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Hydrogeochemical and environmental isotopic studies of ground waters in Pocheon area: application of M3 modeling to understand the hydrogeologic setting of regional ground water system for sustainable exploitation

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In Pocheon area, two distinct groups of bedrock ground water is recognized based on hydrogeochemical and environmental isotopic data. These are: (1) deep (170 to 1,004 m below the surface), 'sodium-bicarbonate' type water; and (2) shallow (20 to 250 m), 'calcium-bicarbonate' type water. The Na-HCO_3 type water has been exploited as H_2S-bearing (<5 mg/l) thermal springs (up to 44℃) and shows hydrochemically the general attainment to equilibrium with host rock (granite). The Ca-HCO_3 type water varies seasonally in water quality and is high in NO_3 concentration. Hydrogeologic conditions constructed based on oxygen and hydrogen isotope data are distinct between the two groups: the deeper, Na-HCO_3 type waters have the lower $\delta^{18}O$ and δD values than Ca-HCO_3 type water, suggesting both their recharge in adjacent high altitudes and their longer and deeper flow paths. During the hydrogeochemical evolution from Ca-HCO_3 type toward Na-HCO_3 type waters, Na, Li, Cl, F, HCO_3 and H_2S are progressively enriched, whereas Ca and SO_4 are decreased. Sulfur isotope data of dissolved sulfates suggest that the generation of H_2S probably occurs by bacterial sulfate reduction at depths. Carbon isotope data of dissolved carbonates and chemical mass balance modeling indicate that hydrochemistry of Na-HCO_3 type water is largely controlled by the silicate hydrolysis and calcite dissolution followed by ion exchange with secondary silicates.

We performed M3 (Multivariate Mixing and Mass balance calculation) modeling (Laaksoharju et al., 1999) in order to explain the recognized spatial variation of water chemistry on the basis of hydrologic mixing among water masses as well as hydrogeochemical reactions. An ideal mixing model among three water masses is suggested, in which each water mass is represented by surface water (sample PCs-2), shallow ground water (PCw-1), and deep ground water (PCd-3). The resultant net chemical reactions also agree well with the results of chemical and isotopic mass balance modeling. We now propose regional hydrogeologic sections showing probable hydrogeologic setting in Pocheon area, which may be used for sustainable development of ground water.

Keywords: Pocheon, bedrock ground water, hydrogeochemistry, environmental isotopes, sulfur system, M3 modeling