Groundwater flow system of Unzen volcano (1): results from chemical and isotopic compositions of water

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Unzen volcano (peak; 1486 m in elevation) is developed on the western part of Beppu-Shimabara Graben (20 km NS wide and 200 km EW long) located at Kyushu island, SW Japan. We are studying groundwater system of the volcano using geochemical and hydrological techniques in order to estimate flux of magmatic volatiles through the groundwater. We have collected over 150 water samples from springs, rivers, and wells, and they are analyzed for major chemistry and stable isotope ratios.

Most of the groundwater recharged at Unzen volcano flows down the slope directed to the east, which is restricted by normal fault system in the graben Fan deposits inside the graben form large groundwater aquifers, through which 150 kt/d of the groundwater are discharged as spring waters at Shimabara city area. The western slope of the volcano, which was formed by the volcanic activities in older ages than the eastern slope, is dissected by relatively small-sized but a lot of rivers.

Hydrogen and oxygen isotopic ratios of groundwaters, rivers and springs are measured. The hydrogen isotopic ratio of the surface waters are in a narrow range from -52 to -42 , indicating that groundwaters recharged at the slope are well-mixed in the course of flow. On the other hand, the groundwaters show a little lower isotopic ratio than that of surface waters, suggesting groundwaters have higher recharge elevation than surface waters. To obtain the isotope altitude effect of meteoric water, we have set up 10 precipitation collectors in and around Unzen volcano, and sampled monthly precipitaions since Nov., 1999. Isotope ratio of the precipitations from higher elevation and western area tends to have lower value. This isotopic feature is attributed to both the altitude effect and rain-shadowing effect caused by dominanby dominant wind direction from the east.

Meteoric waters (springs, rivers, and groundwaters) show a remarkable regional variation in anion concentrations. They have elevated HCO3 concentrations in the Unzen graben, especially on the E-W faults in Shimabara area, being inconsistent with the uniform isotope ratios observed there for the groundwaters. Non-uniform HCO3 distribution as well as high HCO3 concentration in the graben may result from the addition of CO2 gases of deep origin ascending along the faults. To the contrary, Cl and SO4 concentrations show a tendency to be higher outside the Unzen graben. Anthoropogenic activities such as market-gardening and stock-farming are likely to be responsible for these elevated Cl and SO4 concentrations.