

Development of the National Gravity Network in Moldova

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In 2006 the Land Relations and Cadastre Agency of Republic of Moldova in cooperation with the National Geospatial-Intelligence Agency (NGA) of United States of America performed gravity campaign MOLDGRAV06 to establish a National Gravity Network. Gravity measurements were carried out at 20 base stations and their excentric. In order to constrain the relative gravity measurements 3 absolute gravity stations were determined using FG5 absolute gravimeter. The absolute gravity data acquisition and processing were done by Micro-g software. The total uncertainties of the absolute gravity measurements are about 5 μ Gal. The relative gravity stations and local vertical gradients have been measured using three LaCoste & Romberg G meters. The gravity network was designed as polygons, so as to occupy each station at least twice. The preliminary data processing was performed by GVREC, ETIDE and GVCOMP programs. The final network adjustment was performed using GRAVNET program. The RMS error of the relative gravity stations is better than 10 μ Gal. The 2-nd and 3-rd order gravity network densification about 1 point per 15-20 will be performed in 2007-2009.

1. Introduction

This report presents the results of the first-order gravity network survey campaign MOLDGRAV06 carried out by Institute of Geodesy, Engineering Research and Cadastre (INGEOCAD) subordinated to Land Relations and Cadastre Agency of Republic of Moldova in cooperation with the National Geospatial-Intelligence Agency (NGA). The project was requested by National Army Topographic Service.

Three absolute gravity stations were established throughout the country using a Micro-g Solutions FG5 absolute gravimeter. Excenters and several satellite stations for each absolute station ,as well as 17 additional first-order gravity base stations were also established relative to the absolutes using three LaCoste & Romberg G gravimeters (see figure 1).

The survey fieldwork was conducted during the period May–June, 2006. The value of the absolute gravity was established at the floor. The absolute gravity sites were selected by INGEOCAD and Institute of Geophysics and Geology personnel, at two seismic stations and cadastral office with stable isolated concrete piers suitable for measurements (see figure 2).

The location of the absolute gravity sites follow a set of criteria developed to optimize performance of the absolute gravimeter. These criteria include permanency, stability of the underlying ground, adequate space and electricity, temperature stability and protection from the weather. The

relative sites were chosen more as an accessible and stabile location to provide a high accuracy base station available for future surveys (see figures 3, 4).

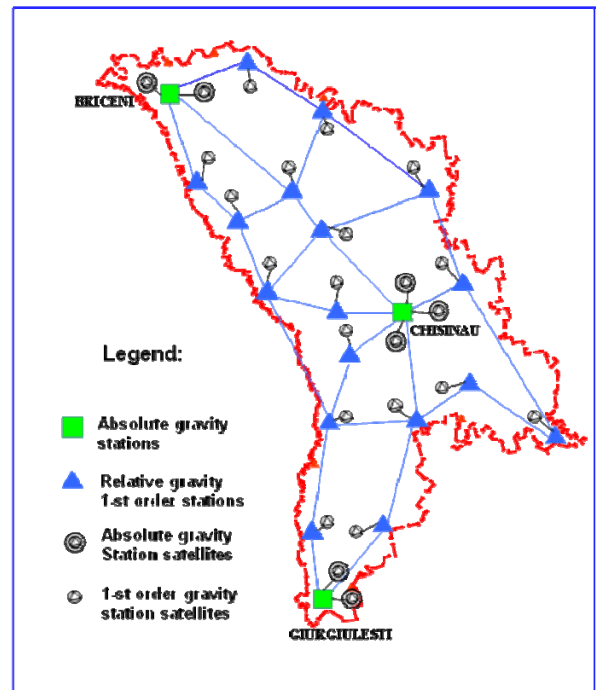


Fig.1 The First order Gravity Network design.

2. Survey operations

The FG5 107 absolute gravimeter was set up and placed into automatic operation at each of the three sites. The meter ran for 24 to 36 data sets, one set of 100 drops per hour. Data was then analyzed and certain sets were rejected. All

gravity data were stored on disk for post processing. A vertical gradient was measured at each absolute and two satellite stations using a combination of three LaCoste & Romberg model G relative gravimeters. The vertical gradient was measured directly over the station by observing at ground level and at a height of +1.00 meter.



Fig. 2 Chisinau AA absolute gravity station on the main pillar of the Institute of Geophysics and Geology.

For easier accessibility, an excenter gravity station was established out of doors close to each absolute station. This was accomplished with the same instruments used for determination of the vertical gradient.



Fig. 3 Palanca E relative gravity station on the EUREF site pillar.

First-order base stations were established using three relative gravimeters in standard double ladder sequence loops with either a newly established absolute or excenter station as control. Each station was observed at least twice by each meter. In some cases stations were observed in

multiple loops from the same or a different control station. A series of polygons were later combined in the data reduction to form a strong country wide first-order gravity network.



Fig. 4 Balti C relative gravity station on the main entrance stairs of the St. Nicolae Cathedral.

Satellite stations were observed in close proximity to each absolute station. The stations were all observed with its respective absolute or excenter station as control, in the same manner as the previously mentioned base stations. Each of these stations also meets the first-order requirements.

3. Computations and analysis

The vertical gradient, updated polar motion coordinates and position information were entered into the Micro-g Solutions program “g” version 4.0 to compute the absolute observations. Standard input parameters, such as earth tides, speed of light correction, local barometric pressure correction, and the DC tidal term (Honkasalo correction) were set to the appropriate values as recommended by Micro-g Solutions and the International Gravity Commission.

The data from the relative gravimeters were recorded and field checked at each site using NGA programs GVREC and GVCOMP. Later it was combined by site and reduced using the NGA program GRAVNET which performs a least squares adjustment on the data, automatically setting the internal weight codes. The preliminary absolute gravity value from the field observations was used as initial control to determine the vertical gradient.

The corrected absolute gravity value was held

fixed in the final adjustment of the relative gravity data, for each site. A combined network adjustment was performed on all network base stations, holding all three absolute stations fixed. Satellite stations were processed separately holding only one respective gravity station fixed.

The final mean gravity value is set within the FG5 gravimeter at a reference height above the ground. The gravity gradient is then mathematically applied to the value in order to obtain a gravity value at the ground surface where the actual station exists. This ground surface value is the absolute station value on which all relative measurements are based (see Table 1).

4. Survey results

The accuracy of the absolute stations is based on the FG5 manufacturer's estimated uncertainties for many different components (see Table 1). These components include uncertainties in the modelling, system and set up. Default values as recommended by Micro-g were used for each set up.

Total uncertainties for each setup are approximately $\pm 5 \mu\text{Gal}$. The measurement precision and set scatter for each station is the standard deviation of all drop sets at each site, each set being approximately 100 drops. This value is a good indication of site stability and should be included when determining the overall accuracy of the gravity station.

Table 1. Gravity value of the absolute stations.

Station name	Gravity Value (mgal)	Total uncertainty (mGal)	Standard deviation (mGal)
CHISINAU AA	980767.445	0.00444	0.00078
GIURGIULESTI AA	980628.643	0.00507	0.00255
BRICENI AA	980867.919	0.00453	0.00116

The Root Mean Square (RMS) values of the remaining relative stations based on the least squares adjustment of the relative gravity observations is better than 0.010 mGal, NGA (2006).

The final precision of the relative stations with respect to the absolute station is obtained by calculating the Root Mean Square of the absolute measurements together with the relative measurements.

5. Conclusions

There have been measured 53 ties with 3 different instruments which link the 20 base stations and their satellites. The solution is perfectly stable everywhere on the territory of the country with accuracy better than $10 \mu\text{Gal}$. The new first order gravity network over Republic of Moldova is well constrained by the 3 absolute gravity stations with the accuracy around $5 \mu\text{Gal}$.

The 2-nd and 3-rd order gravity network densification will be done in 2007-2008. This will allow the final network density about 1 point per 15-20 square kilometres for geophysical applications, precise levelling and the high resolution local quasigeoid modelling.

The final goal is the improvement of normal height determination accuracy from GPS measurements and service organizing for height anomalies calculation in order to distribute real time normal heights.

The future steps are related to the gravity data integration in the IGFS and EUREF programs.

References

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