MONITORING OF THE LONG-STANDING CHANGES OF THE ABSOLUTE GRAVITY IN OBSERVATORY OF JOZEFOSLAW AND AT MAIN TECTONIC UNITS ON POLAND TERRITORY

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1. INTRODUCTION

Gravimetric investigations of the long-standing, not tidal variations of the absolute gravity using ballistic FG – 5 No. 230 gravity meter, bought by Warsaw University of Technology at 2005, were performed on four stations outside the Teisseyre – Tornquist Zone (T – T Zone) as well as at Józefoslaw Astro - Geodetic Observatory of the Warsaw University of Technology, located near Warsaw, near the northern edge of T – T zone on Precambrian Platform. Raw results of observations were corrected by Earth's tide influences, loading effects of the Earth's crust and ocean, by polar motion influence to the gravity as well as from the reason of gravitational and deformation influences of the atmosphere. Monitoring of the gravity on Józefosław station, during three years once a month, pointed out quasi-periodic non-tidal variations. Absolute gravity determinations in previous campaigns (1992 – 2001) on Polish territory were performed using various ballistic gravity meters, many types and quality, as well as there were spread in time. In epochs since 2006 to 2008 with our instrument FG – 5 No. 230 there were obtained the gravity values minor on all investigated stations. It was about 17 μGal on Satellite Lamkówko station, near Olsztyn, and 12 μGal in Borowiec Astro-Geodynamical Observatory of the Space Research Centre, Polish Academy of Sciences with comparison to the results from 8 – 10 y earlier obtained using Polish absolute gravity meter ZZG, Italian IMGC and two FG-5 instruments from Austria and USA. The variation since 1996 to 2006 on Giby (station of the gravity national fundamental net) was appeared as only 7.5 μGal. On very stable station Ojców (Seismic Observatory of the Polish Academy of Sciences) located on Świętokrzyskie Mts. craton, the decrease of gravity equal to 9 μGal has been noticed after 9 years. Recovered variations of gravity on Poland territory might have the sources in gravity global or regional variations in the hydrological influences in the vicinity of stations as well as in incorrect earlier determinations of the gravimetric corrections, mainly in vertical gradient of gravity above absolute stations.

2. PROJECT DESCRIPTION

Precise absolute determinations for geodynamical purposes were carried out at five stations of Poland Absolute Gravity Basestation Net (Figure No. 1). First determinations have been performed in 1995. Since that time precise determinations of g using FG5,

JILAg, IMGC and ZZG apparatus with irregular time intervals have took place at following stations:

- **Józefosław (Astro - Geodetical Observatory of the Warsaw University of Technology);**
- **Lamkówko (Satellite Observatory of the Warmia - Mazurian University);**
- **Borowiec (Satellite - Geodynamic Observatory of the Space Research Centre, Polish Academy of Sciences);**
- **Ojców (Seismic Observatory of the Polish Academy of Sciences);**
- **Giby (gravimetric fundamental network station).**

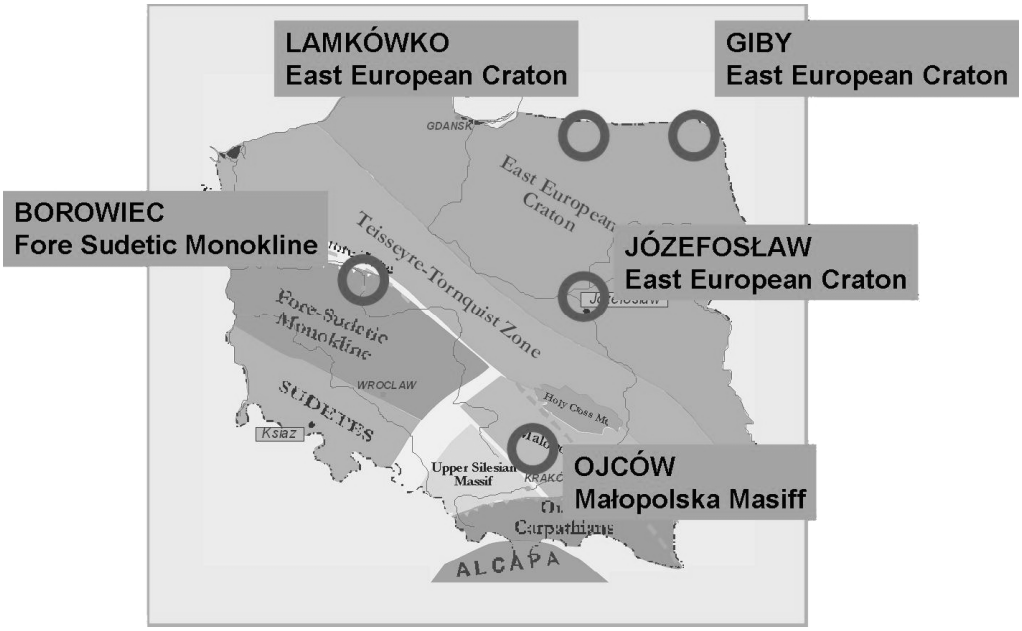

Fig. 1. Stations of Poland Absolute Gravity Basestation Net at main tectonic units on Poland territory.

3. STATIONS DESCRIPTION

<u>Józefosław</u>

Astro-Geodetic Observatory of the Warsaw University of Technology was established in 1957. In 1991 Observatory was jointed to the International GPS Service for Geodynamics (IGS) and now are performed GPS/GLONASS observations in the frame of the IGS/IGLOS/EUREF. In 1997 Jozefoslaw was the reference station in gravity UNIGRACE campaign.

In the frame gravimetric laboratory are operating:

- **ballistic absolute gravimeter FG-5 No. 230;**
- **two spring gravimeters LaCoste & Romberg models D and ET;**
- **meteorological, soil moisture and ground water sensors;**
- **five sites for absolute gravimeters.**

Fig. 2. Astro-Geodetic Observatory of the Warsaw University of Technology in Józefosław.

Lamkówko (Fig. 3a.)
- **Polish Absolute Basenet Station;**
- **GNSS LAMA station (150 meters);**
- **water level recorded, tidal station planned;**
- **absolute measurements since 1996 (IMGC and ZZG).**

Ojców (Fig. 3b.)
- **Polish Absolute Basenet Station;**
- **PAN Seismical Observatory;**
- **absolute measurements since 1996 (FG5).**

Giby (Fig. 3c.)
- **Polish Absolute Basenet Station;**
- **absolute measurements since 1997 (ZZG).**

Borowiec (Fig. 3d.)
- **Polish Absolute Basenet Station;**
- **GNSS BORO station (250 meters);**
- **tidal station planned;**
- **absolute measurements since 1995 (FG5, IMGC and ZZG).**

Fig 3a. Lamkówko station.

Fig 3b. Ojców station.

Fig 3c. Giby station.

Fig 3d. Borowiec station.

4. RESULTS

In the frame of presented project for all stations prepared:

- ✓ **choice of two eccentric points;**
- ✓ **determination of the real vertical gravity gradient;**
- ✓ **determination of geodetic coordinates (BLH) and connection to levelling network.**

Standard procedure of measurement embraces 24 hours cycle with 24 sets. Typically g value is obtained from 2400 drops. The raw values of g are corrected by:

- ✓ **elastic earth tides (ETGTAB precedure) with world's standard coefficients;**
- ✓ **barometric effect (with coefficient 0,3 mGal /mbar);**
- ✓ **polar motion influence (IERS EOP products);**
- ✓ **ocean mass loading (Schwiderski Model);**

and reduced to pillar level height with using linear real vertical gravity gradient.

Figures 4a-4d present results of absolute g value measured at project stations. One can see decreasing of g value on each stations.

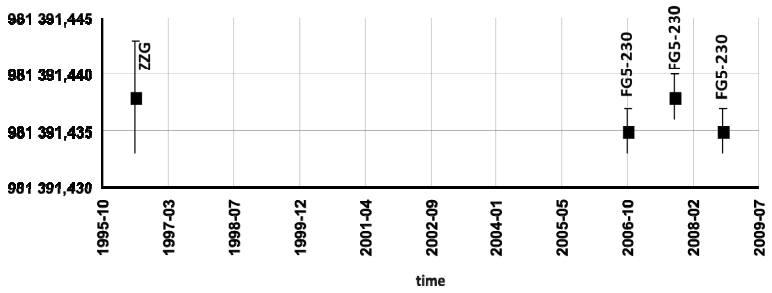

Fig. 4a. Absolute g [mGal] at Giby station.

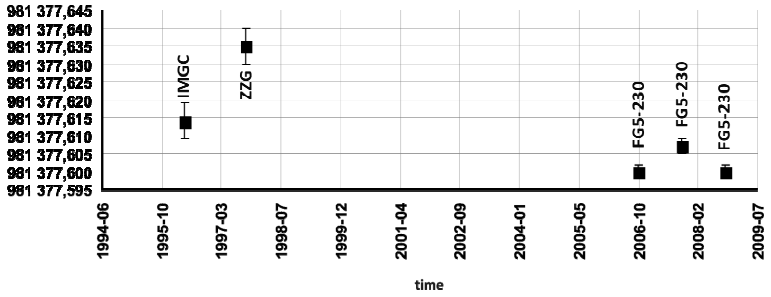

Fig. 4b. Absolute g [mGal] at Lamkówko station.

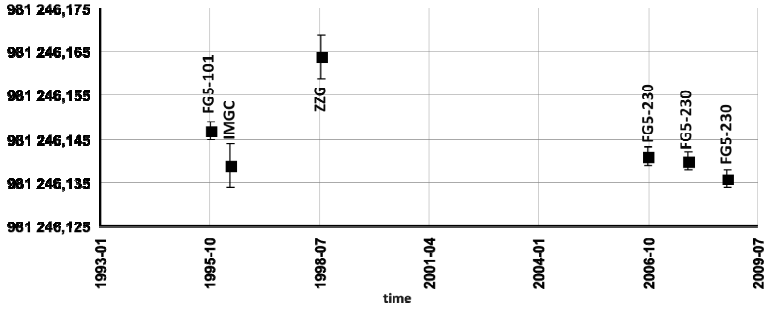

Fig. 4c. Absolute g [mGal] at Borowiec station.

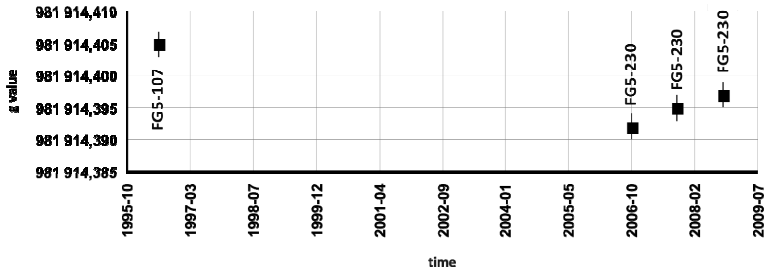

Fig. 4d. Absolute g [mGal] at Ojców station.

At Jozefosław station regularly repeated absolute gravity measurements with month interval and 1 day observation campaigns are carrying since 2005. Figure 5 presents results of absolute g value measured at Jozefosław station.

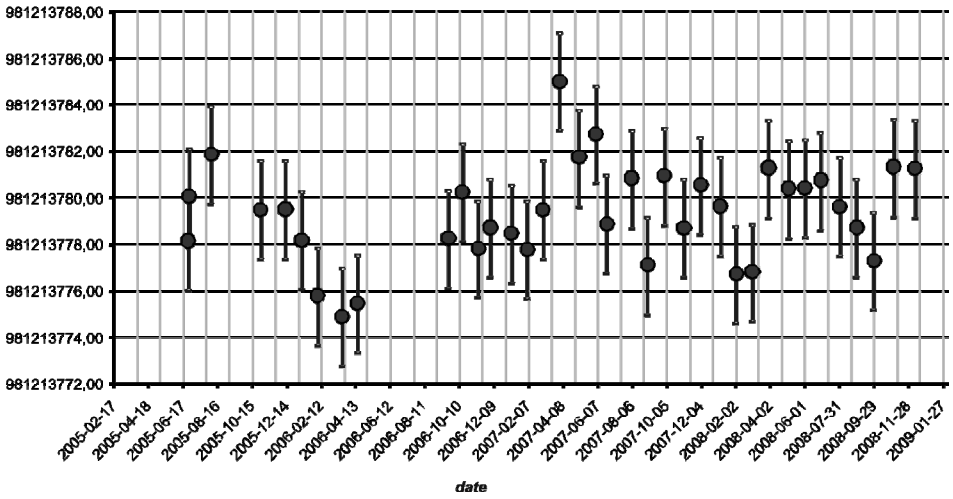

Fig. 5. Observed gravity values at Józefosław station (values in microGals at 100 cm datum height).

5. CALIBRATION OF FG5-230

Polish absolute gravimeter FG5 no. 230 has been made at mid 2005. Time of installation was so late for participating in ICAG2005 meeting. In 2006 local comparison meeting has done with German (BKG) and Czech (GO Pecny) teams.

During simultaneously measurements with FG5-301 (BKG) and FG5-215 (GO PECNY) obtained:

g FG-5 No. 230 – g FG-5 No. 215 = - 0,3 µGal (at Pecny station)

g FG-5 No. 230 – g FG-5 No. 301 = 1,2 µGal (at Bad Homburg station)

In 2007 Fg5 no 230 participated in ECAG2007 meeting. Till now ICET published only preliminary results.

6. AN ATTEMPT OF INTERPRETATION

Differences of the g value might be caused by:
- **vertical movements of Earth,**
- **local, regional and global environmental effects,**
- **uncertainties of previous determinations.**

<u>Vertical movements</u>
Analysis of UP component from GNSS observation (EPN product) for BOROWIEC and LAMKÓWKO stations shows small and insignificant trend to increase of height (see figure 6a and 6b).

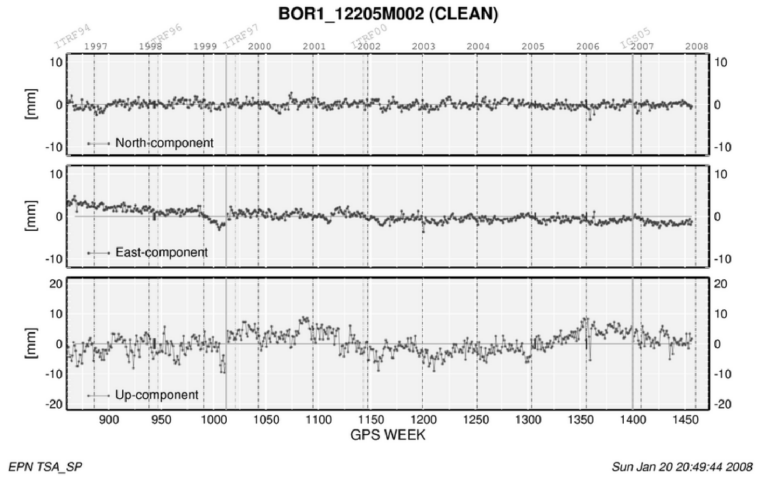

Fig. 6a. Time series of Borowiec station from EPN weekly solution (coordinate outliers are eliminated).

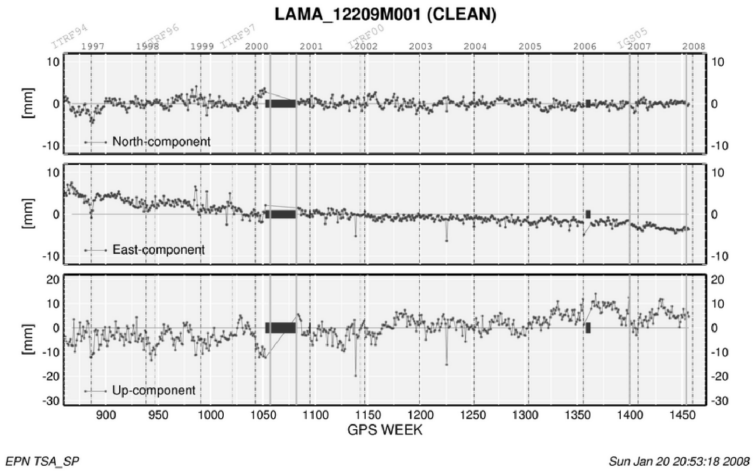

Fig. 6b. Time series of Lamkówko station from EPN weekly solution (coordinate outliers are eliminated).

Map of vertical movements (from repeated levelling) on Polish territory (Fig. 7) shows falling of heights in relation to Baltic Sea. From vertical movements map we can determine only relative movements between main geological structures.

For East European Platform (LAMKÓWKO, GIBY) and Fore Sudetic Monokline (BOROWIEC) vertical displacements are the same: - 3,5 mm/year. For Carpatian region vertical displacements are – 2,0 mm/year. Rising of Carpatian region above EEP and SM is on the level + 1,5 mm/year.

It corresponds with bigger gravity change at OJCÓW station (Carpatian Region).

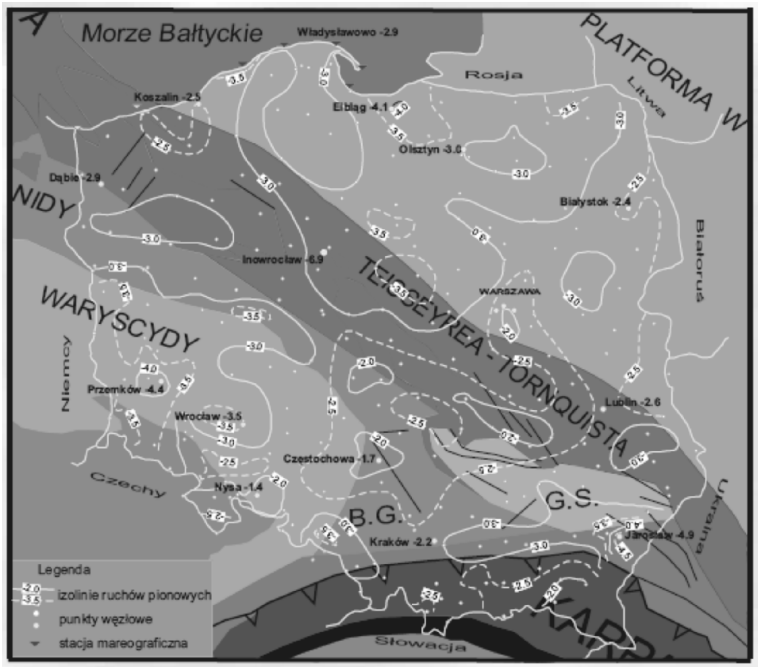

Fig. 7. Map of vertical movements on Polish territory.

Environmental effects

Observed gravity decreasing on each stations on level ten microGals have different source - local and regional hydrological effect. During last 15 years level of ground water decreased 1 meter on Poland territory. It corresponds with similar gravity changes at all stations. Gravitational effect of those changes is c.a. 10 microGal. At GIBY station gravity change is smaller because this point is situated in lake and forest surroundings.

7. CONCLUSIONS

- ✓ **observed gravity changes show decreasing of value g on each stations;**
- ✓ **„power" of these decreasing depends on hydrological effect and vertical displacements (in smaller range);**
- ✓ **for long period of time more significant effect is connected with regional and global environmental effect;**
- ✓ **informations connected with soil moisture should be included to further analysis.**

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