Application to monitoring groundwater flow in soft-sediments using ultra-fast data acquisition system for electrical surveys

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Recently, resistivity method is frequently applied to monitoring of groundwater flow at various fields, for example, change of groundwater level by heavy rainfall at landslide-slope areas, behavior of rainfall penetrating into layers buried by industry rejection, behavior of water penetrating to layers at cultivation tests of groundwater, movement of boundary between fresh water and seawater at the seacoast. However, in order to monitoring fast flow of groundwater in soft-sediments, it is difficult to measure a large number of data sets by 3D resitivtiy configurations within a few minutes using conventional survey systems.

An effective 3D data acquisition system for electrical resistivity survey has been developed, in which a new sampling method has been adopted, enabling 240 stations set to be measured simultaneously using analogue circuit of Fourier transformation and high frequency sine wave (max. 5kHz). For example, it takes only 5 minutes to complete to measure all potential data sets ($120*119=14,280$) in case of 120 stations by pole-pole array.

In order to confirm performance of the system, the monitoring test was carried out by injecting saline into cavity, which was positioned at the center of survey lines in our office ground. The 60 electrodes were placed along two lines (each line has 30 electrodes) and electrode interval is 1m. The cavity is estimated to occur based on old tunnel excavated in loam layer (late Pleistocene). The continuous survey was started a few minutes before injection of saline and finished 20 minutes after injection. The interval of the measurements was 2.5 minutes. The CaCl2 solution (1 ton, 1.4ohm-m) was injected within 110 minutes. The total number of 51 data sets was measured and one data set contains 3,540 potential data. The 51 resistivity sections were analyzed by 2D inversion and the 50 resistivity change rate sections versus the resistivity section before injection were calculated. As a result, we can monitor behavior of saline penetrating into the cavity as continuous resitivity change sections. It is expected that the new data acquisition system contribute to monitor fast flow of groundwater as 3D resistivity imaging.