Origin of saline hot spring and flow system of inland hot spring - Case study on the Yuda hot spring in Yamaguchi City -

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The Yuda hot spring in the Yamaguchi City is characterized by the high content of Na^+ and Cl^-. We carried out that geochemical and isotopic analysis of hot spring water, a geological survey and geophysical exploration to investigate the origin and flow system of the Yuda hot spring.
Deep hot spring water from bedrock characterized by NaCl type. Shallow hot spring water from overlying sediments is characterized by NaCl type and $NaHCO_3$ type. δD and $\delta^{18}O$ of all the hot spring water suggest that the Yuda hot spring water is originated inform a meteoric water. Li/Cl ratio of all deep hot spring waters are about 0.001 that is larger than that of the modern seawaters. $\delta^{13}C$ of DIC shows that the mantle-derived carbon is mixed in the Yuda hot spring waters. These characteristics correspond to the deep-seated fluid. However, the He isotope ratio ($^3He/^4He$) of 0.202 Ra (Yasukawa and Tanaka ,2008) and the Li isotope ratio of +10.84 ‰(Nishio personal communication) suggest that there is no supply of deep-seated fluid at present. As a result of the geochemical studies of the Yuda hot spring water, of the Yuda hot spring waters are thought to be ascended as follows:
1) Deep-seated fluid ascended from deep underground was mixed with meteoric groundwater.
2) The fluid remained at deep underground at once.
3) Isotopic characteristics of these fluids were affected by fluid-rock interaction.
4) Modern geochemical feature of Yuda hot springs were formed.
The resistivity profile obtained by CSAMT method (Controlled Source Audio frequency Magneto-Telluric) could not detect any low resistivity zones. As a result of the core logging, it is assumed that the hot spring water may ascend through the cracky intrusive rock with less than 1 m wide. As a result of the numerical analysis about the relationship between the width of flow path and the estimated resistivity, the flow space with 1 m in width is too small to be detected by CSAMT method.
It is concluded that the meteoric water discharged to deep underground by the local groundwater flow is heated by the geothermal gradient and ascend in a short time through the cracked zones developed in the intrusive rocks. Cl^- is possible to be derived from the deep underground as a deep-seated fluid in the past.

Keywords: Deep-seated fluid, saline hot spring, Yuda hot spring

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