Helium isotopic study of deep groundwater in the Kobe area: Application to groundwater circulation

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The Kobe area has unique characteristics of well out the high-temperature and -chlorine thermal water in its north side (Arima Spa). In order to investigate the possible effect on this thermal water into well water, we reported the results of He isotopes in the groundwater from the Kobe area at the 2002 Japan Earth and Planetary Science Joint Meeting. The samples were collected from 29 springs, shallow wells and deep boreholes (up to 1,000m). Many samples have atmospheric 3He/4He and 4He/20Ne ratios. Nine out of 29 samples show high 3He/4He ratios (up to 3.8x10-8) relative to the air-saturated water. Exceptionally high 3He/4He ratio and unusual isotopic compositions of D-O were found in many thermal waters including Arima Spa from the Kinki district (1, 2, 3, 4). It is reasonable to interpret the high 3He/4He ratio as the addition of this thermal water into the groundwater aquifer beneath the Kobe area. However, the 3He/4He ratio of Arima spa (~1x10-5) is significantly higher than that of groundwater from the Kobe area. It may be related to their geological settings, because the Kobe area is overlaid with deep-seated Quaternary sediments (Osaka group) in spite that the Arima-Takatsuki Tectonic Line extends to the northeast side of Mt. Rokko, bordering the Paleozoic sedimentary rocks to the north and the Cretaceous granites to the south, around the Arima Spa. It is reasonable to consider that the Arima-type thermal water is present in deeper region of Kobe area and accumulates radiogenic He during its stagnation in deep-seated Quaternary sediments.

In this time, we report the additional results on He isotopes in hot spring water from the deep well, (the depth of the well is about 700 to 1,500m) in the Kobe area and discuss about the spatial distribution of 3He/4He ratio of groundwater beneath the Kobe area. All of newly obtained data show high 3He/4He ratios (up to 7.7x10-6) and suggest that the aquifer(s) containing thermal water is (are) widely distributed beneath the Kobe area in lateral direction.

The 3He/4He ratio of groundwater in this region depends on the mixing ratio of high 3He/4He component (Arima-type thermal water) and radiogenic He (3He/4He: 10-7~10-8). Considering that radiogenic He concentration in groundwater increases with increasing groundwater residence time as a first approximation and assuming that advection is the main mechanism of high 3He/4He transportation in Arima-type thermal water, 3He/4He ratio of groundwater reflects the groundwater flow condition such as flux, mixing and residence time. We will attempt to construct the model of water circulation using helium isotopes.

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