Radon-based on-site estimation of extraction efficiencies of krypton and argon by field-degassing device for groundwater dating

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Groundwater immobility is one of the important criteria for the safe and long-term disposal of high-level radioactive waste in deep geological repositories. Because of chemical inertness and conservative natures of noble gas isotopes in aquifers, the groundwater dating by using radiokrypton and radioargon will been applied to the assessment of groundwater mobility at deep disposal site. However, the abundances of these radio-noble gas isotopes are extremely small, and requires > 100L water samples even for the most-sensitive isotope analyses by the ATTA method (Lu et al., 2014). Thus, for this purpose, the purpose-built degassing device is commonly used to extract and isolate dissolved gases into a portable-sized gas container. There are various types of field degassing devices (Yokochi et al., 2016), but neither of them equipped with a function to measure extraction efficiencies of krypton and argon on site.

In this study, we explored the possibility to use on-site analysis of Radon as a proxy to the extraction efficiency of radiokrypton and radioargon from deep groundwater (Ohta et al., 2009, 2019). Based on our test made in the laboratory and also in the deep repository site, we estimated the efficiency of radon extraction from the deep groundwater ranged from 60% to 80% in the field test; the efficiency was 10%–15% and 14%–19% lower than those of Kr and Ar, respectively. These results indicate that the ^{222}Rn extraction efficiency could serve as a conservative estimate of the radiokrypton and radioargon extraction efficiency. This new indicator can be applied to both shallow and deep groundwater because of the ubiquity of U-series elements in natural environment.

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Lu et al., Earth-Sci Rev. (2014), Ohta et al., J. Hydrology (2009), Ohta et al., J. Hydrology (2019 in revision), Yokochi et al., J. Hydrology (2016)