^{36}Cl ages and origins of deep saline groundwater in the Ishikari Lowland and the Tsugaru Plain, Japan

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Long-term sea-level fluctuations due to climate change have impacts on groundwater flow regimes in coastal areas. It can change shoreline distribution and associated topography of inner bay and inland sea areas, which potentially affect groundwater flow regimes. An assessment of the influence of sea-level change on groundwater is therefore important for predicting long-term groundwater flow patterns.

To investigate the influence of past marine transgression on groundwater systems, we applied ^{36}Cl dating to deep saline groundwater of sedimentary rock areas in Japan (the Ishikari Lowland and the Tsugaru Plain). Saline waters were collected from deep boreholes and analyzed for major chemistry, water stable isotopes, and ^{36}Cl/Cl ratios. The majority of the samples were obtained from Miocene to Pliocene sediments, with main sampling depth of 700–2,000 m in Ishikari and 500–1,000 m in Tsugaru. Several rock samples were analyzed for whole-rock chemistry to calculate secular equilibrium ^{36}Cl/Cl ratios in the corresponding reservoirs of sampled groundwater.

Chloride concentrations in the Ishikari Lowland exceed 5,000 mg/L in most locations up to ~40 km from the coast (~30 m.a.s.l.), and ^{36}Cl/Cl ratios range from 3.2×10^{-15} to 7.2×10^{-15}. In the Tsugaru Plain, Cl concentrations are 1,000–5,000 mg/L in locations up to ~35 km inland (~40 m.a.s.l.), and ^{36}Cl/Cl ratios are in the range of $3.5–7.6 \times 10^{-15}$, except for two samples (12.8×10^{-15} and 14.1×10^{-15}). In contrast, the secular equilibrium ^{36}Cl/Cl ratios calculated from rock data are mostly greater than the values in groundwater for both areas ($\sim 10 \times 10^{-15}$). This indicates that the Cl in saline waters has not yet attained an equilibrium for ^{36}Cl, suggesting origins related to seawater derived from past transgression. The obtained ^{36}Cl ages, largely greater than 100 kyr, imply that deep groundwater in sedimentary rock areas cannot be easily flushed during regression-transgression cycles.

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