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Geothermal Reservoir Monitoring by the Hybrid Repeat Gravity Measurement in Takigami Geothermal Field

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It is important to understand the geothermal reservoir behavior in order to produce geothermal fluid for a long time. And it is required to evaluate the influence of the production and reinjection of a large quantity of geothermal fluid in the geothermal area. The mass changes in the geothermal reservoir with production and reinjection of geothermal fluid cause the gravity changes on the surface. Repeat gravity measurements have been applied at the Takigami geothermal field in Central Kyushu, Japan, where the Takigami power plant (25MW) has been generating since November 1996. We started the repeat gravity measurement in May 1991, before the commencement of power generation at the Takigami geothermal power plant, at 26 observation stations. We used a Scintrex CG-3, CG-3M and CG-5 relative gravimeters in order to measure gravity change caused by production and reinjection of geothermal fluid, but we could not estimate the gravity change at the reference station. To solve this problem, we introduced an A10 absolute gravimeter (Micro-g LaCoste, Inc.). In addition, the A10 was used for not only the assessment of the gravity changes at the reference station, but also the detection of the gravity change caused by the subsurface fluid mass changes at some other measurement stations. However, it was impossible that the A10 absolute gravimeter was applied at all of the stations, because the condition of the measurement was strict. We chose 4 stations (T13B, T22A, T26A and T27A) to conduct the repeat absolute gravity measurement. T26A is located in the reinjection area, and there are the other 3 stations in the production area. Therefore we have applied the relative gravimeters to the stations in such strict situation. Thus both absolute gravimeter and relative gravimeter can complement each other in the hybrid gravity measurement.

We have detected the gravity changes which were consistent with the changes of mass balance in the geothermal reservoir by the relative gravity measurements since 1991. We inferred that the current fluid mass in the Takigami geothermal field has recovered to as much as that before production and reinjection had started. As a result of the absolute gravity measurement, the seasonal variation has not been drastic at the reference station (T1), so we have concluded that T1 is appropriate as the reference station of the relative gravity measurements. In Takigami geothermal power plant, the reinjection was stopped for the regular maintenance. We observed the gravity changes caused by suspension of the reinjection before and after the maintenance period in the reinjection area.

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