

Vertical profiles of stable isotopic composition of groundwater in Abukuma granite: comparison with radiocarbon dates

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Groundwater in hard rock aquifer mainly circulates along fractures and fissures, and the flow is mainly governed by the physical properties of the rock heterogeneities such as opening, spacing and connectivity. The present study reported stable isotopic compositions of groundwater in granite fractures. The study site is situated at the northern part of the Abukuma Mountains in Fukushima Prefecture, northeastern Japan. To collect groundwater in granite fractures, three drillings were performed. Groundwater sample in the present study were taken from fractures in the weathered-fissured zone and fracture zone of granite. The radiocarbon dates of groundwater ranged from modern to ~16 ka. The vertical profiles of radiocarbon dates indicate a relatively constant age of 10-16 ka for groundwater deeper than 100 m.

Stable isotopic composition suggests that all groundwater originated from meteoric water. The shallow around-groundwaters indicated wide isotopic range, since the monsoon climate will produce the seasonal isotopic variations of precipitation. The range of stable isotopic compositions of stream waters around Mt. Utsushiga-take showed slightly lower than that of around-groundwater. This suggested that around-groundwater is unlikely originated from recharge area in Mt. Utsushiga-take, although the local groundwater flow was not clarified. Groundwater flow from the mountain to the drilling sites might be blocked off, owing to the faults and tectonic line between Mt. Utsushiga-take and the drilling sites.

The isotopic values of borehole-groundwater beneath the depth of 100 m showed significantly lower values than those of around-groundwaters: the isotopic depletions are 5-10 ‰ in hydrogen isotopic ratio and 1.5-2.0 ‰ in oxygen isotopic ratio. These indicate that they were recharged under colder climate conditions and/or at higher altitudes. The stable isotopic compositions of stream water of the Mt. Utsushiga-take did not represent the same ranges with those of borehole-groundwater. Radiocarbon dates of groundwater beneath the depths of 100 m ranged 10-16 ka, corresponding to be the last glacial period, Oldest, Older and Younger Dryas periods. The colder climate enhances the isotopic fractionation during the air mass transportation and rainfall. Some studies reported the low values of isotopic compositions of groundwater due to recharge under the cold climate such as last glacial period.

This study is regulatory support research funded by the Nuclear and Industrial Safety Agency, Ministry of Economy, Trade and Industry, Japan.