

GRAVITY MEASUREMENTS IN THE GEODYNAMIC NETWORK SUDETY

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ABSTRACT

The Geodynamic Network Sudety was joined to the Czech Gravity Reference Network (CGRN) by two weeks of the relative gravity measurements. The gravity stations of the CGRN were used as the anchor stations. There were used two relative gravimeters LaCoste & Romberg G. The method of measurement, used instruments, mathematical processing, variants of result computations and their accuracy are discussed.

KEYWORDS: gravity measurements, gravity network, gravity acceleration, geodynamic

1. PREFACE

Under the term of cooperation between the Institute of Rock Structure and Mechanics, Academy of Sciences of the Czech Republic (IRSM AS CR) and Land Survey Office (ZU), were performed the gravity measurements in the Geodynamic Network Sudety by the employees of Land Survey Office. The department of Gravimetry of Land Survey Office (ZU) administrates the Czech Gravity Reference Network and performs corresponding measurements.

The gravity measurements together with the positional measurements contribute to the study of the recent movements of the geological units.

2. MEASUREMENT

According to the work schedule we decided to connect the Sudety network (Schenk et al., 1999) to the absolute gravity stations to secure an absolute gravity level and also to take advantage of the recent connecting measurements in the Czech Gravity Reference Network (CGRN) performed by Land Survey Office in this locality in the past. Because of limited time it was impossible to make the completely independent measurements in the whole geodynamic network. Keeping with the schedule were performed measurements on 13 geodynamical stations, but during the campaign the station Biskupská Kupa was not prepared yet. The rest 12 stations were measured in the 7 day units (day unit is gravity measurement during one day). The stations of the geodynamic network were inserted between the stations of the

CGRN. The list of the measured day units is obvious from the figure. The measurements were made by the quadruple method A-B-A-B-A (Trakal and Lederer, 2003,; see Fig. 1.

The measurements were performed in the time period 21.–29.9.2004 with gravimeters LaCoste & Romberg G No.176 (LCR 176) a LaCoste & Romberg G No.1068 (LCR 1068).

Together with the gravity measurements were also measured additional quantities (Trakal and Lederer, 2003) (air pressure by the aneroid Paulin, air temperature by the sling thermometer and heights of the top of the gravimeters above the top of the station stabilization) at the stations. The gravimeters were thermo-regulated during the measurement and turned to the magnetic meridian by the compass at the station. It is necessary to remark, that the location and the type of the stabilization of the stations of the Geodynamic Network Sudety are not the best for the gravity measurements. The stations of the geodynamic network are situated on the mountain ridges in the upper altitude instead of the stations of the CGRN, which can cause turnover of the scale factor of the gravimeters owing to the big measured gravity differences. The type of stations stabilization is not appropriate also from a point of view of time demands and it can unacceptably spin out the measurement. There is no possible to make the measurement with two gravimeters together.

From these reasons it was necessary to reduce the quadruple method (Fig. 2).

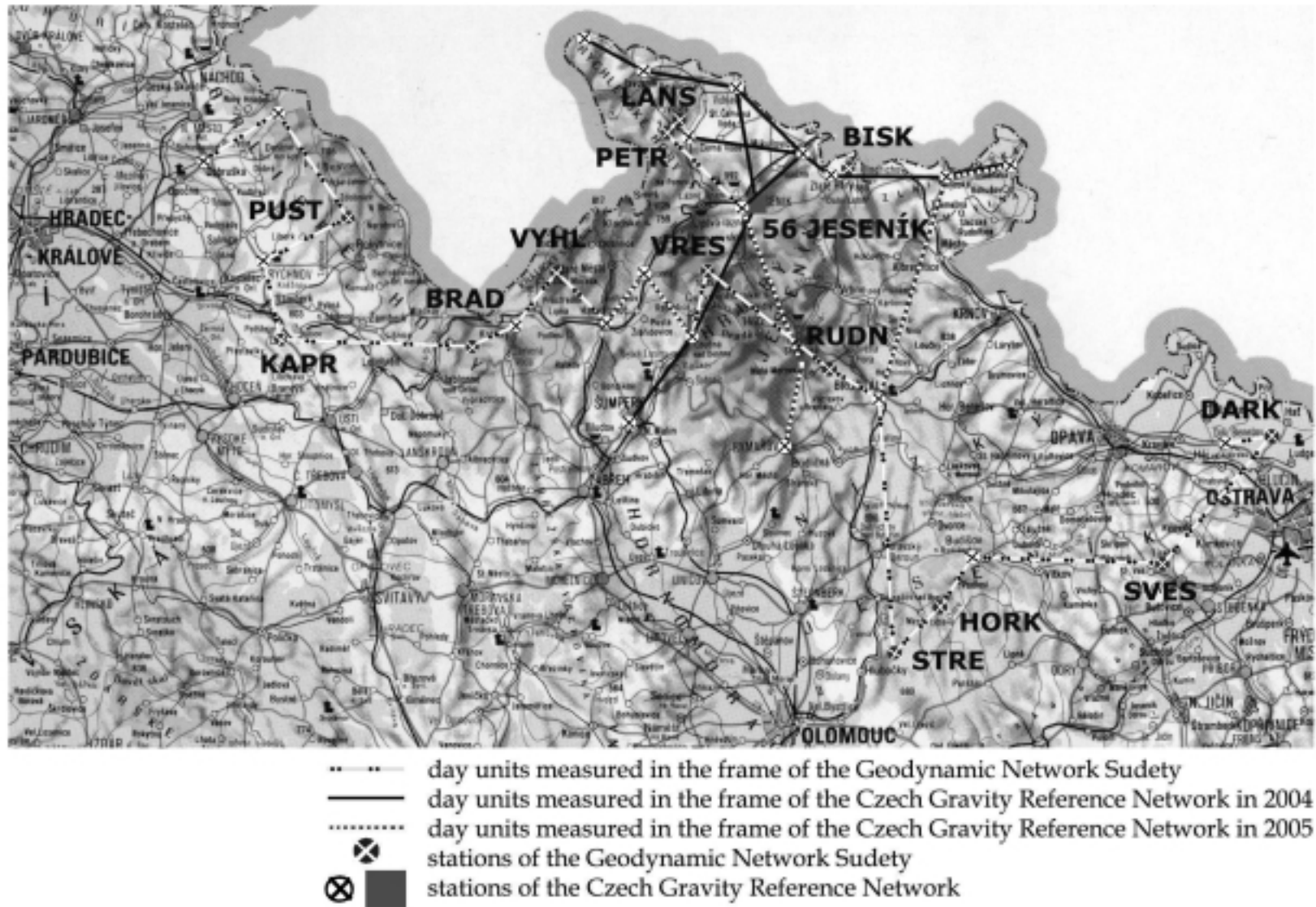


Fig. 1 The list of the day units used in the frame of the Geodynamic Network Sudety.

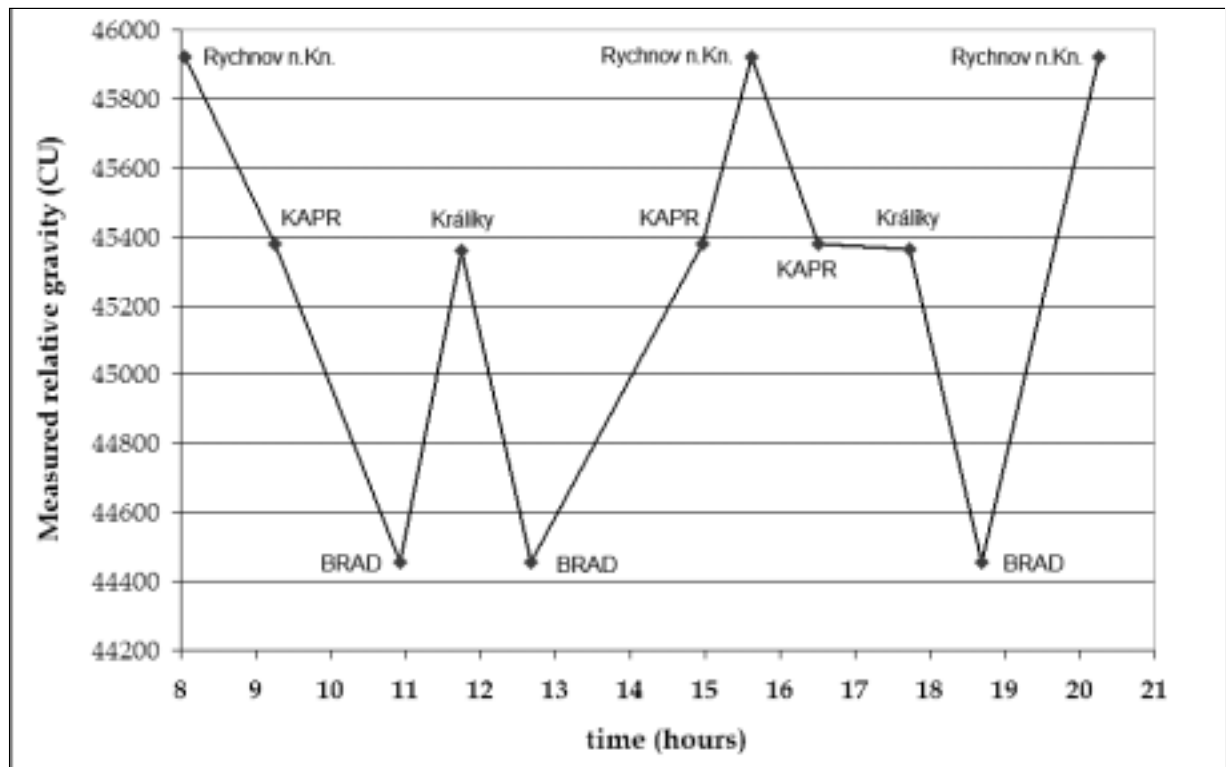


Fig. 2 The measurement of the day unit Rychnov n.Kn.-Kaprad-Bradlo-Kraliky from the day 28.9.2004. The graph shows the measured value of gravity in the counter unit (CU) in the dependence on the day time. There is good visible the cutting of the quadruple method and the missing of some repeated measurements.

3. COMPUTATION

The subsequent computations were made by the scientific computational software (Kvasnička and Träger, 1982; Kostecký, 1992) developed for the gravimetric network calculations. Both the influence of the tides and the drift of the gravimeter were eliminated from the measurements (Fig. 3). The drift is a systematic change of measured values of the gravity acceleration at one base station during time. It has its origin in the stress relief of the measuring system of the gravimeter. The drift was approximated by the polynomial of the 1.-3. degree for the further numerical eliminations. Figure 3 depicts the graphic representation of the approximation polynomial of the individual degrees, which are used for the choice of the right degree in the computational software. After all eliminations we can continue with adjustment of the gravity network.

The software for the adjustment of the day units set (gravity network) uses Givens transformation (Kostecký, 1992; Čepěk, 1992) as the method for evaluation of the inverse matrix by the solving of the normal equations. This method secures good stability of the solution in the case of big numbers of the equations. Benefit of this method is that there is not necessary to separate the internal unknowns (the parameters of the drift approximation, the jumps) and

the external unknowns (the scale factors of the counters of the gravimeters, the unknown gravity accelerations).

4. VARIANTS OF SOLUTION

The final gravity accelerations for the stations of the Geodynamic Network Sudety were computed in three variants (Tab. 1).

The first variant uses the connecting measurements to the absolute gravity station Jeseník (2000-2004) in addition to the mentioned measurements. The level of the network is given by the absolute gravity station Jeseník and the scale of the network by the scale factors, which were entered to the computation directly as an average from the scale factors obtained from the gravimetric baseline Hochkar (Austria) and from the Main Gravimetric Baseline (HGZ) (Lederer, 2004) for the actual year.

The second variant represents the integration of the Geodynamic Network Sudety to the majority of the connecting measurements of the new absolute gravity stations at the territory of the Czech Republic. The level and the scale of the network are given by the group of the 9 absolute gravity stations.

The third variant represents the complete computation of the gravimetric measurements from the previous decades (3036 day units, 28936

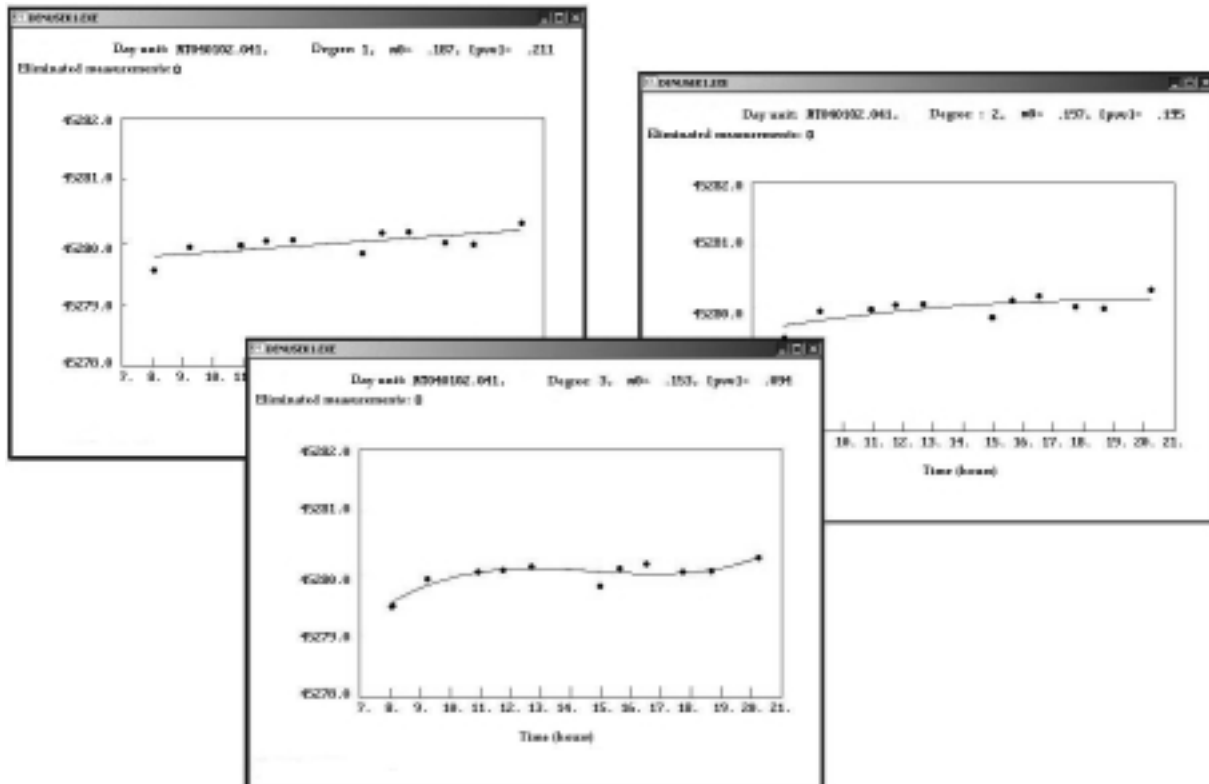


Fig. 3 The approximating polynomial of the individual degrees, which is in the computation software used for the choice of the right degree of the approximating polynomial.

Table 1 The three variant of the resultant gravity acceleration for the stations of the Geodynamic Network Sudety.

station	name	variant 1 [μms^{-2}]		variant 2 [μms^{-2}]		variant 3 [μms^{-2}]	
		g	m_g	g	m_g	g	m_g
600	PETR	9809659.44	0.08	9809659.44	0.09	9809659.33	0.11
601	LANS	9809864.37	0.08	9809864.35	0.09	9809864.27	0.11
603	RUDN	9809260.71	0.10	9809260.67	0.11	9809260.53	0.12
604	VRES	9807962.53	0.11	9807962.59	0.17	9807962.23	0.15
605	VYHL	9808493.43	0.12	9808493.43	0.15	9808493.18	0.12
606	BRAD	9808483.01	0.16	9808483.01	0.19	9808482.71	0.13
607	KAPR	9809407.25	0.16	9809407.18	0.16	9809407.04	0.12
608	STRE	9809067.17	0.11	9809067.18	0.13	9809067.02	0.11
609	HORK	9809222.83	0.11	9809222.83	0.12	9809222.69	0.11
610	SVES	9809826.55	0.15	9809826.50	0.15	9809826.55	0.11
611	DARK	9810056.06	0.15	9810055.99	0.15	9810056.08	0.12
612	PUST	9808883.61	0.20	9808883.58	0.21	9808883.22	0.11

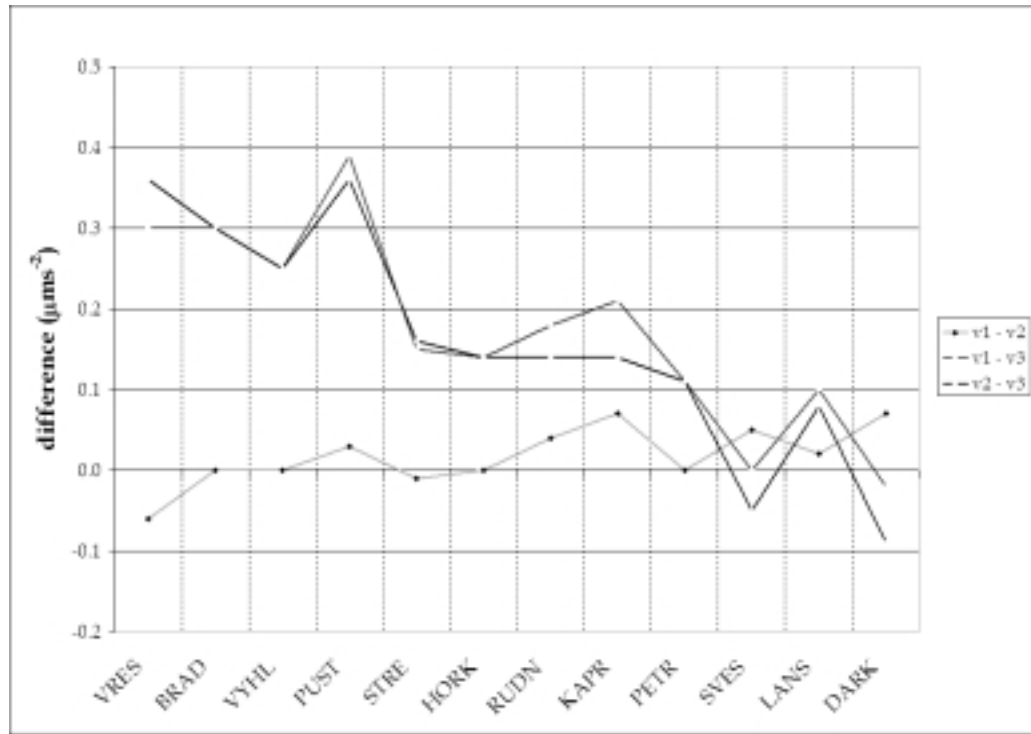


Fig. 4 In the graph are the stations arranged by the altitude from the lowest to the highest. The graph shows a good visible systematic trend of the differences of the resultant gravity accelerations in the first and in the second variant against the third variant. Therefore it is possible to suppose, that the third variant is influenced by some systematic component as a consequence of the using the different scale factor.

observation equations). The level and the scale of the network are given by the group of the 26 absolute gravity stations. Figure 5 shows positions of the CGRN stations).

Firstly there is good visible the sufficient harmony between the 1st and the 2nd variant of the solution in the results. The third variant is a little bit different. At this place it is important to note, that the stations of the geodynamic network are in upper altitudes against the stations of the Czech Gravity Reference Network and it means that the scale factor can be very important at this case. Owing to the big gravity difference, a little change of the scale factor may cause a very big change in the resultant gravity acceleration.

In the graph (Fig. 4) are the stations arranged by the altitude from the lowest to the highest. The graph shows a good visible systematic trend of the differences of the resultant gravity accelerations in the first and in the second variant against the third variant. Therefore it is possible to suppose, that the third variant is influenced by some systematic deformation as a consequence of the using the different scale factor.

5. CONCLUSION

Keeping with these conclusions it seems to be the best to use as a definitive result the 1st variant. In this variant were also used (except the connecting measurements of the absolute gravity station Jeseník) only the measurements from the last two years. It can be also an advantage in the case of the comparison with the results from potential repeated campaigns. The complete results of the gravity accelerations and its accuracy at the stations of the Geodynamic Network Sudety are in table (Tab. 1).

For improving of the real accuracy of the gravity acceleration at the stations of the Geodynamic Network Sudety it is possible to make more measurements, but there is no way to big improvement against the achieved accuracy.

For better accuracy is first of all needful to consider hydrological conditions in the surrounding of the geodynamical stations. It is necessary to perform a few independent gravity measurements in the different seasons to find the annual course of changes. And then remove this effect from the measurements.

Finally, it is important note that the stations are not well designed considering to the relative gravity

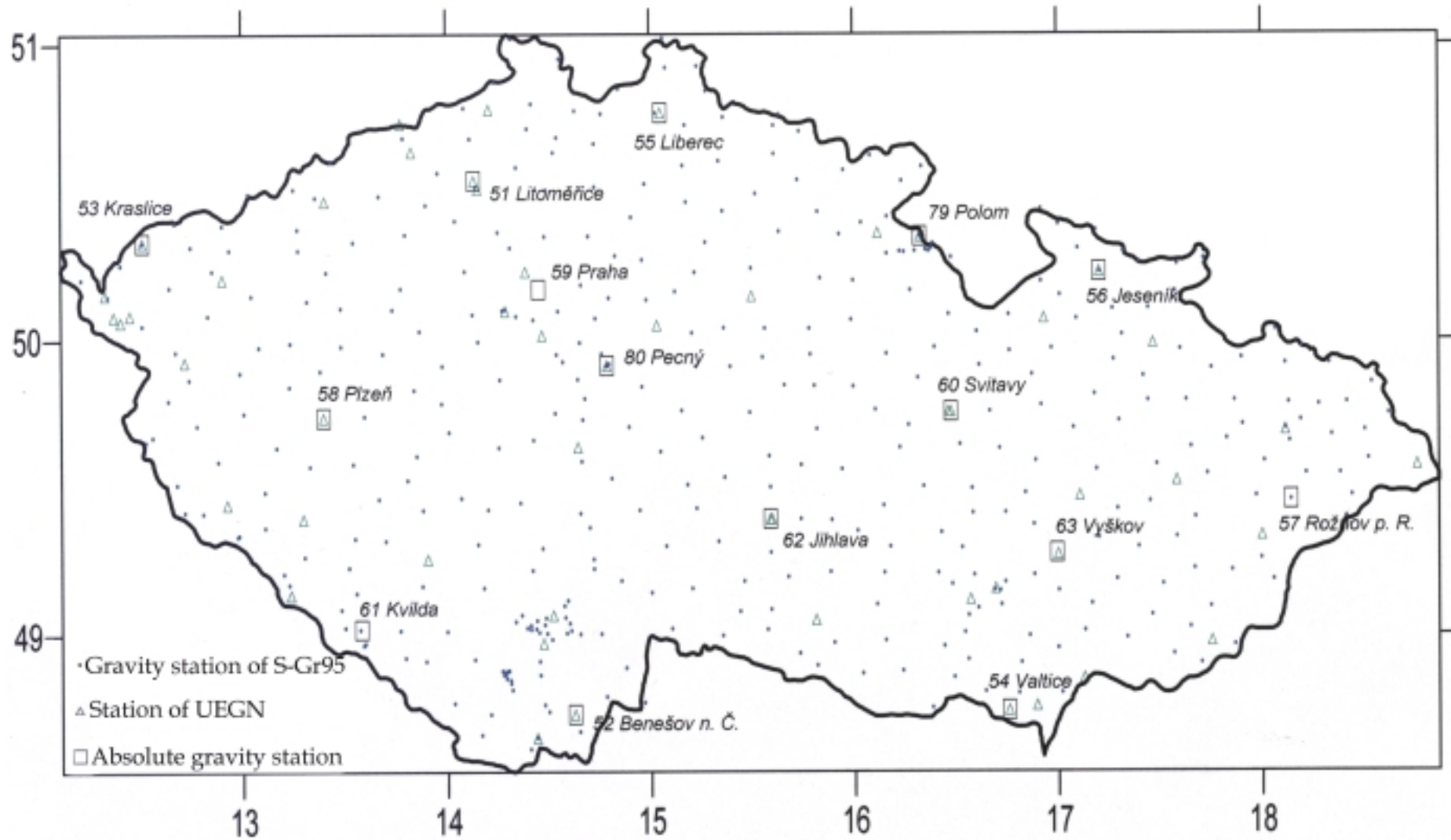


Fig. 5 The positions of stations of the Czech Gravity Reference Network. The absolute gravity stations are marked by the squares with the number and the name of the station (S-Gr95 = 1995 Gravity System on the Territory of the Czech Republic, UEGN = Unified European Gravity Network).

measurements, therefore the scale factor will remain the weak point of it.

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