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Evaluation of Geothermal Reservoir from the Gravity Changes at the Takigami Geothermal Field, Oita Prefecture, Japan

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When the geothermal power plant starts electricity generation, various surveys are conducted in the geothermal area in order to monitor the geothermal reservoir behavior. It is important to understand the geothermal reservoir behavior in order to produce geothermal fluid for a long time. Micro-gravity measurement is one of the methods for geothermal reservoir monitoring. The production of geothermal fluid and the reinjection of hot water cause mass changes and redistributions, which can cause measurable gravity changes on the ground surface. In Takigami geothermal area, we have conducted repeat micro-gravity measurements using Scintrex CG-3 and CG-3M relative gravimeters since before the commencement of Takigami geothermal power plant. We detected gravity changes in the both production and reinjection areas. These gravity changes are consistent with the changes in mass balance in the geothermal reservoir. This study suggests that repeat gravity measurement is an effective method to monitor geothermal systems. We, however, had measured only relative gravity measurements by using relative gravimeters, so we have not been able to evaluate the gravity change at the reference station of the relative gravity measurements. Hence, we introduced an A10 absolute gravimeter (Micro-g LaCoste, Inc.) in 2008. Though 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. We have applied the relative gravimeters in such strict situations in which it was difficult to install A10. Thus both absolute gravimeter and relative gravimeter can complement each other.

As a result of absolute gravity measurements, the gravity change at the reference station 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. Because we judged that the gravity change detected by the relative and absolute gravity measurements illustrated the mass transfer in the geothermal reservoir, 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 4 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