

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

N. Linde et al.

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Received and published: 19 November 2010

Dear Prof. Revil, Thank you for your review. We don't agree with all of your comments and suggestions, but it is clear that this is largely due to the fact that we haven't provided and described all necessary information about the study. Please see my comments with respect to the five issues you raise.

1. I don't consider the introduction overly pessimistic, but rather realistic and indicating why SP is such an interesting research topic (many successful SP studies are cited in the introduction). We will revise the introduction after that the open discussion is closed to make the tone slightly less "pessimistic", while still covering the same type of material. Please notice that the paper is intended for a special issue related to
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river restoration, so it is necessary to explain certain things that appear evident for the experts in SP research. There is a lot of uncritical use of SP data and it is often due to not recognizing some of the challenges that I point out in the introduction.

2. The ERT models are presented in two submitted papers. We will add a representative ERT model of the gravel bar in the updated version of the manuscript.

3. We have done a lot of modeling trying to explain the data with an underlying hydrological flow model (Oliver Genoni, MSc thesis, ETHZ, 2008) and it is rather easy to find a simple flow model that explain the mapping data as suggested by the reviewer, but this doesn't mean that this is the explanation for the observed data (see introduction about non-uniqueness). Also, there is no evidence that the interfaces that we would need to incorporate correlate with structural features in the 3D ERT and GPR data. There are three main reasons why we don't think the data is primarily related to groundwater flow. (1) The data has a suspicious correlation with soil cover; (2) The monitoring data show much larger gradients in the SP magnitudes during rainfall events than what is measured in the mapping application while the hydrological flux in the aquifer is very similar for low- and high river flow and the SP anomaly should be linearly related to the flux in the groundwater (also, the SP anomalies arise before the river flow increases as there is a delay in the catchment's response to rainfall). (3) We performed SP mapping of the same area at another time (one year later) and virtually no SP signals (with respect to the noise level) was recorded when performing the mapping. This is a very strong indication that the SP signal is related to the vadose zone. This will be explicitly stated in the new manuscript. Finally, the conclusion from the SP inversion is that the sources are located in the middle of the aquifer (3 m depth; the aquifer is located between 0-6 m depth), not in the vadose zone. It is the combination of the mapping and the monitoring data later on that leads to our conclusions about the source region.

4. We have measured the SP voltage coupling coefficient (Genoni, MSc, 2008) and the values are around -20 mV/m for an electrolyte conductivity of 0.0343 S/m at 20 degree

C. This information will be added to the final manuscript.

5. As mentioned in 3, doing groundwater flow modeling to explain the SP data was our first approach when analyzing the mapping data. However, the monitoring data and the repeat measurements show that most of the sources explaining the SP data must be located in the vadose zone. I certainly don't dispute that there are contributions from groundwater flow, but the point is that it is virtually impossible to filter away other contributions related to vadose zone processes. This is why I in the outlook suggest that this type of experiments should be carried out within the river. The measured signals will for this case all be related to groundwater flow processes and this is the type of data to use for the type of studies that the reviewer suggest.

We will do our best to address your comments and concerns as outlined above in the revised manuscript. Thank you again for your comments!

Niklas Linde On behalf of the authors

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 8987, 2010.