log scale hardly visible -consider using a different symbol/colour for this type to clearly distinct from the nucleation, above. - Caption: This figure does not show this. It only shows it in comparison to another figure

Please name which figure this relates to. -Caption: The main trends are not indicated (in figure or text) - what are they? To make the point, you could add the trends of the 100 voxels to the figures.

We have reformatted this figure to improve clarity.

The # refers to the experiment code number. The experiments are ordered in the figures as #3, 5, 4 because this order reflects the different loading conditions. From experiment #3, 5, 4, differential stress and effective stress both increase, as stated in the caption to this figure. We are careful to include the loading conditions and fluid pressure with the # notation in all of the figures.

The main trends are described in the results section of the main manuscript: i.e., Figure 5, Figure 6. We now reference these figures in the caption of Figure S1.

Figure S2: -Again, fond size and labelling position are a bit irritating. Why did you change the colour scheme? -Why is this yield (point) line in red, while in a) they are in the same colour as the other lines

We have reformatted this figure to improve clarity. We have changed the color of the yield lines to red everywhere.

Please also note the supplement to this comment:
https://se.copernicus.org/preprints/se-2020-114/se-2020-114-AC2-supplement.pdf

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