Three Dimensional Analyses of Resistivity Monitor in Ground Water Recharge Test

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Water environment is affected by groundwater from agricultural and livestock industries. Techniques to understand the groundwater flow are needed for evaluation of these affects. Authors have examined the application of resistivity monitoring for the assumption of water content by volume change as resistivity change at groundwater flow (Inoue et al. 2006).And also laborsaving three-dimensional resistivity survey was developed and has been applied to a geological structure around the Nojima fault on Awaji Island to examine its effectiveness (Nakazato et al. 2005). The aim of this study is to examine a method for understanding groundwater flow. Resistivity monitoring of a groundwater recharge test in a pyroclastic flow plateau was conducted and resistivity change ratio was inversed three dimensionally by constrained non-linear differential tomography analyses (Sugimoto et al. 1995).

A groundwater recharge test was conducted in an examination field of Agricultural Experiment Station Osumi, Kagoshima Prefecture. A loam layer, reworked shirasu layer and shirasu layer were observed from the surface and the groundwater level before the start of the recharge test was 10 m or less in depth. The groundwater recharge test was conducted by supplying water from the centers of two recharge areas that had a path between them. The amount of recharge was 16.0 m3/h and electric conductivity of the recharge water was 8.9 mS/m. The recharge period was 56 hours, from 13:00 on the 8th to 21:00 on the 10th of November in 2005. Two-dimensional resistivity surveys were continued from 7:00 on the 8th to 12:00 on the 11th of November in 2005 along 4 lines. The specifications of a survey along one line were 48 electrodes, 1m electrode spacing, 47m range of the survey, 698 data, dipole-dipole array, one hour measurement times and 4 hour interval time of measurement. The resistivity change ratio distribution after the start of the recharge test was analyzed by the method of Sugimoto (1995) in which the distribution before the test was an initial value and the resistivity change ratio was used as a parameter of inversion. The resistivity was expected to decrease with an increase in the saturation level by the groundwater recharge, and the resistivity was analyzed with the restrictive conditions such that resistivity during the recharge test would decrease more than the resistivity before the test. Daiyaconsaltant (Ltd.) E-Tomo ver.4.1 was used for the tow-dimensional analysis and E-Tomo3D for three dimensional analysis.

Water content by volume was measured by the neutron moisture meter in a hole in the recharge area and was compared with the distribution of resistivity change ratio at each depth from before the test to after the test. Moreover, the two dimensional cross section of the resistivity change ratio distribution that had been obtained by three dimensional analyses was compared with two dimensional analyses result. In the examination in the sections and planes that were different from the survey lines, the resistivity change ratio distribution that interpolated two dimensional analyses result and the resistivity change ratio distribution of three dimensional analyses results were used. In addition, the volume of the area where the resistivity change ratio of three dimensional analyses result was more than a value was compared with the total amount of the recharge at each time.

Results indicate that the resistivity changes were caused by changes in the saturation level at unsaturated portions by the groundwater recharge because the resistivity changes harmonized with the changes in water content by volume after the groundwater recharge test started. And the possibility of the understanding of uniformed recharge and the direction of groundwater flow was shown.

References

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