Studies on isotope geochemistry related to chemical evolution of the hot springs in Arima region and Kii Peninsula, SW Japan

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Although both Arima region and Kii Peninsula are located on fore-arc region and show no Quaternary volcanic activity, high-temperature thermal brine as well as various kind of hot springs well out in many points. The chemical characteristics of these hot springs are as follows; (1) Oxygen and hydrogen isotopic compositions of chlorine-rich Arima spa and mineral springs in Ishibotoke, Osaka, are sifted from meteoric line towards magmatic water. The magnitude of deviation is correlated with chlorine concentration. (2) Many hot springs show higher 3He/4He ratio than air value. Possible origin of these unusual hot springs is that fluids originated from dehydrated water from subducting slab are incorporated into the surface water. In this study, we discuss about the origin of each type of hot spring and the relationships among different types of hot springs, especially for NaCl- and Na(Ca)HCO3-type hot springs.

Remarkable difference for isotopic composition of the hot springs in Arima region and Kii Peninsula were observed among different types of hot springs. Some NaCl-type hot springs were significantly enriched in the heavy isotopes of oxygen and hydrogen. Clear positive correlation between d18O and chlorine concentration was also observed. These results are consistent with classical work (e.g., Matsubaya et al., 1973). From helium isotopic compositions, the gas component derived from deeper region including upper mantle are the main contributor for both type of hot springs. Distribution of 20Ne concentration is clearly different between NaCl- and Na(Ca)HCO3-type hot springs. The 20Ne concentrations in NaCl-type hot springs are far lower than those in air saturated water (ASW), while most of Na(Ca)HCO3-type hot springs have similar or higher concentration level than ASW. No clear correlation between 20Ne concentration and 3He/4He ratio were observed.

From the observation listed above, we can extract insights about the origin of each type hot spring. High temperature thermal brine with mantle derived component is incorporated into the surface meteoric water and, subsequently, suffered water-gas separation. The gases separated from thermal brine were rich in noble gas with high 3He/4He ratio and were dissolved into meteoric water. The former may corresponds to NaCl-type hot spring, and the latter may corresponds to Na(Ca)HCO3-type one.