

A topographic map of the Sudeten region, showing mountain ranges, valleys, and rivers. The map is rendered in shades of green and brown, with a prominent mountain range running diagonally across the center. The text is overlaid on the map.

15th Czech-Polish Workshop

***ON RECENT GEODYNAMICS OF THE SUDETEN
AND THE ADJACENT AREAS***

ABSTRACTS

**Karlovy Vary, Czech Republic
November 5 - 8, 2014**



Institute of Rock Structure
and Mechanics
of the Academy of Sciences
of the Czech Republic



Institute of Geodesy and
Geoinformatics
Wrocław University of Environ-
mental and Life Sciences



Section of the Geodynamics
Committee of Geodesy
Polish Academy of Sciences

15th Czech-Polish Workshop

ON RECENT GEODYNAMICS OF THE SUDETEN AND THE ADJACENT AREAS

ABSTRACTS

Karlovy Vary, Czech Republic
November 5 - 8, 2014

**Organizing Committee
of the**

15th Czech-Polish Workshop

**ON RECENT GEODYNAMICS OF THE SUDETEN
AND THE ADJACENT AREAS**

Karlovy Vary, Czech Republic
November 5 - 8, 2014

Institute of Geodesy and Geoinformatics
Wrocław University of Environmental and Life Sciences

Institute of Rock Structure and Mechanics
Academy of Sciences of the Czech Republic

Section of the Geodynamics Committee of Geodesy
Polish Academy of Sciences

Dr. Petra Štěpančíková¹⁾ – chairman
Prof. Dr. Bernard Kontny²⁾ – vice-chairman
Dr. Josef Stemberk¹⁾
Prof. Dr. Jaroslav Bosy²⁾
MSc Wojciech Dach²⁾
Monika Hladká¹⁾ – secretary

Editors: Jakub Stemberk¹⁾, Petra Štěpančíková¹⁾

¹⁾ *Institute of Rock Structure and Mechanics, Academy of Sciences of the Czech Republic v.v.i., Prague*

²⁾ *Institute of Geodesy and Geoinformatics, University of Environmental and Life Sciences, Wrocław*

Program of the 15th Czech-Polish Workshop on Recent Geodynamics of the Sudeten and the Adjacent Areas

Karlovy Vary, Czech Republic
November 5 - 8, 2014

WEDNESDAY, November 5, 2014	
10:00-14:00	<i>Registration of the participants</i>
12:00-13:30	<i>Lunch</i>
14:00	Opening Session
14:15	<u>Jamroz O.</u> , S. Stemberk, S. Cacoń: Evaluation of current geodynamic activity of the Waliszow-Nowa Morawa tectonic zone in the view of crack gauge TM71 measurements in chosen points (page 25)
14:30	<u>Baroň I.</u> , L. Plan, B. Grasemann, I. Mitrović: Activity of faults observed in caves of the Eastern Alps: results of the first year of monitoring (page 10)
14:45	<u>Kasza D.</u> , M. Kaczorowski, R. Zdunek, R. Wronowski, T. A. Przylibski, L. Fijałkowska-Lichwa: Installation of modernized TM-71 crack gauge at Geodynamic Laboratory in Książ. Support to the tectonic events mechanics research (page 36)
15:00	<u>Kaczorowski M.</u> , A. Borkowski, K. Ćmielewski, P. Gołuch, J. Kuchmister, R. Zdunek: New concept of integrated tectonic studies in the Geodynamics Laboratory of SRC in Książ (page 29)
15:15	<u>Aleksandrowski P.</u> , J. Badura, A. Bochnacka, S. Ostrowski, M. Pańczyk, B. Przybylski, O. Rosowiecka, K. Sobieć: A new project of the Polish Geological Survey “Recent faults and geothermal waters in the Sudetes and their Foreland in the light of structural, geochronological and thermometric investigations” at its starting point (page 9)
15:30-16:00	<i>Coffee break</i>
16:00	<u>Kaczorowski M.</u> , T.A. Przylibski, L. Fijałkowska-Lichwa, D. Kasza, R. Wronowski: First results of ^{222}Rn activity concentration measurements as a possible precursor of tectonic events registered in underground Geodynamic Laboratory of Space Research Centre in Książ (The Sudetes, SW Poland) (page 28)
16:15	<u>Szczerbowski Z.</u> , J. Jura: Mining Induced Seismic Events and Surface Deformations Monitored by GPS Permanent Stations (page 55)

16:30	<u>Szczerbowski Z.</u> , M. Kaczorowski, J. Wiewiórka, M. Jóźwik, R. Zdunek, A. Kawalec: Underground monitoring of tectonically active areas in scope of the research project by AGH-SRC-KS-Bochnia consortium. New perspective of geodynamic investigations (page 56)
16:45	<u>Czechowski L.</u> , M.Grad: Origin and evolution of asthenospheric layers (page 17)
17:00	<u>Skácelová Z.</u> : Polish-Czech project Sudetes Georoute, geological-tourist guidebook.
17:10	<i>Discussion</i>
17:30 – 18:15	Poster session I (page 7)
19:00	Dinner
THURSDAY, November 6, 2014	
9:00	Chapanov Y., <u>Ron C.</u> , Vondrák J: Millennial cycles of mean sea level excited by Earth orbital harmonics (page 16)
9:15	Štěpánek P., A. Bezděk, <u>J. Kostecký</u> : Modelling of gravity force for the precise orbit determination of low-Earth satellites (page 60)
9:30	<u>Vondrák J.</u> , C. Ron: Can geomagnetic jerks contribute to the changes of Earth's orientation? (page 62)
9:45	<u>Kostecký J.</u> , J. Douša, J. Kostecký Jr.: Analysis of the time series of station coordinates – comparison of the network and PPP access (page 41)
10:00	<u>Kontny B.</u> , P. Grzempowski, P. Aleksandrowski, V. Schenk, Z. Schenková: Horizontal deformation of the Earth's crust in the area of the Sudeten and its northern Foreland (SW Poland) based on GPS data from the period 1997-2012 (page 40)
10:15	<u>Zdunek R.</u> , M. Kaczorowski, A. Borkowski, K. Ćmielewski, P. Gołuch, J. Kuchmister: Results of three years long measurements from GNSS station of Geodynamic Laboratory of SRC in Książ in relation to recent tectonic activity (page 68)
10:30-11:00	Coffee break
11:00	<u>Kaczmarek A.</u> , S. Cacoń, J. Weigel: Contemporary vertical movements on the faults of the Sudetes in the area of Polish and Czech Republic based on levelling data (page 27)
11:15	<u>Sowa W.</u> : An attempt to analyze geodetic and seismic data to detect contemporary activity of tectonic structures in the area of Poland (page 53)
11:30	<u>Kowalczyk K.</u> : The creation of a model of relative vertical crustal movement on Poland's territory on the basis of the data from Active Geodetic Network EUPOS (ASG EUPOS) (page 19)
11:45	<u>Schenk V.</u> , R. Pichl, Z. Schenková: Intraplate movements of the Bohemian Massif structures (page 51)

12:00	<u>Švábenský O.</u> , L. Pospíšil, P. Černota, J. Papčo, M. Witiska, M. Novosad: Morava Network – repeated GPS measurements and results after 18 years (page 61)
12:15	<u>Pospíšil L.</u> , O. Švábenský, J. Weigel.: Risk Zones at Northern Part of the Boskovice Furrow (page 47)
13:00-14:30	Lunch
14:30	<u>Kasprzak M.</u> , M. Ziaja, G. Józków, A. Borkowski: Fluvial transport of the largest grains in river bed: terrestrial laser scanning monitoring (Łomniczka river, Karkonosze Mts) (page 32)
14:45	<u>Wojewoda J.</u> : Świebodzice Unit revisited – kinematic, structural and facial evolution till now (page 63)
15:00	<u>Wojewoda J.</u> , A. Kowalski, M. Rauch: Synsedimentary seismotectonic features in Triassic and Cretaceous sediments within the Intrasudetic Shear Zone (ISZ) - regional implications (page 65)
15:15	<u>Horálek J.</u> , H. Čermáková: West Bohemia/Vogtland earthquake swarms: What actually we know about them? invited lecture (page 23)
15:45-16:15	Coffee break
16:15	<u>Hintersberger E.</u> , K. Decker, Ch. Lüthgens, M. Fiebig: Geological evidence for earthquakes close to the destroyed Roman city of Carnuntum (Austria) invited lecture (page 21)
16:40	<u>Štěpančíková P.</u> , T. Rockwell, D. Nývlt, F. Hartvich., J. Stemberk Jr., Hók J., D. Rood, M. Ortuño, M. Myers, K. Luttrell, N. Wechsler: A signal of Ice Loading in Late Pleistocene Activity of the Sudetic Marginal Fault (Czech Republic)
16:55	<u>Hartvich F.</u> , P. Tábořík, P. Štěpančíková: 3D image of Sudetic Marginal Fault at Bílá Voda site as seen by resistivity survey
17:10	<u>Špaček P.</u> , P. Štěpančíková, P. Tábořík, Z. Sýkorová, J. Pazdírková, O. Bábek, J. Švancara, J. Valenta: The Upper Morava Basin system - evolution, present-day geodynamics and first results of trenching invited lecture (page 58)
17:35	Information on Friday excursion
18:00 – 19:00	Poster session II (page 8)
19:30	Dinner party
FRIDAY, NOVEMBER 7, 2014	
8:00	Bus departure to the excursion
	<ol style="list-style-type: none"> 1. Quaternary volcanoes in the area of Bruntál town (Uhlířský vrch, Mezina) 2. Křížový vrch - view to the Upper Morava basin 3. Seismic station in Mutkov (run by Institute of Physics of the Earth, Masaryk University in Brno)

	<p>4. Šternberk - former baroque Augustinian monastery – guided tour with short organ concert</p> <p>5. Mladeč caves (karst caves known for extremely significant paleontological and archaeological findings; fault movements monitoring run by ÚSMH)</p> <p>The lunch will be provided as take-away. Program of the field trip might slightly change depending on the weather.</p>
18:00	<i>Expected arrival to the Hotel Kamzík</i>
19:00	<i>Dinner</i>
SATURDAY, NOVEMBER 8, 2014	
9:00	<u>Bogusz J.</u> , M. Figurski, A. Kłos: Investigation of non-linearity of GNSS time series using wavelet decomposition (page 15)
9:15	<u>Kłos A.</u> , J. Bogusz, M. Figurski, M. Gruszczyński: Seasonal removal in the context of noise investigation (page 39)
9:30	<u>Nykiel G.</u> , M. Figurski, K. Szafranek, A. Araszkiwicz, Z. Baldysz: Study on the impact of the tropospheric mapping functions on the accuracy of the GNSS precise positioning (page 45)
9:45	Bogusz J., M. Figurski, <u>M. Gruszczyński</u> , A. Kłos: Determination of the common-mode errors in local GNSS-based networks for geodynamical studies (page 14)
10:00	<u>Szafarczyk A.</u> : Tensor analysis of ground deformations evaluated from geodetic measurements in landslide area (page 54)
10:15-10:45	<i>Coffee break</i>
10:45	<u>Gerhátová L.</u> , J. Hefty, J. Papčo, M. Mináriková: Monument instability of GNSS permanent station inferred from precise tilt observations (page 18)
11:00	<u>Kaźmierski K.</u> : Model UNBe.eu for EGNOS (page 37)
11:15	<u>Kratochvíl R.</u> , K. Brátová, T. Hynčicová, M. Kuruc: Determination of Geometrical and Temporal Characteristics of Device for Absolute GNSS Antenna Calibration (page 42)
11:30	<u>Kudrys J.</u> : Periodic changes in GPS signal quality indicators (page 43)
11:45	<u>Kaplon J.</u> : GNSS meteorology. Near real-time estimation of the state of troposphere over the area of Poland (page 31)
12:00	Discussion, conclusions
12:00	<i>Lunch</i>

POSTER SESSION I - NOVEMBER 5, 2014

17:15-18:30

1. Birylo Monika, Jolanta Nastula, Joanna Kuczynska-Siehiem: The Creation of Flood Risks Model Using a Combination of Satellite and Meteorological Models (**page 12**)
2. Kuczynska-Siehiem Joanna, Adam Lyszkowicz, Monika Birylo: Regional Geoid Determination by the Least Squares Modification of Stokes' Formula (**page 43**)
3. Hadas Tomasz, Jaroslaw Boso: GNSS-WARP - real-time GNSS PPP software (**page 20**)
4. Janicka Joanna, Jacek Rapiński: Filtering the results of ZigBee distance measurements with RANSAC algorithm (**page 26**)
5. Pelc-Mieczkowska Renata, Joanna Janicka, Michał Bednarczyk: Comparison of methods for terrain obstacles modeling (**page 47**)
6. Rapinski Jacek: The Application of ZigBee phase shift measurement and ranging (**page 49**)
7. Kieszek Przemysław: Graphic analysis of the objective function in the MAFA method (**page 38**)
8. Baryła Radosław, Katarzyna Stępniać, Jacek Paziewski, Paweł Wielgosz, Grzegorz Kurpiński: Application of geoid models to precise GNSS leveling: LGOM local network case study (**page 11**)
9. Rzepecka Zofia, Katarzyna Stępniać, Jakub Kalita, Paweł Wielgosz: Time series analysis of wet tropospheric delays for short-term forecast (**page 50**)

POSTER SESSION II - NOVEMBER 6, 2014

18:00-19:00

10. Cellmer Sławomir: The validation procedure in the MAFA method (**page 16**)
11. Kasprzak Marek, Filip Duszyński, Aleksandra Michniewicz, Milena Różycka, Piotr Migoń: Landslide recognition using airborne LiDAR and electrical resistivity tomography – a contribution to the contemporary geodynamics of the Sudetes (**page 35**)
12. Małolski Krzysztof, Kazimierz Ćmielewski, Janusz Kuchmiaster, Piotr Gołuch, Olgierd Jamroz, Marcin Belka: The study of displacements of "Geodesy" WUELS building which arising due to construction works carried out in the immediate its vicinity (**page 44**)
13. Blachowski Jan, Wojciech Milczarek, Piotr Grzempowski: Analysis of post mining ground surface movements - a case study of the Wałbrzych area (SW Poland) (**page 13**)
14. Paziewski Jacek, Rafał Sieradzki, Paweł Wielgosz: Properties of GPS-Galileo receiver inter system biases (**page 46**)
15. Próchniewicz Dominik, Ryszard Szpunar, Jacek Kudrys: Stochastic modelling of GNSS observations for precise kinematic positioning (**page 48**)
16. Sieradzki Rafał, Jacek Paziewski: MSTIDs impact on precise GNSS positioning at mid-latitudes (**page 52**)
17. Stemberk Jakub, Petra Štěpančíková, Petr Tábořík: Valley evolution of upper part of the Biala Łądecka river - preliminary results
18. Tomaszewski Dariusz, Jacek Rapiński: Analysis of different INS alignment methods conducted with the use of MEMS-based integrated navigation system (**page 62**)

**A NEW PROJECT OF THE POLISH GEOLOGICAL SURVEY
“RECENT FAULTS AND GEOTHERMAL WATERS IN THE
SUDETES AND THEIR FORELAND IN THE LIGHT OF
STRUCTURAL, GEOCHRONOLOGICAL AND
THERMOMETRIC INVESTIGATIONS”
AT ITS STARTING POINT**

Paweł Aleksandrowski¹⁾, Janusz Badura¹⁾, Agnieszka Bochnacka²⁾,
Szymon Ostrowski²⁾, Magdalena Pańczyk²⁾, Bogusław Przybylski¹⁾,
Olga Rosowiecka²⁾, Katarzyna Sobień²⁾

- ¹⁾ Polish Geological Institute - National Research Institute, Lower Silesia Branch,
Al. Jaworowa 19, 53-122 Wrocław, Poland
- ²⁾ Polish Geological Institute - National Research Institute, Rakowiecka 4, 00-975
Warszawa, Poland

The goal of the 2-years' project is to localize, select and preliminarily explore several (five or more) brittle fault zones that have recently shown tectonic activity, using a number of geological and geophysical methods over the area of the Polish part of the Sudetes and of the Fore-Sudetic block. The exploration is focused on a potential capacity of the faults to serve as conduits for thermal waters of deep circulation. The methods to be employed include studies of available archival data, such as integrated analysis of gravimetric and geological/tectonic maps, interpretation of digital topography elevation models and analysis of the drainage pattern in the study area. They include also field geophysical profiling, using methods of reflection seismics, electroresistivity tomography, VLF, magnetotellurics and radiometry. Samples for Ar-Ar geochronological study are to be collected from Cenozoic basaltoid occurrences adjacent to the selected active fault zones. The thermometric study will consist in monitoring indications of hundreds of electronic sensors deployed in the ground at a depth of ca 1 to 2 m for a period of at least 12 months. The geophysical and geological works will be followed by an estimation of the hydrogeological properties of the studied fault zones and – using methods of structural geology and hydrogeology – by an attempt to set up a forecast of their suitability for further prospection for thermal underground waters. The project is anticipated to be followed by prospection works proper in the frame of separate projects, which will include drilling of shallow exploration boreholes.

NOTES: _____

ACTIVITY OF FAULTS OBSERVED IN CAVES OF THE EASTERN ALPS: RESULTS OF THE FIRST YEAR OF MONITORING

Ivo Baroň ¹⁾, Lukas Plan ¹⁾, Bernhard Grasemann ²⁾, Ivanka Mitrović ¹⁾²⁾

¹⁾ Karst and Cave Group, Natural History Museum, Burgring 7, 1030 Vienna, Austria, ivo.baron@nhm-wien.ac.at, lukas.plan@nhm-wien.ac.at

²⁾ Department of Geodynamics and Sedimentology, University of Vienna, Althanstrasse 14, 1090 Vienna, Austria, bernhard.grasemann@univie.ac.at, ivanka.mitrovic@univie.ac.at

The Eastern Alps represent tectonically and seismically active area in collision realm between the Adriatic Plate and the Bohemian Massif (European Plate). One of the dominant neotectonic processes involves the Neogene and Quaternary lateral extrusion of parts of the Eastern Alps towards the Pannonian Basin, which comprises gravitational collapse and tectonic escape, coeval with north-south shortening. The scope of the FWF project “Speleotect” (2013-2017) is to document the neotectonic activity in the Eastern Alps in caves. Part of the study is focused on monitoring of the recent activity of the major fault systems of the Eastern Alps, such as the (1) Salzach-Ennstal-Mariazell-Puchberg (SEMP), (2) Mur-Mürz, (3) Periadriatic, (4) Lavanttal, and (5) Vienna Basin marginal Faults. Totally seven high-accuracy 3D crack-gauges TM71 were installed in five selected karst caves where faults that are younger than the cave and which could be correlated to one of these fault zones were detected. The recorded micro-displacement events have been correlated with known regional fault kinematics and with regional seismic activity. Within the first year of observation several micro displacement events could be observed and partly correlated with small earthquakes nearby. Further, in some caves mass movements could be recorded that accompany the tectonic moments.

NOTES: _____

APPLICATION OF GEOID MODELS TO PRECISE GNSS LEVELING: LGOM LOCAL NETWORK CASE STUDY

Radosław Baryła¹⁾, Katarzyna StępniaK¹⁾, Jacek Paziewski¹⁾,
Paweł Wielgosz¹⁾, Grzegorz Kurpiński²⁾

- ¹⁾ University of Warmia and Mazury in Olsztyn, Poland;
e-mail: baryla@uwm.edu.pl; katarzyna.stepniak@uwm.edu.pl
²⁾ KGHM Cuprum Ltd Research and Development Centre, Wrocław, Poland

Nowadays, the high accuracy of the horizontal coordinates obtained from GNSS measurements is easily achievable. On the other hand, the precision of GPS-derived heights is clearly lower comparing to the horizontal components. Nevertheless, state of the art measurements technique, field surveying equipment, data processing software and algorithms allow to achieve millimeter-level accuracy for ellipsoidal heights. In order to obtain the normal heights from GPS measurement, application of precise quasigeoid model is necessary. There are several available models covering the territorial of Poland, e.g. PL-geoid-201; EGM2008; “leveling geoid 2001”; European Gravimetric Quasigeoid model EGG2008.

In this paper we investigate performance of the application of the current geoid models to satellite leveling in precise local network at the area of Lower Silesia in Poland. In this region, simultaneous precise geometric and satellite leveling measurements were carried out on over 1000 km of leveling lines. The elaboration of the various geoid corrections was performed in relative mode on the basis of GNSS baselines with different length, height differences and orientation. The GNSS baselines between the monitored points were processed using individual GPS antenna calibrations and special strategy for precise local network processing with Bernese 5.2 software.

NOTES: _____

THE CREATION OF FLOOD RISKS MODEL USING A COMBINATION OF SATELLITE AND METEOROLOGICAL MODELS

Monika Birylo ¹⁾, Jolanta Nastula ²⁾, Joanna Kuczynska-Siehien ¹⁾

¹⁾ University of Warmia and Mazury in Olsztyn

²⁾ Space Research Center Polish Academy of Science

The aim of this research is to check if hydrosphere models derived from GRACE and GOCO missions observations can be useful for local hydrosphere conditions evaluation, and so, flood and drought prediction. The most important part of the work is to understand the phenomenon of water cycle.

Meteorological land hydrosphere models have been processed through an appropriate optimal filtration, and then scaling them to the level of GRACE. The Gaussian filter is checked with a radius of 300 km and 500 km for the calibration of hydrological models. In case of too much reduction in spatial resolution of hydrosphere models occurrence (above 10%), the optimal filter is appointed to the calibration of hydrological models. Each of used hydrological models is examined in terms of decrease in signal amplitude (analysis using spatial trend). The combined GRACE model and hydrosphere model has been created. The aim was to create a model of combined credibility of these studies and to verify the usefulness of models created with GRACE and GOCO data. The limit of water content in the area (and hence the lack of opportunities to absorb further rain water) and expected precipitation readings from meteorological models allows for faster response and protect local people and the environment, and generating risk maps.

NOTES: _____

ANALYSIS OF POST MINING GROUND SURFACE MOVEMENTS - A CASE STUDY OF THE WAŁBRZYCH AREA (SW POLAND)

Jan Blachowski¹⁾, Wojciech Milczarek¹⁾, Piotr Grzempowski¹⁾

¹⁾ Wrocław University of Technology, Faculty of Geoengineering, Mining and Geology, Geodesy and Geoinformatics Division, Wybrzeże Wyspińskiego 27, Wrocław, Poland

The paper focuses on the analysis of post-mining ground surface movements registered in the period of 20 years from the end of underground hard coal mining. The study has been done for the Wałbrzych area in SW Poland, until the mid-nineties a former hard coal mining center. The analysis has been performed in geographic information systems (GIS) using national precise levelling data from 1994 and 2014 and using various interpolation function, i.e. the spline, natural neighbor and kriging. Accuracy of interpolation results has been tested and the continuous fields representing movement of ground surface in the analysed period have been correlated with plans of the abandoned coal mines and tectonics of the area. It has been found that the former mining terrain areas in Wałbrzych experience significant movement to the present day.

KEYWORDS: underground coal mining, abandoned mines, levelling, subsidence, interpolation, GIS.

NOTES: _____

DETERMINATION OF THE COMMON-MODE ERRORS IN LOCAL GNSS-BASED NETWORKS FOR GEODYNAMICAL STUDIES

Janusz Bogusz ¹⁾, Mariusz Figurski ¹⁾, Maciej Gruszczyński ¹⁾, Anna Kłos ¹⁾

¹⁾ Military University of Technology, Faculty of Civil Engineering and Geodesy

The information about lithospheric deformations may be obtained nowadays by analysis of velocity field derived from permanent GNSS observations collected by precise satellite positioning systems like Polish ASG-EUPOS. Despite developing more and more precise models of e.g. ionospheric and tropospheric corrections, the permanent station's residuals must still be considered as coloured noise. Meeting the GGOS (Global Geodetic Observing System) requirements, we are obliged to study the correlations between residuals, which are the result of common mode error (CME) in time series. This type of error may arise from mismodelling of satellite orbits, the Earth Orientation Parameters (EOP), large-scale atmospheric effects or unmodelled satellite antenna phase centre variations which together cause correlations between station's solutions. The above mentioned parameters precisely determined reveal in poor correlation between residuals (Pearson correlation coefficient between 0.2 and 0.4 for detrended and deseasonalised data). For this research we used a seven-year span coordinate time series registered by 38 GNSS permanent stations located near the Sudeten Mountains and on the Sudeten monocline. The determination of stable velocities requires us to filtrate the coordinate time series using different methods. In this study the weighted stacking method was applied. This approach allows to eliminate the CME that can be observed in regional networks up to a few tens of kilometres extent. It is worth mentioning that the daily computed CMEs do not exceed 1 mm and can reach both positive and negative values. We calculated L1 and L2 norms in order to quantify the influence of removing CME. This type of norms are a kind of mean and standard deviation describing the quality of GNSS station solution. The relative reduction of the standard deviation before and after spatial filtration of residuals is equal to 8% and 10% for horizontal and vertical components, respectively. The above-described fact results in more stable time series, and consequently highly precise data. Time series correlation analysis was carried out in terms of distance from the GNSS stations network barycentre. The presentation summarizes analysis, which made it possible to provide more stable station's velocities.

NOTES: _____

INVESTIGATION OF NON-LINEARITY OF GNSS TIME SERIES USING WAVELET DECOMPOSITION

Janusz Bogusz¹⁾, Mariusz Figurski¹⁾, Anna Kłos¹⁾

¹⁾ Military University of Technology, Faculty of Civil Engineering and Geodesy

The GNSS-based systems are being used nowadays for a variety of applications such as high-accuracy positioning, navigation or geodynamical studies, for which velocities of permanent stations are applied. The least-squares processing of GNSS observations results in time series which compose of the functional (deterministic) model and stochastic part. The first one describes the long-term trend (interpreted as station's velocity) as well as the sum of periodic functions with threefold origin of: geophysical sources, model errors and numerical artefacts. The deterministic part is widely investigated using least-squares estimation (LSE) which assumes constant amplitudes and phases of seasonal variations. A wavelet decomposition (WD) may stand as an alternative technique for LSE. With this method the low-frequency bias and high-frequency terms are being separated from the original signal. The sum of the bias and selected details can compose into deterministic part. In this research we used the orthogonal and symmetric Meyer wavelet to decompose North, East and Up time series from selected IGS (International GNSS Service) globally distributed stations. The details corresponding to the frequency intervals of: 0.3 to 0.9 cpy (1.1-3 years), 0.7 to 1.8 cpy (8 months-1.1 year), 1.3 to 3 cpy (4-8 months) and 2.5 to 7 cpy (2-4 months) were investigated. It was noticed here that seasonal amplitudes are rather time-changeable than constant especially for periods lower than 1 year. The most interesting fact is that some of the stations are influenced mainly by one-year variations while others have ter- or quarter-annual terms that prevail in amplitude even the annual one. The WD seasonal part removal results here in amplitudes higher than LSE-estimated ones from 1 to few millimetres. The frequencies lower than 0.3 cpy (derived with WD) were treated here as signal approximations, which can be interpreted as station's velocity and analyzed as non-linearity of the GNSS-based velocity. The key of trend non-linearity analysis is mainly to answer the question whether the long-term correlations still affect the signal although deterministic part removal will or will not have any impact on meeting the GGOS (Global Geodetic Observing System) requirements of velocities stability level. The presentation will discuss over the differences both between seasonal amplitudes determined with LSE and WD for different IGS sub-networks and between linear trend estimated from LSE and the last approximation (not necessarily linear) from WD, but still being able to be interpreted as geodetic velocity.

THE VALIDATION PROCEDURE IN THE MAFA METHOD

Sławomir Cellmer ¹⁾

¹⁾ University of Warmia and Mazury in Olsztyn, Poland

The Modified Ambiguity Function Approach (MAFA) is a method of precise, satellite positioning. So far many tests of this method were performed. The results of these tests show that this method is efficient. It is even possible obtaining a good solution on the basis of GNSS data from single epoch. In this article a validation procedure for the MAFA method is proposed. This procedure is based on defining the confidence region of the float solution and then testing whether the final solution is included in this region. To test the new validation procedure the experiment was designed and performed. The single epoch solutions for some baselines have been analyzed and the results of this research are presented in this paper. Finally some conclusions were drawn on the basis of this analysis.

MILLENNIAL CYCLES OF MEAN SEA LEVEL EXCITED BY EARTH ORBITAL HARMONICS

Yavor Chapanov ¹⁾, Cyril Ron ²⁾, Jan Vondrák ²⁾

¹⁾ National Institute of Geophysics, Geodesy and Geography BAS, Sofia, Bulgaria

²⁾ Astronomical Institute AS CR, Prague, Czech Republic

The millennial climate cycles affect all geosystems accompanied by global environmental changes. These cycles change the polar ice thickness during ice ages what results in the changes of Mean Sea Level (MSL) and consequently in changes of the principal moment of inertia C . The Earth reacts on these changes by variations of rotation velocity. The main cause of ice age periods are so called Milankovic orbital cycles. These orbital cycles are generated by variations of precession, eccentricity and axial tilt with main periods of about 23Ka, 40Ka and 100Ka, respectively. The common millennial cycles of MSL and Earth orbit variations are studied by means of reconstructed MSL time series for the last 800Ka and insolation data from the latest orbital solution of Laskar et al. (2011). The models of the common millennial cycles of MSL and insolation variations are based on partial Fourier approximations with different period bands around 23Ka, 18Ka, 11.5Ka, 7.5Ka, 6Ka and 2.3Ka, respectively. These models may help to analyze the Earth rotation cycles caused by millennial solar activity cycles, such as Hallstatt cycles.

ORIGIN AND EVOLUTION OF ASTHENOSPHERIC LAYERS

Leszek Czechowski¹⁾, Marek Grad

¹⁾ Institute of Geophysics, ul. Pasteura 7, 02-093 Warszawa, Poland

Traditionally, the boundary between the lithosphere and the asthenosphere (LAB) is defined by a difference in response to stress: the lithosphere remains elastic or brittle, while the asthenosphere deforms viscously and accommodates strain through plastic deformation. The basic differences of lithosphere and asthenosphere properties could be explained as a result of the temperature/pressure and the stress tensor. We investigate simultaneously the processes of formation and evolution of low viscosity layers ('asthenospheric layers') resulting from both factors. We find that the time scale of the changes of the low viscosity layer could be of the order of 30 Myr if existence of the layer is determined by the thermal conditions. The characteristic time of the low viscosity layer resulting from stress changes could be much shorter depending on the tectonic situation.

NOTES: _____

MONUMENT INSTABILITY OF GNSS PERMANENT STATION INFERRED FROM PRECISE TILT OBSERVATIONS

Lubomíra Gerhátová ¹⁾, Ján Hefty ¹⁾, Juraj Papčo ¹⁾, Martina Mináriková ¹⁾

¹⁾ Slovak University of Technology, Faculty of Civil Engineering,
Department of Theoretical Geodesy, Radlinského 11, 813 68 Bratislava, Slovakia;
e-mail: lubomira.gerhatova@stuba.sk, jan.hefty@stuba.sk, juraj.papco@stuba.sk,
martina.minarikova@stuba.sk

Recent development of modern measuring devices, new observation technologies, GNSS data modelling and processing, allow geodynamical monitoring with millimetre or even sub-millimetre precision. A number of factors that affect the final accuracy of the actual position of the GNSS antenna have to be considered in the interpretation of observations. The disturbing environmental influences, like temperature variability, direct exposure of monument to sunlight, wind speed and direction, groundwater variability, etc. are factors that to a certain extent could affect the stability of the monument of the geodetic GNSS antenna.

In the paper is presented an analysis of precise tilt observations. The sensor measuring continuously inclination was placed on the on concrete pillar of the EPN GNSS permanent station in Modra-Piesok - MOP2. Time series of inclination observations are independent from the satellite GNSS observations and provide new, qualitative different information about the monument stability. The analyses related to the effect of temperature variability as well as to the dependence of the pillar tilt during the intervals with or without direct sunshine demonstrate the non-negligible instability of the concrete pillar. The results obtained from time series of pillar tilt observations are compared with results of short-term (sub-daily) coordinate variations inferred from GNSS analyses.

KEYWORDS: precise inclination sensor observations, GNSS permanent station monument tilting, environmental influences on pillar instability.

NOTES: _____

THE CREATION OF A MODEL OF RELATIVE VERTICAL CRUSTAL MOVEMENT ON POLAND'S TERRITORY ON THE BASIS OF THE DATA FROM ACTIVE GEODETIC NETWORK EUPOS (ASG EUPOS)

Kamil Kowalczyk¹⁾

¹⁾ University of Warmia and Mazury in Olsztyn, ul. Michała Oczapowskiego 210-719 Olsztyn

Since the satellite systems have been operative, the data from permanent stations have been used for modelling the changes of the coordinates of the stations. One of the components of the changes is the change of the location of the Earth's crust surface. Both horizontal and vertical changes are analysed, as well as their velocities are determined. The system of ASG EUPOS station has been operative in Poland since 2008. The longer the system operates, the more possible it will be to create a model of the vertical crustal movements on Polish territory. The vertical movements can be determined as absolute, or relative. In order not to include the influence of transformation errors, the changes of geoid and eustatic, the changes of velocity between the chosen ASG EUPOS stations can be used to the creation of the model. The purpose of this article is to determine various models of the relative vertical movements from satellite data, as well as their evaluation. The authors of the article concentrated mainly on the determination of the relative velocities, on their equalisation and visualisation. Relative vertical movements between the stations were determined on the basis of various data and for various epochs. They were equalised in several versions. As a result, several models of relative vertical movements were created and evaluated. In addition, there were established the accuracy possibilities of determining the model of the relative vertical movements on the basis of the data from ASG EUPOS.

NOTES: _____

GNSS-WARP - REAL-TIME GNSS PPP SOFTWARE

Tomasz Hadas ¹⁾, Jaroslav Bosy ¹⁾

¹⁾ Wrocław University of Environmental and Life Sciences, Institute of Geodesy and Geoinformatics

Precise Point Positioning (PPP) is a powerful technique to process GNSS (Global Navigation Satellite System) signals, e.g. for maritime navigation and deformation monitoring. As an autonomous technique, it has the advantage over relative positioning, that the position is estimated independently for each receiver. There are still, however, some limitations of PPP, the first of all is the long convergence time. Until recently the PPP was dedicated for postprocessing, but since April 2013 IGS Real-Time Service (RTS) provides precise products in real-time.

In order to challenge PPP limitations and evaluate real-time PPP performance, the GNSS-WARP (Wrocław Algorithms for Real-time Positioning) software has been developed from scratch at Wrocław University of Environmental and Life Science (WUELS) in Poland. An example campaigns using final products and IGS-RTS streams for several GNSS receivers were performed. GPS only and GPS+GLONASS solutions were calculated for static and kinematic mode using the developed software.

The average accuracy of a position obtained with GNSS-WARP using GPS final products was 0.5mm for North, 1.5mm for East and 2.0mm for Up component when processing 24 hours of data. In case of real-time products application and 24-hour long set of data, similar accuracies were obtained: 0.5mm, 1.0 and 2.0 for North, East and Up component respectively. The convergence time increased to about 3 hours, in contrast to 1 hour for final products. The inclusion of GLONASS data provides worse results, which may be explained by a significantly lower performance of real-time GLONASS products than GPS products. Although the accuracy of coordinates was still below few millimetres, the residuals with respect to other solution reached up to 2 cm for horizontal components and 5cm for vertical component.

NOTES: _____

GEOLOGICAL EVIDENCE FOR EARTHQUAKES CLOSE TO THE DESTROYED ROMAN CITY OF CARNUNTUM (AUSTRIA)

Esther Hintersberger¹⁾, Kurt Decker¹⁾, Christopher Lüthgens²⁾,
Markus Fiebig²⁾

¹⁾ Universität Wien, Dept. für Geodynamik und Sedimentologie, Althanstr. 14,
A-1090 Wien,

²⁾ BOKU Wien, Institut für Angewandte Geologie, Peter-Jordan-Str. 70,
A-1190 Wien

The Roman city of Carnuntum was founded in 50 AD at the eastern margin of the Vienna Basin (Austria), a pull-apart basin between the Alps and the Carpathians. Archaeological excavation suggest extensive destruction of the city by an earthquake ($M \sim 6$) in the middle of the 4th century (Kandler, 2006, Decker, 2006). However, since written historic references for earthquakes in the Vienna Basin start only in 1468 AD, the "Carnuntum earthquake" was considered to be a highly speculative event. We present here results from paleoseismological trenching that support the idea of an earthquake destroying Carnuntum.

The Vienna Basin is characterized by moderate historical seismicity ($I_{max}/M_{max} = 8/5.3$; ACORN, 2004) during the last ~ 500 years. Most of the earthquakes within the Vienna Basin are related to the NE-SW striking sinistral strike-slip Vienna Basin Transfer Fault (VBTF) delimiting the basin towards the east. However, seismicity is quite heterogeneously distributed along the VBTF, varying from very active segments at the southern and northern tips to an apparently seismically totally locked segment in the central part of the basin, the so-called Lasseer segment, close to the city of Carnuntum. However, geomorphic and subsurface geophysical data reveal that this fault segment indeed shows horizontal Quaternary displacement of several tens of meters, generated by several subfaults of a negative flower structure.

Since the Lasse segment is the closest part of the VBTF to Carnuntum (~ 8 km), we excavated two paleoseismological trenches at the tectonically controlled western margin of a Pleistocene Danube terrace (luminescence dated to 200-300 ka). Here, the VBTF has produced a ~ 25 m high scarp. The main fault zone within the trench dissects the Pleistocene coarse gravels and intercalated sand lenses whose layering dips towards the fault and against the paleo-current. In addition, several smaller faults showing horizontal displacements up to 0.5 m are observed. The hanging wall consists of colluvial sediments and sandy layers from extrem flooding events. Based on displaced layers, tension cracks and colluvial wedges, at least 3 major earthquakes since ~ 90 ka can be determined, with the most recent one occurring after ~ 40 ka and reaching almost the present-day surface.

Therefore, assuming the apparently seismically locked Lasse segment might have acted as the source of the "Carnuntum earthquake", the Lasse segment should not be considered to be inactive or locked, but to be in a normal interseismic interval.

REFERENCES:

Acorn (2004). Catalogue of earthquakes in the region of the Alps–Western Carpathians–Bohemian Massif for the period from 1267 to 2004, Computerfile, Vienna (Central Institute for Meteorology and Geodynamics, Department of Geophysics) - Brno (Institute of Physics of the Earth, University Brno).

Decker, K., Gangl, G., Kandler, M. (2006). The earthquake of Carnuntum in the fourth century A.D. - archeological results, seismological scenario and seismotectonic implications for the Vienna Basin fault, Austria. *Journal of Seismology* 10, 479-495.

Kandler, M., Decker, K., Gangl, G. (2006). Archäologische Befunde von Erdbebenschäden im Raum von Carnuntum und ihre seismotektonische Interpretation. In: Waldherr G. H./Smolka A. (ed.), *Antike Erdbeben im alpinen und zirkumalpinen Raum*. *Geographica Historica* 24, 116–132.

NOTES:

WEST BOHEMIA / VOGTLAND EARTHQUAKE SWARMS: WHAT ACTUALLY WE KNOW ABOUT THEM?

Josef Horálek¹⁾, Hana Čermáková

¹⁾ Institute of Geophysics, Academy of Sciences, Czech Republic

The origin of earthquake swarms is still unclear. The swarms typically accompany volcanic activity at the plate margins but also occur in intracontinental areas. West Bohemia-Vogtland (border area between Czech Republic and Germany) represents one of the most active intraplate earthquake-swarm areas in Europe. Above, this area is characteristic by high activity of crustal fluids. Seismicity occurs there in the area of about 3 000 km² and is characterised by a frequent reoccurrence of $ML < 4.0$ swarms; focal depths vary from 5 to 20 km. The Nový Kostel focal zone (NK), where more than 35 000 events were recorded during the last 25 years, dominates the recent seismicity of the whole region. There were swarms in 1997, 2000, 2008 and 20011 followed by reactivation in 2013, and extraordinary non-swarm activities (mainshock-aftershock sequences) in 2014 which form a focal belt of about 15 x 6 km.

The swarms are located close to each other in at depths from 6 to 13 km. The 2000 ($ML \leq 3.3$) and 2008 ($ML \leq 3.8$) swarms are “twins” i.e. their hypocenters fall precisely on the same portion of the NK fault; similarly the 1997 ($ML \leq 2.9$), 2011 ($ML \leq 3.6$) and 2013 ($ML \leq 2.4$) swarms also occurred on the same fault segment. The mainshock-aftershock sequences in May ($ML \leq 3.6$ and $ML \leq 4.5$) and August ($ML \leq 3.6$) were located on the edge between 2008 and 2011 swarms. The individual swarm activities differ considerably in their evolution, mainly in the rate of the seismic-moment release and foci migration. We disclose that all the $ML \geq 2.7$ swarm events, which occurred in the 1997 to 2014 period, are located in a few dense clusters. It implies that the most of seismic energy in the individual swarms has been released in step by step rupturing of one or a few asperities.

The source mechanism patters of the individual swarms indicate a complexity of the NK zone. We found a several families of mechanisms, which fit well geometry of respective fault segments being determined by means of the double-difference location: the 2000 and 2008 swarms activated the same portion of the NK fault, hence the source mechanisms are similar. The 1997 and 2011 swarms took place on two differently oriented fault segments, thus two different source mechanisms occurred: the oblique-normal on the one segment and the oblique-thrust type on the other one.

The moment tensors of earthquake swarm in 1997 show fairly different amount of non-DC components in source mechanisms compared to those in 2000 and 2008. It appears that swarm earthquakes, which occurred on the optimally oriented faults relative to the local tectonic stress, are pure shears. It is a case of 2000 and 2008 swarms in which the faulting was governed merely by local tectonic stress. The 1997 swarm in which non- DC mechanisms occurred may indicate occurrence of tensile earthquakes on a less favourably oriented fault segment.

The existing results do not allow us to explain properly why accumulated strain energy releases mostly in earthquake swarms and only rarely in one stronger single earthquake accompanied by aftershock sequence. Nevertheless, some results point to a connection between pressurized fluids in the crust and the earthquake swarm occurrence. Taking this into account, we may infer that earthquake swarms occur on short fault segments with heterogeneous stress and strength, which are affected by crustal fluids. Pressurized fluids reduced normal component of the tectonic stress and lower friction. Thus, critically loaded and favourably oriented faults are brought to failure and the swarm activity is driven by the differential local stress.

NOTES: _____

EVALUATION OF CURRENT GEODYNAMIC ACTIVITY OF THE WALISZOW-NOWA MORAVA TECTONIC ZONE IN THE VIEW OF CRACK GAUGE TM71 MEASUREMENTS IN CHOSEN POINTS

Olgierd Jamroz¹⁾, Josef Stemberk²⁾, Stefan Cacoń¹⁾

- ¹⁾ Institute of Geodesy and Geoinformatics, Wrocław University of Environmental and Life Sciences, Grunwaldzka 53, 50-357 Wrocław, Poland;
e-mail: olgierd.jamroz@igig.up.wroc.pl
- ²⁾ Institute of Rock Structure and Mechanics, Academy of Sciences, Czech Republic, Prague, V Holešovičkách 41, 182 09 Prague 8, Czech Republic;
e-mail: stemberk@irsm.cas.cz

Three-dimensional dilatometer (crack gauge) TM71 was designed in the 60-ies of XX century for monitoring tectonic discontinuities activity. During 1974, these devices have been also used on the geodynamic networks in Sudety Mts., SW Poland. The instruments measure relative displacement with a precision of better than ± 0.007 mm and angular rotations with a precision of better than 0.00016 rad. Presented TM71 were located near Sudetic Marginal Fault in the Waliszów-Nowa Morava tectonic zone, SW Poland. The gauges allowed to detect relative micro-displacement and angular rotation between two adjacent rock blocks using the moiré phenomenon of optical interference. Each gauge is equipped with two orthogonal pair of glass plates with spiral and rectangular grids. Registration was provided by analog and digital photographic method with one-month frequency. Polish positions of TM71 were included in the European monitoring network EU TecNet. EU TecNet was founded by the Institute of Rock Structure and Mechanics, Academy of Sciences, Czech Republic in Prague. Currently it contains about 150 crack gauges TM71 fixed in Europe, Asia, Africa, North and South America. This study presents a comparison of the results of investigations using the TM71 data series recorded at stations: Janowice Wielkie, Wolany, Dobromierz, Złoty Stok, Bear Cave in Kletno and Nowy Waliszów. Data has allowed to determine the tectonic creep trends in the research area. Influence of technogenic and seismic factors were also considered in the interpretation of the results.

NOTES: _____

FILTERING THE RESULTS OF ZIGBEE DISTANCE MEASUREMENTS WITH RANSAC ALGORITHM

Joanna Janicka¹⁾, Jacek Rapiński¹⁾

¹⁾ University of Warmia and Mazury, Institute of Geodesy

Until recently positioning system was mainly based on the satellite observations. However this resolution is not enough because nowadays people want to know their position also inside buildings or below the ground. The traditional satellite positioning system cannot be used in such places but there are some new technologies that allows to realize indoor positioning. Among those methods there is a conception of the RF ranging technologies. This method is based on the distance measurement. A new ranging approach based on the ZigBee protocol that is implemented in Atmel AT86RF233 chip was.

Analyzing the results of the measurement was observed that a large number of them has been disturbed and significantly differs from the correct value (test value). Thus to obtain correct distance filtering of the measurement results must be introduced in order to "smooth" the results. There is a necessity to find an algorithm that filters the observations choosing only those correct. The authors present a RANSAC algorithm that allows removing disturbances from the data.

KEYWORDS: ZigBee distance measurement, RANSAC, filtering.

NOTES: _____

CONTEMPORARY VERTICAL MOVEMENTS ON THE FAULTS OF THE SUDETES IN THE AREA OF POLISH AND CZECH REPUBLIC BASED ON LEVELING DATA

Adrian Kaczmarek¹⁾, Stefan Cacoń¹⁾, Josef Weigel²⁾

- ¹⁾ Wrocław University of Environmental and Life Sciences, Institute of Geodesy and Geoinformatics,
ul. Grunwaldzka 53, 50-357 Wrocław, Poland
e-mail: stefan.cacon@igig.up.wroc.pl; adrian.kaczmarek@igig.up.wroc.pl
- ²⁾ Brno University of Technology, Faculty of Civil Engineering, Institute of Geodesy, Veveří 95, 602 00 Brno, Czech Republic
e-mail: weigel.j@fce.vutbr.cz

In this studies on contemporary tectonics in areas of tectonic zones used data of precision leveling 1st and 2nd class. The measurement data were from different periods. Analyzes were performed for 26 lines (23 lines of 1st class and 3 lines of 2nd class). Among these were isolated segments leveling which crossed main tectonics faults analyzed area. Changes in the benchmarks were references to the benchmark relatively constant for each segments leveling. Benchmark had to be stable over time.

In the area of the Eastern Sudetes on the side of the Czech Republic found the subsidence of the benchmarks in the areas of fault zones (-0.4 mm/year). Elevation the benchmarks occurred in areas of the city Jeseník and Svitavy ($+0.2$ mm/year). On the Polish side of the Eastern Sudetes elevation the benchmarks shown on the southern wing of the Sudetic Marginal Fault ($+0.3$ mm/year - area of the Złoty Stok), as well as elevation the benchmarks in the area of Kudowa Zdrój ($+0.8$ mm/year) in the neighborhood of tectonically active zone Hronov – Porici. In the part Western Sudetes vertical movements on the Polish side were between $-0.2 \div -0.8$ mm/year (subsidence) and $+0.2$ mm/year (elevation). On the Czech Republic side vertical velocities were between $-0.2 \div +0.4$ mm/year respectively.

This type of analysis should be supplemented by other studies such as geological, seismic etc.

KEYWORDS: precise leveling, Eastern and Western Sudetes, tectonic fault.

NOTES: _____

FIRST RESULTS OF ^{222}Rn ACTIVITY CONCENTRATION MEASUREMENTS AS A POSSIBLE PRECURSOR OF TECTONIC EVENTS REGISTERED IN UNDERGROUND GEODYNAMIC LABORATORY OF SPACE RESEARCH CENTER IN KSIĄŻ (THE SUDETES, SW POLAND)

Marek Kaczorowski ¹⁾, Tadeusz A. Przylibski ²⁾, Lidia Fijałkowska-Lichwa ³⁾,
Damian Kasza ²⁾, Roman Wronowski ¹⁾

- ¹⁾ Polish Academy of Sciences, Space Research Centre, Warszawa, Poland;
e-mail: marekk@cbk.waw.pl, roman@cbk.waw.pl
- ²⁾ Wrocław University of Technology, Faculty of Geoengineering, Mining and Geology, Wrocław, Poland;
e-mail: Tadeusz.Przylibski@pwr.edu.pl Damian.Kasza@pwr.edu.pl
- ³⁾ Wrocław University of Technology, Faculty of Civil Engineering, Wrocław, Poland; e-mail: Lidia.Fijałkowska@pwr.edu.pl

Tectonic events in Książ region (Świebodzice basin, Sudetes) observed as vertical movements as well as base inclinations were characterized in previous papers. Tectonic events are the cause of strong (up to 10 tidal amplitudes) asymmetric changes of water level in hydrostatic clinometers localized within the system of active tectonic faults. In 2014, between May 8-th and June 23-th asymmetric changes of water level greater than 5 tidal amplitudes have been observed. These changes were the result of the most recent tectonic event in Książ area. After June 17-th reverse trend – compensation effect was also observed.

From May 18-th radon detectors (SRDN-3 probes) at the same time have started to register clear increasing ^{222}Rn activity concentration in the air of whole space of Underground Laboratory galleries in Książ. The growth of radon concentration reached around 100% of previously measured values in all of 5 operated probes.

^{222}Rn activity concentration growth preceded tectonic event by 4 days. As radon concentration growth was observed 4 days prior to the kinematic effect authors will try to describe relations between tectonic event and radon pumping from rocks to galleries of the laboratory in Książ. In future it may be possible to use radon as a precursor of tectonic activity. Obtained results encourage authors to continue research in Książ on the monitored faults system.

KEYWORDS: Geodynamic, Earth tides, plumb line variations, bedrock, fault blocks, plate tectonic, neotectonic, tectonic effects, non-tidal signals, radon, radioactivity, water-tube tiltmeters, signals analysis, filtering.

NEW CONCEPT OF INTEGRATED TECTONIC STUDIES IN THE GEODYNAMIC LABORATORY OF SRC IN KSIĄŻ

Marek Kaczorowski ¹⁾, Andrzej Borkowski ²⁾, Kazimierz Ćmielewski ²⁾,
Piotr Gołuch ²⁾, Janusz Kuchmister ²⁾, Ryszard Zdunek ¹⁾

- ¹⁾ Space Research Centre, Polish Academy of Sciences, Geodynamic Laboratory in Książ, Bartycka 18A, 00-716 Warszawa, Poland
- ²⁾ Wrocław University of Environmental and Life Sciences, Institute of Geodesy and Geoinformatics, Grunwaldzka 53, 50-357 Wrocław, Poland

The geodynamic laboratory of SRC in Książ is the only one in Poland and one of the few underground observatory in Europe, in which research is carried out a broad spectrum of geodynamic phenomena. Laboratory instruments (clinometers, gravimeter and other) record: field changes of gravitational forces caused by tidal of Earth and non-tidal effects, contemporary tectonic activity in the Sudetes region in the aspects of movement and of the bed rock inclination, signals vibrations own of the Earth and the low-frequency (10^{-3} Hz to 10^{-4} Hz) atmospheric infrasound waves. These studies are possible to realize due to exceptionally favorable natural conditions of the laboratory, such as: an underground system of passages hollowed in a concise and non-absorbent rocks, stable temperature and humidity, and space perfectly suited for installation of highly sensitive geodynamic instruments, that allow to conduct the high-precision measurements. The permanent instruments of the laboratory allowing to conduct studies of mechanisms of contemporary tectonic activity of the Sudetes region, based on current observations of phenomena (in real time), which is unique in the Polish conditions.

Laboratory instruments record vertical movements and tilt of the substrate, Its do not provide information about the main component of the tectonic signal, ie. horizontal movements of substrate. Simultaneously recorded observations of the effects of tectonic activity are purely local, limited to space of laboratory passages. A new concept of integrated tectonic studies includes a plan to supplement the information geodynamic by extending the measurement area of the external laboratory environment, covering the castle hill and the so-called "main southern fault "and the installation in the underground of instruments (gap gauges and extensometers), which will provide the missing information about the horizontal movements of the substrate.

Research-measurement network will be established in surrounded of the laboratory. In the geodetic network will be carried out observations using modern measuring techniques: short-range laser scanning, precise electronic total station, interferometer, precise electronic level, electronic two-axis high precision inclination sensors and 3D photogrammetric gap gauges. The established spatial geodetic control and survey network in connection with measuring instruments and measuring apparatus which have already existed in the laboratory and the ones that will created specifically by authors will provide a holistic-comprehensive picture of the processes that take place in the Książ Massif: tectonic deformation, the bed rock tilts, vertical movements and displacements on faults.

Geodynamic information obtained from the research-measurement network will be integrated with the observations recorded by instruments that are located in the underground of the laboratory and the two GNSS stations located on opposite flanks of the "main southern fault". An integrated measuring-interpretative system will allow the creation of a multi-component model of Książ Massif mechanics, and getting to know the direction, timing and amplitude characteristics of tectonic events. The multi-component model enables to estimate the compensation effect of tectonic deformation and the main direction of stress.

KEYWORDS: geodynamics, tectonic activity of the Earth, tectonics of the Sudetes region, geodetic and geophysical measuring instrume Graphic analysis of the objective function in the MAFA method.

NOTES: _____

GNSS METEOROLOGY. NEAR REAL-TIME ESTIMATION OF THE STATE OF TROPOSPHERE OVER THE AREA OF POLAND

Jan Kaplon¹⁾

¹⁾ Wrocław University of Environmental and Life Sciences, Institute of Geodesy and Geoinformatics, Grunwaldzka 53, 50-357 Wrocław, Poland;
e-mail: jan.kaplon@igig.up.wroc.pl

GNSS signal travelling through the troposphere layer of atmosphere (0 to 10 km a.s.l.) is refracted and in effect delayed. The amount of delay obtained during the GNSS data processing carries the information of the state of troposphere, which may be used for positioning improvement as a priori information, used to calculate the water vapor content in the atmosphere or assimilated to the numerical weather prediction (NWP) models to obtain more detailed information of the state of troposphere. Institute of Geodesy and Geoinformatics at Wrocław University of Environmental and Life Sciences hosts the service calculating the zenith troposphere delay (ZTD) and its horizontal gradients for the area of Poland in near real-time (NRT). The GNSS data is obtained from permanent stations of ASG-EUPOS national network as well as from stations belonging to EUREF Permanent Network (EPN). The troposphere parameters are calculated for approx. 120 stations each hour since November 2012 and are included to the EUMETNET EIG GNSS Water Vapor Programme (E-GVAP). Paper presents the development and current status of NRT ZTD service and the quality assessment of estimated troposphere parameters with respect to EPN products and NWP data.

NOTES: _____

FLUVIAL TRANSPORT OF THE LARGEST GRAINS IN RIVER BED: TERRESTRIAL LASER SCANNING MONITORING (ŁOMNICZKA RIVER, KARKONOSZE MTS.)

Marek Kasprzak¹⁾, Marcin Ziaja²⁾, Grzegorz Jóźków²⁾, Andrzej Borkowski²⁾

¹⁾ Institute of Geography and Regional Development, University of Wrocław, Poland, pl. Uniwersytecki 1, 50-137 Wrocław, Poland;
e-mail: marek.kasprzak@uni.wroc.pl

²⁾ Department of Geodesy and Geodynamics, Wrocław University of Environmental and Life Sciences, Poland, ul. Grunwaldzka 53, 50-357 Wrocław, Poland

The main surface process responsible for contemporary transformation of relief in the Sudetes Mts is fluvial transport. Despite a relatively good recognition of flow conditions due to long-term hydrological measurements, our knowledge about bedload movement in the rivers of the Sudetes is still modest. The bulk of relevant information has been provided by observations and measurements carried out in the Karkonosze Mountains, on the Łomnica river and its tributaries, including an instrumented catchment of Wilczy Potok (creek) (Traczyk 1991, Bieroński, 1992 Katrycz 1998). However, none of the previous studies provided data on the mobility of the largest clasts in mountain streambeds (boulders > 256 mm). The absence of quantitative analysis of the biggest fraction seems related to the fact that retention time in the river bed is long while the frequency of hydrological phenomena capable of transporting material of this size is low. Field measurements carried out by traditional methods (selection of clasts from sedimentation traps) are of limited value to record movement of coarse fractions too. On the other hand, observations conducted during the largest flood events (e.g. in 1997) confirm episodic ability of the current to displace even the biggest rock elements (Kasprzak 2010). Thus, the question arises whether the large boulders are residual lag deposits, revealed through selective washing of the weathered rock and stationary in the long-term, or they are mobile components of debris in the mountain rivers. To resolve this issue, repeated terrestrial laser scanning may be helpful.

This text presents results of monitoring carried out in the Łomniczka river bed in the eastern part of Polish Karkonosze Mountains. The study reach includes a steeply inclined section of the river bed (local slope of channel longitudinal section is over 133 ‰), with a length of about 30 m, where large boulders and blocks are the main components of the lag deposit. The section is located within a Pleistocene alluvial fan at the foot of a fault-generated escarpment (Kasprzak 2009). We performed three measurement campaigns using terrestrial laser scanner Leica Scan Station C10. Measurements were taken from two positions, with the horizontal and vertical

resolution of 5 mm. In order to join scans and to allow their georeferencing to the national coordinate reference system 3 reference points were stabilized. The measurement of reference points were made using GPS-RTK and tachimeter technique. The measurements of the river bed were held on 10 November 2011, 23 October 2012 and 24 October 2013. Autumn was chosen as a period of measurement because of low discharges and maximum emergence of the bed. The data obtained were processed using Leica Cyclone software to create georeferenced point cloud of each scan, to produce DEMs and DEMs of differences (DoD), the latter showing changes in erosion and accumulation in the river bed. Scanning yielded a total of about $1.6 \cdot 10^8$ points during each measurement campaign. The 3D accuracy of the combined point cloud was from 3 mm to 6 mm in individual measuring campaigns.

The resulting DoDs (2011–2012, 2012–2013, 2011–2013) indicate that bed sediment is in motion. The largest rock elements identified to change position during this period had the longest axis of 800 mm and moved over a distance of 2 meters. Within the test reach sediment movement was most evident along a sinusoidal line of the current. The DoDs obtained document an existence of alternating zones of erosion and deposition of the finer fractions of sediment in local sedimentary traps (bed hollows and shadows). Another zone of the river bed subject to transformation are banks suffering from lateral erosion. In the analyzed period higher dynamics was recorded in the period 2012–2013.

The changes in the bed morphology due to movement of the largest bedload components likely occurred during floods. Discharges of the Łomniczka river are monitored at the gauge in the town of Karpacz, below the study reach. According to IMGW (Institute of Meteorology and Water Management) the annual average flow (SSQ) at this location is $0.42 \text{ m}^3 \text{ s}^{-1}$, while the maximum recorded flow was $51.6 \text{ m}^3 \text{ s}^{-1}$ (7th July 1997, more than 120 times the average annual flow). Hydrological data for the period of measurements will be obtained, and monitoring continues. On the basis of the results obtained so far we confirm the usefulness of the method in the studies of bedload transport in mountain streams.

REFERENCES:

Bieroński J., Chmal H., Czerwiński J., Klementowski J., Traczyk A., 1992, Współczesna denudacja w górskich zlewniach Karkonoszy, [w:] System denudacyjny Polski, Prace Geograficzne 155, Polska Akademia Nauk, Inst. Geogr. i Przestrz. Zagospodarowania, s. 151-169.

Kasprzak M., 2009, Geomorfologia stożka Wilczej Poręby, Opera Corcontica, 46, s. 19-39.

Kasprzak M., 2010, Geomorfologiczne i ekologiczne skutki wezbrań, [w:] P. Migoń (red.), [w:] Wyjątkowe zdarzenia przyrodnicze na Dolnym Śląsku i ich skutki, Rozprawy Naukowe Instytutu Geografii i Rozwoju Regionalnego, 14, Uniwersytet Wrocławski, Wrocław, s. 141-203.

Katrycz M., 1998, Transport rumowiska wleczonego w zlewni Wilczego Potoku – Karkonosze Wschodnie, Acta Universitatis Wratislaviensis, No 2061, Prace Inst. Geogr., Ser. A, Geografia Fizyczna 9, s. 37–58.

Traczyk A., 1991, Osady zbiornika przeciwrumowiskowego w Karpaczu i ich znaczenie dla oceny degradacji stoków w zlewni Łomnicy, Czasopismo Geograficzne, LXII, 1-2, s. 77-84.

NOTES:

LANDSLIDE RECOGNITION USING AIRBORNE LIDAR AND ELECTRICAL RESISTIVITY TOMOGRAPHY - - A CONTRIBUTION TO THE CONTEMPORARY GEODYNAMICS OF THE SUDETES

Marek Kasprzak ¹⁾, Filip Duszyński ¹⁾, Aleksandra Michniewicz ¹⁾,
Milena Różycka, Piotr Migoń

¹⁾ University of Wrocław, Institute of Geography and Regional Development

Landslides belong to the most spectacular manifestations of contemporary geodynamics and their geodynamic significance is twofold. First, landslide displacements are most voluminous among gravity-driven processes. Second, landsliding often occurs suddenly and catastrophically, so that the change of the land surface is not only extensive but also nearly instantaneous. In addition, large landslides may play the role of valuable stress indicators in the upper crust and many landslides have been causally associated with earthquake triggers.

The Sudetes have long been considered an area where large-scale, deep-seated mass movements are a very minor and rather insignificant component of the geomorphic system. Research carried out in the last few years has shown that such a view is no longer tenable. In the Kamienne Mountains (Middle Sudetes) in particular a few tens sites of large-scale slope instability have been recognized. Most of them are clearly relict but some landslides may have been active in the late Holocene or even historical times. Landslide field identification in heavily forested terrain of the Sudetes is difficult, especially if geomorphic signatures of landslides are subdued, but high-resolution airborne LiDAR data have become powerful tools of landslide recognition and mapping. Electrical resistivity tomography is another tool which can be used to recognize the near-surface geological structure, including features indicative of large-scale mass movements such as colluvial packages, valley infills, sliding planes, wetter ground sections etc.

In the presentation selected examples from the Kamienne, Stołowe and Bystrzyckie Mountains will be shown to illustrate the potential of LiDAR data for landslide recognition. Landslides vary in size and extent, from minor features affecting less than 1 ha to complex zones of instability exceeding 50 ha. Likewise, their geomorphic signatures indicate the variety of types and mechanism of movement, from sagging and lateral spreading through deep-seated rotational slides to valley-confined flows. For a few sites of mass movements in the Kamienne and Stołowe Mountains ERT profiles will be presented to show the internal structures of landslide bodies and to discuss opportunities and limitations of interpretation.

INSTALLATION OF MODERNIZED TM-71 CRACK GAUGE AT GEODYNAMIC LABORATORY IN KSIAZ. SUPPORT TO THE TECTONIC EVENTS MECHANICS RESEARCH

Damian Kasza ¹⁾, Marek Kaczorowski ²⁾, Ryszard Zdunek ²⁾, Roman Wronowski ²⁾, Tadeusz A. Przylibski ¹⁾, Lidia Fijałkowska-Lichwa ³⁾

- 1) Wrocław University of Technology, Faculty of Geoengineering, Mining and Geology, Na Grobli 15 St., 50-421 Wrocław, Poland
- 2) Polish Academy of Sciences, Space Research Centre, Bartycka 18A St., 00-716 Warsaw, Poland
- 3) Wrocław University of Technology, Faculty of Civil Engineering, 11 Grunwaldzki Sq. 50-377 Wrocław, Poland

A structural geological unit of Swiebodzice Depression (Central Sudetes, SW Poland) is a Polish area which occur contemporary tectonic activity indicators. In addition to the morphological indicators, i.e. horizontal meander deformations of Pelcznica and Szczawnik rivers, records of tectonic events by instruments of Geodynamic Laboratory in Ksiaz (GL) are evidence of tectonic activity in the area. High quality equipment – quartz horizontal pendulums, water-tube tiltmeters (WT), gravimeter and interference extensometer - allows the observation and analysis of subtle geodynamic signals, including these caused by tectonic activity. Recent tectonic activity of Ksiaz area stands out also in geological structure (discontinuity of layers) and dense network of tectonic faults. Additional premise confirming movements of rock blocks with respect to the zones of discontinuity are the damaged architectural elements of buildings (e.g. Ksiaz Castle), which linear course overlaps the known faults. During the nearly 40 years of continuous operation of apparatus dozens of tectonic events have been registered - tiltings of foundation and vertical movements of individual rock blocks, on which have been installed measuring instruments. The observed tectonic events are characterized by repeatability of the process, duration and amplitude. An additional element connecting events is the phenomena compensation period occurring a few days after the event.

Specificity of the GL's research instruments construction does not allow the registration of the main component of recorded tectonic events - the horizontal component, but only the results of its transition to vertical movements and tiltings of foundation. In order to enrich the data on tectonic deformations of the rock mass at one of the documented faults crossing beneath the water-tube tiltmeter 03-04, the crack gauge TM-71 has been installed. Due to the event-character and reversibility of the tectonic effects observed in Ksiaz, the use of a crack gauge in tectonic studies required modernization of the registration module and analysis of the results.

Registration module has been equipped with two TV cameras and a backlighting board. Images of fringes are recorded by a computer with one minute interval. The measuring interval of TM-71 crack gauge electronic recording system has been adapted to the water-tube tiltmeter measuring interval, which sensitivity is several orders higher than the TM-71 crack gauge. Installing a crack gauge surrounded by WT allows comparative works to verify indications of the new instrument (comparison of time series) and to answer the question whether both instruments observe the same phenomenon in the same stage of development.

MODEL UNBe.eu FOR EGNOS

Kamil Kaźmierski ¹⁾

¹⁾ Wrocław University of Environmental and Life Sciences, Institute of Geodesy and Geoinformatics, ul. Grunwaldzka 53, 50-357 Wrocław; e-mail: kamil.kazmierski@igig.up.wroc.pl

The quality of positioning is one of the main issues in modern GNSS world. Therefore, a lot of ground-based and satellite systems are created which allow for improving autonomous operation of the GNSS systems. Among them satellite-based augmentation systems may be distinguished, such as the North American WAAS or the European EGNOS. These systems are mainly used in sea and land transport navigation. Their functioning allows for eliminating numerous errors which occur within the path that a signal follows from a satellite to a receiver. One of the main factors that limits substantially the accuracy increase of position determining is the Zenith Total Delay (ZTD). Estimating the ZTD correctly makes it possible to increase considerably accuracy of positioning. The present study forms an attempt to create an atmosphere model that would be in line with the UNBw.na model functioning in the WAAS system. In this paper the process of creating the new one - UNBe.eu working within the zone of the EGNOS system is presented. Meteorological ISD database established by National Oceanic and Atmospheric Administration (NOAA) was used for model preparation. The new model was verified on the basis of the accuracy check of the ZTD determined with that model and compared with ZTD estimated by UNB3m. The values obtained by both models were evaluated with reference to EUREF Permanent GNSS Network (EPN) stations from the research area.

NOTES: _____

GRAPHIC ANALYSIS OF THE OBJECTIVE FUNCTION IN THE MAFA METHOD

Przemysław Kieszek¹⁾

¹⁾ University of Warmia and Mazury in Olsztyn, Oczapowskiego2, 10-719 Olsztyn

The purpose of this study is a graphic analysis of the objective function in MAFA method. In this elaboration authors present the results of the graphic analysis of the objective function. Some tests were performed. These tests are based on calculation of the objective function on a graph in assumed range.

As the results of these tests 3D graphs were created. These plots depict different variants of input data. On them, authors show the difference between true positions and positions obtained using MAFA method.

Conclusions from this analysis can be helpful to improve the computation algorithms of the MAFA method. nts.

NOTES: _____

SEASONALS REMOVAL IN THE CONTEXT OF NOISE INVESTIGATION

Anna Kłos ¹⁾, Janusz Bogusz ¹⁾, Mariusz Figurski ¹⁾, Maciej Gruszczyński ¹⁾

¹⁾ Faculty of Civil Engineering and Geodesy, Military University of Technology 00-908 Warsaw, Sylwestra Kaliskiego St. 2, Poland

The character of stochastic part (noises) and its parameters directly influence any factors that are determined from GPS time series (e.g. velocities), but before that the removal of each type of residual periodicities in time series is crucial. Generally, the deterministic part of GPS data is subtracted with least-squares method (LS), that assumes trend linearity as well as constant phases and amplitudes of periodic components. On the other hand, it can be also well-modeled with e.g. wavelet decomposition (WD) that gives much more efficient look into time-changeable amplitudes and phases of seasonals or by non-parametric methods like stacking year-by-year. This presentation focuses on topocentric components of daily changes of European IGS (International GNSS Service) sub-network consisted of more than 40 permanently working stations. The GPS data processing was performed in the Military University of Technology EPN (EUREF Permanent Network) Local Analysis Centre (MUT LAC) using Bernese 5.0 software. The longest time series were even 16 years long (1996-2012). Within this research the authors focused on the method of deterministic part removal and its influence on noise estimation. From each of the topocentric time series (North, East and Up), the trend and seasonals were removed twofold: firstly with least-squares method, secondly with wavelet decomposition based on the Meyer symmetric and orthogonal wavelet, subtracting all long-period seasonal signals starting from the quarter-annual one. The remaining data (residuals) were analyzed with the Maximum Likelihood Estimation (MLE) using CATS software to obtain the spectral indices and amplitudes of power-law dependencies that the stochastic part may follow. The median amplitudes and spectral indices shift towards 0 with the change of deterministic part removal approach, what directly influences uncertainties of stations' velocities. Additional simulations showed that the highest differences of spectral indices and amplitudes of power-law noises for different approaches may cause the change of linear velocity uncertainties at the level of 0.5 mm/year.

NOTES: _____

HORIZONTAL DEFORMATION OF THE EARTH'S CRUST IN THE AREA OF THE SUDETEN AND ITS NORTHERN FORELAND (SW POLAND) BASED ON GPS DATA FROM THE PERIOD 1997-2012

Bernard Kontny¹⁾, Piotr Grzempowski²⁾, Paweł Aleksandrowski³⁾,
Vladimír Schenk⁴⁾, Zdenka Schenková⁴⁾

- 1) Institute of Geodesy and Geoinformatics, Wrocław University of Environmental and Life Sciences, Grunwaldzka 53, 50-357 Wrocław, Poland;
e-mail: bernard.kontny@igig.up.wroc.pl
- 2) Institute of Mining, Faculty of Geoengineering, Mining and Geology, Wrocław University of Technology, Na Grobli Str. 15, L-1, 50-421 Wrocław
- 3) Polish Geological Institute - National Research Institute, Lower Silesia Branch in Wrocław, Al. Jaworowa 19, 53-122 Wrocław, Poland
- 4) Institute of Rock Structure and Mechanics, Academy of Sciences of the Czech Republic, v Holešovičkách 41, 182 09, Prague 8, Czech Republic

Monitoring data from permanent GNSS stations located in the study area (EPN and ASG-EUPOS stations and those of the Czech geodynamic networks) and archival periodical measurements made in the frame of research projects executed in 1997 to 2012, were employed in the National Centre of Science research project no. N N526 278940 'Integration of permanent and periodic GNSS measurements for needs of local and regional geodynamic research, using the example of the Polish-Czech network Sudeten' that was completed this year. All the monitoring data were reprocessed with the latest version of the Bern software (BERNESE v. 5.2) in a standardized frame of reference, applying new, absolute models of antenna phase centers and latest models of parameters of the rotary motion of the Earth, as well as models of the atmosphere. An new approach to the estimation of kinematic parameters of the displacements of nodes (stations) of the research networks (displacement velocities) was introduced, consisting in an integration of measurements from permanent GNSS stations with those from periodic measurement sites in a synoptic kinematic model of GNSS network adjustment. Standardized and corrected results of the aggregated and integrated GPS network processing, including all local networks from the study, were used for a preliminary geodynamic interpretation. This concerned primarily the stage of identification of the model of surface deformations in the study area based on calculated velocity vectors. To achieve this target, certain modifications of methods of creating surface models (GRID-based interpolation) of intraplate velocities vector fields referring to motions of the outermost layer of the Earth's crust and of horizontal deformation models of the Earth's surface (linear deformations) well-known from the

literature, were applied. Thus generated models were subjected to geodetic (geometrical) and structural geological interpretation. The latter interpretation was performed together with geologists, geophysicists and seismologists of the Institute of Rock Structure and Mechanics of the Academy of Sciences of the Czech Republic in Prague and of the Polish Geological Institute, Lower Silesia Branch in Wrocław. The outcomes of this interpretation can be considered as the basis for a due recognition of the actual nature of a tectonic behavior of the area of the Sudeten mountains and the Fore Sudetic block at their northern margin, as well as for verification of results of the hitherto made geodetic and geological studies concerning the geodynamics of this area.

ANALYSIS OF THE TIME SERIES OF STATION COORDINATES – COMPARISON OF THE NETWORK AND PPP ACCESS

Jan Kostelecký¹⁾, Jan Douša, Jakub Kostelecký

¹⁾ Research Institute of Geodesy, Topography and Cartography, Ústecká 98,
250 66 Zdíby

Comparison of the results of two methods for the analysis of coordinates time series of the 15 selected European stations, on which it is observed continuously by GNSS technology, is performed. The first method of getting results is the classic network solution using scientific software Bernese 5.0, which uses simultaneous observations. The second method is a solution made by the PPP - Precise Point Positioning access, individually for every station. The analysis of the results uses a method called „unharmonic analysis“, published in the 1970s, by P. Vaníček. Secular and periodic changes of coordinates are determined and compared.

NOTES: _____

DETERMINATION OF GEOMETRICAL AND TEMPORAL CHARACTERISTICS OF DEVICE FOR ABSOLUTE GNSS ANTENNA CALIBRATION

Radim Kratochvíl ¹⁾, Kateřina Brátová ¹⁾, Tereza Hynčicová ¹⁾, Michal Kuruc ¹⁾

¹⁾ Brno University of Technology, Faculty of Civil Engineering, Institute of Geodesy

StAnCa (Station Antenna Calibration) is a device developed at Brno University of Technology, Faculty of Civil Engineering, Institute of Geodesy for the purpose of absolute calibration of geodetic GNSS antennae. It consists of two main parts, a moveable arm, which can be placed on classic geodetic pillar, and a processing unit, which drives movement of the arm. Top of the arm is equipped by the mounting screw in order to carry calibrated antenna.

Knowledge of the mounting screw precise positions (i.e. antenna reference point) in the time of GNSS observations is crucial for the following numerical processing that leads to desired values of phase center offsets and variations. Therefore several testing measurements have already been carried out.

The first group of measurements was focused on small deviations and axes irregularities in construction of the moveable arm. The second group of measurements was aimed at irregularities in arm's movement such as differences between positioning from opposite sides and influence of arm's load. Classic geodetic methods utilizing theodolites as well as own developed photogrammetric method were used. Detected values are used for computation of corrected position of the arm.

The third type of measurement was devoted to temporal synchronization of arm's movement. The processing unit incorporates a PC synchronized with UTC via NTP. Movement of the arm is at current stage of the device development designed to stop for a while at the GNSS measurement time. Proper temporal synchronization of the PC and absence of considerable signal delay in whole driving electronics have been successfully verified. Independent method utilizing state of the art astronomical device MAAS-1 was used, especially it's 25 fps camera and GNSS temporal synchronization device.

NOTES: _____

REGIONAL GEOID DETERMINATION BY THE LEAST SQUARES MODIFICATION OF STOKES' FORMULA

Joanna Kuczynska-Siehiem ¹⁾, Adam Łyszkowicz ¹⁾, Monika Biryło ¹⁾

¹⁾ University of Warmia and Mazury in Olsztyn

Geoid model determination is a crucial challenge in the development of the Earth sciences. Knowledge of the precise geoid model contributes to the study of the Earth's interior, long-term geophysical processes and is used in oceanography. The precise regional geoid model also allows for the replacement of the traditional techniques of height measuring with the faster and more economical GNSS leveling.

In Poland, over the years, a number of geoid/quasigeoid models were calculated basing on different methods. However, there are no models generated using the LSMSA method (Least Squares Modification of Stokes formula with Additive corrections). This method carries a number of advantages, allowing to increase the accuracy of determining geoid model. The preliminary results of determining geoid model for Poland using this method will be shown in this presentation.

PERIODIC CHANGES IN GPS SIGNAL QUALITY INDICATORS

Jacek Kudrys ¹⁾

¹⁾ AGH University of Science and Technology, Krakow, Poland;
e-mail: jkudrys@agh.edu.pl

GPS signal quality is routinely monitored in EPN/IGS data centers. Quality data, such as daily multipath characteristic and cycle slips number, are obtained on the basis of the UNAVCO teqc software. Values of these indicators (mainly mp1 and mp2) depends on many factors connected with the site equipment e.g. receiver type, software options or sampling interval. From that reason, direct comparison of this indicators between sites is difficult.

In this paper, method of spectral analysis of the mp1, mp2 and cycle slips time series obtained from EPN/IGS station is proposed.

NOTES: _____

THE STUDY OF DISPLACEMENTS OF "GEODESY" WUELS BUILDING WHICH ARISING DUE TO CONSTRUCTION WORKS CARRIED OUT IN THE IMMEDIATE ITS VICINITY

Krzysztof Mąkowski¹⁾, Kazimierz Ćmielewski¹⁾, Janusz Kuchmiaster¹⁾,
Piotr Gołuch¹⁾, Olgierd Jamroz¹⁾, Marcin Belka²⁾

- ¹⁾ Institute of Geodesy and Geoinformatics, Wrocław University of Environmental and Life Sciences, Grunwaldzka 53, 50-357 Wrocław, Poland
²⁾ „Geobel” Zakład Usług Geodezyjnych Marcin Belka, Pilczycka 2012/2, 54-144 Wrocław, Poland

Modern building norms, standards and regulations impose the need for monitoring of building structures undergoing influence all kinds of phenomena. These phenomena are mainly:

- ground pressure caused by the building;
- annual cyclical changes in ground moisture;
- the influence of nearby watercourses and water reservoirs to changes in groundwater levels;
- sudden changes in ground moisture caused by atmospheric phenomena (sudden rainfall, prolonged drought);
- intensive road traffic in the immediate vicinity of the object;
- construction of new large-scale buildings causes: local changes in the elevation of the groundwater level, the vibrations due by machines construction (pile drivers), changes in ground pressure resulting from the due to progression of construction work.

In the presentation the authors will discuss the results of the measurements of displacements of the building "Geodesy" of Wrocław University of Environmental and Life Sciences (WUELS). Examined displacement are due to construction work carried out in the immediate vicinity. Building works are associated with the construction of a new Geo-Info-Hydro Centre of WUELS, which are located on the Grunwaldzka Street.

NOTES: _____

The results of relative measurements (the innovative optoelectronic plummet and feeler gauges) and the results of absolute measurements (geometric precision leveling method) were used to study of displacements. Optoelectronic plummet was located on a special observation pillar, established for this purpose on the supporting wall in the basement of the "Geodesy" building. Feeler gauges are arranged on the supporting wall of the building from the side of the investment. Leveling measurements were carried out on the basis of established measurement-control network, which benchmarks are stabilized on the walls of the examined building and in its vicinity. The digital precision leveling instruments have been used to make measurements of leveling.

STUDY ON THE IMPACT OF THE TROPOSPHERIC MAPPING FUNCTIONS ON THE ACCURACY OF THE GNSS PRECISE POSITIONING

Grzegorz Nykiel¹⁾, Mariusz Figurski¹⁾, Karolina Szafranek¹⁾,
Zofia Bałdysz¹⁾, Janusz Bogusz¹⁾

¹⁾ Military University of Technology

Tropospheric delay plays an important role in precise positioning based on GNSS measurements. During propagation through the atmosphere the signal is disturbed by pressure, temperature and water vapor, which increase the length of signal path. Nondispersive character of the troposphere prevents to use dual frequency measurements for eliminating these effects (as in the case of ionospheric delay). Therefore, it is necessary to use different troposphere models and mapping function to eliminate or reduce tropospheric delay. This presentation presents the analysis performed using different mapping functions: VMF1, GMF and modified VMF from University of New Brunswick (UNB) and GeoForschungsZentrum (GFZ). Changes in the annual time series of coordinates and zenith total delay values for selected EUREF Permanent Network (EPN) stations are presented as the result of the GNSS data processing. In total 65 reference stations were taken into account. The presentation also shows results of comparison between all types of solutions with the reference values determined by the MUT Local Analysis Centre on the basis of the official EUREF requirements. PPP solutions for all mapping function are also investigated.

The results proves high agreement between coordinates determined using above mentioned mapping function, however the highest discrepancies concerns coordinates obtained with GMF mapping function. The results can be important from the point of view of setting up the processing strategy for GNSS analysis centres (e.g. EPN LACs).

PROPERTIES OF GPS-GALILEO RECEIVER INTER SYSTEM BIASES

Jacek Paziewski¹⁾, Rafal Sieradzki¹⁾, Pawel Wielgosz¹⁾

¹⁾ University of Warmia and Mazury in Olsztyn, Poland, Oczapowskiego 2 st. 10-719 Olsztyn, Poland; e-mail: jacek.paziewski@uwm.edu.pl

Development of the multiple GNSS systems with overlapping frequencies makes possibility for tightly combining of separate systems signals in one precise positioning observational model. Contrary to the classical approach when separate reference satellites are selected for the both systems, this approach relies on the selecting a single, common reference satellite. This way we strengthen the observational model and improve the performance of the ambiguity resolution. Two overlapping frequencies - L1/E1 and L5/E5a - in GPS and Galileo systems support creating double-differences using mixed tightly combined positioning model. On the other hand, tightly combined model forces taking into account not only time and coordinate system differences, but also receiver Inter System Biases (ISB) which is the difference in the receiver hardware delays. These biases are present in both carrier-phase and pseudorange observations. Hence, this paper investigates the properties of the GPS and Galileo-IOV ISB determination. The presented numerical tests are based on real observational data collected on a zero baselines using different sets of GNSS receivers. In particular, ISB short-term temporal stability, its dependence on the number of Galileo satellites used for estimation and impact of the receiver firmware updates were examined. All calculations were performed with research software – GINPOS – developed at UWM.

NOTES: _____

COMPARISON OF METHODS FOR TERRAIN OBSTACLES MODELING

Renata Pelc-Mieczkowska, Joanna Janicka, Michał Bednarczyk

For satellite measurements, both in navigation and surveying, unobstructed visibility of at least three (2D positioning), four (3D positioning) or five (RTK) satellites is essential. In urban areas or in the vicinity of the trees knowledge of the shape and location of the terrain obstacles may determine the success of the GNSS positioning under such conditions. The aim of the presented research is to investigate the suitability of the use of laser scanning and digital hemispherical photography for modeling terrain obstacles over the GNSS measurement points. The accuracy of the obtained models was examined by taking the model from tacheometric measurement as the reference.

KEYWORDS: GNSS, obstacles modeling, hemispherical photography, fish-eye lens, laser scanning.

RISK ZONES AT NORTHERN PART OF THE BOSKOVICE FURROW

Lubomil Pospíšil ¹⁾, Otakar Švábenský ¹⁾, Josef Weigel ¹⁾

¹⁾ Institute of Geodesy, FCE, Brno University of Technology

The MORAVA network was founded in 1994 as one of the first GPS geodynamics projects in Czech Republic with aim to determine the positional changes at border zone between the Bohemian Massif and the Carpathians. One of the most important tectonic zones here is the Boskovice furrow.

Results of GNSS measurements in combination with earthquake data from respective period indicate increasing activity at marginal faults of the Cretaceous basin with proceeding of structures in continuation of the Boskovice basin.

In the paper the basic structural-tectonic relations in the aforementioned area are discussed, and the possibilities of identification of movement tendencies on base of GNSS observations and repeated precise leveling measurements are considered.

KEYWORDS: Moravia, Železné hory - Tišnov fault, GNSS displacements, movement tendencies.

STOCHASTIC MODELLING OF GNSS OBSERVATIONS FOR PRECISE KINEMATIC POSITIONING

Dominik Próchniewicz¹⁾, Ryszard Szpunar¹⁾, Jacek Kudrys²⁾

- ¹⁾ Warsaw University of Technology, Faculty of Geodesy and Cartography, Poland;
e-mail: d.prochniewicz@gik.pw.edu.pl
- ²⁾ AGH University of Science and Technology, Cracow, Poland

The proper definition of mathematical positioning model is prerequisite to the optimal estimation of unknown parameters. This model is defined by both the functional model which describes the deterministic relationship between observations and variables and the stochastic model which describes the stochastic properties of observations. While the GNSS functional model was the subject of detailed research conducted over the past twenty years, the issue of proper definition of stochastic model has been undertaken in recent few years and is still an open research problem. Especially with respect to precise kinematic applications which are characterized by weakening model strength, incorrect or simplified definition of stochastic properties of observations causes that the performance of ambiguity resolution and position estimation can be limited.

In this paper we investigate the methods of describing the measurement noise of GNSS observations and its impact to the solution of precise kinematic positioning model. In particular the stochastic modelling of individual components of the variance-covariance matrix of observation noise taking into account elevation dependency, cross-correlation and time correlation is analyzed. Numerical tests are performed by using observations from a very short-length baseline (between KRAW and KRA1 stations) to separate measurement noise from other errors. The results of ambiguity resolution as well as rover positioning accuracy shows that the utilizing the individual stochastic model of observations increase the reliability of precise kinematic performance and could be important part in a comprehensive calibration procedure of GNSS equipment.

NOTES:

THE APPLICATION OF ZIGBEE PHASE SHIFT MEASUREMENT AND RANGING

Jacek Rapinski¹⁾

¹⁾ University of Warmia and Mazury, Institute of Geodesy

Indoor positioning techniques are gaining a lot of attention in the modern society. Among many indoor positioning techniques the radio frequency positioning is very promising. Recently a new method of distance measurement was introduced in the field of RF ranging and communication. The paper presents the possibility to use phase shift measurement with ZigBee AT86RF233 devices for distance measurement and navigation. It consists of device description and preliminary measurement results along with possible applications. The results obtained are analysed and accuracy of ranging is estimated.

NOTES: _____

TIME SERIES ANALYSIS OF WET TROPOSPHERIC DELAYS FOR SHORT-TERM FORECAST

Zofia Rzepecka ¹⁾, Katarzyna Stepniak ¹⁾, Jakub Z. Kalita ²⁾, Pawel Wielgosz ¹⁾

¹⁾ University of Warmia and Mazury in Olsztyn

²⁾ Department of Civil Engineering, Environmental Engineering and Geodesy, Koszalin University of Technology; e-mail: zofia.rzepecka@uwm.edu.pl, katarzyna.stepniak@uwm.edu.pl, jakub.kalita@tu.koszalin.pl

Tropospheric wet delay is one of the most significant source of errors that influences on the Global Navigation Satellite System (GNSS) observations. It causes non-refractive systematic bias of several centimeters for near zenith satellites, depending on the atmospheric conditions. The bias increases with decrease of satellite elevation angle. The current models use numerical weather data for precise estimation of the tropospheric parameters. In real time precise positioning, only the predicted values can be used. The predicted values of the dry tropospheric delay component, both zenith and mapped, can be safely used in real time precise applications. On the other hand, the predicted values of the wet component generally are not considered as precise enough to be safely applied in precise real time absolute positioning, where the wet component value is treated as an unknown parameter.

The purpose of this paper is to analyze the tropospheric wet component behavior on the basis of data provided by the GGOS Atmosphere Service conducted at the Vienna University of Technology. In the studies, the wet delay values were taken for selected stations located in different regions, treated as time series data. These data were then analyzed using modern tools of time series analysis, like the ARMA, ARIMA, power spectral density analysis and FFT methods. The greatest importance was placed on the study of short-term forecast possibility and its accuracy, with respect to the Precise Point Positioning method.

KEYWORDS: wet tropospheric delay, time series analysis, forecast, ARMA, ARIMA, power spectral density analysis, FFT, PPP.

NOTES: _____

INTRAPLATE MOVEMENTS OF THE BOHEMIAN MASSIF STRUCTURES

Vladimír Schenk¹⁾, Richard Pichl²⁾, Zdeňka Schenková¹⁾

¹⁾ Institute of Rock Structure and Mechanics of the ASCR, v. v. i., 182 09 Prague 8, Czech Republic; e-mail: schenk@irsm.cas.cz

²⁾ Air Navigation Services of the Czech Republic, Department of Safety, 252 61 Jeneč, Czech Republic.

An analysis of recent intraplate movements of the Bohemian Massif structures in the Eurasian lithospheric plate and their causal relation to the post-orogenic Alpine dynamics are presented. Site positions determined from satellite geodesy observations on more than 130 sites in the period of 1997-2012, allowed this dynamics to be investigated. GNSS data of the GEONAS, TopNET and CZEPOS permanent networks were extended for annual campaign GPS data monitored on five regional networks (EAST SUDETEN, GEOSUD, WEST SUDETEN, HIGHLANDS, WEST BOHEMIA); all campaigns were performed continuously for two GPS days. Sites altogether cover an area of 400 x 220 km and are placed close to main Bohemian Massif tectonic zones to investigate recent movements along them. To ensure reliability of site velocity determinations, the campaigns were carried out in the same yearly season to diminish tropospheric changes. The GPS satellite signals were monitored always by the same antenna on the same site to exclude undesirable phase-center effects. All recorded data were processed simultaneously by the Bernese software v. 5.0. Intraplate site movements, equaled to differences between observed site movements and their Eurasian plate movements, were statistically analyzed and a general pattern of these movements with respect to fundamental geological units of the Bohemian Massif was obtained. It was found that the whole complex of the Bohemian Massif structures moves slowly, around 1mm/year towards the north or northwest. Inside the Massif, among its structures left-lateral movements dominate but right-lateral and somewhere also dip-slip movements can be identified.

NOTES: _____

MSTIDS IMPACT ON PRECISE GNSS POSITIONING AT MID-LATITUDES

Rafal Sieradzki¹⁾, Jacek Paziewski¹⁾

¹⁾ University of Warmia and Mazury in Olsztyn, Poland, Oczapowskiego 2 st, 10-719 Olsztyn; e-mail: rafal.sieradzki@uwm.edu.pl

The fluctuations of electron content in the ionosphere are one of the main, still unresolved problems degrading ambiguity resolution and related with it accuracy of GNSS positioning. In the case of relatively stable and quiet conditions at mid-latitudes, impact of the upper parts of atmosphere is primarily associated with medium-scale traveling ionospheric disturbances (MSTIDs) originated by acoustic gravity waves. Their amplitudes reached up to a few TEC units can significantly affect the performance of GNSS-based coordinates determination. In this work is presented the case study of MSTIDs impact on rapid static positioning (5 minute long sessions) in the Sudeten area on 19.12.2013. Additionally, we demonstrate the performance of GNSS positioning using developed rate of TEC corrections algorithm mitigating the MSTIDs influence. This algorithm allows for reduction of epoch-wise ionospheric delays to one parameter for each double-differenced arc. The results were compared with geometry-based relative positioning model including weighted ionosphere and troposphere, which can be treated as a reference level. The comparison of both strategy proves the considerably improvement of positioning reliability especially during MSTIDs occurrence.

NOTES: _____

AN ATTEMPT TO ANALYZE GEODETIC AND SEISMIC DATA TO DETECT CONTEMPORARY ACTIVITY OF TECTONIC STRUCTURES IN THE AREA OF POLAND

Wojciech Sowa¹⁾

¹⁾ Institute of Geodesy and Geoinformatics, Wrocław University of Environmental and Life Sciences

For the Area of Poland geodynamic research are carried out for years, and one of their goals is to provide model of vertical and horizontal movements. In that kind of research data from geodetic measurements is used, including precise leveling and satellite measurements.

The paper presents results of analyzes of geodetic and seismic data, used to detect seismic activity of tectonic structures located on territory of Poland. In the study seismic and geodetic data were used: precise leveling and satellite measurements. Satellite data used in the study were data from ASG-EUPOS system. Sites of the system are located throughout the country. The measurements are carried out from 2008 to the present. Precise leveling data development (data from measurement campaigns of I class precise leveling network, from the years 1972-1982 and 1997-2003) were used as well. Seismic data were acquired from domestic and foreign services providing information about seismic events in the territory of Poland. In the analysis tectonic division of the country arising from geological structure of Poland were assumed.

NOTES: _____

TENSOR ANALYSIS OF GROUND DEFORMATIONS EVALUATED FROM GEODETIC MEASUREMENTS IN LANDSLIDE AREA

Anna Szafarczyk¹⁾

¹⁾ Assistant professor, AGH University of Science and Technology, Faculty of Mining Surveying and Environmental Engineering, Cracow, Mickiewicza 30, Poland; e-mail: szafarcz@agh.edu.pl

Geodetic surveys, performed serially in the area subject to deformations, allow to determine deformation rates, of which, for most building structures, horizontal strains appear to be the most important ones. There are horizontal tensile and compressive strains.

Tensile strains of land cause the greatest damage to residential buildings, resulting in hairline and larger cracks, or even construction disasters in extreme cases. Depending on the adopted surveying method, it is possible to determine the values of strains more or less accurately. For the strains with small values it is necessary to determine the length directly (from the total station measurement), whereas for the strains with large values it is possible to use the GPS measurement results.

The article presents the surveying method and the measurement results of landslide fragments deformation.

Geodetic points were stabilized in the form of a control network called a rosette. Measurements of the rosette were performed and, on their basis, horizontal strains were calculated for the directions of the stabilized sides. The further stage included determining surface strain tensor components, from which it is possible to determine the direction and the values of the occurring extreme strain.

NOTES: _____

MINING INDUCED SEISMIC EVENTS AND SURFACE DEFORMATIONS MONITORED BY GPS PERMANENT STATIONS

Zbigniew Szczerbowski ¹⁾, Janusz Jura ¹⁾

¹⁾ AGH University of Science and Technology, Faculty of Mining Surveying and Environmental Engineering, Department of Mining Areas Protection, Geoinformatics and Mining Surveying, Al. A. Mickiewicza 30 30-059 Kraków, Poland

GPS/GNSS surveys carried out by reference stations of national or local networks provide a new type of data. On the base of continuous-time or quasi-continuous-time observations it is possible to determine mobility (as vertical displacements) large areas. Such mobility can be a result of both natural (as tectonic) or anthropogenic effects (as mining). Displacements of large areas can be not detected by classical geodetic surveys. What's more they can have an episodic performance, what makes the methods inefficient in reliable studies. The classical methods can fail as well in determination of non-stationary displacements that can be determined by permanent observations. Results from GPS/GNSS permanent stations of Legnica–Głogów Copper District (LGCD) and Upper Silesian Industrial Region (USIR) from time moments of mining tremors are discussed by the authors.

The spatial-temporal evolution of surface vertical displacement of mentioned areas demonstrated a relation with seismic events. They provide probably effects that – due to area size and duration of deformation process – can't be detected by classical surveys. However, a certain specificity of displacements of permanent stations makes that the process is not directly readable in temporal distributions of coordinates.

It would be worth devoting further effort to study the problem of effects of mining tremors but it requires more examples of observations. There is a practical aspect of such study. It deals with adjustment of results of classical surveys carried out in reference to coordinates of GPS/GNSS stations affected temporally by mining tremors. The authors involved in geodetic monitoring based on such coordinates applied for estimation of safety of engineering structures affected by mining that requires rigorous criteria of measurement accuracy and consideration of any sources of errors.

KEYWORDS: mine surveying, mining tremors, permanent GPS observation.

NOTES: _____

**UNDERGROUND MONITORING OF TECTONICALLY
ACTIVE AREAS IN SCOPE OF THE RESEARCH PROJECT BY
AGH-SRC-KS- BOCHNIA CONSORTIUM.
NEW PERSPECTIVE OF GEODYNAMIC INVESTIGATIONS**

Zbigniew Szczerbowski ¹⁾, Marek Kaczorowski ²⁾, Janusz Wiewiórka ³⁾,
Michalina Józwik ¹⁾, Ryszard Zdunek ²⁾, A. Kawalec ³⁾

- ¹⁾ AGH University of Science and Technology, Faculty of Mining Surveying and Environmental Engineering, Department of Mining Areas Protection, Geoinformatics and Mining Surveying, A. Mickiewicza 30 30-059 Kraków, Poland
- ²⁾ Space Research Centre, Polish Academy of Sciences, Geodynamic Laboratory in Książ, Bartycka 18A, 00-716 Warszawa, Poland
- ³⁾ The Bochnia Salt Mine, Campi 15, 32-700 Bochnia

Geodynamic studies on tectonic activity in region of Polish Carpathians have been carried out since many years with insufficient results. There are applied two approaches in method of registration of tectonic activity. The first method bases on geological indicators informing about effects of processes ongoing in the past. The second method uses geodetic technique concerns measurements and evaluation of deformations fields and displacements of reference points. The modern methods: geophysical as well as geodetic apply permanent monitoring of geodynamic parameters with micro or even nanometric precision depicting properties of tectonic activity in details. These methods provide reliable information about stress-strain variations and determine their linearity or non-linearity in tectonic processes. The mentioned, permanent measurements are carried out in Geodynamic Laboratory of SRC PAS in Książ. The Książ laboratory is the role model, where permanent signals of basement inclination, changes of vertical and displacements of blocks on surfaces of faults are registered with help of the long water-tubes hydrostatic clinometers. The instruments mounted in Książ laboratory except crack-meters are of tidal accuracy devices. The results of previous geodetic measurements in the Bochnia mine suggest tectonic activity. Thus the authors intend to adopt verified in Książ laboratory measurement system to investigate tectonic activity of Carpathians orogen. Repeated measurement sessions demonstrate several effects such as displacements of shaft lining and northern orientation of horizontal displacements having no spatial relations between displacement vectors and location of mining excavations. The mining effect in outline of deformations is also observed but it does not explain spatial pattern of compressions. The Bochnia main outline of horizontal displacements and deformation of shafts correspond to similar effect observed in the Wieliczka salt mine: northward

tendency despite of the differences of geological and mining environments. The difference is in observed rates of displacements: in the Bochnia mine they are much higher (double more) than in Wieliczka and their maximal displacements amount to 15 mm/yr. The experience obtained in Książ with measurements of tectonic signal creates good opportunity in planned underground investigations of tectonic activity of Carpathian Foothill where the effects of tectonic deformations in Bochnia and Wieliczka seems to be understood. The essential problem is to separate sources of the signal: mining and tectonic, so pre and post processing solutions applied in Książ will be helpful. Gathered experience and geological setting supply us conclusions about general assumptions of measurement systems, which provide us reliable and satisfied description of tectonic activity of Carpathian orogen.

KEYWORDS: geodynamics, tectonic activity, mine surveying, tectonics of the Carpathians region, geodetic and geophysical measuring instruments.

NOTES: _____

THE UPPER MORAVA BASIN SYSTEM - EVOLUTION, PRESENT-DAY GEODYNAMICS AND FIRST RESULTS OF TRENCHING

Petr Špaček¹⁾, Petra Štěpančíková²⁾, Petr Tábořík²⁾, Zdeňka Sýkorová¹⁾,
Jana Pazdírková¹⁾, Ondřej Bábek³⁾, Jan Švancara¹⁾, Jan Valenta²⁾

- 1) Institute of Physics of the Earth, Masaryk University, Brno;
e-mail: spacek@ipe.muni.cz
- 2) Institute of Rock Structure and Mechanics, Academy of Science of the Czech Rep.,
Prague
- 3) Palacký University in Olomouc, Department of Geology at the Faculty of Science,
Czech Republic

The Upper Morava Basin system (UMBS) is a group of sedimentary basins with Late Cenozoic sedimentary infill, superposed onto the contact of the Bohemian Massif with the Outer Western Carpathians. While its pre-middle Miocene evolution is poorly known due to large erosion or non-deposition, major subsidence phase occurred in early Middle Miocene, soon after the docking of Outer Carpathian flysch nappes. A significant boost of tectonic activity in latest Miocene, Pliocene and earliest Quaternary resulted in further subsidence, formation of graben-like basins and accumulation of fluvio-lacustrine clastic successions, which locally exceeds 300 m of thickness. In Middle Pleistocene (Elsterian), third significant phase of localized subsidence is indicated by up to 50-60 m thick accumulations of mostly fluviolacustrine sediments in narrow graben-shaped depressions.

The formation and development of the UMBS was apparently controlled by the 25-35 km wide zone of steeply dipping, NW-SE to N-S striking faults (Haná fault zone). Based on the available dating of the sediments and their vertical elevation range and taking into account the major change in the Morava River course suggested by previous authors, the minimum cumulative vertical throw of around 100 m is estimated for some faults (or fault sets) of the Haná zone since Elsterian.

The UMBS is located within presently active crustal domain of the eastern Sudetes characterised by regionally anomalous weak historical and present-day seismicity and increased CO₂ flux (Nysa-Morava Zone). The clear concentration of seismicity at the NW margin of UMBS, and the general-scale coincidence of SW margin of UMBS with that of the whole seismically active domain, suggest an ongoing slip on some faults of the Haná zone.

However, direct linking of the Middle Pleistocene subsidence and present-day seismicity is hindered by apparent lack of significant post-Elsterian sediment accumulation. To learn about the Late Pleistocene and Holocene fault slip history and kinematics we are currently studying selected faults in UMBS by means of shallow geophysical survey and trenching.

In 2013 we started a detailed research at one of the major faults of the UMB with length of 30+ km and pronounced morphology, the NW-SE trending Kosíř fault. In a 30 m long and 4-6 m deep trench across the fault segment terminating the Tertiary basin against the Late Carboniferous shales (locality Stařečovice near Prostějov) we exposed a unique profile in the upper part of the >17 m thick succession of sediments accumulated at the foot of the fault scarp. The succession of several generations of loess with paleosol and colluvia on top of the bedrock is disrupted by numerous steep (60-80°), SW dipping faults and minor antithetic faults, both exhibiting prevailing normal slip ranging from <1 cm to 1.6 m. These faults form a splay-like system resulting in the stepwise shape of the basin margin revealed by electric resistivity tomographic profiles. Both syn- and post-sedimentary faults are present and clear basinward increase of their age is indicated.

The succession exposed in the trench was dated at 12-60 ka by one ¹⁴C and five OSL ages (all internally consistent) allowing a detailed, time-constrained reconstruction of sedimentary and deformational processes. At the main fault, relatively large slip rate of 0.2-0.3 mm/a is indicated for Late Weichselian to Early Holocene (17-11 ka). Tectonic origin of the faults is suggested by repeated long-term activity localized in a relatively narrow zone with only meter-scale migration towards the slope. However, some features observed suggest that they were likely formed by near-surface, creep-like relaxation of the topographic instability. The latter was possibly controlled by tectonic slip on the main fault, nevertheless, the proportions between the tectonic and non-tectonic phenomena are presently unknown.

We emphasize here a need of caution when interpreting structures on faults with assumed normal kinematics in regions with strong regional Pleistocene mass wasting. New trenches with different topographic setting will soon be opened to get conclusive data for Kosíř fault as well as other faults in UMBS.

NOTES: _____

MODELLING OF GRAVITY FORCE FOR THE PRECISE ORBIT DETERMINATION OF LOW-EARTH SATELLITES

Petr Štěpánek, Aleš Bezděk, Jan Kostelecký¹⁾

¹⁾ Research Institute of Geodesy, Topography and Cartography, Ústecká 98, 250 66 Zdíby

Gravitational forces not only define an ideal Kepler movement of Earth orbiters, but also cause its major perturbations. The precise orbit determination of satellites in low Earth orbits cannot be realized without precise modelling of static and dynamic forces of gravity origin. The calculation methods implemented in the precise orbit determination software packages do not use the most precise modelling of these forces, because the computer processing time would be undesirably long. The application of the static gravity field, accompanied with linear and harmonic modelling of its time-variations as well as the modelling of the tidal gravity forces is always limited, usually by setting up the maximum degree (and order) of geopotential harmonic coefficients (static field or time-variable change). It is common practice that this limit is not set according to what is needed in a particular problem solved. Thus there is a risk of underestimation of modelling errors and their unwanted introduction to the computation. For this reason, many teams rather overestimate the setting of these limits. However, such an approach is also not optimized from the point of view of the computer processing time management.

The presentation will show the impact of the gravitational forces on the precise orbit determination of satellites with different altitude (300–6000 km), namely for satellites Champ, Lageos-1, SPOT-5 and Jason-2. The subject of interest is the static gravity field, its periodic variations and secular changes as well as the tidal gravitational effect with the focus on the ocean tides modelling. For SPOT-5 and Jason-2, we study not only the orbit prediction, but also the quality of orbits estimated by DORIS observation fit. The orbit determination accuracy is analysed as function of the limited degree/order of the geopotential models used. Internal and external accuracy characteristics of satellite orbits in question are taken into account.

NOTES: _____

MORAVA NETWORK – REPEATED GPS MEASUREMENTS AND RESULTS AFTER 18 YEARS

Otakar Švábenský ¹⁾, Lubomil Pospíšil ¹⁾, Pavel Černota ²⁾, Juraj Papčo ³⁾,
Michal Witiska ⁴⁾, Miroslav Novosad ²⁾

- 1) Institute of Geodesy, FCE, Brno University of Technology
- 2) Institute of Geodesy and Mine Surveying, FMG, Technical University Ostrava
- 3) Department of Theoretical Geodesy, FCE, Slovak University of Technology Bratislava
- 4) Ing. Michal Witiska, Svatopluka Čecha 9, 58601, Jihlava

Among the first GPS geodynamics projects in Czech Republic the MORAVA network was founded in 1994 with aim to determine the positional changes at border zone between the Bohemian Massif and the Carpathians. Initial project included three successive GPS campaigns in period 1994 – 1996, but was not continued because of lack of support. It had been possible to carry out new measurements in southern part of the MORAVA network including five stations, after gap of 15 to 18 years.

In the paper comparison of previous and contemporary results of epoch GPS measurements are presented, which indicate block movement tendencies at the Bohemian Massif and the Western Carpathians border, thus confirming activity of the area up to present days.

Interpreted data enable to determine new risk area along or near the recently active tectonic zone. Among main active tectonic zone in Moravian part of the Bohemian Massif belong the Čebín-Diendorf tectonic zone and Železné Hory Mts. - Tišnov tectonic system. In the western part of the Outer Western Carpathians the Myjava – sub-Tatra boundary is considered, where recent, linear oriented earthquake foci have been localized.

NOTES: _____

ANALYSIS OF DIFFERENT INS ALIGNMENT METHODS CONDUCTED WITH THE USE OF MEMS-BASED INTEGRATED NAVIGATION SYSTEM

Dariusz Tomaszewski ¹⁾, Jacek Rapiński ¹⁾

¹⁾ University of Warmia and Mazury, Institute of Geodesy

Nowadays, along with the advancement of technology, the dynamic development of miniaturization in electronics can be noticed. Currently produced micro gyroscopes, accelerometers, magnetometers and GPS receivers have accuracy performance impossible to achieve few years ago. Thanks to this development, it is possible to build mobile integrated navigation systems based on satellite (GNSS) and inertial observations (IMU). Such method of navigation consists of several steps. The first stage is the determination of initial orientation of inertial measurement unit, called INS alignment. During this process, on the basis of acceleration and the angular velocity readings, values of Euler angles (pitch, roll, yaw) are calculated allowing for unambiguous orientation of the sensor coordinate system relative to external coordinate system. Recently, many alignment methods have been developed. The following study presents the comparative tests of the most popular calculation methods.

CAN GEOMAGNETIC JERKS CONTRIBUTE TO THE CHANGES OF EARTH'S ORIENTATION?

Jan Vondrák ¹⁾, Cyril Ron ¹⁾

¹⁾ Astronomical Institute AS CR, Prague, Czech Republic

Recently we used schematic excitations applied at the epochs of geomagnetic jerks (rapid changes of the second time derivative of Earth's geomagnetic field) to derive its influence on the motion of the spin axis of the Earth in space (nutation). We demonstrated that this effect, if combined with the influence of the atmosphere and oceans, improves substantially the agreement with celestial pole offsets, observed by Very Long-Baseline Interferometry. Since now there exist similar studies, hinting that geomagnetic jerks can also affect polar motion and Earth's speed of rotation, we concentrate our efforts to study possible influence of geomagnetic jerks on temporal changes of all five Earth orientation parameters, defining complete Earth orientation in space.

ŚWIEBODZICE UNIT REVISITED – KINEMATIC, STRUCTURAL AND FACIAL EVOLUTION TILL NOW

Jurand Wojewoda¹⁾

¹⁾ Department of Structural Geology and Geological Mapping, Institute of Geological Sciences, Wrocław University

For many years, the Świebodzice Unit has been considered as a separate structural unit in the Sudetes, with a separate geological history and defined borders (Teisseyre 1956, Oberc 1957, Gunia 1968). However, it had not been that evident in the past. On early geological maps, the Świebodzice Unit area had similar facies and lithostratigraphy as the area of the adjacent Intrasudetic Synclinorium (Berg et al., 1910; Crammer et al., 1921). Cartographic and structural/sedimentological investigations done by the author, as well as revised ages of the rocks forming the Świebodzice Unit (Górecka 2014, oral information), allow one to propose a completely new pattern of evolution of this area. The new model takes into account the permanent development of the area as a diamond-shape / pull-apart sedimentary basin developing due to a regional trend of clockwise strike-slip (cf. Porębski 1981)(Fig.1). In this scheme, the oldest sediments are the Książ and Chwaliszów Conglomerates that occur in the central (axial) part of the former sedimentary basin. Their most probable age is Tournaisian-to-Namurian. The heterolithic series of the Pelcznica and Pogorzała Fms., occurring at the NE and SW parts of the unit (basin), are somewhat younger and, according to the most recent studies are of Namurian and Westphalian age. In each of them both pelagic and near margin facies can be distinguished, including complexes of redeposited olistolites and slumps of older rocks (Devonian?) near basin edges.

REFERENCES:

- Berg, G., Dathe, E., Zimmermann, E.**, 1910. Geologische Karte von Preussen und benachbarten Bundesstaaten, 1:25000.
- Blatt Freiburg. Cramer, R., Finckh, L., Zimmermann, E.**, 1921. Geologische Karte von Preussen und benachbarten Bundesstaaten, 1:25000,
- Blatt Schweidnitz. Gunia, T.**, 1968. On the fauna, stratigraphy and conditions of sedimentation of the upper Devonian in the Świebodzice Depression (Middle Sudetes). *Geologia Sudetica*, vol. IV, 115-220.
- Oberc, J.**, 1957. [in: Teisseyre, H., Smulikowski, K., Oberc, J., - *Regionalna Geologia Polski. Sudety*, T.III, z. 1. Porębski, S., 1981. Świebodzice succession (Upper Devonian – lowest Carboniferous; western Sudetes): a prograding, mass-flow dominated fan-delta complex. *Geol. Sudetica*, vol. 16: 99-190. Teisseyre, H., 1956. Świebodzice depression as geological unit. *Biul. Inst. Geol.*, nr 106.

ŚWIEBODZICE UNIT EVOLUTION

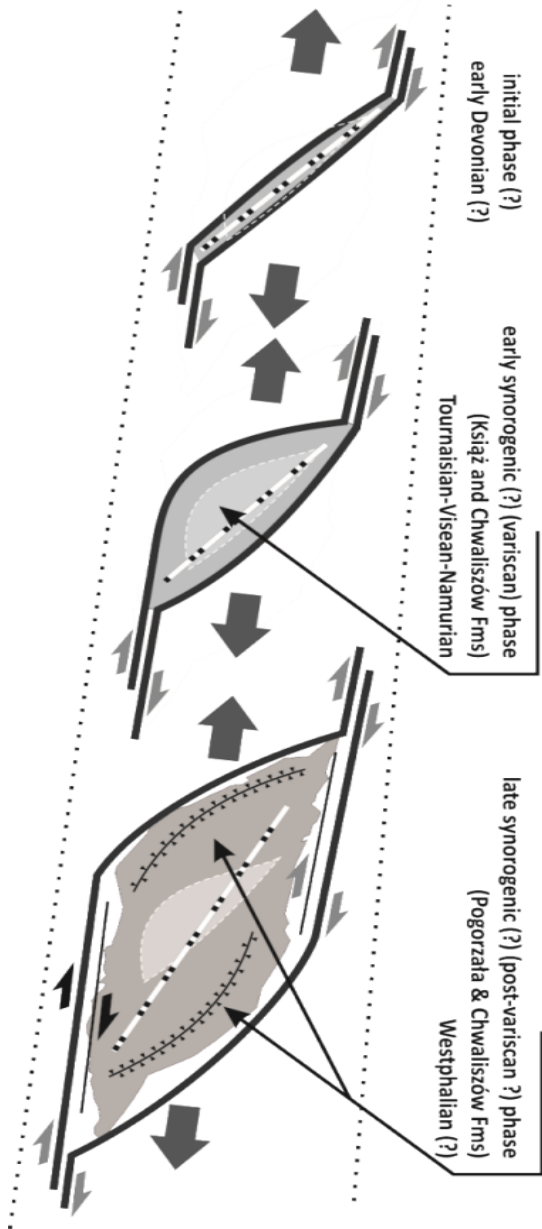


Fig. 1 Evolutionary scheme of the Świebodziće Unit

SYNSEDIMENTARY SEISMOTECTONIC FEATURES IN TRIASSIC AND CRETACEOUS SEDIMENTS WITHIN THE INTRASUDETIC SHEAR ZONE (ISZ) - REGIONAL IMPLICATIONS

Jurand Wojewoda¹⁾, Aleksander Kowalski¹⁾, Marta Rauch¹⁾

¹⁾ Department of Structural Geology and Geological Mapping, Institute of Geological Sciences, Wrocław University

In **Triassic** and **Cretaceous** sediments, which build a structural and morphological elevation between **Červený Kostelec** and **Upice (U Deveti Krizi quarry)**, synsedimentary deformation structures were recognized, among others sand eruption and **collapse structures**, and **listric faults**. Their shapes and spatial distribution highly coincide with regional tectonic structures within the **Intrasudetic Shear Zone, (ISZ)** mostly with faults bounding **diamond-shape depressions and elevations** (see Wojewoda, 2007, 2009) (Fig. 1 & 2). The deformation structures developed near subsurface of sediments and they most likely resulted from **extensional and strike-slip kinematics within the ISZ**.

REFERENCES:

Wojewoda, J., 2007 a. Neotectonic Aspect of the Intrasudetic Shear Zone. Acta Geodynamica et Geomaterialia, 4, 4 (148): 1-11.

Wojewoda, J., 2007 b. Palaeogeography and tectonic evolution of the Žernov-Nachod-Kudowa sedimentary area. In: CETEG'5, April 11-14.04.2007, Tepla.

Wojewoda, J., 2007 c. Žďárky-Pstrážna Dome - dextral strike-slip fault-related structure at the eastern termination of the Poříčí-Hronov Fault Zone (Sudetes, Góry Stołowcław Universitye Mts.). In: CETEG'5, April 11-14.04.2007, Tepla.

Wojewoda, J., 2009 a. Žďárky-Pstrážna Dome: a strike-slip fault-related structure at the eastern termination of the Poříčí-Hronov Fault Zone (Sudetes). Acta Geodynamica et Geomaterialia, 6 (3): 273-290.

Wojewoda, J., 2009 b. The role of the Poříčí-Hronov Fault Zone in foundation of sudetic basins. In: CETEG'7, 13-16.05.2009, Pecs. Abstracts, p. 60.

Wojewoda, J., 2009 c. Palaeoseismicity in the Sudetes. 10th Cz-Pl Workshop Rec. Geodyn. Sudeten and Adj. Areas. 5-7.11.2009, Szklarska Poręba, Poland.

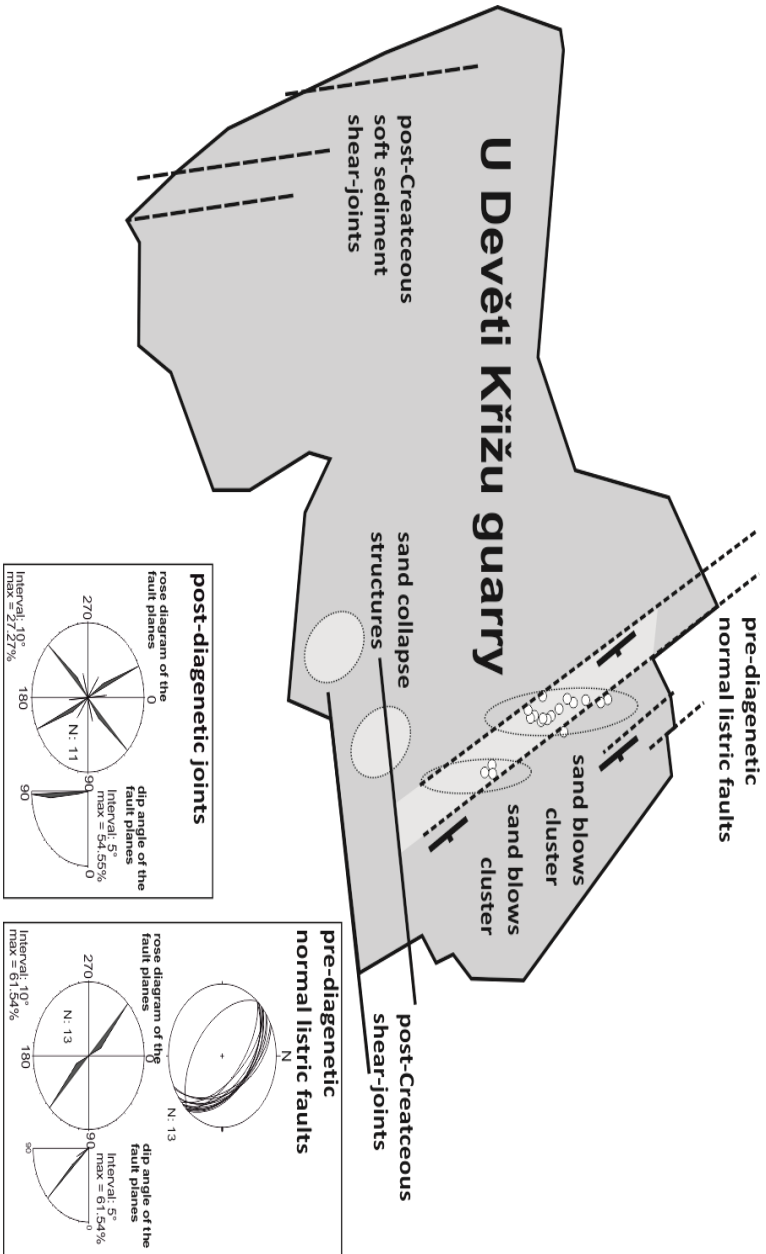


Fig. 1

U Devěti Křížů quarry

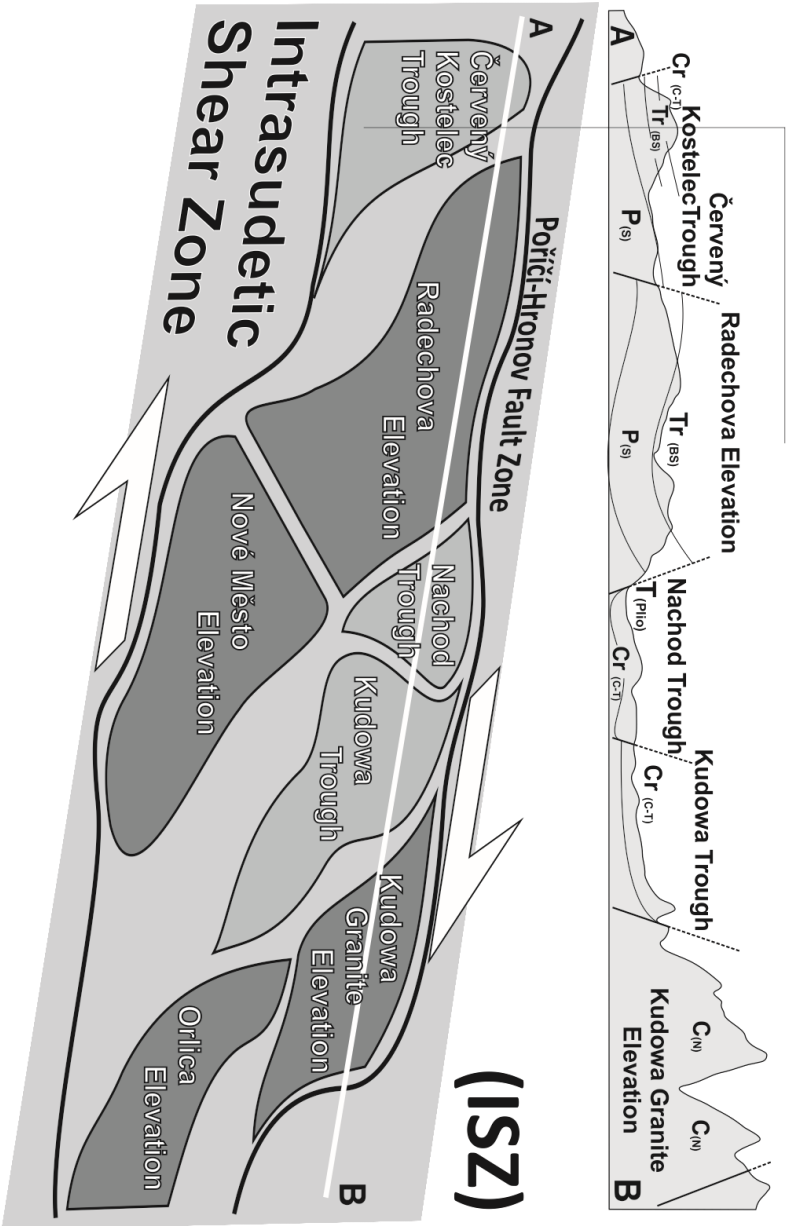


Fig. 2

RESULTS OF THREE YEARS LONG MEASUREMENTS FROM GNSS STATION OF GEODYNAMIC LABORATORY OF SRC IN KSIĄŻ IN RELATION TO RECENT TECTONIC ACTIVITY

Ryszard Zdunek ¹⁾, Marek Kaczorowski ¹⁾, Andrzej Borkowski ²⁾, Kazimierz Ćmielewski ²⁾, Piotr Gołuch ²⁾, Janusz Kuchmister ²⁾

¹⁾ Space Research Centre, Polish Academy of Sciences, Geodynamic Laboratory in Książ, Bartycka 18A, 00-716 Warszawa, Poland

²⁾ Wrocław University of Environmental and Life Sciences, Institute of Geodesy and Geoinformatics, Grunwaldzka 53, 50-357 Wrocław, Poland

Since 1974 in Geodynamic Laboratory in Książ (LG) tidal signal observations were starting using horizontal quartz pendulums. In addition to the tidal signals, irregularly were occurred strong, non-tidal signals, with amplitudes one order greater than the tidal signals in Książ. The situation radically was improved in 2003, when started with observation two new, significantly more accurate instruments: water-tube tiltmeters (WT). Quickly it turned out that the irregular signals of strong variations of water level in hydrodynamic system of WT correspond to tilting of foundation of 300 m.a.s. magnitude. During the insightful exploration of possible sources of these signals all the effects except local tectonic activity were practically excluded. Unfortunately, on account of construction of WT instruments it is not possible to observe any horizontal movements of the instruments, which is normally the main component of tectonic signal. In addition, our observations of the effects of tectonic activity are very local and limited only to space of underground corridors of the laboratory. On account of further interpretation and verification of local kinematic models of deformations of Książ massif, the geodetic network was established. Recognized and measured faults in underground corridors of LG laboratory, crossing WT tubes, show that the proposed multi-fault, five-elements model, which describes the observed tectonic events is consistent with the existing state of the faults. Looking for possible real sources of the observed strong non-tidal signals we found the significantly deformed meander of the valley of Pełcznica river, indicating the possibility of running in this place a geological fault. This was confirmed by geological map including tectonic faults identified in this area. The so called 'main southern fault', which is the central element of our local kinematic model for Książ massif, runs in about one hundred meters distance from Książ LG. Observed by WT tectonic deformations of sub-millimeter level, limits the possibility of application of GPS/GNSS satellite technique for direct verification and comparative works of tectonic phenomena.

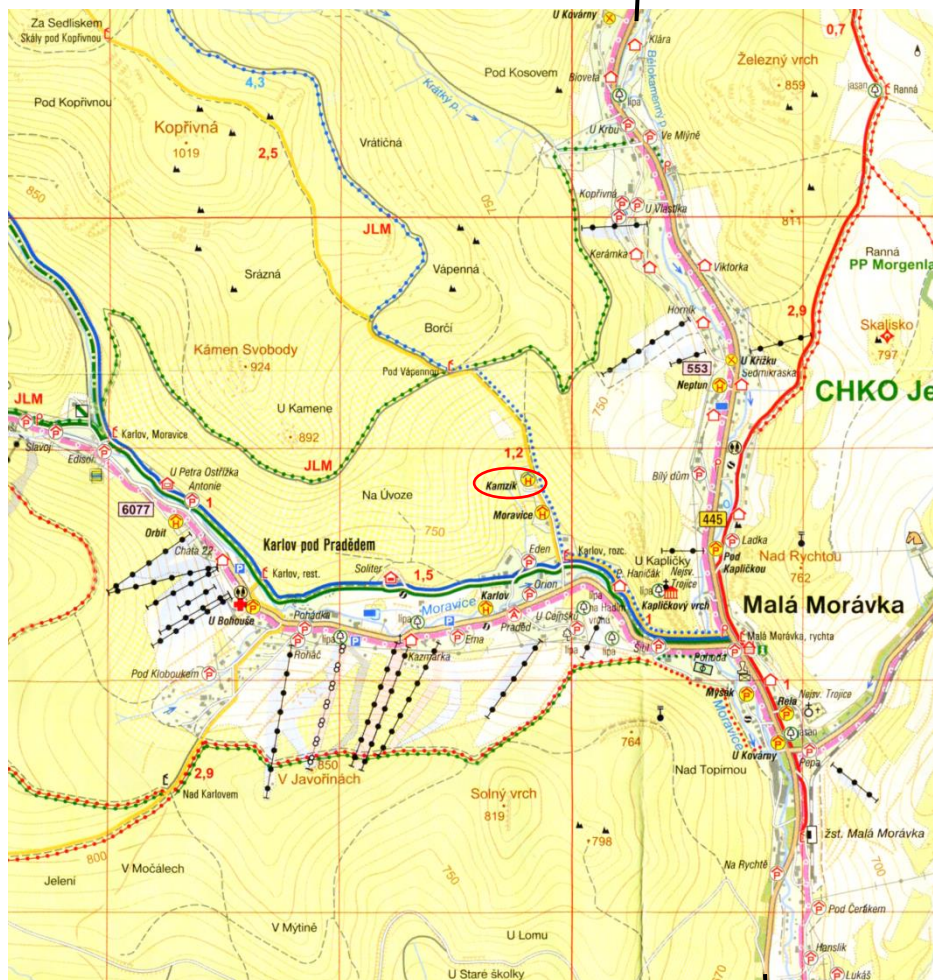
However, the analyses of GPS data series provide us with important geodynamic information in respect to the possibility of stresses accumulation in Książ massif, as caused by changes of relative distances between surrounding tectonic units and Świebodzice Trough. For this purpose the GPS Station in Książ LG (KSIA) was established in autumn 2010. The results of more than 3 years long GPS data elaboration show different displacements of the Książ massif in relation to selected GPS reference stations. It is probable that differences of velocity vector of GPS KSIA station in relation to the velocity vectors of the GPS reference stations is created by influence of movement of the 'main southern fault' wing. In respect of dominant meaning of this fault we decided to establish the second GPS station (KSI1) on the southern wing of the fault in May 2013, collecting till now more than 1 year of observations. The results obtained so far suggest directions and methods of further research of tectonic activity providing geodynamic information, in particular about horizontal movements of the Książ massif, using new measurement techniques and technologies applied inside and outside the Książ Geodynamic Laboratory.

KEYWORDS: GPS technique, station velocity vector, non-tidal signals, recent tectonic activity, tectonic geology, tectonic faults, Sudeten tectonic activity, geodynamics.

NOTES: _____

MAP OF HOTEL KAMZÍK SURROUNDINGS

Road to Jeseník, Karlova Studánka



Road to Rýmařov, Šternberk