**Hydrology and Earth System Sciences Discussions**

Interactive
Comment

# *Interactive comment on* "Thermal conductivity of unsaturated clay-rocks" *by* D. Jougnot and A. Revil

**Anonymous Referee #3**

Received and published: 9 September 2009

Review of 'Thermal conductivity of unsaturated clay-rocks'; by D. Jougnot and A. Revil.

General comments

The paper's main point of interest is the thermal conductivity of rocks. Since this property is difficult to measure, the paper sets out to link the thermal conductivity to the more easily measured electrical conductivity. The stated aim is to develop a non-intrusive measurement technique of the electrical conductivity from which the thermal conductivity can then be derived.

Overall I can agree with this approach but there are some glitches: the authors seem to find the relevance of the thermal conductivity self-evident, but it would strengthen the

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argument if the Introduction could elaborate on that; this need not be extensive, just an indication in a few lines should suffice. The single sentence devoted to it now is too concise to be convincing.

The proposed link between electrical and thermal conductivity is developed in a few equations. The presentation suffers from lack of clarity about the meaning and the dimensions of the variables, but this should be easily remedied. I consider this the major contribution of the paper, and it is worthwhile presenting it clearly.

The developed model is tested on rock samples, but the authors lost me there: the methodology is not clearly laid out (a section 'Materials and Methods' is entirely lacking), and bits of it appear scattered throughout the paper. I had a hard time finding the size of the samples, the method by which they were obtained, the location and depth from which they were obtained, the composition (notably the electrical conductivity) of the liquid phase in the samples, etc. I also believe the samples to be disturbed and am left wondering if that does not severely hamper the test of the model: if it works on disturbed samples, how can we be sure that it works on undisturbed material as well, which probably has a very different fracture network. All in all this section of the paper is a bit hectic and confusing. If the underlying sampling technique and experimental methodology is sound, this can all be remedied by careful rewriting.

Finally, there seems to be a discrepancy between the desire to develop a non-intrusive in situ measurement technique and the actual achievements of this paper: there is no field test after the work on cores. The authors have not even come close to proven this, and I expect this to take substantial additional work. Again this relates to the very brief introduction. Expectations are being raised to unrealistic levels. Although the long-term goal could be stated there it should also point out that this paper focuses on a first step in the desired development of a new measurement methodology.

The paper would greatly benefit from a careful rewriting. The Introduction can be extended (it is about 30 lines now) to better point out the relevance of this work, and its

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objectives. A Material and Methods section is highly desirable. This could also include a more extensive description of the geological formation from which the samples were taken; the geological units (see Table 2 for instance) remain clouded in mystery for me. The section introducing the model deserves a more careful presentation to improve its clarity.

In its current sate I find it very hard to assess the merit of this paper. I suspect but am not fully convinced the work is sufficiently novel and substantial to warrant publication in HESS. I hope a revised version sheds more light on this.

Specific comments

Please have the English checked. Many sentences are a bit awkward, and the use of present and past tense in a single paragraph occurs here and there but is usually not warranted. The use of the past tense for actions that took place in the past is often inappropriate. I suggest some improvements below, but not exhaustively.

Please rethink the use of terminology. What is a 'scale of porosity' (section 3)? Is the pore size the radius or the diameter? At some point 'texture' (usually referring to the shape and size of the particles) is used to denote structure (the spatial arrangement of the particles, the pore architecture, the presence and nature of cracks, etc.).

p. 2412, below l. 15: this belongs in Materials and Methods

p. 2413, top paragraph: this is a result.

p. 2413, section 3: The part of section 3 on p. 2413 belongs in Materials and Methods.

p. 2413, l. 16. The variation in porosity seems to be extraordinarily small. What was the sample size, how many samples were there, and how were the porosity and its variation determined?

p. 2413, l. 20-25: please provide references for the methods you discuss.

p. 2413: please provide more detail about the two porosities you define here, and their

connection to bound water. Also: how do you define bound water?

p. 2413, l. 25: How do you know the fraction of the porosity that is unconnected?

p. 2414, l.4-5 This is methodology. Please give more detail about the wetting process. Can hysteresis e a factor?

p. 2414, l. 6: Texture or structure?

p. 2414, l. 7: I do not understand the part about the galleries. Please rephrase. Should that information really be given at this location in the paper?

p. 2415, l. 1-7. Does this belong in Materials and Methods? You use present tense here, but you seem to report how you did things; is the simple past tense not better suited for that?

p.2415, l. 12: What was the correlation coefficient of the 'quite good correlation'?

p. 2416: I find the conclusions not too convincing. You speculate that the method works in disturbed samples and undisturbed material, but you show no proof. Also, the scale issue involved in upscaling to much larger in situ scales is not addressed. If you rewrite the Introduction and the objectives, you should rephrase the conclusions too, I think.

Technical corrections

Explain variables on first occurrence and specify their dimensions.

p. 2415, bottom paragraph: single and past tense used inconsistently.

p. 2410, Abstract: parameters should be in italics.

p. 2410, l. 8: two times 'first';

p. 2410, l. 12: a phase cannot have a variable saturation: ...at different water saturations.

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p. 2411, l. 5 and elsewhere: Gruescu et al.: (2007) or (2006)?

p. 2411, Eq. (1): there are nested ( ) in the equation; please use the prescribed order of nested brackets

p. 2412, l. 1: remove typo.

p. 2412, l. 12: add space before n

p. 2412, l. 22: exponents and the verbs should be plural.

p.2412, l. 24: experimentally observed...and the corresponding N calculated values...

p. 2413, top paragraph: past tense seems better.

p. 2413, l. 14: ...a completely connected porous skeleton.

p. 2413, l. 15: ...material is granular.

p. 2414, l. 5-6: ...required to let the water evaporate...

p. 2414, l. 12: ...first discuss...

p.2414, l. 20: prior -> priori

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 5, 2409, 2008.

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