Seismic Activity Related to Geothermal Activity -A Case Study of Kuju Volcanic Field-

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An active fumaloric field called Kuju-iwoyama exists in the central part of Kuju volcano in central Kyushu, Japan. Hatchobaru geothermal field is situated about 5km northwest of Kuju volcano. Seismic activity at Kuju-iwoyama and in Hatchobaru geothermal field is very active. Since these areas are the zones where geothermal fluid ascends and flows laterally, microearthquakes may occur by geothermal activity. In this research, we observed microearthquakes at Kuju-iwoyama and in Hatchobaru geothermal field, and investigated the relation between seismic activity and geothermal activity by comparing seismic activities in both areas.

At Kuju-iwoyama, a high microearthquake activity zone exists just beneath the fumarolic area down to about 1.5km. Daily frequency of seismic events was about 10 in the late 1980's, but it decreased before the 1995 phreatic eruption, and increased again after the eruption. Recently, it decreased again to about 2 events per day, and some microearthquakes occurred in deeper parts and the hypocenter distribution extended to northwest of the active seismic zone beneath the fumarolic field.

In Hatchobaru geothermal field, the active seismic zone exists in about 5km northwest of Kuju-iwoyama, in depth of about 0.5km to 3.5km. Daily frequency of seismic events was about 8, and earthquake swarms occurred occasionally in depth of about 0.5km to 6km. Some seismic activities that occurred in the active seismic zone moved from the deeper part to the shallower part. The cause of such seismic activities may be quick upflow of geothermal fluid.

We observed microearthquakes simultaneously in both areas from 2001/10/27 to 2001/12/2 (Term[1]) and from 2002/6/7 to 2002/7/16 (Term[2]), and compared the daily frequency of seismic events, the b-values and the hypocenter distribution of both areas. The following results are obtained: In Term[1], earthquake swarms in both areas occurred complementarily. Each swarm occurred in the shallower part, in depth of about 0.5km to 2.5km. In Term[2], earthquake swarms in both areas occurred simultaneously. In this term, earthquake swarms occurred in the shallower part at Kuju-iwoyama, but in the deeper part (about 6km) in Hatchobaru geothermal field. The b-values were about 1.5 in the shallower part of both areas, but more than 2.0 in the deeper part of Hatchobaru geothermal field.

In the intense geothermal activity area, generally microearthquakes may occur because of flow of high temperature/pressure fluid, high reservoir pressure and boiling of fluid etc. At Kuju-iwoyama, microearthquakes occur just beneath the fumarolic area, so we guess microearthquakes occur by geothermal activity, that is, fluid upflow and lateral flow. In Hatchobaru geothermal field, we guess microearthquakes did not occur by only geothermal activity. Some of them may occur by fault movement. During this observation, earthquake swarms occurred complementarily in the above two fields. This may indicate that earthquake swarms occurred by regional tectonic stress under high reservoir pressure. Microearthquakes occur above about 6km in Hatchobaru geothermal field, but above about 2km at Kuju-iwoyama. The maximum depths of microearthquake hypocenters in both areas coincide a temperature of about 400 degrees, so this may explain by the depth of the brittle-plastic transition.