

# Geochemical study of groundwater in Sabae City, Fukui Prefecture, Japan, for the heat usage

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In Sabae City, Fukui Prefecture, Central Japan, several natural cold springs such as Tougen and Tona Shouzu have been used for drinking and agriculture since ancient time. There are many artificial wells for groundwater which has been also used for industry, fields of irrigation and snow melting on road. At winter time, groundwater level is lowered due to pumping of groundwater for snow melting. This causes well wither and land subsidence (Report of Fukui Prefecture, 2014). As one of the solution to the problems, a geothermal heat pump (Geo-HP) can be considered for snow melting and room heating. In particular, the open-type Geo-HP using groundwater has been often used because of the low cost. In the Sabae City, the highest and lowest of air temperatures are  $>30\text{ }^{\circ}\text{C}$  in summer and  $<0\text{ }^{\circ}\text{C}$  in winter, respectively, whereas water temperature of groundwater is always kept to be  $15\text{ }^{\circ}\text{C}$ . In the Geo-HP system, groundwater is pumped to the surface, heat-exchanged and returned to the aquifer through a reinjection well.

The purpose of this study is to perform the evaluation of flow mode and quality of groundwater in the study area by the geochemical point of view and to examine the possibility of usage of the open type Geo-HP in this area. Twenty three shallow groundwater and 5 river water samples were collected in the study area. The precipitation has been collected once a month at the central part of the study area. Water samples were collected in 100 ml and 250 ml plastic bottles. Water temperature, pH, EC, and ORP were measured at the sampling site. Water samples were analyzed for the major chemical compositions (Na, K, Ca, Mg, Cl,  $\text{NO}_3$ , and  $\text{SO}_4$ ) and  $\delta\text{D}$  and  $\delta^{18}\text{O}$  in the laboratory.

Precipitation samples are plotted along a local meteoric water line ( $\delta\text{D}=8\delta^{18}\text{O}+20$ ). The  $\delta\text{D}$  and  $\delta^{18}\text{O}$  values of groundwater are  $-51.8\sim-41.1\text{‰}$  and  $-9.3\sim-7.4\text{‰}$ , respectively. There is no relationship in the  $\delta\text{D}$  and  $\delta^{18}\text{O}$  values between groundwater and river water. These results show that groundwater is mainly composed of precipitation with minor contribution of river water. From the chemical compositions, groundwaters can be divided into two groups; Ca- $\text{HCO}_3$  type in eastern part of the study area and Na- $\text{HCO}_3$  type in the western part.