

Preliminary Assessment of the Precision, Repeatability, and Accuracy of Absolute Gravimeter A10-008

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The precision, repeatability, and accuracy of absolute gravimeter A10-008 were assessed at the Walferdange Underground Laboratory for Geodynamics (WULG) in Luxembourg in summer 2004. A preliminary analysis of the data indicates that the instrument performed within the specifications of the manufacturer. The specified precision at a quiet site is about 1 μGal in 30 minutes, the specified repeatability on a high quality pier is 10 μGal , and the specified accuracy is 10 μGal (Micro-g Solutions, Inc., 2004). For A10-008, the precision was 0.48 ± 0.18 μGal in 30 minutes, the average repeatability was 2.7 ± 1.4 μGal , and the average accuracy compared to absolute gravimeter FG5-216 was 2.1 ± 3.0 μGal .

Four gravimeters were used in this experiment at the WULG, which is equipped to accommodate the measurement of absolute gravity at 15 quiet sites. Absolute gravimeter A10-008 was operated by the United States Geological Survey (USGS), absolute gravimeter FG5-216 and a superconducting gravimeter (SG) were operated by the European Center for Geodynamics and Seismology (ECGS), and a relative gravimeter Scintrex CG5 was operated by scientists from both ECGS and USGS. The Scintrex CG5 was used to measure the vertical gravity gradient of each site. The superconducting gravimeter was not used in the preliminary analysis of the data because its drift has not yet been corrected; FG5-216 will be used to correct the drift of the SG. The corrected SG data will provide a continuous record of gravity during the period of the experiment. The absolute data will be adjusted for temporal changes in gravity to provide improved measures of the repeatability and accuracy of A10-008. For this preliminary analysis, gravity was treated as constant at each site during the duration of the experiment. The HeNe laser of A10-008 was calibrated on June 27, 2004, against an iodine stabilized HeNe laser (the type used by FG5-216). The rubidium clocks of the absolute gravimeters were calibrated against LORAN-C (A10-008 on August 26, 2004), and the barometers of the absolute gravimeters were calibrated in November 2003. Geophysical corrections were applied consistently to both absolute gravimeters; polar motions were taken from International Earth Rotation and Reference Systems Service, the barometric admittance factor was 0.3 $\mu\text{Gal}/\text{mBar}$, and observed tidal corrections were used.

The acceleration of gravity was measured with A10-008 at all 15 sites between August 27, 2004, and September 20, 2004. Each site was occupied at least three times. Occupation times were either 30 minutes or overnight. Thirty-minute data consisted of 10 sets of 120 drops with a set interval of 3 minutes, and overnight data consisted of 12 to 24 sets of 200 drops with a set interval of 1 hour. The data collected by A10-008 could be divided into two groups of distinct time and quality. The first group was collected between August 27 and September 15, when the standard deviation of the sets ranged

from 0.5 to 3.0 μGal ; the second group was collected between September 16 and September 20, when the standard deviation of the sets ranged from 3.3 to 5.3 μGal . The measured values of gravity in the second group were all lower than in the first group. A comparable decline in gravity was not measured by FG5-216. Therefore, it was concluded that A10-008 was not working properly after September 15; the data collected after this time were rejected and were not considered in the preliminary analysis. The accepted data from A10-008 consist of three occupations of 30 minutes at all 15 sites, and three occupations of 12 to 24 hours at 5 sites. The precision, repeatability, and accuracy of A10-008 were determined for the 30 minute data, the 12 to 24 hour data, and all the data. The precision was $0.48 \pm 0.18 \mu\text{Gal}$, $0.40 \pm 0.17 \mu\text{Gal}$, and $0.46 \pm 0.18 \mu\text{Gal}$ respectively. The repeatability was $2.5 \pm 1.5 \mu\text{Gal}$, $2.4 \pm 1.4 \mu\text{Gal}$, and $2.7 \pm 1.4 \mu\text{Gal}$ respectively. The accuracy compared to FG5-216 was $2.7 \pm 2.8 \mu\text{Gal}$, $0.5 \pm 3.8 \mu\text{Gal}$, and $2.1 \pm 3.0 \mu\text{Gal}$, respectively.

Reference

Micro-g Solutions, Inc. (2004). Absolute Gravimeter Comparison Chart: accessed November 18, 2004 at URL <http://www.microgsolutions.com/hardware.htm>.