

Possible existence of vapor-dominated geothermal reservoirs in the hydrothermal system of Kuju Volcano –Discussion by numerical modeling–

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Laboratory of Geothermics, Kyushu University has been conducting numerical modeling of the broad geothermal system that has the scale of a volcanic area including some geothermal power station areas in the volcanic area to explain the generation and development of the hydrothermal system by the heat sources like magma chambers. Till now the numerical models of Unzen Volcano and Kuju Volcano have been tried to construct by using a geothermal system simulator HYDROTHERM Ver. 2.2 (Hayba and Ingebritsen, 1994).

The numerical model of Kuju Volcano has the horizontal size of 49 km in NW-SE direction, 39 km in NE-SW direction, and the vertical size from the ground surface to the depth of -10000 m asl. Approximate dimension and location of a magma chamber were determined by reference to the low velocity part of the seismic velocity structure proposed by Sudo and Matsumoto (1998) and Yoshikawa et al. (2005). And the simulation scenario, this magma chamber was emplaced 50000 years ago and Kuju-Iwoyama at which there are some fumarolic areas started its volcanic activity 15000 years ago, was based on the volcanic history of Kuju Volcano proposed by Kobayashi (2010) and Kamata (1997). The numerical simulation of the present hydrothermal system of Kuju Volcano has conducted with modifying the model (change of the cap rock and fault structure, etc.) to replicate the temperature profiles of 41 wells in the modeling area (Japan Atomic Energy Agency, 2014). The currently most suitable model explains the temperature profiles of the wells in the Hatchobaru area in Oita Prefecture and the Takenoyu-Sugawara area in Kumamoto Prefecture even though some wells in other areas don't indicate good fitting.

Generally, it is considered that the geothermal reservoirs of the geothermal power station areas in Kuju Volcano are liquid-dominated. The currently most suitable numerical model of Kuju Volcano shows the domain where the temperature and pressure exceed 374°C and 22 MPa at a large portion and the shallower part of the magma chamber. It means that the fluid of this domain becomes supercritical state in the model. On the NW-SE vertical slice passing through Hatchobaru and Takenoyu, the supercritical fluid reaches to the relatively shallower part (about -2000 to -2500 m asl) beneath Hatchobaru and Mt. Waita. And the shallower part above the supercritical domain is liquid-dominated in the vicinity of Hatchobaru, while a vapor-dominated domain, on which a liquid-dominated domain lies, appears above the supercritical domain beneath Mt. Waita.

HYDROTHERM Ver. 2.2 can treat up to 1200°C and 1000 MPa, but the geothermal fluid is treated as pure water. So there is a possibility of overestimation for the existence of the vapor-dominated reservoir. However, the numerical model of Kuju Volcano of this study indicates the possible presence of the vapor-dominated geothermal reservoir not only the liquid-dominated reservoir.

Keywords: Kuju Volcano, hydrothermal system, geothermal reservoir, vapor-dominated, liquid-dominated, numerical modeling

