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Interactive comment on "Measuring hydraulic fracture apertures: a comparison of methods" *by* Chaojie Cheng et al.

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The preprint paper "Measuring hydraulic fracture apertures: a comparison of methods" by Chaojie Cheng, Sina Hale, Harald Milsch, Philipp Blum deals with a comparison of three methods used to estimate the mechanical and hydraulic aperture of fractures under controlled lab conditions. The paper is well written, and the figures are nicely drafted and easy to understand. I think that this is going to be an important addition to the experimental literature aimed at quantifying fracture permeability with laboratory methods. I have some comments about the way the methods are presented and the context in which the results obtained are relevant. Some eleaboration of the authors on the following issues might help strengthen the paper:

(1) The aperture measured at the surface of an outcrop might not have anything to do with the aperture measured at reservoir or aquifer conditions, because of the stress state at depth. This issue has always hampered the recognition of any validity of fracture aperture measurements from cores, lab experiments, or outcrops.

(2) The boundary conditions during a measurement made with the Tiny Perm might lead to a non-uniform sampling of the fracture and to erroneous results. For example, there might be gas slippage from the fracture at the end of the nozzle. In this case the permeability measurement is affected by an asymmetry of the flow field, so that the real hydraulic aperture of the fracture is not obtained. The fact that the different methods give similar results does not mean that they can be extended beyond the experimental conditions tested.

(3) In the case of measurements made on fractures with smooth surfaces shut by the confining pressure, the instrument might read matrix permeability and not the hydraulic aperture of the fracture.

(4) I find the statement in the conclusion "For such purposes, this study shows that the transient air flow permeameter offers a fast and highly efficient approach for accurate hydraulic aperture determination" very strong and a bit misleading. The number of samples tested and the experimental conditions (stress state, scale, and dimensions) are rather limited for such a strong statement. The air flow permeameter is as good as the calibration curve that allows to empirically correlate the pressure decay to the hydraulic aperture. Given the peculiar and heterogeneous flow field of the permeameter within the fracture, this empirical correlations is likely to vary a lot from sample to sample.

Some technical remarks:

Line 18 ". . .aperture differences between samples are merely reproduced qualitatively." I don't find this sentence clearly written. Line 26 Also CO2 injection site characterization might benefit from your work . . . Lines 113-116 Some references would

help making clear what you have done here. Line 126 I would change the sentence like this:" ... pressure profile through time measured by the instrument pressure transducer and flowmeters" Lines 224-225 These fractures are likely closed and the TP measures matrix permeability Fig. 7 What are the black dots in the graph above measurements FF2, FF3, FF4, and FOF4? Line 262 Width or length? Fig. 9 What are the black dots above the boxplots? Lines 273-275 This sentence is not clear, please explain. Lines 338-339 "... the derived mean and ...." This is not clear what it means. Line 341 You talk about temperature in the conclusions but I am not sure you have investigated this in your experiments.

Please also note the supplement to this comment:
https://se.copernicus.org/preprints/se-2020-76/se-2020-76-RC1-supplement.pdf

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