

Interaction of deep-seated waters with shallow groundwater system

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On the basis of the literature and the field survey, an investigation into the geographical distribution of Cl-rich shallow groundwater was made nationwide on the wells of ca.10 m in depth or shallower and springs located in the inland areas of Japan. As of 2009, ca. 250 shallow wells and springs across Japan were identified as those producing Cl-rich groundwater. The Cl concentration ranges up to 23,000 mg/l and, with some exceptions, water temperature was nearly the same as Cl-poor, local meteoric waters in the vicinity.

These shallow brackish and saline groundwaters proved to be unevenly distributed: there is a swarm around the Quaternary volcanoes. Dense distribution is also observed along the active, large faults such as the Median Tectonic Line and the Itoigawa-Shizuoka Tectonic Line, on the oil- and gas-producing regions such as Niigata and Toyama along the Japan Sea, and on the gas-producing regions like Boso, Yaizu, and Miyazaki along the Pacific Ocean. These distribution patterns of Cl-rich shallow groundwater is assumed to reflect the geotectonic structure of the Japanese Archipelago.

As Japan has long been in the active mobile belt under humid climate condition throughout the geological age, there is no possibility of occurrence of rock salt underground. In stead, the isotopic analyses allowed us to confirm that a couple of end-members with heavy delta-D and delta-¹⁸O values and an elevated Cl concentration are responsible for the generation of Cl-rich shallow groundwaters in the inland areas of Japan. Magmatic water in and around the volcanic front, water originated from slab-dehydration in the forearc region between the subduction zone and the volcanic front (the so-called Arima-type fluid; Kazahaya et al., 2009), and formation water in the oil- and gas-producing regions (geochemically alternated fossil sea water) are cited as plausible end-members contributing much Cl to the shallow aquifers of the respective areas. A case study in the Wataruse district (2km² in area), Saitama Prefecture, proved that, as of 2009, areal Cl flux from depth into the shallow groundwater has reduced to 1/10 compared with that in 1963. A further study is needed to evaluate whether this reduction in areal Cl flux has resulted from natural or anthropogenic factors.

Keywords: deep-seated water, shallow groundwater system, Cl-rich shallow groundwater, mixing, geographical distribution, isotopes