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Reproduction of the Transition between Spouting and Pause by the Dynamical Model of a Geyser Induced by Gas Inflow with Consideration of Influx of Groundwater

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Extended Abstract

A geyser is defined as the natural spring that sends hot water and steam intermittently into the air from a hole in the ground. Geysers are classified into two types dependent on inducer. That is, one is a geyser induced by boiling and the other is a geyser induced by gas inflow.

The dynamical model of a geyser induced by gas inflow has been derived and modified and regular or irregular spouting dynamics of geysers induced by gas inflow has been reproduced by the model [1-11]. As a result, spouting mechanisms of all types of observed geysers induced by gas inflow could be explained through the dynamical model in principle. The existence of a certain volume of underground cavities (bubbles) assumed in this model has recently been confirmed both observational [12] and indoor experimentally [13].

However, although the repetition cycle of the jet state and the rest state and the temporal variation of the water head of the spouting water can be reproduced by the static model and the dynamical model of a geyser induced by gas inflow, respectively, construction of a "comprehensive" dynamical model describing all the continuous transitions from a spouting state to a pause state or from a pause state to a spouting state has not been completed.

Under such situation, I suggested the possibility that the flow of groundwater from the wall of the spouting pipe is promoted by the decrease in the pressure in the spouting pipe during the spouting period obeying Bernoulli's theorem, thereby the volume of the water column in the spouting pipe increases and finally the spouting state transits to a pause state by connecting the water column with the reservoir of underground hot spring water when the water column descends [14].

In this study, a "comprehensive" dynamical model describing all the continuous transitions from a spouting state to a pause state or from a pause state to a spouting state is derived, based on this idea. And I show that the continuous transitions from a spouting state to a pause state or from a pause state to a spouting state is reproduced through numerical simulation of this model.

And it is seen that the period of transition from the spouting state to the pause state depends on the magnitude of the static frictional force preventing the transition from the pause state to the spouting state and the amount of the inflow of groundwater per unit time during spouting through numerical simulation of this model. Because, if it is assumed that the volume of groundwater exuded per unit time from the wall of the spouted pipe is proportional to the pressure drop in the spouting pipe, the volume of groundwater exuded per unit time is almost proportional to the square of the water flow velocity in the spouting pipe. Note that the water flow velocity during spouting increases as the static frictional force increases.

On the other hand, it is seen that the period of transition from the pause state to the spouting state depends on not only the volume of underground cavity, gas supply rate at the cavity and the depth and the cross section of the spouting pipe as clarified by our past research but also the magnitude of the static frictional force preventing the transition from the pause state to the spouting state.

In addition, it is shown that each underground parameter value of the geyser can be estimated more accurately through the comparison of the numerical simulation result of this model and the observation result of the real geyser induced by gas inflow.

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