The Cl-rich inland shallow groundwaters of Japan: Distribution and their isotopic composition

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Field survey and literature investigation about the Cl-rich shallow groundwater was made nationwide on the wells less than 5 m in depth and springs located in the inland areas of Japan. As a result, more than 150 wells and springs across Japan were identified as those producing cold Na-Cl type groundwaters. The Cl^- concentration ranges from ca. 500 mg/l to 37,800 mg/l and, with some exceptions, water temperature was nearly the same as Cl-poor shallow groundwaters of meteoric water origin in the vicinity. These shallow saline groundwaters proved to be unevenly distributed. There is an overconcentration around the Quaternary volcanoes. An intensive concentration is also observed along the active, large faults such as the Median Tectonic Line and Itoigawa-Shizuoka Tectonic Line, and on the oil and gas fields along the Japan Sea and the Pacific Ocean, indicating their distribution reflects well the geotectonic structure of the Japanese Islands. The isotopic analyses (dD, $d^{18}O$, $d^{13}C$, $^3He/^4He$) allowed us to confirm that a couple of end-members with heavy isotopic ratios and an elevated Cl^- concentration are responsible for the generation of saline shallow groundwaters in the inland areas. Magmatic water, slab-derived water, and formation water (fossil sea water) from oil and gas fields are cited as three plausible end-members contributing to the shallow aquifers of the respective areas.