Numerical Models for the Hydrothermal System/Thermal Structure of Kuju Volcanic Area

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The Laboratory of Geothermics, Kyushu University has been conducting the researches of the Kuju Volcano in Kyushu Island, Japan for the research of future volcanic energy utilization since the 1970s. And we have constructed some numerical models of the thermal structure and hydrothermal system of the Kuju Volcano in order to integrate the obtained research results at each step since the late 1980s. From the early stage of the numerical modeling of the Kuju Volcano, two types of models, namely broad area models that cover the whole of the Kuju Volcanic Area and local area models around Kuju-Iwoyama, which is the solfatara field of Kuju Volcano, were already constructed and this modeling policy has continued until now.
The broad area model in the 1980s was a 2-D transient thermal conduction model of a vertical N-S section that had an extension of 50 km. The model showed that the present heat flow distribution of the Kuju Volcano estimated by 5 deep geothermal wells is explained by a cooling magma that had been emplaced 50,000 years ago. And the local area model in the 1980s was a cylindrical coordinates geothermal fluid flow model that had a diameter of 5 km centered on Kuju Iwoyama and a height from the ground surface to the depth of 2 km. The local area model concluded that a concentration zone of microearthquake hypocenters (a cylindrical zone of about 500 m in diameter and 2 km height beneath the solfatara field) is a two phase permeable zone (a volcanic geothermal reservoir). We used FINITEG (Lee et al., 1980) for the 2-D transient thermal conduction model and SHAFT79 (Pruess and Schroder, 1980) for the cylindrical coordinates geothermal fluid flow model.
When the 1995 phreatic eruption occurred at Kuju Iwoyama, many organizations conducted various observations. And we constructed a 3-D transient geothermal fluid flow model, which had the horizontal extension of 5.1 km (N-S) by 5.1 km (E-W) and covered from the ground surface to -500 m asl, as a local area model to explain the temporal changes of the heat discharge rate by the fumarolic activity and of the volcanic body temperature estimated by the geomagnetic observation. In recent, we are trying to improve the 3-D local area model to explain the gravity change observed during the volcanic activity period of the 1995 eruption. Moreover, we are also conducting a 3-D transient geothermal fluid flow model, which has the horizontal extension of 49 km (NW-SE) by 39 km (NE-SW) and vertically covers from the ground surface to -10 km asl, as a broad area model to explain the development of the hydrothermal systems in the Kuju Volcanic Area including some geothermal power station regions. We have been utilizing HYDROTHERM Version 2.2 (Hayba and Ingebritsen, 1994) and Version 3.2 (Kipp Jr. et al., 2008) for these models.

Keywords: Kuju Volcano, hydrothermal system, thermal structure, numerical modeling

