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Abstract

The high precision portable absolute gravimeter A-10 No 20 has been installed at the Borowa Gora Geodetic-Geophysical Observatory in September 2008. Since then a number of test laboratory measurements as well as field measurements with the use of mobile gravimetric laboratory developed was conducted. The results obtained indicate high quality of gravity determination with A-10 under laboratory conditions and unprecedented quality under field conditions. They confirm the applicability of the A-10 absolute gravimeter to the modernization of gravity control and high precision gravity survey required in modern gravity networks, but also its usefulness in microgravimetry as well as geodynamics.

1. Introduction

The absolute gravimeter A-10 (Serial Number 20) was installed in September 2008 at the Borowa Gora Geodetic-Geophysical Observatory of the Institute of Geodesy and Cartography. It is a high precision portable apparatus that can be used for gravity survey in the laboratory as well as in the field. Since September 2008 a number of test measurements with the A-10 were conducted both in the laboratory of the Borowa Gora Geodetic-Geophysical Observatory and in the field. Gravimetric laboratory of the of the Borowa Gora Observatory together with gravimetric laboratory at Jozefoslaw Observatory of the Warsaw University of Technology have been submitted in 2006 to the BIPM as a joint regional laboratory for comparisons of absolute gravimeters.

The A-10 gravimeter provides a new standard in the absolute gravity measurements. It is optimized for fast data acquisition and portability in outdoor applications in World-Wide operating dynamic range with 10 μ Gal accuracy, 1 μ Gal precision. The A-10 provides absolute value of gravity with good precision in a very short time.

2. Gravimetric laboratory in Borowa Gora

In the gravimetric laboratory in Borowa Gora there are 6 pillars designated for gravity survey; 4 of them are suited for absolute gravity survey (Fig. 1).



Fig. 1. Schematic map of the Borowa Gora Observatory with indication the location of the pillars for absolute gravity survey

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Figure 2 shows the gravimetric network at the Borowa Gora Observatory with the maps of horizontal gravity gradients at the pillars for absolute gravity survey.



Fig. 2. Gravimetric network at the Borowa Gora Observatory

Absolute gravity is systematically measured with the A-10 gravimeter at the points of the network (Fig. 2) since September 2008.

3. Mobile gravimetric laboratory

The VW Transporter has been adapted as a field laboratory for transporting the A-10 gravimeter (Fig. 3).



Fig. 3. Mobile gravimetric laboratory

The instrument transported in two special boxes (Fig. 4), together with the infrastructure of the measuring system developed constitute an efficient tool for measuring absolute gravity in the field.



Fig. 4. Transport of the A-10 for the field survey

Mobile gravimetric laboratory and A-10 absolute gravimeter during the survey are shown in Figure 5.



Fig. 5. Field survey with the A-10 using mobile gravimetric laboratory

Additional equipment, such as a tent for protecting the A-10 against external weather conditions during field measurements has been developed (Fig. 6).



Fig. 6. A tent for protecting the A-10 against external weather conditions during field measurements

4. Preparation and setting up the A-10

Preparation of the A-10 to gravity survey (Fig. 7) concerns verification/setting up required level of vacuum in the dropping chamber, correct thermal balance and laser power.



Fig. 7. Preparation of the A-10 to data acquisition

To set up the required vacuum level in the dropping chamber of the A-10 an external turbo pomp (on the left in Fig. 7) is used. After 24 hours of operation the turbo pomp is replaced by the ion-pomp which keeps the required vacuum level as long as the A-10 is connected to the power supply. Disconnecting the gravimeter from the power supply for longer than 15 minutes results in the necessity of correcting the vacuum level with the turbo pomp followed by the test measurement.

5. Laboratory measurements with the A-10

Absolute gravity was measured with the A-10 at two laboratory stations, A-BG and BG-G2, at the Borowa Gora Observatory (Fig. 8).



Fig. 8. Regular laboratory measurements at the absolute gravity station at the Borowa Gora Observatory

The results of gravity survey with the A-10 on the A-BG pier were compared with the value of g obtained with the use of other absolute gravimeters (Fig. 9).



Fig. 9. Absolute gravity measured at the A-BG station

The first three measurements at the A-BG station (Fig. 9) slightly differ from the remaining ones, since they were taken in the framework of the demonstration of the A-10 gravimeter during its installation by the manufacturer when a few people were moving around. Mean value of gravity from last three measurements taken with the A-10 differs from g obtained with FG5-230 by only 1.6 μ Gal.

The results of gravity survey with the A-10 at the BG-G2 pier were compared with gravity value obtained from the adjustment of the Polish gravity control network (POGK97) (Fig. 10). The mean value of the A-10 measurements differs from the adjusted gravity value by 1.7μ Gal.



Fig. 10. Absolute gravity measured at the BG-G2 station

6. Field measurements with the A-10

Absolute gravity was measured with the A-10 also at three field stations of the POGK97: 156 Borowa Gora that was selected for conducting repeatable survey, and two other stations 155 Wyszkow and 160 Nowy Dwor Mazowiecki that were surveyed once only. The results of gravity survey with the A-10 at those stations were compared with gravity value obtained from the adjustment of the Polish gravity control network POGK97. In addition, the results of gravity survey with the A-10 at 156 Borowa Gora were compared with the value of g obtained with the use of other absolute gravimeters (Fig. 11).



Fig. 11. Absolute gravity measured at field stations

7. Software for data processing

g8 software provided by the The user-friendly manufacturer of the A-10 gravimeter is a multifunctional one. It provides continuous control of measuring system such as level of vacuum, thermal conditions, laser power and many other parameters. It is also used for processing all acquired data and calculating the estimate of the absolute value of gravity. The g8 software requires the setting of correct measurement parameters, such as station coordinates, tide corrections and polar motion corrections. The operation of the gravimeter, status of data acquisition as well as intermediate results of pre-processed data can be watched on the screen of the computer linked with the measuring system during the survey with the A-10. The State, Drop Gravity, Set Gravity, Residuals (Fig. 12) as well as Set Histogram, Set Corrections, Set Sensors, Drop Parabola, Drop Fit Sensitivity: TOP and Drop Fit Sensitivity: BOTTOM can be displayed. The g8 software makes also possible to select one detailed view and monitor chosen parameter, for example Set Gravity (set of means of the individual series of drops) (Fig. 13) which provides information for the estimation of gravity and its precision.







Fig. 13. Example of detail view in the g8 software - Set Gravity

7. Conclusions

The precision and repeatability of gravity measurements with the A-10 gravimeter depend on numerous factors,

such as the performance of the instrument, quality of the pier, the ability of the operator to set up the gravimeter correctly, weather conditions, etc. To prevent negative effects of weather in field measurements it is necessary to use additional equipment, such as protective tent to protect the instrument against the wind and Sun. Proper preparation of the A-10 gravimeter before the data acquisition is extremely important. When the required vacuum level in the dropping chamber as well as correct thermal balance are fulfilled the A-10 gravimeter can provide gravity at the field station with 10-11 μ Gal accuracy in 30 minutes.

The precision and repeatability of gravity measurements with the A-10 gravimeter obtained in test surveys under laboratory conditions proof their high quality that is comparable with the one of the FG5 data.

The field experiments performed and the results obtained show the usefulness of the A-10 for the modernization of gravity control, in particular for its densification with absolute gravity points.

High quality of the A-10 data make the gravimeter suitable for geodynamic research not only under laboratory conditions but also in the field in the regions of stronger geodynamic activity.

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