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Delineating flow systems of traditionally well-known groundwater and spring water in South Korea using water stable isotopes and tritium

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We investigated about 140 sites of traditionally well-known hot spa, mineral spring, and spring water in South Korea for environmental isotopes of water to evaluate their characteristics of recharge, residence time, and mixing properties as a part of efforts to compile valuable mineral water resources in Korea. Stable isotopes of water indicated that groundwater derives from average precipitation of summer and winter season in Korea. Altitude effect of water stable isotopes was observed up to 1000 m asl. while it was insignificant at higher altitude. Hot spa and mineral spring had more depleted isotopic compositions compared to spring water suggesting the former derives from higher altitude areas. Depleted isotopic composition prevailed in the northeastern and eastern mountainous areas while enriched composition in the southwestern and western plain areas. Contribution of winter precipitation is significant in spring water of high altitude areas. Tritium in groundwater was in the range of <0.3 TU to 6 TU with lower values in hot spa and higher in spring water. Some of hot spa and mineral spring had tritium lower than 0.5 TU indicating dominance of old groundwater recharged before 1950s. Tritium in groundwater showed no clear difference between aquifer lithology. However, volcanic aquifer had no old groundwater and granitic aquifer had highest fraction of recent recharge. Mineral spring with lower tritium had more depleted stable isotopic composition and higher mineral content implying longer residence time is related with higher altitude recharge or longer flow paths, and higher degree of water-rock interactions. This study shows that environmental isotopes of water can be useful to understanding of flow systems of variably mineralized groundwater at regional scales with diverse lithological and topographical settings.