R003-P02
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自然湧水を利用した水上自然電位観測に関する実験的検討

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Experimental study of the self-potential measurement on water surface at a natural spring site

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The self-potential(SP) method is known as a geophysical method sensitive to groundwater flow. This method has been used to explore hydrothermal systems formed in volcanic and geothermal regions. The method has recently been widely used in exploring submarine springs, submarine hydrothermal deposits, and other water areas, expanding the range of its applications. As an example, Ikardet al. (2018) fixed a pair of electrodes to the hull of a canoe and made continuous potential measurements while flowing down a river to determine the SP distribution on the river channel, and discussed the exchange relationship between river water and groundwater within a watershed. As described above, many experiences of SP measurement in water areas have been obtained in various regions. However, sufficient data have not been obtained on how the vertical distance from the bottom to the electrode and the speed at which the electrode is moved affect the measurement results. The purpose of this study was to investigate the influence of the measurement conditions on the observed data, and to this end, several experimental measurements were made in a natural spring using an observation boat.

The SP observation was carried out at the “Kasasugi no shimizu” natural spring located in Yokote City, Akita Prefecture, Japan. At this site, water springs out from within a rectangular concrete frame (approximately 1.3 m long, 0.9 m wide, and 0.5 m deep) with its long axis oriented in the WNW-ESE direction. We carried out two types of observations on this spring. The first was an observation to grasp of the two-dimensional SP distribution in the horizontal direction on the surface of the spring. For this observation, the concrete frame of the spring was divided into a grid, and the intersections of the grid were set as observation points. After fixing the two electrodes on the water surface, we waited until the potential stabilized, and recorded the potential value at the point where no change in value was observed. Data were obtained at all of the intersections of the grid of 64 points, and the SP distribution on the water surface of the spring was determined.

In the second type of observation, the potential was measured by moving a small observation boat with electrodes attached on the spring water. A commercially available milk carton (10 cm in length and width) was cut at an appropriate height to serve as the main body of the boat, and self-made electrodes were attached to the front and rear of the boat in the direction of movement. The electrodes were Cu-CuSO4 electrodes, and the saturated copper-sulfate solution was gelatinized with polysaccharide thickener to prevent leakage of the internal solution when the boat shook on the surface of the water. In the observation, the boat was moved along the grid lines that divided the spring, and potential data was measured every 0.1 seconds. Data was obtained on a total of 13 survey lines.

The two-dimensional SP distribution on the surface of the water was observed to gradually decrease from the upstream side (SE direction) of the spring to the downstream side (NW direction). This tendency was confirmed in all observations made in the past. The maximum SP difference in the spring was 12-13 mV, and it was revealed that it has an average potential gradient of about 5.6 mV/m.

The potential data obtained by the observation boat was integrated for the direction of the boat’s movement to calculate the SP value on the water surface. An example of the result is shown in the figure. In the figure, the white circles represent the SP values obtained at the intersection of grids, and the solid lines represent the SP values along the grid lines. Although the two sets of data do not completely match, there were similarities in the elevation relationships shown by the potential distribution and the potential difference values within the measurement line. In this observation, the average boat speed was 6-10cm/sec, and it was suggested that this range of speed, the potential data obtained while the ship was moving could reproduce the SP distribution on the water surface in the direction of the route.