HYDROGEOLOGICAL SITUATION OF AN AQUIFER-RIVER SYSTEM AS REVEALED FROM HIGH RESOLUTION GEOELECTRIC MEASUREMENTS AND GROUNWATER ANALYSIS

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The Werra river which flows mainly along the Hessen-Thüringen (former West/East Germany) border has been used for decades to discharge waste water (consisting mainly of dissolved NACL) from the Potash industry, primarily at the Thüringen side. Although the situation has improved significantly since the reunification (1990) and the subsequent partial demise of this industry, high saline concentrations of up to 3000 ppm Cl^- (corresponding to electric conductivities of ~5 mS/cm) are often still measured in the Werra river water. Although the Werra, like most of the natural rivers in moderate climatic zones, is normally an effluent (gaining) stream, it becomes periodically influent (loosing water) during large flood events. This poses the threat that the adjacent alluvial aquifer might be polluted by the saline river water. Although the evidence for this is not unequivocal at present, the intrusion of such a saltwater front can be used as a natural tracer, providing an additional tool to understand parts of the river-groundwater interaction. As part of a comprehensive research project to quantify the various facets of river-aquifer interaction, namely to describe the hydrogeological situation, high resolution 2D geoelectric measurements have been carried out in the "Wendershauser Aue" section of the Werra river floodplain. 12 geoelectric sounding-mapping profiles with a Wenner-spread of 5m were measured along 4 profiles transects located mainly perpendicular to the Werra river course and then inverted iteratively to obtain a 2D vertical resistivity map. The resistivity measurements were supplemented by laboratory measurements on soil and a few groundwater samples. This allowed to compute the formation factor K independently. The latter turned out be in good agreement with each other and appear to be constant in homogeneous sections of the aquifer. Using Archie's law, electric conductivities of up to 10 mS/cm for the saturated groundwater are calculated, which is higher than that measured for the Werra river, the refore putting into question the assumption of a homogeneous formation factor. As for the lithology of the subsurface deduced from the 2D resistivity maps, one can deduce the following formations: A clay top soil layer 3 m thick is underlain by the first unconfined sand-gravel aquifer with an average thickness of 6m, saturated with saline groundwater having a conductivity of ~2 mS/cm. This is followed underneath by a low resistivity layer (~20 Ohm m), about 10 m thick, which from historical borehole records, were identified as having a clay-dolomite composition, therefore marking the confining bottom layer of the sand quifer. Finally, at a depth of 18-20m the well-known sandstone formation with resistivities of ~40 Ohm m begins. The hydrogeological results are presently being implemented in a 3D groundwater flow and transport model to further quantify the dynamical processes that may lead to intrusion of saline Werra river water into the alluvial aquifer.