INVERSION OF WATERBORNE GRADIENT SELF-POTENTIAL (WaSP) DATA FOR REGIONAL AND HYPORHEIC SURFACE-WATER - GROUNDWATER EXCHANGE PATTERNS IN A MEANDERING RIVER

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In the Gulf Coastal Plain of south-central Texas, the rocks that contain the Carrizo-Wilcox aquifer crop out at the land surface along a relatively narrow band that strikes from southwest to northeast. The lower Guadalupe River is incised into the outcrop and is forming a depositional alluvial terrace on top through valley filling and entrenchment into the fill. Surface-water (SW) and groundwater (GW) exchanges are difficult to map in the river and quantify by streamflow gaging because streamflow is regulated by dam releases. A water-borne self-potential (WaSP) logging survey was therefore completed in 2016 to map gaining and losing sub-reaches in the lower Guadalupe River by measuring the electrical streaming-potential in the river along a 15-kilometer long profile across the outcrop. The WaSP geophysical inverse problem is formulated herein and solved to confirm qualitative interpretations of apparent gaining and losing sub-reaches inferred from the 2016 WaSP survey data and demonstrate that the electrical potential measured in the lower Guadalupe River was a streaming-potential attributed to superimposed SW-GW exchanges occurring simultaneously over variable spatial-scales. Qualitative interpretations of SW gain and loss from WaSP data are supported by the regularized inverse models of the geospatial distributions of streaming-current sources and sinks on and beneath the riverbed, which reproduce the streaming-potential measured in the SW and characterize gaining and losing reaches of the river by the opposing dipolar electrical polarities of streaming-current and GW sources and sinks on the riverbed. The inverse modeling results indicate that WaSP surveying is a viable method to map SW-GW exchange processes in rivers and may enable quantification of streamflow gains and losses over variable spatial scales if a petrophysical relation between electrical resistivity and riverbed permeability can be established.