

The 5<sup>th</sup> Czech - Polish - Slovak Workshop  
ON RECENT GEODYNAMICS  
OF THE SUDETEN AND ADJACENT AREAS

# ABSTRACTS



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# TECTONIC STRUCTURE AS A POTENTIAL THREAT FOR SAFE OPERATION OF PLANNED KAMIENIEC WATER DAM

Jan Blachowski

The Kamieniec Dam will be constructed on the Nysa Kłodzka River, in the Paczków graben close to the Sudetic Marginal Fault separating two major geological units: the Sudety Massif and the Sudetic Foreland. The graben has complicated tectonic structure characterized by a network of secondary faults dividing it into smaller units. The performed cycle of geodynamic observations indicates present-day tectonic activity of the planned reservoir area. The results of repeated precise levelling measurements show 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 influence of the dam and reservoir on the ground and tectonic faults located about 250 to 350 m on the downstream side of the dam has been modelled with Finite Element Method (FEM). The results will be the reference for future control measurements of this object and its surroundings. The registered initial state of the ground will allow for reliable interpretation of deformation measurements of the planned object in the cause-effect aspect.

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## DEFORMATION ANALYSIS OF THE UPPERMOST LITHOSPHERE LAYER IN THE SNIEZNIK MASSIF (POLISH AND CZECH SIDE BETWEEN 1993 AND 2003)

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Snieznik Massif is characterized by complicated geo-tectonic structure. Present-day movements of the lithosphere confirm mobility of this area. It has been proved on the grounds of geological, geodetic (precise levelling) and satellite (GPS) investigations. 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 conducted on the Snieznik. Levelling and gravimetric observations supplemented these investigations. In the Bear Cave in Kletno observations of relative movements of rock block with two TM-71 crack gauges are performed in a monthly cycle.

Three joint (Czech-Polish) GPS observation campaigns (1993, 1994 and 2003) and a number of GPS measurements in Polish (16 points) and Czech (11 points) networks have been performed by teams from partner institutes. The results of above-mentioned investigations, particularly the 1993-2003 cycle, are a subject of analyses and interpretations in this paper. The results of researches conducted independently by the teams on both sides of the border augment them.

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

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The Sniezka (SNIE) point is a epoch station supervised by the Department of Geodesy and Photogrammetry in Wrocław that has been used for geodynamic research connected with the EXTENDED SAGET, CERGOP and CEGRN international programs for the past 20 years. The satellite GPS observations have been performed on former triangulation network point stabilized with a block of rock. Since summer 2001 the Institute of Rock Structure and Mechanics, Academy of Sciences of the Czech Republic, Prague, started with permanent monitoring the GPS satellite signals on the stone geodetic pillar established in 1824 as a fundamental trigonometric point of the Austrian-Hungarian monarchy. For cold and winter season the GPS Ashtech antenna Choke-Ring is moved on the reinforced and fortified chimney of small building inside it the Ashtech registration equipment Z-18 is placed. During international programs GPS registrations on both Czech points SNEZ were organized simultaneously. This fact enabled to transfer geodynamic observations from the SNIE (PL) point to the SNEZ (CZ) permanent GPS observatory. The observations lasting for several days on all three GPS points were carried out concurrently for this purpose. Independent range and angle measurements with precise Leica TCA 2003 total station were performed to verify and to link GPS observations mutually. The obtained results have made the base for detailed analysis of relative positions of all three GPS points.

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## UTILIZATION OF ZENITH TOTAL DELAY (ZTD) TO ESTIMATE ELLIPSOIDAL HEIGHT

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At the beginning of 2003 year seven permanent GPS stations were established in Southern Poland. Currently three of them (KATO, KRAW, ZYWI) belong to the EUREF Permanent Network (EPN). One of the products of EUREF is time series of ZTD. Knowing a ZTD on a given GPS station one can directly obtain tropospheric delay. For the closest points the coordinates are unknown, we can interpolate ZTD and then GPS observations can be improved for tropospheric delay. We make ourselves free from strong correlation between station height and ZTD. Such approach considerable improves height estimation. In the paper the effectiveness of applied method on numerical examples is presented.

# ORIENTATIONS OF RECENT PRINCIPAL STRESS AXES IN THE JESENÍKY REGION – PRELIMINARY RESULTS

Josef Havíř

The focal mechanisms of weak tectonic events were used for the stress analysis. These weak tectonic events were detected by stations of Dlouhé Stráně local network during years 2001 and 2002 and they were located into region NW of Šumperk, region NNE of Šternberk and NW of Bruntál.

The axis of maximum compression is orientated in the direction NNW-SSE and it is probably dipping towards NNW. This orientation well corresponds with published orientations of horizontal stresses investigated using breakouts (Peška 1992) and hydrofracturing method (Staš et al. 1997) in the Czech part of the Upper Silesian Basin. The axis of maximum extension is orientated in the direction ENE-WSW.

## Reference:

Peška P. (1992): Stress indications in the Bohemian Massif: reinterpretation of borehole televiewer data. - *Studia geoph. et geod.*, 36, 307-324

Staš L., Rakowski Z., Hortvík K., Souček K. (1997): Měření primárních horizontálních napětí české části hornoslezské pánve metodou hydroporušování stěn vrtu. - *Výsledky nových studií seismologie a inženýrské geofyziky*, 248-256. Ostrava

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## THE ANALYSIS OF DISPLACEMENTS OF SELECTED TECTONIC STRUCTURES IN SUDETEN REGISTERED WITH TM71 CRACK GAUGES

Blahoslav Košťák, Stefan Cacoň

The region of Sudeten is characterized by a complex geologic-tectonic structure. A series of discontinuities of the tectonic zones in Sudeten on the Czech and Polish side along the state border-line were instrumented with TM71 crack gauges to register displacements.

In Poland:

- three points in the Sudeten marginal fault – Dobromierz and Zloty Stok;
- one point in the Central Sudeten fault – Janowice Stare;
- two points on secondary faults in Bear Cave, Kletno;

In the Czech Republic:

- eight points in the Poříčí-Hronov fault zone – table hills Ostaš and Hejda;
- two points on secondary faults in Rychlebské Hory Mts., Na Pomezí Cave, Sudeten marginal fault;
- two points on structures parallel with Sudeten fault in Rychlebské Hory Mts., Na Špičáku Cave.

Obtained results based on data registered with monthly frequency for years provide evidence about mobility in the superficial lithospheric Crust zone in Sudeten. The analysis shows also deformation effects that can be explained as reactions to deformation waves advancing slowly through Earth Crust and reaching remote regions of Europe in periods of strong earthquakes.

# EVALUATION OF EXPERIMENTAL SEISMOLOGICAL MEASUREMENT IN MORAVO-SILESIA REGION IN 1997-2003

Zdeněk Kaláb and Jaromír Knejzlik

Detailed research of mobility of tectonic zones of Moravo-Silesian region was begun in 1997 due to support of Grant Agency of the Czech Republic. The main part of grant was geodynamical measurement using GPS signals on geodetic points. Seismological monitoring and geological and structural mapping were necessary supplements of this investigation. Seismological fraction of project represents direct seismological monitoring of current local seismic activity because more intensive natural earthquakes were documented in this area in past (i.e. 1785-1786, 1931-1935, 1986, 1992-1993).

More than 10 local temporary seismic stations were operated by staff of Institute of Geonics ASCR Ostrava (hereafter UGN) during period 1997-2003. Recorded data from national seismic station of Ostrava – Krásné Pole (OKC) and local seismic stations operated by staff of Institute of the Physics of the Earth was also partly included into database of current earthquakes. Local seismic stations of UGN were situated in surface structure to obtain quick information about selected points, i.e. without construction of seismic pillars for seismometers. Therefore, artificial noise was high and trigger level must be set relatively high. Registration of these seismic stations confirms not only higher number of seismic events in this area due technical and industrial reasons as well but also current occurrence of weak natural earthquakes. Therefore, location is looking for long term monitoring in optimal seismological conditions. The location of this point must also accepted results of GPS measurement.

Experimental seismological measurement in period 1997-2003 documents the occurrence of weak natural earthquakes with local magnitude that usually don't exceed value of 0. It is evident that only shocks in the surrounding of these stations were recorded. The main source areas are wider surroundings of Opava town, eastern margin of Hrubý Jeseník Mts. (e.g. Rýžoviště), parts of Hrubý Jeseník and surrounding of Staré Město town. Due to low intensity of these shocks, often only one seismic station made records of these ones. Therefore, it is not possible to make serious seismological study of detected seismic activity. At this time we suppose that the microearthquakes occur near of the E-W and NW-SE trending faults (the most significant structural geological units in the investigated area).

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## THE ATTEMPT AT ESTIMATION OF CORRELATION BETWEEN EPN STATION VELOCITIES AND THE TECTONICS OF EUROPE

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The analysis base on the EPN station velocities (ITRF2000) estimated from time series of the station positions taken from EUREF weekly solutions. Velocities were reduced to intraplate velocities using APKIM model. On the base these data the clustering of the stations has been performed using velocity vector congruency criterion. The relation between results of classification and location of the stations with respect to main tectonic structures of Europe, focused to Sudetes has been analyzed at the last stage.

## SEISMIC STATION IN ZLATÉ HORY

Jaromír Knejzlík

In summer 2003 new seismic station in Zlaté Hory near Jeseník (North Moravia) was established. The main aim was to increase detection power of weak seismic earthquakes in this region. Sensors were located on seismic pillar about 60 m below surface in abandoned mine opening in inaccessible part of current children's medical institution (named Edel). This paper deals with description of instrumentation of this station.

Short-period SM-3 seismometers in three-component arrangement are connected to digital telemetric transmitter. Digitally coded seismic signal is transferred via telephone line (about 400 m) to the PCM3-EPC recorder. The PCM3-EPC is equipped by embedded PC and ZIP disc and/or flash disc drive. Time information is synchronized by DCF radio time normal. Seismic signals are amplified within the frequency range 0.5-30 Hz. Sampling frequency and dynamic range of AD conversion are 100 Hz and 90 dB respectively. Triggered regime of signal record is usually used, but it is possible to start continuous record for predefined time (up to 9 hours).

Checking of apparatus function, setting of trigger parameters, start of continuous record and recorded data transmission are possible to carry out using telemetry connection through GSM network.

Experimental operation of seismic station in Zlaté Hory (ZLHC) was started in August 2003. The seismic noise don't exceed value of  $5 \cdot 10^{-8} \text{ m} \cdot \text{s}^{-1}$ . Records of seismic events are in the first quality, examples of records will be also presented.

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

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Lower Silesia was broken into numerous tectonic blocks, graben and horsts during late Alpine orogeny. These movements were at its peak in the Neogene. Throughout the Quaternary till the present times this activity wakened, nevertheless their existence is still felt as local earthquakes. The major tectonic zones are connected with the Sudetic Marginal Fault. 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 points of these profiles within the "GEOSUD" project (1996–2002). The analysis of the results of these measurements shows that tectonic activity of the Sudetic Marginal Fault zone is still going on, but individual segments of this zone are marked by different character of movements.



# SPACE DISPLACEMENTS OF THE STATIONS WITHIN THE FRAME OF INDIVIDUAL PLATES BASED ON THE ITRF2000

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Global horizontal and vertical movements were computed for individual tectonic plates from the velocity vectors published for ITRF2000. For the stations within the frame of those plates the model NUVEL-1A was corrected. Residual motions with respect to the global displacements and their rms errors were then computed. Limits of the rejection of the hypothesis of global expansion / compression of the Earth are derived.

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## REMOTE CONTROL OF GPS OBSERVATORY USING SMS

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The GPS observatory works in autonomous regime. The receiver Ashtech Z18 is connected to PC, data are continuously stored on local hard disk and downloaded approximately once per two or three months to the notebook. To be able to remote check the station, a GSM phone Ericsson A1018s is connected to serial port of PC. Using Windows scheduler, a simple batch is run once per day. This batch checks if data of previous day exist and sends a SMS message with corresponding code. Problems and their solutions connected with GSM remote check are discussed in this contribution.

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## EXAMINATION OF A SMALL OBJECT DEFORMATIONS BASED ON A CLASSICAL AND SATELLITE GPS SURVEY METHODS ON THE EXAMPLE OF AN INACTIVE QUARRY IN THE KOZY VILLAGE

Krzysztof Małkowski, Mirosław Kaczałek, Jan Kapłon

The subject of the described studies concerns ground deformation measurement of an inactive sandstone quarry in the Kozy near the Bielsko-Biała. A landslide has occurred there as a result of mineral storage, threatening the nearby village. The measurements were done using classical (spatial angle – line network and precise leveling) and satellite GPS methods. The deformations obtained from separate and combined processing of the above-mentioned measurements are compared and presented.

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

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KARKONOSZE geodynamic network consist of 19 GPS points located on the area of Karkonosze Mts. and its foreland. Their locations reflect geological and tectonic structures of investigated area. Three GPS campaigns (2001, 2002 and 2003) of the local geodynamic network KARKONOSZE were done. Three year monitoring period allows to start the first interpretations. ITRF2000 velocities of the network points have been estimated and their residuals have been analyzed. Independently relative velocities of the selected baselines lengths have been computed for identification of stable and unstable areas.

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## THE FORE-SUDETIC GRABENS – HOW TO SOLVE THE PROBLEM OF THEIR ORIGIN

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The Fore-Sudetic Grabens are narrow, deep structures, limited by faults. The sediments hosted by the grabens are deposited since Oligocene till Recent. The grabens origin is an open question. This rather restricted field of researches carries enormous potential for helping the scientific community to understand the geological processes that operate in Sudetes in Tertiary and Quaternary. Till now, concerning the nature of those grabens four different models are emerging:

- 1) grabens are similar feature as the Fore-Carpathian Basin, which is a symptom created by an elastic response of the Fore-Carpathian basement against the loading, created by Carpathian overthrust. In contrary, the Fore-Sudetic basement reaction on loading was not elastic but brittle.
- 2) the Fore-Sudetic Grabens as an answer of the Fore-Sudetic basement against the push of the Sudetic Block (compression).
- 3) grabens are not the result of compression, but tension.
- 4) grabens could be the secondary phenomena formed during the strike-slip movements along the Fore-Sudetic Fault. (Wojewoda 2003).

All of these propositions mentioned above could be easy restricted, and some of them eliminated, by a careful examination of the shape of the faults, which confine the Fore-Sudetic Grabens. The solution of the problem of the origin of the grabens will be a significant step forward in understanding the tectonic processes, which operated in Tertiary and Quaternary. The key rests now in the hands of geophysicists in cooperation with geologists.



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