Waterborne spectral induced polarization imaging to investigate stream-aquifer exchange

Philipp Hoehn[1], Adrián Flores Orozco[2], Thilo Hofmann[3]

1 University of Vienna, Department of Environmental Geosciences Vienna,
philipp.hoehn@univie.ac.at
2 TU-Wien, Department of Geodesy and Geoinformation, adrian.flores-orozco@geo.tuwien.ac.at
3 University of Vienna, Department of Environmental Geosciences Vienna,
thilo.hofmann@univie.ac.at

Geometrical and hydraulic streambed properties define infiltration and are therefore important to manage bank filtration sites. Currently available methods tend to lack spatial resolution to capture these. Provision of spatially distributed estimates of hydraulic conductivity and thickness of colmated substream sediment as well as stream stage is considered to determine dataset worth for numerical groundwater flow models. We investigated the applicability of spectral induced polarization (SIP) imaging results to improve the prediction of stream-aquifer exchange. SIP imaging measurements were collected in a selected losing-disconnected subalpine stream reach in a broad frequency bandwidth (0.5-225 Hz) using a fully submerged array of 32 electrodes (0.5 m spacing). They were complemented with over 300 depth-discrete transient infiltration tests to determine horizontal hydraulic conductivity of the streambed along the arrays. SIP imaging results have provided two main observations: (i) the real component (σ') shows only consistency to the main lithological units, permitting to delineate stream stage and the general substream architecture; whereas (ii) the imaginary component (σ'') reveals a large spatial variability, which we compare with the variability observed in hydraulic conductivity measurements. Patterns of the first derivatives of σ'' with depth suggest variable thickness of an immediate sub-stream layer, associated to the strongest polarization effect, as expected of a streambed colmation layer. Our results illustrate that SIP images can constrain value ranges for parameters commonly required in groundwater flow models and can be used to reduce uncertainty in model predictions.