Geophysical Research Abstracts
Vol. 12, EGU2010-14994-1, 2010
EGU General Assembly 2010

Effects of the proximity of groundwater level on short and long normal logging measurements

Myung Jin Nam (1) and Seho Hwang (2)

(1) Sejong University, Energy and Mineral Resources Engineering, Republic Of Korea, (2) Korea Institute of Geoscience and Mineral Resources Geologic Environment Division, Daejeon, Republic Of Korea

Resistivity logging instruments were designed to measure electrical resistivity of formation, which can be directly interpreted to provide water-saturation profile. Using short and long normal logging, Korea institute of geosciences and mineral resources (KIGAM) has monitored seawater intrusion in a coastal aquifer, Yeonggwang, Jeonnam, Korea, and groundwater distribution in Korea including Jeju Island. Short and long normal logging measurements are made under groundwater level. In some investigation sites, groundwater level reaches to a depth of a few hundred meters. It has come to attention that the proximity of groundwater level might distort short and long normal logging readings, when the measurements are made near groundwater level, owing to the proximity of an insulating air. In this study, to investigate the effects of the proximity of groundwater level (and also the proximity of earth surface) on short and long normal logging measurements, we simulate normal logging measurements near groundwater level. In the simulation, we consider all the details of real logging situation, i.e. the presence of wellbore including casing, the tool mandrel with current and monitoring electrodes, and current return and reference potential electrodes. We also model the air to include the earth's surface in the simulation rather than the customary choice of imposing a boundary condition. To compute the voltage at a monitoring electrode, we subtract the potential at a reference potential electrode from the potential at the monitoring electrode. Note that the actual tool also measures the voltage, i.e. the difference of potential at a monitoring electrode with respect to the potential at the reference potential electrode. The simulation is challenging since we have large contrast in dimension (the large computation domain, which can be several kilometers, and small size of an electrode, which is several centimeters) and in resistivity (the resistivity of conductive electrode is 10-6 ohm-m, while the resistivity of mandrel is 106 ohm-m). For the simulation, we use a two-dimensional, goal-oriented and high-order self-adaptive hp finite element refinement strategy (h denotes the element size and p the polynomial order of approximation within each element). The hp refinement algorithm automatically conducts local mesh refinements to construct an optimal grid for a problem under consideration. Numerical results indicate that the hp refinement strategy produce highly accurate and reliable simulation results. Due to the proximity of insulating air, normal resistivity logging near groundwater level can yield distorted apparent resistivity readings. The distortion on long normal logging measurements is more acute than that on short normal logging measurements.