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Monitoring Groundwater Variations Using a Portable Absolute Gravimeter

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In urbanized areas, one of the urgent problems is to monitor the groundwater variations especially connected with land subsidence. Although the groundwater variations are usually measured by water level meters, gravity measurements can provide us additional information about the water mass movements which should be beneficial for the analyses of groundwater flow and the managements of water resources as well. Therefore, in order to establish a new technique to monitor the groundwater variations by means of the gravity measurements, we investigated the applicability of a portable type absolute gravimeter (Micro-G LaCoste Inc. A10-017). We will report the results of some test measurements in Japan, and the outline of the surveys in Jakarta, Indonesia.
As for the absolute gravity measurements, FG-5 of MGL would be more popular. FG-5 is a high precision absolute gravimeter with a 2ugal-accuracy for laboratory use, while the nominal accuracy of A-10 is 10ugal (measurement precision: $\pm$5ugal). In spite of the disadvantage, A-10 is well suited for the field surveys because it is much smaller than FG-5 and can be operated with 12VDC power. The repeated measurements using A10-017 in Kyushu University show good correlations between the measured gravity values and the groundwater levels in nearby observation wells. In a geothermal plant of Takigami, we also observed the gravity changes associated with the cycle of the geothermal fluid. All these test measurements have proved that the gravimeter can achieve a 10ugal (10nm/s2) or better accuracy in the field surveys.
In Jakarta, Indonesia, excess groundwater pumping is going on and it causes land subsidence. To reveal the associated gravity changes, we conducted the first gravity survey in August 2008 and the second survey in July 2009. Mainly due to the instrumental troubles during the 2008 surveys, we have not obtained enough reliable data yet. Nevertheless the result obtained so far suggested the gravity increases in the coastal area where the large subsidence has been observed. We plan to conduct the same measurements in 2010 and then we expect to obtain more definite results.