Relationship between helium isotopes in groundwater and geological structure

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Dissolved noble gases in groundwater become potential tracers in isotope hydrology. In particular, helium is useful for both groundwater dating and exploration of groundwater origin. While dating methods using radioactive elements, such as T, ^{14}C, ^{36}Cl etc, are based on the depletion of the elements of interest according to their half-lives, helium concentration in groundwater is generally increasing with increasing the groundwater age. Quantifying the accumulation rate of ^{4}He into groundwater is typically the largest challenges in the quantitative use of ^{4}He as a groundwater dating tool.

Dissolved ^{4}He consists of both crustal and mantle He in addition to atmospheric He. Crustal He is the component produced from radioactive decay of U and Th series elements in and around the aquifer and in the whole crust. Production rate of this component can be calculated from the chemical compositions of rocks. Accumulation rate into groundwater, however, is not identical among the aquifers inferred from numerous geochemical and hydrological researches around the world.

Taking account of these points, we will discuss relationship between characteristics of dissolved helium isotopes and geological structure in the Osaka and Kanto sedimentary basins. In the Osaka sedimentary basin, we have already found out incorporation of Arima-type thermal brine with the mantle He component into meteoric water, and presented the model for estimating the very long residence time of groundwater where mixing of waters of different origin occurs, using dissolved ^{4}He concentration and He isotopic ratio (Morikawa et al., 2005).