Volcanic thermal fluid simulation (VTFS)-(3) volcanic tremor in hydrothermal area

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Volcanic tremor at the shallow depth beneath the volcano is inferred to reflect the hydrothermal activities related to heat supply from magma. In this study, we developed numerical simulations for the instabilities of the water-steam two-phase flow and considered the source mechanism of volcanic tremor.

The experiments of two-phase flow by Veziroglu and Lee [1968] revealed the two kinds of oscillating modes, density wave oscillation with the period of a few seconds and pressure drop oscillation with the period of dozens of seconds. These modes were mainly controlled by the pressure difference between inlet and outlet, flux rate of fluid and heat supply rate. Especially, the former mode appears when the flux rate is small and the latter does when the pressure difference and heat supply rate are larger.

We performed some preliminary numerical simulation of these oscillations in water-steam flow in a cylindrical conduit using FUJI-RIC a-flow. As an example, we assume the flow in conduit of 4 m length with the valves at inlet and outlet with the conditions of non-slip at the wall. As initial conditions, the inlet and outlet pressures are fixed to be 1.2E5 Pa and 1.0E5 Pa, respectively, water temperature of 370 K, heat supply of 1.0E6 - 2.0E7W/m^3. The friction except the valve area is assumed to be 1000kg/m^3. After the heating condition becomes stable, we shut the valve at the outlet, then detect the significant oscillation. The shut of valve physically corresponds to geometrical narrowing, choking, and non-linear effect for the flow in porus medium. In case of the heat supply of 1.1E7W/m^3, density drop oscillation with the period of 0.16s has appeared.

These plumbing systems correspond to cracks and conduits beneath the volcano and the oscillation originated in two-phase flow instability may be a candidate for the source mechanism of volcanic tremor. This research is supported by ACT-JST.