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Solid Earth Discussions

Interactive comment on "Digital Carbonate Rock Physics" *by* Erik H. Saenger et al.

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The overall quality of the paper is good but a number of minor revisions are needed to make it clearer and ensure good understanding. This paper presents a novel approach for estimating elastic properties of carbonate rocks combining laboratory measurements, imaging technique and simulations. The technique in itself is not new but the authors approach differs regarding the image segmentation to estimate unresolved porosity or unidentified phases and then the measured porosity is used for estimating rock properties. As the editor mentioned, I strongly recommend adding some relevant references regarding previous major works regarding DRP and rock physics: Arns et al., (2002, Geophysics Vol.27), Derzhi et al., (2010, SPE 138586), Ringstad et al., (2013, EAGE) etc. . . The authors should compare their results with previous published works as per today DRP results regarding elastic properties are rarely matching experimental data and are often overestimating Vp and Vs. Part of the author's technique is

based on image segmentation into different classes. In Page 6, last paragraph should be improved for better understanding. What defines "global thresholds"? Why do you end up with 5 intermediate classes? Please make it more specific. In page 8, first and second paragraph (line 10) should be clearer. It is difficult here to understand the Figure 7 description you made here. How do you end up with a minimum and maximum porosity for each subsample? You mentioned that you selected the "most relevant subsamples" on which criteria is based your choice (porosity only)? A table for both high and low resolution summarizing both calculated and experimental poro/perm will be maybe useful as it is difficult to understand why Figure 7 and 9 are so different. In page 10, Line 18 you highlight the scale issue which is well known from previous studies when comparing DRP and experimental study. Have you made any attempts to upscale DRP results to plug scale? Maybe citation of existing study could be necessary here to avoid misleading conclusions. Paragraph 5.1 you state that even with the highest resolution achievable you cannot resolve all the smallest pores which is true. But techniques exist to overrule these limitations as dry and wet imaging as described by Bhattad et al. (2014, SCA-2014-24) for example. This should be mentioned. Paragraph 5.2 page 12, you write that "porosity values of carbonate using micro-XRCT will only provide estimates with relatively high uncertainty due to significant amount of unresolved pore feature in images". I do disagree with this statement; your approach based on single scale imaging is not suitable for proper porosity estimation. Numbers of published papers show the opposite (Lopez et al, 2012). You should be more specific here and mentioned that for carbonate having one image at a single resolution is not enough for porosity estimation. And this is what you work is supporting, that with a single image and doing some assumptions due to unresolved structures it is still possible to estimate some of the effective properties! Paragraph 5.4, for the Vp and Vs it would have been nice to have the value at infinite resolution as described by Arns et al. (2002) in their Figure 4c. In summary, this paper demonstrates a new way of estimating elastic properties of carbonates containing micritic phases based on micro-XCRT and experimental nano-indentation. This is an elegant way to define moduli that are often

not well known for non-pure minerals and use them for elastic properties determination.

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