

Estimating groundwater flow system based on stable isotopes of river waters: Abukuma granite region, north Japan

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An approach for characterizing groundwater flow system in fractured Cretaceous granitic rocks in Abukuma district, Japan, is presented. The hydrochemistry of a site (150 km² in area; 700m difference in elevation) was studied by means of conventional river water sampling from 215 locations in a dry period, when the stream discharge is exclusively fed by groundwater. The site is characterized by numerous fractures of small to medium scales distributed evenly across the site, with two prominent north-south trending fracture zones in the west and center. Mt. Utsurigatake (944m a.m.s.l) occupies eastern part of the site.

The river waters were found lower in isotopic composition (less than -65 per mil in dD) on the fracture zones and their near vicinity, presenting a clear contrast with those away from the fracture zones (in the range from -60 to -55 per mil in dD, or more). The hydrochemical and isotopic analyses suggest that these isotopic composition anomalies on the fracture zones result from a contribution of isotopically depleted waters fed by a regional groundwater flow system with higher recharge altitudes. An altitude effect indicates a mean recharge area for this regional groundwater flow is 500-750 m altitude on the Mt. Utsurigatake slopes.

The study demonstrates that high-density isotopic data on river waters in a dry period can be of great use for solving groundwater flow system in fractured granitic rocks.