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Flow system and recharge storage of shallow groundwater in Iwate volcano, Japan, derived from tritium concentrations

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Physical and chemical features of river and spring water around volcanoes reflect structures of volcanic bodies because the existence form and flow system of groundwater in volcanic bodies were strongly restricted by its internal structure that was affected by complex formation processes. Kazahaya and Yasuhara (1999) estimated the average recharge altitude of river and spring waters in Iwate volcano, Japan, using oxygen and hydrogen stable isotope ratios, and found that most part of summit area works as a recharge area of two large springs located in low altitude area (Kanazawa-Shimizu spring: 60000 m^3/day, and Oide spring: 48000 m^3/day). In addition, Sato et al. (2000) indicated that the high SO_4^{2-} concentrations of these two large springs is due to the addition of volcanic gases to groundwater. The aim of this study is to evaluate groundwater flow system and recharge storage around Iwate volcano using tritium concentrations of river and spring waters, and groundwater collected from 1995 to 2006.
Tritium concentration in 1995 and 2006 are ranged from 4.3 to 16.1 T.U., and from 3.1 to 7.5 T. U., respectively, and the concentration decrease at all stations from 1995 to 2006. However, the degree of the decrease are different between stations. It may be due to the different flow system of groundwater between volcanic areas. The simulation of the flow system and mean residence time (MRT) using a lumped parameter model showed that shallow groundwater around Iwate volcano can mainly be divided into four type of flow systems, and the mean residence time is ranged from 3 to 66 years. On the other hands, the relationship between MRT and mean recharge altitude reveals that there are three types of aquifer in Iwate volcano; Type A: deep aquifers that reserving waters recharged around caldera area in high altitude (1200-1500 m). Type B: shallow aquifer that reserving waters recharged on slopes of the volcano. Type C: deep aquifers that reserving waters recharged in low altitude (600-1000 m). The river and spring waters and groundwater originated from type A aquifers show higher delta^{13}C values (-11.7- -1.8 per mill) compared with those of other two types of aquifers (delta^{13}C = -18.9- -13.0 per mill). It indicates the contribution of volcanic CO_2gases (delta^{13}C = around -4 per mill) to the Type A aquifer.
Finally, the recharge storage of Iwate volcano body was estimated from MRT and flow rate. The volume of type A, type B and type C aquifers are 1.39, 1.32, and 0.13 hundred million tons, respectively, and at least 2.70 hundred million ton of water is storage in the volcano body. The two large springs discharge about 92% of groundwater stored in Type B aquifer.

Keywords: volcano, groundwater, stable isotope, tritium, mean recharge altitude, mean residence time