

***Interactive comment on “Impact of controlled changes in grain size and pore space characteristics on the hydraulic conductivity and spectral induced polarization response of “proxies” of saturated alluvial sediments” by K. Koch et al.***

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Received and published: 10 September 2010

The manuscript by Koch et al. discusses the effect of the texture of very simple porous media (proxies of saturated alluvial sediments) upon the spectral induced polarization response in the laboratory. I am not aware of the publication of such a work in the literature. I especially like the compaction experiments as they show that something is going

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on in the relaxation time that is not described in available models. This manuscript is well written. The description of the EDL is a bit fuzzy: we can read "towards the outer limit of the EDL, where ions are in equilibrium with the solution" is not correct. Indeed each element of the diffuse layer is in equilibrium with the neutral part of the pore water. Actually the Boltzmann distributions for the concentration profiles of the cations and anions are derived from the equality of the electrochemical potentials between any distance in the diffuse layer and infinity (for which the electrostatic potential is zero), see for instance Revil, A., & Glover, P.W.J., Theory of ionic surface electrical conduction in porous media, *Physical Review B*, 55(3), 1757-1773, 1997. Another sentence that is really wrong is the following: Much of today's conceptual understanding is based on the work of Schwarz" Actually (i) Schwarz never mentioned the Stern layer in his seminal paper. His model was supposed to represent the entire double layer. (ii) the standard model used in colloidal chemistry is the Dukhin and Shilov model based on the polarization of the diffuse layer, and (iii) most of the geophysicists still believe that the membrane polarization is the dominant mechanism of polarization. This is only since the work of Revil and co-workers (Leroy et al, 2008, Leroy and Revil, 2009, Jougnot et al., 2010, and Revil and Florsch, 2010) that the Stern layer has been considered to be the potential main contributor to low frequency complex resistivity. There was no work published previously in geophysics that were pointing out a dominant role to the Stern layer. De Lima and Lesmes in several papers pointed out the potential role of the Stern layer but the model they used was based on the Dukhin and Shilov theory of diffuse layer polarization. This historical note needs probably to be put in relief in this manuscript because one may believe that the Stern layer polarization model has always been something obvious to geophysicists, which is grossly untrue. The model of Titov is a membrane polarization mechanism, it should not be listed with a Stern layer polarization mechanism as presently written in the text. Both contributions are however compatible (they can exist simultaneously). I therefore do not understand the discussion of the Titov model after the point raised that the polarization of the Stern layer is the dominant mechanism. The experiments and the interpretation of the re-

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sults in term of the cole cole parameters is good. This sentence is going backward: These findings corroborate (...) are consistent with the original findings of Kozeny and Carman in that the specific surface area of a porous material is in general the determining parameter for permeability" I would say that this is simply untrue and 70 years of works in petrophysics have demonstrated that the specific surface area is certainly not the relevant parameter characterizing the permeability (think about dead ends for instance, you should read the folowing apper and references therein: Revil, A., and Cathles, L.M., Permeability of shaly sands, Water Resources Research, 35(3), 651-662, 1999. The authors should make for their benefit a short review of the available literature on this subejct and this idea has been strongly discussed and foughted by many researchers. I fully agree with the conclusions of the compaction experiments that are great and puzzling results. In conclusion, I think this ms can be published with minor revision. It is a very timely work.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 6057, 2010.

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