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Modeling of Geothermal System from Gravity Monitoring at the Takigami Geothermal Field, Oita Prefecture, Japan

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In order to utilize the geothermal resources sustainably, it is necessary to monitor and recognize the behavior of geothermal reservoirs. Micro-gravity measurement is one of the serviceable methods for geothermal reservoir monitoring. Because of the underground mass change caused by the groundwater flow, the gravity change on ground surface is detected. Therefore, the gravity measurements have been introduced in the various geothermal fields. In the Takigami geothermal area, we have continued the geothermal reservoir monitoring by using Scintrex CG-3, CG-3M and CG-5 relative gravimeters since before the commencement of the Takigami geothermal power plant.

In order to estimate the gravity change caused by the mass redistribution in geothermal reservoir, it is necessary to remove the gravity change caused by the effect of the ground water flow in shallow parts. In this study, we tried to calculate a gravity response to precipitation by using G-WATER [E](Kazama et al., 2011).

We introduced an A10 absolute gravimeter (Micro-g LaCoste, Inc.) in 2008. Although it was impossible that the A10 absolute gravimeter was applied at all of the stations because the condition of the measurement was strict, we utilized the A10 gravimeter for not only the assessment of the gravity changes at the reference station, but also the detection of the absolute gravity change caused by the subsurface fluid mass changes at some other measurement stations. We chose 4 stations (T13B, T22A, T26A and T27A) to conduct the repeat absolute gravity measurement. T26A lies in the reinjection area, and there are the other 3 stations in the production area. As a result of absolute gravity measurements, the gravity change at the reference station T1 of the relative gravity measurements is small enough for this evaluation, within about 10 microgal. Therefore, we estimated that this reference station is appropriate for the relative gravity measurements.

As a result, shortly after the Takigami geothermal power plant had started power generation, a sharp gravity decrease occurred in the production area, after that, the gravity changed stably for 2 years in entire area, and then gradually decreased until 2002, and the gravity has increased since 2002. We divided the Takigami geothermal area into 3 areas from the pattern of the gravity change after the commencement of the Takigami geothermal power plant, and we estimated the 5 stages of geothermal fluid flow pattern from temporal gravity change. Based on these classifications, we led a conceptual reservoir model of the Takigami geothermal area.

Keywords: Repeat Gravity Measurement, Absolute Gravimeter, Relative Gravimeter, Takigami Geothermal Area