Verification of groundwater dating methods in Great Artesian Basin, Australia

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On site selection and safety assessment of high-level waste disposal, it is important to evaluate groundwater flow. However, there are some difficulties to characterize very slow groundwater flow. The groundwater dating method focusing on radionuclide is one of the most promising methods.

We have been developing the groundwater dating method using Chorine-36 and Helium-4 range of about one million years. Because Cl-36 decays with 300 ky half-life, and He accumulates in crust by decaying Uranium and Thorium. The series of groundwater sapling has been conducted in Great Artesian Basin (GAB) to verify the groundwater dating method. Because the geological formation and groundwater flow are very simple in GAB.

We took 88 samples from water bore located in Central Eromanga Basin and Eastern Eromanga Basin, and analyzed major ions, stable isotopes (deuterium and oxygen), radioisotopes(C-14 and Cl-36), and noble gases (He, Ne, Ar).

The origin of groundwater is rainwater based on major ions and stable isotopes. The groundwater flow in GAB is evaluated from the distribution of Cl-36 and He-4. Base on these results, groundwater recharge at Great Dividing Range and flow towards Lake Eyre in Central Eromanga Basin. In Eastern Eromanga Basin, groundwater recharge at mountain located at eastern margin and flow towards Lake Eyre. According to these results, the groundwater recharge at mountain area and flows toward low-elevation area (Lake Eyre). In the central area, dissolved He-4 is lower than the other area. It is caused by degassing due to high water temperature.

The change of Cl-36 and He-4 are summarized along the flow path based on stiff diagram and previous research. There is close relationship between Cl-36 and distance from recharge area. Based on these results, the velocity of groundwater flow is ranging from 0.1 m/y to 1 m/y. He-4 are correlated with C-14 and Cl-36. The order of accumulation rate of He-4 is estimated about 1.0e-11 ccSTP/gw/y. These relationships show that He-4 dating will be key tool to verify the groundwater dating and to connect the radioisotope dating.

As a result, it is proved that Cl-36 and He-4 indicate the groundwater residence time in simple groundwater flow system. In the future, we will conduct these groundwater dating methods to other sites for increasing the applicability.

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