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GEODYNAMIC RESEARCH CONCERNING RECENT MOVEMENTS IN THE KARKONOSZE MTS. AND KARKONOSZE FORELAND

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Abstract

The aim of the research is to determine recent geodynamic movements in the polish part of Karkonosze Mts and in the Karkonosze Foreland in Western Sudetes. The necessity of research derives from signs of such movements detected in the Karkonosze Massif and from the need of determining a threat to the stability of technical constructions and inanimate nature objects located at the site. KARKONOSZE GPS network consist of 19 points located in the research area. Periodic, yearly measurements of the investigation network points are performed with use of the satellite GPS and gravimetric methods. Two measurement campaigns have been carried out in the KARKONOSZE Network (2001, 2002). Longer observation times, use of the same antennas equipped with ground planes, resulted in a significant accuracy improvement, and repetition of the 2002 campaign results in comparison with those ones of the 2001 campaign. The analyses of vector lengths' differences between GPS points have shown significant changes (greater than 5 mm) near water reservoirs and mining areas. The values of changes of gravitational acceleration for particular stations are small. The double RMS value has been exceeded in the case of two points only. Nevertheless, the regularity in direction of changes of gravitational acceleration, for points located in the same rock formations has been noticed.

1. Introduction

Karkonosze massif is a great granitic massif in Poland. It occupies the border zone between Poland and Czech Republic. Its longest axis reaches nearly 70 km. The Karkonosze massif is a multiple pulsatory granitic magma intrusion which is dated by radiometric methods on 310-330 my. (Pin et al., 1988). Interesting are the results of measurements of its gravimetric field. In the central part is situated a great negative Bouger gravimetric anomaly which has –45 μGal (Królikowski and Petecki, 1995). It should be also taken into account the measurements of Schwimmer (1928) who discovered that the thickness of the granitic body has two extreme. One is located beneath the Śnieżka (1602 m) and the other one under the Jelenia Góra kettle. These data could be the reason of different vertical movements within the granite body and also the cause of the granite uplift in relation to the mantle rocks. Therefore in our task, the levelling points are situated on the granite and also outside it, on the mantle rocks. During the levelling measurements there are stated also horizontal movements which nature is still enigmatic.

2. Geodynamic GPS network KARKONOSZE

KARKONOSZE investigation network (Fig. 1) has been established in Western Sudetes. GPS network consist of 19 points located in the research area.

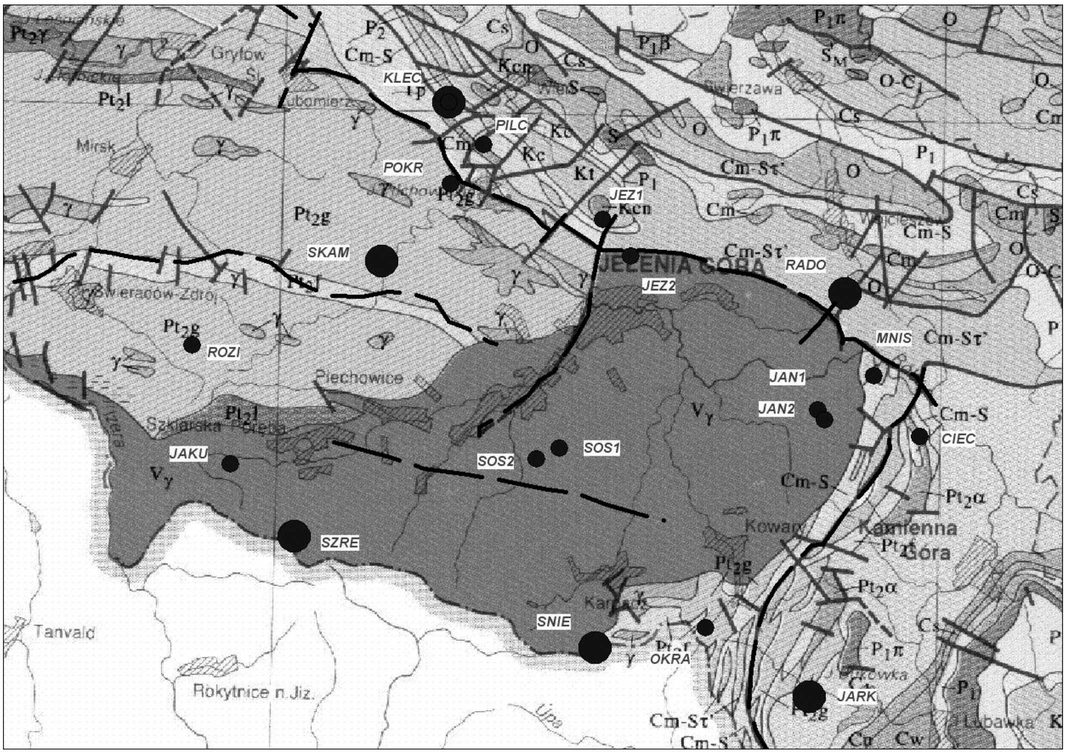

Fig. 1. KARKONOSZE investigation network on the background of geological structure and tectonics of the Karkonosze Mts (Oberc, 1985).

The investigation network consists of 19 points (Fig. 1). A considerable part of them (8 points: SNIE, SZRE, JAKU, SOS1, SOS2, JEZ2, JAN1 and JAN2) has been situated on the Variscan granite of the Karkonosze Mts and of the Jelenia Góra Kettle. The remaining points have been located on units of very differentiated geological structure, which embrace the Karkonosze granite. The points ROZI, SKAM and POKR have been distributed north-westwards from the granite, on the Izera Mts gneisses, and mica-schists. The points KLEC, JEZ1, PILC and RADO have been monumentated on Paleozoic formations of the Kaczawa Mts region (greenstones, metamudstones, metasandstones, volcanites), situated northwards. The points MNIS, OKRA, CIEC and JARK have been located on a part of old Rudawy Janowickie Mts orogen, built of metamorphic rocks (gneisses, schists, limestones and greenstones), situated eastwards from the Karkonosze granites. In the distribution of the network points the tectonic structure of the Karkonosze Mts has been also taken into account.

3. GPS measuring campaigns 2001 and 2002

The first measurement of the research network was realised between the 31st of August – to the 2nd of September and on the 4th of September (days no. 244, 245, 246 and 249). Points of the network (Fig.1) have been divided into two groups: 1st segment of points (measured twice in the 24-hour sessions) and the 2nd only one (in the 12-hours sessions). To ensure the cohesion of the network while computation process, the point of "SNIE" ("Śnieżka") was constantly being observed during the 4 days and the points of "SZRE" and "KLEC" were being observed during the 3 days of the measuring campaign (Kontny et al., 2002).

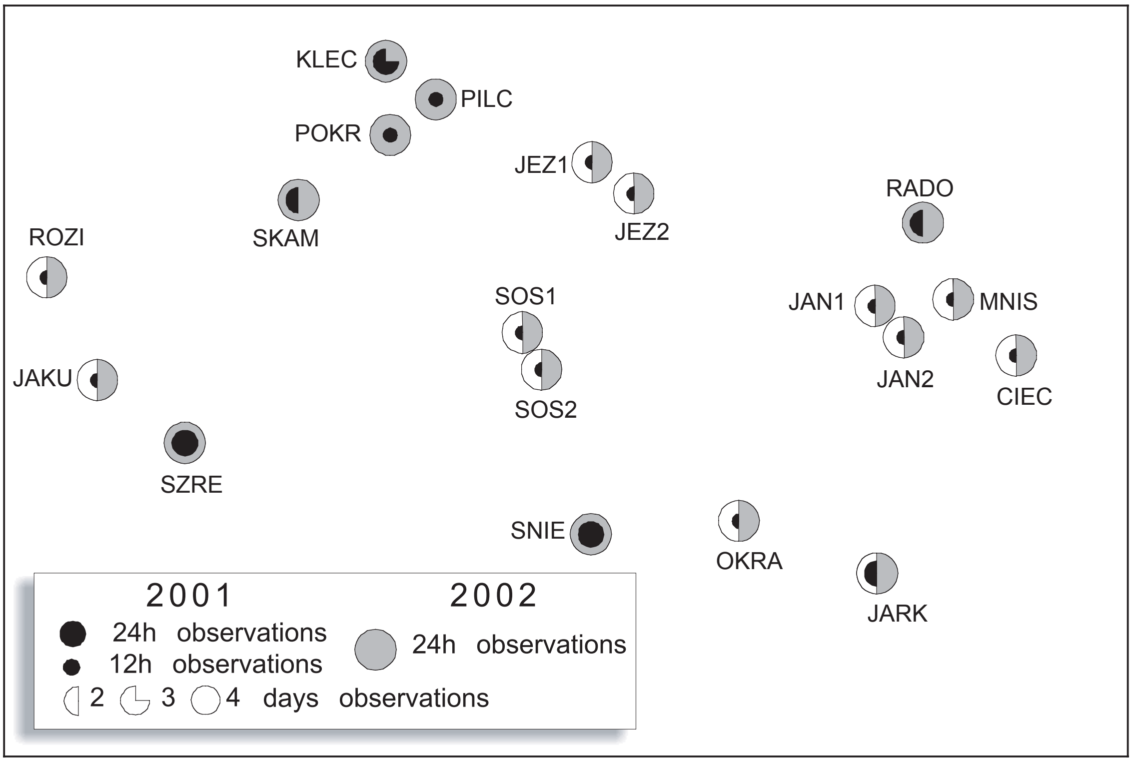

Fig. 2 Characteristics of GPS observation campaigns 2001 and 2002 (Makolski and Bosy, 2003).

Measurements in 2002 were performed in the days: 24 and 25 as well as in the 27-28 Aug 2002 (the days: 236, 237, 239 and 240). After modification of the rules of measurements in relation to the year 2001 over all the network points the 24-hour observations were performed (Makolski and Bosy, 2003). However, on selected points the observations were continued through all the four days and on the other points, through two days- the situation has been presented in the (Fig. 2).

4. GPS data processing and deformation analysis

The computation process of the obtained data has been realised by using the Bernese GPS Software v. 4.2 using Bernese Processing Engine (BPE) module (Hugentobler et al., 2001) following the strategy of local network solution described in (Bosy and Kontny, 1998; Kontny et al., 2002; Bosy et al., 2003). The CODE precise orbits (coming from the Centre for Orbit Determination in Europe, Berne) have been used. The Earth rotation parameters as well as the pole motions also from CODE have been used. Antennas phase centre characteristics have been obtained from IGS and US National Geodetic Survey - Geosciences Research Division. Geocentric and geographic coordinates have been computed in the ITRF2000 reference frame.
Calculations have been realised for user baselines definition: year 2001 (Fig. 3), year 2002 (Fig. 4) and with wide-lane ambiguity solution strategy including regional CODE ionosphere model.

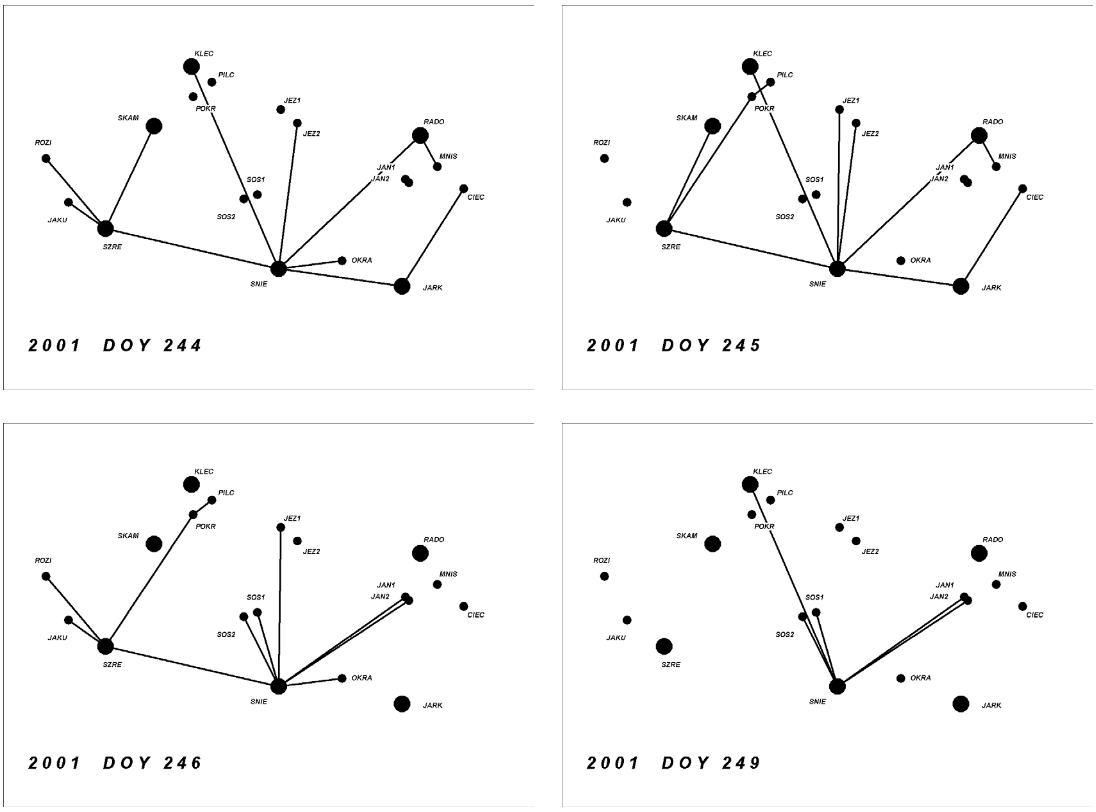

Fig. 3 The independent baselines used for GPS data processing in KARKONOSZE 2001 network

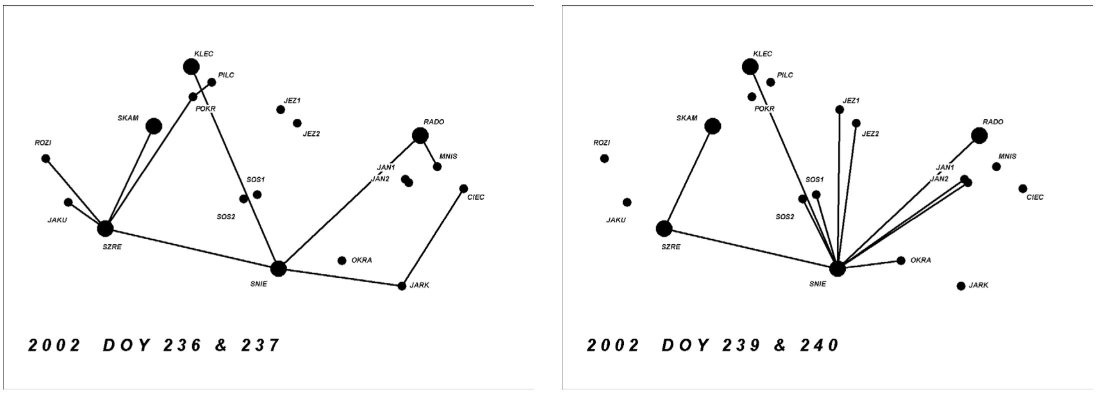

Fig. 4 The independent baselines used for GPS data processing in KARKONOSZE 2002 network

Original configuration of independent vectors from 2001 and 2002, presented in (Kontny et al., 2002; Makolski and Bosy 2003) has been modified to maximize their repeatability during data processing.

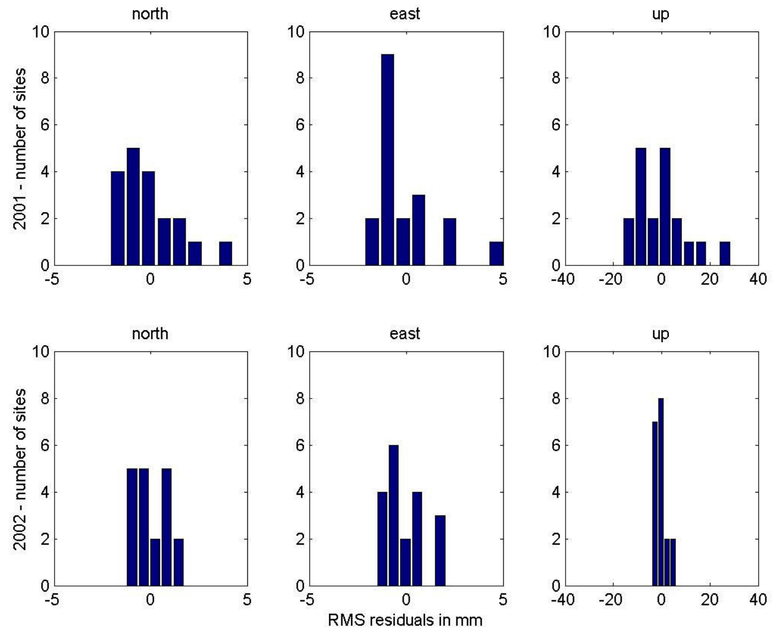

Fig. 5 Histogram of unweighted RMS of coordinate residuals for campaigns 2001 and 2002.

Obtained results have presented a significant accuracy improvement in accordance with evaluation of the 2001 campaign's results (Fig. 5). Increase of observation time as well as application of the same antennas additionally equipped by ground plane rings have caused a significant accuracy improvement as well as repeatability of the 2002 campaign results in comparison to the results of the 2001 campaign (Makolski and Bosy, 2003). With the help of ADDNEQ software (Hugentobler et al., 2001) changes of vector lengths in the 2001-2002 period have been calculated. The values are shown in Fig. 6.

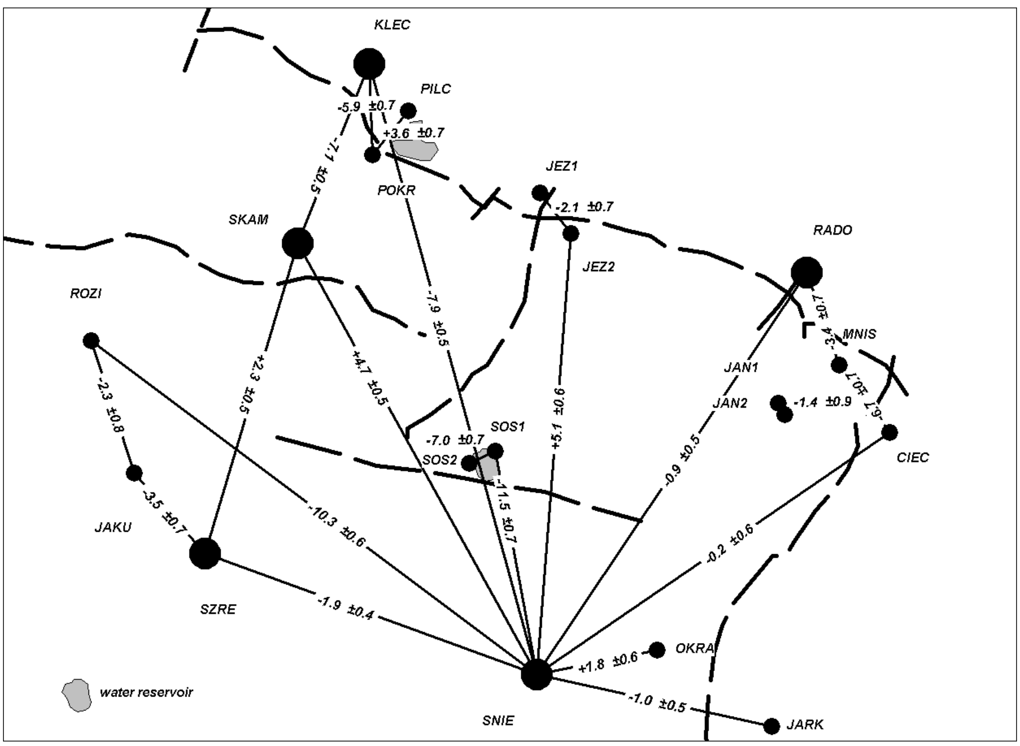

Fig. 6 The relative changes of selected vectors' length in years 2001-2002 (in mm).

Analysing changes of vectors lengths presented in Fig. 6 it can be staled that the greatest values occur for vectors connecting points located near water reservoirs (the vectors: POKR-PILC, POKR-KLEC and SOS1-SOS2) and areas of present-day (ROZI point area), or previous mining activity (point MNIS).

5. Gravity measuring and analysis of changes

Apart from satellite measurements, precise relative gravimetric measurements are conducted on the “Karkonosze” object. As in the case of satellite measurements, two cycles of gravimetric measurements have been performed till now. The first one between the 17th and the 23rd of September 2001, the second one in the 04-07.10.2002 period. Both measurements have been linked to two points of fundamental gravimetric network SZKLARSKA POREBA and KAMIENNA GORA. The corrections due to: the instrument height over the point, tide and drift of the instrument have been included in the calculation process. The accuracies of the conducted measurements are: for a pair of observations performed in a given measurement cycle ±7mGal and ±16mGal for observations repeated in separate measurement cycles (Olszak, 2002). The gravity changes of particular points of KARKONOSZE network are shown in Fig. 7.

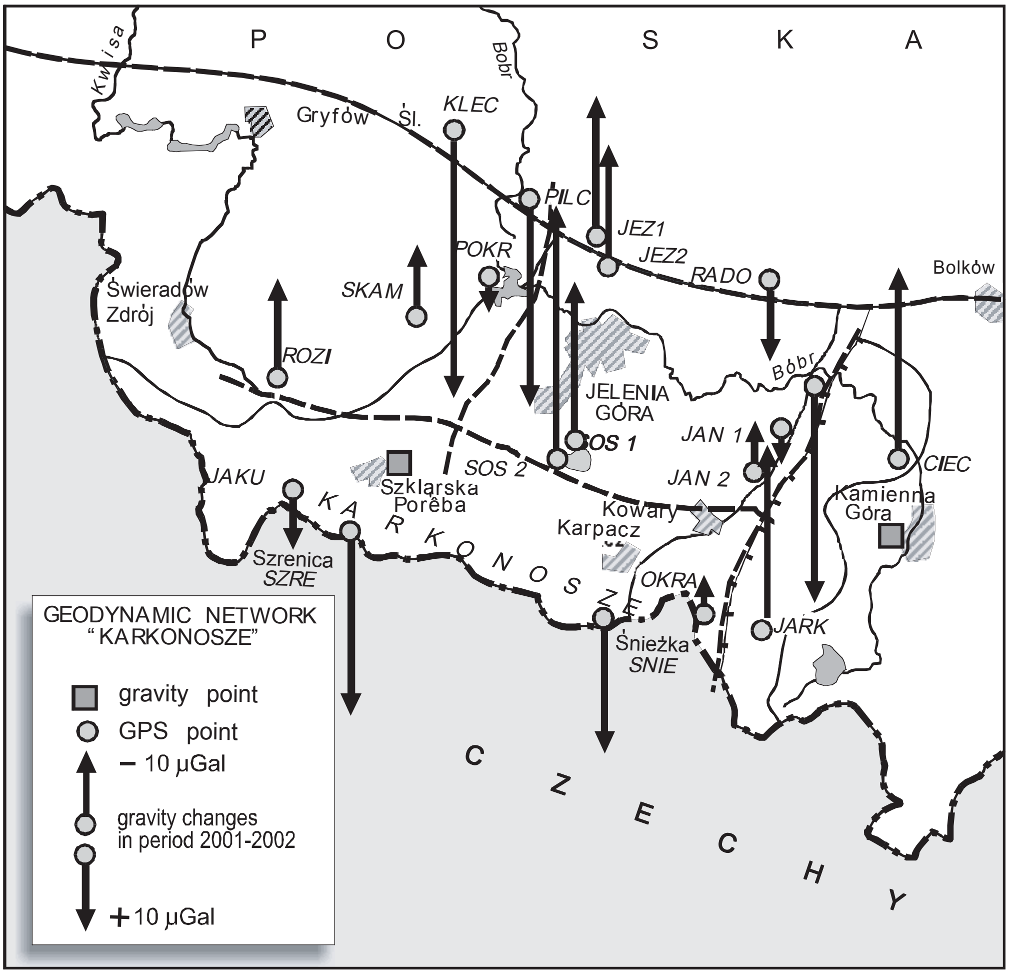

Fig. 7 Relative Gravity changes of KARKONOSZE network points (period 2001-2002).

The differences are insignificant with only the points: KLEC and SOS2 showing values above double RMS error. Nevertheless, the regularity in direction of changes of gravitational acceleration for points located in the same rock formations has been noticed

6. Conclusions

The presented results of satellite and gravimetric measurements refer to two observation cycles conducted within the time of one year. However horizontal changes near water reservoirs (points: POKR, PILC, KLEC, SOS1, SOS2) and areas of present-day or past mining activity (point ROZI) and have been noticed. Magnitude of changes of gravitational acceleration for particular points are very small with only two points KLEC and SOS2 above double RMS error value. Taking into consideration the character of the research work these results must be treated as preliminary and the presented deductions need verification during subsequent stages of investigations. The presented results of changes of vector lengths and values of gravitational acceleration are the outcome of relative values comparisons. In a longer research period these should be related to points located outside the area of investigations.

Acknowledgements

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