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Hydrology and Earth System Sciences
Discussions



# *Interactive comment on* "Large scale 3-D modeling by integration of resistivity models and borehole data through inversion" *by* N. Foged et al.

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## General comments

In general, the topic of combining borehole data and (airborne derived) resistivity data to obtain a 3D geological / geohydrological model is very relevant. The use of airborne EM data will be much more accepted in the near surface geological user-group if the geophysical data can be "converted" to an useful geological model. Therefore, I think the research is highly relevant. In my opinion, the translator function can be seen as a meaningful way to describe the relation between resistivity and clay fraction. It reflects the general knowledge about the way sediments influence electrical resistivity (clay is a conductor, sand is a resistor) and also the non-linearity of this relation. It is



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also a fruitful way to use the (often general) way in which boreholes sometimes are logged in terms of lithology. It is important to note that the translator function is not able to distinguish between different types of clay and lutum-content (which is done by the authors). The effect of non-water saturated sediments and that of groundwater quality needs to be stated more explicit. I would think that there is data available from watersamples, well-logging or any other information, that provides information about the height of the watertable and confirms that the groundwater is fresh, and as such not a major factor in the resistivity.

Specific comments

There are some issues in the paper I do not understand / are not clarified satisfactorily. One of the main issues is scale. The translator function is defined on a 1km grid and then applied to boreholes in order to obtain consistency between clay fraction from the lithology log and clay fraction from the resistivity models, Fig. 1 and 2. On page 1468, the authors mention the procedure to define the translator function at the resistivity models, but the effects of the large distance between grid-node of the translator model and the resistivity models is not discussed. The final model has a grid size of 100m x 100m, which is considerable more detailed than the translator model. The consequences of this difference in scale should be discussed. Besides that, the consistency comparison between clay fraction from the resistivity models and from the lithology logs (Fig. 1) involve some decisions about which borehole to use for the comparison. For example, is there a distance constraint used for comparing boreholes with nearest resistivity model? On page 1468, lines 14-18, the migration of the translator function to areas with few / no boreholes needs justification. The decision to do this is rather crucial for the resulting model and at least an attempt should be made to estimate the effects. Page 1468, lines 19-23, the procedure is explained for obtaining the clay-fraction from the resistivity model at the location of the borehole. Point kriging is used, and I would recommend that the authors make clear that this is carried out with keeping in mind the maximum correlation distance. Beyond that distance, the



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interpolation is merely a local averaging. The results, as displayed in Fig 6 and 7 are promising. It seems to confirm the general geology of the area, but there is no rigorous validation of the procedure, e.g. performing cross-validation (leaving boreholes out of the dataset, one by one, and comparing the estimate with the borehole data) to judge the performance. Another option would be to split the dataset (e.g. 20%-80%) and estimate the quality of the procedure on using 80% of the data on the remaining 20%. This would give the reader a better "feel" of the quality of the results. The results are defined in terms of clay-fraction: the fraction of the length of an interval that is clay. How would this convert to hydrological parameters? The authors mention that, after clustering, the Norsminde are can be divided into sub-areas, with different hydrological parameters. Is there a way to use the results of the clay-fraction model directly into groundwater models?

Detailed comments on the manuscript

Detailed comments can be found in the annotated pdf.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/11/C671/2014/hessd-11-C671-2014-supplement.pdf

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 1461, 2014.