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A model of recent vertical movements of the earth's surface in Lithuania: integration of geodetic levelling data and geological parameters

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The precise geodetic levelling reveals the recent activity of the vertical movements of the earth's crust. However, the main shortcoming of the levelling networks is scarceness of the measurement tracks that cannot be compensated for by a high density of the levelling sites within the tracks. The pattern and trends of vertical movements between the measured lines remain unknown. A special approach has been developed to allow prediction of vertical movements within the test grounds. It is based on the multicomponent statistical correlation of the levelling data with the significant geological parameters. The correlations between among parameters were derived separately for each particular test ground and then combined into one common model. It allowed compilation of a rather detailed map of vertical movements in Lithuania during the past 30–40 years. The rate of vertical movements of the earth's surface, obtained from the geodetic levelling, varies from –2.7 mm to 3.5 mm/y. The closest correlation of the recent movements was identified for the topography and the sub-Quaternary surface. It indicates that the major morphological features of Lithuania have a tectonic background. Furthermore, a close correlation was obtained with the gravity and in some parts with the magnetic fields which reflect the deep structure of the earth's crust. A close correlation suggests that the heterogeneity of the crust is important for the distribution of its vertical movements. The application of the close correlation with the geoparameters allowed a considerable improvement of the map of the vertical movements in Lithuania.

Key words: geodetic levelling, vertical movements, statistics, morphotectonics, neotectonic

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INTRODUCTION

The platform areas are characterized by low-intensity tectonic activity that can be detected by precise geodetic levelling. The first-class geodetic network of Lithuania was established as far back as the beginning of the twentieth century. Since then, several measurement campaigns were held. The whole Lithuanian network has recently been renovated and re-measured (1998–2006) (Petroškevičius et al., 1996; Petroškevičius et al., 1998; Petroškevičius et al., 2005; Paršeliūnas et al., 2000; Skeivalas, 2007). A recent study of different measurement cycles of the Lithuanian network revealed that the vertical movements are characterized by some inversion of the regional- and local-scale structures (Šliaupa et al., 2008). Mixing up data of various measurement cycles may lead to erroneous results. Therefore, the compilation of the Map of the Recent Vertical Movements of Lithuania was based on the two last measurement cycles, i. e. for the period of the last 30–40 years.

Precise levelling has a high accuracy that can detect low-intensity vertical movements of different-scale structures. However, the main shortcoming of the levelling networks is the scarceness of the lines, which cannot be compensated for by a high density of levelling sites along the lines. Therefore, the knowledge of the vertical movements between the measured tracks remains unclear (Liesis, 1960; Randjarvas, 1968, 1973, 1993; Mackova, 1963).

A new approach has been developed in order to allow the prediction of the vertical movements within the test grounds. It is based on a multicomponent statistical correlation of the levelling data with significant geological parameters (Zakarevičius, 1994; 2000; 2003; Šliaupa et al., 2005). However, the correlation of the country-scale set of data is subject to some mistakes, as the correlation trends may change across the country (Zakarevičius, Anikėnienė, 2007 a, b). The presented approach improves the models. The correlations between different parameters were derived separately for each particular test ground and then combined into one common model. It allowed compilation of a rather detailed map of the recent vertical movements in Lithuania.

Geological setting

Lithuania is located in the western margin of the Precambrian East European Craton overlain by the Baltic sedimentary basin. The Phanerozoic layers are only slightly tectonized, indicating a rather stable tectonic regime since the establishment of the basin in the Cambrian time. The thickness of the sedimentary cover varies from 200 m in the southeast to 2 km in the west of Lithuania. The surface of Lithuania was shaped by a continental ice sheet and meltwater activity during the Quaternary. The topography varies from 0 m along the Baltic Sea coast to almost 300 m in the southeast. So long as no marine sediments of the Neogene age are available in Lithuania, the reconstruction of the Neotectonic vertical movements is rather complicated. It is generally assumed that the smoothed bottom of the Quaternary deposits roughly reflects the pattern and magnitude of vertical movements (Šliaupa et al., 1995). The forms identified in the Sub-Quaternary surface are reflected in the present relief. The Sub-Quaternary uplifts are characterised by a more intensive accumulation of Quaternary deposits, whereas the thickness of the Quaternary is considerably smaller within the depressions (Šliaupa et al., 1995).

Data

The vertical movements of the earth's crust were calculated from repeated measurements of nine tracks of the first-class geodetic levelling network of Lithuania (Fig. 1; Table 1). The most recent measurement campaign was held in 2002–2006 (two lines were measured in 1998) as a part of renovation and expansion

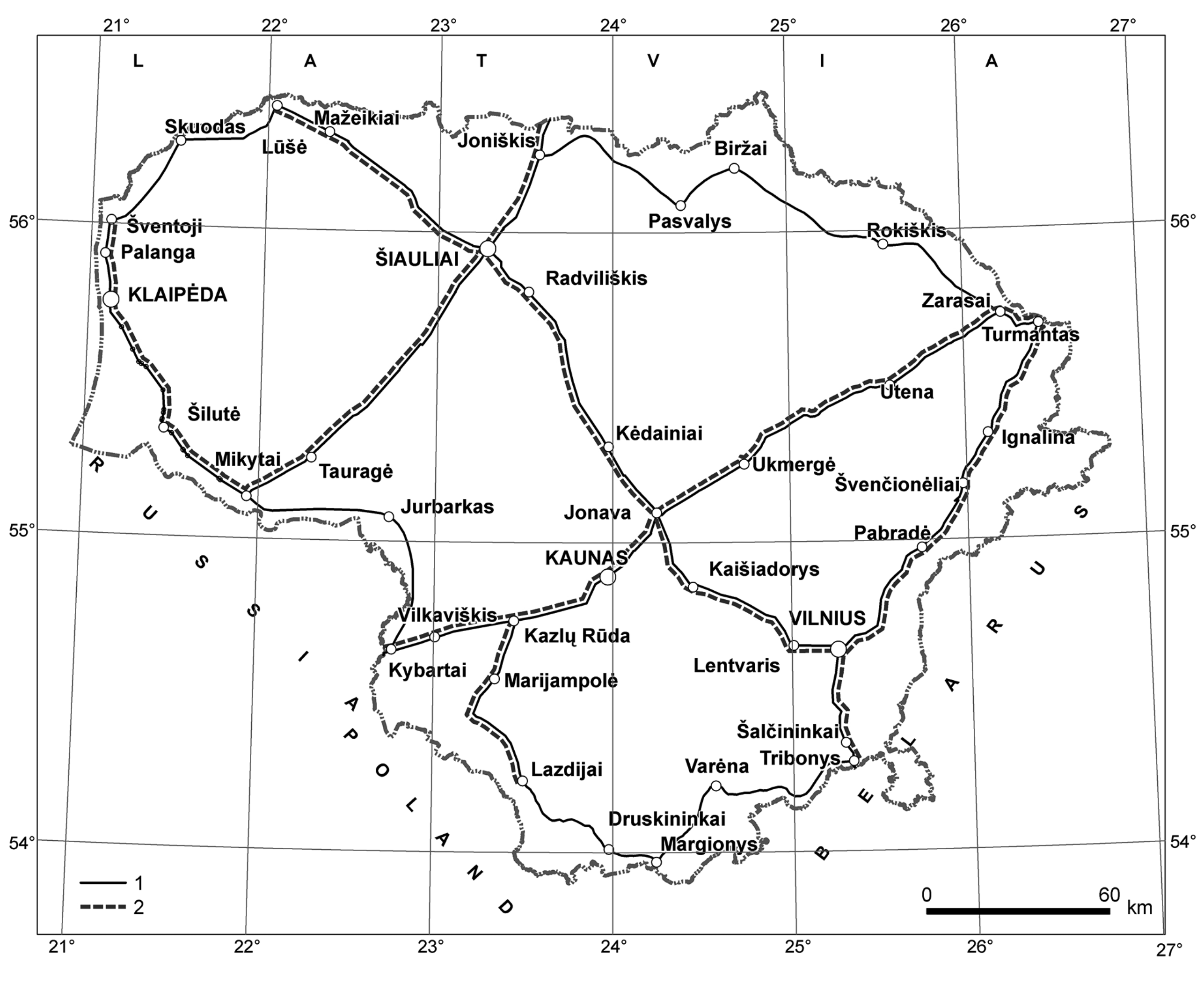

Fig. 1. First-level geodetic levelling network of Lithuania. *1* – tracks of a trial ground polygon; *2* – repeated measurement

1 pav. Lietuvos pirmos klasės niveliacijos tinklas. *1* – niveliacijos linijos, *2* – pakartotiniai matavimai

Table 1. **The processed tracks of the geodetic network of Lithuania used in the study**
1 lentelė. **Analizuotos Lietuvos geodezinio tinklo niveliacijos linijos**

No.	Year	Measuring institution	Accuracy, mm/km	Number of sites
		Šiauliai–Kužiai–Mažeikiai–Lūšė		
1	1965	KPI Geodesy Department	0.46	16
2	2004	VGTU Institute of Geodesy	0.47	
		Šiauliai–Tauragė–Mikytai		
3	1976	Geodesy and Cartography Survey	0.83	27
4	2002	VGTU Institute of Geodesy	0.40	
		Mikytai–Šilutė–Klaipėda–Palanga–Butingė		
5	1973–1975	VISI Geodesy Department	0.37	19
6	2003	VGTU Institute of Geodesy	0.42	
		Jonava–Gaižiūnai–Palemonas–Kaunas–Kazlų Rūda–Kybartai		
7	1970	Geodesy and Cartography Survey	0.47	22
8	1998	VGTU Institute of Geodesy	0.39	
		Vilnius–Jonava		
9	1970–1971	Geodesy and Cartography Survey	0.53	14
10	1998	VGTU Institute of Geodesy	0.36	
		Jonava–Zarasai–Turmantas		
11	1980	Geodesy and Cartography Survey	0.62	26
12	2005	VGTU Institute of Geodesy	0.38	
		Turmantas–Vilnius		
13	1985–1987	Geodesy and Cartography Survey	0.69	29
14	2005–2006	VGTU Institute of Geodesy	0.34	
		Jonava–Šiauliai–Joniškis		
15	1970–1971	Geodesy and Cartography Survey	0.53	22
16	2002	VGTU Institute of Geodesy	0.41	
17	2004	VGTU Institute of Geodesy	0.48	
		Kazlų Rūda–Šeštokai–Lazdijai–Polish border		
18	1982	Geodesy and Cartography Survey	0.92	20
19	1998	VGTU Institute of Geodesy	0.47	

of the network (Table 1). The preceding measurements were carried out in different years. Most of tracks were measured in 1970–1976, one track was measured in 1965, and three tracks were measured in 1980–1986. Accordingly, the time span between the most recent and previous measurement campaigns varies from 17 to 39 years.

Different geological parameters were incorporated into the model of the recent vertical movements of the earth's surface of Lithuania. Data on the gravity and magnetic fields, topography, depth of the crystalline basement, depth of the sub-Quaternary surface, thicknesses of the sedimentary cover, Prequaternary and Quaternary deposits of Lithuania were used in the model.

Approach

The measurement sites are rather densely distributed along the particular geodetic levelling tracks, enabling detection of activity of both large- and small-scale tectonic structures. However, the spacing of the tracks is in the order of 100 km, and there is no knowledge of the recent tectonic activity within the test grounds. The interpolation of the measurement data can reveal activity of only large-scale structures. Previous studies show that the recent vertical movements of the earth's surface correlate with various geological factors (Zakarevičius, 1994; 2000; 2003; Šliaupa et al., 2005). It is, therefore, assumed that the correlation obtained along the levelling tracks can be expanded to the internal areas of test grounds in order to reconstruct the distribution and magnitude of vertical movements (Zakarevičius and Anikėnienė, 2007 a, b, c). A model can be written in form of a regression equation (Aivazian, Mchitarian, 1998):

$$v = a_0 + a_1x_1 + a_2x_2 + \ldots, \quad (1)$$

here v is the modelled vertical movements of the earth's surface, x_n are the geological parameters, a_n are the coefficients of the regression model.

In order to obtain the values of the geological parameters at the levelling sites, data on the gravity field, magnetic field, topography, depth of the crystalline basement, depth of the sub-Quaternary surface, thickness of the sedimentary cover, Prequaternary and Quaternary deposits of Lithuania were transformed into the format of the MapInfo Professional GIS program (Dėnas et al., 2003). The data were gridded in the same framework. It allowed an automatic identification of the values of the geological parameters at the sites and modelling points.

The regression models were calculated separately for each individual trial ground, as it was realised that the correlation between the used parameters changes across the country (Table 2). The STATGRAPHICS program was used to calculate the regression coefficients. Analysis of levelling tracks indicates a consistent fit of the observed and the modelled velocities (Fig. 2).

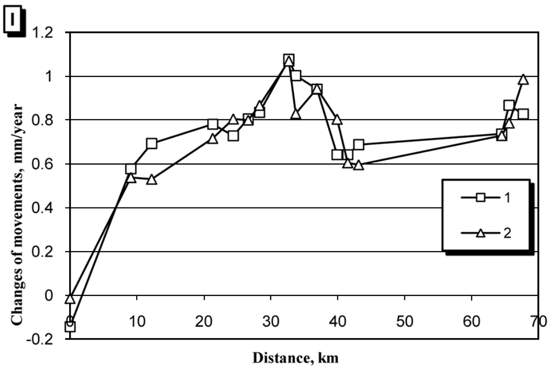

Fig. 2. Comparison of measured (1) and modelled (2) vertical movements of the earth's surface for individual geodetic levelling tracks: A – Vilnius–Jonava (1998–1970/71), B – Jonava–Zarasai–Turmantas (2005–1980), C – Turmantas–Vilnius (2005/06–1985/87), D – Jonava–Gaižiūnai–Palemonas–Kaunas–Kazlų Rūda–Kybartai (1998–1970), E – Kazlų Rūda–Šeštokai–Lazdijai (1998–1982), F – Jonava–Šiauliai–Joniškis (2002/04–1970/71), G – Mikytai–Šilutė–Klaipėda–Palanga–Būtingė (2003–1973/75), H – Šiauliai–Tauragė–Mikytai (2002–1976), I – Šiauliai–Kužiai–Mažeikiai–Lūšė (2004–1965)

2 pav. Atskirų niveliacijos linijų matuotų (*1*) ir modeliuotų (*2*) vertikalių judesių palyginimas

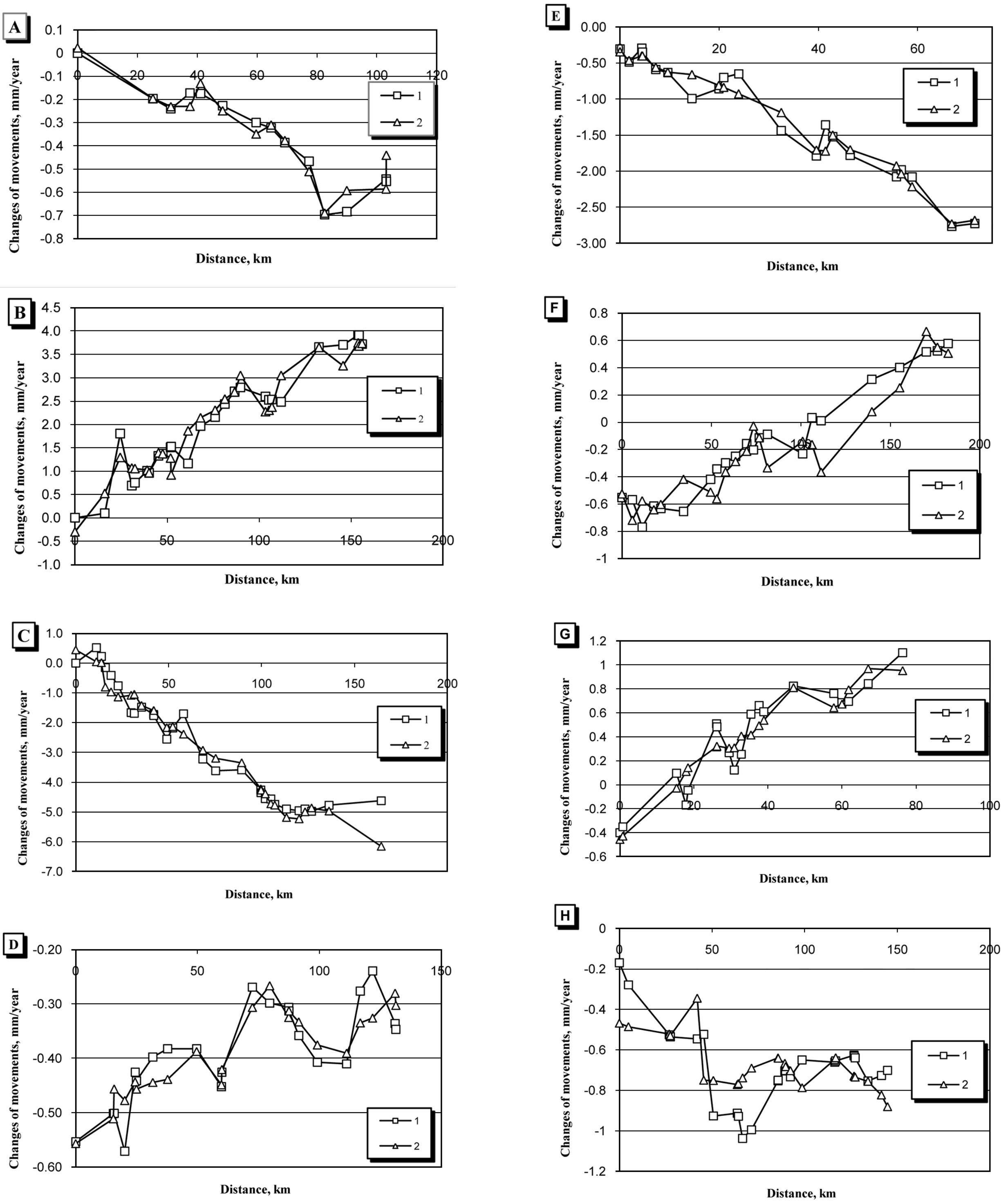

Table 2. **Regression models for individual trial grounds of the geodetic network of Lithuania (see Fig. 3 for the numbering of grounds)**

2 lentelė. **Lietuvos geodezinio tinklo atskirų poligonų vertikaliųjų judesių regresiniai modeliai (poligonai nurodyti 3 pav.)**

Trial ground	Regression model
1	$\hat{V} = -6.520 + 3.261 \cdot 10^{-2} \cdot x_1 - 0.110 \cdot x_2 + 7.104 \cdot x_3 - 5.008 \cdot x_4 - 2.084 \cdot x_5 - 3.021 \cdot x_6 - 4.083 \cdot x_7 - 0.922 \cdot x_8$
2	$\hat{V} = -0.220 + 1.134 \cdot 10^{-2} \cdot x_1 - 0.921 \cdot 10^{-2} x_2 - 0.441 \cdot x_3 + 0.139 \cdot x_4 + 0.307 \cdot x_5 + 0.299 \cdot x_6 + 0.139 \cdot x_7 - 0.008 \cdot 10^{-2} \cdot x_8$
3	$\hat{V} = 0.438 + 5.831 \cdot 10^{-2} \cdot x_1 + 0.764 \cdot 10^{-2} x_2 - 1.575 \cdot 10^{-2} x_3 - 1.017 \cdot 10^{-2} \cdot x_4 + 5.489 \cdot 10^{-2} \cdot x_5 - 1.482 \cdot 10^{-2} \cdot x_6 + 3.762 \cdot 10^{-2} \cdot x_7 - 4.952 \cdot 10^{-2} \cdot x_8$
4	$\hat{V} = -7.669 - 3.189 \cdot 10^{-2} \cdot x_1 - 1.627 \cdot 10^{-2} \cdot x_2 + 10.046 \cdot 10^{-2} \cdot x_3 - 8.160 \cdot 10^{-2} \cdot x_4 + 1.252 \cdot 10^{-2} \cdot x_5 + 2.213 \cdot 10^{-2} \cdot x_6 - 10.399 \cdot 10^{-2} \cdot x_7 + 3093 \cdot 10^{-2} \cdot x_8$
5	$\hat{V} = 1.708 + 4.250 \cdot 10^{-2} \cdot x_1 + 7.864 \cdot 10^{-2} x_2 - 0.153 \cdot x_3 + 3.554 \cdot 10^{-2} \cdot x_4 + 0.121 \cdot x_5 + 0.095 \cdot 10^{-2} \cdot x_6 + 3.394 \cdot 10^{-2} \cdot x_7 + 0.005 \cdot 10^{-2} \cdot x_8$

Note. x_1 is the gravity field, x_2 is the magnetic field, x_3 is the topography, x_4 is the depth of the crystalline basement, x_5 is the sub-Quaternary surface, x_6 is the thickness of the Quaternary deposits, x_7 is the thickness of the sedimentary cover, x_8 is the thickness of the Prequaternary sediments.

To verify the model, the probability of a fit of the model to the observed data was calculated, and the probability of the fit was found to exceed 0.95 for all tacks. It was, therefore, concluded that the models were consistent and could be used for compiling the map of vertical movements for the whole territory of Lithuania.

At the initial stage, five separate models (fragment maps) were calculated for each trial ground using the corresponding regression equations (Table 2). The vertical movements were obtained for a 15 × 15 km grid between the tracks, whereas the observed values were kept the same as they had been measured.

At the next step, these trial ground models were fitted together to allow a compilation of the common map, as the modelled values inevitably had some misfit at the junction points of the neighbouring grounds (Fig. 3). The values of vertical move-

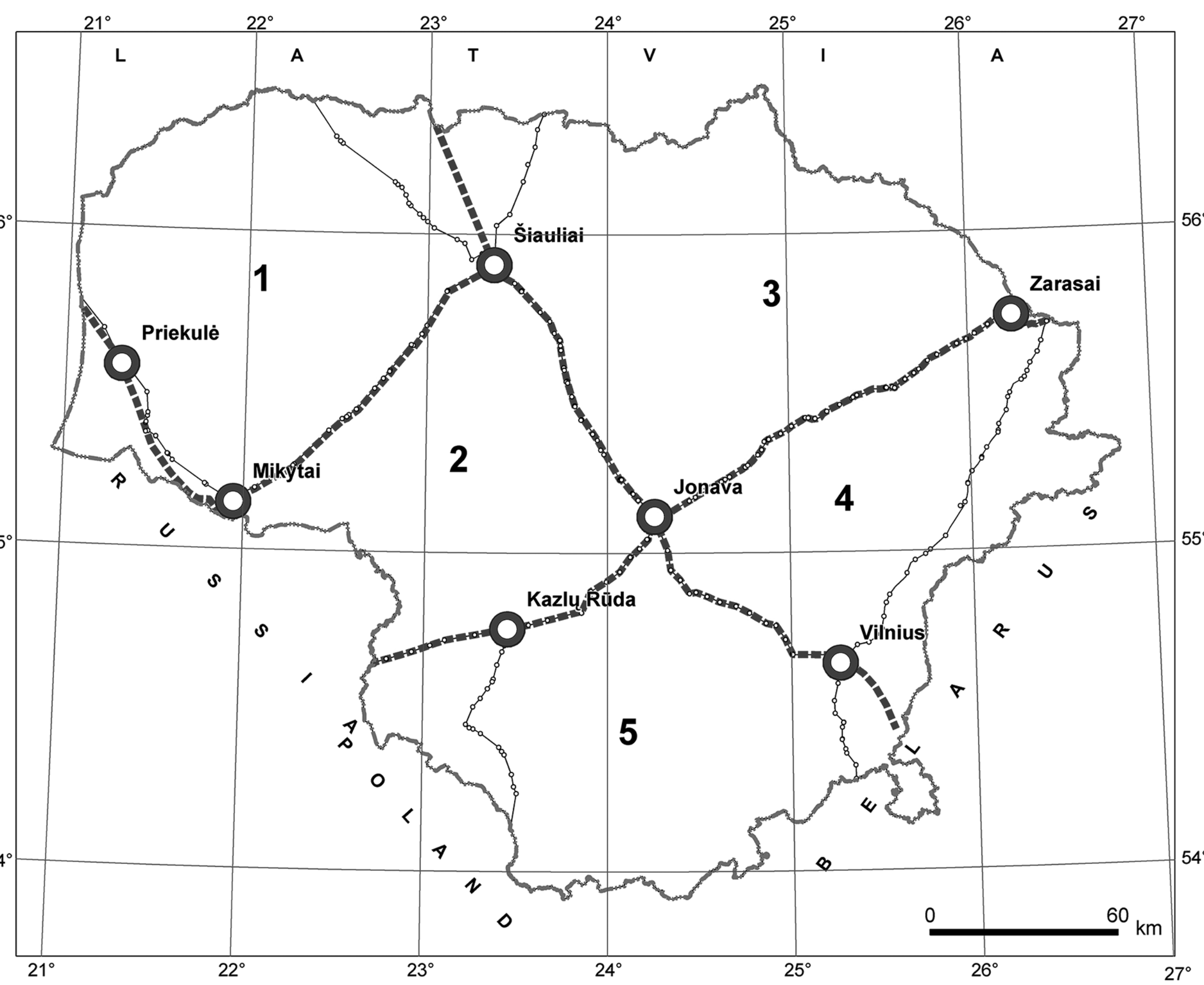

Fig. 3. Numbering of modelled geodetic polygons grounds and junction points

3 pav. Modeliuotų geodezinių poligonų numeracija ments were recalculated as an average value of the adjacent sites. The ground models (fragment maps), calculated using equations presented in Table 2, were transformed applying the correction equations. Those were derived from a misfit of the observed and the modelled values. The obtained correction equations are as following:

$$\Delta\nu_1 = 57.983 + 1.554 \cdot 10{-}5\,Y - 1.048 \cdot 10{-}5\,X, \quad \text{(ground 1)}$$

$$\Delta\nu_2 = -\,10.993 - 9.530 \cdot 10{-}7\,Y + 0.188 \cdot 10{-}5\,X, \quad \text{(ground 2)}$$

$$\Delta\nu_3 = -\,78.090 + 1.026 \cdot 10{-}5\,Y + 1.184 \cdot 10{-}5\,X, \quad \text{(ground 3)}$$

$$\Delta\nu_4 = -\,6.443 + 2.452 \cdot 10{-}5\,Y - 0.124 \cdot 10{-}5\,X, \quad \text{(ground 4)}$$

$$\Delta\nu_5 = 40.130 + 1.926 \cdot 10{-}7\,Y - 0.662 \cdot 10{-}5\,X, \quad \text{(ground 5)}$$

here $\Delta\nu_1$, $\Delta\nu_2$, $\Delta\nu_3$, $\Delta\nu_4$, $\Delta\nu_5$ are correction values of the vertical movements (mm/y), *X* and *Y* are LKS 94 coordinates of the sites (m). Those values were summed with the values calculated from the regression models.

Recent vertical movements from geodetic levelling

The rate of the vertical movements of the earth's surface, obtained from the geodetic levelling, varies from −2.7 mm to 3.5 mm/y relative to the reference Vilnius site (Fig. 4). In general, the northern part of Lithuania shows a relative tectonic uplift. The maximum uplift rates were identified in the north-eastern part of Lithuania. This anomaly is bounded by the west–east trending gradient zone which is confined to the Drūkšiai fault studied in detail in the Ignalina NPP area (Marcinkevičius, Laškovas, 2007). The central part of Lithuania shows a relative subsidence (−0.6 to −0.8 mm/y). A local subsidence anomaly of −1.8 mm/y was identified north-east of Vilnius. The most intensive subsidence was registered in southwest Lithuania (−2.7 mm/y).

The map based on the observed values is evidently inconsistent for the whole territory of Lithuania (Fig. 4). The distance between the measurement lines exceeds 100 km, and the erroneous extrapolation between the lines can not be compensated for by a close spacing of the measurement sites along the geodetic lines.

Model of the vertical movements of the earth's surface of Lithuania

The map of the vertical movements of the earth's surface, compiled using the regression model(s) (Fig. 5), is much more detailed compared to the map based on geodetic data alone (Fig. 4). The different-scale active tectonic structures are defined. The southern boundary of the Northeast Lithuanian uplift is controlled by the large-scale west–east trending Polotsk fault (Fig. 6). The uplift is linked to the north–south elongated Vilnius uplift; its activity can be related to the system of the faults striking the same direction, the largest of them being the Rūdiškės fault. This uplift seems to control the sharp change of the direction of the Nemunas River.

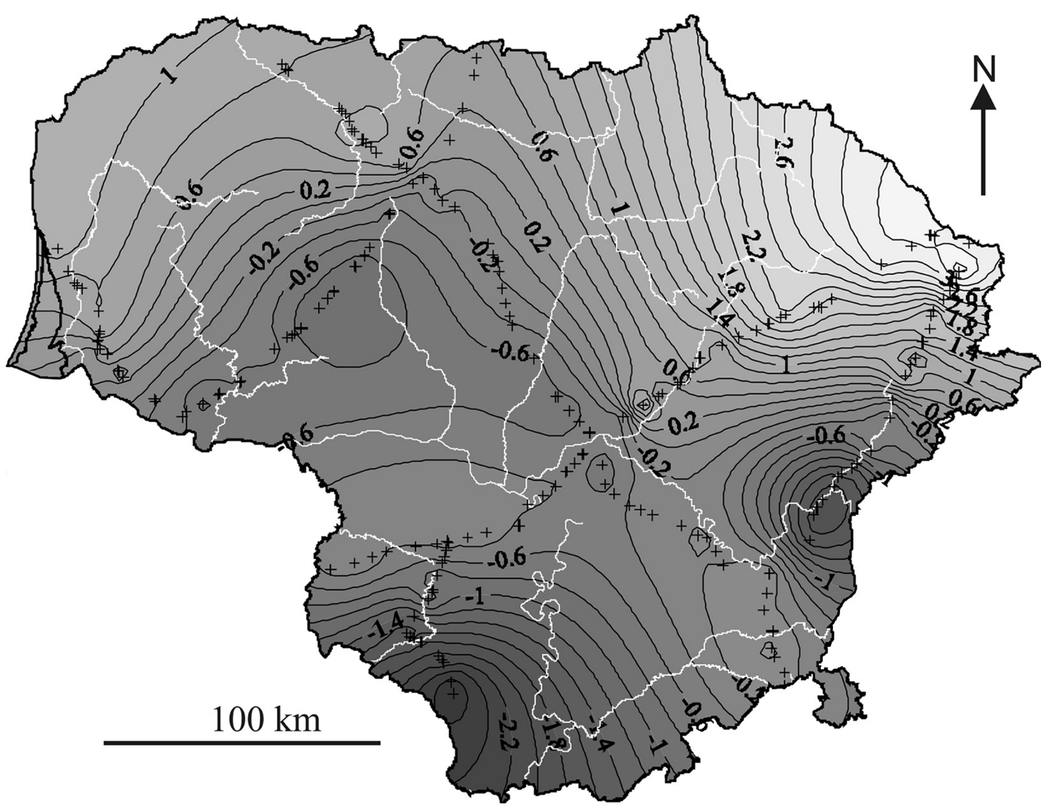

Fig. 4. Vertical movements of the earth's surface (mm/y) derived from precise geodetic levelling (with Vilnius as reference site)

4 pav. Vertikalūs Žemės paviršiaus judesiai (mm/m.) remiantis niveliacijos duomenimis (pagal Vilniaus atraminį punktą)

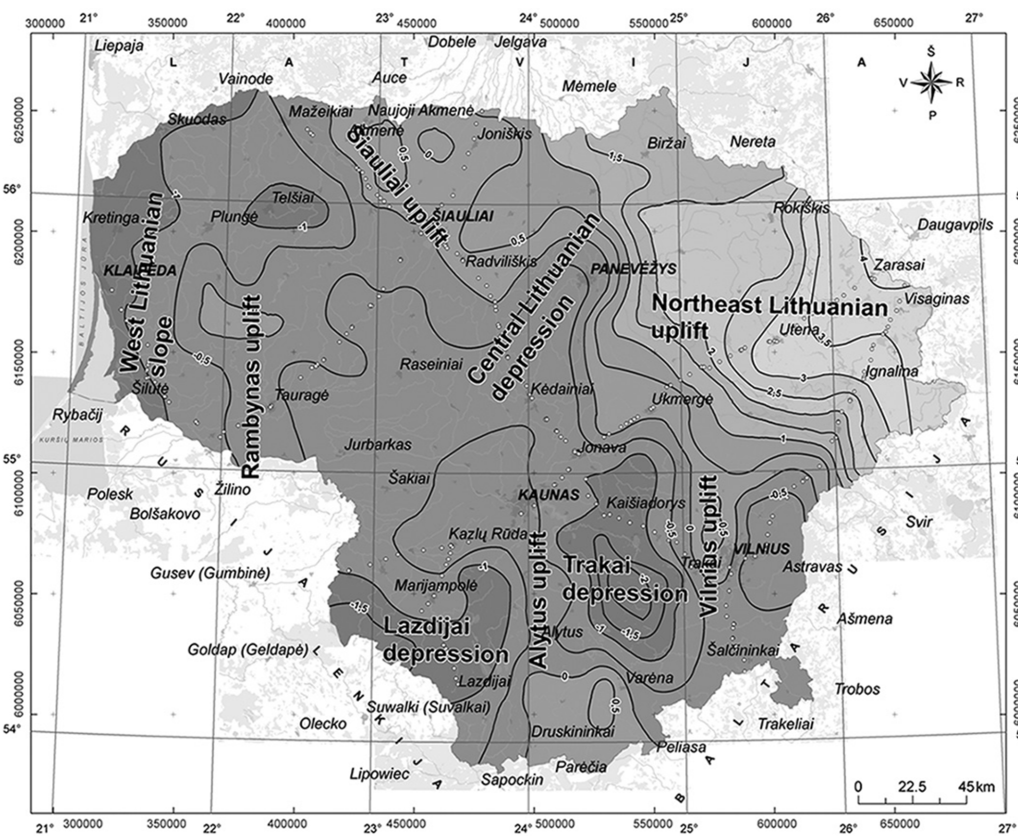

Fig. 5. Integrated model of vertical movements of the earth's surface, derived from the geodetic and geological data (regression model) (with Vilnius as reference site)

5 pav. Vertikalių Žemės paviršiaus judesių integruotas modelis remiantis niveliacijos ir geologiniais duomenimis (pagal Vilniaus atraminį punktą)

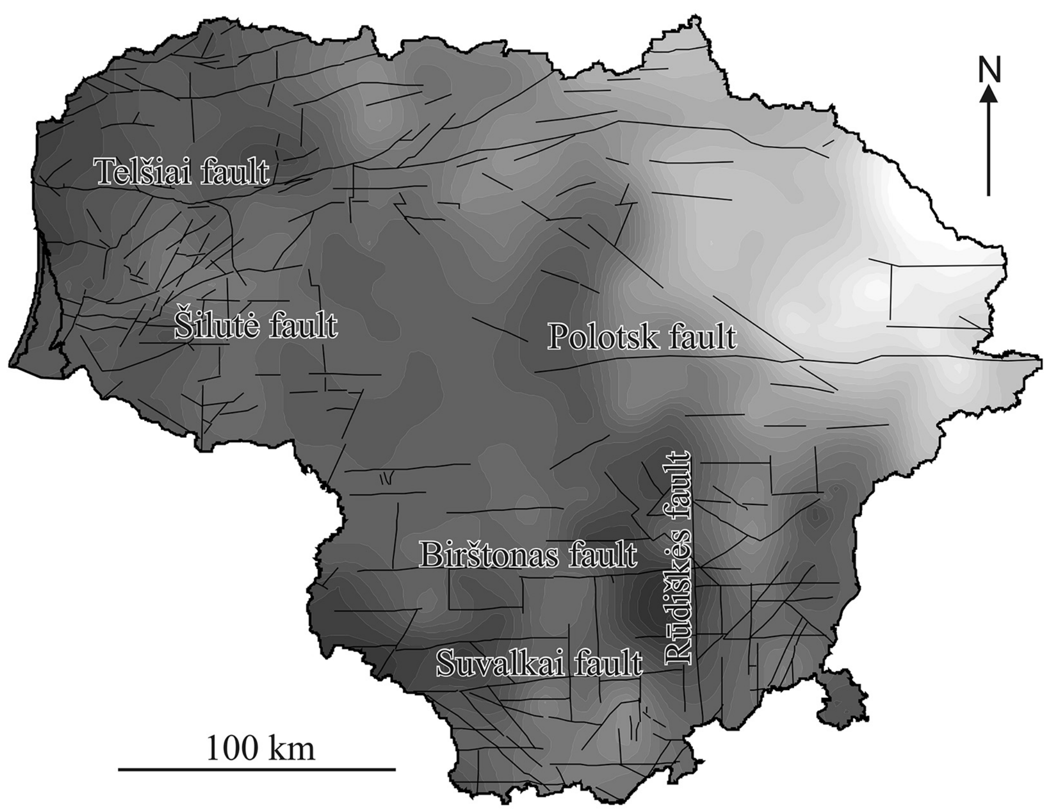

Fig. 6. Comparison of vertical movements (grey scale) and faults of the sedimentary cover. Major faults are named

6 pav. Vertikalių judesių (spalvinė skalė) ir nuosėdinės dangos lūžių palyginimas. Nurodyti pagrindinių lūžių pavadinimai

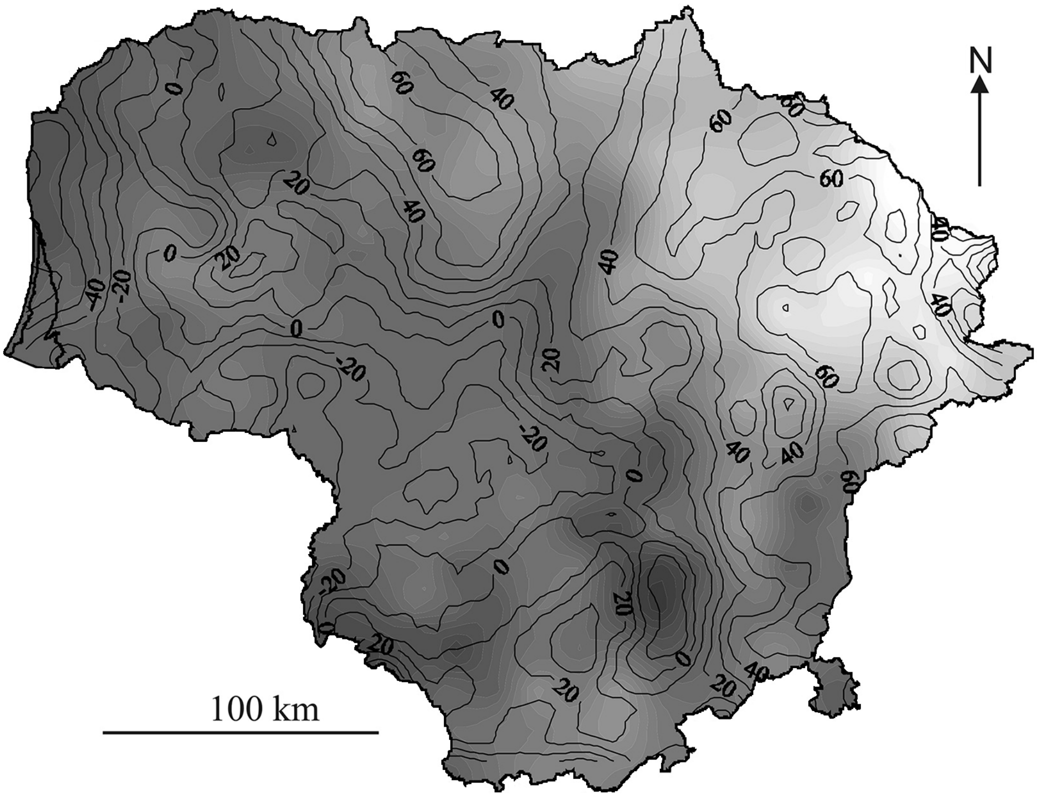

Fig. 7. Comparison of vertical movements (grey scale) and smoothed depths of sub-Quaternary surface (contour lines)
7 pav. Vertikalių judesių (spalvinė skalė) ir aproksimuoto pokvartero paviršiaus reljefo (izolinijos) palyginimas

West of the Vilnius uplift, a distinct Trakai depression is defined. The northern part of the depression is crossed by the Vilnius–Jonava levelling track. The maximum subsidence further to the south is inferred from the geological parameters and is confined to the depression identified in the sub-Quaternary surface (Fig. 7). The depression is flanked by the north–south trending Alytus uplift that partially reflects the sub-Quaternary uplift, similarly to the Lazdijai depression in the west.

The West Lithuanian and the Central Lithuanian depressions are separated by the Rambynas uplift striking north-south. This uplift is well recognised in the Permian deposits and is recognizable in the sub-Quaternary surface. One of the most distinct features in the western part of Lithuania is the Telšiai fault (Fig. 7), the northern flank of which is subsiding. In the central part of Lithuania, the Šiauliai uplift, one of the most distinct features in the sub-Quaternary surface, is also tectonically active. The Central Lithuanian depression, another distinct feature of the sub-Quaternary surface and present topography, is also reflected in the recent vertical movements of the earth's surface.

DISCUSSION AND CONCLUSIONS

The statistical analysis of the measured recent vertical movements of the earth's surface reveals a rather close correlation of the recent tectonic activity with different geological parameters, implying an inheritance of the tectonic movements. The closest correlation of the recent tectonic activity was identified for the topography and sub-Quaternary surface (Table 3). The topography correlates reversely with the vertical movements (from –0.13 to –0.95), except the Northeast Lithuanian uplift (+0.69 to +0.89). A similar pattern is obtained for the sub-Quaternary surface relief and the thickness of the Quaternary deposits. It indicates that the major morphological features of Lithuania have a tectonic background.

Furthermore, a close correlation was obtained for the gravity field, which reflects the deep structure of the earth's crust. This close correlation suggests that the heterogeneity of the earth's crust is important for the distribution of vertical movements. In most of the levelling tracks, the gravity field positively correlates with the vertical movements (correlation coefficient ranges from 0.30 to 0.87); in other words, the denser blocks have a tendency of uplifting. Only in the Northeast Lithuanian uplift this correlation is reverse and is as high as –0.69 to –0.86. The magnetic field correlates either directly or reversely in different parts of Lithuania.

The obtained rates of the recent vertical movements are typical of the craton areas, varying from –2.7 mm to 3.5 mm/y. In general, the northern part of Lithuania manifests a relative uplift, while the southern part of the country shows the dominating trend of relative subsidence. The obtained close correlation of the recent vertical movements of the earth's surface allowed a considerable improvement of the map of vertical movements. The tectonic trends can be thus modelled between the levelling tracks. The statistical calculations indicate that the modelled velocities are consistent with the measurement data.

Table 3. **Correlation of vertical movements with geological parameters**
3 lentelė. **Vertikalių judesių ir geologinių parametrų palyginimas**

Gravity field	Magnetic field	Topography	Basement	Sub-Quaternary surface	Quaternary thickness	Sedimentary cover thickness	Prequaternary thickness
				Vilnius–Jonava			
0.25	0.07	0.89	0.88	0.77	0.64	–0.85	–0.85
				Jonava–Zarasai–Turmantas			
0.31	–0.11	0.89	0.12	0.80	0.62	0.44	0.32
				Turmantas–Vilnius			
–0.86	–0.31	0.69	–0.94	0.22	0.45	0.93	0.95
				Vilnius–Jonava–Zarasai–Turmantas–Vilnius			
–0.69	0.02	0.29	–0.57	0.45	–0.03	0.70	0.67
				Šiauliai–Kužiai–Mažeikiai–Lūšė			
0.63	–0.14	–0.48	0.03	–0.46	–0.28	–0.14	–0.09
				Šiauliai–Tauragė–Mikytai			
–0.12	–0.49	–0.13	0.24	0.22	–0.32	–0.38	–0.24
				Mikytai–Šilutė–Klaipėda–Palanga–Būtingė			
0.07	–0.70	–0.16	–0.41	–0.80	0.81	0.40	0.24
				Jonava–Gaižiūnai–Palemonas–Kaunas–Kazlų Rūda–Kybartai			
0.59	0.52	–0.27	–0.57	–0.69	0.40	0.57	0.43
				Jonava–Joniškis			
0.70	0.28	–0.19	–0.63	0.32	–0.69	0.57	0.62
				Kazlų Rūda–Šeštokai–Lazdijai–Lenkijos siena			
0.87	0.53	–0.95	–0.75	–0.89	–0.88	0.53	0.68

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LIETUVOS DABARTINIŲ VERTIKALIŲ ŽEMĖS PAVIRŠIAUS JUDESIŲ MODELIS PANAUDOJANT GEODEZINĖS NIVELIACIJOS DUOMENIS IR GEOLOGINIUS PARAMETRUS

Santrauka

Tikslūs geodeziniai matavimai leidžia nustatyti dabartinį vertikalių žemės plutos judesių aktyvumą. Nepaisant pakankamai tankaus matavimo punktų išdėstymo niveliacijos linijose, pagrindinis šių matavimų trūkumas yra dideli atstumai tarp niveliacijos linijų. Vertikalių judesių intensyvumas ir tendencijos tarp niveliacijos linijų lieka neišaiškintos. Siekiant prognozuoti vertikalius judesius poligonų viduje, buvo sukurta vertikalių judesių modeliavimo metodika, kurios esmę sudaro matavimo duomenų daugiakomponentė statistinė koreliacija su svarbiais geologiniais parametrais. Pirmiausia buvo apskaičiuoti atskirai kiekvieno poligono statistiniai regresiniai modeliai, vėliau sujungti į bendrą modelį. Tai leido sudaryti gana detalų pastarųjų 30–40 metų vertikalių judesių Lietuvoje žemėlapį. Geodezinių matavimų metu gauti vertikalių žemės paviršiaus judesių dydžiai kinta nuo –2,7 iki 3,5 mm per metus. Stipriausia vertikalių judesių koreliacija nustatyta dabartinio reljefo ir pokvartero paviršiaus. Tai rodo, kad Lietuvos paviršiaus morfologijos bruožus nulėmė tektoninės priežastys. Be to, buvo gauta glaudi koreliacija su gravitaciniu ir magnetiniu laukais, kurie atspindinti žemės plutos giluminę sandarą. Ši koreliacija rodo, kad Žemės plutos nevienalytiškumas yra svarbus vertikalių judesių pobūdžiui. Glaudi koreliacija su geoparametrais leido gerokai patobulinti vertikalių judesių Lietuvoje žemėlapį.

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МОДЕЛЬ СОВРЕМЕННЫХ ВЕРТИКАЛЬНЫХ ДВИЖЕНИЙ ЗЕМНОЙ КОРЫ НА ТЕРРИТОРИИ ЛИТВЫ, ПОЛУЧЕННАЯ ПО ДАННЫМ ГЕОДЕЗИЧЕСКОЙ НИВЕЛИРОВКИ С ИСПОЛЬЗОВАНИЕМ ГЕОЛОГИЧЕСКИХ ПАРАМЕТРОВ

Резюме

Точные геодезические измерения позволяют определить интенсивность вертикальных движений земной коры. Однако основным недостатком таких измерений являются большие расстояния между линиями нивелирной сети, даже при довольно густом расположении измеренных пунктов на линиях нивелировок. Интенсивность и тенденции вертикальных движений внутри нивелирных полигонов являются неопределенными. Создана методика моделирования вертикальных движений земной коры в целях прогнозирования вертикальных движений внутри полигонов. Эта методика основана на использовании множественной корреляции результатов измерений и геологических параметров. Статистические регрессионные модели созданы для каждого полигона в отдельности с последовательным объединением их в общую модель. Это позволило создать довольно подробную карту современных вертикальных движений земной коры на территории Литвы для последних 30–40 лет. По результатам геодезических измерений значения скоростей вертикальных движений находятся в пределах от 2,7 мм до 3,5 мм в год. Наиболее тесная корреляция вертикальных движений установлена с современным рельефом и подчетвертичной поверхностью. Это доказывает, что морфологические особенности территории Литвы определяют тектонические причины. Установлена значительная корреляция с гравитационным и магнитным полями, в которых отражается глубинное строение земной коры. Данные корреляции показывают, что характеристики вертикальных движений связаны с особенностями земной коры. С использованием корреляционных связей результатов измерений с геопараметрами была значительно усовершенствована карта современных вертикальных движений земной коры на территории Литвы.