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Environmental tracer data (CFCs, SF_6, ^3H, ^{18}O, ^2H) coupled with hydrochemistry to delineate the groundwater flow dynamics

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Understanding groundwater flow dynamics in complex volcanic stratigraphy is challenging due to *heterogeneity*, which makes it difficult to manage volcanic aquifers in islands properly. Meanwhile, environmental tracer data coupled with hydrochemistry is a good tool to reach a better understanding of groundwater flow dynamics when available knowledge on aquifer structures and hydraulic parameters is limited. The study area, Jeju Island, South Korea, was formed by basaltic volcanic activities during the Pleistocene and Holocene epochs. A shield volcano called Mt. Halla is located in the middle of the island, reaching 1950 m above sea level. In addition, a total of 368 parasitic cones are distributed across the island. The volcanic rocks containing highly permeable structures (e.g., clinkers, lava tubes) form principal aquifers. The regional groundwater flow is expected to be from high-altitude regions around Mt. Halla to coastal areas with local disturbances. To identify the groundwater flow system in the southeastern area of the volcanic island, we collected 602 groundwater samples from 16 wells from March 2016 to October 2020. Hydrochemistry and environmental tracers (CFCs, SF_6, ^3H, $\delta^{18}O$, δD) were analyzed. Lumped parameter model (LPM) developed by US EPA was used for groundwater dating using CFCs, SF_6, and ^3H in selected wells (n=10). To decide a flow model in LPM, borehole logging data and hydrochemical patterns were considered. Based on the hydrochemistry and water isotopes ($\delta^{18}O$, δD), groundwater samples were classified into two groups: one with lower ion concentrations and lighter isotopic compositions and the other with relatively higher ion concentrations and heavier isotopic compositions. Seasonal variations in tracer data and major ions including Cl^-, NO_3^-, Ca^{2+}, Mg^{2+} were also high in the latter. This result implies a regional flow with a short-circulating flow in the studied watershed. The combined use of environmental tracers and hydrochemical data effectively evaluated the groundwater flow dynamics in the complex geologic system. [Acknowledgement] This study was financially supported by the Jeju Province Development Co.