

Study of isotopic geochemical analysis for Arima-type deep crustal fluid

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Arima-type fluid is characterized as Na-Cl-HCO₃ (high Cl and HCO₃ concentration) and Fe suspension, and found at the specific points, Arima-Takaraduka (Hyogo Pref.), Ishibotoke (Osaka Pref.) and Kashio (Nagano Pref.) areas. We discussed them taken from the Arima Spa and Ishibotoke area using isotopic approaches, hydrogen, oxygen, carbon and helium. The one of the major differences of spring water between these two areas is temperature. The relationship between Cl and HCO₃ concentration of groundwater taken along the MTL in the Ki-i Peninsula showed a positive correlation. This suggests that Arima-type fluid is up-welled more large-scale area except specific points mentioned above. The isotopic features of Arima-type fluid are: (1) the hydrogen and oxygen isotopic relationship showed a different trend from the meteoric water line; (2) ³He/⁴He ratio is 1.1×10^{-5} ; and (3) $\delta^{13}\text{C}$ and $\delta^{14}\text{C}$ values are ca. -5 per-mil and -1000 per-mil, respectively. The isotopic signals of helium and carbon suggest that the volatiles in Arimatype fluid are come from upper mantle.

Field observation focused on Arima-type fluid was carried out at Arima Spa and Ishibotoke area. We measured water temperature, Eh and pH, and sampled spring water, groundwater and/or bubble gas. Soil air was taken at Tori-Jigoku and Mushi-Jigoku in Arima Spa for carbon isotopic measurements. Observation and sampling were carried out almost whole area of the Ki-i Peninsula. We took ~160 samples in the present study. At the laboratory, main chemical components and hydrogen-oxygen isotopic ratios were measured. Carbon and helium isotopic ratios were measured for several samples of them.

Hydrogen-oxygen isotopes of hot spring water and groundwater taken along the MTL represented a contamination of Arima-type fluid. Its contribution was not constant, but this is supported by the relationship between Cl and isotopic ratios, and carbon and helium isotopic ratios of gas samples also. Especially, radiocarbon concentration of gas samples taken from Arima and Ishibotoke springs was not contained. This showed that CO₂ isolated from ambient carbon cycle, i.e., deep environment was supplied to hot spring and its contribution is almost 100%. Helium isotopic analysis also represented high contribution of deep fluid.

Our analyses can be represented contribution of deep fluid, but these are focused on respective components, e.g., water, carbon and helium. Hence, those contributions were influenced from budgets of water, carbon and helium cycles at the surface environment, concentration of volatiles in deep fluid, and so on. However, the fact of deep fluid contamination observed using water and volatile components suggests that the volatiles, CO₂ and helium, were moved together in dissolving to the deep fluid.