

## Delineations of groundwater circulations and geothermal water origins using the geochemistry and noble gas of groundwater around the Yangsan fault, Republic of Korea.

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The geochemistry and noble gas isotope of groundwater in 10 deep groundwaters and 3 geothermal waters were examined for the characterization of groundwater circulations and the heat source origins of geothermal waters around major fault such as Yangsan fault, southeastern part of the Korean peninsula. The pH values of groundwaters and geothermal waters were in ranges from 5.65 to 8.16 and from 7.0 to 7.98, respectively. In the geothermal waters such as the Haeundae geothermal waters and the Dongrae geothermal waters, the average electrical conductivity was relatively high (3,890  $\mu\text{S}/\text{cm}$ ) due to the high Na and Cl concentrations. It indicates that the geothermal waters in the hot spring areas are affected by the seawater intrusion. The geochemical types of groundwaters and geothermal waters were  $\text{Ca-HCO}_3$  ( $\text{Ca-SO}_4(\text{Cl})$ ) and Na-Cl type, respectively and showed indistinct relationship with the geological characteristics. In the results of noble gas analysis, the most of groundwaters were plotted along the air-crust mixing line on  $^3\text{He}/^4\text{He}$  vs.  $^4\text{He}/^{20}\text{Ne}$  diagram. It implied that the  $^3\text{He}$  of groundwater except one groundwater sample are dominantly derived from the air and are mixed with the helium originated from the crust. Also, it indicates that the groundwater actively circulates along the faults and the faults cannot play a role of upward pathway of a deep-seated helium gases. The  $^4\text{He}$  concentrations of groundwater were relatively high in the aquifer. It indicated that the groundwaters are sufficiently interacted with the basement rock. The  $^3\text{He}/^4\text{He}$  ratios of the geothermal waters, plotted on the air-crust mixing line, were in ranged from  $0.4 \times 10^{-6}$  to  $0.8 \times 10^{-6}$ . It suggested that the He gases in the geothermal waters are mainly originated from the atmosphere and crust, and partly from the mantle sources.

Keywords: fault, geochemistry, noble gas, groundwater, geothermal water