

## Simultaneous observation of the land-ocean connection along the coast of Akahama Otsuchi: Measurements of groundwater flow velocity

\*Yuji Miyashita<sup>1</sup>, Hisami Honda<sup>2</sup>, Hideki Hamamoto<sup>3</sup>, Jun Shoji<sup>4</sup>, Ryo Sugimoto<sup>5</sup>, Tomohiko Kawamura<sup>6</sup>, Osamu Tominaga<sup>5</sup>, Makoto Yamada<sup>7</sup>, Makoto Taniguchi<sup>2</sup>

1. Hot Springs Research Institute of Kanagawa Prefecture, 2. Research Institute for humanity and Nature, 3. Center for Environmental Science in Saitama, 4. Hiroshima University, 5. Faculty of Marine Biosciences, Fukui Prefectural University, 6. International Coastal Research Center, AORI, UTokyo, 7. Faculty of Economics, Ryukoku University

Alluvial lowlands have developed in many coastal areas of Japan, and the aquifer is thickly deposited. In these aquifers, the water head was higher in the area than in the ground surface in many areas, and the groundwater was spring out from the well that drilled through the impermeable layer. However, with the development of economic activity and the increase in water demand due to population concentration, deep groundwater use increased in many coastal areas. As the use of groundwater increased, the decrease of the artesian well area, depletion of spring water, ground subsidence due to lowering of groundwater level, etc. became obvious. On the other hand, in recent years, the importance of submarine groundwater discharge (SGD) in coastal ecosystems has been recognized, and surveys to grasp SGD from the ocean floor in the sea area have been conducted.

Therefore, in this study, we conducted simultaneous observations in the land - ocean connection with the aim of grasping the SGD from the ocean floor at the Akahama coastal area of Otsuchi Town, Iwate prefecture in February 2017. In this report, we report on the results of the survey on the groundwater flow in the each depth conducted at a observation well in the International Coastal Research Center, AORI, UTokyo. In February 7, 2017, the groundwater flow velocity was measured at 10 depths using a groundwater flow velocity meter GFD-3a manufactured by JFE Advantech Co., Ltd. Also, before measuring the groundwater flow velocity and flow direction, the vertical distribution of the temperature in the well was measured. And on February 8, 2017, a double packer type groundwater sampler was installed in the well, and groundwater was collected and measured at 6 depths. In the groundwater sampled, pH, electric conductivity, dissolved oxygen concentration, and oxidation reduction potential were measured at the site. In addition, collected groundwater samples were sorted by measurement items and analyzed at the Research Institute for humanity and Nature.

As a result of the observation, the groundwater flowed in the direction toward the sea, from the depth of 5 m to the depth of 12 m. On the other hand, at a depth of 13 m or more, it was flowing eastward, which roughly parallels the Akahama heading out of the bay from the mouth of Otsuchi Bay. On the other hand, the groundwater flow velocity was approximately 0.01 cm/min which is the lower measurement limit up to the depth of 10 m, 0.02 to 0.06 cm/min at the depth of 11 m to 14 m, and 1.5 cm/min at the depth of 15 m near the hole bottom. In addition, the electrical conductivity of groundwater sampled by depth was wide from 420 mS/m to 4040 mS/m, and it was high value of more than 2500 mS / m when depth was more than 13 m.

Assuming that the electric conductivity of seawater is 5000 mS/m and the value of the groundwater in this area is 8 mS/m, the mixing ratio of sea water in coastal groundwater was calculated. As a result, it was found that it was in the brackish state that it was 50% ~ 80% at the depth of more than 13 m whereas it was about 10% or less up to the depth of 10 m and 13 ~ 19% at the depth of 11 ~ 12 m. At this depth, the groundwater flow direction flowed from the inside of the Otsuchi bay towards the outside of the bay, so at

the time of observation it was inferred that the seawater invaded the land side deeper than 13 m. On the other hand, under the depth of 12 m or less, it was actually measured that the groundwater flowed out in the sea direction.

Keywords: groundwater flow velocity, salt wedge, subsurface temperature, Submarine groundwater discharge(SGD) , Otsuchi Bay