

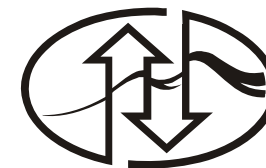
**Department of Geodesy and Photogrammetry
Agricultural University of Wrocław, Poland**

**Institute of Rock Structure and Mechanics
Academy of Science of the Czech Republic**

**Section of the Geodynamics Commission of Geodesy
Polish Academy of Science**

2nd Czech - Polish Workshop

**ON RECENT GEODYNAMICS
OF THE EAST SUDETY MTS.
AND ADJACENT AREAS**



April 6-8, 2000 Bolesławów, Poland

Organizing Committee
of the

2nd Czech-Polish Workshop

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Prof. Stefan Cacoń¹, Chairman
RNDr. Vladimír Schenk Dr Sc², Vice Chairman
RNDr. Zdeňka Schenková CSc²
Dr. Jarosław Bosy¹
Dr. Bernard Kontny¹
Dr. Olgierd Jamroz¹, Secretary
Ing. Pavel Kottnauer²

¹ Department of Geodesy and Photogrammetry
Agricultural University of Wrocław, Poland

² Institute of Rock Structure and Mechanics
Academy of Sciences of the Czech Republic, Prague

ABSTRACTS

Contents

<i>Janusz Śledziński</i> Programme of Geodynamic Research Realised in the Frame of the International Cooperation of the CEI WGST Section C "Geodesy"	5
<i>Vladimír Schenk, Stefan Cacoń, Jarosław Bosy, Bernard Kontny, Zdeňka Schenková, Pavel Kottnauer</i> GPS Network „Sudeten” - Preliminary Results of the Campaigns 1997-1999	6
<i>Marcin Barlik</i> Gravimetric Investigations of Geodynamic Phenomena of the East Sudety Mts. and Fore-Sudetic Block.....	7
<i>Jarosław Bosy, Stefan Cacoń, Bernard Kontny</i> Local Geodynamic GPS Network „GEOSUD” – Preliminary Results of the Campaigns 1997-1999	9
<i>Otakar Švábenský, Josef Weigel, Jiří Bureš, Miroslav Švec</i> Results of Geodetic Measurements in Czech Part of the Sněžník Network - Analysis 1992-1999	10
<i>Andrzej Dąbrowski, Olgierd Jamroz</i> Statistical Evaluation of the Śnieżnik Massif Deformations.....	11
<i>Krzysztof Małkowski, Miroslaw Kaczatek</i> The Dynamic of Deformation of the Bear Cave Rock Mass.....	12
<i>Zdeněk Kaláb, Jaromír Knejzlik</i> Weak Natural Earthquakes in the Opava Area in Period 1997-1999	13
<i>Zuzana Skácelová, Jaroslav Skácel</i> Seismic Activity on the Eastern Margin of the Bohemian Massif	14
<i>Radomír Grygar, Jan Jelínek</i> Sudetic Faults Frameworks in West and East Sudetes - Comparative Structure and Geomorphologic Studies.....	15

<i>Janusz Badura, Bogusław Przybylski</i> Cartometric and Geologic Identification of Potential Fault Scarps in Sudetic Foreland, SW Poland.....	16
<i>Blahoslav Košťák</i> An Aseismic Tectonic Event in Krušné Hory Mts., Czech Republic.....	18
<i>Josef Stemberk</i> Late Quaternary Tectonic Evolution of the Krušné Hory Mts.....	19
<i>Jan Mrlina</i> Experience with Precise Levelling in the Main Epicentral Zone of West Bohemia.....	20
<i>Witold Zuchiewicz, Antoni K. Tokarski</i> Late Neogene to Recent Structural Development of the Polish Segment of the Outer Carpathians in the Light of Structural and Geomorphic Data	22
<i>Aniela Makowska</i> Tatra Mountains - Geodynamic Investigations	24
<i>Marcel Mojzeš, Kazimierz Czarnecki</i> Geodynamics of the Tatra Mountains - Present Status and Future Development of the Project.....	25
<i>Stefan Cacoń, Stanisław Dyjor</i> Project of Geodynamic Investigations Development in the Sudeten and Adjacent Areas.....	26
<i>Marek Kaczorowski</i> New Perspectives of Investigations of Plumb Line Variations in the Książ Geophysical Station.....	27

**PROGRAMME OF GEODYNAMIC RESEARCH REALISED
IN THE FRAME OF THE INTERNATIONAL COOPERATION
OF THE CEI WGST SECTION C "GEODESY"**

Janusz Śledziński

*International Coordinator of the CEI WGST Section C "Geodesy"
Chairman of the IAG Subcommission
"Geodetic and Geodynamic Programmes of the CEI"*

*Warsaw University of Technology, Institute of Geodesy and Geodetic Astronomy
Pl. Politechniki 1, 00-661 Warsaw, Poland
e-mail: sledzinski@gik.pw.edu.pl, <http://www.gik.pw.edu.pl/igga/cei.html>*

ABSTRACT

The paper includes concise information on some recent geodetic and geodynamic projects that are realised in international cooperation of the European countries in the frame of the scientific programme of sixteen countries assembled in the CEI (Central European Initiative) WG Science and Technology Section C "Geodesy". The main achievements of the first phase of the international geodynamic project CERGOP (Central Europe Regional Geodynamics Project) are outlined. The main objectives of another CEI project UNIGRACE (Unification of Gravity Systems in Central and Eastern Europe) and the results of the 1998 campaign of absolute gravity measurements are pointed out. The programme of activities of the Section C Working Group on Satellite Navigation Systems and actions realised by the Working Group on University Education Standards are summarised. Special role of satellite permanent GPS stations for geodynamic research and creating national navigation systems is pointed out. Some cooperation links between CEI WGST Section C "Geodesy" and European Geophysical Society and International Association of Geodesy are mentioned.

GPS NETWORK „SUDETEN”-PRELIMINARY RESULTS OF THE CAMPAIGNS 1997-1999

**Vladimír Schenk¹, Stefan Cacoń², Jarosław Bosy²,
Bernard Kontny², Zdeňka Schenková¹, Pavel Kottnauer¹**

¹ *Institute of Rock Structure and Mechanics*

Academy of Sciences of the Czech Republic

V Holesovickách 41, 181-09 Prague 8, Czech Republic

e-mail: schenk@irms.cas.cz, zdschenk@irms.cas.cz, kottnauer@irms.cas.cz

² *Department of Geodesy and Photogrammetry, Agricultural University of Wrocław*

Grunwaldzka 53, 50-357 Wrocław, Poland

e-mail: cacoon@kgf.ar.wroc.pl, bosy@kgf.ar.wroc.pl, kontny@kgf.ar.wroc.pl

ABSTRACT

The geodynamic GPS network SUDETEN covers the area Middle- and East-Sudety Mts. and Sudety Foreland and links together existing Czech and Polish local GPS networks in this area. The Polish part of this network includes selected points of network GEOSUD, established by Department of Geodesy and Photogrammetry of Agriculture University of Wrocław in 1996. The Czech part consists mainly of the network SILESIA built in 1997 by the Institute of Rock Structure and Mechanics of the Czech Academy of Sciences in Prague. The first joint GPS observation campaign of both networks was performed in August 1997, second in September 1998 and third in September 1999. The results of first two campaigns were presented on the 1st Polish-Czech Workshop in Ramzova (November 1998). Methodology of the GPS satellite signals monitoring applied in last two campaigns allows the errors in the horizontal directions 2mm and in the vertical direction 5-6 mm not to be exceeded. The GPS observation data of all campaigns were reprocessed now by the authors using Bernese GPS Software v. 4.2. The network was linked to three EUREF permanent stations (GOPE, PENC and BOR1) and their data were included to the reprocessing. The preliminary results concerning to the first geodynamical evidences in the Sudety Mts. obtained from the GPS data, seismological observations and a brittle tectonic mapping are presented.

GRAVIMETRIC INVESTIGATIONS OF GEODYNAMIC PHENOMENA OF THE EAST SUDETY MTS. AND FORE-SUDETIC BLOCK

Marcin Barlik

Institute of Geodesy and Geodetic Astronomy

Warsaw University of Technology, Warsaw

pl. Politechniki 1, 00-661 Warsaw, Poland

e-mail: barlik@gik.pw.edu.pl

ABSTRACT

Non-tidal gravity changes with time can be monitored by repeated gravity measurements. For this reason high measurements accuracy is required. The repetition rate has to be adapted to the temporal evolution, that means period of the gravity change. Precision gravity networks ought to be established for monitoring long-term changes in certain region. It is easy to recognise that local gravity disturbances are caused by variations of atmospheric pressure, groundwater level and soil moisture. They could be caused by man-made mass displacements, also. Local and regional gravity networks together with elevation changes monitoring system have the main objective to find out the phenomena with a geodynamical origin due to the close relationship between gravity changes and elevation changes. In eastern part of Sudety Mountains, in Kłodzki Śnieżnik Massif and in Fore-Sudetic Block, since 1992, during five cycles, the observations of gravity differences between installed geodynamical stations have been performed. There have been monitored temporal variations of the gravity using precise LaCoste&Romberg (Model G and D) and Scintrex CG-3 Autograv gravity meters in reference to some stations located outside geological structures under investigation. The reference level for these measurements has been supported by the gravity on fundamental station at Józefosław Observatory, near Warsaw, where the absolute gravity by ballistic instrument ZZG has been determined periodically many times and by gravity point situated at the building of the Agriculture University in Wrocław. This last one is connected with permanent GPS station established there.

Gravity change measurements carried out in Eastern Sudeten and Fore-Sudetic Block have been carried out within the frame of one from the segments of monitoring and control system implemented on geodynamic polygons: “Śnieżnik Massif”, “Paczków Graben”, “Stołowe Mountains”.

As it was mentioned in other papers written by the author and Prof. S. Cacoń, in Śnieżnik Massif, there was pointed out a clear tendency of gravity arising on points in lower parts of geodynamic test field and decreasing of gravity in upper parts. The most interesting situation in Fore-Sudetic Block, in Paczków Tectonic Graben has been appeared. Our investigations pointed out the gravity decreasing to the East from Nysa and, anti-symmetrically, the gravity increasing on the western part of this complex.

Taking into account of the ascertained values of gravity variations as well as a good their documentation, the author suggests some changes in the gravimetric monitoring system. It is necessary to make re-stabilisation or new "more gravimetric" stabilisation of some observational stations, located in Śnieżnik Massif and Paczków Graben. The pillars installed there have microseismic influences. On other hand, the complex referential gravity measurements ought to be planned in connection to the absolute determinations of the gravitation and in connection to the gravimetric works from south side of the polygons. The author suggests, once again, the necessity of an installation of the gravimetric calibration baseline in a vicinity of the area under investigation with possible great value of gravity differences, stabile monumentation and marks conservation.

LOCAL GEODYNAMIC GPS NETWORK „GEOSUD” – PRELIMINARY RESULTS OF THE CAMPAIGNS 1997-1999

Jarosław Bosy, Stefan Cacoń, Bernard Kontny

*Department of Geodesy and Photogrammetry, Agricultural University of Wrocław
Grunwaldzka 53, 50-357 Wrocław, Poland
e-mail: bosy@kgf.ar.wroc.pl, cacon@kgf.ar.wroc.pl, kontny@kgf.ar.wroc.pl*

ABSTRACT

The local geodynamic GPS network GEOSUD covers the area Middle- and East Sudety Mts and Sudety Foreland on the Polish side of border. The network was established by Department of Geodesy and Photogrammetry of Agriculture University of Wrocław (Poland) in 1996. The first GPS observation campaign of the network was performed in September 1996, second in August 1997, third in September 1998 and last in September 1999. GPS observation data of all campaigns were processed by the authors using Bernese GPS Software v. 4.2. Observation data of the local networks were processed and adjusted both: as the independent free networks and as the networks connected to the EUREF permanent stations network (data from three EUREF stations: GOPE, PENC and BOR1 were included to the processing). The first results of the processing show that the accuracy of the point position determination, using GPS observation, on the level of one millimetre of the horizontal coordinates is possible to achieve. The general strategy of the GPS data processing of the network, using CODE and EUREF products, is presented in the paper. The preliminary results of the GPS data processing are shown and commented in geodetic focus.

RESULTS OF GEODETIC MEASUREMENTS IN CZECH PART OF THE SNIŽNÍK NETWORK - ANALYSIS 1992-1999

Otakar Švábenský, Josef Weigel, Jiří Bureš, Miroslav Švec

*Department of Geodesy, Brno Technical University, Veverí 95
CZ 66237 Brno, Czech Republic
e-mail: gdsva@fce.vutbr.cz, gdwei@fce.vutbr.cz*

ABSTRACT

Overview of all geodetic, astronomic, gravimetric and satellite measurements in Czech part of the Snižník network in time span of eight years (1992-1999). Experiences from combination of classical geodetic, GPS and other data. Some results of overall reprocessing of all GPS data. Stability evaluation of single points on ground of GPS baselines time series analysis. Common performance of various GPS receiver types and some remarks on GPS antenna calibration procedures.

STATISTICAL EVALUATION OF THE ŚNIEŻNIK MASSIF DEFORMATIONS

Andrzej Dąbrowski¹, Olgierd Jamroz²

¹ *Department of Mathematics, Agricultural University of Wrocław
Grunwaldzka 53, 50-357 Wrocław, Poland
e-mail: dabr@ozi.ar.wroc.pl*

² *Department of Geodesy and Photogrammetry, Agricultural University of Wrocław
Grunwaldzka 53, 50-357 Wrocław, Poland
e-mail: jamroz@kgf.ar.wroc.pl*

ABSTRACT

Geodynamical network „Śnieżnik” and external reference network were founded in 1992. Points of the polygon „Śnieżnik” were located in polish (16) and czech (11) part of Śnieżnik Massif. Particular location was connected with geological and tectonic structure of the object as well as topography and forestation. The researches are continuation and enlargement of monitoring activity of the Bear Cave in Kletno which has been leading since 70-ties.

The aim of researches was to determine changes of the upper crust of Śnieżnik Massif. Satellite GPS, gravimetric and other geodetic and relative methods were used in the investigations. All of measurements were provided ones in the year (in September) from 1992 to 1997 according to the control-monitoring system. In the paper results analysis only from polish part of founded polygon are presented.

The most active part of this region is Kleśnica River Valley. Changes of the horizontal positions of the stations it is about 10-15 mm and vertical movements is maximal to 11 cm. Points with the largest vertical movements have also maximal changes of gravitation.

Four tectonical blocks were determined in the research area by geological and tectonic data. Distance matrixes describing dynamic of changes of the Śnieżnik crust were constructed in the work. The results of investigations were prepared and verified by statistical methods multidimensional scalling and hierarchical classification. Procedures which were prepared allowed reduction of variables describing dynamic of changes of the Śnieżnik crust. Statistical analysis have been proved existing of four tectonical blocks.

THE DYNAMIC OF DEFORMATION OF THE BEAR CAVE ROCK MASS

Krzysztof Mąkowski, Mirosław Kaczalek

Department of Geodesy and Photogrammetry, Agricultural University of Wrocław
Grunwaldzka 53, 50-357 Wrocław, Poland
e-mail: makolski@kgf.ar.wroc.pl, kaczalek@kgf.ar.wroc.pl

ABSTRACT

The paper presents the geodetic measurement results of vertical displacements of benchmarks inside and outside the Bear Cave in the period 1984-1999. The results of benchmarks displacements and the comparative analysis results of measured height differences between benchmarks in relation to their position at the detected and expected tectonic faults are presented. The geodetic results have been analysed in relation to stability of rock masses after finishing of excavation in neighbour stone mine.

WEAK NATURAL EARTHQUAKES IN THE OPAVA AREA IN PERIOD 1997-1999

Zdeněk Kaláb, Jaromír Knejzlík

Institute of Geonics, Academy of Sciences of the Czech Republic
CZ-708 00 Ostrava-Poruba, Studentska 1768, Czech Republic
e-mail: kalab@ung.cas.cz

ABSTRACT

Weak natural seismic activity is documented from the Opava area (e.g. Boráňová et al., 1999). The last more important earthquakes occurred in this region on 20th and 21st February 1999 (Kaláb and Skácelová, 1999). Using spectral analysis of seismic signal from local station "Hradec nad Moravicí" the following source parameters were obtained for the most intensive shock with local magnitude 0.8: source dimension (Madariaga model) 53 m, seismic moment $9 \cdot 10^{10}$ Nm, stress drop $3 \cdot 10^5$ Pa, average displacement 0,5mm and seismic energy $8 \cdot 10^4$ J.

The local stations (HRMC, ZLHC, ZARC) work as self-contained instruments under the regime of triggered records. According to results of experimental operation, the top of recorded velocity amplitude was set to $0.25 \text{ mm} \cdot \text{s}^{-1}$ - i.e. conversion constant is $7.66 \text{E-}9 \text{ m} \cdot \text{s}^{-1} / \text{LSB}$ (Kaláb and Knejzlík, 1999).

Records are stored into the hard disk of PC. Seismic events are possible to divide into three main groups:

- Local seismic events - the main number of these events is determined as blasts in quarries in the surrounding of seismic stations. Little amount of events have character of natural earthquakes (23 events). At present we make seismologic interpretation to obtain their basic parameters and to exclude their interchange with man-made seismic events.
- Mining induced seismic events - there are recorded stronger events from the Ostrava-Karviná Coal Basin, the Polish part of Upper Silesian coal basin and cooper mine in the Lubin area (Poland).
- Undefined parts of teleseismic events.

Percentage occurrence of number of recorded seismic events in period 1998-1999 within particular categories is shown by the following table (Boráňová et al., 1999):

	ZLHC	ZARC	HRMC
Local seismic events & blasting	20	15	30
Induced events of OK coalfield	1	4	4
Induced event of Polish part of basin & of Lubin area	39	53	45
Parts of remote earthquakes	40	28	21

SEISMIC ACTIVITY ON THE EASTERN MARGIN OF THE BOHEMIAN MASSIF

Zuzana Skácelová¹, Jaroslav Skácel²

¹ *Institute of Physics of the Earth, Masaryk University
Tyrdeho 12, 602 00 Brno, Czech Republic
e-mail: zuzka@ipe.muni.cz*

² *Havlíčková 1022, 790 01 Jeseník, Czech Republic*

ABSTRACT

Seismic activity on the eastern margin of the Bohemian Massif (Moravia and Silesia) is relatively weak. Registrations and localisation are possible thanks to monitoring of seismic activity by very sensitive seismological stations operated by the IPE, that were built up in this region since year 1992 and by co-operation with other scientific institutions – Technical University of Ostrava and Institute of Geonics of the Academy of Sciences of the Czech Republic.

In the period from October 1994 to December 1999 on whole 32 microearthquakes were localised into the area of North Moravia and Silesia (Czech Rep.). Most of them originated in the area between Rýmařov and Moravský Beroun. The maximum local magnitude was 1.6.

Seismic activity is concentrated particularly on the south part of Culm unit along the faults of Sudetic direction NW-SE (Klepáčov, Temenice faults). There are numerous mineral water springs in this region and several Tertiary and Quaternary volcanoes are close to it. It is interesting, that the northernmost registration of seismic activity was localised into the area of Kralický Sněžník, near of Kletno Fault.

SUDETIC FAULTS FRAMEWORKS IN WEST AND EAST SUDETES - COMPARATIVE STRUCTURE AND GEOMORPHOLOGIC STUDIES

Radomír Grygar, Jan Jelínek

*Institute of Geological Engineering VSB TU Ostrava
CZ-708 33 Ostrava, Czech Republic
e-mail: radomir.grygar@vsb.cz, jan.jelinek@vsb.cz*

ABSTRACT

The term “Sudetic faults system” in the geological literature concerned to the tectonics of the Bohemian Massif is usually used for the faults striking NW-SE. However significant trend scatter should be observed, if an individual fault sets relationships are analysed more precisely. We are studying them by way of morphostructural analysis and the digital terrain modelling combined with structure field mapping.

Two main Sudetic faults – Intra-Sudetic Fault and Sudetic Boundary Fault – display 25 degrees trend deviation. It is also evident, that the Sudetic Boundary Fault is younger - superposed over Intra-Sudetic fault. Also whole Sudetes Mts., as a typical horst-like mountain, is running WNW-ESE-ward and it is limited southward by Lužice tectonic zone. This trend is disturbed by Orlice Mts. horst system, so as by Litice and Potštejn asymmetric horsts, altogether oriented NW-SE. Eastward of the Orlice zone we cannot follow both Lužice and Intra-Sudetic faults. The same is valid for the East Sudetes, where NW-SE up-to NNW-SSE fault frameworks prevail (Bělá fault, Bušín fault, Opavice zone etc.). These faults were at the latest activated during the late-Variscan tectogenesis, but after that they were severe times rejuvenated. Most significant reactivation belongs to Late Cretaceous, resulting also to the tectonic inversion of the Permo-Carboniferous Orlice furrow into above-mentioned Litice and Potštejn half-horst structures. Also pull-apart structure of the Klodzsko Graben corresponds to this geodynamics stage, which is represented by distinct ENE-WSW stretching induced by NNW-ward Alpine orogeny compression. Next stage of the same ENE-ward Alpine foreland stretching corresponds to opening of the Upper Morava Depression also belongs to a pull-apart type, developed in dextral transpressional dynamic regime. Also pattern of the NW-SE oriented horst in the High and Lower Jeseník Mts. area was originated in this geodynamic fields. The highest horst structure corresponds to Praděd Horst, which one could be followed up-to Morava Gate Graben, where the main watershed belongs to it.

Based on the complex structure and geomorphology studies we presented idea of the significant differences between the East and West Sudetes faults framework and its geodynamics development.

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CARTOMETRIC AND GEOLOGIC IDENTIFICATION OF POTENTIAL FAULT SCARPS IN SUDETIC FORELAND, SW POLAND

Janusz Badura, Bogusław Przybylski

*Polish Geological Institute, Lower Silesian Branch, Wrocław
al. Jaworowa 19, 53-122 Wrocław, Poland
e-mail: jbad@pigod.wroc.pl, boguslaw.przybylski@pigod.wroc.pl*

ABSTRACT

Manifestation of the youngest tectonic activity is one of many reasons which form the fault scarps. Recognition of tectonic activity by cartometrical methods resolves into the analysis of the relief shown on topographic maps and their transformations, such as creating dense contour line maps and measurement of characteristic elements of the relief. Tectonic studies in aseismic zones, like Poland area, mostly bring to recognition old, partial fossil forms. So, geologic investigations show mostly older tectonic zones, while topographic maps analysis reflect tectonic zones active at least till modern times. The combination of two methods makes possible to define more precisely the spatial connection between fossil fault scarp and scarps recorded on modern topographic maps.

The analysis of the youngest tectonic activity of Eastern Sudetes foreland show that slight tectonic movements has been present here up to now. The biggest intensity of the movements can be observed between Złote Góry Mountains and Sowie Góry Mountains in the marginal sudetic fault. In the Nysa Kłodzka valley, in Bardo, the total uplift reached about 50 meters (in relation to the foreland 30 meters) since Mezopleistocene to Holocene. In the Bystrzyca valley the Sudetes ridge lifted 30 meters up (in relation to the foreland 15 meters), at the same time. The uplift of the foreland related to the Wrocław Plain, reach about 20-40 meters during Quaternary.

In the middle part of Lower Silesia between Sudetes and Trzebnica Hills there are three main provinces in which connection of morphologic scarps with deeper located faults ought to be differently interpreted. The first area is related to exposing or shallow located crystal bed rocks, second to shallow located Mesozoic bedrock and third to thick layer of Neogene sediments.

In the Niemcza-Strzelin Hills area, where zones of crystal bedrock occurs quite shallow the relation of morphologic scarps to fault zones is very sharp. Scarps are mostly related to crystal bedrock outcrops or they are located shallow under the surface. In the area of Niemodlin plain relation between scarps and brittle dislocations is harder to be proved, because we know very little about tectonic structure of Cretaceous of Opole Depression. On the ground of indirect premises it

can only be determined that net of faults, cutting Trias and Upper Cretaceous sediments, is considerably more dense than in crystal bed.

The biggest problem to prove the tectonic genesis of scarps occurs in the area where Cainozoic sediments are thick, and where deep located crystal bedrock has been drilled very seldom, like in Silesian Rampart. Chains of segmented hills are visible in cartographic picture of this area. Some of them are additionally cut from south by straight morpholineaments forming scarps of relative height exceeding 50 meters. Till now the relation between the scarps and faults can not be explicitly proved, except of general statement that northern fascicle of middle Odra faults goes in bed of Silesian Rampart.

AN ASESMIC TECTONIC EVENT IN KRUŠNÉ HORY MTS., CZECH REPUBLIC

Blahoslav Košťák

*Institute of Rock Structure and Mechanics, Czech Ac. Sci., Prague
V Holesovickach 41, 181-09 Prague 8, Czech Republic
e-mail: kostak@alpha.irsm.cas.cz*

ABSTRACT

Mining operations in the North Bohemian Brown Coal Basin approached Krušné Hory Fault Slope in the eighties. To minimize losses in coal reserves and avoid accidents a complex system of monitoring in the area affected by mining was established. Thus, the problem of stability in the mine forefronts induced investigations regarding possible long-term movements and their consequences in the marginal zone of the mountains. The investigations included all kind of activities and measurements. Data from the monitoring had been under studies to serve as a basic and permanent information for mining engineers during the operations as data needed by the survey mining authorities, providing data comparable with calculations and safety criteria. Direct effects of mining were analyzed primarily. However, expected deformation effects had to be reconsidered as a complex result, because mining effects could be interfered with the effects of natural origin.

About fifteen years methodical experience dealing with individual monitoring methods was evaluated. Long-term deformation monitoring in the steepest fault slope section of Krušné Hory Mts. have proved slow active tectonic movements, which were neither bound to seismic events nor to mining operations directly. Precise tape extensimetric measurements in the two galleries Jezerka and Jezeří provided detailed data about long-term rock behavior deep in the massif. Due to a persisting horizontal pressure the rock has been found creeping. This creep effect reads about 1,5 to 3,0mm per year horizontally at a gallery length of 200m deep in the hard crystalline rock. The process proves to be dependent on structural slips mainly. Besides, massif has been found suffering slow episodic tectonic shock events. The best evidenced event of such a type was that of the episode of 1994, when both galleries Jezerka and Jezeří came simultaneously under an elastic slow pressure shock of almost one year duration. During the event increased rock pressure induced significant variation in gallery lengths.

Although detailed data come from the underground galleries, additional data have been obtained and may be compared with those from the surface. These, due to natural conditions, are not so well interpretable. The complex of such data can be discussed in regard of implications of resulting movements to all kind of measurement deformation activities in the mountainous terrain as represented there in the terrain of Krušné Hory Mts.

LATE QUATERNARY TECTONIC EVOLUTION OF THE KRUŠNÉ HORY MTS.

Josef Stemberk

*Institute of Rock Structure and Mechanics, Czech Ac. Sci., Prague
V Holešovičkách 41, 18209 Prague, Czech Republic
e-mail: stemberk@alpha.irsm.cas.cz*

ABSTRACT

Studies into time and space principles of origin and evolution of geodynamical phenomena are an important area of problems under attention of dynamical engineering geology. Regarding the long-term and nonlinear character of geodynamical processes, the whole information about their recent activity cannot be based on direct measurements only.

During last 10 years, the multidisciplinary research of recent geodynamical processes in the Krušné hory Mts. area was done. Data from geological and geomorphological sciences were collected together with data from direct measurements of present geodynamical processes activity.

From the point of view of Quaternary tectonic evolution, the selected data showed, that there are indications of change in the stress state in the investigated area during Quaternary. The area came gradually from Tertiary extension to a state of compression by the beginning of Quaternary. An important quantitative change occurred obviously during Mindel to Riss. This compression is oriented S – N approximately. Under such conditions, the fault inclined to such an orientation – notably the main faults of the Krušné hory Mts. or Chomutov fault – are likely to produce even a horizontal component of movements. On this fact may show also the location of several earthquakes epicentres in the ridge part of the Krušné hory Mts. This is difficult to be explained only due to presence of normal faulting along the foot of Krušné Hory Mts. slope.

EXPERIENCE WITH PRECISE LEVELLING IN THE MAIN EPICENTRAL ZONE OF WEST BOHEMIA

Jan Mrlina

*Geophysical Institute, Acad. Sci. of the Czech Republic
Bocni II 1401, 141 31 Prague 4, Czech Republic
e-mail: jan@ig.cas.cz*

ABSTRACT

Significant contribution to the study of crustal dynamics is provided by geodesy. In the last decade the classical geodetic methods (triangulation) were replaced by the revolutionary GPS system (Global Positioning System). This satellite technique of position determination eliminated time-consuming geodetic measurements and enabled to install large-scale networks even in extremely difficult conditions. The disadvantage of GPS is relatively lower precision in vertical component (height), as even many hours of recording do not provide the accuracy better than 1 centimetre. From this reason a precise levelling method has to be applied in some cases of vertical movements investigation.

Since 1994 annual campaigns of precise levelling have been performed on the network established in the surroundings of Nový Kostel. The network covers the most dynamic part of the West Bohemia seismoactive region with a total of 70 points in 1999. The maximum size of the final network area is about 5 km in N-S and 2.5 km in E-W directions. The measurements are connected to a reference point of the national levelling system and to our GPS-gravity network. It was proved by the error and confidence level of the data that small displacements of three and more millimetres can be recognised.

The data analysis showed that all points of our network could be divided into several groups according to temporal changes of height. Mutual comparison of these changes enabled to detect both general and very local short-term movements. It appeared that, in general, the involved part of the mountain block is subsiding relative to the Cheb basin. This is in contradiction to the recent uplift of the Krušné hory Mts.

The correlation between vertical displacements and earthquake swarms was examined with the conclusion that during a swarm period the movements have special homogeneous pattern, contrary to inter-periods. The division line of different displacements (a fault zone?) for the swarms 1994 and 1997 was determined. This line is sub-parallel with the epicentral axis of the main seismoactive zone in Western Bohemia (Nový Kostel – Kraslice). Long-term detailed study could contribute to the determination of local tectonic setting and define the character of vertical movements in relation to seismic activity.

Some indications can be also derived from levelling measurements on national networks in adjacent regions. Unfortunately, the frequency of the campaigns is very low and irregular. Some levelling sections have been measured only two or three times up to now.

There are areas of similar importance for precise levelling studies in the territory of the Bohemian Massif. One of them could be the active fault Hronov-Poříčí in Central Sudeten.

LATE NEOGENE TO RECENT STRUCTURAL DEVELOPMENT OF THE POLISH SEGMENT OF THE OUTER CARPATHIANS IN THE LIGHT OF STRUCTURAL AND GEOMORPHIC DATA

Witold Zuchiewicz, Antoni K. Tokarski

*Institut of Geological Sciences, Jagiellonian University
Oleandry 2A, 30-063 Cracow, Poland
e-mail: witold@ing.uj.edu.pl*

ABSTRACT

The Polish segment of the Outer Carpathians witnessed differential uplift in the Pliocene and Quaternary. The uplift in Pliocene times was probably of block-type in the western segment of the belt, that in the medial and eastern segments being restricted to subparallel and relatively narrow upwarped zones. The total size of uplift, approximated by the amount of erosional dissection of the Plio-Pleistocene planation surfaces and Quaternary straths, varied from 150 m to *ca.* 900 m, averaging at around 300 m. These figures are compatible with those inferred from seismostratigraphic studies. The uplift might have been a result of both post-orogenic isostatic rebound related to erosional unroofing, particularly intensive in the western part of the area, and of the steepening of frontal parts of some nappes due to relaxation of remnant horizontal stresses, accumulated during the Neogene thrusting. Episodes of intensified Quaternary uplift, restricted to relatively narrow zones oriented subparallel to the structural grain of the area and coinciding with frontal parts of overthrust nappes and larger slices, occurred during the Cromerian-Elsterian 1/2, Eemian-early Weichselian and Weichselian Late Glacial-Holocene times, at rates varying from 0.15 to 2.0 mm/yr. These long (100-250 km) and narrow (15-25 km) zones of localised uplift appear to be a result of the Quaternary relaxation of remnant horizontal stresses that have led to the steepening of the frontal parts of nappes and imbricated slices.

The available pieces of structural evidence imply that during the Late Neogene times structural development of the Polish segment of the Outer Carpathians was controlled by normal faulting. This interpretation is corroborated by geomorphic data indicative of *en block* uplift in the western part of the belt. However, there is no unequivocal evidence to decide whether the faulting was due to successive phases of alternating N-S and E-W extension or owing to one or more phases of multidirectional extension. Moreover, the geomorphic data from the medial and eastern parts of the belt suggest the occurrence of compressional stress regime during Pliocene times. The data available for Quaternary times show an apparent

contradiction. On one hand, different pieces of geomorphic evidence imply compressional stress arrangement, with the maximum compressive stress being oriented roughly perpendicular to the belt. This interpretation is compatible with the present-day orientation of the S_{Hmax} inferred from the breakout analysis and from focal solutions of the Krynica earthquakes. On the other hand, Quaternary normal faulting within the intramontane basins and in localised narrow zones of frontal parts of nappes and larger slices points to extensional stress arrangement. This contradiction can be explained by a concept of normal faulting restricted to the gradually steepening frontal parts of nappes and large slices, whose shortening has been induced by the Recent relaxation of remnant horizontal stresses, accumulated during the Neogene thrusting. These processes were probably not uniform, as shown by differentiated rates of erosional dissection of Quaternary straths in individual geomorphic units within different Quaternary stages. Another, although not contradictory explanation, lies in the general isostatic post-orogenic uplift, being overprinted by coeval relaxation of remnant horizontal motions within the flysch cover. Summing up, we conclude that the Quaternary stress pattern within the Polish Outer Carpathians has been differentiated depending on depth, position within the belt, and time.

TATRA MOUNTAINS - GEODYNAMIC INVESTIGATIONS

Aniela Makowska

*Institute of Geodesy and Cartography
Jasna 2/4, 00-013 Warsaw, Poland
e-mail: astro@igik.edu.pl*

ABSTRACT

Many years measurements on Tatra geodynamic research area are presented in the paper. These works are aimed to determine crustal motion and gravity field changes. Investigations mentioned here were performed in co-operation with Czech and Slovak scientific institutions, in common terrestrial and satellite measurements.

GEODYNAMICS OF THE TATRA MOUNTAINS - PRESENT STATUS AND FUTURE DEVELOPMENT OF THE PROJECT

Marcel Mojzeš¹, Kazimierz Czarnecki²

¹ *Slovak University of Technology, Department of Theoretical Geodesy
Radlinského 11, 81368 Bratislava, Slovakia
e-mail: mojzes@cvt.stuba.sk*

² *Warsaw University of Technology
Institute of Geodesy and Geodetic Astronomy
pl. Politechniki 1, 00-661 Warsaw, Poland
e-mail: kcz@gik.pw.edu.pl*

ABSTRACT

The Slovak-Polish Project was launched in 1997 as a Slovak initiative “Tatra Mountains without Borders”. Initially Project was aimed at height determination of Tatra’s peaks and local geoid (quasigeoid) examination. Soon the Project has been extended to geodynamical studies of the area. In 1998 Project area was enlarged covering also sub-Tatra region. Network of more than 20 GPS stations in the Slovak territory and 6 stations situated at the Polish-side was observed in the summer 1998. Paper presents preliminary results of geoid determination according to the gravity and GPS data. Future development of the Project will comprise both, geoid determination and studies of recent tectonic activity of the region applying geodetic methods. Besides GPS satellite yearly repeated observations, terrestrial levelling and gravity measurements will be executed. Gravity reductions will be supported by digital terrain model. Deflection of vertical along a control profile crossing Tatra-chain will be determined applying GPS and astronomical observations.

PROJECT OF GEODYNAMIC INVESTIGATIONS DEVELOPMENT IN THE SUDETEN AND ADJACENT AREAS

Stefan Cacoń¹, Stanisław Dyjor²

¹ *Department of Geodesy and Photogrammetry, Agricultural University of Wrocław
Grunwaldzka 53, 50-357 Wrocław, Poland
e-mail: cacoon@kgf.ar.wroc.pl*

² *Polish Geological Institute, Lower Silesian Branch, Wrocław
al. Jaworowa 19, 53-122 Wrocław, Poland*

ABSTRACT

The Bohemian Massif has been broken into many tectonic blocks in the latter stages of Alpine orogenesis tectonic movements. These movements are particularly strongly marked in the northern fringe of the Massif including Sudeten and the Fore-Sudetic Block. In Neogene period large fault zones have originated or have been renewed in Sudeten and the Fore-Sudetic Block: the Lusatian thrust with adjacent wisp of faults, Middle Sudeten Fault, Sudeten Border Fault together with fore-mountain tectonic rifts and the Middle Oder Fault Zone. These splits have reached deep into the earth's crust, to the Moho zone. Basaltic volcanism had been connected with these. The intensity of tectonic activity has diminished in the Quaternary and in the modern times. Present day and historical earthquakes, occurrences of thermal and mineral waters as well as clearly marked morphological edges at numerous faults indicate final stages of these movements.

Satellite, gravimetric and geodetic investigations carried out during the 90'ies in Eastern Sudeten and Fore-Sudetic Block have shown present day mobility of some geologic – tectonic structures. It refers mainly to the Paczków Tectonic Graben and Śnieżnik Massif. Results of quality geological investigations showing that tectonic movements in this region (with culmination in Neogene) have not yet ceased, have been confirmed. These facts fully justify purposefulness of widening geodynamic investigations to the whole Sudeten region as well as adjacent areas.

Within the frames of "GEOSUD II" project three new investigation profiles have been selected in Central and Western Sudeten as well as neighbouring areas located on the Fore-Sudetic Block. These profiles cut through Sudeten Marginal Fault and nearby tectonic faults parallel to it.

Periodic satellite GPS, gravimetric and geodetic observations are planned in expanded research network, organized according to verified standards. Investigations to be carried out will make it possible to determine zones of present day tectonic movements. It should be mentioned that SW Poland is very urbanized with well developed transport infrastructure. Tectonic hazards are mainly concentrated in the regions of underground and surface mineral resources exploitation and reservoir dams located in tectonically active zones.

NEW PERSPECTIVES OF INVESTIGATIONS OF PLUMB LINE VARIATIONS IN THE KSIĄŻ GEOPHYSICAL STATION

Marek Kaczorowski

*Space Research Centre, Polish Academy of Sciences
Bartycka 18A, 00-716 Warsaw, Poland
e-mail: marekk@cbk.waw.pl*

ABSTRACT

The project - "Installation of the long water tube tiltmeter in Książ Geophysical Observatory" was accepted to realisation by the Committee of Scientific Research of Poland (KBN). The works over a new tiltmeter were started in 1997.

The long water-tube tiltmeter consists of two perpendicular tubes, 81 and 92 m length. The tubes are partially filled with water. Variations of the water level at the ends of tubes are measure with very high precision near to single nanometers with use interferometric method. The pictures of the interference rings are reading by the CCD-cameras, analysing and storing on hard disc of the PC-computer. The lack of drift of the long water tube tiltmeter permits on new investigations. We can expect that collected measurements allow to considerably improving accuracy of the tidal waves parameters determination as well as investigate the secular and long period variations of the plumb line. The phenomena of present movements of the tectonic plates, movements in Sudeten formation as well as rate of erosion processes are on the list of new investigations. The applications of a new tiltmeter also contain investigations over plumb line variations, generated in ocean and produced by "global greenhouse effect". The "greenhouse effect" is reason of long period and systematic variations of the plumb line as well as modulation of tidal waves (Chojnicki, 1989, 1991 and 1991) (Kaczorowski, 1989 and 1989).

On the list of applications of a new tiltmeter there are also investigations of non-periodic effects of plumb line variations produced by atmospheric phenomena.

An additional aspect of construction of the long water tube tiltmeter is possibility of initiation comparatives works between two different kind tiltmeters.

The comparison between long water tube and horizontal pendulums will allow determination of the instrumental drift of quarc horizontal pendulums, working in Książ station since 30 years and increase scientific value of 30-years long continuous series of observations, performed at the Książ station.

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