A FIELD TEST OF RELATIONSHIPS BETWEEN SELF-POTENTIAL, GROUND WATER FLOW AND THICKNESS OF VADOSE ZONE

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Self-Potential (SP) was observed on the plot containing a dam between a fresh water reservoir and a river. The subsurface consists of sand, gravel sand and sandy clay. The water table is situated at the depth range 0 - 2.5 m. A resistivity tomography and observation of water level in small boreholes and trench were carried out. The conductivity of water from reservoir, river, boreholes and drains was also measured. The observed low in magnitude SP is not directly related to the ground water flow from the reservoir to the river. To understand the reasons causing SP, the observed data were treated assuming that SP depends on the thickness in vadose zone (Aubert, 2000) and water preferential passageways in aquifer. Firstly, the correlation between the SP and the local thickness in vadose zone (h) was studied. An inverse correlation SP(h) was found. Using minimal square method the relationship between the "vadose" SP (U_v, in mV) and h (in meters) was established as: U_v=-6.8h+14. Simple physical scheme based on vertical infiltration is proposed to explain this phenomenon. Second, the "vadose" SP was assessed using the relationship established for the studied plot. The residual SP was calculated as difference between the observed and the "vadose" SP. The negative and positive values of the residual SP correspond to areas of feeding and local discharge of ground water flow, respectively. The feeding zone situates under the reservoir, and the local discharge corresponds to swamping areas. To validate the qualitative interpretation, the SP was numerically modelled. The computer program GWFGEM provided the successive solution of 2D differential equations for water head and electrical potential on the basis of finite differences method was applied. Firstly, the water heads were calculated using the value of hydraulic conductivity typical for sands. The hydraulic model was calibrated by minimal difference between the observed and calculated ground water level. Second, the SP was calculated using the water head distribution, resistivity (that were obtained from tomography) and sand typical value of streaming current coefficient. The electrical model was calibrated by minimal difference between calculated and residual SP. A good satisfaction of residual and calculated SP confirms that observed SP is completely ascribed to (1) variations in thickness of vadose zone, (2) feeding and discharge of ground water flow and (3) inhomogeneities in resistivity. The work is supported by INTAS (contract N 32046).