

Interactive
Comment

Interactive comment on “Classification and quantification of pore shapes in sandstone reservoir rocks with 3-D X-ray micro-computed tomography” by M. Schmitt et al.

Anonymous Referee #1

Received and published: 7 December 2015

An adequate description of pore space properties is essential to understand effective behavior of rocks. The authors focus on a particular pore space property, the pore shape. They discuss how choices made during the image processing workflow have an effect on final shape parameters. The scope of the paper is a bit limited and might therefore be more suited to be submitted as a method paper and not as a research article in terms of MS type. The main findings are that 1) the Feret caliper provides a more robust estimate of length ratios than bounding boxes as it accounts for arbitrary orientation of pores and that 2) equivalent diameters have little meaning when the pores are very anisotropic. Both findings are not surprising and it is a matter of taste whether in combination they already suffice for a standalone paper. Actual permeabil-

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ity results (simulated or modeled) for all three rock types would have been helpful in order to discuss image-derived pore shape properties in relation to physical properties. Phrasing and spelling need to be improved occasionally. Some specific issues should be addressed:

1. Why do you analyze the very small pore disconnected pores in the NoBin images at all, e.g. in Table 3 and Fig. 11? They only constitute <1% of the pore volume and are therefore not representative for the pore space. Moreover, they are afflicted with the highest uncertainty in the segmentation step. The shape results for these small clusters do not have any physical relevance and can therefore be easily omitted. Instead you could just concentrate on the comparison between different marker extent parameters.
2. What causes the removal of smallest pore clusters when the watershed algorithm is done with the Bin option (compare Fig. 4, top row and also evident in Fig. 5)? Do the numbers 1,3,10 have a numeric meaning or do they just represent an arbitrary graduation.
3. S, I and L are equal for a sphere. Why are the different shape ratios not 1 for all pore clusters in the equivalent sphere results?
4. In section 3.4.2: The differences for different ROI are very small. Since you use the largest ROI volume eventually, you can omit this ROI analysis altogether and save some space.

Technical comments:

I30-31: That's a very general statement that I would question altogether. The 2D quantification comes from the 2D nature of imaging with conventional microscopy. However, with CT at hand, one would typically also apply 3D algorithms and most people have done so in the past.

I33-35: Careful with phrasing. The mass transport does not strongly depend on geo-physical characterization.

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I41-42: What is the difference between pore type and pore shape?

I45: What is pore network detachment?

I67-68: This sentence doesn't make sense. Why and how do you determine boundary conditions like flow rates or mechanical loads with image analysis, when they are typically well-defined in an experiment? Secondly, why do you need pore shape description for that?

I73: The term ganglia is usually associated with isolated clusters of non-wetting fluid in a porous medium. I would rather call it disconnected pore clusters.

I75: Please explain what the marker extent parameter is. Alternatively omit this statement here and describe it in the method section.

I80: replace 'absolutely mismatched' with 'inaccurate'

Table 1: name convention is confusing. Is the correct name S1 or BE02b?

I121: the error of what property?

I134-135: Remove this sentence.

I140: remove 'all those'

I170-210: Only state the name and age in the listing and move the explanation completely to the paragraphs thereafter or provide the full explanation in the bullet list. At the moment it's a mix of both.

I174: What are better-ordered grains? Narrow size range, more spherical shape, ...

I207: Replace 'Conclusively' with 'In summary'

Table 2: The #projections only sum up to 350°?

I229: The median filter doesn't enhance edge contrast. It removes noise without blurring the edges.

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I229-232: Does interactive mean that the user can make adaptations of any kind? Then why is it at the same time automatized? How do you mix SEM information with CT information?

I244: Bad phrasing: undefined image's grey level

I247: power of three missing in denominator

I256: replace 'one can visualize' with 'depicts'

I275: remove 'fairly'

I280: replace 'highest' with 'biggest'

I295: do you mean 'without the Bin command' instead of 'without the watershed command'?

I328: typo in 'bonding-box'

I350: remove 'straightforwardly'

I369: what does 'equally embossed' mean?

Fig. 7,8,9 (equancy plot): If I/L and S/L are equal, then only plot one of them. In turn, if lines and symbols belong to different axis, then state in the caption, how to read the figure.

I442: Remove 'The graphics in'

I453: bad phrasing: 'singular'

I485: remove 'forms'

I485-498: Where do you show permeability results (simulated or measured)? I would argue that porosity and pore connectivity are more important for permeability than average pore shape. You cannot really discuss permeability without addressing the other important pore space properties.

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I522-525: Wrong. Mercury intrusion capillary pressure relates the the maximum inscribed sphere method and not the equivalent sphere method.

Interactive comment on Solid Earth Discuss., 7, 3441, 2015.

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