Database compilation and numerical modeling of hydrothermal system of Kuju volcano before and after the 1995 eruption

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We have been observed volcanic activity of Kuju Iwoyama, the central part of Kuju volcano, since late 1970s. Especially, we added gravity, fumarole temperature, heat discharge rate and magnetic observations to the previous seismic observation at the 1995 eruption. Additionally, we have been trying to construct a model of the thermal structure and hydrothermal system of Kuju volcano at each stage of the observations, and the latest numerical model explains the cooling process of the volcanic edifice of Kuju Iwoyama based on the result of the magnetic observation. However, the result of each observation technique could be compared each other at the discussion, but the modeling based on the compilation result of all of the observation data has not been performed.

We compiled a database of several kinds of observation results conducted at the Kuju volcanic area, and tried to construct a numerical model based on the comparative discussion on the observation data. After the comparative review of the data, the active state of Kuju volcano up to 2007 can be divided into 6 stages that consist of 2 stages before the 1995 eruption and 4 stages after the eruption. We used a computer code HYDROTHERM (Hayba and Ingebritsen, 1994) Version 2.2 for the numerical modeling of each stage with the modeling region of 5.1 km (N-S) by 5.1 km (E-W) and vertically from the ground surface to 500 m below sea level. Kuju Iwoyama exists at the center of the modeling region. We set a source block of the high enthalpy water as the magmatic fluid inlet at the bottom of the modeling region, and changed the production rate of the high enthalpy water and the permeability and porosity values of the conduit blocks connecting to the ground surface by trial and error to fit the calculated heat discharge rate from the existing fumarolic area and the new craters of Kuju Iwoyama to the observed one.

The most suitable model explains temporal change of the heat discharge rate, but is difficult to explain the inflow of groundwater to the two-phase volcanic reservoir just beneath the existing fumarolic area inferred by the gravity observation and the cooling rate of the volcanic edifice estimated by the magnetic observation. In order to decrease the temperature of the mountain body, we had to decrease the permeability of the conduit that led to decrease of the calculated heat discharge rate for 2007. This result may show a possibility of smaller value of the actual heat discharge rate from Kuju Iwoyama in 2007 than the latest measured value of that in 2003, and should be confirmed by the observation.

Hayba, D. O. and Ingebritsen, S. E. (1994) The computer model HYDROTHERM, a three-dimensional finite difference model to simulate ground-water flow and heat transport in the temperature range of 0 to 1,200 deg C. Water-Resources Investigations Report 94-4045, U. S. Geological Survey, 85p.