# Origin of Helium and $CO_2$ Gas from Natural Carbonated Waters in the North-Eastern Area of South Korea.

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Many carbonated springs are found in Mesozoic granitoids and surrounding rocks in South Korea. Their presence is mainly restricted to the Kangwon and Kyungpook provinces. Discharge of many carbonated waters is mainly related to the geologic structures, i.e., the geologic boundaries, fault and dykes that could be a pathway for the rising of deep-seated $CO_2$ gas.

The composition of carbonated waters can be classified into three chemical types; Ca-$HCO_3$ water, Ca(Na)-$HCO_3$ water, and Na-$HCO_3$ water. Most of the carbonated waters are characterized a high $CO_2$ concentration ($P_{CO2}$ 0.12 atm to 5.21 atm), a slightly acid pH (5.19 to 6.47), and high ion concentration.

Oxygen and hydrogen isotope data indicates that the carbonated waters are of meteoric origin. $\delta^{13}C$ data of −6.6 to −0.3‰ suggest that the $CO_2$ gas in carbonated waters is mainly derived from a deep-seated source, but is partly mixed with $CO_2$ derived from carbonate rocks. The $^3He/^4He$ ratios of carbonated waters range from $1.51x10^{-6}$ to $8.38x10^{-6}$. The data are mainly plotted along the air-mantle mixing line on the $^3He/^4He$ versus $^4He/^{20}Ne$ diagram. These data strongly supported the deep-seated origin of $CO_2$ gas by $\delta^{13}C$ data.

Keywords: carbonated waters, CO2 gas, δ13C , 3He/4He ratio

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