Spatial variation of deep-seated carbon contribution in groundwater

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Carbon isotopic ratio in groundwater can be used for identifying a contamination of deep source carbon, e.g., magmatic or deep-seated crustal fluids. In the present study, we focused on the identification of deep-seated carbon in groundwater using carbon isotope in order to obtain the spatial variation of deep-seated crustal fluid contribution to groundwater.

We measured the stable carbon isotopic ratio of DIC in groundwater or hot-spring samples taken from South-Tohoku, Kanto, Tokai, Hokuriku, and Kinki areas (N=˜1000). Chemical composition and stable isotope were also measured in these samples. Groundwater showing a low concentration of Cl and HCO3, below 500mg/L in total of both, was considered as that originated from shallow groundwater and meteoric water. Other samples showing high concentration of Cl and HCO3 likely contain deep-seated carbon contribution. We computed the contribution of deep source carbon in DIC of groundwater using isotopic mass balance. It must be notice that carbon isotopic fractionation between bubbling CO2 and DIC in groundwater, thermal decomposition of organic matter or seawater mixing cause high carbon isotopic ratio of DIC, resulting in overestimation of deep-seated carbon contribution.

Spatial variation showed that hot-springs showing high Cl concentration were located at costal area (1), large structural planes, e.g., Osaka, Nobi and Kanto (2), Aizu area (3), Arima area (4), belted area along the Median tectonic line, i.e., south Osaka/Wakayama-Mie-Ina-Kanto (5), belted area along Itoigawa-Shizuoka tectonic line (6), and Matsushiro in Nagano (7). Those of high HCO3 concentration were shown at (3), (5), (6), (7), and (8) areas.

Spatial variation of deep-seated carbon showed the high contribution in (3), (4), (5) except Aichi-Nagano Prefectures, (7), (8) and Hokuriku (9) areas. This variation is similar with that of HCO3. One of the features of spatial variation in deep-seated carbon is quite high contribution along the Median tectonic line. This suggested that the large tectonic line played a role of the path of deep-seated carbon from deeper depth to shallow. On the other hand, our estimation can not eliminate the effect from ancient seawater trapped in sediments, e.g., Green-tuff (3) and (9) areas. However, we can obtain the general trend of spatial variation of deep-seated carbon contribution using carbon isotopic ratios.