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Hydrology and Earth System Sciences Discussions

Interactive comment on "Self-potential investigations of a gravel bar in a restored river corridor" *by* N. Linde et al.

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I think the paper by Linde et al regarding the self-potential investigation of a river bank is a very interesting contribution in hydrogeophysics. I like the combo of field work, forward and inverse modeling. I have few comments listed below that the authors should at least discussed.

1. I found the introduction a bit pessimistic. All the researchers working with SP know that SP is not a stand alone method and requires resistivity to be interpreted. This has been mentionned in a number of publications. In addition, SP has been a very popular methods because most of the times it works very well, which means in a lot of cases, one contribution seem to dominate the others. So I think the authors shoudl be a bit

less pessimistic about the use of this method.

2. I would like to see resistivity data. As mentionned by the authors, SP cannot be interpreted properly if resistivity data are not there to help to locate the current sources and define the boundaries between hydrogeological units. I think it is fair to ask the authors to show the resistivity data at their site.

3. My biggest complain is about the SP inversion and its interpretation. The authors used a classical deterministic approach to invert the position of the volumetric source current density in the ground incorporating some information regarding the resistivity distribution in the inverse problem. The self-potential inverse problem is both underdetermined and ill-posed as mentionned by the authors themselves. It has been shown by Revil and co-workers that a better option is to use a prior model based on the modeling of ground water flow to start a determinitic inversion (see Boleve et al., 2009)or to use a stochastic inversion of the material properties assuming some knowledge about the position of the interfaces from independent information (GPR, Seismic, etc.) (see Jardani and Revil, GJI, 2009). My experience is that using the type of algorithm discussed by Linde et al, the position of the sources are usually found to be shallower than they truly are, even using a good normalization of the kernel with depth. Therefore, I have some doubts that the current sources are located in the vadose zone. Therefore I have also doubts about the physical interpretation of their results (the response is due to henetrogenities in the vadose zone rather than in the saturated portion of the ground). Also if I look at their figure 9, it seems that the infiltration through the vadose zone produces only minor SP changes (few tenths of mV by comparison with 10 mV measured at the surface). Regarding at the data, I still believe that the signals are just cause by the flow in the aquifer (with different coupling coefficient for different materials) and the continuity of the electrical potential distribution above and below the water table (the potential below the water table being proportional to the head via the streaming potential coupling coefficient).

4. Maybe it would be good to take some materials from the site and measure the

streaming potential coupling coefficient.

5. Maybe the authors should simulate the flow of water in the unconfined aquifer and compute the source current density and resulting SP response from such modeling. This would offer an alternative to their modeling and check if yes or no the flow of water in the aquifer is responsible for the observed SP anomalies.

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