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Role of deep-seated fluid in formation of CO2-rich springs in the central part of San'in district

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Many CO_2-rich springs are distributed in the central part of San'in district, southwest Japan. It has been assumed that they are affected by volcanic fluid owing to existence of a small-scale Quaternary active volcano (Sambe volcano) at the center of the distribution area. It is expected, however, that deep-seated fluid derived from lower crust contributes to the formation of CO_2-rich springs, because the discharge points of them exist more than 10km away from the Quaternary volcanos. For investigate of the above mentioned details, the geochemical feature and formation process of CO_2-rich ($>$ 250mg/L) thermomineral spring and well waters were discussed.

From the chemical composition of major dissolved solids, CO_2-rich springs are divided into Na-Cl and Na-HCO_3 types. The former is located around the Quaternary volcanos (Mt. Sambe and Oe-Takayama volcanic group) and the latter is located in the Chugoku mauntains composed of Paleozoic basement rocks and many granite intrusions. Isotopically, we could not found influence of deep-seated water except for Yodani hot spring (Na-Cl type) slightly shifted for magmatic water on delta-diagram.

To detect the deep-seated fluid contained in CO_2-rich spring waters, a ternary diagram (proposed by Ohsawa et. al., 2010) plotted on relative ratio of chlorine (Cl), lithium (Li) and boron (B), which are conservative components in fluid, were used in this study. All of Water samples were plotted along the B-Li axis between inter-layer dehydrated water of clay minerals (B-rich) and Arima-type brine (Li-rich), which is likely originated from dehydrated water from altered basalts in the Philippine Sea slab. Na-Cl type waters were clustered close to Arima-type brine, while Na-HCO_3 type waters were plotted nearer part of the B-enrichment inter layer water. Difference of Li/B ratio between Na-Cl and Na-HCO_3 types may be related to the originated depth of fluid (Hrajima et. al., 2010). Therefore, Na-Cl type waters with higher Li/B ratio are originated from deeper part of crust (probably lower crust).

Carbon isotope composition of dissolved inorganic carbon in water samples were ranging from -8.7 to -2.4 per mil indicating that deep source CO_2 play a important role for the formation of CO_2-rich springs. The contribution rate of deep source CO_2 in Na-Cl type waters was high compared with that in Na-HCO_3 type ones.

Deep low frequency earthquakes are occurring at about 30km depth beneath the Sambe volcano, where Na-Cl type waters are distributed, and northern part of the Miyoshi city, where Na-HCO_3 type waters are found, indicating that aqueous fluid exist in the lower crust. The fluid in lower crust might be dehydrated (degassed) from solidifying basaltic magma (Kazhaya, 2010). Difference of the geochemical feature of Na-Cl and Na-HCO_3 type waters may be related to the different geological structures which influence the rise of deep-seated fluid in both Quaternary volcanic and non-volcanic area.

Keywords: CO2-rich spring, isotopes, Cl-B-Li composition, deep source CO2, deep-seated fluid