N O T E S

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6th Czech–Polish Workshop

ON RECENT GEODYNAMICS OF THE SUDETY MTS. AND ADJACENT AREAS

ABSTRACTS

Łężyce, Poland
November 4–6, 2004

Organizing Committee
of the

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ABSTRACTS

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TECTONIC EVOLUTION OF LOWER SILESIA, SW POLAND, IN THE LIGHT OF AN ANALYSIS OF SUB-CAINOZOIC AND SUB-QUATERNARY TOPOGRAPHY

Janusz Badura[1], Bogusław Przybylski[1] and Witold Zuchiewicz[2]

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ABSTRACT

The sub-Cainozoic and sub-Quaternary surface maps presented in this study display buried palaeotopography whose interpretation proves helpful in identification of tectonic dislocations in the area of Lower Silesia, including the Sudetes, Fore-Sudetic Block, and Fore-Sudetic Monocline. The maps have been constructed on the basis of nearly 11,500 borehole logs, vertical geoelectrical soundings, and detailed mapping of exposures of pre-Quaternary rocks. Well-bore data have been reinterpreted with a view to reconstruct the original depth to the top of the crystalline basement. Many archival borehole descriptions place the boundary between Tertiary strata and the Proterozoic-Palaeozoic substratum at the top of poorly weathered rocks, including regoliths of the crystalline substratum into the Tertiary cover. The presented maps portray for the first time the actual morphology of the sub-Cainozoic surface. A comparison between the sub-Cainozoic and sub-Quaternary surface maps enables us to document changes in tectonic mobility throughout Cainozoic times. An additional source of information is provided by thickness maps of individual time-slices of the Cainozoic. The palaeosurface cutting the Fore-Sudetic Block and Permo-Triassic rocks of the Fore-Sudetic Monocline had been shaped during a period of deep subsurface weathering before deposition of the Upper Cretaceous strata. It is probable that an etchplain-type surface originated in those times. After the retreat of the Late Cretaceous sea, erosional processes affected first the Upper Cretaceous marine deposits and later on the sub-Cretaceous surface, presently called the sub-Cainozoic surface, upon both the Fore-Sudetic Block and the Wrocław Monocline. During deposition of Tertiary strata, the boundary between these two units was poorly marked. A prolonged period of erosion lasting until the Late Oligocene and subsequent accumulation of progressively southward-increasing extent indicate a change in the stress field parametres in Lower Silesia at the turn of the Late Oligocene and Early Miocene. New tectonic structures were then formed whose boundaries do not coincide exactly with those of the Fore-Sudetic Block and Fore-Sudetic Monocline. The onset of a new tectonic regime was marked by the formation of intramontane troughs, rejuvenation of the Sudetic Marginal Fault, and incipient volcanism. A

newly formed stress field led to the formation of the uplifted Sudetes block, Fore-Sudetic belt of depressions with the Roztoka, Mokrzeszów, and Paczków Grabens, the Kędzierzyn Graben, a belt of uplifts associated with the western continuation of the Metacarpathian Swell and, in the north, a zone of subsidence. Such a stress field persisted until the end of the Middle Miocene. The Late Miocene reorientation of the stress field led to the retreat of the Paratethys sea from the western part of the Carpathian Foredeep. Intensified subsidence in the present-day Odra River valley area and migration of its axis towards the SE resulted in the disruption of the Metacarpathian Swell near Grodków. It is likely that a similar stress field has largely been maintained until recent times.

HYPOTHESIS OF EARTH'S SPREADING IN THE LIGHT OF SPACE GEODESY RESULTS

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ABSTRACT

Hypothesy of the Earth's spreading is shortly summarized. Quantification based on the theory is provided and compared with recent results of space geodesy methods. These results leads to the turn-down of the above mentioned hypothesis with high statistical probability.

„EASTERN SILESIAN" GEODYNAMIC GPS NETWORK – PRELIMINARY RESULTS OF THE CAMPAIGN 2003–2004

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ABSTRACT

Geodynamic GPS network has been established in the area limited by four permanent GPS stations – KRAW (Kraków), ZYWI (Żywiec), KATO (Katowice), LELO (Lelów). It is an extension of geodynamical network of the vicinity of Krakow into Eastern Part of Silesian Coal Basin. One of the basic problems occurring in this area which is subject to particularly significant deformations resulting from intensitive mining is the current modernization of its geodetical frames. Present state of the Geodynamic GPS network linked to the above nearest permanent GPS stations, POLREF system and levelling network GIGANT are presented. Proposals of inspection method of classical levelling network in mine area by means of GPS measurement are also given. Special attention has been paid to the method of ground deformation monitoring in mine areas.
The research has been supported by the grant No. 5T12 023 23 of State Committee for Scientific Research.

DYNAMICS OF SLOW MOVEMENTS IN CAVES, RELATED TO DEEP-SEATED LANDSLIDES, RAČA UNIT, MAGURA NAPPES, OUTER WESTERN CARPATHIANS

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ABSTRACT

Flysch mountain areas in the eastern part of the Czech Republic are due to specific bedrock properties affected often by deep-seated slope movements. Caves of cleft or scree origin have developed in close relation to deep seated-slope failures. The caves could indicate current dynamics of the slope movements. We aimed our attention to the Vlčí Díra cave at the Vaculov – Sedlo slope failure, the Naděje and Slimrovka caves at the Kopce slope failure, the Zbojnická cave at the Křížový Vrch slope failure, and the Pokladnice cave at the Kobylská slope failure. All of the localities are situated in the Raca Unit (Magura Nappe Group) of the Outer Western Carpathians (E Moravia, Czech Republic). For displacement measurement, we used a rod dilatometer "Hölle" of the length 70 cm. Dilatometric rivets were fixed directly into the cave-walls. Readings were provided each month since December 2001 till September 2004, approximately in the second third of the month. Air temperature at place of the dilatometric readings was measured; all of the readings were corrected for temperature-volume changes of the tool. We tried to compare the readings with the precipitations and air temperature, to speculate on the whole failure dynamics and the main external factors. The meteorological data were obtained from the Vsetín observatory located in between all of the localities.
We have analyzed 5-, 10-, 15-, 20-, 25-, 30-, 35-, 40-, 45-, 50-, 55-, 60-, 70-, 80-, 90- and 100-days sums of precipitation and 5-, 10-, 15-, 20-, 25-, 30-, 35-, 40-, 45-, 50-, 55-, 60-days mean-day-temperature averages as the main factors by using of MS Excel statistical tools. Although, the results were not significant from mathematical point of view, a coefficient of correlation was compared for each dilatometric distance and for all of the studied meteo-factors.

Preliminary results show that just a pseudo-karst cave presence shouldn't unconditionally indicate the current slope movement. Some readings represent the seasonal temperature-volume changes. Only the readings at the Vlčí Díra and Zbojnická caves represent significant slope movement.
The influence of precipitation and temperature on the rock-blocks behaviour differed at all of the measured distances in relation to blocks volume and depth below the ground surface.
The movement has a different character, e.g., spreading, boulder subsidence, shear (both horizontal and vertical) or rotation and toppling. Changes of the sedimentary structures orientation (e.g. bedding, current marks), measured on the cave walls, have helped to decode the resulting deformation character.

APPLICATION OF GEOPHYSICAL METHODS IN THE STUDY OF LANDSLIDE MOVEMENTS, TAKING INTO ACCOUNT GEOLOGICAL CONDITIONS IN THE SUDETY MOUNTAINS

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ABSTRACT

Geophysical department of G IMPULS Praha systematically deals with the issues of landslide movements and possibilities of their detection by geophysical methods. In this paper we want to call attention to certain possibilities that might be exploited also in systematic investigation (including the monitoring) of landslide movements in the Sudety Mountains and adjacent areas.
a) For the first time on the banks of a half-built Nechranice dam site (Bárta 1964) and later also in other locations it was demonstrated by field measurement that reviving landslides are manifested by increased moisture content which is particularly typical of sliding surface area (root areas). Water movement down the slope causes an increase in electric filtration potentials (special type of spontaneous polarization). By systematic monitoring of electric potentials, locations vulnerable to landslides can be detected and development of such areas predicted.
b) In eliminating consequences of disastrous floods (particularly in Moravia, 1997), field measurements demonstrated relation between the state of stress of rock environment and magnitude of seismic waves propagation (particularly Bystřička, Mikulůvka, Halenkovice and Soláň locations in northern Moravia). A surface layer which was affected by landslide movement or which is vulnerable to such movement, can be very well detected by seismic investigation. As relatively sharp there appear reflection planes that are of quasicylindrical shape and most probably represent fossil slip planes. In crack areas (zones of separation), velocity (stress) changes can be observed, and their activation and stilling can be monitored.

c) In the areas of stress changes there occurs a decrease or on the other hand an increase in density of rock environment. These changes that are characteristic of landslide areas, are detectable by means of precise gravity measurement (for example, Beneš, Bystřička location). Besides landslide movements, also last traces of liquidation of old mining pits and shafts (for example, Beneš, Příbram location) can be monitored, or backfilling performed in remediation of affected terrains, etc. can be inspected.
d) Relatively limited in studying landslides is the application of geological radar (GPR). In preparing a project of GPR application it is important to take into account that landslide areas are largely characterized by lower values of resistivity. This results in lower penetration depth of GPR measurement (an optimum is 5 metres). Also manipulation of an antenna system in a complicated terrain affected by landslide is demanding, not always guaranteeing good reproducibility of data.
e) Very good experience was gained in application of resistivity tomography (multielectrode system of measurement). At Bystřička location (Bárta 2003, 2004), a large landslide area was monitored. Resistivity cross-sections allow us to demonstrate that landslides at the point of measurement are located at a sharp boundary between a sandstone and a clayey block and that it will be possible to study long-term changes in the area of interest.
The findings hinted in the abstract above are documented by Figures in the paper. The authors are prepared to discuss any queries at an e-mail address (see above).

PROJECT OF TECTONIC MOVEMENT OBSERVATIONS IN THE FORMER MINING REGION OF WAŁBRZYCH

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ABSTRACT

The many years of underground coal mining carried out, in difficult deposit conditions, in the Wałbrzych area disturbed its geological and tectonic structure and caused ground settlement both during and after the exploitation was stopped. Occurrences of mining damages are still being observed on the surface today. Threats to the city's infrastructure, buildings and public safety associated with closures of mines gave the inspiration to start an interdisciplinary research project. Its practical aims concern developing new methods of surface deformation moni-

toring after mining activity was stopped. The scientific aspects of the project relate to the assessment of present-day ground movements in the Wałbrzych region and adjacent areas, which have been caused by disturbance of the natural ground stability, change of groundwater conditions in a result of mining works and tectonic activity of the Sudety Mts. and the Fore-Sudetic Block.
In the paper one of the main project tasks – setting up of research network for satellite GPS measurements – is presented. Its plans take into consideration: location of precise levelling lines, correlation of research stations with main geologic and tectonic units as well as former mining areas. Connection of the proposed network with the present regional geodynamic network "GEOSUD" including satellite network points located on the Dobromierz and Dzierzoniów profiles set-up across the Sudetic Marginal Fault and other faults is also planned.

Key words: geodynamic observations, deformations from former mining activity

DATA PROCESSING OF LOCAL GPS NETWORK LOCATED IN MOUNTAINS AREA

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ABSTRACT

Precise position determination of network points, particularly their vertical component is especially difficult in mountainous areas. Significant altitude differences and spatial variations of atmospheric conditions require the best possible approach to tropospheric delay (TZD) estimation expressed by maximum reduction of systematic error caused by tropospheric refraction. The study of influence of tropospheric refraction onto GPS measurements was performed on the example of two local networks: ŚNIEŻNIK and KARKONOSZE.

RESULTS OF PERIODIC MEASUREMENTS OF NATIONAL PRECISE LEVELLING NETWORK (I AND II CLASS) AS A BASE FOR VERTICAL CRUSTAL MOVEMENTS INVESTIGATION OF LOWER SILESIA REGION

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ABSTRACT

According to geological researches, satellite GPS and gravimetrical measurements Sudety Mts. and Fore-Sudetic Block is tectonically unstable region. Observations made in 50's, 70's, 90's years of last century (1st and 2nd order of Polish national leveling lines) were used to detect vertical changes in fault's areas.
Only precise leveling lines situated across the main faults zones (Sudetic Marginal Fault and Mid-Sudetic Fault) were chosen to analyses. Within the scope of this paper authors try to prove vertical changes on Sudetic Marginal Fault and Mid-Sudetic Fault caused by tectonic activity.

INVESTIGATION OF ROCK BLOCKS DISPLACEMENTS OF UPPER EDGE OF "SZCZELINIEC WIELKI" MASSIF

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[2)] *Institute of Rock Structures and Mechanics, Czech Academy of Science Prague, Czech Republic, e-mail: kostak@irsm.cas.cz*ABSTRACT

Researches of rocky block mass movements in Szczeliniec Wielki have been started in 1972, when local geodetic network was established (in front of shelter-house). Similar observations are being made in the "Piekiełko" rift. These measurements are made with different frequency – the last were made in September 2004. Except local geodetic networks, three crack gauges (TM-71) were established in the survey area – 1974 in front of shelter-house, 1979 in "Piekiełko", 1998 – near "Stare Schody". Results of series of repeated geodetic measurements and TM-71 observations acknowledge rocky block mass movements in survey

area. Interpretation of results indicate tectonic instability of the Szczeliniec Wielki Massif and paleoseismic character of changes in upper part of Szczeliniec Wielki.

GEODYNAMICAL STUDIES OF THE PIENINY KLIPPEN BELT – CZORSZTYN REGION (2001–2003)

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ABSTRACT

The Test-field of the Pieniny Klippen Belt (PKB) is situated in Southern Poland close to the Polish/Slovak border. The Klippen Belt is a tectonic formation separating the outer from the inner Carpathians. The Polish part of the Klippen Belt forms a mountains group called the Pieniny Mountains. Geodynamical studies of the area were performed continuously from early sixties until 1995. Diversified vertical motion (on the level of some mm/year) and horizontal displacements (reaching 10 mm/year) were proved. Construction of the dam on Dunajec-river and creation of the artificial lake may contribute significantly recent crustal activity of the area. New project sponsored by the State Polish Research Committee was launched in the autumn 2000.

In the period of 2001–2003 geodynamic studies of the Pieniny klippen belt have been resumed. Geodetic methods (terrestrial and satellite) and geophysical methods (gravimetric, seismic sounding, electric resistance profiling) have been applied. The results were compared with those obtained earlier in the years 1970––1980–1995 in the same region by the Institutes of the Warsaw University of Technology. The aim of new project was to find how the construction of the dam on Dunajec-river and creation of the artificial lake have influenced recent activity of the region. Results of precise leveling and trigonometric leveling have proved significant (6–7 mm) vertical depression of the PKB relating adjacent tectonic units: Magura nape (in North) and Podhale flish (in South). Horizontal movements between the control points monitored by laser-distance and satellite GPS measurements have demonstrated shortening at the northern contact of the PKB and differentiated extension trend at the southern contact. The character of the motion corresponds with changes in the seismic wave velocities: increasing in the region of the northern contact and decreasing in the southern contact comparing with those of 1988. Such a behavior can be explained by the increase and decrease of the stresses in the basement resulting probably from the water loading of the artificial lake. Gravimetric measurements have shown inessential increase of gravity in the region of the PKB. The results of geodynamic studies have proved recent activity of the area considerable enough to take it into account in the process of forecasting safety of the dam in Niedzica and the Czorsztyn Lake. For the same reason the studies should be repeated no later then after five years.

GPS PERMANENT STATION KRAW – FIRST SCIENTIFIC RESULTS

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ABSTRACT

The GPS permanent station KRAW is located on the building of Faculty of Mining Surveying and Environmental Engineering (AGH-UST). The station KRAW was included in EUREF Permanent Network (EPN) at the end of January 2003. The station KRAW is also included in Polish Active Geodetic Network (ASG-PL). Moreover station KRAW participates in the following projects:

- EUREF-IP
- Troposphere Parameter Estimation (NRT observations)
- ASG-PL RTK (VRS).

The results of researches in the range of increasing accuracy, reliability, and efficiency of positioning with the help of GPS measurements from station KRAW are presented. The research has been supported by the AGH-UST in frame of project No. 11.11.150.478.

CONTRIBUTION OF GPS PERMANENT STATIONS IN CENTRAL EUROPE TO REGIONAL GEO-KINEMATICAL INVESTIGATIONS

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ABSTRACT

Central Europe is recently covered by hundreds of GPS permanent stations of scientific, operational or commercial character. The regular systematic processing of network of selected permanent stations allows monitoring their short-term and long-term kinematics. Besides, the permanent stations serve as reference for epoch-

wise GPS observing campaigns within regional and local geodynamical projects. At the Slovak University of Technology in Bratislava is continuously processed network of more than 35 stations situated in Central Europe. The analysis of two-years interval of daily station coordinates enables evaluation of their short-term stability, coordinate repeatability, seasonal variations and detecting potential irregular station behaviour. We attempt to separate the geodynamically induced signals from observation and instrumental influence. The quality of stations is evaluated and recommendations for choice of reference sites for local investigations are proposed.

SPACE-TIME DISTRIBUTION OF EARTHQUAKE SWARMS AND SOURCE MECHANISMS IN THE WESTERN PART OF THE BOHEMIAN MASSIF

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ABSTRACT

The NW Bohemia/Vogtland region situated at the western part of the Bohemian Massif is characteristic in a frequent reoccurrence of earthquake and micro-earthquake swarms. We present a comprehensive pattern of the space and time distribution of seismic energy release in the region in question, particularly in the main focal zone Novy Kostel (NK), for the period 1991 to 2003 and for the intensive 1985/86 swarm. Most of the seismic energy in the NK zone was released during the two intensive 1985/86 and 2000 swarms and in the course of the weaker January 1997 swarm, further 27 swarm-like sequences (micro-swarms) were identified and discriminated from solitary micro-earthquakes (background activity). The earthquake locations revealed a pronounced planar character of the NK focal zone. Most of the events, including those of the intensive 1985/86 and 2000 swarms, were located at the main focal plane (MFP) striking 169° N and dipping 80° westward at depths between 6 and 11 km. The space distribution patterns of larger events and of micro-swarms at the MFP differ: larger events predominantly grouped in two-dimensional clusters while the micro-swarms lined up along two parallel seismogenic lines. The geometry of the MFP and plunge of the seismogenic lines corresponds quite well to the focal mechanisms of the largest events of the 1985/86 and 2000 swarms. The temporal behaviour was examined from two aspects: (a) migration and (b) recurrence of the seismic activity. It was found that (a) the seismic activity in the time span 1991–2003 migrated in an area of about 12 × 4 km and (b) several segments of the MFP were liable to reactivation. Most of the source mechanisms show the N–S left-lateral movements with a subsidence of the western block southwards.

CRUST DEFORMATION MONITORING IN THE POLISH PART OF SNIEZNIK MASSIF – NEXT RESULTS

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ABSTRACT

Śnieżnik Massif is characterized by complicated geological and tectonic structure. Geodynamical network "Śnieżnik" was founded in 1992 as a local network for monitoring of Śnieżnik Kłodzki Massif crust deformation (27 points on Polish and Czech part). Neotectonic activity of this area is confirmed both by results of repeated satellite (GPS), gravimetric and some other field measurements. Results of researches from the period of 2003–2004 in Polish part of the network in the comparison of changes that had been determined previously are presented in this paper. Statistical analysis of the received dates allowed to determine four major tectonic blocks in the investigated region. Authors try to confirm trends of this area mobility.

YEARLY SERIES OF PLUMB LINE VARIATIONS FROM WATER TUBE TILTMETER. PROBLEM WITH PHASES IN QUARTZ TILTMETERS. NON-TIDAL EFFECTS OF PLUMB LINE VARIATIONS

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ABSTRACT

We collect first yearly series of plumb line variations obtained on the base of long water tube tiltmeter. This new instrument there is in the Ksiaz geophysical observatory in Southwestern Poland. In the paper results of tidal adjustments of yearly series of plumb line variations were contained. We notice significant discrepancy between phases obtained from adjustment long water tube observations and adjustment of observations obtained from quartz horizontal pendulums. The phases

of some strong tidal waves from quartz horizontal pendulums in many years long tidal series are positive. This results are very systematic. In case of results of adjustment of observations from long water tube we obtained negative phases for main tidal waves. We find the reason of phases discrepancies in wrong evaluation of the influence of pendulums azimuth variations on plumb line variations. Interesting feature of long water tube was noticed during very strong earthquake (8.4 magnitude) which took place 25 September 2003 near to Japan coast. At this moment instrument observed about two hours long anomaly of plumb line variations of the order of 10 milliseconds. This strong earthquake produced three oscillations of the Earth. Most of geophysical instruments like seismographs, gravimeters, clinometers etc. are insert in phase of resonance which ends observations. In case of the long water tube resonance effect was not occurred. It made possible to register all the progress of earthquake phenomenon.

NOTES TO IDENTIFICATION OF CURRENT WEAK EARTHQUAKES IN THE EAST SUDETEN

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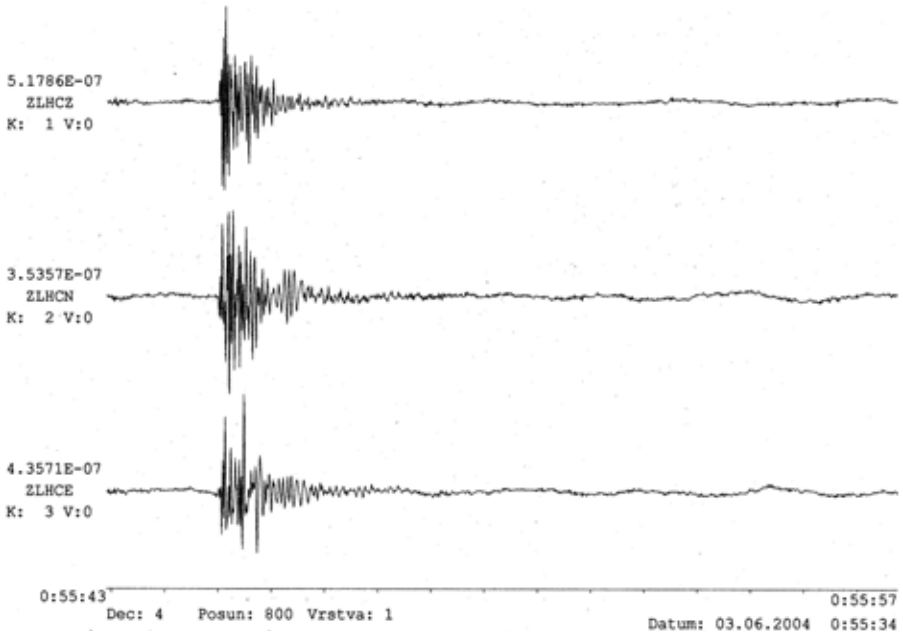
ABSTRACT

Three permanent solitaire seismic stations were built in the East Sudeten by the Institute of Geonics, Ostrava. One of these stations has seismometers placed in cellar (castle Radun near Opava); second one in inspection gallery (dam Slezska Harta) and third one in Blue Gallery of abandoned mine Zlate Hory (children sanatorium).
The sensitivity and the triggering parameters of the used equipment determined the amount of recorded events (data are collected using GSM modem). The lowest practically considered magnitudes of earthquakes are about 1.0 for the region under investigation. Many false events of technical seismic events and other vibrations are recorded, too. The best seismological conditions are at Zlate Hory seismic station, therefore, the majority of interpreted seismic records is from this station data set. During 2004 weak natural earthquakes near Zlate Hory were recorded (for example see figure). All local earthquakes were recorded at one station only.



Record of weak natural earthquake originated near Zlate Hory seismic station

MONITORING OF DISPLACEMENTS IN TECTONIC FAULT ZONES. "DOBROMIERZ" AND „JANOWICE WIELKIE" MICRO NETWORKS

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ABSTRACT

Geodynamic networks "Dobromierz" and "Janowice" were established in 2000 and 2001. Geodynamic researches there are based on repeated observations in local geodetic networks and relative observations with TM-71 crack gauges.
Researches mentioned above are connected to regional geodynamic network "GEOSUD" with GPS observations. Geodetic networks are measured with Leica TCA 2003 total station and Ni 007 precise level. Except periodic geodetic observations, the gravitational acceleration changes are measured with LaCoste&Romberg gravimeter.

ANALYSIS OF THE RESULTS OF MICRO TECTONIC MOVEMENTS MONITORING USING TM-71 IN POLISH SUDETES

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[2)] *Institute of Rock Structures and Mechanics, Czech Academy of Science Prague, Czech Republic, e-mails: kostak@irsm.cas.cz, stemberk@irsm.cas.cz*ABSTRACT

Since 70'ties of XX Century at least 10 crack-gauges TM-71, constructed by Košťák, were installed on the Polish side of Sudetes for micro-movement monitoring. Some first of its were established for rock block displacement monitoring (Szczeliniec Wielki Massif in Table Mts.), next were installed for micro tectonic movement detection (Bear Cave near Stronie Slaskie, Dobromierz, Zloty Stok, Janowice Wielkie). TM-71 data time series have been put to the analyses including:

- Linear trend analysis using Least Squares method and M-estimation (robust method);
- Frequency component analysis using discrete Fast Fourier Transform;
- Temperature dependency analysis with the help of correlation coefficient estimation;
- Episodic movement detection and analysis of correlation with earthquake occurrence.

Results of the presented analyses show that several years long time series of observations enable estimation of linear trends but estimation of periodicity requires longer (more then 15 years) time series without many gaps in data. One year periodicity is dominant due to temperature dependence. Also longer periods are detectable (e.g. ca 12 years). Very slow relative movements (below 0.1 mm/y) are detectable at the most sites in Sudetes. One site (Dobromierz) results show horizontal movements above 2 mm/y. Probable echoes of the earthquakes are also detectable in the time series of TM-71 data.

FUNDAMENTAL GEODYNAMICAL NETWORK OF THE CZECH REPUBLIC – PRESENT STATUS

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ABSTRACT

Czech Republic consists 32 stations regularly distributed over whole territory of the CR with respect to the main geotectonic structures. Five categories of monumentation is used to make possible GPS, precise levelling and gravimetric observations on the every observing site. Results of four observing campaigns (1995–1999) are presented. Critical insight to this results leads managers to provide modernisation at present and future time.

PERMANENT GPS OBSERVATORIES FOR MONITORING OF GEODYNAMIC MOTIONS IN THE BOHEMIAN MASSIF OPERATED BY IRSM AS CR

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ABSTRACT

Since 2001 within activities of the National Centre of Earth Dynamic Research five permanent GPS observatories have been established to the purpose of geodynamic studies of the Bohemian Massif. Their positions in the Massif were set up with respect to its geological structures and the existence of already operated GPS observatories. They were situated at the following sites:

a) SNEC – on the highest point of the Czech Republic, at a top of the Sněžka Mt.,
b) BISK – on a stone watchtower at the Biskupská kupa hill near Zlaté Hory town,
c) MARI – on the chimney of building in Mariánská near Jáchymov town located at the eastward wing of the seismoactive Mariánské Lázně tectonic zone,
d) POST – at a roof of panel house in Poustka near Františkovy Lázně town situated at the opposite westward wing of the same tectonic zone, and
e) VACO – at a roof of panel house in Vacov near Vimperk town (district Prachatice).

The observatories MARI and POST are closed to the German GPS observatories Grünbach (GRNB) and Neustadt (NEUS). The observatory VACO is located on an opposite side of the shear zones of the "Bavarian Pfahl" with respect to the EPN German observatory Wettzell (WTRZ). All observatories are equipped with Z-18 Ashtech receivers and precise choke-ring Ashtech antennas, that allow both NAVSTAR and GLONASS satellite signals to be monitored. The remote control of these observatories, the GPS data transmission from observatories to IRSM server and daily data storage are presented.

THE METHODOLOGY OF GRAVIMETRIC SURVEY IN TRACING GEODYNAMIC PROCESSES IN TIME IN SELECTED EXAMPLES

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ABSTRACT

Geodetic methods are these that are used most frequently to trace geodynamics processes; however, geophysical methods are also applied in this kind of research works. The phenomena that take place during these processes are related to the displacement of rock masses as well as changes in density of lithosphere, which allows for using gravimetric method.

Gravimetric method is currently used on many geodynamic traverses all over the world, also in Poland. The Institute of Geophysics of the University of Science and Technology has been also involved in investigating this issue.

The authors are currently carrying out research works within the framework of KBN 5 T12E 031 25 researches carried out on two geodynamics traverses – in the area of the Polish segment of Western Outer Carpathian Mountains and in the area of "Dębina" salt dome. The works carried out on the Carpathian traverse serve to trace natural processes i.e. contemporary tectonic activity of the Carpathian Range. The changes of gravity in the area of "Dębina" salt dome are connected with the dynamic processes induced by human activity.

In the area of the Polish segment of the Outer Carpathian two measurement profiles, meridian oriented, have been determined: 1. Orawska Valley, 2. Dunajec Fissure Valley

Profile 1 which cuts through the contact between Inner and Outer Carpathian, shows contrast tendencies characteristic of young tectonic movements. The profile no 2 cuts through these fragments of Polish Outer Carpathian that was most uplifted in Quaternary.

Measurement points have been stabilized on profiles every five kilometres. These points used in gravimetric researches and GPS have been specially constructed. Each point was driven below the freezing zone and, if possible, fixed in the rock base.

Over "Dębina" salt dome two profiles, oriented N–S and W–E, have been determined with the use of points of the KWB Bełchatów local geodetic network and selected geodetic points. "Dębina" salt dome separates Bełchatów deposit from Szczerców deposit. Currently, the exploitation on the Bełchatów field approaches the salt dome limits and at the same time the construction of the new Szczerców strip mine has been started, which influences the dynamics of the phenomena occurring in the salt dome.

In order to ensure high accuracy of gravimetric observation, the measurement is carried out using the double chain method with several gravimeters. In this method, observations are performed twice in each outer point of chain and thrice in internal point. Such method of survey allows for calculating changes in gravity between the points on the basis of the increase between them measured three times, which in turn considerably enhances accuracy of these points determination. Therefore, applying this method, great precision can be obtained in determining the values of differences in gravity between measurement points without the necessity to adjust measurement network (additional error resulting from adjustment is thus eliminated). The analysis of changes in gravity in time will be performed based on the differences calculated as described above.

The results of the first measurements series will be used for gravity modelling performed on the basis of the known geological structure of the analysed area. This will allow defining the connection between the determined anomalies of the gravity in Bouguer reduction and geological structure. When combined with the distribution of changes in gravity in time, it will also allow locating the sources of the geodynamic processes.

STRONG GROUND MOTION MONITORING NETWORK IN THE LEGNICA–GŁOGÓW COOPER MINING DISTRICT

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ABSTRACT

Some of mining areas are characterized by occurrence of mining tremors caused by exploration. Vibration caused by mining tremors may be dangerous for people and surface structures. We can observe this in The Legnica–Głogów Cooper District. Strong ground motion generated by mining activity should be controlled especially in the highly urbanized areas exposed to high seismic hazard.

The monitoring network in the Legnica–Głogów Cooper District was initiated by connection to the SEJS-NET system two measuring station in 2001. At present there is dozen of measuring station belongs to the network, which controls vibration level of ground and buildings localized in the mining areas and nearby its boundary.
Monitoring network is using Internet technologies to data collection and distribution. Authorized users reach access to the system using web browsers, palmtops and cellular phones. It gives possibility to work together independent group of interest.

RECOGNIZE OF THE BOJSZOWSKI FAULT ZONE USING HIGH-RESOLUTION SEISMIC DATA

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ABSTRACT

High-resolution seismic is the method which can be used with success to recognize complicated tectonic and geological formation on coal mining areas. This method is as with quick so with relatively cheap and it lets to explore large areas. Seismic sections obtained in such way correlated with borehole data give completely information about geotectonic situation.
High-resolution seismic investigations were provided on the area of "Piast" coal mine (Upper Silesia Coal Basin, Poland). Investigations were designed to observe course of the bojszowski fault, to verify if this fault cuts carboniferous roof and transmits water from tertiary layers.
Interpretation showed three another faults besides the bojszowski fault, secondary to main the bojszowski fault. FAPS system used during interpretation of high-resolution seismic data allowed to precise describes of the bojszowski fault and secondary faults.

THE RELATIVE MOVEMENTS OF THE TATRA MOUNTAINS DETERMINED FROM GPS OBSERVATIONS

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ABSTRACT

The six years GPS repeated observations in the Tatra Mountains were used for determinations of relative velocity vectors related to permanent GPS stations GRAZ, GOPE, BOR1, JOZE and PENC. For processing GPS data and determination of relative velocity vectors was used standard linear model. The horizontal relative velocity vectors are significant different in West Tatra Mountains and East Tatra Mountains. Detailed information on GPS measurement, processing GPS data and discussion about results will be given in presentation.

TECTONICS OF THE AREA STARÉ MĚSTO POD SNĚŽNÍKEM – BRANNÁ – HANUŠOVICE, NORTHERN MORAVIA

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ABSTRACT

The Ramzová tectonic zone (RTZ), in the area of Staré Město pod Sněžníkem – Branná – Hanušovice, is an important geological discontinuity in the NE part of the Bohemian Massif. Along this tectonic zone, two large geological units – Lugicum and Silesicum (or the West Sudetic and East Sudetic Systems) ajoin. According to Cymerman (1997), the Ramzová "overthrust" is a dextral strike-slip and it represents a border of two terrains. Also Aleksandrowski and Mazur (2002) proposed that the Ramzová zone represents a border of two terrains: the Moravian and Brunovistulicum terrains. The Moravian terrain incorporates both the Velké Vrbno Dome and the Branná Group and it is positioned between the Moldanubian and Brunovistulicum terrains. Opletal and Pecina (2004) brouht evidence that RTZ is steeply dipping to the west and has a character of sinistral shear zone with predominant horizontal movement. It is trending NNE–SSW for a distance of 55 km on the territory of the ČR, while the whole lenght known at present is about 90 km. The RTZ is ca. 50 m wide and represents a zone of an intensive cataclastic deformation. The RTZ has been active for a long time – since the Variscan orogeny till

present. As the tectonic zone functions as a significant infiltration and collector structure, it is important for hydrogeology.
In the southern part of the area, the RTZ represents the boundary between the Branná Group (BG) and the Staré Město Group (SMG). In the northern part of the area, the Velké Vrbno Group (VVG) is positioned between the BG and SMG . The western flank of the Velké Vrbno Group (or Dome) is limited by the Nýznerov fracture zone and on east side it is bound by the RTZ. According to Květoň (1951) and Skácel (e. g. 1977, 1979, 1989; also Schulmann and Gayer 2000) it belongs to the East Sudetic System or Silesicum. Kröner et al. (2002) have proposed, that VVG belongs to the „transition zone" between the Lugicum and Silesicum, together with the Staré Město Group. Skácel (1979, 1989 a.o.) interpreted the VVG as belonging to the East Sudetic System or Silesicum. Aleksandrowski and Mazur (2002) considered the Velké Vrbno Dome as belonging to the Moravian terrain.
In the western part of the area of interest, the core of the Orlice–Snieznik Unit (OSU) occurs. It represents the easternmost part of Lugicum. The core is composed of orthogneisses and further east by mica schists of the Stronie Formation and the Staré Město Group. Opletal ed. (1999), Pecina ed. (1999), Opletal and Pecina (2000), Aichler et al. (2002) and Opletal (2003) determined 6 nappe slices in the SMG, which are separated by longitudinal overthrust faults. These faults are trending generally NNE–SSW and they are characterized by tecton contacts with alternation of rock-types, by boudinage, ultramylonitization and locally by bodies of ultrabasic rocks.
The allochthonous units include the following:
1. orthogneisses of the core of the OSU, 2. mica schists of the Stronie Formation; units 3. to 7. are parts of the SMG: 3. (gabro-) amphibolites, 4. tonalites with pearl gneiss and migmatitic gneisses, 5. amphibolites with intercalations of acid metavolcanites, 6. mica schists to gneisses. According to mapping (partly in Opletal et al. 1996), the lovermost unit (7.) is represented by Brousek quartzite.
The new mapping shows that the VVG is positioned structurally below the SMG and it consists of a complicated set of tectonic slices. The rocks of the VVG are corresponding to rocks of the Stronie Group, Staré Město Group and probably the Nové Město Group. Petrographically, the rocks include variable gneisses, mica shists, phyllites, graphitic phyllites to mica shist, amphibolites, acid volcanites, orthogneisses and crystalline limestone to dolomitic limestone. All these rocks belong to the Lugicum. Several thrust zones bounding of the slices are marked by lenses of serpentinites, Brousek quartzite or crystalline limestone to dolomitic limestone. In the western part of the VVG, the tectonic border strikes generally N–S. In the southern part, the nappe borders were rotated up to the W–E directions and in the eastern part to the NE–SW direction. That is why the VVG appears in maps as a dome-like structure.
In the eastermost part of the studied area, there is the Branná Group (BG). The upper part of BG is usually correlated with Devonian and the lower part with the Upper Proterozoic. According to Cháb et al. (1994), the BG represents a set of

tectonic slices positioned on top of the Keprník nappe. Single slices are in places completely missing, while others are very thick. The Branná Group has 3 sections:
1. The lower section is composed of biotite schists to gneisses with intercalations of crystaline limestones and calcareous gneisses. Some rocks contain macroscopically visible staurolite and andalusite. NW of Hanušovice, there are small bodies and dykes of fine-grained biotite granodiorite. 2. The middle section is mainly mica schist to calcareous shist, very often with thin interlayers of limestone. 3. At the base of the upper section there are quartzites with interbeds of metaconglomerates. There is a tectonic discontinuity between quartzites and the underlying rocks. Structurally above quartzites follow mainly phyllites with interbeds of crystalline limestones.
In the studied area are numerous transversal faults. They are trending mainly NW–SE to W–E. The most important is the Pleče fault with a horizontal displacement of between 2 and 4 km.

PROBLEMS IN CREATION OF MESOCLIMATIC MAPS FOR VERTICALLY BROKEN REGIONS

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ABSTRACT

Contemporary landscape is a result of long-term mutual action effects of many natural as well as subjective influencing factors. However, while mankind and society traces are more distinctive from the beginning of industrial revolution, exogenous and endogenous forces are influencing from the very beginning of the Earth's geological progress untill today. The landscape does have a large internal memory which makes it possible to deduce backwards the conditions of its successive formation on grounds of many internal components, f.e. composition and stratification of soil horizons, petrographic composition, location of biological material etc. This fact is very important especially for studies of climatic evolution. Its parameters can be exactly described on grounds of instrumental measurements roughly 200 years backwards. For earlier periods the inscriptions in various literary sources (f.e. in urban chronicles) may be interpreted, but often only decriptions of states of crisis in connection with some extraordinary climatic event are found there Climatic conditions in geological past times then may be interpreted only on grounds of indirect indications (f.e. when in contemporary conditions of mild climactic zone the geotopography formations are found which were modelled by periglacial phenomena in cold periods, or on the other hand by thermo-karst geomorphological processes in warm periods). But descriptions of climatic

situations in such periods are not very reliable and mostly impossible on grounds of the indirect indications. Climate (macroclimate) is usually defined as long-term weather regime conditioned by energetical budget, by total atmospheric circulation, by character of the active surface, and by human interventions. Morphometric parameters of the terrain topography therefore does not belong to fundamental direct clima determining factors because of the substantial disproportion between its dimensions and dimensions of macroclimatic processes. Only the absolute height above sea level is more distinctly influencing the macroclimatic regionalisation, because most meteorological elements are height dependent. Creation of maps of macroclimatic specialisation is therefore fundamentally not problematic.

Terrain forms of large dimensions are more or less reflecting the actual location of the region in specified macroclimatic zone. In its limits the probability of any radical change is small in reasonable time horizons. But if we go into more details we must work on mesoclimatic scale (topoclimate, local climate). Mesoclimate can be defined as a climate formed under direct influence of geotopography, its active surface, and with participation of mankind. The main key factors by its forming are the morphometric parameters of the terrain topography together with its active surface which are conditioning the components of radiation and energetic budget and thus determine the thermal transport intensity in vertical as well as horizontal directions. The geotopography modifies mainly the thermal and humidity conditions in lowest atmosphere layers and local circulation parameters.

In case of mesoclimatic studies the interest is therefore not focused on complete atmosphere layer, but only on its planetary limit layer (about 1500 m over the earth surface), where the immediate effects of physical attributes of the active surface and the geotopography are showing. Also holds the reverse relation when the physical-chemical properties of this lower atmosphere layer influence significantly the morphometric parameters of geotopography forms on medium and small scale, and the modeling processes (f.e. weathering effects, frost surging etc.).

For evaluation of these processes it would be advisable to know i.e. also the area distribution and the dynamics of the mesoclimatic phenomena. Quantitative characteristics of the mesoclimate are very variable and therefore their objective identification by direct measurement is very difficult or in some cases impossible. It would need very dense network of measuring and monitoring stations where the atmosphere parameters would be observed in vertical profiles. In present time such observations are mostly substituted by mesoclimatic maps of scales from 1:5 000 to 1:25 000 or smaller, where the mesoclima is categorized mostly on ground of qualified subjective estimations. Various indirect indicators may be used (f.e. form of the tree crowns for evaluation of dominant wind direction, specific vegetation composition for evaluation of thermal inversions in deep valleys, etc.). Because the vertical complexity of the geotopography is the determining factor of mesoclimate spatial differentiation, the fundamental aid for creation of mesoclimatic maps are the topographic maps with detailed heights expressed by contours or better the digital terrain model (DMT). DMT is the principal pre-requisite for quick creation

of maps of slopes and orientations of the terrain topography, with following construction of actual mesoclimatic map.

In the paper the methodology of creation of the mesoclimatic map in vertically broken topography on example of Králický Sněžník and Brno Highland regions. The methods of cartographic interpretation of areal mesoclimatic processes (f.e. extent and intensity of local and regional thermal inversions including evaluation of the potential appearance of accompanying condensation phenomena etc.), and processes with linear character (f.e. transfer of limited atmosphere volumes along the slopes, and microadvective atmosphere interchange between the thermally contrast areas) are proposed. The methodology is also employed by preparation of grounds for evaluation of environmental impact assessment (E.I.A.) of structures.

ELECTROMAGNETIC PHENOMENA IN LANDSLIDES

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ABSTRACT

Electromagnetic radiation which occurs in a landslide is associated with the mechanical stresses and the friction resulting from the displacement of the landslide's layers under sliding-down force F, as shown in fig. 1.

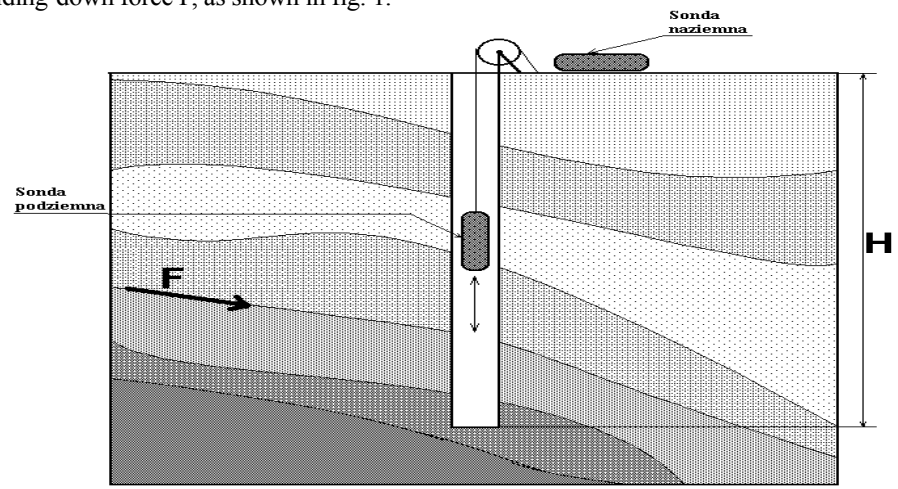

Fig. 1. Idea of earth's natural electromagnetic radiation in landslide (ground probe, underground probe)

The emitted electromagnetic field has impulse character and its maximum intensity occurs in a frequency range of up to 50 kHz. As the rate of creep of the landslide increases so does the number of registered impulses.

The fundaments of PEE (Pulsed Electromagnetic Emission) were presented by V. Vybiral in [1]. The method consists in recording, using a measuring probe inserted into a borehole (fig. 1), the electromagnetic impulses emitted by the landslide. The activity of the PEE field is expressed in imp/secs (impulses per second). Typical PEE fields are shown in fig. 2.

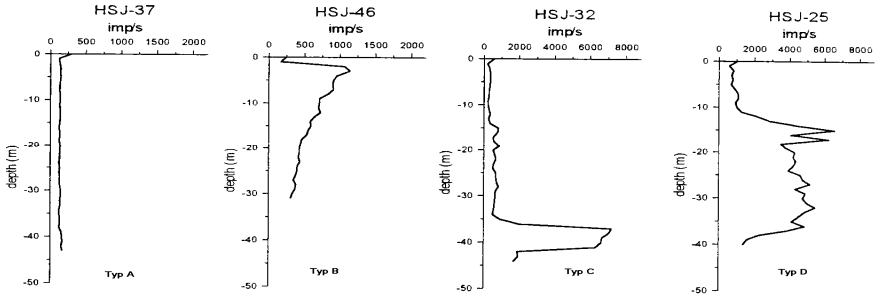

Fig. 2. Typical PEE fields registered in measurement boreholes (Vybiral 2002)

In the case of trace A, a roughly constant number of impulses per time (practically 150÷300 imp/sec) is registered along the whole borehole. The trace is characteristic of landslides in a stable condition. In the case of trace B, a large number of impulses is registered at the earth's surface. The number decreases with depth. This condition is characteristic of landslides in which their surface layer is active. In contrast to the above, in trace C a surge in the registered number of impulses occurs at certain depth *h*, which after the probe has been lowered by another few meters returns to the initial value. This indicates a large rock fragment at depth *h*, shifting in the landslide's body. When the landslide divides into two layers, trace D is registered. The near-surface layer is stable, as evidenced by the small number of registered impulses. The deeper layer is subject to strong landslide processes.

A landslide magnetic radiation measuring system, whose diagram is shown in fig. 3, has been developed at the Institute of Telecommunications and Acoustics. A patent for the system has been applied for [2]. The measurement consists in recording the number of magnetic field impulses over time or the value of the magnetic field intensity along a borehole with depth *H*, lined with a pipe which does not damp magnetic radiation. Measurements are performed using two probes as shown in fig. 1. One of the probes is passed in the borehole with a measuring step *h* through the anticipated slip boundary. The other probe is placed on the surface and it continuously records the magnetic field outside the borehole. The number of registered impulses increases at the slip boundary between the landslide's internal layers under the action of sliding-down force *F*. The underground probe is hermetically encased. The probe is lowered in the borehole on an optical fibre cable

which also transmits the measured signal. Owing to the fibre optical transmission of data from the two probes the system's sensitivity to interference has been reduced. The system includes a depth meter which determines the depth at which the probe is located with an accuracy of 10 cm. The signals from the probes are fed into the processing block (inputs A and C) which incorporates optical fibre line receivers whose output is an analog electric signal. The amplification of each of the measuring paths can be controlled. The resultant differential signal is fed into the peak detector module. The differential signal can be monitored by means of an oscilloscope (output D) to which an impulse counter, indicating the activity of the slide at depth *h*, is connected. The constant voltage corresponding to the instantaneous peak value of the trace is processed in an analog-to-digital converter. The voltage is indicative of the magnetic field intensity in a given point, which corresponds to the intensity of the landslide processes. The measured signal is recorded by a computer.

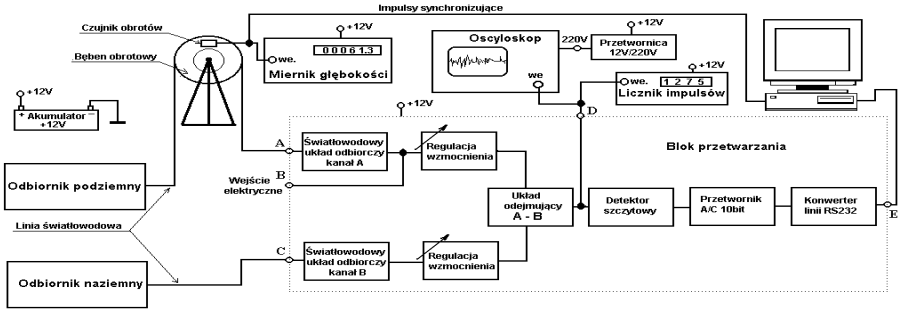

Fig. 3. Block diagram of measuring system (revolving drum, sensor of revolutions, depth gauge, oscilloscope, synchronizing impulses, converter, impulse counter, battery, optical-fibre receiving system channel A, amplification control, processing block, underground receiver, electric input, subtracting system A–B, peak detector, 10bit a/d converter, line converter RS232, optical fibre line, ground receiver, optical-fibre receiving system channel B, amplification control)

This paper was presented at conference [3]. The correctness of measurements performed by means of the system has not been verified yet but proper landslides are being sought for this purpose. Measurements are planned for the beginning of September this year.

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STRATEGY OF EPOCH GPS MEASUREMENTS FOR RECENT GEODYNAMIC MOTIONS STUDIES

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ABSTRACT

Epoch GPS measurements realized on regional networks are one of possible ways that allow geodynamic movements among individual network sites to be detected in a relatively short time. Statistical and trend analyses of GPS epoch data of the EAST SUDETEN network sites, processed since 1997 up-to-now, tested their quality rates from viewpoints of their accuracies obtained for various sets of multiple epoch campaigns and their reliability for geodynamic studies. In addition, these results displayed a relationship between an efficiency of time schedules of the campaigns and their cost-effectiveness.

STRATEGY OF EPOCH GPS MEASUREMENTS FOR RECENT GEODYNAMIC MOTIONS STUDIES

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ABSTRACT

Epoch GPS measurements realized on regional networks are one of possible ways that allow geodynamic movements among individual network sites to be detected in a relatively short time. Statistical and trend analyses of GPS epoch data of the EAST SUDETEN network sites, processed since 1997 up-to-now, tested their quality rates from viewpoints of their accuracies obtained for various sets of multiple epoch campaigns and their reliability for geodynamic studies. In addition, these

results displayed a relationship between an efficiency of time schedules of the campaigns and their cost-effectiveness.

RECENT GEODYNAMICS OF THE EAST PART OF THE BOHEMIAN MASSIF

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ABSTRACT

Movement velocities of the EAST SUDETEN GPS network sites were taken as basic quantitative geodynamic data. Their correlation with geologic materials, geophysical and other geodetic data allows the geodynamic model of the east part of the Bohemian Massif to be determined. All observed movement trends indicated that recent geodynamics of this area is affected by the latest Alpine orogene phases of the mid-Miocene time. Accuracy of processed GPS data and obtained movement velocities were thoroughly tested. Motions of fundamental geological structures in the East Sudeten area were assessed and in the contribution are discussed in detail. Preliminary stress and strain fields have been compiled and appropriate geodynamic terranes have been delineated as well. Finally, an example of the direct application of monitored GPS data in a field-planning task, in a tunnel designing under the Červená hora saddle (the Jeseníky Mts.), is delivered.

GPS DATA PROCESSING IN TRIMBLE TOTAL CONTROL SOFTWARE AND THE RESULTS OF COMPARATIVE METHODS FOR INDIVIDUAL CAMPAIGNS

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ABSTRACT

In the last ten years the GPS technology becomes the major method for displacement monitoring in geodynamic field. This technology gives under certain circumstances millimeter accuracy for distances in the range of tens or hundreds kilometers. The final accuracy is significantly determined by measuring workflow, measurement equipment and also the measured GPS data processing. This data

processing is limited by the type of used GPS software and subsequently by the process settings.

This paper shows the possibilities and achieved results in case of using Trimble Total Control GPS software from Trimble Company and some problems in applying comparative methods. All mentioned data are adopted from processing geodynamic network Cheb. The network is situated in the west part of Czech Republic and it was established under the project carried out by Geophysical Institute of the Academy of Sciences of the Czech Republic in 1993.

This local geodetic network Cheb is divided into two parts. The inner part consists of 18 points located in the most seismic active area around the village Nový Kostel. It is spreading on 250 square kilometers with the longest baselines up to 10 kilometers. The new 8 points were set up out of seismic active area to ensure maximum stability as an outer part in 1994. This part of network is spreading on 1300 square kilometers with the longest baselines up to 40 kilometers. Every network point is realized by 5 meter long vertical steel pipe filled up and fixated by concrete. The steel pipes extend beyond the earth surface of 1.5 meter. The points provide compulsory centering of GPS antennas.

There are two types of campaigns. The annual main campaign is performed on all points of the network. The campaign takes five days and the average total occupation time at one point is 10 hours. Points that are occupied more than once do not have to be strictly measured by the same set of antenna and receiver. The small campaigns are performed irregularly throughout the year as one 24 hour session or two 10 hour sessions at each point. In this case the same sets of antenna and receiver are used anytime the points being measured.

Under these circumstances not worse that following accuracy characteristics were achieved in adjustment of data from any campaign. 5 mm 95% confidence maximum horizontal radius of point for main campaign and 2 mm 95% confidence maximum horizontal radius of point for small campaign. The results of these campaigns were compared using 2D/3D transformation with scale factor set to 1 when all points were used to solve the transformation parameters. The values of displacement vectors hardly ever significantly exceed accuracy characteristics mention above. For that reason current effort is focused to apply some more sophisticated methods that use statistical tests to detect the points suspected of displacement. One of method is based on decreasing standard deviation of transformation residuals by omitting the suspicious points from computing transformation parameters. Another method is based on adjustment when data from both compared campaigns are adjusted together. In this case the suspicious points are considered as two different points with individual final coordinates.

MORPHOSTRUCTURAL ANALYSIS OF THE NE PART OF THE RYCHLEBSKÉ HORY MTS. AND MONITORING OF THE TECTONIC DISPLACEMENTS

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ABSTRACT

The Sokolský hřbet Ridge, a geomorphological subunit of the Rychlebské hory Mts. situating in the north-eastern spur of the Bohemian Massif and including morphologically distinct Marginal Sudetic Fault, has been put through the morphostructural analysis. The morphostructural analysis within the studied area, as a part of ongoing morphotectonic research, comprising analyses of joint and fault system, drainage pattern, and morpholineaments, was performed in order to dermine the correlation between the structural conditions and landforms. The direction NW–SE, parallel with the Marginal Sudetic Fault, represents very significant direction in the entire studied area. Other distinct structural directions are NE–SW and N–S. The faults and joints of these directions have influenced development of landforms in the area as it is clearly seen from the arrangement of morpholineaments.

Monitoring of tectonic displacements by means of the crack gauges TM-71, which are installed in two karst caves Na Pomezí and Na Špičáku in the studied area, has been carried out since 2001 in order to assess tectonic activity in the region of interest. Analysis of microdeformation records from the cave Na Pomezí shows a clear deformation wave recorded by both installed devices. It seems that the deformation wave does not correspond to seismic events nor climatically controlled influences (such as precipitation and temperature) registered in that region. It may suggest the preliminary conclusion that those deformations are aseismic ones conditioned by tectonic activity in the region in question. Trend and orientation of the recorded microdeformations will be discussed.

COMBINING GPS AND VLBI MEASUREMENTS OF CELESTIAL MOTION OF THE EARTH'S SPIN AXIS AND UNIVERSAL TIME

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ABSTRACT

GPS and VLBI are used to measure global parameters of Earth's orientation in space-polar motion, celestial motion of the spin axis, and universal time (defining the Earth's angle of rotation around the spin axis). Polar motion (i.e., the motion of the spin axis with respect to terrestrial frame) is observed by both methods. However, only VLBI is capable to observe the latter two components directly (i.e., with respect to celestial frame); GPS, because of simultaneously determined orientation of the satellite orbits, can observe only their time derivatives. The method of "combined smoothing", recently developed at the Astronomical Institute in Prague, is used to provide a unique combined solution that fits well both to the values observed by VLBI and their rates observed by GPS. We shall present two combinations:

1. Universal time (observed by VLBI) with length-of-day changes (observed by GPS).
2. Celestial pole offsets (observed by VLBI) with their rates (observed by GPS).

The results of these combinations, covering the last decade, will be presented and analyzed.

NOTES