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ON RECENT GEODYNAMICS
OF THE SUDETEN AND ADJACENT AREAS

ABSTRACTS



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PROJECT OF THE GEODETIC NETWORK FOR RESEARCH OF THE RECENT GEODYNAMIC ACTIVITY IN THE MIDDLE ODRA FAULT ZONE

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In 2007 the geodynamic research of the Middle Odra Fault Zone in Lower Silesia has been begun. The GPS networks were created in the border zone between Fore-Sudetic Block and Fore-Sudetic Monocline. Project of the network were preceded by analysis of the geological - tectonic conditions and analysis of vertical height changes of benchmarks in precise levelling lines of the 1st order, passing across middle Odra fault zone in the Wrocław section. The researches include the interpretation of vertical displacement of benchmarks in Zabkowice Śląskie – Wrocław, Wrocław – Syców, Wrocław – Brzeg, Wrocław – Krotoszyn lines measured in 1953 –1958, 1974-1980 and 1999 - 2000 periods. That levelling lines traverse continental, regional and local fault zone, e.g. fore-sudetic block dislocations, border zone of the fore- sudetic block and fore-sudetic monocline, Poznań – Oleśnica Fault Zone and Hanover – Kraków Fault Zone. The vertical height changes of benchmarks in the background of the geological – tectonic conditions.

Distinct connection between anomalous measurements of precise levelling and the bedrock structures has been noticed in many places. This tendency is best expressed at the line Zabkowice-Wrocław where in the south section the sub-Cainozoic bedrock is relatively near the surface. The general trend of precise levelling shows that area south of Wrocław, together with the southern districts of the city, has been uplifted. This region coincides with the area with relatively shallow crystalline bedrock.

In many places the position of the individual tectonic dislocations in the Middle Odra Fault Zone is not exactly definite. Cover of unconsolidated Cainozoic sediments is locally relatively thick, reaching more than 300 and even 400 m, whereas the density of boreholes and geophysical recognition are not enough for precise location of faults. Analysis of the morphostructures as the landforms with potentially tectonic origin has been the additional criterion for location of GPS points. Rectilinear edges of the southern slopes of Trzebnickie Hills and several depressions and elevations between Grodków and Opole have been taken into account. A few measuring points have been located near borders of palaeo- (buried) depression of Wrocław Basin. This tectonically induced depression is filled by 60-80 m of Quaternary, mainly Elsterian glacial deposits, whereas in the neighbouring areas quaternary sediments have thickness between 0-20 m. Age of glacial deposits in depression, and almost invisible reflection in present-day relief indicates that the main phase of Quaternary tectonic activity and subsidence was before Saale glaciation.

We assume that long-standing GPS measurements and further precise levelling will allow to state if the analysed zone is still tectonically active.

2.0mm/year. The radar scenes from Rybnik (PL) – Ostrava (CZ) area from the years 1992-1993, 1995-1996, 1996-1997, 1997-1998, 1998-1999, 1999-2000 and 2003-2006 (ERS and ENVISAT) were processed by the Gamma Remote Sensing AG, Switzerland (Dr. Urs Wegmüller) in a frame of the TerraFirma project, which initiated under ESA's GMES Service Element Programme. Landslides that were registered by the Czech Geological Survey – Geofond at the sites of Michálkovice, Orlová, Doubrava, Stonava a Kaczyce were studied with their possible relation to undermining. Preliminary results are presented and discussed.

GROUND DEFORMATIONS IN A FORMER COAL BASIN DURING THE REVITALISATION PERIOD

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The grounds of the former Wałbrzych Hard Coal Mines (WKWK) located in SW Poland are an area of revitalization processes. These processes are associated with various phenomena. Ground deformations, difficult to predict, delay new development of these grounds.

In this paper the results of analyses of surface deformations along a selected leveling line on the grounds of former "Thorez" Coal Mine have been presented. The results of line "100" measurements realized in 2000 and 2008 have been compared. These show more or less regular elevation of the ground's surface over the exploited hard coal seams (between 10 and 20 cm). Noticeable change has been found in the zone of a tectonic fault where anomalous elevation of the ground has reached over 40 cm.

In general, these changes can be explained as return of the groundwater levels to its former state of balance. More detailed interpretations of these changes are required in the area of the tectonic fault.

Abovementioned facts call for continuation of this research. Organization of spatial observations of the ground surface deformations on the area of former WKWK with the use of GPS technique is planned. This will allow measurements of horizontal changes, a particularly important factor, considering complicated geology and tectonics of the former mining grounds in the Wałbrzych Coal Basin.

STRUCTURAL DETERMINATIONS OF GEODETICAL MONITORING NETWORK POSITIONING IN THE GÓRY STOŁOWE AREA

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On the basis of new geological data from Table Mountain area a new system of regional geodynamic monitoring has been proposed in the 2008th. The principle for projected and then realized measurement network constituted geomorphic and structural criteria. DEM analysis helped to pick up the areas of potentially strike slip motion. Geological structural investigations, including descriptions of recent damages of the engineering constructions, support long time lasting tendencies in strike slip motion since late Cretaceous till now. The points of new measurement network were located across active faults as well as across structural unit that is defined by recent extent of the upper Cretaceous sedimentary cover.

The most important zones which are actually under monitoring are Czerwona Woda Creek Graben bordered by Czerwona Woda Faults System, border fault of the Kudowa tectonic depression and till now unnamed fault system that border from the north Cretaceous sedimentary plateau and follow a line defined by Radków-Wambierzyce-Chocieszów. Estimated from geomorphic and structural features horizontal displacements can reach up to 50 m in a period of last 60-20 000 years what gives app. annual rate of displacement on the level of 0,8 -2,5 mm. The predicted vertical yearly displacements may exceed 1,2 mm.

The geodynamical research network on the Stołowe Mountains National Park area consists of 10 measuring points. The monumentation of research network points was done on June, 2008. The first GPS and gravimetric measurements were held on September, 2008.

THE BALANCE OF THE EARTH SURFACE IN GEOLOGY

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Geophysical arguments are looked for in favour of the idea that the Earth surface increases due to cosmic matter in fall. Annual bulk of the cosmic matter falling on the earth surface is used to calculate the gravity effect with the help of opposite gravity reduction formula including free air and Bouguer corrections. Changes of the Earth radius and mass, rotation period, and the parameters for its solar orbit are seen qualitatively. To this purpose, both extraterrestrial dust particles and heavier massive cosmic bodies as well cosmic dark matter concentrated in the vicinity of our planetary system are considered together with the known estimates of the Earth's accretion rate of the cosmic matter.

CRUST AND UPPERMOST MANTLE STRUCTURE OF THE BOHEMIAN MASSIF ALONG THE REFRACTION AND WIDE-ANGLE REFLECTION S04 PROFILE OF THE SUDETES 2003 EXPERIMENT

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The Sudetes area represents the NE-most exposed part of the Variscan crystalline basement in Europe. It widespreads along the boundary of the Czech Republic and Poland and constitute the NE margin of the Bohemian Massif. It is the area of variously metamorphosed volcano-sedimentary successions and igneous suites of pre-Carboniferous age covered by sediments contained in Late Devonian to Carboniferous intramontane troughs and intruded by voluminous late- to post-orogenic Carboniferous granites.

The deep structure of this area was studied using the data of the international seismic experiment SUDETES 2003 (Grad *et al.*, 2003). A refraction and wide-angle reflection profile S04 is 740 km long and is of the NW-SE orientation. It concentrates not only on the northern parts of the Bohemian Massif but also delimits its contact with the Carpathian Foredeep and the Carpathians. It starts at the north-western part of the Bohemian Massif, continues along the Elbe Fault zone, through the Carpathian Foredeep and the Carpathians and terminates in the Pannonian Basin. Velocity studies along this profile reveal different structure especially on the contact with the Carpathian Foredeep. Position of the Moho discontinuity ranging from 23 km to 33 km and the reflectors within the crust complements the P-wave velocity distribution. The Moho is the deepest in the central part of the Bohemian Massif at the northern rim of the Moldanubian, and shallows to the Pannonian Basin.

Grad, M., A. Špičák, G. R. Keller, A. Guterch, M. Brož, E. Hegedüs, and Working Group (2003), SUDETES 2003 Seismic Experiment, *Stud. Geophys. Geod.*, 47, 681-689.

GEODETIC AND MORPHOTECTONIC CONSTRAINTS OF A PLANNED GEODETIC NETWORK IN THE NW PART OF THE WALISZÓW – MORAWA TECTONIC ZONE

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The paper presents geodetic and morphotectonic constraints of spatial distribution of benchmarks of the satellite-gravimetric and repeated levelling network that is planned to detect ground motions in the area of Krowiarki, Śnieżnik Massif, and the northern part of the Upper Nysa Kłodzka graben, Sudety Mts. The area in question has been tectonically active

since the Late Cretaceous. The presence of young tectonic movements is indicated by changes of the drainage network and occurrence of trapezoidal and triangular facets along fault scarps bounding morphotectonic steps. Based on altitudinal differences between benchmarks of the state precise levelling of the 1st and 2nd class, as well as morphotectonic analyses, the location of observation points and courses of precise levelling transects will be selected.

DISCUSSION ON THE PHENOMENON OF NON-TIDAL PLUMB LINE VARIATIONS OBSERVED IN GEODYNAMIC LABORATORY OF PAS IN KSIAZ

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Since 1975 in the Geodynamic Laboratory in Książ there are continuously performed measurements of plumb line variations. During 27 years we applied quartz horizontal pendulums only. In 2002 the long water-tubes tiltmeter starts its work. New instrument consists of two perpendicular tubes 65 and 83 meters-long. Technique applied to measure water level variations achieves accuracy equal single nanometer. This accuracy corresponds to internal sensitivity of tiltmeter close to single microarcsecond. The differential method of data elaboration allowed us to eliminate instrumental drift and initiate investigations of long-standing, non-tidal signals. In years 2003-2007 we observed five epochs of extremely strong non-tidal signals. The largest signals of plumb line variations happened in different months without seasonal correlations. During epochs of strong signals the magnitude of plumb line changes exceeded hundred of mass. Time of durations of these epochs varies between two weeks, and one month. First information of the probable existence of the large plumb line variations comes from measurements carried on with help of the quartz horizontal pendulums. Phenomena of large plumb line variations produce large variations of azimuths of equilibrium of pendulums until their limiters. Since 1975 almost every year we observed one or two epochs of unstable work of pendulums. Because of limitation of the range of measurements of pendulums large effects of plumb line variations were registered incompletely. On the basis of pendulums measurements it was difficult to prove geodynamic origin of the large plumb line variations. Initiation of measurements of the long water-tube tiltmeter brings us new view on this problem. The measurements of the long water-tube tiltmeter confirmed existence of phenomenon of large plumb line variations. In 2006, after three years of inactivity, pendulums equipped with new system of electronic registration were restarted. This circumstance opens possibility of comparative works to verification strong non-tidal signals detected by long water tube as well as horizontal pendulums. Detection of correlation between signals from both tiltmeters confirms the thesis that large signals have geodynamic, not instrumental origin. In this moment we are able only to exclude phenomena such as variations of air pressure loading effects, seasonal variations of mean temperature, non-tidal loading effects produced by variations of mean ocean level, variations of ground water level, and other seasonal effects as probable reason of large plumb line variations. Actually we do not know what the size of tectonic unit subjecting to tilt is. The question is if we register local tilt associated with Książ orogen or tilting of greater tectonic structure such as Sudeten massif?

PS IN SAR – A TOOL FOR DETECTION SURFACE MOVEMENTS CASE EXAMPLES: THE PRAGUE AND OSTRAVA-KARVINÁ AREAS

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Permanent Scatterers Interferometry SAR (PSInSAR) allows ground movements of large areas to be detected. Results of this remote sensing technique are the rates of vertical movement for targets on the surface (called permanent scatterers) that are representing particularly by individual buildings in urban areas and rock outcrops in a landscape. The PSInSAR technique provides measurements with high accuracy below a millimetre range. Rate of subsidence and uplift in the Prague area reaches millimetres to centimetres per year. On basis of the PSInSAR analysis in the urban area for period from 1992 to 2005 primarily vertical movements of local significance, mostly subsiding of individual buildings and/or object complexes were identified. The Ostrava and Karviná areas are heavily affected by long-term undermining activities. The PSInSAR data from these areas related to the 1995–2000 period displayed that in the urban area of Ostrava town the subsiding effects of coal-mining have decreasing trend, while in the Karviná coal mining area are still in a progress. Some areas located in this undermined region move down up to several decimetres per year. Since detectable rate of vertical movement obtained by the PSInSAR application reaches at most 1,5 centimetre per year, the ALOS PALSAR data were processed by new Differential Interferometry (DInSAR) in L-band frequency for broad Ostrava area where fast movements are still occurring that allows movements of several decimetres per year to be detected. A few examples of the DInSAR technology will be presented.

The research was funded from the European Space Agency projects: PECS and GMES/TerraFirma No. 98042.

RESEARCH ON THE MARGINAL SUDETIC FAULT ACTIVITY WITH THE USE OF GPS TECHNOQUE AND PRECISE LEVELLING

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In the work the horizontal and vertical velocities are presented as a result of processing of the data from the GEOSUD and the national levelling network surveys. GPS results from the 1996-2005 period, as well as results of two GPS surveys (2006 and 2007) on selected points of that network were processed with the use of *Bernese GPS Software 5.0*. The resultant velocities were the basis for testing the hypothesis of recent strike-slip activity of the marginal sudetic fault (MSF). The second part of the work describes the research of vertical activity of the MSF with the use of relative vertical velocities of the 1st and IInd class benchmarks located

on the both sides of the MSF. The nonlinear regressions of the velocities and the distance of GPS and levelling benchmarks to the fault's edge were performed to describe the fault's sides movements. The results were compared to the active fault models known from the literature.

HORIZONTAL MOVEMENTS OF THE TECTONIC UNITS OF EUROPE BASED ON DATA OF EPN SERVICE

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Contemporary geodynamic investigations on a global and regional scale are being realized by network of permanent GNSS stations distributed all over the Earth. The Continental EPN (EUREF Permanent Network) is a European network of 200 permanent stations and the main assignment of EPN is the maintenance of ETRF89. One from many available products as part of project "EPN Coordinate Time Series Analysis Special Project" are components of the velocity vectors of EPN stations. The analysis, interpretation and visualization of motion velocity vectors of permanent stations can be used for different interdisciplinary research, especially for locally geodynamic investigations. The main aim of the elaboration was to find a correlation between velocity fields of EPN stations and the tectonics of Europe. Based on the geological maps, major tectonic structures have been distinguished. For each unit the continuous velocity field has been developed by means of kriging's method of interpolation. Moreover, to establish the areas of homogenous changes, the k-means method of cluster analysis technique was used. One of the research stages was to find the answer to the question about possibility to determine average velocity vector of motion for each tectonic unit, which will be illustrating mobility of the whole tectonic structure.

AUTOMATIC DETERMINATION OF THE DEFLECTIONS OF THE VERTICAL – FIRST SCIENTIFIC RESULTS

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The astrogeodetic method of detailed geoid determination needs astronomical observations of longitude and latitude. Together with GPS observations it may be used to vertical deflections determination. In the article the portable system for automatic determination of astrogeodetic vertical deflection components developed at AGH - University of Science and Technology is described. The design, main error sources, and preliminary results of the test measurements are presented.

research, there will be anticipated a new profile. It will be DS profile, along the valley Soły between Ujsola and with Oświęcim Valley.

DS (Ujsoly - Żywiec - Kęty - Oświęcim) is cutting in two Magura unit, subMagura unit, Silesia unit and subSilesia unit and south part of Fore-Carpathian Depression.

The methodology offered in the project of gravity observation consists in relative measurements of changes in the gravity in points of midwives in mutual distances of 5 km in length marked out of profiles.

An attempt of quantitative interpretation of gotten scores is an essence of the research problem taken up.

ANALYSIS OF LEVELLING BENCHMARKS HEIGHT CHANGES ON THE JELENIA GÓRA BASIN AND ADJACENT AREAS

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The paper analyses the levelling benchmarks heights obtained from recent national levelling measurements compared to the same measurements from sixties and eighties years of the XX. Century.

The analyses concern of the Jelenia Góra basin and adjacent areas: Izerskie Mts., Izerskie Mts. Foreland, Kaczawskie Mts., Kaczawskie Mts. Foreland and Rudawy Janowickie Mts.

PEAK GROUND ACCELERATION ATTENUATION RELATIONSHIP BASED ON RBF NEURAL NETWORK

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Artificial neural networks (ANN) are used in many of scientific and engineering disciplines. In this work we use ANN in engineering seismology for prediction of horizontal peak ground acceleration and compare this with results obtained from standard attenuation equation. The research area is The Legnica-Głogów Copper Mining District (Poland) where mining-induced seismicity occurs. The event catalogue used for computation contains 969 strong ground motion events, for which exists standard attenuation equation.

GEODYNAMICALLY ACTIVE AND RISC AREAS OF BOHEMIAN MASSIF AND POSSIBILITY THEIR GEODETIC AND GEOPHYSICAL ANALYSES

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Geodynamical and seismotectonic activities in Bohemian Massif mapped by classic geological methods for more as 50 years period. Last 15 years geodynamic processes are mapped by modern geodetic and geophysical technologies.

In the contribution the review of geodynamical and seismotectonic active areas in Bohemian Massif is presented. The emphasis is given especially on areas recently analyzed and processed, and on problematic areas with their possible catastrophic impact upon its surroundings. The second one we recommended for next future recognizing project.

INVESTIGATING THE STATE OF THE TROPOSPHER WITH VARIOUS TECHNIQUES

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The deep knowledge of the troposphere cannot be gained using just on ground measurements (temperature, pressure, water vapor, wind direction and speed, radiation) and cloud observations. To extent the information, other techniques might be employed. First of all the balloon probes, that are launched 4 times a day at the airports, but this technique suffers from low spatial distribution. The other possibility is to obtain satellite data from one of the Aqua's satellite sensors – Atmospheric InfraRed Sounder (AIRS). The level 2 product is, a ready-to-use, hdf format profiles of temperature, humidity and geopotential high, but it might fail to produce profiles well under overcast condition. Another option is to use reprocessed data from some Numerical Weather Prediction models which may produce desired parameters at chosen pressure levels, but the obtained results may not fit the ground data. Here the usage of Coupled Ocean/Atmosphere Mesoscale Prediction System as a meteorological data source is presented. Each of the technique has its limitation but united may give a better insight into the state of the troposphere.

The paper addresses the problem of combining data from four different source with various space and time resolution. It is also an attempt to merge distinct and continuous observations with mesoscale model prediction results. The derived methodology for data combination and interpolation has been employed on data from Karokonosze Mountains 25th and 26th of August 2007. This work has been financed as a research project N520 014 31/2095 from the Polish science funds for the period 2006-2008 and the Wrocław Centre of Networking and Supercomputing (<http://www.wcss.wroc.pl/>) computational grant using Matlab Software License No: 101979.

SOME REMARKS ABOUT THE CALCULATION OF APPARENT PLACES OF STARS FOR AUTOMATIC DETERMINATION OF VERTICAL DEFLECTIONS

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The calculation of apparent places of stars is a part of algorithm for automatic determination of vertical deflections. This calculation requires input data included in fundamental stellar catalogues. In this article, Author analyzes the influence of choice of fundamental catalogue on calculated apparent places of stars.

COLLISION MOVEMENTS DETECTED IN SUDETEN MARGINAL FAULT ZONE, BOHEMIAN MASSIF

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Monitoring of micro-displacements in caves and galleries organized to analyse behaviour of tectonic structures in Bohemian Massif verified signs of increased dynamics that occurred during the last decade. Analysis discovered similarity in micro-movement variations registered at points hundreds of km apart. A tectonic pressure impulse reaching Bohemian Massif in the second half of 2003 from S was registered at a series of points. The impulse initiated a deformation process during which a couple of local earthquakes occurred. As a result of the impulse characteristic cyclic collision movement developed between Sudeten Marginal Fault flanks. The process has been registered and described.

LONG TERM STRESS CHANGES MEASUREMENT IN SITU DURING LONGWALL MINING

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This contribution deals the first experiences of in-situ measurement of the stress tensor changes during a long wall extraction. A device designed on base of local deformations measurement on compact conical ended borehole was used for long term monitoring of stress changes.

THE RELATION BETWEEN ONE YEAR PERIODIC COEFFICIENTS OF GPS PERMANENT STATIONS AND TROPOSPHERE TIME SERIES

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The movement that is observed at GPS permanent stations is a result of many factors. The largest observable effects are periodic effects. In this work periodic coefficients of GPS permanent stations coordinate time series were compared with troposphere time series (temperature, pressure, dew point) from balloon soundings.

Area of interest covers Poland, Germany, Czech Republic and Slovakia.

Periodic components of troposphere time series were computed with use of wavelet algorithm implemented in MATLAB®.

Periodic effects of GPS stations time series were computed with use of Fast Fourier Transform (FFT) algorithm implemented in MATLAB® environment.

NEOTECTONICS OF THE CARPATHIANS: A STATE OF THE ART

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Neotectonics of the Carpathians used to be studied extensively, particular attention being paid to the effects of large-scale domal uplifts and open folding above marginal zones of thrust and imbricated map-scale folds, and rarely to the characteristics of young faulting. Neotectonic faults tend to be associated with the margins of the Orava-Nowy Targ Basin, at the boundary between the Inner and Western Carpathians, as well as some regions within the Outer Carpathians (cf. reviews in: Zuchiewicz, 1998; Zuchiewicz et al., 2002). The size of Quaternary tilting of the Tatra Mts. on the sub-Tatric fault were estimated at 100 to 300 m, and recent vertical crustal movements of this area detected by repeated precise levelling do not exceed 0.4 mm/yr in rate (see references in: Zuchiewicz, 1995 and Makowska, 2003).

Quaternary grabens within the Orava-Nowy Targ Basin, oriented E-W, reveal throws of up to 120 m (cf. Baumgart-Kotarba, 2001). Reactivation of the northern boundary fault of the Pieniny Klippen Belt was shown to have occurred as late as in the Holsteinian. Minor vertical block movements of oscillatory character (0.5-1 mm/yr) were detected along faults cutting the Pieniny Klippen Belt owing to repeated geodetic measurements performed on the Pieniny geodynamic test area (Czamecki, 2004). The rates of such motions, however, usually fall into



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