Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW023-P15 Room:Convention Hall Time:May 25 16:15-18:45

Application of ^{36}Cl to deep fluid systems in Japan: Implications for the sources and residence time of chlorine

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This study applied the long-lived radionuclide ^{36}Cl to better elucidate the sources of chlorine in deep fluids in Japan. Several regions with different tectonic/geological settings were selected for the collection of deep fluid samples from hot spring wells: e.g., a coastal sedimentary basin in Aomori, surroundings of volcanic calderas in Hokkaido, and vicinity of tectonic faults in western Japan. Concerning the samples obtained from a coastal sedimentary basin, the ^{36}Cl/Cl ratios mostly fall on the seawater-shallow groundwater mixing trend line, with a few samples deviating upward possibly due to the build-up of nucleogenic ^{36}Cl in the subsurface. The calculated ^{36}Cl/Cl ratios of assumed seawater fractions were positively correlated with crustal ^{4}He concentrations, associated with increasing residence time of the fluids in the subsurface. This trend suggests that the source of deep fluids in this area is probably old seawater. In the case of the samples nearby major tectonic faults, the delta ^{18}O-delta D relationship depicts a shift to Arima-type thermal brine (Matsubaya et al., 1973) or magmatic water (Giggenbach, 1992). These samples tend to show low ^{36}Cl/Cl ratios close to the seawater value (1-2 x 10^{-15}) especially for the samples with high ^{3}He/^{4}He ratios similar to that of the upper mantle. It implies a deep-seated source of these fluids, such as mantle- or magma-derived components, and also suggests a relatively short residence time in the crust without significant production of nucleogenic ^{36}Cl.

References

Giggenbach, W.F. (1992): Isotopic shifts in waters from geothermal and volcanic systems along convergent plate boundaries and their origin. *Earth and Planetary Science Letters*, **113**, 495-510.

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Keywords: deep fluid, chlorine, origin, residence time, chlorine-36