

## Groundwater age determination by using $^{85}\text{Kr}$ and its verification by other hydrogeochemical tracers

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Krypton 85 ( $^{85}\text{Kr}$ ) is a man-made trace gas from reprocessing plant origin whose atmospheric concentrations have been increasing over the past few decades. As it is soluble in water, it can be used as groundwater age indicators over timescales ranging from a few years to a few decades. In this study,  $^{85}\text{Kr}$  specific activities in groundwater were measured with an on-site dissolved Kr gas extraction system using an external flow through type hollow fiber membrane modified after Ohta et al. (2009).

$^{85}\text{Kr}$  specific activities in groundwater were confirmed at 3 sites in Miyakonojo basin, south-western Japan, considering regional groundwater flow system. Estimated groundwater age were 2 years, 11 years and 60 years in the recharge, intermediate and stagnant discharge areas along the groundwater flow line, respectively. In order to verify these  $^{85}\text{Kr}$  ages, we also measured other age tracer gases such as Sulfur hexafluoride ( $\text{SF}_6$ ) and Chlorofluorocarbons (CFCs) at the same sampling wells of  $^{85}\text{Kr}$  measurement. The result of the  $\text{SF}_6$  age dating in the three locations were well harmonized with the  $^{85}\text{Kr}$  dating results; the  $\text{SF}_6$  age were 1 year, 23 years and over 60 years. However, CFCs could not show reasonable groundwater age due to the local contamination by the urban and industrial origin CFCs.

The seasonal fluctuation of the stable isotopes ( $\delta^{18}\text{O}$  and  $\delta\text{D}$ ) in groundwater were also measured to evaluate the comprehensive groundwater age tendency. Relatively high seasonal fluctuation of the stable isotopes were measured only in the shallow unconfined well site at the recharge area, which reflect the seasonal isotopic fluctuation in the precipitation. This is another evidence of the relatively young groundwater characteristics to support the  $^{85}\text{Kr}$  and  $\text{SF}_6$  age in the recharge area.

Keywords: Krypton-85, Groundwater age, Groundwater flow system, Sulfur hexafluoride, Groundwater age tracer, Miyakonojo basin