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A geochemical study on groundwater flow processes in Unzen volcano, southern Japan

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Groundwater flow processes in Unzen volcano have been studied using geochemical and hydrological techniques. More than 150 water samples were collected from springs, rivers, and wells and some 50 pore waters were extracted from 100-1200 m deep drilled cores at the eastern flank of the volcano by the centrifuge technique. These water samples were analyzed for their major chemistry and stable isotope ratios. As a result, it was confirmed that most of groundwater recharged at the eastern flank of the volcano flows down the slope eastward and discharged at the Shimabara city area, being controlled by the major fault system developed in the Beppu-Shimabara graben. The hydrogen isotope ratios of spring and river waters are in a narrow range from -48 to -45 per mil, indicating groundwaters recharged at the slope are well-mixed in the course of flow. On the basis of the isotopic altitude effect, the mean recharge elevation of groundwater is found around 800 m on the slope. As for the chemical composition, non-uniform HCO3 distribution as well as the elevated HCO3 concentration were observed in the eastern part of the graben, which may result from the addition of CO2 gases of deep origin ascending along the faults. For pore waters extracted from USDP-2 cores, isotopic composition for the 170 m depth and 420-550 m interval plot clearly away from the present local meteoric water line. Especially, that for the 500 m depth is characterized by a remarkably low dD value. Plausible explanation for this are: 1) groundwaters at these depths were recharged under the climate condition different to the present; 2) contribution of deep-seated volcanic fluids with different isotope ratios. As isotope ratios of pore waters for the upper 300 m are nearly the same as those of the present meteoric waters, it is considered that groundwaters to the 300 m below the surface is comprised in the present shallow groundwater flow system. The further understanding of vertical distribution of isotopic ratios of pore waters must give an insight into the origin and flow system of deep groundwaters in the volcano.