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Interactive comment on "The influence of sample geometry on the permeability of a porous sandstone" *by* Michael J. Heap

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Reviewer #1 (Mathieu Colombier)

The author of "The influence of sample geometry on the permeability of a porous sandstone" studies the permeability fluctuations for rock samples of a similar origin (sandstone) for different lengths, diameters and aspect ratios. The author shows that, under the range of sample volume and aspect ratio taken into consideration, there are very limited variations of permeability. This study therefore provides results of broad interest for researchers studying permeability of rocks and is an essential step towards a community consensus for permeability measurements.

The manuscript is clearly written, easy to follow. To my opinion, the manuscript is

Printer-friendly version

Discussion paper

already suitable as it is for publication. I only provide a couple of minor comments for the author.

>We thank the reviewer for these endorsements.

Minor comments

Last page of the discussion, line 2-4 The author discuss the use of X-ray computed tomography on small-diameter cores and proposes that laboratory measurements of permeability might bring confidence on the results of XCT. Studies of pore structure using XCT frequently focus on even smaller rock samples (diameter and height <5mm). Would the author expect that such volumes would still be representative for the Darley Dale sandstones studied here? Or does the author expect a scattering of permeability values at volumes smaller than those analyzed in this study? At which critical volume would this scattering occur? It already looks from Figure 3b that there is slightly more variability of the permeability at low volume of interest.

>It is questions like these that I'd hoped to stimulate from the permeability-measuring community. In the absence of experimental data, my guess would be that the permeability of Darley Dale sandstone cores with lengths and radii shorter than the cores measured herein would be the same. Given that the pore size of Darley Dale sandstone is on the order of 200 microns, and that the pore structure is very homogenous, cores 2-3 mm in length and/or 2-3 mm in diameter may be sufficient (i.e. volumes between 0.006 and 0.02 cm3). I've now added an additional sentence to the discussion section to this effect:

>"Based on the small pore size and homogenous pore structure of Darley Dale sandstone, core samples smaller than those measured herein (e.g. samples with diameters and/or lengths of 2 or 3 mm) may be sufficient to obtain reliable values of permeability."

>I must stress, however, that this prediction is for Darley Dale sandstone only: rocks with a larger pore size would surely require larger samples (an interesting hypothesis

to test) and rocks with the same pore size as Darley Dale sandstone, but a higher porosity, may also require larger samples (another interesting hypothesis to test). Experimentally, there's plenty of room for further study.

>Regarding Figure 3b, I agree that it appears as though the permeability of the 10 mm-diameter sample is decreasing as the sample volume is decreased. However, this is largely a result of the semi-log scale: the permeabilities of the 10 mm-diameter samples are, when one considers the expected variability between different measurements, essentially identical (see the listed values in Table 1).

Line 5 Pore size, shape, aperture size, anisotropy, tortuosity and connectivity will likely all have a role for other types of samples.

>Agreed. This is discussed towards the end of the discussion section. I've now added an additional reference that deals with the complexity of pore connectivity in volcanic rocks (Colombier et al., 2017):

>"However, samples that contain, for example, very large pores or inhomogeneously connected porosity structures may still provide erroneous values of permeability if their lengths, diameters, and/or aspect ratios are low. Examples of rocks that are often characterised by complex microstructures include volcanic rocks (e.g., Farquharson et al., 2015; Colombier et al., 2017)."

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