

Investigation of groundwater level measurement method by microtremor array survey

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1. Introduction

"Microtremor array survey (ISO24057)", which is one of the geophysical survey methods, is a survey method that obtains the S-wave velocity structure in the vertical one-dimensional direction at the survey point. Since the S-wave velocity is determined by the physical properties of the ground, the vertical distribution of the S-wave velocity can be used to understand geological structures such as the distribution of aquifers and bedrock. On the other hand, the ground consists of three phases: a solid phase part such as soil and rocks, a liquid phase part such as groundwater and soil water, and a gas phase part existing in the unsaturated zone near the surface. Therefore, if the ratio of the liquid phase in the ground ($\approx$ groundwater level) changes, it is expected that the S-wave velocity will change. Takahashi (2019) reviewed and model-analyzed the relationship between rock S-wave velocity and saturation, and pointed out the possibility that variation in water content affects S-wave velocity. Therefore, in this study, the seasonal variation of the S-wave velocity distribution was investigated for the purpose of detecting the seasonally changing groundwater level by conducting microtremor surveys at different times at the same site.

2. Method

Microtremor survey was conducted 9 times during the period from June to November 2014 at two points (Kanagawa Prefecture Ashigara Plain upper area (H54, R50)) that can be compared with groundwater level observation wells. On the other hand, microtremor surveys in 4 regions with different climates and topography (Western Kanagawa Prefecture: 12 sites, Central Saitama Prefecture: 17 sites, Mid-Western Yamanashi Prefecture: 11 sites, Central Fukushima Prefecture: 16 sites) will be conducted in two periods from 2019 to 2021. Each region was visited twice a year.

Microtremor observation was performed using JU210 at 2014 and JU410 at 2019-2021 manufactured by Hakusan Kogyo with a sampling interval of 200 Hz. The results of microtremor exploration were analyzed according to the method of Senna et. al, (2014).

3. Results and discussion

Microtremor survey data at two points (H54, R50) in Ashigara Plain conducted nine times in 2014 were converted to S-wave velocity vertical distribution by Simple Inversion Method (SIM) and compared with the groundwater level.

The S wave velocity near the groundwater table is 370 to 880 m/s at the H54 point and 230 to 370 m/s at the R50 point. The results show that the S wave velocity differs greatly depending on the exploration time. In addition, explorations in which the S wave velocity changed up and down across the vicinity of the water table were observed in 6 out of 9 explorations at H54 and 8 out of 9 at R50. On the other hand, as a result of taking the difference in the analytical S-wave velocity distribution for each exploration, the difference became larger at deeper depths, and it became clear that there were issues with reading accuracy and analysis methods (Miyashita et al. 2021).

In the SIM, the vertical distribution of the S-wave velocity is calculated by reading the point where the relationship between the frequency and the phase velocity changes and performing inverse analysis.

Therefore, in order to eliminate the reading error in the SIM, the vertical distribution of the S-wave velocity was converted directly by the Simple Profile Method (SPM), and the difference between the two periods was calculated. As a result, at the H54 site, correspondence was found between the change depth of the S-wave velocity and the depth of the groundwater level in 6 out of 9 . On the other hand, at the R50 point, the depth distribution of the S-wave velocity calculated by the SPM was deeper than the groundwater level, so it was not possible to correspond to the change in the groundwater level.

In the future, we will continue to examine the analysis method, and also examine the results of microtremor surveys in the four regions.

Keywords: Microtremor exploration, groundwater level, repeated measurements, Simple Inversion Method, Simple Profile Method