

POST-ALPINE TECTONICS OF THE UPPER NYSA KŁODZKA GRABEN: A REPLY

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Abstract

The paper aims to answer the critical remarks presented by Don and Wojewoda (in this issue) related to our papers published in *Acta Montana* (Badura et al., 2002, Badura et al., 2003). Answering those we have noticed that the terms brachysyncline and brachyanticline are improper with regard to the young Alpine rebuilding of the Upper Nysa Kłodzka Graben. In this paper we present the basic reasons for our hypothesis of young tectonic movements in the studied area more widely. Our morphotectonic analyses are based on the digital elevation models (DEM) and the electroresistance survey of the researched area located near Kamienna and north of Długopole Zdrój. The results of our research show that despite of the long history of the geological studies – longer than 100 years, the region is still a very challenging research area. In this paper we point out that application of the DEM and electroresistivity methods gives the new important results. Those should definitely be taken into consideration together with palaeontological research and geological mapping. We really wonder that the authors of the critical paper unequivocally negate the results of our studies and suggest that the continuation of such research and geodetic survey in the area is aimless.

KEYWORDS: neotectonics, digital terrain models, Upper Nysa Kłodzka Graben, Kamienna Graben

THE SUDETIC MARGINAL FAULT BETWEEN BÍLÁ VODA AND LIPOVÁ LÁZNĚ

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Abstract

The Sudetic Marginal Fault is near the northern border of the Bohemian Massif in the length about 250 km. But misses the character of the markedly visible line in the southeastern part (in the Jeseník area). The geological mapping between Bílá Voda and Lipová Lázně (Czech Republic) has shown the Sudetic Marginal Fault to be a zone of parallel en echelon faults 4 km in width (in the NW–SE direction). The velocity of the vertical movement was not continuous for the separate faulted-block. Individual authors have variously interpreted the different denudation levels. The disposition of the Sudetic Marginal Fault System probably predates the early Variscan. More intense movements along the main faults signaled the end of the main Variscan orogenic event in the Silesian region, as this fault system was an unstable zone that responded to changes in field force. Faults with directions from NNW–SSE to N–S between Bílá Voda and Lipová Lázně area seem to be younger than the Sudetic Marginal Fault System.

KEYWORDS: Sudetic Marginal Fault, Rychleby Mts., vertical and horizontal movements

IS THE SUDETIC MARGINAL FAULT STILL ACTIVE? RESULTS OF THE GPS MONITORING 1996 - 2002

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Abstract

The major tectonic structure of the Lower Silesia Region is connected with the Sudetic Marginal Fault (SMF), which past and contemporary activity has been pointed by many authors. Within the “GEOSUD” project the geodynamic profiles have been set up across the most active tectonic zones covering Sudetes and Fore–Sudetic Block. Repeated every year satellite GPS measurements were carried out on the sites of these profiles during the period 1996–2002. The analysis of the results of these measurements shows that tectonic activity of the SMF zone is still going on, but individual segments of this zone are marked by different character of horizontal movements.

KEYWORDS: Sudetic Marginal Fault, GPS, tectonic activity monitoring

THE RAMZOVÁ TECTONIC ZONE: THE CONTACT BETWEEN LUGICUM AND SILESICUM

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Abstract

The contact of the two great geological units at NW edge of the Bohemian Massif – Lugicum and Silesicum is by many authors laying on the Ramzová “overthrust“. This is thought of equivalent of the Moldanubian “overthrust“. On this tectonic zone is often putting a boundary between the West Sudetic and East Sudetic Systems. Appearances to dispute about tectonical character of this zone was made a trench near Habartice, 3 km north from Hanušovice. Detailed mapping and trench prove, that on contact of marbles of Branná Group and migmatites of Staré Město Group is up to 50 m of cataclasites. This tectonic zone on the contact between Lugicum and Silesicum is very probably steeply dipping to west and it has character of left-handed horizontal movement. Quartz, graphite, limonite and locally ankerite or dolomite, rarely chalcopyrite occur often on the crushed zones. This tectonic zone is not only important geological border, but also a significant infiltration and collector structure.

KEYWORDS: Ramzová “overthrust”, Lugicum, Silesicum, Staré Město Group, Branná Group, tectonics

ORIENTATIONS OF RECENT PRINCIPAL STRESS AXES IN THE JESENÍKY REGION

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Abstract

Seven focal mechanisms computed for micro-earthquake events located into the Jeseníky region were used for the stress analysis. The epicentres of these discussed seven events occurring in period 2001-2003 are situated in four separated epicentral areas. In spite of this dispersion of locations, the focal mechanism data are homogeneous. Seeming heterogeneity of the collection of all nodal planes is probably caused only by influence of the auxiliary nodal planes which are not real faults. These auxiliary nodal planes can contradict the stress conditions.

The axis of maximum compression is sub-horizontal or only gently dipping and it is orientated in the direction NNW-SSE. The axis of maximum extension is orientated in the direction ENE-WSW. This orientations well corresponds with published orientations of horizontal stresses investigated using breakouts (Peška, 1992) and hydrofracturing method (Stoš et al., 1997) in the Czech part of the Upper Silesian Basin, similar stress fields were found also in other regions of the Bohemian Massif (Havíř, 2000; Peška, 1992; Reinecker and Lenhardt, 1999).

KEYWORDS: NE part of the Bohemian massif, recent stress field, recent tectonic activity, focal mechanism

DEFORMATION ANALYSIS OF THE UPPER PART OF THE EARTH CRUST IN THE ŚNIEŻNIK MASSIF (POLISH AND CZECH SIDES BETWEEN 1993 AND 2003)*

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Abstract

The Śnieżnik Massif has complicated geological and tectonic structure. The continuing crust movements, proved on the grounds of geological, geodetic (precise levelling) and satellite (GPS) investigations, confirm present-day mobility of this area. During the past decade (1993-2003) geodynamic research based on repeated satellite (GPS) measurements in a network of 27 points located on both sides of the border has been realized in the Śnieżnik area.

Two joint (Czech-Polish) GPS observation campaigns (1993 and 2003) and a number of GPS measurements in Polish (16 points) and Czech (11 points) networks have been performed by scientists from the two partner Institutes. The results of above-mentioned investigations, particularly the 1993-2003 cycle, are the subject of analyses and interpretations presented in this paper. These are supplemented by the results of researches realized independently by the teams on both sides of the border.

KEYWORDS: Śnieżnik Massif, GPS, deformation analysis, cluster analysis

**ANALYSIS OF MUTUAL POSITIONS OF GEODETIC OBSERVATION POINTS
SITUATED ON THE ŚNIEŻKA MOUNTAIN
BASED ON GPS AND TOTAL STATION TECHNOLOGIES**

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Abstract

On the Śnieżka mountaintop in the Giant Mts. there are situated three GPS points. The first one situated on the Polish side (SNIE), a former fundamental trigonometric station, is an epoch site maintained by the Department of Geodesy and Photogrammetry AU Wrocław that has been used for geodynamic research connected with the EXTENDED SAGET, CERGOP and CEGRN international programmes for the past 10 years. Since 2001 two other GPS sites are located on the Czech side of the Śnieżka Mt. One of them (SNE1), placed on the Czech fundamental trigonometric point, serves for an occasional GPS epoch measurement point and the other one (SNEC) belongs to a permanent GPS observatory point maintained by the Institute of Rock Structure and Mechanics AS CR, Prague. Since GPS observations have been performed in 2001 and 2002 simultaneously within a few international research programmes, this fact enabled to transfer geodynamic observations from one site to another one, e.g. from the epoch site SNIE point to the permanent GPS observatory SNEC. From this viewpoint, several day observations were carried out at the same time on all three GPS points SNIE, SNEC and SNE1 in 2002. Afterwards range and angle measurements with precise Leica TCA 2003 Total Station were performed to verify and mutually link relative positions of all three GPS points.

KEYWORDS: geodynamics, GPS, SNIE and SNEC points, the Giant Mts, Sněžka, Śnieżka

RESULTS OF FOUR YEARS MONITORING OF DISPLACEMENTS OF ROCK BLOCKS IN THE KRKONOŠE MTS.

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Abstract

The epoch measurements of displacements of the rock blocks started in 2000 in western part of Krkonoše Mts. The local area of investigations in vicinity of Labská meadow and Violík was covered by three single geodetic networks named „A, B, C”. The measuring activities were initiated by KRNAP (the Krkonoše Mts. National Park Administration) in connection with the research project concerning the complex analysis of long-term changes of the Krkonoše mountain tundra with special aim to investigate the relevantly important hydro-geological structural elements.

The paper presents detailed description of the single networks and the employed measuring technologies. Besides GPS also other classical geodetic measuring techniques (precise levelling, angle and distance measurements) were used for monitoring of the relative horizontal and vertical positional changes. GPS campaigns were repeated after year, epoch interval for height measurements after half a year. In 2003 the network „C” was extended by additional points at rock blocks situated on southern slopes of Violík, where greatest possible changes should be expected. The paper also presents some results of geodetic measurements covering four years of displacements monitoring which indicate possible movements of some measured blocks mostly in vertical direction.

KEYWORDS: geodesy, deformation monitoring, geodynamics

LOCAL GEODYNAMIC NETWORK KARKONOSZE – THE RESULTS OF THREE YEARS OF MEASUREMENTS AND FIRST INTERPRETATIONS

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Abstract

The KARKONOSZE geodynamic network has been established in the Western Sudetes in year 2000. The GPS network consists of 19 points located on the area of the Karkonosze Mts. and its foreland. The KARKONOSZE network is connected with and also composes western parts of the GEOSUD and SUDETES geodynamic networks. Three measurement campaigns of the local geodynamic network KARKONOSZE were realized (2001-2003). The data from GPS observations was processed using BERNESE v.4.2 software, in the ITRF reference frame with connection to the "Wrocław" GPS permanent station. In the paper the comparison of preliminary results from data processing of the three GPS KARKONOSZE 2001-2003 campaigns are presented. The horizontal velocity vectors of the stations and geometrical changes of vectors for pairs on network points were calculated to assess changes taking place in the investigated area.

KEYWORDS: GPS, geodynamic researches, Karkonosze Mts.

TEN YEARS OF GRAVIMETRIC MONITORING ON THE POINTS OF GEODYNAMIC NETWORKS IN THE SUDETY MTS

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Abstract

In the paper ten years of gravimetric monitoring on the points of a geodynamic networks in the Sudety is reported. This material allows for an attempt to be made to discover tendencies in gravity changes. The first measurement cycle took a place in 1992 and was related to the region of the Śnieżnik Massif and the Paczków Graben (Barlik et al., 1999). Over the ten years the network became larger involving, by 2003, 78 points which were observed on a yearly basis (Barlik et al., 2001). In this article the observations of ten years are analysed in investigations of characteristic points or structures relating to groups of points, where the behaviour of gravity indicates a clear trend. It was recognised the tendency of arising the gravity in upper parts of Szczeliniec network. In opposite, the decreasing of gravity was pointed out in Kłodzki Śnieżnik massif. Karkonosze Mts. has very complicated, divided into subparts in gravity changes trends. Situation touching the gravity field in Paczków Graben is clear. The eastern part is characterised by moderately paced increase of gravity.

KEYWORDS: gravimetry, geodynamics, time variations of gravity

**CZECH PERMANENT GPS OBSERVATORIES FOR GEODYNAMIC
INVESTIGATIONS OF THE BOHEMIAN MASSIF OPERATED BY THE INSTITUTE
OF ROCK STRUCTURE AND MECHANICS, PRAGUE**

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Abstract

Since 2001 four GPS permanent observatories (BISK, MARI, POST and SNEC) monitoring NAVSTAR and GLONASS satellite signals were established by the Institute of Rock Structure and Mechanics Acad. Sci. (IRSM) to detect recent geodynamic movements of the Bohemian Massif. Their geographic positions, technical equipment and standard setting are described. Firstly the remote observatories were controlled using GSM modem and monitored data were stored on the PC hard disk, later GPRS technology was used for GPS data transfer from the observatories to the IRSM server.

KEYWORDS: geodynamics, GPS (NAVSTAR/GLONASS) permanent observatories, the Bohemian Massif

THE ANALYSIS OF GPS MEASUREMENTS IN TATRA MOUNTAIN

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Abstract

The geodynamic investigation of Tatra Mountain is a local crust movements project supported by Slovak Grant Agency of the Ministry of Education of Slovak Republic and the Slovak Academy of Sciences No. 1/8251/01. The annual GPS measurements from 1998 to 2002 were realised by the Slovak University of Technology, Department of Theoretical Geodesy Bratislava together with the Warsaw University of Technology, Institute of Geodesy and Geodetic Astronomy. The GPS network consists of 11 special monument sites, 7 in the Slovak and 4 in the Polish part. The five GPS observation campaigns were processed with three different models. The preliminary results show the no linearity horizontal and vertical movements of the measured points. The results and discussion are presented in this paper.

KEYWORDS: GPS measurements, crust movements, Tatra Mountain

INTEGRATION OF EPOCH-WISE GPS MEASUREMENT CAMPAIGNS INTO A PERMANENT REFERENCE FRAME

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Abstract

Precise GPS geodetic observations are frequently used for identification and quantification of recent movements of Earth's crust. The GPS technique is preferred because of its precision, availability of observing instruments, automated observations, and high coordinates repeatability. Two kinds of GPS observations applied for geodynamic investigations are performed, namely the epoch-wise and permanent. The epoch networks allow to monitor the selected territory in detail, however the short observation period is influenced by systematic phenomena, which complicate the interpretation of obtained crustal movements. The permanent monitoring yields a more realistic insight into the crustal kinematics, however is restricted to limited number of stations. The paper presents the mathematical model for complex analysis of long-term observations and consecutively the method of inclusion of epoch campaign coordinates and covariance matrices into the permanent network adjustment.

KEYWORDS: processing and analysis of GPS time series, geodynamic monitoring, GPS networks

HORIZONTAL AND VERTICAL DISPLACEMENTS OF THE STATIONS WITHIN THE FRAME OF THE INDIVIDUAL PLATES BASED ON THE ITRS2000 REFERENCE SYSTEM

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Abstract

Global horizontal and vertical movements were computed for individual tectonic plates from the velocity vectors published for ITRS2000. For the stations within the frame of those plates the differences from the global displacements and their rms errors were then computed. Global vertical motion (expansion/compression) of the Earth if exists is lower 1 cm/year (with 66% probability) or 2.5 cm (with 95% probability). Global horizontal motion of individual plates was detected and model NUVEL-1A was corrected, but accuracy of the model does not allow to detect residual motions of individual stations lower 1 cm/year (with 95% probability) in most cases.

KEYWORDS: eodesy, geodynamics, plate movements, terrestrial reference systems

SEISMOLOGICAL MEASUREMENT IN THE MORAVO-SILESIA REGION IN 2003

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Abstract

A detailed research of the mobility of tectonic zones in the Moravo-Silesian region was begun in 1997 due to the support of the Grant Agency of the Czech Republic. A major part of the grant was for a geodynamical measurement using GPS signals on geodetic points. The seismological monitoring results are described in the paper, and the geological and structural mappings of these points are necessary components of the analysis.

The registered information of these seismic stations confirms not only higher number of seismic events in this area due to technical and industrial reasons but also current occurrences of weak natural earthquakes. Experimental seismological measurement in 2003 documents the occurrence of weak natural earthquakes with local magnitude that usually do not exceed the value of zero. It is evident that only shocks in the surrounding of the stations were recorded. The main source areas are the wider surroundings of Opava town, the eastern margin of Hrubý Jeseník Mts. (e.g. Rýžoviště), parts of Hrubý Jeseník and the surroundings of Staré Město town.

KEYWORDS: weak local seismic activity, Moravo-Silesian Region, seismic station Zlaté Hory

**WATER TUBE TILTMETER IN LOW SILESIAN GEOPHYSICAL OBSERVATORY.
RESULTS OF ADJUSTMENT OF HALF YEARLY SERIES OF PLUMB LINE
VARIATIONS**

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Abstract

In years 1996 to 2002 in Low Silesian Geophysical Observatory in Ksiaz there was built high sensitive tiltmeter (Kaczorowski, M. 1999a, 1999b). New instrument bases on phenomenon of hydrostatic equilibrium. It consists of two tens of meters long, perpendicular tubes partially filled with water. At the ends of the tubes interferometric gauges were installed. Luni-Solar forces produced tidal variations of water level in the tubes. Applied technique allowed us to measure these variations with accuracy 10^{-9} m. For hundred of meters long tube changes of water level of order 10^{-9} m correspond to plumb line variations of order 10^{-3} (msec) of arc. During the time of construction as well as during first years of exploitation of a new instrument there appeared unexpected problems. There were disturbances of free water surface caused by mechanical and organic origin. These problems significantly retard moment of initiation of permanent measurements. Therefore, the first time series of plumb line variations suitable for tidal analysis were obtained at the end of 2002. The tidal analysis basing on mean square method was applied to adjusted suitable data. The results of tidal analysis confirm high sensitivity of long water tube tiltmeter (Bower, D.R. 1973), (Ozawa, I. 1967), (Tsumura, K. 1960), (Takahasi, R. 1930) and indicate reasons of disturbances. We are still working to diminish ratio of noise to tidal signals. For this purpose special constructions in environment of long water tube like curtains and roofs were made. In water system low frequency filters was installed to slow down water level variations in measure chambers of interferometers and to reduce high frequency water waving. Organic disturbances have been fully eliminated by chemical method. System of registration and managing interference figures as well as their processing, bases on four programs written in Space Research Centre (SRC). All programs can be used in Windows 95, 98, 2000 and XP systems.

KEYWORDS: geodynamic, earth tides, tidal deformations, tilt effect, tiltmeters.

TECTONIC STRUCTURE AS A POTENTIAL THREAT TO SAFE OPERATION OF THE PLANNED KAMIENIEC DAM

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Abstract

The Kamieniec Dam will be constructed on the Nysa Klodzka River, in the Paczkow Graben situated close to the Sudetic Marginal Fault separating two major geological formations: the Sudety Massif and the Sudetic Foreland (SW Poland). The Tertiary graben has complicated tectonic structure characterized by a network of secondary faults dividing it into smaller blocks. Geodynamic investigations, including analysis of repeated precise levelling measurements, have been undertaken to assess tectonic safety of the planned object. The results indicate present-day tectonic activity in the reservoir area. The analysis of levelling measurements shows differentiated vertical movements of separate tectonic blocks of up to $\pm(0.3-0.4)$ mm/year. Satellite GPS observations have proved horizontal movements of individual blocks inside the graben in the western (3 mm/year) and southern (1.5 mm/year) directions. The examined relevant geological and engineering documentations have given evidence of insufficient identification of the dam foundations.

The influence of the dam and reservoir on the surrounding ground and faults located about 250 to 350 m on the downstream side of the dam has been modelled with Finite Element Method (FEM). No direct interaction of the structure and nearby fault zone has been found.

The results of accomplished studies will act as the reference for future control measurements of the dam and its surroundings. The registered initial state of the ground will allow for reliable interpretation of deformation measurements of the planned dam in the cause-effect aspect.

KEYWORDS: embankment dam, geodynamic investigations, FEM modelling

TECTONICS OF THE UPPER NYSA KŁODZKA GRABEN: CONTENTIOUS ISSUES

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Abstract

This paper is a critical comment on two articles published in the Acta Montana (Badura et al., 2002, Badura et al., 2003), in which the on-sided collected geophysical data as well as their interpretation constituted a base for quite new and very controversial interpretations of the well documented and known since a long time regional tectonic structures – the Idzików Brachysyncline and eastern flexure of the Upper Nysa Kłodzka Trough.

KEYWORDS: Sudetes, Upper Nysa Kłodzka Graben, sedimentary basin, tectonics, Cretaceous, discussion

POST-ALPINE TECTONICS OF THE UPPER NYSA KŁODZKA GRABEN: A REPLY
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Abstract

The paper aims to answer the critical remarks presented by Don and Wojewoda (in this issue) related to our papers published in Acta Montana (Badura et al., 2002, Badura et al., 2003). Answering those we have noticed that the terms brachysyncline and brachyanticline are improper with regard to the young Alpine rebuilding of the Upper Nysa Kłodzka Graben. In this paper we present the basic reasons for our hypothesis of young tectonic movements in the studied area more widely. Our morphotectonic analyses are based on the digital elevation models (DEM) and the electroresistance survey of the researched area located near Kamienna and north of Długopole Zdrój. The results of our research show that despite of the long history of the geological studies – longer than 100 years, the region is still a very challenging research area. In this paper we point out that application of the DEM and electroresistivity methods gives the new important results. Those should definitely be taken into consideration together with palaeontological research and geological mapping. We really wonder that the authors of the critical paper unequivocally negate the results of our studies and suggest that the continuation of such research and geodetic survey in the area is aimless.

KEYWORDS: neotectonics, digital terrain models, Upper Nysa Kłodzka Graben, Kamienna Graben