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Underground fluid flow monitoring using a A10 absolute and CG-3M relative gravimeter

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Repeat gravity measurements have been applied at Takigami geothermal power plant in central Kyushu, Japan in order to monitor the mass balance between the production and the recharge from the surrounding area. Takigami geothermal field is located in the southwestern part of Oita prefecture, central Kyushu, Japan. The Takigami power plant (25MW) was completed in November 1996. We conducted repeat gravity measurement in May 1991, at 26 observation points. The production depth is about 2500m and the reinjection depth from 1000m to 1500m. The amount of production is about 12Mt/year, and about the 85% of production is reinjected to the underground not to cause the ground subsidence.

We used Scintrex CG-3 and CG-3M gravimeters to measure precise gravity change. And we applied a multivariate regression model and removed the effect of shallow groundwater level change in order to extract the gravity change associated with the production and reinjection of geothermal fluid. We detected gravity decrease and increase in the production and reinjection zone. 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.

But we cannot assess the gravity change at the reference station, because we only used the relative gravimeter. Hence we introduced the A10 absolute gravimeter (Micro-g LaCoste, Inc) for not only the assessment of the gravity changes at the reference station, but also the detection of the gravity change caused by the underground fluid flow changes. We selected the 4 stations (T13 B, T22, T26 and T27) to conduct the repeat gravity measurement using the vehicle battery. The regular repair was carried out in the end of March to April. We conducted the absolute gravity measurement before and after the regular repair. We observed gravity decrease (19micro gal) in the reinjection zone just after the resumption of the reinjection. On the other hand, Small gravity decrease (4.4 micro gal) was observed in the production zone just after the regular repair. We will report the result of the absolute gravity measurement after 2 years from the regular repair.

Keywords: Groundwater level monitoring, A10 absolute gravimeter, Absolute gravimetry