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high level of radioactivity in shallow granite aquifer: radiogenic He as a proxy of strong in-situ supply from residual soils

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In Korea, where weathered granitic rocks are dominant, a previous study has reported high ^{222}Rn concentrations from 37.4 to 100.3 Bq/L (< 50 m, below ground surface, bgs) with the highest concentration occurring at a shallow depth of 35 m, bgs. This eventually led to the closure of production wells. In this study, we analyzed radiogenic ^{4}He, as a proxy of increase of radioactivity in shallow groundwater. The distribution of radiogenic ^{4}He in the shallow aquifers was largely dependent on the geology, where three distinct trends in He isotope excesses existed: 1) a strong volcanic influence with He isotopes with ~6.7 R_A (R_A = air = 1.39 x 10^{-6}) on Jeju Island, 2) a relative weaker volcanic influence in Yanggu with 2.3 R_A, and 3) a purely radiogenic source of ^{4}He (i.e., no volcanic/mantle influence) throughout the remaining five aquifers. Notably, the Jurassic biotite granite aquifer in Wonju exhibited a measurable amount of radiogenic ^{4}He, with the concentration peaks occurring at the relatively shallow depth of 18.5 m. This was attributed to the high range of ^{4}He accumulation rates (3.51 x 10^{-9} – 1.17 x 10^{-8} $cm^3STP/g/y$), which originated from the strong *in-situ* production of residual soils weathered from U-abundant protolith. The radiogenic sources scattered in the shallow granite aquifer caused localized peaks of the radioelements, refuting the diffusive supply of the radioelements from deep depths.

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