Characteristics of the confined groundwater based on the monitoring results in the western part of Osaka area: For thermal utilization of groundwater

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Utilization of renewable thermal energies has been promoted for several years in Japan. For the purpose of reduction of CO_2 emissions using renewable energies, thermal utilization of groundwater has been focused in Osaka area, where large amount of groundwater is potentially available for thermal sources. Recently, a demonstration experiment of Aquifer Thermal Energy Storage (ATES) system, which is one of the open-loop systems for large-scaled thermal utilization of groundwater, was performed at the redeveloped site near the Osaka Station. However, since widely ground subsidence was caused by excessive pumping of shallow groundwater in 1960’s, appropriate managements must be performed for effective use of groundwater. On the basis of these backgrounds, we observed groundwater chemistries, levels, and temperatures in order to clarify the initial characteristics and evaluate the possibilities of utilization for ATES system in the western part of Osaka area.

Pliocene to Quaternary sediments reach a maximum thickness of 1,500 m beneath the Osaka plain, and more than 20 marine clay layers deposited in association with cyclic global sea level changes are intercalated with freshwater sand and gravel layers. In this study, we investigated the confined groundwaters in Pleistocene sandy gravel layers so-called Dg1, Dg2 and Dg3. These three confined aquifers are widely distributed in the western part of Osaka Plain within the depth of 100 m from ground surface.

Seasonal variations of the chemical compositions were negligibly small. The analyzed groundwater samples mostly had reductive characteristics, e.g., about 80 % of iron was existed as dissolved ions. In order to long-term utilization of ATES system, it is necessary to maintain reductive groundwater condition to prevent precipitation of iron hydroxides which may cause clogging of well screens. All of sampled waters had Na^+-Cl^- type characteristic as major composition, however, the total concentrations of dissolved ions were higher in the groundwater samples of Dg1 than those of Dg2 and Dg3. Comparing the same aquifer, total concentrations of dissolved ions were lower in the northern part (Umeda-Fukushima area) than in the southern part (Nakanoshima area) of the studied area. Because groundwater chemistries were significantly different in each aquifer, pumped groundwater must be surely recharged into the original aquifer.

Groundwater levels had few variations at each monitoring site for all of the above three aquifers. Therefore, it is suggested that water flow velocities were very slow, stagnant groundwater environment. Artificial sharp declines in the groundwater levels of Dg2 were observed several times in 2017. Such remarkable declines of groundwater levels could not be observed in Dg1 and Dg3, i.e., these three aquifers must be independent at least in the studied area.

Groundwater temperatures were measured 4 times per year for every 1m depth. Both seasonal and locational variations were observed at the shallower than 30 m depth, however, the groundwater temperatures at the depth of more than 30 m showed constant trend around 18 celsius degree in the

western part of Osaka area. On the other hand, they were about 2 celsius degree higher in the northeastern part of Osaka city (near Uemachi Upland) than that of in the western regions.

Finally, this study is based on the results obtained from a “Renewable energy heat utilization technology development” project commissioned by the New Energy and Industrial Technology Development Organization (NEDO), a Japanese national agency.

Keywords: western part of Osaka area, Aquifer Thermal Energy Storage (ATES) system, confined groundwater

