Geochemical Assessment of Vanadium Distribution in Groundwater of Jeju Volcanic Island

JI-HYE JEONG[1], HO-RIM KIM[1], IK-HYEN HYEN[2], SANG-KYU KAM[3], SOO-HYUNG MOON[4], SEONG-TAEK YUN[1*]

(styun@korea.ac.kr)

1 Dept. of Earth & Environmental Sciences and KU-KIST Green School, Korea University, Seoul, South Korea

2 Jeju Special Self-Governing Province Institute of Environment Research, Jeju, South Korea

3 Jeju National University, Jeju, South Korea

[4] Jeju Province Development Co., Jeju, South Korea

Vanadium(V) is typically more enriched in mafic rocks such as basalt than in felsic rocks and its behavior of leaching and mobility is sensitive to oxidation-reduction condition. Recently there has been a public interest on the use of vanadium-rich groundwater in Jeju volcanic island of South Korea and other localities in the world. Thus, better knowledge on the occurrence and geologic/geochemical controls of vanadium enrichment in groundwater is needed. In this study, spatio-temporal patterns of the distribution of vanadium in groundwater in Jeju are evaluated using hydrochemical data of groundwater samples that were collected by the Institute of Enviroment Research of Jeju Special Self-Governing Province and Jeju Province Development Corporation between 2009 and 2014. Data of a total of 757 groundwater samples (134 in 2009, 296 in 2010, 327 in 2014) are used in this study and include major ions (Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, HCO_3^-, NO_3^-, SO_4^{2-}, F^-), vanadium and other minor elements (Cr, Mn, Fe, As, Al, Cu, Se, Si, Sr, Li, Zn).

The concentrations of vanadium in Jeju groundwater from trachybasaltic to basaltic aquifers are wide from “not detected (< 2.5 μg/L)” to 64.8 μg/L, with the median value of 9.1 μg/L. Any temporal change of V concentration is not observed. However, distinct correlations ($p<0.05$) with altitude, land-use, and groundwater level are observed; higher concentrations preferentially occur in mid-altitude regions where grasslands and forests are prevailing, while V concentration tends to be lowered toward low-altitude regions dominantly with farmlands and residential areas. In addition, hydrochemistry of the groundwater with vanadium enrichment is typically of Na-HCO_3 type with oxic to suboxic and slightly alkaline characteristics. The concentration of V is negatively correlated with that of nitrate. Vanadium is originated from water-rock interaction and is later controlled by dilution due to the inflow of nitrate-rich groundwater.