

Interactive comment on “Porosity and permeability determinations of organic rich Posidonia shales based on 3D analyses by FIB-SEM microscopy” by Georg H. Grathoff et al.

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This manuscript titled "Porosity and permeability determinations of organic rich Posidonia shales based on 3D analyses by FIB-SEM microscopy" from the authors Grathoff, G.H., Peltz, M., Enzmann, F. and Kaufhold, S., consists to visualise shales in high definition, down to the intra-organic matter scale, to assess the pore topology and its connectivity in order to estimate the storage & transport properties of two gas shales from Posidonia with different TOC content. I think the imaging methodology is rigorous and quite well explained, pushing the resolution limits of each technique and the data are well presented. The overall is clear and easy to follow. The manuscript is well written and after few clarifications that I will define in the following section, the paper

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should be ready for publication. However, I have issue with the usability of the scientific data of this work to the community that I will explain below. Without considering stress and preserved hydration condition, I really have concern about the results from the pore topology and even more for permeability computations point of view. The authors are working on unpreserved shale samples and therefore completely damaged shales affected by (i) brutal degassing of the gas from the organics leading to change the pores, especially connectivity; (ii) without proper clay hydration, the effective porosity reading from the different methods is wrong, especially pore throat size access for gas and wettability of the minerals (clays and organics); and (iii) without stress during imaging/data acquisitions, cracks & pore throats/pore size distribution is affected, especially in shales, leading to over-estimate drastically all the storage capacity and transport properties. In other words, I'm not sure if anyone can use these data to compute storage capacity and gas productivity from these Posidonia shales !? However, I insist that the methods used in this work are very well applied and properly explored; no doubt about that. That's why it's kind of complicated to give the green light for publication of this work.

I would invite the authors to clarify few points of discussions: - Thoroughly insist in the introduction & discussion the consequences of working on unpreserved shale samples and without stress condition (i.e. In-situ reservoir conditions) to image and measure pore sizes/pore volumes...etc. This point HAS TO be clearly presented. All the methods (MICP, N₂, CO₂, FIB-SEM) require dry samples that partially destroy the pore structure and affect organics in shales. The clay bound water in shales is crucial and mostly affect all the studied parameters in this work. This point needs to be discussed. - The authors need to have in hand the true TOTAL porosity for reference from density calculation (the most robust and independent of hydration level of shales; though the stress will still influence the result). Ideally, get the bulk density from logs and measure grain density in lab to properly compute the total porosity. Then get the data from these shales about organics adsorption capacity (Langmuir curves) and water content to see if the extracted porosities from the different methods used in this work are coherent.

- For the permeability, it's hard for the readers to trust the authors about permeability estimations without data support from their shales: permeability measurements with water/gas. The authors give references from others permeability shales that cover more or less all the range of shales permeabilities. One order difference will change drastically the producibility of the studied shales. In other words, in the way it is for now, this permeability estimation remains for me a black box giving a magic number !

- I think there is an inversion in the definition of intra- and inter-particles (lines 33-34, page2): Inter is between particles and intra is inside/within particles. - I don't think the paper claiming fluid and gas flow related to shale diagenetic history (line 10 page 2) is achieved. No flow experiments are presented in this dataset. All the data are recorded in static condition for storage capacity estimation, without stress regime. So I'm not not sure of the true capacity of storage of this studied shales.

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