

Origin of deep saline groundwater based on halogen composition in Tohoku

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Saline groundwater basically contains various origin of water such as meteoric water, seawater, connate water, and slab-related water. Origins are presumed using chemical and isotopic features of waters, however, estimation of mixing contribution of each end-member including slab-derived water has not been tried. In this study, we determined contribution of seawater, connate water, and slab-derived water using I/Cl and Br/Cl ratios of groundwater collected from Tohoku area, Japan.

Over 90 saline groundwater samples (Cl: >200 mg/L) were collected from Iwate, Akita, Miyagi, Yamagata, Niigata Prefectures. Bromine and Cl concentrations were determined by ion chromatography (Dionex, DX-500) and inductively coupled plasma mass spectrometry (Agilent 7700).

Contribution of seawater, connate water, and slab-derived water were calculated for groundwater samples, assuming I/Cl ratio (molar, 10⁻⁶) and Br/Cl ratio (molar, 10⁻³) of 0.8 and 1.53 (seawater), 3500 and 5.5 (connate water), and 30-110 and 0.5 (slab-related water), respectively. Contribution of meteoric water was removed assuming mixture of seawater and river water using Cl concentration.

The samples collected from hot springs near the volcanoes were found to be mixtures of 50-95% of slab-derived water and 5-50% of seawater. The 5-40% of slab-derived water was also found in the samples from fore-arc area. The mixing ratios of connate water were 5-50% for the samples collected from oil and gas field in back-arc area. Almost 100% of seawater samples were found not only near the coast but also inland area. Such seawater have been left behind in Miocene sedimentary rocks. Based on these data, fluid circulation in subduction zone along NE Japan arc will be discussed, using such as ¹²⁹I/¹²⁷I, ³⁶Cl/Cl, and ³He/⁴He in the future study.

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