

Interactive comment on “The usefulness of outcrop analogue air permeameter measurements for analysing aquifer heterogeneity: testing outcrop hydrogeological parameters with independent borehole data” by B. Rogiers et al.

Anonymous Referee #1

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This paper contains relevant information with respect to the relation between outcropping sediments and subsurface sediments from the aquifer. As an analogue air permeability measurements are used in the paper to describe the saturated hydraulic conductivity. Grain size distribution between outcrop sediments is compared as well as values of the hydraulic conductivity. Relations between porosity and the hydraulic conductivity are investigated and the scale effect on hydraulic conductivity obtained from different data sources (small soil cores, pump tests, etc.) is investigated. Also the vertical anisotropy factor is compared among the different investigated geological formations.

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At the end of the paper the spatial variability for the different data sets is investigated by the use of experimental and modelled semivariograms. The paper is well written and contains important materials that have a scientific relevance which is within the scope of HESS. What could be improved is the description of Materials and Methods. Also it is difficult to interpret the quality of the geostatistical analysis.

In the Materials and Methods a more detailed explanation on how the air permeability measurements were performed not only referring to Rogiers et al. (2013) should be presented. In general it is difficult to get an overview of the different kind of hydraulic measurements related to the work. Also it is difficult to figure out which of the data that relate to the current work or to others work. I suggest a table with a complete overview of the different type of measurement (borehole core samples, pump test, and air permeameter), the scale of the measurement, number of measurements, reference, etc). Also there are some issues that in the paper have to be clarified. This includes an explanation of the empirical equation from Iversen et al. (2003) and the subsequent numerical upscaling step (p. 9694, line 6-7). Later on there is also a need to clarify how you numerically upscaled measurements grids to obtain equivalent horizontal and vertical K values at the scale of the outcrop (p. 9694, lines 24-25).

In the Results and Discussion an explanation on the influence on larger cracks/pores on the saturated hydraulic conductivity is lacking. It is well known that large pores will have a high effect on values of the saturated hydraulic conductivity. The larger the measurement scale the larger the probability that the measurement encompasses a representative elementary volume. A sandy sediment will most likely have a smaller representative elementary volume than a more clayey sediment. This is probably also one of the reasons why the sandy sediments of your study show a higher similarity between your outcrop data and borehole data. A sample volume of 100 cm³ is most likely below the representative elementary volume for the clayey sediments in your study when measuring the saturated hydraulic conductivity. This needs to be discussed.

I find it confusing that your experimental and modelled semivariograms are plotted with

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the lag (x axis) on a logarithmic scale (Fig. 8). Since you not include any statistics in relation to your fitted variograms it is difficult to judge the quality of the fittings. Maybe this has to do with the log scale (or the poor quality of the Figure), but I find it difficult to see that it should be possible to fit the outcrop data of the sandy Kasterlee Fm and the clayey and sandy Diest Fm (Fig. 8 B, D and E) having a sill and a range. The same goes for the borehole data of Mol Fm and the sandy Diest Fm. Also I question the fitting of the pooled data. A suggestion could be that you include some statistics that objectively describe the quality of the fitted variograms.

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