Authors comments on the topical editor's comments and suggestions

Dear Mr. Heap,

Thank you for your comments and suggestions concerning our manuscript. We submit an updated version of our manuscript that considers most of your suggestions. We highlighted the changes in the text by yellow background.

Although reviewer #1 disagrees with the use of the Debye model, I appreciate that the authors now include a more detailed reasoning. However, I would like the authors to include more information that outlines why Revil et al. (2014) consider that, to quote their paper: "…the Warburg function, rather than the Debye function, is the correct transfer function to determine the pore size or the pore size distribution". Revil et al. (2014) provide a lengthy discussion on this topic. Since the authors disagree with the reasoning of Revil et al. (2014), I would like them, in a few sentences or short paragraph, to explain why they disagree and why they have decided to use the Debye model.

We have extended the paragraph in the Theory chapter to explain our motivation to use the Debye decomposition:

"Florsch et al. (2014) demonstrated that a variety of models can be used as kernel for the decomposition of the spectra. Revil et al. (2014) compare the results of Debye and Warburg decomposition. Their argumentation, which is based on mechanistic grain size models describing the polarization of charged colloidal particles and granular material, supports the application of the Warburg decomposition that results in a narrower distribution of polarization length scales. It should be noted that a uniform grain size does not automatically generate a uniform pore size. Besides it can be clearly seen by the scanning electron microscopy images, that the investigated sandstones feature a distinct range of both, grain and pore (throat) sizes. Considering that the pore size and not the grain size controls the polarization of sandstones, as observed and by different authors (e.g. Scot & Barker, 2003; Niu & Revil, 2016), a wider distribution of length scales can be expected. According to our opinion, there are no clear indications for superiority of the Warburg decomposition. Up to now, a theoretical model that confirms the validity of the Warburg model in describing the polarization of a simple pore space geometry has not been presented. Therefore, we prefer to use the Debye decomposition, which has proved to be a useful tool in the processing of IP data in both time and frequency domain (e.g. Terasov and Titov, 2007; Weigand and Kemna, 2016)."

There are still several instances where the authors mention that MIP yields the pore radii, rather than the pore throat radii. For example, on line 373: "The MIP yields the widest range of pore radii." Due to the subject matter of the paper, I think it's important to be precise here and elsewhere in the manuscript.

We agree with this point and have been more precise within distinct parts of the manuscript using "pore radii", "pore body radii" and "pore throat radii", respectively.

I think that the authors should offer more information on their method of permeability. Gas permeability measurements on porous sandstones typically require a Forchheimer correction. Did you correct for turbulent flow? Under what confining pressure were the measurements performed?

We have added additional information on the permeability measurements at the end of the Methods section of the manuscript:

“Permeability measurements have been performed by using a steady-state gas permeameter (manufactured by Westphal Mechanik, Celle, Germany), using nitrogen as the flowing fluid. This device features a so called “Fancher-type” core holder as described by Rieckmann (1970). With this special type of core holder, significantly lower confining pressures are needed than by using a conventional “Hassler-type” core holder (12 bar for the “Fancher-type” core holder versus min. 35 - 50 bar for the “Hassler-type” core holder), leading to much less initial mechanical influence (compaction) upon the sample material. Measurements have been derived under steady-state flow conditions with accordingly low flow rates in range from 3 to 5 ml/min, leading to measured pressure drops in range from 2 to 7 mbar from sample inlet to outlet. The derived apparent permeability values have been corrected, to address the Klinkenberg-effect of gas slippage (Klinkenberg, 1941; API, 1998). Due to the usage of a steady-state technique with low gas flow rates, correction of the Forchheimer effect of inertial resistance can be neglected (API, 1998).”

Regarding the comment of reviewer #1 about the "very poor review of the existing literature", the 2005 paper of Louis et al., for example, discusses the microstructure of Bentheim and Rothbach sandstone. Perhaps the authors can compare their results with those in this paper?

The mentioned paper in general deals with anisotropy of susceptibility and p-wave velocity. It does not give any comparable insight towards the pore structure (though it is mentioned in the headline, only grain size distributions > 50 µm equivalent diameter from 2D analysis are shown). Besides, Rothbach (Vogesen, France) and Röttbacher (Mainz, Germany), sandstones are from different locations, though they are both related to the Bunter Sandstone and hence to Triassic age. It would not be reasonable to compare different locations with each other without having all relevant data.

Nevertheless, we have added seven more references in order to improve the review of existing literature.

There’s a typo on line 87: “intention”.

We have corrected the spelling of this word.